TARS SENSORS ZEROING FUNCTION

Technical Note

1.0 DESCRIPTION

The zeroing function allows users to remove mounting orientation variations. Users may use fixed values, known values, or automated zeroing commands. Zeroing may be done repeatedly, if necessary. The results are stored in non-volatile memory. The zeroing function angles use the user frame of reference as selected in the orientation section of the configuration.

2.0 EXAMPLE

The example shown in Tables 1 and 2 is a message to reset the zeroing values and automatically set the roll and pitch to 0 deg.

TABLE 1. ZEROING PGN 61184

Frame Format	29-Bit ID						Data (8 Bytes)							
Field	**P**	**EDP**	**DP**	**PF**	**PS**	**SA**	**ID**	**CMD[2]**	**Roll[1]**		**Pitch[1]**		**Yaw[1]**	
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x19			0xEF	0xE2	0xF6	0X02	0x68	0x00	0x00	0x00	0x00	0x00	0x00
									BL	BH	BL	BH	BL	BH

[1] Angle (deg) = $(B_H * 2^8 + B_L - 2^{15}) / 100$
[2] CMD Definition

PS: Destination Address
SA: Requester Address

Roll/Pitch/Yaw: RPY value (0,0,0)

TABLE 2. CMD

Type	All		Roll		Pitch		Yaw	
# Bits	2		2		2		2	
Bit ID Position	7	6	5	4	3	2	1	0
CAN Message	01b		10b		10b		00b	

All status definitions are defined as:
00b: No action
01b: Set
10b: Add
11b: Reserved

Set All: Resets the zeroing values for roll/pitch/yaw to RPY (0,0,0).
Set Roll/Pitch/Yaw: Replaces the zeroing values for roll/pitch/yaw with the RPY values in the PGN.
Add Roll/Pitch: Updates the existing zeroing values for roll/pitch with the difference between the values supplied in the zeroing PGN and the roll/pitch currently outputted by the TARS.

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3.0 USAGES

3.1. CLEAR ALL PREVIOUS ZEROING VALUES

Erases all previously stored zeroing values.

TABLE 3. ZEROING PGN 61184

Frame Format	29-Bit ID						Data (8 Bytes)							
Field	P	EDP	DP	PF	PS	SA	ID	CMD	Roll		Pitch		Yaw	
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x19			0xEF	0xE2	0xF6	0X02	0x40	0x00	0x00	0x00	0x00	0x00	0x00
									BL	BH	BL	BH	BL	BH

Using the Set All CMD (0x40) clears all zeroing values. Roll/pitch/yaw values in Zeroing PGN are ignored.

3.2. SET THE ROLL/PITCH/YAW ZEROING VALUES MANUALLY

Manually replaces the stored zeroing offset value with the ones provided.

TABLE 4. ZEROING PGN 61184

Frame Format	29-Bit ID						Data (8 Bytes)							
Field	P	EDP	DP	PF	PS	SA	ID	CMD	Roll		Pitch		Yaw	
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x19			0xEF	0xE2	0xF6	0X02	0x01	0x00	0x00	0x00	0x00	0x64	0x00
									BL	BH	BL	BH	BL	BH

Use the Set Yaw CMD (0x01) to replace the stored zeroing value for yaw with the value provided in the yaw field (0x0064h = 100d = +1 deg).

3.3. ADJUST THE ROLL/PITCH/YAW ZEROING VALUES USING THE OBSERVED MEASURED VALUES

Uses the roll/pitch values currently reported by ARS to adjust the stored zeroing values. creating the desired target values.

TABLE 5. ZEROING PGN 61184

Frame Format	29-Bit ID						Data (8 Bytes)							
Field	P	EDP	DP	PF	PS	SA	ID	CMD	Roll		Pitch		Yaw	
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x19			0xEF	0xE2	0xF6	0X02	0x28	0x96	0x00	0x9C	0xFF	0x00	0x00
									BL	BH	BL	BH	BL	BH

Using the Add Roll/Pitch CMD (0x28) updates the stored zeroing values for roll/pitch to offset the reported outputs to match the values in the zeroing PGN's roll/pitch fields.

Roll: 0x0096h = 150d = +1.5 deg

Pitch: 0xFF9C = -100d = -1.0 deg

Yaw: Ignored (If values for yaw are entered in the Zeroing PGN message, they will be ignored.)

4.0 BEST PRACTICES

4.1 SINGLE STEP ZEROING

Using just one command message makes the TARS device report 0 deg roll/pitch. In this procedure:

- The previously stored zeroing values are cleared.
- Adds roll & pitch, currently outputted by TARS, to the zeroing values for roll & pitch, respectively.

TABLE 6. ZEROING PGN 61184

Frame Format	29-Bit ID						Data (8 Bytes)							
Field	P	EDP	DP	PF	PS	SA	ID	CMD	Roll		Pitch		Yaw	
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x19			0xEF	0xE2	0xF6	0X02	0x28	0x00	0x00	0x00	0x00	0x00	0x00
									BL	BH	BL	BH	BL	BH

CMD = 0x28h = 00101000b

TABLE 7. CMD

Type	All	Roll	Pitch	Yaw
# Bits	2	2	2	2
Bit ID Position	7 6	5 4	3 2	1 0
CAN Message	01b	10b	10b	00b

4.2 REVERSE DIRECTION

When a target roll/pitch/yaw is not known, use multiple commands to create the zeroing values.

1. Send the single step zeroing message shown in Section 4.1.
2. Change the machine's direction (yaw) and send the following zeroing message using the Add Roll/Add Pitch CMD.
3. Repeat Step 2 as often as desired. If the direction from Step 1 and Step 2 is 180° apart, repeated steps are neither needed nor advised.

TABLE 8. ZEROING PGN 61184

Frame Format	29-Bit ID						Data (8 Bytes)							
Field	P	EDP	DP	PF	PS	SA	ID	CMD	Roll		Pitch		Yaw	
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x19			0xEF	0xE2	0xF6	0x02	0x28	0x00	0x00	0x00	0x00	0x00	0x00
									BL	BH	BL	BH	BL	BH

CMD = 0x28h = 00101000b

TABLE 9. CMD

Type	All	Roll	Pitch	Yaw
# Bits	2	2	2	2
Bit ID Position	7 6	5 4	3 2	1 0
CAN Message	00b	10b	10b	00b

The second message uses the roll/pitch currently outputted by TARS, which already includes the zeroing offsets from previous zeroing to calculate corrections to the zeroing values.

4.3 REMOVE YAW ERROR

In applications with expected large range of movements in roll/pitch, the yaw mounting error may contribute considerably to the roll and pitch error. To observe and remove this error, follow these steps:

1. Send the Clear All message shown in Section 3.1.
2. Set Add Roll/Add Pitch CMD as shown in Section 4.1.
3. Change the machine's attitude to a known position (roll & pitch) .
4. Send Add Yaw CMD with RPY (0°, -30°, 0°, known position from Step 3) and TARS will internally calculate the zeroing offset to correct the yaw mounting error.
5. Confirm zero by changing to a new attitude.

TABLE 10. EXAMPLE

Step	Command	TARS Output After Command	
		Roll	Pitch
1	Reset ALL = 01b (Set)	3.22	-2.34
2	Adjust ROLL = 10b and PITCH = 10b (Add)	0.00	0.00
3	Tilt TARS to known RPY (0°, -30°, 0°)	-0.24	-29.98
4	Adjust YAW = 10b (add)	0.04[1]	-29.99
5	Tilt TARS to known RPY (0°, -60°, 0°)	0.03[1]	-59.88

[1] Remaining roll error after yaw mounting error correction. At attitude setting of Roll 0° and Pitch -30°, roll error is 0.04° and pitch error is 0.01°. At attitude setting of Roll 0° and Pitch -60°, roll error is 0.03° and pitch error is 0.12°.

Step 1: Reset All

Time	Chn	PGN	Name	Send node	Src	Dest	Prio	Dir	DLC	Data
16.362312	1	F02Ap	ARI		E2	--	3	Rx	8	BF 7C 65 7D 74 7D 00 05
16.352867	1	F02Dp	ACCS		E2	--	2	Rx	8	B6 7C E2 7C 36 79 00 00
16.353415	1	F029p	SSI2		E2	--	3	Rx	8	97 1B 7C 66 26 7F 00 05
16.319978	1	1EF00p	PGN_TARE		F6	E2	6	Tx	8	02 40 00 00 00 00 00 00

Step 2: Add Roll/Pitch

Time	Chn	PGN	Name	Send node	Src	Dest	Prio	Dir	DLC	Data
35.389828	1	F02Ap	ARI		E2	--	3	Rx	8	B9 7C 5D 7D 6F 7D 00 05
35.380395	1	F02Dp	ACCS		E2	--	2	Rx	8	00 7D 00 7D 33 79 00 00
35.380952	1	F029p	SSI2		E2	--	3	Rx	8	83 04 7D AB 05 7D 00 05
32.462899	1	1EF00p	PGN_TARE		F6	E2	6	Tx	8	02 28 00 00 00 00 00 00

Step 4: Add Yaw

Time	Chn	PGN	Name	Send node	Src	Dest	Prio	Dir	DLC	Data
153.005756	1	F02Ap	ARI		E2	--	3	Rx	8	BA 7C 5B 7D 74 7D 00 05
153.006312	1	F02Dp	ACCS		E2	--	2	Rx	8	EE 7E 00 7D B6 79 00 00
153.006860	1	F029p	SSI2		E2	--	3	Rx	8	4E FC 7C 25 CC 6D 00 05
149.745100	1	1EF00p	PGN_TARE		F6	E2	6	Tx	8	02 02 47 F4 00 00 00 00

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000684-1-EN | 1 | 09/22

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