

# In-Vehicle Networking

Lecture 10 Application Layers  
ISO 11783 Part 7,8 J1939-71  
BAE 5030 - 353  
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## Message structure

ID(PGN)	Parm 1	Parm 2	Parm 3	Parm 4	Parm 5
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- Parameter Groups (messages)
  - Packaged groups of parameters that fit into one or more 8 byte CAN frames and identified by a Parameter Group Number (PGN)
- Parameters
  - characters (ASCII)
  - scaled data (numbers)
  - function states (on/off/error/not available)

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## SLOTS - Parameter specification

- Parameters are encoded in an unsigned binary format with a standardized encoding and decoding process
- The specification of each parameter includes:
  - Scaling
    - The value for a bit change or gain
  - Limits
    - Maximum and minimum values to be stored in the parameter
  - Offset
    - The amount of offset from zero for the parameter
  - Transfer Function
    - The method for encoding or unencoding
    - Binary value in Message = (un-encoded value – offset)\*scaling
    - un-encoded value = (binary value in message/scaling) + offset

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## SLOT Examples

- Currently 85 slots defined (1999)

Parameter	Scaling (Resolution)	Limits (Range)	Offset	Parameter Size
Angle/Direction	10 <sup>-7</sup> deg/bit	-211 to 211.108 122 deg	-210	32 bit
	1/128 deg/bit	-200 to 301 deg	-200	16 bit
	1/128 deg/bit	0 to 502 deg	0	16 bit
Brake Applications	1 brake appl/bit	0 to 4 227 858 431 appl	0	32 bit
Component ID	1 ID/bit	0 to 250 ID	0	8 bit
Distance	0.125 km/bit	0 to 526 385 151.9 km	0	32 bit
	0.125 m/bit	-2500 to 2500 m	-2500	16 bit
Economy, liquid	1/512 km/L per bit	0 to 125.5 km/L	0	16 bit
Economy, gaseous	1/512 km/kg per bit	0 to 125.5 km/kg	0	16 bit
Electrical Current	1 A/bit	-125 to 125 A	-125	8 bit
	1 A/bit	0 to 250 A	0	8 bit
Electrical Potential	0.05 V/bit	0 to 3212.75 V	0	16 bit

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## Parameter Example

### 5.2.5.43 Barometric Pressure - Absolute air pressure of the atmosphere.

Data Length: 1 byte  
Resolution: 0.5 kPa/bit gain, 0 kPa offset  
Data Range: 0 to +125 kPa (0 to +18.1 psi)  
Type: Measured  
Suspect Parameter Number: 108  
Reference: 5.3.35

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## Message Example

### 5.3.35 AMBIENT CONDITIONS

Transmission repetition rate: 1 s  
Data length: 8 bytes  
Data page: 0  
PDU format: 254  
PDU specific: 245  
Default priority: 6  
Parameter group number: 65,269 (00FEF516 )

Byte:	1	Barometric pressure	5.2.5.43
	2,3	Cab interior temperature	5.2.5.11
	4,5	Ambient air temperature	5.2.5.12
	6	Air inlet temperature	5.2.5.13
	7,8	Road surface temperature	5.2.5.9

**Note:** This fits into 1CAN frame and this is desirable but not required

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## Parameter characterization

- Data Types (ISO 11783)
  - command - state or set point
  - measured - observed parameter
- Data Types (SAE J1939)
  - Status - state or set point resulting from a calculation
  - measured - observed parameter

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## Parameter Data Types and Ranges

**TABLE 1 TRANSMITTED SIGNAL RANGES**

Range Name	1 byte	2 bytes	4 bytes
Valid Signal	0 to 250 00 <sub>16</sub> to FA <sub>16</sub>	0 to 64 255 0000 <sub>16</sub> to FAFF <sub>16</sub>	0 to 4 211 081 215 00000000 <sub>16</sub> to FFFFFFFF <sub>16</sub>
Reserved range for future indicator bits	251 to 253 FB <sub>16</sub> to FD <sub>16</sub>	64 256 to 65 023 FB00 <sub>16</sub> to FDFF <sub>16</sub>	4 211 081 216 to 4 261 412 863 FB000000 <sub>16</sub> to FDFFFFFFFF <sub>16</sub>
Error indicator	254 FE <sub>16</sub>	65 024 to 65 279 FExx <sub>16</sub>	4 261 412 864 to 4 278 190 079 FExxxxxx <sub>16</sub>
Not available or not requested	255 FF <sub>16</sub>	65 280 to 65 535 FFxx <sub>16</sub>	4 278 190 080 to 4 294 967 294 FFxxxxxx <sub>16</sub>

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## Discrete Parameter Ranges

### TRANSMITTED VALUES FOR DISCRETE PARAMETERS (MEASURED)

Range Name	Transmitted value
Disabled (off, passive, etc.)	00
Enabled (on, active, etc.)	01
Error indicator	10
Not available or not installed	11

### TRANSMITTED VALUES FOR CONTROL COMMANDS (STATUS)

Range Name	Transmitted value
Command to disable function (turn off, etc.)	00
Command to enable function (turn on, etc.)	01
Reserved	10
Don't care/take no action (leave function as is)	11

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## Application Layers

- ISO 11783 Part 7 Basic Messages
  - Ground Speed, Time/Date
  - Three Point Hitch, Auxillary Valves, PTO
  - Navigation/GPS (Refers to NMEA)
  - Power Keep-Alive
  - Lighting
  - Process Data Message (Task Controller/Implement)
- ISO 11783 Part 8, SAE J1939/71
  - Broad vehicle info and control messages
    - Engine/Transmission/Braking/lpanel
    - Speed/Temperatures/Pressures
    - etc. ( ~200+ pages)
- ISO 11783 Part 9 Tractor ECU
- ISO 11783 Part 10 Task Controller
- ISO 11783 Part 12 Diagnostics
- ISO 11783 Part 13 File Server
- ISO 11783 Part 14 Sequence Control

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## ISO 11783 Part 7 Basic Messages

### Message Title

Time and Date

Wheel Based Speed and Distance

Ground Based Speed and Distance

GPS Position and Status data

Attitude (Bearing, Pitch, Roll, Altitude)

Hitch Status (Position and Draft)

Power Takeoff Status

Auxiliary Valve Status

Hitch and PTO Commands

Auxiliary Valve Commands

Lighting

Process Data

ECU Power Status and Extension

### Normal Source

Tractor ECU

Tractor ECU

Tractor ECU

GPS/Navigation ECU

GPS/Navigation ECU

Tractor ECU

Tractor ECU

Tractor ECU

Implement ECU

Implement ECU

Tractor ECU

Task Controller/Implement ECU

Tractor/Implement ECU

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## Time / Date

- Time (local) - seconds, minutes, hours
- Date - day, month, year
- Existing J1939/71 PGN except local minute & hour offset are not supported

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## Speed, Distance, and Direction

- Ground-based Parameters
  - Ground-based implement speed
  - Ground-based driven distance
  - Ground-based driven direction
- Wheel-based Parameters
  - Wheel-based implement speed
  - Wheel-based driven distance
  - Wheel-based driven direction

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## Electrical Power Parameters

- Key Switch State
- Maximum Time (remaining) of Tractor Power
- Maintain ECU Power
- Maintain Actuator Power

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## Navigational System Parameters

- Use NMEA 2000 (IEC 61162-3) messages
- Preferred (minimum) message set:
  - GNSS Position Data
  - GNSS High Output Position
  - GNSS Pseudorange Noise Statistics

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## Implement State Parameters

- Implement Transport State
- Implement Park State
- Implement Work State

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## Hitch Parameters

- (Front / Rear) Hitch (Position / Position Command)
- (Front / Rear) Hitch In-Work Indication
- (Front / Rear) Draft
- (Front / Rear) nominal lower link force

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## PTO Parameters

- (Front / Rear) PTO output shaft (speed / speed set point / set point command)
- (Front / Rear) PTO (engagement / engagement command)
- (Front / Rear) PTO (mode / mode command) - 540 v. 1000 PRM
- (Front / Rear) PTO economy (mode / mode command) - engine speed lower than normal PTO mode

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## Auxiliary Valve Parameters

- Auxiliary valve number (range: 0-63)
- (Extend / Retract) port (measured / estimated / commanded) flow
- Valve float (enable / enable command)
- (Extend / Retract / Return) port pressure
- Nominal Implement Position

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## Lighting Parameters

- Head Light (High / Low) Beam
- Alternate Head Light
- Work Lights command
- (Left / Right) Turn Signal Lights
- (Left / Right / Center) Stop Light
- (Left / Right / Center) Marker Light
- Rotating Beacon Light
- (Front / Rear) Fog Lights
- Reversing Lights

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## Language Parameters

- Language code command
- Decimal symbol command
- Date (format) command
- Time (format) command
- Units of measure parameter
  - distance
  - area
  - volume
  - mass

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## Repetition Rate Parameters

- Request for Repetition Rate
- Responses for Repetition Rate

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## Tractor remote control messages

- Implement remote control command
- Implement remote control command tractor response
- Tractor facilities response message
- Required tractor facilities message
- Allows
  - Cruise control
  - Combined constant PTO speed and cruise control
  - Auxiliary valve slip control with cruise control

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## Process Data Message

- Used to communicate data from a task controller to one or more “implements” and from an “implement to a task controller
- Can communicate either configuration data or process data values
- Data identity determined by a data dictionary element number of the Process Data Dictionary
- Uses single destination specific PGN
- Only 1 parameter per PGN
- Has a capacity to address the whole implement, sections of the implement, and elements within sections of an implement through the use of a 12 bit element number
- Uses a 4 byte process data value
- Allows proprietary process data

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## Process Data Message

- Device Classes (See ISO 11783 Part 1)
  - 1 - Basic Attributes
  - 2 - Tractor
  - 3 - Tillage
  - 4 - Secondary Tillage
  - 5 - Planters / Seeders
  - 6 - Fertilizers
  - 7 - Sprayers
  - 8 - Harvesters
  - 9 - Root Harvesters
  - 10 - Forage
  - 11 - Irrigation
  - 12 - Transport / Trailer
  - 13 - Farm Yard Operation
  - 14 - Powered Aux Devices
  - 15 - Special Crops
  - 16 - Earth Work

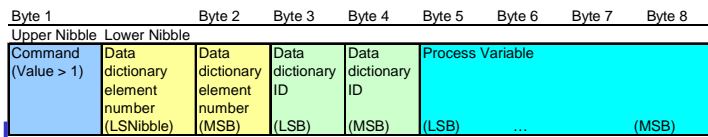
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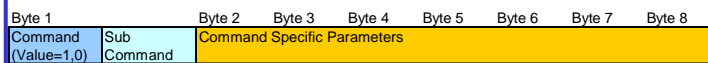
## Process Data Message

- Process Data Message Fields

### Type 1



### Type 2



## Process Data Message

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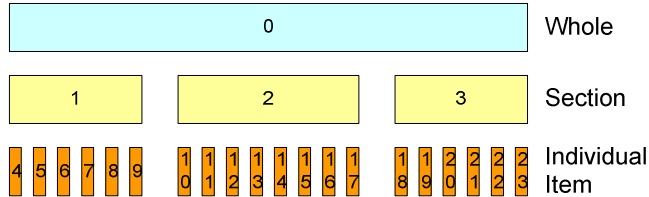
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<b>Command Values</b>	
00H	Sub Command for capabilities message of a Task Controller or Working Set Master
01H	Sub Command for the transfer and management of Device Description Data message
02H	Request Value command. The value of data element specified by the Data Dictionary Identifier is requested.
03H	Value command. The Process Data value is the value of the data element specified by the Data Dictionary Identifier. This command is used both to answer a Request Value command and to set the Value of a Process Data element.
04H	Measurement Command: Process Data value is the time interval for sending the data element specified by the Data Dictionary Identifier. The Working Set has to send the value of this data element to the Task Controller cyclic with this time interval. The unit of the time interval is milliseconds.
05H	Measurement Command: Process Data value is the distance interval for sending the data element specified by the Data Dictionary Identifier. The Working Set has to send the value of this data element to the Task Controller cyclic with this distance interval. The unit of the distance interval is millimeters.
06H	Measurement Command: Process Data value is the minimum within threshold for sending the data element specified by the Data Dictionary Identifier. The Working Set has to send the value of this data element to the Task Controller when the value is higher than the threshold value. The unit of the threshold is specified by the Data Dictionary Identifier definition.
07H	Measurement Command: Process Data value is the maximum within threshold for sending the data element specified by the Data Dictionary Identifier. The Working Set has to send the value of this data element to the Task Controller when the value is lower than the threshold value. The unit of the threshold is specified by the Data Dictionary Identifier definition.
08H	Measurement Command: Process Data value is the change threshold for sending the data element specified by the Data Dictionary Identifier. The Working Set has to send the value of this data element to the Task Controller when the value change is higher than the change threshold since last transmission. The unit of the threshold is specified by the Data Dictionary Identifier definition.
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<b>Command Values</b>	
09H	Reserved
0AH	Reserved
0BH	Reserved
0CH	Reserved
0DH	Message is a Negative Acknowledge (NAK). Command is rejected for reason included in response Process Data value.
0EH	Task Controller Status – send cyclic each 2 seconds from Task Controller to Working Set Master or directly on Task Status change. This message is sent to the destination specific global address (0xFF). The Working Set Master times out the connection after 6 seconds when this message fails. Process variable value is used for Task Status: Definition Task counters active: 0 = inactive, 1 = active On 0 to 1 transition: Internal ECU counters are reset to zero and counting starts On 1 to 0 transition: Internal ECU counters are stopped and may be queried by Task Controller through a series of Request Value commands.
0FH	Working Set Task Message – send by the Working Set Master – send cyclic each two seconds or directly on Task Status change.
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## Element Number and Example

- Description syntax {Element Number, Parent}
- A sprayer of three boom sections with 6 nozzles on the first boom section, 8 nozzles on the second boom section and 6 nozzles on the third boom section would be described as:
  - {0,Null}
  - {1,0}, {2,0}, {3,0}
  - {4,1}, {5,1}, {6,1}, {7,1}, {8,1}, {9,1}
  - {10,2}, {11,2}, {12,2}, {13,2}, {14,2}, {15,2}, {16,2}, {17,2}
  - {18,3}, {19,3}, {20,3}, {21,3}, {22,3}, {23,3}
  - The element number would be 0 to address the implement sprayer. The element number would be 2 to address the second boom section. To address the second nozzle on the third boom, the element number would be 19.



March 10, 2008

BAE 5030-353

## Process Data Dictionary (Example)

<b>DD Entity</b>	<b>52 - Actual Tillage Depth</b>
Definition	Actual Tillage Depth of Device Element below soil surface, value increases with depth
Comment	
Device Class(es)	2 - Primary Soil Tillage 3 - Secondary Soil Tillage 4 - Planters /Seeders 5 - Fertilizer
Unit Symbol	mm - Length
Resolution	1
SAE SPN	not specified
Range	0 - 2.14748e+009
Submit by	Part 10 Task Force
Submit Date	2003-08-01 00:00:00
Submit Company	89 - Kverneland Group, Electronics Division
Current Status	ISO-Published
Status Date	2005-02-02 00:00:00
Request Document	
Annex Release Date	2005-03-01 00:00:00
Status Comments	DDEs have been moved to published for creating the new Annex A version.

March 10, 2008

BAE 5030-353

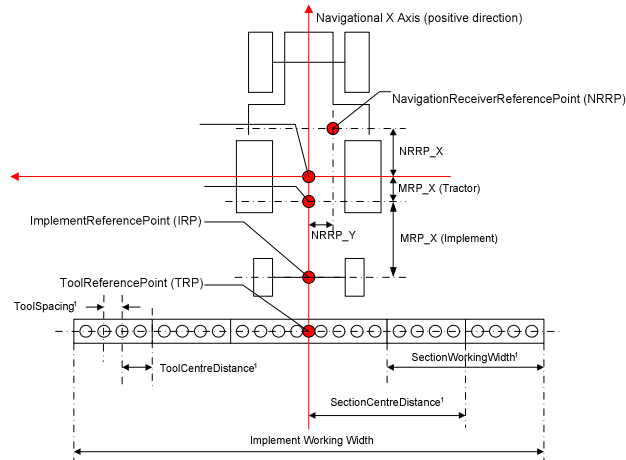
## Process Data Message

- Process Variable Value
  - Four byte parameter containing the actual data for the Process Data Message.
  - Defined as signed long integer data type.
  - May be a setpoint, actual value, etc. as defined in the data dictionary

March 10, 2008

BAE 5030-353

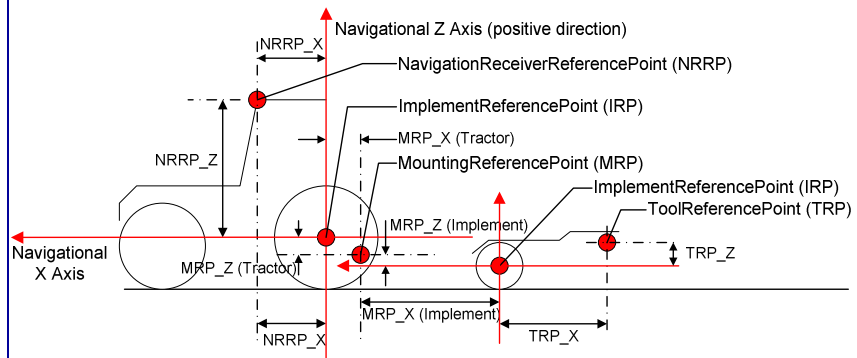
## Implement Geometry: Offset Definitions



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## Implement Geometry: Offset Definitions



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