



est. 1878

# USER-MANUAL

## E20 -Thermometer

### ASTM E2877



ISO 9001 : 2015  
NL/PRO 238239125

Van 't Hoffstraat 12  
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E20 Thermometer man.docx Rev. 3.03 UK 0319

## Tamson Instruments bv

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## 1 SAFETY AND WARNINGS

Make sure before installing or operating the equipment to read and understand all instructions and safety precautions listed in this manual. If there are any questions concerning the operation of the equipment or about the information given in this manual please contact your local dealer or our sales department first.

Performance of installation, operation, or maintenance other than those described in this manual may result in a hazardous situation and may void the manufacturer's warranty.

Never operate equipment that is not correctly installed. Unqualified personnel must not operate the equipment. Avoid damage to the equipment, or its accessories, caused by incorrect operation.

Important:

- When performing service, maintenance or moving the apparatus, always disconnect the apparatus at the main's socket,
- Proper skilled and trained personnel are only allowed to operate this equipment,
- Take notice of warning labels and never remove them,
- Refer service and repairs to qualified technician,
- If a problem persists, call your supplier or Tamson Instruments b.v.

## 2 WARRANTY

Tamson Instruments b.v. warrants that all their manufactured equipment is free from defects in material and workmanship, preventing the device from normal operation. Tamson Instruments b.v. does not warranty that the equipment is fit for any other use than stated in this manual. The manufacturer can only be held responsible for the security, reliability and performance of the equipment, when operated in accordance with the operating instructions, extensions, adjustments, changes and/or if repair is performed by Tamson Instruments b.v. or authorized persons only. This warranty is limited to one year from the date of invoicing. All equipment and materials are subject to standard production tolerances and variations.

## 3 Disclaimer

For relevant measurements always an independent reference measurement is needed. Tamson can not be held responsible for misinterpretation or consequences of an erroneous reading



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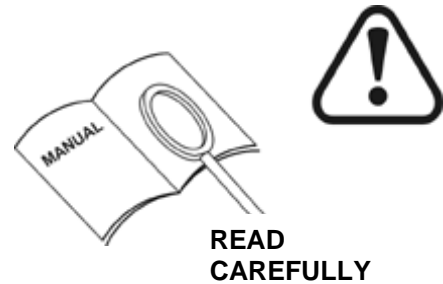
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## 4 PRECAUTIONS AND HAZARDS

**Before attempting to operate the thermometer read all parts of this manual carefully to insure smooth operation and avoid damage to the equipment or its accessories.**

If a malfunction occurs, consult section "Trouble shooting", page 21. If the problem persists email at [service@tamson.com](mailto:service@tamson.com). Never operate the equipment if not correctly installed. The equipment must be operated only by qualified personnel. Avoid damage to the equipment or its accessories through incorrect operation.



## 5 INSTALLATION

### 5.1 Important

Tamson Instruments bv is not responsible for any consequential damage or harm caused by using this thermometer. Repairs on the electrical system of the thermometer may only be carried out by well trained and authorized persons.

### 5.2 Unpacking

Before leaving the factory Tamson products are adequately packed to prevent damage during normal transportation. Check the packing for external damage and make a note on the shipping documents if any damage is found. Always retain the cartons and packing material until the product has been tested and found in good condition. (Transport companies generally will not honor a claim for damage if the respective packing material is not available for examination).

## 6 PRACTICAL USE AND PROTECTION

This thermometer is a highly sensitive measuring device.

Therefore prevent shock from the thermometer body or sensor.

Do not drop the thermometer housing.

Do not drop the thermometer sensor / probe.

The thermometer housing is of thermoplastic and sensitive to heat. Prevent operating the thermometer at temperatures higher than ambient.

The temperature sensor is of stainless steel. Prevent temperatures higher than 250°C at the tip of the sensor.

Keep the thermometer away from water and dust.

Keep the serial connector and sensor connector (PT100) away from water. Corrosion of the PT100 connector will seriously influence the calibration.



## 7 SPECIFICATIONS

### 7.1 Use conforming to ASTM E2877

The E20 Thermometer specifically is designed to be used conforming the standard guide for digital contact thermoemters ASTM E2877. This Guide describes general-purpose, digital contact thermometers or “digital thermometers” that provide temperature readings in units of degrees Celsius or degrees Fahrenheit, or both.

The thermometer conforms to the highest accuracy class type “A” of the described 9 classes “A” to “I”

Class	Tolerance
A	± 0.01 °C
B	± 0.02 °C
C	± 0.05 °C
D	± 0.1 °C
E	± 0.2 °C
F	± 0.5 °C
G	± 1.0 °C
H	± 2.0 °C
I	± 5.0 °C

### 7.2 Accuracy

For technical specifications see Dimensions and performance page 20.

### 7.3 Response time

For technical specifications see Dimensions and performance page 20.

The fast response to temperature changes of the E20 thermometer ensures a  $T_{63}$  response time of less than 3 seconds. That means that at least 63 percent of the temperature change is displayed within three seconds. The E20 thermometer is equipped with a 3 mm outer diameter shaft. Differences in response time are indicated in figure 1.

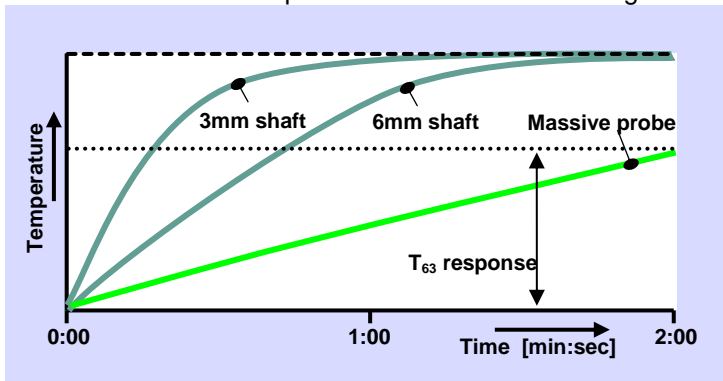


Figure 1

The response time is a very important parameter. When using a thick metal PT100 probe, it appears as though the temperature reading is stable (indicated by the light green line, figure 2). However this false stability is caused by the large thermal mass of the probe. This thermal mass prevents rapid temperature changes so it looks like the temperature reading is stable. This phenomenon gives a technician a false sense of temperature stability. It's not a stable temperature but the PT100s' thermal mass masters the temperature fluctuations which results a feeling of having a stable temperature. In reality the dampened temperature fluctuations may result in significant error during viscosity measurement. Depending on the pt100 probe-mass misreading's in the range of 0.1°C are easily possible.

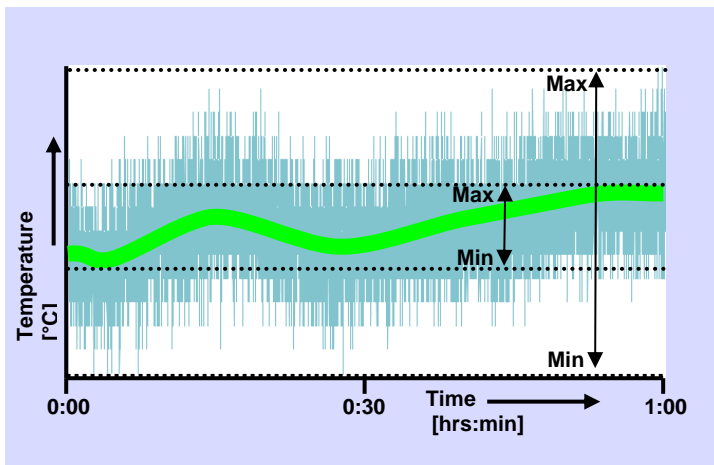


Figure 2

Another disadvantage of a long response time is that it takes longer for the thermometer to reach the true temperature. This difference is indicated in figure 3 below

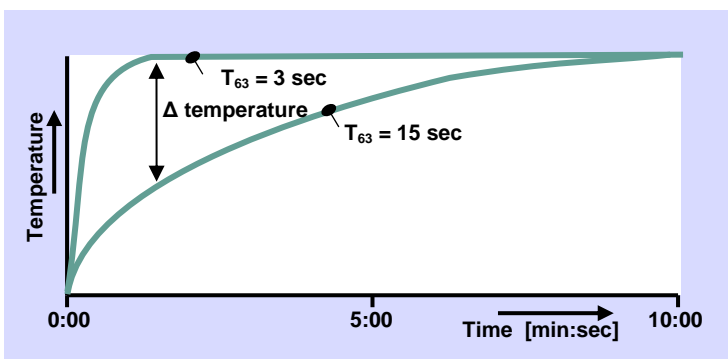
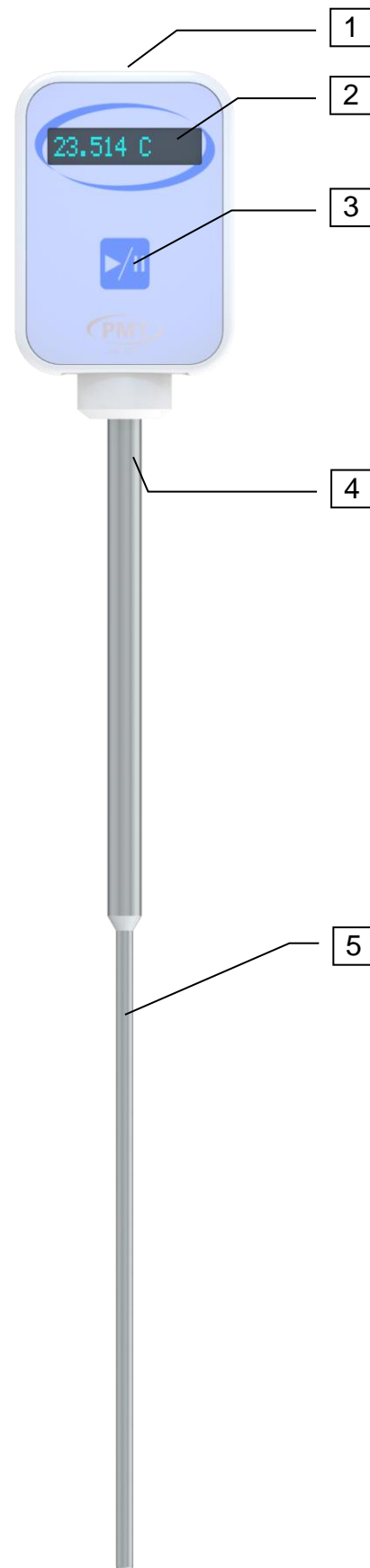


Figure 3

## 8 What is what

- 1 Connector power / communication
- 2 OLED display
- 3 Button
- 4 PT100 shaft diameter 6mm
- 5 PT100 tip



### 8.1 Start

Connect the power cord to the connector on top of the thermometer.

Connect the USB connector of the power cable to the USB power adapter

The thermometer will light up.

### 8.2 Menu structure

When switched on, select the temperature readout:

Degree C,	"°C"
Degree F,	"°F"
Digital,	"B"

### 8.3 Communication

The communication between PC and E20 thermometer uses a protocol based on addresses. In the microcontroller data is stored in EEPROM using memory addresses. The temperature is stored at memory address 376, 377, 378 en 379. Four bytes are stored at this address to form a float.

The protocol between the PC and thermometer is a copy function as it copies a variable of bytes from or to the computer.

The temperature is a 32 bit signed float thus four bytes of data are exchanged

Running at 19200 baud, 8 data bits, no parity  
The data from and to the PC is exchanged using a so called package:



## 8.4 Protocol

- 'Byte 1 Synchronisation, decimal 84 (this is a fixed character)
- 'Byte 2 Length of package, 7..255.  
Each package needs a minimum of 6 bytes  
These 6 bytes are the so called overhead:  
Byte1,2,3,4,5,7  
A package is formed by these six bytes plus additional data.
- 'Byte 3 Command
- bit 0  
0 = data read  
1 = data write
- bit 1 and 2  
00 = not used  
01 = Location is SRAM  
10 = Location is FLASH  
11 = Location is external EEPROM
- 'bit 3  
0 = No extra routine  
1 = Set Real Time Clock
- 'Byte 4 Address high byte
- 'Byte 5 Address low byte
- 'Byte 6 Data, the actual information - 1 to 248 bytes
- 'Byte 7 Checksum, all data is added, last two hex are used.  
I.e. a value of &h 30D returns 0D as checksum.

## 8.5 Send and receive

In order to receive the actual temperature from the E20 thermometer following hex code must be send to the thermometer:

54 0A 02 01 77 00 00 00 00 **D8**  
(The red value "D9" is the checksum)

Now assume the thermometer reads 25.147°C, than the response from the thermometer will be:

54 0A 02 01 77 **63 2D C9 41 72**

In **Red** the checksum

In **Green** the temperature indicated in hexadecimal

Please note that the LSB is send first whilst the MSB is last.

So the data must be swapped:

41 C9 2D 63



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This 32bit HEX data must be converted to a float. The value of &H 41 C9 2D 63 is 25.1472.

One can use a HEX to Float converter like <https://gregstoll.com/~gregstoll/floattohex/>

Or look at Wikipedia on how to convert a 32 bit Hex value into a floating point.



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## 8.6 Installing a RS232 to USB converter

Following is needed in order to communicate with the thermometer. In Windows 10 the driver already is standard available when using this operating system. After plugging in for the first time, driver files automatically are installed in the background and after approximately 2 minutes the converter is available.

The thermometer uses a FTDI RS232 to USB converter chip. In order to set up the communication this driver should be installed for previous Windows systems. So if you have Windows 8.1 or older this so called Virtual Com Port (VCI) should be installed before plugging in the thermometer. Drivers are available from [www.ftdi.com](http://www.ftdi.com). See home, drivers and then VCP Drivers.

Previous Windows versions may not install automatically. Select to install the driver yourself. Please see the screens on the right.

Installation is in progress

Confirm that the software isn't digitally signed

Confirm installation

Sometimes it is necessary to perform the installation twice, as there might be one or more USB hub controllers. If Windows asks to install for a second time this second installation must be performed. It will not harm your system.

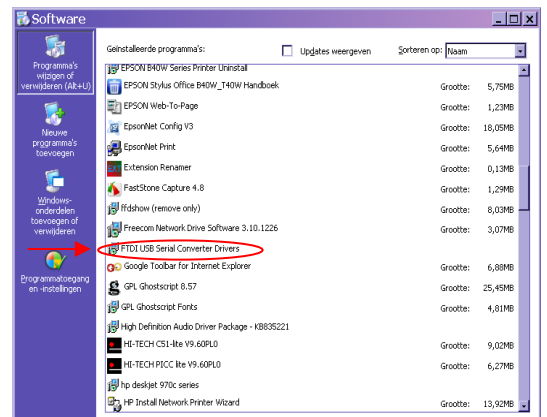


## 8.7 Uninstall RS232 to USB converter

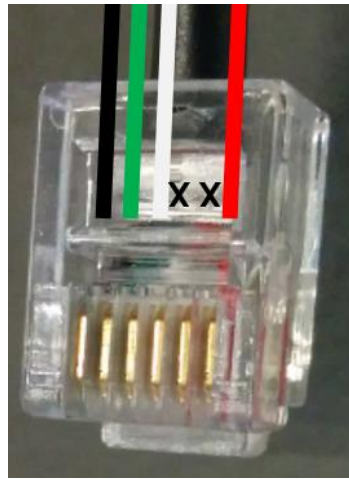
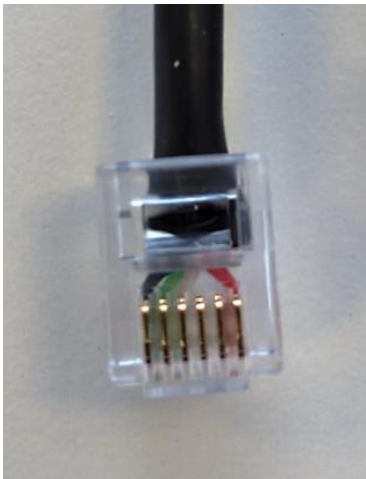
Use Start, configuration screen, software.

A list will be displayed.

Select the driver, FTDIUSB Serial Converter Drivers and perform an uninstall.



## 8.8 Connector cable



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## 9 Calibrating the thermometer

### 9.1 Software

Tamson instruments offers a software program to generate IEC90 coefficients. 5 coefficients are needed to linearize and calibrate the E20 thermometer. To do so this program needs 5 reference temperatures at which the ADC value is read from the Thermometer display. A shipped E20 thermometer offers 3 readings:

- Degree Centigrade, indicated with a "C"
- Degree Fahrenheit, indicated with a "F"
- Analog to Decimal binary value, indicated with a "B"

A fourth reading, degrees Kelvin, is optional.

The temperature readout can be selected using the front button. The digital readout [B] of the thermometer is used as input for the calculation.




**Download** the file from the website by selecting it in the download section. The description of the package is "Tamson Thermometer Toolbox".

**Save** the file to disk and copy it to a specific map. The file now must be unpacked.

Right press the "ZIP" file press the right mouse button and choose extract all. Three files now will be extracted.

The "TTT.ZIP" file can be dragged to the dustbin as this file now is no longer needed.

A shortcut to the windows desktop can be made by right clicking the "TTT.EXE" file and select "send to" and "Desktop (create shortcut)".

 Customer.E20	11-12-2016 21:56	1 kB
 TTT.exe	6-5-2015 08:10	5.547 kB
 TTT.zip	14-1-2017 14:41	2.328 kB

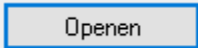
## 9.2 Starting the Tamson Thermometer Toolbox

First connect the thermometer to the USB port. A cable is supplied with a "USB -A" connector and a "RJ45 -6 pole" connector on the other. Next start the program by a double click on the icon on your desktop (when you made a shortcut, see previous chapter). Or simply double click the "TTT.EXE" to start the program.

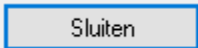
The program will work fine under Windows 7, 8 or 10. The computer must have a free USB port available.

Once the thermometer is connected to the PC USB use the pull down menu "COM Port" to select the active port

Select the port to open

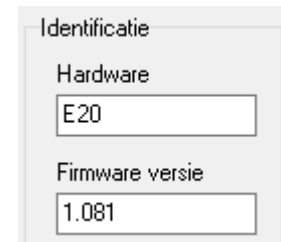
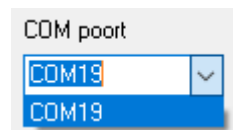
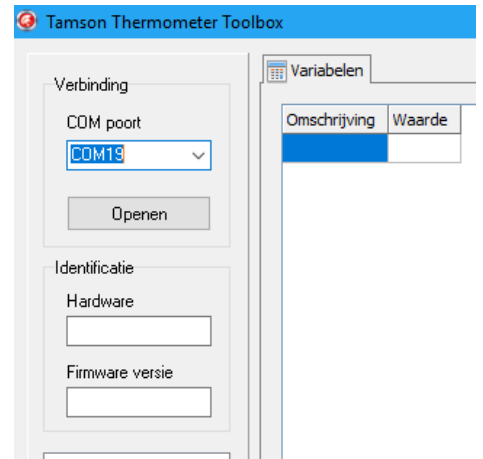
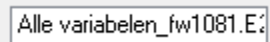


When the thermometer is successfully connected, the box changes into



The software also identifies the attached thermometer:

Below this a table is offered, which will open when double clicked





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A list of parameter now will show Depending on the user. Not all parameters will show or can be edited.

Item	Description	Value
1	Serial	Text
2	Calibrator initial	Text
3	Low range	Numerical
4	High range	Numerical
5	Filter	Numerical 0..255
6	Temp unit	Value
7	Precision	See table [Item 7]
8	Units	See table [Item 8]
9	Coefficient A	Float
10	Coefficient B	Float
11	Coefficient C	Float
12	Coefficient D	Float
13	Coefficient E	Float

Protection for parameters		
Item	User	Factory
1*	Hidden	Selectable
2*	Hidden	Selectable
3*	Hidden	Selectable
4*	Hidden	Selectable
5	Selectable	Selectable
6	Selectable	Selectable
7*	Hidden	Selectable
8	Selectable	Selectable
9	Selectable	Selectable
10	Selectable	Selectable
11	Selectable	Selectable
12	Selectable	Selectable
13	Selectable	Selectable

[Item 7] Settings for decimals	
0	No decimals
1	1 decimal
2	2 decimals
3	3 decimals.

[Item 8] Settings for decimals				
Value	Celsius	Fahrenheit	Kelvin	ADC
1	Yes			
2		Yes		
3	Yes	Yes		
4			Yes	
5	Yes		Yes	
6		Yes	Yes	
7	Yes	Yes	Yes	
8				Yes
9	Yes			Yes
10		Yes		Yes
11	Yes	Yes		Yes
12			Yes	Yes
13	Yes		Yes	Yes
14		Yes	Yes	Yes
15	Yes	Yes	Yes	Yes

Omschrijving		Waarde
Serienummer	1*	01BH01
Calibrator initialen	2*	RvH
Laagste waarde meetbereik	3*	-45
Hoogste waarde meetbereik	4*	150
Afvlakfactor	5	150
Temperatuureenheid	6	3
Aantal cijfers achter de komma	7*3	
Selectie temperatuureenheden	8	11
Coefficient 1	9	-246,783220971056
Coefficient 2	10	0,000892200157532599
Coefficient 3	12	8,40679086060666E-11
Coefficient 4	11	5,88917145866885E-17
Coefficient 5	13	3,29123253357102E-24



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### 9.3 Taking measuring points

Five measuring points must be taken in order to calibrate and linearize the thermometer. This method fully conforms to ITS90.

Each measuring point consists of a temperature with 3 decimals. At each point the stable digital readout from the thermometer is taken. Each temperature value must maintain a stability of + or - 0.001°C over 60 seconds in order to successfully calibrate the E20 thermometer. An example of these 5 points is found the table 1

The colon "Temp" gives the temperature with an accuracy of ± 0.001°C over one minute.

The colon "Reading" gives the readout on the E20 thermometer. This reading also must be stable over 60 seconds + or - one digit.

### 9.4 Process the calibration data

The data of "Table 1" can now be used to calculate the ITS90 coefficients to linearize the E20 thermometer. The coefficients will linearize the E20 thermometer to within ±0.01°C linearity and accuracy.

In the TTT program, select the tab "coefficienten". Data from "Table 1" now can be used to fill Reference (Y) and Meting (X).

Use the button  to calculate the coefficients A, B, C, D, E.

Select each coefficient with your mouse and copy it (Copy or [CTRL-C]).

Go to Tab Variables , select the coefficient and replace the coefficient (paste or [CTRL-V]).

Repeat this for all coefficients

Temp*	Reading
-42,106	224342
0,004	268904
39,980	310723
79,991	352037
119,979	392821
141,989	415050
Tabel 1	

\* +/- 0,001 stable over 60 seconds. Absolute accuracy of 0.006°C

Referentie (Y)	Meting (X)
-42,106	224342,000
0,004	268904,000
39,980	310723,000
79,991	352037,000
119,979	392821,000
141,989	415050,000

A	-252,63500369149
B	0,000964085329983042
C	-2,64385769565915E-10
D	7,96941081798127E-16
E	-5,7140105431241E-22

A	252,63500369149
---	-----------------

Coefficient 1



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After copying each coefficient the value is verified. If for some reason the value is not copied correctly into the thermometer, the value is indicated in bold. This means there is a difference between the EEPROM value in the thermometer and the value in the Tamson Thermometer Toolbox.

Omschrijving	Waarde
Serienummer	01BH01
Calibrator initialen	RvH
Laagste waarde meetbereik	-45
Hoogste waarde meetbereik	150
Afvlakfactor	150
Temperatuureenheid	3
Aantal cijfers achter de komma	3
Selectie temperatuureenheden	11
Coefficient 1	-252,63500369149
Coefficient 2	0,000964085329983042
Coefficient 3	-2,64385769565915E-10
Coefficient 4	7,96941081798127E-16
Coefficient 5	-5,7140105431241E-22

Close the communication using the close button, re-open and try to send the value(s) again.

COM poort  
COM19  
Sluiten



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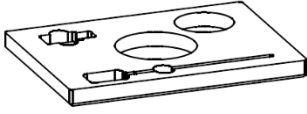
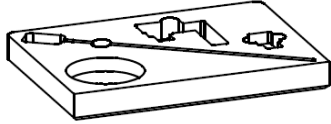


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## 10 Spare parts list

Ordering code	Image	Description
10T6097		Works certificate Range - 5 test points
10T6098		Verification calibration extra test point per point [-40 .. +145°]
		Suitcase for thermometer short
		Suitcase for thermometer long
24T0013		5V Adapter*
28T2040		Cable RJ11 to USB-A 1.8 metre



Range	-40 .. + 20°C	0 .. +80°C	20 .. + 120°C	-40 .. + 140°C
Two decimal precision $\pm 0.02^\circ\text{C}$ probe <b>short*</b>	19T4021	19T4022	19T4023	19T4024
Three decimal precision $\pm 0.01^\circ\text{C}$ probe <b>short*</b>	19T4031	19T4032	19T4033	19T4034
Two decimal precision $\pm 0.02^\circ\text{C}$ probe <b>long*</b>	19T4041	19T4042	19T4043	19T4044
Three decimal precision $\pm 0.01^\circ\text{C}$ probe <b>long*</b>	19T4051	19T4052	19T4053	19T4054
Additional works verification calibration per point	10T6098	10T6098	10T6098	10T6098



ISO 9001 : 2015  
NL/PRO 238239125

Van 't Hoffstraat 12  
2665 JL Bleiswijk, The Netherlands  
T. 31 (0) 10 522 43 73

E20 Thermometer man.docx Rev. 3.03 UK 0319

**Tamson Instruments bv**

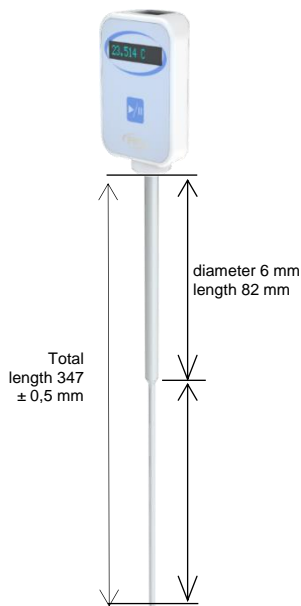
E-mail: sales@tamson.com  
Website: www.tamson.com

VAT: NL 80 66 34 984 B01  
Bank account no.:  
NL28 INGB 0007 350 370  
NL95 RABO 0160100046  
Chamber of commerce 27 16 95 41  
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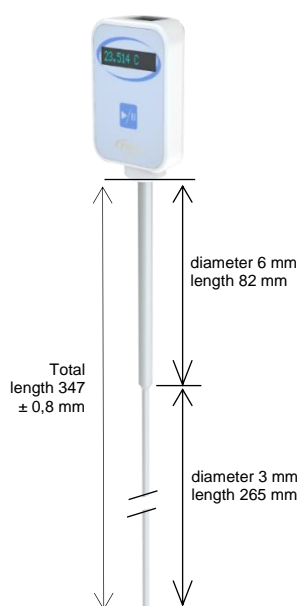
## 11 Dimensions and performance

Dimensions housing			Remark
Length	39	[mm]	
Width	22	[mm]	
Height	62	[mm]	
Weight*	50	[grams]	
Power consumption			
Adapter	5V / 20mA		
Accuracy			
Resolution	0.001	[°C]	3 Digit reading
	0.010	[°C]	2 Digit reading
Accuracy [stDev]	±0.01	[°C]	3 Digit reading
	±0.01	[°C]	2 Digit reading
Linearity [stDev]	±0.01	[°C]	2 and 3 Digit reading
Temperature drift			
Per year	0.001	[°C]	
Per [°C] ambient	0.0005	[°C]	
Working condition (ambient)			
Temperature	20..30	[°C]	
Humidity	10..90	[%]	relative humidity
Sensor	PT100		

\*Probe Short



\*\*Probe Long



## 12 Trouble shooting

### 12.1 Display shows strange characters

Unplug thermometer  
Wait for 60 seconds  
Reconnect

### 12.2 Communication gives problems

=> Cables too long  
Use shorter cables, or lower baud rate.

=> Windows Driver Interference

Use other com port, handle as follows:


Configuration screen  
System  
Device manager


Select "Port (COM & LPT)"

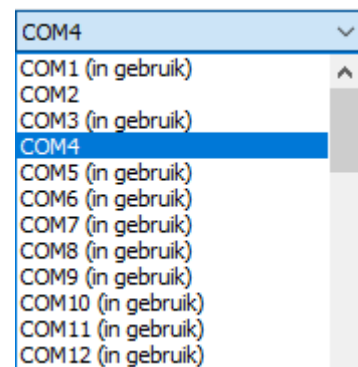
Double click on the connected thermometer

Use the TAB port settings  
Advanced

Now select another COM port, i.e. COM2 or a port which can be overwritten (i.e. COM5 .. COM12)

 Poorten (COM & LPT)

 USB Serial Port (COM4)





est. 1878

### 13 EC DECLARATION OF CONFORMITY THERMOMETER E20 Thermometer

Following equipment is in compliance with EMC Directive 2014/30/EU:



Product: Thermometer  
 Model: E20  
 Serial code: Effective from 01BHxxx  
 Manufacturer: Tamson Instruments bv  
 van 't Hoffstraat 12  
 2665 JL Bleiswijk  
 The Netherlands

The products to which this statement relates, is manufactured and dully carried out in compliance with the provisions of Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility.

The products are in conformity with the following specification:

Conducted emission - EN55016-2-1 + EN61326+A1  
 Radiated emission - EN55016-2-3 + EN61326+A1+A2+A3  
 ESD: - EN61326 +A1+A2+A3 and EN61000-4-2 +A1+A2  
 Radiated immunity - EN61000-4-3 +A1

Item	Reference	Description	Test result
a	<b>RoHS Directive</b>	2011/65EU	p
b	<b>EN60950-1</b>	Low Voltage Directive	p
c	<b>EN61000-4-2 +A1+A2</b>	ESD	p
d	<b>EN61000-4-3 +A1+A2</b>	Radiated immunity	p (anechoic room)
e	<b>EN61000-4-6+A1</b>	Conducted immunity	p
f	<b>EN55016-2-1</b>	Conducted emission	p
g	<b>EN55016-2-3</b>	Radiated emission	p (anechoic room)

p = Pass

June 2016, Tamson Instruments bv, The Netherlands

**Entity responsible for marking this declaration :**

Manufacturer, Tamson Instruments bv, van 't Hoffstraat 12, Bleiswijk The Netherlands,

Name :  R.C. van Hall  
 Function : Director  
 Date : January, 2016  
 Version : 1.04



ISO 9001 : 2015  
NL/PRO 238239125

## Tamson Instruments bv

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