POSITAL
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USER MANUAL
TILTIX MEMS INCLINOMETER WITH J1939 INTERFACE

AMERICAS
FRABA Inc.
1800 East State Street, Suite 148
Hamilton, NJ 08609-2020, USA
T +1 609 750-8705, F +1 609 750-8703
www.posital.com, info@posital.com

EUROPE
FRABA AG
Carlswerkstrasse 13c
51063 Cologne, GERMANY
T +49 221 96213-0, F +49 221 96213-20
www.posital.com, info@posital.eu

ASIA
FRABA Pte. Ltd.
20 Kallang Avenue
Singapore 339411, SINGAPORE
T +65 6514 8880, F +65 6271 1792
www.posital.com, info@posital.sg

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1. General Safety Advice

1.1 Important Information

Read these instructions carefully, and have a look at the equipment to become familiar with the device before trying to install, operate, or maintain it.

The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention towards information that clarifies/simplifies a procedure.

Please Note: Electrical equipment should be serviced only by qualified personnel. No responsibility is assumed by POSITAL for any consequences arising out of the use of this material. This document is not intended as an instruction manual for untrained personnel.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

2. About this Manual

2.1 Background

This user manual explains how to install and configure the TILTIX inclinometer with J1939 interface.

2.2 Version Management

- Updated On: 20160302
- Manual_TILTIX_J1939

2.3 Imprint

FRABA B.V.
Jan Campertstraat 11,
NL-6416 SG Heerlen
T +49 221-96213-0
info@fraba.com, www.fraba.com

2.4 Copyright

2.5 User Annotation

All readers are highly welcome to send us feedback and comments about this document. Depending on your region you can reach us by e-mail at the following e-mail addresses. For America info@posital.com, for Asia info@fraba.sg, for Europe info@posital.eu.

2.6 Document History

Document	Manual_TILTIX_J1939
Created	20160302
Author	JOR
Reviewers	
Versions	First Release – 20160302

3. Introduction

This manual explains how to install and configure the TILTIX gravity referenced inclinometers with a J1939 interface, suitable for industrial, military and heavy duty applications.

3.1 TILTIX Inclinomter

TILTIX inclinometers sense and measure the angle of tilt (inclination/slope/elevation) of an object with respect to the force of gravity.

The basic principle behind this TILTIX inclinometer is a Micro-Electro-Mechanical Systems (MEMS) sensor cell that is embedded to a fully molded ASIC. The angle is measured with the relative change in electrical capacitance in the MEMS cell.

3.2 TILTIX J1939

The TILTIX J1939 inclinometer is available in industrial and heavy-duty housings, and two measurement axes variants. The single axis measurement variant with a range of 360° and a dual axis measurement capable TILTIX model with a range of ±80°. In addition to high resolution, accuracy and protection class of IP69K, it has built-in active linearization and temperature compensation. This makes TILTIX suitable for rugged environments and versatile applications in industrial, heavy duty and military applications.

Various software tools for configuration and parameter-setting are available from different suppliers.

3.3 Typical Applications of TILTIX

- Cranes and Construction Machinery
- Medical Systems
- Elevated Platforms
- Mobile Lifts and Fire Engines
- Automated Guided Vehicles (AGV)
- Automatic Assembling Machinery
- Boring and Drilling Applications
- Leveling and Flattening

4. Technical Data

4.1 Electrical Data

Model	ACS-080	ACS-360
Measurement Range	± 64°	360°
Number of Axes	2	1
Resolution	0.01° (0.002 deg/bit)	
Accuracy (T = -10 °C to +40 °C)*	0.1°	
Temperature Gradient	0.004°/ K	
Sensor Response Time	10 ms (without filter)	
Recommended Measurement Rate	Up to 10 Hz	
Interface	SAE J1939 Transceiver According ISO 11898, Galvanically Isolated by Opto-Couplers	
Transmission Rate	Adjustable: Max. 1 MBaud (Default Setting : 250 kBaud)	
Addressing	Default Setting: 192	
Supply Voltage	10 to 30 VDC (Absolute Maximum Ratings)	
Current Consumption	Max. 57 mA at 10 V DC; Max. 53 mA at 24 V DC	
EMC	Emitted Interference: EN 61000-6-4	
	Noise Immunity : EN 61000-6-2	

4.2 Mechanical Data

For additional electrical and mechanical information please refer to the product specific datasheet available at posital.com

4.3 Programmable Parameters

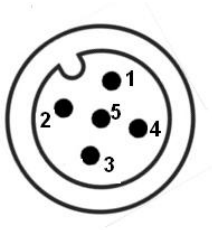
Resolution per 1°	The resolution parameter per 1° is used to program the desired number (1°, 0.1° and 0.01°) of steps per 1°.
Preset Value	The Preset value is the desired position value, which should be reached at a certain physical position of the axis. The position value is set to the desired process value by the preset parameter.
Moving Average-Filter	This filter can be used to adjust the bandwidth of measuring values to minimize the influence of vibration. Factory Setting: Moving average filter activated for 20 subsequent readouts.
Digital Recursive Filter	This filter can be used for weighting the last measured value with the last previous value. This is useful to suppress sudden peaks in the angle measurement.

5. Installation

5.1 Pin Assignment

The inclinometer is connected via an integrated cable or a 5-pin round M12 connector. (Standard M12, Male side at sensor, Female at connector counterpart or connection cable).

Signal	5 pin round connector (ACS…P_)	Cable Exit ACS…-_W)
CAN Ground	1	Green
VS Supply Voltage	2	Red
0 V Supply Voltage	3	Yellow
CAN High	4	White
CAN Low	5	Brown



5.2 Installation Precautions

Warning: Do not remove or mount while the inclinometer is under power!

Avert any modifications to the housing!

Avoid mechanical load!

Prior to installation, please check for all connections and mounting instructions to be complied with. Please also observe the general rules and regulations on operating low voltage technical devices, for safety and sustainability of TILTIX Inclinometers over a long period of time.

Please read the installation leaflet for detailed instructions and precautions during mounting and installation.

5.3 Mounting Instructions

TILTIX is a pre-calibrated device which can be put into immediate operation, upon simple and easy installation. The mounting surface must be plane and free of dust and grease. We recommend hex-head screws with M4 or UNC bolts #6 (TILTIX Industrial) and M6 or UNC bolts ¼ (TILTIX Heavy-Duty) for the best possible and secure mounting.

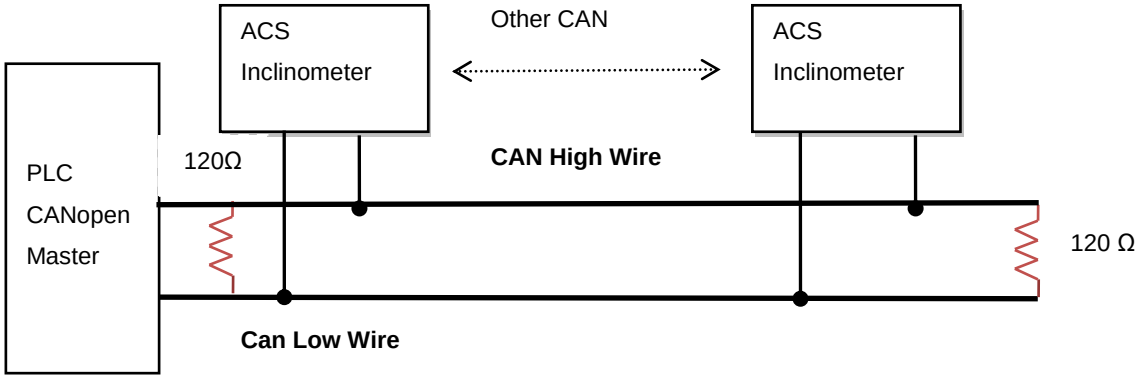
Use all screw holes for mounting but restrict the tightening torque in the range of 1.5 – 2.5 Nm for the screws. The M12 connectors are to be perfectly aligned and screwed till the end with a tightening torque in the range of 0.4 – 0.6 Nm. Use the same tightening torque for all the screws. Strain relief should be applied to the cable within 6" of mounting to prevent excessive stress on the housing.

5.4 Bus Termination

If the inclinometer is connected at the end or beginning of the bus or is used at transmission ≥ 50 kBaud a termination resistor of 120 Ohm must be used in order to prevent reflection of information back into the CAN bus. TILTIX sensors have built-in termination resistors that can be activated (1) or deactivated (0) if necessary.

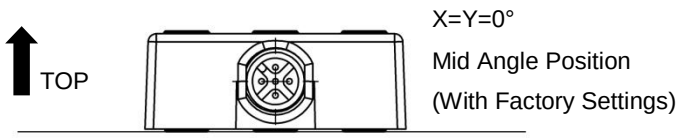
The bus wires can be routed in parallel or twisted, with or without shielding in accordance with the electromagnetic compatibility requirements. A single line structure minimizes reflection.

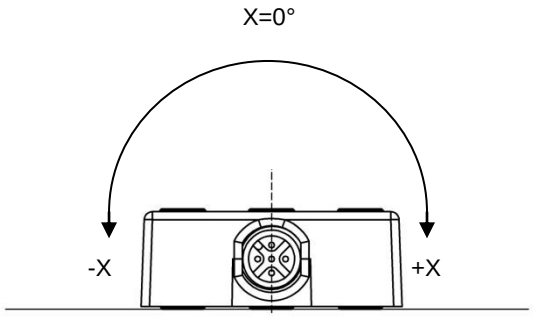
The following diagram shows the components for the physical layer of a two-wire CAN bus:



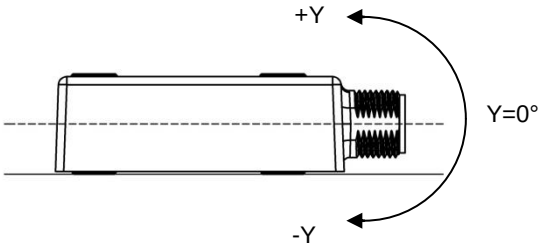
5.5 Measurement Axes

TILTIX 80 – Dual Axis Inclinometer



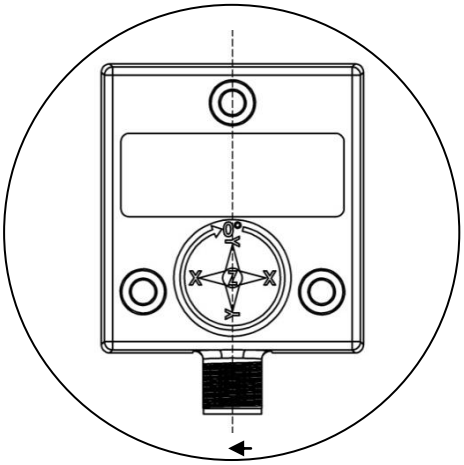


X-Axis Inclination



Y-Axis Inclination

TILTIX360 – Single Axis Inclinometer



Z=0°

Initial Starting Point (Factory Settings)

6. PGN Configuration

Status Message 65450	
PGN	65450 (0xFFAA)
Bit Rate	250K bits/sec
Data Page	0
PDU Format	255 (0xFF)
PDU Specific	170 (0xAA)
Data Length	8 bytes

PGN 61459 (dual axis sensor, broadcast)

Inclinometer position	**Broadcast communication**	
Transmission repition rate	10 ms (default)	
Data Length	8 bytes	
PDU format PF	0xF0	
PDU specific PS	0x13	
Default priority	6	
Parameter group number PGN	61459	
Structure of data field	**Position in data field**	**Description**
Pitch angle	1-2	Pitch angle according to SPN 3318 (UINT16)
Roll angle	3-4	Roll angle according to SPN 3319 (UINT16)
Pitch rate	5-6	Pitch rate not supported (0xffff)
Pitch angle figure of merit	7.1-7.2	00b: value in range, 01b: value out of range (2bits)
Roll angle figure of merit	7.3-7.4	00b: value in range, 01b: value out of range (2bits)
Pitch rate figure of merit	7.5-7.6	11b: not supported (2bits)
Pitch and roll compensated	7.7-7.8	01b: compensation on(2bits)
Pitch and roll measurement latency	8	Estimated measurement latency (0.5ms/count ->fixed @ 100ms right now) (UINT8)

Configuration write parameter PGN 61184 (peer to peer, unacknowledged) *Note: yy below needs to be the current device address			
Identifier	**CAN data**	**Definition**	**Data type**
0x18EFyyxx	01 00 xx xx xx xx xx xx	Index 0x01: Direction pitch (0: SAE J670, 1: opposite direction)	UINT8
0x18EFyyxx	02 00 xx xx xx xx xx xx	Index 0x02: Direction roll (0: SAE J670, 1: opposite direction)	UINT8
0x18EFyyxx	03 xx xx xx xx xx xx xx	Index 0x03: Resolution pitch (not settable, default: 500 -> 0.002°/count)	(UINT16)
0x18EFyyxx	04 xx xx xx xx xx xx xx	Index 0x04: Resolution roll (not settable, default: 500 -> 0.002°/count)	(UINT16)
0x18EFyyxx	05 0A 00 xx xx xx xx xx	Index 0x05: cycle time PGN 61459 (1ms/count)	UINT16
0x18EFyyxx	06 7F xx xx xx xx xx xx	Index 0x06: Address (0-255 allowed, default: 1)	UINT8
0x18EFyyxx	07 04 xx xx xx xx xx xx	Index 0x07: Baudrate (default: 4 -> 250kBaud)	UINT8
0x18EFyyxx	08 40 00 xx xx xx xx xx	Index 0x08: Filter length (mv. avg. filter, default: 64, only 2^n, max 256)	UINT16
0x18EFyyxx	09 00 00 xx xx xx xx xx	Index 0x09: Preset pitch (max offset of 15° with respect to default allowed)	INT16
0x18EFyyxx	0A 00 00 xx xx xx xx xx	Index 0x0A: Preset roll (max offset of 15° with respect to default allowed)	INT16
0x18EFyyxx	0B 00 xx xx xx xx xx xx	Index 0x0B: Termination resistor (0: off, 1: on)	UINT8
0x18EFyyxx	FA 73 61 76 65 xx xx xx	Index 0xFA: Save all parameter non-volatile with reset	UINT32
0x18EFyyxx	FC 6C 6F 61 64 xx xx xx	Index 0xFC: Restore all parameter to factory default with reset	UINT32
xx: source address, don't care	xx: don't care	' xx' can be filled with '00'	

Configuration read parameter PGN 59904 (peer to peer),
Index is internally incremented after read and wraps around at highest index
*Note: yy below needs to be the current device address

Direction	Identifier	CAN data	Definition	Data type
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	01 00 FF FF FF FF FF FF	Index 0x01: Direction pitch (default: 0)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	02 00 FF FF FF FF FF FF	Index 0x02: Direction roll (default: 0)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	03 F4 01 FF FF FF FF FF	Index 0x03: Resolution pitch (default: 500 -> 0.002°/count)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	04 F4 01 FF FF FF FF FF	Index 0x04: Resolution roll (default: 500 -> 0.002°/count)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	05 0A 00 FF FF FF FF FF	Index 0x05: Cycle time in ms (default: 10, 1ms/count)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	06 7F FF FF FF FF FF FF	Index 0x06: Address (default: 1)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	07 04 FF FF FF FF FF FF	Index 0x07: Baud rate (default: 4 -> 250kBaud)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	08 40 00 FF FF FF FF FF	Index 0x08: Filter length (default: 64)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	09 00 00 FF FF FF FF FF	Index 0x09: Preset pitch (default: 0)	INT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	0A 00 00 FF FF FF FF FF	Index 0x0A: Preset roll (default: 0)	INT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	0B 00 FF FF FF FF FF FF	Index 0x0B: Termination resistor (default: 0 -> off)	UINT8
	xx: source address, don't care	xx: don't care	‘ xx’ can be filled with ‘00’	

Position Data, PGN 65467 (Single axis sensor – z-axis)
PGN 65467 (single axis sensor, broadcast)

Inclinometer position	**Broadcast communication**	
Transmission repetition rate	10 ms (default)	
Data Length	8 bytes	
PDU format PF	0xFF	
PDU specific PS	0xBB	
Default priority	6	
Parameter group number PGN	65467	
Structure of data field	**Position in data field**	**Description**
Angle (z-axis)	1-4	Angle in z-direction according to datasheet with resolution 0.002°/count (INT32)
Reserved	5-8	Reserved for future use

Configuration write parameter PGN 61184 (peer to peer, unacknowledged)
*Note: yy below needs to be the current device address

Identifier	**CAN data**	**Meaning**	**Data type**
0x18EFyyxx	01 00 xx xx xx xx xx xx	Index 0x01: Direction z-axis according to datasheet	UINT8
0x18EFyyxx	03 F4 01 xx xx xx xx xx	Index 0x03: Resolution z-axis (1-65535, default: 500 -> 0.002°/count)	UINT16
0x18EFyyxx	05 0A 00 xx xx xx xx xx	Index 0x05: cycle time PGN 65467 (1ms/count)	UINT16
0x18EFyyxx	06 7F xx xx xx xx xx xx	Index 0x06: Address (0-255 allowed, default: 1)	UINT8
0x18EFyyxx	07 04 xx xx xx xx xx xx	Index 0x07: Baudrate (default: 4 -> 250kBaud)	UINT8
0x18EFyyxx	08 40 00 xx xx xx xx xx	Index 0x08: Filter length (mv. avg. filter, default: 64, only 2^n, max 256)	UINT16
0x18EFyyxx	09 00 00 xx xx xx xx xx	Index 0x09: Preset z-axis (in current resolution, range 0-(360*res-1))	INT32
0x18EFyyxx	0B 00 xx xx xx xx xx xx	Index 0x0B: Termination resistor (0: off, 1: on)	UINT8
0x18EFyyxx	FA 73 61 76 65 xx xx xx	Index 0xFA: Save all parameter non-volatile with reset	UINT32
0x18EFyyxx	FC 6C 6F 61 64 xx xx xx	Index 0xFC: Restore all parameter to factory default with reset	UINT32
xx: source address, don't care	xx: don't care	‘ xx’ can be filled with ‘00’	

Configuration read parameter PGN 59904 (peer to peer)
Index is internally incremented after read and wraps around at highest index
*Note: yy below needs to be the current device address

Direction	Identifier	CAN data	Meaning	Data type
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	01 00 FF FF FF FF FF FF	Index 0x01: Direction z-axis (default: 0)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	03 F4 01 FF FF FF FF FF	Index 0x03: Resolution z-axis (default: 500 -> 0.002°/count)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	05 0A 00 FF FF FF FF FF	Index 0x05: Cycle time in ms (default: 10, 1ms/count)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	06 7F FF FF FF FF FF FF	Index 0x06: Address (default: 1)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	07 04 FF FF FF FF FF FF	Index 0x07: Baud rate (default: 4 -> 250kBaud)	UINT8
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	08 40 00 FF FF FF FF FF	Index 0x08: Filter length (default: 64)	UINT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	09 00 00 FF FF FF FF FF	Index 0x09: Preset z-axis (default: 0)	INT16
Request	0x18EAyyxx	00 EF 00	Read request	-
Response	0x18EFxxyy	0B 00 FF FF FF FF FF FF	Index 0x0B: Termination resistor (default: 0 -> off)	UINT8
	xx: source address, don't care	xx: don't care	‘ xx’ can be filled with ‘00’	

7. Examples

Filter Examples

Moving Average Filter		
Filter time 300ms, internal sensor update time 2ms Therefore the moving average filter size: 300ms/2ms → 150		
Identifier	CAN data	Description
0x18EFC0xx	08 00 xx xx xx xx xx xx	Set moving average as active filter
0x18EFC0xx	0E 96 xx xx xx xx xx xx	Set moving average filter size to 150 (96h)
0x18EFC0xx	0D 02 xx xx xx xx xx xx	Set internal sensor update time to 2ms

Recursive Filter Example		
99% of end value after 200ms, internal sensor update rate 4ms 200ms/4ms = 50 iterations, 100% -99% = 1% = 0.01→ 50th root of 0.01 = 0.912 → filter value 912 (factor 1000)		
Identifier	CAN data	Description
0x18EFC0xx	08 01 xx xx xx xx xx xx	Set recursive filter as active filter
0x18EFC0xx	0C 90 03 xx xx xx xx xx	Set recursive filter factor to 912 (390h)
0x18EFC0xx	0D 04 xx xx xx xx xx xx	Set internal sensor update time to 4ms

Linear Regression Example		
Linear regression filter is not adjustable, but internal sensor update time is Filter time 125ms per 1ms internal sensor update time; filter time 250ms → internal sensor update time 2ms		
Identifier	CAN data	Description
0x18EFC0xx	08 02 xx xx xx xx xx xx	Set linear regression
0x18EFC0xx	0D 02 xx xx xx xx xx xx	Set internal sensor update time to 2ms

8. Example to Change Address of Device

- Hardware : CAN Capture by Murphy Controls
- Software : dataTaker
- Part No: ACS-360-1-C901-VK2-PM

Original Address: 0xC0 (192d)
New Address: 0xC1 (193d)

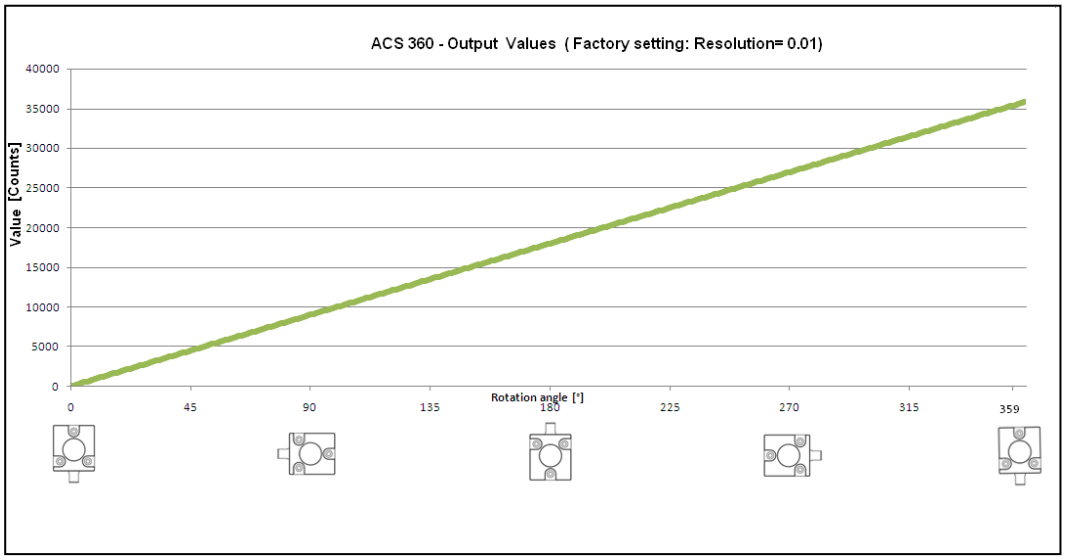
Type	Priority	PDU-F	PDU-S	Src Addr	PGN	PID	DLC	Data
29-Bit	6	FF	BB	C0	FFBB	18FFBBC0	8	D4 AC 01 00 FF FF FF FF
29-Bit	6	EA	C0	00	EAC0	18EAC000	3	00 EF 00
29-Bit	6	EF	00	C0	EF00	18EF00C0	8	06 C1 00 FF FF FF FF FF
29-Bit	6	EF	C0	00	EFC0	18EFC000	8	FA 73 61 76 65 00 00 00
29-Bit	6	FF	BB	C1	FFBB	18FFBBC1	8	B2 B7 01 00 FF FF FF FF

Row 3 is the example for data sent to change
Row 4 is the required store and reset message sent on the older address

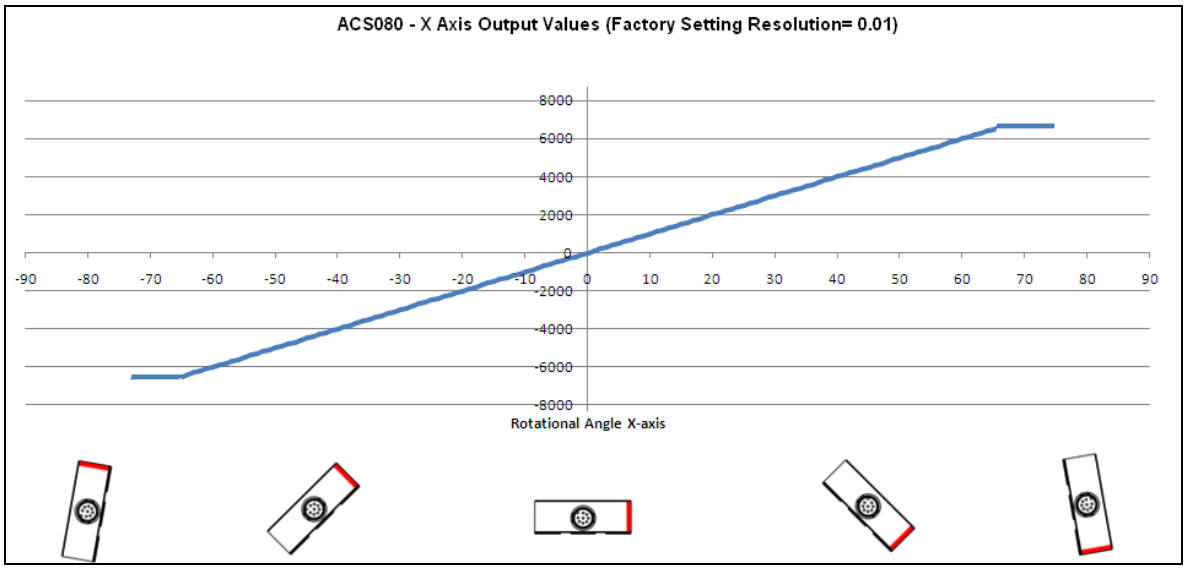
Row 5 is the new position value coming from the newly addressed 0xC1

9. Output Graphs

9.1 TILTIX 360: J1939 Output Values



9.2 TILTIX 080: J1939 Output Values



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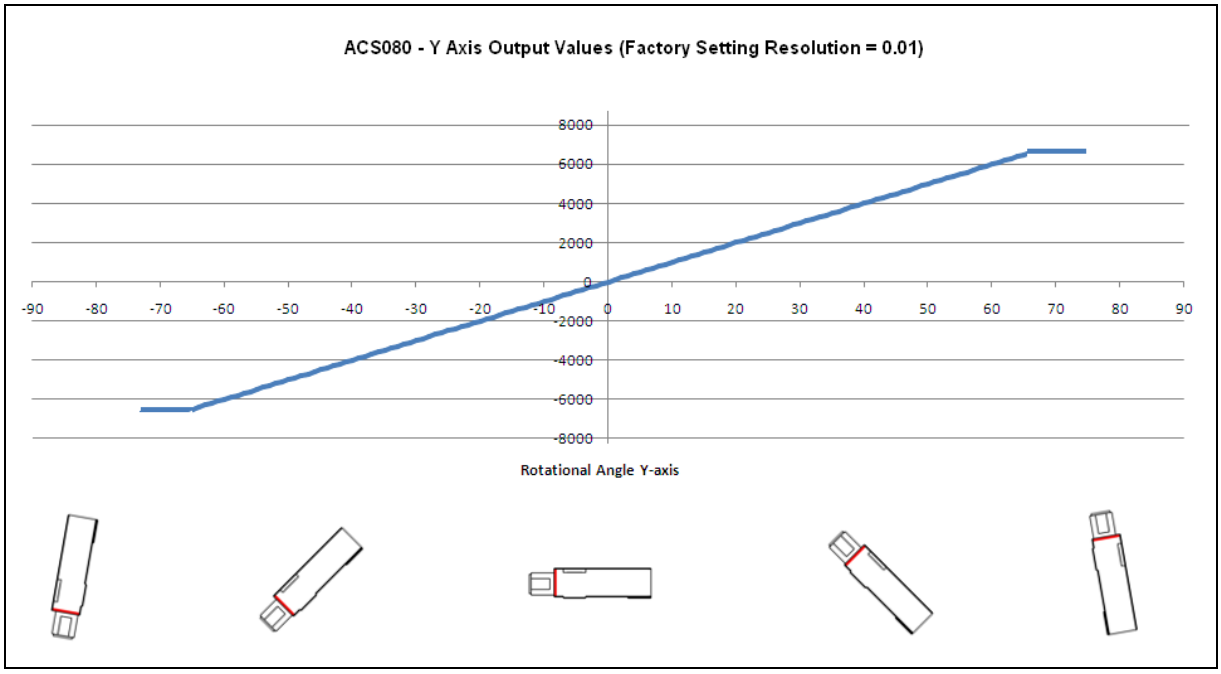

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