

Tactical

Multi-Stage Thermostat 505MST/M for MK3 HST

Instruction Manual

Contents

Introduction	2
System control	2
Temperature setpoints	2
Lower level damper solenoid	5
Sensor	6
Installation	7
Test and calibration	8
System layout diagram	9
System connection diagram	10
Internal board layout diagram	11
Sensor dimensional drawing	12
Technical Specification	13
Ordering information	15
Supplier information	15

Copyright (C) 1998 Tactical Controls Limited

This document contains proprietary information which is protected by copyright. All rights reserved. This document or parts thereof may not be reproduced in any form without written permission of the publishers.

The information in this document is subject to change without notice and should not be construed as a commitment by Tactical Controls Limited. Tactical Controls Limited shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance or use of this material.

Introduction

The 505MST/M is an electronic five-stage thermostat which caters for the heating and cooling requirements on the MK3 HST trailers, replacing a electromechanical device.

The 505MST/M is an intelligent thermostat unit. Its design is based on the latest micro-controller chip technology.

Special features of the 505MST/M include: the 'Winter/Summer' temperature compensation, prevention of temperature overshoot and undershoot, selectable setpoint temperature switchings and time-delay.

System control

The 505MST/M Electronic Thermostat consists of two sensor inputs; one sensor monitors the saloon temperature and the second sensor monitors the ambient (outside air) temperature.

The Thermostat has five relay outputs. These are primarily used for the switching of:

1. Heater 1
2. Heater 2
3. Heater 3
4. Low level damper solenoid
5. Cooling

The relay outputs are designed to drive externally connected contactors.

Temperature setpoints

Table A, B and C give four possible manually selectable saloon temperature setpoints for the winter period.

Note 1: Under Table A, the winter and summer periods use the same temperature switching points.

Note 2: Under Table B and C, the settings are for the winter periods.

Note 3: During the summer period, the 505MST/M automatically use Table A settings. However, during the winter period, there are three possible temperature settings, depending on the setpoint switch (see Table S2).

Table A, Output switching (SW3=0, SW4=0)

Output	State	Temperature	Description
H3	OFF	18.5°C	16KW ON
	ON	17.5°C	24KW ON
H2	OFF	20.5°C	8KW ON
	ON	19.5°C	16KW ON
H1	OFF	21.5°C	Heat OFF
	ON	20.5°C	8KW ON
LLDS	ON	21.5°C	LLDS energised (no timer)
	TD then OFF	20.5°C	After timer-delay (TD), LLDS de-energised
C	ON	22.5°C	Cooling ON
	OFF	21.5°C	Cooling OFF

Table B, Output switching (SW3=0, SW4=1)

Output	State	Temperature	Description
H3	OFF	19.5°C	16KW ON
	ON	18.5°C	24KW ON
H2	OFF	21.5°C	8KW ON
	ON	20.5°C	16KW ON
H1	OFF	22.5°C	Heat OFF
	ON	21.5°C	8KW ON
LLDS	ON	22.5°C	LLDS energised (no timer)
	TD then OFF	21.5°C	After timer-delay (TD), LLDS de-energised
C	ON	23.5°C	Cooling ON
	OFF	22..5°C	Cooling OFF

Table C, Output switching (SW3=1, SW4=0)

Output	State	Temperature	Description
H3	OFF	20.5°C	16KW ON
	ON	19.5°C	24KW ON
H2	OFF	22.5°C	8KW ON
	ON	21.5°C	16KW ON
H1	OFF	23.5°C	Heat OFF
	ON	22.5°C	8KW ON
LLDS	ON	23.5°C	LLDS energised (no timer)
	TD then OFF	22..5°C	After timer-delay (TD), LLDS de-energised
C	ON	24.5°C	Cooling ON
	OFF	23.5°C	Cooling OFF

H3 - Heater 3; **H2** - Heater 2; **H1** - Heater 1; **C** - Cool; **LLDS** - Low level damper solenoid.

Automatic winter/summer switching

An ambient sensor is fitted inside the thermostat unit and must be exposed to the ambient temperature.

There are three possible winter/summer switching temperature, the selections are made using the (SW1 and SW2) of the 4-way (dual-in-line) switch. See Table S1.

For example, using Table S1 (SW1=0, SW2=1). During the rising ambient temperature and at 15°C, the unit automatically switches to summer period; during a falling temperature and at 12°C, the unit automatically switches to winter period.

Table S1, Winter/summer setpoint switch

SW1	SW2	Winter	Summer
0	0	<9°C	>12°C
0	1	<12°C	>15°C
1	0	<15°C	>18°C
1	1	<12°C	>15°C (default value)

Note that the SW1 and SW2 setpoint switches will not be provided in the final production units, as the temperature switching would be decided after the trial period.

Winter/summer LED indication

A green Led becomes illuminated to indicate a summer ambient temperature. This LED is visible from the outside of the MST505/M unit, via the clear perplex window.

With reference to Table S1, the green LED becomes illuminated when the ambient temperature reaches 12°C or 15°C or 18°C during the rising temperature.

The LED is off when the temperature falls below 9°C or 12°C or 15°C.

The LED is useful during testing and commissioning, as it is the only indication for ambient temperature. For example, if the LED is off, it is in the winter switching condition and that Table B is referred to (if SW3=0, SW4=1); if the green LED is on, Table A is referred to (refer to Note 3 of clause 3).

Temperature setpoint switch

A PCB mounted, SW3 and SW4 parts of the 4-way (dual in line) switch is used for the selections of temperature settings. There are three possible temperature settings, as shown under Table S2.

Note that during the summer period (green LED on), the unit automatically refers to Table A temperature settings.

Table S2, Temperature setpoint switch

SW3	SW4	Descriptions
0	0	Table A
0	1	Table B
1	0	Table C

Lower level damper solenoid (LLDS)

The LLDS is energised to close the damper whilst in the "Vent" or "Cooling" stages.

The LLDS is energised when the VENT LED is ON. LLDS is de-energised when the VENT LED is OFF.

During rising temperature, when heater 1 (H1) is switched OFF, the LLDS is immediately energised.

LLDS time delay

During falling temperature, from "Vent on", to "Heater 1 on"; there is a time delay before the LLDS could be de-energised, that is "Vent off". If however, in the event that the saloon temperature rises again above the "H1 off", the timer would be reset to zero and that the LLDS would remain energised.

The time delay is adjustable between 30 to 158 seconds using a 25-turn encapsulated potentiometer. Clockwise adjustment increases the time delay.

The LLDS time delay potentiometer is located on the top left-hand corner of the PCB, easily identified with the following legends on the PCB (please refer to Internal board layout diagram for detail):

PT
FULLY CW - 120 SEC
FULLY CCW - 30 SEC

Note: CW indicates ClockWise. CCW indicates Counter ClockWise.

IMPORTANT

It is important to note that the time delay PT potentiometer is the only potentiometer which is user adjustable.

DO NOT adjust the other three potentiometers, PA, PS and PZ - these are used for factory calibration adjustments.

Sensor

There are two temperature sensors in each 505MST; saloon sensor and ambient sensor.

Saloon sensor

The saloon sensor is a platinum resistance thermometer PT100 to BS1904 class B, with error not greater than ± 0.3 °C, 2-wire connection.

A two core, screened cable is used; type BR Cat.No: 6/146700; the screen of the cable is connected to the SCREEN terminal provided inside the unit. The distance between the sensor and the thermostat unit must be less than 5 metres.

The saloon sensor is located outside the 505MST/M unit and is connected to the inside of the unit via a common cable gland.

Please refer to the Sensor dimensional drawing for detail.

Testing of saloon sensor

To test the saloon sensor, it is necessary to use the TC1000 portable test-jig, by simply plug in the Litton plug of the TC1000 test-jig into the 505MST/M diagnostic socket. If the saloon sensor is healthy, it would indicate a correct temperature on the TC1000 LCD display.

If the saloon connection to the 505MST/M unit is broken, the TC1000 would show a "1bbb" reading (b: blank display).

Ambient sensor

The ambient sensor is a Negative Temperature Coefficient sensor (NTC), type 10KA31; it has a temperature accuracy of ± 0.2 °C.

The ambient sensor is fitted inside the 505MST/M, for this reason the 505MST/M thermostat assembly must be located, so that it is exposed to the ambient temperature.

The ambient sensor is located at the top, left-hand side of the PCB, clearly identified with the legion "NTC".

Testing of ambient sensor

The ambient sensor works in association with the green LED; during the summer period, the green LED is on.

During testing, the ambient sensor could be fooled into winter by spraying it with an Aerosol Freezer (RS 497-274), this would result the green LED to turn off.

During the winter period (green LED off); if a warm finger touches the ambient sensor (NTC), it would turn the 505MST/M into summer period, as indicated by the green LED becoming on.

Installation

Please refer to System layout diagram for details.

Fixings

The 505MST/M thermostat unit could be mounted in any orientation by 4xM6 fixing holes.

Electrical connection

Please refer to System connection diagram for details.

Supply connection

The 505MST/M thermostat is powered by a 110Vdc and connection is made to the M4 stud terminal marked "0" and "110".

The '0' volt terminal is to be connected to an external earth point (it is not connected to the thermostat internal earth).

The thermostat 110Vdc inputs are reverse polarity protected.

Output connection

There are six M4 stud terminals for output connection: A1, A2, A3, A4, A5 and A6.

The A1 terminal is connected to the "COMMON" of the five thermostat relays.

Terminals A2, A3 and A4 are connected to external heater contactors, namely: Heater 3 (via FADSR), Heater 2 and Heater 1 respectively.

Terminal A5 is connected to drive the Lower lever damper solenoid (LLDS).

Terminal A6 is connected to the external Cool contactor.

Supply and outputs Terminal

Terminals	Descriptions
A1	Common supply of output relays, 415Vac or 110Vdc
A2	Heater 3 and Fresh air damper
A3	Heater 2
A4	Heater 1
A5	Lower level damper solenoid
A6	Cooling
0V	Supply 0Vdc
110Vdc	Supply 110Vdc

Termate M4 stud terminals are used; these have a voltage clearance of 20mm and 25mm creepage distance and is suitable for 415Vac switching.

Non-metallic fixings are used on the terminal to meet the voltage clearance requirement.

Sensor connection

The saloon sensor, external to the thermostat unit, has three wire connections, a screen (green) and two sensor wires (red and blue). It is supplied with 250mm of screen cable, type BR Cat. No. 6/146700.

The green wire is to be connected to the M4 stud terminal marked "SCREEN" inside the thermostat unit; the two sensor wires (red and blue) can be connected in any order to the M4 terminal marked "0V" and "SALOON" (the PT100 sensor is a passive resistive device and has no polarity).

The other sensor, which senses the ambient temperature, is factory fixed inside the thermostat unit.

Sensor terminal

Terminals	Descriptions
SALOON	Saloon air sensor (to be connected)
0V	Supply 0Vdc terminal
SCREEN	Sensor screens

A 3-way Termate M4 stud terminals are used for the connections of the saloon sensor.

Diagnostic Test socket

Terminals	Descriptions
SALOON	Saloon air sensor
0V	Common returns from sensor and supply
20Vdc	Supply to TC1005 test equipment

A 5-way Litton rear-panel mounted receptacle is fitted to the thermostat unit.

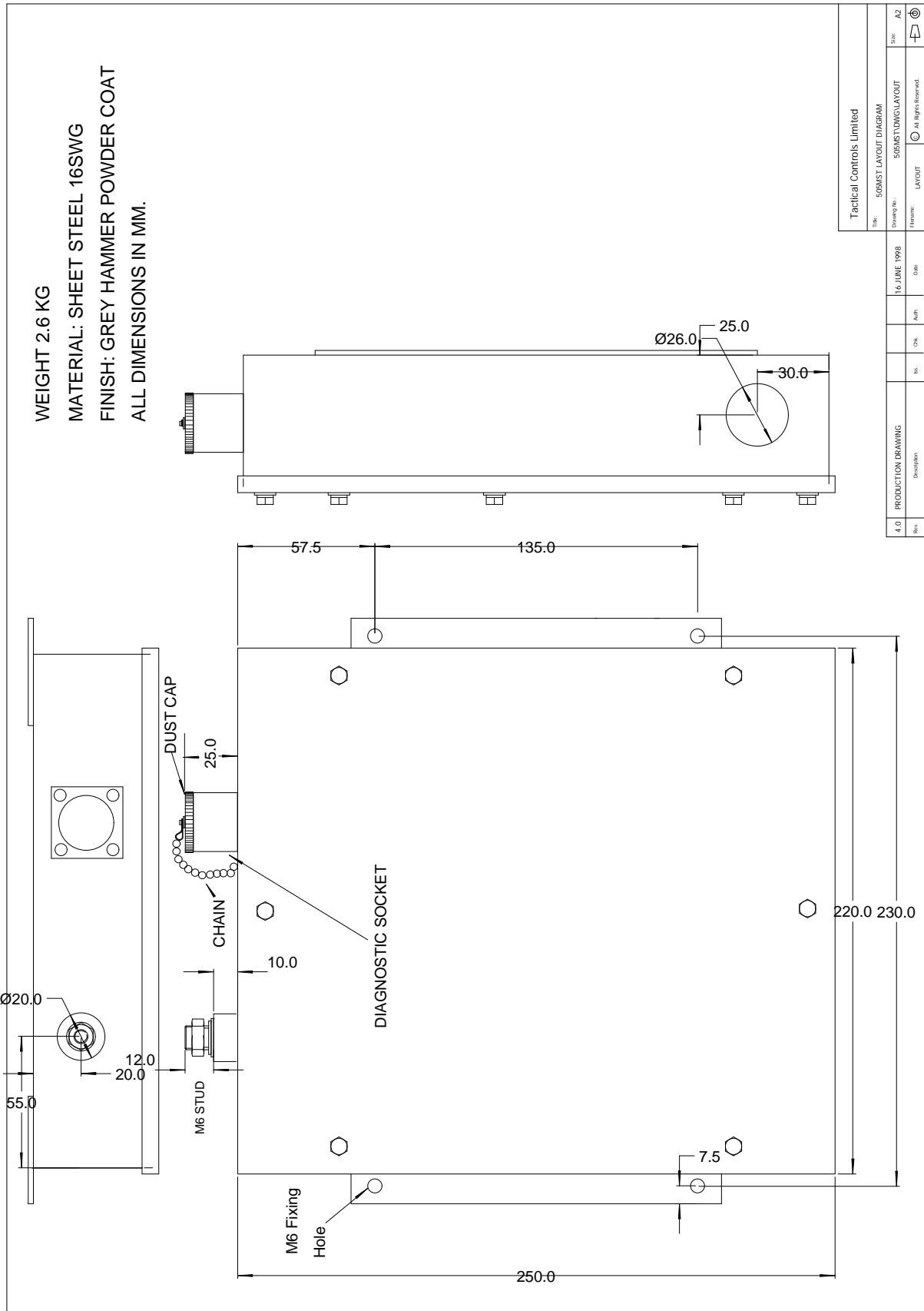
Test and calibration

The 505MST/M thermostat units can be tested and calibrated on site with a dedicated Test and Calibration unit, model TC1000.

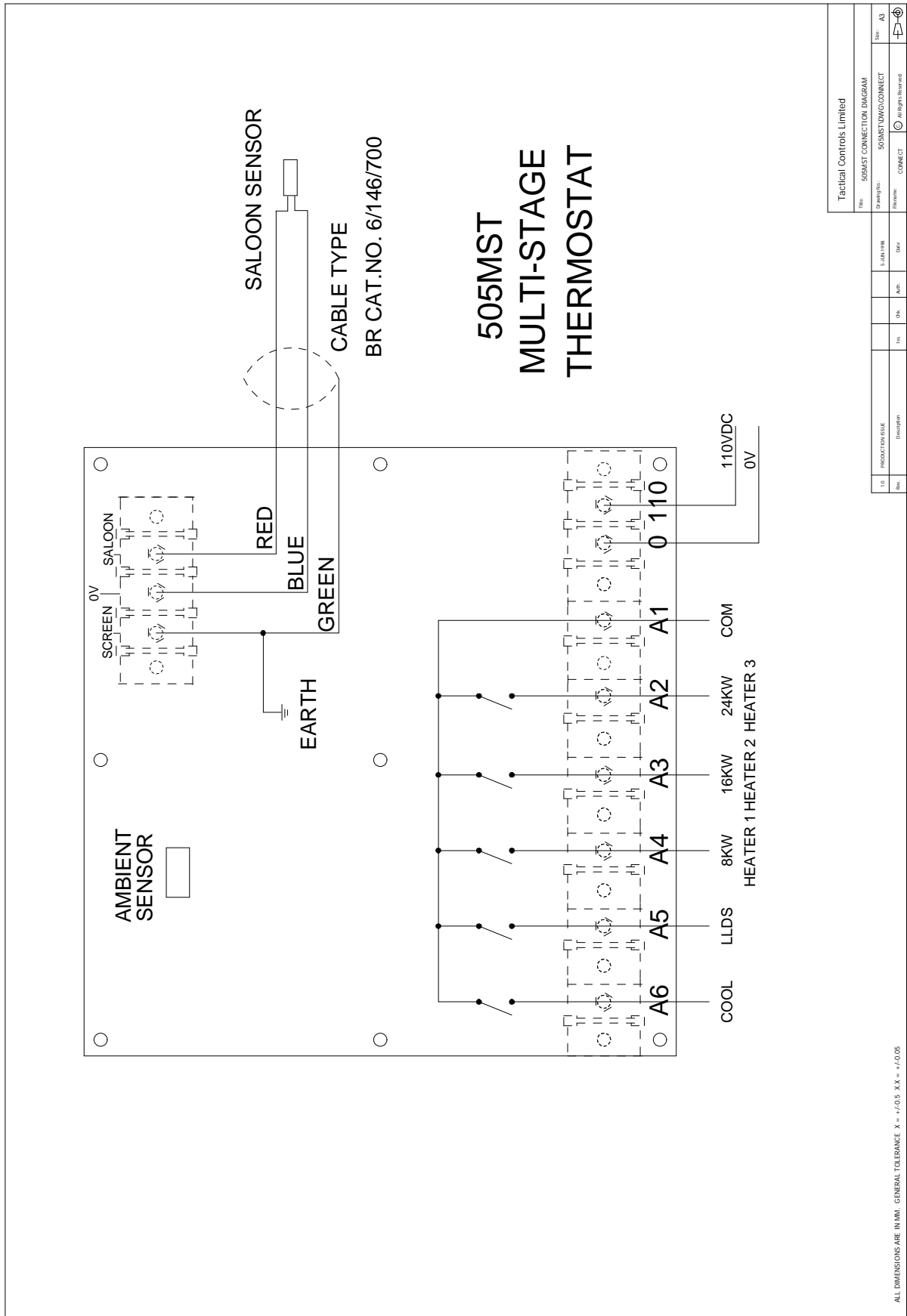
The TC1000 unit consists of a LCD display, a 10-turns potentiometer and one switch. Connection of the unit to the system is made via a 5-way connector. The TC1000 comes with its own carrying case.

The TC1000 unit's LCD display two different temperatures: the saloon sensor temperature and the saloon simulated test temperature.

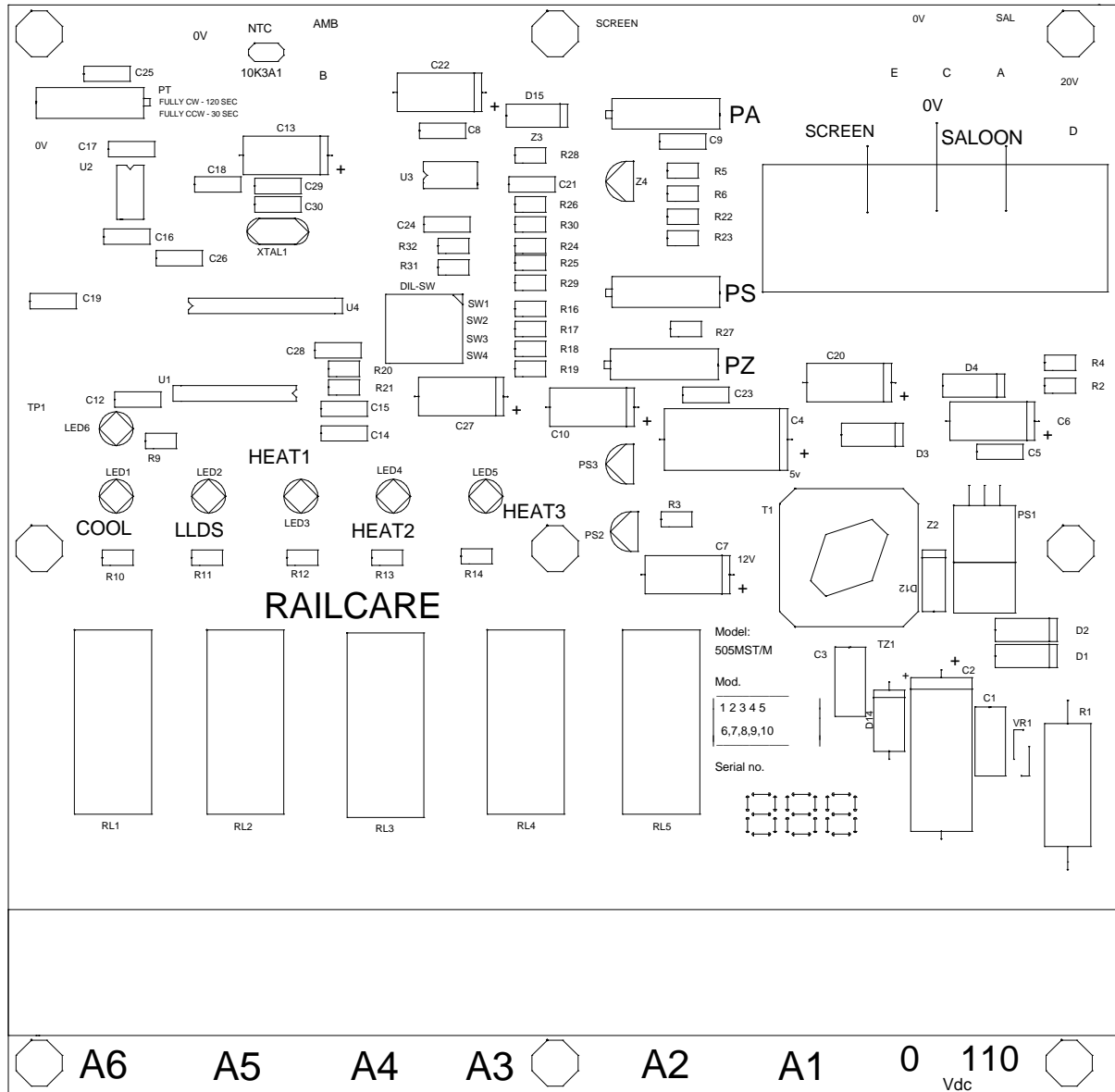
System layout diagram



System connection diagram



Internal board layout diagram



Technical specification**POWER SUPPLY**

Voltage	70Vdc to 130Vdc; 110Vdc nominal
Ripple	Unaffected by 4 volt peak to peak
Input protection	Reverse polarity protection. Surge and transients to BRB/RIA 12
Current consumption	100mA maximum at 110Vdc

SENSOR

Saloon sensor	Platinum resistance PT100 to BS1904 class B; sensor error within $\pm 0.3^{\circ}\text{C}$; two wire and sensor leads must be less than 5 meters
Lead resistance error	If sensor lead greater than 5 meter is used - lead resistance input compensation is required. This is achieved by means of an "offset-value" in software in the microcomputer
Screened cable	Sensor cable wires must be screened and connected to the system earth
Interchangeability	Temperature probes are easily detachable and interchangeable with sensor error altered by not more than $\pm 0.3^{\circ}\text{C}$
Time constant	20 to 40 seconds when the sensor is subject to an air stream of 2m/s

INDICATORS

Heat 3 output	Red LED; illuminates when heat 3 is ON
Heat 2 output	Red LED; illuminates when heat 2 is ON
Heat 1 output	Red LED; illuminates when heat 1 is ON
LLDS output	Yellow LED; illuminates when LLDS is ON (energised); (LLDS: Lower Lever Damper Solenoid)
COOL output	COOL LED; illuminates when cool is ON
Winter/Summer	Green LED; illuminates during summer period
DC supply	At least one of the LEDs would be ON when the DC supply is connected

OUTPUT SWITCHING

Relays	Five relays, change-over, normally open contacts: Schrack RP330024, single pole
Contact rating	250Vac, 16Aac; 440Vac, 100mAac
Mechanical life	Greater than 30 million operations
Electrical life	Greater than 1 million operation at 440Vac, 100mAac

OUTPUT SWITCHING

Accuracy	$\pm 0.2^{\circ}\text{C}$ of each setpoint temperature
Hysteresis	1.0 $\pm 0.1^{\circ}\text{C}$; for example, Heat 1 setpoint is 18.5°C , it would switch off at 18.5°C on rising temperature and off at 17.5°C on falling temperature
Maximum drift	$\pm 1.0^{\circ}\text{C}$ over operating temperature range of -25°C to 50°C

ENVIRONMENT

Operating temperature	-25°C to 55°C
Storage temperature	-30°C to 85°C
Relative humidity	0 to 90°C
IP rating	IP65

MECHANICAL

Test socket	Military grade, Litton 5-way socket pins, rear panel mounted bayonet connector
Housing	Sheet steel 16SWG; grey hammer powder coat

STANDARDS

RSE/STD/031-PART 1: ISSUE B	General requirements for electronic equipment
BRB/RIA NO.13:1990	General specification for electronic equipment used on rolling stock
BRB/RIA NO.12:1984	Transient and Surges in DC control systems
BRB/RIA NO.18:1990	Interference testing for electronic equipment
BRB/RIA NO.20: 1988	Vibration and shock testings

Ordering information

Ordering code: 505MST/M

You are welcome to order the unit by code or by description - 505MST/M multi-stage thermostat for MK3 HST.

Supplier information

Tactical Controls Limited

Unit 4 Marlborough Road
Lancing, West Sussex BN15 8TR
England
Tel: (01903) 750800
Fax: (01903) 750678