

# The Inside Stuff

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**Kindly forward this product manual to the end user. The user is requested to read the manual thoroughly before operating the instrument.**

# As you unpack

*Congratulations on buying  
Temperature Scanner series  
Scanner !*

As you unpack kindly ensure that

1. The material received is in good condition
2. You have received following material:
  - i) Temperature scanner as per your order
  - ii) Mounting bracket pair.
  - iii) This manual along with Test & Warranty certificate

In case of any discrepancies contact our customer support department immediately.

*We are sure you will get long and trouble free service  
from our system.*



## **We need your feedback :**

Every attempt is made to make this manual clear and easy to understand, so that the user can install, take care of and feel confident in using our product. We welcome your valued suggestions to help us improve this product as well as the document and make it more user friendly.

# Temperature Scanner series



## Introduction

Temperature Indicators and Controllers play an important part in any process industry. Quick and accurate measurement and control of a process temperature will help to improve the final product quality, reliability and reduce rejection. Temperature indication and control is therefore one of the prime considerations in any process industry.

When the process is complex and critical, the measurement locations are many and they have inter-relationship between one another which needs to be recorded, analysed and stored. In such a situation Data Acquisition System becomes a necessity. The Intelligent series serves this purpose very effectively.

The ESD *Temperature Scanner series* is based on microcontroller and is designed for fast and accurate measurement and control of temperature. The instrument is designed using highly reliable electronic components. This series accepts all types of Thermocouples, Pt - 100, 0 to 20 mA as well as 4 - 20 mA as input. Wide ranges of measurements are available depending on the sensor used. The instrument is immune to mechanical vibrations. Even the mounting position will not affect the measurement accuracy. The large bright red LED seven segment display allows long distance readability. Use of highly reliable electronic components with low temperature coefficient ensure long and trouble free service. The instrument is tested for its performance under various climatic conditions. ESD's *Temperature Scanner series* offer communication to PC. The data from the instrument is logged on to the PC in a file. The data in these files can be opened in a spread sheet package like MS-Excel so as to obtain various graphs and carry out trend analysis

## Principle of operation :

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The ESD Intelligent series is based on the principle high input impedance amplifier feeding an analog to digital convertor. The input signal generated by the transducer is fed to a sensor compensation circuit, where automatic ambient compensation in case of thermocouple & lead resistance compensation in case of Pt-100 is achieved. Duly compensated signal is fed to a signal conditioning amplifier, output of which is given to CPU through ADC. The linearization of the input signal from the transducer is done by software. This linearized signal is directly displayed on the display and compared with the set value by processor. Depending upon the status of input w.r.t. set point output to the relay driver is activated.

The processor scans all the inputs at a very fast rate and stores it in the memory. This stored data and programmed set values are displayed automatically as per the preset scan times.

### Features :

- Proven field performance
- Highly compact
- Dust & vermin proof enclosure with epoxy powder coating.
- LED display gives better readability at long range
- Fast response time
- RS 485 for long distance communication
- Designed for Thermocouples, RTD and 4 - 20 mA input
- Fail safe relay logic
- Maximum MTBF and minimum MTTR
- User friendly front facia and display.

# Specifications

Model	: Smart S004 / Smart S108 / Smart S216
No. of Inputs	: 04 / 08 / 16
Ranges	: As per chart below.
Input	: Pt-100 (3 wire sys) / Thermocouple / 4-20 mA
Display	: <b>Smart S004 / Smart S108</b> 4 digit 7 segment 12.5mm RED LED for parameter value and 1 digit 12.5mm GREEN LED for channel <b>Smart S216 ( 8/16 points)</b> 7 digit 7 segment 12.5 mm RED LED (2 for channel number and 4 for parameter value and 1 for unit)
Indication accuracy	: Better than +/- 0.25 % of FS +/- 1 digit
Least count	: 0.1 °C upto 400 °C, 1°C above 400 °C
Input impedance	: > 10 M ohms, (only for thermocouple input )
Accuracy deviation due to	
a) Temperature Variation	: +/- 0.01 % / °C , ref at 25 °C
b) Supply Variation	: +/- 0.005 % /V
Input update time	: 0.5 seconds / channel
Ambient Temp. range	: 0 to 55 °C
Ambient Temperature compn	: Built in upto 55 °C
Sensor break indication	: Up scale [oPEn]
Scan Time	: Adjustable from 0 to 99 Sec for each channel.
Channel Skip	: By setting scan time = Zero
Programming	: Using 4 keys membrane keypad
Program Backup	: All programmed values are preserved by NVRAM.
Relative Humidity	: 90 % Non Condensing
Power supply	: 230 V AC, +/- 10 % , 50 Hz
Power consumption	: 6 VA
Weight	: 800 grams approx.
Mounting	: Flush Panel mounting
Termination	: Screwed type suitable for 2.5 sq. mm wire
Password Protection	: Password protected. Default password is 134.
Optional	
Serial Interface	: RS 485 (2 wire) for communication
Protocol	: Modbus RTU ( For details refer communication sheet)

Dimensions (mm) :

Model	Facia	Cutout	Depth
Smart S004	96 x 48	92 x 45	100
Smart S108	96 x 96	92 x 92	80
Smart S216	192 x 96	186 x 92	120

■ Add 25 for terminals

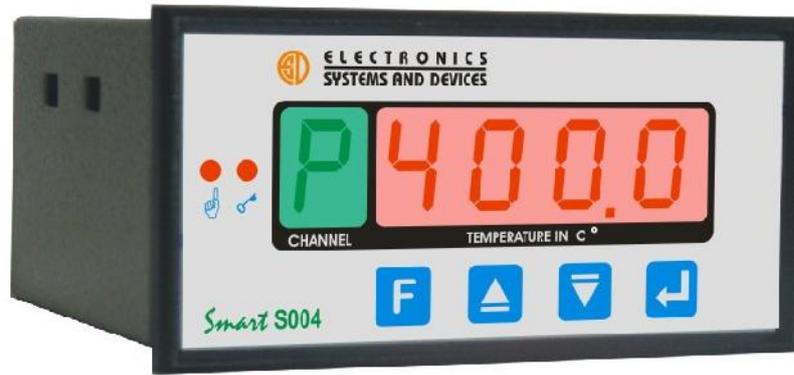
Ranges :

Input	Standard Ranges in °C
Pt-100	-100 to +200 / 0 to 400
J	0 - 600
K	0 - 1200
R, S	0 - 1600
mA / mV	0 to 100 % or process value

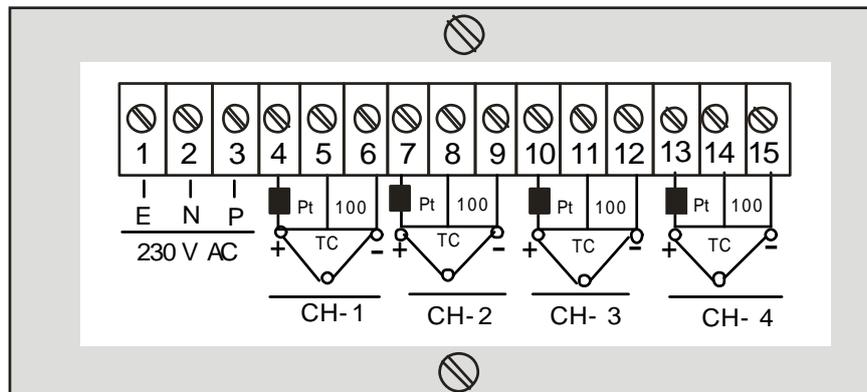
# Illustrations

## Smart S004

A) Front View



B) Rear View

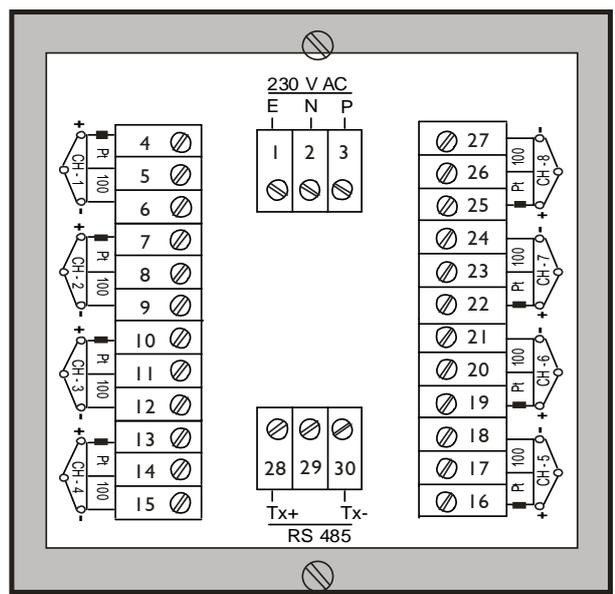


# Smart S108

A) Front View

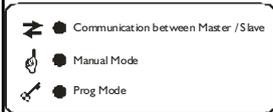


B) Rear View



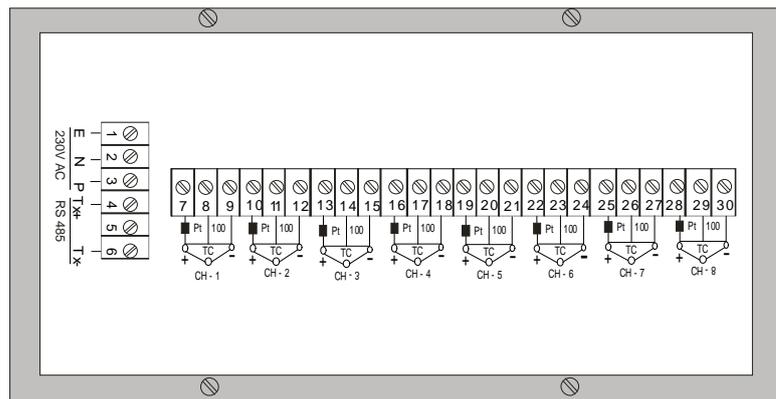
# Smart S216

## A) Front View

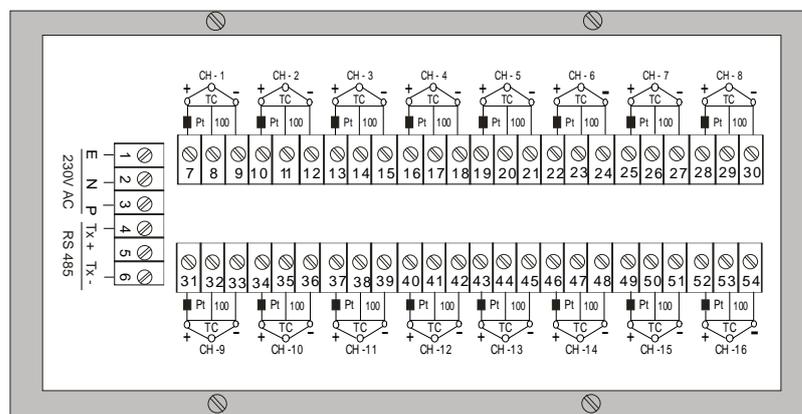


- Mode key
- Shift key
- Increment key
- Decrement key
- Enter key

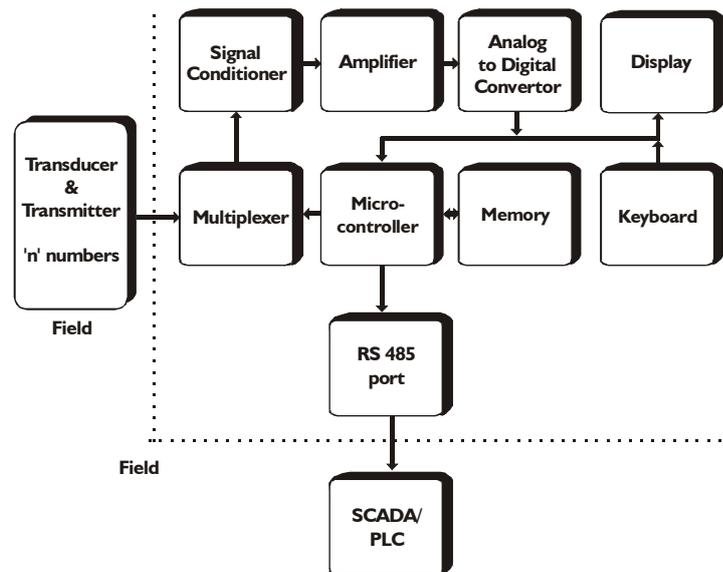
## B) Rear view connection for 8 pt scanner



## B) Rear view connection for 16 pt scanner



# Operation



## Signal Conditioning

This circuit block takes input from the temperature sensors connected in the field and converts the received signals into appropriate levels for further processing. It consists of a simple bridge adjusted to give a mV o/p corresponding to the temperature sensed by the transducer, i.e. 0 mV at 0 °C, 100 mV at 100 °C etc.

## Multiplexer

Since there are multiple analog inputs, they have to be processed individually. The multiplexer sequentially selects each input, connecting it to the further circuitry for a fixed time period, after which it switches the next input.

## Analog to Digital Convertor

This block consists of the Analog to digital converter chip, and its associated circuitry. It takes the analog signal from the previous stage and converts it to an equivalent digital signal. This digital value is then passed on to the main processor for further processing.

## The Microcontroller

The microcontroller used in scanner is Intel's MCS 51 family's IC 8031. This is the brain of the instrument and executes overall control on it. All functions of scanning the input signal via multiplexers, data processing, data monitoring, displaying, storage of data and output control are performed by the microcontroller.

## Keyboard and Display

Bright seven segment displays are used to show parameter values and also to prompt messages to the user. Super bright LED's are used to indicate other parameters such as alarms, relay status, and mode of operation. The keyboard is a 4 key membrane keypad which gives good firm contact and a longer life. The user can program the scanner through this keypad.

## Memory

The Scanner has 2 separate needs for the memory

1. To hold the System Firmware
2. To hold the Program parameters of the Scanner

The firmware resides in an EPROM, whereas the programme parameters are stored in a static RAMs.

## RS 485 Port

This full duplex serial communication port gives the signals for serial communication when a serial transmission is initiated.

## Installation Procedure :

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☞ Also observe **Precautions** on page 26

The instrument should be mounted in a place where it is clearly visible and accessible.

1. Insert the instrument in a suitable cutout and fix it using the bracket pair provided on the sides.
2. Make connections as shown in connection diagram ( page 6,7,8) .
3. In case of Platinum Resistance bulb connect Red wire to terminal indicated with a **Box**. The other two wires of the sensor are to connected to the remaining two terminals.
4. In case of thermocouple type instruments, connect the positive and negative leads of sensor to respective terminal.
5. Use correct type of compensating cables for thermocouple type instruments.
6. Ensure proper earthing to the instrument.
7. Connect a series combination of  $0.1 \mu\text{F}$  /600 V non polarised capacitor &  $220 \Omega$  1/2 W resistor across phase & neutral.
8. When power to the unit is switched ON the unit will automatically go in Auto mode. The display will show parameters of all channels in sequence as per the factory set scan time values.

For changing the scan time values as per your requirement follow the programming procedure given in the manual.

☞ **Note:** If any transducer is not connected properly, or is faulty, the display for that particulars channel will show 'OPEN' or erratic readings

# Programming Procedure

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## Mode Selection

The process scanner Smart series has following modes.

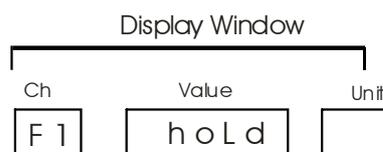
- |                       |                      |
|-----------------------|----------------------|
| 1. HOLD mode          | 7. ALARM 1 mode      |
| 2. DISPLAY mode       | 8. ALARM 2 mode      |
| 3. OFFSET mode        | 9. SETPOINT mode     |
| 4. CALIBRATION mode   | 10. DECIMAL mode     |
| 5. COMMUNICATION mode | 11. LOWER LIMIT mode |
| 6. CONFIGURATION mode | 12. UPPER LIMIT mode |

Modes from configuration to setpoint (6 to 9 ) are not applicable for Scanner series. If the type of input is 4 - 20 mA, then modes from 10 to 12 are to be used for programming the range of the unit. Refer page no 22 to 24 for the same.

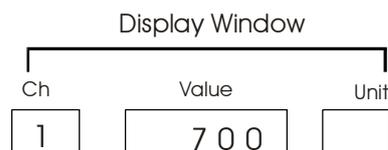
## Procedure for Hold mode

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This is manual mode. In this mode, user can hold a particular channel continuously.



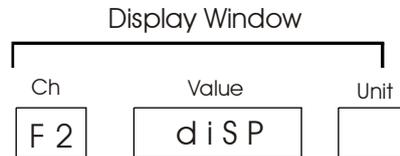
After entering into the hold mode user can go to any channel using increment keys.



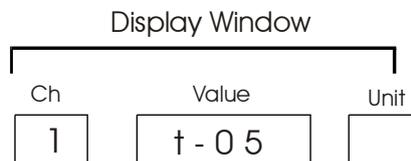
To return to Auto mode, press the mode key twice.

## Procedure for Display mode

This mode is for programming of individual channel display time.

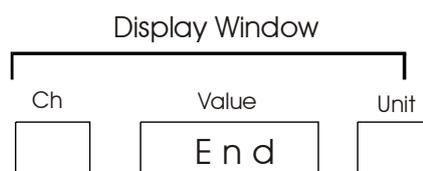


After entering into the disp mode user can set the display time for each channel in between 0 to 99 seconds.



This mode is password protected (For password setting refer Page no 25) Using increment and shift keys user can set display times for each channel. To skip a particular channel, set display time as 0 seconds.

To go to next channel, press the Enter key. After programming the display time of the last channel, unit will show this message and will go to Automode.



## Programming procedure for Offset mode.

This mode is related to offset setting. Using this mode, user can correct the sensor error if required.



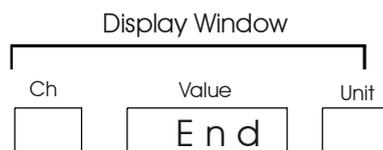
When user press enter key unit will display following message, using increment and shift keys user can set offset value in between - 9.9 to + 9.9 for particular channel.



This mode is password protected (For password setting refer Page no 25). User can go to next channel by pressing enter key. Repeat the same procedure for other channels.



After the last channel unit displays following message and will go to Automode.



## **Procedure for Calibration mode**

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**Warning :** This procedure is to be carried out strictly by technically qualified personnel only.

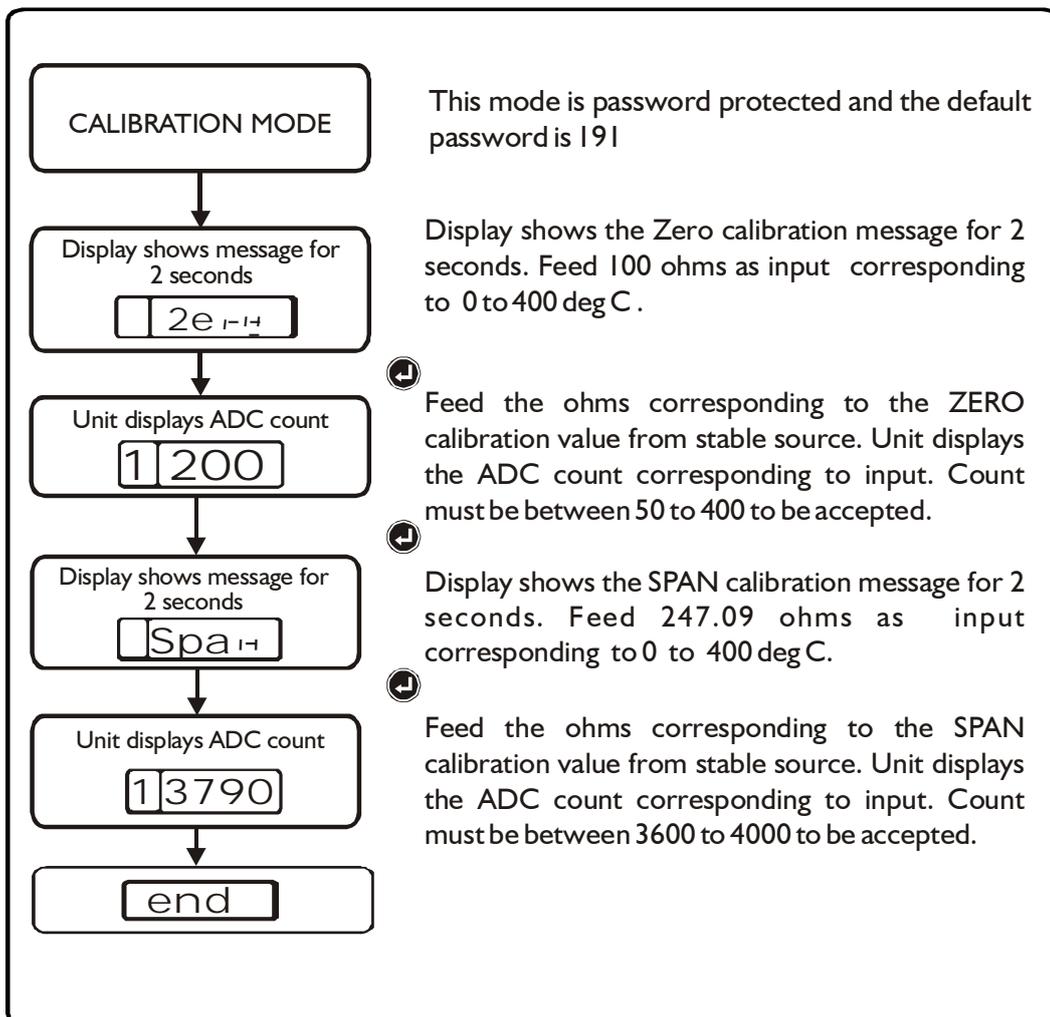
The instrument is calibrated at the factory using accurate calibrating equipment traceable to international standards. No calibration should be required in normal course, however if the instrument requires recalibration, the procedure to be followed is given below.

- i. Remove the cover of the instrument, by removing the fixing screws at the back side of the instrument.
- ii. Switch on the supply and allow 5 min. to achieve thermal stability. Depending on the type of input connect a stable signal simulator / source to channel number 1.
- iii. We have shown calibration of for following types of input.
  - a) Pt 100 positive range
  - b) Pt 100 negative range
  - c) 4 to 20 mA
  - d) CR AL (K type Thermocouple)
  - e) FE KO (J type Thermocouple)

For any other type of input, please contact us.

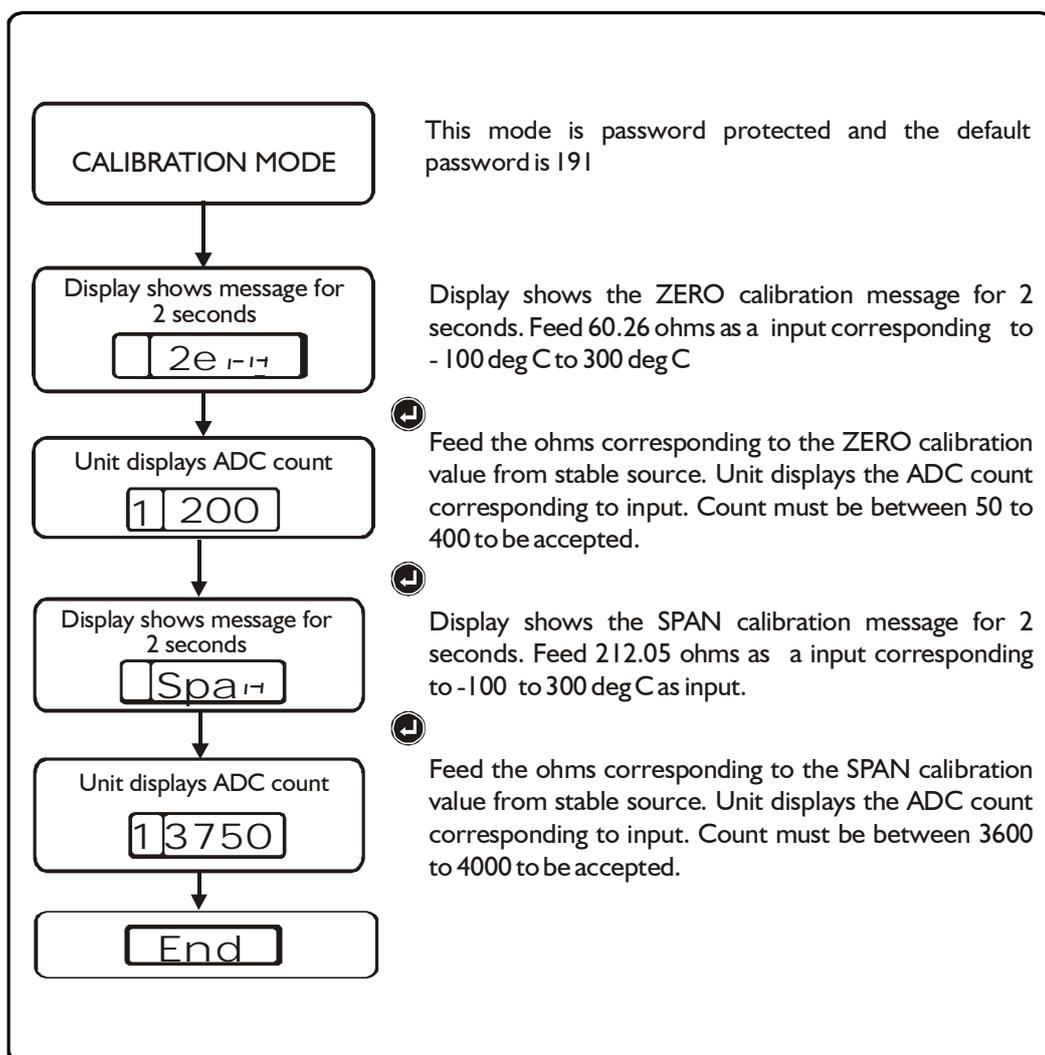
## Calibration procedure for PT-100 positive range

For a unit, having range 0 to 400 deg C use this calibration procedure. While calibrating a device using Pt-100, connect a stable resistance source to channel no. 1 and follow the following procedure.



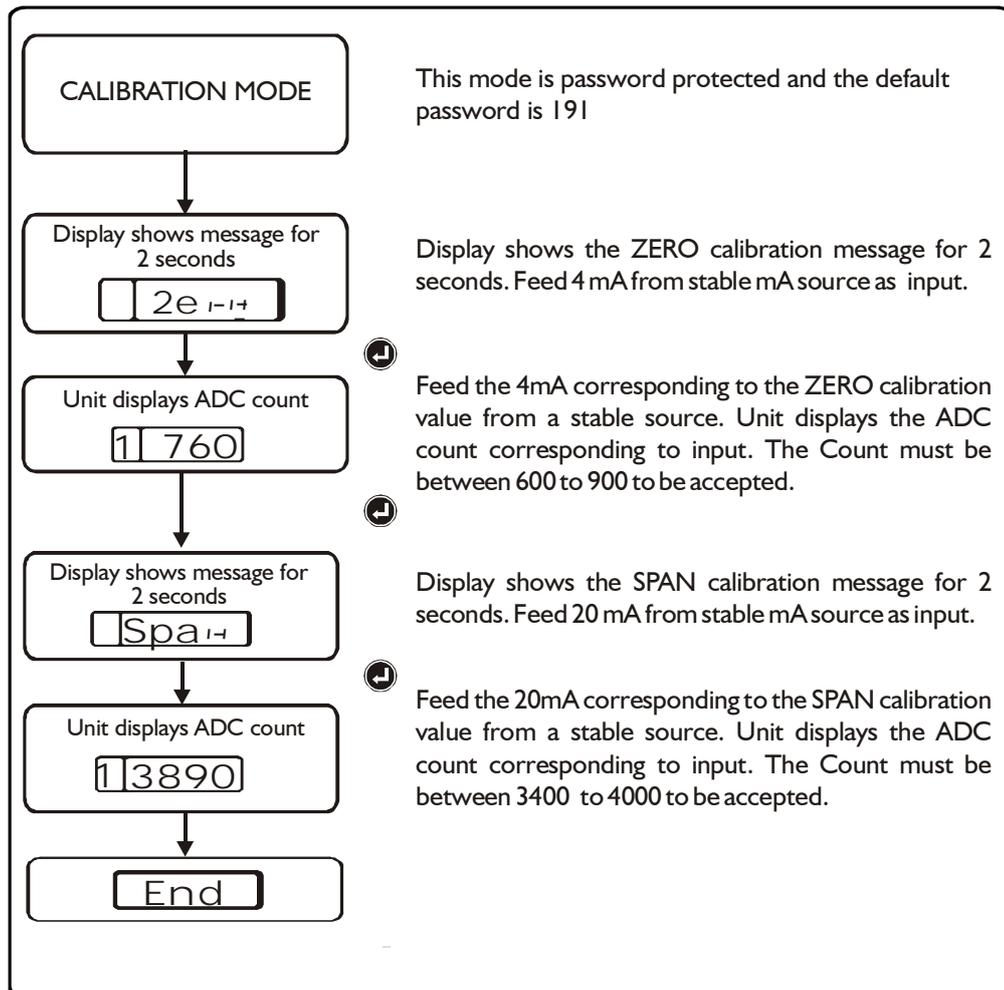
## Calibration procedure for PT-100 negative range

For a unit, having range -100 to 300 deg C use this calibration procedure. While calibrating a device using Pt-100, connect a stable resistance source to channel no. 1 and follow the following procedure.



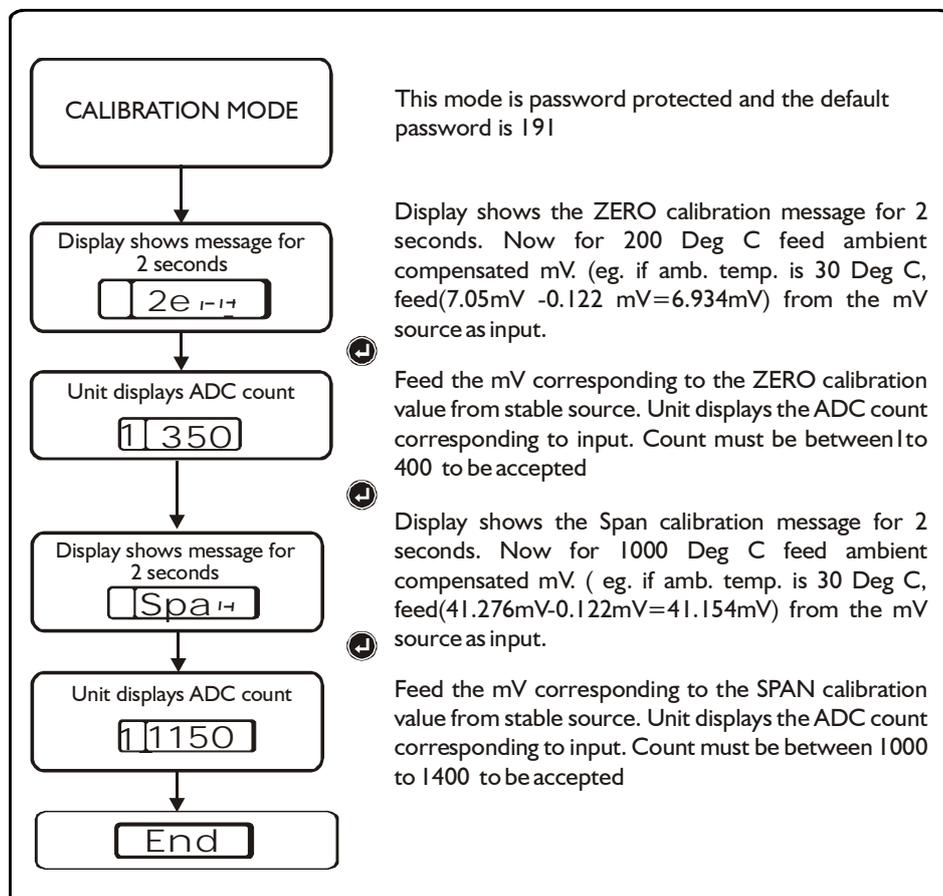
## Calibration procedure for 4-20 mA input type

While calibrating a device having 4 - 20 mA , connect a mA source to channel no. 1 and follow the following procedure.



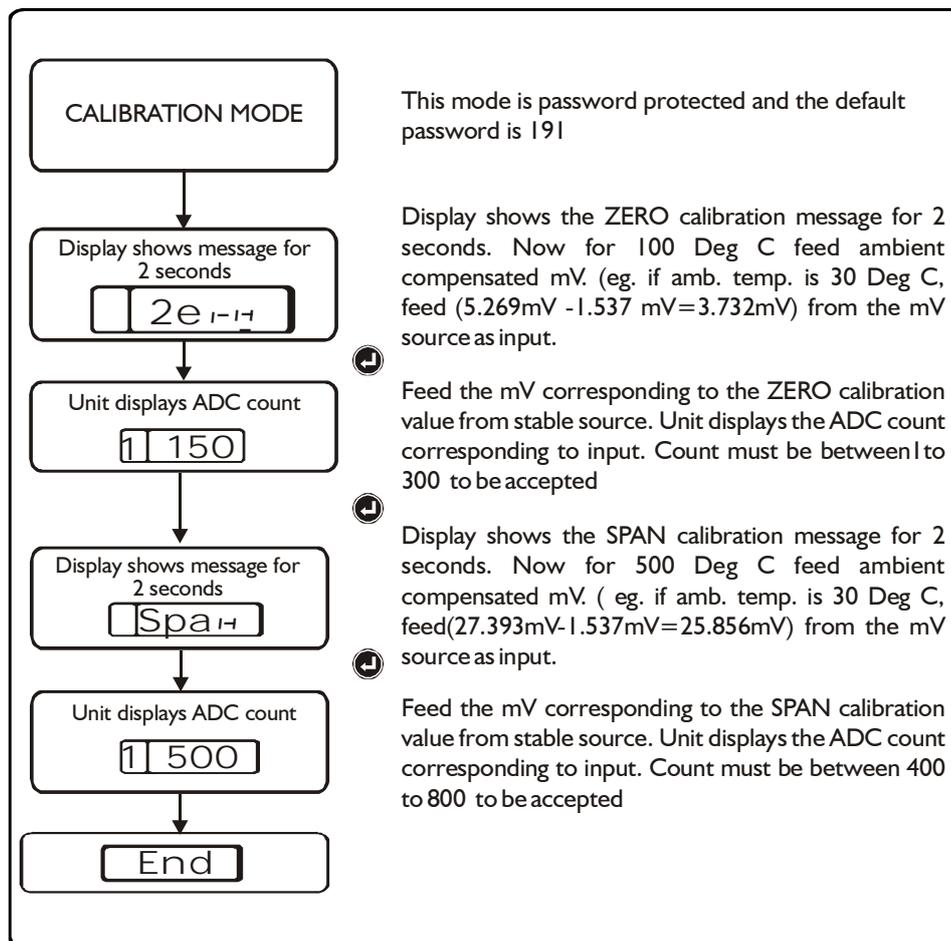
## Calibration procedure for CR AL(K type) type Thermocouple

While calibrating a device having CR AL type thermcouple input, connect a mV source to channel no. 1 and follow the following procedure.



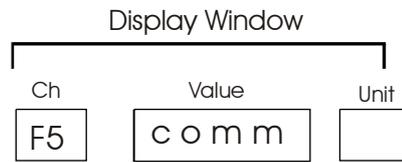
## Calibration procedure for FE KO (J Type) Thermocouple

While calibrating a device having FE KO (J type) thermocouple input, connect a mV source to channel no. 1 and follow the following procedure.

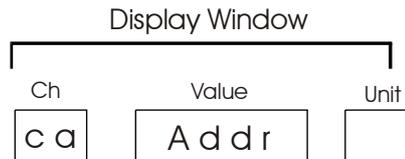


## Programming procedure for Communication mode:

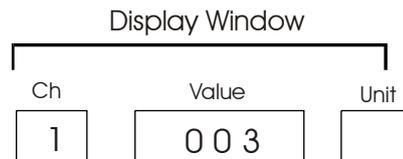
This mode is related to communication setting.



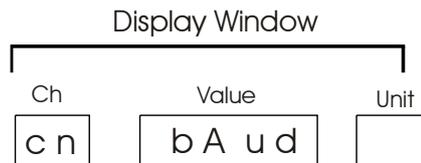
When user presses enter key unit will display following message of slave address.



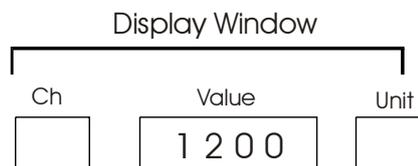
After pressing enter key, unit displays the slave address.



User can set slave address in between 1 to 255 using increment and shift keys. This mode is password protected (For password setting refer Page no 25). When user presses enter button unit displays following message.



After pressing enter key, unit displays the existing baud rate value.



Using increment key user can choose between the following baud rates of 1200,2400,4800 or 9600. After pressing enter key, unit returns to Auto mode.

**COMMUNICATION**

Communication : RS 485  
 Protocol : MODBUS RTU  
 Baud Rate : Selectable between 1200,2400,4800 and 9600 bps.  
 Device Address : Programmable from 1- 255  
 Functions supported : 1. Read Holding Registers (04) and Read Input Registers (03)  
 Settings : Data bits - 8, Parity - none, Stop bits - 1.  
 Response Timeout (By master) 500 milliseconds

**1.1 Function : Read Input Registers (04) Read Process Values for 8 channels at a time**

Starting Address	Contents of the location (Two byte - High & Low)
0000	Process Value - 1
0001	Process Value - 2
0002	Process Value - 3
0003	Process Value - 4
0004	Process Value - 5
0005	Process Value - 6
0006	Process Value - 7
0007	Process Value - 8

Starting Address	Contents of the location (Two byte - High & Low)
0008	Process Value - 9
0009	Process Value - 10
0010	Process Value - 11
0011	Process Value - 12
0012	Process Value - 13
0013	Process Value - 14
0014	Process Value - 15
0015	Process Value - 16

**1.2 Function : Message Formats**

**Message Format :** (Request initiated by the master)

Slave Address	Function Code	Start Address (Hi)	Start Address (Lo)	No. of Points (Hi)	No. of Points (Lo)	CRC Check (Lo)	CRC Check (Hi)
---------------	---------------	--------------------	--------------------	--------------------	--------------------	----------------	----------------

**Message Format :** (Response by the slave for the request initiated by the master)

Slave Address	Function Code	Byte Count	Data (Hi)	Data (Lo)	CRC Check (Lo)	CRC Check (Hi)
---------------	---------------	------------	-----------	-----------	----------------	----------------

**1.3 Exception Codes Supported**

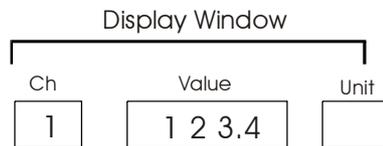
Exception Codes	Condition
0x02	Invalid Data Address

## Programming procedure for decimal point:

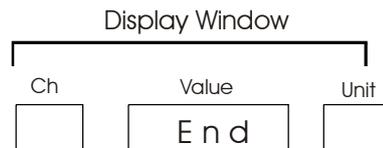
This mode is applicable only for 4 - 20 mA input type. User can set the decimal position of the display in this mode.



When the user presses the enter key, unit displays the following message.

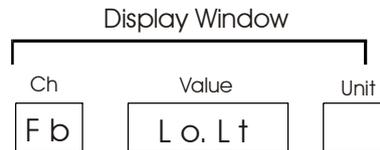


This mode is password protected (For password setting refer Page no 25) Using increment and shift keys, user can select the decimal position as per the range. This setting is common for all the channels. After pressing enter key, unit shows following message and goes to Auto mode.

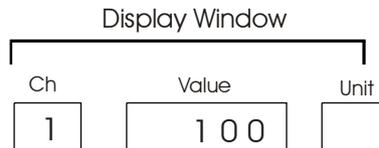


## Programming procedure for Lower limit:

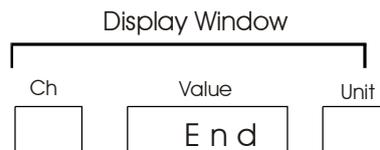
This mode is applicable only for 4 - 20 mA input type. User can set the lower limit corresponding to 4 mA of the input range of all channels in this mode.



This mode is password protected (For password setting refer Page no 25) Using increment and shift keys, user can set the lower limit value of each channel as per the range.

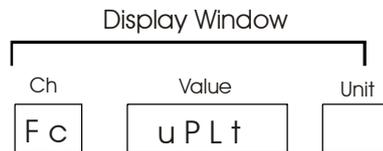


After pressing enter key, unit goes to the next channel. After the programming of the last channel is completed unit displays following message and will go to Auto mode.

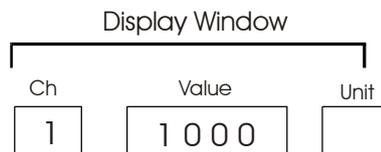


## Programming procedure for Upper limit:

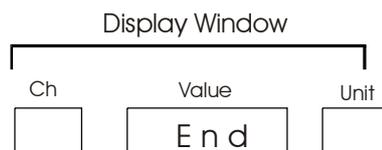
This mode is applicable only for 4 - 20 mA input type. User can set the upper limit corresponding to 20 mA of the input range of all channels in this mode.



This mode is password protected (For password setting refer Page no 25) Using increment and shift keys, user can set the upper limit value of each channel as per the range.



After pressing enter key, unit goes to the next channel. After the programming of the last channel is completed unit displays following message and will go to Auto mode.

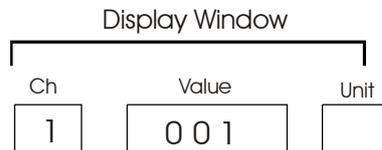


## Password Setting

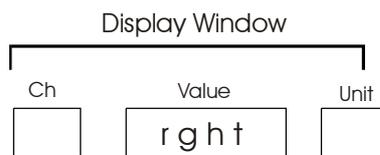
Whenever user sees the following message, it means unit is asking for the user to enter the correct password to proceed further.



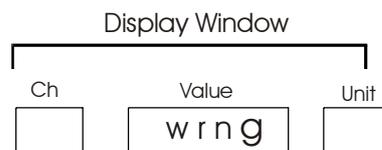
Unit displays above screen for 2 seconds and then the following window.



Using increment and shift keys, user has to enter the correct password. The default password is 134. For calibration purpose the password is 191. After entering the password the user must press the enter key. If the password is correct, unit displays the following message for 2 seconds and then shows the value which user wants to change.



If the user enters wrong password, unit displays following message and goes to the previous menu.



## Precautions

Taking care of your equipment is just as important as buying the best equipment. So simply take the following precautions and ensure a long, trouble- free service from your temperature measurement and control system.

### Use

- Three wire system for connecting Pt-100 sensor to the instrument.
- Same area of cross section for all the three wires.
- Appropriate compensating cables for connecting T/C to an instrument
- Appropriate Thermally conductive media between Thermowell & sensor sheath.
- Proper sheathing material as per application and environment.
- Proper size crimped wire termination lugs with insulated sleeves & ferrule no's.
- Proper size screw driver for making connections to the terminations and also while adjusting calibration and set points.
- Fuses of correct ratings for mains and relay outputs.

### Do's

- Sensor cables must be isolated from power cables.
- Insert minimum required sensitive length in the measurement object.
- Operating temperature should be 80 % of the maximum specified temperature.
- Check that all the wiring is firm and as per wiring diagram.
- Recalibrate instruments only when errors are confirmed with the help of certified calibrators.
- Output loads connected should be within specified limits.
- Select a Sensor / Instruments / Instrumentation Panel manufacturer who has the required technical knowledge and infrastructure inhouse.

### Avoid

- Terminal joints or junction boxes. Only firm soldered joints must be made if necessary.
- Exposure of thermocouple head to temperatures greater than 90°C.
- Too large sheath diameter as this may introduce time lag.
- Mechanical stresses and vibrations.
- Sharp objects for operating front panel membrane keys.
- Excessive relative humidity.
- Magnetic field / inductive pick up / noise.
- Excessive Ambient temperature variations.
- Direct radiant heat.
- Corrosive gasses in the surroundings.
- Chemicals or pressure wash for cleaning instruments.
- Excessive tightening of mounting accessories.
- Excessive light from being incident on displays.

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## Fault diagnosis

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### 1. *Erroneous / Irrelevant indication*

Improper sensor

Improper sensor connection

Calibration error.

System Hang (Restart the system).

### 2. *No indication on display*

No Supply .

Supply voltage not as per specifications.

Loose PCB interconnections.

System Hang (Restart the system).

### 3. *'OPEn' indication on display*

Improper sensor connection.

Sensor open.

### 4. *Fluctuations in Readings*

Supply voltage not within specified limit.

Sensor faulty / improper sensor connection.

Noise pick-up on sensor / sensor cable (use proper shielding / isolation).

Excessive ambient temperature.

### 5 *No alarm and trip indication*

Sensor connection faulty

Settings incorrect

*If a problem persists please contact our customer service department immediately.*

# Look-up Table

Temperature V/s Sensor output

Temp in °C	Pt-100 Res. in Ω	T/C Output in mV (Reference junction at 0°C)			
		Fe-Ko (J)	Cr-Al (K)	Pt-Pt-13% Rh (R)	Pt-Pt-10% Rh (S)
-150	39.71	-6.499	-4.912	-	-
-100	60.25	-4.632	-3.553	-	-
-50	80.31	-2.431	-1.889	-	-
-25	90.13	-1.239	-0.368	-	-
0	100.00	0.000	0.000	0.000	0.000
10	103.90	0.507	0.397	0.111	0.055
15	105.85	0.762	0.597	0.082	0.084
20	107.79	1.019	0.798	0.171	0.113
22	108.57	1.122	0.879	0.123	0.125
24	109.35	1.225	0.960	0.135	0.137
26	110.12	1.392	1.041	0.147	0.148
28	110.90	1.432	1.122	0.158	0.161
30	111.67	1.536	1.203	0.232	0.173
32	112.45	1.640	1.285	0.183	0.185
34	113.22	1.745	1.366	0.195	0.197
36	113.99	1.849	1.468	0.207	0.210
38	114.77	1.994	1.529	0.220	0.222
40	115.54	2.058	1.611	0.296	0.235
50	119.40	2.585	2.022	0.363	0.299
60	123.24	3.115	2.436	0.431	0.365
70	127.07	3.649	2.850	0.501	0.432
80	130.89	4.186	3.266	0.573	0.502
90	134.70	4.725	3.681	0.643	0.573
100	138.50	5.268	4.095	0.723	0.645
120	146.06	6.359	4.919	0.879	0.795
140	153.58	7.457	5.733	1.041	0.950
160	161.04	8.560	6.539	1.208	1.109
180	168.46	9.667	7.338	1.380	1.273
200	175.84	10.777	8.137	1.557	1.440
250	194.07	13.553	10.151	2.017	1.873
300	212.02	16.325	12.207	2.498	2.323
350	229.67	19.089	14.292	2.997	2.786
400	247.04	21.846	16.395	3.511	3.260
500	280.90	27.388	20.640	4.580	4.234
600	313.59	33.096	24.902	5.696	5.237
700	345.13	39.130	29.128	6.860	6.274
800	-	-	33.277	8.072	7.345
900	-	-	37.325	9.203	8.448
1000	-	-	41.269	10.503	9.585
1100	-	-	45.108	11.846	10.754
1200	-	-	48.828	13.224	11.947
1300	-	-	-	14.624	13.155
1400	-	-	-	16.035	14.368
1500	-	-	-	17.445	15.576
1600	-	-	-	18.842	16.771

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) +$$

$$^{\circ}\text{K} = 273.15 + ^{\circ}\text{C}$$

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