

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.

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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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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	ARHSWIMC	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".

Enable	PGN/SPN	Name	Length	Type
☒	64741	HOP	8 Bytes	Broadcast
☐	5533	Hydraulic Oil Dynamic Viscosity	16 Bits	
☐	5534	Hydraulic Oil Density	16 Bits	
☐	5535	Hydraulic Oil Relative Dielectricity (high resolution)	16 Bits	
☐	5536	Hydraulic Oil Temperature (High Resolution)	16 Bits	

Conversion Conversion False RAW Data Type Unsigned Byte Order Little Endian Scaling 0,03125 Offset -273 Minimal Value -273 Maximal Value 1734,96875 Unit C IEC Datatype	General SPN 5536 Name Hydraulic Oil Temperature (High Resolution) Description Hydraulic Oil Temperature. This hydraulic fluid is for the ent Length (Bits) 16 Byte Position (0..1784) 6 Bit Position (0..7) 0
--	---

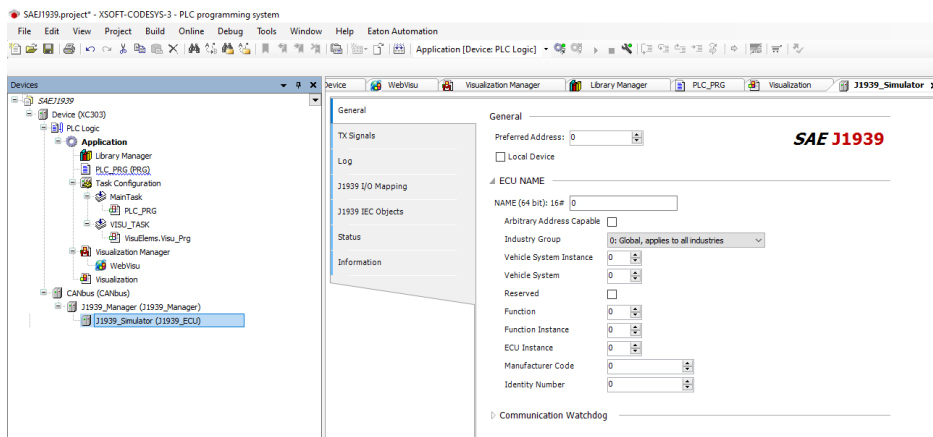
3 SAE J1939 in XSOF-TCODESYS

3.1 Requirements

- min. XSOF-TCODESYS V3.5.4
- PLC with CAN-Interface

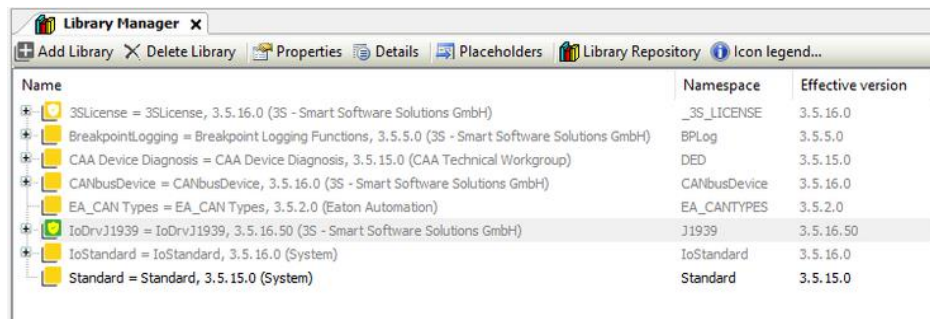
3.2 Creating a XSOF-TCODESYS project

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



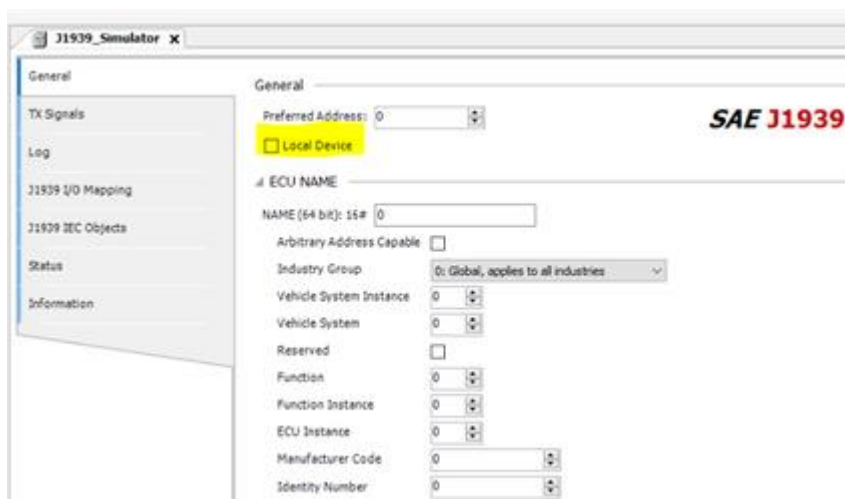
3.3 Adding libraries

- Library «IoDrvJ1939» will be automatically added



3.4 ECU remote

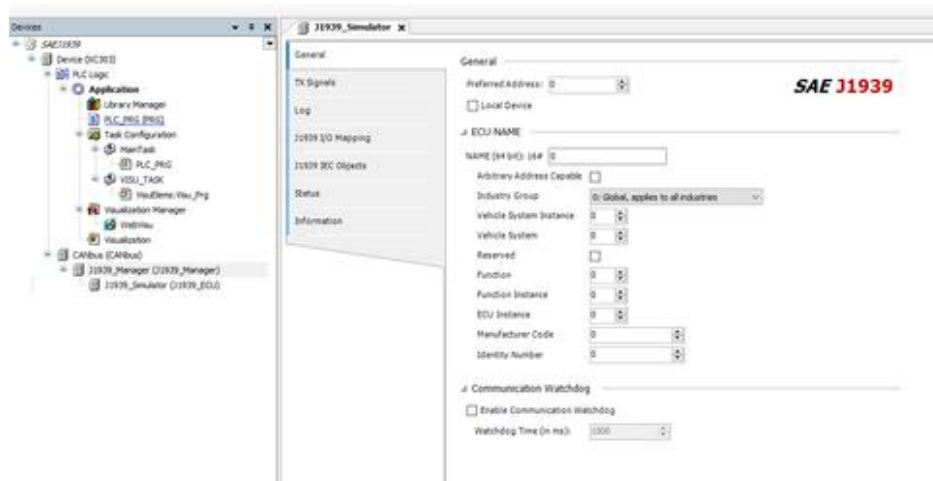
If the PLC should only receive Data from a J1939 ECU, the ECU has to be declared as remote ECU. The "Local device" checkbox must be deactivated for this.



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

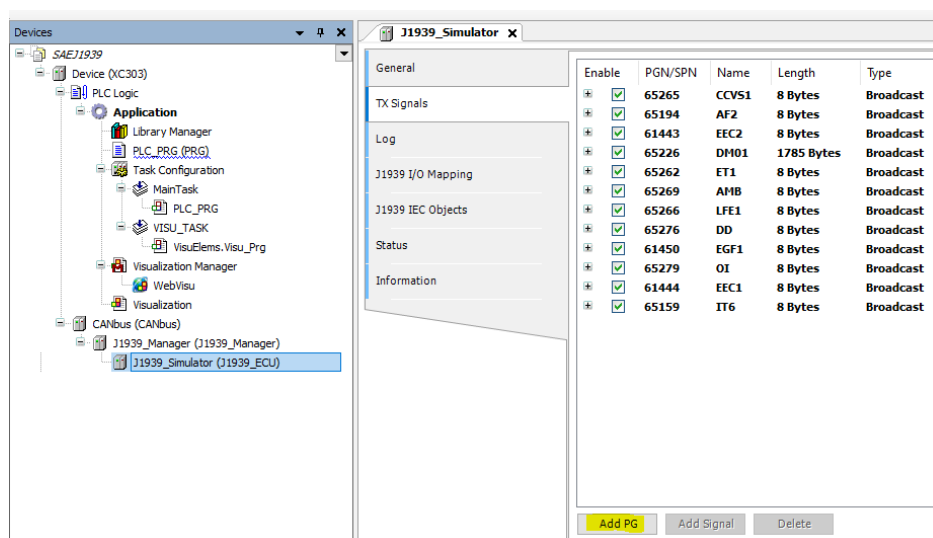
- Communication Watchdog can be set



3.4.2 TX Signals/Add PG

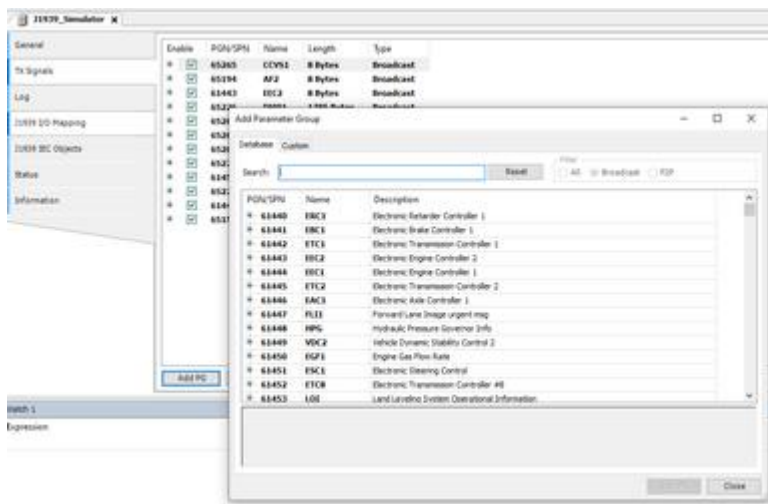
Broadcast messages of the ECU have to be configured under the tab "TX Signals".

- Use "Add PG" button

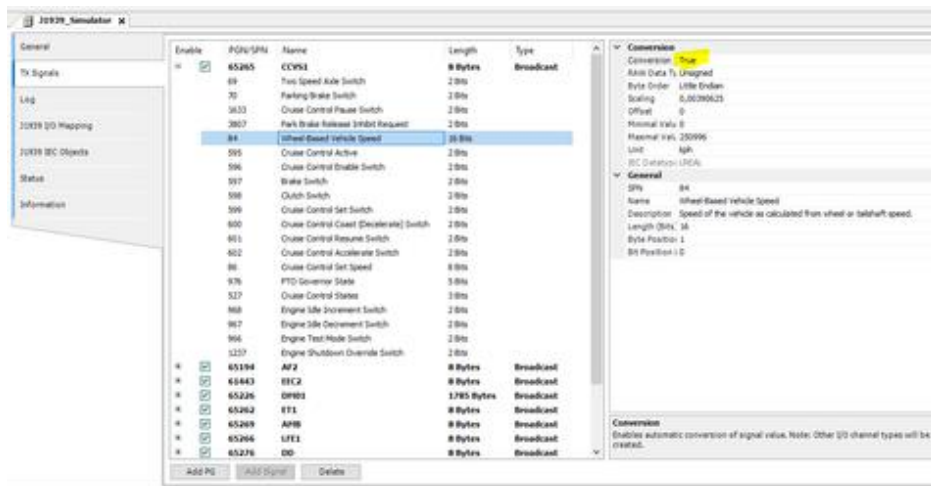


3.4.2.1 Database

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

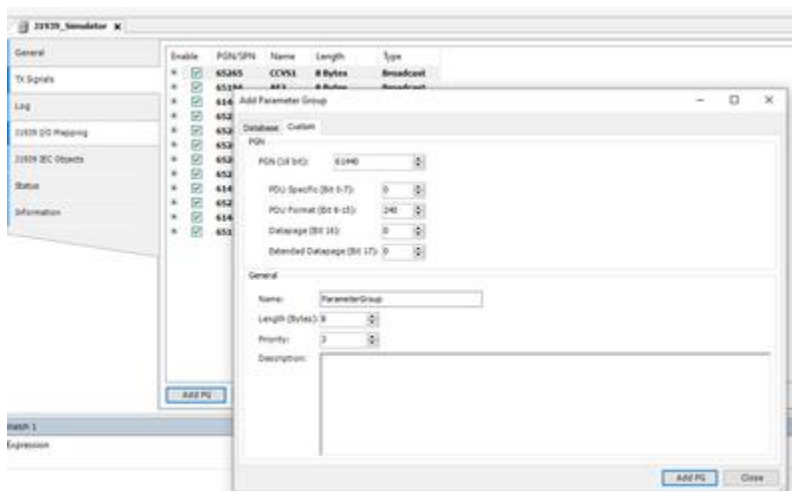


- After adding PGN, the conversion of SPN can be activated. The "Conversion" has to be set to "True". With the activated conversion a scaling of the values is possible.
- The parameters of the conversion are predefined from the database, but adjustments are possible.



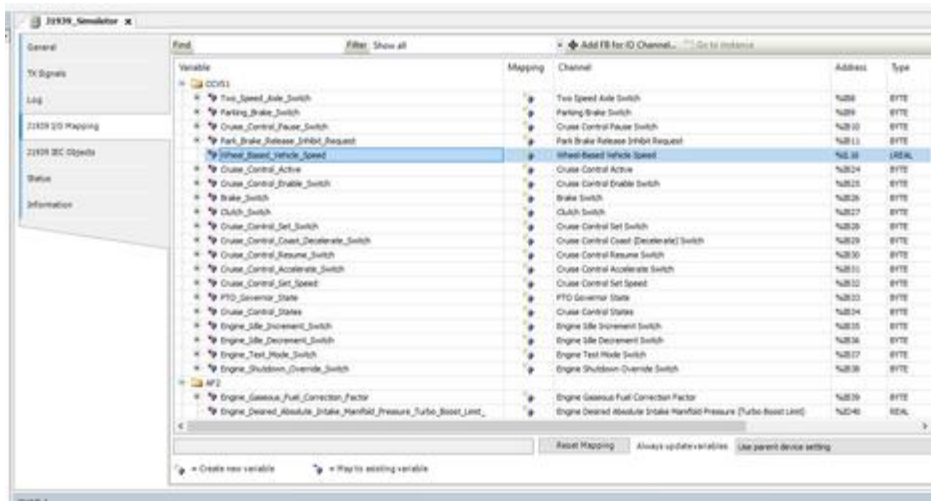
3.4.2.2 Custom

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



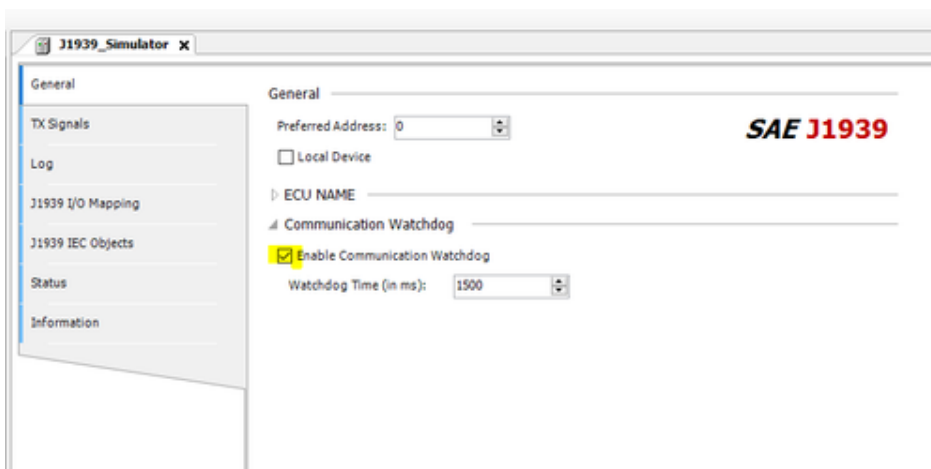
3.4.3 J1939 I/O Mapping

- 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 X
1 PROGRAM PLC_PRG
2 VAR
3     //Communication State
4     DeviceStateSimulator: DED.DEVICE_STATE;
5     stDeviceStateSimulator: STRING;
6 END_VAR

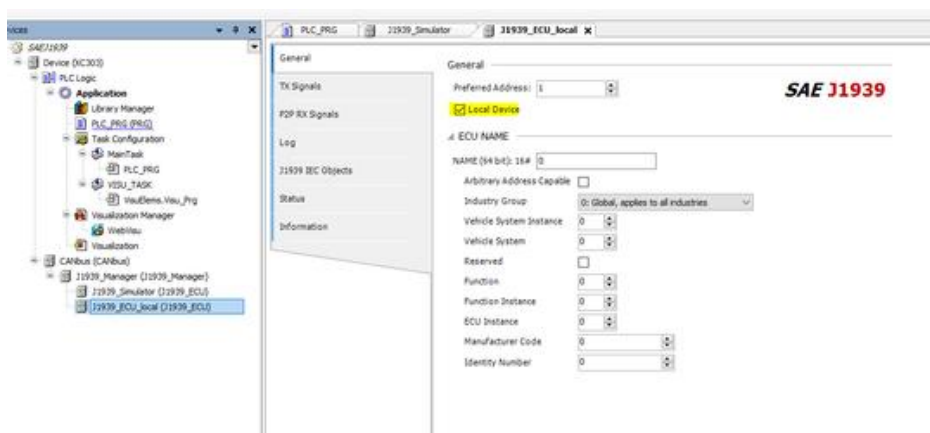
1 //Communication State
2 DeviceStateSimulator:=J1939_Simulator.GetDeviceState();
3
4 CASE DeviceStateSimulator OF
5     DED.DEVICE_STATE.CONFIGURED:      stDeviceStateSimulator:='CONFIGURED';
6     DED.DEVICE_STATE.DISABLED:        stDeviceStateSimulator:='DISABLED';
7     DED.DEVICE_STATE.ERROR:           stDeviceStateSimulator:='ERROR';
8     DED.DEVICE_STATE.NOT_CONFIGURED:  stDeviceStateSimulator:='NOT_CONFIGURED';
9     DED.DEVICE_STATE.NOT_FOUND:       stDeviceStateSimulator:='NOT_FOUND';
10    DED.DEVICE_STATE.RUNNING:          stDeviceStateSimulator:='RUNNING';
11    DED.DEVICE_STATE.STOPPED:          stDeviceStateSimulator:='STOPPED';
12    DED.DEVICE_STATE.UNKNOWN:         stDeviceStateSimulator:='UNKNOWN';
13 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.

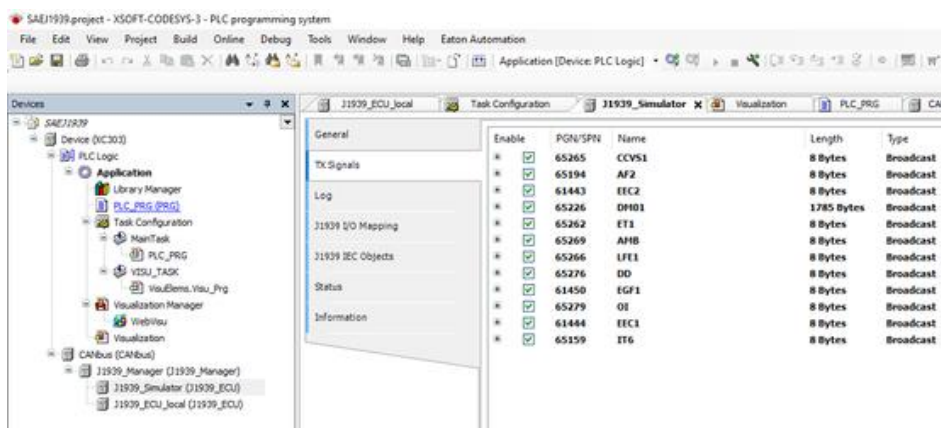
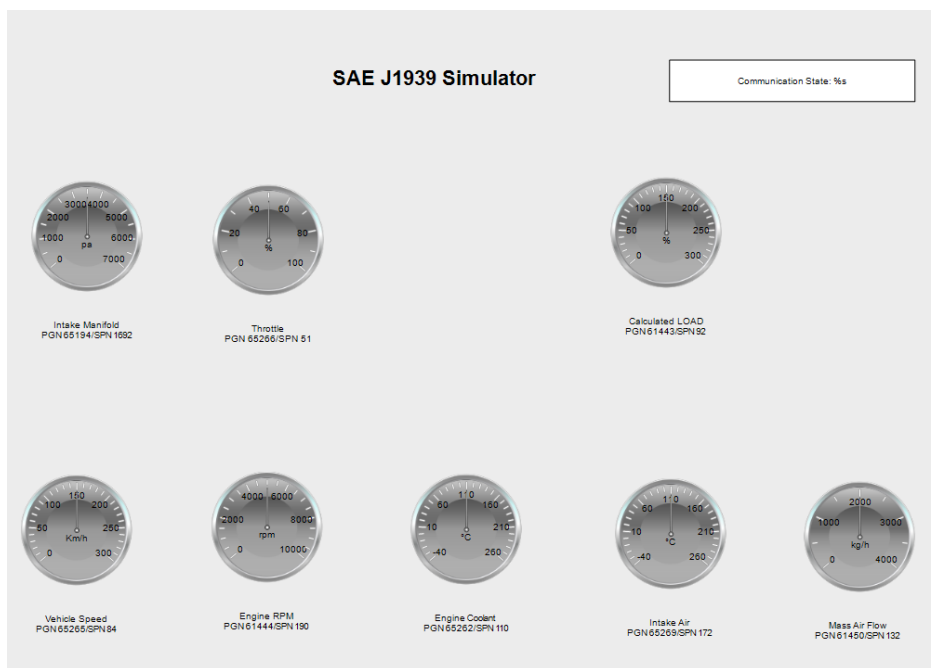


4 Example project - J1939 Simulator

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.



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