SAE J1939: First steps in Codesys 3

Level 4	1 – Fundamental – No previous experience necessary 2 – Basic – Basic knowledge recommended 3 – Advanced – Reasonable knowledge required 4 – Expert – Good experience recommended

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Original Application Note

Original document is the German version of this document.

Translation

All non-German language versions of this document are translations of the original application note.

1. Edition 2025, publication date 07/2025

DANGER!
DANGEROUS ELECTRICAL VOLTAGE!

Before commencing the installation

- Installation requires qualified electrician
- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally retriggered
- Verify isolation from the supply
- Ground and short-circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 part 100) may work on this device/ system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or to the potential equalizing. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 V supply. Only use power supply units complying with IEC 60364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410).
- Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the technical data, otherwise this may cause malfunction and dangerous operation.
- Emergency-Stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency switching off devices must not cause restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state, desk-top devices or portable devices only when the housing is closed.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency switching off devices should be implemented
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, etc.).

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Content

1 General

Eaton PLCs offer a CAN-Interface which is compatible with the protocol SAE J1939. This application note should be supportive using EATON PLCs with SAE J1939 components. It describes in a short form the basics of J1939 and first steps in XSOFT-CODESYS.

1.1 Hardware requirements

- Eaton PLC's with CODESYS Runtime 3.5 and CAN-Interface: XC303, XC204, XC104, XV102, XV303.

1.2 Software requirements

- min. XSOFT-CODESYS 3.5.4
- this example was created with XSOFT-CODESYS 3.5.16 BF4

2 Basics

SAE J1939 is a standard that defines how ECUs (*electronic control units)* communicate via the CAN bus in heavy-duty vehicles.

It's a High-layer protocol which used CAN as a physical medium.

In other words: The CAN bus is the media like a "telephone" and the SAE J1939 protocol is the "language".

2.1 Quick facts

- Uses the 29-bit extended CAN identifier
- Standardized CAN baud rates of 250 kbits/s and 500 kbits/s.
- Has point-to-point addressing (node addressing) and global addressing (message addressing)
- Up to 1785 bytes can be transmitted with multi-packet messages
- Bus access control via own network management
- Standardized messages for the overall vehicle communication
- Allows manufacturer-specific message definition
- Defines own diagnostic interface

2.2 PGN (Parameter Group Number)

The PGN defines how data is interpreted. Parameter Group Numbers are defined from the SAE J1939 standard and characterize a function of heavy-duty vehicles.

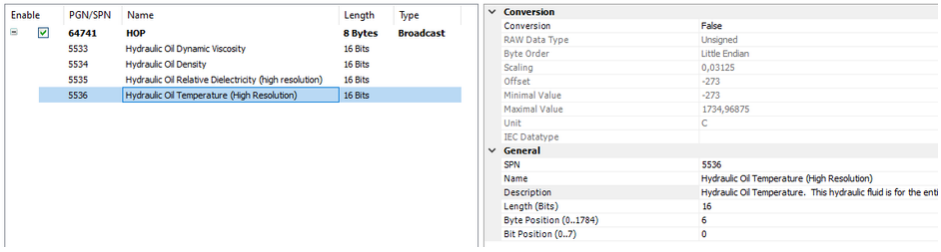
Example: The PGN 64741 defines "Hydraulic Oil Properties".

PGN/SPN	Name	Description
64731	AT1DPF1S3	Aftertreatment 1 Diesel Particulate Filter 1 Soot 3
64732	CCVS3	Cruise Control 3
64733	AT2AC3	Aftertreatment 2 Air Control 3
64734	AT1AC3	Aftertreatment 1 Air Control 3
64735	EFL/P12	Engine Fluid Level/Pressure 12
64736	DPFC2	Diesel Particulate Filter Control 2
64737	LFE2	Fuel Economy 2 (Liquid)
64738	SFS	Supplemental Fan Status
64739	EBCC	Engine Exhaust Brake Control
64740	EFP	Engine Fuel Properties
64741	HOP	Hydraulic Oil Properties
5533	Hydraulic Oil Dynamic Viscosity	
5534	Hydraulic Oil Density	
5535	Hydraulic Oil Relative Dielectricity (high resolution)	
5536	Hydraulic Oil Temperature (High Resolution)	
64742	VLS2	Vehicle/Chassis Lubrication System 2
64743	EC3	Engine Configuration 3
64744	IVAC	Intake Valve Actuation Control
64745	ARMSWIMC	Armrest Switch Matrix Commands

2.3 SPN (Suspect Parameter Number)

SPN defines the value within a Parameter Group.

Example: The SPN 5536 defines the "Hydraulic Oil Temperature".



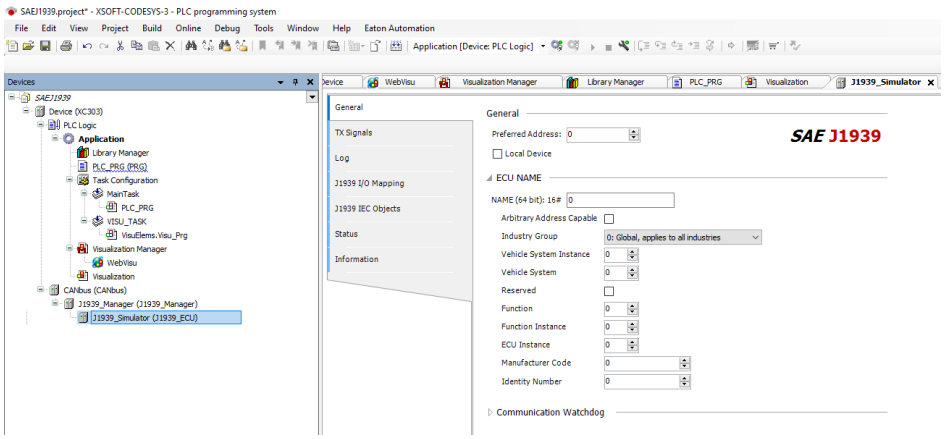
3 SAE J1939 in XSOFT-CODESYS

3.1 Requirements

- min. XSOFT-CODESYS V3.5.4
- PLC with CAN-Interface

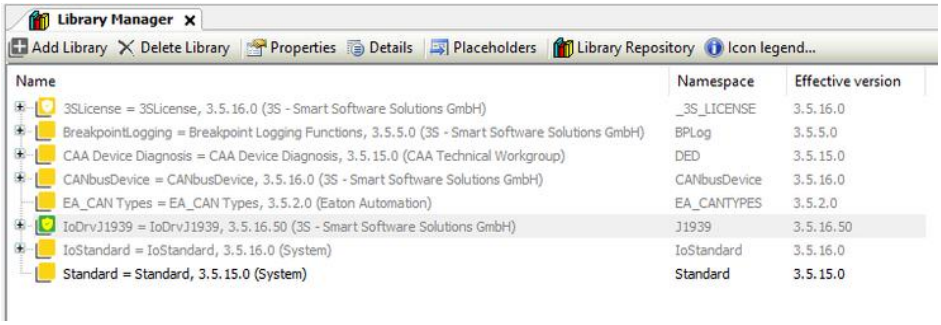
3.2 Creating a XSOFT-CODESYS project

- New project building
- Append device ... CANbus
- Append device ... J1939_Manager
- Append device ... J1939_ECU



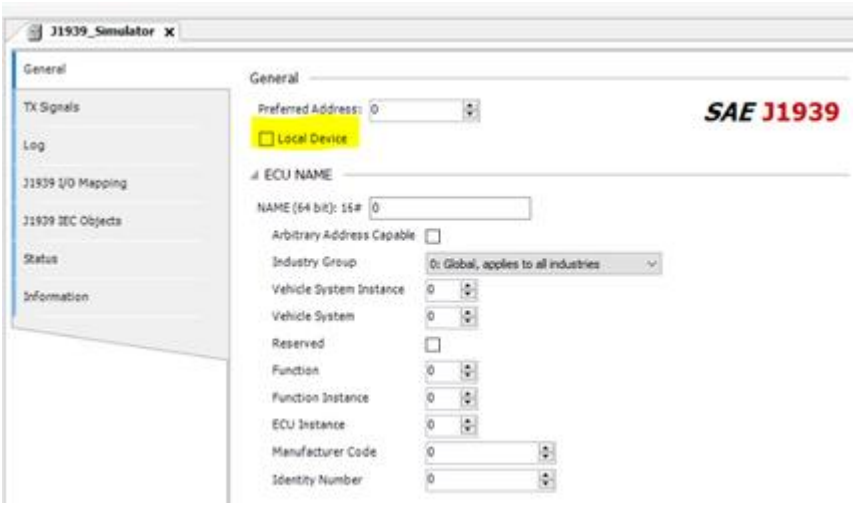
3.3 Adding libraries

- Library «IoDrvJ1939» will be automatically added



3.4 ECU remote

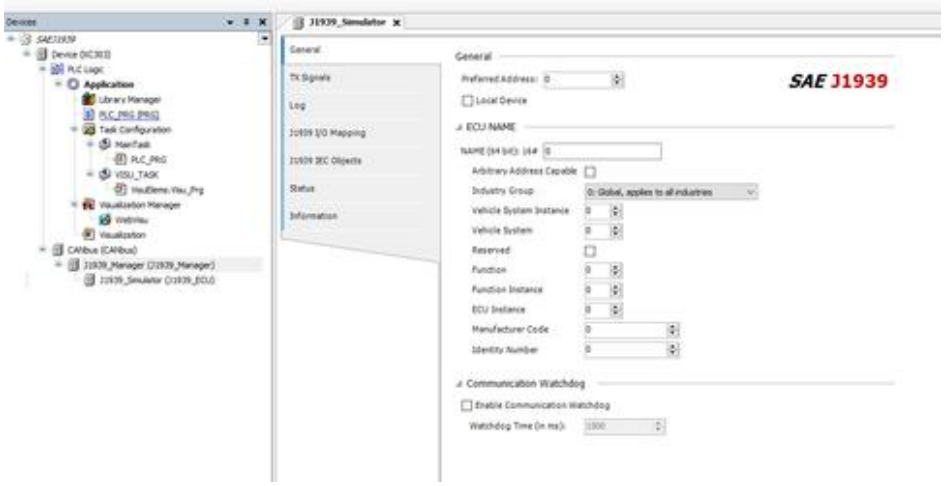
If the PLC should only receive Data from a J1939 ECU, the ECU has to be declared as remote ECU. The "Local device" checkbox must be deactivated for this.



3.4.1 General settings

- Remote ECU's address entry
- If the PLC should only receive Data from a J1939 ECU, please don't activate "Local Device" checkbox
- ECU NAME is not obligated to be registered and not related

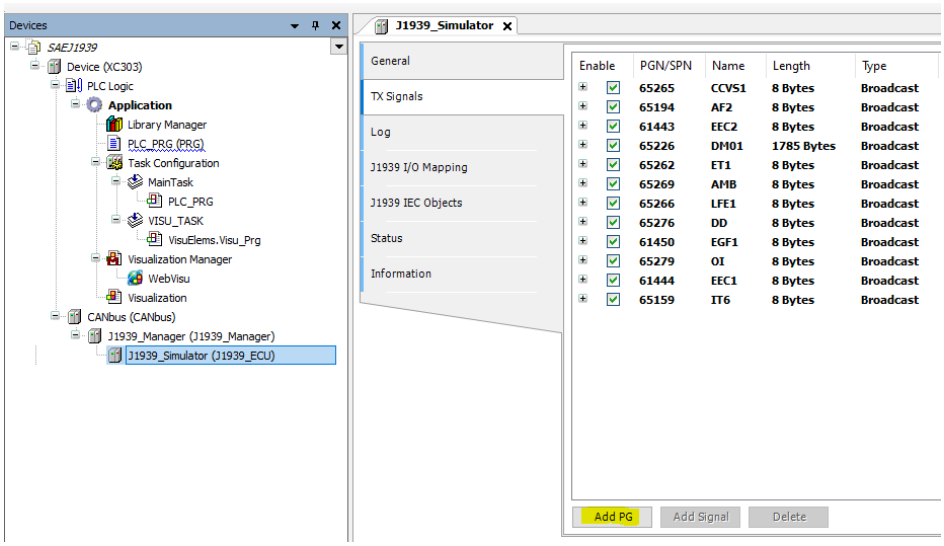
- Communication Watchdog can be set



3.4.2 TX Signals/Add PG

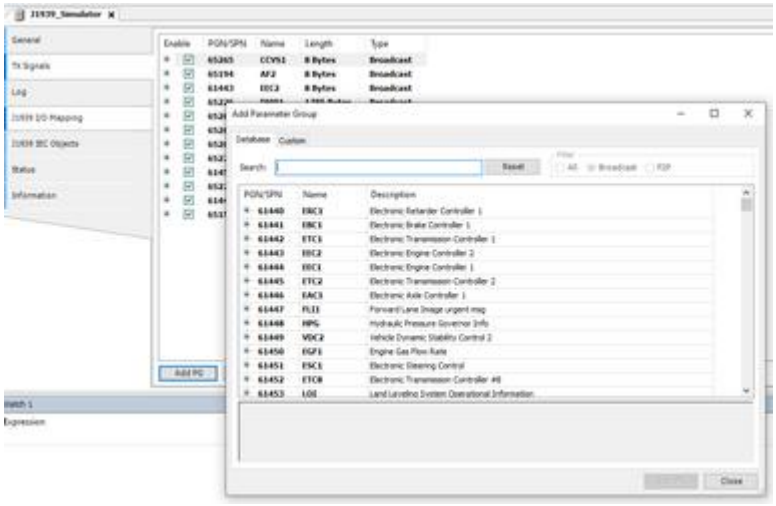
Broadcast messages of the ECU have to be configured under the tab "TX Signals".

- Use "Add PG" button

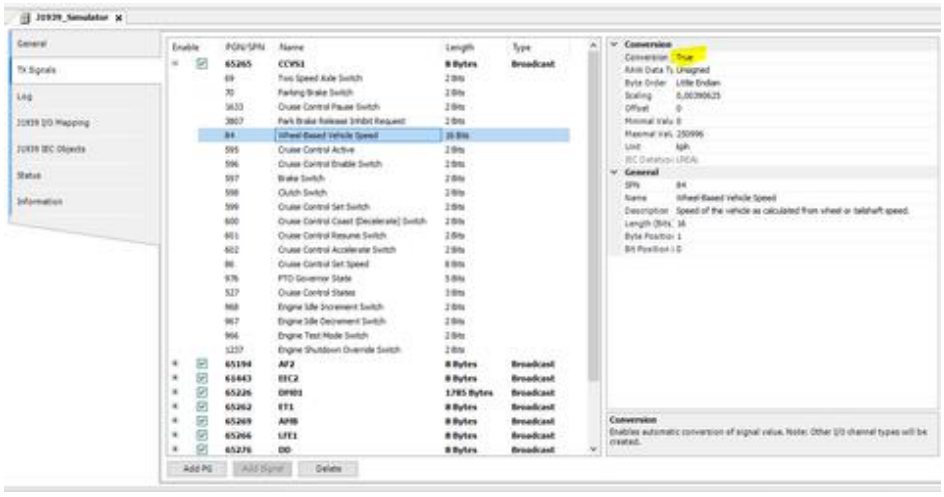


3.4.2.1 Database

- XSOFT CODESYS provides a database with predefined PGN's from the J1939 standard.

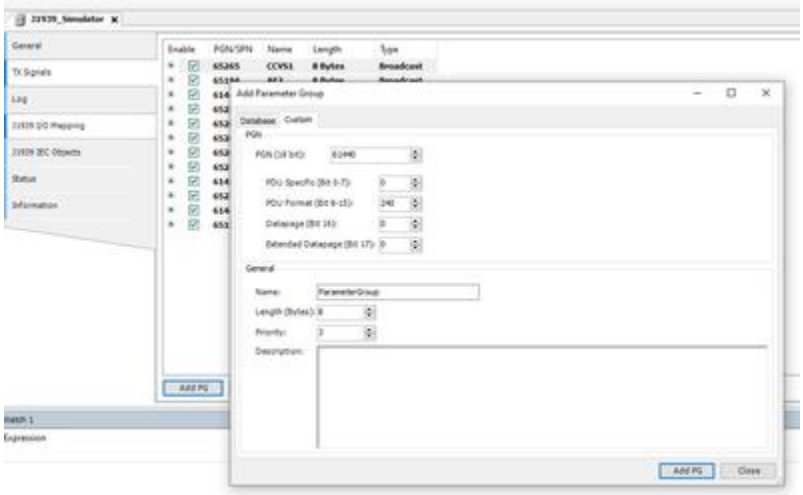


- After adding PGN, the conversion of SPN can be activated. The "Conversion" has to be set to "True". With the activated conversion a scaling of the values is possible.
- The parameters of the conversion are predefined from the database, but adjustments are possible.



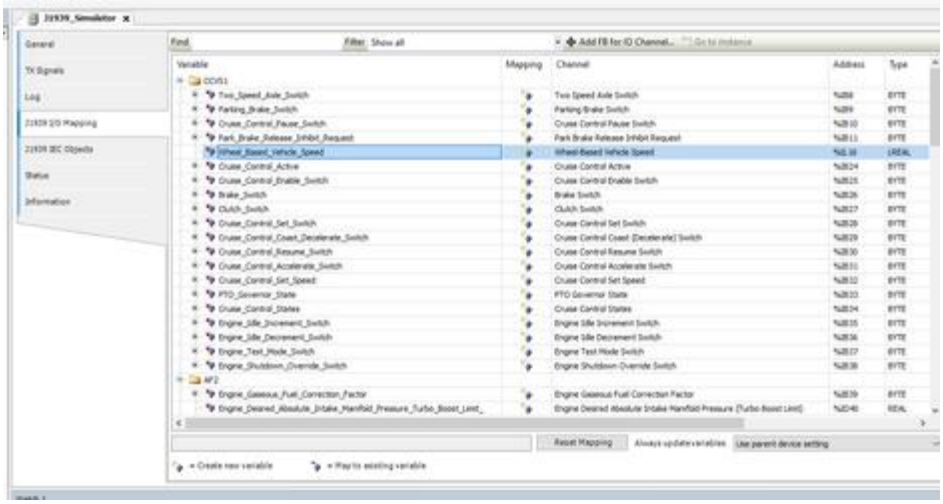
3.4.2.2 Custom

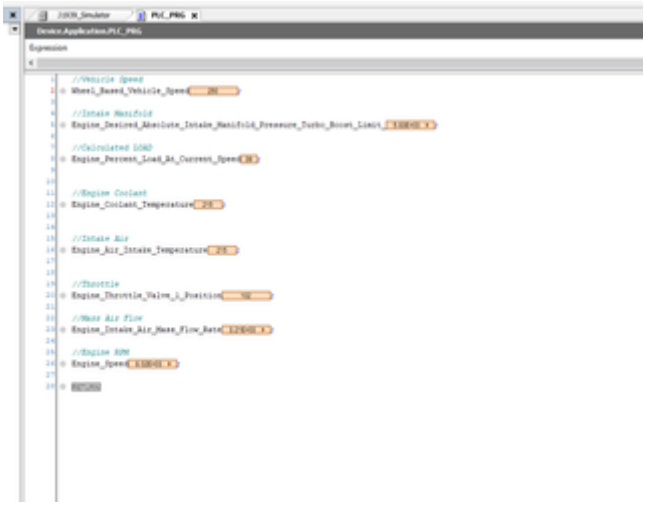
If the PGN is not available in this database, it can be created under the tab "Custom".



3.4.3 J1939 I/O Mapping

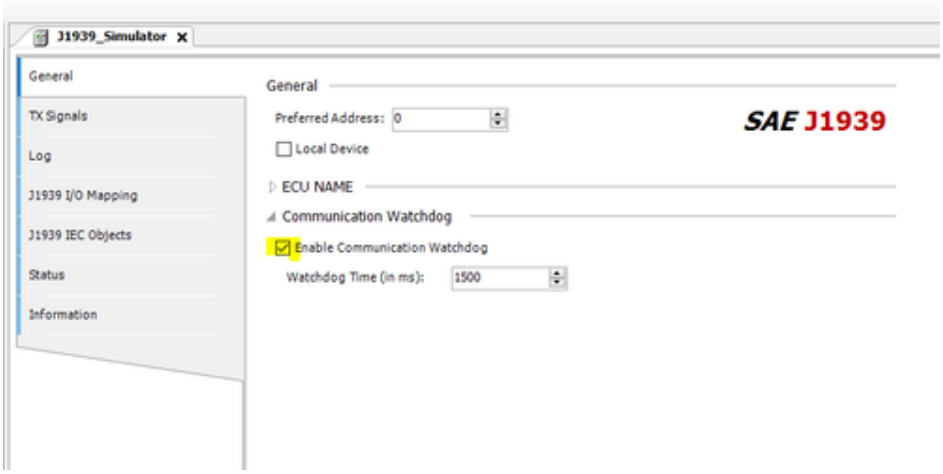
- Global variables are automatically generated and can be used directly in POE.





3.4.4 Communication Watchdog / State

The communication watchdog can be activated in the "General" settings.



With the method "GetDeviceState" the State of our J1939 participant can be requested:

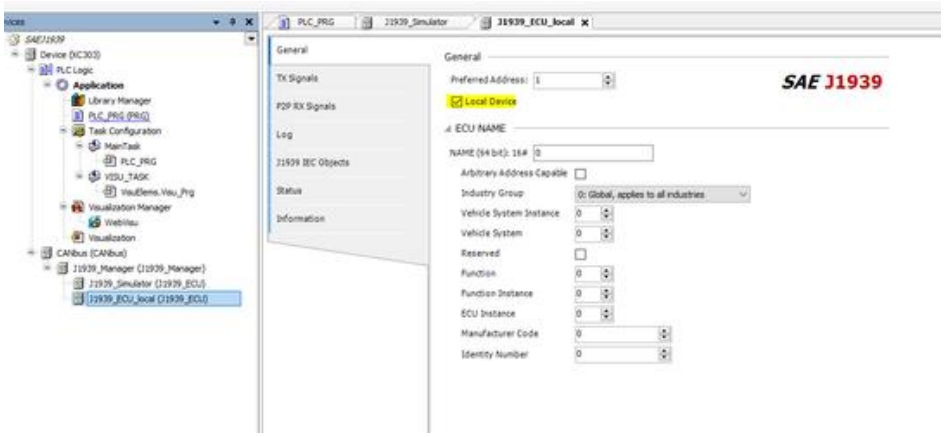
```
PLC_PRG
PROGRAM PLC_PRG
VAR
    //Communication State
    DeviceStateSimulator: DED.DEVICE_STATE;
    stDeviceStateSimulator: STRING;
END_VAR

//Communication State
DeviceStateSimulator:=J1939_Simulator.GetDeviceState();

CASE DeviceStateSimulator OF
    DED.DEVICE_STATE.CONFIGURED:        stDeviceStateSimulator:='CONFIGURED';
    DED.DEVICE_STATE.DISABLED:          stDeviceStateSimulator:='DISABLED';
    DED.DEVICE_STATE.ERROR:             stDeviceStateSimulator:='ERROR';
    DED.DEVICE_STATE.NOT_CONFIGURED:    stDeviceStateSimulator:='NOT_CONFIGURED';
    DED.DEVICE_STATE.NOT_FOUND:         stDeviceStateSimulator:='NOT_FOUND';
    DED.DEVICE_STATE.RUNNING:           stDeviceStateSimulator:='RUNNING';
    DED.DEVICE_STATE.STOPPED:           stDeviceStateSimulator:='STOPPED';
    DED.DEVICE_STATE.UNKNOWN:           stDeviceStateSimulator:='UNKNOWN';
END_CASE
```

3.5 ECU local

If the PLC should send data to other J1939 components, a local ECU device has to be added. With this "device" it is possible to transmit data and receive P2P signals.

3.5.1 General settings

- this ECU has to be defined as "Local Device". The "Local device" checkbox must be activated for this.

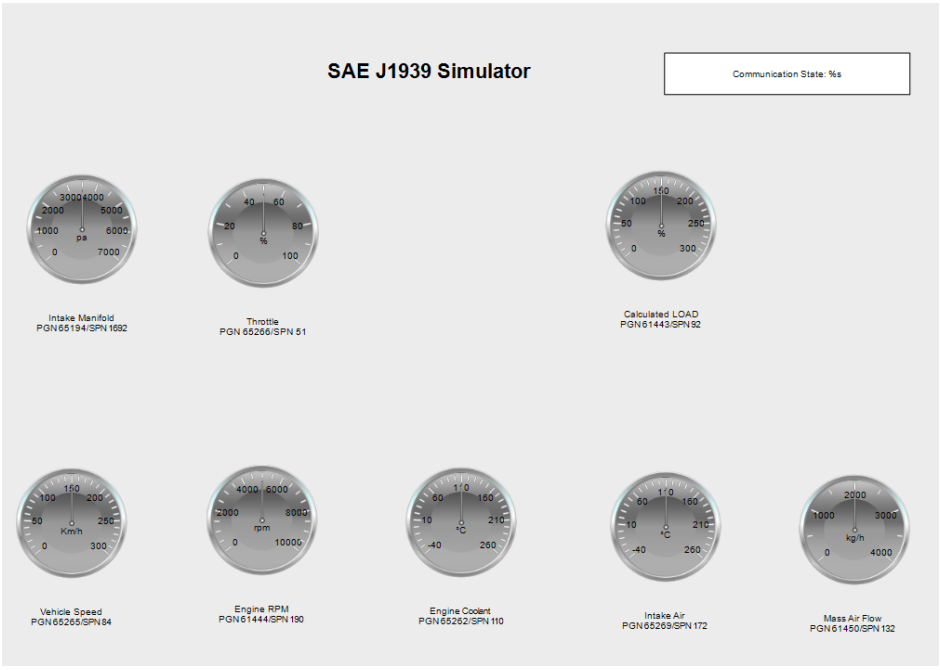


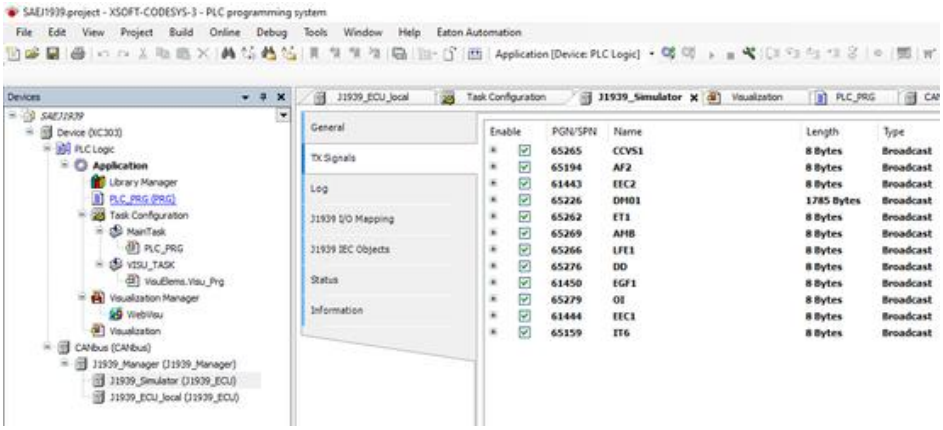
4 Example project - J1939 Simulator

Downloadlink:

https://eaton-corp.atlassian.net/wiki/download/attachments/8017518/SAEJ1939.projectarchive?api=v2

This example project shows how J1939 can be used with XSOFT CODESYS V 3.5.16 and a Eaton PLC (XC303). As J1939 hardware is used a simulator board which produces values like "Vehicle Speed", "Engine RPM" or "Intake Air". This values are shown in a visu mask.


SAE J1939 Simulator
Communication State: %s
Intake Manifold
PGN 65194/SPN 1692
Throttle
PGN 65266/SPN 51
Calculated LOAD
PGN 61443/SPN 92
Vehicle Speed
PGN 65265/SPN 84
Engine RPM
PGN 61444/SPN 190
Engine Coolant
PGN 65262/SPN 110
Intake Air
PGN 65269/SPN 172
Mass Air Flow
PGN 61450/SPN 132


SAEJ1939.project - XSOFT-CODESYS-3 - PLC programming system
File Edit View Project Build Online Debug Tools Window Help Eaton Automation
Devices
SAEJ1939
Device (XC303)
PLC Logic
Application
Library Manager
PLC_PRG (PRG)
Task Configuration
MainTask
PLC_PRG
VISU_TASK
VisuElems.Visu_Prg
Visualization Manager
WebVisu
Visualization
CANbus (CANbus)
J1939_Manager (J1939_Manager)
J1939_Simulator (J1939_ECU)
J1939_ECU_local (J1939_ECU)
J1939_ECU_local
Task Configuration
J1939_Simulator
Visualization
PLC_PRG
General
TX Signals
Log
J1939 I/O Mapping
J1939 IEC Objects
Status
Information
Enable PGN/SPN Name Length Type
65265 CCVS1 8 Bytes Broadcast
65194 AF2 8 Bytes Broadcast
61443 EEC2 8 Bytes Broadcast
65226 DM01 1785 Bytes Broadcast
65262 ET1 8 Bytes Broadcast
65269 AMB 8 Bytes Broadcast
65266 LFE1 8 Bytes Broadcast
65276 DD 8 Bytes Broadcast
61450 EGF1 8 Bytes Broadcast
65279 OI 8 Bytes Broadcast
61444 EEC1 8 Bytes Broadcast
65159 IT6 8 Bytes Broadcast

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