EPSON

IMU (Inertial Measurement Unit) - CAN Interface

M-G552PC1x
Data Sheet

SEIKO EPSON CORPORATION

Rev.1.5

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1. OVERVIEW

The M-G552 is a small form factor inertial measurement unit (IMU) with 6 degrees of freedom: tri-axial angular rates and linear accelerations and provides high-stability and high-precision measurement capabilities with the use of high-precision compensation technology.

The M-G552PC1 features a built-in attitude angle output function using an extended Kalman filter optimized for high-speed operation and highly accurate attitude angle (Roll/Pitch). This exceptional real time performance is achieved using our unique DSP processing architecture for efficiency, and low power consumption. The application or system level power consumption and complexity can be reduced by offloading the high-speed processing from the host system that would otherwise be necessary to achieve highly dynamic posture angle.

A variety of calibration parameters are stored in memory of the IMU, and are automatically reflected in the measurement data being sent to the application after the power of the IMU is turned on.

With Controller Area Network (CAN) interface support for host communication, the M-G552PCx reduces technical barriers for users to introduce inertial measurement and minimizes design resources to implement inertial movement analysis and control applications.
This unit is packaged in a water-proof and dust-proof metallic case. It is suitable for use in industrial and heavy duty applications.

The features of the IMU such as high stability, high precision, and small size make it easy to create and differentiate applications in various fields of industrial systems.

1.1 Features

Item	Specification	Note
Sensor		
Integrated sensor	SEIKO EPSON inertial measurement sensor Low-noise, High-stability Gyro bias instability: 1.2 °/h Angular random walk: 0.08 °/√h Initial bias error: 360 °/h (1σ)/ 4 mG(1σ) 6 Degree of freedom Triple Gyroscope: ±450 °/s Tri-axis Accelerometer: ±10 G Tilt function Inclination mode: ±80 ° Euler mode: ±180 °(Pitch), ±45 °(Roll) Resolution: 0.01 ° Accuracy: Static: ±0.2 ° (1σ), Dynamic: ±0.2 ° (1σ) 16bit data resolution Calibrated stability (Bias, Scale factor, Axial alignment)	
Output data rate	1000/500/250/125/62.5/31.25/15.625 400/200/100/80/50/40/25/20 sps up to 200 sps (When attitude angle output enabled) Max 1,000 sps (Sampling mode, when 6 DOF sensor output enabled) 500sps (Sync mode, when 6 DOF sensor output enabled)	Default: 100sps
LPF	Built-in moving average filter and FIR Kaiser filter	Default:

Item		Specification	Note
			FIR tap=32 fc=50Hz
Interface			
	Protocol	CANopen	With no conformance
	Physical layer	ISO11898-2 (High speed CAN)	
	Data link layer	ISO11898-1 (High speed CAN)	
	Frame format	CAN2.0A	
	Frame byte order	Little Endian	Intel Format
	Profile	DS-301	Standard profile
		DS-404 (with proprietary)	Device profile for measuring devices
	Bit rate	1M/ 800k/ 500k/ 250k/ 125k/ 50k/ 20k/ 10k bps	250kbps (Default setting)
	Node-ID	1 to 127	1 (default setting)
Other function			
	Indicator	Run-LED (Green)/ Error-LED (Red)	Accordance with DS-303-3
	Terminator	Not included	A terminator should be attached to the network.
General characteristics			
	Voltage supply	9 V to 32 V	
	Power consumption	33 mA typ	Vin=12V Default setting
	Operating temperature range	-30 °C to +80°C	
External dimension			
	Outer packaging	Overall metallic shield chassis	
	Size	65 x 60 x 30 mm^3 (Including projection.)	
	Weight	115 g	
	Interface connector	CAN connector: 5-pos, M12, waterproof	
	Water-proof: Dust-proof:	IP67 equivalent	
Regulation			
	CE	CE marking (EN61326/RoHS Directive) class A	
	FCC	FCC part15B class A	

1.2 Block Diagram

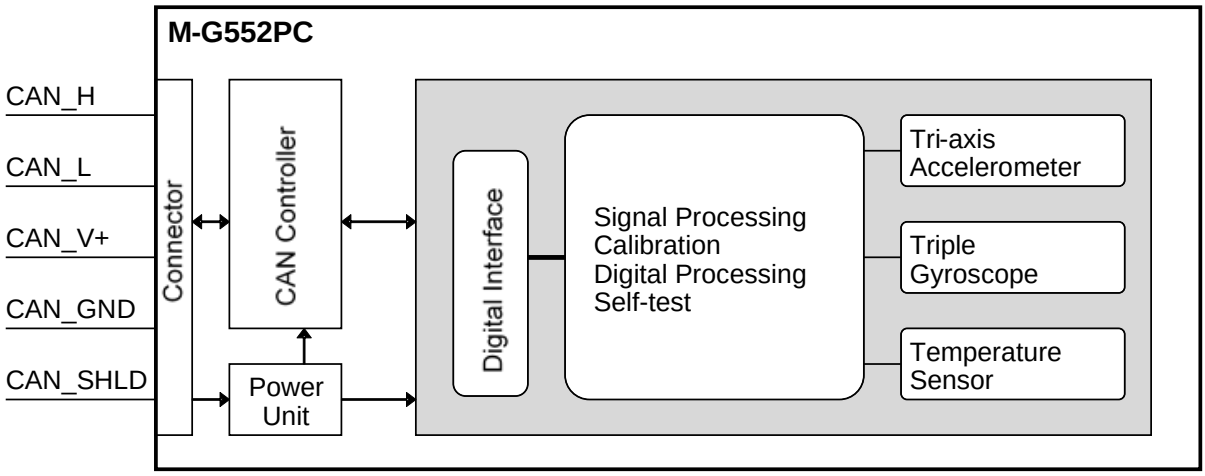


Figure 1-1 Functional Block Diagram

1.3 Definitions

The definition of terms used in this manual.

CAN-ID
: An identifier for CAN data and remote frames. This unit uses 11bit CAN-ID.

Client
: A device that sends a request to a server. In this manual, the host device like a PC becomes the client.

COB
: Communication Object; consists of 1 or more CAN frames, COB encompasses all types of data transmitted via CANopen.

COB-ID
: COB Identifier; defines a unique COB and also determines its priority.

Consumer
: A device that receives messages from a producer and communicates with a producer.

DLC
: Data Length Code, this shows the number of bytes in the data field of the message.

FC
: Function Code, this is the high-order 4 bits of the CAN-ID.

HB
: Heartbeat

NMT
: Network Management

Node-ID (NID)
: 7 bits network-wide unique identifier for each CANopen device. It is inserted in the low-order 7 bits of COB-ID. Values from 1 to 127 are normally used, 0 is used for special purpose.

OD
: Object Dictionary; list of user-accessible parameters stored in the slave node.

Producer
: A device that sends messages to one or more consumers.

RSDO
: Receive Service Data Object, Receive SDO request from CANopen bus master.

Server

A device that contains an OD. It returns a response when it receives the request from client. In this manual, SDO server refers to the sensor unit.

SYNC
: Synchronization Object

TPDO
: Transmit PDO channel

TSDO
: Transmit SDO response to CANopen bus master

2. PRODUCT SPECIFICATIONS

2.1 Absolute Maximum Ratings

Table 2-1 Absolute Maximum Rating

Parameter	Term	Conditions	Range	Unit
Power supply voltage	V_{IN}	CAN_V+ to CAN_GND	-0.3 ~ +32V	V
Port input voltage	V_{port}	CANH/CANL to CAN_GND	-3 ~ +32	V
Storage temperature	T_{STG}		-40 ~ +85	°C
Operating temperature1	T_{OPR1}		-30～+80	°C
Acceleration / Shock		Half-sine 0.5ms, once per ±each axis(6times)	1000	G
Sine sweep vibration		MIL-STD-202G METHOD 204	10	G
Random vibration		MIL-STD-810, METHOD 514.x ANNEX E, Category24 (20～2kHz)	7.7	Grms

If the unit is operated beyond the absolute maximum rating, malfunction may occur, or the unit may fail completely. Although the unit may appear to operate normally, reliability may decrease.

2.2 Recommended Operating Conditions

Table 2-2 Recommended Operating Conditions

Ta=25°C, Vin=12V, RL=60Ω, unless otherwise specified; all voltages are defined with respect to ground

Parameter	Term	Condition	Min.	Typ	Max.	Unit
Power supply voltge	V_{IN}	CAN_V+ to CAN_GND (*1)	9(*2)	12 (24)	32	V
Port input voltage	V_{PORT}	CANH/CANL to GND	-2	-	7	V
Operating temperature	T_{OPE}		-30	-	80	°C

*1. The power supply voltage must reach the recommended operating condition within 2 seconds after power is applied to a node.

*2. When power supply voltage is 9V or less, the master may not be able to communicate with this node normally even if the run-LED turns on.

2.3 Characteristics and Electrical Specifications

Table 2-3 Sensor Characteristics

T_A=25°C, angular rate=0 °/s, ≤±1G, unless otherwise noted.

Parameter	Test Conditions / Comments	Min.	Typ.	Max.	Unit
Gyroscope					
Sensitivity					
Output range		—	±450	—	°/s
Scale factor	16bit	Typ-0.2%	0.0151515	Typ+0.2%	(°/s)/LSB
Non-linearity (Best fit straight line)	1 σ, <300 deg/s	—	0.05	—	% of FS
	1 σ, >300 deg/s	—	0.2	—	% of FS
Misalignment	1 σ,Axis-to-axis, Δ = 90° ideal	—	0.01	—	°
Bias					
Initial error	1 σ, −30°C ≤ T_A ≤ +80°C	—	360	—	°/h
Repeatability	1 σ, turn-on to turn-on *3	—	36	—	°/h
Bias instability	Average	—	1.2	—	°/h
Angular random walk	Average	—	0.08	—	°/√h
Linear acceleration effect	Average		18		(°/h)/G
Noise density	f = 10 to 20 Hz	—	6.9	—	(°/h)/√Hz, rms
Frequency Property					
3 dB Bandwidth		—	472	—	Hz
Accelerometer					
Sensitivity					
Output range	—	—	±10	—	G
Scale factor	16bit	Typ-0.1%	0.4	Typ+0.1%	mG/LSB
Non-linearity (Best fit straight line)	1 σ, ≤ 5G	—	0.1	—	% of FS
Misalignment	1 σ,Axis-to-axis, Δ = 90° ideal	—	0.01	—	°
Bias					
Initial error	1 σ, −30°C ≤ T_A ≤ +80°C	—	4	—	mG
Repeatability	1 σ, turn-on to turn-on *3	—	3	—	mG
Bias instability	Average	—	16	—	µG
Velocity random walk	Average	—	0.033	—	(m/s)/√h
Noise density	f = 10 to 20 Hz	—	80	—	µG/√Hz, rms
Frequency Property					
3 dB Bandwidth		—	167	—	Hz
Inclinometer					
Dynamic range	Inclination mode	-80	—	+80	°
	Euler mode ANG1(roll)	-45	—	+45	°
	Euler mode ANG2(pitch)	-180	—	+180	°
Scale factor	16bit	—	0.00012207	—	rad/LSB
		—	0.00699411	—	°/LSB
Accuracy*4*5	Static	—	±0.2	—	°
	Dynamic (100 °/s, max)	—	±0.2	—	°
Temperature Sensor					
Scale factor *1*2	16bit Output=2634(0x0A4A)@+25°C	—	-0.0037918	—	°C/LSB

*1. This is a reference value used for internal temperature compensation. There is no guarantee that the value gives an absolute value of the internal temperature.

*2. This is the temperature scale factor for the upper 16bit.

*3. Turn-on to turn-on / Day by day, estimated variation during 5 consecutive days.

*4. Dynamic accuracy is based on measurement data that has been measured from a stationary state.

*5. Attitude output accuracy is based on measurement data for modeA of motion profile.

Note) The values in the specifications are based on the data calibrated at the factory. The values may change according to the way the product is used.

Note) The Typ values in the specifications are average values or 1σ values.

Note) Unless otherwise noted, the Max / Min values in the specifications are design values or Max / Min values at the factory tests.

Table 2-4 CAN Characteristics

Ta=25°C, Vin=12V, RL=60Ω, unless otherwise specified; all voltages are defined with respect to ground; positive currents flow into the sensor unit.

Parameter	Term	Condition	Min.	Typ	Max.	Unit
Output voltage (dominant)	VO (dom)	CANH	2.75	3.5	4.5	V
		CANL	0.5	1.5	2.25	V
Output voltage (recessive)	VO (rec)	CANH/CANL	2	2.5	3	V
Differential output voltage(dominant)	VO (dif)dom	CANL to CANH	1.5	-	3	V
Differential output voltage(recessive)	VO (dif)rec	CANL to CANH	-120	-	12	mV
Output current (dominant)	IOS (dom)	CANL=open; VCANH=+0.3V	-100			mA
		CANH=open; VCANL=+32V			100	mA
Output current (recessive)	IOS(rec)	VCANH=VCANL	-5	-	5	mA

Table 2-5 Current Consumption

Ta=25°C, RL=60Ω, unless otherwise specified; all voltages are defined with respect to ground; positive currents flow into the sensor unit; Sampling mode; CAN bitrate 250kbps, Sensor sample rate 100Sps

Parameter	Term	Condition	Min.	Typ	Max.	Unit
Mean current in measurement state	$I_{IN(OP)}$	Vin=12V, 250kbps,100sps	-	33	-	mA
		Vin=24V, 250kbps,100sps	-	19	-	mA
Mean current in idle state	$I_{IN(ready)}$	Vin=12V, 250kbps	-	30	-	mA
		Vin=24V, 250kbps	-	17	-	mA
Maximum input current	$I_{IN(max)}$	With No-Host, CANbusBusy Vin=9V	-	-	60.0	mA

2.4 Timing Characteristics

Table 2-6 Measurement Timing Characteristics @1Mbps CAN bitrate

Parameter	Term	Condition	Min.	Typ	Max.	Unit
Response time	t_{RS}	From received SYNC to send TPDO	-	0.1	0.4	msec

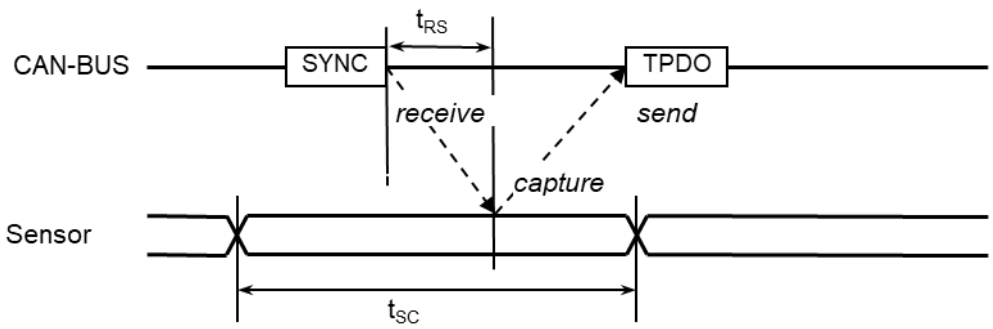
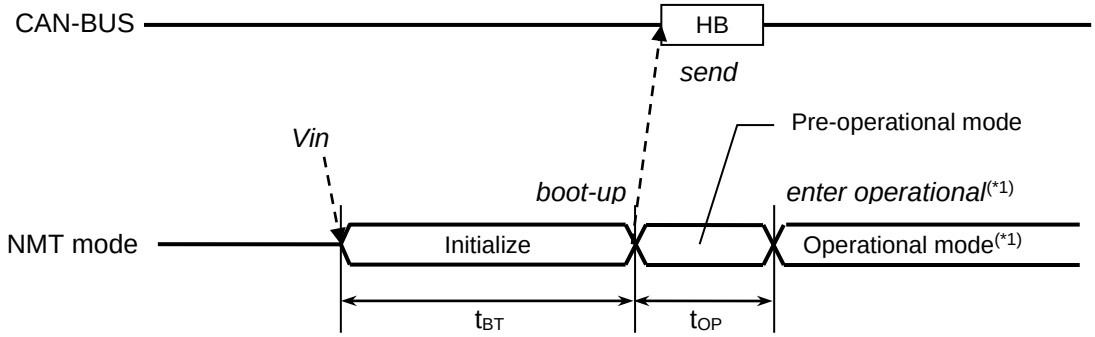


Figure 2-1 Measurement Timing Characteristics

Table 2-7 State Change Timing Characteristics

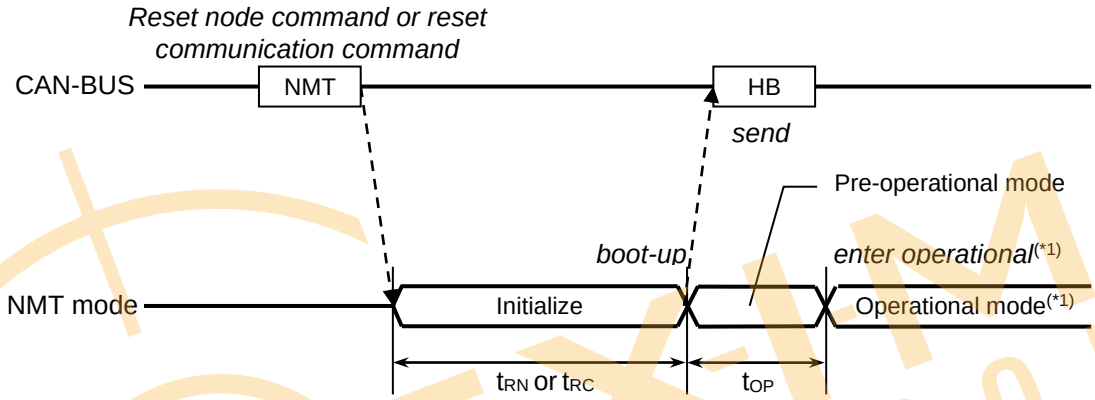
Parameter	Term	Description	Min.	Typ	Max.	Unit
Power-on boot-up time	t_{BT}	Time to boot-up completion from power on.	-	-	4000	msec
Reset node boot-up time	t_{RN}	Time to boot-up completion from a reset node command reception.	-	-	1600	msec
Reset communication boot-up time	t_{RC}	Time to boot-up completion from a reset communication command reception.	-	-	500	msec
Enter start time	-	Time to Start mode from Pre-operational or Stop mode		-	500	msec
Enter stop time	-	Time to pre-operational mode from Operational or stop mode	-	-	100	msec
Enter pre-operational time	t_{OP}	Time to pre-operational mode from Operational or stop mode	-	-	1300	msec
Reset node complete time	t_{RN} + t_{OP}	Time to NMT completion from a reset node command reception.		-	3000	msec

To confirm the NMT mode status after boot-up, decode the status flag in the HB message or set the startup mode OD [1F80h, 00h] to pre-operational mode and manually change to operational mode via NMT Start command. The LED indicator changes into green after mode setting.



(*1) When start-up mode is the operational mode.

Figure 2-2 Boot-up Timing Characteristics



(*1) When start-up mode is the operational mode.

Figure 2-3 Reset Timing Characteristics

2.5 Non-volatile Memory Characteristics

Table 2-8 Non-volatile Memory Parameter Save Characteristics

Ta=-30°C～+80°C

Parameter	Term	Condition	Min.	Typ	Max.	Unit
Write cycles	Nlog		100,000	-	-	cycles
Retention time	t_{RET2}	Powered	10	-	-	years

2.6 Connector Specification

Table 2-9 Connector Specification

Model number	SACC-DSI-MS-5CON-M12-SCO SH(X)
Manufacturer	PHOENIX CONTACT

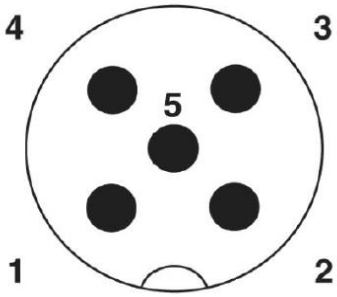


Figure 2-4 Terminal Layout

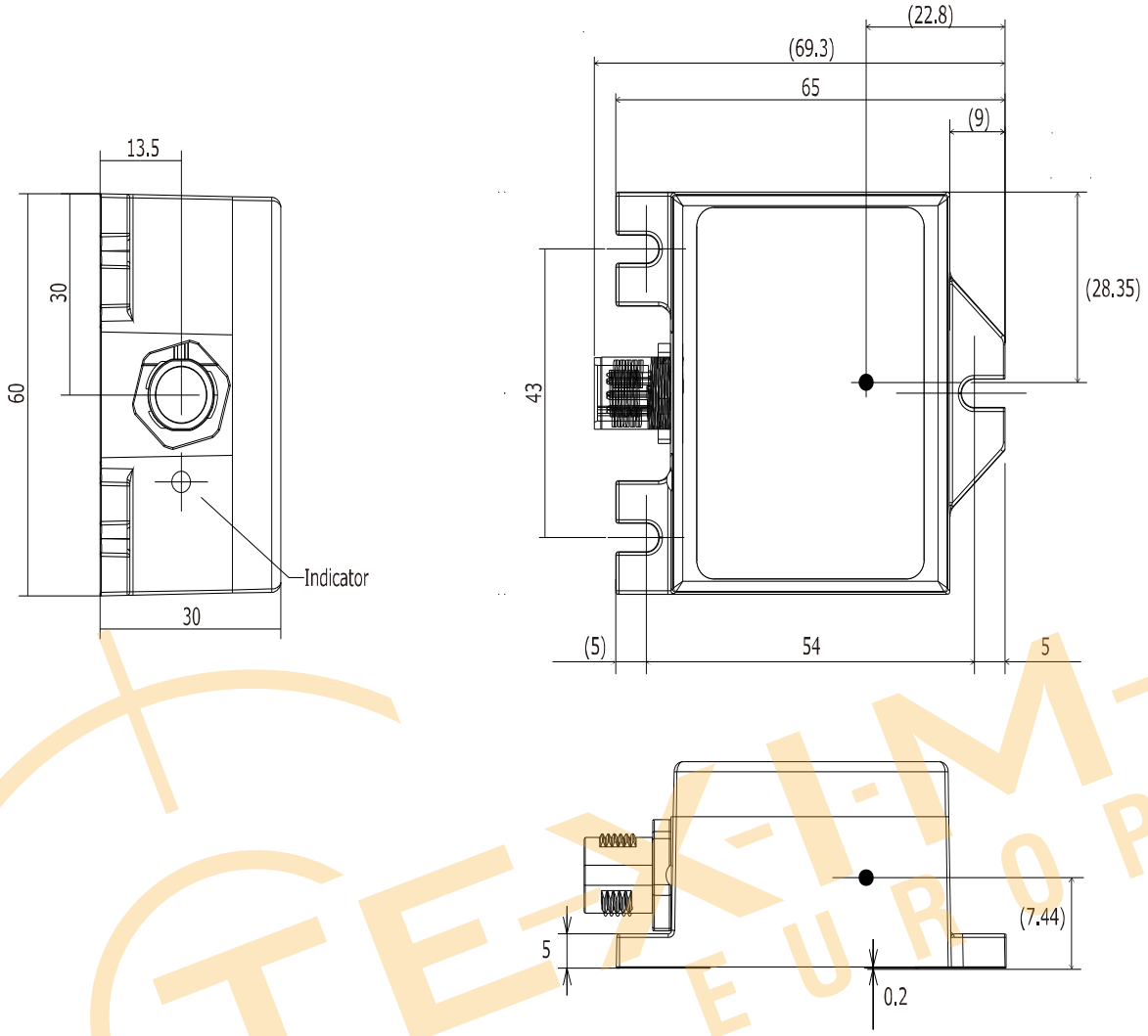
Table 2-10 Terminal Function

No	Pin Name	I/O	Description
1	CAN_SHLD	-	CAN Shield (*1)
2	CAN_V+	I	External power supply (9-32V)
3	CAN_GND	-	Ground
4	CAN_H	I/O	CAN H bus line
5	CAN_L	I/O	CAN L bus line

NOTE: This device should be connected to a connector that satisfies at least the IP67 waterproof and dustproof specification.

*1. CAN_SHLD is connected to the case. CAN_SHLD is internally connected to CAN_GND via a capacitor 0.01uF/100V

3. MECHANICAL DIMENSIONS



● [Accelerometer origin]

Figure 2-5 Outline Dimensions (millimeters)

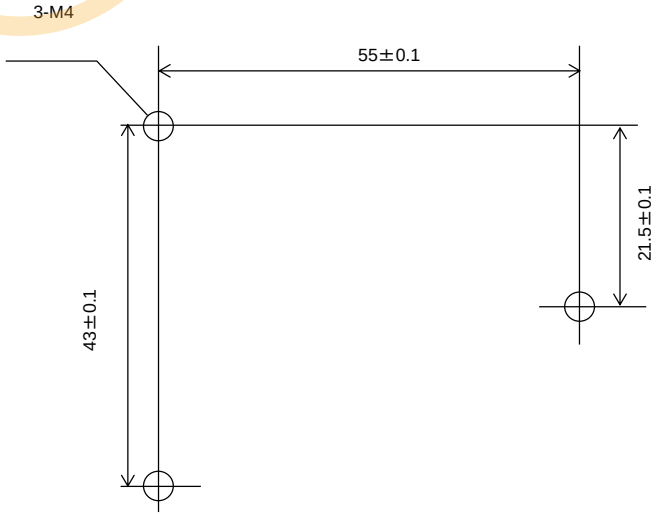


Figure 2-6 Recommended Mounting Dimension

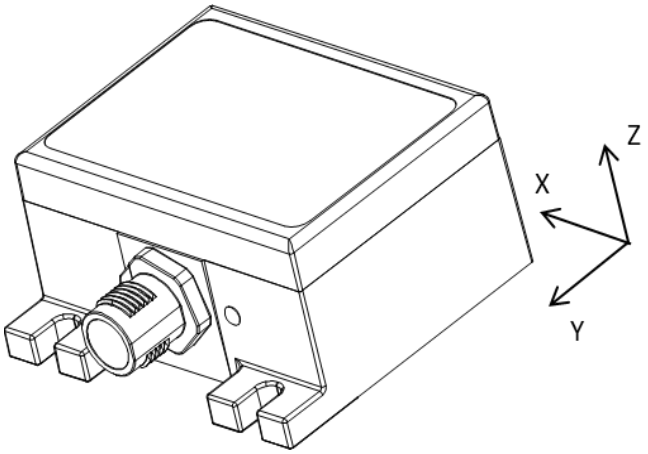


Figure 2-7 Axial Direction

4. TYPICAL PERFORMANCE CHARACTERISTICS

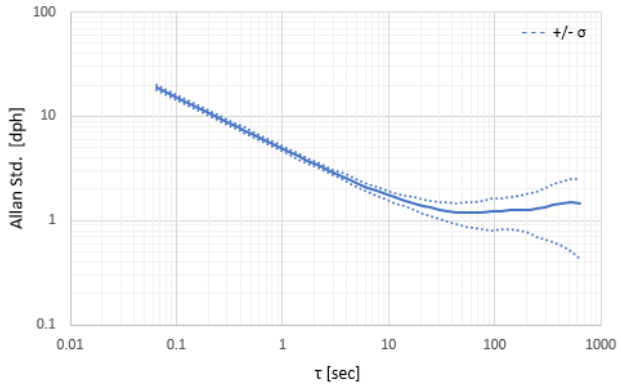


Figure 4-1 Gyro Allan Variance

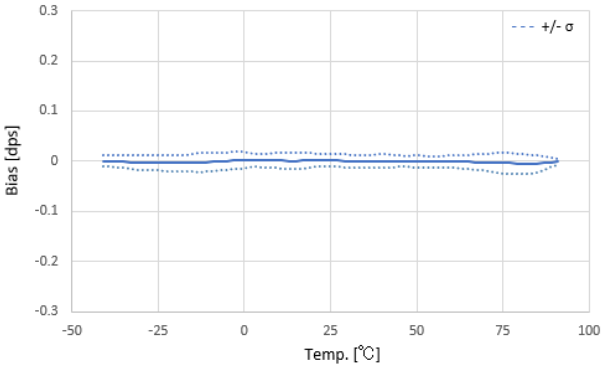


Figure 4-2 Gyro Bias vs. Temperature

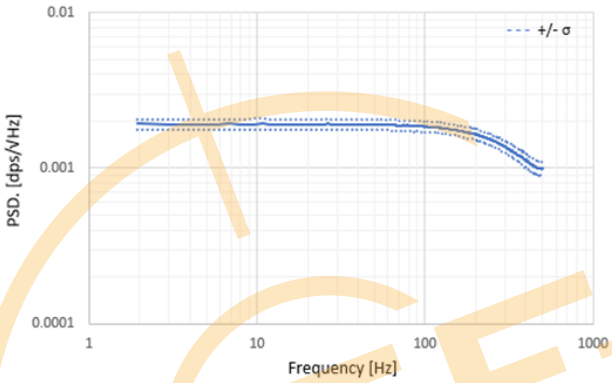


Figure 4-3 Gyro Noise Frequency

The product characteristics shown above are just examples and are not guaranteed as specifications.

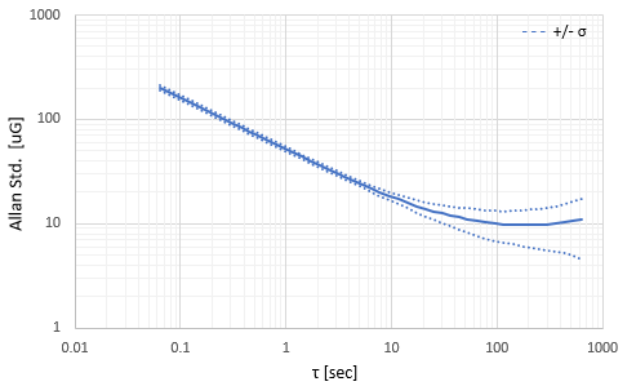


Figure 4-4 Accelerometer Allan Variance

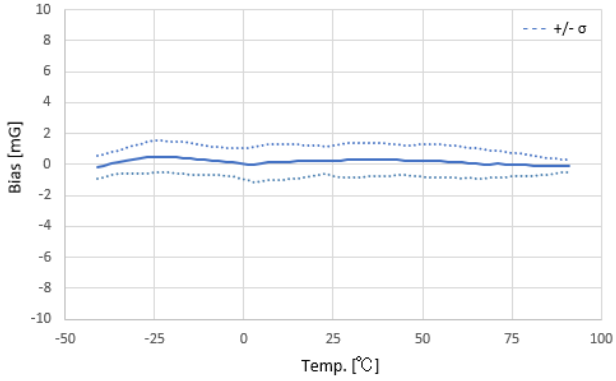


Figure 4-5 Accelerometer Bias vs. Temperature

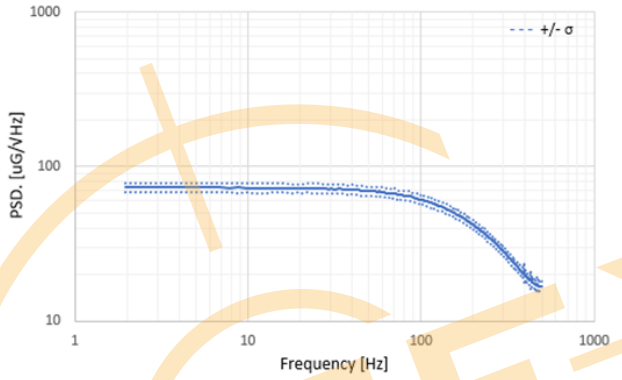


Figure 4-6 Accelerometer Noise Frequency

The product characteristics shown above are just examples and are not guaranteed as specifications.

5. CONNECTION EXAMPLE

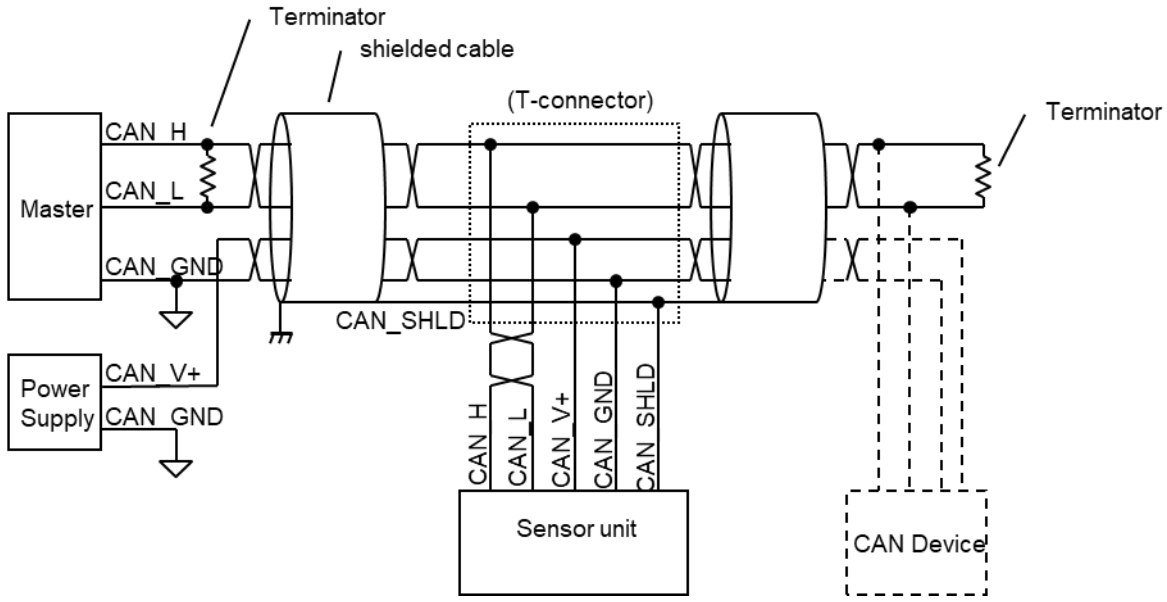


Figure 5-1 Connection Example

5.1 Precautions for Wiring and Cabling

- This product has no internal terminator. The user is required to connect a terminator to both ends of the cable.
- It is recommended that shield connects to ground.
- It is recommended that the cable meets the requirements of the CAN standard.
- Refer to Table 5-1 which defines the maximum practical length of cable wiring in a CAN network. Communication may be unstable depending on the system environment even if the system satisfies
- Care must be given to the effects of voltage drop by line resistance for the power supply line (CAN_V+, CAN_GND).

Table 5-1 Maximum Recommended Total Length of Cable (Reference)

CAN Bitrate	Total Length
1000kbps	40m
500kbps	100m
250kbps	250m
125kbps	500m

5.2 Precautions for Supplying Power

- The user should be aware of serious risks on the power supply exposure to the following:
  High voltage noise by increased resistance and inductance on power supply line.
  Surge voltage from lightning and environmental equipment.
- Figure 5-2 describes the external reference protection circuit against the lightning surge with a surge level based on IEC61000-4-5, +/-1kV(power supply line to the power supply ground) and +/-2kV(power supply line to the earth).

VP: CAN_V+ (Power supply)
PGND: CAN_GND (Power supply ground)
FGND: EARTH (System ground earth)
U3039: Surge absorber to power supply ground (Okaya Electric Industries)
ERZ-V14D390: Surge absorber to earth ground (Panasonic)

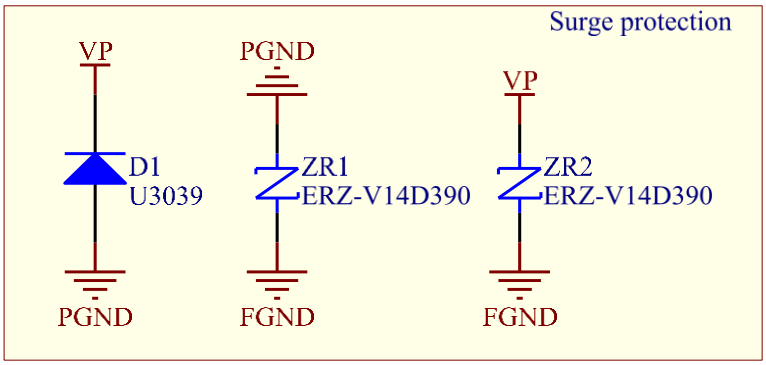


Figure 5-2 Surge Protection Circuit

6. CONTROL SEQUENCE

6.1 Message

This host device communicates with the sensor unit using the message types as shown by Table 6-1. See Appendix1 for the detailed description of the message types.

Table 6-1 Message List

COB	CAN-ID		DLC	Data field (Byte) (*1)								Description
	FC	Node-ID		1	2	3	4	5	6	7	8	
NMT	0000b	0000000b	2	Cs	Id							Cs=command specifier Id=node-ID
SYNC	0001b	0000000b	1	Cn								Cn=SYNC counter
			or									
			0									
TIME	0010b	0000000b	6	Ms				Dy				Dy=days Ms=milliseconds
TPDO1	0011b	0000001b to 1111111b	8	Tc		Gx		Gy		Gz		Tc=trigger counter Gx/Gy/Gz=gyro data
TPDO2	0101b	0000001b to 1111111b	8	Tc		Ax		Ay		Az		Tc=trigger counter Ax/Ay/Az=accel data
TPDO3 *2	0111b	0000001b to 1111111b	8	Tc		Te		Reserved		STS		Tc=trigger counter Te=temperature STS= Status information
TPDO3 *3	0111b	0000001b to 1111111b	8	Tc		ANG1		ANG2		STS		Tc=trigger counter ANG1= Attitude data1 ANG2= Attitude data2 STS= Status information
TPDO4	1001b	0000001b to 1111111b	8	Tc		Ms				Dy		Tc=trigger counter Ms=time Milliseconds Dy=time of day
TSDO	1011b	0000001b to 1111111b	8	Cs	Pi		Ps	Pd				Cs=command specifier Pi=index Ps=sub-index Pd=data
RSDO	1100b	0000001b to 1111111b	8	Cs	Pi		Ps	Pd				Cs=command specifier Pi=index Ps=sub-index Pd=data
HB	1110b	0000001b to 1111111b	1	St								St=state

*1. Byte order is little endian

*2. When 6 DOF output is valid by writing [11h] to OD[2005h,00h]

*3. When attitude angle output is valid by writing [21h] to OD[2005h,00h]

6.2 Object Dictionary

6.2.1 Read / Write Sequence

To read and write an OD entry, the client sends a request to the server, the server answers the message from the client. The client may request read-OD and write-OD accesses while the sensor unit is in the pre-operational mode or operational mode. This unit supports expedited SDO communication, so the data length of OD is 1, 2 or 4 Bytes.

Read-OD Sequence

1. The SDO client sends a request using the command (Cs) 40h RSDO message and specifies the index (Pi) and sub-index (Ps).
2. The SDO server replies using a TSDO message with the OD value copied to the Pd data field. The SDO server specifies 43h, 4Bh or 4Fh in the command (Cs) depending on the size of the data field.

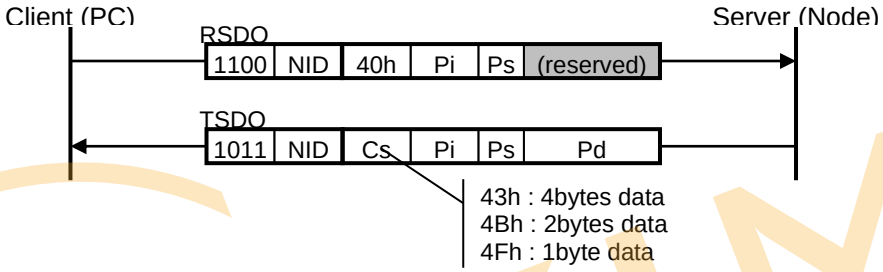


Figure 6-1 Read-OD Sequence

Write-OD Sequence

1. The SDO client sends a request by the RSDO message and specifies the index (Pi), sub-index (Ps) and data (Pd). The client specifies 23h, 2Bh or 2Fh to the command (Cs) depending on the size of the data field.
2. The SDO server replies using the command (Cs) 60h TSDO message, when the data has been written correctly.

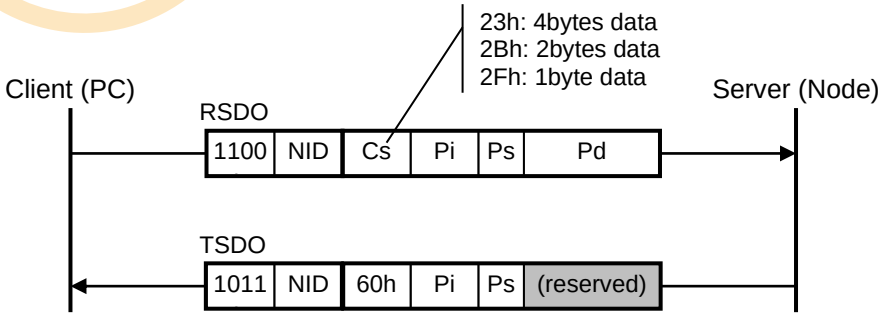


Figure 6-2 Write-OD Sequence

If an error has occurred, the SDO server returns the command (Cs) 80h TSDO message with an abort code, shown in Figure 6-3, contained in the data (Pd) of the write-OD sequence and the read-OD sequence.

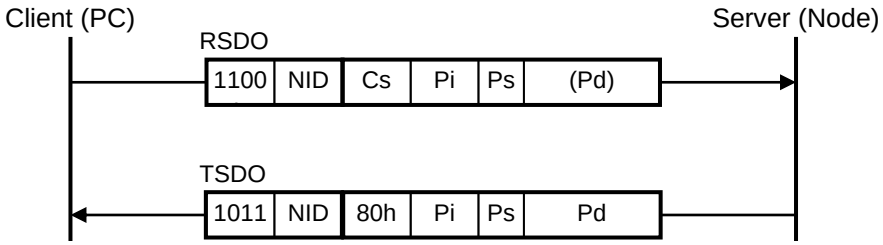


Figure 6-3 OD Abort Sequence

Table 6-2 List of Abort Codes

Abort code	Description
05030000h	Toggle bit not alternated
05040000h	SDO protocol time out
05040001h	Client/server command specifier not valid or unknown.
05040005h	Out of memory.
06010000h	Unsupported access to an object.
06010001h	Attempt to read a write only object.
06010002h	Attempt to write a read only object.
06040041h	Object cannot be mapped to the PDO.
06020000h	Object does not exist in the object dictionary.
06060000h	Access failed due to a hardware error.
06070010h	Length of service parameter does not match.
06090011h	Sub-index does not exist.
06090030h	Invalid value for parameter.
08000000h	General error
08000021h	Data cannot be transferred or stored to the application because of local control.
08000022h	Data cannot be transferred or stored to the application because of the present device state.

6.2.2 Object Dictionary Access Time

Table 6-3 describes O.D. execution time.
Keeping O.D access time greater than O.D execution time is recommended.
See Appendix2 OBJECT DICTIONARY for a detailed description of each OD entry.

Table 6-3 OD Execution Time (@1Mbps)

Index	Sub	Function	Execution Time (max)	Comment
1010h	01h	Save all parameters	200msec	
1011h	01h	Restore all default parameters	100msec	
2005h	00h	Apply parameters	1000msec	
-	-	OD other than the above	1msec	

6.2.3 Object Dictionary List

Table 6-4 contains the list of OD on the sensor unit. See Appendix2 OBJECT DICTIONARY for a detailed description of each OD entry.

Example

Index	Sub	Function	Type	Access	Default Value	Save
(1)	(2)	（Overview）	(3)	(4)	(5)	(6)

(1) Index Number
(2) Sub Index Number
(3) Data type
  U8 = 8bit unsigned integer (0 to 255)
  U16 = 16bit unsigned integer (0 to 65535)
  U32 = 32bit unsigned integer (0 to 4294967295)
  I16= 16bit signed integer (-32768 to 32767)
  VS4 = Array[4] of character (ex: 65766173h = "save")
(4) Access type
  const = Constant (never changed)
  ro = read only
  rw = read /write
(5) Default value
(6) An OD entry that has '#' in “Save” column supports saving to non-volatile memory.

Table 6-4 DS-301 OD (Communication Parameters)

Index	Sub	Function	Type	Access	Default Value	Save
1000h	00h	Device type	U32	const	0002 0194h	
1001h	00h	Error register	U8	ro	00h	
1002h	00h	Manufacturer status register	U32	ro	0000 0000h	
1005h	00h	SYNC COB-ID	U32	rw	0000 0080h	#
1006h	00h	Communication cycle period	U32	rw	0000 2710h	#
1008h	00h	Manufacturer device name	VS	const	3235 3547h	
1009h	00h	Manufacturer hardware version	VS	const	3031 4350h	
100Ah	00h	Manufacturer software version	VS	const	3030 2E31h(latest Rev)	
1010h	00h	highest sub-index supported	U8	const	01h	
	01h	Save all parameters	VS	rw	0000 0001h	
1011h	00h	highest sub-index supported	U8	const	01h	
	01h	Restore all default parameters	VS	rw	0000 0001h	
1012h	00h	TIME COB-ID	U32	const	8000 0100h	
1017h	00h	Producer heartbeat time	U16	rw	0000h	#
1018h	00h	highest sub-index supported	U8	const	01h	
	01h	Vender ID	U32	const	0000 0000h	
1019h	00h	Synchronous counter overflow value	U8	rw	00h	#
1200h	00h	highest sub-index supported	U8	const	02h	
	01h	RSDO COB-ID	U32	ro	0000 0600h + NID	
	02h	TSDO COB-ID	U32	ro	0000 0580h + NID	
1800h	00h	highest sub-index supported	U8	const	02h	
	01h	TPDO1 COB-ID	U32	rw	4000 0180h + NID	#
	02h	TPDO1 transmission type	U8	rw	FEh	#
1801h	00h	highest sub-index supported	U8	const	02h	
	01h	TPDO2 COB-ID	U32	rw	4000 0280h + NID	#
	02h	TPDO2 transmission type	U8	ro	(FEh)	(#)
1802h	00h	highest sub-index supported	U8	const	02h	
	01h	TPDO3 COB-ID	U32	rw	C000 0380h + NID	#
	02h	TPDO3 transmission type	U8	rw	(FEh)	(#)
1803h	00h	highest sub-index supported	U8	const	02h	
	01h	TPDO4 COB-ID	U32	rw	C000 0480h + NID	#
	02h	TPDO4 transmission type	U8	ro	(FEh)	(#)
1A00h	00h	highest sub-index supported	U8	const	04h	
	01h	TPDO1 mapping1 (Tc)	U32	const	2100 0010h	
	02h	TPDO1 mapping2 (Gx)	U32	const	7130 0110h	
	03h	TPDO1 mapping3 (Gy)	U32	const	7130 0210h	
	04h	TPDO1 mapping4 (Gz)	U32	const	7130 0310h	
1A01h	00h	highest sub-index supported	U8	const	04h	
	01h	TPDO2 mapping1 (Tc)	U32	const	2100 0010h	
	02h	TPDO2 mapping2 (Ax)	U32	const	7130 0410h	
	03h	TPDO2 mapping3 (Ay)	U32	const	7130 0510h	
	04h	TMAP2 mapping4 (Az)	U32	const	7130 0610h	
1A02h	00h	highest sub-index supported	U8	const	04h	
	01h	TPDO3 mapping1 (Tc)	U32	const	2100 0010h	
	02h	TPDO3 mapping2 (Temp) TPDO3 mapping2 (ANG1)	U32	const	7130 0710h (6dof) 7130 810h(Attitude)	
	03h	TPDO3 mapping3 (Reserved) TPDO3 mapping3 (ANG2)	U32	Const	2022 0410h(6dof) 7130 0910h(Attitude)	
	04h	TPDO3 mapping4 (STS)	U32	const	2022 0110h	
1A03h	00h	highest sub-index supported	U8	const	03h	
	01h	TPDO4 mapping1 (Tc)	U32	const	2100 0010h	
	02h	TPDO4 mapping2 (Ms)	U32	const	2101 0220h	
	03h	TPDO4 mapping3 (Dy)	U32	const	2101 0110h	
1F80h	00h	NMT Startup Mode	U32	rw	0000 0008h	#

Index	Sub	Function	Type	Access	Default Value	Save
2000h	00h	highest sub-index supported	U8	const	02h	
	01h	CAN node-ID	U8	rw	01h	#
	02h	CAN bitrate	U8	rw	03h	#
2001h	00h	Sensor sample rate	U8	rw	0Ah	#
2005h	00h	Apply parameters	U8	rw	10h	#
2020h	00h	highest sub-index supported	U8	const	1Bh	
	01h	Inc / Euler select	U8	rw	00h	#
	02h	Reference attitude	U8	rw	00h	#
	03h	Motion profile	U8	rw	00h	#
2100h	00h	Trigger counter	U16	rw	0000h	
2101h	00h	highest sub-index supported	U8	const	02h	
	01h	Time of day	U16	ro	indefinite	
	02h	Time difference	U32	ro	indefinite	
6110h	00h	highest sub-index supported	U8	const	0Ah	
	01h	AI sensor type 1	U16	ro	28A1h	
	02h	AI sensor type 2	U16	ro	28A1h	
	03h	AI sensor type 3	U16	ro	28A1h	
	04h	AI sensor type 4	U16	ro	2905h	
	05h	AI sensor type 5	U16	ro	2905h	
	06h	AI sensor type 6	U16	ro	2905h	
	07h	AI sensor type 7	U16	ro	0064h	
	08h	AI sensor type 8	U16	ro	28A1h	
	09h	AI sensor type 9	U16	ro	28A1h	
	0Ah	AI sensor type 10	U16	ro	28A1h	
6131h	00h	highest sub-index supported	U8	const	0Ah	
	01h	AI physical unit PV 1	U32	ro	0041 0300h	
	02h	AI physical unit PV 2	U32	ro	0041 0300h	
	03h	AI physical unit PV 3	U32	ro	0041 0300h	
	04h	AI physical unit PV 4	U32	ro	FDF1 0000h	
	05h	AI physical unit PV 5	U32	ro	FDF1 0000h	
	06h	AI physical unit PV 6	U32	ro	FDF1 0000h	
	07h	AI physical unit PV 7	U32	ro	002D 0000h	
	08h	AI physical unit PV 8	U32	ro	0h	
	09h	AI physical unit PV 9	U32	ro	0h	
	0Ah	AI physical unit PV 10	U32	ro	0h	
61A0h	00h	highest sub-index supported	U8	const	0Ah	
	01h	AI filter type 1	U8	const	02h	
	02h	AI filter type 2	U8	const	02h	
	03h	AI filter type 3	U8	const	02h	
	04h	AI filter type 4	U8	const	02h	
	05h	AI filter type 5	U8	const	02h	
	06h	AI filter type 6	U8	const	02h	
	07h	AI filter type 7	U8	const	02h	
	08h	AI filter type 8	U8	const	02h	
	09h	AI filter type 9	U8	const	02h	
	0Ah	AI filter type 10	U8	const	02h	
61A1h	00h	highest sub-index supported	U8	const	0Ah	
	01h	AI filter tap constant 1	U8	rw (*1)	08h	#
	02h	AI filter tap constant 2	U8	ro	08h	
	03h	AI filter tap constant 3	U8	ro	08h	
	04h	AI filter tap constant 4	U8	ro	08h	
	05h	AI filter tap constant 5	U8	ro	08h	
	06h	AI filter tap constant 6	U8	ro	08h	
	07h	AI filter tap constant 7	U8	ro	08h	
	08h	AI filter tap constant 8	U8	ro	08h	
	09h	AI filter tap constant 9	U8	ro	08h	
	0Ah	AI filter tap constant 10	U8	ro	08h	
7130h	00h	highest sub-index supported	U8	const	0Ah	

Index	Sub	Function	Type	Access	Default Value	Save
	01h	AI input PV 1	I16	ro	indefinite	
	02h	AI input PV 2	I16	ro	indefinite	
	03h	AI input PV 3	I16	ro	indefinite	
	04h	AI input PV 4	I16	ro	indefinite	
	05h	AI input PV 5	I16	ro	indefinite	
	06h	AI input PV 6	I16	ro	indefinite	
	07h	AI input PV 7	I16	ro	indefinite	
	08h	AI input PV 8	I16	ro	indefinite	
	09h	AI input PV 9	I16	ro	indefinite	
	0Ah	AI input PV 10	I16	ro	indefinite	

*1 When OD[61A1h,01h] is set, the same value is set from OD[61A1h,02h] to OD[61A1h,0Ah] automatically.

6.3 Change NMT Mode

The sensor unit changes its NMT mode, shown in Figure 6-4, upon receiving a request from the NMT producer.
NMT mode status is described by LED (green) pattern in Figure 6-4. The sensor unit performs measurement operation in operational mode and OD configuration in pre-operational mode. The main difference between operational mode and pre-operational mode is that TPDO output is only valid during operational mode. Some ODs do not permit modification in operational mode. Refer to Table 6-5 and OBJECT DICTIONARY for details.
The measurement operation is suspended in stop mode. During stop mode, all functions are suspended except the output of heartbeat message. Therefore, the host cannot access the OD during stop mode. The sensor measurement is active during operational mode only. The current NMT mode is reflected in the status parameter (St) of the heartbeat message.

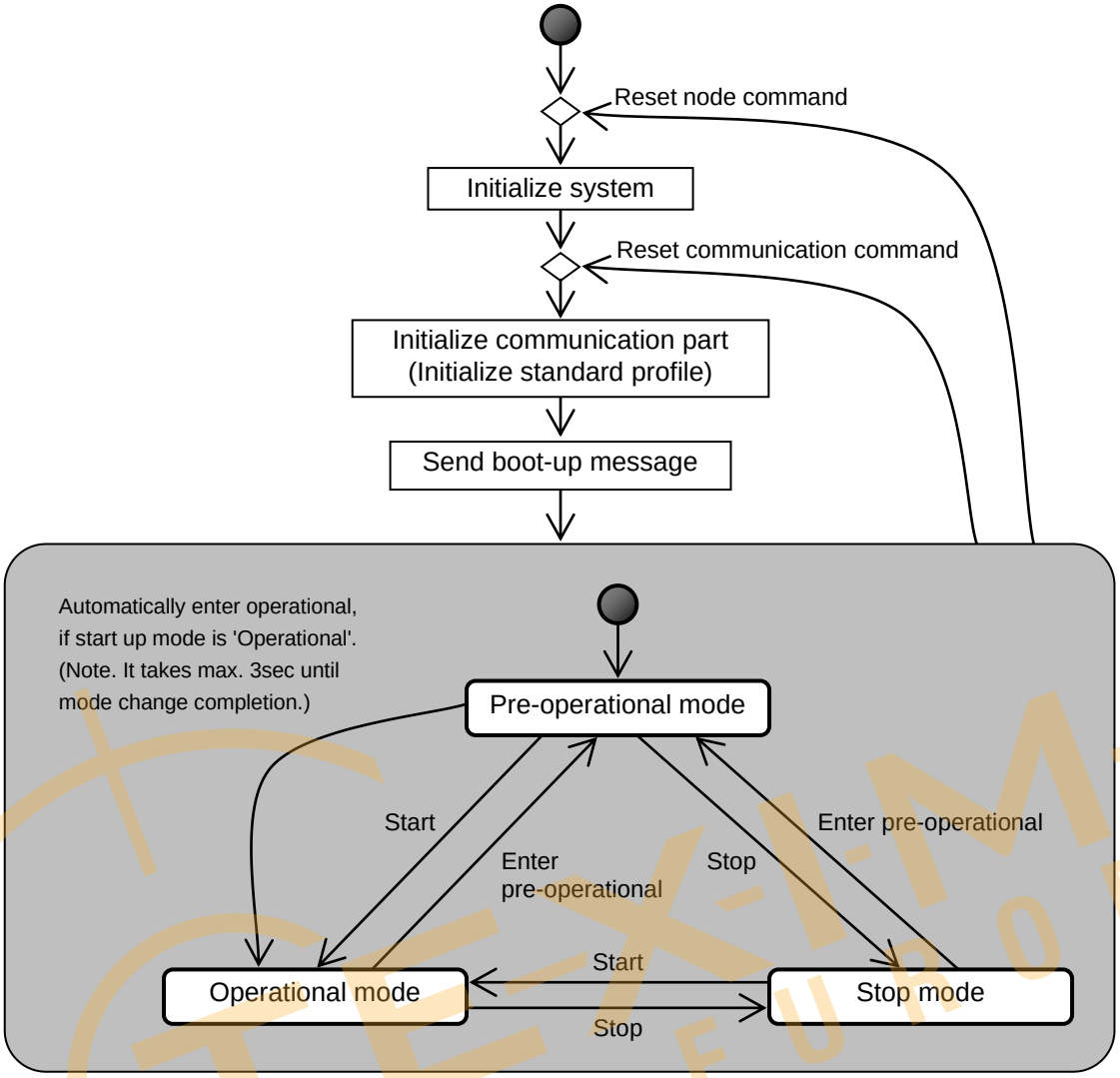


Figure 6-4 NMT State Change Diagram

The sensor unit sends the bootup message (heartbeat message (700h + NID) with status parameter 00h) when the initialization state is finished, and the unit enters pre-operational mode. In this state, the sensor unit is continuously sending the bootup message until any other CAN node on the network sends back ACK. This unit can be configured to automatically enter operational mode after initialization by clearing the NMT startup mode OD [1F80h, 00h] bit2. In this case, it could take up to 4 seconds from when the power supply is applied until the unit completes the transition to operational mode.

The reset node command and the reset communication command can be used to reset this unit. The reset node command resets the entire system including software and hardware. The reset communication command resets the DS-301 OD (communication parameters).
The NMT messages for each NMT state command are shown in Figure 6-5. The host device can broadcast to all NMT consumers in the network by setting "00h" to the node-ID parameter (Id) of the NMT message.

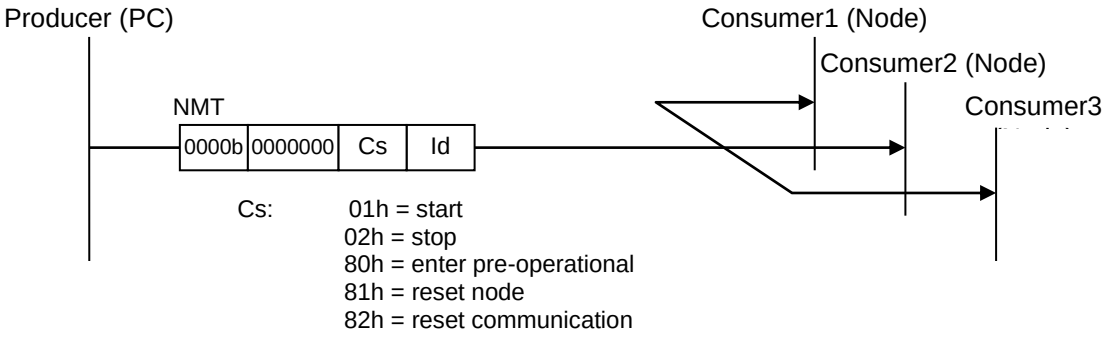


Figure 6-5 NMT Message

Table 6-5 Valid Function of Each NMT State

Function	Initialization	Pre-operational	Operational	Stop
Boot-up message	valid	-	-	-
TPDO producer	-	-	valid	-
SDO server	-	valid	valid	-
SYNC producer	-	valid	valid	-
TIME consumer	-	valid	valid	valid
HB producer	-	valid	valid	valid
Sensor			active	

6.3.1 Reset Node (81h)

Sensor unit is initialized in the same way as power reboot.

6.3.2 Reset Communication (82h)

Sensor unit initializes the following O.D. parameters.

- OD[1005h]sub[00h]
- OD[1006h]sub[00h]
- OD[1017h]sub[00h]
- OD[1019h]sub[00h]
- OD[180xh]sub[01h] / sub[02h]
- OD[1F80h]sub[00]

6.4 Measurement

During operational mode, this sensor unit sends TPDO messages whenever it receives a SYNC message or is triggered by a sensor sampling event. TPDO messages can only be sent during operational mode. This unit has two transmit modes as classified by the kind of trigger shown at Table 6-6 Transmit Mode

Transmit mode	Trigger	Operation
Synchronous mode	SYNC message	This unit sends TPDO periodically after the specified number of SYNCs.
Sampling mode	Sensor sampling event	This unit sends TPDO periodically with interval equal to sensor sampling event.

Table 6-6 Transmit Mode

Transmit mode	Trigger	Operation
Synchronous mode	SYNC message	This unit sends TPDO periodically after the specified number of SYNCs.
Sampling mode	Sensor sampling event	This unit sends TPDO periodically with interval equal to sensor sampling event.

6.4.1 Synchronous Mode

Synchronous mode is the mode used to send TPDO messages periodically after a specified number of SYNCs. A host can specify 1 to 240 as the value of SYNC period.
When Synchronous mode selected, the output data rate must be set to less than 500sps (more than minimum interval 2ms). Otherwise, the user may experience abnormal behavior.
A sample procedure for activating this mode is given below.

1. Enter pre-operational mode.
2. Disable TPDO1, TPDO2, TPDO3 and TPDO4.
   Write C000 0180h + NID to TPDO1 COB-ID OD [1800h, 01h].
   Write C000 0280h + NID to TPDO2 COB-ID OD [1801h, 01h].
   Write C000 0380h + NID to TPDO3 COB-ID OD [1802h, 01h].
   Write C000 0480h + NID to TPDO4 COB-ID OD [1803h, 01h].
3. Set counter overflow value
   Write 00h to Synchronous counter overflow value OD [1019h,00h].
   Refer to 6.15 Application of Synchronous Counter in case of setting value of 02h-F0h.
4. Set to synchronous mode
   Write desired value for SYNC period (1 to 240) to TPDO1 transmission type OD [1801h, 02h].
   The same value is set to TPDO2/3/4 transmission type OD [180x, 02h].
5. Apply OD[2005h,00h] settings.
   Write x1h to OD[2005h,00h] to Apply parameters. (This takes several seconds to complete.)
6. Set Internal Filter
   Write value to AI filter tap constant1 OD[61A1h, 01h].
7. Enable TPDO (ex. TPDO1/2/4 on)
   Write 4000 0180h+NID to TPDO1 COB-ID OD[1800h,01h].
   Write 4000 0280h+NID to TPDO2 COB-ID OD[1801h,01h].
   Write 4000 0480h+NID to TPDO4 COB-ID OD[1803h,01h].
8. After the sensor unit has been set to operational mode, TPDOs will be sent when the specified number of SYNCs are received.

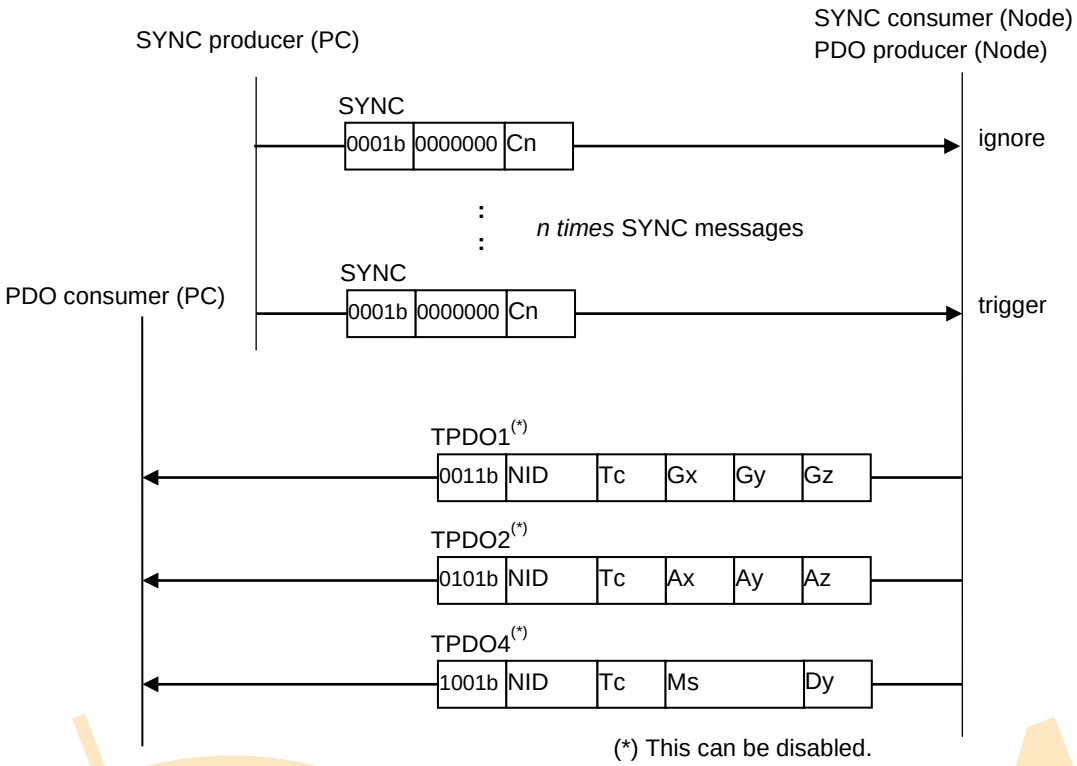


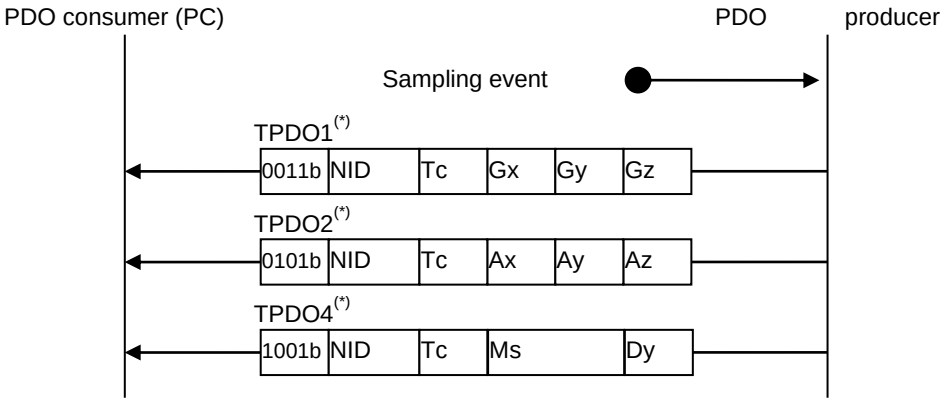
Figure 6-6 Synchronous Mode Sequence

If the sensor unit operates as SYNC consumer and the synchronous counter overflow value OD [1019h, 00h] has a value of 00h, the counter parameter (Cn) inside the SYNC message is ignored. In this case, the sensor unit determines when to send a TPDO message by updating an internal counter for each received SYNC message.

6.4.2 Sampling Mode

The Sampling mode is the mode used to send TPDO message periodically with interval equal to sensor sampling event timer. A sample procedure for activating this mode is given below.

1. Enter pre-operational mode.
2. Disable TPDO1, TPDO2, TPDO3 and TPDO4.
   Write C000 0180h+NID to TPDO1 COB-ID OD [1800h,01h].
   Write C000 0280h+NID to TPDO2 COB-ID OD [1801h,01h].
   Write C000 0380h+NID to TPDO3 COB-ID OD [1802h,01h].
   Write C000 0480h+NID to TPDO4 COB-ID OD [1803h,01h].
3. Set to Sampling mode.
   Write “FEh” to TPDO1 transmission type OD [1800h,02h].
   (The same value is set to TPDO2/4 transmission type OD [180x, 02h].)
4. Apply OD[2005h,00h] settings.
   Write x1h to OD[2005h,00h] to Apply parameters. (This takes several seconds to complete.)
5. Set the timer interval.
   Write interval timer value to Timer interval OD [2001h,00h].
6. Set Internal Filter
   Write valure to AI filter tap constant1 OD [61A1h,01h] settings.
7. Enable TPDO
   Write 4000 0180h+NID to TPDO1 COB-ID OD [1800h,01h].
   Write 4000 0280h+NID to TPDO2 COB-ID OD [1801h,01h].
   Write 4000 0480h+NID to TPDO4 COB-ID OD [1803h,01h].
8. After the sensor unit has been set to operational mode, TPDOs will be sent by timer event trigger.



(*) This can be disabled.

Figure 6-7 Sampling Mode Sequence

6.5 Measurement Value

The accelerometer axes are defined as is shown in Figure 6-8 and the gyroscope axes follows the right-hand rule. The list of measurement values are shown in Table 6-7 Measurement Value

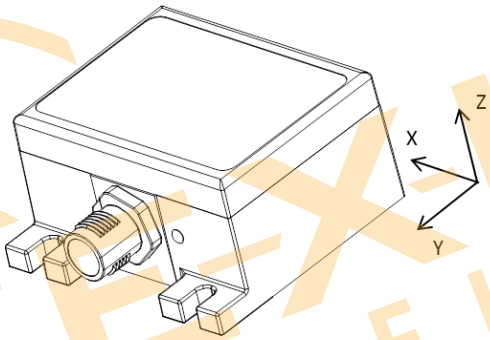


Figure 6-8 Definition of Axes

Table 6-7 Measurement Value

Name	Code	OD Mapping	Sensor Type	Data Type	Resolution
Angular velocity (x)	Gx	OD[7130h,01h]	gyroscope	INTEGER16	0.01515[dps/LSB]
Angular velocity (y)	Gy	OD[7130h,02h]			
Angular velocity (z)	Gz	OD[7130h,03h]			
Acceleration (x)	Ax	OD[7130h,04h]	accelerometer	INTEGER16	0.4[mG/LSB]
Acceleration (y)	Ay	OD[7130h,05h]			
Acceleration (z)	Az	OD[7130h,06h]			
Attitude 1(Roll)	ANG1	OD[7130h,08h]	attitude	INTEGER16	0.00012207 rad/LSB
Attitude2(Pitch)	ANG2	OD[7130h,09h]			0.00699411 rad/LSB
Temperature	Te	OD[7130h,07h]	temperature	INTEGER16	T[°C] = -0.0037918 * (Te - 2634) + 25
Time of day	Dy	OD[2101h,01h]	time stamp	UNSIGNED16	days (the Gregorian calendar)
Time difference	Ms	OD[2101h,02h]		UNSIGNED32	msec (from 0:00am)
Trigger counter	Tc	OD[2100h,00h]	counter	UNSIGNED16	count

6.6 Trigger Counter

The Trigger counter value contains an unsigned integer value that increments by 1 from 0 to 65535 (= 0xFFFF). After 65535, the sampling count returns to 0. The same trigger counter value is entered in each TPDO message at the same time, so it is possible to time correlate the sample data.

6.7 Filter

This device contains built-in user configurable digital filters that are applied to the sensor data. The type of filter (moving average filter or FIR Kaiser filter), numbers of TAPs, and related filter cutoff frequency (if applicable) can be set with in AI filter Setting constant 1 (OD [61A1h, 01h]).

(1) Moving Average Filter:

TAP setting can be N= 2, 4, 8, 16, 32, 64, or 128.
Below shows the characteristics of this filter.

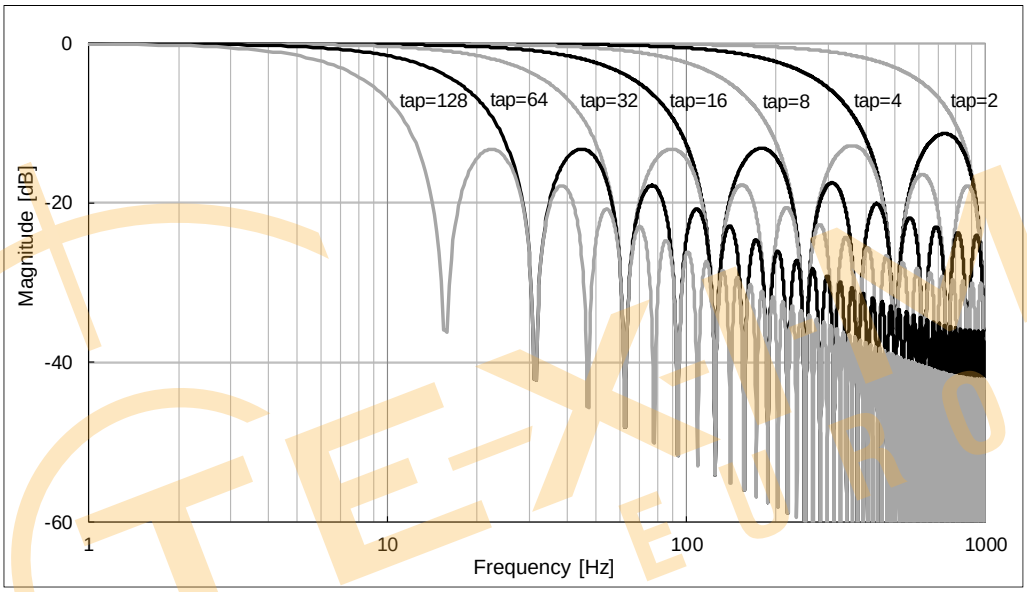


Figure 6-9 Moving Average Filter Characteristics

Since the number of filter taps to select for moving average is based on the sensor internal sampling rate of 2000 sps, it is recommended to set it based on the following formula according to the sampling theorem.

Recommended moving average tap number >= Internal sampling rate／Data output rate

(2) FIR Kaiser filter:

Uses Kaiser Window(parameter=8)

TAP setting can be N= 32, 64, or 128 with cutoff frequency fc= 50, 100, 200, or 400Hz.

Belows show the typical characteristic of this filter.

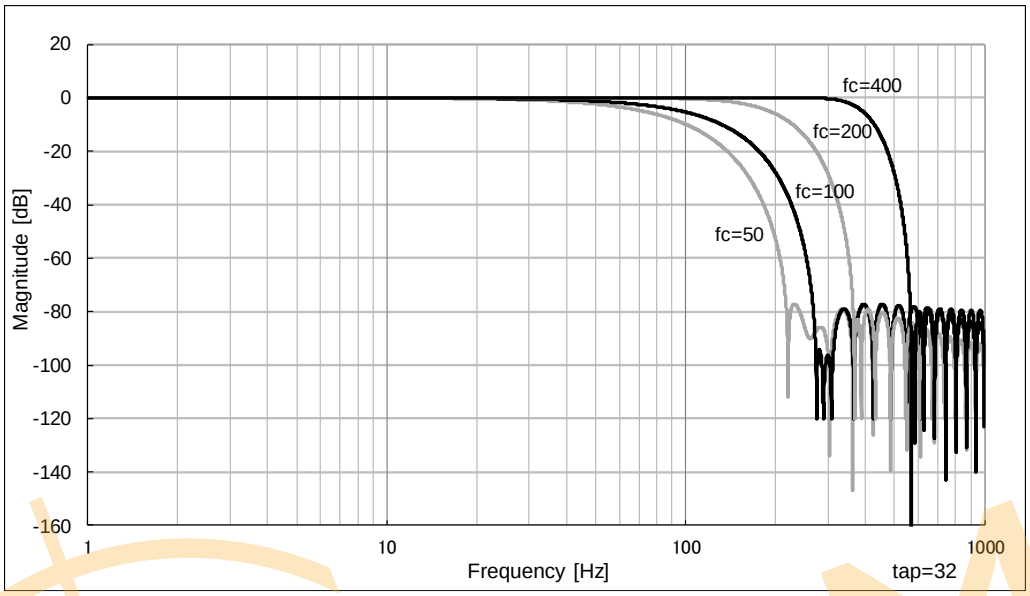


Figure 6-10 FIR Kaiser Filter Typical Characteristic 1

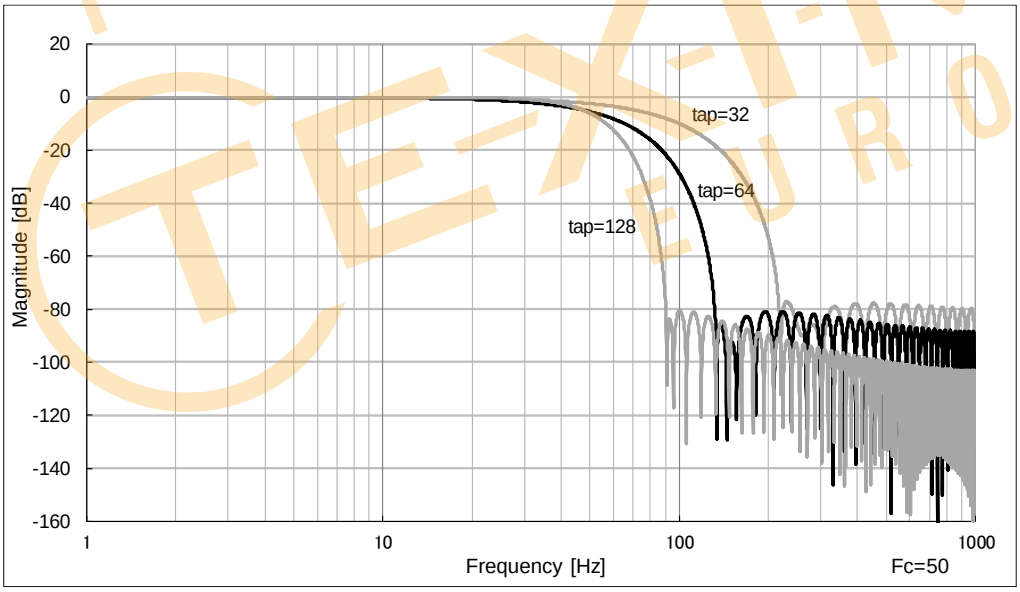


Figure 6-11 FIR Kaiser Filter Typical Characteristic 2

Please note that the transient response of the digital filter is a maximum of 63 samples from the sampling start time and varies depending on the output data rate and the filter tap setting. Refer to Table 6-8 Transient Response in Number of Samples Based on Output Data Rate vs Filter Tap which describes the transient response in terms of number of samples for the combinations of output data rate and filter tap setting.

Table 6-8 Transient Response in Number of Samples Based on Output Data Rate vs Filter Tap

	TAP2	TAP4	TAP8	TAP16	TAP32	TAP64	TAP128
1000sps	0	1	3	7	15	31	63
500sps		0	1	3	7	15	31
400sps			1	3	6	12	25
250sps			0	1	3	7	15
200sps				1	3	6	12
125sps				0	1	3	7
100sps					1	3	6
80sps					1	2	5
62.5sps					0	1	3
50sps						1	3
40sps						1	2
31.25sps						0	1
25sps							1
20sps							1
15.625sps							0

Table 6-9 Valid Combinations of Output Rate Settings and Filter Setting (Attitude Output Mode)

			Attitude Angle Output Enable							
			200	125	100	80	62.5	50	40	31.25
Filter Setting	Moving Average Filter*2	tap=2								
		tap=4								
		tap=8								
		tap=16	**OK**	**OK**						
		tap=32	OK	OK	**OK**	**OK**	**OK**			
		tap=64	OK	OK	OK	OK	OK	**OK**	**OK**	**OK**
		tap=128								
	FIR Kaiser Filter	tap=32, fc=50Hz	OK	OK	OK					
		tap=32, fc=100Hz	OK							
		tap=32, fc=200Hz								
		tap=32, fc=400Hz								
		tap=64, fc=50Hz	OK	OK	OK					
		tap=64, fc=100Hz	OK							
		tap=64, fc=200Hz								
		tap=64, fc=400Hz								
		tap=128, fc=50Hz								
		tap=128, fc=100Hz								
		tap=128, fc=200Hz								
		tap=128, fc=400Hz								

*1. Bold indicates the filter compulsory setting value immediately after setting the sampling rate.
*2. The sampling rate is based on 2000sps.

Table 6-10 Valid combinations of output rate settings and filter setting (6dof outputmode)

			Attitude Angle Output Disable														
			1000	500	400	250	200	125	100	80	62.5	50	40	31.25	25	20	15.625
Filter Setting	Moving Average Filter*2	tap=2	**OK**														
		tap=4	OK	**OK**													
		tap=8	OK	OK	**OK**	**OK**											
		tap=16	OK	OK	OK	OK	**OK**	**OK**									
		tap=32	OK	OK	OK	OK	OK	OK	**OK**	**OK**	**OK**						
		tap=64	OK	OK	OK	OK	OK	OK	OK	OK	OK	**OK**	**OK**	**OK**			
		tap=128	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	**OK**	**OK**	**OK**
	FIR Kaiser Filter	tap=32, fc=50Hz	OK	OK	OK	OK	OK	OK	OK								
		tap=32, fc=100Hz	OK	OK	OK	OK	OK										
		tap=32, fc=200Hz	OK	OK	OK												
		tap=32, fc=400Hz	OK														
		tap=64, fc=50Hz	OK	OK	OK	OK	OK	OK	OK								
		tap=64, fc=100Hz	OK	OK	OK	OK	OK										
		tap=64, fc=200Hz	OK	OK	OK												
		tap=64, fc=400Hz	OK														
		tap=128, fc=50Hz	OK	OK	OK	OK	OK	OK	OK								
		tap=128, fc=100Hz	OK	OK	OK	OK	OK										
		tap=128, fc=200Hz	OK	OK	OK												
		tap=128, fc=400Hz	OK														

*1. Bold indicates the filter compulsory setting value immediately after setting the sampling rate.
*2. The sampling rate is based on 2000sps.

6.8 Reference Attitude

The reference attitude can be changed by writing OD value to [OD2020h,02h] in Pre-operational mode.

Refer to A.2.2.6 Attitude axis conversion or Table 6-11 Reference Attitude Settings for details on the setting method.

Table 6-11 Reference Attitude Settings

OD Value	Attitude(*1)				Euler Mode(*2)		Inclination Mode(*3)	
	Name	Front Axis	Left Axis	Up Axis	ANG1 (Roll)	ANG2 (Pitch)	ANG1	ANG2
0x00	a	X	Y	Z	X	Y	X	Y
0x01	b	X	Z	-Y	X	Z	X	Z
0x02	c	X	-Y	-Z	X	-Y	X	-Y
0x03	d	X	-Z	Y	X	-Z	X	-Z
0x04	e	Y	Z	X	Y	Z	Y	Z
0x05	f	Y	X	-Z	Y	X	Y	X
0x06	g	Y	-Z	-X	Y	-Z	Y	-Z
0x07	h	Y	-X	Z	Y	-X	Y	-X
0x08	i	Z	X	Y	Z	X	Z	X
0x09	j	Z	Y	-X	Z	Y	Z	Y
0x0A	k	Z	-X	-Y	Z	-X	Z	-X
0x0B	l	Z	-Y	X	Z	-Y	Z	-Y
0x0C	m	-X	Y	-Z	-X	Y	-X	Y
0x0D	n	-X	-Z	-Y	-X	-Z	-X	-Z
0x0E	o	-X	-Y	Z	-X	-Y	-X	-Y
0x0F	p	-X	Z	Y	-X	Z	-X	Z
0x10	q	-Y	Z	-X	-Y	Z	-Y	Z
0x11	r	-Y	-X	-Z	-Y	-X	-Y	-X
0x12	s	-Y	-Z	X	-Y	-Z	-Y	-Z
0x13	t	-Y	X	Z	-Y	X	-Y	X
0x14	u	-Z	X	-Y	-Z	X	-Z	X
0x15	v	-Z	-Y	-X	-Z	-Y	-Z	-Y
0x16	w	-Z	-X	Y	-Z	-X	-Z	-X
0x17	x	-Z	Y	X	-Z	Y	-Z	Y

(*1) Direction of X, Y, and Z are marked on the casing of this device.
(*2) Euler angle output indicates the angle to rotate about each axis center in the order of ANG 1 (Roll) and ANG 2 (Pitch). The direction of rotation (+) is the right-hand screw direction.
(*3) Inclination angle output indicates the minimum angle that each axis makes with the horizontal plane.

6.9 Attitude Motion Profile Selection

The attitude motion profile can be changed by writing OD value to [OD2020h,03h] in Pre-operational mode. Refer to A.2.2.7 Attitude motion profile for details.

Optimal angle accuracy can be achieved by setting according to the operating speed of the application. It is strongly recommended to evaluate all motion profiles to determine optimal setting.

Table 6-12 Attitude Motion Profile Setting

OD value	Estimated Operating Speed	Application Example
0x0: mode A	3m/s	General purpose (no specific application is expected)
0x1: mode B	20m/s	Vehicle
0x2: mode C	1m/s	Construction machinery

6.10 Inclination Angles

To enable inclination angle output, configure the following OD setting in Pre-operational mode, then shift to the Operational mode.

- Write 00h to [OD2020h,01h]

Refer to A.2.2.5 Attitude control for details.

The inclination angle data are transmitted periodically as TPDO3 messages.

The inclination angle output shows the minimum angle that each axis makes with the horizontal plane.

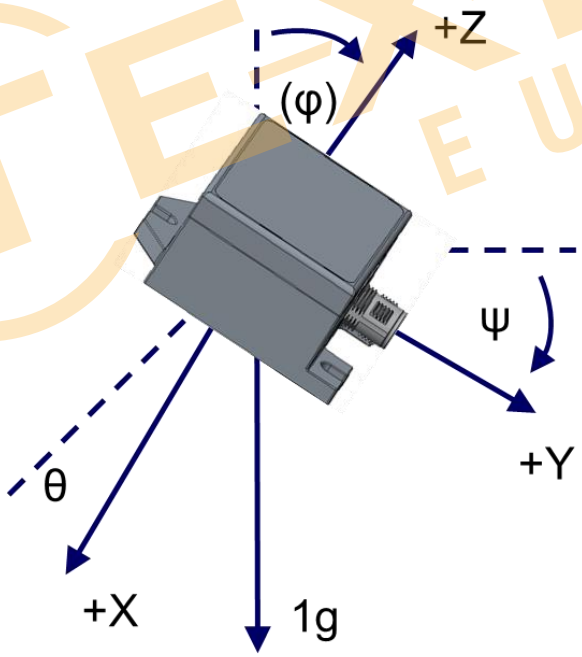


Figure 6-12 Inclination Angle

θ :ANG1[15:0] Attitude angle data 1

Ψ :ANG2[15:0] Attitude angle data 2

6.11 Euler Angles

To enable euler angle output, configure the following OD setting in Pre-operational mode, then shift to the Operational mode.

- Write 01h to [OD2020h,01h]

Refer to A.2.2.5 Attitude control for details.

The Euler angle data are transmitted periodically as TPDO3 messages.

Euler angle output indicates the angle to rotate about each axis center in the order of ANG 1 (Roll) and ANG 2 (Pitch). The direction of rotation (+) is the right-hand screw direction.

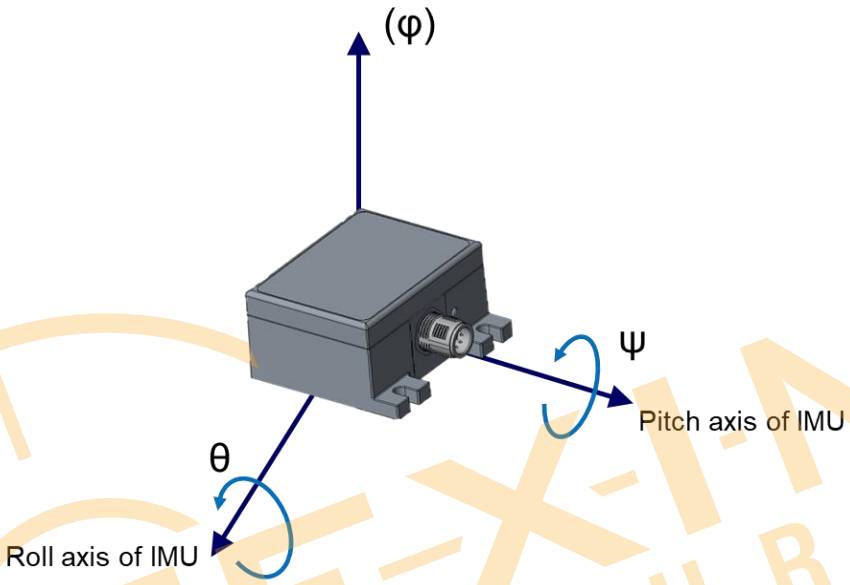


Figure 6-13 Euler Angles

θ : ANG1[15:0] Attitude angle data 1

Ψ : ANG2[15:0] Attitude angle data 2

6.12 Time Setting

The internal timer in this sensor unit is initialized by the host sending a time message. If there are several time stamp consumers in the bus, the time message will set the internal timer of all nodes in the bus.
The time is represented as days since January 1 1984 (readable from OD [2101h, 01h]) and milliseconds since 0:00 midnight (readable from OD [2101h, 02h]). The OD must not be read from until at least 3 milli-seconds have elapsed since the last time message has been sent. The sensor unit can accept a time message during pre-operational and operational modes. However, it is recommended that the time message be sent to a node in pre-operational mode to prevent delays in setting the internal timer of the unit.
Do not set a value equal to or larger than 86400000msec (one day maximum) to the milliseconds parameter (Ms) of the time message. The valid values for days parameter (Dy) is 0 to 65535.

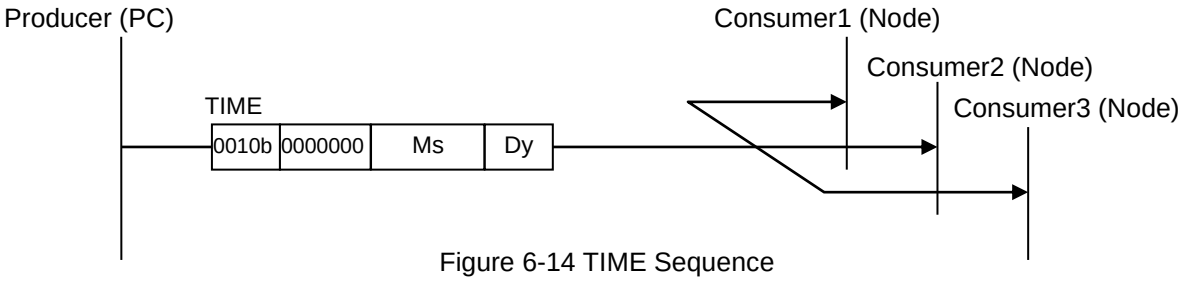


Figure 6-14 TIME Sequence

Table 6-13 Time Information Format

Item	Bit field	Content	Value	Comment
Ms	bit3-0	reserved	(fixed 0)	
	bit31-4	Milli-second from 0:00am	0 to 86399999	Local time
Dy	bit15-0	Days from 1.Jan,1984	0 to 65535	Gregorian calendar

6.13 Heartbeat

If enabled, the sensor unit can send a periodic heartbeat message indicating its status. The HB consumer uses this message to check the state of a sensor unit. HB consumer can detect abnormality of sensor unit and its communication. This unit operates as HB producer only.

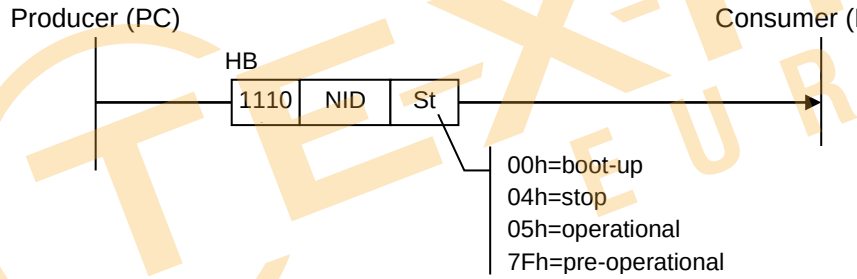


Figure 6-15 HB Sequence

The period of the heartbeat message is specified by the value of producer heartbeat time OD [1017h]. If this OD is set to 00h, HB message is disabled. By default, this message is disabled. The sensor unit sends one heartbeat message as a bootup message after initialization is complete, regardless of the value specified in OD [1017h, 00h]. There is no way to disable the bootup message output.

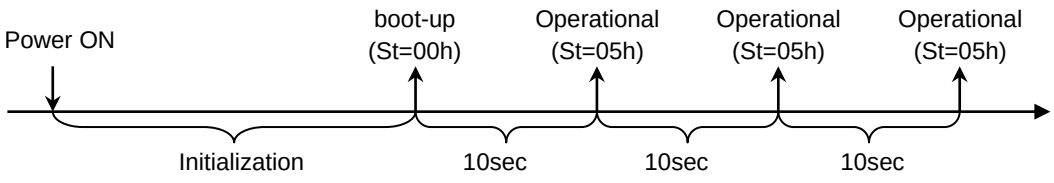


Figure 6-16 HB Operation Example

6.14 Sync Producer

The sensor unit can be configured to transmit a periodic SYNC message by enabling the SYNC producer function. By using this function, other SYNC consumers can be synchronized to transmit TPDOs simultaneously. This unit can also send TPDO messages after receiving its' own SYNC message.

A sample procedure for activating this mode is given below.

1. Disable SYNC producer.
   Write 0000 0080h to SYNC COB-ID OD [1005h, 00h].
   Write 0000 0000h to Communication cycle period OD [1006h, 00h].
2. Set SYNC counter overflow value. (Note: This step is optional.)
   Write desired value (00h or 02h to F0h) to synchronous counter overflow value OD [1019h, 00h].
   If this OD is set to 00h, the SYNC counter function is disabled, and the SYNC message does not contain a SYNC counter parameter (Cn).
   Refer to 6.15 Application of Synchronous Counter in case of setting value of 02h-F0h.
3. Set SYNC period value.
   Write desired value in units of microseconds (0000 0000h to FFFF FFFFh) to communication cycle period OD [1006h, 00h]. Values written to this OD are automatically rounded down to milliseconds; therefore, the write value must be a multiple of 1000. If this OD is set to 0000 0000h, the sensor unit will not send SYNC messages.
4. Enable SYNC producer. SYNC message will be sent periodically.
   Write 4000 0080h to SYNC COB-ID OD [1005h, 00h].

If the sensor unit operates as SYNC producer and the SYNC counter overflow value OD [1019h, 00h] has a value of 02h to F0h, the SYNC message transmitted by the unit will contain a counter parameter (Cn). The counter starts from 1 and increments by 1 after each SYNC message. When the counter reaches the overflow value, on the next SYNC message the counter returns to 1.

(ex) Synchronous counter overflow value is 3.

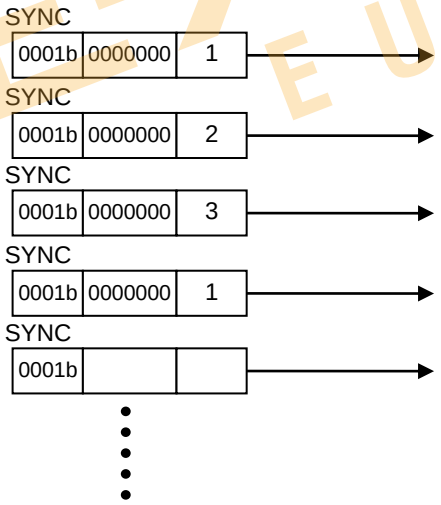


Figure 6-17 SYNC Counter Overflow Example

6.15 Application of Synchronous Counter

This section describes the application with SYNC counter in the synchronous mode.

Ex1. TPDO output once every three times SYNC message

TPDO is output according to the number of receptions of SYNC messages. And it does not depend on the presence of the counter value of the SYNC counter.
A sample procedure for this mode is given below.

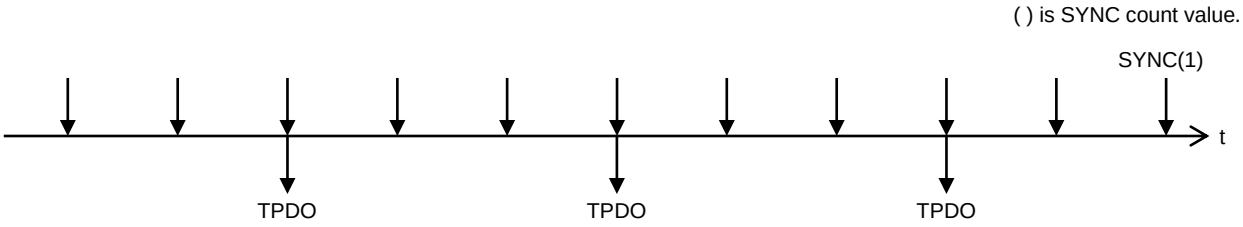


Figure 6-18 TPDO Output Once Every Three SYNC Messages

1. Enter pre-operational mode.
2. Disable TPDO1, TPDO2, TPDO3 and TPDO4.
   Write C000 0180h + NID to TPDO1 COB-ID OD [1800h, 01h].
   Write C000 0280h + NID to TPDO2 COB-ID OD [1801h, 01h].
   Write C000 0380h + NID to TPDO3 COB-ID OD [1802h, 01h].
   Write C000 0480h + NID to TPDO4 COB-ID OD [1803h, 01h].
3. Disable SYNC producer.
4. Set SYNC counter overflow value.
   Write 00h to synchronous counter overflow value OD [1019h, 00h].
5. Set SYNC period value.
   Write desired value in units of microseconds (0000 0000h to FFFF FFFFh) to communication cycle period OD [1006h, 00h]. Values written to this OD are automatically rounded down to milliseconds; therefore, the write value must be a multiple of 1000. If this OD is set to 0000 0000h, the sensor unit will not send SYNC messages.

   The following 6 to 7 steps refer to TPDOn where (n = 1, 2, 3).

6. Set to synchronous mode (SYNC period value set to 3 for example).
   Write 03h for SYNC period (1 to 240) to TPDO1 transmission type OD [1800h, 02h].
   The same value is set to TPDO2/3/4 transmission type OD [180x, 02h].
7. Enable TPDOn.
   Write 4000 0180h+NID to TPDO1 COB-ID OD [1800h,01h]
   Write 4000 0280h+NID to TPDO2 COB-ID OD [1801h,01h]
   Write 4000 0380h+NID to TPDO3 COB-ID OD [1802h,01h]
8. Enter operational mode.
9. Enable SYNC producer. SYNC message will be sent periodically.

Ex2. TPDO output once when SYNC counter is multiple of three

TPDO is output when the SYNC counter value of the SYNC message becomes the multiple of n. The SYNC counter must be included in the SYNC message.
A sample procedure for this mode is given below, in this case, the synchronous counter overflow value is set to 5, and the SYNC period value is set to 3.

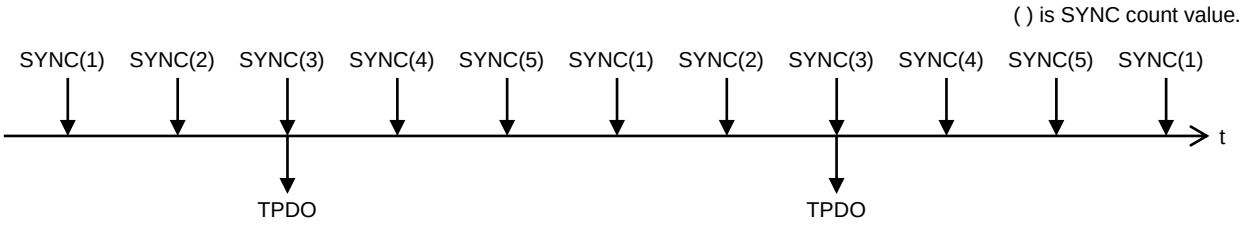


Figure 6-19 TPDO Output Once When SYNC Counter is Multiple of Three

1. Enter pre-operational mode.
2. Disable TPDO1, TPDO2, TPDO3 and TPDO4.
   Write C000 0180h + NID to TPDO1 COB-ID OD [1800h, 01h].
   Write C000 0280h + NID to TPDO2 COB-ID OD [1801h, 01h].
   Write C000 0380h + NID to TPDO3 COB-ID OD [1802h, 01h].
   Write C000 0480h + NID to TPDO3 COB-ID OD [1803h, 01h].
3. Disable SYNC producer.
   Set SYNC counter overflow value.
   Write 05h to synchronous counter overflow value OD [1019h, 00h].
4. Set SYNC period value.
5. Write desired value in units of microseconds (0000 0000h to FFFF FFFFh) to communication cycle period OD [1006h, 00h]. Values written to this OD are automatically rounded down to milliseconds; therefore, the write value must be a multiple of 1000. If this OD is set to 0000 0000h, the sensor unit will not send SYNC messages.
6. Set to synchronous mode (SYNC period value set to 3 for example).
   Write 03h for SYNC period (1 to 240) to TPDO1 transmission type OD [1800h, 02h].
   The same value is set to TPDO2/3/4 transmission type OD [180x, 02h].
7. Enable TPDOn.
   Write 4000 0180h+NID to TPDO1 COB-ID OD [1800h,01h]
   Write 4000 0280h+NID to TPDO2 COB-ID OD [1801h,01h]
   Write 4000 0380h+NID to TPDO3 COB-ID OD [1802h,01h]
8. Enter operational mode.
9. Enable SYNC producer. SYNC message will be sent periodically.

6.16 Auto Output Setting

This section describes the Auto output setting, which enables the sensor unit to send measurement data output immediately after boot-up and initialization.

A sample procedure for this mode is given below.

1. Enter pre-operational mode.
2. Disable TPDO1, TPDO2, TPDO3 and TPDO4.
   Write C000 0180h + NID to TPDO1 COB-ID OD [1800h, 01h].
   Write C000 0280h + NID to TPDO2 COB-ID OD [1801h, 01h].
   Write C000 0380h + NID to TPDO3 COB-ID OD [1802h, 01h].
   Write C000 0480h + NID to TPDO4 COB-ID OD [1803h, 01h].
3. Set to sampling mode.
   Write FEh to TPDO1 transmission type OD [1800h, 02h].
   (The same value is set to TPDO2/3/4 transmission type OD [180x, 02h].)
4. Set the timer intervals.
   Write interval timer value to Timer interval OD [2001h,00h].
5. Set Internal Filter
   Write value to AI filter tap constant 1 OD [61A1h, 01h].

6. Enable TPDO.
   Write 4000 0180h+NID to TPDO1 COB-ID OD [1800h,01h]
   Write 4000 0280h+NID to TPDO2 COB-ID OD [1801h,01h]
   Write 4000 0380h+NID to TPDO3 COB-ID OD [1802h,01h]
   Write 4000 0480h+NID to TPDO3 COB-ID OD [1803h,01h]
7. Set NMT startup mode to Operational
   Write 0000 0008h to NMT startup mode OD[1F80h,00h].
8. Save OD settings to non-volatile memory
   Write 6576 6173h to Save all parameters OD [1010h,01h].
   During the saving process, do not power off the device before completion (Otherwise non-volatile memory can be corrupted).
9. Power off after 3 seconds has elapsed.

6.17 CAN Node Setting

This section describes the node setting, which changes the node-ID and CAN bitrate of the sensor unit. Only one node should be connected so that the node-ID does not overlap.

1. Enter pre-operational mode.
2. Set node-ID and CAN bitrate.
   Write value of 0 -127 as node-ID to CAN node-ID OD [2000h,01h].
   Write following value to CAN bitrate OD [2000h,02h].

00h=1Mbps	01h=800kbps	02h=500kbps
03h=250kbps	04h=125kbps	05h=50kbps
06h=20kbps	07h=10kbps	

3. Save OD settings to non-volatile memory
   Write 65766173h to Save all parameters OD [1010h,01h].
   During the saving process, do not power off the device before completion (Otherwise non-volatile memory can be corrupted).
4. Power off after 3 seconds has elapsed.

6.18 Sensor Setting

This section describes the sensor setting which is used to change the sampling rate and filter setting.
The recommended value of filter tap when using the moving average filter is 2000 divided by the sensor sample rate. If FIR Kaiser filter is desired, ensure the selected cutoff frequency (fc) is ½ or lower than the sample rate setting in Sensor Sample Rate OD[2001h,00h].

1. Enter pre-operational mode.
2. Set Sensor sample rate and filter setting.
   Write following value to Sensor sample rate OD[2001h,00h].

01h = 1000sps	02h = 500sps	03h = 250sps
04h = 125sps	05h = 62.5sps	06h = 31.25sps
07h = 15.625sps	08h = 400sps	09h = 200sps
0Ah = 100sps	0Bh = 80sps	0Ch = 50sps
0Dh = 40sps	0Eh = 25sps	0Fh = 20sps

   Write following value to AI filter setting constant 1 OD[61A1h,01h].

01h = tap 2	02h = tap 4	03h = tap 8
04h = tap 16	05h = tap 32	06h = tap 64
07h = tap 128		
08h = FIR Kaiser tap 32 fc=50 Hz		
09h = FIR Kaiser tap 32 fc=100 Hz		
0Ah = FIR Kaiser tap 32 fc=200 Hz		

0Bh = FIR Kaiser tap 32 fc=400 Hz
0Ch = FIR Kaiser tap 64 fc=50 Hz
0Dh = FIR Kaiser tap 64 fc=100 Hz
0Eh = FIR Kaiser tap 64 fc=200 Hz
0Fh = FIR Kaiser tap 64 fc=400 Hz
10h = FIR Kaiser tap 128 fc=50 Hz
11h = FIR Kaiser tap 128 fc=100 Hz
12h = FIR Kaiser tap 128 fc=200 Hz
13h = FIR Kaiser tap 128 fc=400 Hz
Other settings=reserved

These changes are effective immediately and can also be saved to non-volatile memory.

6.19 Bus Status & LED Indicator

Bus status and error mode of the unit is defined as shown in Table 6-14 Bus / Error Status. The bus status depends on the frequency of a bus error (send error or receive error).
NOTE: During system boot-up, the bus status does not change to the bus-off, regardless of the frequency of bus error occurrence.

Table 6-14 Bus / Error Status

Bus/Error Status	Descriptions	LED(RED)	Comment
Bus Normal	Normal condition or the error rate is low	Off	The unit is working properly.
Bus Heavy	The error rate on the bus is high.	Single flash ON for 200msec OFF for 1000msec	This is a warning state. The unit is still working.
Boot-up Message Error	The host device is not working during boot-up.		The host device on the bus should be checked.
Bus Off	Critical failure on the bus.	On	The bus has a serious condition and the unit has stopped normal operation. To recover Bus off, the Bus off release procedure or a reboot of the system is necessary.
Parameter Memory Checksum Error	The parameter data saved in non-volatile memory is incorrect.	Blink ON for 200msec OFF for 200msec	The most recent save parameter operation failed and must be saved again. After successful save parameter operation, reboot the system.

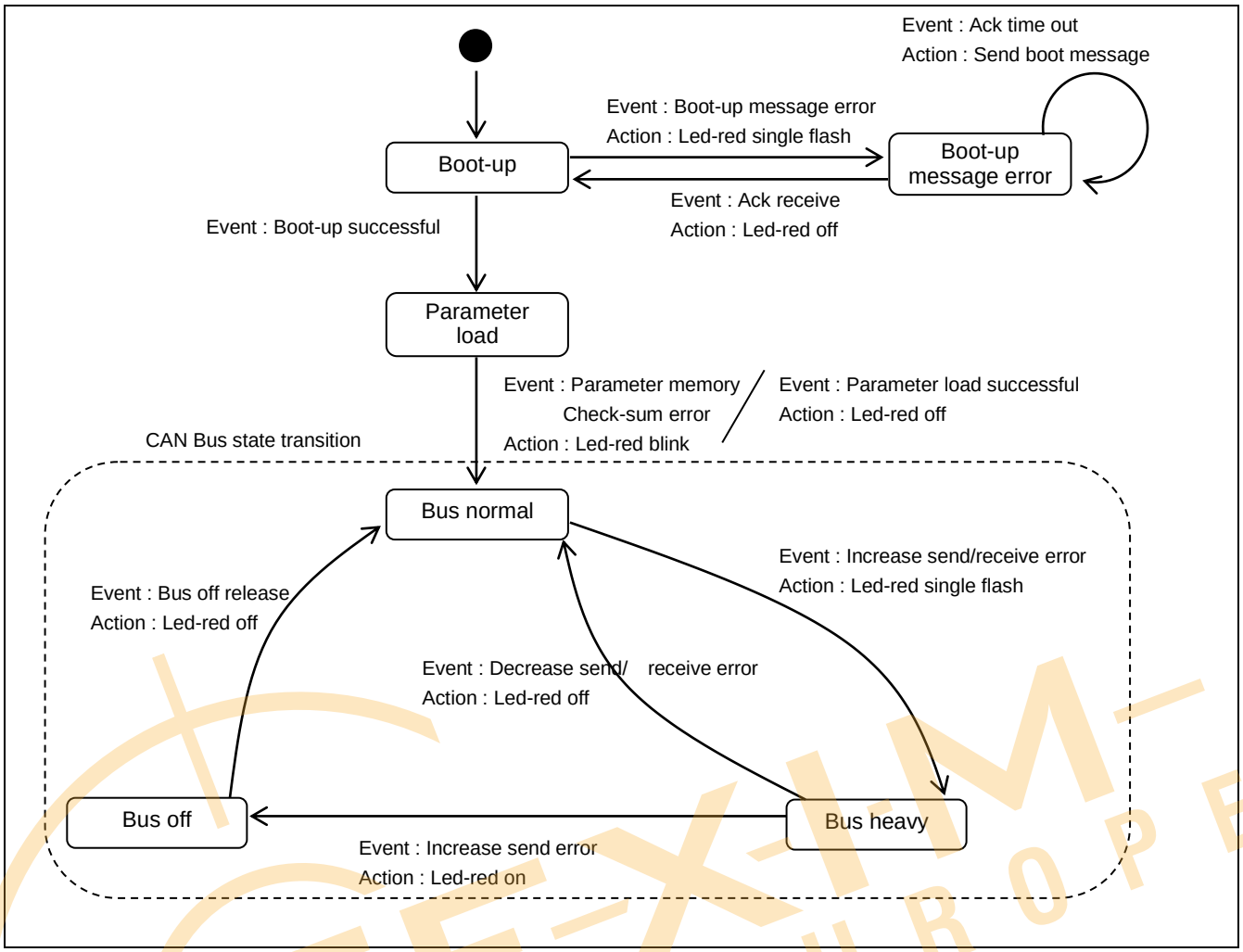


Figure 6-20 CAN Bus State Transition Diagram

During Bus-off state, the unit enters a special mode where message transmission is prohibited.
The unit can still receive NMT commands during Bus-off state.

There are two possible procedures to recover from Bus-off state as given below.

- Power off and Power on of the unit, or
- Send the reset node command or reset communication command after receiving of the 11-bit recessive signal 129 times (Normally, except for master device on the network, no other node should be transmitting any message on the bus during this period).

The protocol used for LED indicators is a slightly modified version of the CANopen specification as described in CiA DS-303-3. When the green LED and the red LED are ON, the indicator looks orange, because of the bi-color LED.

Table 6-15 Run LED Status

Status	Run LED (green)	Comment
Initialization	Off	
Pre-operational	Blinking	ON for 200msec, OFF for 200msec
Operational	On	
Stopped	Single flash	ON for 200msec, OFF for 1000msec

7. HANDLING NOTES

7.1 CAUTIONS FOR ATTACHING

- The product contains quartz crystal oscillator created by microfabrication. Take precaution to prevent falling or excessive impact. Do not use the product after an accidental fall or it experiences excessive impact. The possibility of a failure and risk of malfunction from failure increases.
- Excessive vibration, shock, continuous stress, or sudden temperature change may increase the possibility of failure.
- The product should be kept powered on for more than 15 minutes to measure with highest precision and accuracy.
- Do not connect the product to a CAN bus network with the supply voltage turned on.
- When attaching the product, ensure that the product is properly mounted to avoid mechanical stress such as a warping or twisting. In addition, ensure appropriate torque is applied when tightening the screws but not too excessive to cause the mount of the product to deform or break. Use screw locking techniques as necessary.
- When setting up the product, ensure that the equipment, jigs, tools, and workers maintain a good ground in order not to generate high voltage discharge. Applying over current or static electricity to the product may damage the product permanently.
- When installing the product, ensure that metallic or other conductive material do not enter the product. Otherwise, malfunction or damage of the product may result.
- If excessive shock is applied to the product when, for example, the product falls, the quality of the product may be degraded. Ensure that the product does not fall when you handle it.
- Before you start using the product to obtain measurements, test it in the actual equipment under the actual operating environment to confirm proper operation.
- When connecting a cable to this product, tighten the screw enough after inserting it completely. This product may not satisfy IP67 if tightening is insufficient.
- Do not use the product in a situation where power is always applied to the joint of connector.
- Ensure that the signals are wired correctly with attention to the name and the polarity of each signal.
- Since the product has capacitors inside, inrush current occurs immediately after power-on. Evaluate in the actual environment in order to check the effect of the supply voltage sag caused by inrush current in the system.

7.2 OTHER CAUTIONS

- This product is water-proof and dust-proof in conformity with IP67. We do not guarantee the operation of the product when exposed to condensation, dust, oil, corrosive gas (salt, acid, alkaline, etc), or direct sunlight which surpass IP67. Do not use this product under water.
- Only use a connector that conforms with IP67. In case of improper or incomplete connection, water-proofness and dust-proofness is not guaranteed.
- This product is not designed to be radiation resistant.
- Never use this product if the operating condition is over the absolute maximum rating. Otherwise, permanent damage to the product may result.
- If the product is exposed to excessive external noise or other similar conditions, degradation of the precision, malfunction, or damage to the product may result. The system needs to be designed so that the noise itself is suppressed or the system is immune to the noise.
- This product is not designed to be used in equipment that demands extremely high reliability and where its failure may threaten human life or property (for example, aerospace equipment, submarine repeater, nuclear power control equipment, life support equipment, medical equipment, transportation control equipment, etc.). Seiko Epson Corporation will not be liable for any damages caused by the use of the product for those applications.

- Do not apply shock or vibration to the packing box. Do not spill water over the packing box. Do not store or use the product in an environment where dew condensation occurs due to rapid temperature change.
- Do not put mechanical stress on the product while it is stored.
- Do not alter or disassemble the product.
- Do not use in water except if it gets temporarily wet based on IP67. This product does not achieve the sufficient waterproof performance if the connector is mated incorrectly or if the mating connector does not satisfy IP67.
- The power supply to this product must satisfy the voltage rating within 2 seconds after it is turned on.
- Do not use thinner or similar liquids on this product. When cleaning this product, alcohol may be used.
- Total length of cables should be less than the maximum total length of cable defined in Table 5-1. It is recommended that the cable satisfy the CAN standard.

7.3 LIMITED WARRANTY

- The product warranty period is one year from the date of shipment.
- If a defect due to a quality failure of the product is found during the warranty period, we will promptly provide a replacement.

8. PART NUMBER / ORDERING INFO

Interface	Model	Order Code	Comment
CAN interface	M-G552PC10	X2G000121000400	-

Appendix1. MESSAGES

A.1.1 NMT message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
0000b	0000000b	2	Cs	Id						

Cs command specifier
01h = start
02h = stop
80h = enter pre-operational
81h = reset node
82h = reset communication
otherwise = reserved

Id consume node-ID
00h = all node
01h-7Fh = node-ID
otherwise = reserved

This message changes the state of the node specified by Id. If the reset node or reset communication command is specified by Cs, this message resets the node. If Id is 00h, this message affects all nodes in the network.
The sensor unit operates as NMT consumer only.

A.1.2 SYNC message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
0001b	0000000b	1	Cn							
		or								
		0								

Cn SYNC counter
01h-F0h = count value
otherwise = reserved

This message is used for the synchronized transmission of the PDO sequence. This message gives the measurement trigger to all SYNC consumers on the network. A SYNC consumer that receives a SYNC message returns measurement data as TPDO message. The SYNC message has an optional counter Cn which can be used by SYNC consumers that support this feature. SYNC messages which have no Cn will have DLC = 0.

The sensor unit can operate as a SYNC consumer or SYNC producer. When operating as a SYNC producer, the SYNC counter is optional and is enabled by OD [1019h, 00h].

A.1.3 TIME message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
0010b	0000000b	6	Ms				Dy			

Ms time difference
bit3-0: (fixed 0)
bit31-4: the progress milli-second from 0:00am(midnight)
Dy time of day
0000h-FFFFh = the progress days from 1.Jan,1984

This message sets the time synchronization for all timestamp consumers on the network. The sensor unit operates as timestamp consumer only. A recommendation is to send this message in pre-operational mode, to prevent delays in setting the internal timer of the unit. Do not set a value to bit31-4 (Ms) greater than or equal to 86400000msec (the maximum value of one day).

A.1.4 TPDO1 message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
0011b	Node-ID	8	Tc		Gx		Gy		Gz	

Tc trigger counter
Gx raw gyro data along x-axis
Gy raw gyro data along y-axis
Gz raw gyro data along z-axis

The sensor unit outputs the gyroscope measurement data using the TPDO1 message. Transmission of TPDO1 message is triggered by a SYNC message or sensor sampling event. A host device may enable or disable TPDO1 output by TPDO1 COB-ID OD [1800h, 01h].

A.1.5 TPDO2 message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
0101b	Node-ID	8	Tc		Ax		Ay		Az	

Tc trigger counter
Ax raw acceleration data along x-axis
Ay raw acceleration data along y-axis
Az raw acceleration data along z-axis

The sensor unit outputs the accelerometer measurement data using the TPDO2 message. Transmission of TPDO2 message is triggered by a SYNC message or sensor sampling event. A host device may enable or disable TPDO2 output by TPDO2 COB-ID OD [1801h, 01h].

A.1.6 TPDO3 message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
0111b	Node-ID	8	Tc		Temp[*1] ANG1[*2]		Reserved[*1] ANG2[*2]		STS	

Tc trigger counter
Temp [*1]/ ANG1[*2] temperature / raw attitude output data along x-axis (roll-axis)
Reseved[*1] / ANG2[*2] reserved / raw attitude output data along y-axis(pitch-axis)
STS Sensor status Information

STS (Sensor status Information) means range over occurred flag. The details are as follows.

Bit0: Attitude Range Over flag
Bit1-7: Reserved
Bit8: ZACCL Range Over flag
Bit9: YACCL Range Over flag
Bit10: XACCL Range Over flag
Bit11: ZGyro Range Over flag
Bit12: YGyro Range Over flag
Bit13: XGyro Range Over flag
Bit14: Reserved
Bit15: Reserved

*1. 6DOF output mode
*2. Attitude output mode

The sensor unit outputs the attitude measurement data information (if enabled) of measurement data using the TPDO3 message. Transmission of TPDO3 message is triggered by a SYNC message or sensor sampling event. A host device may enable or disable TPDO3 output by TPDO3 COB-ID OD [1802h, 01h]

A.1.7 TPDO4 message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
1001b	Node-ID	8	Tc		Ms				Dy	

Tc trigger counter
Ms time difference
bit3-0: (fixed 0)
bit31-4: the progress milli-second from 0:00am(midnight)
Dy time of day
0000h-FFFFh = the progress days from 1.Jan,1984

The sensor unit outputs the time information of measurement data using the TPDO4 message. Transmission of TPDO4 message is triggered by a SYNC message or sensor sampling event. A host device may enable or disable TPDO4 output by TPDO4 COB-ID OD [1803h, 01h]

A.1.8 TSDO message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
1011b	Node-ID	8	Cs	Pi		Ps	Pd			

Cs command specifier
43h = 4byte data (read sequence)
4Bh = 2byte data (read sequence)
4Fh = 1byte data (read sequence)
60h = success (write sequence)
80h = failure (write sequence)
Pi index
Ps sub-index
Pd (read sequence) data
(write sequence) fixed 0000h
(error case) abort code

The sensor unit sends this message as a response to a request message from an SDO client. In a read sequence, this message contains the data output. In a write sequence, this message contains the result of the write operation. If an error occurred, this message contains the abort code.

A.1.9 RSDO message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
1100b	Node-ID	8	Cs	Pi		Ps	Pd			

Cs command specifier
40h = read request (read sequence)
23h = 4byte data (write sequence)
2Bh = 2byte data (write sequence)
2Fh = 1byte data (write sequence)
Pi index
Ps sub-index
Pd (write sequence) data
(read sequence) don't care

The SDO client sends this message as request to the sensor unit. In a read sequence, the SDO client sets the index and sub-index. In a write sequence, it sets the index, sub-index and data.

A.1.10 HB Message

COB-ID		DLC	CAN data field							
FC	NID		1	2	3	4	5	6	7	8
1110b	Node-ID	1	St							

St state of unit
00h = boot-up
04h = stop
05h = operational
7Fh = pre-operational

If enabled, the sensor unit sends a heartbeat message periodically. This message contains information of the current NMT state of the sensor unit. By default, this message is not enabled. A host device may enable heartbeat output by specifying the heartbeat interval in Producer heartbeat time OD [1017h, 00h]. The sensor unit sends one heartbeat message as a bootup message during initialization, regardless of the value specified in OD [1017h, 00h]. There is no way to disable the bootup message output.

Appendix2. OBJECT DICTIONARY

Example

Index	Sub	Data type	Access type	Default value	Save
(1)	(2)	(3)	(4)	(5)	(6)
Function					
Data field					
Description					
Restriction					

(1) Index No
(2) Sub index No
(3) Data type
U8 = 8bit unsigned integer (0 to 255)
U16 = 16bit unsigned integer (0 to 65535)
U32 = 32bit unsigned integer (0 to 4294967295)
I16= 16bit signed integer (-32768 to 32767)
VS = Array[4] of character (ex: 65766173h = "save")
(4) Access type
const = Constant (never changes)
ro = read only
rw = read /write
(5) Default value
(6) An OD entry that has "#" in "SAVE" column is saved to non-volatile memory.

A.2.1 Communication Profile (DS-301)

A.2.1.1 Device type

Index	Sub	Data type	Access type	Default value	Save
1000h	00h	UNSIGNED32	const	0002 0194h	-
Function		Device type			
Data field		bit15-0: device profile 0194h(404)=DS-404（DS-404 standard, measurement device profile） bit31-16: measurement type 0002h=Analog input block			

A.2.1.2 Error register

Index	Sub	Data type	Access type	Default value	Save
1001h	00h	UNSIGNED8	ro	00h	-
Function		Error register			
Data field		bit0: generic error (Bus off error) 0=no error 1=error Bit6-1: (reserved) Bit7: sensor error 0=no error 1=error			
Description		This register shows a generic error status of the sensor unit.			

A.2.1.3 Manufacturer status register

Index	Sub	Data type	Access type	Default value	Save
1002h	00h	UNSIGNED32	ro	0000 0000h	-
Function		Manufacturer status register			
Data field		bit0: n/a bit1: Program memory error (0=no error, 1=error) bit2: OD memory read error (0=no error, 1=error) bit3: OD memory read error (0=no error, 1=error) bit4: RAM read/write error (0=no error, 1=error) bit5: Parameter memory error (0=no error, 1=error) bit6: (reserved) bit7: sensor check error (0=no error, 1=error) bit8: n/a bit9: sensor communiction error (0=no error, 1=error) bit10: sensor time out error (0=no error, 1=error) bit15-11: (reserved) bit16: Internal memory backup error (0=no error, 1=error) bit17: sensor internal error1 (0=no error, 1=error) bit18: sensor memory comm error (0=no error, 1=error) bit19: n/a (0=no error, 1=error) bit20: sensor communication error (0=no error, 1=error) bit21: sensor hardware error0 (0=no error, 1=error) bit22: sensor hardware error1 (0=no error, 1=error) bit23: n/a bit24: n/a bit25: n/a bit26: n/a bit27: acceleration error (0=no error, 1=error) bit28: Z axis gyro error (0=no error, 1=error) bit29: Y axis gyro error (0=no error, 1=error) bit30: X axis gyro error (0=no error, 1=error) bit31: n/a			
Description		This register shows a particular error status of the sensor unit. If a sensor error occurred, the bit 7 becomes 1. If a logging memory delete error occurred, the bit 8 becomes 1.			

A.2.1.4 SYNC COB-ID

Index	Sub	Data type	Access type	Default value	Save
1005h	00h	UNSIGNED32	rw	0000 0080h	#
Function		SYNC message output control and SYNC COB-ID			
Data field		bit10-0: SYNC COB-ID (fixed 0001 0000000b) bit29-11: (fixed 0) bit30: generate SYNC message 0=not generate 1=generate bit31: (fixed 0)			
Description		This OD enables or disables the SYNC producer. The host device must set the communication cycle period OD [1006h, 00h] and the synchronous counter overflow value OD [1019h, 00h], before starting the SYNC producer. If the unit operates as SYNC producer and OD [1019h, 00h] = 02h-F0h, the SYNC message transmitted by the unit will have a Cn (counter) parameter with initial value of 1. The SYNC COB-ID is fixed.			
Restriction		The message for “generate” is valid at operational mode only.			

A.2.1.5 Communication cycle period

Index	Sub	Data type	Access type	Default value	Save
1006h	00h	UNSIGNED32	rw	0000 2710h	#
Function	Period of SYNC message output				
Data field	bit31-0: SYNC cycle period [usec] 0000 0000h the SYNC message is not generated.				
Description	This OD sets the period of SYNC message output. The value written to this OD is automatically rounded down to [msec].				
Restriction	When Sync message is enabled (OD[1005h] bit30=1) this OD is not changed.				

A.2.1.6 Manufacturer device name

Index	Sub	Data type	Access type	Default value	Save
1008h	00h	VISIBLE_STRING4	const	3235 3547h ("G552")	-
Function	Device name				
Data field	bit31-0: device name G552xxxx 3235 3547h ("G552")				
Description	-				

A.2.1.7 Manufacturer hardware version

Index	Sub	Data type	Access type	Default value	Save
1009h	00h	VISIBLE_STRING4	const	depend on H/W version	-
Function	Hardware version				
Data field	bit31-0: hardware version G552PC1x: 30314350h ("PC10")				
Description	-				

A.2.1.8 Manufacturer software version

Index	Sub	Data type	Access type	Default value	Save
100Ah	00h	VISIBLE_STRING4	const	depend on F/W version	-
Function	Software version				
Data field	bit31-0: software version ex. 30302E31h ("1.00") The latest version is stored as an ASCII code				
Description	Software version				

A.2.1.9 Save all parameters

Index	Sub	Data type	Access type	Default value	Save
1010h	01h	VISIBLE_STRING4	rw	0000 0001h	-
Function		Save OD settings to non-volatile memory			
Data field		(Write) bit31-0: keyword 6576 6173h("save")=save parameters otherwise=ignore (Read) bit31-0: (fixed 0000 0001h)			
Description		When the host device writes "save" (6576 6173h) in ASCII to this OD, all saveable OD are stored to non-volatile memory. Confirm the save OD command is accepted by SDO response. Wait for at least 200msec after execution, and then reset or reboot. During saving process, the power supply must be stable. In case of power off or unstable level, non-volatile memory may be written incorrect data.			

A.2.1.10 Restore all default parameters

Index	Sub	Data type	Access type	Default value	Save
1011h	01h	VISIBLE_STRING4	rw	0000 0001h	-
Function		Load OD with factory default values from non-volatile memory			
Data field		(Write) bit31-0: keyword 6461 6F6Ch("load")=restore parameters otherwise=ignore (Read) bit31-0: (fixed 0000 0001h)			
Description		When the host device writes "load" (6461 6F6Ch) in ASCII to this OD, all saveable OD are restored to factory default values. It takes 1sec to load the values. The newly-restored values are not saved automatically to non-volatile memory. The host device is required to send a save command to make the changes permanent. Finally, a reboot or NMT Reset Node message is required before the changes in OD become valid.			

A.2.1.11 TIME COB-ID

Index	Sub	Data type	Access type	Default value	Save
1012h	00h	UNSIGNED32	const	8000 0100h	-
Function		TIME message COB-ID			
Data field		bit10-0: TIME COB-ID (fixed 0010 0000000b) bit30-11: (fixed 0) bit31: (fixed 1)			
Description		The TIME consumer is always enabled. The TIME COB-ID is fixed.			

A.2.1.12 Producer heartbeat time

Index	Sub	Data type	Access type	Default value	Save
1017h	00h	UNSIGNED16	rw	0000h	#
Function	Period of heartbeat output				
Data field	bit15-0: heartbeat cycle period [msec]				
Description	This OD sets heartbeat cycle time in milliseconds. The heartbeat message output becomes valid after a non-zero value is written to this OD. The heartbeat message output is disabled when 0000h is written to this OD.				

A.2.1.13 Synchronous counter overflow value

Index	Sub	Data type	Access type	Default value	Save
1019h	00h	UNSIGNED8	rw	00h	#
Function	SYNC counter output control and overflow value				
Data field	bit7-0: synchronous counter overflow value 00h=SYNC message has no counter 02h-F0h=overflow value otherwise=reserved				
Description	When the host device sets 02h-F0h to this OD, the SYNC message transmitted by the unit (when operating as SYNC producer) has an optional counter. The SYNC producer increments the counter value by 1 every time it sends a SYNC message. When the counter value matches the maximum value defined by this OD, the counter resets to 1 at the next SYNC. The SYNC counter starts with a value of 1 in the first SYNC message, which is transmitted when 1 is written to bit 30 of the SYNC Producer Enable OD [1005h, 00h]. The SYNC message has no optional counter when 00h is written to this OD.				
Restriction	The host device can change the value of this OD only when the communication cycle period OD [1006h, 00h] is 0000 0000h.				

A.2.1.14 RSDO COB-ID

Index	Sub	Data type	Access type	Default value	Save
1200h	01h	UNSIGNED32	ro	0000 0600h+NID	-
Function	RSDO message COB-ID				
Data field	bit10-0: RSDO COB-ID (1100 0000000b+ NID) bit31-11: (fixed 0)				
Description	The RSDO COB-ID is permanently fixed to 00000600h + NID.				

A.2.1.15 TSDO COB-ID

Index	Sub	Data type	Access type	Default value	Save
1200h	02h	UNSIGNED32	ro	0000 0580h+NID	-
Function	TSDO message COB-ID				
Data field	bit29-0: TSDO COB-ID (1011 0000000b+ NID) bit31-30: (fixed 0)				
Description	The TSDO COB-ID is permanently fixed to 00000580h + NID.				

A.2.1.16 TPDOn COB-ID

Index	Sub	Data type	Access type	Default value	Save
1800h 1801h 1802h 1803h	01h	UNSIGNED32	rw	4000 0180h+NID 4000 0280h+NID C000 0380h+NID C000 0480h+NID	#
Function	TPDOn message output control and TPDOn COB-ID				
Index	1800h=TPDO1, 1801h=TPDO2, 1802h=TPDO3, 1803h=TPDO4				
Data field	bit10-0: TPDOn COB-ID (read only) bit29-11: (fixed 0) bit30: (fixed 1) bit31: validity of TPDOn message output 0=TPDOn is enabled 1=TPDOn is not enabled				
Description	This OD enables or disables the output TPDOn message. The TPDOn COB-ID is permanently fixed to 0n80h+NID.				

A.2.1.17 TPDOn transmission type

Index	Sub	Data type	Access type	Default value	Save
1800h 1801h 1802h 1803h	02h	UNSIGNED8	rw ro ro ro	FEh (FEh) (FEh) (FEh)	#
Function	TPDOn transmission type				
Index	1800h=TPDO1, 1801h=TPDO2, 1802h=TPDO3, 1803h=TPDO4				
Data field	bit7-0: TPDOn transmission type 00h=synchronous mode (by every SYNC message) 01h-F0h=synchronous mode (by n times SYNC messages) FEh=Sampling mode otherwise=reserved				
Description	This OD specifies the transmission type. When the value of this OD is 00h, the transmission type is synchronous mode. The sensor node sends TPDO messages for every SYNC message received. When the value of this OD is 01h to F0h, the transmission type is synchronous mode too. This unit sends TPDO messages when the number of SYNC messages received matches the value of this OD. If the value of Synchronous counter overflow OD [1019h, 00h] is not 00h, this unit sends TPDO messages when the value of SYNC counter (Cn) is a multiple of the value of this OD. When the value of this OD is FEh, the transmission type is sampling mode. In sampling mode, the TPDO is output by the setting of sensor sample rate OD[2001h,00h] .				
Restriction	Only OD[1800h,02h] setting is programmable. OD[1801h,02h], OD[1802h,02h] and OD[1803h,02h] are set automatically. OD[2005h,00h] should be set to apply these parameters. Writing “FEh” to OD[1800h,02h] is accepted only at Pre-operational mode. (Returns Abort code: 0x08000022)				

A.2.1.18 TPDO1 mapping

Index	Sub	Data type	Access type	Default value	Save
1A00h	01h 02h 03h 04h	UNSIGNED32	const	2100 0010h 7130 0110h 7130 0210h 7130 0310h	-
Function	TPDO1 mapping				
Data field	bit7-0: data size [bit] bit15-8: sub-index bit31-16: index				
Description	The parameters of TPDO1. Parameter1 = Tc: Trigger counter OD[2100h,00h] Parameter2 = Gx: AI input PV 1 OD[7130h,01h] Parameter3 = Gy: AI input PV 2 OD[7130h,02h] Parameter4 = Gz: AI input PV 3 OD[7130h,03h] The mapping is fixed.				

A.2.1.19 TPDO2 mapping

Index	Sub	Data type	Access type	Default value	Save
1A01h	01h 02h 03h 04h	UNSIGNED32	const	2100 0010h 7130 0410h 7130 0510h 7130 0610h	-
Function	TPDO2 mapping				
Data field	bit7-0: data size [bit] bit15-8: sub-index bit31-16: index				
Description	The parameters of TPDO2. Parameter1 = Tc: Trigger counter OD[2100h,00h] Parameter2 = Ax: AI input PV 4 OD[7130h,04h] Parameter3 = Ay: AI input PV 5 OD[7130h,05h] Parameter4 = Az: AI input PV 6 OD[7130h,06h] The mapping is fixed.				

A.2.1.20 TPDO3 mapping

Index	Sub	Data type	Access type	Default value	Save
1A02h	01h 02h 03h 04h	UNSIGNED32	const	2100 0010h 7130 0710h 2022 0410h 2022 0110h	-
Function	TPDO3 mapping				
Data field	bit7-0: data size [bit] bit15-8: sub-index bit31-16: index				
Description	The parameters of TPDO3. 6 DOF sensor mode: Parameter1=Tc: Trigger counter OD[2100h,00h] Parameter2= Temp: AI input PV 7 OD[7130, 07h] Parameter3= Reserved：: OD[2022h,04h] Parameter4=STS: OD[2022h 01h] Attitude output mode: Parameter1=Tc: Trigger counter OD[2100h,00h] Parameter2=ANG1: AI input PV 8 OD[7130h,08h] Parameter3=ANG2: AI input PV 9 OD[7130h,09h] Parameter4=STS: OD[2022h 01h]				

A.2.1.21 TPDO4 mapping

Index	Sub	Data type	Access type	Default value	Save
1A03h	01h 02h 03h	UNSIGNED32	const	2100 0010h 2101 0220h 2101 0110h	-
Function	TPDO4 mapping				
Data field	bit7-0: data size [bit] bit15-8: sub-index bit31-16: index				
Description	The parameters of TPDO4. Parameter1=Tc: Trigger counter OD[2100h,00h] Parameter2= Ms: Time difference OD[2101h,02h] Parameter3= Dy: Time of day OD[2101h,01h] The mapping is fixed.				

A.2.1.22 NMT startup mode

Index	Sub	Data type	Access type	Default value	Save
1F80h	00h	UNSIGNED32	rw	0000 0008h	#
Function	NMT startup mode				
Data field	bit1-0: (fixed 0) bit2: startup mode 0=enter autonomously operational mode 1=stay pre-operational mode bit3: (fixed 1) bit31-4: (fixed 0)				
Description	This OD sets the NMT state after bootup of the sensor node. If bit 2 of this OD is 0, the sensor node will go to operational state after bootup. There is 3 seconds maximum interval from pre-operational mode to operational mode.				

A.2.2 Manufacturer OD Profile

A.2.2.1 CAN node-ID

Index	Sub	Data type	Access type	Default value	Save
2000h	01h	UNSIGNED8	rw	01h	#
Function		CAN node-ID			
Data field		bit7-0: CAN node-ID 01h - 7Fh = node-ID otherwise = reserved			
Description		This OD allows the user to set and read the node-ID. Writing to this parameter does not take effect until the sensor unit is rebooted or the reset node command is received. The host device is required to send a save command to make the change permanent.			
Restriction		This parameter can only be modified when the sensor unit is in pre-operational mode. (returns abort code: 0x08000022)			

A.2.2.2 CAN bitrate

Index	Sub	Data type	Access type	Default value	Save
2000h	02h	UNSIGNED8	rw	03h	#
Function		CAN bitrate			
Data field		bit7-0: CAN bitrate 00h=1Mbps 01h=800kbps 02h=500kbps 03h=250kbps 04h=125kbps 05h=50kbps 06h=20kbps 07h=10kbps 08h=reserved otherwise=ignore (returns abort code: 0x06090030)			
Description		This OD allows the user to set and read the CAN bitrate. Writing to this parameter does not take effect until the sensor unit is rebooted or the reset node command is received. The host device is required to send a save command to make the change permanent.			
Restriction		This parameter can only be modified when the sensor unit is in pre-operational mode. (returns Abort code: 0x08000022)			

A.2.2.3 Sensor sample rate

Index	Sub	Data type	Access type	Default value	Save
2001h	00h	UNSIGNED8(32)	rw	0Ah	#
Function		Sample rate			
Data field		bit7-0: sensor sample rate 01h=1000sps 02h=500sps 03h=250sps 04h=125sps 05h=62.5sps 06h=31.25sps 07h=15.625sps 08h = 400sps 09h = 200sps 0Ah = 100sps 0Bh = 80sps 0Ch = 50sps 0Dh = 40sps 0Eh = 25sps 0Fh = 20sps otherwise=ignore (returns abort code: 0x06090030)			
Description		This OD allows the user to set and read the sensor sample rate.			

	The selection of the sample rate and filter setting must be set correctly for optimal performance. Refer to the restrictions as described in Section A.2.3.6 AI Filter Setting Constant OD[61A1h] for more information.
Restriction	This parameter can only be modified when the sensor unit is in pre-operational mode. (returns abort code: 0x08000022) Check the relationship between Sensor sampling rate and filter setting. Refet to Table 6-9, Table 6-10 and A.2.3.10AI filter tap constant1for detail setting. (returns abort code: 0x08000021)

A.2.2.4 Apply parameters

Index	**Sub**	**Data type**	**Access type**	**Default value**	**Save**
2005h	00h	UNSIGNED8	rw	10h	#
Function		Set sensor type and apply parameters			
Data field		bit7-0: application control 01h = apply parameters 11h = apply parameters as 6DOF output mode 21h = apply parameters as attitude output mode others = reserved Be sure to set “1” for the lower 4 bits. otherwise=ignore (returns abort code: 0x08000021) Invalid value for upper 4 bits ignore (returns abort code: 0x06090030)			
Description		01h Apply parameters under the current measurement conditions. 11h Apply parameters as 6DOF sensor 21h Apply parameters as attitude output mode 31h reserved 41h reserved After command execution, bit0 is cleared to 0.			
Restriction		This parameter can only be modified when the sensor unit is in pre-operational mode. (returns abort code: 0x08000022) Command resend during command execution returns abort code: 0x08000021			

A.2.2.5 Attitude control

Index	**Sub**	**Data type**	**Access type**	**Default value**	**Save**
2020h	01h	UNSIGNED8	rw	00h	#
Function		Selects attitude angle output mode.			
Data field		00h Inclination angle 01h Euler angle otherwise=ignore (returns abort code: 0x06090030)			
Description		It is valid only in the attitude output mode.			
Restriction		This parameter can only be modified when the sensor unit is in pre-operational mode. (returns abort code: 0x08000022)			

A.2.2.6 Attitude axis conversion

Index	Sub	Data type	Access type	Default value	Save
2020h	02h	UNSIGNED8	rw	00h	#
Function	Selects the reference attitude.				
Data field	Refer to 6.8Reference Attitude for details. 00h~17h is acceptable otherwise=ignore (returns abort code: 0x06090030)				
Description	It is valid only in the attitude output mode.				
Restriction	This parameter can only be modified when the sensor unit is in pre-operational mode. (returns abort code: 0x08000022)				

A.2.2.7 Attitude motion profile

Index	Sub	Data type	Access type	Default value	Save
2020h	03h	UNSIGNED8	rw	00h	#
Function	Select the attitude motion profile depending on the application you use.				
Data field	Refer to 6.9 Attitude Motion Profile Selection for details. 00h mode A 01h mode B 02h mode C otherwise=ignore (returns abort code: 0x06090030)				
Description	It is valid only in the attitude output mode.				
Restriction	This parameter can only be modified when the sensor unit is in pre-operational mode. (returns abort code: 0x08000022)				

A.2.2.8 Trigger counter

Index	Sub	Data type	Access type	Default value	Save
2100h	00h	UNSIGNED16	rw	0000h	-
Function	Value of the trigger counter				
Data field	bit15-0: count value (0 to 65535)				
Description	The value of the trigger counter is incremented by 1 when the sensor node receives a trigger (SYNC message or timer event). By setting this OD to some value, the trigger counter will start from that value.				

A.2.2.9 Timestamp of day

Index	Sub	Data type	Access type	Default value	Save
2101h	01h	UNSIGNED16	ro	indefinite	-
Function	current date				
Data field	bit15-0: days since January 1 1984				
Description	This OD represents the current date.				

A.2.2.10 Timestamp Millisecond

Index	Sub	Data type	Access type	Default value	Save
2101h	02h	UNSIGNED32	ro	indefinite	-
Function		current time (milliseconds)			
Data field		bit3-0: fixed = 0 bit31-4: milliseconds after 0:00am(midnight)			
Description		This parameter represents the current local time.			

A.2.3 Measuring Device Profile (DS-404)

A.2.3.1 AI sensor type 1-3

Index	Sub	Data type	Access type	Default value	Save
6110h	01h 02h 03h	UNSIGNED16	const	28A1h	-
Function	The sensor type of analog input 1-3.				
Data field	bit15-0: sensor type 28A1h (10401) = gyroscope (manufacture specific)				

A.2.3.2 AI sensor type 4-6

Index	Sub	Data type	Access type	Default value	Save
6110h	04h 05h 06h	UNSIGNED16	const	2905h	-
Function	The sensor type of analog input 4-6.				
Data field	bit15-0: sensor type 2905h (10501) = accelerometer (manufacture specific)				

A.2.3.3 AI sensor type 7

Index	Sub	Data type	Access type	Default value	Save
6110h	07h	UNSIGNED16	const	0064h	-
Function	The sensor type of analog input 7.				
Data field	bit15-0: sensor type 0064h(100)=temperature				

A.2.3.4 AI sensor type 8-10

Index	Sub	Data type	Access type	Default value	Save
6110h	08h 09h 0Ah	UNSIGNED16	const	28A1h	-
Function	The sensor type of analog input 8-10.				
Data field	bit15-0: sensor type 28A1h(10401)=gyroscope (manufacture specific)				

A.2.3.5 AI physical unit PV 1-3

Index	Sub	Data type	Access type	Default value	Save
6131h	01h	UNSIGNED32	const	0041 0300h	-

	02h 03h				
Function	The unit of analog input 1-3.				
Data field	bit31-0: physical unit 00410300h = degrees / second [dps]				

A.2.3.6 AI physical unit PV 4-6

Index	Sub	Data type	Access type	Default value	Save
6131h	04h 05h 06h	UNSIGNED32	const	FDF1 0000h	-
Function	The unit of analog input 4-6.				
Data field	bit31-0: physical unit FDF10000h = *g* / 1000 [*mg*]				

A.2.3.7 AI physical unit PV 7

Index	Sub	Data type	Access type	Default value	Save
6131h	07h	UNSIGNED32	const	002D 0000h	-
Function	The unit of analog input 7.				
Data field	bit31-0: physical unit 002D 0000h=°C				

A.2.3.8 AI physical unit PV 8-10

Index	Sub	Data type	Access type	Default value	Save
6131h	08h 09h 0Ah	UNSIGNED32	const	0000 0000h	-
Function	The unit of analog input 8-10.				
Data field	bit31-0: physical unit (0041 0000h)=deg (rad)				

A.2.3.9 AI filter type 1-10

Index	Sub	Data type	Access type	Default value	Save
61A0h	01h 02h 03h 04h 05h 06h 07h 08h 09h 0Ah	UNSIGNED8	const	02h	-

Function	The filter type of analog input 1-10.
Data field	bit7-0: filter type

A.2.3.10 AI filter tap constant1

Index	Sub	Data type	Access type	Default value	Save
61A1h	01h	UNSIGNED8	rw	08h (09h)	#
Function		The filter setting constant of analog input 1.			
Data field		bit7-0: filter tap constant 01h=tap 2 02h=tap 4 03h=tap 8 04h=tap 16 05h=tap 32 06h=tap 64 07h=tap 128 08h=FIR tap 32 fc 50 09h=FIR tap 32 fc 100 0Ah= FIR tap 32 fc 200 0Bh= FIR tap 32 fc 400 0Ch=FIR tap 64 fc 50 0Dh=FIR tap 64 fc 100 0Eh= FIR tap 64 fc 200 0Fh= FIR tap 64 fc 400 10h=FIR tap 128 fc 50 11h=FIR tap 128 fc 100 12h= FIR tap 128 fc 200 13h= FIR tap 128 fc 400 otherwise=ignore (returns abort code: 0x06090030)			
Description		This parameter is applied for analog input 1-6			
Restriction		This parameter can only be changed in the pre-operational mode. OD[2005h,00h] should be set to apply these parameters. When the timer interval is changed, this parameter must be set again.			

A.2.3.11 AI filter tap constant 2-6

Index	Sub	Data type	Access type	Default value	Save
61A1h	02h 03h 04h 05h 06h 07h 08h 09h 0Ah	UNSIGNED8	ro	08h	
Function		The filter setting constant of analog input 2-10. (Same as OD[61A1h, 01h])			
Description		The value of AI filter setting constant 1 is automatically copied to these OD.			

A.2.3.12 AI input PV 1-3(Gx/Gy/Gz)

Index	Sub	Data type	Access type	Default value	Save
7130h	01h 02h 03h	INTEGER16	ro	indefinite	-
Function	Measurement value of analog input PV 1-3. (Gx/ Gy/ Gz)				
Data field	bit15-0: process value (-32768 to 32767)				
Description	This OD shows the value of 3 axis gyroscope. The resolution is 0.01515 [dps/LSB].				

A.2.3.13 AI input PV 4-6 (Ax/Ay/Az)

Index	Sub	Data type	Access type	Default value	Save
7130h	04h 05h 06h	INTEGER16	ro	indefinite	-
Function	Measurement value of analog input PV 4-6. (Ax/Ay/Az)				
Data field	bit15-0: process value (-32768 to 32767)				
Description	This OD shows the value of 3 axis accelerometer. The resolution is fixed to 0.4 [*mg*/LSB]				

A.2.3.1 AI input PV 7 (Temp)

Index	Sub	Data type	Access type	Default value	Save
7130h	07h	INTEGER16	ro	indefinite	-
Function	Measurement value of analog input PV 7. (Te)				
Data field	bit15-0: process value (-32768 to 32767)				
Description					

A.2.3.2 AI input PV 8-10 (ANG1/ANG2/-)

Index	Sub	Data type	Access type	Default value	Save
7130h	08h 09h 0Ah	INTEGER16	ro	indefinite	-
Function	Measurement value of analog input PV 8-10. (ANGX/ANGY/reserved)				
Data field	bit15-0: process value (-32768 to 32767)				
Description					

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CAN ICES-3(A)/NMB-3(A)

REVISION HISTORY

Attachment－1

Rev. No.	Date	Page	Category	Contents
Rev.1.0	Apr. 2021	All	New	New
Rev.1.1	Jul. 2021	4,9	Modify	unit change of Gyro Characteristics °/s → °/h
Rev.1.2	Apr. 2022	50	Modify	Product Number Change
Rev.1.3	Dec. 2022	74	Modify	UKCA compliance and regulatory amendments
Rev.1.4	Jul. 2023	cover	Modify	Corporate logo change
Rev.1.5	Feb. 2024	14	Modify	Added acceleration origin in Figure 2-5

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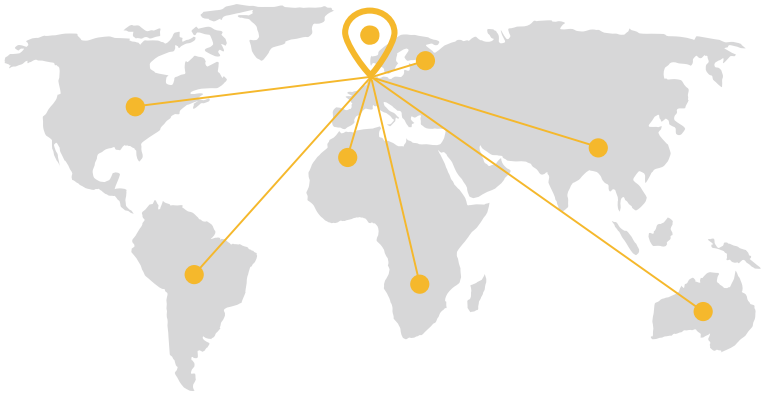

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