An Introduction to High Country Tek Inc.

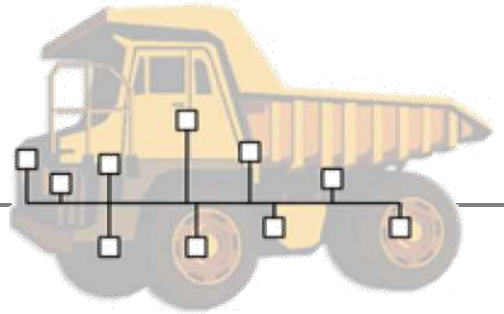
SAE J1939 Overview 2015

Date: Wednesday, December 09, 2015
J1939 Overview – Oct 2015.pptx

Today's Agenda

- Introductions.
- SAE J1939 Overview
- HCT code examples.
- HCT Products for J1939
- Information sources.

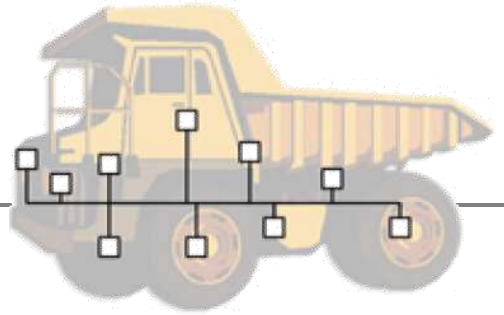
SAE J1939 - Information



J1939 comprises the following sub standards:

- **J1939** - Recommended Practice for a Serial Control & Communications Vehicle Network
- **J1939/11** - Physical Layer – 250k bits/s, Shielded Twisted Pair
- **J1939/13** - Off-Board Diagnostic Connector
- **J1939/21** - Data Link Layer
- **J1939/31** - Network Layer
- **J1939/71** - Vehicle Application Layer
- **J1939/73** - Application Layer – Diagnostics
- **J1939/81** - Network Management

SAE J1939 - General Aspects

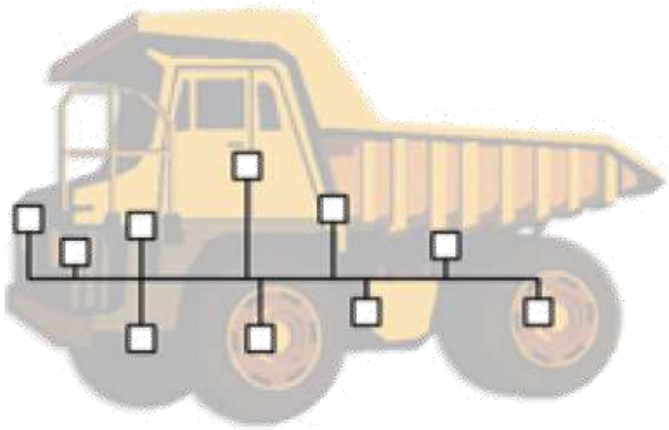


- **Higher-Layer protocol based on Controller Area Network (CAN)**
- **Provides serial data communications between Electronic Control Units (ECU)**
- **Can be used in any kind of heavy duty vehicle.**
- **Protocol features based on J1708 (RS485) and J1587**
- **Clever protocol design with very little overhead**
- **Takes full advantage of all standard CAN features**
- ***Detailed documentation ONLY available through SAE*.**

SAE J1939 - Applications

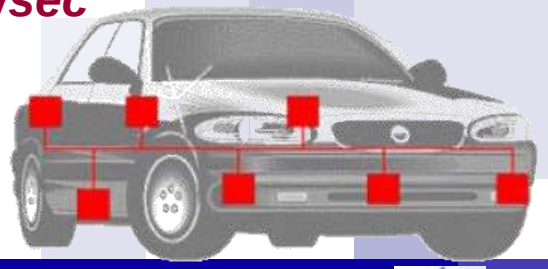
- **J1939 protocols are used in:**

  - ❖ **Diesel power-train applications**
  - ❖ **Inter-vehicle networks for trucks & busses**
  - ❖ **Ag and Forestry machinery (ISO 11783)**
  - ❖ **Truck-Trailer connections**
  - ❖ **Military vehicles (MILCAN)**
  - ❖ **Mining, research and drilling equipment**
  - ❖ **Fleet management systems**
  - ❖ **Recreational vehicles**
  - ❖ **Marine navigation system (NMEA2000)**



What is CAN - General Aspects

- **Serial network for embedded solutions**
- **Originally designed for Bosch for automotive industry**
- **Became very popular with industrial automation**
- **Network technology established among Micro-controllers**
- **Well suited for high speed /real time applications**
- **Replaces expensive Dual-port RAM technology**
- **Excellent error detection and fault confinement**
- **Extremely reliable in field operation and in extreme conditions**
- **Max baud rate of 1MBit/sec – *SAE J1939 uses 250kBit/sec***



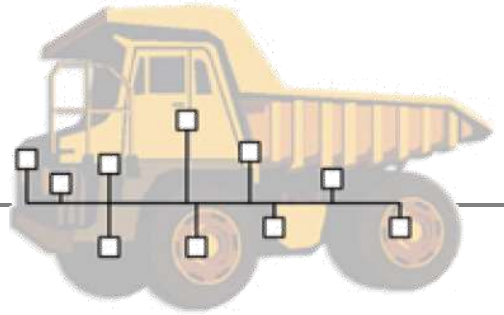
SAE J1939 - Quick Reference

- **J1939 takes advantage of CAN features such as:**
  - **Maximum reliability**
  - **Excellent error detection and fault confinement**
  - **Collision-free bus arbitration**

SAE J1939 - Quick Reference

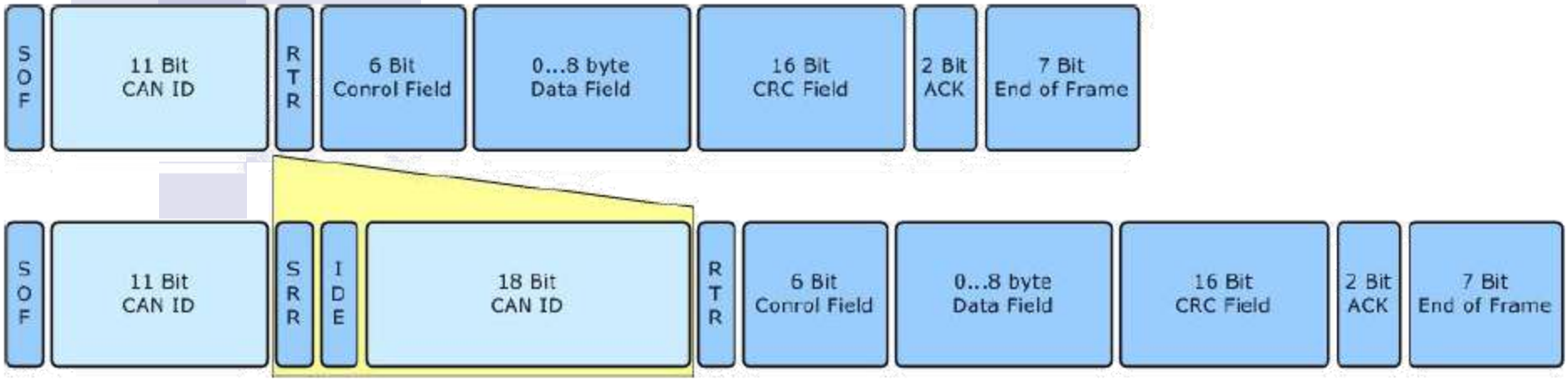
- **J1939 specifications:**
  - **Shielded, twisted pair of wires.**
  - **Max. network length of 40 meters (~120ft).**
  - **Standard baud rate of 250 kBit/sec (mobile equipment).**
  - **Used 29-Bit message ID.**
  - **Max. 30 nodes (ECU's) in a network.**
  - **120Ω termination resistors (2 off).**

SAE J1939 - Quick Reference



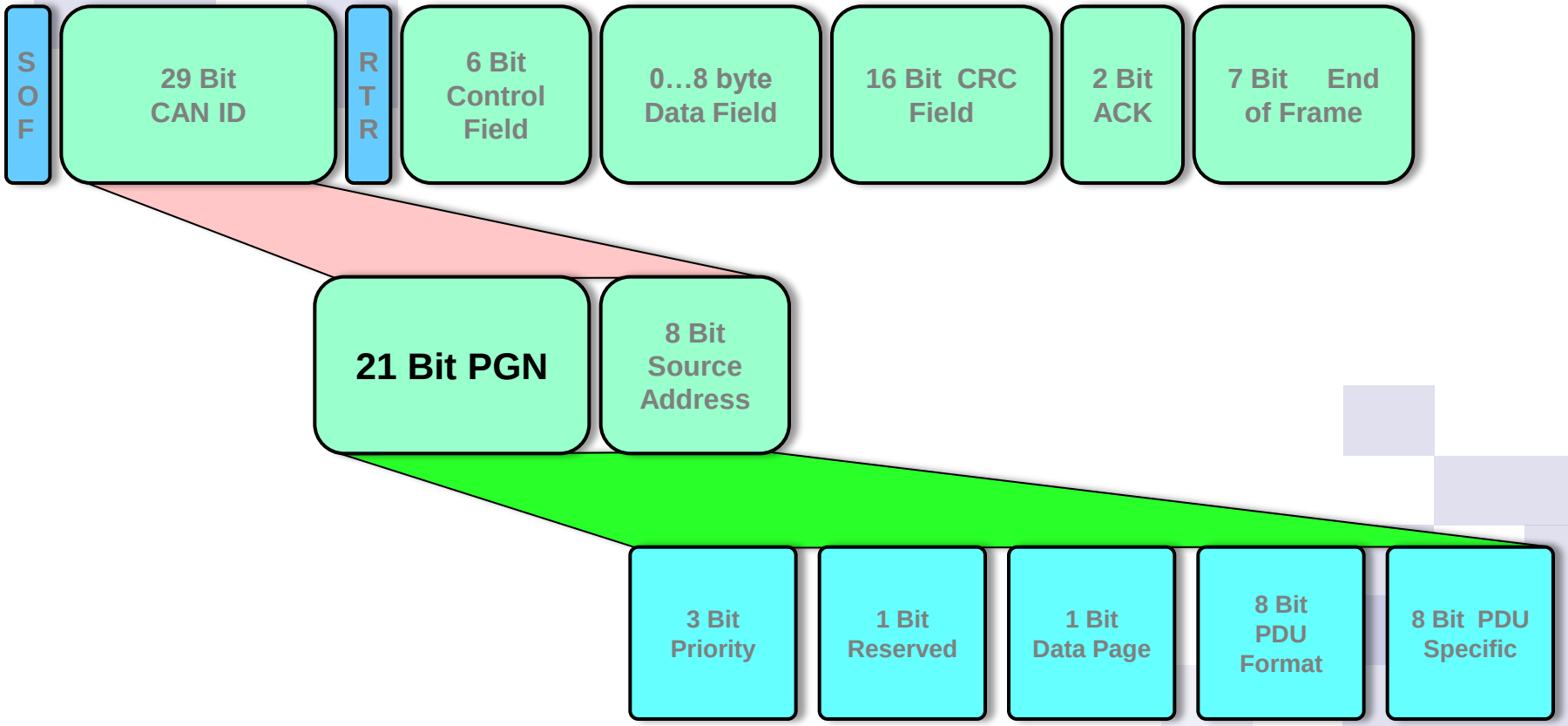
- **J1939 specifications:**
  - **Does NOT support Master/Slave or Client/Server configuration**
  - **Does NOT support node monitoring**
  - **Features ‘Address Claiming’ immediately after network start-up**
  - **Allows ‘Plug-and-Play’ feature**
  - **Allows segmentation of messages larger than 8 bytes**

SAE J1939 - Message Format (J1939/21)

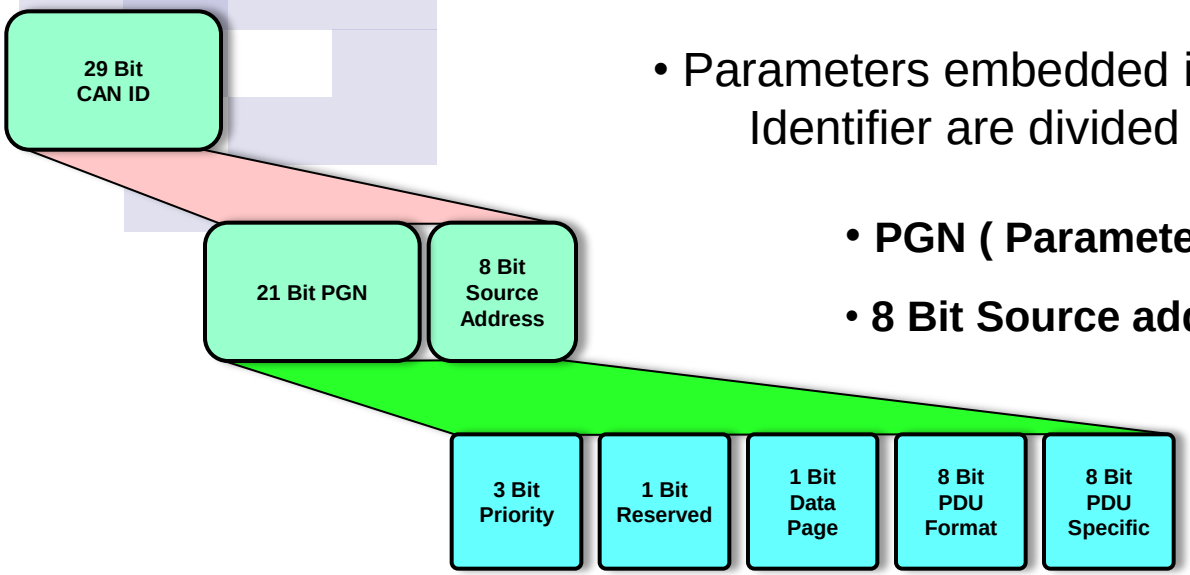


- CAN standard 2.0A was extended to 2.0B to allow a 29-Bit identifier
- IDE Bit indicates 11-Bit or 29-Bit Message Identifier
- Both formats can co-exist on the same CAN bus
- MilCAN uses J1939 29-Bit Message ID and CANopen 11-Bit Message ID
- J1939/21 also defines the segmentation of messages larger than 8 bytes

SAE – J1939 - Parameter Group Number



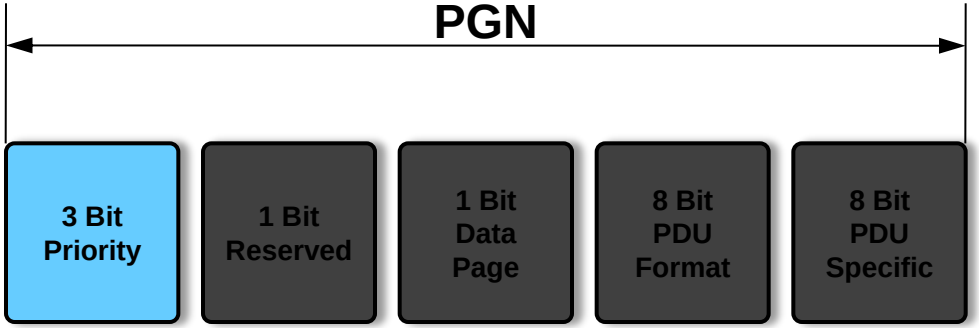
SAE – J1939 - Parameter Group Number



- Parameters embedded in the 29-Bit Message Identifier are divided into two sections:
  - **PGN (Parameter Group Number)**
  - **8 Bit Source address**

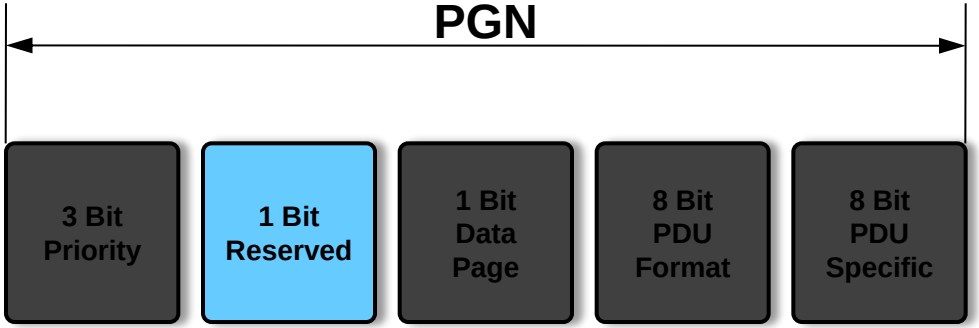
- **PGN Identifies the parameter group (PG)**
- **PG's point information of parameter assignments within 8 byte CAN data field, repetition and priority.**
- **8672 different Parameter Groups per page**

SAE – J1939 - Parameter Group Number



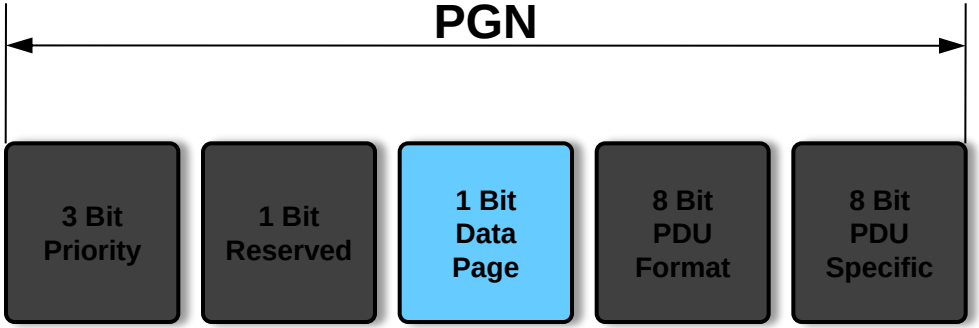
- **Priority:**
  - First three bits represent priority during arbitration process
  - Provides eight priority levels
  - A value of 0 (000) = Highest priority
  - A value of 8 (111) = lowest priority
  - High priority messages assigned to time critical data such as torque, control data from transmission to engine
  - Lower level priorities suitable for non-time critical data such as engine configuration data.

SAE – J1939 - Parameter Group Number



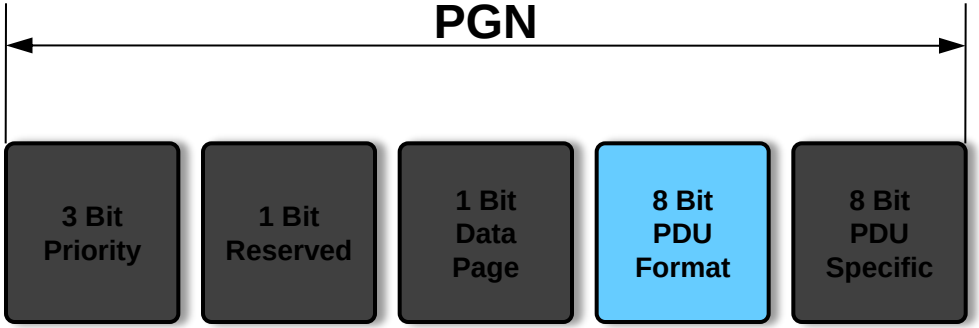
- **Reserved**
  - **Reserved for future purpose**
  - ***Should always be set to 0 when transmitting messages*.**

SAE – J1939 - Parameter Group Number



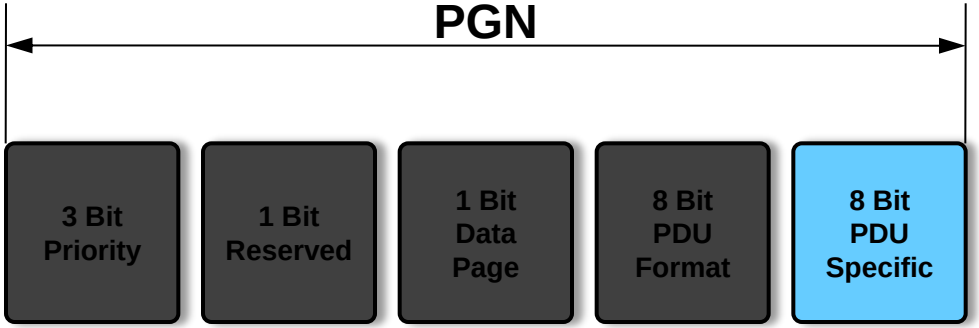
- **DP – Data Page:**
  - **Page selector for PDU (Protocol Data Unit) Format (PF) field**
  - **Currently at 0, Pointing to page 0**
  - **Page 1 for future purpose**

SAE – J1939 - Parameter Group Number



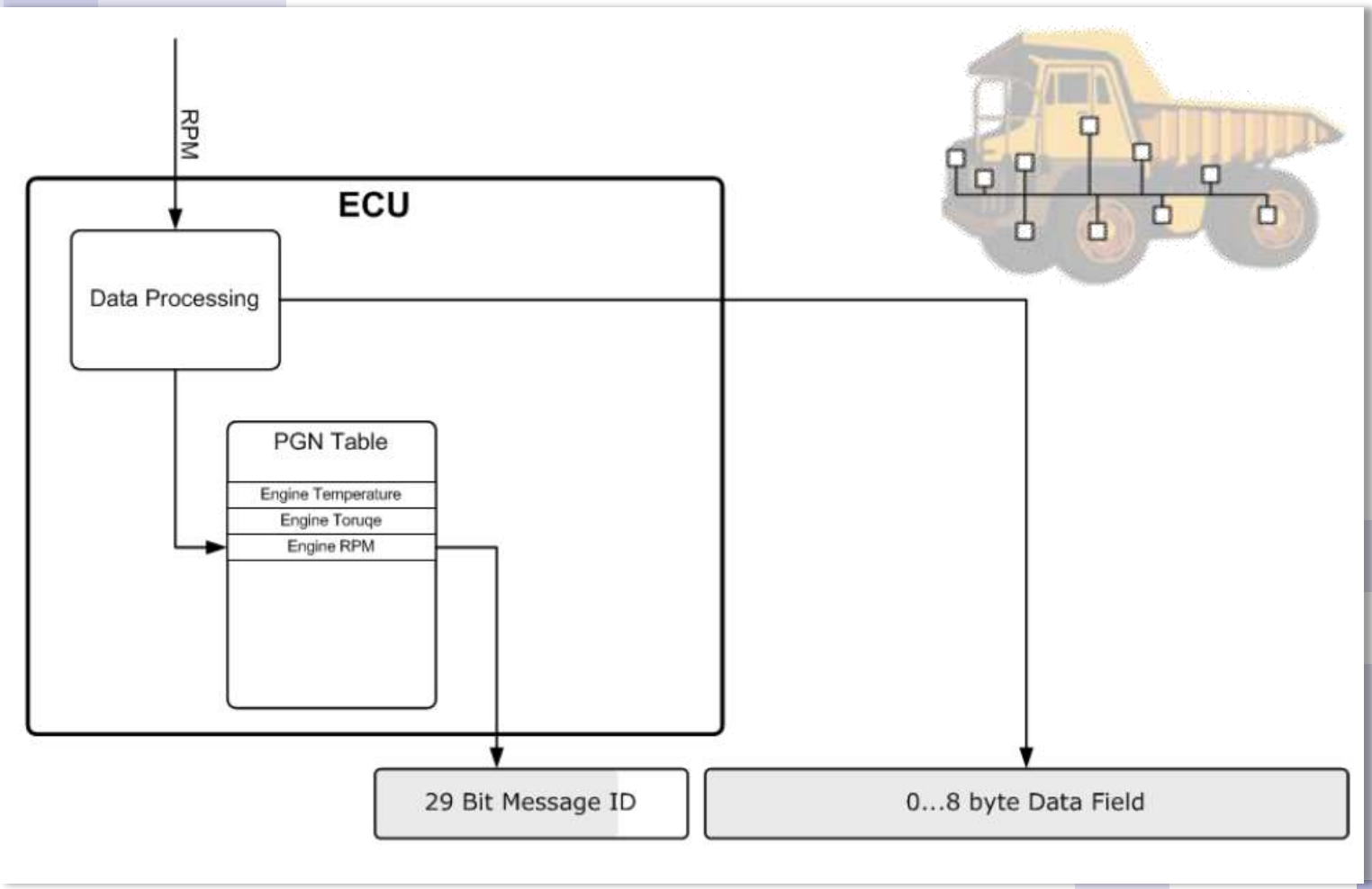
- **PDU Format (PF):**
  - **PF = 0-239 (PDU1) indicates a destination address in PS**
  - **PF = 240-255 (PDU2) indicates extension to PDU Format (PF)**

SAE – J1939 - Parameter Group Number

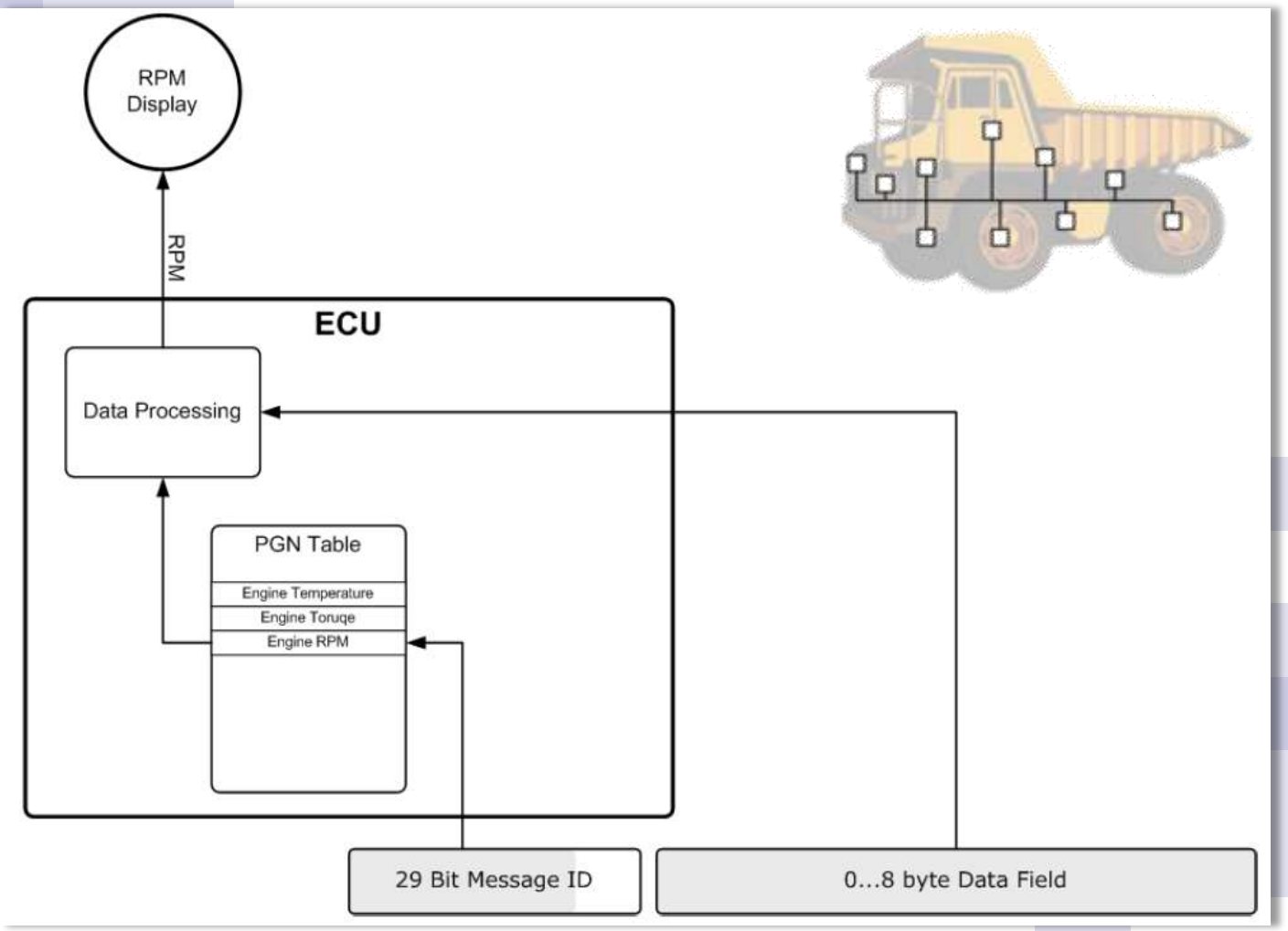


- **PDU Specific (PS):**
  - **Content interpreted according to information in PDU Format (PF)**

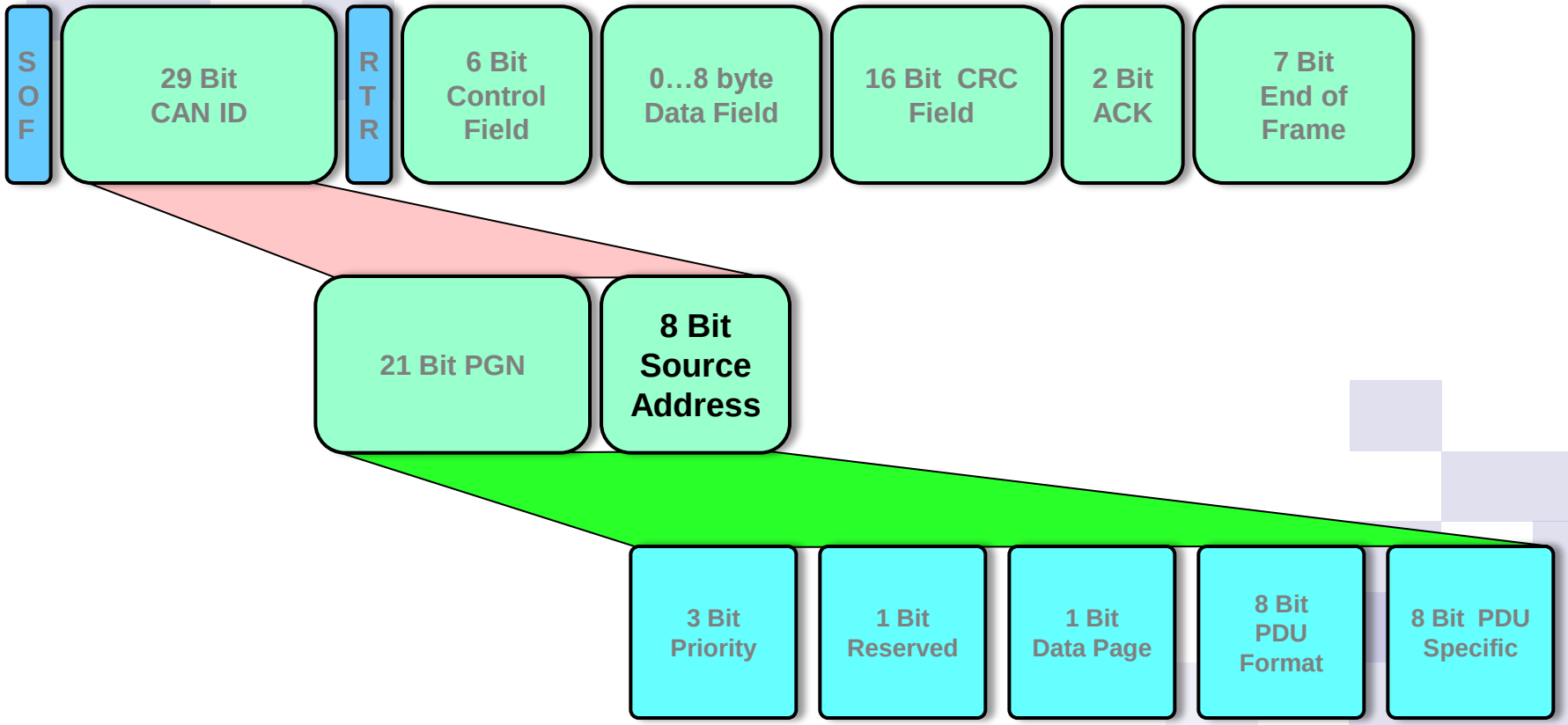
Example - Sending RPM



Example - Receiving RPM



SAE J1939 - Source Address



SAE J1939 - Source Address

- **Source Address (SA) = Last 8 bits of 29-Bit message identifier**
- **Source Address = address of transmitting ECU (node)**
- **A total of 254 addresses available**
- **Every address must be unique within network**
- **ECU's CANNOT share address**
- **PGN's are independent of Source Address**
- **Every ECU is allowed to transmit any message**

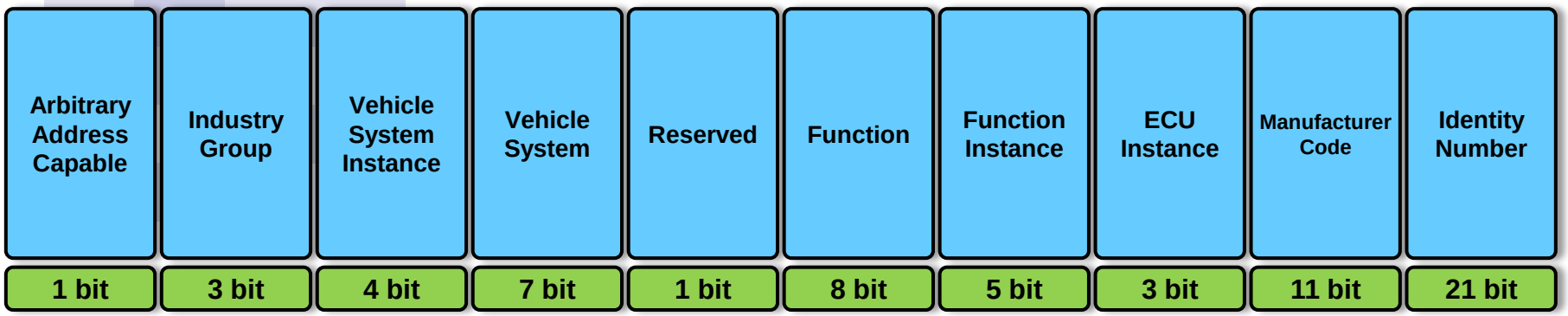
NOTE:

The CAN standard in itself does NOT support node (ECU) addresses, only message ID's.

SAE-J1939 - Network Management

- *Network management defined in SAE J1939/81*
- **Handles auto allocation of node addresses per address claiming procedure**
- **Address claiming not supported per default in any other high level protocol**
- **Network Management identifies ECU's and their primary function**
- **Node monitoring is not defined in J1939 – must be application specific**
- **J1939 does not support Master/Slave or Client/Master – must be application specific.**

SAE – J1939 - Address & Name



- SAE J1939 defines 64-Bit name to uniquely identify each ECU
- Each ECU must hold at least one NAME and one ADDRESS for identification purposes
- ECU ADDRESS defines the source or destination for message
- ECU NAME indicates main function performed at ECU address
- Function instance indicator used when multiple ECU's with same main function share the same network.

SAE – J1939 - Address Claiming

- 64-Bit name to uniquely identify nodes (ECU's)
- Necessitates unreasonable resources to maintain standard communications
- Each ECU uses an 8-Bit address to identify the source of a message or to access (destination address) another ECU in the network
- Address Claim Procedure:
  - Designed to assign addresses to ECU's right after the network startup
  - Assuring that assigned address is unique to ECU
  - SAE J1939 standard defines Preferred Address to commonly used devices in order to minimize the rate of multiple devices demanding the same address

SAE – J1939 - Address Claiming

Two possible scenarios:

Sending an address Claimed message (Standard):

- ECU sends Address Claimed message into the CAN bus
- ECU's receiving address claim will record & verify claimed address with internal address table.
- In case of address conflict ECU with lowest NAME value will succeed
- Remaining ECU's must claim different address or stop transmitting to network

Request for Address Claimed message:

- Necessary procedure for ECU's powering up late (E.g. trailers, diagnostics tools, e.t.c.)
- Used to determine and claim available address or to find out which ECU's are currently on the network

SAE J1939 - Communications Methods

Destination Specific Communications:

- USE PDU1 (PF Values 0 to 239)
- Destination address required:

Broadcast Communications:

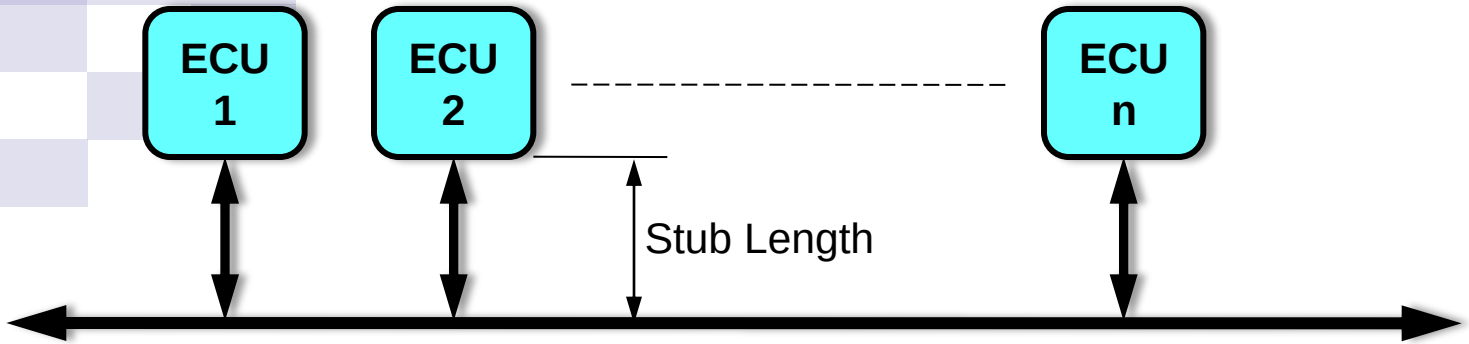
- Use PDU2 (PF values 240 to 255)
- Sending a message from a single or multiple sources to single destination
- Sending a message from a single or multiple sources to multiple destinations

Proprietary Communications*:

- Use either PDU1 or PDU2
- CAN be either Destination Specific or Broadcast
- Use propriety PGN's

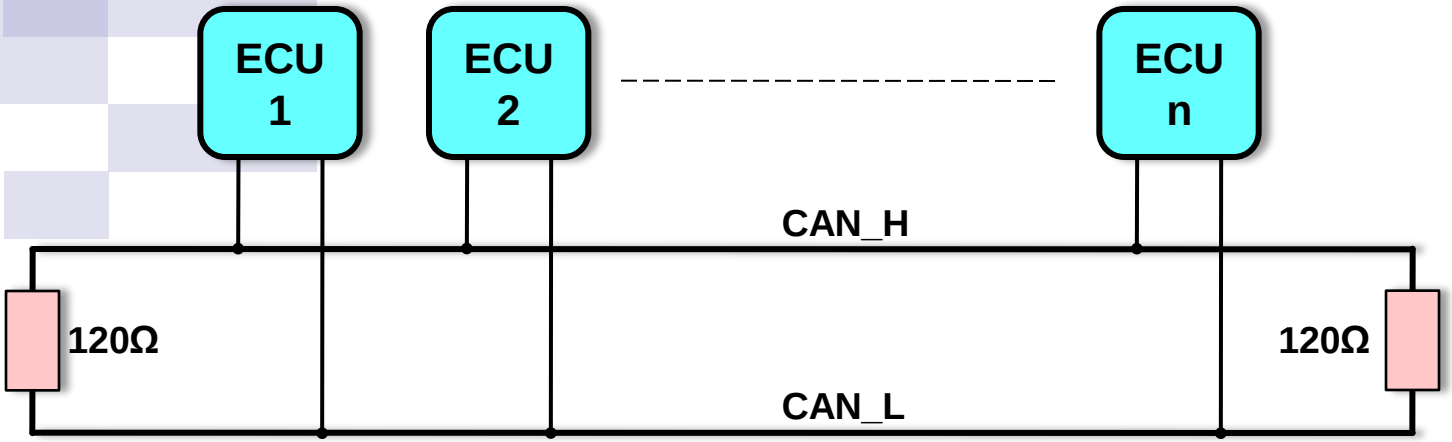
*According to SAE J1939

SAE J1939 - Network Topology



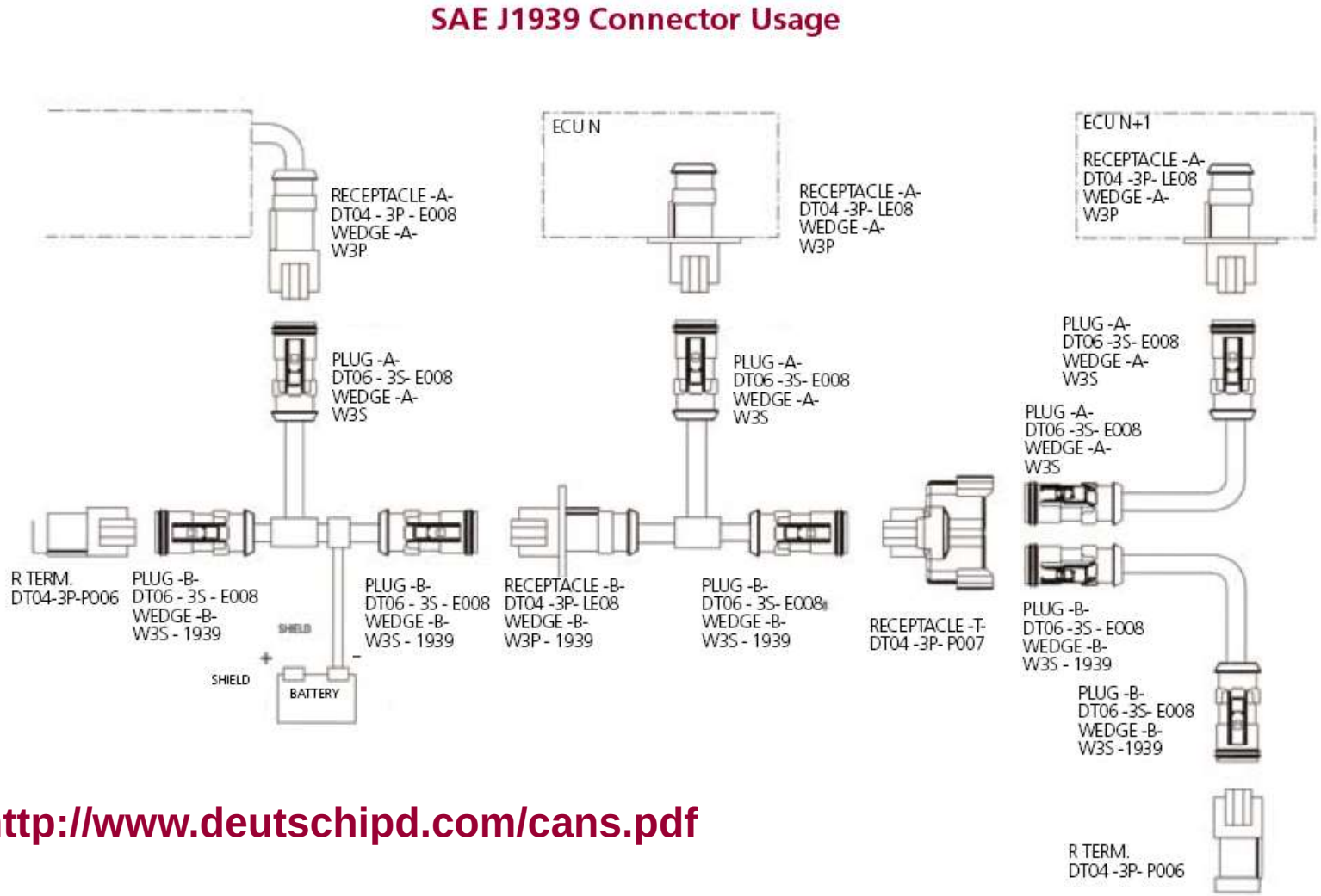
- **ECU's in a J1939 network segment are connected by a single, linear shielded twisted pair of wires.**
- **Wiring topology of the network should be as straight as possible to minimize electrical reflections.**
  - **Short stub lengths**
  - **Avoid complex network structures**

SAE J1939 - Network Topology



- Each bus segment should be terminated by resistors, typically 2x 120Ω
- Termination resistors should always be on both ends of the bus
- Dividing network into sub-networks may be necessary (for truck and trailer)
- Segmentation requires bridges

J1939 - Connector Usage



http://www.deutschipd.com/cans.pdf

J1939 - Off-Board diagnostic connector

- **J1939/13 defines a standard connector for external diagnostics**
- Deutsch HD10 - 9 – 1939 **(9 pins, round connector)**

HIGH COUNTRY TEK

Electro-Hydraulic Control Solutions

HCT Products Compatible with J1939

HCT Products for J1939

Displays

PV780, PV450, PV380

- Receive/Transmit
- Standard/Custom Messages

Fan Controllers

EMC-6, EMC, HFS-J

- Receive/Transmit
- Standard/Custom Messages

Configurable & Programmable Valve Drivers

evc, DVC700 Series

- Receive/Transmit
- Standard/Custom Messages

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Electro-Hydraulic Control Solutions

Code Examples

Intella™ Suite

Programming Tool:

- All variables are 16 bit words (65535d), Unsigned.
- Integer math, no decimal points.

- Decimal to Hexadecimal Calculator

PGN 61444

Electronic Engine Controller 1 - EEC1:

- Engine related parameters
- Transmission Repetition engine speed dependent
- Data Length: 8
- Data Page: 0
- PDU Format: 240
- PDU Specific: 4
- Default Priority: 3
- Parameter Group Number: 61444 (0xF004)

PGN 61444

Start Position	Length	Parameter Name	SPN
1.1	4 bits	Engine Torque Mode	899
2	1 byte	Driver's Demand Engine - Percent Torque	512
3	1 byte	Actual Engine - Percent Torque	513
4-5	2 bytes	Engine Speed	190
6	1 byte	Source Address of Controlling Device for Engine Control	1483
7.1	4 bits	Engine Starter Mode	1675
8	1 byte	Engine Demand – Percent Torque	2432

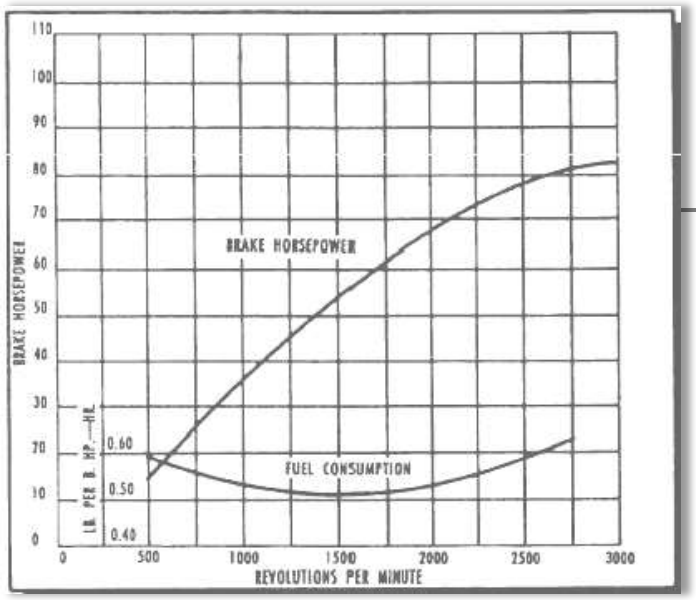
PGN 61444

PGN – Parameter Group Number (EEC1):

- PGN 61444d → F004h
- F0h → 240d, (61444 / 256 = 240)
- 04h → 4d

SPN 190

SPN 190 Engine Speed:



Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 offset
Data Range:	0 to 8,031.875 rpm
Type:	Measured
Supporting information:	PGN 61444

PGN 65272

PGN 65272 (R) Transmission Fluids - TF

- Transmission Repetition 1 s
- Data Length: 8
- Data Page: 0
- PDU Format: 254
- PDU Specific: 248
- Default Priority: 6
- Parameter Group Number: 65272 (0xFEF8)

PGN 65272

Start Position	Length	Parameter Name	SPN
1	1 bits	Clutch Pressure	123
2	1 bits	Transmission Oil Level	124
3	1 bits	Transmission Filter Differential Pressure	126
4	1 bytes	Transmission Oil Pressure	127
5 - 6	2 byte	Transmission Oil Temperature	177
7	1 byte	Transmission Oil Level High / Low	3027
8.1	4 bits	Transmission Oil Level Countdown Timer	3028
8.5	4 bits	Transmission Oil Level Measurement Status	3026

SPN 177

SPN 177 Transmission Oil Temperature:

- Temperature of the transmission lubricant.
- Data Length: 2 bytes
- Resolution: 0.03125 deg C/bit, -273 deg C offset
- Data Range: -273 to 1735 deg C
- Type: Measured
- Supporting information: PGN 65272

SPN 177 - Detail

‘Engineering units to J1939 counts
(1735 + 273) / 0.03125 = 64256

Counts = 0 to 64256

' 0.03125/C gain, -273 offset
if (transmission.srcaddr = 3) then
transmission_oil_temperature = transmission.temp_low + (transmission.temp_high * 256)
end if

' calculate max_ transmission_oil_temperature, (temperature in Deg C + 273) / 0.03125
if (transmission_oil_temperature > max_ transmission_oil_temperature) then ……
End if

Code Examples

PGN 0 Torque/Speed Control 1 - TSC1:

NOTE:

- Retarder may be disabled by commanding a torque limit of 0%.
- Using '**limit mode**' allows the use of the retarder only up to the limit specified in the request.

This can be used to permit retarding of up to 50%, for example, if:-

- That limit is required by some device such as an EBS,

Or

- It can disable the use of the retarder by others, as when an ABS controller detects wheel slip.

Code Examples

PGN 0 Torque/Speed Control 1 - TSC1:

- Transmission Repetition when active; 10 ms to engine - 50 ms to retarder
- Data Length: 8
- Data Page: 0
- PDU Format: 0
- PDU Specific: DA PGN Supporting Information:
- Default Priority: 3
- Parameter Group Number: 0 (0x0)

Code Examples

Start Position	Length	Parameter Name	SPN
1.1	2 bits	Engine Override Control Mode	695
1.3	2 bits	Engine Requested Speed Control Conditions	696
1.5	2 bits	Override Control Mode Priority	897
2-3	2 bytes	Engine Requested Speed/Speed Limit	898
4	1 byte	Engine Requested Torque/Torque Limit	518

Code Examples

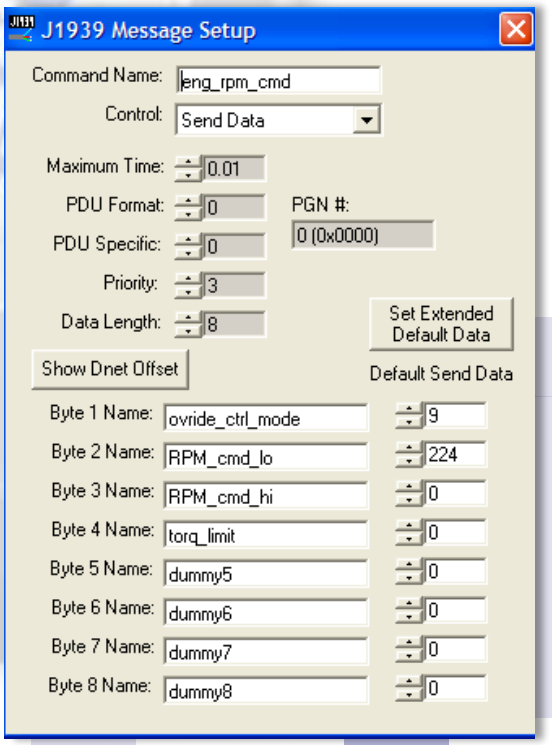
```
' CAT engine RPM control
engine_speed_cmd = low_engine_speed

' calculate RPM command based on Resolution: 0.125 rpm/bit, 0 offset
' Data Range: 0 to 8,031.875 rpm

engine_speed_calc = (engine_speed_cmd * 1000) / 125
' check for maximum RPM command of 1800 RPM
if (engine_speed_calc > 14400 ) then
    engine_speed_calc = 14400
end if

' send low byte then high byte
eng_rpm_cmd.RPM_cmd_lo = engine_speed_calc and 0xff
eng_rpm_cmd.RPM_cmd_hi = engine_speed_calc / 256

' sets engine control performance
eng_rpm_cmd.ovride_ctrl_mode = 9
eng_rpm_cmd.disable = false
```

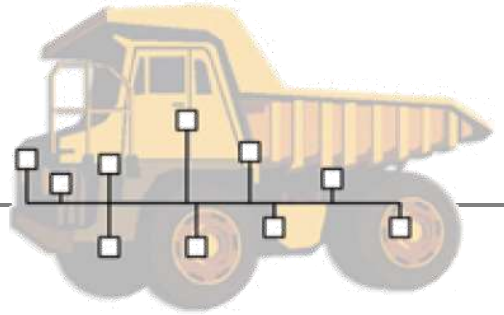


HIGH COUNTRY TEK

Electro-Hydraulic Control Solutions

Information Sources

SAE J1939 – Standards Collection



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ONLY available from SAE – go to website to download.

http://www.sae.org/servlets/index

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