APN 044
Displaying Engine Data Using SAE J1939

Jetter

43 Km/h

12:25 Uhr
Time / Date
Backgroundcolor
Language
DM1 Messages
Teachmode
Back

0000332 Km

min⁻¹
x 1000

P x 2 bar

Application Note

Jetter

Table of Contents

1   Introduction

Introduction

This application note provides an overview of the sample application SAE_J_1939 and its functions, and describes how they are used. Once you have read this application note you can copy the program section from the STX program SAE_J_1939 and insert it into your JetSym program. The sample program has been provided with detailed and clearly arranged comments.

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Introduction

Sample Application - Communication on J1939 CAN Bus

This sample application "Displaying Motor Data Using SAE J1939" is supposed to help you getting started with communication between Jetter devices using the SAE J1939 protocol on a CAN bus. This application has been created with the HMI JVM-407 in mind. Its functions are described in detail in the following chapters. The JVM-407 can directly be connected to the vehicle's J1939 CAN bus. It reads and displays engine data, such as engine RPM, speed or coolant temperature.

Required Software

You need the following software tools to upload the sample application to the JVM-407:

- JetSym   Version 4.3.0
- JetViewSoft   Version 3.2.0

Cross References

Besides this application note, you need the following documents:

- User Manual JVM-407 with SAE J1939-STX-API
- Documentation provided by the vehicle manufacturer

Supported Parameters

The sample application supports the following parameters sent over the J1939 CAN bus:

- Speed
- Engine RPM
- Coolant temperature
- Filling level of engine oil
- Oil pressure
- Fuel level
- Odometer reading
- Rear view camera when changing to reverse gear
- Signal: Handbrake applied
- Distance to service
- Trip counter
- Fuel consumption per km
- Fuel consumption per hour
- Coolant level
- Current fuel consumption km/kg / Average fuel consumption km/kg
- DM1 Messages

Restrictions

Depending on the manufacturer, engine controllers may transmit different parameter sets using the J1939 protocol. Therefore, individual features of the instrument cluster used in our example may not be available.

Additional ECUs   The structure of the application program allows for new ECUs to be added without problems. To do so, you need the technical documentation provided by the manufacturer of the ECU. Instead, you may also use the "Teaching mode" implemented in the sample application program SAE_J_1939.
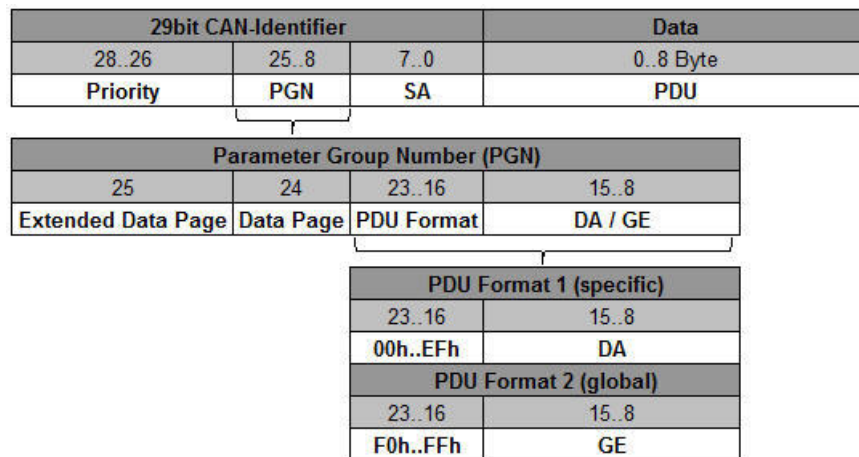
J1939 Protocol - Layer Description

Physical Layer

The protocol SAE J1939 is based on the CAN bus and uses as physical layer CAN Highspeed to ISO 11898.

- Baud rate 250 kBit
- 30 nodes max.
- 2-wire line with a terminating resistor of 120 Ω
- Bus length (without tap line) 40 m
- Max. tap line length 1 m

Content of a J1939 Message

The following diagram shows the content of a J1939 message:

29bit CAN-Identifier			Data
28..26	25..8	7..0	0..8 Byte
Priority	PGN	SA	PDU

Parameter Group Number (PGN)			
25	24	23..16	15..8
Extended Data Page	Data Page	PDU Format	DA / GE

PDU Format 1 (specific)	
23..16	15..8
00h..EFh	DA

PDU Format 2 (global)	
23..16	15..8
F0h..FFh	GE

Abbreviation	Description
DA	Destination Address
GE	Group Extensions
PDU	Protocol Data Unit
PGN	Parameter Group Number
SA	Source Address

Identifier Structure

The following example shows the structure of an identifier (hexadecimal):

0x18**FEE9**27

Identifier component	Description
27	Source Address
FEE9	Parameter Group Number
18	Priority

Meaning of SPN - Suspect Parameter Number

The SPN is a number defined by the SAE J1939 standard containing individual parameters (e.g. engine RPM) as standardized message.

Below is an example of SPN parameters:

spn110 - Engine Coolant Temperature - Temperature of the engine coolant.

Data Length:	1 byte
Resolution:	1 °C/bit , -40 °C offset
Data Range:	-40 to 210 ℃
Type:	Measured value
Suspect Parameter Number:	110
Vehicle Application Layer - J1939-71 (J1939-71 Rev. Aug 2002)	
Parameter Group Number:	[65262]

Meaning of the Parameter Group Number (PGN)

The PGN is a number defined in the SAE J1939 standard that groups together several SPNs into a meaningful group. The PGN is part of the CAN identifier. The 8-byte data (PDU) contain the values of individual SPNs.

The example below shows a PGN 65262 (0xFEEE):

PGN 65262 **Engine Temperature 1** **- ET1**

Part of the PGN	Value	Remarks
Transmission Repetition Rate	1 s	
Data Length	8	
Extended Data Page	0	
Data Page	0	
PDU Format	254	
PDU Specific	238	PGN Supporting Information
Default Priority	6	
Parameter Group Number	65262	in hex: 0xFEEE

Start position	Length	Parameter name	SPN
1	1 byte	Engine Coolant Temperature	110
2	1 byte	Engine Fuel Temperature 1	174
3 - 4	2 bytes	Engine Oil Temperature 1	175
5 - 6	2 bytes	Engine Turbocharger Oil Temperature	176
7	1 byte	Engine Intercooler Temperature	52
8	1 byte	Engine Intercooler Thermostat Opening	1134

Related Topics

- **Workspace Structure** on page 18
- **Description of Structure** on page 19

2   Basic Features

Introduction

This chapter describes the optical structure of the engine data display. For each display element this description provides a brief overview of its functions. This chapter consists of two parts: Start Screen and Function Screen.

Contents

Engine Data Display - Start Screen

Start Screen - Optical Structure

Once you have connected the JVM-407 to the power supply, the HMI starts booting. When the boot process is completed, the start screen is displayed. This screen allows you to select one the following options:

- Language
- Engine manufacturer / Teaching mode (Taught Engine)

The illustration below shows the start screen of the engine data display:
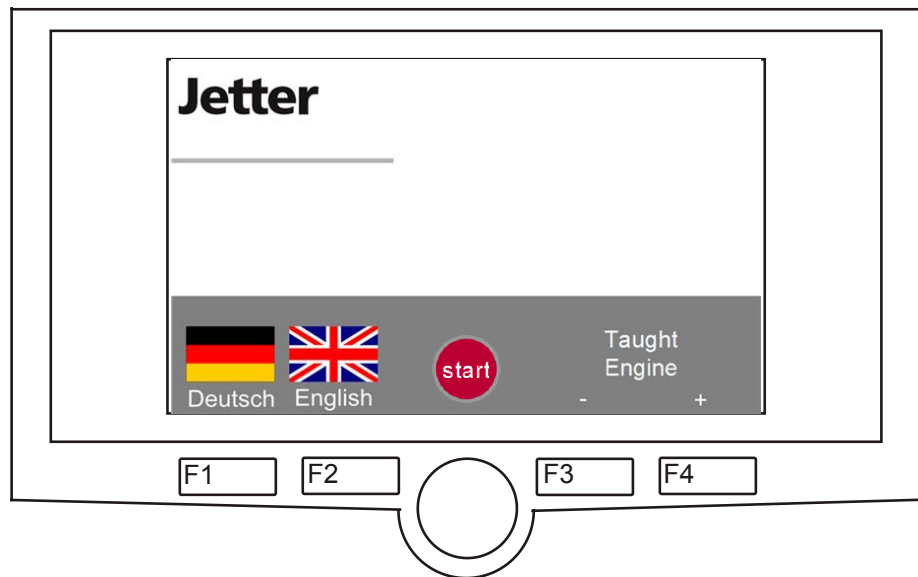
Select here one of the following functions:

- Language Selection
- Engine Selection / Teaching mode Selection
- Launching the Program

Language Selection

Function keys F1 and F2 are for selecting the language.

Step	Action
1	To select the German language: Press the key F1 on the JVM-407.

or ...

Step	Action
1	To select the Englisch language: Press the key F2 on the JVM-407.

Result: The flag of the selected language is highlited.

Engine Selection /
Teaching Mode Selection

Function keys F3 and F4 on the JVM-407 are for selecting motor type or Teaching mode.

Step	Action
1	To select the engine type: Press key F3 (-) or F4 (+) on the JVM-407.

or ...

Step	Action
1	To select the Teaching mode: Press key F3 (-) or F4 (+) on the JVM-407.

Result: The selection you have made is displayed above the function keys F3 and F4 on the screen. For example, when you have selected Teaching mode, "Taught Engine" is displayed on the start screen of the engine data display.

Launching the Program

The DigiPot is used to launch the application program.

Step	Action
1	To launch the application program: Press the DigiPot on the JVM-407.

Result: The engine data display switches from Start Screen to Function Screen.

Related Topics

- **Engine Data Display - Function Screen** on page 14

Engine Data Display - Function Screen

**Function Screen -
Optical Structure**

When the start screen is active, press the DigiPot once to go to the function screen. The function screen comprises the major gauges of a truck instrument cluster.

The illustration below shows the function screen of the engine data display:
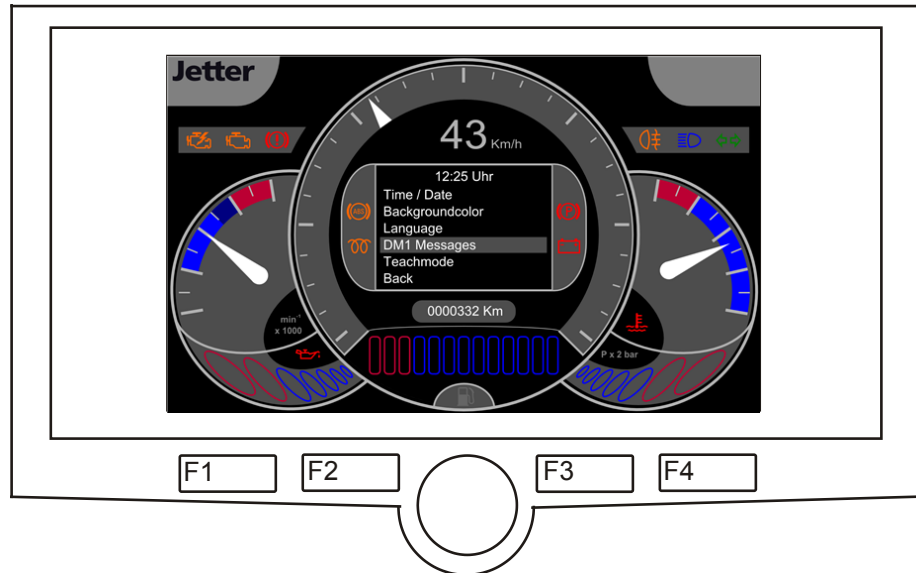
The following functions can be found here:

- Components of the instrument cluster
- Selection of on-board computer parameters to be displayed
- Selecting/Adjusting Settings

Pressing the function keys F1 and F2 simultaneously lets you return to the start screen.

**Components of the
Instrument Cluster**

The various gauges display values that will increase or decrease depending on the transmitted SAE J1939 value. Or indicators will be activated/deactivated. The gauges are for displaying information, such as fuel level, engine RPM, traveling speed.

**Selection of Parameters
to be Displayed**

Information coming from the on-board computer is displayed in the center of the function screen. By turning the knob of the digipot the user selects between the values to be displayed, such as trip counter, fuel consumption per kilometer, etc.

**Changing the
Background Lighting
Settings**

To change the brightness of the background lighting press the F1 and F2 keys on the JVM-407.

Step	Action
1	To make the background lighting brighter: Press the key F1.

or ...

Step	Action
1	To make the background lighting darker: Press the key F2.

Selecting/Adjusting Settings

The following menu items can be found in the menu **Settings** of the on-board computer display:

- Time / date
- Background color
- Language selection
- DM1 Messages
- Teaching mode (if this item has already been selected: "Taught Engine")
- Back

Navigation within the menu items and setting of individual values is always made in the same way:

Step	Action
1	Make your selection: Turn the digipot.
2	Confirm your selection: Push the digipot once.

This is an example of how to change the time setting in menu item **Time / Date**:

Step	Action
1	Turn the digipot until the focus is on **Hour**.
2	Confirm your selection: Push the digipot once.
3	Change the settings in this menu item: Turn the digipot until the desired value is displayed.
4	Confirm your selection: Push the digipot once.
5	Exit menu item **Time / Date**: Turn the digipot until the focus is on **Back**. Push the digipot once.

Result: You have changed the "Hour" settings and are back in the **Settings** menu.

Confirming your changes in menu items **Background Color** and **Language Selection** will automatically bring you back to menu item **Settings**.

Menu Item DM1 Messages

Menu item **DM1 Messages** comprises the screen for DM1 messages. This screen is for displaying all DM1 diagnostic messages transmitted from the vehicle. These diagnostic messages are also stored to the SD card (if applicable) along with a time stamp. The DM1 message reports all failures currently occuring on the vehicle.

Menu Item Teaching Mode

Menu item **Teaching Mode** is available only if you have selected "Taught Engine" on the start screen.

Menu item **Teaching Mode** is for entering vehicle-specific source addresses. Entered source addresses are stored until the next time you use the teaching mode to overwrite them. During **Teaching Mode**, the system tries to obtain all required PGNs from all allowed source addresses. The source address for any received data record is stored. If no data are available for a PGN, value "255" is stored.

Step	Action
1	Connect the JVM-407 to the CAN bus of your vehicle.
2	Switch the ignition on.
3	On the start screen of the JVM-407 select "Taught Engine": Press key F3 (-) or F4 (+) until "Taught Engine" is displayed.
4	Launch the program: Press the digipot.
5	Open menu item **Settings** and select **Teaching Mode**: Turn the digipot until the focus is on **Teaching Mode**.
6	Start the teaching process: Push the digipot once.

Result: The teaching mode starts automatically. After successfully completing the teaching process, the JVM-407 restarts and displays the start screen. The acquired source addresses are now available in menu item "Taught Engine".

Related Topics

3   Program Structure

Introduction

This chapter describes the structure of the sample application SAE J1939. It provides an overview of structures, functions, and teaching mode.
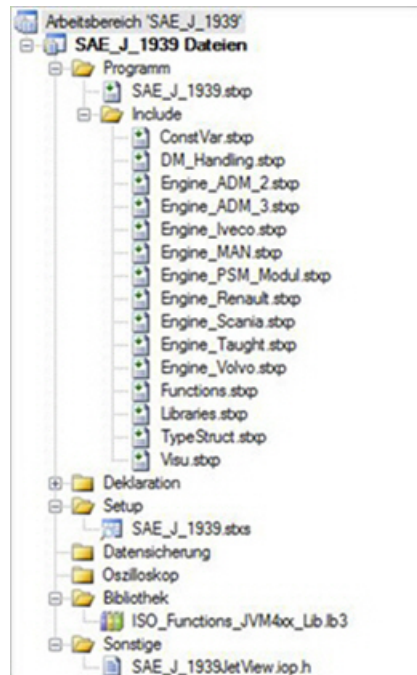
Contents

Workspace Structure

Workspace   The illustration below shows the folder structure of the JVM-407 application program in the programming tool JetSym:

The file SAE_J_1939.stxp comprises all Includes and the initialization task (incl. start screen and associated settings). It also comprises the task Request PGN. The file ConstVar.stxp holds the declarations of all global constants and variables. The file DM_Handling.stxp comprises the function for requesting and processing DM1 messages.

All files starting with the prefix Engine_... comprise the corresponding engine interface. They hold the declaration of all engine-specific and manufacturer-specific variables. In these files all function calls for visualization purposes take place. The function "Teaching Mode" is for teaching in the parameters of a new engine control unit. It is part of the file Engine_Taught.stxp.

The file Functions.stxp contains the declarations of all PGN requests. The file TypeStruct.stxp holds the declarations of all PGNs and their associated SPNs.

The file Visu.stxp contains all requests required for making changes on the display.

Related Topics

- **Description of Structure** on page 19
- **Description of Functions** on page 21

Description of Structure

TypeStruct.stxp - Description

The file TypeStruct.stxp contains the declaration of all PGN numbers available to the author along with their associated SPN numbers according to SAEJ1939 standard.

Example of a structure:

```
PGN_65113_Air_Suspension_Control_3_ASC3  : Struct
    //SPN_1721 Bit Start Position 1-2 /2 bytes
    Relative_Level_Front_Axle_Left      : Word;
    //SPN_1722 Bit Start Position 3-4 /2 bytes
    Relative_Level_Front_Axle_Right     : Word;
    //SPN_1724 Bit Start Position 5-6 /2 bytes
    Relative_Level_Rear_Axle_Left       : Word;
    //SPN_1723 Bit Start Position 7-8 /2 bytes
    Relative_Level_Rear_Axle_Right      : Word;
End_Struct;
```

Components of a Structure Variable

The following example shows the components of a structure variable:

```
PGN_65113_Air_Suspension_Control_3_ASC3
```

Components of the variable	Description
`65113`	Parameter Group Number (PGN) to SAE J1939 standard
`Air_Suspension_Control_3`	PGN name
`ASC3`	PGN acronym

Components of a SPN

The following example shows the components of an SPN:

```
Relative_Level_Front_Axle_Left      : Word;
```

Part of the SPN	Description
`Relative_Level_Front_Axle_Left`	Name of the Suspect Parameter Number (SPN) according to SAE J1939 standard
`: Word;`	SPN memory size on the controller

3   Program Structure

Structure of a Comment   The comment specifies the start byte, start bit and data length of the corresponding SPN. The following example shows the structure of a comment:

`//SPN_1721 Bit Start Position 1-2 /2 bytes`

Component of a Comment	Description
SPN_1721	SPN 1721 according to SAE J1939 standard
Bit Start Position 1-2	Startbyte: 1 Bit position: 1
/2 bytes	Data length: 2 bytes

Description of Functions

Introduction

This chapter provides you with an overview of the structure of the file Functions.stxp. The structure of SAE J1939AddRx/Tx is not covered in this description. For more information refer to chapter "J1939-STX-API Interface" in the JVM-407 manual.

Structure of this Function

The following source code illustrates the structure of the function used:

```
Function add_PGN_00000_Torque_Speed_Control_1_TSC1
(source_address : int , ref PGN_00000_status_priority_rx : J1939Rx,
ref return_value : PGN_00000_Torque_Speed_Control_1_TSC1)
SAEJ1939AddRx(CAN_no ,0 ,source_address ,1 ,1 ,SAEJ1939_2BIT
,sizeof(Byte) ,return_value.Override_Control_Mode
,PGN_00000_status_priority_rx, event_100ms, inhibit_30ms);
End_Function;
```

Operating Principle of Functions.stxp

The file Functions.stxp contains all structure declarations from the file TypeStruct.stxp in the form of functions. These functions are for reading out the SPNs associated with the corresponding PGN from the CAN bus. Jetter's J1939-STX-API interface is used for this function.

Required Parameters

The following parameters are to be transmitted:

- Source Address /
- Status_priority_rx (vom Typ J1939Rx) /
- and a type variable of the same type as the invoking PGN.

The functions are called in the corresponding include files for the engine. Missing functions can easily be added later.

Related Topics

- **Description of Structure** on page 19

Engines

Description of Engine Include Files

The file names of motor include files start with the prefix "Engine_...". These files contain information about engine manufacturers or engine control units. The include files used are only examples. Not all available PGNs are used in the sample application.

Structure of an Engine_... File

The declaration of all PGNs supported by the ECU including one associated status variable is located between "`Var`" and "`End_Var`". In addition, the declarations of ECU-specific source addresses are located here, too,

The variable declaration is followed by the related ECU function. This function first specifies the ECU-specific source addresses. Then it invokes from the J1939 CAN bus all PGNs supported by the ECU with their associated SPNs.

Data are globally stored to the variables which have been declared in the Engine_... file. Functions stemming from the J1939-STX-API are processed only once. Then, all data transmitted over the bus are automatically read in, processed and stored globally.

The function for teaching in additional source addresses is contained in the file Engine_Taught.

Physical Networking of ECUs
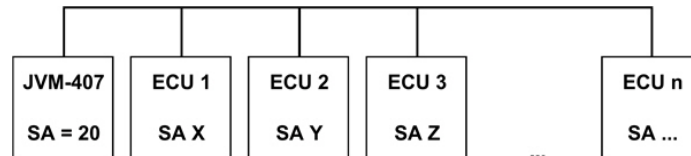
Abbreviation	Description
JVM-407	Hardware name
ECU	CAN node
SA	Source Address

Related Topics

- **Motor Data Display - Appendix** on page 26
- **Teaching Mode - Description** on page 24

Visualizing the Program

Visu.stxp - Description

The file Visu.stxp contains all visualization functions.

All values coming from the J1939 CAN bus are evaluated, converted and transmitted to the display. JetViewSoft reads the file SAE_J_1939JetView.iop.h to obtain the "defines" required for this purpose. Visualization instructions from JetSym ISO_Functions_JVM4xx_Lib.lb3 are used to transmit data to the display.

Related Topics

Teaching Mode - Description

TeachMode.stxp - Description

If this application is to be used in combination with "unknown" ECUs connected to the CAN bus, it is necessary to teach in the source addresses of these ECUs.

The teaching mode in this example comprises all PGNs required for this application. The PGN, as well as the start byte and start bit of the SPN contained in the PGN must be transmitted to the teach-in function.

Teach-in function - example:

```
Function Teaching
    sa_pgn_61444 := Teachmode(pgn_61444,4,1);
    sa_pgn_61445 := Teachmode(pgn_61445,1,1);
    sa_pgn_65216 := Teachmode(pgn_65216,2,1);
    sa_pgn_65217 := Teachmode(pgn_65217,1,1);
    sa_pgn_65248 := Teachmode(pgn_65248,1,1);
    sa_pgn_65257 := Teachmode(pgn_65257,1,1);
    sa_pgn_65262 := Teachmode(pgn_65262,1,1);
    sa_pgn_65263 := Teachmode(pgn_65263,3,1);
    sa_pgn_65265 := Teachmode(pgn_65265,2,1);
    sa_pgn_65266 := Teachmode(pgn_65266,5,1);
    sa_pgn_65276 := Teachmode(pgn_65276,2,1);
    sa_pgn_65260 := Teachmode(pgn_65260,1,1);
End_Function;
```

Related Topics

- **Workspace Structure** on page 18
- **Engine Data Display - Function Screen** on page 14

Appendix

Contents

A: Appendix

Abbreviations

In this document the following abbreviations are used:

Abbreviation	Description
DA	Destination Address
GE	Group Extensions
PDU	Protocol Data Unit
PGN	Parameter Group Number
SPN	Suspect Parameter Number
SA	Source Address

Troubleshooting

Should a manufacturer be specified, but no data are displayed, the source addresses (SA) of the ECUs in the vehicle may have changed. If this is the case, it is advisable to read out the CAN data using a CAN monitor, and to adjust the SAs in the JetSym file Engine_....stxp accordingly.

The teaching mode offers another feature: With a laptop/PC connected and an active connection, the taught in SAs can be read out of the setup file. Source address 255 indicates that this PGN is not used on this bus.

This application does without listening to all SAs, as several devices on the bus may send the same PGN, thus, producing inconsistent data.

Several engine manufacturers offer parameterizable special modules for body builders, e.g., the PSM module by Mercedes Benz trucks. It might be necessary to parameterize these special modules before commissioning the JMV-407 with the sample application. This is the only way of ensuring that the sample application works properly. Otherwise it is advisable to connect the JVM-407 directly to the J1939 on-board CAN bus before the special module.

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