TILT – 50A
Three-Axis Accelerometer
Three-Axis Gyroscope

Dual–Axis Dynamic Inclinometer
Datasheet

CTi

Features
- **Dynamic tilt measurement**
- **Measuring range: Pitch: ±90°, Roll: ±180°**
- **Three-axis accelerometer**
- **Three-axis gyroscope data**
- **Static accuracy: ≤ 0.15°**
- **Dynamic accuracy: ≤ 1.0° (RMS)**
- **High resolution: 0.025° | 0.5 mg**
- **Simple ASCII interface language**
- **IP 67 compliant connector, cable and housing**
- **LED heartbeat and transmission indicators**
- **Robust aluminum housing**
- **Low power consumption: < 250 mW (< 50 mA @ 5 V)**

Applications
- **Dynamic platform alignment, and stabilization**
- **Vehicle control, ship, robot, automotive**
- **Tilt sensing and leveling**
- **Automotive safety systems**
- **Motion and position measurement**
- **Navigation and GPS compensation**
- **Robotics position sensing and control**
- **Agricultural and industrial vehicle tilt monitoring**

Specifications – electrical

Power source	4.1 – 38 VDC
Measuring range	Pitch: ±90°, Roll: ±180°
Resolution	0.025°	0.5 mg (@ data rate ≤ 5)
Zero offset error[†]	< ±0.1° (@20°C)[‡], maximum offset drift is ±0.011° /°C
Accuracy (typical)	≤ 0.15° Static ≤ 1.0° Dynamic (RMS)
Accelerometer range	±2 g/±4 g/±8 g selectable Default: ±4g
Gyroscope range	±250/500/1000/2000°/s selectable Default: ±500°/s
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 and 200 Hz selectable
LED indicators	Green: CPU heartbeat Flashing at 1 Hz Red: Data transmission rate Flashing at current data rate
Power consumption	< 250 mW (< 50 mA @ 5V)
GUI software	WinCTi-Tilt®
Serial interface options	RS232, RS422, RS485, USB, SSI, 3.3V TTL UART, Wireless (Bluetooth 4.2) RS485 with multi-drop networking
Temperature sensor resolution	1°C

Accessories
Connector and cable

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

Specifications – mechanical

Protection	IP 67 (housing, connector and cable)
Dimension	1.65" x 2.15" x 1.00"
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+	–	Gray
Pin 6	–	RX-	–	Pink

	Device: M 8 – 6-contact (female)	Cable: M 8 – 6-pin (male)

[†] 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.

TILT – 50A
Three-Axis Accelerometer
Three-Axis Gyroscope

Dual–Axis Dynamic Inclinometer
Datasheet

CTi

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.
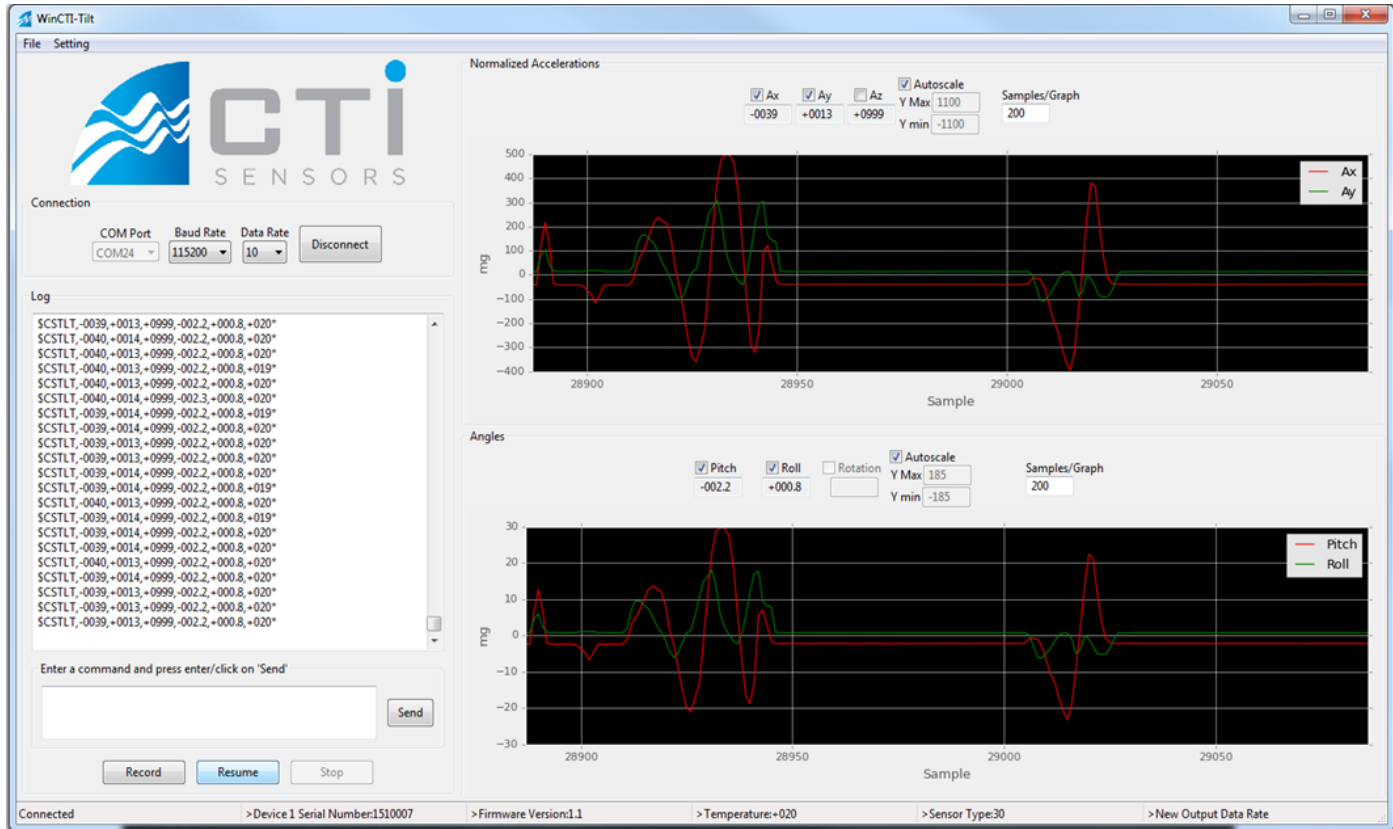
Serial interface and data format

TILT-50A uses the following ASCII format, very similar to the widely used NMEA 0183 protocol, for data output:

- Inclinometer message (default): `$CSTLT,`$A_X,A_Y,A_Z,\alpha_X,\alpha_Y,$`T*CC<CR><LF>`
- Sensor data message (optional): `$CSAGD,`$A_X,A_Y,A_Z,G_X,G_Y,G_Z,$`T*CC<CR><LF>`

Which:

A_X,A_Y,A_Z: X, Y and Z accelerations in milli g (three-axis accelerometer data)

G_X, G_Y, G_Z: X, Y and Z angular velocities in deg/s (three-axis gyroscope data)

α_X, α_Y: Roll & Pitch angles in degrees

`T`: Internal temperature in degree centigrade

`CC`: Checksum (Two ASCII characters)

`<CR> <LF>`: Carriage return, and line feed characters

Example:

- `$CSTLT,+0010.2,-0070.6,+0990.9,+000.59,-004.07,+027*73`   Data rate < 10
- `$CSTLT,+0010,-0070,+0991,+000.58,-004.09,+027*6E`   Data rate ≥ 10

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.

Three-Axis Accelerometer
Three-Axis Gyroscope

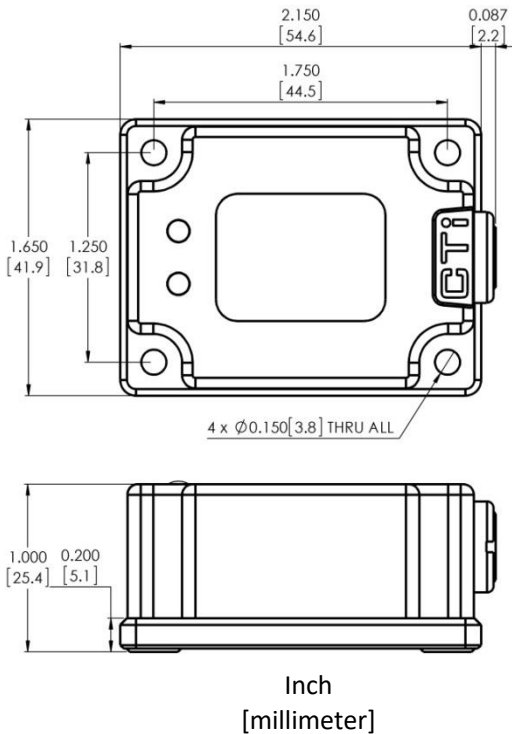## Dual–Axis Dynamic Inclinometer
Datasheet

Configuration commands

TILT-50A 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-50A 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-50A 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≤ m ≤ 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
[nBnnn<cr>	Baud rate setting: nnn= 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, dddddd, 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.
[nDnn<cr>	Data rate setting: nn= 1, 2, 5, 10, 20, 25, 40, 50,100, 200 and 400 Hz	>New Output Data Rate: nnn	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: +/-ng	New accelerometer range will be saved into the flash memory (Default: ±4 g).
[nGRn<cr>	Selecting gyroscope measurement range: n=0,1,2,3 0:2000, 1:1000, 2:500, 3:250 °/s	>New Gyroscope Range: ±nnnn°/s	New gyroscope range will be saved into the flash memory (Default: ±500°/s)
[nZA<cr>	Zero g offset correction for X and Y axes	>Accelerometer Zero Offset Adjusted: X Offset: ddd, Y Offset: ddd	Resolution of the offset registers is 2 mg, with an effective offset adjustment range of -256 mg to +254 mg for each axis.
[nMxy<cr>	Output messages ON/OFF x= I: Inclinometer data S: Sensor data (accelerometer and gyroscope) 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 status!	Current message ON/OFF status will be saved into flash memory.
[nFDR<cr>	Factory default reset (firmware version 1.43 and higher)	> Reset to factory default!	Resets the selectable parameters (except baud rate) to their default values.

TILT – 50A

Three-Axis Accelerometer
Three-Axis Gyroscope

Dual–Axis Dynamic Inclinometer
Datasheet

CTi

Dimensional drawing

2.150 [54.6]
0.087 [2.2]
1.750 [44.5]
1.650 [41.9]
1.250 [31.8]
4 x Ø0.150[3.8] THRU ALL
1.000 [25.4]
0.200 [5.1]

Inch
[millimeter]

Part number

TILT – XX X – X – XX

Design model
A1

Interface
3 RS232
4 RS422
8 RS485
U USB/UART
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

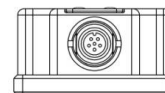## Horizontal installation position

Measuring range: ±90° (two-dimensional)
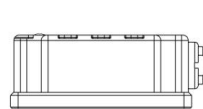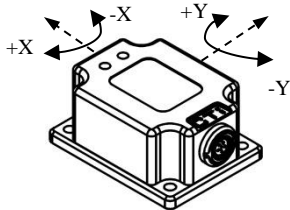
Default
Y=0
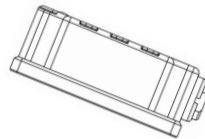
Inclination
Y=+30

Default
X=0

Inclination
X=+30

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.

CTi Sensor, INC.
30301 Emerald Valley Parkway, Solon, OH 44139
Phone: (440) 264 - 2370
Email: Sales@CTiSensors.com

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