

**Specifications – electrical**

Power source	4.1 – 38 VDC
Measuring range (dual mode)	±90° (two-dimensional) ±180° (one-dimensional)
Resolution	<0.005° 0.1 mg (@data rate ≤ 5)
Noise density	±0.0014°/√Hz
Accuracy: Horizontal installation	Err. ≤ ±0.04° (typical), ±0.08° (maximum error in full range)
Vertical installation	Err. < ±0.08° (within ±30° of Vertical)
Zero offset error [†]	< ±0.02° (@20°C) [‡]
Temperature offset drift	±0.002° /°C (typical)
Repeatability	< 0.02°
Low-pass filter bandwidth	Selectable, 1 Hz to 1kHz
Baud rate	2.4kbps – 921.6kbps selectable, default: 115.2kbps
Data format	ASCII, port settings: 1 start bit, 8 data bits, 1 stop bit & no parity
Output data rate	1, 2, 5, 10, 20, 25, 40, 50, 100, 200, and 500 Hz selectable
LED indicators	Green: CPU heartbeat Flashing at 1 Hz Red: Data transmission rate Flashing at current data rate
Power consumption	< 30 mA (@ 5 V)
GUI software	WinCTi-Tilt®
Serial interface options	RS232, RS422, RS485, USB, SSI, Wireless (Bluetooth 4.2) RS485 with multi-drop networked
Temperature sensor resolution	0.2°C

Accessories**Connector and cable**

MSKS 6F/CS12187	Male cable M8, 6-pin
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Features

- Dual mode digital inclinometer
 - Dual-axis, horizontal installation: ±90°
 - Single-axis, vertical installation: ±180°
- High resolution: < 0.005° | 0.1 mg
- High accuracy: err. ≤ 0.04° (typical)
- Ultra low noise: ±0.0014°/√Hz
- Very low temperature offset drift: ±0.002°/°C (Typical)
- Selectable accelerometer range: ±2 g/±4 g/±8 g
- Programmable bandwidth and response time
- Simple ASCII interface language
- IP 67 compliant connector, cable, and housing
- Robust aluminum housing
- Low power consumption: < 30 mA (@ 5 V)

Applications

- Platform control, alignment, and stabilization
- Inclination and rotational movement measurement
- Antenna and satellite dish tracking and control
- Vibration and condition monitoring
- Navigation and GPS compensation
- Robotic position sensing and control
- Agricultural and industrial vehicle tilt monitoring

Specifications – mechanical

Protection	IP 67 (housing, connector and cable)
Dimension	1.64" x 2.14" x 0.85"
Material (cable is optional as a third party product)	Enclosure: anodized aluminum Connector: brass / nickel Cable molded head: TPU Cable carrier: TPU or nylon Conductor insulation: PVC
Temperature range [§]	-40°C to +85°C (-40°F to +185°F)
Connection	Cable gland connector M8, 6-contact (female)

Terminal Assignment

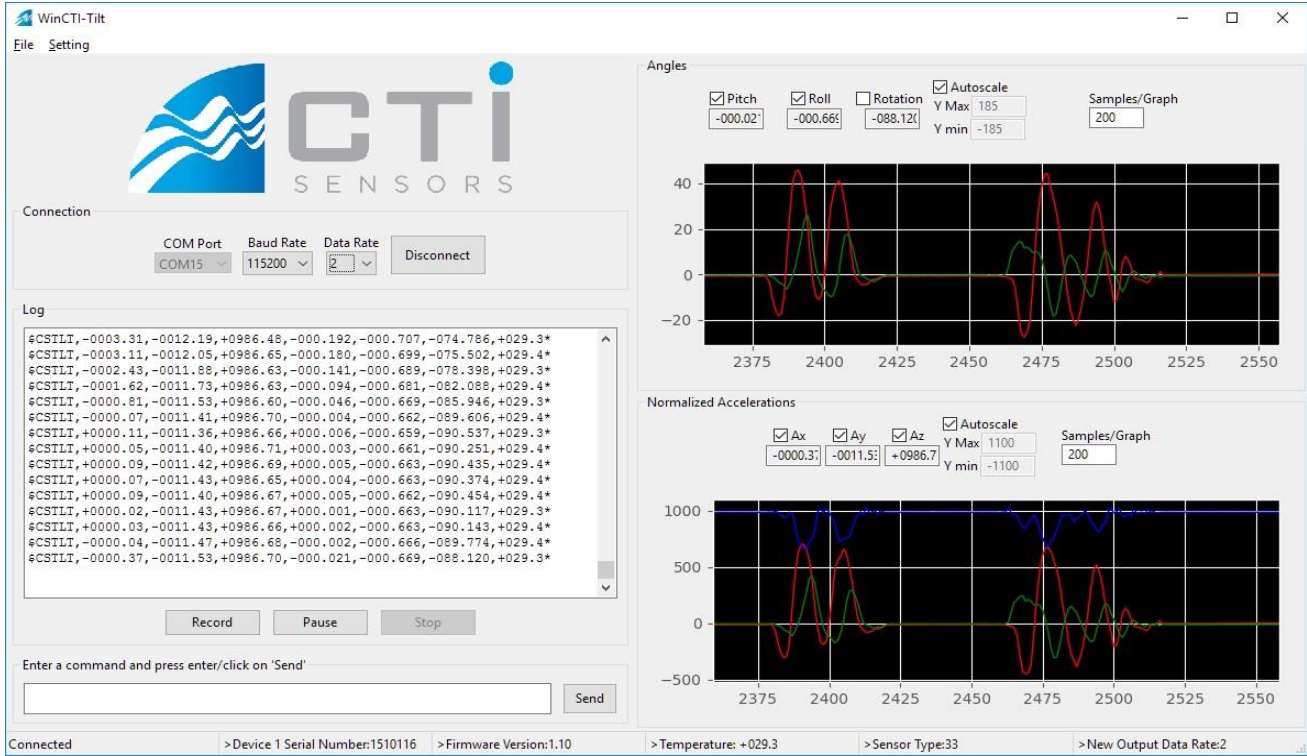
Connector	RS232/UART/USB ^{**}	RS422	RS485	Wire Color
Pin 1	+Vin	+Vin	+Vin	Brown
Pin 2	GND	GND	GND	White
Pin 3	TX	TX+	D+	Blue
Pin 4	–	TX-	D-	Black
Pin 5	RX	RX+	D+	Gray
Pin 6	–	RX-	D-	Pink

	Device: M 8 – 6-contact (female)		Cable: M 8 – 6-pin (male)
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[†] Zero g offset can be easily corrected and saved by user.[‡] Units can be calibrated between -40°C and 85°C on request.[§] Cable is a third party product with temperature tolerance from 40°C to +105°C (-40°F to +221°F).^{**} USB uses UART interface and a UART to USB cable.

WinCTi-Tilt software

WinCTi-Tilt is a graphical user interface (GUI) software provided by CTi Sensor Inc. for visualization aide, device configuration, and data logging. WinCTi-Tilt is designed to be user-friendly and intuitive to users. The package can be downloaded from the CTi Sensors website.



Serial interface and data format

TILT-33A uses the following ASCII format, very similar to the widely used NMEA 0183 protocol, for data output:

- Default message: $\$CSTLT, A_{XN}, A_{YN}, A_{ZN}, \alpha_X, \alpha_Y, R, T^*CC<CR><LF>$
- Optional message: $\$CSACC, A_X, A_Y, A_Z, T^*CC<CR><LF>$

Which:

A_{XN}, A_{YN}, A_{ZN} : Normalized X, Y and Z accelerations in milli g
 A_X, A_Y, A_Z : True X, Y and Z accelerations in milli g
 α_X, α_Y : Pitch and Roll angles in degrees, horizontal installation
 R : Rotation angle in degrees, vertical installation
 T : Internal temperature in degree centigrade
 CC : Checksum (Two ASCII characters)
 $<CR> <LF>$: Carriage return, and line feed characters

Example:

- $\$CSTLT, +0011.24, -0032.10, +0991.07, +000.650, -001.854, -109.301, +027.7^*70<CR><LF>$
Data rate < 10
- $\$CSTLT, +0011.2, -0032.1, +0991.4, +000.65, -001.85, -109.12, +027.7^*72<CR><LF>$
10 ≤ Data rate < 100
- $\$CSTLT, +0011, -0032, +0991, +000.7, -001.8, -109.0, +028^*4F<CR><LF>$
Data rate ≥ 100

8-bit Checksum

Checksum is calculated by XORing all characters between \$ and * (not including the \$ and the * characters) based on the NMEA standard. It results in two hexadecimal characters, which are sent in ASCII format.

Configuration commands

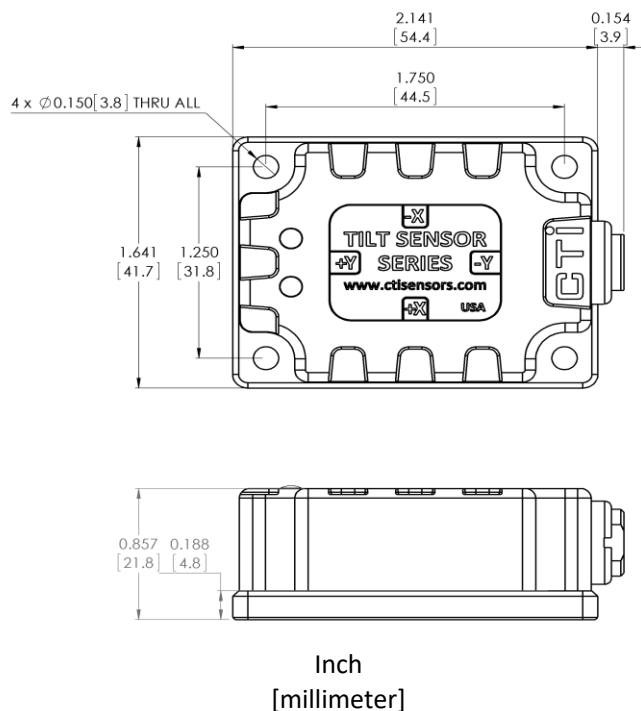
TILT-33A uses a simple command format which allows user to change the device configuration and request specific information or data. All commands start with a '[' character, and end with a carriage return character. All responses end with a carriage return and newline character. Table I shows the list of the interface commands for TILT-33A series. Letter 'n' after '[' character is the unit number which is set to n=1 by default, and can be set by user to any number from 1 to 9.

Table I: Interface commands for TILT-33A series

Command	Comments	Response	Comments
[n<cr>	Ping unit number n	!n<cr><lf>	Acknowledge ping
[N?<cr>	Request unit number	> Unit Number: n	Returns unit number, default: n=1
[n#m<cr>	Change unit number n to (non-zero) unit number m, $1 \leq m \leq 9$	>New Unit Number: n	n=old unit number, m=new unit number, default: n=1
[n#FW<cr>	Save unit number into flash memory	> Current Unit Number, n, was written into flash memory as the default Unit Number for this device!	Unit number will be changed permanently, and current unit number will be saved into the flash memory as the default unit number.
[nV<cr>	Firmware Version	> Firmware Version:d.d	Returns firmware version
[nS<cr>	Serial Number	> Device n Serial Number:ddddddd	Returns 7-digit serial number
[nBn<cr>	Baud rate setting: n= 2:2400, 4:4800, 9:9600, 19:19200, 38:38400, 57:57600, 115:115200, 230:230400, 460:460800, 921:921600 (bps)	> Change to new Baud Rate:dddddd	Selected baud rate should support current data rate. Otherwise, baud rate will not be changed.
[nBFW<cr>	Save baud rate into flash memory	> Current Baud Rate, ddddd, was written into flash memory as the default Baud Rate!	Baud rate will be changed permanently, and current baud rate will be saved into the flash memory.
[nDn<cr>	Data rate setting: n= 1, 2, 5, 10, 20, 25, 40, 50, 100, 200, and 500 Hz	> New Output Data Rate: n	Default data rate is 2 Hz. New data rate will be saved into the flash memory.
[nARn<cr>	Selecting accelerometer measurement range: n=2, 4, 8	> New Accelerometer Range is: +/-ng	New accelerometer range will be saved into the flash memory (default: ± 2 g).
[nLPFn<cr>**	Low-pass filter bandwidth setting: n=0 to 10. Projected bandwidth is 2^n Hz	> Low-pass Filter Bandwidth: dddd Hz	Set the bandwidth of low-pass filter for accelerometer data (default: n = 4, bandwidth = 16Hz).
[nZA<cr>	Zero g offset correction for X and Y axes	> Accelerometer Zero Offset Adjusted: X Offset: ddd.d, Y Offset: ddd.d	Current value of X and Y accelerations (Pitch and Roll angles) will be used as the zero level.
[nMxy<cr>	Output messages ON/OFF x= I: Inclinometer data A: Accelerometer data y=S: single message C: Continuous message X: Message Off	Data message will be sent out once, continuously or will be turned off	Example for inclinometer data: [1MIS: Sends out one data message [1MIC: Continuously sends out data message [1MIX: Stops sending out data message
[nMICFW<cr>	Save output message ON/OFF status into flash memory	> Current ON/OFF message status was written into flash memory as the default!	Current message ON/OFF status will be saved into flash memory.
[nRFD<cr>**	Reset to factory default	> Reset to factory default!	Resets the selectable parameters (except baud rate) to their default values.

** Firmware version 1.16 and higher

Dimensional drawing

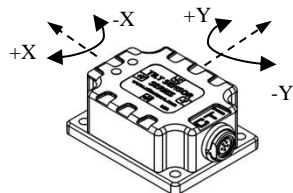


Part number

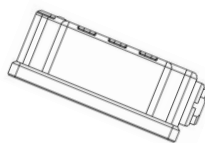
TILT	-	XX	X	-	X	-	XX
							Design model
							A1
							Interface
							3 RS232
							4 RS422
							8 RS485
							U USB
							S SSI
							W Wireless
							Housing material
							A Aluminum
							P ABS Plastic
							S Stainless Steel 316L
							O OEM (No Housing)
							Family Series
							05 Small size board (1"x1")
							10 Board with multiple interfaces
							15 High accuracy analog inclinometer board
							20 Low cost, ABS plastic enclosure
							3x High accuracy, aluminum enclosure
							5x Dynamic inclinometer, aluminum enclosure
							70 Harsh environment, stainless steel enclosure

Horizontal installation position

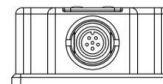
Measuring range: $\pm 90^\circ$ (two-dimensional)



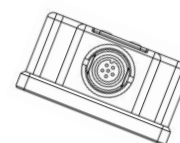
Default
Y=0



Inclination
Y=+30

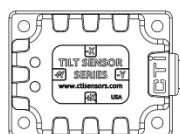
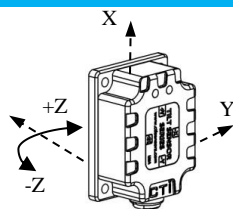


Default
X=0

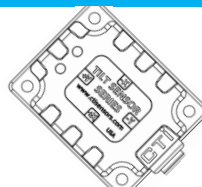


Inclination
X=+30

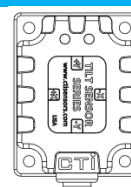
Vertical installation position



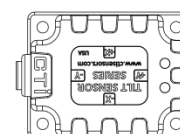
Rotation
R=0



Rotation
R=+45



Rotation
R=90



Rotation
R=+180

Warranty: This product has 18 months limited warranty.
For more information, please visit:

www.CTiSensors.com/warranty

**This product is fully designed and
manufactured in the U.S.A.**

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All contents of this document are subject to change without any notice.