INSTALLATION INSTRUCTIONS FOR THE **TRANSPORTATION ATTITUDE REFERENCE SYSTEM, TARS SERIES**

32332897
Issue D

1.0 GENERAL INFORMATION

Honeywell's Transportation Attitude Reference System (TARS) Ruggedized Inertial Measurement Unit (IMU) is designed to provide motion sensing with six degrees of freedom by reporting angular rate, acceleration, and attitude data through a CAN J1939 interface. It is ruggedized to withstand harsh environments and demanding applications.

2.0 CALIBRATION

TARS-IMU devices are calibrated on an aerospace-grade rate table providing consistency between units and minimizing the customer's need to calibrate the IMU.

3.0 INSTALLATION

Mount the sensor using the three mounting holes and three M8 bolts. The mounting tabs accommodate various bolt head styles, such as hex, socket head cap, and hex flange bolt head. Torque to 20 Nm ±2 Nm.

- Mating connector: AMPSEAL 16™ Series, 776487-1 for 18-16 AWG conductors or 776524-1 for 20-18 AWG conductors
- Mounting direction: +Z

4.0 SPECIFICATIONS

See tables 1 through 6, and figures 1 through 4.

TABLE 1. SENSOR SPECIFICATIONS

CHARACTERISTIC	MIN.	TYP.	MAX.	UNIT
Gyroscope 3 axis performance				
Range[1]	-245	–	+245	deg/s
Resolution	–	8.75	–	mdps
In-run bias stability	–	1	–	mdps
Noise density	–	4	–	mdps/√Hz
Offset (0°C to 50°C)	–	±0.8	–	deg/s
Offset (-40°C to 85°C)	–	±1.6	–	deg/s
Accelerometer 3 axis performance				
Range[1]	-78.48	–	+78.48	m/s^2
Resolution[2]	–	0.01	–	m/s^2
In-run bias stability	–	50	–	µg
Noise density	–	65	–	µg/√Hz
Offset (0°C to 50°C)	–	±0.05	–	m/s^2
Offset (-40°C to 85°C)	–	±0.15	–	m/s^2
Inclination (pitch and roll)				
Range[1]	-85	–	+85	deg
Resolution	–	0.014	–	deg
Static error (0°C to 50°C)	–	±0.3	–	deg
Static error (-40°C to 85°C)	–	±0.9	–	deg
Translational acceleration error	–	±0.5	–	deg
Centripetal acceleration error	–	±0.5	–	deg

[1] Sensors are calibrated in the following ranges: ±60 deg/s for angular rate, ±9.80665 m/s^2 for acceleration, and ±30 deg for pitch and roll. Calibrated ranges may be extended to maximums shown with deviation to performance specifications.

- Angular rate outputs per PGN 61482; Z-down convention required by J1939.
- Acceleration outputs per PGN 61485; Z-up convention required by J1939.
- Pitch and roll outputs per PGN 61481; Z-down convention required by J1939.

[2] Accelerometer resolution is limited by the J1939 protocol.

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TABLE 2. ELECTRICAL SPECIFICATIONS • TARS-LCASS

CHARACTERISTIC	MIN.	NOMINAL	MAX.	UNIT
Supply voltage	4.5	5	5.5	V
Supply current	–	–	100	mA
Start-up time	500	–	2000	ms
Short circuit protection	ISO 16750-2: 2012 — CAN output shorted to supply voltage or ground without damage			
Open circuit protection	ISO 16750-2: 2012 — Single-line and multiple-line interruption			
Power interruption	ISO 11783-5: 2009 — 10 ms interruption, 100 ms apart; no resets or loss of data in volatile memory			
Reset response	ISO 16750-2: 2012 — Automatic recovery after voltage dropout			
CAN output characteristics per SAE J1939				
Baud rate	125	250[1]	500	kbps
Signal update rate	–	–	100[2]	Hz

[1] Factory default setting is 250 kbps.
[2] Factory default setting is 100 Hz.

TABLE 3. ELECTRICAL SPECIFICATIONS • TARS-HCASS

CHARACTERISTIC	MIN.	NOMINAL	MAX.	UNIT
Supply voltage	9	12/24	36	V
Supply current	–	–	100	mA
Reverse voltage	–	–	-36	V
Overvoltage	–	–	36	V
Start-up time	500	–	2000	ms
Short circuit protection	ISO 16750-2: 2012 — CAN output shorted to supply voltage or ground without damage			
Open circuit protection	ISO 16750-2: 2012 — Single-line and multiple-line interruption			
Power interruption	ISO 11783-5: 2009 — 10 ms interruption, 100 ms apart; no resets or loss of data in volatile memory			
Reset response	ISO 16750-2: 2012 — Automatic recovery after voltage dropout			
Power line test pulse 1	ISO 7637-2: 2004 AMD1: 2008 / 12 and 24 V system			
Power line test pulse 2a	ISO 7637-2: 2004 AMD1: 2008 / 12 and 24 V system			
Power line test pulse 2b	ISO 7637-2: 2004 AMD1: 2008 / 12 and 24 V system			
Power line test pulses 3a and 3b	ISO 7637-2: 2004 AMD1: 2008 / 12 and 24 V system			
Load dump - suppressed	ISO 16750-2: 2012 / 12 and 24 V system			
CAN output characteristics per SAE J1939				
Baud rate	125	250[1]	500	kbps
Signal update rate	–	–	100[2]	Hz

[1] Factory default setting is 250 kbps.
[2] Factory default setting is 100 Hz.

TRANSPORTATION ATTITUDE REFERENCE SYSTEM, TARS SERIES *Issue D* ***32332897***

TABLE 4. ENVIRONMENTAL SPECIFICATIONS[1]

CHARACTERISTIC	PARAMETER
Operating temperature	-40°C to 85°C [40°F to 185°F]
Storage temperature[2]	-40°C to 105°C [40°F to 221°F]
Housing	PBT thermoplastic
Random vibration	10 hours at 25 Grms per MIL-STD-810, Method 514.7, Procedure I, Annex D, Category 20, 5 Hz to 500 Hz (flat spectrum)
Mechanical shock	50 g 11 ms half-sine, 3 each direction, 18 total, pulse per MIL-STD-202, Method 213
Chemical compatibility	diesel fuel, hydraulic oil, ethylene glycol, motor oil, brake fluid, urea nitrogen, liquid lime, NPK fertilizer, ammonium hydroxide, alkaline degreaser, transmission oil, power steering fluid, and axle oil
Moisture resistance	per MIL-STD-202, Method 106 (10 cycles, 24 hours/cycle)
Thermal shock	250 cycles, -40°C to 85°C, 73 min dwell
Salt spray	5 % salt solution, 96 hours
Ingress protection	IP67, IP69K (DIN40050-1993) with mating connector installed
RoHS	compliant
REACH	compliant
UV rating	housing material meets outdoor suitability requirements per UL746C F1 rating

[1] For environmental conditions not covered by product specification, consult with Honeywell Engineering.
[2] In installed condition; otherwise, maximum storage temperature is 85°C [185°F].

TABLE 5. EMC SPECIFICATIONS

CHARACTERISTIC	STANDARD	TEST LEVEL, FREQUENCY
Radiated immunity	ISO 11452-2: 2019	125 V/m, 400 MHz to 2.5 GHz
Bulk current injection	ISO 11452-4: 2011	125 mA, 1 MHz to 400 MHz
Radiated emission	ISO 13766-1: 2018	30 MHz to 1 GHz
I/O line coupled transients	ISO 7637-3: 2016	test pulse a and test pulse b (-80 V, +80 V)
ESD handling	ISO 10605: 2008 AMD1: 2014	direct ±8 kV, air ±15 kV
ESD operational	ISO 10605: 2008 AMD1: 2014	direct ±8 kV, air ±15 kV

TABLE 6. INSTALLATION SPECIFICATIONS

CHARACTERISTIC	PARAMETER
Mating connector	AMPSEAL 16™ Series: 776487-1 for 18-16 AWG conductors or 776524-1 for 20-18 AWG conductors
CAN termination	120 ohm termination resistor, not included in TARS-IMU unit
Weight	170 g approx.
Mounting direction	+Z
Mounting bolt	M8, installation torque 20 Nm ±2 Nm

FIGURE 1. BODY DIMENSIONS (FOR REFERENCE ONLY: mm [in])

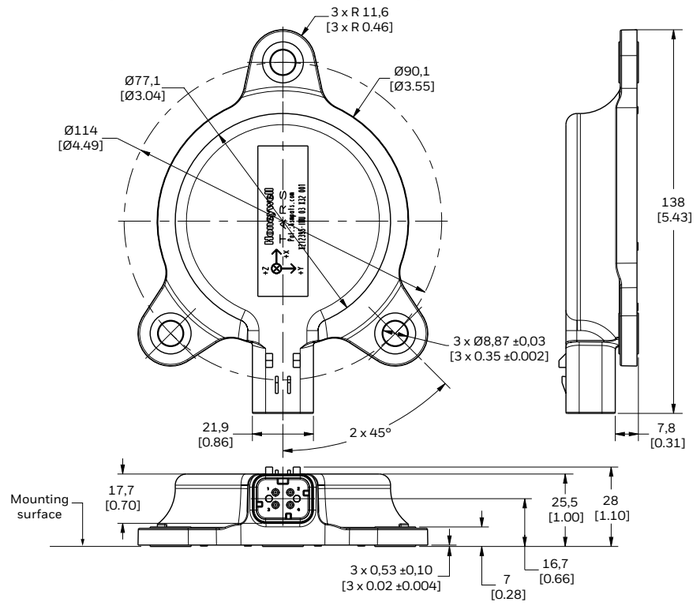


FIGURE 2. MOUNTING HOLES DIMENSIONS (FOR REFERENCE ONLY: mm [in])

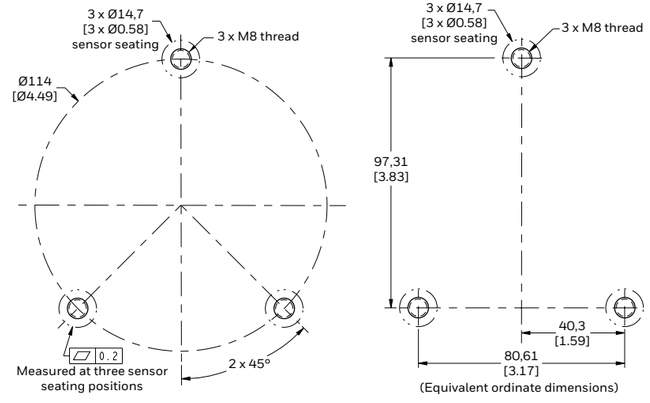
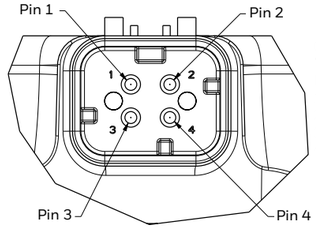


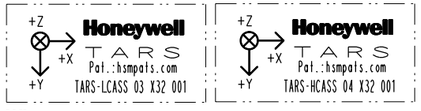
FIGURE 3. PINOUT



Connector Termination

Pin	Description
1	dc power
2	CAN high
3	Ground
4	CAN low

FIGURE 4. MARKING INFORMATION



Where

03, 04 Product configuration code: 03 (LCASS) or 04 (HCASS)

X32 Date code, where:

X: Year code for 2016, Y for 2017, Z for 2018, A for 2019, etc.

32: Week of final test

001 is a consecutive number, different for each product

NOTE: The axis origin triad marked on the housing defines a Z-Down axis system for pitch and roll output, and the sign convention is in accordance to the right-hand rule.

5.0 CAN MESSAGES AND COMMUNICATION

TARS-IMU utilizes CAN J1939 protocol and message format to report data. Please refer to the J1939 standard for information regarding communications and system implementation.

5.1 CAN J1939 DEVICE IDENTIFICATION

The ID is a 4-byte value that identifies the message being transmitted. The J1939 Protocol Data Unit (PDU) 29-Bit Identifier (CAN Extended Format) definition does not include the following three CAN Data Frame Bits: Start of Frame (SOF), Substitute Remote Request (SRR), and Identifier Extension Bit (IDE), as these bits are controlled entirely by ISO 11898-1. The J1939 PDU is comprised of a 29-bit identifier (see Table 7): Priority (P), Data Page (DP and EDP), PDU Format (PF), PDU Specific (PS), and Source Address (SA). Additionally, the PDU may also include a 0-8-byte data field that changes in length and definition based upon the message.

TABLE 7. 29-BIT IDENTIFIER (J1939 FRAME FORMAT)

FIELD	PRIORITY (P)			EDP	DP	PDU FORMAT (PF)								PDU SPECIFIC (PS)								SOURCE ADDRESS (SA)							
# Bits	3			1	1	8								8								8							
Bit ID Position	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

6.0 TARS-IMU SPECIFIC MESSAGES

The TARS-IMU transmits broadcast data as configured by the signal update rate.

6.1 PGN 61481 (0xF029) PITCH AND ROLL BROADCAST DATA

TABLE 8 PGN 61481 PDU

FRAME FORMAT	29-BIT ID						DATA (8 BYTES)							
Field	P	EDP	DP	PF	PS	SA	Pitch Angle			Roll Angle			Status	Latency
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x0C			0xF0	0x29	0xE2	0x00	0x00	0x7D	0x00	0x00	0x7D	0x00	0x05
							BL	BM	BH	BL	BM	BH		

$uint32 = B_H*2^{16} + B_M*2^8 + B_L$
Angle (deg) = (uint32 - 8192000) / 32768

e.g., 0xCF029E2, 0x00, 0x00, 0x7D, 0x00, 0x00, 0x7D, 0x00, 0x05
Transmit 0 deg on both pitch and roll with priority 3, fully functional MEMS and compensation with 2.5 ms latency from address 0xE2.

6.1.1 PGN 61481 STATUS

The status byte is comprised of compensation status and MEMS status for each data message.

TABLE 9. PGN 61481 STATUS

TYPE	COMP PITCH		MEMS PITCH		COMP ROLL		MEMS ROLL	
# Bits	2		2		2		2	
Bit ID Position	7	6	5	4	3	2	1	0
CAN Message	00b		00b		00b		00b	

All status definitions are defined as:
00b = Fully functional
01b = Degraded
10b = Error
11b = Not available

6.2 PGN 61482 (0xF02A) ANGULAR RATE BROADCAST DATA

TABLE 10. PGN 61482 PDU

FRAME FORMAT	29-BIT ID						DATA (8 BYTES)							
Field	P	EDP	DP	PF	PS	SA	Pitch Rate		Roll Rate		Yaw Rate		Status	Latency
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8	8
CAN Message	0x0C			0xF0	0x2A	0xE2	0x00	0x7D	0x00	0x7D	0x00	0x7D	0x00	0x05
							BL	BH	BL	BH	BL	BH		

uint16 = B_H*2^8 + B_L
Angular Rate (deg/s) = (uint16 - 32000) / 128

e.g., 0xCF02AE2, 0x00, 0x7D, 0x00, 0x7D, 0x00, 0x7D, 0x00, 0x05
Transmit 0 deg/s on pitch rate, roll rate, and yaw rate with priority 3, fully functional MEMS with 2.5 ms latency from address 0xE2.

6.2.1 PGN 61482 STATUS

The status byte is comprised of MEMS status for each data message.

TABLE 11. PGN 61482 STATUS

TYPE	PITCH		ROLL		YAW		UNUSED	
# Bits	2		2		2		2	
Bit ID Position	7	6	5	4	3	2	1	0
CAN Message	00b		00b		00b		00b	

All status definitions are defined as:
00b = Fully functional
01b = Degraded
10b = Error
11b = Not available

6.3 PGN 61485 (0xF02D) ACCELERATION BROADCAST DATA

TABLE 12. PGN 61485 PDU

FRAME FORMAT	29-BIT ID						DATA (7 BYTES)						
Field	P	EDP	DP	PF	PS	SA	Lateral		Longitudinal		Vertical		Status
# Bits	3	1	1	8	8	8	8	8	8	8	8	8	8
CAN Message	0x08			0xF0	0x2D	0xE2	0x00	0x7D	0x00	0x7D	0xD5	0x80	0x00
							BL	BH	BL	BH	BL	BH	

uint16 = B_H*2^8 + B_L
Acceleration (m/s^2) = (uint16 - 32000) / 100

e.g., 0x8F02DE2, 0x00, 0x7D, 0x00, 0x7D, 0xD5, 0x80, 0x00
Transmit 0 m/s^2 on lateral and longitudinal acceleration, and +1 g (9.81 m/s^2) on vertical acceleration with priority 2, fully functional MEMS from address 0xE2.

6.3.1 PGN 61485 STATUS

The status byte is comprised of MEMS status for each data message.

TABLE 13. PGN 61485 STATUS

TYPE	LATERAL		LONGITUDINAL		VERTICAL		UNUSED	
# Bits	2		2		2		2	
Bit ID Position	7	6	5	4	3	2	1	0
CAN Message	00b		00b		00b		00b	

All status definitions are defined as:
00b = Fully functional
01b = Degraded
10b = Error
11b = Not available

TRANSPORTATION ATTITUDE REFERENCE SYSTEM,
TARS SERIES
Issue D
32332897

7.0 TARS FIRMWARE

The TARS-IMU contains two different user-updatable firmware files: application firmware and a personality file. Both files must be loaded on the TARS-IMU for correct operation. The general sales listings are supplied from the Honeywell factory preloaded with application firmware and a personality file. The latest application firmware may be downloaded from the Honeywell website:

https://sensing.honeywell.com/sensors/interial-measurement-unitsd/tars-imu-series

Software tools for installing these files onto the TARS-IMU are also available at this website.

NOTICE
FIRMWARE REVISION

When evaluating TARS-IMU for new applications, it is highly recommended that the latest application firmware be used to realize the latest advancements in performance.

7.1 APPLICATION FIRMWARE

The application firmware contains the TARS-IMU sensor fusion algorithm. As advancements and improvements are realized, application firmware updates are made available for download at the Honeywell website referenced in section 7.0. Customers may update the application firmware if a new feature is desired or to access the latest performance improvements.

7.2 PERSONALITY FILE

The personality file defines settings for all variables in the application firmware. The personality file facilitates simplified customization of the TARS-IMU. Parameters, such as mounting orientation at which pitch and roll output zero degrees, preferred CAN bus address, signal update rate, filter settings, etc., may be set in the personality file. Once settings are determined for an application, they may be saved using a unique name for the personality file. This enables the same hardware, e.g., TARS-HCASS, to be customized for one application using personality file A, and quickly changed to be customized for another application using personality file B, etc. The TARS-IMU may be customized at the point of installation by loading the appropriate personality file.

7.3 FIRMWARE DEPLOYMENT

As described in section 7.2, the personality file may be used to allow the same TARS-IMU hardware to be configured for many different applications. Similarly, the application firmware may be deployed at the point of installation. Applying the application firmware and the personality file at the point of installation allows for deployment of firmware with minimal part numbers established for purchase. If preferred, the TARS-IMU may be preloaded with specific application firmware and personality file and identified by a unique catalog listing, TARS-LCASS-NNN or TARS-HCASS-NNN, where NNN designates a unique 3-digit number.

8.0 TARS CONFIGURATOR TOOL (TCT) SOFTWARE

8.1 DESCRIPTION

The TARS-IMU may be customized to best meet application needs by using the TCT software to change selected parameters, such as broadcast rate, orientation, filter settings, etc. This tool creates a unique personality file which is then uploaded to the TARS-IMU for implementation.

⚠ WARNING
PERSONAL INJURY, EQUIPMENT DAMAGE

Ensure TCT software users understand how:

- The TARS-IMU output is used in the end application.
- The TARS-IMU output impacts the function and safety of the products in which it will be used.
- Potentially hazardous operating conditions may result from the activity or non-activity of a control system responding to the output of a TARS-IMU that has been customized by a personality file created with the TCT software.
- Implementing a personality file in a TARS-IMU that is unsuitable for an application may result in damage to equipment, the surrounding environment, and/or injuries to personnel. Risks exist so long as the unique personality file is loaded on the TARS-IMU.

Failure to comply with these instructions could result in death or serious injury.

8.2 IMPORTANT USER INFORMATION

NOTICE
USER HELP

The information in this section (8.0) provides an overview of the TCT software and is not intended to provide a complete review of its functionality. For user help:

- Refer to the "TARS Configurator User Manual" available under the TCT software "Help" menu item.
- To view additional information about customizable parameters, hover over these items in the TCT software and a grey box will appear containing the information.

8.3 TCT SOFTWARE DOWNLOAD

To access the TCT software, go to following link and download the file "TARS Configurator Tool" to a location of your choice on your computer. Activate by double-clicking on the .exe file.

https://sensing.honeywell.com/sensors/inertial-measurement-unitsd/tars-imu-series

8.4 PERSONALITY FILE MANAGEMENT

Personality files are saved using the following standard memory storage formats:

- Motorola S record (.srec)
- Intel Hex format (.hex)

Personality files may be created and downloaded to the TARS-IMU. The personality file currently loaded on a TARS-IMU may be read and saved.

8.5 ORIENTATION AXIS AND COORDINATE SYSTEM

The TARS-IMU is oriented using the North/East/Down convention (see Figure 5): X axis facing forward, Y axis facing right, and Z axis facing down. The extrinsic axis frame of reference for the TARS-IMU is as follows: X axis = positive at front side, Y axis = positive at right side, Z axis = positive at bottom side.

FIGURE 5. TARS-IMU AXES

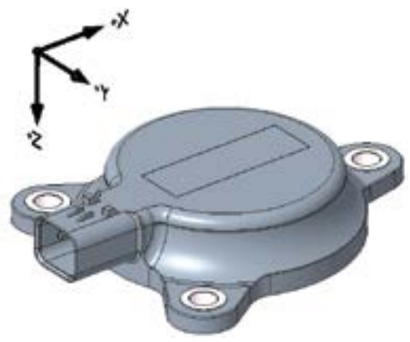


TABLE 14. TARS-IMU ORIENTATION

CONFIGURATION[1]	POSITIVE ROTATION[2]	DESCRIPTION
yaw	clockwise	rotation about the Z axis
pitch	clockwise	rotation about the Y axis
roll	clockwise	rotation about the X axis

[1] Orientation is configured in the order of yaw, pitch, roll.
[2] Positive rotation is established using the right-hand rule.

TRANSPORTATION ATTITUDE REFERENCE SYSTEM,
TARS SERIES
Issue D
32332897

8.6 CUSTOMIZABLE PARAMETERS

The TCT software facilitates adjustment of the following parameters within range limits.

8.6.1 J1939 TAB (FIGURE 6)

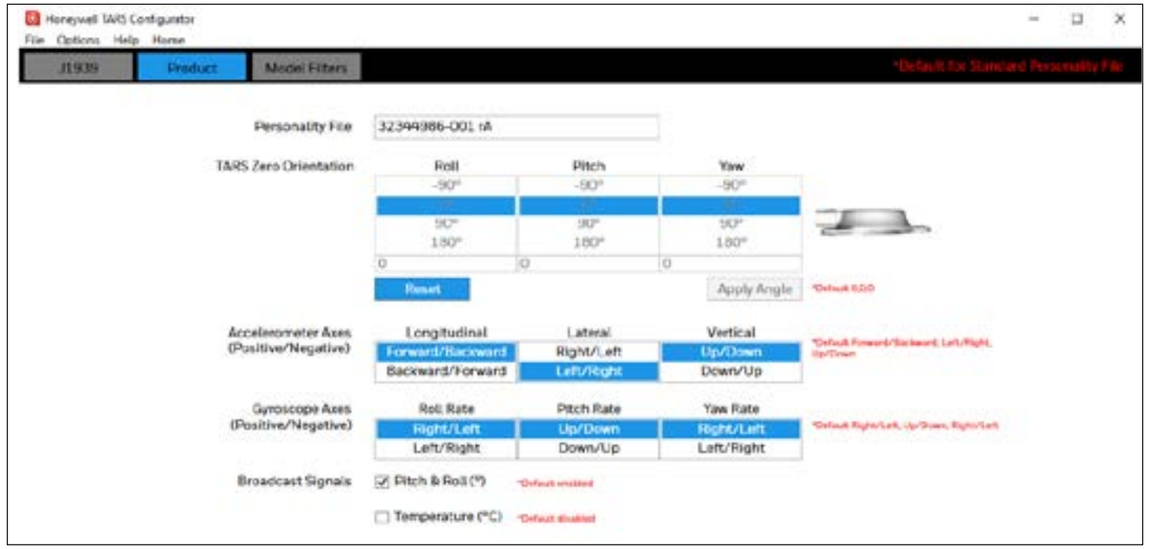
- **J1939 Preferred Address.** Assign a unique CAN bus address.
- **CAN Baud Rate.** Set the rate at which data is transferred.
- **CAN Broadcast Rate.** Set a controlled update rate for the broadcast of PGNs.

FIGURE 6. J1939 TAB

8.6.2 PRODUCT TAB (FIGURE 7)

- **TARS Zero Orientation.** Set the orientation at which pitch and roll outputs will read zero degrees when mounted to machinery (see also Figure 5).
- **Accelerometer Axes.** Alter the sign convention for acceleration output.
- **Gyroscope Axes.** Alter the sign convention for angular rate output.
- **Broadcast Signals.** Select which signals to broadcast on the CAN bus.

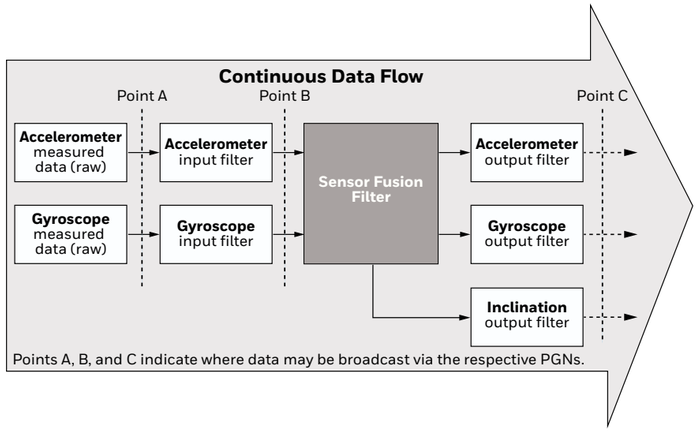
FIGURE 7. PRODUCT TAB



8.6.3 MODEL FILTERS TAB (FIGURE 9)

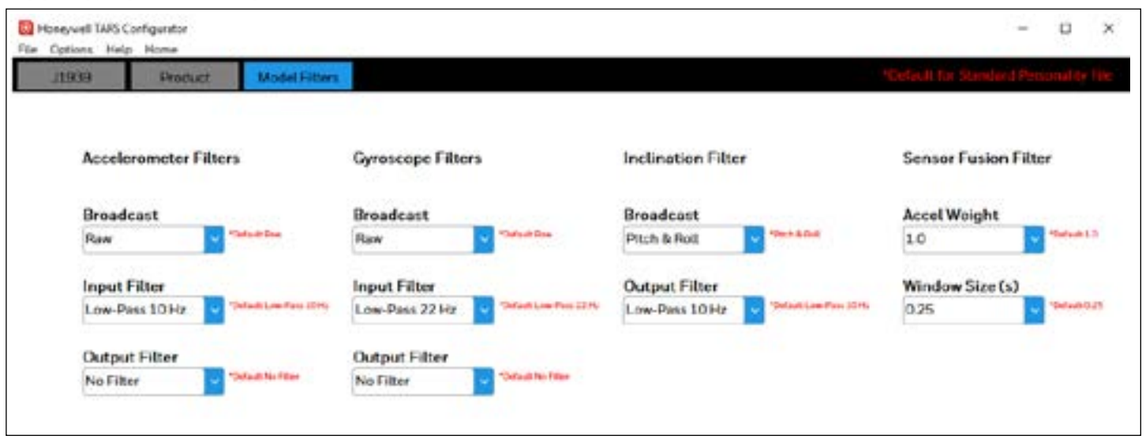
Figure 8 represents an overview of the data flow through the TARS-IMU.

FIGURE 8. DATA FLOW BLOCK DIAGRAM



- **Accelerometer Filters.** Select the data to be broadcast to PGN 61485: data from Point A (raw), Point B (after the input filter is applied), or Point C (after the output filter is applied). Assign which filters to apply to data both before and after Sensor Fusion Filter (input and output filter selection).
- **Gyroscope Filters.** Select the data to be broadcast to PGN 61482: data from Point A (raw), Point B (after the input filter is applied), or Point C (after the output filter is applied). Assign which filters to apply to data both before and after Sensor Fusion Filter (input and output filter selection).
- **Inclination Filter.** Assign which filter to apply to PGN 61481 broadcast data after Sensor Fusion Filter (output filter selection).
- **Sensor Fusion Filter.** Adjust the weighting factor on accelerometer data (higher values apply more weight to accelerometer data and less to gyroscope data). Set the window of time used to monitor incoming data.

FIGURE 9. MODEL FILTERS TAB

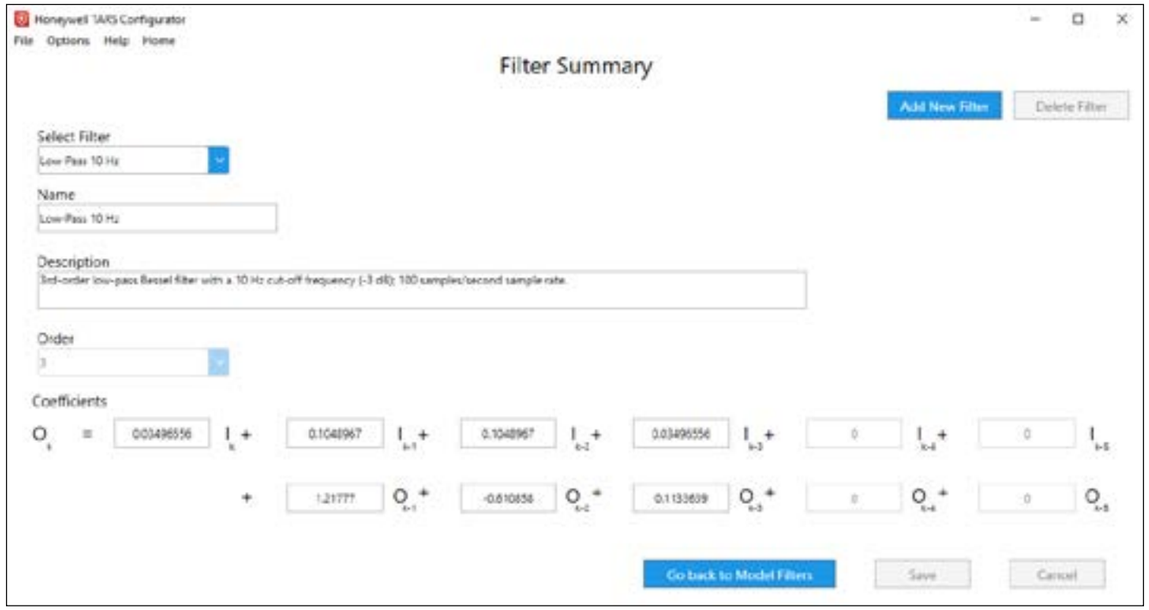


8.7 MODEL FILTER MANAGEMENT (FIGURE 10)

The "Filter Summary" page facilitates the following:

- Creation of new input/output filters
- Adjustment of Bessel filter equation coefficients

FIGURE 10. FILTER SUMMARY PAGE



⚠ WARNING
PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.

Warranty/Remedy

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship during the applicable warranty period. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgment or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items that Honeywell, in its sole discretion, finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

While Honeywell may provide application assistance personally, through our literature and the Honeywell web site, it is buyer's sole responsibility to determine the suitability of the product in the application.

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this writing. However, Honeywell assumes no responsibility for its use.

Honeywell serves its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact your local sales office or:

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Internet: sps.honeywell.com/ast
Phone and Fax:
USA/Canada +1-302-613-4491
International +1-815-235-6847; +1-815-235-6545 Fax

Honeywell
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830 East Arapaho Road
Richardson, TX 75081
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