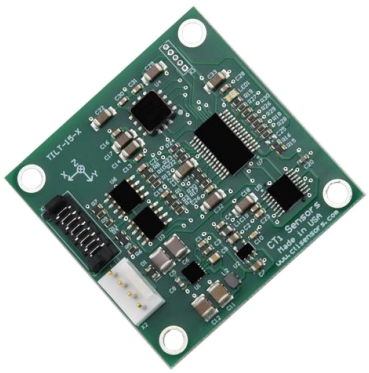
TILT–15–X

Dual – Axis Inclinometer
Analog and Digital Output
High Accuracy



Specifications

Power source	4.1 – 38 VDC
Power consumption	20 ± 2 mA (@ 5 V)
Measurement range options	±5°, ±10°, ±15°, ±30°, ±45°, ±90° (two-dimensional)
Resolution	< 0.005°
Accuracy	0.05° (Typical), 0.1° (Maximum error in full range)
Zero offset error[†]	< ±0.05° (@20°C)[‡]
Temperature offset drift	±0.002°/°C (Typical) ±0.004°/°C (Maximum)
Noise density	0.001°/$\sqrt{\text{Hz}}$
Analog Output	
Analog voltage output	0.25 V to 4.75[§] V
Sensitivity	150 mV/° : range ≤±15° 34 mV/° : ±30° ≤ range ≤±60° 25 mV/° : ±90° full range
Reference voltage output	2.5 ±0.003 V
Digital Output	
Serial interfaces	3.3V TTL UART
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, 50, 100, and 200 Hz selectable
Accelerometer data	±2 g/±4 g /±8 g selectable
LED indicators	Data transmission rate Flashing at current data rate
GUI software	WinCTi-Tilt®
Temperature sensor resolution	0.2 °C
Operating Temperature	-25°C to +80°C (-13°F to +176°F)

Features

- Analog and digital output signals
- Measurement range options, two-dimensional: ±5°, ±10°, ±15°, ±30°, ±45°, ±90°
- High accuracy: 0.05° (Typical)
- High resolution: 0.005°
- Ultra-low noise: 0.001°/$\sqrt{\text{Hz}}$
- Very low temperature offset drift: ±0.002°/°C (Typical)
- Three-axis accelerometer (Digital output)
- Programmable bandwidth and response time
- Digital interface: 3.3V TTL UART

Applications

- Platform control, alignment, and stabilization
- Solar panel tracking and control systems
- Tilt sensing and leveling
- Weighting systems
- Telescopic and scissor platform monitoring
- Motion/position measurement
- Navigation and GPS compensation
- Robotic position sensing
- Agricultural and industrial vehicle tilt monitoring

Accessories

GUI Software	WinCTi-Tilt®

Terminal Assignment

X1	Name	Description	Type
Pin 1	+Vin	+Vin (4.1 V to 38 V DC)	Input
Pin 2	Vref	Voltage reference (2.5 V)	Output
Pin 3	GND	Ground	Input
Pin 4	OUT X	Analog signal, X axis	Output
Pin 5	OUT Y	Analog signal, Y axis	Output
Pin 6[**]	OUT T	Analog signal, Temperature	Output
Pin 7	RX	Digital signal, receive data	Input
Pin 8	TX	Digital signal, transmit data	Output

X2	Name	Description	Type
Pin 1	+Vin	+Vin (4.1 V to 38 V DC)	Input
Pin 2	GND	Ground	Input
Pin 3	OUT X	Analog signal, X axis	Output
Pin 4	OUT Y	Analog signal, Y axis	Output

[†] Zero g offset can be easily corrected and saved by user with digital interface command.

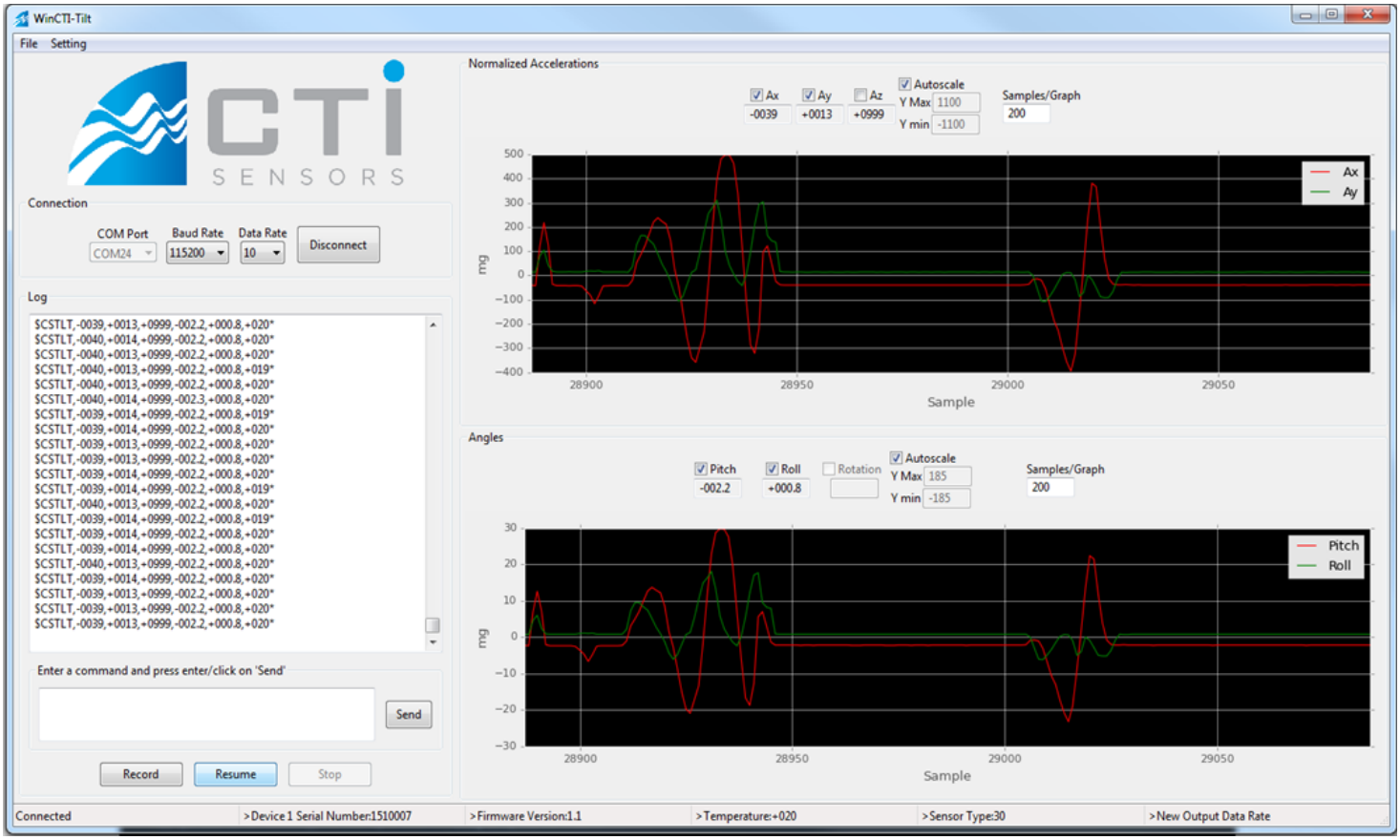
[‡] Units can be calibrated between -25°C and 80°C on request.

[§] The maximum analog output voltage 4.75 V (for ±90° full range) needs the power source ≥ 5.25 V.

[**] Firmware version 1.20 and higher.

WinCTi-Tilt Software

WinCTi-Tilt is a graphical user interface (GUI) software provided by CTi Sensors 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–15 –X uses the following ASCII format, very similar to the widely used NMEA 0183 protocol, for data output:

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

Which:

A_{XN},A_{YN},A_{ZN}: Normalized X, Y and Z accelerations in mg

A_X,A_Y,A_Z: True X, Y and Z accelerations in mg

α_X, α_Y: X and Y inclination or tilt angles in degrees, horizontal installation

T: Internal temperature in degrees centigrade

CC: Checksum (Two ASCII characters)

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

Example:

- $CSTLT,+0028.70,-0003.59,+0999.58,+001.645,-000.205,+023*44<CR><LF>
  Data rate ≤ 5
- $CSTLT,+0028.7,-0003.6,+0999.6,+001.64,-000.20,+023*75<CR><LF> Data rate > 5
- $CSACC,+0028.70,-0003.58,+0999.58,+023*4F<CR><LF>

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–15–X 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–15–X. 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.

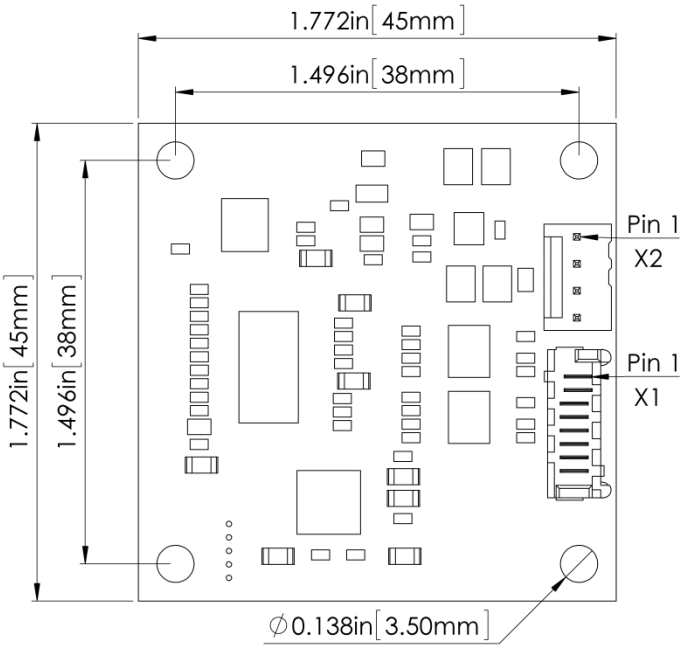
Table I. Interface commands for TILT–15–X

Command	Description	Response	Description
[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: m	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.dd	Returns firmware version
[nS<cr>	Serial Number	>Device n Serial Number:ddddddd	Returns 7-digit serial number
[nBxxx<cr>	Baud rate setting: xxx= 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.
[nDxxx<cr>	Data rate setting: xxx= 1, 2, 5, 10, 20, 25, 40, 50, 100 and 200 Hz	>New Output Data Rate: xxx	The default data rate is 2 Hz. New data rate will be saved into the flash memory.
[nARx<cr>	Selecting accelerometer measurement range: x=±2, ±4, ±8 g	>New Accelerometer Range is: +/-x g	New accelerometer range will be saved into the flash memory (the default range is ±2 g).
[CALZFAUTO <cr>	Zero g offset correction for X and Y axes	>Accelerometer Zero Offset Adjusted: X Offset: ddd.d, Y Offset: ddd.d	Current values of AX and AY will be saved into the flash memory as the zero g offset.
[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

Continued…

Command	Description	Response	Description
[nMxCFW<cr>	Save output message ON/OFF status into flash memory x = I: Inclinometer data A: Accelerometer data	>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. Example: [1MICFW
[nLPFx<cr>	Lowpass filter bandwidth setting: x=0 to 10. Projected bandwidth is 2^xHz	>Lowpass Filter Bandwidth: dddd Hz	Set the bandwidth of lowpass filter for accelerometer data. Default bandwidth is 16Hz for x = 4.

Dimensional Drawing



Part Number [5]

TILT – XX X – X – XX

Design Model
A1

Interface[6]
3 RS232
4 RS422
8 RS485
A Analog
U USB/UART
W Wireless

Housing Material[7]
A Anodized Aluminum
P ABS Plastic
S Stainless Steel 316L
O OEM (No Housing)

Family Series
05 Small Size Series (1"x1")
10 Multi Interface Series
15 Digital and Analog Series
20 Economical Series
3x Static Inclinometer Series
5x Dynamic Inclinometer Series
70 Harsh Environment Series

Family Series 15 – X Expansion

Part Number	Range
TILT – 15 – X – 05	±5°
TILT – 15 – X – 10	±10°
TILT – 15 – X – 15	±15°
TILT – 15 – X – 30	±30°
TILT – 15 – X – 45	±45°
TILT – 15 – X – 90	±90°

[5] Available options for this model are underlined
[6] Refer to family series 15-X expansion.
[7] Refer to family series 15-X expansion.

Warranty

This product has 18 months limited warranty:

CTi Sensor, Inc. “CTi” warrants its products against defects in material and workmanship for a period of 18 months from the date of the shipment to the customer provided the products have been stored, handled, installed and used under proper conditions. CTi’s liability under this limited warranty shall extend only to repair or replace the defective product, at CTi’s option. This warranty does not cover misuse or careless handling and it is void if the product has been altered or repaired by personnel not authorized by CTi. CTi disclaims all liability for any affirmation, promise, or consequential damages caused by the product. No warranties, expressed or implied, are created with respect to CTi’s products except those expressly contained herein. The customer acknowledges the disclaimers and limitation contained herein and relies on no other warranties or affirmations.

For more information, please refer to the following link:

www.CTiSensors.com/warranty

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