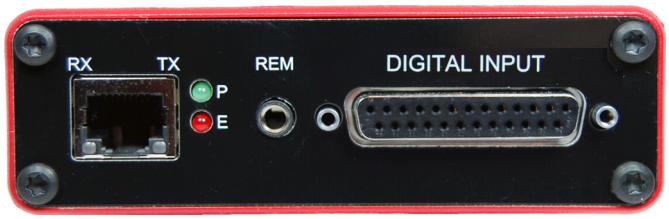
Titan
Mini-Digital Pod

User Manual Supplement



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Warning

Only a qualified technician or representative of Mars Labs should attempt to service the components of this system. There are no user-serviceable parts inside.

For safety and protection of the equipment, power must be turned off prior to connecting or disconnecting cables and sensors.

Titan Mini-Digital Pod Supplement v2.3
MNL 1015
September 2023

Table of Contents

Introduction

Designed to add digital sensor support to Titan Mini-Recorders, the optional Mini-Digital Pod expansion board supports up to five digital sources, including three CAN_FD inputs (ISO & non-ISO, rates up to 1M), one serial input and one GPS input. Data obtained from the digital sources is merged with sensor data from the 16 analog channels, resulting in a composite data stream that can be recorded, observed, analyzed and archived using the Titan Control Software (TCS) application.

This supplement is intended to provide an overview of the Titan Mini-Digital Pod with complete feature descriptions, specifications, and connection and operational information. It contains important safety information as well.

NOTE: *Titan products that include the optional Mini-Digital Pod expansion board are identified by the additional "DF' in the product name:*

Titan BMS16HR-53 -> 16 analog input channels
Titan BMS16HRDF-53 -> 16 analog input channels plus digital channels

Furnished Accessories

Titan devices that include a Mini-Digital Pod may also be shipped with an optional Breakout Cable Assembly. This cable splits the DB-25 Digital Input connector into individual DB9 connections for CAN, Serial, and GPS data sensors, and is optimally configured for the Lord Microstrain 3DM Inertial Measurement Unit (IMU):

Mars Labs P/N ICA-TIDP5 - Mini-Digital Pod Breakout Cable

NOTES:
1. *See the Mini-Digital Pod Breakout Cable drawing on page 21*
2. *Custom breakout cable configurations (powered and unpowered) are also available; please contact the factory for more information.*

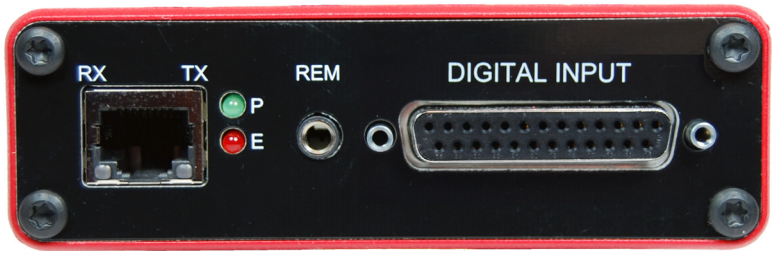
Support

Support for this product is available by contacting the factory during regular business hours (9am – 6pm EST) at 301-470-3278. Additional information can be found on our web site: http://www.marslabs.com

Operation

Rear Panel

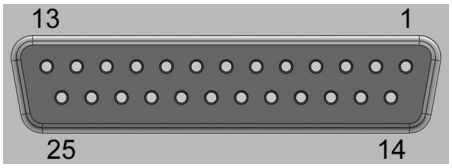
Titan devices that include the Mini-Digital Pod expansion board have a modified rear panel that accommodates the Digital Input connection. The Digital Input connector is a female DB-25 as shown below. The pinout of the digital input connector is defined in the following section.



NOTE: *The function of the COMM port, LED status indicators, and Remote [REM} jack are described in the Mini-Recorder User Manual.*

Connectivity

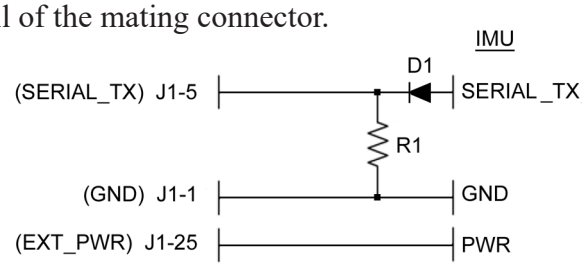
The Digital Input connector pinout and orientation is displayed at right and below. The connector view shown (DB-25F) is looking *into* the rear panel.



1		GND
	14	CAN1_L
2		CAN1_H
	15	CAN2_L
3		CAN2_H
	16	GPS_PPS
4		GPS_TX
	17	GPS_RX
5		IMU_TX
	18	IMU_RX
6		CAN3_L
	19	CAN3_H
7		(Reserved)
	20	(Reserved)
8		(Reserved)
	21	(Reserved)
9		(Reserved)
	22	(Reserved)
10		(Reserved)
	23	(Reserved)
11		(Reserved)
	24	(Reserved)
12		(Reserved)
	25	EXT_PWR
13		GND

IMU Connection

The interface to the IMU requires the additional circuitry shown below. To insulate and protect the components, the diode and resistor should be wired inside the backshell of the mating connector.



Components: D1 - 1N4148
R1 - 1K ohm

NOTE: *The optional Mini-Digital Pod Breakout Cable (ICA-TIDP5) includes the IMU interface circuitry shown. For information on fabricating your own interface cable, see the drawing on page 21.*

Features and Specifications

Key Features

- Provides three CAN inputs, plus GPS and Serial Data inputs
- CAN ports support CAN FD (ISO and non-ISO), SAE J1939, and multiple WFT protocols,including Kistler and Michigan Scientific
- Supports CANbus rates up to 1 Mb
- Support for the 3DM-GXx-25 Inertial Measurement Unit (IMU) [6 DOF channels and 3 Euler channels]
- GPS support for the Garmin LX18-5Hz [12 channels + PPS]
- Connection via industry-standard D-sub connector

Specifications

Physical Interface:	DB-25 female
Power Requirements:	Power is supplied by the Titan Mini-Recorder or Pod

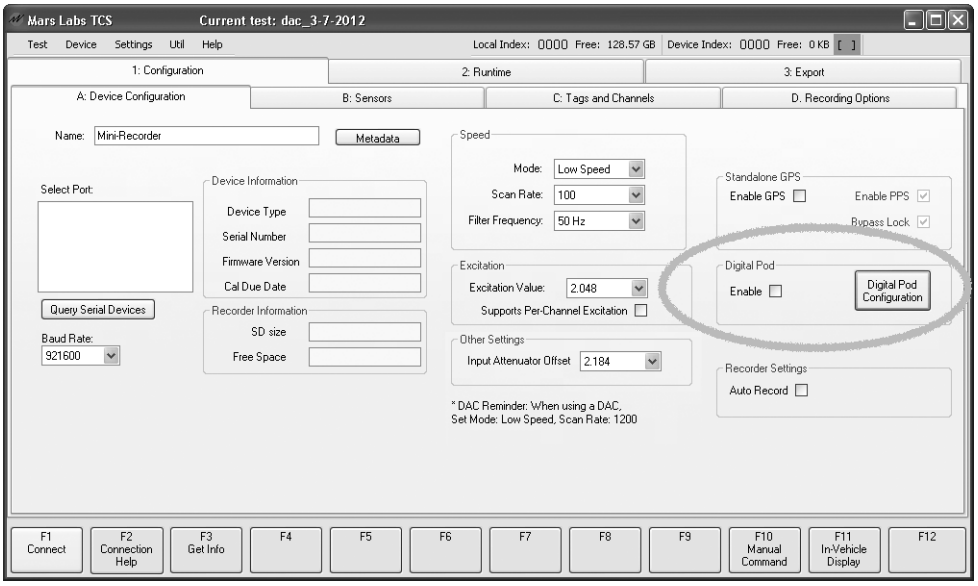
Optional Accessories

ICA-TIDP5 – Mini-Digital Pod Breakout Cable
CBL-OBDIDP1 – DB9 to OBD2 Adapter Cable

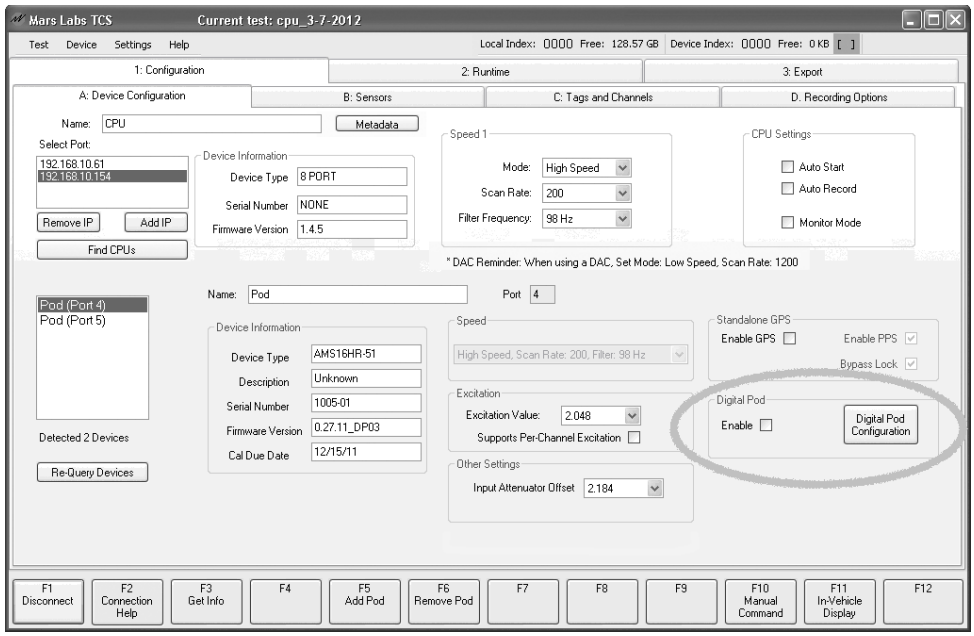
Configuring the Digital Pod in TCS

NOTE: *The information presented here is duplicated in the TCS User Manual.*

Digital sensors are configured on the *Device Configuration* screen by enabling the Digital Pod and clicking on the Digital Pod Configuration button:

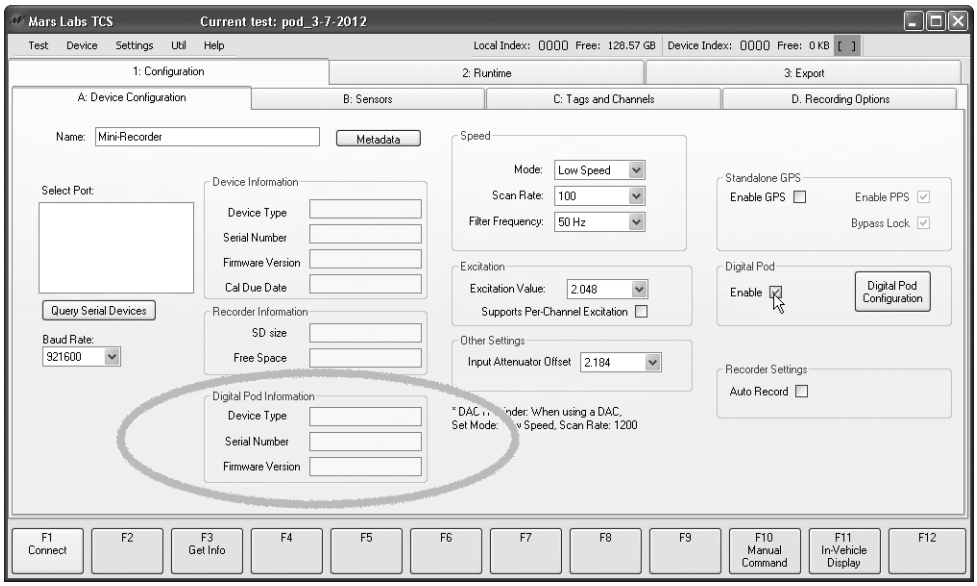


Mini-Recorder screen (similar for DAC screen)



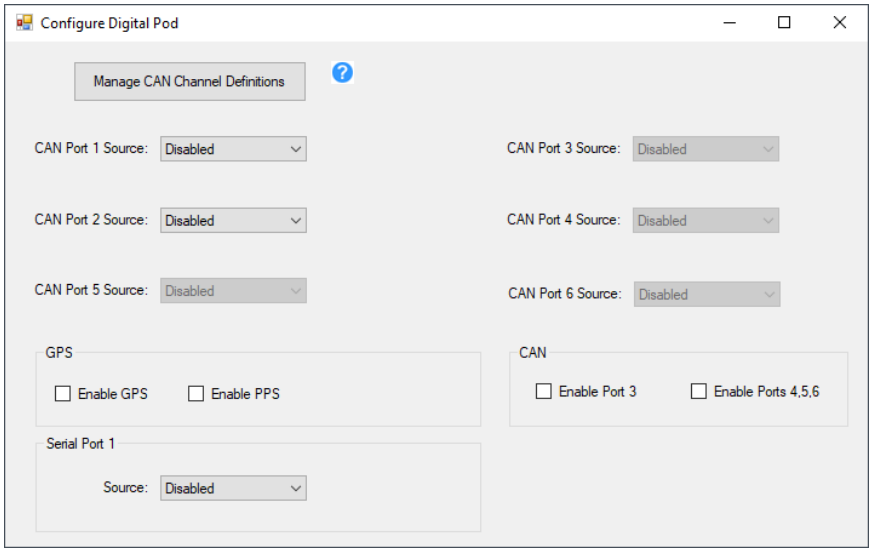
Titan CPU screen

When the Digital Pod 'Enable' box is checked, TCS sets up the communication parameters for the Digital Pod and adds information fields to the *Device Configuration* screen as shown:



Mini-Recorder screen

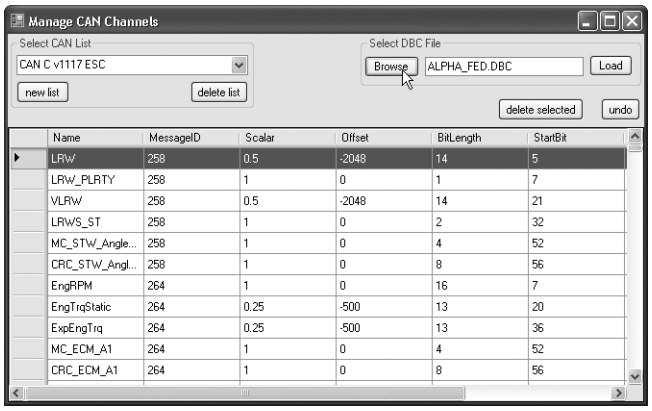
Clicking on the 'Digital Pod Configuration' button produces a configuration window that allows you to select setups for CAN ports, the GPS and Serial inputs, as well as access a CAN channel definition management function:



***NOTE:** The Digital Pod supports both ISO CAN and non-ISO CAN protocols. **The factory default setting is ISO CAN**. CAN ports can be switched between ISO CAN and Non-ISO CAN modes.*
For more information, refer to 'Changing the CAN Mode', pg 18

Managing CAN Channel Definitions

The ‘Manage CAN Channels Definitions’ button produces a configuration window that allows you to select and manage channel definitions in DBC files:



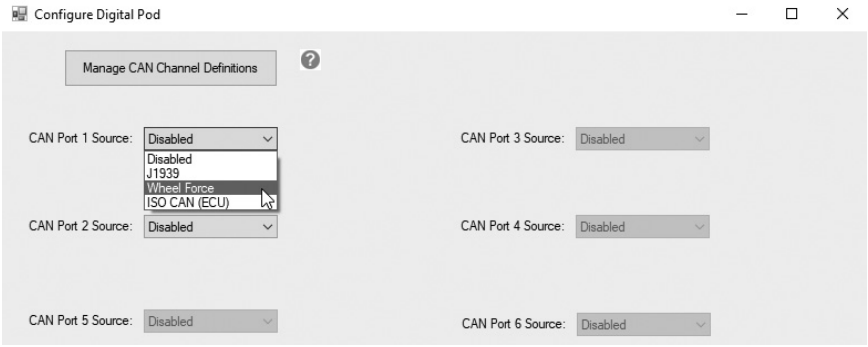
CAN Channel Management Window controls:

Browse – Selects the DBC file
Load – Loads the selected DBC file into TCS
Select CAN List – A dropdown that displays the DBC files that have been loaded
New List, Delete List, Delete Selected and Undo – Functions not yet implemented

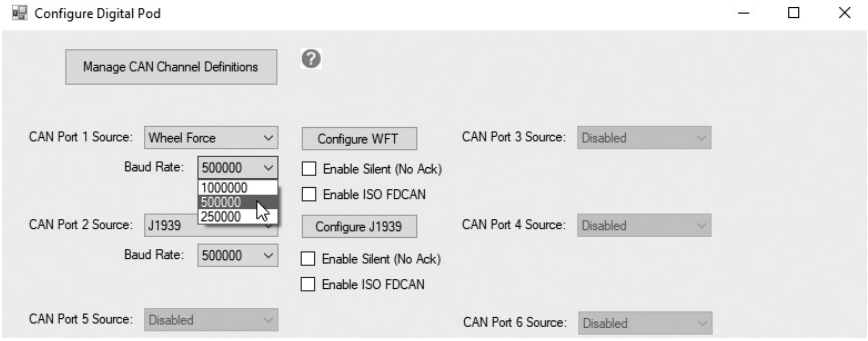
NOTE: *When configuring the Digital Pod for Wheel Force Transducers, you will need to load the associated DBC file into the CAN Management window prior to configuring the WFT.*

Configuring CAN Port Sources

CAN Port Sources are selected from a dropdown menu as shown:



After selecting a CAN Port source, a Baud Rate selection dropdown is displayed along with a button to access the configuration options for the selected source ('Configure ISO CAN', 'Configure WFT' or 'Configure J1939'), and a checkbox to enable Silent mode (when enabled, no acknowledgement sent in response to CAN channel messages - see NOTE below)



The recommended Baud Rate setting is dependent on the chosen CAN source:

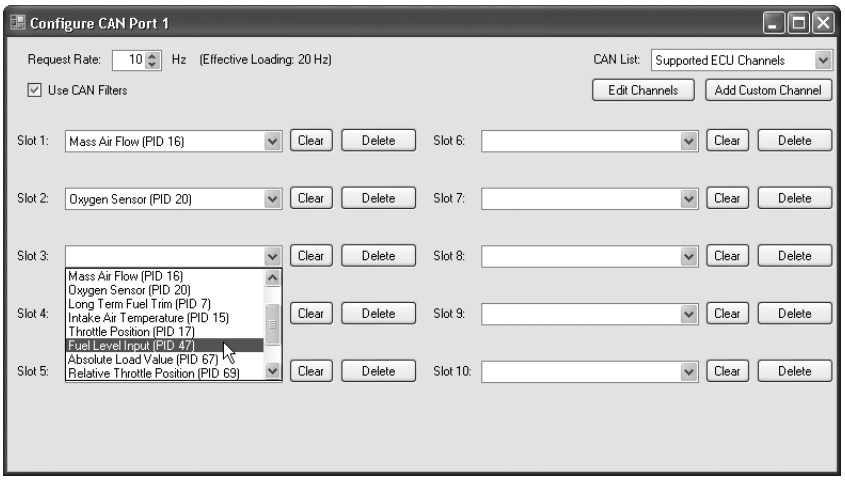
For J1939: 250,000
For WFT: 500,000
For ISO CAN: 500,000 or 250,000

The specific configuration options for each CAN Port Source, as well as the GPS and Serial Port, are described in the following pages.

NOTE: *The CAN ports on Digital Pods default to NORMAL mode. This allows the hardware to automatically send acknowledgements upon the reception of CAN frames. In some situations, however, you may want to monitor the CAN bus without interacting with it, or stop issuing acknowledgements for other reasons. For these situations, enabling SILENT mode prevents acknowlegement messages from being issued.*

ISO CAN

The ‘Configure ISO CAN’ button produces a configuration window that allows you to assign ECU channels as shown. Up to ten ECU channels can be assigned:



Managing CAN Channel Definitions

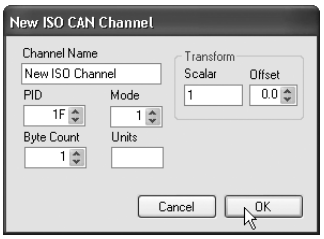
ISO CAN is request-based; that is, the system will not receive any data unless it asks for it. Because of that, you must define the channels that the Digital Pod will request and how frequently it will issue requests. There is a practical limit to how frequently a CAN bus can be requested, which is determined by the effective loading: one request for each channel, multiplied by the request rate. If the system issues requests too frequently, the CAN bus will be overloaded and you will receive no data. Mars Labs has determined that a reasonable request rate with most vehicles is 10 Hz, effective loading. Your system may be able to handle more frequent requests - this will provide more data points. To change the request rate, use the Request Rate field in the top left of the form.

TCS comes with several pre-defined channels from the list of standard Parameter Identifiers (PIDs). Not all cars implement all of these channels, but the list is provided as a starting point to creating tests with ISO CAN. This is the list that is selected by default as the source of channel definitions, since there are no user-defined channels when you start TCS.

To enable a channel, click on the dropdown associated with the slot you wish to use as shown above. You will see a list of channels in the currently selected set of definitions. Click on the one you want to use.

Defining a Custom Channel

To define a custom channel, click on the 'Add Custom Channel' button at the top right of the ISO CAN configuration window. In the 'New ISO CAN Channel' window, you must specify all of the components that make up an ISO CAN channel. An exception here is the 'Units' field, which TCS uses to display the data; 'Units' is not integral to the data collection in the way other fields are.



PID (Parameter Identifier) is the unique number identifying the channel, specified in hex.

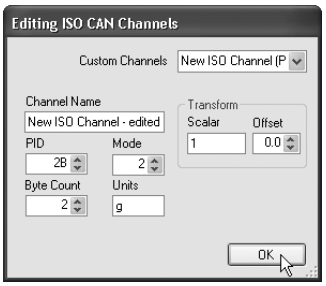
'Mode' is the CAN mode; a value of 1 indicates 'show current', which is usually correct, unless you need to configure something that is manufacturer-specific.

'Byte Count' refers to the number of data bytes in each message from the ECU.

The transform group defines how to handle the data in each message in the format '(scalar * data) + offset'.

Editing a Custom Channel

To change a custom channel that is already defined, click on the 'Edit Channels' button on the ISO CAN configuration window. This will launch a new window, allowing you to select from the list of user-defined channels and edit their values:



Selecting Custom Channels

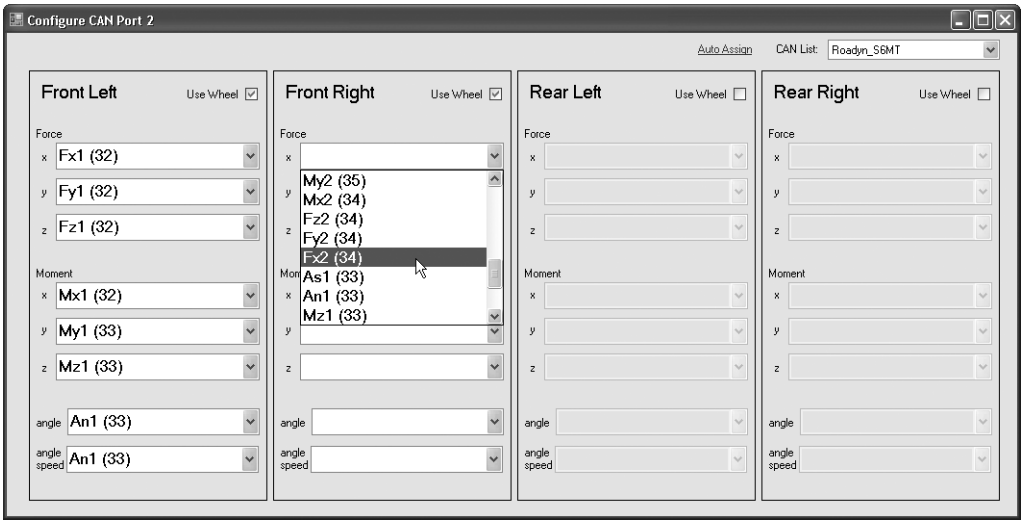
To assign a custom channel to a slot, select 'Custom Channels' from the CAN list dropdown in the upper right corner. This will change the available selection in the slot dropdowns from predefined to custom channels:

Any assigned slot can be cleared by clicking on the associated 'Clear' button. If the slot contains a custom channel, that channel can be deleted by clicking on the associated 'Delete' button.

NOTE: *The 'Delete' button will not remove a predefined channel.*

Wheel Force Transducer

The ‘Configure WFT’ button produces a configuration window where you assign channels to individual wheel force elements:



The parameters that appear in the dropdowns are derived from the ‘CAN List’ DBC selection in the upper right corner.

NOTE: *Listings that appear in the ‘CAN List’ dropdown are loaded into TCS from the ‘Manage CAN Channel Definitions’ window*

If the channel names in the selected DBC file match the field labels in TCS, clicking on the ‘Auto Assign Channels’ button will automatically map the proper channels to all wheels, eliminating the need for individual assignments.

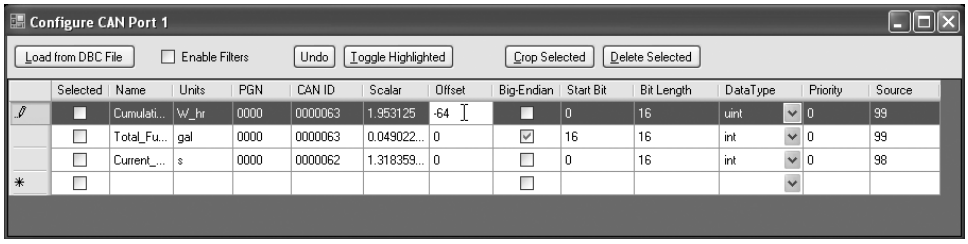
After all channel assignments are complete, clicking on the close box enters the assignments into TCS. Channel assignments are stored when the test is saved.

Other WFT Configuration Window Controls:

CAN List – A dropdown to select DBC files
Auto Assign Channels – A button that automatically assigns the proper channels when the channel names in the DBC file match TCS field labels
‘Use Wheel’ – Checkboxes to enable/disable selected wheel tables

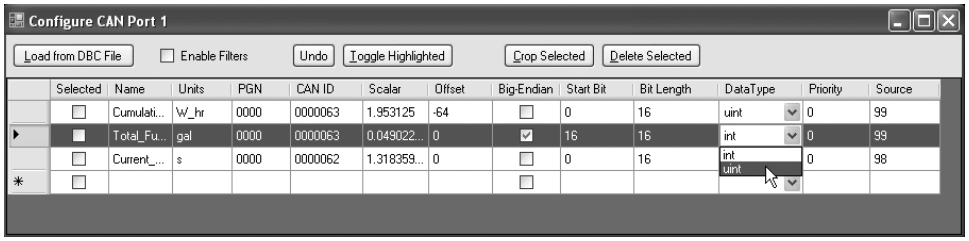
J1939

The ‘Configure J1939’ button produces a configuration window that allows you to load an existing DBC file, select/delete channels, edit field values (shown below), or define additional channels by manually entering the data (an example of manual entry appears on the following page):



NOTE: *The CAN ID value comprises the Priority, Parameter Group Number (PGN) and Source values. The Can ID value is displayed in Hex. The PDU is formatted as two bytes in Hex and represents the PDU Format and PDU Specific values.*

The ‘Data Type’ drop-down menu selects signed integer (‘int’) or unsigned integer (‘uint’) values:



Channel Selections

To select contiguous channels in DBC files, select the first channel, hold the SHIFT key and then select the last channel. All channels between these two points will be selected. To make non-contiguous ‘island’ selections, hold the CTRL key while clicking on desired channels. After making selections, use the ‘Crop’ or ‘Delete’ buttons to trim the list to the desired test configuration.

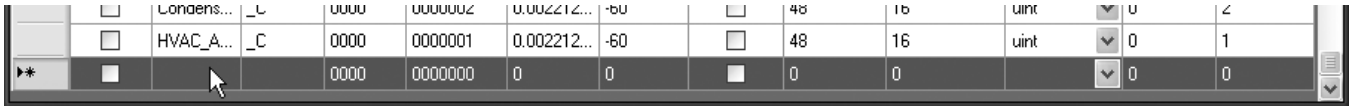
J1939 Configuration Window Controls:

Load from DBC File – Allows you to select and load a DBC file
Enable Filters – When checked, this sets up filters based on the message ID for each configured J1939 channel.
Undo – Undo the last action
Toggle Highlighted – Toggles all selected channels ON/OFF.
Crop Selected – Retains selected channel definitions and deletes all others
Delete Selected – Deletes selected channel definitions

After all channel assignments are complete, clicking on the Close box enters the assignments into TCS. Channel assignments are stored when the test is saved.

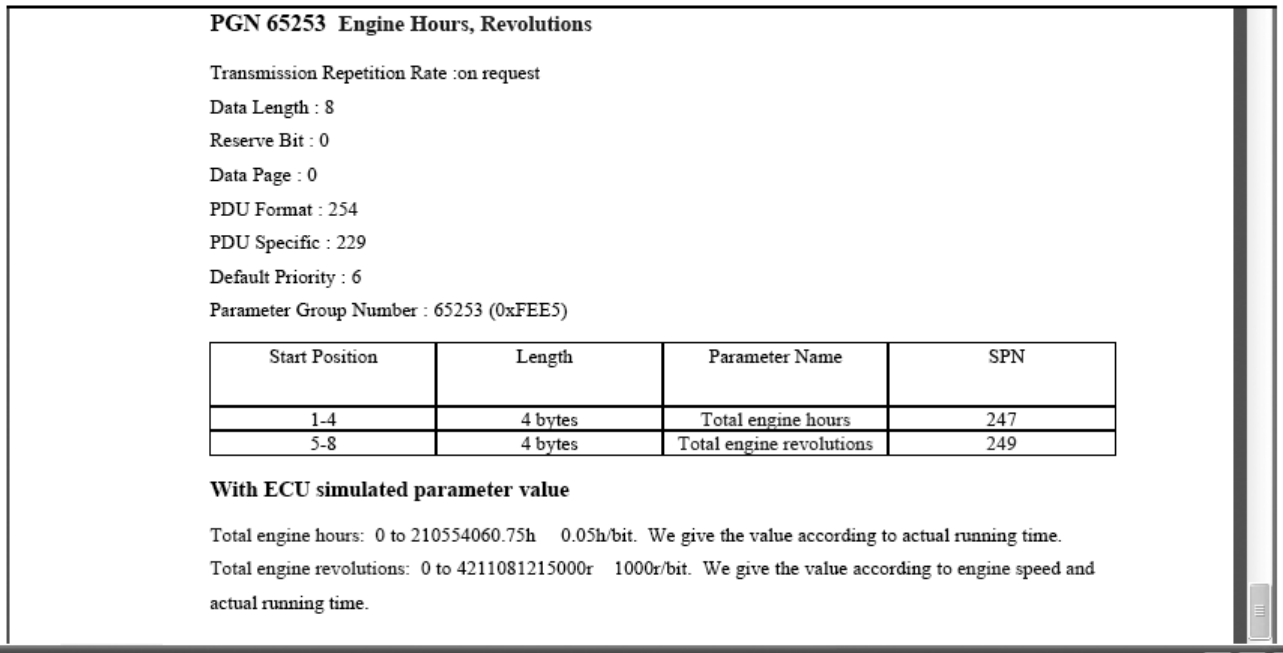
J1939 - Manual Entry

To add a manual entry to an existing DBC file, scroll to the bottom of the file and make the entry in the field marked by the asterisk (*):



		Condens...	_C	0000	0000002	0.002212...	-60		48	16	uint	0	2
		HVAC_A...	_C	0000	0000001	0.002212...	-60		48	16	uint	0	1
*				0000	0000000	0	0		0	0		0	0

An example of manual entry of several J1939 channels from a data sheet:



PGN 65253 Engine Hours, Revolutions

Transmission Repetition Rate :on request

Data Length : 8

Reserve Bit : 0

Data Page : 0

PDU Format : 254

PDU Specific : 229

Default Priority : 6

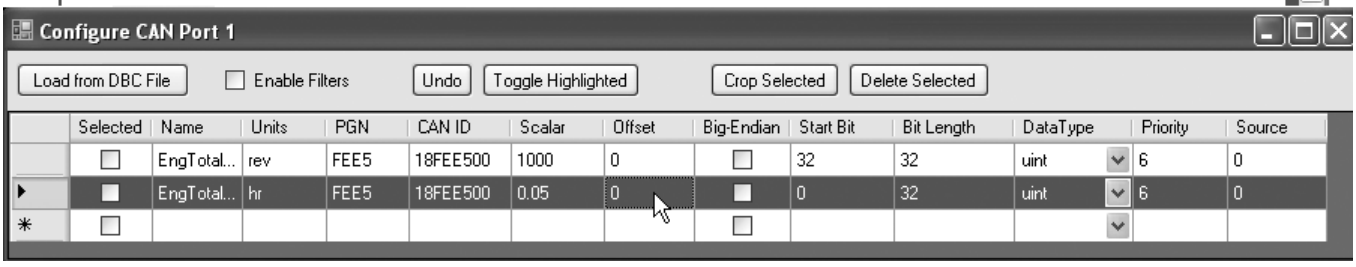
Parameter Group Number : 65253 (0xFEE5)

Start Position	Length	Parameter Name	SPN
1-4	4 bytes	Total engine hours	247
5-8	4 bytes	Total engine revolutions	249

With ECU simulated parameter value

Total engine hours: 0 to 210554060.75h 0.05h/bit. We give the value according to actual running time.

Total engine revolutions: 0 to 4211081215000r 1000r/bit. We give the value according to engine speed and actual running time.



Configure CAN Port 1

Load from DBC File | Enable Filters | Undo | Toggle Highlighted | Crop Selected | Delete Selected

	Selected	Name	Units	PGN	CAN ID	Scalar	Offset	Big-Endian	Start Bit	Bit Length	DataType	Priority	Source
		EngTotal...	rev	FEE5	18FEE500	1000	0		32	32	uint	6	0
▶		EngTotal...	hr	FEE5	18FEE500	0.05	0		0	32	uint	6	0
*													

Note that the TCS Start Bit is the bit position of the channel message. If the data sheet lists the Start Position instead of the Start Bit (as shown above), the Start Bit is computed as:

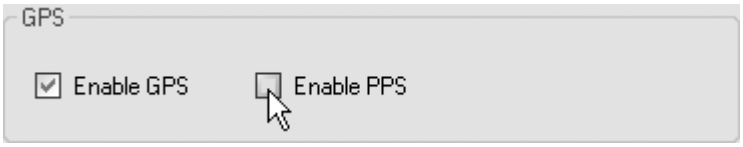
(Start Position -1) * 8

For example, a Start Position of ‘5’ translates to a Start Bit value of ‘32’:

(5-1) * 8 = 32

Note that the Bit Length parameter in TCS is specified in bits, not bytes. Note also that the Parameter Group Number (PGN) is entered as a decimal value. TCS converts the value to Hex and automatically computes the CAN ID value using the PGN, Priority and Source values.

GPS



Checking the 'Enable GPS' box enables the Digital Pod's GPS port to accept data from a Garmin LX18X 5 Hz sensor.

Checking the 'Enable PPS' box enables the Digital Pod's GPS port to accept Pulse Per Second data from the Garmin LX18X 5Hz sensor.

NOTE: *Whenever the GPS/PPS option is enabled in the Digital Pod, PPS must also be enabled on the Device Configuration page. If the PPS option is not selected, PPS data exports will not increment as expected.*

Serial Port

Serial port sources are selected from a dropdown menu in the Serial Port pane. Support is provided for 3DM-GX3 and 3DM-GX5 IMU devices. The baud rate setting is fixed at 115,200, which means that you will need to configure your IMU device to stream data at the same rate.

NOTE: *If an IMU is supplied by Mars Labs, the IMU will be pre-configured for the proper baud rate, the sample rate (125 Hz), and messaging output (Acceleration, Angular Rate and Orientation matrix).*

NOTE: *Because the Digital Pod configuration screen is much smaller than the TCS window, it's possible for the Digital Pod configuration screen to fall behind the TCS window, appearing to be closed. Since changes to the Digital Pod configuration do not take place in TCS until the configuration screen is closed, it's possible to make changes without the changes actually taking effect. For this reason, always be sure to close the Digital Pod configuration screen after making assignments or changes.*

Changing the CAN mode

The Digital Pod supports both ISO CAN and non-ISO CAN protocols. **The factory default setting is ISO CAN.** Any of the three CAN ports can be switched between ISO CAN and non-ISO modes using the following procedure. Note that there are two preamble commands (step 3) that must always be issued BEFORE issuing the change mode commands. Once changed, the new mode is persistent thru power cycles.

For devices directly-connected via USB (standalone operation):

1. Launch TCS and Connect [F1] to the Titan device.
2. In TCS, select [F10] 'Manual Command'
3. In the Manual Command window, enter:
   SET_AUX_BAUD_RATE 1843200<CR>
   TCS will respond with an acknowledgement (ACK)
   AUX GET_SW_VERSION<CR>
   TCS will respond with the current software version.
   These commands prepare the device for the Mode change.

4. To set a CAN port for 'ISO OFF' (non-ISO), enter:
   AUX SET_CAN1_NISO 1<CR> (for CAN1)
   AUX SET_CAN2_NISO 1<CR> (for CAN2)
   AUX SET_CAN3_NISO 1<CR> (for CAN3)

5. To set a CAN port for 'ISO ON' (ISO), enter:
   AUX SET_CAN1_NISO 0<CR> (for CAN1)
   AUX SET_CAN2_NISO 0<CR> (for CAN2)
   AUX SET_CAN3_NISO 0<CR> (for CAN3)

6. To check the setting for a given port, enter:
   AUX GET_CAN1_NISO<CR>
   AUX GET_CAN2_NISO<CR>
   AUX GET_CAN3_NISO<CR>

   The value that is returned indicates the current mode ('0' = ISO, '1' = non-ISO)

For devices connected to a Titan CPU Channel Expander (system configuration):

1. Launch TCS and Connect [F1] to the Channel Expander
2. In TCS, select [F10] 'Manual Command'
3. In the Manual Command window, enter:
   SET_PORT X <CR> where 'X' is the port number of the connected device with the Internal Digital Pod.
   Note that you must place a space before the value 'X' in the command
   For a 12-Port Channel Expander, valid input values are 1 thru 12
4. With the desired port selected, enter the preamble commands from step 3 above for directly-connected devices and follow the remaining steps.

Notes & Known Issues

HARDWARE

Setting the Scan Rate

The scan rate setting for analog data *must be greater than or equal to* the output of Wheel Force Transducer.

Analog Scan Rate >= WFT Output

Remote Recording Issues with large files

Due to the speed at which data can be written to the SD card, there is a limitation on the amount of data that remote recording will support. Tests performed at the factory have determined that file sizes of about 200KB is the practical upper limit for remote recording (independent of the scan rate). This file size is the equivalent of 1 analog sensor (i.e. a default sensor) plus 700 digital (CANbus) channels.

Power Cycling the Device

When power cycling a device with a Mini-Digital Pod, you should remove power and then wait at least 10 seconds before re-applying power. If power is reapplied too quickly, the device may power up scanning (the behavior is unpredicatable).

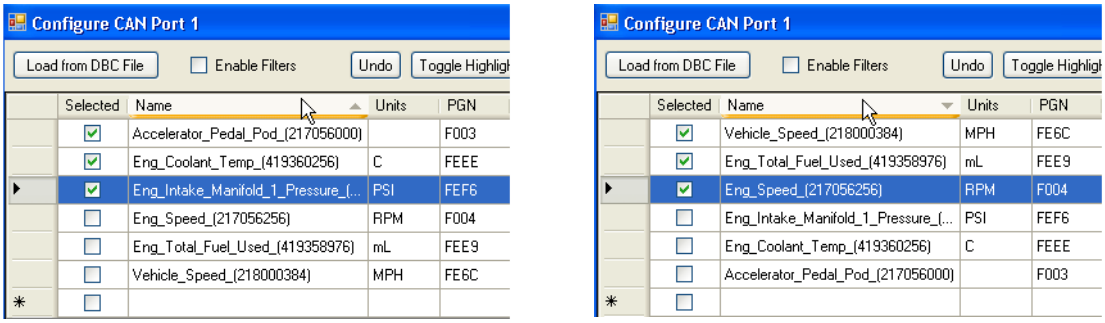
Configuration Times - Sending scan data to the Pod

When starting a scan with large files there may be a considerable wait time while TCS sends the configuration data to the Pod. TCS may not issue any messages while configurations are being transmitted.

SOFTWARE (TCS)

Selecting J1939 channels

When selecting J1939 channels in the 'Configure CAN Port' display, the checkboxes that are enabled do not move with the associated channels when the channels are sorted:



The example above shows that clicking on 'Names' column header reverses the sorting order of the entries, but the 'Selected' checkboxes do not follow the re-ordered display.

Digital Pod Display

1. The Digital Pod Display will support up to 250 channels; any channel past that number is not displayed. Recording of digital data is not affected by this limitation.

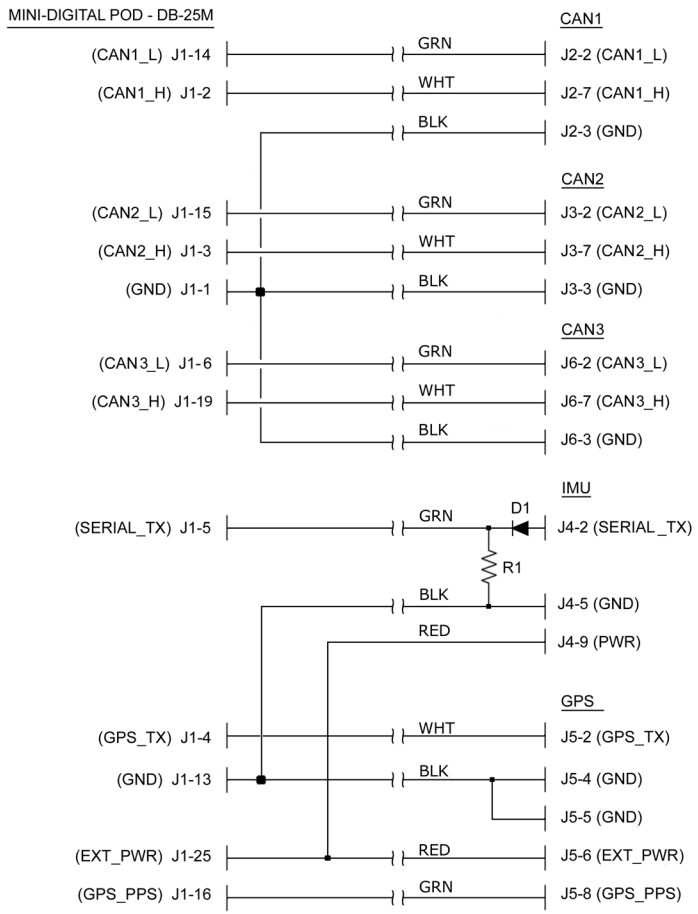
2. When J1939 is selected on both CAN ports, TCS will display all channels from Port 1 before displaying channels from Port 2.

3. If the Digital Pod Display screen is resized after scrolling to the bottom of a large list of values, the screen will not properly display all channels when you scroll back to the top. If this happens, switch away from the Digital Pod Display and then switch back again. This will refresh the screen and all channels will be displayed. Recording of digital data is not affected.

Digital Pod Configuration:

Whenever the GPS/PPS option is enabled in the Digital Pod, PPS must also be enabled on the Device Configuration page. If the PPS option is not selected, PPS data exports will not increment as expected.

BREAKOUT CABLE



REFERENCE

MINI-DIGITAL POD BOARD PINOUT - DB25F:

1	⊢	GND
14	⊢	CAN1_L
2	⊢	CAN1_H
15	⊢	CAN2_L
3	⊢	CAN2_H
16	⊢	GPS_PPS
4	⊢	GPS_TX
17	⊢	GPS_RX
5	⊢	IMU_TX
18	⊢	IMU_RX
6	⊢	CAN3_L
19	⊢	CAN3_H
7	⊢	(Reserved for future use)
20	⊢	(Reserved for future use)
8	⊢	(Reserved for future use)
21	⊢	(Reserved for future use)
9	⊢	(Reserved for future use)
22	⊢	(Reserved for future use)
10	⊢	(Reserved for future use)
23	⊢	(Reserved for future use)
11	⊢	(Reserved for future use)
24	⊢	(Reserved for future use)
12	⊢	(Reserved for future use)
25	⊢	EXT_PWR
13	⊢	GND

REVISION RECORD			
LTR	ECO NO.	APPROVED	DATE
B	PN-1353	EBF	11/17/21
C	PN-1353	EBF	1/3/22

Notes/Assembly Instructions:

1. Mount diode D1 and resistor R1 on the J4 connector so that the components fit inside the backshell.
2. Refer to BOM-2162 for complete part information and cable labeling instructions.
3. Item identification: **ICA-TIDP5**

Breakout Cable Assembly
(image for reference only)

Drawn: GEK	Date: 5/4/16		
Checked: DSP	Date: 5/4/16		
Quality Control:	Date:		
Released: EBF	Date: 5/4/16		

MARS LABS

Title: Mini-Digital Pod Breakout Cable (no CAN power)

Code:	Size:	Drawing No:	Rev:
	B	ASY-2150	C

SHEET 1 OF 1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