MAIN BEARING TEMPERATURE MONITORING SYSTEM

OPERATION MANUAL

CONTENTS

1 References

REFERENCE DOCUMENTATION	
ITEM	DESCRIPTION
1	MJR Drawing No. POIS_001_E0_AF.DWG, EDITION 1, DATE:29/08/2002

2 Overview

The MJR Controls Bearing Monitor is designed to continuously monitor the temperature of the main bearings in a marine diesel engine in order to assist in preventing catastrophic damage to the crankshaft main bearing journals in the event of a bearing failure.

Wherever possible, the system is constructed from readily available, field proven industry standard components and is based around a PLC (Programmable Logic Controller) in order to provide the reliability, flexibility and power required to implement a sophisticated monitoring system.

The system is designed to interface to most common types of probes such as Thermocouple, Pt100 and Thermistor. In this particular installation NTC Thermistor probes are installed.

The monitoring unit carries out signal conditioning, galvanic isolation and linearization of the probe inputs to produce the correct engineering units (in this case ^{o}C) and the actual temperature values are presented on a user friendly Human Machine Interface (HMI).

High (H) and High High (HH) alarm limits are applied to the actual temperature values to give a first stage pre-alarm (H), followed by a second stage shutdown (HH). Each alarm limit on each channel can be individually preset, allowing compensation for the normal running variations of bearing temperatures across the engine. The H and HH alarm limits can be set and viewed on the HMI.

H and HH alarm states are indicated on the HMI and individual voltage free alarm relay outputs are provided for each engine for signaling of H and HH alarm states. The H alarm relay output will typically be connected to the main machinery monitoring system to provide a pre-alarm indication and the HH alarm relay will typically be connected to the main engine shutdown circuit/system to provide an automatic stop.

A facility is also included to allow overriding of the shutdown outputs in certain circumstances such as maneuvering. When this inhibit is activated, the HH alarm functions as normal but the relay output is not activated. The inhibited state is indicated by a panel front LED.

3 Specification

The specification for this application is…

POWER SUPPLY……	24 VDC (+10%, -15%) 50W.	
ENVIRONMENTAL…….	Ambient Temperature	0–55° C (in operation) –20 ±70° C (in storage)
	Ambient Humidity	35–85% RH, no condensation (in operation)
	Vibration Resistance	10–55Hz 0.5mm (0.02 in.) (Max. 2G) 2 hours in each of 3 axis directions (0.5G on DIN rail)
	Shock Resistance	10G 3 times in 3 directions
	Noise Immunity	1000 Vpp noise voltage, 1 µs pulse width at 30–100Hz
	Operating Environment	Free from corrosive gasses. Dust should be minimal

INPUTS……. 14 Channels NTC Thermistor.
Range: 30 – 130°C.
Individually galvanically isolated to 1500vdc.

USER INTERFACE Colour Graphics HMI (LCD).
Continuous bar graph channel presentation.
Continuous indication of channel alarm limits.
Continuous indication of channel alarm status.
Keypad for alarm limit adjustment.

ALARMS…… Individual High (H) & High-High (HH) on each input channel.
H ALARM when **ACTUAL VALUE >= H ALARM SETPOINT**.
HH ALARM when **ACTUAL VALUE >= HH ALARM SETPOINT**.
User adjustable alarm limits over full sensing range.

OUTPUTS……. **H ALARM** - single pole changeover volt free contacts.

DE-ENERGIZED ON H ALARM.

HH ALARM - single pole changeover volt free contacts.
ENERGIZED ON HH ALARM.

SYSTEM FAIL ALARM - single pole changeover volt free contacts
DE-ENERGIZED ON FAIL when…

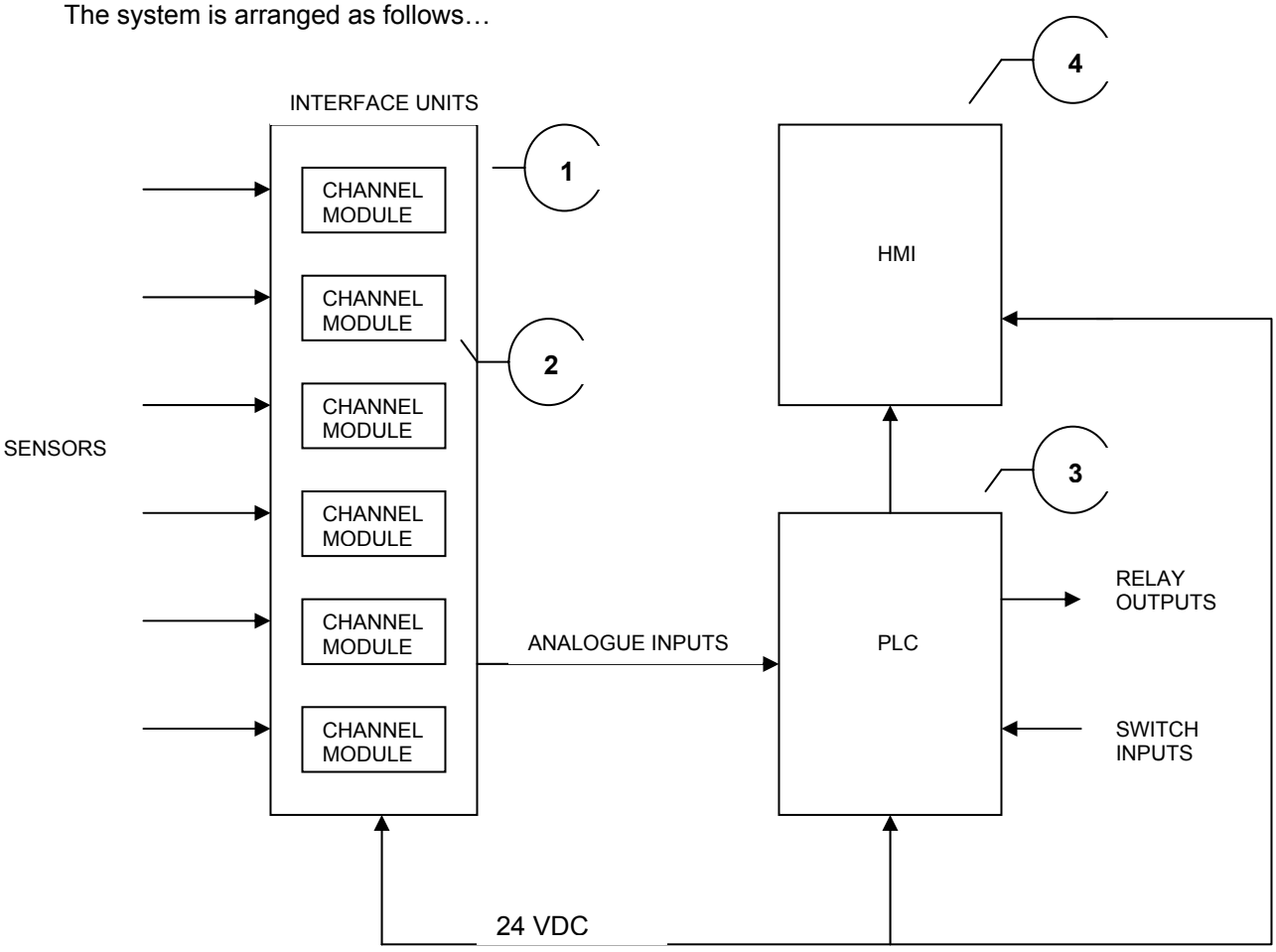
- Power failure
- PLC not running/failure

INHIBITS…….. Keyswitch inhibit on HH relay output only, HH alarm functions normally. Inhibited state indicated by red LED on panel front.

4 Hardware Description

As far a practically possible, readily available, off the shelf industry standard hardware is used throughout the design.

The system is arranged as follows…



The sensors (thermistors) are connected to hardware based interface units **(1)** which consists of individual isolated channel modules **(2)** that provide the following functions…

- Galvanic isolation between the inputs so that an earth leakage problem on one input does not affect the others. This also provides protection to the PLC system in the event that extremes of voltage are applied to individual inputs such as inadvertent high voltage insulation (“megger”) testing or connection to other extraneous voltage sources.

  In these cases only the input channel module **(2)** concerned would be damaged and the remainder of the system would remain unaffected. The damaged module can then be replaced quickly, simply and at low expense.

- Amplification & linearization to convert the highly non-linear sensor output to a signal level compatible with the PLC.

The isolated, conditioned sensor signals from the interface units **(1)** are then connected to the PLC **(3)** via analogue input units.

The PLC **(3)** runs the software routines that carry out the following functions…

- Sensor signal processing.
- Data display on HMI **(4)**.
- Alarm limit comparators.
- Output switching.
- Fault detection.

In common with most PLCs, the software is executed continuously in a sequential manner and is written in either ladder or symbolic instruction code. At the start of the program sequence an input read cycle is executed that reads all inputs and stores their values in data registers for use during the remainder the of the program sequence.

As the program executes, the status of the various outputs are affected by the program however, none of the outputs states are actually altered during the program sequence. At the end of the program sequence a final cycle is executed which writes the output states to the outputs.

The application software that is executed by the PLC is stored in RAM which is battery backed up. A further backup is provided by non-volatile EEPROM. If the battery becomes discharged and the power is removed, the RAM memory will be lost. If this is occurs, the EEPROM backup memory is automatically loaded into RAM and the application program executes normally with no operator intervention required.

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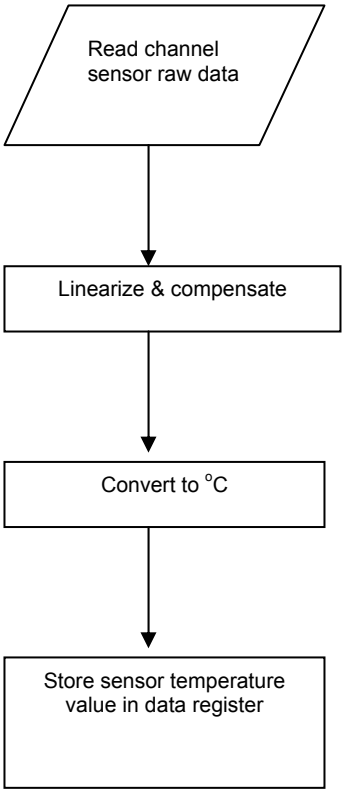
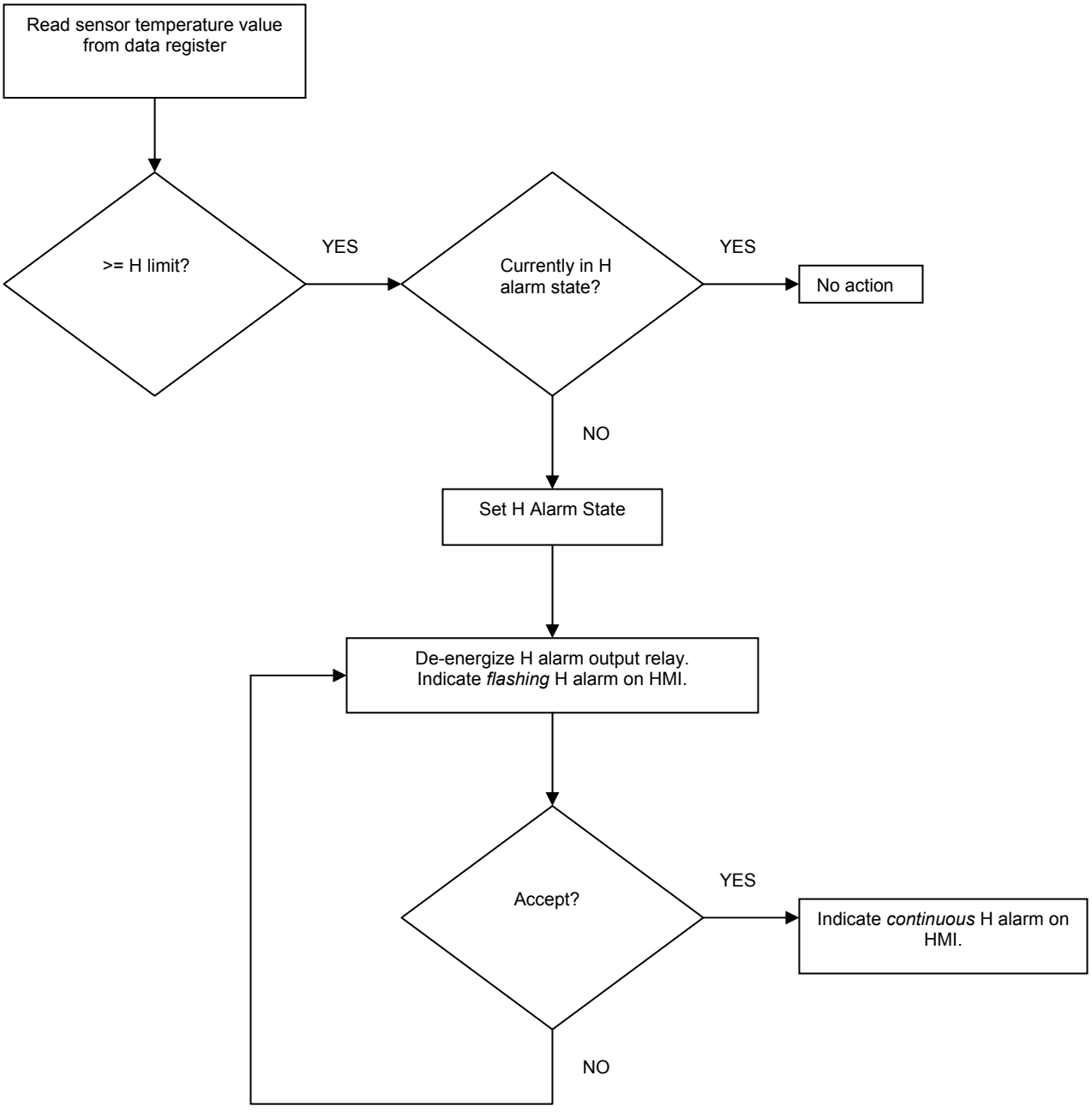
5 Software

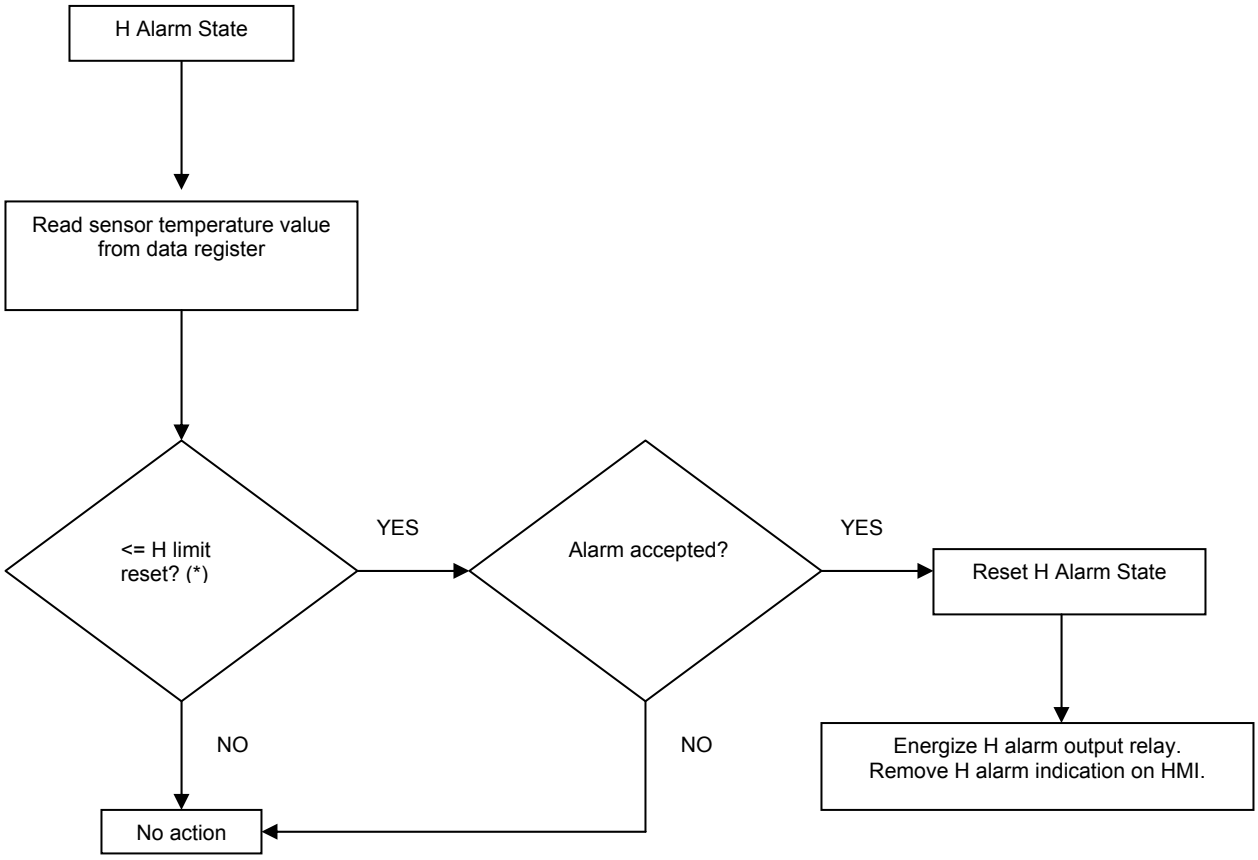
The software is the same for every sensor channel and operates as follows…

5.1 Sensor signal processing



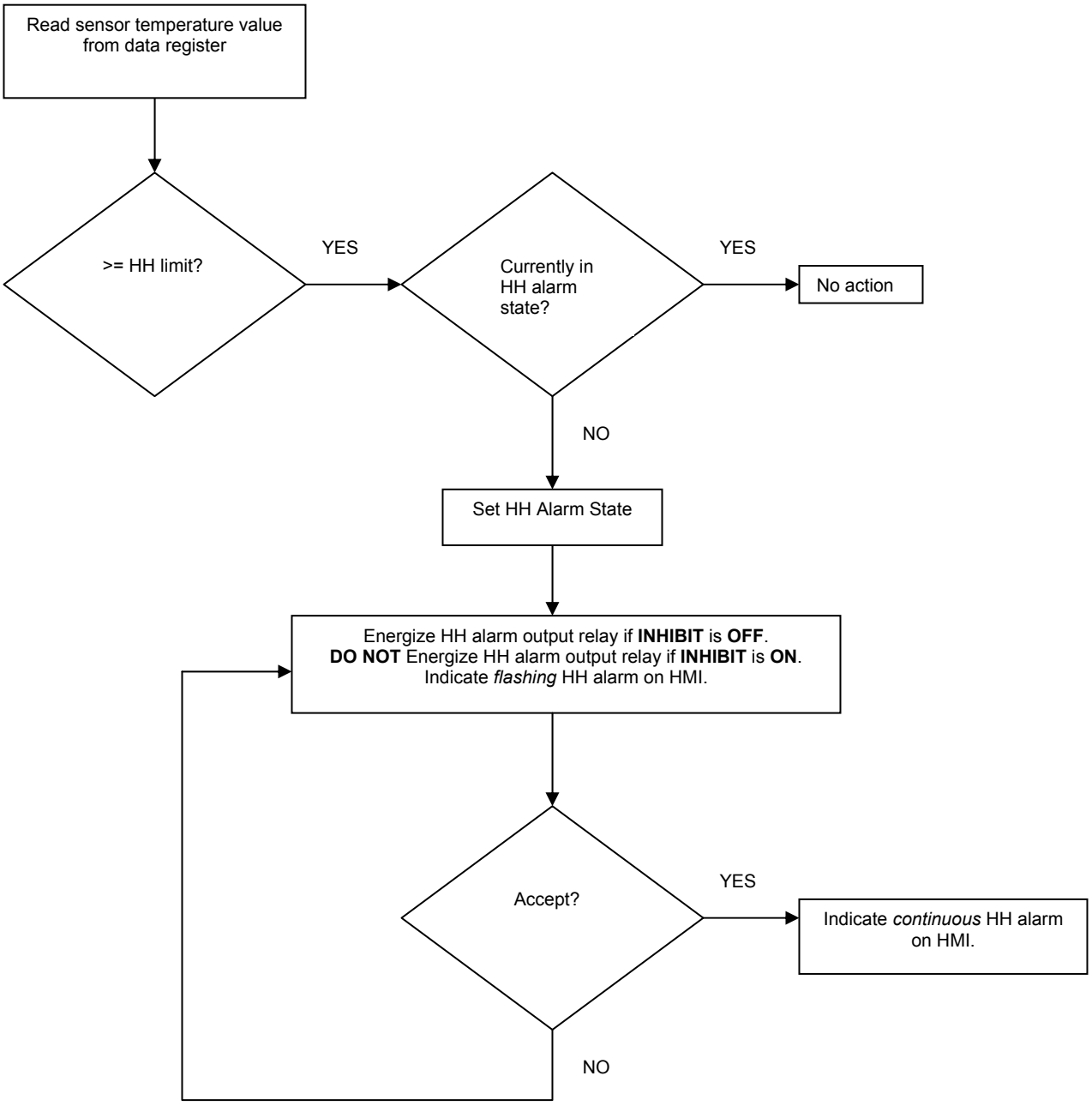
5.2 H alarm limit comparator & state setting

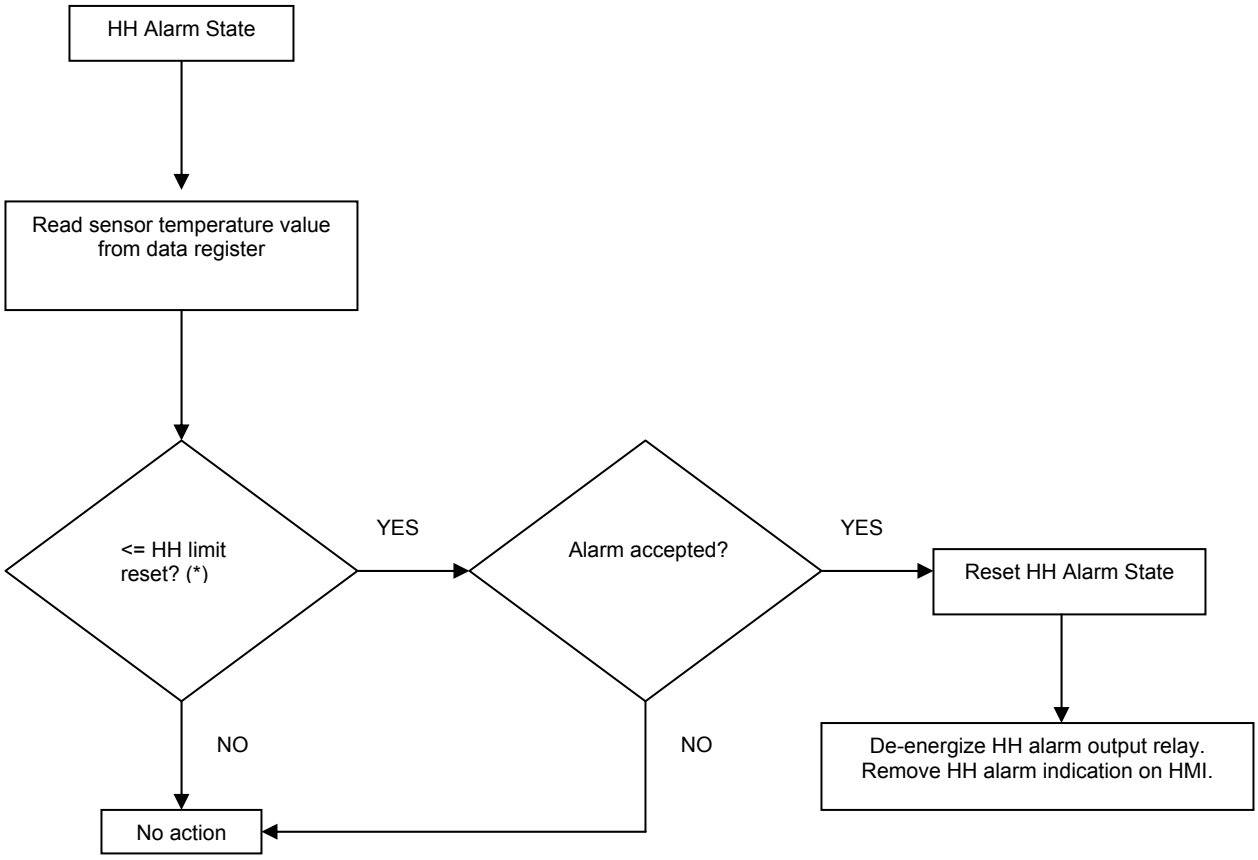




(*) H limit reset = H limit – reset hysterisis value

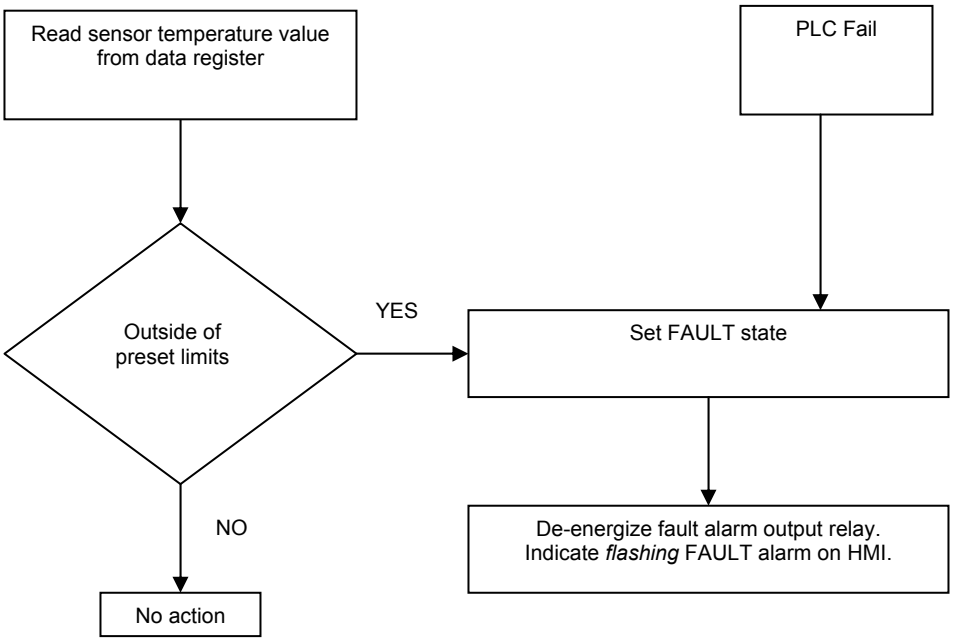
5.3 HH alarm limit comparator & state setting

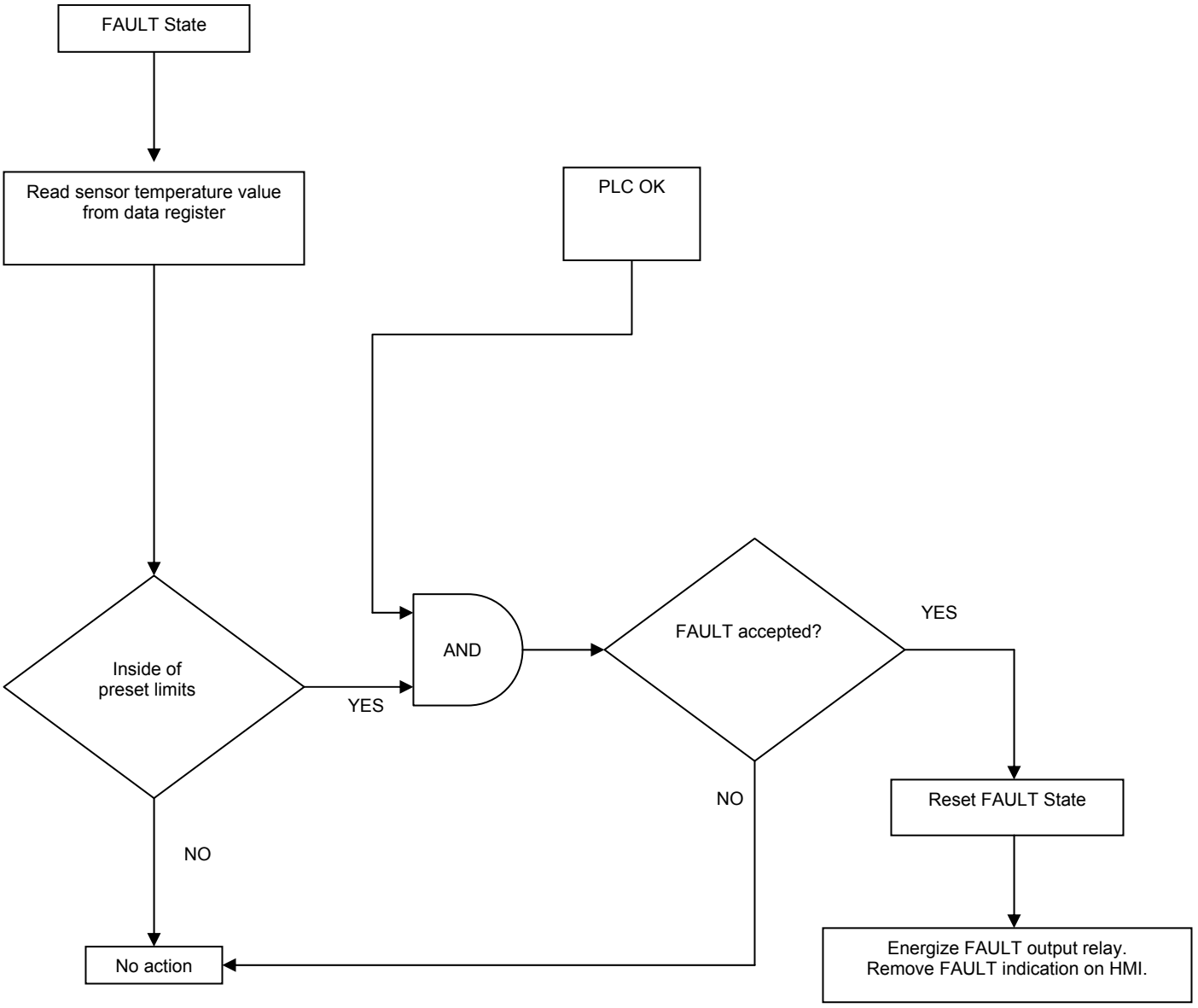




(*) HH limit reset = HH limit – reset hysterisis

5.4 Fault detection





Note: on power failure the FAULT relay will de-energize.

6 Operation

Operation is carried out from the panel front HMI (which comprises a number of graphics screens, membrane keys and LEDs) and panel front pushbuttons.

The HMI is used to…

- Display the bearing temperatures graphically & numerically grouped by engine.
- Display alarm summary screens.
- Enable to user to carry out trending on individual channels.
- Enable the user to modify alarm (H) and shutdown (H-H) set points.

The panel pushbuttons are used to…

- Silence the buzzer.
- Accept alarms.
- Test the shutdown inhibit lamps and buzzer.

6.1 HMI Operation

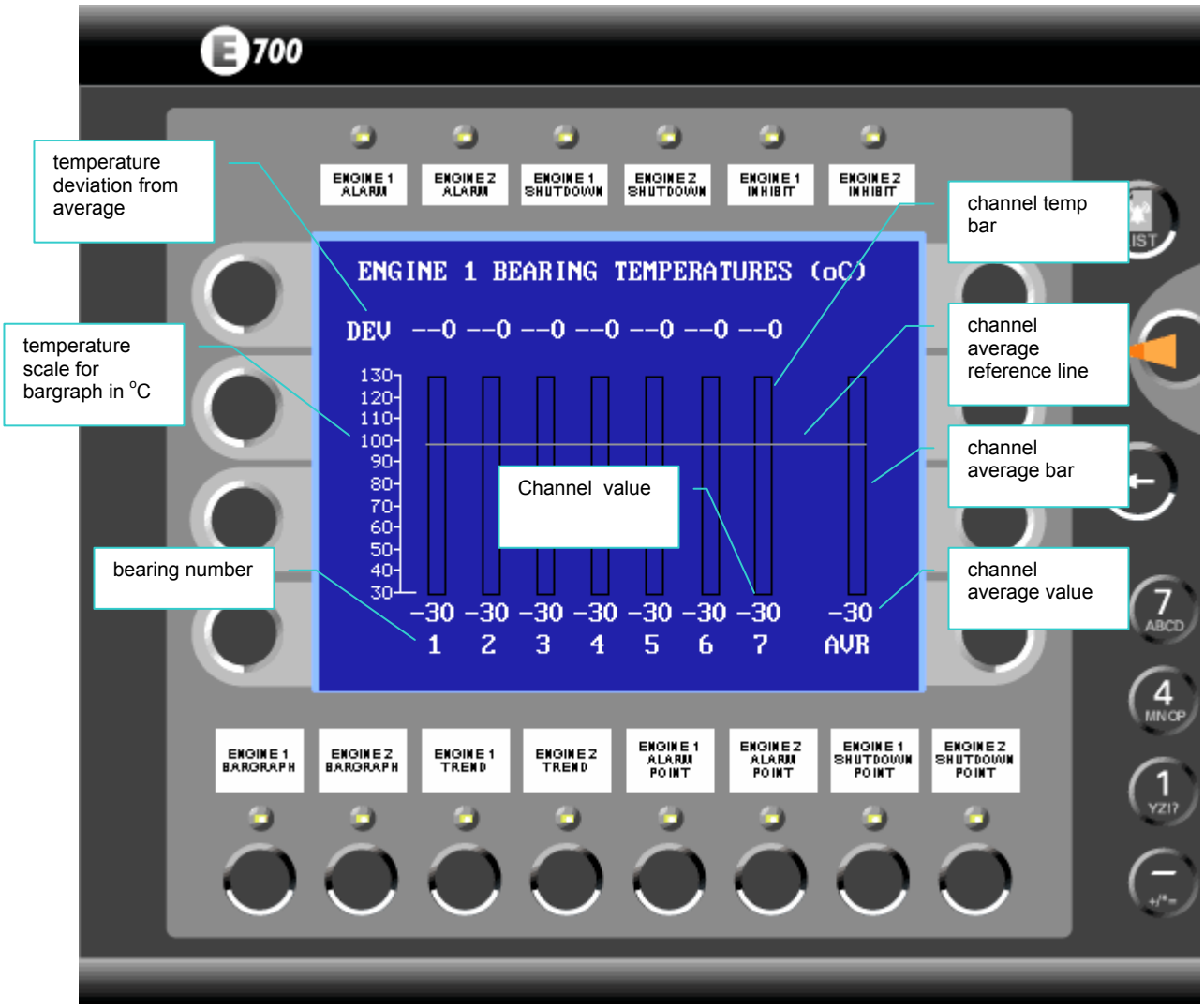
The HMI is arranged as follows and comprises a number of operator screens accessed from the membrane keys (beneath the screen) and a row of status LEDs located above the screen.

Status LEDs flash red to indicate an unaccepted alarm or shutdown condition.
Status LEDs are lit continuously when the alarm is accepted (but not reset).
Status LEDs operate irrespective of the selected graphics screen.

Membrane keys and LEDs are used to select and indicate the individual graphics pages. Pressing the key activates the graphics page labeled.

ENGINE 1 BARGRAPH is displayed in this example and explained in more detail in 6.2.

6.2 Engine # Bargraph



This screen continuously displays the bearing temperatures in both absolute and deviation format with graphical and numerical value presentation.

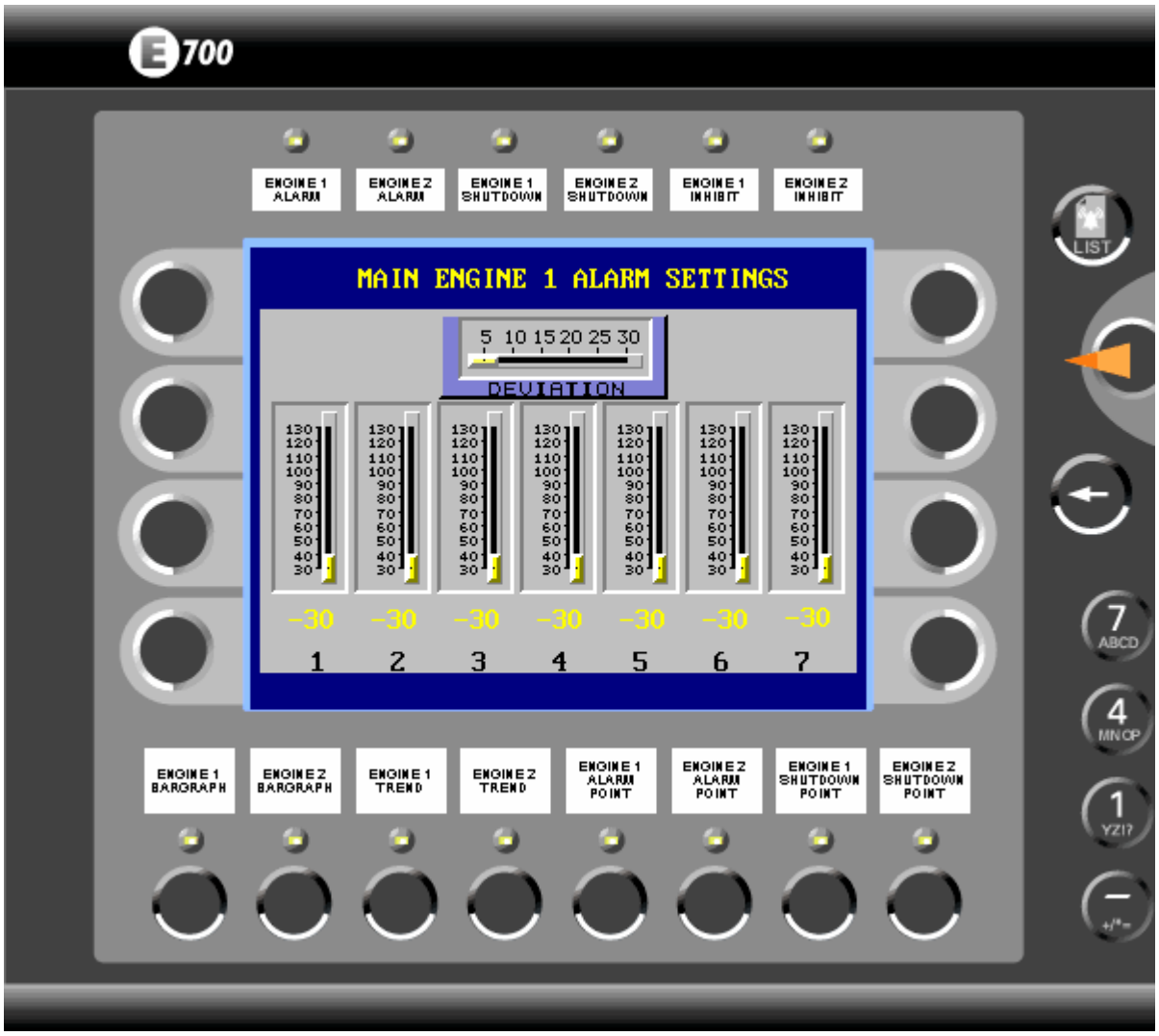
- Channel bars are coloured green beneath the H limit, yellow between the H and H-H limits and red above the H-H limit.
- When a channel is in fault condition (out of range) the channel bar flashes.
- The average channel value is displayed as a bar, a value and a dynamic reference line that moves vertically making it easy to see if an individual channel value is significantly different from the average reading.
- Engine 1 & 2 Bargraph screens are identical in operation.

6.3 Engine # Trend

With this screen the user can record or “trend” an individual bearing temperature in real time. This is useful when faultfinding.

- When the trend screen is selected for either engine 1 or 2 the above style screen is presented. Choose which channel to trend by pressing the appropriate membrane key (numbered 1 – 7).
- When the key is pressed, trending begins in real time and the trend trace is displayed on the screen.
- To change the trend time base, press the ENTER key and a box is displayed allowing changes to be made. Once the changes have been made press the ENTER key again to apply them.
- Engine 1 & 2 Trend screens are identical in operation.

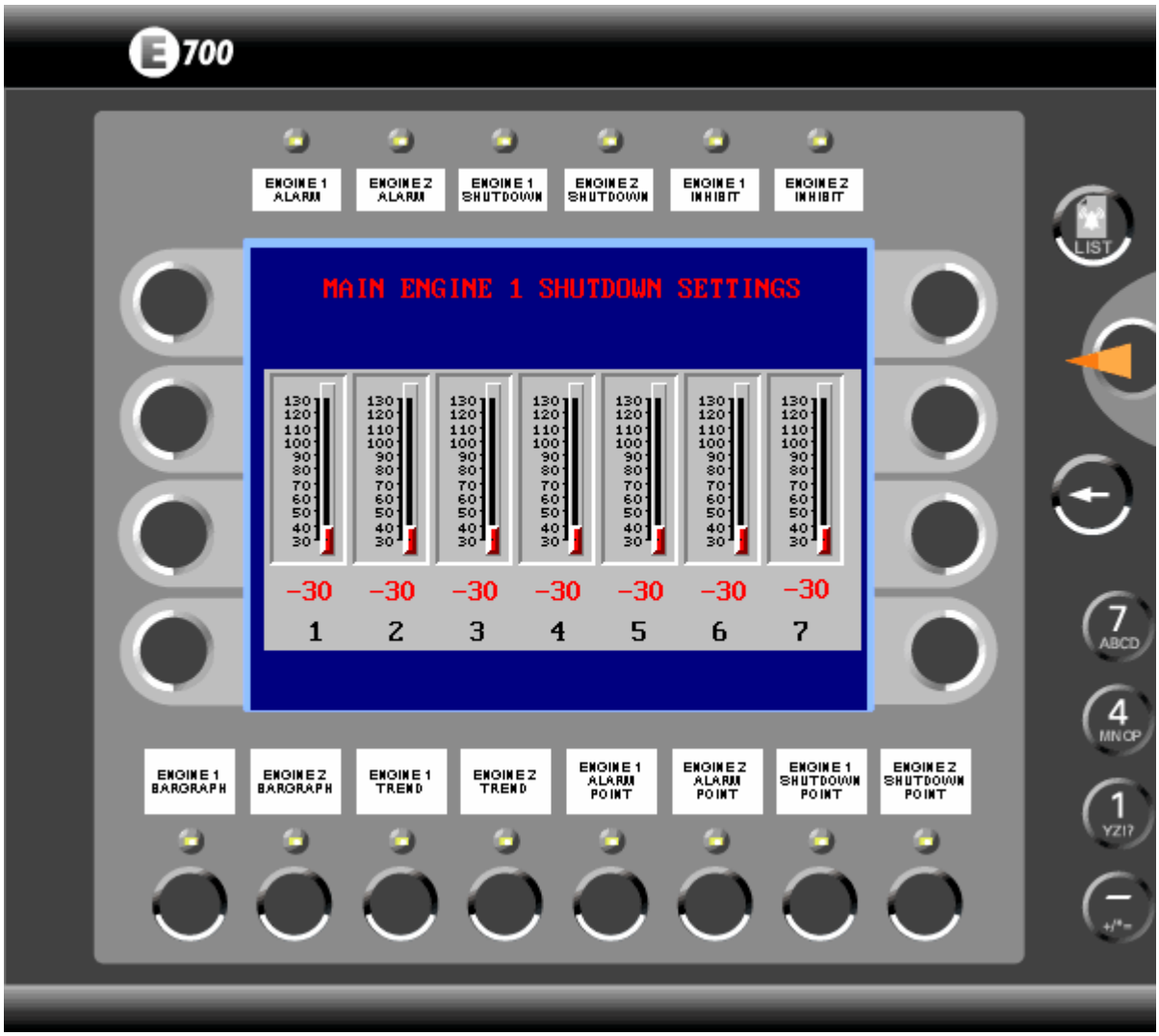
6.4 Engine # Alarm Point



With this screen the user can modify the alarm (H) set points.

- When the alarm point screen is selected for either engine 1 or 2 the above style screen is presented and set points at which the alarm will operate can be changed. Individual set points can be applied to each individual channel (numbered 1 – 7).
- To change the set point value use the ORANGE LEFT AND RIGHT KEYS (top right hand side of the panel) and highlight the channel that is to be modified.
- When the relevant channel is highlighted, press the ENTER key and use the ORANGE UP AND DOWN KEYS (top right hand side of the panel) to increase or decrease the value by moving the slider up or down.
- When the correct value is selected press the ENTER key and the new value becomes active.
- Engine 1 & 2 Alarm Point screens are identical in operation.

6.5 Engine # Shutdown Point



With this screen the user can modify the shutdown (H-H) set points.

- When the shutdown set point screen is selected for either engine 1 or 2 the above style screen is presented and the operator can select and change the set points at which the shutdown will operate. Individual set points can be applied to each individual channel (numbered 1 – 7).
- To change the set point value use the ORANGE LEFT AND RIGHT KEYS (top right hand side of the panel) and highlight the channel that is to be modified.
- When the relevant channel is highlighted, press the ENTER key and use the ORANGE UP AND DOWN KEYS (top right hand side of the panel) to increase or decrease the value by moving the slider up or down..
- When the correct value is selected press the ENTER key and the new value becomes active.
- Engine 1 & 2 Shutdown Point screens are identical in operation.

6.6 Alarm Screen

When an alarm occurs a bell icon is displayed on the currently displayed screen. Press the LIST key to go to the alarm screen which displays the alarms in a text format.

To accept the alarms either use the ACCEPT pushbutton on the panel front or the ACK key on the HMI. It is recommended to accept alarms using the ACCEPT pushbutton to prevent unnecessary wear on the HMI membrane keypad.