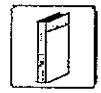

User Instructions Manual

for

Zwick Roell

K7500 Controller

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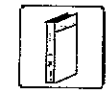


For Your Safety Please Read The Following Carefully

WARNING:

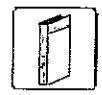
Users of servo-hydraulic testing equipment are reminded of the dangerous nature of high speed high force servo-actuators. It is essential to thoroughly understand the contents of this handbook before using the equipment. Roell Amsler accepts no liability for any damage to materials, goods or persons resulting from the use of this equipment.

EMC:

The mains lead fitted to this equipment includes an inline mains filter circuit. If this is removed or replaced with a non-filtered mains lead this equipment will no longer meet the European Standards for Electromagnetic Compatibility (EMC). Some external equipment connectors may be supplied with covers for protection against static discharge. These covers should remain in-situ if the connector is not used. All external cables should be screened in accordance with good installation practise

IMPORTANT:

This equipment uses a 3 wire mains lead: Live, Neutral, Earth. For safety & EMC aspects the earth lead must be connected to the supply earth connection. All replacement fuses must be of the same type and rating.



K7500 Operator Manual

Basic Operation

This manual provides the user with a step-by-step guide to the operation of a K7500 Servocontroller. The procedures cover each of the basic functions associated with the installation and start-up stages. It is recommended that Chapters 1 and 2 of the Reference Manual are read before commissioning the Servocontroller on a hydraulic supply.

The digital Servocontroller offers a complete solution for test and control systems with a wealth of advanced control and safety features. To access these techniques efficiently it is necessary to first read the appropriate sections of the Reference Manual.

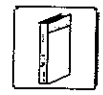
Please note that the use of high pressure servo-mechanisms can be dangerous. Zwick Roell accepts no responsibility for any form of damages falling within the scope of the equipment and Manual.

STEP-BY-STEP GUIDE

STEP OPERATION

1. Initial Connections
2. Servovalve Current Setting
3. Transducer Assignment and Calibration
4. Hydraulic Supply Pressure Control Options
5. Simulation 'Control'
6. Function Generator (Setting up a Dynamic Test)
7. System Monitoring
8. Safety Limits
9. Control Loop Gain Settings (Tuning)

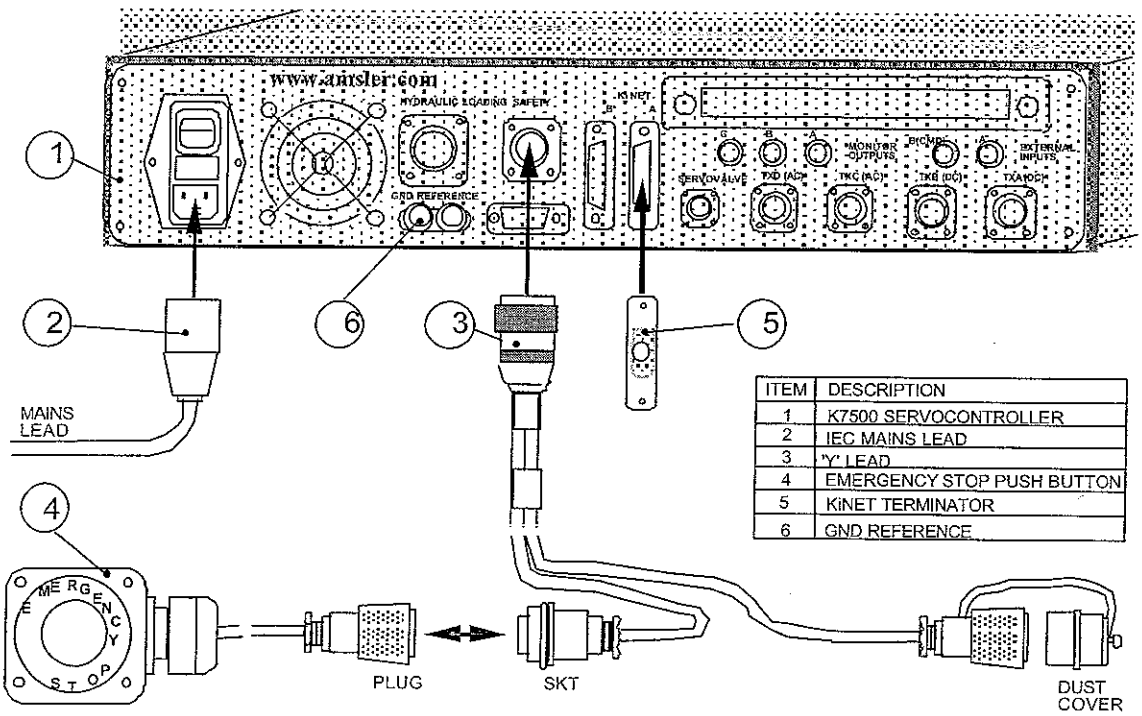
CONTENTS



1. Initial Connections for a Single K7500 Servocontroller

Items included in the delivery with your Servocontroller are:

- K7500 Servocontroller
- IEC mains lead
- Emergency stop 'Y' lead with dust cap
- Emergency stop push button
- K7500 quick reference chart
- User Reference Manual
- KiNet Terminator



ITEM	DESCRIPTION
1	K7500 SERVOCONTROLLER
2	IEC MAINS LEAD
3	'Y' LEAD
4	EMERGENCY STOP PUSH BUTTON
5	KiNET TERMINATOR
6	GND REFERENCE

When setting up the K7500 Servocontroller (item 1), the following connections should be made to the rear panel - see drawing above.

a. IEC mains lead (item 2).

b. Emergency stop (item 4).

This usually consists of two parts, a 'Y' lead (item 3, part no. EK1583/003) which plugs into the 'safety connector' and an emergency stop push button (item 4, part no. EK1503/002). The other 'Y' connector permits system expansion for a number of Servocontrollers and should be protected with the dust cover sheet when not used. Without the emergency stop push-button circuit being made, the Servocontroller display will indicate limit error 'EMERGENCY STOP', with a repetitive audible warning from the system sounder. With the emergency stop correctly terminated (when pins H, J and L are connected together), the EMERGENCY STOP limit can be reset by pressing the status push button.

c. KiNet Terminator (item 5, part no. AK1561/001). This 25-way 'D' type plug should be plugged in, for single channel operation see figure 1.

KiNet is a method for connecting servocontrollers together for multi-channel applications.

d. The 4 mm GROUND REFERENCE terminal (Item 6) (black) and the mains earth terminal (green) on the rear panel should be connected together for single channel applications.

For locations where the mains earth is of poor quality, Kelsey Instruments recommends the removal of the ground reference link and the connection of the (black) ground reference terminal to an external 'quiet' earth.

These are the minimum connections which will allow the Servocontroller to be used in simulation mode.

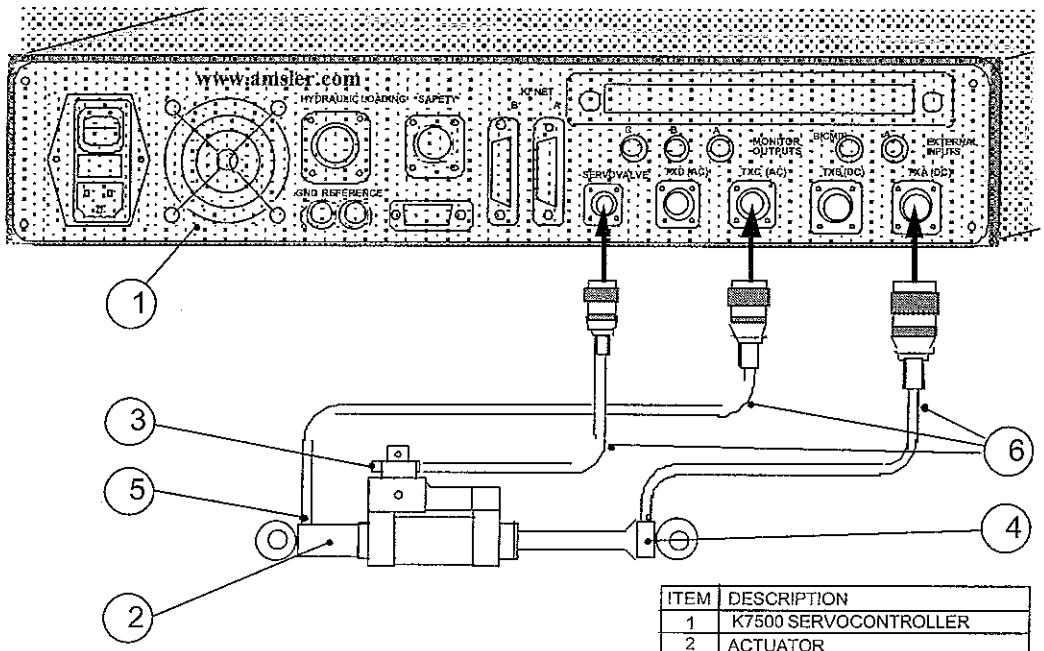
See Reference Manual : Chapter 1

1.1. Servo Actuator Cable Connections

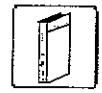
In order for the K7500 Servocontroller to operate a servo actuator, a minimum of two cables must be connected to the rear back panel, these are:

1. Servovalve
2. Feedback transducer for the control variable (there may be more than one)

Typical control variables for feedback are position or load. In the case of some actuators with both, this will make three cable connections to the rear panel. The drawing below shows a typical cable connection arrangement.



ITEM	DESCRIPTION
1	K7500 SERVOCONTROLLER
2	ACTUATOR
3	SERVOVALVE
4	LOADCELL (LOAD FEEDBACK)
5	LVDT OUTPUT
6	ACTUATOR CABLE



Feedback transducers are plugged into TX inputs for signal conditioning. Four inputs are provided, divided into two conditioning groups:

Group 1 (DC) Used for DC type transducers connected to TX'A' or TX'B', Transducers such as strain gauge bridges used in load cells etc.

Group 2 (AC) Used for AC type transducers connected to TX'C' and TX'D', Transducers such as LVDT's used for position measurement.

Information regarding the feedback transducer is normally found with the actuator data.

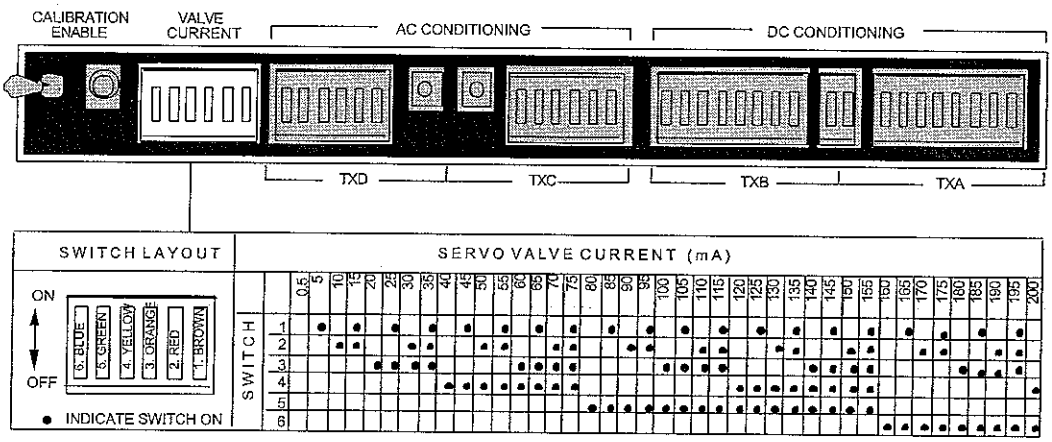
For additional safety, connectors with a different number of pins are used to prevent mis-connection of the servovalve with signal conditioning and inputs. To connect an externally conditioned transducer use the External Input BNC.

For transducer connections see Chapter 2.

2. Servovalve Current Setting

The servovalve current required for full rated flow must be set using the servovalve manufacturer's details, e.g. 40 ma = 38 litres/min = full flow.

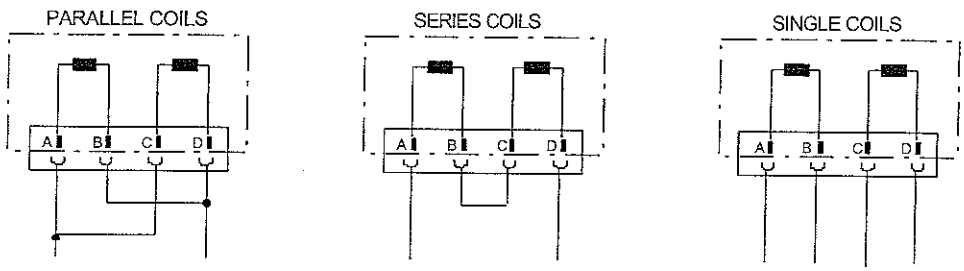
This current is set by using the switches found on the rear panel underneath the removable calibration cover, see drawing below.



The calibration cover is removed by twisting the fastener through 90 degrees (1/4 turn), using the slot in the front face; a screwdriver or coin may be required to twist the fastener. Replacement is a push fit, make sure the 'calibration enable' switch lines up with the hole in the cover.

For the majority of servovalves, a standard pin layout connection is used for the two coils in the servovalve connector. Kelsey Instruments recommend the parallel coil connection is used, as shown below.

STANDARD ELECTRICAL CONFIGURATION

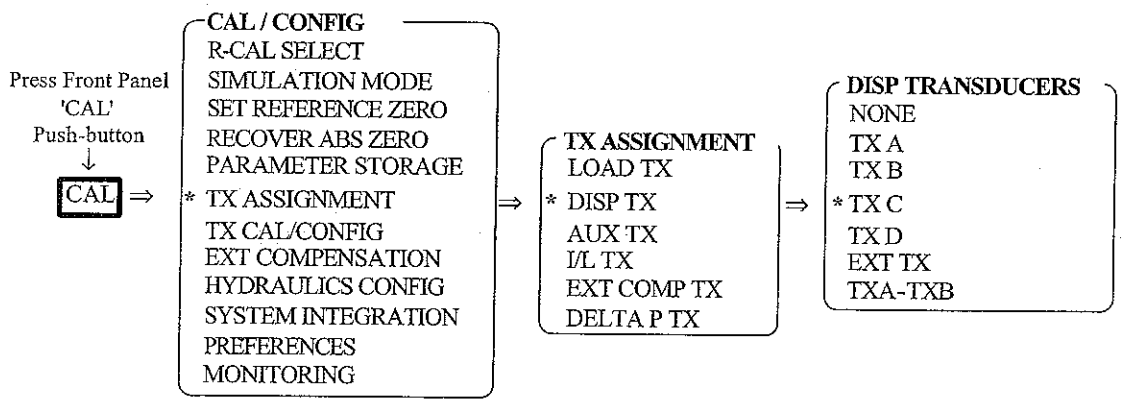


Below is a typical range of servovalve coil resistance against showing the current required.

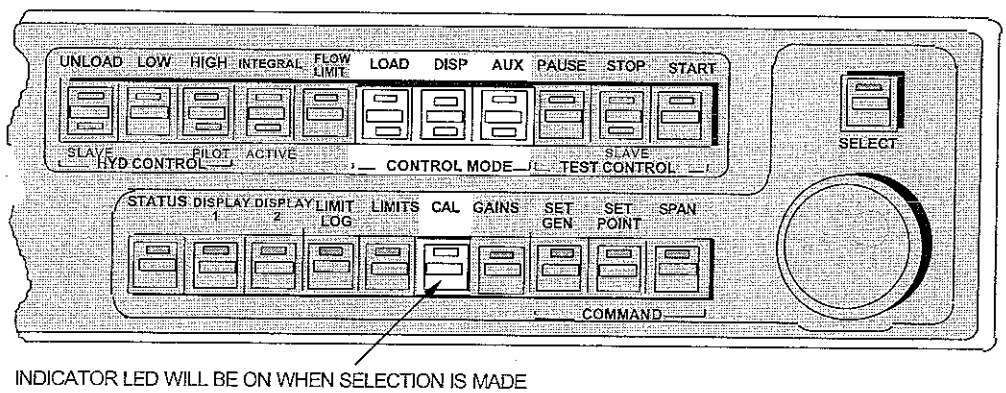
COIL CONNECTION RESISTANCE-OHMS			CURRENT SETTING FOR THE PARALLEL CONNECTION mA
SINGLE COILS	SERIES COIL CONNECTION	PARALLEL COIL CONNECTION	
1000	2000	**500**	**10**
200	400	**100**	**15**
80	160	**40**	**40**
80	160	**40**	**50**
22	44	**11**	**80**
28	56	**14**	**100**

3. Transducer Assignment (Control Mode) Menu

The system transducers must be assigned to their various modes/roles through the Transducer Assignment menu. When the actuator feedback transducers have been connected to the TX inputs, they are programmed by using the menu to assign the TX input for the required function. (Chapter 1, Overview, illustrates how to use the SELECT button and menu).



The above example shows the path through the menus for transducer input TX'C' to be assigned to the DISPlacement control mode from the front panel 'CAL' push-button.



INDICATOR LED WILL BE ON WHEN SELECTION IS MADE

As transducer inputs are assigned to the required functions, these will be indicated on the TX ASSIGNMENT menu for reference purposes.
The example shows input TX'A' assigned to load control mode, TX'C' to displacement and TX'D' used for inner loop.

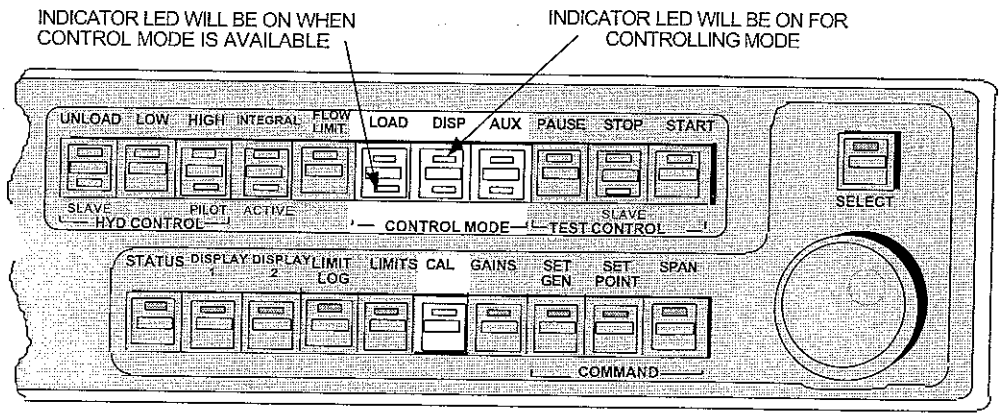
TX ASSIGNMENT
LOAD TX (A)
* DISP TX (C)
AUX TX
I/L TX (D)
EXT COMP TX
DELTA P TX

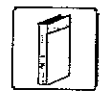
Similarly TX'A' is designated the Load Transducer.

⇒ **TX ASSIGNMENT**
* LOAD TX
DISP TX
AUX TX
I/L TX
EXT COMP TX
DELTA P TX

⇒ **LOAD TRANSDUCERS**
NONE
* TX A
TX B
TX C
TX D
EXT TX
TXA-TXB

When a transducer has been assigned to one of the three control modes (load, displacement, or auxiliary) the lower LED in the appropriate control mode push-button will be illuminated. This indicates which control modes are available, they are not the controlling mode. By pressing one of the control mode push-buttons, the upper LED will illuminate, indicating the Servocontroller's active control mode. It will also remove a command clamp limit which is active when no control mode is selected.





The K7500 Servocontroller will not allow an input to be assigned twice. As an example, if TX'A' is assigned to LOAD, it cannot also be assigned to DISPlacement, an error message will be displayed:

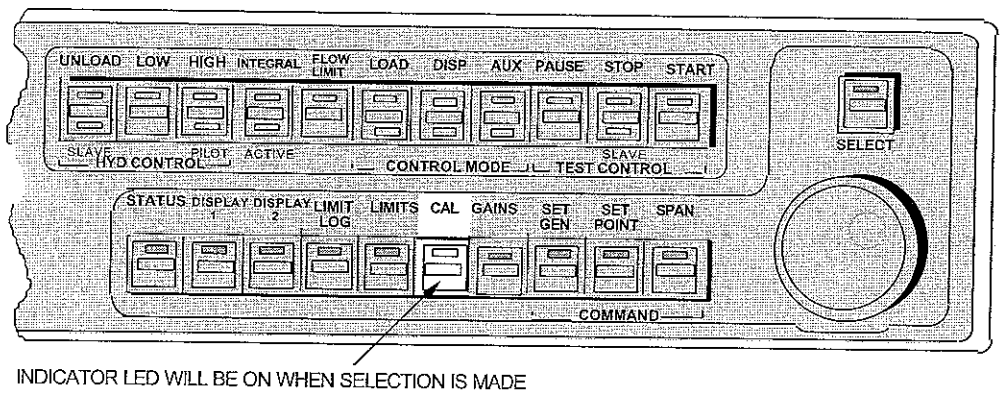
'ERR: IN USE (LOAD)'.

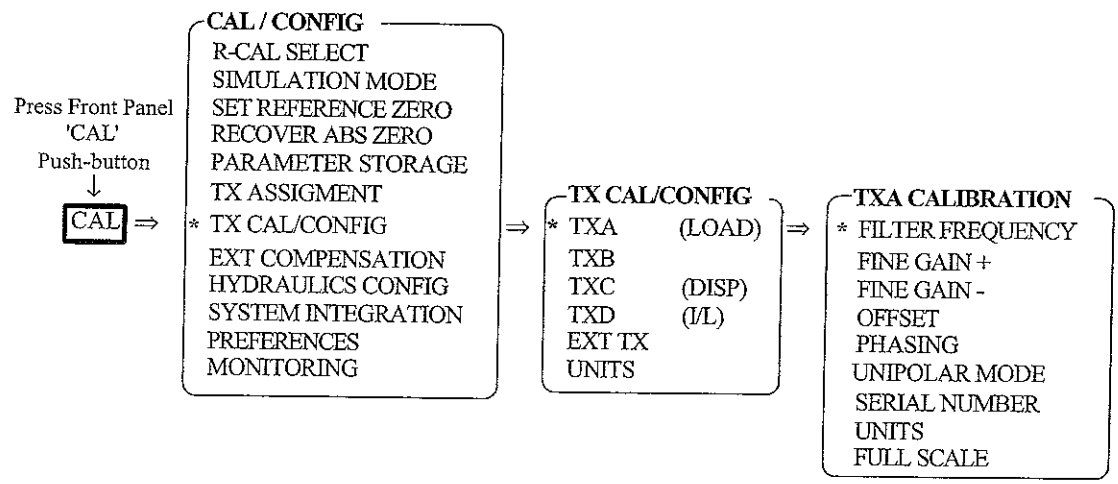
See Reference Manual : Chapters 1 & 4

3.1. Transducer Calibration

When the actuator feedback transducer has been assigned, the transducer amplifier must be calibrated from the menu using the calibration information supplied with the transducer. Using the chart for course gain settings shown in Chapter 4, page 26), choose the nearest gain setting that, when multiplied by the transducer output, will result in 10 volts.

To enter calibration menu press CAL.





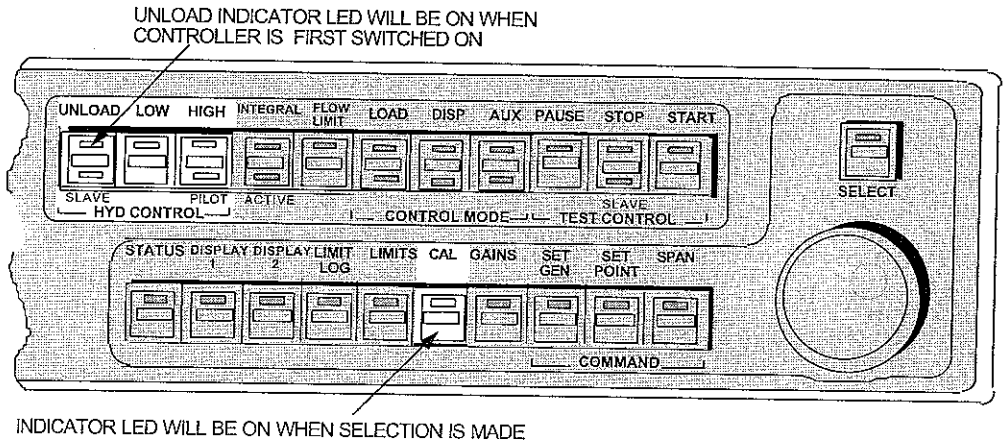
The above example shows the path through the menus for transducer input TX'A' (LOAD) to the TX'A' CALIBRATION menu. More details of the TX'A' CALIBRATION method are shown in Chapter 4

4. Hydraulic Supply Pressure Configuration Options

This section includes control options for HIGH pressure selection only and HIGH and LOW pressure selection.

The K7500 Servocontroller includes a special feature that ensures a 'bumpless' start-up condition when the hydraulic pressure is applied to the system. The bumpless condition is achieved by forcing the command signal to follow the feedback signal in the absence of hydraulic pressure, this condition is terminated by the operation of the HIGH (or LOW) PRESSURE push-button.

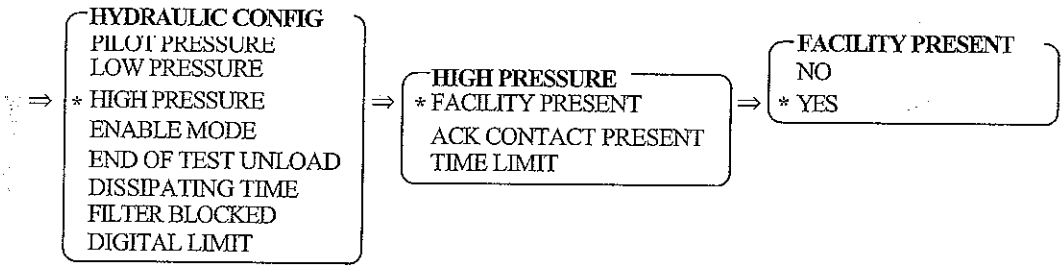
As a consequence the HIGH PRESSURE push-button is always used at start-up whether it controls the hydraulic pressure or not.



The Servocontroller will energise a solenoid operated valve in the high pressure line of the pump unit when configured as follows:

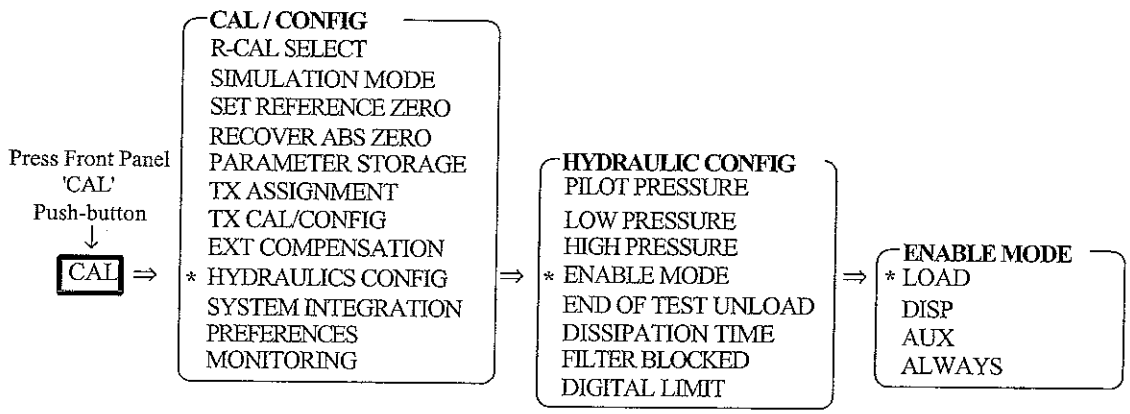
4.1. Option 1-HIGH pressure Control Only

Set YES to FACILITY PRESENT in HIGH PRESSURE by:



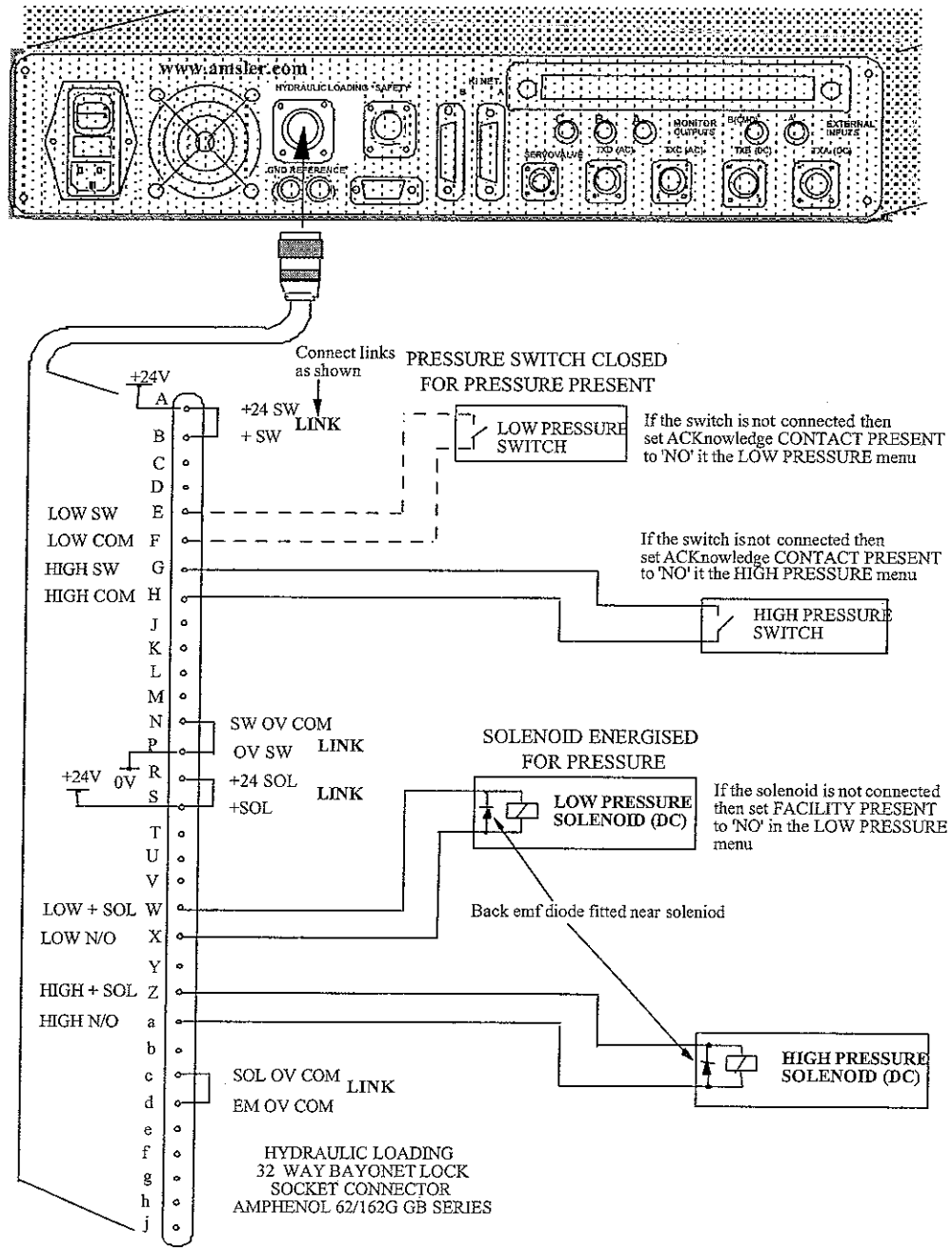
Note the pilot and low hydraulic pressure selections are not used, so their corresponding FACILITY PRESENT must be set to NO.

The ENABLE MODE should be set to the required control mode for start-up. The selection of an enable control mode will permit selection of HIGH PRESSURE.



4.2. Option 2 -Connections & Menu Setup for LOW & HIGH Pressure Return Selection (Single Unit)

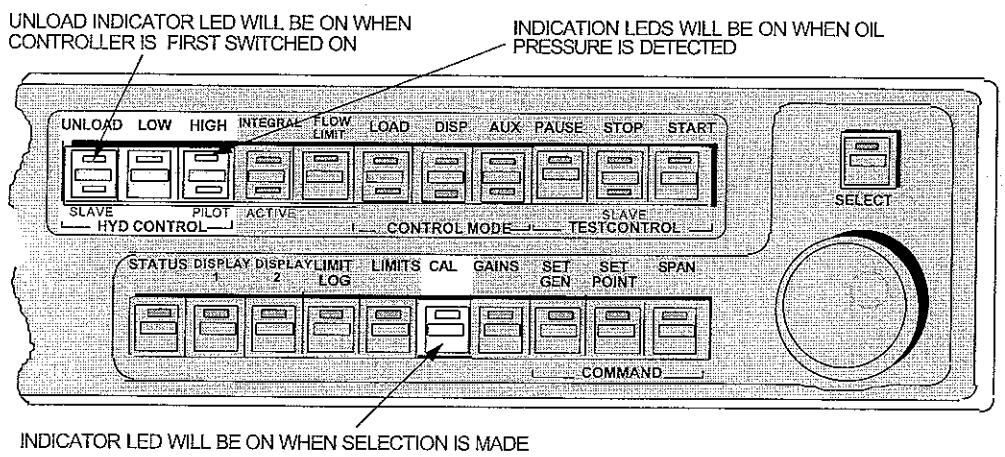
Two 24 volt DC drives for solenoid operated valves are available at the HYDRAULIC LOADING CONNECTOR. These circuits are for the hydraulic valves used to apply LOW or HIGH pressure to the servo-actuator. They are under the control of the three front panel push-buttons UNLOAD, LOW and HIGH.



With the connections made to the hydraulic solenoid valves and pressure switches, as shown (and if fitted inputs from pressure switches indicate the presence of pressure), the Servocontroller must be set-up to the appropriate HYDRAULIC CONFIGuration.

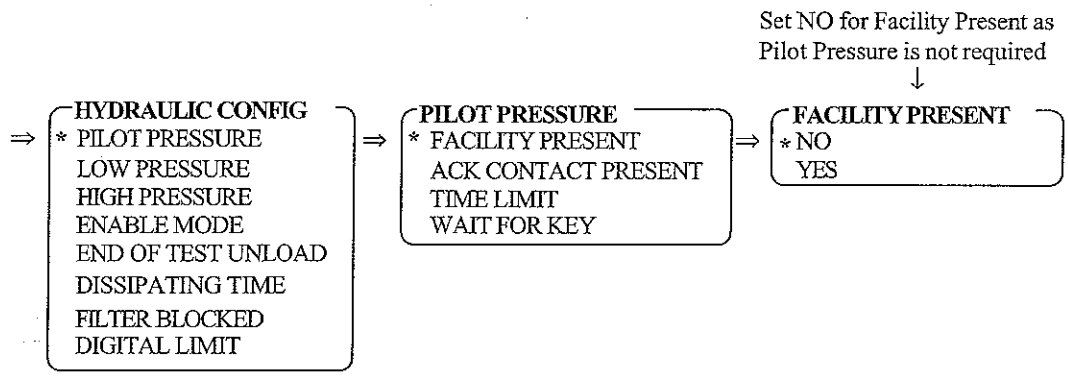
(See Chapter 5, 'Hydraulic Pressure Configuration Menu' for more information, together with Chapter 1, Initial Connections for a Single K7500 Servocontroller.)

The following should be set up using the front panel 'CAL' push-button and via the CAL/CONFIG menu to the HYDRAULIC CONFIGuration.



4.3. Pilot Pressure

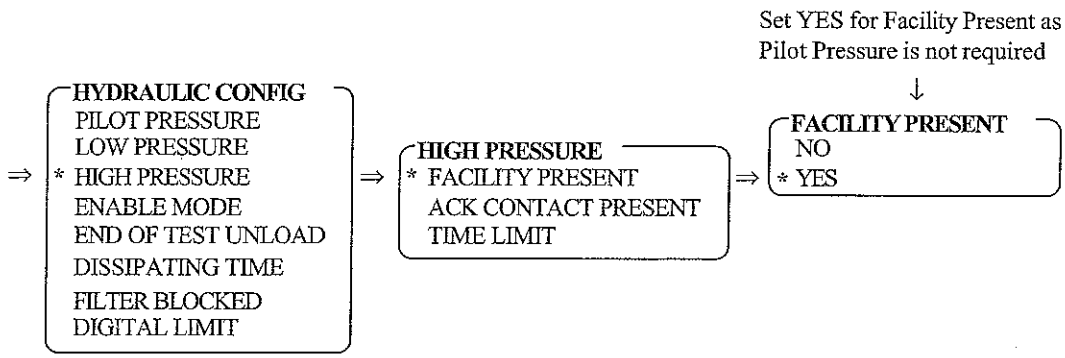
In this configuration the PILOT PRESSURE facility is not used.



Once the pilot facility has been set to NO the other parameters for that facility are not required and do not have to be set up.

4.4. Low Pressure

With the low pressure facility present this enables the LOW PRESSURE push-button to energise the external hydraulic solenoid valve.



Associated with the LOW pressure are three other parameters:

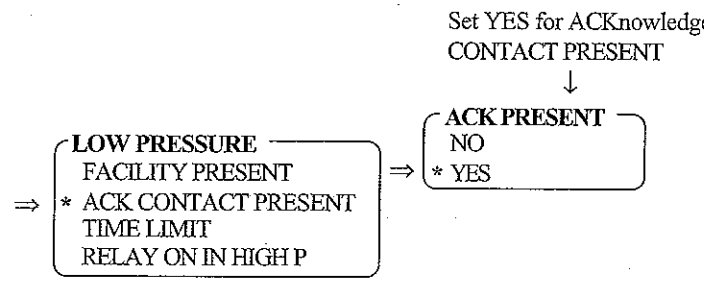
ACKnowledge CONTACT PRESENT, TIME LIMIT and RELAY ON IN HIGH Pressure

4.5. Acknowledge Contact Present

A hydraulic low pressure detection switch must be fitted for ACKNOWLEDGE CONTACT PRESENT to be used. It must be set to a pressure which is lower than the hydraulic supply pressure.

This is used as a safety feature. If hydraulic pressure should drop to a value which is under the setting of the low pressure switch - due to a burst pipe as an example - the K7500 Servocontroller will de-energise the low pressure hydraulic solenoid valve.

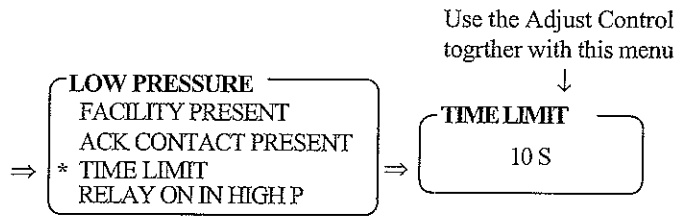
If a low pressure switch is fitted the K7500 Servocontroller requires the contacts to close, thus detecting low pressure.



4.6. Time Limit

When hydraulic low pressure is first applied it will take time for the hydraulic pressure to rise to the value which is set on the low pressure switch.

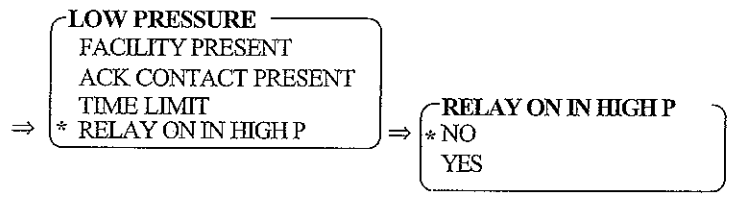
For the numeric value of the time set on the TIME LIMIT the K7500 Servocontroller prevents de-energisation of the low pressure hydraulic solenoid valve output, allowing the hydraulic pressure to rise. Once pressure has been obtained the K7500 Servocontroller ignores any further time that may elapse before it reaches the value set for the TIME LIMIT.



The TIME LIMIT is also used when there is no low pressure switch fitted, after the time has elapsed (this looks like a time period to allow the pressure to increase) the controller is then enabled for other functions such as a high pressure selection.

4.7. Relay On In High Pressure

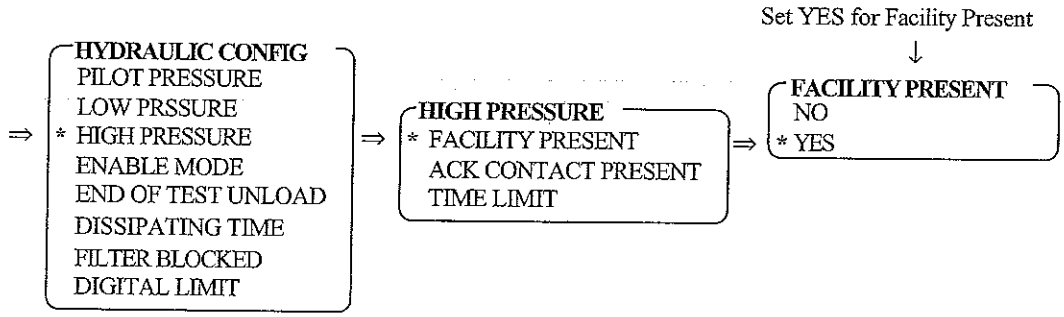
This is used when the external hydraulic configuration also requires the energising of the low pressure solenoid for the high pressure state. It is normally set to **NO.**



4.8. High Pressure or Pressure

This output can also be considered as the hydraulic PRESSURE on/off if no low pressure facility is present.

The high pressure facility present enables the HIGH PRESSURE output from the K7500 Servocontroller to be operated from the front panel HYDraulic CONTROL by pressing the 'HIGH' push-button which will energise the external hydraulic solenoid valve.



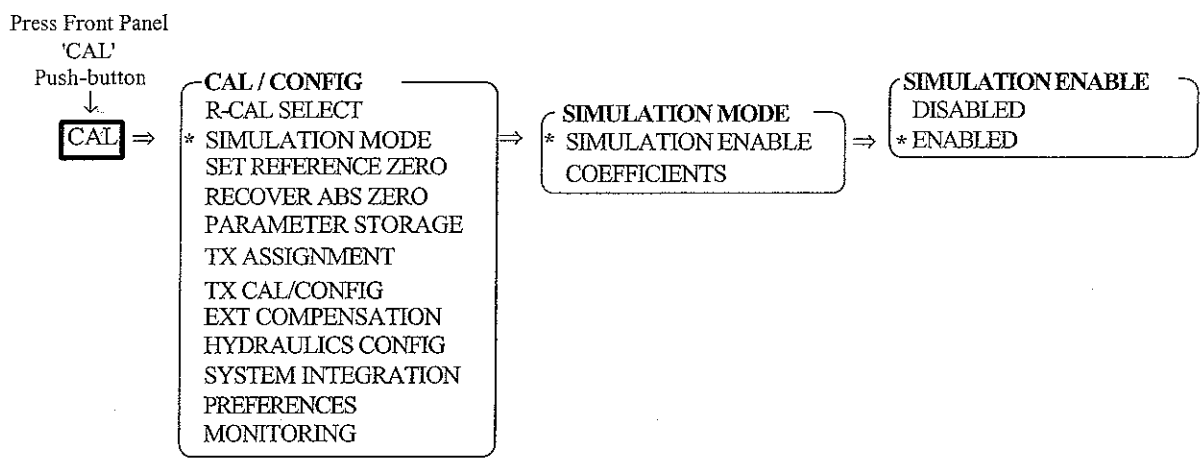
Associated with the HIGH pressure are two other parameters:

ACKnowledge CONTACT PRESENT and TIME LIMIT

The function and settings for these parameters follow the same menu structure as for low pressure above.

5. Simulation

SIMULATION MODE enables "closed loop" operation without using the servo-actuator. The example below shows the path through the menus to ENABLE the simulation mode from the CALibration push-button.

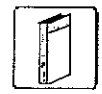


Before simulation can be used check for:

1.	Initial connections for a single Servocontroller	-	Wiring details.
2.	Transducer assignment menu	-	A TX input selected for each controlling modes required (inner loop is not simulated)
3.	Calibration feedback transducer menu	-	Set a numeric value for FULL SCALE for each TX allocated

With these set, the function generator can be used with the monitoring facilities to view the operation of the K7500 Servocontroller.

It is advisable to use the existing default SIMULATION COEFFICIENTS.



The default values for the coefficients are:

LOAD = 10%
DISP = 3%
AUX = 0% (May be changed to 10%)
OFFSET = 0
LAG + 50%

The default MODE GAINS for PROPORTIONAL and SERVO GAIN are set to '1'.

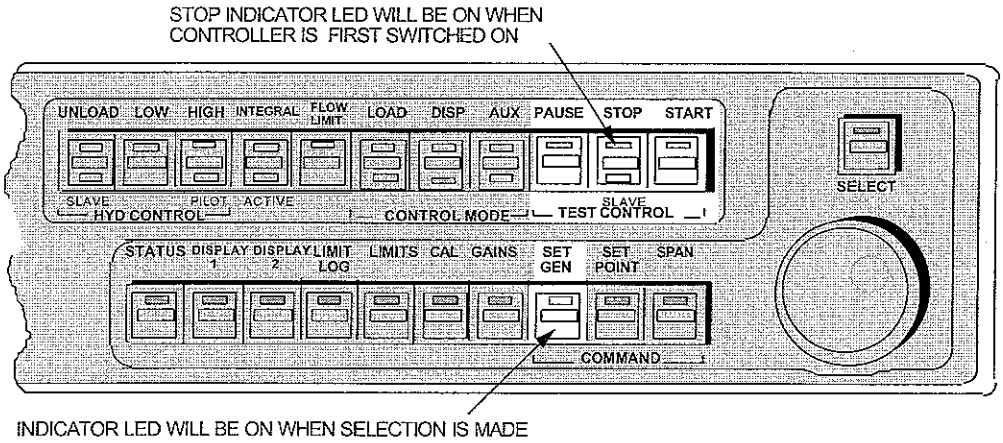
For a quick check that the K7500 Servocontroller is in simulation mode, the status display DIRECT value for the control feedback will change in response to operation of the SET POINT.

When in SIMULATION, it is possible that limit action will take place. This can be prevented by increasing the transducer limit values beyond the range of the command.

6. SETTING UP A TEST USING THE FUNCTION GENERATOR

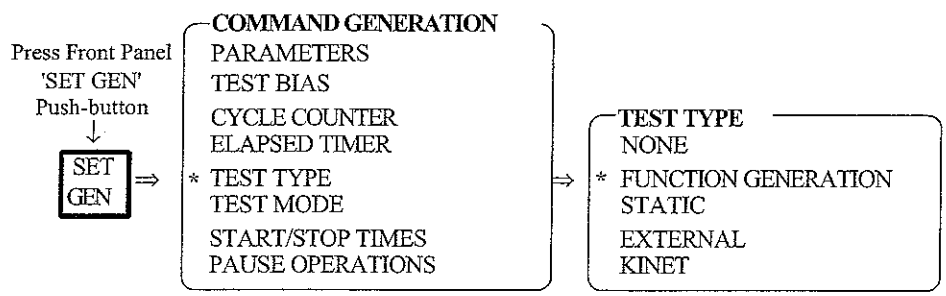
To use the Function Generator for a dynamic test, it is necessary to set up its parameters using the COMMAND GENERATION menu. This menu also permits the assignment of a Test Control Mode to prevent the use of function generation in the incorrect control mode.

The PAUSE, STOP and START push-buttons highlighted below exercise control over the running of the Function Generator.

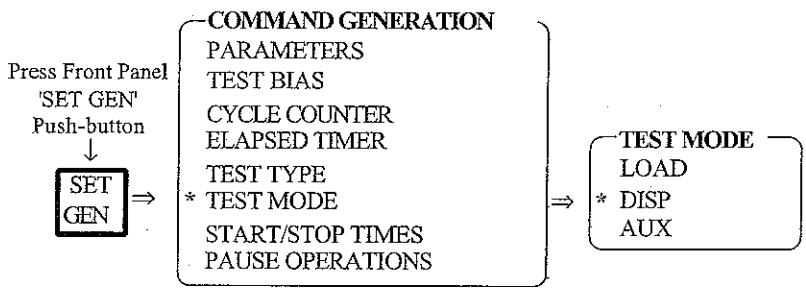


The SET GEN push-button will select the COMMAND GENERATION menu.

The FUNCTION GENERATION should be selected from TEST TYPE menu. The example below shows the path through the menus to the FUNCTION GENERATOR from the SET GENerator push-button.



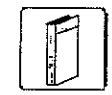
The TEST MODE should be set to LOAD, DISPlacement or AUXiliary for the control mode in which the function generator is required. This is a safety feature/interlock for when more than one control mode is available as it only allows the function generation for a specified control mode. The following example shows how the function generator is connected to the DISPlacement control system.



The TEST MODE may be set to a control mode which is not available, in which case the selection will be allowed but a warning of 'ERR: NO TRANSDUCERS' will be displayed which will also prevent operation of the function generator.

6.1. Function Generator Numerical Settings

There are a number of essential numeric values to be set, which are divided into two groups.



6.2. Group (i)

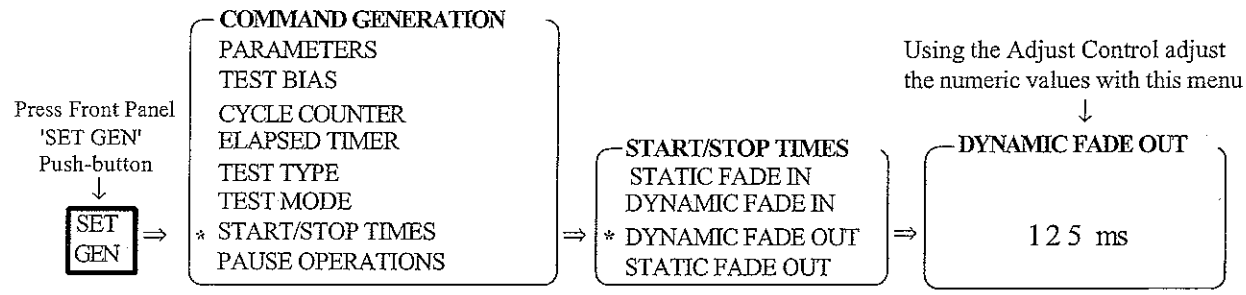
These three settings are common to all TEST TYPE as follows:

1. START/STOP TIMES (FADE)

Four start/stop times are required for:

STATIC FADE IN

DYNAMIC FADE IN
DYNAMIC FADE OUT
STATIC FADE OUT



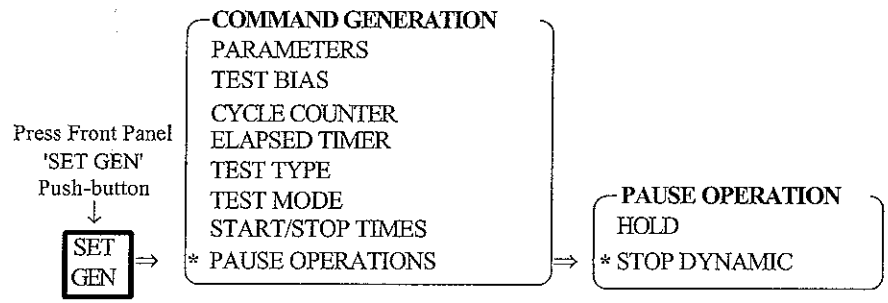
The above example shows the path through the menus from the SET GENerator push-button to the DYNAMIC FADE OUT which is set to 125 milliseconds.

When TEST TYPE is set to STATIC the units change to seconds from milliseconds to be entered for STATIC FADE IN or STATIC FADE OUT.

(As DYNAMIC FADE IN and DYNAMIC FADE OUT parameters are not used in a static test the message 'NO CHANGES ALLOWED' will be displayed if these parameters should be selected in error.)

6.2.1. Pause Operations

The operation of the PAUSE push-button has two programmable actions, these are HOLD (to freeze the command) or STOP DYNAMIC (fade to zero). When on, the indicator LED in the PAUSE push-button shows that the pause operation has been activated either by the operator's action of pressing the push-button or from an internally activated limit action. The example below shows the path through the menus to STOP DYNAMIC FROM THE SET GENerator push-button.



When TEST TYPE is set to STATIC the PAUSE button activates a HOLD condition.

When TEST TYPE is set to EXTERNAL the PAUSE button activates a STOP DYNAMIC condition. In both cases no other selection is allowed.

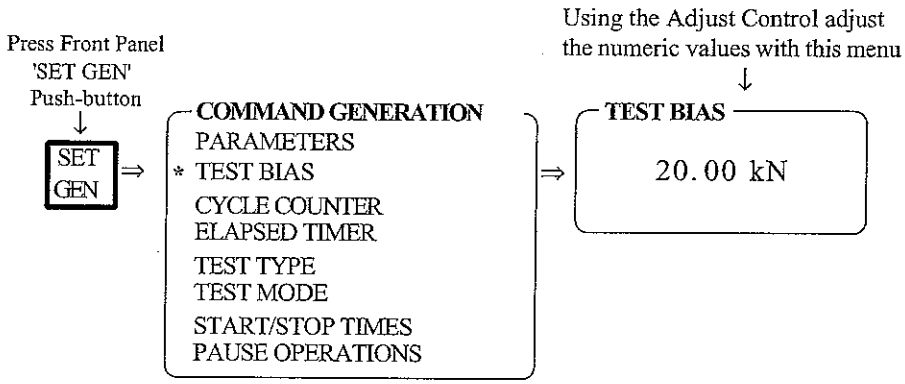
6.2.2. Test Bias

TEST BIAS can also be considered as the mean about which the dynamic waveform is based.

It should not be adjusted such that a peak level exceeds the value set for FULL SCALE, otherwise when starting the function generator the error message:

'LIM: COMMAND CLAMP' will be displayed

The example below shows the path through menus from the SET GENerator push-button to the TEST BIAS, which in this case is set to 20.00 kN.



The units for TEST BIAS are determined by the units allocated to the feedback transducer in the selected test mode for control.

6.2.3. Automatic Test Bias

The value of the TEST BIAS is also determined by the values entered for the UPPER PEAK LEVEL and the LOWER PEAK LEVEL as found in the PARAMETERS menu.

The value is automatically calculated by the formula:

$$\text{TEST BIAS value} = \frac{\text{UPPER PEAK LEVEL value} + \text{LOWER PEAK LEVEL value}}{2}$$

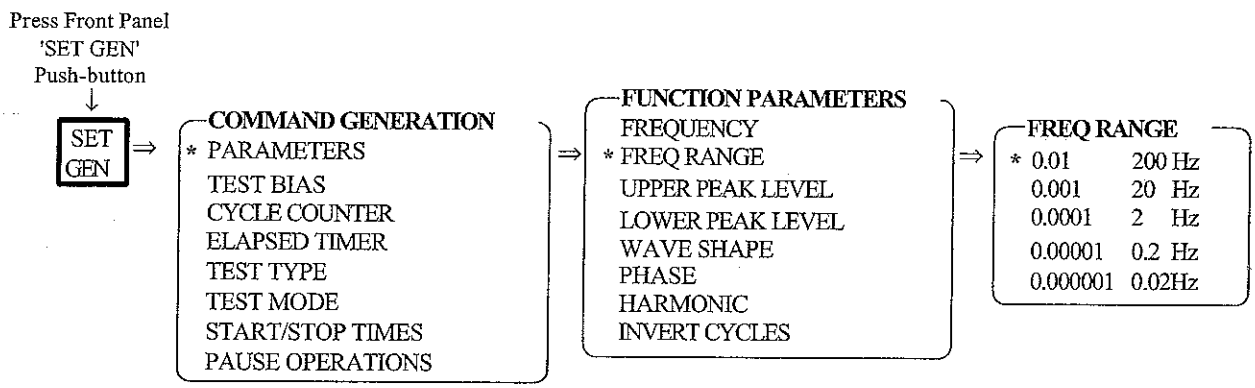
Hence TEST BIAS can be considered as the mean of the two peak level values. Adjustment of the TEST BIAS value will adjust equally the two peak level values. (See Upper Level and Lower Peak Level later in this Manual.)

6.3. Group (ii)

These eight settings can only be adjusted when TEST TYPE is selected for FUNCTION GENERATION, otherwise the message 'NOT APPLICABLE' will be displayed.

6.3.1. Frequency Range

The example below shows the path through menus from the SET GENerator push-button to the FREQuency RANGE, which in this case is set for 0.01 to 200 Hz.

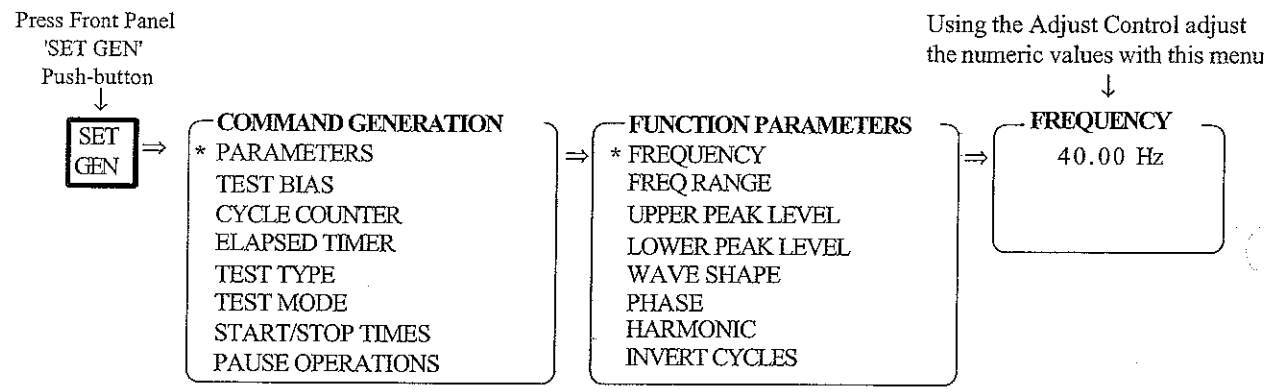


Adjusting the FREQuency RANGE will automatically adjust the decimal point position when setting the numeric FREQUENCY value.

The frequency generated also depends on the HARMONIC which has a default setting of '1'.

6.3.2. Frequency

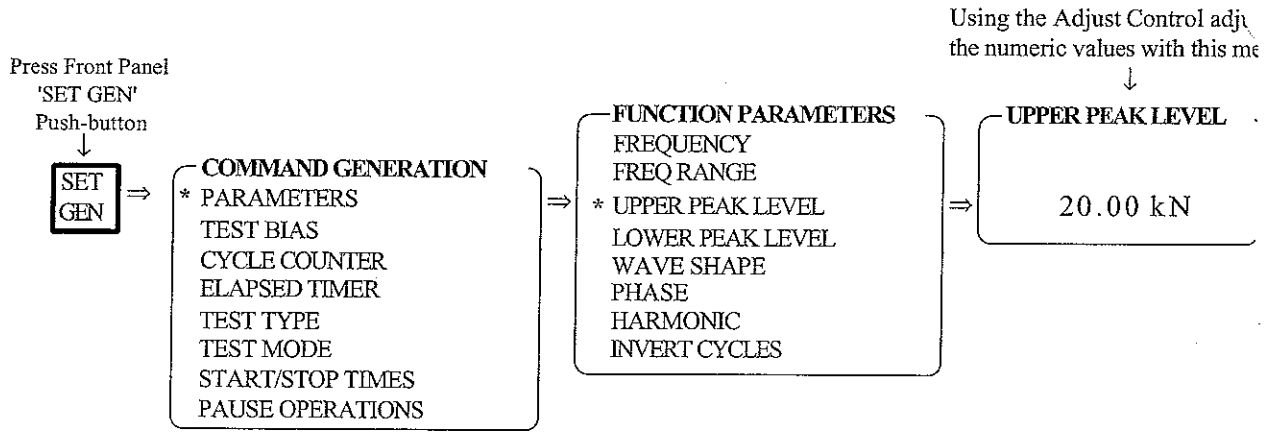
The FREQUENCY required is set in conjunction with the FREQUENCY RANGE selection.

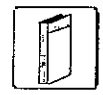


The previous example shows the path through the menus from the SET GENerator push-button to FREQUENCY which in this case is set to 40.00 Hz.

6.3.3. Upper Peak Level And Lower Peak Level

The example below shows the path through menus from the SET GENerator push-button for setting the UPPER PEAK LEVEL which in this case is set to 20.00 kN. The same method is used for adjusting the LOWER PEAK LEVEL.





The units for the PEAK LEVELS are determined by the units allocated to the feedback transducer used for the TEST MODE for control.

It is not possible to set the numerical value of the LOWER PEAK LEVEL value greater than the setting of the UPPER PEAK LEVEL or vice versa. Should the lower peak level be increased until it exceeds the upper peak level, then the upper peak level will also increase and take the same value as the lower peak level.

The value for the SPAN is also determined by the values entered for the UPPER PEAK LEVEL and the LOWER PEAK LEVEL.

The value is automatically calculated by the formula:

$$\text{SPAN (Value in \%)} = \frac{\text{UPPER PEAK LEVEL value} - \text{LOWER PEAK LEVEL value}}{2} \times \frac{100}{\text{FULL SCALE}}$$

Hence SPAN can be considered to be the difference between the two peak level values expressed as a percentage. Adjustment of the SPAN value will adjust the two peak level values equally.

As an example if:

UPPER PEAK LEVEL = +60.00 kN	Difference between peak levels = 50 kN
LOWER PEAK LEVEL = +10.00 kN	
for a FULL SCALE = 100 kN	Then SPAN = 25%

If the SPAN is now increased to 40% the peak levels will be:

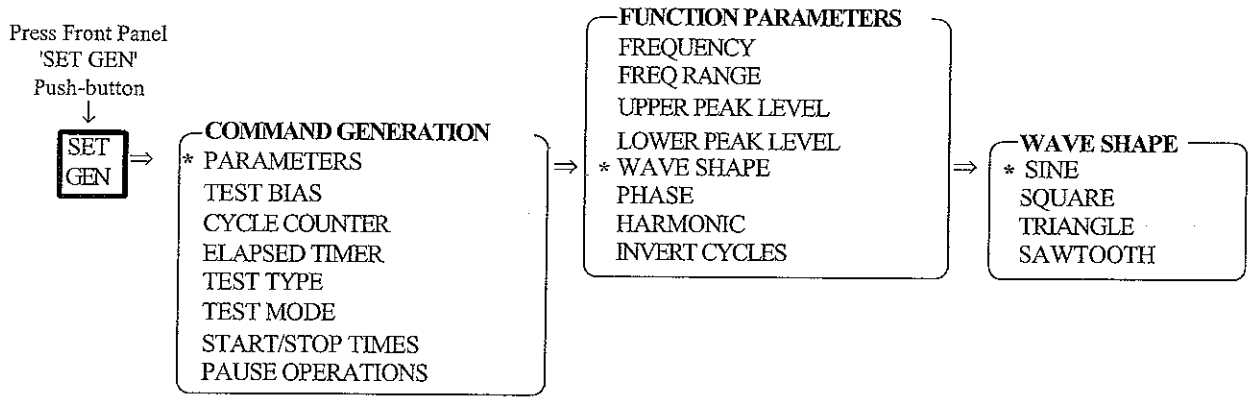
UPPER PEAK LEVEL = +75.00 kN	Difference between peak levels = 80 kN
LOWER PEAK LEVEL = -5.00 kN	
for a FULL SCALE = 100 kN	With a SPAN = 40%

SPAN can also be considered as the amplitude for the dynamic portion of the required waveform.

It should not be adjusted such that a peak level exceeds the value set for FULL SCALE, otherwise when starting the function generator the error message:

'LIM: COMMAND CLAMP' will be displayed.

6.3.4. Waveshape

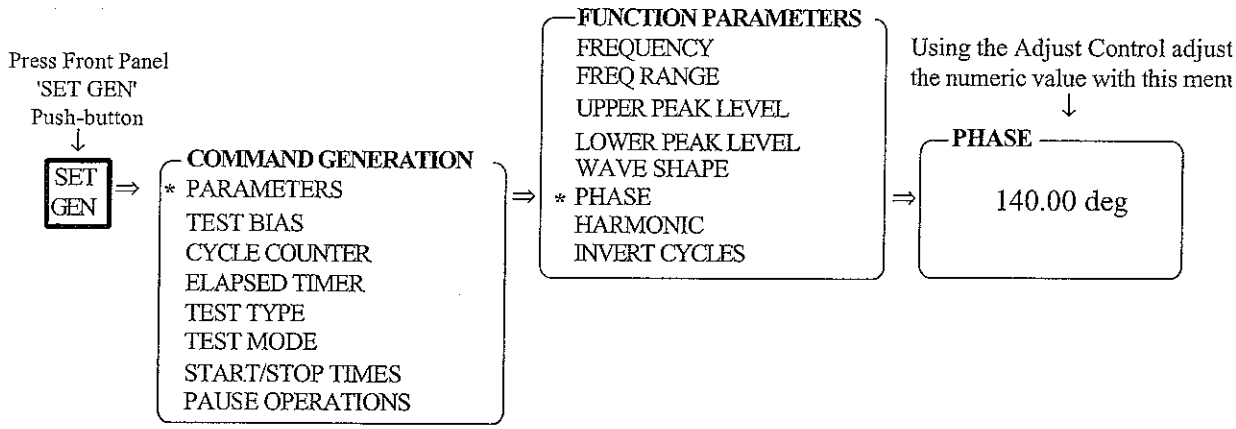


The example above shows the path through the menus from the SET GENerator push-button to the WAVE SHAPE which in this case is selected to SINE from the four wave shapes available.

The wave shape selection is also shown on a line in the status display, i.e. 'SOURCE: SINE'.

When operating more than one K7500 Servocontroller in a master/slave configuration, the slave units may be operated in a harmonic frequency and/or be phased displaced from the master unit, as described below.

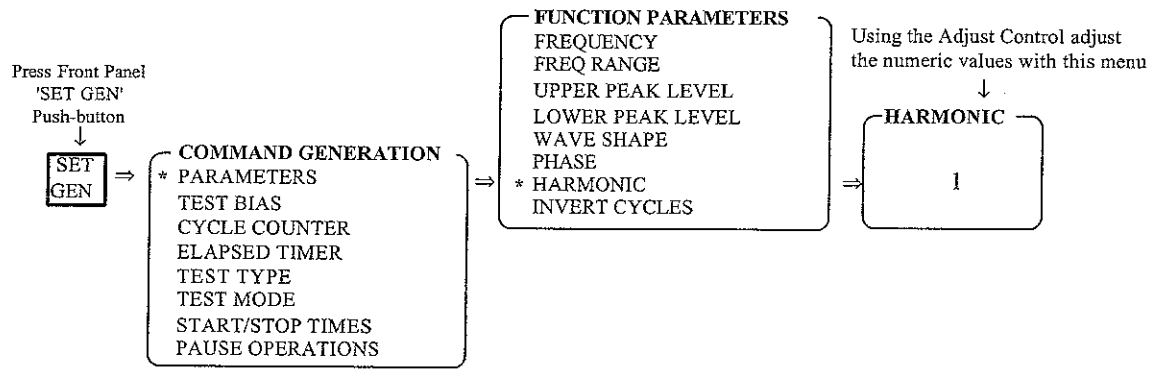
6.3.5. Phase



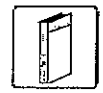
The example above shows the path through the menus from the SET GENerator push-button to the PHASE which in this case is set to 140.00 degrees.

PHASE is used for multi-channel applications and can be set in the range -180.00 to +180.00 degrees, the default value is 0.00 degrees.

6.3.6. Harmonic



The example above shows the path through the menus from the SET GENerator push-button to the HARMONIC setting which, in this case, is set to the numeric value of '1', the default setting.



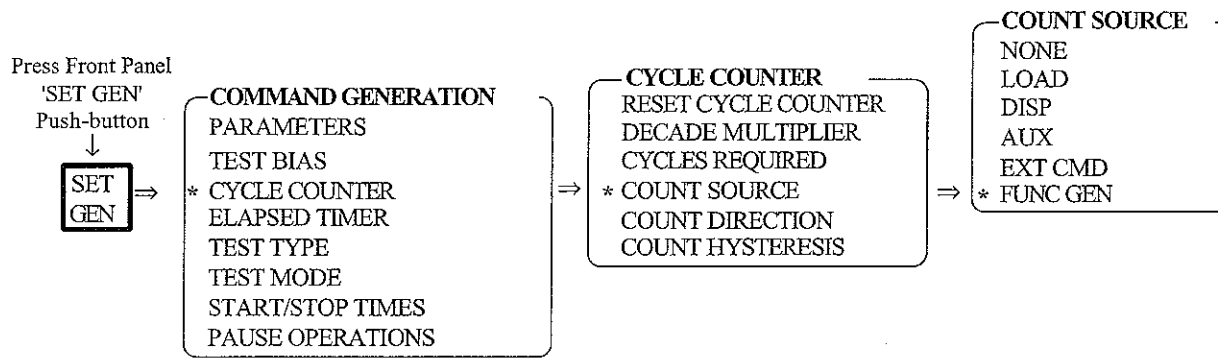
HARMONIC is normally used for multi-channel applications, it can be set in the range of 1 to 5 with a default value of '1'.

A typical use would be to generate the required command waveform for a second actuator which must be (say) twice the frequency applied to the first actuator (the fundamental) and also be synchronised with fundamental.

6.4. Cycle Counter For Function Generator

To enable the operation of the CYCLE COUNTER a number of input and numeric values must be set.

6.4.1. Count Source

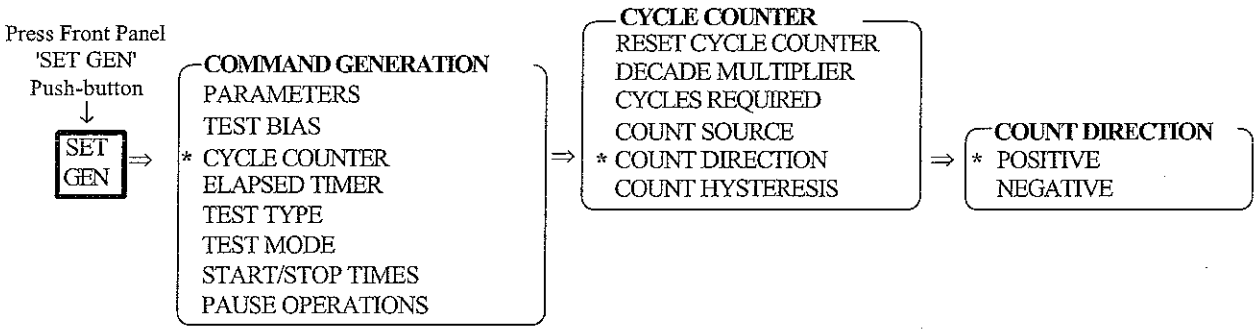


The example above shows the path through the menus to set the COUNT SOURCE from the SET GENerator push-button.

Although the COUNT SOURCE may be set to a number of sources, it is normally set to FUNCtion GENerator.

The other count sources enable counting cycles of different transducer feedbacks.

6.4.2. Count Direction

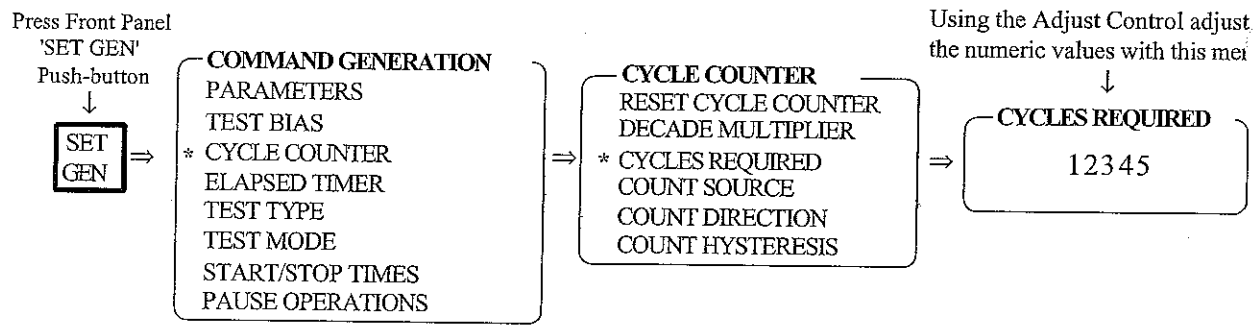


The example above shows the path through the menus to set the COUNT DIRECTION to POSITIVE from the SET GENerator push-button.

Normally the COUNT DIRECTION is set to POSITIVE which means that the counter will be incremented on the upper peak turning point of the dynamic waveform.

6.4.3. Cycles Required

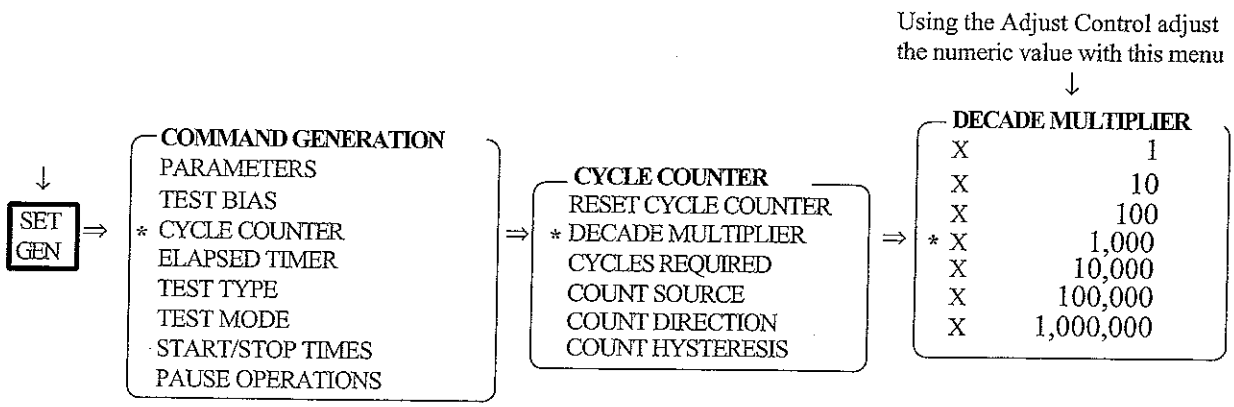
The number of CYCLES REQUIRED is set in conjunction with the DECADE MULTIPLIER



The example above shows the path through the menus from the SET GENerator push-button to the CYCLES REQUIRED which in this case is set to the value of 12345.

If the DECADE MULTIPLIER is set to X1 then these will be the number of cycles counted before the set limit action takes place.

6.4.4. Decade Multiplier



The example above shows the path through the menus from the SET GENerator push-button to the DECADE MULTIPLIER which in this case is set to X 1,000.

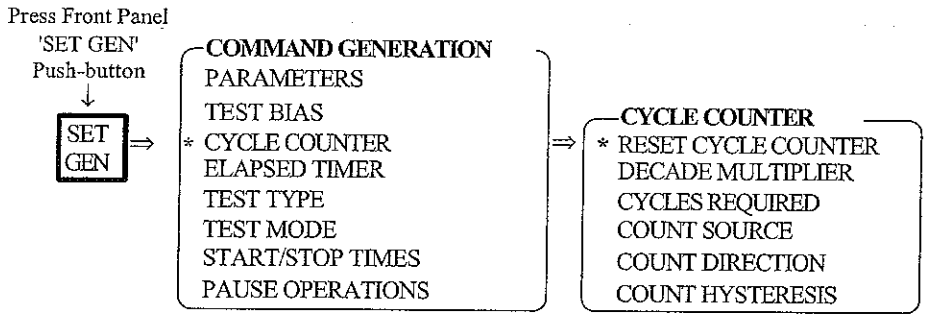
In the example above the CYCLES REQUIRED is set to 12345 and the total number of cycles set will be 12,345,000 after multiplication.

The total number of CYCles REQuired is also continually displayed on a line in the status display, which for the above example would look like:

CYC REQ: 12345000

The Function Generator may now be run by pressing the START push-button.

6.4.5. Reset Cycle Counter



The above example shows the path through the menus to RESET CYCLE COUNTER from the SET GENerator push-button, there is no further menu selection. Because this is the first line in the CYCLE COUNTER menu it will always be selected when the menu is entered. To initiate counter reset action the SELECT push-button must be depressed.

The number of CYCles CoMPleted is also continually displayed on a line in the status display, for example:

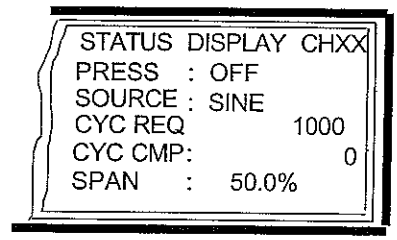
CYC CMP: 10145016

After cycle counter reset this will look like :

CYC CMP: 0

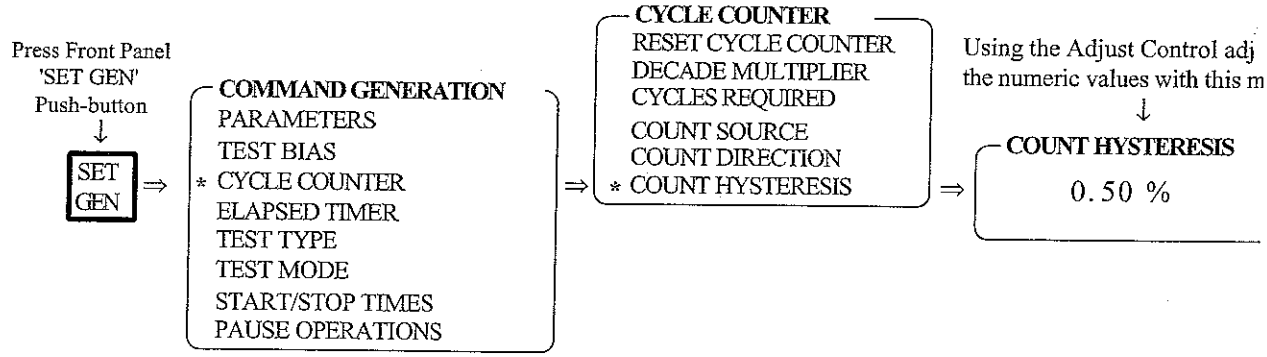
If there is a time set on the elapsed timer which is shorter than the time required for the total number of cycles as set by the cycle counter, then the set limit action will take place due to the elapsed timer and not the cycle counter.

The status display below shows a typical display with the cycle counter for the test CYCcles REQuired set to 1000 and the CYCles COMPleted set to zero. The display is toggled between elapsed timer and cycle counter by the front panel STATUS push-button.



6.4.6. Count Hysteresis

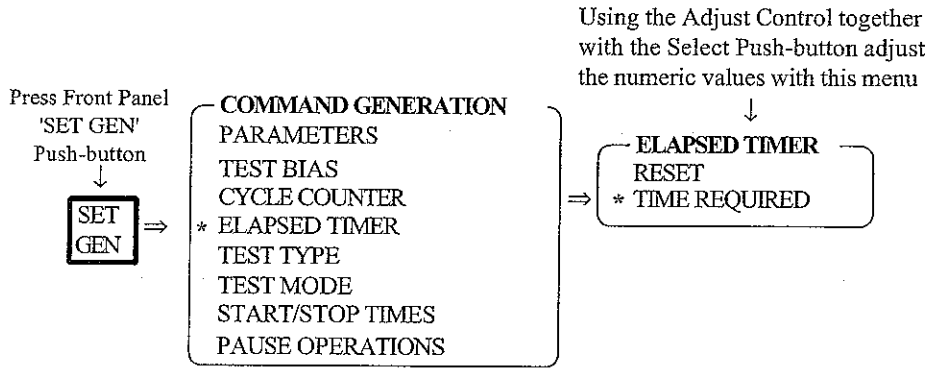
COUNT HYSTERESIS may need to be adjusted if the COUNT SOURCE is set for a specific transducer feedback. It can be increased to accommodate noisy feedback waveforms and so help to prevent spurious cycle counts.



This example shows the path through the menus from the SET GENerator push-button to the COUNT HYSTERESIS which, in this case, is set to the numeric value of 0.50%. This is the default value and is used when FUNCtion GENerator is selected for COUNT SOURCE.

6.5. Elapsed Timer

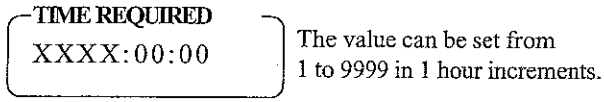
To use the ELAPSED TIMER in place of cycle counting, the numeric value of the TIME REQUIRED must be set:



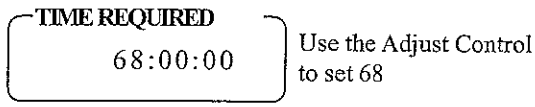
The above example shows the path through the menus from the SET GENerator push-button to the TIME REQUIRED which in this case is set to 68 hours, 45 minutes and 29 seconds; after this time has elapsed the set limit action (master) takes place.

When the time is set to the value of 0:00:00 this is detected as a default value and indicates that the elapsed timer is not required.

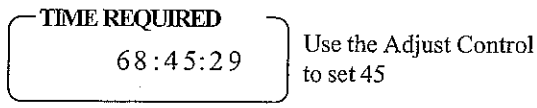
When this menu is first selected the numeric value for hours can be entered, using the adjust control.



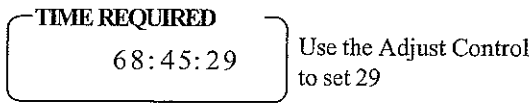
Below is an example showing the display if a numeric value to be set is 68 hours.



After the hours value is set, pressing the select push-button enables the minutes to be set, in 1 minute increments up to 59. If the numeric value to be set is 45 minutes the display will look like the example below.



After the minutes value is set, pressing the select push-button enables the seconds to be set, in 1 second increments up to 59. If the numeric value to be set is 29 seconds the display will look like the example below.



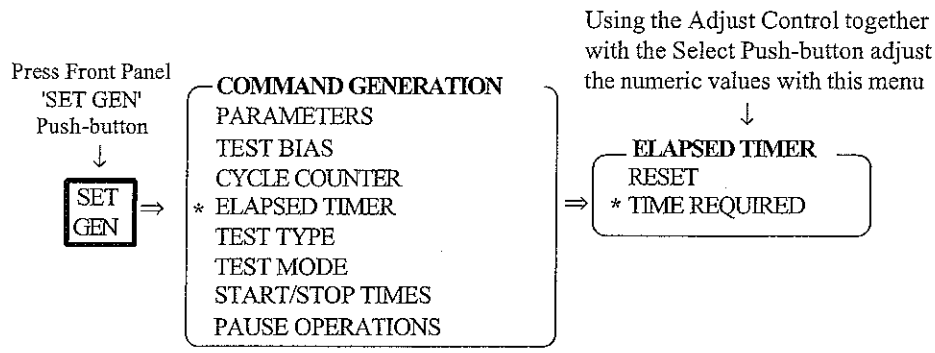
After the seconds value is set, pressing the SELECT push-button returns the display back to the ELAPSED TIMER menu.

The elapsed time set is also continually displayed on a line in the status display, which for the above example would look like this:

TIME: 68:45:29

If an incorrect time is set in error the above process must be repeated, this will start with the hours selection again. If this numeric value does not need to be adjusted it can accepted by pressing the SELECT push-button.

6.5.1. Reset Elapsed Timer



The above example shows the path through the menus to the elapsed timer RESET from the SET GENerator push-button, there is no further menu selection. Because this is the first line in the ELAPSED TIMER menu it will always be selected when the menu is entered. To initiate timer RESET action the SELECT push-button must be depressed.

The actual test elapsed time is also continually displayed on a line in the status display which, before reset, may look like:

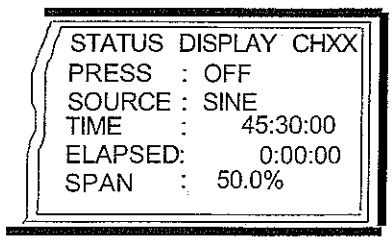
ELAPSED: 45:13:49

After reset this will look like :

ELAPSED: 0:00:00

If the time taken for the total number of cycles set on the cycle counter is shorter than the elapsed time, then the set limit action will take place due to the cycle counter and not the elapsed timer.

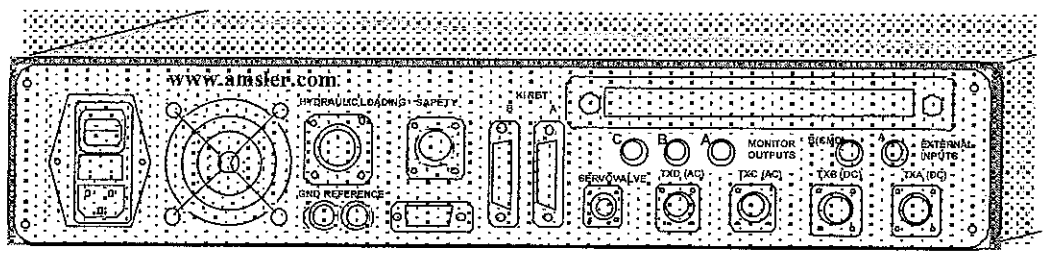
The drawing below shows a typical front panel display with the TIME for the test set to 45 hr and 30 min and the ELAPSED timer set to zero. The display is toggled between elapsed timer and cycle counter by the front panel STATUS push-button.



For more information regarding Function Generation see Reference Manual, Chapter 7.

7. System Monitoring

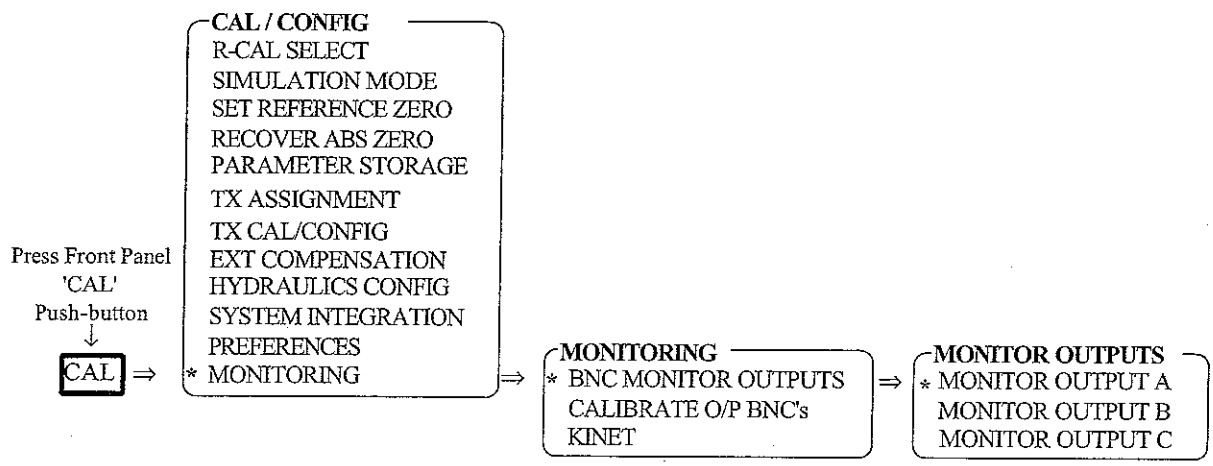
Mounted on the rear panel of the K7500 Servocontroller are three BNC type monitor output connectors, labelled 'A', 'B', and 'C'. These provide an analogue voltage output to drive monitoring equipment, i.e. oscilloscopes, DVM, chart recorder etc.



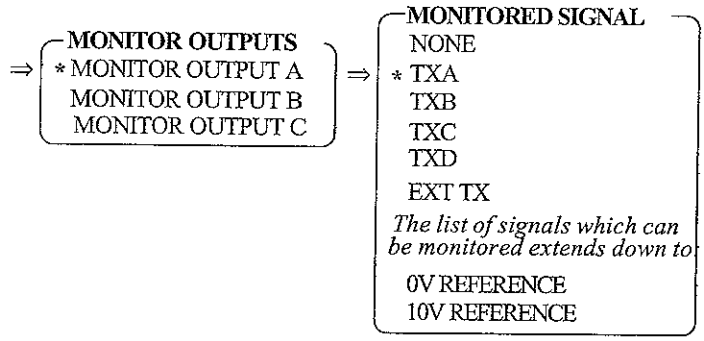
7.1. Monitor Facility

This facility enables external equipment to monitor the selected activity of the test system. Instruments such as an oscilloscope may be connected to inspect the response of the system by monitoring command and feedback signals.

The example below shows the path through the menus for the BNC output connector MONITOR OUTPUT A to be selected from the CALibration push-button.



Using the MONITOR OUTPUTS menu, one of the three BNC outputs can now be assigned to a particular signal from the list of signals available. The following example shows BNC MONITOR OUTPUT A assigned to INPUT TX'A'.



To check the system response as an example, the following could be set:

BNC monitor output A = command

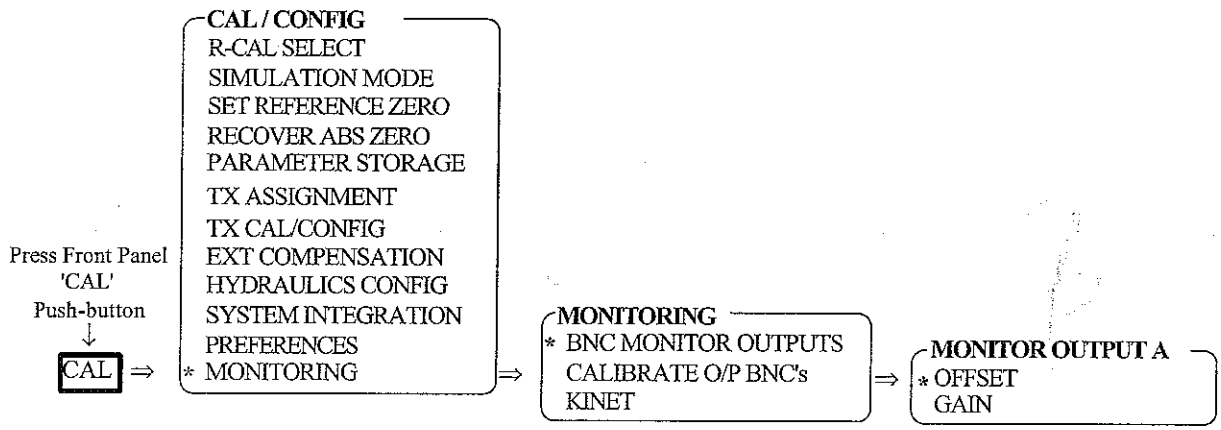
BNC monitor output B = control feedback

These two signals can be connected to a dual channel oscilloscope so that the feedback output waveform shape can be compared to that of the command input.

7.2. Calibration Facility

The output of each BNC can be adjusted for OFFSET or GAIN. This permits the monitor output to be adjusted to suit the external measuring equipment.

The example shows the path through the menus for the OFFSET associated with the BNC output connector MONITOR OUTPUT A.



The calibration is 'factory set' such that a +/-10V output represents +/- the full scale setting.

7.3. Output BNC Calibration

The offset and gain are used to adjust the calibration of the output DAC. The list of signals which can be monitored also include '0V REFERENCE' and a '10V REFERENCE' from the internal precision voltage source.

By setting a BNC output to the 0V REFERENCE the OFFSET for it can now be adjusted for a numeric output value of 0V +/-1 mV using an external DVM to measure the voltage.

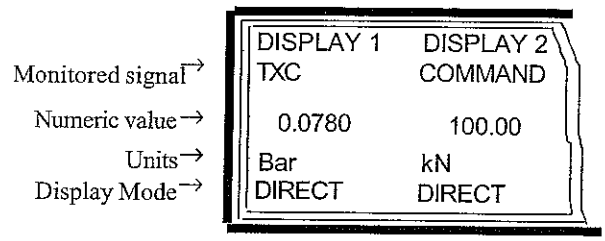
Setting the output to the 10V REFERENCE enables the GAIN to be adjusted for a numeric output value of 10V +/-1 mV.

See Reference Manual : Chapter 5

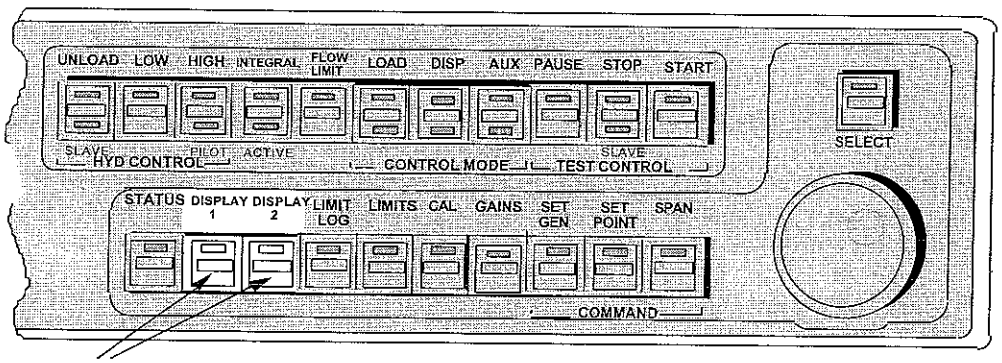
7.4. Front Panel Digital Panel Meter (DPM) Simple Selection

Dual Digital Displays facilitate the reading of any parameter with a choice of display mode.

The example below shows the layout of the two front panel displays. The 'Engineering Units' are automatically selected for the Monitored signal from the units entered during transducer calibration.



Each display has its own front panel DISPLAY selector push-button.

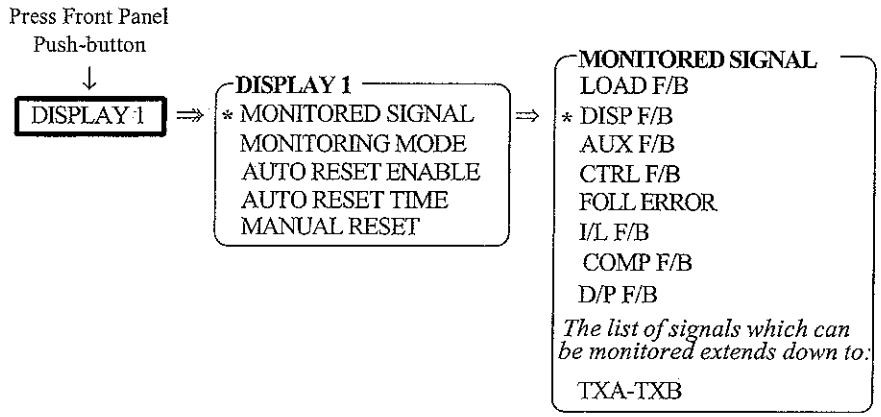


INDICATOR LED WILL BE ON WHEN SELECTION IS MADE

The displays each require two settings to be programmed via the menus for MONITORED SIGNAL and display MODE.

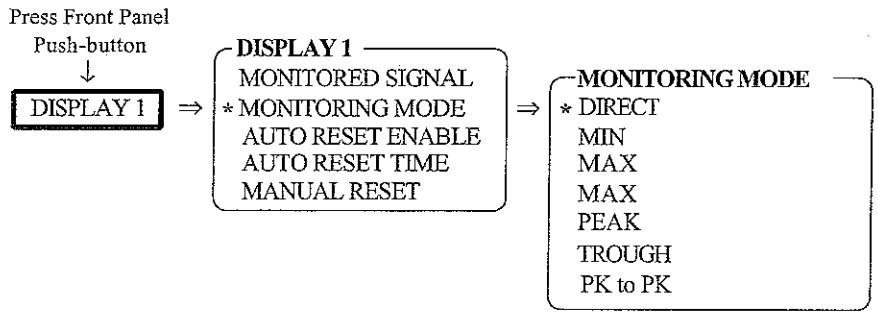
7.5. Monitored Signal

The example below shows the path through the menus for the DISPlacement Feedback to be shown by DISPLAY 1 from the front panel push-button DISPLAY 1.

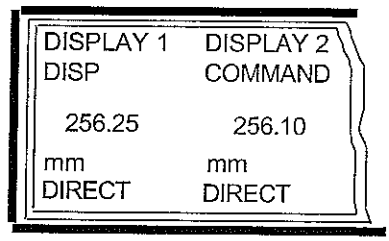


7.6. Mode

There are a number of display modes available. DIRECT provides a numeric value which is continually updated. The following example shows the path through the menus for DISPLAY 1 to be set to DIRECT monitoring mode:



Direct examples:



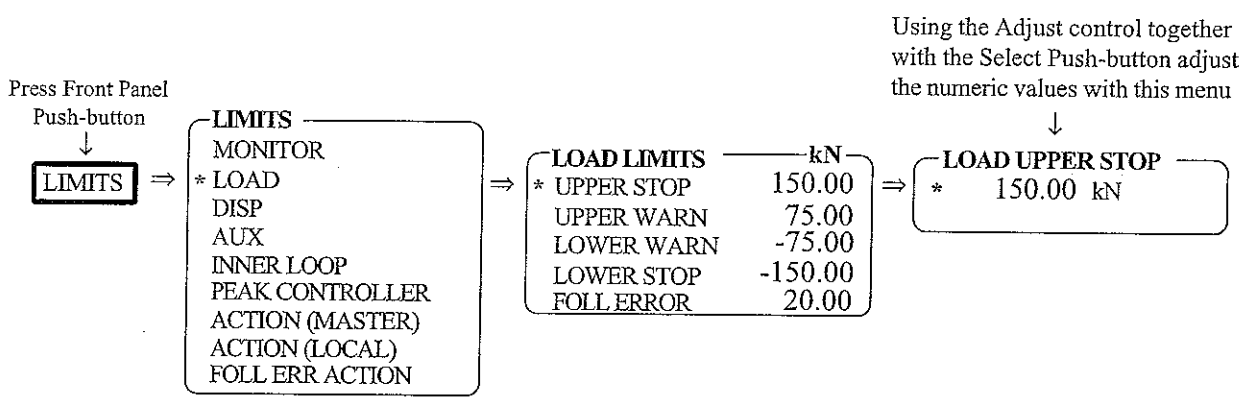
Dynamic readings of PEAK and TROUGH values may be selected. These are up-date readings that apply to monofrequency signals.

MIN. and MAX. readings record absolute values and will require a manual reset action or a timed reset auto reset enable/time.

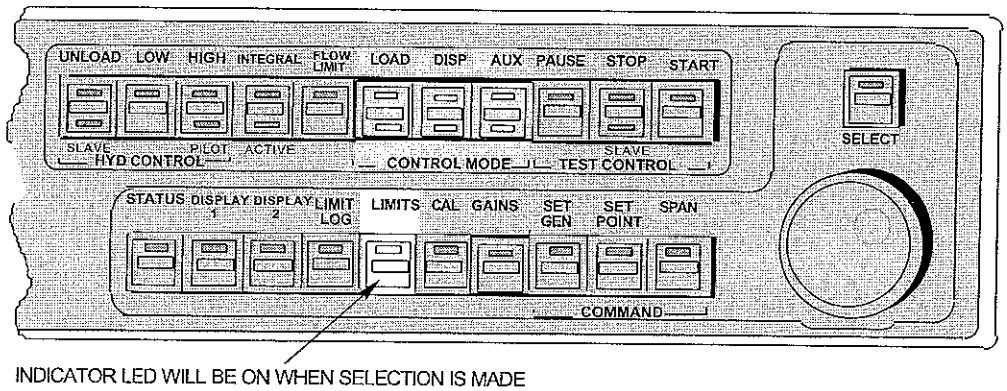
See Reference Manual : Chapter 5

8. Safety Limits

For each of the three control modes (load, displacement or auxiliary) and inner loop there is an associated set of outer limits. These outer limits will only be active when a transducer is assigned to the control mode.



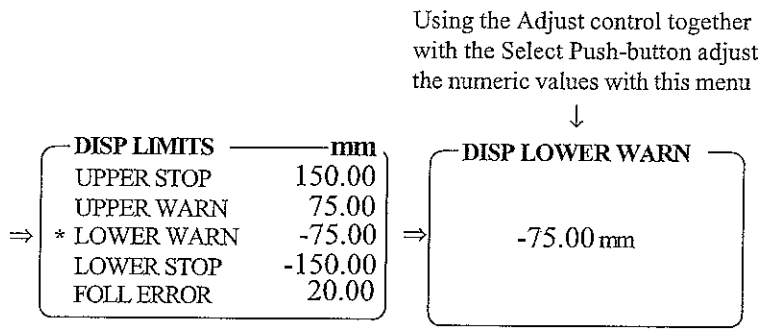
The above example shows the path through the menus from the front panel LIMITS push-button to the LOAD UPPER STOP outer limit which, in this case, is set to a numeric value of 150.00 kN.



The menu structure is used in the same way to set the outer limits for the other control modes.

The limits screen indicates the control mode and also shows for reference purposes the numeric value that the limits have been set to, together with the units. The units are automatically displayed from the units which can be entered when the feedback transducer is calibrated.

The example below shows for the DISPlacement LIMIT that a numeric value of -75.00 mm is set for the DISPlacement LOWER WARNing outer limit.



The maximum value that may be set for an outer limit is 150% of the FULL SCALE value that has been set for the feedback transducer assigned to the CONTROL MODE.

As an example, if the FULL SCALE for the transducer assigned to LOAD is set to 80 kN, then the maximum the load limits can be set to is 80 x 1.5 = (+/-)120 kN.

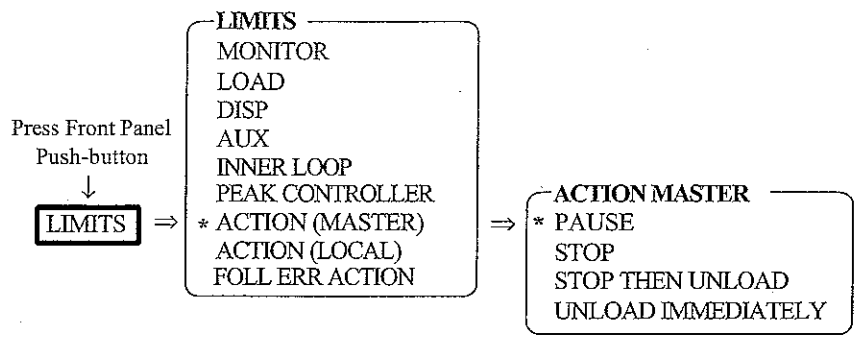
The LIMIT ACTION for a particular load limit cannot be turned off, but can be disabled by setting it to a value which is higher than any values which will be obtained from the feedback transducer during the test.

8.1. Limit Action

Both UPPER STOP or LOWER STOP limit will have the same assigned action. The selection for the limit actions is divided into two groups as follows:

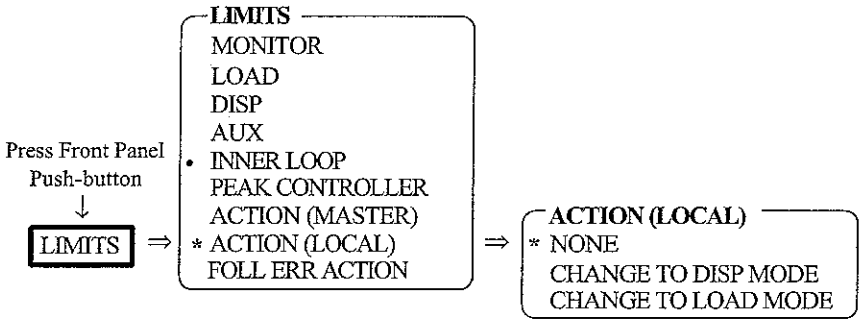
8.1.1. Action (Master)

This applies equally to the Servocontroller when used as a stand alone unit, or the master unit of a multi-channel test group. The following example shows the path through the menus for the ACTION (MASTER) to be set to PAUSE from the front panel LIMIT push-button:



8.1.2. Action (Local)

This applies to each individual Servocontroller. The example below shows the path through the menus for the ACTION (LOCAL) to be set to NONE from the front panel LIMIT push-button:



If an attempt is made to change the local action to a control mode which is not available, say load, then the error message 'NO LOAD TX' will be displayed.

8.2. Following Error Action

The FOLLowing ERROR limit applies to any of the control modes but can have a different numeric value between control modes, although the limit action will be the same.

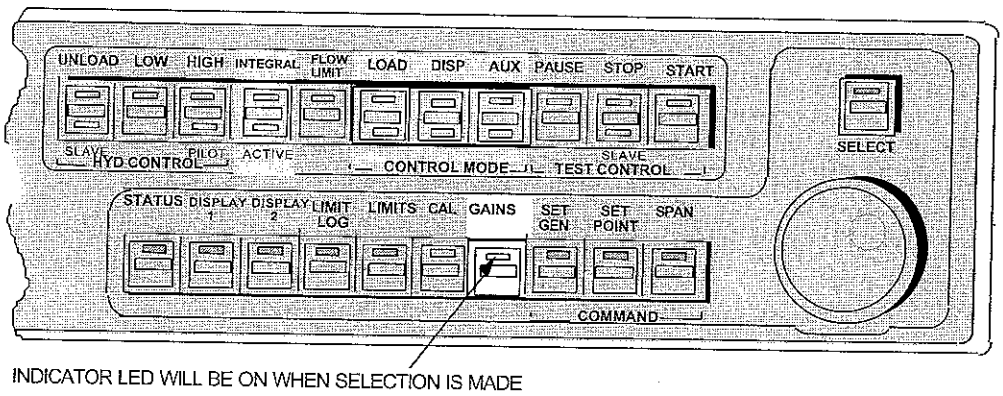
Limit action can be selected for WARNING, or the same as that set for MASTER ACTION

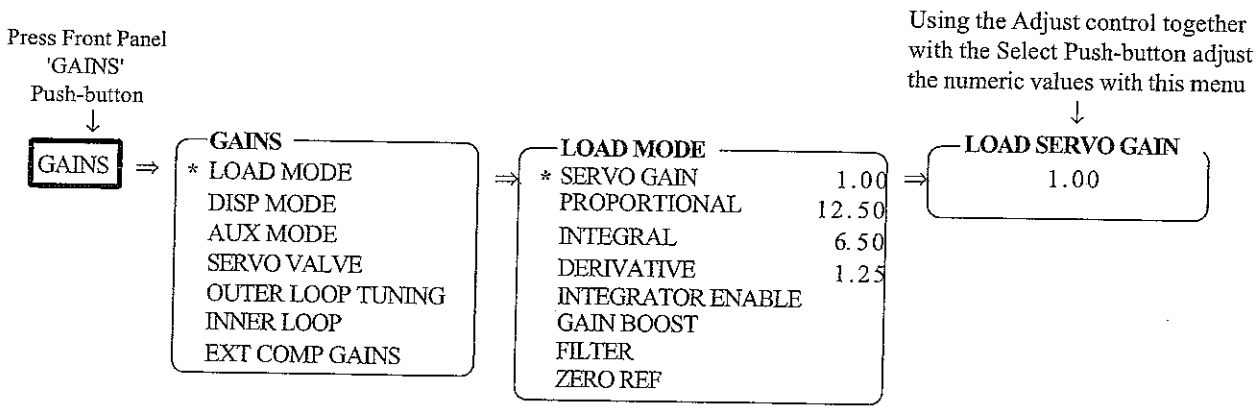
9. Control Loop Gain Settings

For each of the three control modes (load, displacement or auxiliary), the associated values for the loop gains need to be tuned to suit the application using the GAINS menu.

The loop gain terms are SERVO GAIN, PROPORTIONAL, INTEGRAL, and DERIVATIVE (PID).

(The integral term is not available for displacement control mode.)

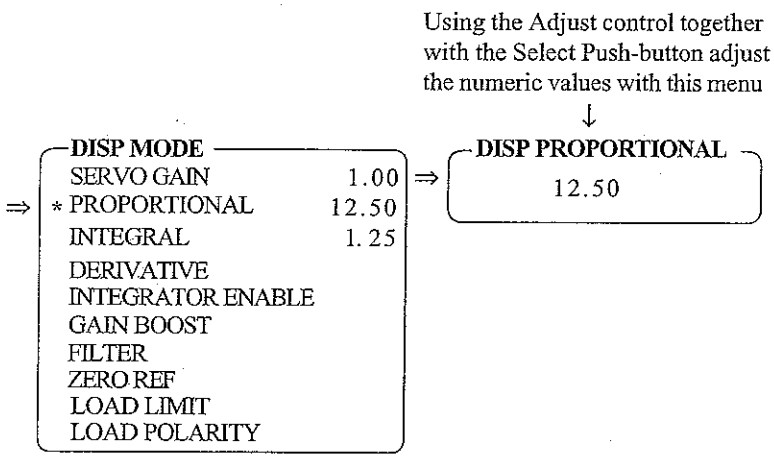




The above example shows the path through the menus from the front panel GAINS push-button for the LOAD SERVO GAIN which, in this case, is set to 1.00.

The menu is used in the same way to set the loop gains for the other two control modes.

The MODE screen indicates the control mode and also shows the numeric value of the servo gains.



Optimisation of Control Loop Gain

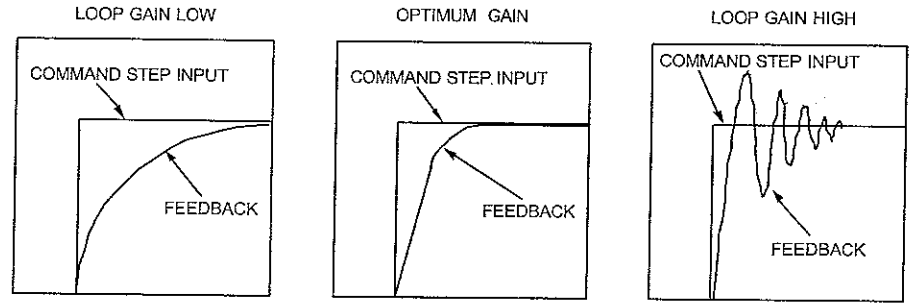
Select Hydraulic Pressure, (Low pressure should be used in the first instance, if available), then using an oscilloscope connected to the control feedback (Monitor BNC) and a low level, low frequency square wave form, optimise the PID gains as shown below.

The control loop performance is affected by the specimen mass and stiffness together with the servovalve and actuator ratings.

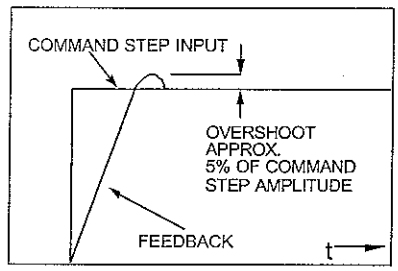
For a starting point:

1. Set the dynamic amplitude using span to 10%
2. Set the function generator for a square waveform, frequency 1 Hz
3. Set servo gain to 1
4. With all other gain terms at zero start increasing the proportional term.
5. Adjust the value for a very small overshoot. The following graph shows an ideal response.

The graphs show how the response (feedback from the controlling transducer) for a servo system alters as the gain is changed using this step change in the command.



9.1.1. Proportional Gain Term



The 'servo gain' multiplies the P, I and D values by a constant, as an example consider the loop proportional gain for:

With 'servo gain' = 1 and P= 1, the loop gain is 1 X 1 = 1 (as loop gain = 'servo gain' X P)

This means that a following error of 100% gives a servovalve drive of 100%.

(Following error is the difference between feedback and command.)

With 'servo gain' = 1 when P is increased to 10, the loop gain is 1 X 10 = 10

Then a following error of 10% gives a servovalve drive of 100%

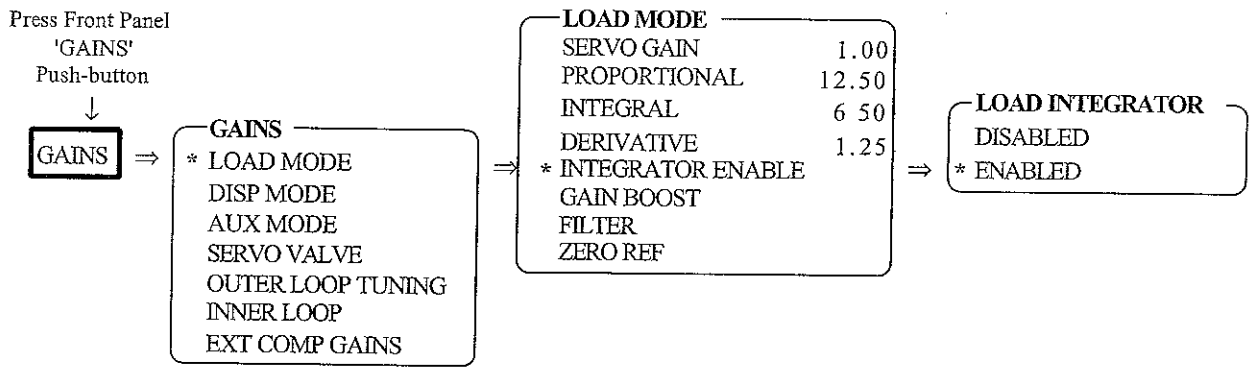
Increase 'servo gain' to 2 and P = 10, the loop gain is 2 X 10 = 20

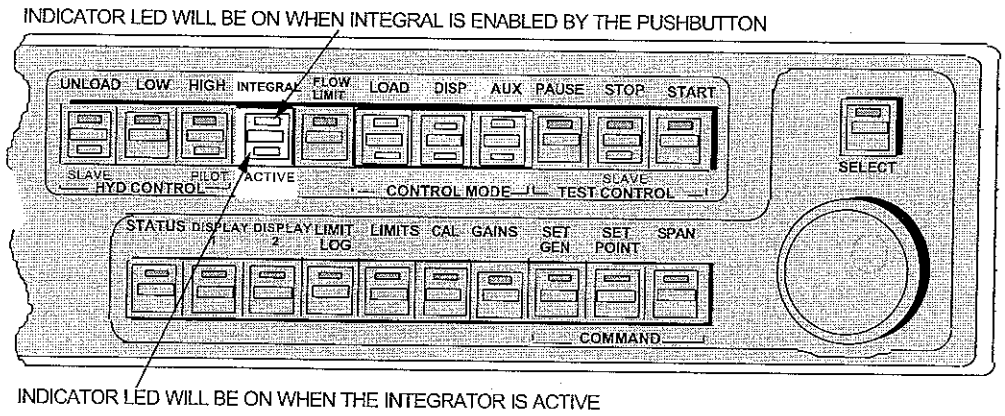
Then a following error of 5% gives a servovalve drive of 100%

9.1.2. Integral Gain Term

Integral is primarily used to remove the steady state error and to reduce following errors. This is important for systems using load as the controlling mode as it improves the static load accuracy. The integral term is only available for LOAD and AUXiliary control modes.

The example below shows the path through the menus for the LOAD mode to the ENABLED selection for the integrator from the GAINS push-button:





The upper LED in the INTEGRAL push-button when 'on' indicates that the integrator, if required, is available. The LED is controlled by the push-button which has a toggle action; depressing the push-button puts the LED 'on', depressing the push-button again switches the LED 'off' and removes integral action.

Provided that the top LED is 'on', then the lower LED when 'on' indicates that the integrator is active - it has been enabled via the menu structure and is also the selected controlling mode.

9.1.3. Derivative Gain Term

Derivative will help to improve the overall dynamic (or transient) system response but can lead to instability if the value is set too high.

For more information on servo-loop gain optimisation see Chapter 6.

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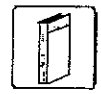

User Reference Manual

for

Zwick Roell

K7500 Controller

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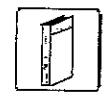
http:\\zwick.com



For Your Safety Please Read The Following Carefully

WARNING:

Users of servo-hydraulic testing equipment are reminded of the dangerous nature of high speed high force servo-actuators. It is essential to thoroughly understand the contents of this handbook before using the equipment. Roell Amsler accepts no liability for any damage to materials, goods or persons resulting from the use of this equipment.

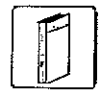
EMC:

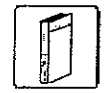
The mains lead fitted to this equipment includes an inline mains filter circuit. If this is removed or replaced with a non-filtered mains lead this equipment will no longer meet the European Standards for Electromagnetic Compatibility (EMC). Some external equipment connectors may be supplied with covers for protection against static discharge. These covers should remain in-situ if the connector is not used. All external cables should be screened in accordance with good installation practise

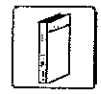
IMPORTANT:

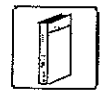
This equipment uses a 3 wire mains lead: Live, Neutral, Earth. For safety & EMC aspects the earth lead must be connected to the supply earth connection. All replacement fuses must be of the same type and rating.

Contents









1. OVERVIEW

This Handbook relates to the use of the K7500 Digital Servocontroller in mechanical testing and motion control systems. In addition to providing an extensive range of advanced software configurable features for closed loop control of servo hydraulic-actuators, the controller also offers a wide range of complementary system functions which can eliminate the need for peripheral units.

The power and versatility of the K7500 system in static and dynamic testing is to be found in the main functional sections set out below:

- User configurable control loops
- PID controller with self tune and gain boost features
- User configurable hydraulic power control
- Programmable transducer signal processing
- Internal static and dynamic function generator (Test Management)
- Integrated safety system with event logging
- Dual multi-mode digital displays
- Digital interface options for networking-data acquisition/command

1.1 Single And Multi-Channel Operation

Whilst the above features permit the K7500 to be a stand-alone control system for single channel tests, it is also capable of operation with other units so that multi-channel test systems may be configured.

This is achieved using the KiNet digital interface. This high performance network will permit up to 16 units to be connected together. Each unit has a unique address where only one unit will be the master and furnish the other slave units with the essential timing and synchronisation data.

Multi-channel operation is software configured and will determine the type of hydraulic control and test management. The K7500 options for single and multi-channel operation are as follows:

- Stand Alone Operation
- Slave: Test management by the master with optional hydraulic control
- Master: Control over the group of slave units

Mechanical test systems, single or multi-channel, that are required to interface with external command wave form such as time/history generators or data acquisition equipment, can do so either using the K7500 programmable analogue connectors or the high speed KiNet digital interface.

KiNet offers network communications via optional interface units.

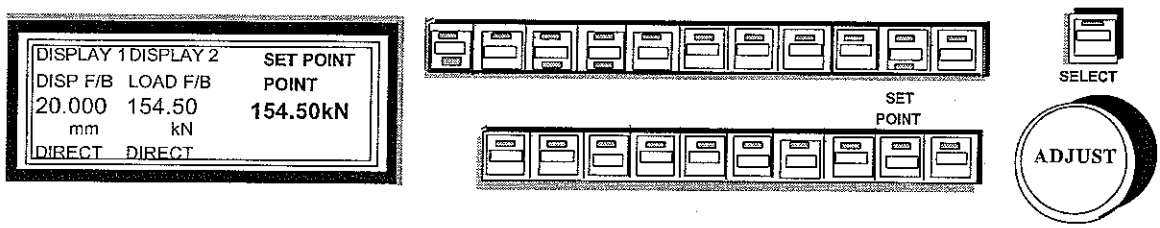
1.2. The User Interface

The K7500 has been carefully designed to ensure genuine ease of use; in particular, it offers the ability to set up a test in a very short period and to return to that test at a later date using a simple test recall instruction.

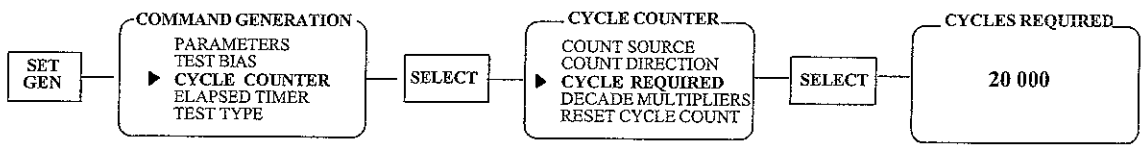
The K7500 user interface incorporates a 'soft' alphanumeric display with two dedicated parameter readouts and a configuration/status monitoring area. Function keys and soft controls provide a full digital implementation with the ease and simplicity of an analogue front panel.

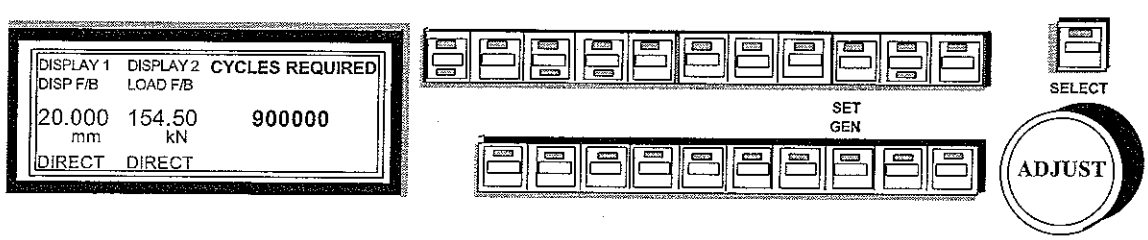
Access to the K7500 controls is prioritised in a hierarchical manner such that the most frequently used features have direct function key action, whereas features used less often are accessed in descending order through a series of self-driven menus.

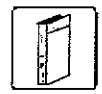
This principle of operation is illustrated in the example below where manual control of set point, which may require repetitive adjustment during start up, is accessed by operation of the SET POINT button. This single action converts the rotary ADJUST control to a proportional set point command variable.



Conversely the setting of a test cycle count is normally set only once during start up. It is accessed by entering the top level SET GENerator menu and selecting the CYCLE COUNTER sub menu using the ADJUST control. See below. Once CYCLES REQUIRED has been selected the ADJUST control is used to set the required cycle count value.



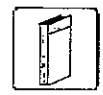




It is important to note that the ADJUST control, which is the unit's only control knob, offers the user an accelerated rate of change if rotated quickly.

All set up and test parameters entered in this way are retained in non-volatile memory and this principle of operation is adopted throughout the control and test management system.

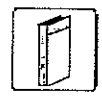
New users are recommended to select SIMULATION under the top level CAL/CONfiguration menu to explore the wide range of self-configuring system controls and monitoring functions.



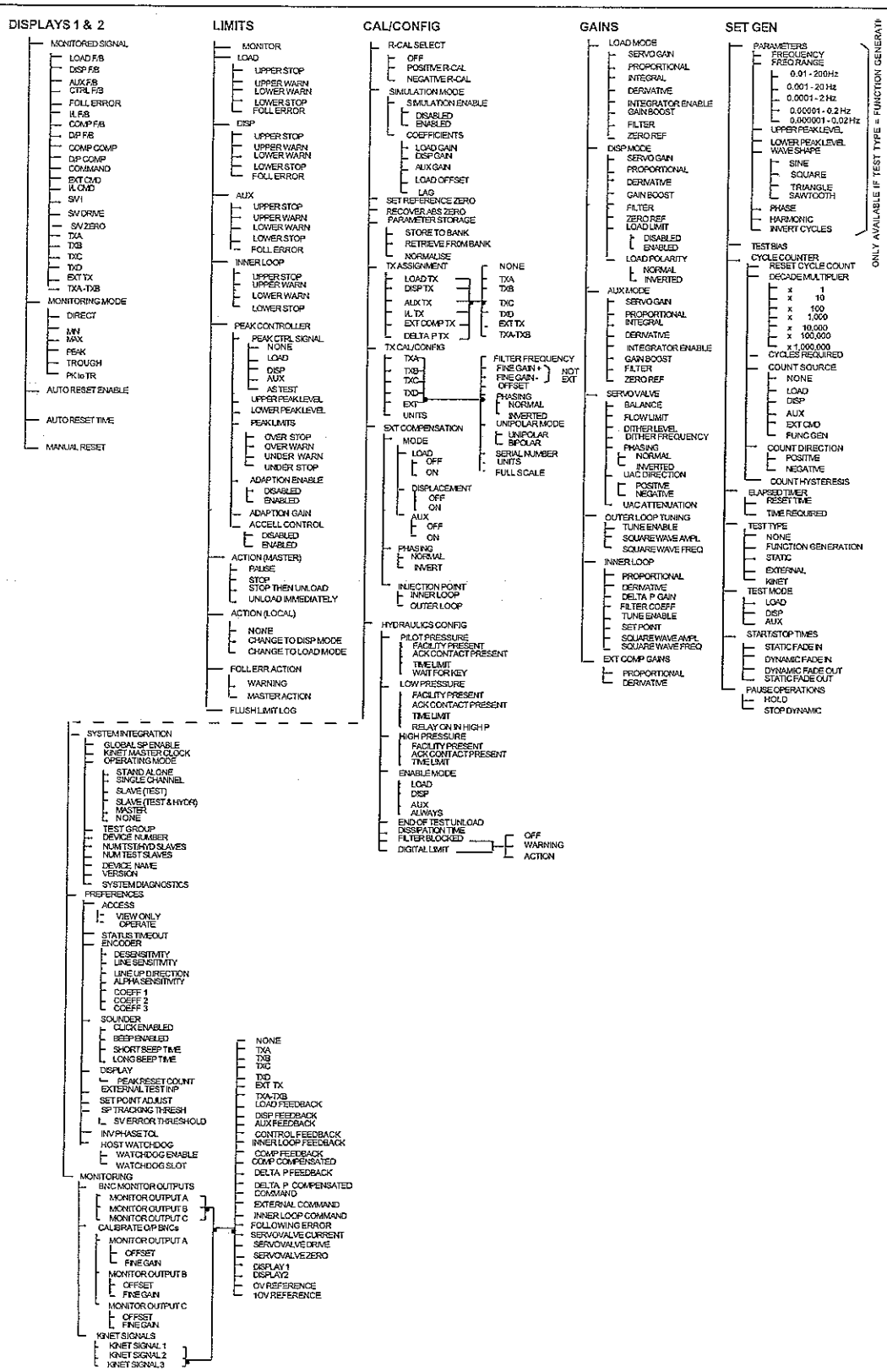
1.3 Summary of User Interface Principles

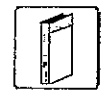
1. Parameter selection is achieved by menus, the top most level of which is available on direct function keys. On pressing one of these keys the status/adjustment area reverts to the first level of options for that key and the LED in the pressed key will glow to indicate the chosen top level option.
2. Descent through the options is achieved by selecting choices from textual lists presented in the status/adjustment area of the display. A cursor (*) is moved through the list by turning of the ADJUST control and final selection performed by pressing a 'SELECT' key.
3. Lists are confined to the status/adjustment display area but where the list exceeds 5 items the status/adjustment area effectively becomes a window on this long list and turns of the ADJUST control will cause the list to scroll when the cursor hits the edge of the display area.
4. Exit from any level of selection can be done at any time by pressing any of the top level keys.
5. While making a selection, the LED in the 'SELECT' key will glow continuously. Descent through menus will result in access to a controller parameter, allowing modifications to the parameter through turns of the ADJUST control. Under these circumstances the LED in the 'SELECT' key will flash quickly to indicate that turns of the rotary adjust control will result in parameter adjustment. Adjustment is concluded by pressing the 'SELECT' key or any top level option key.
6. The direct function key 'STATUS' displays general running status. This is a good place to 'park' the instrument when no adjustment is required and, in any case, the instrument will revert to this option automatically after 5 minutes of non use, both to protect the settings and to show the current status.
7. Pressing the 'STATUS' key whilst the status information is being displayed and the STATUS LED is illuminated will toggle the display between Cycle-Counter and Elapsed Timer information.
8. The top line of the status display is a title line which is user programmable so that a channel can be labelled, e.g. 'FRONT LEFT VERTICAL'.
9. While the K7500 is showing the status display, the 'SELECT' button enables the display contrast to be adjusted.

   Ascent through the sub-menus is achieved by pressing the illuminated key for the top level menu that the user is in.



1.4. Overview of Menus


DISPLAYS 1 & 2
MONITORED SIGNAL
LOAD F/B
DISP F/B
AUX F/B
CTRL F/B
FOLL ERROR
IL F/B
COMP F/B
DP F/B
COMP COMP
DP COMP
COMMAND
EXT CMD
IL CMD
SVI
SV DRIVE
SV ZERO
TXA
TXB
TXC
TXD
EXT TX
TXA-TXB
MONITORING MODE
DIRECT
MIN
MAX
PEAK
TROUGH
PK to TR
AUTO RESET ENABLE
AUTO RESET TIME
MANUAL RESET
LIMITS
MONITOR
LOAD
UPPER STOP
UPPER WARN
LOWER WARN
LOWER STOP
FOLL ERROR
DISP
UPPER STOP
UPPER WARN
LOWER WARN
LOWER STOP
FOLL ERROR
AUX
UPPER STOP
UPPER WARN
LOWER WARN
LOWER STOP
FOLL ERROR
INNER LOOP
UPPER STOP
UPPER WARN
LOWER WARN
LOWER STOP
PEAK CONTROLLER
PEAK CTRL SIGNAL
NONE
LOAD
DISP
AUX
AS TEST
UPPER PEAK LEVEL
LOWER PEAK LEVEL
PEAK LIMITS
OVER STOP
OVER WARN
UNDER WARN
UNDER STOP
ADAPTION ENABLE
DISABLED
ENABLED
ADAPTION GAIN
ACCELL CONTROL
DISABLED
ENABLED
ACTION (MASTER)
PAUSE
STOP
STOP THEN UNLOAD
UNLOAD IMMEDIATELY
ACTION (LOCAL)
NONE
CHANGE TO DISP MODE
CHANGE TO LOAD MODE
FOLL ERR ACTION
WARNING
MASTER ACTION
FLUSH LIMIT LOG
CAL/CONFIG
R-CAL SELECT
OFF
POSITIVE R-CAL
NEGATIVE R-CAL
SIMULATION MODE
SIMULATION ENABLE
DISABLED
ENABLED
COEFFICIENTS
LOAD GAIN
DISP GAIN
AUX GAIN
LOAD OFFSET
LAG
SET REFERENCE ZERO
RECOVER ABS ZERO
PARAMETER STORAGE
STORE TO BANK
RETRIEVE FROM BANK
NORMALISE
TX ASSIGNMENT
LOAD TX
DISP TX
AUX TX
IL TX
EXT COMP TX
DELTA P TX
NONE
TXA
TXB
TXC
TXD
EXT TX
TXA-TXB
TX CAL/CONFIG
TXA
TXB
TXC
TXD
EXT
UNITS
FILTER FREQUENCY
FINE GAIN +
FINE GAIN -
OFFSET
NOT EXT
PHASING
NORMAL
INVERTED
UNIPOLAR MODE
UNIPOLAR
BIPOLAR
SERIAL NUMBER
UNITS
FULL SCALE
EXT COMPENSATION
MODE
LOAD
OFF
ON
DISPLACEMENT
OFF
ON
AUX
OFF
ON
PHASING
NORMAL
INVERT
INJECTION POINT
INNER LOOP
OUTER LOOP
HYDRAULICS CONFIG
PILOT PRESSURE
FACILITY PRESENT
ACK CONTACT PRESENT
TIME LIMIT
WAIT FOR KEY
LOW PRESSURE
FACILITY PRESENT
ACK CONTACT PRESENT
TIME LIMIT
RELAY ON IN HIGH P
HIGH PRESSURE
FACILITY PRESENT
ACK CONTACT PRESENT
TIME LIMIT
ENABLE MODE
LOAD
DISP
AUX
ALWAYS
END OF TEST UNLOAD
DISSIPATION TIME
FILTER BLOCKED
DIGITAL LIMIT
OFF
WARNING
ACTION
GAINS
LOAD MODE
SERVO GAIN
PROPORTIONAL
INTEGRAL
DERIVATIVE
INTEGRATOR ENABLE
GAIN BOOST
FILTER
ZERO REF
DISP MODE
SERVO GAIN
PROPORTIONAL
DERIVATIVE
GAIN BOOST
FILTER
ZERO REF
LOAD LIMIT
DISABLED
ENABLED
LOAD POLARITY
NORMAL
INVERTED
AUX MODE
SERVO GAIN
PROPORTIONAL
INTEGRAL
DERIVATIVE
INTEGRATOR ENABLE
GAIN BOOST
FILTER
ZERO REF
SERVO VALVE
BALANCE
FLOW LIMIT
DITHER LEVEL
DITHER FREQUENCY
PHASING
NORMAL
INVERTED
UAC DIRECTION
POSITIVE
NEGATIVE
UAC ATTENUATION
OUTER LOOP TUNING
TUNE ENABLE
SQUARE WAVE AMPL
SQUARE WAVE FREQ
INNER LOOP
PROPORTIONAL
DERIVATIVE
DELTA P GAIN
FILTER COEFF
TUNE ENABLE
SET POINT
SQUARE WAVE AMPL
SQUARE WAVE FREQ
EXT COMP GAINS
PROPORTIONAL
DERIVATIVE
SET GEN
PARAMETERS
FREQUENCY
FREQ RANGE
0.01 - 200Hz
0.001 - 20Hz
0.0001 - 2Hz
0.00001 - 0.2Hz
0.000001 - 0.02Hz
UPPER PEAK LEVEL
LOWER PEAK LEVEL
WAVE SHAPE
SINE
SQUARE
TRIANGLE
SAWTOOTH
PHASE
HARMONIC
INVERT CYCLES
ONLY AVAILABLE IF TEST TYPE = FUNCTION GENERATOR
TEST BIAS
CYCLE COUNTER
RESET CYCLE COUNT
DECADE MULTIPLIER
x 1
x 10
x 100
x 1,000
x 10,000
x 100,000
x 1,000,000
CYCLES REQUIRED
COUNT SOURCE
NONE
LOAD
DISP
AUX
EXT CMD
FUNC GEN
COUNT DIRECTION
POSITIVE
NEGATIVE
COUNT HYSTERESIS
ELAPSED TIMER
RESET TIME
TIME REQUIRED
TEST TYPE
NONE
FUNCTION GENERATION
STATIC
EXTERNAL
KINET
TEST MODE
LOAD
DISP
AUX
START/STOP TIMES
STATIC FADE IN
DYNAMIC FADE IN
DYNAMIC FADE OUT
STATIC FADE OUT
PAUSE OPERATIONS
HOLD
STOP DYNAMIC
SYSTEM INTEGRATION
GLOBAL SP ENABLE
KINET MASTER CLOCK
OPERATING MODE
STAND ALONE
SINGLE CHANNEL
SLAVE (TEST)
SLAVE (TEST & HYDR)
MASTER
NONE
TEST GROUP
DEVICE NUMBER
NUM TST-HYD SLAVES
NUM TEST SLAVES
DEVICE NAME
VERSION
SYSTEM DIAGNOSTICS
PREFERENCES
ACCESS
VIEW ONLY
OPERATE
STATUS TIMEOUT
ENCODER
DESENSITIVITY
LINE SENSITIVITY
LINE UP DIRECTION
ALPHA SENSITIVITY
COEFF 1
COEFF 2
COEFF 3
SOUNDER
CLICK ENABLED
BEEP ENABLED
SHORT BEEP TIME
LONG BEEP TIME
DISPLAY
PEAK RESET COUNT
EXTERNAL TEST INP
SET POINT ADJUST
SP TRACKING THRESH
SV ERROR THRESHOLD
INV PHASE TOL
HOST WATCHDOG
WATCHDOG ENABLE
WATCHDOG SLOT
MONITORING
BNC MONITOR OUTPUTS
MONITOR OUTPUT A
MONITOR OUTPUT B
MONITOR OUTPUT C
CALIBRATE O/P BNCs
MONITOR OUTPUT A
OFFSET
FINE GAIN
MONITOR OUTPUT B
OFFSET
FINE GAIN
MONITOR OUTPUT C
OFFSET
FINE GAIN
KINET SIGNALS
KINET SIGNAL 1
KINET SIGNAL 2
KINET SIGNAL 3
NONE
TXA
TXB
TXC
TXD
EXT TX
TXA-TXB
LOAD FEEDBACK
DISP FEEDBACK
AUX FEEDBACK
CONTROL FEEDBACK
INNER LOOP FEEDBACK
COMP FEEDBACK
COMP COMPENSATED
DELTA P FEEDBACK
DELTA P COMPENSATED
COMMAND
EXTERNAL COMMAND
INNER LOOP COMMAND
FOLLOWING ERROR
SERVOVALVE CURRENT
SERVOVALVE DRIVE
SERVOVALVE ZERO
DISPLAY 1
DISPLAY 2
0V REFERENCE
10V REFERENCE



1.5. Quick Start

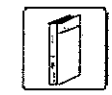
The design of the K7500 Servocontroller puts primary emphasis on the safety of the test article. This naturally necessitates the connection of a number of external safety devices such as pressure and limit switches etc.

The following instructions provide the user with a QUICK START-UP procedure to permit operation without the full range of safety monitoring devices. It should be used with care for rapid test system evaluation purposes only.

When first switching on the Servocontroller the display will indicate limit errors for:

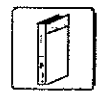
- Emergency Stop) The system sounder will bleep a repetitive audible warning
- Command clamp) which must be cleared before the unit may be operated.

1. Plug in Emergency Stop button at rear SAFETY connector and press the STATUS push button. This action will connect pins H to J and pins K to L of this connector and reset the Emergency Stop condition.
2. Plug in the servovalve and using the rear panel switches shown in Section 4.4 set the required servovalve current. (Note valve current is not present until a pressure selection has been activated.)
3. Plug in the feedback transducer at appropriate rear Tx connector (A & B for DC transducers, C & D for AC transducers, connections shown in Section 2.6). Using coarse gain switches shown in Section 4.4 set the signal conditioning gain to within ± 20% of the required value.
4. Select CAL main menu and obtain Tx ASSIGNMENT screen to assign connected transducer to the appropriate control mode (DISP, LOAD or AUX.). When completed the lower LED indicator of the chosen control mode push button will be illuminated.
5. Press the assigned control mode push button. This will illuminate the upper LED indicating the controller's active control mode. It will also remove the command clamp limit.
6. Using the CAL menu once again, follow the procedure in Section 4.5 to calibrate the transducer, i.e. scale, units and fine gain etc. (Note the calibration protection switch located on the rear panel must be operated for this procedure)
7. For operation without connection to the hydraulic control equipment, select HYDRAULICS CONFIG under the CAL main menu and ensure that (i) the ENABLE MODE is set to the control mode selected in 4 above, (ii) that the FACILITY PRESENT is set to YES in the HIGH PRESSURE sub-menu.
8. Operate the HIGH PRESSURE push button. This will activate the servo loop and the valve drive current for operation. Actual system pressure may now be applied.
9. Select SET POINT and verify control using rotary adjust control for manual operation.



(Set Digital Display to direct reading as in Section 5.2).

10. Note: To use wave form generation in the SET GEN menu described in Section 7.3, the Test Mode and Start Enable Mode must be set as in 4 above.



1.6. EMC Testing

To enable Roell Amsler products to meet the European Standards for Electromagnetic Compatibility (EMC) the following tests have been applied:

BSEN 55011 Class B	Radiated and Conducted Emissions
BSEN 61000-4-4	Fast Burst Transients to Level 2
BSEN 61000 4-2	Static Discharge to Level 2
BSEN 61000-4-11	100% for 0.5 Cycles
Low Voltage Directive 73/23/EEC	BSEN 61010 and 60204

2. GENERAL DESCRIPTION (The K7500 Hardware)

2.1. Power Supply

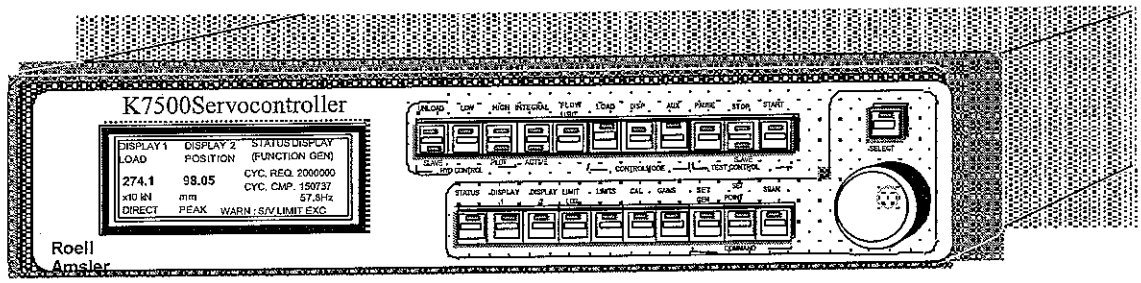
The K7500 may be connected to any single phase mains supply in the range 90 to 130 volts or 180 to 260 volts, 50 to 60 Hz. There is no requirement to select an input setting as the unit will automatically adjust to whatever supply is connected.

The mains supply enters the unit via a fused switch which includes an RF filter for rejection of spurious mains borne noise.

A replacement 20 mm anti-surge fuse type T HRC rated at 6.3 amperes is supplied in the switch housing.

Separate ground terminals are provided for the star ground connection of units.

2.2. Front Panel Controls



The front panel includes the following controls and displays:

LCD DISPLAY

The LCD display has a maximum display of 8 lines of 40 characters. The display is used to indicate the test status and to access and modify the controller's variable parameters. The display includes three dedicated areas:

- Display 1)
- Display 2) for parameter values
- Test status and menu area

ADJUST CONTROL A high resolution rotary encoder is used to provide incremental parameter selection and adjustment. To permit large

modifications and yet maintain fine resolution the encoder provides variable rates by sensing velocity. The control will, as a consequence, offer very rapid adjustment at continuous high speed rotation and very fine resolution at low speeds.

2.3. K7500 Direct Control Function Keys

These push buttons are allocated to direct functions for the hydraulic and test control.

UNLOAD

This is a red button which removes hydraulic pressure.

The upper LED on this button indicates that hydraulic pressure is removed while the lower LED indicates that the hydraulic section of the instrument (and also flow limit and integral selection) is under remote control from an external master.

LOW

This button requests attainment of low hydraulic pressure.

The upper LED on this button indicates attainment of low hydraulic pressure. Where a pilot pressure facility exists, pilot pressure will be sequenced automatically when requesting low pressure.

HIGH

This button requests attainment of high hydraulic pressure.

The upper LED on this button indicates attainment of high hydraulic pressure. Where a pilot pressure facility exists, pilot pressure will be attained automatically when requesting high pressure.

INTEGRAL

This button toggles the integral running selection.

The upper LED on this button indicates the current state of this on/off control while the lower LED indicates actual integral operation after all interlocks have been considered.

FLOW LIMIT

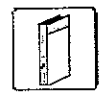
This button toggles the flow limit selection.

The upper LED on this button indicates the current state of this on/off control.

LOAD

This button requests a change to load control.

The upper LED on this button indicates that load is the current mode while the lower LED indicates availability of load mode.



DISP

This button requests a change to displacement control.

The upper LED on this button indicates that displacement is the current mode while the lower LED indicates availability of displacement mode. A special version of displacement mode 'load limited displacement mode' is indicated by a flashing upper LED.

AUX

This button requests a change to auxiliary control.

The upper LED on this button indicates that auxiliary is the current mode while the lower LED indicates availability of auxiliary mode.

PAUSE

This button requests that command generation is paused.

The upper LED on this button indicates that command generation is paused.

STOP

This button requests that command generation is stopped.

The upper LED on this button indicates that command generation is stopped while the lower LED indicates that the command generation control section of the instrument is under remote control from an external master.

START

This button requests that command generation is started.

The upper LED on this button indicates that command generation is started.

Parameter Selection/Adjustment Push Buttons

These provide access to ten top level menus for selection of sub-menus and/or parameter adjustment:

STATUS

DISPLAY 1

DISPLAY 2

LIMIT LOG

LIMITS

CAL/CONF

GAINS

SET GEN

SET POINT

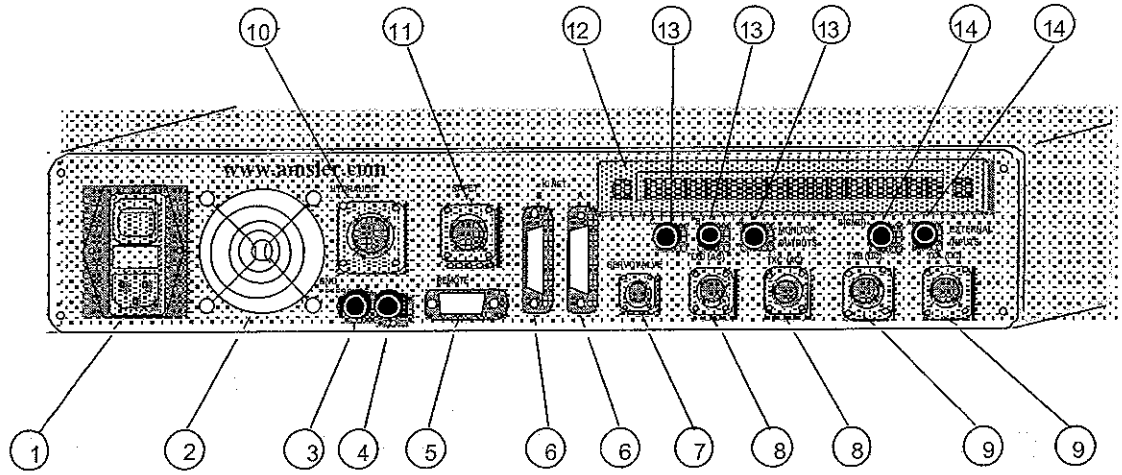
SPAN

Note that Menus for these are described in the following Chapters.

} **Commands**

2.4. Rear Panel Components

The rear panel provides a connection interface for all system transducers and safety interlocks etc.



KEY

1 Mains Input
2 Fan
3 Safety GND
4 Internal GND I/P
5 Remote Keypad
6 KiNet Interface
7 Servovalve
8 AC Transducer I/Ps
9 DC Transducer I/Ps
10 Hydraulic Power Control
11 Systems Safeties
12 Calibration Access Panel
13 Analogue Monitor Outputs
14 Analogue I/P

2.5. Calibration Access Panel (ref page 4.4)

This access panel provides security for all calibration settings of the K7500 including internal software settings. The user can use traditional seals across the panel to detect unauthorised access. Behind the calibration access panel are the following components:

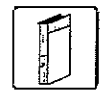
1 Course gain switches for the four conditioning amplifiers.

2 A current range selection switch for the servovalve.

3 Phase adjustments for the AC amplifier demodulators.

4 A switch to permit user access to software calibration settings.

5. DC Excitation.



Note the calibration on/off switch must be activated (left) to permit calibration and returned to the right before refitting the security cover, with a calibration 'on' LED indicator.

2.6. Transducer Signal Conditioning

The K7500 provides 5 transducer channels, 4 of these include signal conditioning and all may be calibrated and distributed by software to configure the required control and monitoring systems. See CAL/CONFIG menus.

The K7500 signal conditioning comprise 2 A.C. and 2 D.C. amplifiers that operate as follows.

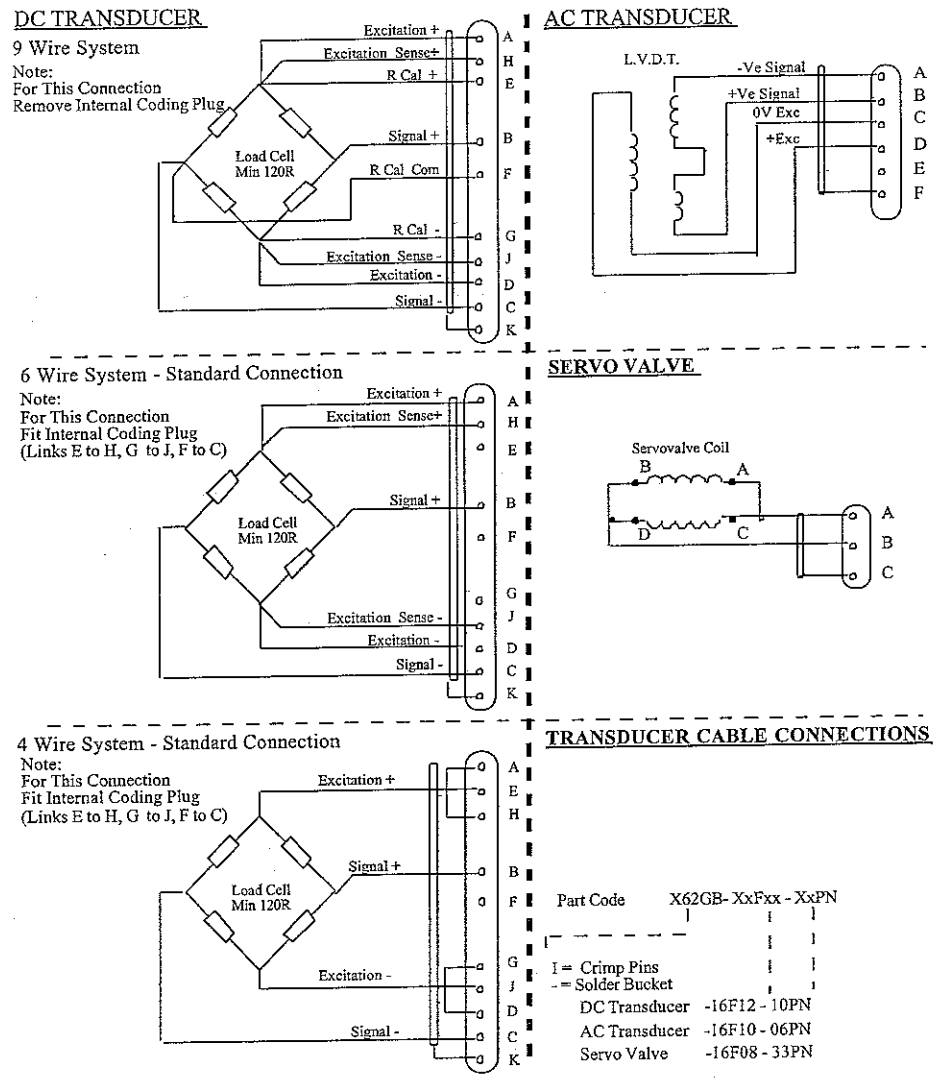
	TXA & TXB	**TXC & TXD**
Gain range (v/v)	1 to 1,000	0.5 to 20
Transducer Excitation	5 or 10 V	2.5 or 5 V @ 5 kHz

Minimum bridge impedance's down to 120R.

A direct input facility enables the connection of a transducer having signal conditioning external to the unit. The K7500 requires that the externally conditioned signal is externally compensated for scale and offset to provide 10V full scale

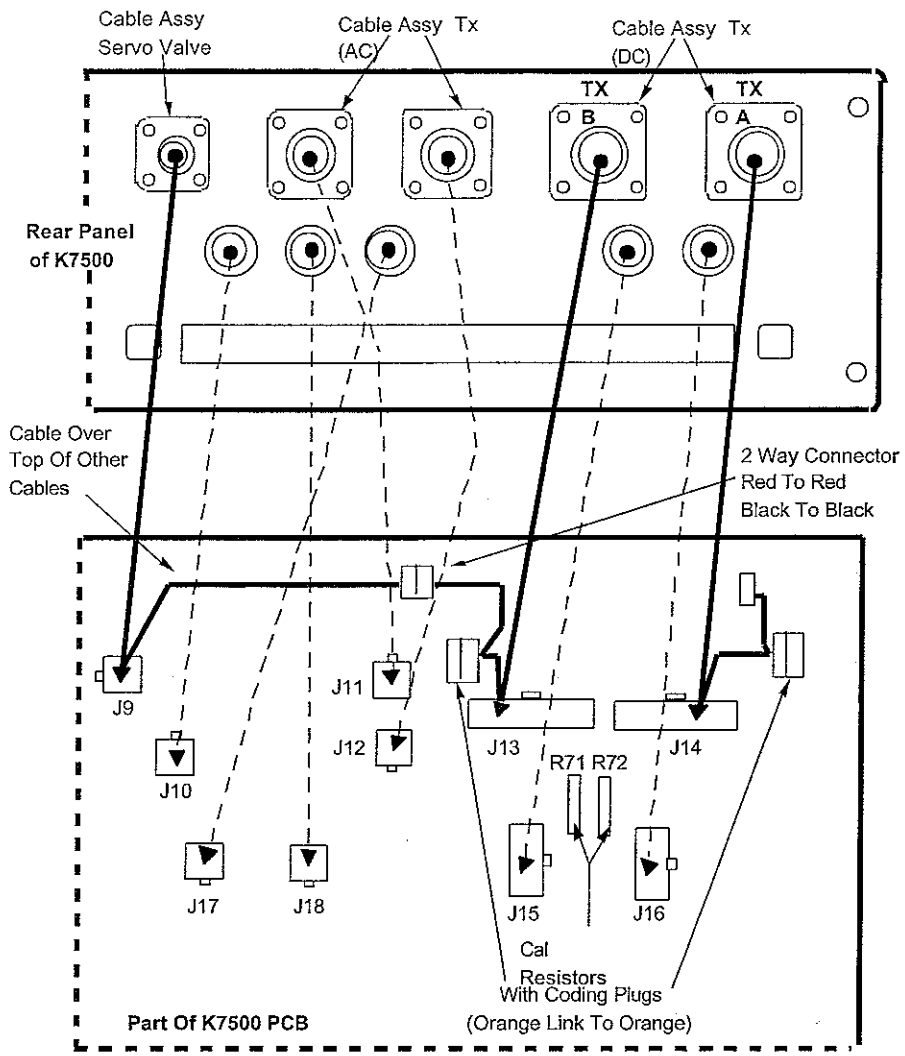
2.7. Transducer Connections

Connections to the transducers are made using MS bayonet connectors situated on the rear panel.



The function of the DC TRANSDUCER input is determined by an internal coding plug as follows:

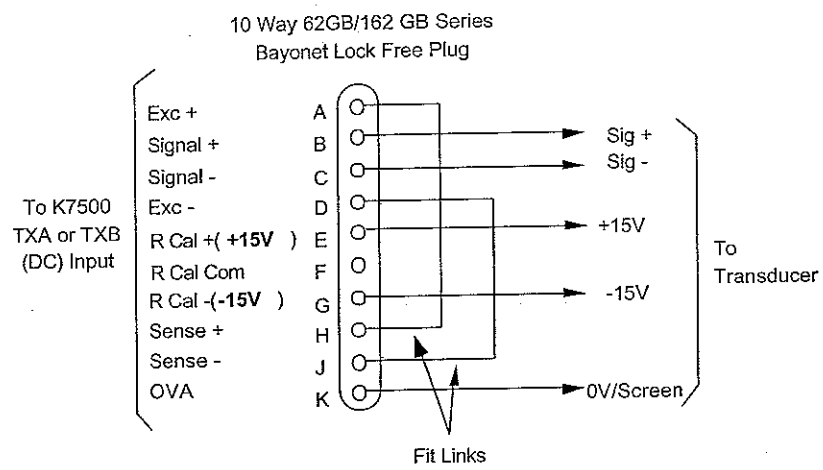
The diagram shows the internal cable assemblies and connections for the TXA and TXB inputs and indicates the standard arrangement for 4 & 6 wire load cell bridge configuration. For nine wire bridge configuration the coding plug should be removed.



The coding plug may also be used to provide a ± 15 volt excitation option.

This feature enables transducers that require ±15 volt power supply excitation to be connected to the existing rear panel 'TXA' or 'TXB' DC inputs.

For the feature to operate connections have to be reconfigured inside the K7500 which changes the function of 2 pins in the 'TXA' or 'TXB' inputs. Only one input may be reconfigured.



In the free plug, 2 links must be made for pins A to H, and D to J.

Pin E is +15V (It's previous function was R Cal+)

Pin G is -15V (It's previous function was R Cal -)

Pin K may be used as a 0V and/or cable screen

2.8. K7500 Reconfiguration

Access to the K7500 is via the base cover. Remove the base cover (4 screws) and remove the 2 screws that holds the hinged PSU in position.

With the PSU panel hinged upwards, access can be obtained for the cables from the 'TXA' or 'TXB' rear panel connectors.

The +/-15V is obtained from the servovalve connector J9, using a red/black flying lead. This connects to an equivalent red/black flying lead for either 'TXA' or 'TXB'. Connection must be made such that wire red is connected to red and the black wire to black.

For the input 'TX' selected the coding plug must be reversed such that the orange link is not opposite the orange wires (taken out, turned around and plugged back in).

For normal connections the orange link is opposite the orange wires.

2.9. Remote Inching Box

The remote button box provides actuator 'inching' with slow and fast speeds. This unit also

activates the 'zero' force displacement control mode. Note load limit is 2% F.S.

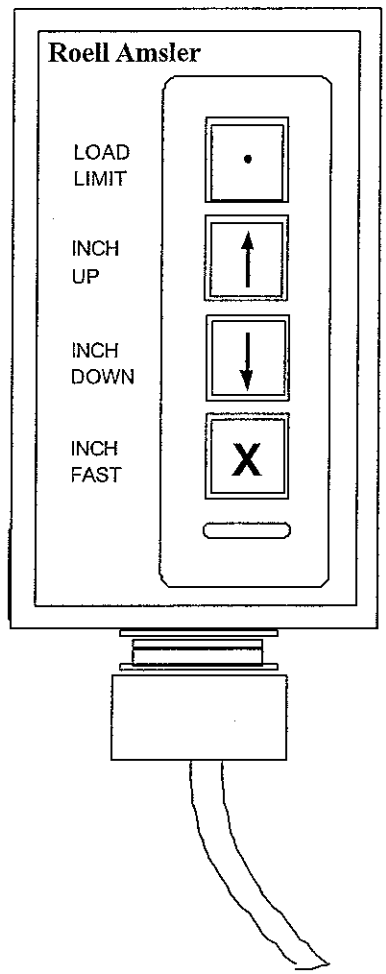
1 An 'up' button to smoothly increase the manual set point, provided the current control mode is displacement.

2 A 'down' button to smoothly decrease the manual set point, provided the current control mode is displacement.

3 A 'fast' button to increase the speed of manual set point adjustment.

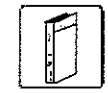
4 A 'load limit' button to toggle on and off the load limited displacement control feature.

5 A LED indicating the on/off state of the load limited displacement control mode feature.



2.10. Warning

If forced, the button box connectors can be plugged in upside down. Whilst this does not cause any particular problems it will inhibit the correct operation of this unit.



2.11. K7500 Test Control Remote Stop/Start Operation

A remote input can be used to operate the front panel Test Control 'Stop' and 'Start' pushbuttons. This takes the form of a single digital input connected in place of the remote keypad input.

When this input is asserted i.e. the contact is closed, the action of the controller is equivalent to pressing the front panel 'Start' pushbutton. When the input is released i.e. the contact opens, the action of the controller is equivalent to pressing the front panel 'stop' pushbutton.

Note:- The 'Stop' and 'Start' pushbuttons remain operational regardless of the state of the remote stop/start input i.e. if the 'stop' button is pressed whilst the remote input is asserted the stop condition will be true. To start the test again from the remote digital input it will first be necessary to release the external stop/start contact.

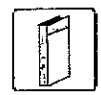
To enable the remote stop/start it is necessary to set the configuration as follows:-

Enter CAL/CONFIG menu
select PREFERENCES
select EXTERNAL TEST INP
select ENABLED

Connections for the remote stop/start input are as follows:
Rear panel Remote Keypad Connector (15 way high density 'D' connector - socket) connect remote contact between:-

Pin 1	+5V
Pin 6	remote stop/start

The keypad connector inputs are TTL level signals but a reed relay could be used to provide a contact closure across the above noted pins



3. HYDRAULIC CONTROL

3.1. General

This powerful hydraulic control section offers a wide range of control options for the Hydraulic Power Unit or the Line Conditioning Units. These are presented in a similar manner to a programmable logic controller (PLC) and are accessed by the top level menu CAL.

The hydraulic controls of the K7500 can be operated in one of three basic modes: Stand-alone, Master and Slaved. When operating stand-alone, the K7500 responds to its own hydraulic control buttons and sequences its own pressure loading circuits. As a master unit, its hydraulic control buttons will control each of the slaved pressure loading circuits. Slaved units will also interlock with other slaved units to ensure that a safe loading sequence is maintained for a multiple pressure selection system. Note that units that are slaved to a master unit will indicate that their hydraulic control buttons are unused by the illumination of the lower LED on the unload pressure button.

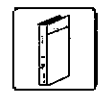
The number of pressure loading valves, service manifolds or line conditioning units (LCUs) will vary from test to test. At one extreme there may be as many pressure loading facilities as there are actuators, whilst at the other extreme one LCU may serve all actuators. The K7500 accommodates these variations by assuming that each K7500 unit has pressure loading controls which will interact with the master unit to provide the essential test system or group interlocks. For those channels actually without pressure loading facilities software switches are provided to inhibit operation of the local loading relays and provision made to interact with the interlocks. In the event where a channel has no hydraulic pressure loading hardware whatever, this channel will have no effect when obeying pressure load instructions other than to return the required acknowledgements.

3.2. Hydraulic Sequencing

The K7500 master unit controls the automatic hydraulic pressure sequencing, i.e. from pilot pressure (if used) to low or high pressure. It will inhibit the application of pressure for the following reasons:

1. The emergency stop contacts are open. Note: if this contact opens at any time after the achievement of pressure, all pressure loading is aborted.
2. A channel, master or slave may not be in the correct mode to apply pressure.
3. A limit may have been violated which activates an inhibit pressure loading action.

From the unloaded pressure condition the user may request low or high pressure at which time the master unit will instruct all slaved units to load their pilot pressure and those units that support pilot pressure will immediately close their pilot pressure request contacts. A timer is then started on the master and if all pilot pressure acknowledgements are not received before the time-out of this time limit, the master will abort pilot pressure loading by instructing all slaved units to open their pilot pressure request contacts and display a



warning message.

This scheme serves the different cases of pilot pressure options as follows:

1. Those units with no pilot pressure facility will not close contacts, but will immediately return pilot pressure acknowledgement so that pressure loading is not impeded.
2. Those units with a pilot pressure facility but no acknowledgement contacts will close contacts and immediately return pilot pressure acknowledgement. However, such units will be permitted the time limit (for settling purposes) before proceeding to main pressure.

3. Those units with a pilot facility and acknowledgement contacts will be subject to the time limit in which to receive a response from the external contacts.

Each of pilot, low and high pressure facilities have a separate menu to identify which of these options the unit supports.

Attainment of pilot pressure is indicated on each unit by an LED below the 'HIGH' pressure button.

A software switch exists on the master to permit the system to pause at the pilot pressure stage, i.e. not proceed immediately to main pressure. This condition is indicated by a message "PILOT WAITING". This option exists for the user who wishes to tune or exercise the pilot stages before proceeding to main pressure. When this facility is used, a second press of a pressure loading button is required to continue to main pressure.

Procedure to main pressure begins with an instruction from the master to load low or high pressure. It will not be possible to proceed to main pressure when a unit is performing inner loop tuning.

From the pilot pressure condition the user may request low pressure or high pressure, at which time the master instructs all units to load low or high pressure, and all units will immediately close their low or high pressure request contacts.

The user is permitted to change their mind at this point , i.e. proceeding to high pressure despite originally requesting low pressure in order to obtain pilot pressure.

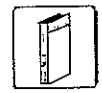
When low or high pressure request contacts are closed a timer is started on the master. The timer is permitted to run to the time limit before the master aborts main pressure loading, at which point the master will instruct all units to abort main and pilot pressures.

This scheme serves the different cases of main pressure options as follows:

1. Those units without acknowledgement contacts will close contacts and immediately return low or high pressure acknowledgement.
2. Those units with acknowledgement contacts will be subject to the time limit in which to receive a response from the external contacts.

Where a unit supports high pressure only, then it will respond equally to low pressure loading requests and high pressure loading requests and provide acknowledgements according to which is requested. This serves the situation where only certain channels have a low pressure facility.

Subsequently, the user can alternate between low and high pressure running by pressing the



low and high pressure buttons. On doing so, the master will immediately issue the new instruction and time the acknowledgement in the way described for initial loading.

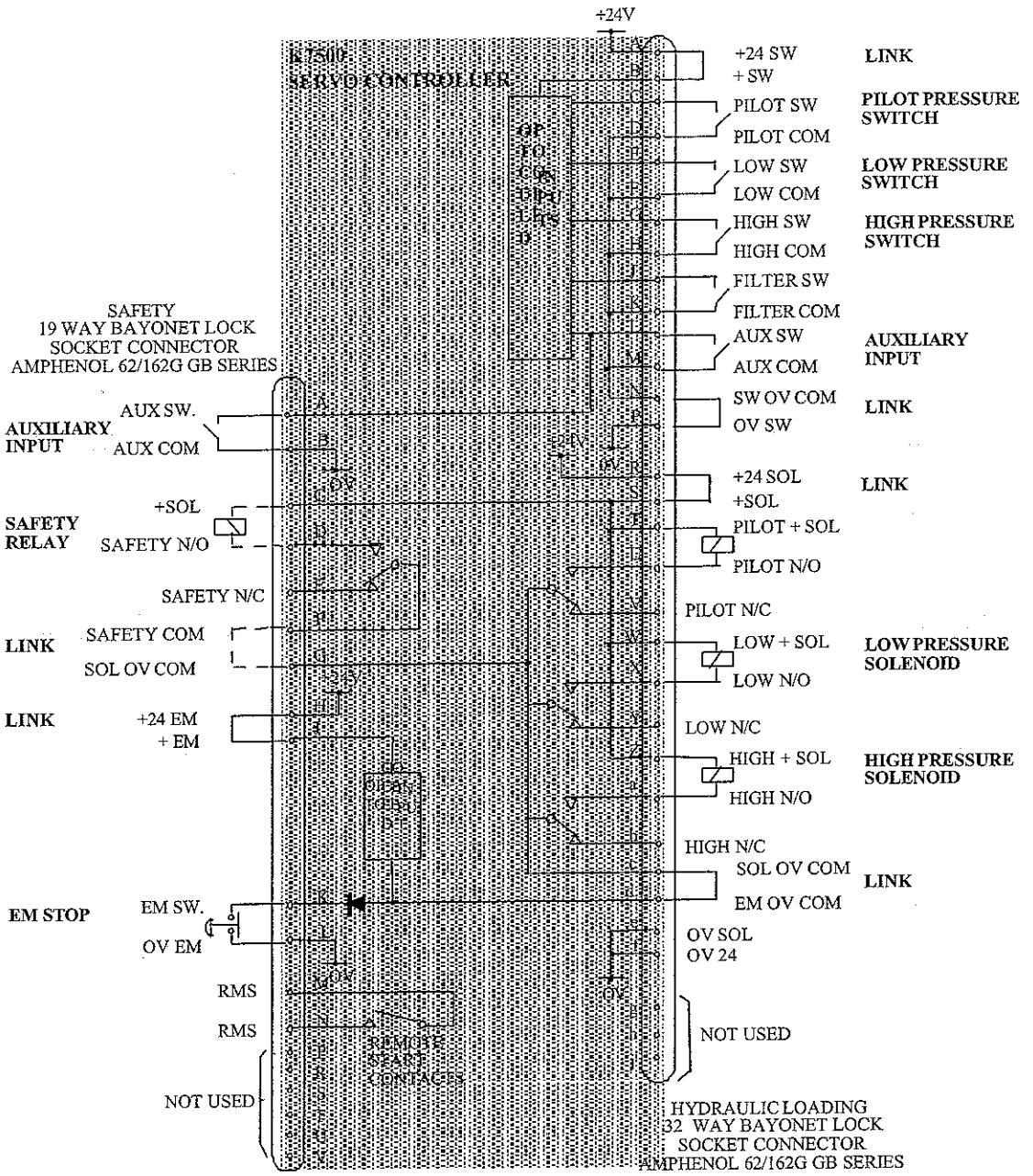
A software switch exists on each unit to permit different hydraulic solenoid valve combination to be used between low and high pressure.

Finally, the user can shut down hydraulic pressure at any time by pressing the 'UNLOAD' button (or by using the external emergency stop button) at which all pressure loading contacts are opened. After contacts are opened, main pressure acknowledgement contacts continue to be monitored to prevent activation of, for example, automatic set point tracking which could have dire consequences should there be any residual pressure.

A user specified dissipation time is combined with this interlock to guarantee a minimum time for pressure dissipation on those channels which do not have acknowledgement contacts.

3.3. Connection Of Hydraulic Interlocks

The figure below shows the pin connections of the Safety and Hydraulic connectors which provide for the connection of additional safety interlocks such as filter switches, etc. A typical arrangement is indicated, other external connections can be configured to suit a particular application. Please refer to notes on following page.

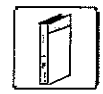


REMOTE START (REED RELAY) CONTACT RMS
RATED AT:-
MAX SWITCHED CURRENT 0.5A
MAX SWITCHED VOLTAGE 100V DC
MAX SWITCHED POWER 10W
CONTACT RESISTANCE 150 milli- Ohms

HYDRAULIC PRESSURE LOADING AND SAFETY CONTACTS
RATED AT:-
5A @ 110V ac/24V dc

3.4. System Installation Hydraulic Loading Connector

The input and output connections of the hydraulic loading connector can be considered in two parts as follows:



3.4.1. INPUTS

All the inputs to the K7500 from external (volt free) contacts are via opto-couplers which will also provide complete galvanic isolation. For normal operation the internal 24v DC power supply is used by linking pins A to C for +24v and pins N to P for 0v; the common return from the contacts.

The inputs will accept a wide range of input voltages from 5 to 50v and are suitable for crude DC, i.e. full wave rectified 24v AC. For normal 24v operation the K7500 provides a contact wetting current of approx. 10ma. Although the inputs are polarity sensitive no harm will be done if reversed polarity is mistakenly connected, from say a common external 24v supply which is being used because of other requirements for the complete control system.

3.4.2. OUTPUTS

All the outputs take the form of volt free change over relay contacts. When using the internal 24v PSU link R to S for +24 and either c to d (for connection via an external Emergency Stop) or c to e for 0v . Up to three 1 Amp hydraulic pressure solenoid valves may be connected, however if only one is used this may be rated for up to 3 Amps. All external solenoids must have back emf diodes fitted.

If the system configuration (i.e. some multi-channel test applications) is such that an external power supply is used then the above ratings still apply.

It is not recommended to directly switch 110v AC solenoid valves, a slave relay should be fitted.

3.5. Safety Connector

This connector provides:

1. A repeat of the Auxiliary input external contact
2. The K7500 safety relay is deenergised if the any of the following limits occur:

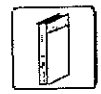
   Servovalve continuity failure

   Emergency stop

   TxA or TxB excitation failure

   KiNet failure

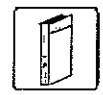
Note that it takes 28 seconds for the controller to energise the fault relay following removal of the limit condition. The safety relay output is a volt free change over contact (rated at 3 Amps) but it may be connected via links F to G to operate a hydraulic solenoid connected between pins C and D



3. Emergency Stop input: Link pin F to G (for +24) with the external emergency stop connected to pins K and L. The isolation diode indicated enables a number of K7500's to be connected together for a multi-channel test with one common emergency stop push button. In this case all the pin K's and then all the pin L's are connected together to the emergency stop.

3.6. Remote Start Contact (RMS)

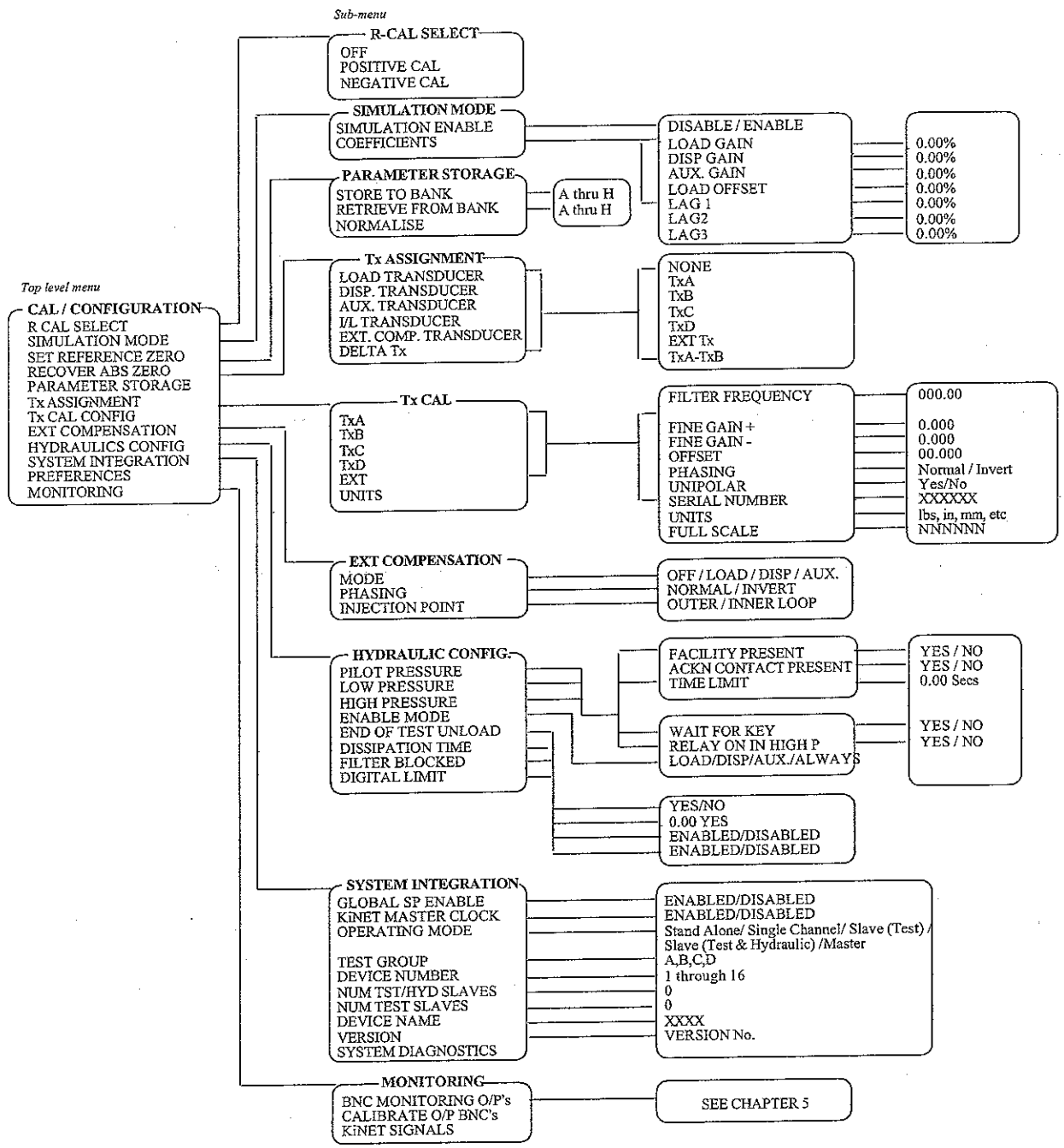
The remote start relay is intended for handshake control when the K7500 is running an external command test. The K7500 is intended to be used for test start and stop. The K7500 therefore energises the remote start relay when the static fader has completed and the dynamic fader begins. The relay is de energised when the dynamic fader completes. The external device can therefore be switched on to provide the dynamic command signal and then off upon test completion. The internal reed relay connecting the external command has volt free normally open contacts.



4. SYSTEM CONFIGURATION AND TRANSDUCER CALIBRATION

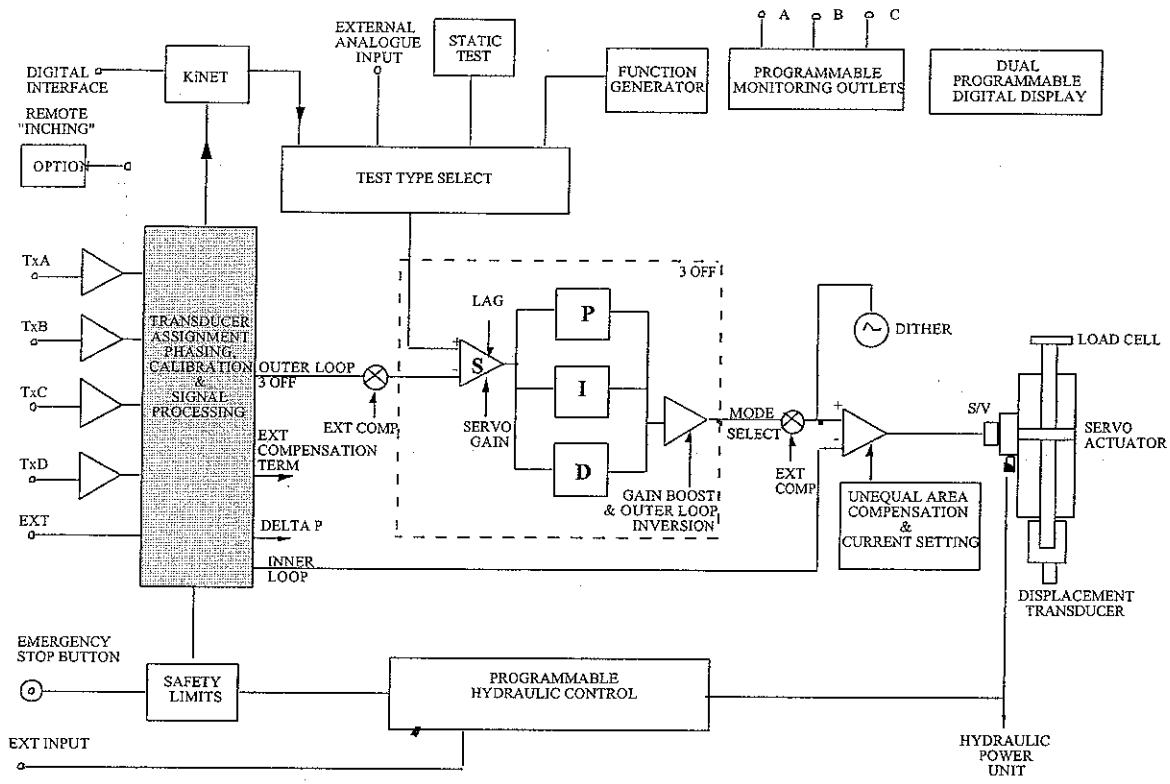
The servocontroller hardware may be software configured for a wide variety of control applications using the top level menu CAL/CONfig. This menu enables the transducer conditioning amplifiers to be assigned to the control systems, calibrated in engineering units and allocated a serial number.

The CAL/CONfig. menu also contains the necessary configuration files for hydraulic control and the master/slave grouping for multi-channel operation.


Top level menu
CAL / CONFIGURATION
R CAL SELECT
SIMULATION MODE
SET REFERENCE ZERO
RECOVER ABS ZERO
PARAMETER STORAGE
Tx ASSIGNMENT
Tx CAL CONFIG
EXT COMPENSATION
HYDRAULICS CONFIG
SYSTEM INTEGRATION
PREFERENCES
MONITORING
Sub-menu
R-CAL SELECT
OFF
POSITIVE CAL
NEGATIVE CAL
SIMULATION MODE
SIMULATION ENABLE
COEFFICIENTS
DISABLE / ENABLE
LOAD GAIN
DISP GAIN
AUX. GAIN
LOAD OFFSET
LAG 1
LAG2
LAG3
0.00%
0.00%
0.00%
0.00%
0.00%
0.00%
0.00%
PARAMETER STORAGE
STORE TO BANK
RETRIEVE FROM BANK
NORMALISE
A thru H
A thru H
Tx ASSIGNMENT
LOAD TRANSDUCER
DISP. TRANSDUCER
AUX. TRANSDUCER
I/L TRANSDUCER
EXT. COMP. TRANSDUCER
DELTA Tx
NONE
TxA
TxB
TxC
TxD
EXT Tx
TxA-TxB
Tx CAL
TxA
TxB
TxC
TxD
EXT
UNITS
FILTER FREQUENCY
FINE GAIN +
FINE GAIN -
OFFSET
PHASING
UNIPOLAR
SERIAL NUMBER
UNITS
FULL SCALE
000.00
0.000
0.000
00.000
Normal / Invert
Yes/No
XXXXXX
lbs, in, mm, etc
NNNNNN
EXT COMPENSATION
MODE
PHASING
INJECTION POINT
OFF / LOAD / DISP / AUX.
NORMAL / INVERT
OUTER / INNER LOOP
HYDRAULIC CONFIG.
PILOT PRESSURE
LOW PRESSURE
HIGH PRESSURE
ENABLE MODE
END OF TEST UNLOAD
DISSIPATION TIME
FILTER BLOCKED
DIGITAL LIMIT
FACILITY PRESENT
ACKN CONTACT PRESENT
TIME LIMIT
WAIT FOR KEY
RELAY ON IN HIGH P
LOAD/DISP/AUX./ALWAYS
YES / NO
YES / NO
0.00 Secs
YES / NO
YES / NO
YES/NO
0.00 YES
ENABLED/DISABLED
ENABLED/DISABLED
SYSTEM INTEGRATION
GLOBAL SP ENABLE
KiNET MASTER CLOCK
OPERATING MODE
TEST GROUP
DEVICE NUMBER
NUM TST/HYD SLAVES
NUM TEST SLAVES
DEVICE NAME
VERSION
SYSTEM DIAGNOSTICS
ENABLED/DISABLED
ENABLED/DISABLED
Stand Alone/ Single Channel/ Slave (Test) /
Slave (Test & Hydraulic) /Master
A,B,C,D
1 through 16
0
0
XXXX
VERSION No.
MONITORING
BNC MONITORING O/P's
CALIBRATE O/P BNC's
KiNET SIGNALS
SEE CHAPTER 5

4.1. Diagrammatic Representation Of Servocontroller

The diagram below shows the configuration flexibility in the assignment and distribution of transducer signals within the Servocontroller.



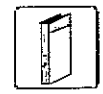
4.2. Feed forward Loop Compensation

Control over the loop assignment and phase of each transducer input, permits special loop compensation such as feedforward.

4.3. Transducer Assignment

A flexible scheme provides for the assignment of transducers to control modes and other points of connection within the control loop.

The K7500 has conditioning amplifiers for two AC and two DC transducers. Additionally, it has provision for attachment of external signal conditioning in the form of a BNC connector. Assignment of these to the various control modes is made totally flexible by the use of software switches in a 'CAL/CONfig' sub menu. Transducer roles are labelled as follows:



1. The load control transducer.
2. The displacement control transducer.
3. The auxiliary control transducer.
4. The inner loop transducer.
5. The external compensation transducer
6. The delta p transducer (for inner loop compensation only)

The assignable options are:

1 NONE
2 TxA
3 TxB
4 TxC
5 TxD
6 EXT

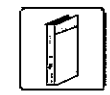
} **(D.C. Transducers)**

} **(A.C. Transducers)**

7 TxA-TxB - (D.C. Transducers)

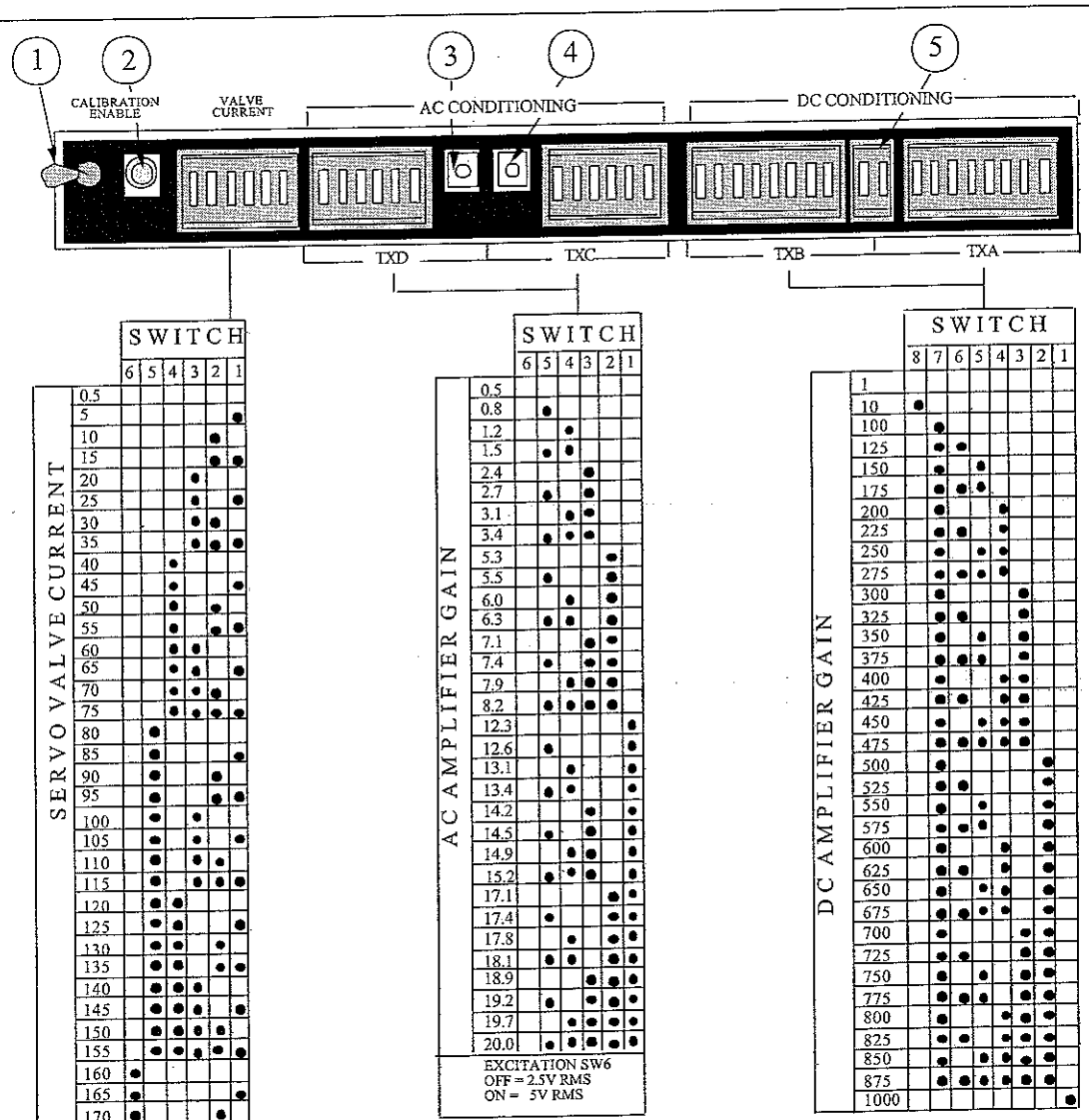
The ' TXA-TXB' option 7 permits control modes or monitoring functions based on the difference of two signals, e.g. differential pressure.

The assignment of transducers to physical amplifiers is used extensively in the K7500 and not just for deciding the source of controller signals. For example, the assignment of the inner loop transducer to 'NONE' is taken as an indication that there is no inner loop facility. This has the effect of disabling the inner loop summing junction and compensation terms.

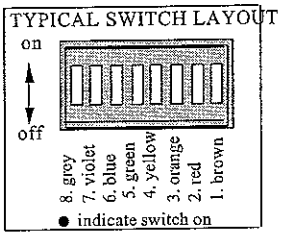


4.4. Coarse Gain Settings

The K7500 has four transducer amplifier coarse gain settings. These are found beneath the calibration panel located on the rear of the unit. Once the detachable panel has been removed the CALIBRATION ENABLE switch should be pushed to permit transducer (and servovalve) gain settings to be made see below.



TYPICAL SWITCH LAYOUT



Key

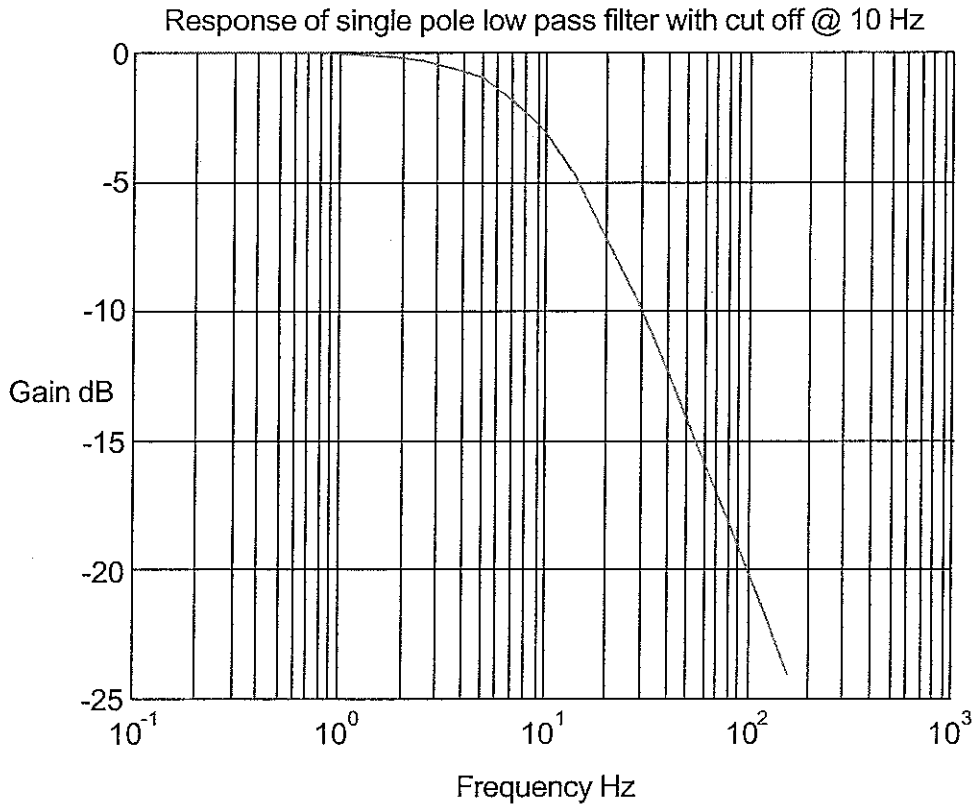
1. Calibration on/off switch
2. Calibration 'on' led indicator
3. TXD input phase control
4. TXC input phase control
5. DC excitation off = 10v on = 5v
   TXA input - switch 1 (brown)
   TXB input - switch 2 (red)

4.5. Programmable Transducer Signal Processing

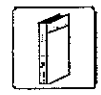
The following programmable terms are provided to condition transducer signals prior to their use in control and monitoring:

1. Low pass filter (single pole)

   The filter is set in %, with the actual filter frequency (Hz) displayed is the 3 dB breakpoint displayed underneath. When 100.00% is set the filter is off, the first breakpoint setting available is for 99.99% is approximately equal to 3,000 Hz. Settings below 0.33% are approximately equal to 1 Hz are not normally recommended.



The filter frequency (Hz) displayed is the 3 dB break point of a simple first order filter. It will affect the amplitude of signals at frequencies below that set. To avoid this effect, the filter setting should be an order of magnitude above the test frequency. For example, if your maximum test frequency is 10 Hz, the filter should be set to 100 Hz or higher to avoid attenuation of higher frequencies in test. The figure above shows the frequency response of a single pole low pass filter with 3 dB point at 10 Hz in the band 0-200 Hz. The effects of filter roll-off can be seen clearly from 1 Hz.



2. Fine gain adjustment (positive and negative).

   This pair of gain terms compensate for gain errors in the conditioning amplifier and transducer by providing independent gain settings for positive and negative signals.

3. Offset compensation.

   The offset control compensates for small offsets in the transducer & conditioning amplifier.

4. Phasing switch.

   The transducer signal can be used directly or inverted. Default (Std.) Tension = +VE.

5. Unipolar switch.

   This switch enables transducer signals constrained to the range 0 to +10V to be expanded to +/-10V in software.

6. User set transducer serial number.

   This is a text of up to 16 characters. The K7500 makes no use of this number but retains it in non-volatile storage for verification purpose later.

7. User set engineering units.

   Up to 8 characters.

8. User set full scale (in the engineering units).

The user accesses these parameters through a 'transducer CAL/CONfig' option in a sub menu of CAL/CONfig.

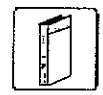
The fine gain facility performs an equivalent function to the span control on traditional analogue signal conditioners. Most of the gain required for each transducer is provided by instrumentation amplifiers whose gains are programmed by course gain switches, accessible from the rear panel of the K7500. These have fairly coarse settings and additional fine gain must be provided which brings the total gain up to that required.

The fine gains are also responsible for compensating for gain tolerances in both the transducers and the amplifiers.

The fine gain control ranges between 0.732 and 1.221 with increments of 0.0001

NOTE: The external input must provide 10V full scale.

Access to the fine gain compensations is through a sub menu of the 'CAL/CONfig' option



and is subject to the calibration state as determined by the software calibration protection switch, accessible from the rear panel. By use of this switch, the fine gains can be protected for normal day to day running.

4.6. Transducer Offset

The offset compensation has a range of +/-100.000% with increments of 0.005%, i.e. a full scale offset can be nulled. If the offset compensation exceeds +10% however, the K7500 cannot guarantee to resolve the entire range. For example, a +25% offset might only allow feedbacks in the range -110% to +95%. This is very important and a warning is given to the user whenever large offset compensation (>10%) are being used.

4.7. Engineering Units and Scale

The K7500 supports the use of engineering units for transducer signals. The user can set:

1. A textual string for the units (e.g. 'kN'). The user can also, if required, load anything into this string. A number of common units can be quickly loaded by straightforward menu selection.
2. A number representing the full scale in the chosen units, i.e. what does 10V represent? This number is restricted to the range 1..20000, a choice based on the resolution of the display monitors (a scale setting of 10 is used for volts)

   Should this range be inadequate for a given application, the user has the option of embedding multipliers in the units string e.g. a full scale of 40000 lbs can be entered thus:

   i Units string: "X1000 lbs'

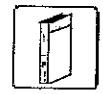
   ii Scale: 40

The pre-selected choice of common engineering units are:

1. V
2. %
3. kN
4. m
5. mm
6. in
7. lb(f)
8. m/s
9 Nm
10. g

The scale and units, once defined for a transducer, are broadcast around the instrument so that they can be used for all relevant parameter adjustments, thus:

1. Display monitors for relevant command, feedback and error.
2. Manual set point.
3. Associated transducer limits.
4. Error limits (for associated control mode).
4. Test wave form specification, e.g. target levels, peaks, etc.



4.8. R-CAL Facility

For the purpose of DC amplifier calibration and for checking for drift, relays are included in the K7500 which can apply calibration resistors to either arm of the DC bridges. Access to this facility is through a software switch in a sub menu of CAL/CONfig. and the following options are supported:

1. OFF	The relays are off and no calibration resistors are applied.
2. POSITIVE CAL	The relays apply the calibration resistors to cause positive deflection of the DC transducer signals.
3. NEGATIVE CAL	The relays apply the calibration resistors to apply negative deflection of the DC transducer signals.

Note that the roles of POSITIVE and NEGATIVE will be reversed if a transducer has its phasing switch in the INVERT position.

Factory fitted high precision resistors of RC55 0.1% 15ppm 100k (Welwyn) are fitted on headers at locations R71 and R72

The R-CAL facility is interlocked with the hydraulics to prevent its use while hydraulic pressure is on:

1 The R-CAL facility is disabled if pilot or main pressure has been requested or attained.

2 Pressure loading is inhibited if the R-CAL facility is enabled.

Note that once activated, the user may leave the appropriate sub menu for R-CAL and access any other K7500 parameter, including transducer fine gains. The calibration relays will remain energised until the user alters the R-CAL software switch and the user can immediately discern the R-CAL condition by the state of the display monitors.

Any attempt to load pressure while a unit is in the R-CAL condition will cause a bleep and a message. The user has simply to disable R-CAL at which pressure loading will again be possible and the displays will revert to their normal functions.

4.9. Simulation Mode

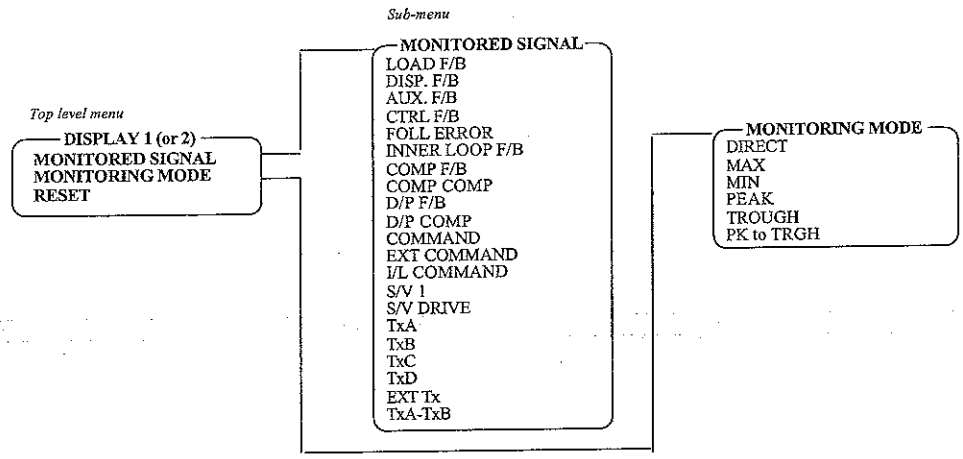
When in this mode the transducer signals, along with the servovalve drive signal, are routed to a system model (actual valve current is forced to zero). This simple model will emulate a sprung mass, providing appropriate load, displacement and strain (auxiliary) feedbacks in response to 'valve currents'.

This feature allows the user to learn about K7500 operation without the risk of specimen damage and without tying up expensive hydraulic testing equipment.

5. DISPLAY MONITOR

5.1. General Description

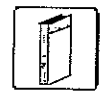
The left and central areas of the Display Monitor are dedicated to the display of system parameter values. They are accessed by the top level menus DISPLAY 1 and DISPLAY 2.



5.2. Monitored Signal Selection

The K7500 display areas are designated 'Display 1' and 'Display 2', each display can be programmed to monitor one of the following controller signals:

1.LOAD F/B	Load feedback signal.
2. DISP F/B	Displacement feedback signal.
3. AUX F/B	Auxiliary feedback signal.
4. CTRL F/B	Control feedback signal
5. FOLL ERROR	Following error for the current control mode.
6. INNER LOOP F/B	Inner loop transducer signal.
7. COMP F/B	External compensation feedback signal.
8. COMP COMP	External compensation compensated feedback signal
9. D/P F/B	Delta - P feedback signal
10. D/P COMP	Delta - P compensated feedback signal
11. COMMAND	The composite controller command.
12. EXT COMMAND	Input applied to BNC connector B.



13. I/L COMMAND	Inner loop command
14. S/V I	Servovalve current
15. S/V DRIVE	Servovalve drive signal.
16. TxA	Output of TxA signal conditioning amplifier.
17. TxB	Output of TxB signal conditioning amplifier.
18. TxC	Output of TxC signal conditioning amplifier.
19. TxD	Output of TxD signal conditioning amplifier.
20. EXT TX	The external transducer signal applied to BNC connector A.
21. TxA-TxB	Output of TxA less output of TxB signal conditioning amplifiers.

5.3. Monitoring Mode

The method of signal monitoring can also be programmed:

1. DIRECT	This mode indicates the instantaneous value of a signal.
2. MIN	This mode records the lowest observed value of a signal. A reset instruction is required to arm for a new minimum measurement.
3. MAX	This mode records the highest observed value of a signal. A reset instruction is required to arm for a new maximum measurement.
4. PEAK	This mode indicates the latest peak measurement and (unlike 'MAXIMUM') is refreshed on detection of a new peak. Thus the user has a continuous indication of the peak value of a cyclic signal.
5. TROUGH (-Ve PEAK)	This mode indicates the latest trough measurement and (unlike 'MINIMUM') is refreshed on detection of a new trough. Thus the user has a continuous indication of the trough value of a cyclic signal.
6. PEAK TO TROUGH	This mode simply indicates the difference between peak and trough so that the entire peak to trough amplitude of a signal can be displayed.

Note that the PEAK, TROUGH, and PEAK TO TROUGH readings will only be updated if the cycle counter is set up so that cycles are being counted. Also, these numbers are not updated while the signal is fading in or out.

While samples of each indicated value are made available at a sample rate of 2048/s, the displays are actually updated only four times per second. On each update, the displayed value is obtained from an integration of the preceding update period i.e. the mean of some 512 samples taken over the last 250 millisec. This serves to attenuate noise on static

signals and to display at a user friendly rate.

5.4. Display Resolution And Autoranging

The displays are 5 digit with floating decimal point such that the range 0.00001..99999 can be displayed. The scale and units for a displayed signal are automatically set by the transducer assignments, and thereby the signal is presented in engineering units (in the case of valve current, the scale is assumed to be 100 %).

The displays autorange in centuries rather than decades to meet the following criteria for displayed signals:

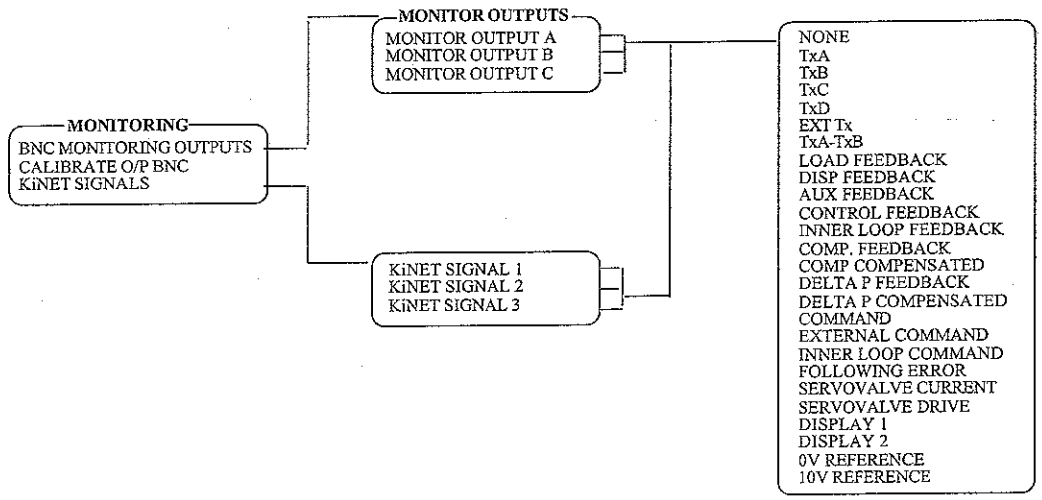
1. On all scales, a decade of over range is available.
2. On all scales, a resolution of one part in one thousand is always present, even on signals representing 1% of the full scale (the worst case being for a full scale of 1.0).
3. Autoranging never occurs on the full scale value.

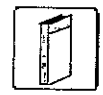
These criteria are necessary for conformance to traceable standards for load calibration.

The autoranging feature includes a delay which prevents rapid 'hunting' when the display is showing a reading close to one of the autorange points. The displayed value must have stayed below an autorange point for at least one second before the 'sensitivity' is increased.

5.5. Analogue Monitor Outputs

The K7500 has three output BNCs for the use of external equipment. These BNCs are accessed through the CAL/CONfiguration top level menu as shown below:





5.6. Kinet Monitor Outputs

There are three Kinet time slots reserved per channel for transmitting monitoring signals for digital monitoring. These signals are set using the CAL/CONFIG top level menu as displayed above

5.7. Display Contrast Control

The user may adjust the display contrast while in status menus by pressing the 'SELECT' key and turning the rotary encoder. This method of access ensures that contrast adjustment is possible even when the display is unreadable.

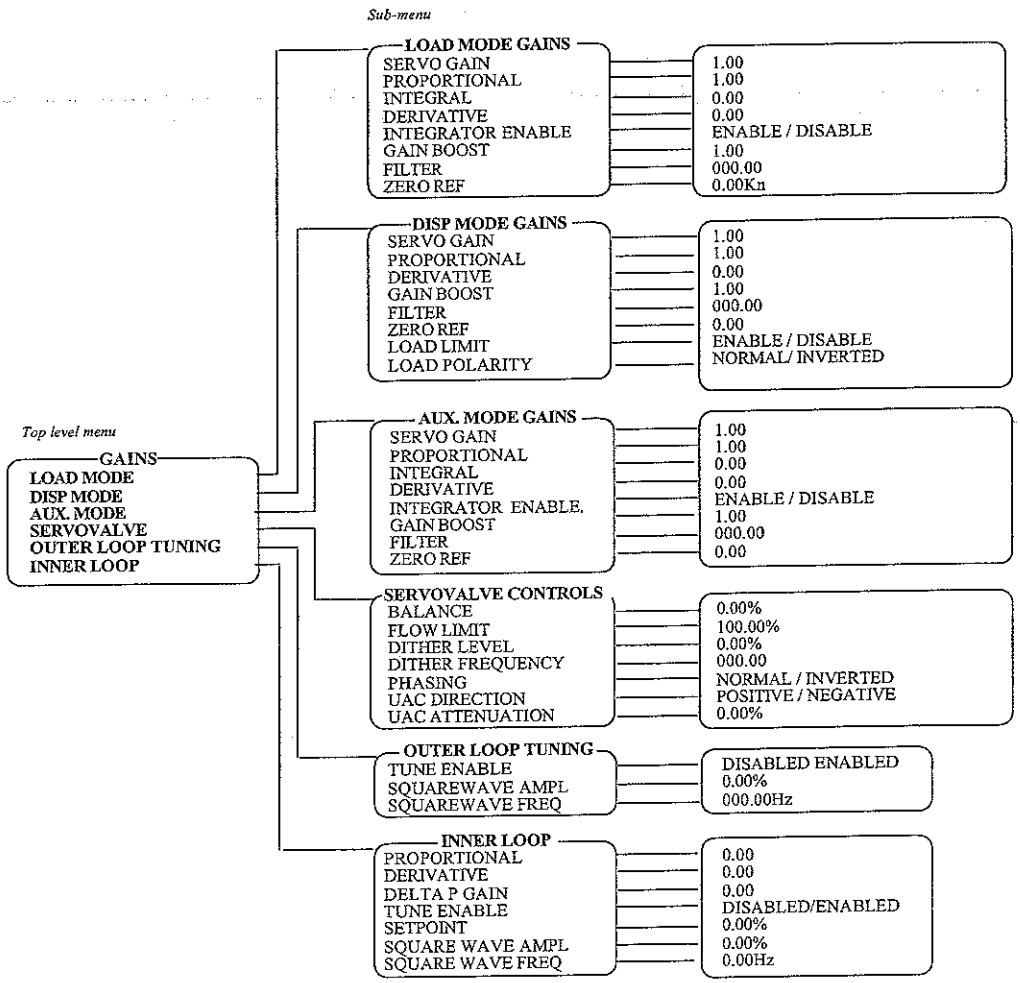
6. SERVO LOOP GAIN TUNING

6.1. Outer Loop (Control Variable)

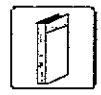
The K7500 outer control loop compares the command signal to the selected feedback and produces a 'following error' signal which is used to drive the servovalve for optimum control of the closed loop variable. The command is a combination of manual set point, mean level and dynamic signals while the feedback is obtained from one of the three mode transducers channels LOAD, DISP or AUX.

The following error signal simultaneously drives an outer loop PID compensator and a limit detector. The latter enables the user to program an action should the error become unacceptable.

The servo loop gain tuning is presented under the following top level menus and sub menus:



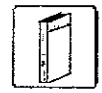
The compensator for the outer loop has the following terms:



PROPORTIONAL	This term produces servovalve signals directly proportional to the instantaneous error. The constant of proportionality - 'Proportional Gain' - may be adjusted between 0.01 to 16.00 with increments of 0.01
INTEGRAL ('RESET')	This term produces servovalve currents which escalate in the presence of continuous error and serves to remove static errors and reduce following errors. The term may be set between 0.00 and 128.00 with increments of 0.01, a setting of 0.00 is off.
DERIVATIVE ('rate')	This term produces servovalve currents which are proportional to the instantaneous rate of change of error. Derivative is useful for improving responsiveness of the control loop. This term may be set between 0.00 and 8.00 with increments of 0.01, a setting of 0.00 is off.
SERVO GAIN	There is a fourth 'servo gain' adjustment in connection with PID which permits gain adjustments to the error path without disturbing the respective ratios of P, I and D. This is useful where previous tuning has established the ratio of P, I and D, and where minor adjustments (e.g. to reduce overshoot) only necessitate a small collective reduction in gain. Gain adjustment is from 0.01 to 32.00 with increments of 0.01. With proportional and servo gain both set to unity '1' the forward path gain is also unity. This means that a 100% or 10V following error will result in 100% servovalve signal, the servovalve will be fully open. The forward path gain is proportional gain times servo gain. As an example, a proportional gain of 2.5 and a servo gain of 2 results in a forward path gain of 5 so that a following error of 20% will be required for a 100% servovalve signal. Settings of less than 1 means attenuation.
LAG TERM	Prior to the PID network is an adjustable low pass filter which emulates an analogue lag network. This filter has user adjustable roll-off with the same response as the transducer (Tx) filter. Straightforward gain for this filter is already provided by the servo gain term so that a gain control is not required.
SELF TUNE	Although the user has direct access to the above terms for the purpose of manual tuning, a self-tuning feature is also included, which adjusts these terms automatically.
GAIN BOOST	A compensation facility exists which enables the error path gain to be lifted, under dynamic conditions, to overcome the fall-off in response, that results from high demands for oil flow. The gain profile is derived from the absolute command derivative, suitably filtered to provide a direction independent indication of command velocity.

The 'absolute command velocity' signal is used to modulate error path gains by controlling a gain element that scales the proportional gain thus:

1. Under static conditions, the gain element has unity gain resulting in no change to the



proportional gain.

2. Under dynamic conditions, the gain element increases in gain, in response to the absolute command velocity signal, and in proportion to a 'Gain Boost' setting to be found in the GAINS sub menus. This causes a transient increase of the proportional gain. The setting may be adjusted from 1.000 to 17.000 with increments of 0.001, the default is 1.000 for off.

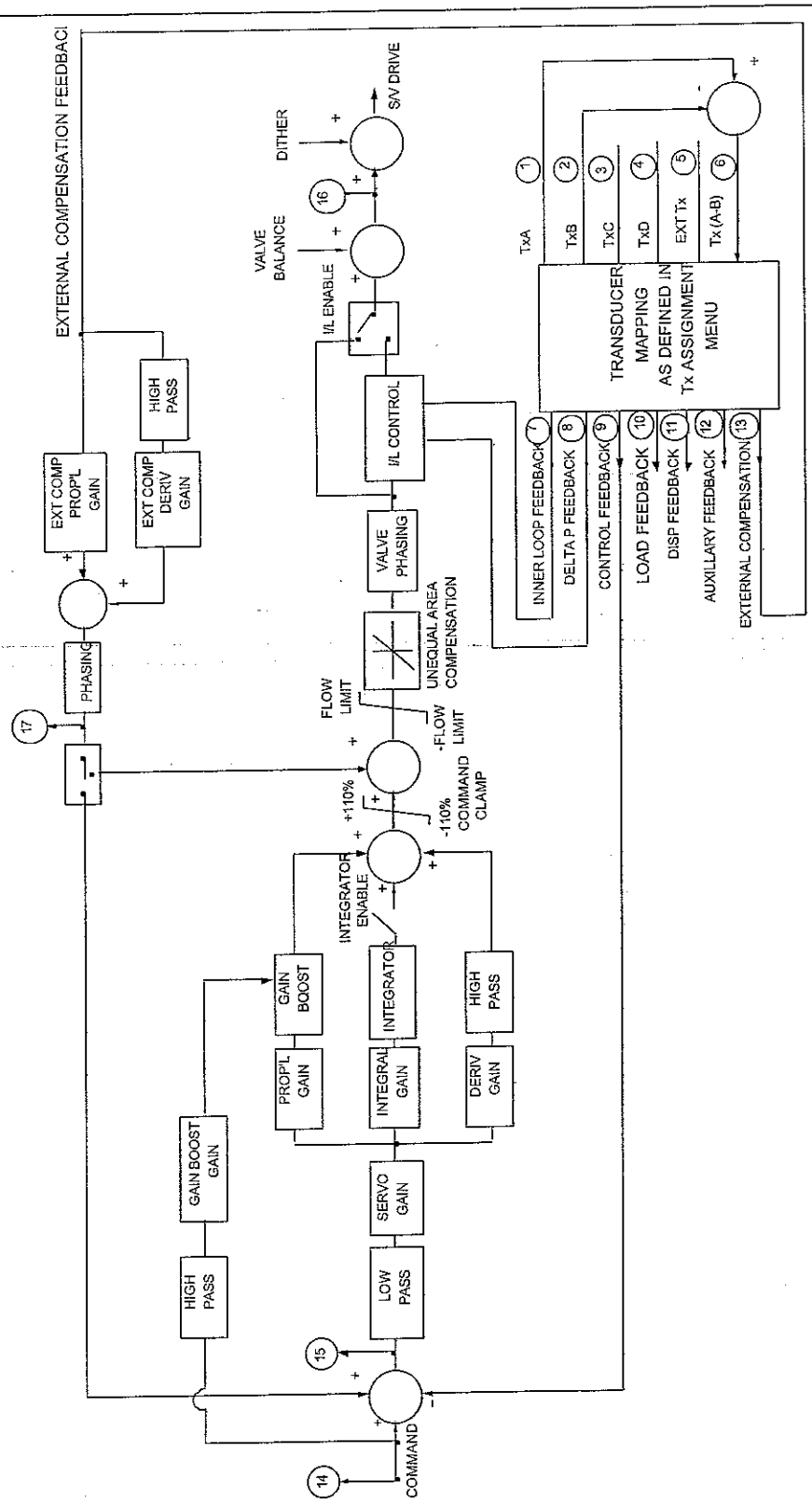
Each control mode has independent gain boost settings.

This facility has the attractiveness of providing high gain when servo action is most critical, i.e. "on the fly" while ensuring a return to safe, low gains when the system comes to rest again.

Note: Because integrators are inclined to 'run out' when feedback loops are broken, an enable signal is generated to restrain the outer loop integrator whenever run out is likely to occur. The enable signal is indicated by the lower LED on the INTEGRAL button.

1. The integrator must be enabled for the particular control mode in question. A menu for making this selection is to be found amongst the gain settings for each control mode.
2. The global integrator switch (front panel button, possibly on a master K7500) must have been enabled by the user.
3. Flow limit must not be enabled.
4. Low pressure or high pressure must have been acknowledged (i.e. not simply requested).

6.2. K7500 Control Loop Schematic


EXTERNAL COMPENSATION FEEDBACK
EXT COMP PROP'L GAIN
HIGH PASS
EXT COMP DERIV GAIN
PHASING
17
DITHER
S/V DRIVE
16
VALVE BALANCE
I/L ENABLE
I/L CONTROL
VALVE PHASING
UNEQUAL AREA COMPENSATION
FLOW LIMIT
-FLOW LIMIT
+110%
-110%
COMMAND CLAMP
INTEGRATOR ENABLE
GAIN BOOST
INTEGRATOR
HIGH PASS
PROP'L GAIN
INTEGRAL GAIN
DERIV GAIN
GAIN BOOST GAIN
SERVO GAIN
HIGH PASS
LOW PASS
15
14
COMMAND
TxA
TxB
TxC
TxD
EXT Tx
Tx (A-B)
TRANSDUCER MAPPING AS DEFINED IN Tx ASSIGNMENT MENU
INNER LOOP FEEDBACK
DELTA P FEEDBACK
CONTROL FEEDBACK
LOAD FEEDBACK
DISP FEEDBACK
AUXILLARY FEEDBACK
EXTERNAL COMPENSATION

6.3. Outer Loop Self-Tuning

The K7500 includes a self-tune algorithm for automatic outer loop tuning. The tuning is based on 'model reference' adaptive control and involves the application of a low amplitude square wave as the outer loop command. The user is required to specify a number of parameters:

1. The amplitude of square wave commands for the purpose of exciting the control system. The square wave is superimposed on the current manual set point.
2. The frequency of the square wave.

The user is required to determine suitable square wave amplitude and frequency. This setting is a trade off between applied load and extended tuning time as a result of low amplitude signals.

Outer loop tuning is available to the user under the following conditions:

1. Main hydraulic pressure is achieved (high or low pressure).
2. No test waveforms are in progress.
3. The user has entered the outer loop self tuning sub menu of GAINS top level adjustment option.
4. Flow Limit is turned on.
5. Control loop does not use external compensation.
6. Gain boost will be automatically set to zero.

Once permitted, there are two effects:

1. Test starting is inhibited.
2. The START, STOP and PAUSE buttons change their purpose to become controls for the application of the self tuning square wave.

Note: 1. The self tuning square wave generator is entirely separate from the test function generator. This enables the tuning algorithm to control the application of the exciting edges but, more importantly, avoids alteration to the test program.

2. Upon completion (successful or otherwise) the self tuning process will automatically disable the self tune process. Therefore, to repeat self tune it is necessary to re-enable it.

6.4. Inner Loop

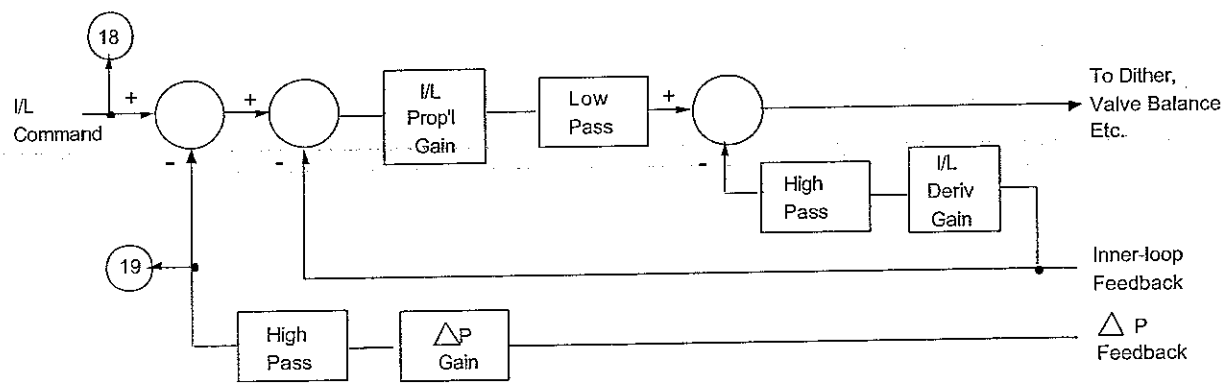
The K7500 has an optional inner loop for control of spool displacement on high flow three stage servovalves (or 2 stage valves with electrical feedback). The presence of an inner loop is determined by assignment of the inner loop transducer in the transducer assignments sub menu of CAL/CONfig. When used, a two level (cascade) control system is implemented whereby signals from the outer loop compensator (PID) are used to command spool displacements in the inner loop.

If no inner loop transducer is assigned ('NONE'), then the outer loop drives the servovalve directly. If an inner loop transducer is assigned, however, then an inner loop error signal is formed from the difference of the inner loop command (provided by the outer loop PID terms) and the inner loop feedback signal. There are two gains available for setting up the inner loop as shown in the inner loop control schematic on the following page.

Inner Loop proportional gain may be adjusted from 0.00 to 32.00 in increments of 0.01, and derivative from 0.00 to 8.00 in increments of 0.01.

Since all transducers possess limit detectors, the inner loop transducer limit detector can be used to protect the specimen from excessive spool displacements (and therefore large main stage flows).

6.5. Inner loop Control Schematic



6.6. K7500 System Monitoring Points

1	TxA
2	TxB
3	TxC
4	TxD
5	Ext Tx
6	TxA - TxB
7	INNER LOOP FEEDBACK
8	DELTA P FEEDBACK
9	CONTROL FEEDBACK
10	LOAD FEEDBACK
11	DISPLACEMENT FEEDBACK
12	AUXILIARY FEEDBACK

13 EXTERNAL COMPENSATION FEEDBACK
14 COMMAND
15 FOLLOWING ERROR
16 SERVOVALVE DRIVE
17 EXTERNAL COMPENSATION COMPENSATED
18 INNER LOOP COMMAND
19 DELTA P COMPENSATED
20 EXTERNAL COMMAND
21 SERVOVALVE CURRENT

6.7. Inner Loop Manual Tuning

The K7500 includes a facility for manual tuning of the inner loop which involves the application of a square wave as the inner loop command (PID is temporarily disconnected). The user is required to specify parameters for inner loop tuning:

1. The amplitude of square wave commands for inner loop tuning.
2. The frequency of the square wave.

Inner loop tuning is available to the user under the following conditions:

1. Pilot pressure only is achieved.
2. A transducer is assigned for inner loop feedback.
3. The user has entered the GAINS sub menu for adjustment of the inner loop gain term.

Once permitted, there are two effects:

1. Main pressure loading is inhibited.
2. The START, STOP and PAUSE buttons change their purpose to become controls for the application of the inner loop tuning square wave.

Note that the inner loop tuning square wave generator is entirely separate from the test function generator. This avoids alteration to the test specification in order to perform inner loop tuning.

The inner loop tuning square wave is applied directly before the inner loop summing junction, but directly after the phase, flow clamp, balance and Unequal Area Compensation (UAC) processes.

There is a servovalve current enable feature. Servovalve currents are permitted whenever

pilot pressure is achieved, or when main pressure is requested or achieved. Additionally, valve currents continue to be applied for a time after loss of main hydraulic pressure, such that linear control is maintained while the system pressure decays. At all other times the valve current is held at zero.

6.8. Servovalve Parameters

There are a number of other servovalve related parameters that the user can access in a sub menu of the top level menu GAINS:

1. A SERVOVALVE PHASING SWITCH

   This has the options 'NORMAL' and 'INVERT' and permits servovalve drive signals to be inverted, possibly to correct for phasing inversions in the cabling.

2. A FLOW LIMIT SWITCH

   It is possible to limit servovalve drive signals in from 100% to 5.00% in increments of 0.01% to restrict flow and thereby improve safety. The level of limiting is user programmable and acts on both positive and negative servovalve signals. The normal setting is 100% for no limit. As an example, a setting of 70% will only allow servovalve drive signals of up to 70%. In master/slave configurations all flow limits are activated by the master.

3. VALVE BALANCE

   It is possible to offset the servovalve signal from 0.00 to +/- 10.00% in increments of 0.01% for the purpose of nulling, i.e. obtaining zero flow for a zero error drive signal.

4. UNEQUAL AREA COMPENSATION (UAC)

   It is possible to compensate for the asymmetric servo performance that is caused by an unequal area actuator. The requirement in this case is to attenuate servovalve deflections of one direction or another so that the more responsive direction is under driven and therefore compensated.

   The user can compensate for unequal areas by setting appropriate values in the following parameters (note UAC = 'unequal area compensation'):

   a. UAC DIRECTION

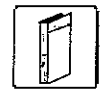
      This software switch identifies the polarity of servovalve deflections that must be attenuated. The options are POSITIVE and NEGATIVE.

   b UAC ATTENUATION

      This is a simple scaling factor from 0.00 to 100.00% in increments of 0.01% and specifies the degree of attenuation applied to the polarity of the servovalve signals identified by the DIRECTION switch.

5. DITHER LEVEL AND FREQUENCY

   The dither facility excites the servovalve with a low level, high frequency oscillation. This helps to overcome hysteresis in the servovalve and reduces susceptibility of the



spool to silting with the small particles that are suspended in the oil. Dither level may be set between 0.00% and 100.00% in increments of 0.01% and dither frequency set between 0.00 Hz and 1000.00 Hz in approximate steps of 0.03 Hz. (Note: 100% dither level represents 12.5% of valve current)

The above feature may also be used to improve control performance.

6.9. External Compensation Capability

The K7500 is capable of injecting signals into the error path for external compensation purposes. This feature can be used to implement feed forward terms or for stabilising loops using differential pressure feedback etc. Differential pressure feedback has it's own gain term which may be set between 0.000 and 1.000 in increments of 0.001, a setting of 0.000 is off.

The source of the compensation signal is determined by the transducer assignment sub menu in CAL/CONfig. NONE would disable the feature and cause no signals to be injected into the error path.

Assuming the feature is enabled, a number of other settings amongst the CAL/CONfig. sub menus become relevant also:

1. A mode selection switch.

   The user must specify which control modes (LOAD, DISP or AUX) the feature is pertinent to. For modes other than the ones selected, no injection of signals is performed.

2. A phasing switch.

   The signal can be injected as 'NORMAL' or 'INVERTED', according to the need for positive or negative feedback.

3. An injection point selection switch.

   The signal can be injected into the outer loop, or the inner loop.

   Note : The external compensation inner loop feature is not related to the inner loop control for 3 stage valves. It is intended as an advanced control feature to increase stability of the outer loop where necessary in high performance systems. Removing the inner loop transducer disables inner loop control but does not affect external compensation.Additionally, there is a sub menu in the GAINS menus for setting the proportional and derivative gains for the external compensation feedback path. Proportional gain may be set from 0.00 to 16.00 in increments of 0.01 and derivative gain from 0.00 to 8.00 in increments of 0.01

7. RUNNING A TEST

7.1. Bumpless Start Up and Transfer of Control Mode

The K7500 Servocontroller is capable of controlling one of three parameters identified as LOAD, DISP and AUX. These labels are chosen in anticipation that most applications will involve load control, displacement control and possibly one other method of control such as strain, although there is no hardware constraint which forces this assignment.

Front panel buttons are provided to instruct movement between these three 'control modes' and each button has an integral LED to indicate which parameter is currently being controlled. Movement between modes is performed 'bumplessly', that is with very little, if any, disturbance to the test system.

Availability of a control mode is indicated by the lower LED on each button. Reasons for the non-availability of a mode include:

1. No transducer assignment to a mode.
2. A continuity fault on the transducer assigned to the mode (as indicated by the excitation sense circuitry).
3. Set point tracking outside of the command clamp range. This can occur when a large transducer offset compensation is being employed.

The interlock with hydraulics loading provides for 'bumpless start up' whereby hydraulic loading can take place without disturbance to the actuator position (other than unavoidable disturbances resulting from the application of high pressure oil). As a safety precaution, the user can specify an ENABLE MODE 'from the HYDRAULICS CONFIGuration sub menu of the CAL/CONFIGuration menu.

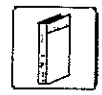
1. LOAD
2. DISP
3. AUX
4. ALWAYS

The last choice indicates that there is no preferred enable mode. In the case of the other three, however, pressure loading will be inhibited if the unit is not in the control mode identified.

On power up, the K7500 unit will default to the first valid mode in the following list:

1. DISP
2. LOAD
3. AUX

The case of 'no mode selected' is possible and is indicated when all upper LEDs on the mode control keys are extinguished. This can occur when, for example, no transducers are assigned, or where a previously valid mode becomes invalid due to the development of a cable continuity fault. Hydraulic loading is inhibited in this condition and servovalve currents



are forced to zero.

Manual transfer is available at all times by use of the front panel buttons. Additionally, another source of transfer instruction can come from the limits, in the case where a unit is programmed locally, to change mode when a test stop occurs. In either case a special feature is employed to accommodate a mode transfer when test wave form generation is in progress.

A 'static fader bypass' forces a state where all command is provided from the manual set point at the moment of mode change. This feature ensures that, after a mode change, test waveforms form no component of the command, the latter originating entirely from the manual set point. This condition will persist until the static fader signal, as provided by the test control section, has ramped down to zero naturally, as a result of a normal test stop procedure. At this point the static fader bypass will unlock so that, from then on, a test start will be possible.

This contingency is necessary even where no apparent mode change takes place, as the implication of the mode change is that control should revert back to the manual set point, by use of which the command can be frozen or ramped to zero.

7.2. Load Limited Displacement Mode

The K7500 has the ability to control in displacement mode whilst monitoring the load feedback to limit the level of load applied. This mode is useful when using the SET POINT control to set up a test rig in displacement control as high loads from accidental contact are prevented.

Load limited displacement mode is only available when no test is running and acts on the manual displacement set point. The load limit is fixed at 2.5% F.S. and the rate of manual set point adjustment is fixed at 10%/second for every 1% of excess load.

There are two ways that the user can control this feature:

1 There is a programmable switch to enable the feature, in one of the GAINS sub menus.

2 There is a button on the remote button box to enable and disable this feature.

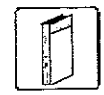
The active state of this feature is indicated by a flashing LED above the DISP mode button.

It is important to note that this feature assumes the following relationship between displacement mode and load control. A positive change in displacement will result in a positive change in load. If this is not the case in a particular system, then the LOAD POLARITY switch should be set to INVERTED.

7.3. DISP Limit Start Up Inhibit

An unloaded, unrestrained actuator may, as a result of sinking to the bottom of its stroke, show an excess of displacement which ordinarily would cause a limit violation, preventing pressure loading.

In recognition of this, the DISP transducer limits are inhibited during the unloaded state and



continue to remain inhibited until the feedback enters the safe range of these limits. This might happen as a result of the user inching the actuator out of its end stop.

Once inside the safe operating area of the DISP transducer limits they become live and any subsequent excursion beyond these limits will then immediately result in their programmed action.

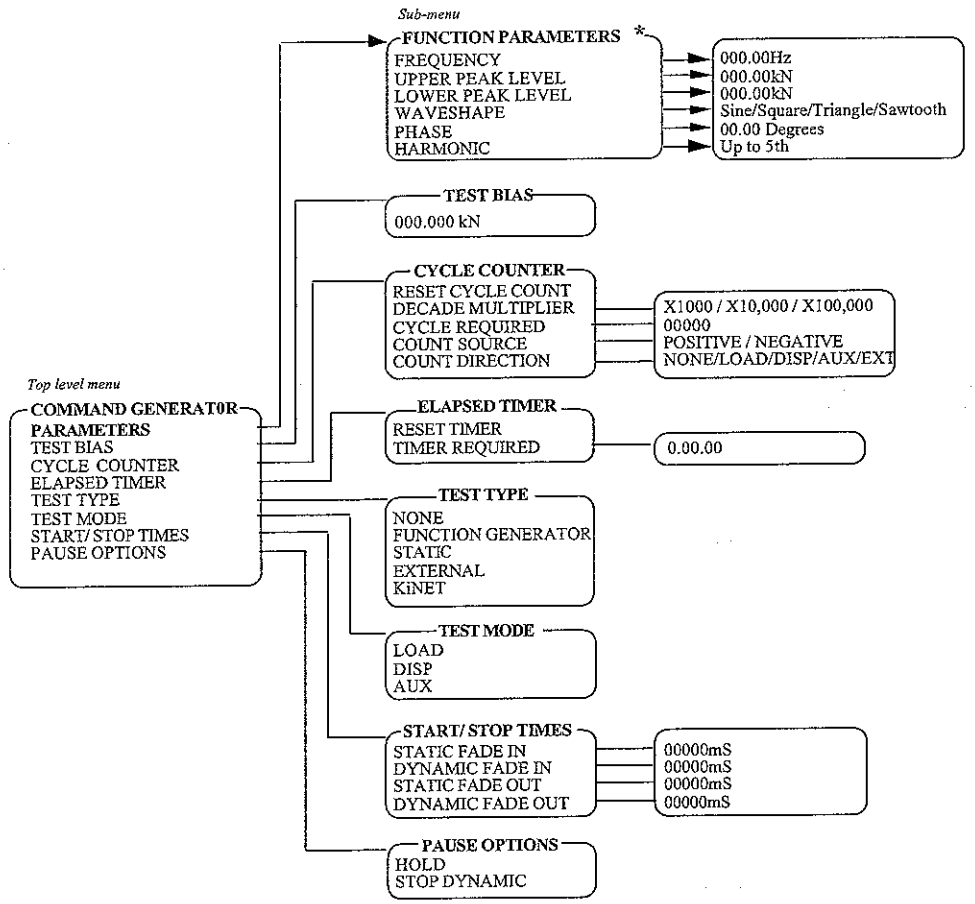
SPAN	The SPAN function button provides the user with a dynamic scaling control which is used to scale the selected dynamic command generator. It may be adjusted from 0.00 to 100.00% in increments of 0.01%
SET POINT	The SET POINT command provides the user with manual control of the servo actuator in the selected control mode and in the units associated with test mode. Typically, this command is used during start up procedure. Note: Changes to the SETPOINT are prohibited when the pressure is off and the unit is not in simulation mode. This is because the set point is tracking the feedback to ensure bumpless start up upon pressure being applied.
SET GEN	The SET GENerator function button selects the top level menu for Command Generator. This menu in turn provides access the sub-menus which are used for the selection and setting up of a test condition.

Note: Some of these sub-menus provide access to 'Normalised' factory settings and will not require user input unless normal settings are changed.

A Test Type should be selected, thereafter the menus will provide the user with the required parameter selection and adjustment.

7.5. Set Generator Menu

The full SET GENerator Menu is shown below. It illustrates how the internal FUNCTION GENERATOR is set up through its Parameters sub-menu. Once the start conditions have been satisfied, i.e. the test mode selected with no other system errors, a soft start or stop of the selected test is obtained through the command fade function supporting the START and STOP buttons.



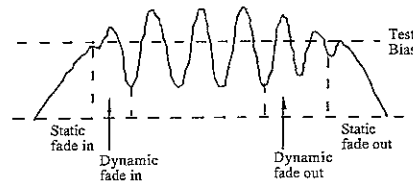
NOTE:
* = ONLY WHEN TEST TYPE IS FUNCTION GENERATOR

7.6. Test Control Operation

This section describes the components responsible for generation of the different types of dynamic test wave form. The description is in terms of a multi-channel test where there is a master unit and a number of associated slaves. For a stand alone unit, the situation is entirely similar, except that a unit is considered its own master and certain communications are handled internally to the K7500, rather than via the KiNet interface.

The K7500 can accept commands from an external generator in either analogue form

(through a rear panel BNC) or in digital form (via KiNet). Additionally, the K7500 is capable of generating the following types of commands without the assistance of an external generator:



1. Static levels.
2. Sine, square, triangle, and sawtooth waveforms (Function Generator).

A master unit is responsible for introduction, exit and phase synchronisation of test waveforms via KiNet.

KiNet communications for the purpose of test control are:

1. Start/stop instructions.
2. A signal 'static fader' put out by the test group master.
3. A signal 'dynamic fader' put out by the test group master.
4. A signal 'command index' put out by the test group master.

When operating K7500s in a multi-channel test only the test control buttons on the master actually respond, those on the slaves are inoperable although the LEDs will continue to function on the slaves. Test control sequencing proceeds as follows.

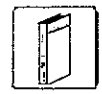
On pressing the 'START' button, the unit may respond with a bleep and a warning message, this could be an error or an inhibit as follows:

INHIBITS

1. Cycles already completed.
2. Elapsed timer already completed.
3. The unit has not detected pressure (or simulation).
4. The test type of all controllers in the test group is not the same.
5. The waveshape of all controllers in the test group is not the same.
6. The control mode is not the same as the test mode.
7. The cal switch is ON.
8. The test slaves setting does not agree with the number of detectedslaves.
9. The currently selected menu is dangerous when a test is running.

ERRORS

1. The test has already started.
2. The unit is a slave.
3. The limit log has some entries which must be cleared before the test is started (FLUSH LIM LOG is an option on the LIMITS menu).



In such a case, it is intended that the unit causing the inhibit issues a warning message so that the user can quickly identify the source of the problem.

Assuming no such condition exists, however, the first action performed by the master is the static fade. This involves ramping the static fader signal smoothly from zero to 100% in a time set by the user, that is a smooth transition of command from their manual set point to their mean levels or test bias. This method of static entry ensures that the static set point does not offset the test, while permitting a smooth return to the manual set point when the test is stopped.

The second phase of test starting is the 'dynamic fade'. This involves ramping the dynamic fader signal smoothly from zero to some level in a time set by the user to achieve a smooth introduction of the dynamic command signal. The level to which the dynamic fader moves is set by a 'master span' control which the user can modify to effect dynamic scaling on all channels.

Simultaneous to the start of the dynamic fade, the command generator (internal or external) is given the command to continue so that command signals are being generated as the fader signal rises, thus ensuring a smooth introduction of the dynamic signal. The signal to continue is delivered to the master generator for internally generated commands or to a command relay for an externally generated signal.In the context of the internal generator, the continue signal 'unfreezes' the ramp generator or oscillator which controls the test and also releases an 'elapse timer' so that action can be taken when a specified number of hours have accrued. The 'PAUSE' button has a programmable effect on the function generator. When the option is set to 'hold' (PAUSE OPTIONS under SET GEN menu) the function generator will hold the current level when paused. When the option is set to 'stop dynamic' the dynamic signal is ramped down over the dynamic fade stop timer. The elapsed time will not operate while the PAUSE button is operable (ie. the PAUSE LED is illuminated).

The command generation relay provides a simple start/stop instruction to externally attached wave form generators. In a multi-channel test the external generator will take its instructions from the master unit of a testing group.

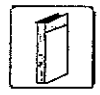
Stopping a test is the reverse of starting. On receiving the instruction to stop (either from the 'STOP' button at the end of a test or as a result of a limit trip), the dynamic fade signal is ramped linearly to zero in a time specified by the user. On reaching zero, the command generator is instructed to hold which, in the case of an external source, causes the command relay contacts to open.

Secondly, the static fade signal is ramped linearly to zero in a time specified by the user, causing all channels to return their commands to their respective manual set points. Static and dynamic fade in/out times may be set from 0 to 37,767ms with an increment of 1 ms.

7.7. Static Test Specification

The user must specify static tests as follows:

1 The user enters the required static level which is in the units appropriate to the chosen control mode. This is entered into the test bias setting. The static fade control will determine the rate of application and for a static test may be set from 0 to 32,767 seconds in 1 second increments.



For a multi-channel static test, each unit must be programmed with the required static level for that channel. Progress of a static test can be monitored by use of the elapse timer.

7.8. Function Generator (Cyclic) Test Specification

The user is required to specify cyclic tests as follows:

1. Enter the upper peak level which is in the units appropriate to the chosen control mode.
2. Enter the lower peak level which is in the units appropriate to the chosen control mode.
3. Enter a phase offset in the range -180..+180 (degrees) in increments of 0.01 (degrees).
4. Enter the required frequency range. One of 5 ranges may be selected, starting from 0.01 Hz to 0.000001 Hz.
5. Enter the required frequency. The first range is from 0.01..200 Hz. The user may alter the frequency by use of the 'ADJUST' during the course of the test.
6. Select the required waveshape.
7. Optionally, the user may wish to set a starting position for the wave form by adjusting the generator phase control which is in the range -180..+180 (degrees) in 0.01 degree increments.

When the waveform is defined by the peak values the K7500 will automatically calculate the test bias and the span required. The same waveform can be defined by the test bias and span, in which case the peak values are calculated.

For a multi-channel cyclic test each unit must be programmed with the required peak levels and phase offset for each channel.

Each channel of a cyclic test has independent control of phase (-180..+180 degrees) and harmonic selection (1.5).

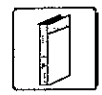
For multi-channel cyclic tests the master unit must be programmed with the required frequency, waveshape and starting phase. Slave units will ignore this aspect of the test specification.

Progress of a cyclic test can be monitored by observing the cycles counter or by use of the elapse timer.

7.9. Peak Controller

It is anticipated that most applications of the cyclic test facility will operate in a part of the servo loop performance where gain roll-off and phase shifts will be very appreciable, and normal servo action will not be sufficient to ensure that the required precision is being met. To improve accuracy in these circumstances, therefore, the K7500 includes the following two features:

1. 'Peak limits' which compare feedback peaks to user set limits.



2. 'Peak adaption' which automatically compensates for peak mean and level distortions by pre-processing the command signal.

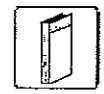
Both of these can be used with external cyclic wave forms as well as with the function generator supplied with the K7500.

Monitoring software automatically detects peaks on the feedback signal and compares each identified peak to the user set limits. This provides a means of ensuring that adequate peak accuracy is being achieved. There are two important points to mention regarding this facility.

1. The source of monitoring is programmable and need not be the servocontroller variable. This is useful where displacement cycles are being applied to a specimen but where load cycles must be monitored in order to detect a change in the stiffness of the specimen.
2. There are two levels of peak limits so that the user can set an inner warning and an outer stop limit.

The user accessible parameters for the peak limits are in the PEAK CONTROLLER option of the 'LIMITS' menu and include the following options:

PEAK CONTROL SIGNAL
UPPER PEAK LEVEL
LOWER PEAK LEVEL
PEAK LIMITS
ADAPTION ENABLE



7.10. Peak Control Signal

The peak control signal can be selected as one of the following options:

1. NONE

   No peak monitoring will be performed. Additionally, peak monitoring will not be operable for static or ramp test wave forms.

2. LOAD
3. DISP
4. AUX
5. AS TEST

   This is a quick way of setting the peak monitoring source and the peak limit levels in accordance with the test specification which, for the peak limits to be operable, must be set for a cyclic test wave form or an externally generated wave form.

7.11. Upper and Lower Peak Levels

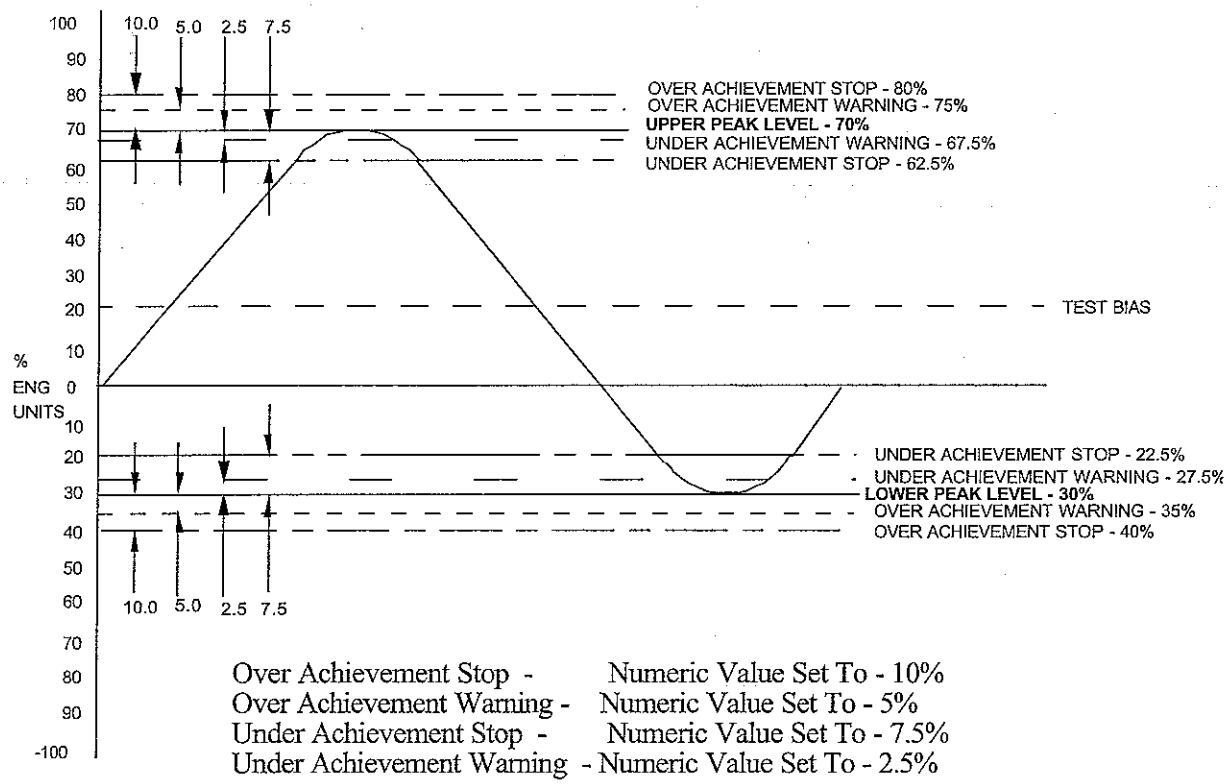
These options allow the upper and lower peak levels to be set in the engineering units of the appropriate Tx (depending on the peak control signal). Note that the upper can never be set to a value less than the lower and, conversely, the lower level can never be set higher than the upper level.

7.12. Peak Limits

The peak limits menu option, when selected, results in the following options:

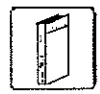
OVER STOP
OVER WARN
UNDER WARN
UNDER STOP

These limits are set in the range 0 to 100% full scale of the Tx. They are displayed in the appropriate units of the peak control transducer. (If there is no source then they are displayed in percent). The limits are relative to the peak limits, i.e. the values set using the above options are not absolute. The following picture shows how these limits are calculated.



Over Achievement Stop - Numeric Value Set To - 10%
Over Achievement Warning - Numeric Value Set To - 5%
Under Achievement Stop - Numeric Value Set To - 7.5%
Under Achievement Warning - Numeric Value Set To - 2.5%

Note that the peak limits are not enabled until the dynamic fader has completed. This prevents spurious limit trips.



7.13. Adaption Enable

Peak adaption is a separate facility to the peak limits which can be independently enabled and disabled by use of this software switch. Peak adaption permits the test specification to be modified, in response to measured peak levels, in order to bring the measured peaks to the levels defined by the peak levels. This is accomplished by augmenting the test specification as follows:

1. The mean level is augmented to correct for mean level errors on the measured peaks.
2. The dynamic amplitude is augmented to correct for peak-to-peak errors on the measured peaks.

The latter can compensate in both directions, i.e. the command signal can be attenuated below the level set in the test specification if necessary. Over drive of the command signal is more likely and some headroom must be made available for this purpose.

It is obvious, when realising that the peak controller modifies the test specification, that the 'real' test specification resides in the peak limits when peak adaption is being employed. In fact the test specification, as supplied by the user, acts merely as a starting point for the adaption process and can, in most cases, be determined by estimates of the specimen stiffness, gain roll-off, etc.

ADAPTION GAIN - This may be adjusted between 0.000 and 1.000 in increments of 0.001, normal default setting is 0.500.

7.14. Acceleration Control

This is enabled when the peak controller is used for acceleration control (the peak control signal is derived from an accelerometer mounted to the specimen) with the K7500 servocontroller in displacement control mode.

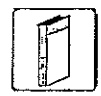
The action of acceleration control is to remove the DC drift of the position test bias which is normally calculated from the upper and lower peak levels.

In acceleration control the upper, low and peak levels are constrained to be equal and opposite around a fixed displacement point which is the displacement test bias.

7.15. Test Specification - General

With all types of dynamic wave form, including externally generated waveforms, the user has the following additional controls:

1. Optionally, the user may arm the elapse timer to terminate any test after a specified time.
2. Optionally, the user may arm the cycles counter to terminate a cyclic or externally



generated test after a specified number of cycles have been applied. Note that the cycles counter can count from an external source making it applicable to external commands and not just to the internal cyclic wave form generator.

3. The user can scale down a test on a global basis using the master span control on the master unit.
4. The user can scale down a test on a per-channel basis using the local span control on each controller.

7.16. Pause Options

A software switch permits the user to determine the effect of the PAUSE button when used for test control. For multi-channel tests the user must set the required PAUSE action on the master unit of a testing group. The options on this switch are:

HOLD	The wave form will hold at its instantaneous value. In the case of an externally generated wave form, this is instructed by opening the command generation relay contacts.
STOP DYNAMIC	This option causes the dynamic component of the test wave form to be faded down and stopped which, in the context of an externally generated wave form, includes the opening of the command generation relay contacts at the end of the fade. Consequently, the command holds at the mean level.

7.17. Stop At End Of Test

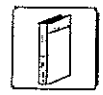
The K7500 will automatically stop at the end of a test. The stop procedure is identical to that for a user instigated stop by use of the 'STOP' button. Automatic stop is triggered by:

1. The elapse timer reaching the user set time limit: if the user wishes to disarm the elapse timer, set a time limit of zero.
2. The cycles counter reaching the user set count limit: if the user wishes to disarm the cycles counter, set a count source of 'NONE'. Note that, due to the dynamic fade (in and out), slightly more than the requested number of cycles may be applied.

There is an on/off switch in a CAL/CONfig. sub menu to control the facility for automatic shutdown of the hydraulics on test completion. When enabled on a master unit pressure unloading will be instructed at the end of the static fade back to manual set points.

7.18. Elapse Timer

The K7500 has an elapse timer which indicates and controls the duration of the testing wave form. There is also a user set time limit which can be used to terminate a test after a required duration of an external wave form has been applied. Though present on every K7500 unit, the elapse timer is only functional on the master of a testing group as its operation depends on intimate connection with the test wave form generator.



The format for presentation and entry of time is hhhh:mm:ss where 'hhhh' is hours in the range 0..9999, 'mm' is minutes in the range 0..59, and 'ss' is seconds in the range 0..59.

There is provision for the user to manually reset the elapse timer. The elapse timer accumulates time whenever a test wave form is started but not paused.

7.19. Cycles Counter

The K7500 has a ten digit counter for accumulating test wave form cycles. There is also a user set count limit which can be used, for example, to terminate a test after the required number of cycles have been applied to a specimen. Though present on every K7500 unit, the cycles counter is only functional on the master unit of a testing group. The cycle counter can be set from 1 to 20,000 in increments of 1 count. For setting a higher cycle count a decade multiplier is used such that the highest count is 4,294,000,000.

There is provision for the user to manually reset the cycles counter.

The source of count pulses is user programmable by use of a 'COUNT SOURCE' option:

1. NONE

   The cycles counter is disabled and cannot stop the test.

2. LOAD

   Cycles of the LOAD transducer signal are counted.

3. DISP

   Cycles of the DISP transducer signal are counted.

4. AUX

   Cycles of the AUX transducer signal are counted.

5. EXT CMD

   Cycles of the external command input are counted.

6. FUNC GEN

   Cycles produced by the function generator are counted.

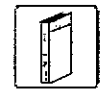
For all but the last of these options, there are a number of parameters which define the trigger characteristics for detection of a count event:

1. COUNT DIRECTION

   This defines the direction of threshold crossing which causes a count event and is either POSITIVE or NEGATIVE.

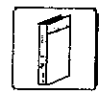
2. COUNT HYSTERESIS

   The count hysteresis provides some degree of immunity to false counting caused by noise.



7.20. Status Display of Cycles Counter or Elapsed Timer

Information regarding cycle count or elapsed time can be viewed on the front panel status display. LCD will alternate between cycle and time displays whenever the status button is pressed.



7.21. Invert Cycles

This feature is found in the SET GENerator menu

PARAMETERS
- FREQUENCY
- FREQ RANGE
- UPPER PEAK LEVEL
- LOWER PEAK LEVEL
- WAVE SHAPE
- PHASE
- HARMONIC
- **INVERT CYCLES**
  - **0 to 32767** (count setting **n**)
  - 0=off, 32767 maximum setting

It would be used with sine or triangle waveforms from the internal function generator, normally for load control although position control could be used.

The feature is enabled when the invert cycle count is set greater than 0. A count setting of 0 disables the feature and is the default setting. It can only be used when TEST TYPE is set for FUNCTION GENERATION.

The feature will produce **n** cycles of inverted command waveform about **zero command** after **n** cycles of non-inverted command. This process will then repeat until end of test which is normally the total number of cycles set on the system cycle counter. The number of cycles of inverted command **n** is the same as the number of non-inverted cycles, all cycles which are inverted or non-inverted are counted by the system cycle counter. For example, if **n** = 50, the command waveform will start with 50 cycles of normal followed by 50 cycles of inverted, at which point the system cycle counter will read 100.

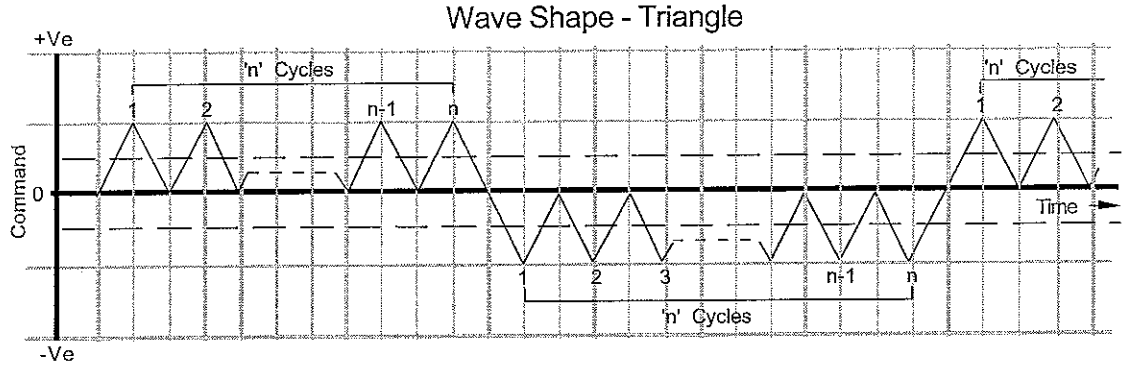
As the feature uses the cycle counter this must be set for the the number of test cycles required with the COUNT SOURCE normally set to FUNCtion GENerator. COUNT DIRECTION is normally set to POSITIVE and COUNT HYSTERESIS is set to 0.5%.

Obviously, inversion of the command signal can only occur at, or near, zero crossings and the feature therefore does not invert the waveform until the zero crossing following the **n** cycles. Zero is assumed to be attained when the command is within a tolerance of zero which is programmable under the PREFERENCES menu as follows:

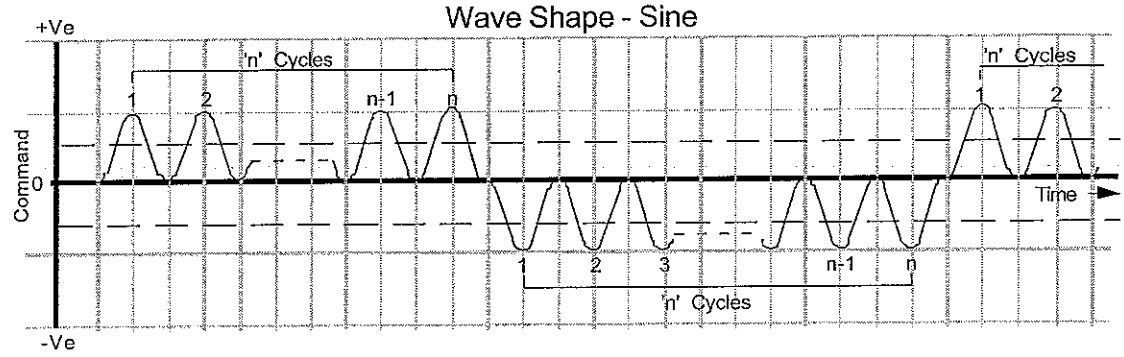
CAL
- PREFENCES
  - **INV PHASE TOL**
    - 0.00-100% (100% ? 16.38V)
    - Suggested setting is 0.02%

The waveforms produced by this feature are heavily dependent on the settings for the test. The Figure below shows the "ideal" settings in which one of the peaks is zero. The signal is then smooth at the point of inversion:

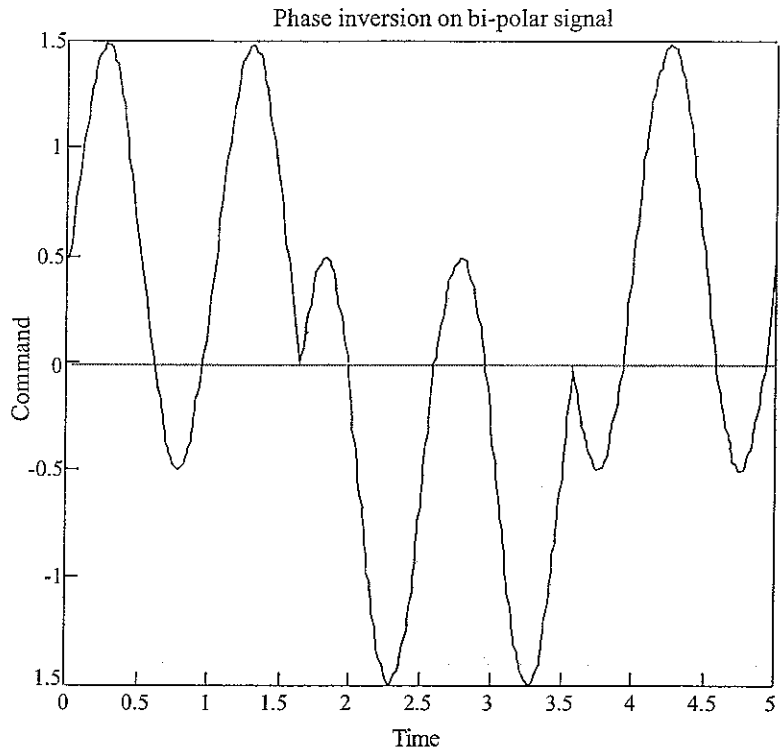
Wave Shape - Triangle



Wave Shape - Sine



It is possible to use this feature on a bipolar waveform but this can result in severe edges as shown below:

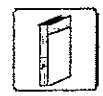


7.22. Multi-Channel Application

When the invert cycle feature is required for more than one channel in a K7500 multi-channel servocontroller master/slave test, the counter configuration must also be set on the channels using the feature. The counter in the master K7500 servocontroller is normally considered as the system counter, to count the number of cycles required for the test. The counters on the channels using the invert facility should be set the same as each other and the same as the master for:

TEST TYPE	=	FUNCTION GENERATOR
COUNT SOURCE	=	FUNCTION GENERATOR
COUNT DIRECTION	=	POSITIVE
COUNT HYSTERESIS	=	0.5%
	also	
INVERT CYCLES	=	number required
INVert PHASE TOLerance	=	0.02%

If the invert cycle feature should ever get out of synchronisation between channels, i.e. by setting a different number of invert cycles or failing to set the command amplitudes correctly so that one of the peaks is not zero etc., the inverse counter must be re-set by re-selecting the count number before starting another test.



7.23. Transducer limit detectors

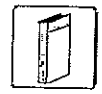
The K7500 provides continuous limit checking on all assigned transducers. Each transducer is compared against maximum and minimum limits which are specified by the user in engineering units.

For each transducer, there are two sets of maximum and minimum limits designated 'warn level' and 'stop level' limits, these permit the user to implement a two level limit system. The first limits enable the user to be given a warning for small excursions beyond the safe region of a transducer, while the second instigate a test stop when large excursions are detected. The test stop is, in fact, the Master Limit action which can be programmed to PAUSE or to STOP the test. It is also possible to dump the oil as explained in the Master unit limit action section later in this chapter.

7.23.1. Following error limit detector

There is a single following error limit detector which continuously compares the following error to the user set limit. Following error is intended for low frequency use only, i.e. up to 3 Hz. The user is required to specify following error tolerances independently for each mode because it is recognised that each mode may have different degrees of control or precision in performance.

As mode changes take place, the error limits alter to those set against the active mode. There is one level of following error detection which will cause the master limit action to be performed.



7.23.2 Command clamp limit

There is a clamp on the command signal whose clamp levels are set automatically according to the headroom available after the transducer offset compensation. Excess command is clamped but, additionally, a test stop is instructed.

7.23.3. Miscellaneous 'limits'

There are a number of other events which can cause termination of a test and unloading of oil:

1. Filter blockage.

   This is a digital input from the hydraulic pressure loading facility.
2. Auxiliary limit.

   This is a digital input which may be used for limit switches, etc.
3. Emergency Stop Button(s)

7.23.4. Master unit limit action

The master unit of a multi-channel test, or a unit operating stand-alone, can be programmed to take one of the following actions in response to a limit in respect of its test control and hydraulic control responsibility:

1. PAUSE

   (The user may then resume the test by pressing the START button).
2. STOP
3. STOP THEN UNLOAD

   Cause test stop as for user press of STOP button, then unload hydraulics at end of static fade.
4. UNLOAD IMMEDIATELY

   Cause test stop as for user press of STOP button, and simultaneously unload hydraulics.

A continuous limit excess may prevent the starting of command generation. At the very least, it may cause the test control to enter the paused state immediately after completion of the static fade. Additionally, and depending on the option selected, the user may find the attempts to load hydraulics are inhibited.

The cause of a load inhibit or test start inhibit is indicated on an offending unit. All such start inhibits require the user to determine and rectify the cause of the impeding limit violation.

7.23.5. Controller limit action

Each controller can be programmed individually, to take one of the following actions in response to a limit:

1. NOTHING

   No local action is required.

2. CHANGE TO DISP MODE

   Change to displacement mode and hold still.

3. CHANGE TO LOAD MODE

   Change to load mode and relax load. The rate of load relaxation is factory set to 100% sec.

In the case of 2 and 3 above, the controller will force the transfer of command from the test wave form section to the manual set point immediately (by use of a 'static fader bypass') so that the mode change can be executed.

This forced condition is applied even when no mode change seems to happen (i.e. when the test uses the same mode as the programmed limit action). The controller will remain in this condition until a 'real' test stop moves the static fader back to the manual set point.

7.24. Limit monitor

An option in the LIMITS sub menu permits the user to view, simultaneously, all controller limit states. Very terse labels are employed on this screen because of the large number of displayed limits. The following table explains these labels

K7500 LIMIT MONITOR ABBREVIATIONS

LIMITS MONITOR

	Load	Displ.	Aux	Inner-loop			
TX	L	D	A	I	PEAK		MISC
US:	Upper Stop				OS:	Over-stop	FE: Following Error
UW:	Upper Warn				OW:	Over-warn	CC: Command Clamp
LW:	Lower Warn				UW:	Under-warn	FB: Filter Blocked

LS: Lower Stop

US: Under-stop

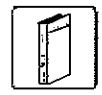
AC: Auxiliary (digital) limit

7.25. Limit log

To assist in the determination of the reason for a test stop, the K7500 has a limit log which records the limit events (including warnings) in the period ten seconds prior to a test stop and in the period ten seconds after a test stop. Events are time tagged in milliseconds in the range -9999..+9999, zero being the moment of the first stop event. Events outside this range are not tagged although they are still sorted in time order.

Examination of the limit log is undertaken by use of the rotary Adjust control to permit the events to be scrolled through the viewing area on the LCD screen. Room for at least one hundred events exists in the K7500 memory. The limit log is non-volatile.

To protect the limit log in the event of accidental restart of the test, old limit log contents are not discarded but allowed to accumulate until storage limitations cause very old log records to 'fall off the end of the log memory'. Test runs are separated by distinctive markers which clearly delineate logs from successive test runs.



8. TEST PARAMETER STORAGE

The adjustable parameters are all non-volatile. As adjustments are made by the user, or as non-volatile indicators such as cycle counts alter, their new values are automatically updated in a storage area called the 'active' parameter bank. Consequently, all settings of the K7500 can be recovered after a power cycle. Operation can continue from the point where power was removed.

In recognition that the K7500 may be frequently re-configured, the K7500 has provision for a further 8 storage banks in addition to the active bank. These 'user assignable' storage banks are labelled A to H and permit rapid saving and recovery of K7500 settings by allowing the user to transfer between these banks and the active bank. The banks are accessed by the CAL/CON top level menu.

In addition to recovery of previous settings, the user has the option to load settings from an internal table which puts the K7500 in an 'ex-factory' condition. The settings loaded by this command are intended to be safe starting values from which a new set up can begin. The act of loading the active bank in this way is called instrument 'normalisation'. See Chapter 9.

Entirely separate to parameter storage is the limit log. This is non-volatile memory for limit events which operates in the first in, first out fashion and does not participate in the storage bank scheme.

A number of parameters are 'global', i.e. they are non-volatile but do not change when a new bank is loaded. This includes the following data:

INNER LOOP TUNE ENABLE

OUTER LOOP TUNE ENABLE

FILTER BLOCKED LIMIT ENABLE

DIGITAL LIMIT ENABLE

KiNET MASTER CLOCK ENABLE

DEVICE NUMBER

KiNET GROUP

OPERATING MODE (Stand alone, single channel etc.)

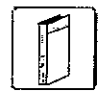
NUMBER OF TEST SLAVES

NUMBER OF TEST/HYD SLAVES

ACCESS LEVEL (View only, Operator)

DEVICE NAME

CONFIG DATA (Preferences)



9. MULTI-CHANNEL OPERATION

9.1. KiNet Communications Overview

The K7500 digital servocontroller will function as a stand alone test system or using a digital communications interface, as a multichannel and multi-test system.

In the simple case it is required that a number of K7500s centralise their hydraulic controls and maintain synchronism of command generation in order to ensure total test integrity. At the other extreme, several groups of K7500's must run independently in testing groups and source their commands from other peripheral equipment, preferably in digital form.

To accommodate this wide range of requirements, the KiNet interface provides a simple, high performance communications network for the K7500 products. KiNet provides a 'software backplane' for the real-time conveyance of digital signals and status codes etc. Data transmission includes real-time download command signals and the upload of analogue to digital conversion of the five transducer channels of the K7500.

9.2. Hardware

KiNet supports up to 16 K7500 units which are linked by multi-core cable sets (Part No. EK1590/001). The maximum cable length is 25m. Devices have two KiNet connectors so that devices can be 'chained' using point to point cables. The first and last devices should have terminator plugs installed in the unused connectors.

Connectors are 25 way 'D' type and the cable itself is comprised of 12 twisted pairs for the transmission of differential digital signals (RS485 standard). It provides 128 channels, each supporting the passage of 2,048 16 bit words per second.

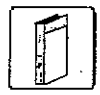
For multi-channel tests a 'chained' emergency stop cable provides a means of linking multiple K7500 units together by way of the safety interface socket.

9.3. KiNet Advantages

KiNet has the following advantages over industry standard interfaces:

1. Hardware (dumb) interfacing is simple.
2. Software interfacing is simple (no protocols).
3. High bandwidth.

Although KiNet has only 42% of the bandwidth of Ethernet, the lack of protocols means that the practical bandwidth of KiNet is far higher than Ethernet for the transport of digital signals.



9.4. Multi-channel Mounting Option

For multi-channel applications, K7500 may be stacked using a racking mounting option.

Note: 19" Rack Mounting Kit Part No. MK1564.

9.5. Master/Slave Operation

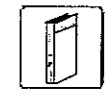
To implement multi-channel operation, the K7500 units may be operated in a Master and Slave(s) arrangement. In this configuration one unit is assigned the role of 'Master' and will furnish essential timing and status signals to other units nominated as 'Slaves'. A Master unit may control just the test management of its Slave units (e.g. phase shift and harmonics) or the test management and the hydraulic loading sequence. (*See Chapter 7.2 for test control and Chapter 3 for more details of hydraulic control.*)

The designation of Master/Slave channels may be set by the user within the sub-menu SYSTEM INTEGRATION from the top level menu CAL/CONfig:

Top level menu
CAL/CONfig

Sub menu
SYSTEM INTEGRATION

OPERATING MODE	
- STAND ALONE	(The normal setting.)
- SINGLE CHANNEL	(Will receive digital commands over KiNet interface.)
- SLAVE [Test]	(For test waveforms and cycle counting.)
- SLAVE {Test & Hyd.]	(Hydraulic sequencing and test waveforms.)
- MASTER	(Test control of Slave units from master function keys.)
GLOBAL SP ENABLE	(For Master/Slave configuration, Global SET POINT adjustments.)
KiNet MASTER CLOCK	(Channel used for timing, normally the Master.)
TEST GROUP	(Up to 4 groups on Workstation configuration.)
DEVICE NUMBER	(Device or Channel number in multi-channel configuration.)
NUMBER OF TEST/HYD SLAVES	(Security check.)
NUMBER OF TEST SLAVES	(Security check.)
DEVICE NAME	(Device or Test channel name, eg. Vertical Axis No. 3.)
VERSION	(Firmware version number for information only.)
SYSTEM DIAGNOSTICS	(Service personnel only.)



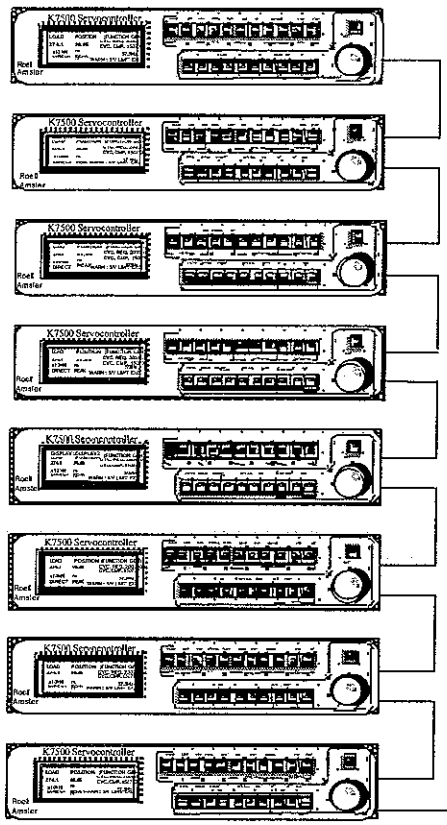
Warning: Following a power down of a Master/Slave arrangement, the Master should be powered up first to ensure the correct initialising instructions are transmitted to the Slave units. Failure to follow this procedure will result in Slave units starting up as Stand Alone units and subsequently failing the NUMBER OF SLAVES security check performed by the Master. This latter security action will inhibit the application of hydraulic pressure and the starting of a test.

9.6. Host Adapters (Dumb And Intelligent Devices)

A range of options are available that permit the connection of the small area KiNet network to host computers and associated standard laboratory networks. These include a KiNet to a PC/AT bus interface and IEEE488 adapter.

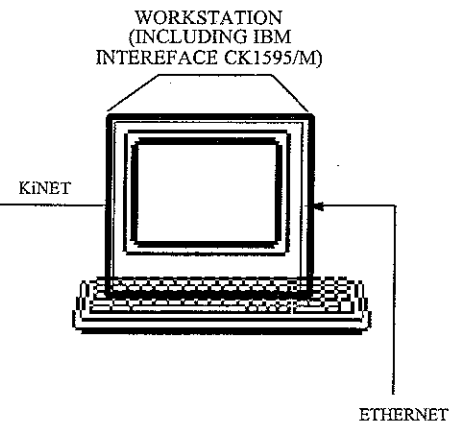
Dumb devices such as I/O ports may also be interfaced with KiNet, such as an extra large 6 digit LED numeric display option (Part No. AK1594/001) for remote indication of test parameters.

9.7. Computer Option & Application Programs

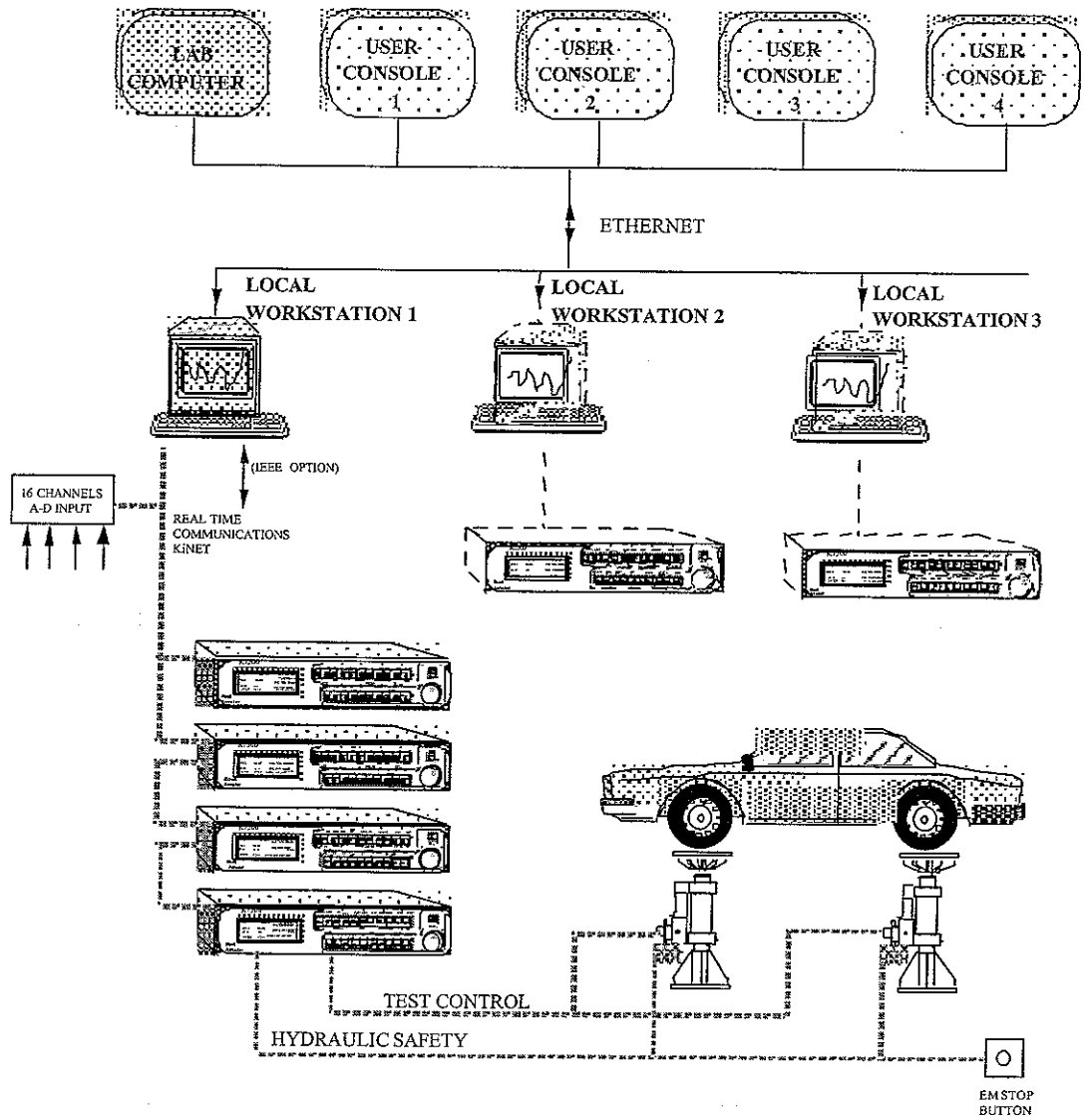


Optional Ki Test Application Programs Offer

- Block Program / Static Test
- Swept Sine
- Time / History Replay
- Flight Loading Spectrum
- Time / History Replay with data acquisition and analysis



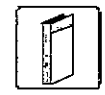
9.8. Laboratory Networking



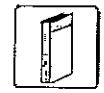
The K7500 multi-channel test laboratory system uses Ethernet communications for transfer of information between the laboratory host computer and local workstations. The Ethernet links also enable test system status interrogation and analysis by the users on the host computer network.

The Ki Workstation is a highly cost competitive PC-AT486 computer incorporating a 120 Mbyte hard disk. Communication over the Ethernet permits the Workstation to act as a remote node on the laboratory network.

Test Programs such as down-loaded time history replay or internally generated sine sweep are fed from the Workstation to the servocontrollers in real-time over the high speed KiNet link. This communication system transfers synchronous sample streams at a much higher



rate than Ethernet and enables the connection of up to 16 high bandwidth channels.



10. Normal Settings

The NORMALISE instruction loads K7500 programmable settings as follows:

Display 1:
Signal=load
Mode=direct

Display 2:
Signal=disp
Mode=direct

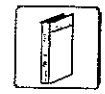
Limits:
Load, disp, aux, inner loop:
Upper stop=+10
Upper warn=+5
Lower warn=-5
Lower stop=-10
Load foll error, disp foll error, aux foll error:
Stop level=10
Warn level=5
Peak controller:
Peak ctrl signal=NONE
Upper peak level=0
Lower peak level=0
Peak limits:
Pk over ach stop=10
Pk over ach warn=5
Pk under ach warn=5
Pk under ach stop=10
Adaption enable=DISABLED
Action (master)=STOP THEN UNLOAD
Action (local)=NOTHING

Cal/conf:
R-CAL select=OFF
Simulation mode=DISABLED
Title line=STATUS DISPLAY
System integration:
KiNet master enable=DISABLED
Operating mode=STAND ALONE
Device address=0
Testing group=0
Tx assignment:
load=DC1
disp=AC1

Aux=NONE
Inner loop=AC2
Ext comp=NONE
Tx cal/config:
Dc1, dc2, ac1, ac2, ext:
Filter freq=500
Fine gain += 1.0
Fine gain -= 1.0
Offset comp=0
Phasing=NORMAL
Unipolar mode=DISABLED
Serial number=0
Units=%
Scale=100
Ext compensation:
Mode=DISP
Phasing=NORMAL
Injection point=OUTER LOOP
Hydraulics config:
Pilot facility=WITH PRESS SWITCH
Min pil pr on delay=5 (sec)
Max pil pr ack time=10 (sec)
Pause at pilot=ENABLED
Main pr facility=HI ONLY (WI PR SW)
Min press on delay=5 (sec)
Max press ack time=10 (sec)
Min press diss time=10 (sec)
Start up mode=DISP
End of test unload=ENABLED
Hi/lo sw mode=HI ON ALWAYS
Pause button option=HOLD
Global SP enable=DISABLED

Gains:

Load mode gains, aux mode gains:
Servo gain=1
Low pass filter frequency = 1000 Hz
Proportional gain=1
Integral gain=0
Derivative gain=0
Integral enable=DISABLED
Gain boost=0
Disp mode gains:
Servo gain=1
Low pass filter frequency = 1000 Hz
Proportional gain=1
Derivative gain=0
Gain boost=0



Load limit enable=ENABLED
Servovalve controls:
Balance=0
Flow limit enable=ENABLED
Dither level=0
Phasing=NORMAL
UAC direction=POSITIVE
UAC attenuation=100
Dither freq=150
Outer loop tuning:
O/l sq wave ampl=5
O/l sq wave freq=1
Inner loop tuning:
Inner loop gain=5
I/l sq wave ampl=5
I/l sq wave freq=1
Ext comp gain=0

Set gen:

Test control mode=DISP
Test type=STATIC
Test mean level=0
Cyclic spec:
- Frequency=1
- Upper peak level=0
- Lower peak level=0
- Phase offset=0
- Harmonic=1
- Master phase=0

Cycles counter:
- Count source=NONE
- Count level=0
- Count direction=POSITIVE
- Cycles required=0000000000

Elapse timer:
- Time required=000:00:00:00

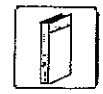
Test start/stop:
- Stat fade in time=10
- Stat fade out time=10
- Dyn fade in time=10
- Dyn fade out time=10

Set point:

Local set point=(set by automatic tracking)
Global set point=0 (0 on entry in any case)

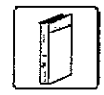
Span:

Local span=0
Master span=0



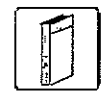
11. ERROR MESSAGES

Type	Message	Meaning/Action
SW!:	"CAN'T DERIVE"	Contact Roell Amsler if this message is displayed.
SW!:	"ZERO RANGE"	The value being input currently has a range of 0 to 0.
SW!:	"NULL ->menu and ->input"	Contact Roell Amsler if this message is displayed.
SW!:	"Mode Control(mode) !"	Contact Roell Amsler if this message is displayed.
SW!:	"NO MEMORY"	Contact Roell Amsler if this message is displayed.
SW!:	"NO MODE"	The self-tune process does not recognise the current control mode. This will be displayed if a self-tune is invoked before the control modes have been configured.
SW!:	"EXCESS GAIN"	The current control loop gain settings are too high for the self-tune process.
SW!:	"NO 'PG'"	The proportional gain is zero and there is no integrator in the loop during an attempted self-tune.
SW!:	"CAN'T TUNE"	The self-tune process cannot tune the system to the desired response because the measured dynamics are not controllable with a PID.
SW!:	"COMPLETE"	The self-tune process is complete.
SW!:	"WAVTAB=waveshape "	Contact Roell Amsler if this message is displayed.
SW!:	"BAD TEST TYPE"	The non-volatile index for test type has become corrupted and lies outside the legal range. This can be repaired by resetting the Test Type in the Command Generation menu.
INH:	"CYCLES COMPLETE"	The test cannot start because the cycles count requested has already been achieved.
INH:	"TIME COMPLETE"	The test cannot start because the elapsed time requested has already been achieved.
INH:	"PRESSURE"	The test cannot start because there is no pressure or the unit is not in simulation mode.

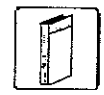


INH:	"TEST TYPE"	The test cannot start because the test type on a slave is inconsistent with the master.
INH:	"WAVESHAPE"	The test cannot start because the waveshape on a slave is inconsistent with the master.
INH:	"CONTROL MODE"	The test cannot start because the control mode is not the same as the test mode.
INH:	"INNER TUNE"	The test cannot start because the inner-tune is enabled (on a slave).
INH:	"OUTER TUNE"	The test cannot start because the outer-tune is enabled (on a slave).
INH:	"CAL SWITCH ON"	The test cannot start because the calibration switch is on.
INH:	"NO TST SLAVE(S) "	The test cannot start because the number of test slaves set in the configuration is inconsistent with the number of slaves sensed by the master.
INH:	MENU OPTION	The test cannot be started because the current menu contains options that are unsafe to change while a test is running. This menu must be left before the test can be begun.
INH:	"UNKNOWN Tinhibit Code"	Contact Roell Amsler if this message is displayed.
INH:	"SIM MODE"	The pressure cannot be requested because the unit is in simulation mode.
INH:	"CONTROL MODE"	The pressure cannot be requested because the control mode is inconsistent with the enable mode in the hydraulic configuration.
INH:	"DISSIPATING"	The pressure cannot be requested because the dissipation timer is not yet complete and the oil is assumed to be dissipation.
INH:	"RCAL ACTIVE"	The pressure cannot be requested because the calibration resistor is being applied.
INH:	"INNER TUNE"	The pressure cannot be requested because the inner-tune is enabled.
INH:	"NO T/H SLAVE(S) "	The pressure cannot be requested because the number of test and hydraulic slaves set in the configuration is inconsistent with the number sensed by the master.

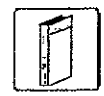
INH:	MENU OPTION	The pressure cannot be requested because the current menu contains options that are unsafe to change while the system is pressurised. This menu must be left before the pressure can be requested.
INH:	"UNKNOWN PInhibit Code"	Contact Roell Amsler if this message is displayed.
ERR:	"MASTER FAILURE"	The KiNet group master is no longer present so the slave unit has disconnected itself from KiNet.
ERR:	"KiNET FAILURE"	The KiNet master clock has stopped working.
ERR:	"SLAVE LOST (chan)"	The KiNet slave with channel number 'chan' is no longer present.
ERR:	"2 TRANSFERS!"	Contact Roell Amsler if this message is displayed.
ERR:	"ABORTED"	The self-tune process has aborted because self-tune has been disabled.
ERR:	"NO MEMORY"	The Self-tune process cannot allocate memory for the self-tune data. Report to Roell Amsler if this occurs.
ERR:	"NO MODE"	The self-tune process has been started in no control mode. (Attempting to self-tune a system with no Txs assigned will cause this error.)
ERR:	"EXT COMP"	The self-tune process cannot tune in the current mode because there is an external compensation term in the loop.
ERR:	"NO FLOW LIMIT"	The self-tune process cannot start because the flow limit is not enabled.
ERR:	"NO FEEDBACK"	The self-tune process could detect no change in the feedback (this would be caused by attempting to tune without oil or with insufficient pressure to drive the rig).
ERR:	"FULL 'SG'"	The self-tune process cannot tune the system because it has used up all the servo gain.
ERR:	"FULL 'PG'"	The self-tune process cannot tune the system because it has used up all the proportional gain.
ERR:	"FULL 'IG'"	The self-tune process cannot tune the system because it has used up all the integral gain.
ERR:	"PILOT PRESSURE"	The PILOT pressure has not been acknowledged by the external pilot pressure switch.



ERR:	"LOW PRESSURE"	The LOW pressure has not been acknowledged by the external low pressure switch.
ERR:	"HIGH PRESSURE"	The HIGH pressure has not been acknowledged by the external high pressure switch.
ERR:	"PRESSURE LOSS"	The system has detected that the pressure has been lost whilst still being requested.
ERR:	"NOT RELEVANT"	The menu option is not relevant on a slave.
ERR:	"NOT ALLOWED"	The system will not allow entry to the sub-menu.
ERR:	"ZERO SCALE"	The input value cannot be adjusted because it has a zero range. This is probably due to the fact that the Tx scale has not been set.
ERR:	"TEST ACTIVE"	The inner-loop or outer loop square wave generators cannot be started because a test is already running.
ERR:	"ALREADY STARTED"	The test cannot be started because it is already started.
ERR:	"NO I/L TX"	The inner-loop square wave generator cannot be started because there is no inner-loop Tx.
ERR:	"NEED PILOT"	The inner-loop square wave generator cannot be started because there is no pilot pressure or there is low/high pressure.
ERR:	"NEED PRESSURE"	The outer-loop self tune cannot proceed because there is no main (low or high) pressure.
ERR:	"TEST SLAVE"	The unit cannot start a test because it is a test slave.
ERR:	"INHIBIT ON device_num	The unit with device number device_num is inhibiting pressure requests or test start. Interrogate that unit for the reason.
ERR:	"USING KiNET"	This message is printed if a unit that is currently using KiNet is normalised. The normalisation cannot proceed until the unit is removed from KiNet.
ERR:	"NO TEST MODE"	The upper and lower peak level for a test cannot be entered because the Test Mode has not been set.
ERR:	"NO TX CAL"	The upper and lower peak cannot be set because the test mode Tx has not been calibrated.
ERR:	"NO TEST TYPE"	The parameters menu could not be accessed because the test type has not been set to function generator, therefore there are no parameters to set.



ERR: "NO TRANSDUCER"	i) The unit cannot change into the mode selected as there is no control Tx assigned for that mode. ii) The test mode could not be selected because that mode has no control Tx assigned.
ERR: "NO TX SCALE"	The test mode cannot be assigned because the transducer assigned to this mode has a zero scale.
ERR: "ACTIVE MODE"	The transducer cannot be unassigned because it is currently the control transducer. It is necessary to change control mode.
ERR: "IN USE (control function)"	The transducer cannot be assigned because it is already in use for the indicated control_function.
ERR: "HYDRAULIC SLAVE"	The unit cannot request pressure because it is a hydraulic slave.
ERR: "INHIBIT ON "device number"	The device numbered "device number" is inhibiting pressure request or test start.
ERR: "KiNET ACTIVE"	The unit cannot be made a KiNet Master Clock because there is already a KiNet Master Clock active.
ERR: "KiNET INACTIVE"	The operating mode cannot be changed from stand-alone because there is no KiNet Master Clock.
ERR: "NO MASTER"	The operating mode cannot be set to slave (test or test and hydraulic) because there is no group master for the current group.
ERR: "MASTER HAS OIL"	The operating mode cannot be set to Test & Hydraulic Slave because the Master currently has pressure.
ERR: "GROUP IN USE"	i) The operating mode cannot be set to Master because the group already has a Master OR ii) The group cannot be changed on a Master because there is already a Master on the target group.
ERR: "CHANNEL IN USE"	The device number cannot be set because there is already a unit driving that channel.
ERR: "NO MASTER"	i) The unit cannot be set to Slave because there is no Master OR ii) The group cannot be changed on a Slave because there is no Master on the target group.



ERR:	"NO LOAD TX"	i) The Peak Control Source cannot be set to LOAD because there is no LOAD Tx OR ii) The Local Limit Action cannot be set to Change to Load Mode because there is no Load Tx.
ERR:	"NO DISP TX"	i) The Peak Control Source cannot be set to DISP because there is no Displacement Tx OR ii) The Local Limit Action cannot be set to Change to Displacement Mode because there is no Displacement Tx.
ERR:	"NO AUX TX"	The Peak Control Source cannot be set to AUX because there is no Auxiliary Tx.
ERR:	"NO TEST TX"	The Peak Control Source cannot be set AS TEST because there is no Test Tx.
ERR:	"LOW THRESHOLD"	The Upper Peak Level cannot be set any lower because it has the same value as the Lower Peak Level.
ERR:	"HIGH THRESHOLD"	The Lower Peak Level cannot be set any higher because it has the same value as the Upper Peak Level.
ERR:	"NO LOAD MODE"	The Load Limited Displacement control mode cannot be enabled because there is no LOAD Tx.
ERR:	"LOC LIM TO LOAD"	The LOAD Tx cannot be unassigned because the Local Limit Action is set to Change to Load Mode.
ERR:	"LOC LIM TO DISP"	The DISP Tx cannot be unassigned because the Local Limit Action is set to Change to Disp Mode.
ERR:	"SP TOO BIG"	The Set Reference Zero cannot be performed as the Set Point is outside the Valid range of ±53%
INF:	"NOT APPLICABLE"	There are no parameters for the currently selected test type.
INF:	"n SLAVE(s)"	There are currently **n** Slaves detected by the Master.
INF:	"COMPLETE"	The self-tune process has completed. (Note that self-tune is automatically disabled once this message has been displayed).
INF:	"ADJUST 'IG'"	The self-tune process is adjusting the Integral gain term.
INF:	"ADJUST 'PG'"	The self-tune process is reducing the Proportional gain term.

INF:	"CHECK 'PG'"	The self-tune process is adjusting the Proportional gain term.
INF:	"ADJUST 'SG'"	The self-tune process is adjusting the Servo gain term.
INF:	"INIT"	The self-tune process is initialising.
INF:	"PILOT WAITING"	The system has obtained PILOT pressure and will not request LOW or HIGH pressure until the appropriate key is pressed. (This is for tuning the inner loop on a three-stage valve).
INF:	"Press SELECT first"	The diagnostics screen can only be removed by pressing the SELECT key.
INF:	"KEY DOWN: key name"	The key named key has been pressed continually.
INF:	"EXPLAIN..."	The Master is requesting the channel that is inhibiting the pressure or the test to explain why. This message is followed by an Inhibit message.
LIM:	"Limit name"	The named limit has tripped.

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