T9 Auto Calibration

T9 is RTD temperature measurement module, with 12 channel RTD-to-digital converters, designs specific for Auto Calibration Application.

- 12 channel platinum RTD temperature measurement and data logger
- Works with PT100 RTD temperature sensors
- Compatible with 4-wire sensors
- 24-Bit ADC Resolution
- Temperature and Calibration report
- Stand-alone application
- RS232 Serial Communications
- Powered by USB port or DC adaptor

Auto Calibration eliminates several human errors and inaccuracies when a person performs manual calibration. T9 uses a resistance-to-digital converter which optimizes for platinum resistance temperature detectors. An external resistor and 24-bit delta-sigma ADC are used to convert RTD resistance to a digital value. T9 can measure temperature from multiple sensors at the same time, so it was time-saving and better sensor data. Calibration Value is calculated automatically when a temperature stable condition and stable time is met, then T9 will update all the values immediately. T9 uses RS232 Serial Communication for data transfer and Calibration function. Temperature value, Calibration value and Calibration time, all this information is saved to Micro SD Card, so data can be analyzed when needed.

Specifications

T9 Auto Calibration	
Sensor	RTD PT100
Ranges	-200 to 800 °C *depending on external PT100 sensor
Accuracy	0.1 °C
Resolution	0.001 °C
Overvoltage Protection	35V
ADC Resolution	24 bits
Conversion Time	168ms per channel
Communications	RS232
Sensor Inputs	12
Sensor Connectors	Mini DIN 4-Pin
I/O Ports	DB9, USB
Power Supply	USB or DC 12V
Dimensions	H60 x W240 x D220 mm

T9 Auto Calibration

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Table Of Contents

T9 Auto Calibration

User’s Guide

Important Information

Do not use T9 near the high frequency or electrical noise area. High frequency or electrical noise results in inaccurate measurement.

Do not connect the sensor or any of the T9 parts to dangerous equipment. The hazardous voltage on the equipment can damage the A/D converter circuit and anything that connects with T9.

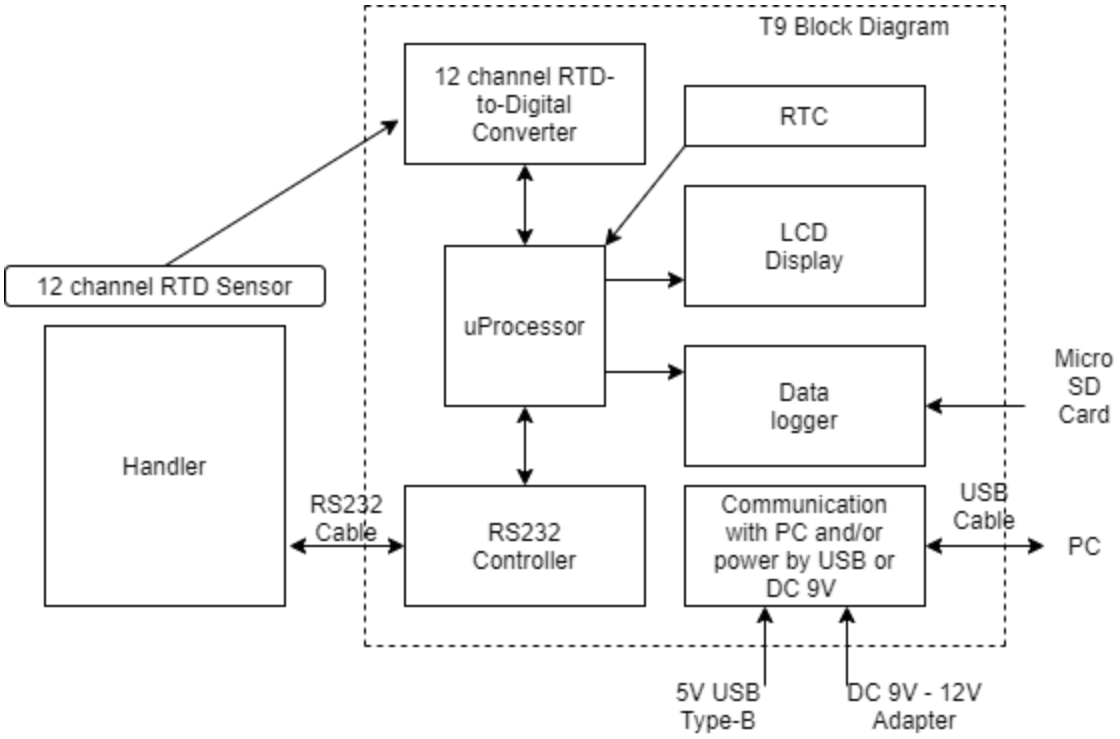
T9 is protected by copyright law, attempting to replace or modify T9 electronic components and/or any part including the enclosure is not allowed.

All accompanying documents, especially this datasheet/user's guide, must be passed to and acknowledged by T9 users.

Redistribution of T9 documents, this datasheet, must retain all copyright notices that are currently in place, and the conditions in this page without modification.

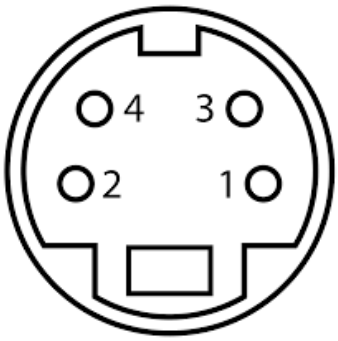
T9 owners shall not be responsible or liable for any loss, damage or injury, however caused, related to the use of T9.

T9 Block Diagram



RTD Sensor wiring

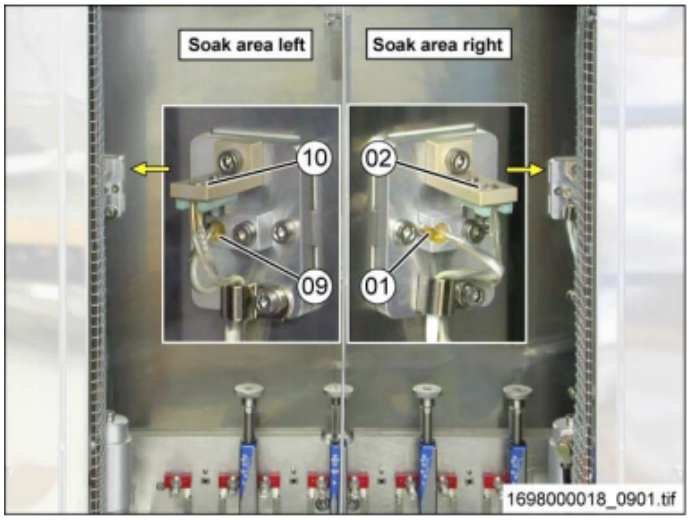
Use a multimeter to determine which RTD wires connect together directly (2 ohms) and which connect through RTD.



Connect RTD wires that connect together to mini-DIN 4 pin no. 1 and 4, and connect other pairs to mini-DIN 4 pin no. 2 and 3

T9 Channel: Handler External Sensor Position

Ch1: Sensor 01 soak area right
Ch2: Sensor 03 contact area right
Ch3: Sensor 05 track B, upper contact site
Ch4: Sensor 07 track B, lower contact site
Ch5: Sensor 09 soak area left
Ch6: Sensor 11 contact area left
Ch7: Sensor 13 track C, upper contact site
Ch8: Sensor 15 track C, lower contact site
Ch9: Sensor 17 track A, upper contact site
Ch10: Sensor 19 track A, lower contact site
Ch11: Sensor 21 track D, upper contact site
Ch12: Sensor 23 track D, lower contact site


Soak area left
Soak area right
10
09
02
01
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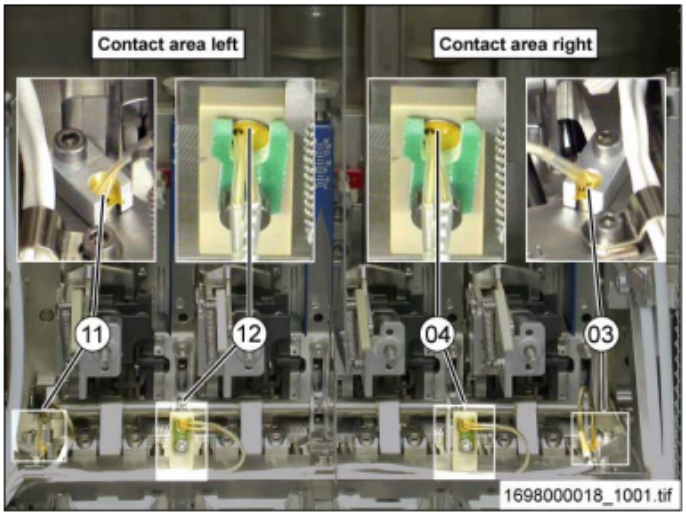
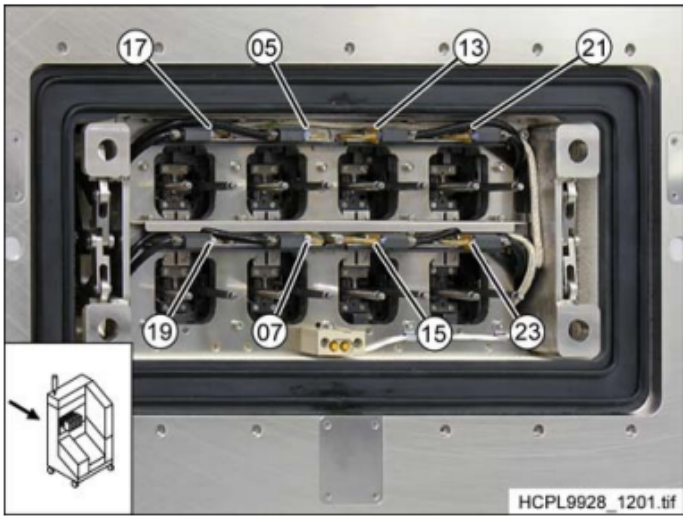

Contact area left
Contact area right
11
12
04
03
1698000018_1001.tif


17
05
13
21
19
07
15
23
HCPL9928_1201.tif

Calibration Setup

1. Place RTD sensor at Handler specific location and connect RTD sensors mini-din 4 pin connector to T9 12 channel inputs
2. Connect RS232 cable between Handler and T9
3. Connect power supply to T9 , use one of power source options
    a. USB connector
    b. AC-to-DC adapter 7 - 12 volts
4. Insert Micro SD Card into Card Slot
5. On Handler go to > RS232 Interface Configuration
    a. Enable RS232-Interface
    b. Disable Termination: CR/LF
6. On T9
    a. Stand Alone
        i. Go to application selection screen by press [NEXT] Button
        ii. Select Auto Calibration menu and press [NEXT]
        iii. Set Setpoint and Calibration Value for each channel, all value is preserve for current session *** value = value x 10
        iv. Set Internal Sensor Stability and External Sensor Stability
        v. Set stability Time
        vi. when ready press T9 [START] button to begin calibration

T9 Application

There are two applications, first is Calibration which is the main application of T9, second is Temperature Measurement for measuring internal temperature, external temperature or measures internal and external temperature.

Main Menu

- Calibration: enter this menu for Calibration Application
    - Calibration Settings
        - Internal Sensor Stability
        - External Sensor Stability
        - Stable Time
        - RTD Wire
        - Edit Table
- Temperature Measurement: use this menu to measure RTD temperature
    - Internal Sensor Measurement
    - External Sensor Measurement
    - Internal and External Sensor measurement
    - Offset Setting (set temperature offset)
    - OFFSET: Enable/Disable

Calibration Settings

Stability Setting is used to filter temperature and determine if the temperature is in stable condition. The units of setting are in degree celsius and can increment by 0.1 degree. After changing the stability value, pressing the [BACK] button will automatically save the value. The internal sensor is the default sensor inside the Handler, the external sensor is the PT100 RTD sensor that is placed at a specific location on the Handler. Internal sensor stability is used with internal sensors, external sensor stability is used with external sensors. Internal Sensor Stability min = 0.1, max = 2, External Sensor Stability min = 0.1, max = 2

Stable Time is the time period begins when first temperature stability condition occurs and sensor temperature must be within stability condition until complete stable time period. If sensor temperature is out of the stability condition then the current stable time counter will be terminated and count value will reset to zero.

RTD Wire setting**:** The default value is set to 4-wire which is recommended for accuracy measurement.

Edit table: this is Calibration Table where user can enter Setpoint and Calibration Value

Temperature Measurement

- Internal Sensor Measurement: T9 use RS232 serial protocol to read internal sensor from each sensor position inside Handler
- External Sensor Measurement: T9 read external sensor via 12 channel inputs
- Internal and External Sensor Measurement: T9 read internal and external sensor
- Temperature Offset: Temperature measurement can be adjusted to nearly or close to the reference system by using the offset. Use this menu to set offset values.
- Temperature Offset Enable/Disable: enable or disable temperature offset

OFFSET Setting

T9 has temperature measurement accuracy of 0.1 degree celsius. It is rare occasions that the accuracy will deviate from specification, in this case use offset setting to correct the value.

An example of how to use offset1

1. select Temperature Measurement menu
2. set desire setpoint e.g. -55, 0, 75, 155 on reference system (calibrator)
3. get sample data (read T9 temperature value, 20 or 30 samples) at specific setpoint (sample data also save to sd card)
4. calculate average temperature value from sample data
5. calculate offset for current setpoint (calibrator temperature - step 4)
6. go to step 2. and set next setpoint, repeat each step until completed all setpoint then go to step 7
7. calculate an average value from step 5
8. goto Temperature Measurement menu and enable offset
9. goto offset setting menu and set offset to value from step 7
10. Offset value will be saved permanently when press [< / back] button to go to temperature measurement menu

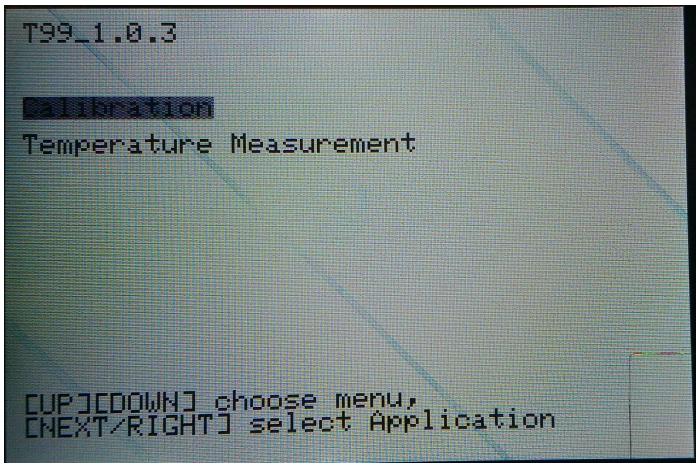
T9 on-screen menu and navigation

There is an LCD display and button to help navigate to each setting or selection menu. At the bottom of the screen also has navigation text to help where to go to the next section. Users can go to the next screen by pressing the [NEXT/RIGHT] button or go back to the previous screen by pressing the [BACK/LEFT] button. Use [UP/+] button or [DOWN/-] button to increase or decrease the value or navigate up/down on the sub-menu. [START] button, press this button when ready to begin calibration or start to measure temperature. [RESET] button, use this button to reset T9.

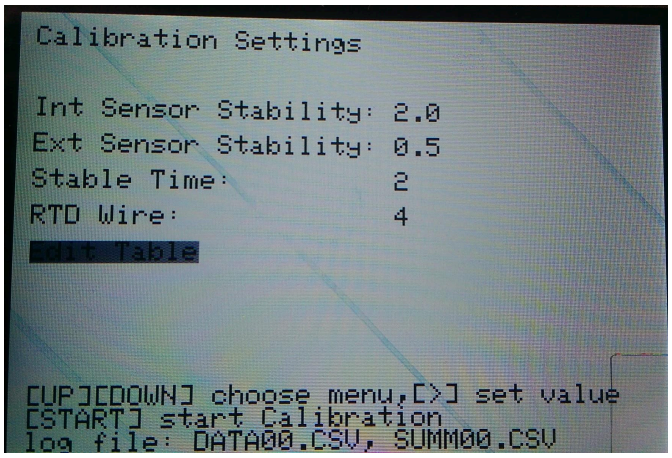
T9 stand alone

1. After power on reset T9 will display the waiting screen
2. Insert Micro SD Card into SD Card Slot

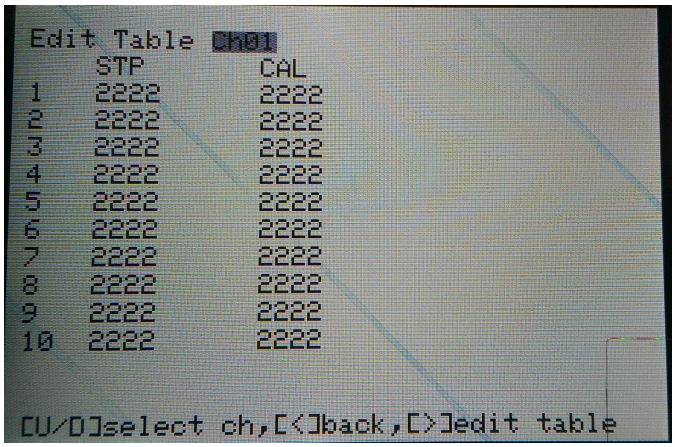
3. Press next button will display Application Selection screen
4. Choose Calibration and press next button



5. On Calibration Settings screen choose Edit Table and press next button

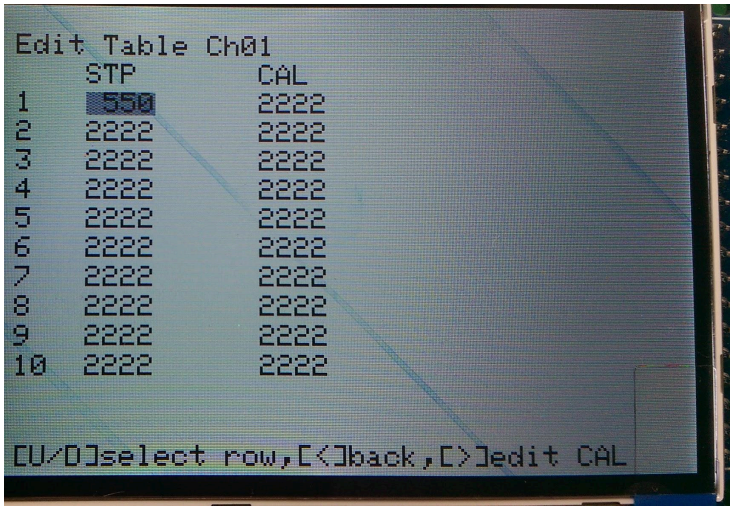


6. On Edit Table screen select channel 01 to 12 by press UP/DOWN button

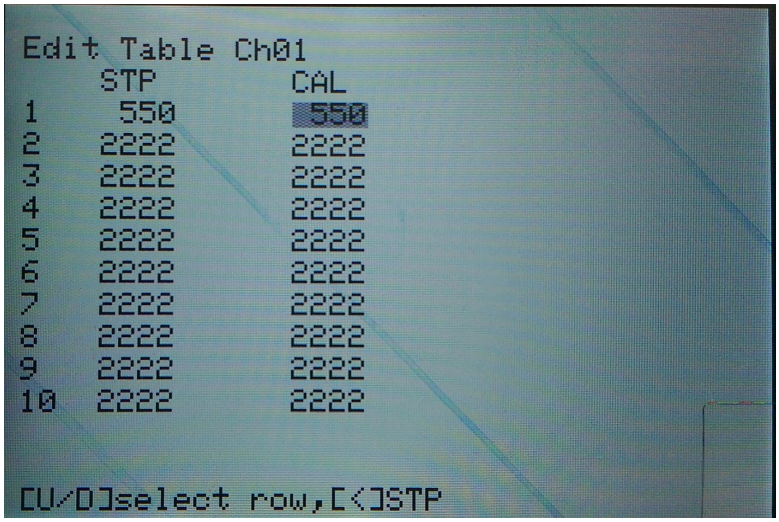


7. Press next goto edit table Setpoint (STP)

8. Enter Setpoint Value by press numeric key



9. Press next button
10. Enter Calibration Value (CAL)



11. Press the back button to go back to step 6
12. Repeat step 6 to step 10 until complete all 12 channel
13. Go back to settings screen
14. Set Stability value to the specification requirements
15. Press start button to start Calibration

While in the calibration process T9 will show current setpoint value, calibration information and number of update counts. The real time data is displayed on the T9 LCD screen. If multiple Setpoints are used, T9 will start calibrating at a lowest setpoint first and when finished T9 will calibrate at the next higher setpoint until complete all setpoints. It will take some time until all sensors get into temperature stability range (setpoint +/- stability value). If all sensors stay within stability range and stable time has passed then T9 will update Handler Calibration Table Value. The update can occur many times until the current calibration setpoint is complete and then PT1 will calibrate the next setpoint. Stable time is 2 to 30 minutes (default is 2 minutes) depending on the user-specified. Stable Time starts to count when all sensors reach the temperature stability condition. Usually it takes around 30 minutes or more to complete one setpoint. Message “Calibration at setpoint xx xx completed.” will be shown when all calibration is completed.

Data on SD Card

When auto calibration was completed calibration data was also saved to the Micro SD Card. Analysts can take the SD Card and view the calibration data with the PC. There are 2 files for calibration application DATAxx.CSV, SUMMxx.CSV and 1 file TEMPxx.CSV when measuring temperature, each file has a .csv extension which can be opened with spreadsheet software like Microsoft Excel. The xx character in the file name is the number that starts at 00 to 99, e.g. DATA00.CSV - DATA99.CSV. This is the auto generated file name and the number is incremented by 1. When file number is reached 99 all files should be deleted otherwise there will be an error.

Calibration Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	Date Time	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
93	20/07/21 19:07:14	61.8	60.5	60.2	60	61.4	59.9	60.1	60	59.9	59.9	60	60.1	60.9	60.7	60.9	60.8	60.7	61	60.9	60.8	60.6	60.8	60.8	60.9	-0.9	-0.7	-0.9	-0.8	-0.7	-1	-0.9	-0.8	-0.6	-0.8	-0.8
94	20/07/21 19:07:29	61.7	60.5	60.2	60	61.3	59.9	60.1	60	59.9	59.9	60.1	60.1	60.7	60.7	60.8	60.8	60.6	60.8	60.8	60.7	60.6	60.7	60.7	60.7	-0.7	-0.7	-0.8	-0.8	-0.6	-0.8	-0.8	-0.7	-0.6	-0.7	-0.7
95	20/07/21 19:07:45	61.6	60.4	60.2	60	61.2	59.9	60.1	60	60	59.9	60	60.1	60.7	60.6	60.8	60.7	60.7	60.8	60.8	60.7	60.5	60.6	60.6	60.7	-0.7	-0.6	-0.8	-0.7	-0.7	-0.8	-0.8	-0.7	-0.5	-0.6	-0.6
96	20/07/21 19:08:00	61.5	60.4	60.2	60	61.2	59.9	60.1	60	60	59.9	60.1	60.1	60.6	60.5	60.7	60.7	60.6	60.7	60.6	60.6	60.4	60.6	60.6	60.5	-0.6	-0.5	-0.7	-0.7	-0.6	-0.7	-0.6	-0.6	-0.4	-0.6	-0.6
97	20/07/21 19:08:16	61.4	60.4	60.2	60	61.1	59.9	60.2	60.1	60	60	60.1	60.1	60.6	60.5	60.7	60.6	60.6	60.6	60.7	60.5	60.3	60.6	60.5	60.5	-0.6	-0.5	-0.7	-0.6	-0.6	-0.6	-0.7	-0.5	-0.3	-0.6	-0.5
98	20/07/21 19:08:32	61.4	60.4	60.2	60	61	59.9	60.2	60.1	60	60	60.1	60.1	60.5	60.4	60.6	60.5	60.3	60.7	60.6	60.5	60.3	60.4	60.5	60.4	-0.5	-0.4	-0.6	-0.5	-0.3	-0.7	-0.6	-0.5	-0.3	-0.4	-0.5

Log data

Column name	*Description*
Datetime	Time when data was saved, yyyy/mm/dd hh:Mm:ss
I0 to I12	Temperature of internal sensor inside handler
E0 to E12	Temperature of external sensor RTD PT100
D0 to D12	Difference between setpoint and external sensor (setpoint - external sensor)
N0 to N12	New calculate calibration value
O0 to O12	Old calibration value
Info Message	Information, e.g. handler id, status or error message
Update CAL Count	The number of count when T9 update handler calibration value
Update CAL Time	Elapsed time of each time T9 update handler calibration value
INT_to_STB(sec)	Elapsed time when internal sensor reach temperature stable condition
INT STB	Internal temperature stability value
EXT STB	external temperature stability value
Setpoint	Calibration Setpoint

Summary

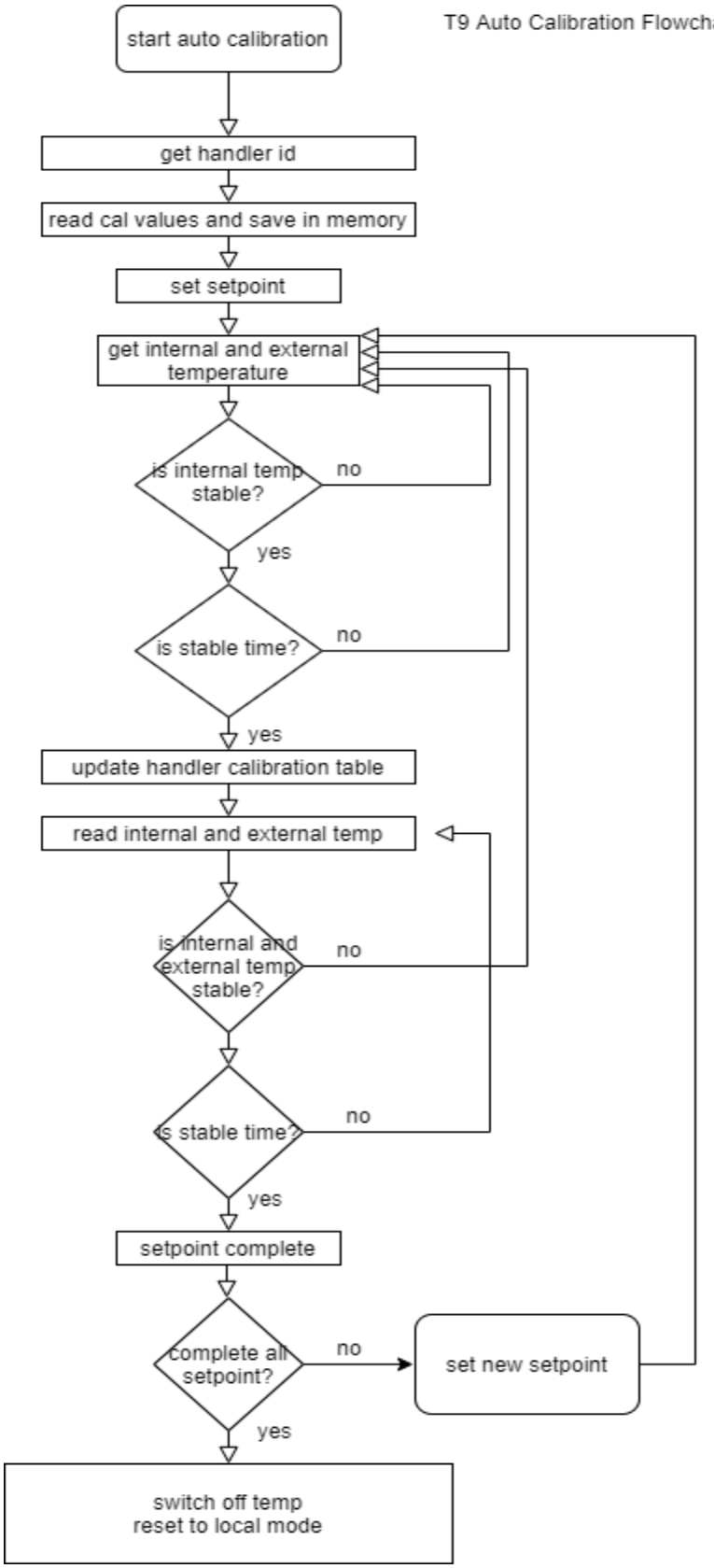
Column name	*Description*
Handler ID	Handler id number
Start Time	Start calibration time, yyyy/mm/dd hh:mm:ss
Finish Time	Finish calibration time, yyyy/mm/dd hh:mm:ss
Setpoint	Calibration setpoint
INT0 to INT12	Internal Temperature
EXT0 to EXT12	Temperature of external sensor RTD PT100
CAL0 to CAL12	Calibration value
Update CAL Count	Total update count when calibration completed.
Calibration Time	Time when calibration completed.

Temperature

Column name	*Description*
Datetime	Date and time, yyyy/mm/dd hh:mm:ss
I0 to I12	Temperature of internal sensor inside handler
E0 to E12	Temperature of RTD PT100

T9 Auto Calibration Flowchart

T9 Auto Calibration Flowchart



RTC (Real-time Clock) Date and Time Settings

T9 has an RTC (real-time clock) which maintains the date and time of the system. RTC devices operate at 3v and use batteries to keep date-time running even if there is no power supply connected to the system. The accuracy of RTC remains at +/-3.5ppm (+/-0.3024 seconds/day). Normally the battery life is about 3 - 5 years but in some cases users may need to reprogram RTC. RTC date and time can be reprogram by do the following:

run T9 in debug mode

1. connect USB type B connector to T9 and connect USB type A to PC
2. on PC open Terminal Software (any Terminal Software can be use)
3. on Terminal software:
    a. select port
    b. setting baud rate to 150200 bps and use 8 N 1 settings
4. connect Terminal Software to T9
5. wait and watch stream of text flow on Terminal screen
6. When text " Off State " is shown, it means initialization is complete.

reprogram date-time of RTC module

a. run T9 in debug mode from Step 1. to 6.
b. input command into Terminal Software
   date-time command: "W yyyy, mm, dd, hh, mm, ss"
   * yyyy = year, mm = month, dd = day, hh = hour, mm = minute, ss = second
c. restart
d. verify date and time is correct

Version history

Version	Date	Description
1.0	2020/10/07	Initial
1.1	2020/11/19	Added T9 picture, add dimensions
1.2	2020/12/11	Added offset section
1.3	2021/02/14	Added clear table before enter new value (when use with pc), offset value is saved when press [< / back] button
1.4	2023/08/30	Added software installation instruction, Add TOC
1.4a	2023/09/03	Added system requirements, RTC Settings
1.5	2025/07/10	*
1.5a	2025/07/10	Stand alone version

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