Mini CTA

54T30

Installation & User's guide

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1. Contents

2. Mini CTA Anemometer 54T30.

2.1 Introduction.

The MiniCTA is a versatile anemometer that can be used with several of Dantec wire probes. The MiniCTA is mounted in a small box equipped with BNC connectors and operated from a 12 VDC power adapter or alternatively by a battery. It is designed for measurement of velocity and turbulence in subsonic flows with moderate frequency content and is especially suited for educational purposes and for field measurements. Its small size makes it well suited for building into test models close to the probe. The bandwidth (5 - 10 kHz) is optimised for use with wire probes. The anemometer accepts probes with cold resistances typically up to 10 ohms. Overheat setup and signal conditioning are performed via dip switches and jumpers inside the box. Setting the overheat ratio is assisted by the MiniCTA software package or by an Excel spread sheet, which can be downloaded from Dantec Dynamics web site.

2.2 Installation.

The anemometer has two BNC connectors (one for the probe cable and one for the output voltage) and one input connector for the power adapter. *It is important to connect the probe and probe cable to the box and to adjust the overheat, before the power adapter is connected and power is switched on, in order to avoid burn-out of the probe.*

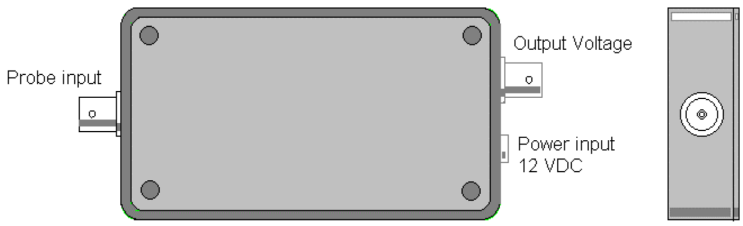


Fig. 1. *Connecting and grounding of the MiniCTA output signal via a 100 kΩ resistor.*

Connect the 4 m coax cable (Dantec no. 9006A1863 supplied with the anemometer) with its probe support to the Probe input BNC connector on the CTA-box and insert the probe into the probe support. Connect the BNC connector marked 'Output' to a voltmeter or data acquisition system, see Fig. 1. Finally connect the power adapter to the power input. The polarity is arbitrary, as the power is fed through a bridge rectifier. It is normally recommended to connect the MiniCTA output signal differentially to the A/D board input, as the power supply is floating. If more MiniCTA's are attached to the same power supply, their outputs must be connected differentially.

Do not turn the line power on until you have checked that the overheat is correctly adjusted (see below) and mounted the probe!

2.2.1 Grounding of the MiniCTA.

The Power Adaptor for the MiniCTA is not grounded and the MiniCTA acts as a floating signal source. It is therefore important to use differential input, when the anemometer voltage is acquired via an A/D board and to connect the anemometer signal ground to the Analog input ground (PC ground) via a resistor in order to avoid noise problems. When more MiniCTA’s are connected, it is mandatory that all outputs are grounded via their own resistor.

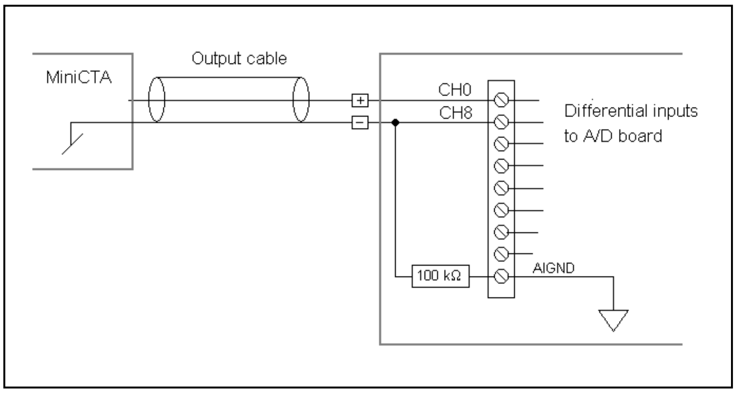


Fig. 2. *Connecting and grounding of the MiniCTA output signal via a 100 kΩ resistor.*

2.3 General set up

2.3.1 Factory settings

The overheat resistance is preset at the factory to match 55P11-16 and 55P61-64 wire probes connected with 4 m probe cables to the MiniCTA. The system is ready for use without any adjustments for these combinations. Note, for use with other probes an adjustment of the overheat can be necessary and in some cases a modification of the MiniCTA may be required. Please, check with your local Dantec representative.

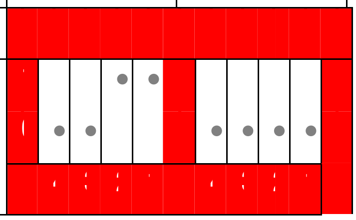
Probe type $R_{20} \geq 3.2\ \Omega$	Cable length	Recommended decade setting ($20 \cdot R_T$)	Dip switch SW1	Dip switch SW2
Wire probes 55P11-16 55P61-64	9006A1863 4 m	140 Ω		

Fig. 3. Factory overheat setup.

2.3.2 Selecting and adjusting overheat.

The overheat resistor or decade resistor, R_D, is adjusted so that the desired wire operating temperature, T_w, is established when the power to the MiniCTA is turned on. Recommended T_w (or sensor working temperature, T_{sensor}) is found on the label on the probe box.

The decade resistance, R_D, in the 1:20 ratio CTA bridge, which actually determines the operating resistance, is:

$$R_D = 20 \cdot (R_w + R_L + R_S + R_C)$$

where R_w, R_L, R_S and R_C are the wire operating resistance, the lead resistance, the probe support resistance and the probe cable resistances respectively.

The wire operating resistance, R_w, can be calculated either from the probe resistance R_{20} and α_{20}, both related to 20 °C ambient temperature found on the probe box or from the probe resistance measured at the actual ambient temperature. Based on data on probe box one gets for the operating resistance R_W:

$$R_w = R_{20} + \alpha_{20} \cdot R_{20} \cdot (T_w - 20)$$

or, if the ambient temperature T_{amb} differs from 20 °C:

$$R_w = R_{amb} + \alpha_{20} \cdot R_{20} \cdot (T_w - T_{amb})$$

For a tungsten wire T_W is recommended to be less than 250°C, in the following T_W = 242 °C is used.

2.3.3 Overheat calculation using Excel spreadsheet.

The overheat can be calculated using the MS Excel spreadsheet "MiniCTA overheat spreadsheet", which can be downloaded from Dantec Dynamics web site:
http://www.dantecdynamics.com/Default.aspx?ID=705

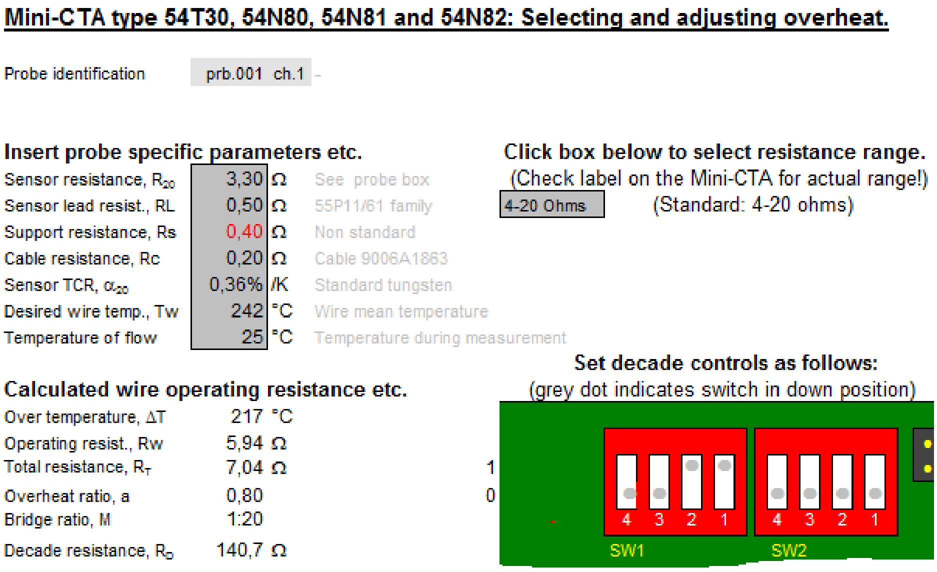


Fig. 4. Overview of "MiniCTA overheat spreadsheet".

1) First enter the probe and channel number for a correct documentation of your system settings.

2) Before continuing to the next step check that the resistance range on the MiniCTA label matches the setting in the spreadsheet. If the range is incorrectly - click the box to choose a correct range. This is usually only valid for modified MiniCTA's.

Click box below to select resistance range.
(Check label on the Mini-CTA for actual range!)
4-20 Ohms (Standard: 4-20 ohms)

3) Then enter the data from the probe box and the data for the probe support and the probe cable together with the desired wire operating temperature T_W (= 242 °C) and the ambient temperature during measurement, T_{amb} (= 25 °C).

Insert probe specific parameters etc.

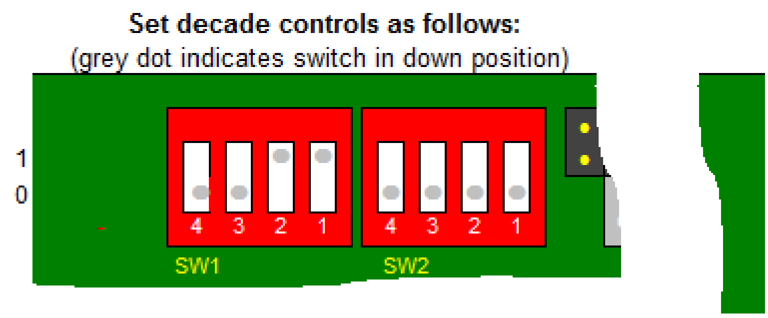
Sensor resistance, R_{20}	3,30	Ω	On probe box
Sensor lead resist., RL	0,50	Ω	55P11 and similar
Support resistance, Rs	0,40	Ω	55H20/24/27 or similar
Cable resistance, Rc	0,20	Ω	Cable 9006A1863
Sensor TCR, α_{20}	0,36%	/°K	Standard tungsten
Desired wire temp., Tw	242	°C	Wire mean temperature
Temperature of flow, T_{amb}	25	°C	Temperature during measurement

The spreadsheet then calculates the decade resistance (R_D):

Calculating wire operating resistance etc.

Over temperature, ΔT	217	°C
Operating resist., Rw	5,94	Ω
Total resistance, R_T	7,04	Ω
Overheat ratio, a	0,80	
Bridge ratio, M	1:20	
Decade resistance, R_D	**140,7**	**Ω**

and displays the corresponding dip switch settings (Fig. 5):



SW1 = BINx20 *SW2 = BINx1.4*

Fig. 5. *The setting of the decade control as in appears in the spreadsheet. A grey dot indicates that this side of the dip switch is pressed down (towards "1" or 0").*

The binary switch setting for "SW1_bin" = 0011. Converting this binary setting to a decimal number: Dec(0011) = **3** (see binary to decimal conversion in table 1.)

The binary switch setting for "SW2_bin" = 0000. Converting this binary setting to a decimal number: Dec(0000) = **0**

The decade resistance (R_D) can be checked for this example by:

R_D = 80 Ω * + **3**·20 Ω (SW1) + **0**·1.4 Ω (SW2) = 140 Ω.

* 80 Ω is fixed resistor in series with the additional resistance defined by SW1 and SW2 in the decade circuit.

Note that the decade resolution is 1.4 Ω. This means that with a bridge ratio of 1:20 the corresponding resolution of e.g. the operating resistance is 0.07 Ω (“equivalent decade resolution”). Depending on the exact probe values (for a similar probe) entered in the spreadsheet the displayed setting of SW2 can therefore differ from this example.

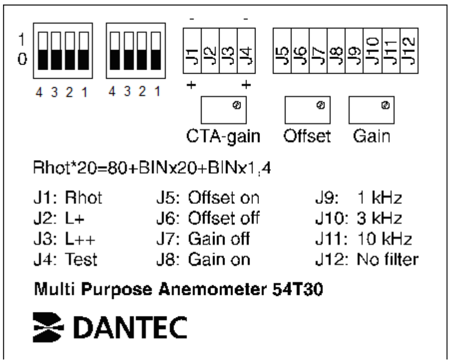


Fig. 6. *Label inside the MiniCTA identifying switches, jumpers and adjustments.*

2.3.4 Overheat adjustment

Do not turn on the power on until you have checked that the overheat is correctly adjusted. Wrong settings can immediately result in a burned wire.

Remove the four screws retaining the box lid and remove the lid. Locate switches SW1 and SW2 inside the MiniCTA. Set the decade resistance according to the pattern (position of the individual dip switches for SW1 and SW2) displayed in the Excel spreadsheet or the calculations from section 4.1 below. The grey dots in the calculated pattern indicate towards which side each dip switch should be pressed down (see Fig. 5).

Now turn on the power and see that the voltage of the output rises to a finite stable value. Wave gently over the sensor and observe that it responds to the flow. The anemometer is now ready for use.

2.4 Additional adjustments.

Following additional settings that can be made by moving jumpers and adjusting potentiometers:

Offset, Gain and Filter.

The default settings of the 3 jumpers are:

J6(Offset OFF), J7(Gain OFF) and J12(LP Filter OFF).

The user should not make changes to jumpers J1 through J4 and should not adjust the CTA-gain (servo-amplifier).

2.4.1 Offset adjustment.

Set Offset to ON by moving the jumper from J6 to J5. By means of the potentiometer 'Offset' it is now possible to add an offset voltage in the range from -0.9 to -2.2 volts.

A typical offset of 1.3 volts can be set to zero by means of this adjustment.

Note that the normal temperature correction routines are no longer valid, when an offset has been applied to the output voltage.

2.4.2 Gain adjustment.

Set Gain to ON by moving the jumper from J7 to J8. By means of the potentiometer 'Gain' it is possible to adjust the output gain in the range 2 to 5 times. This is especially suited for investigating small scale turbulence with very little variation of the mean velocity.

2.4.3 Filter settings.

Set Low Pass filter by moving the jumper from J12 to:

J9 = 1 kHz , J10 = 3 kHz, J11 = 10 kHz.

3. Specifications, 54T30.

Bridge ratio:	1:20
Maximum output voltage:	5 Volts
Maximum probe current (4 Ω):	230 mA
Probe operating resistance:	4-20 Ω
Equivalent decade resolution:	0.07 Ω
Frequency response:	5-10 kHz (3 dB limit)
DC-offset:	0.9-2.2 Volts
DC-Gain:	2 to 5 (cont.)
Power supply:	10,5 -14 VDC
Output impedance:	150 Ω
Size excl. connectors (L,W, H):	3x6x11 cm
Weight:	0.25 kg

4. Appendix

4.1 Overheat calculation by hand

The decade setting for the above example can be calculated as follows: (Note, use parameters corresponding to the specific probe configuration. This information can be found e.g. on the probe box.)

1) Calculate operating resistance (R_W), total resistance (R_T) and corresponding decade resistance (R_D):

Ambient temperature: $T_{amb} = 25°C$

Operating temperature: T_w = 242° C

R_{20}= 3.30, Ω, .R_L= 0.50 Ω, R_S= 0.40 Ω, R_C= 0.20 Ω and α_{20} =0.0036 /°C (= 0.36 %/K)

Operating resistance:

$$R_w = R_{20} \cdot (1 + \alpha_{20} \cdot (T_{amb} - 20)) + R_{20} \cdot \alpha_{20} \cdot (T_w - T_{amb}) = 5.94\Omega$$

(Note that the contribution from the term $R_{20} \cdot \alpha_{20} \cdot (T_{amb} - 20) = 0.06\Omega$ is small and can be omittted for T_{amb} close to 20°C)

Total resistance:

R_T= R_w +R_L +R_S +R_C = 7.04 Ω

Decade resistance:

R_D=20·R_T=20·7.04 Ω=140.8 Ω

2) Calculate the value (settings) of the binary switches SW1 (BINx20) and SW2 (BINx1.4):

Rbin = 20·R_T -80 = 20·7.04-80= 60.8 Ω

SW1_value = Bin(SW1_dec) = Bin(int(*Rbin*/20)) = Bin(int(60.8/20)) = Bin(**3**) = 0011

See decimal to binary conversion in table 1 below. (SW1_dec is a variable name for the decimal value corresponding to the setting of the dip switches for SW1.)

For SW1 the value “0011” means that dip switch 1 & 2 should be pressed down towards “1” and dip switch 3 & 4 should be pressed down towards “0”, see Fig. 5.

3) Calculate remaining resistance:

$Rrest = Rbin - \mathbf{3} \cdot 20 = 60.8 - \mathbf{3} \cdot 20 = 0.8\ \Omega$

SW2_value = Bin(SW2_dec)= Bin(int(Rrest/1.4)) =
= Bin(int(0.8/1.4)) = Bin(**0**) =0000

For SW2 the value "0000" means that all dip switches should be pressed down towards "0", see Fig. 5.

4) Check the decade setting by using the equation:

$R_{T,check} = (80+(SW1\_dec) \cdot 20+(SW2\_dec) \cdot 1.4)/20$
$= (80+\mathbf{3} \cdot 20+\mathbf{0} \cdot 1.4)/20 = 7.0\ \Omega$

If the difference between the total resistance R_T and the check value $R_{T,check}$ is larger than 0.035 Ω (corresponding to half of the equivalent decade resolution 0.07 Ω) a fine adjustment can be performed. The value of R_T is increased or decreased by 0.01 Ω, until the difference is smaller than about 0.035 Ω. In this example the difference is 7.04-7.0=0.04 Ω, and further adjustments are not necessary.

Dec:	0	1	2	3	4	5	6	7
Bin:	0000	0001	0010	0011	0100	0101	0110	0111
Dec:	8	9	10	11	12	13	14	15
Bin:	1000	1001	1010	1011	1100	1101	1110	1111

***Table 1**. Conversion from decimal to binary values.*