MiniCTA
54T42

Installation & User's guide

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2. MiniCTA Anemometer 54T42

2.1 Introduction

The MiniCTA version 54T42 is a versatile anemometer that can be used with many of Dantec's wire and film/fiber-film 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 especially designed for measurements in air of velocity and turbulence in subsonic flows with moderate frequency content. With a proper set-up measurements of low velocities and fluctuations in water can also be performed. The flexible and compact unit is well 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 CTA electronics is optimised for use with wire probes in air (bandwidth >= 10 kHz at 50 m/sec). The anemometer has an operational resistance range (probe + cable) of 4-36 Ohms and can be configured to operate with probes with cold resistances above 20 Ohms (depending on probe overheat selection!).

Note:

The overheat resistance is preset at the factory to match Dantec 55P11-16 and 55P61-64 wire probes connected with 4 m probe cables to the MiniCTA. (The default setting accepts cable lengths of 1 - 10 m). The MiniCTA is ready for use without any adjustments for these combinations. For use with other probes or cable lengths longer than 10 m (max. 20 m) an adjustment of the overheat and cable compensation will be necessary.

Overheat adjustment, signal conditioning and selecting cable compensation are performed via DIP-switches and jumpers inside the box. The overheat adjustment is assisted by the MiniCTA software package or by an Excel spreadsheet, which can be downloaded from Dantec Dynamics web site.

A proper grounding of the MiniCTA is necessary for correct measurements, especially important for water applications! See paragraph 2.2.1.

The unit is to be used in controlled EMC environments only! See paragraph 2.2.2.

2.2 Disposal of Electronic Equipment (EE)

Electronic equipment should not be disposed of together with other waste. Waste EE must be disposed of according to local rules and regulations.

2.3 **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 - if necessary - 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. *The MiniCTA box with connections for probe input, output voltage, power input and ground-connection. A LED indicates that the power is connected.*

Connect the coax cable (4 m 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 supply to the power input. If a custom power supply is used it must be a double-isolated 12 VDC type with positive center pin (minimum 0.5 A output). It is 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 inside the MiniCTA box (see below) and the probe is connected/mounted!

2.3.1 Grounding of the MiniCTA

There is no ground connection through the double-isolated DC Power Adaptor for the MiniCTA and the MiniCTA acts as a floating signal source. It is therefore most important to use differential input, when the anemometer voltage is acquired via an A/D board - and also to connect the anemometer signal ground to the Analog input ground (or PC ground) via a resistor in order to avoid noise problems. For this purpose the cabinet of the MiniCTA box is provided with a ground terminal screw. Alternatively, the shield of the output cable can be used as shown in Fig. 2. When more MiniCTA's are connected to the same A/D board, it is mandatory that all outputs must be grounded via their own resistor.

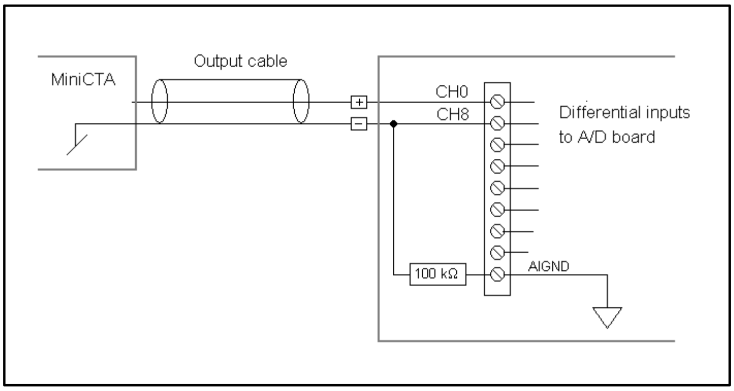

Fig. 2. *Connecting and grounding of the MiniCTA output signal via a 100 kΩ resistor.*

For A/D boards (with no dedicated signal ground connection) connected to the PC via a USB cable it is advised to use the PC ground/chassis as signal ground. However, it must then be checked that the USB cable shield is properly connected to the PC chassis.

2.3.2 Grounding of the MiniCTA in water applications

For all CTA-applications in water (only fresh water should be used!) a grounding electrode should be placed in the water close to the CTA-probe. The electrode should be connected via a thick wire to the MiniCTA ground connection. The complete measurement system/chain should be connected to the same ground connection. The objective is to eliminate any potential differences to avoid electrical strike-through of the probe insulation.

Except for the special precautions needed when measuring in water/liquids CTA probes and probe cables should normally be electrically insulated from any conductive parts.

2.3.3 Electromagnetic Interference

Due to the nature of the CTA measurement system with a servo-loop with relatively high bandwidth it is not possible to build a CTA system that can pass standard EMC tests. CTA systems should always be used in so-called 'controlled EMC environments'. However, with a proper grounding of the MiniCTA system to a ground reference 'far away' from the ground reference for e.g. the wind tunnel motor control system it should still be possible to minimize electromagnetic interference. This also means that the MiniCTA system should be kept well away from all motor cables etc. because it might be a matter of simple magnetic coupling if the motor cables are not shielded carefully with proper grounding of the shield.

2.4 General set up

2.4.1 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 defult setting accepts cable lengths of 1 - 10 m). The system is ready for use without any adjustments for these combinations. For use with other probes or cable lengths longer than 10 m (max. 20 m) an adjustment of the overheat will be necessary. To change the settings DIP switches inside the MiniCTA box must be set in a correct manner as described below.

Warning! An incorrect setting may result in damaged probes!

Probe type $R_{20} \geq 3.2\ \Omega$	Cable length	Recommended decade setting ($20 \cdot R_T$)	DIP switch SW1	DIP switch SW2	DIP switch SW3
Wire probes 55P11-16 55P61-64	9006A1863 4 m	140 Ω			

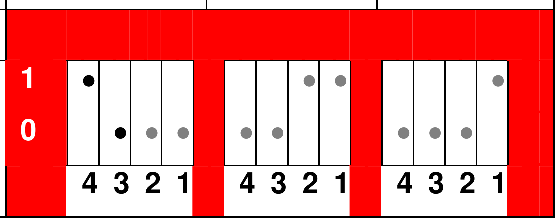

Fig. 3. *Factory overheat setup. Dots indicate switch in down position. For SW1 switches Dip_3, and Dip_4 are used to set the cable compensation according to cable length (4 or 20 m).*

2.4.2 Selecting cable length

The MiniCTA is preset at the factory to match wire probes connected with 4 -10 m probe cables (RG-58 coax cable - 50 Ohms impedance). If longer cables than 10 m (max. 20 m) are used the cable length setting inside the MiniCTA should be changed to the 20 m setting. SW1 switch 4 & 3 are used to set the cable length (see Fig. 3). The standard 4 m setting corresponds to a switch setting with Dip_4 = 1 and Dip_3 = 0. The 20 m setting corresponds to Dip_4 = 0 and Dip_3 =1.

2.4.3 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 supports 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.

2.4.4 Overheat calculation using Excel spreadsheet

The overheat can be calculated using the MS Excel spreadsheet “54T42 MiniCTA - overheat calculation”, which can be found on the installation CD or downloaded from Dantec Dynamics web site:

http://www.dantecdynamics.com/Default.aspx?ID=705

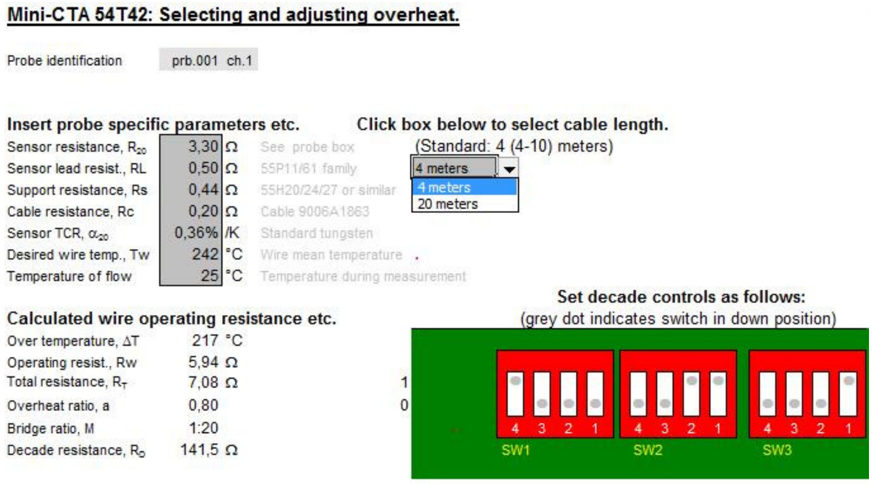

Fig. 4. *Overview of "MiniCTA overheat spreadsheet".*

1) Before starting check that spreadsheet is the correct for use with the 54T42 version of the MiniCTA.

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

3) Select the cable length **4 meters** (for 1-10 m cables) or **20 meters** for cables longer than 10 m (max. allowed cable length is 20 m).

4) 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	55P11/61 family
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	7,08	Ω
Overheat ratio, a	0,80	
Bridge ratio, M	1:20	
Decade resistance, R_D	**141,5**	**Ω**

The corresponding DIP switch settings are displayed in the spreadsheet, see figure 5 below:

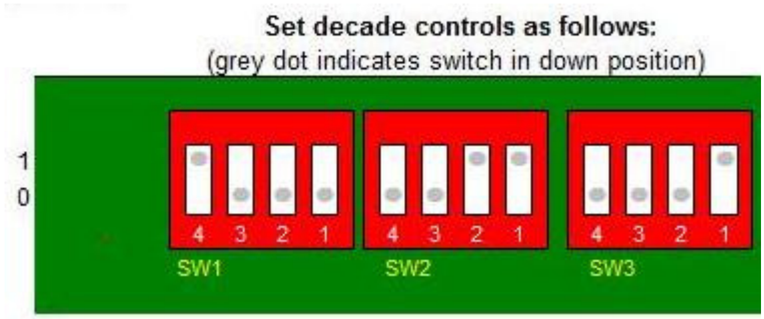

Fig. 5. *The setting of the decade control as in appears in the spreadsheet. A grey dot indicates that this side of the DIP switch is pressed down (towards "1" or 0").*

Checking the decade setting:

SW1: Note that for SW1 only the two rightmost DIP_switches (DIP_1, and DIP_2) are used for the setting the decade resistance. The binary switch setting is in this example for "SW1_bin" = 00. Converting this binary setting to a decimal number:

Dec(00) = **0** *

SW2: The binary switch setting for "SW2_bin" = 0011. Converting this binary setting to a decimal number:

Dec(0011) = **3** *

SW3: The binary switch setting for "SW3_bin" = 0001. Converting this binary setting to a decimal number:

Dec(0001) = **1** *

* *See binary to decimal conversion in table 1.*

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

$R_D = 80\ \Omega + \mathbf{0}\cdot 160\ \Omega$ (SW1) $+ \mathbf{3}\cdot 20\ \Omega$ (SW2) $+ \mathbf{1}\cdot 1.4\ \Omega$ (SW3) $= 141.4\ \Omega$.

The first term on the right side, 80 Ω, is a fixed resistor in series with the additional resistance defined by SW1, SW2 and SW3 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 SW3 can therefore differ from this example.

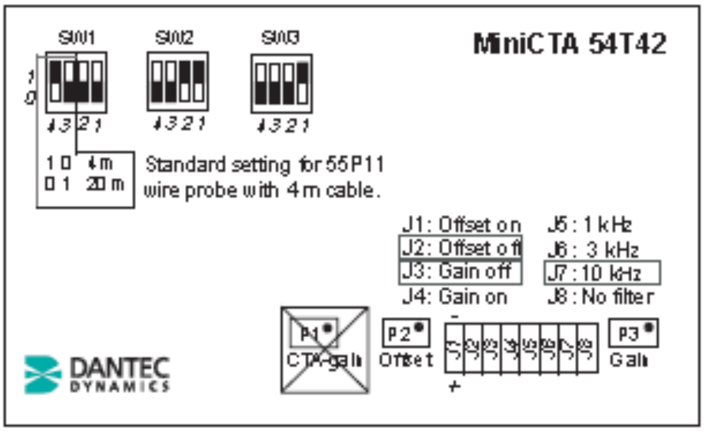

Fig. 6. *Label inside the MiniCTA identifying switches, jumpers and adjustments. The black side of the switches (SW1,2 & 3) indicate towards which side each DIP switch should be pressed down to match the default setting.*

2.4.5 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 and SW3 inside the MiniCTA.

Note that for SW1 only the two rightmost DIP switches (DIP_1, and DIP_2) are used for the setting the decade resistance. The two leftmost DIP switches (DIP_3, and DIP_4) are used to set the cable compensation according to cable length. This is also shown in Fig. 6. The default setting is made for 4 m cables (DIP_3 = 0, DIP_4 = 1).

Set the decade resistance according to the pattern (position of the individual DIP switches for SW1 (DIP_1, and DIP_2) SW2 and SW3) 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 the power on 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.

2.5 Additional adjustments

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

Offset, Gain and Filter.

The default settings of the jumpers are:

J2 (Offset OFF), J3 (Gain OFF) and J7 (LP Filter 10kHz).

Note: the user should ***not*** *adjust the CTA servo-amplifier gain-potentiometer, P1).*

2.5.1 Offset adjustment

Set Offset to ON by moving the jumper from J2 to J1. By means of the potentiometer P2 'Offset' it is now possible to add an offset voltage in the range from 0.9 to 2.2 volts.

E.g. a typical zero-velocity output of 1.4 volts can be offset to 0 VDC on the signal output by means of this adjustment.

Note: As the Mini-CTA electronics is implemented using single-polarity amplifiers the signal output voltage should never be adjusted below 0.05 VDC using the 'Offset' adjustment.

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

2.5.2 Gain adjustment

Set Gain to ON by moving the jumper from J3 (default) to J4. By means of the potentiometer P3 '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.

In most cases it is convenient to combine the 'Gain' adjustment with an appropriate 'Offset' setting.

When both Offset and Gain is set to OFF the gain is actually 1 and the signal output equal to the CTA bridge top voltage.

2.5.3 Filter settings

Change the Low Pass filter setting by moving the jumper from the default setting (J7 = 10 kHz) to

J5 = 1 kHz, J6 = 3 kHz, or J8 = No filter.

3. Specifications, 54T42

Bridge ratio:	1:20
Output voltage:	0.05 – 7 Volts
Maximum probe current (4 Ω):	300 mA
Probe operating resistance:	4-36 Ω
Equivalent decade resolution:	0.07 Ω
CTA bandwidth:	>= 10 kHz (55P11 and 50 m/sec in air)
DC-offset:	0V or 0.9-2.2V adj.
DC-Gain:	1 or 2-5 (cont. adj.)
Output low-pass filters (-3 dB):	1 kHz, 3 kHz, 10 kHz, OFF (approx. 50 kHz)
Max. Cable length:	20 m
Power supply*:	10.5 -14 VDC (min. 0.5 A)
Output impedance:	< 150 Ω
Size excl. connectors (L,W, H):	3x6x11 cm
Weight:	0.25 kg

* double-isolated type with positive center pin.

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= 0.44 Ω, R_C= 0.20 Ω and α_{20} = 0.0036 /°C (= 0.36 %/°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 omitted for T_{amb} close to 20°C.)

Total resistance:

$R_T = R_w + R_L + R_S + R_C$ = 7.08 Ω

Decade resistance:

R_D=20•R_T=20·7.08 Ω=141.6 Ω

2) Calculate the start value

The decade resistance (R_D) should be reached by the sum:

R_D = 80 Ω + **X**•160 Ω (SW1) + **Y**•20 Ω (SW2) + **Z**•1.4 Ω (SW3) = 141.6 Ω .

where 80 Ω is a fixed resistor in series with the additional resistance defined by SW1, SW2 and SW3 in the decade circuit.

The following steps will identify the appropriate integer values for X, Y and Z and how to set this in a binary correct form on each switch (SW1, SW2 and SW3).

Start value: (subtract the value of the fixed resistor)

Rbin = R_D -80 = 141.6-80= 61.6 Ω

3) Calculate the value (settings) of the binary switch SW1

Note: only switch 1 and 2 are active for decade setting on SW1!

SW1_value = Bin(SW1_dec) = Bin(int(*Rbin*/160)) = Bin(int(61.6/160)) = Bin(**0**) = 00

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 “00” means that both DIP switch 1 and 2 should be pressed down towards “0”, see Fig. 5.

4) Calculate the value (settings) of the binary switch SW2

$Rrest = Rbin - \mathbf{0} \cdot 160 = 61.6 - \mathbf{0} \cdot 160 = 61.6\ \Omega$

SW2_value = Bin(SW2_dec)= Bin(int(*Rrest*/20)) = = Bin(int(61.6/20)) = Bin(**3**) =0011

For SW2 the value “0011” means that DIP switch 1 and 2 should be pressed down towards “1” and DIP switch 3 and 4 should be pressed down towards “0”, see Fig. 5.

5) Calculate the value (settings) of the binary switch SW3

$Rrest = Rbin - \mathbf{3} \cdot 20 = 61.6 - \mathbf{3} \cdot 20 = 1.6\ \Omega$

SW3_value = Bin(SW3_dec)= Bin(int(*Rrest*/1.4)) = = Bin(int(1.6/1.4)) = Bin(**1**) =0001

For SW3 the value “0001” means that DIP switches 1 should be pressed down towards “1” and DIP 2, 3 and 4 should be pressed down towards “0”, see Fig. 5.

6) Check the decade setting by using the equation

$R_{T,check}$ = (80+(SW1_dec) $\cdot$160+(SW2_dec) $\cdot$20 + (SW3_dec) $\cdot$1.4)/20= $(80+\mathbf{0}\cdot 160+\mathbf{3}\cdot 20+\mathbf{1}\cdot 1.4)/20=7.07\ \Omega$

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 7.08-7.07=0.01 Ω, and any further adjustment is not necessary.

Dec:	0	1	2	3	4	5	6	7
Bin:	0000	0001	0010	0011	0100	0101	0110	0111
Bin:*	00	01	10	11				
Dec:	8	9	10	11	12	13	14	15
Bin:	1000	1001	1010	1011	1100	1101	1110	1111

* *For SW1.*

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