CAN protocol (J1939 / ISOBUS) for Sense42

22.01.2020

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FROM MIND TO MOTION

J1939 / ISOBUS Overview
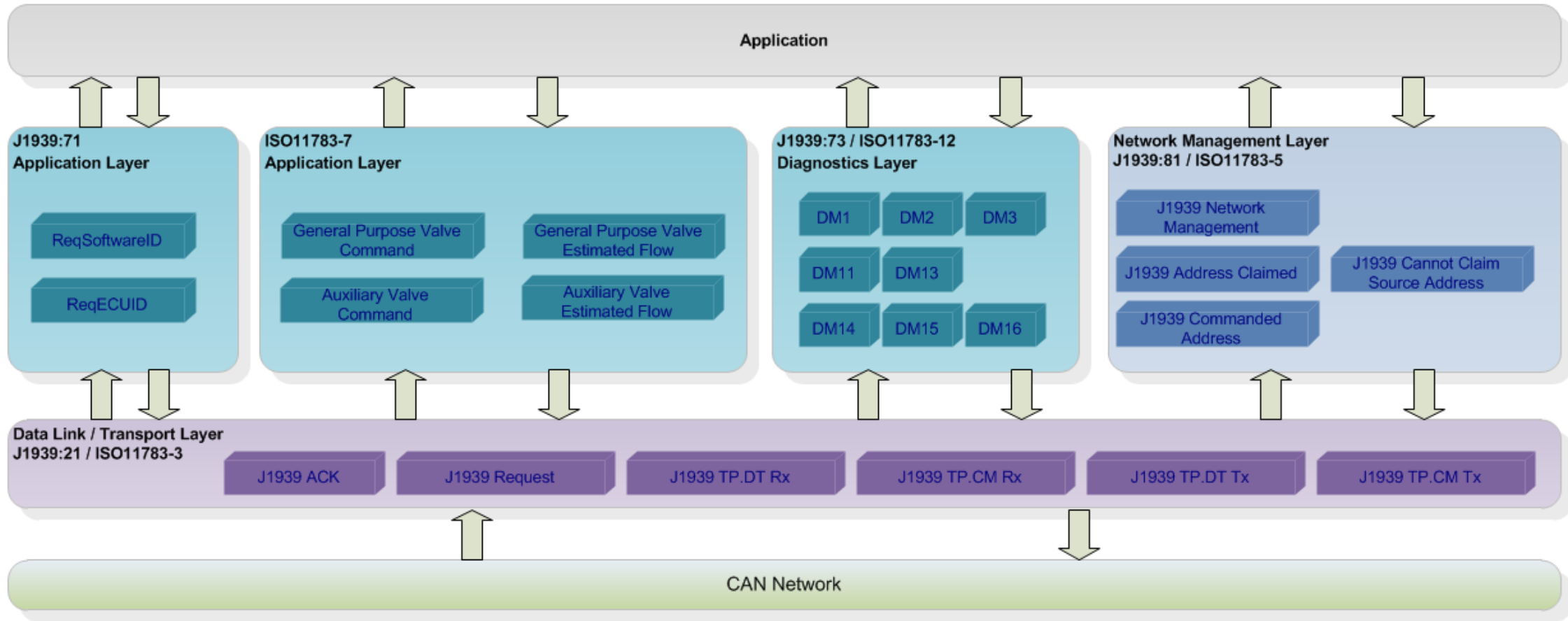
ISO11783/ISOBUS : Tractors and machinery for agriculture and forestry
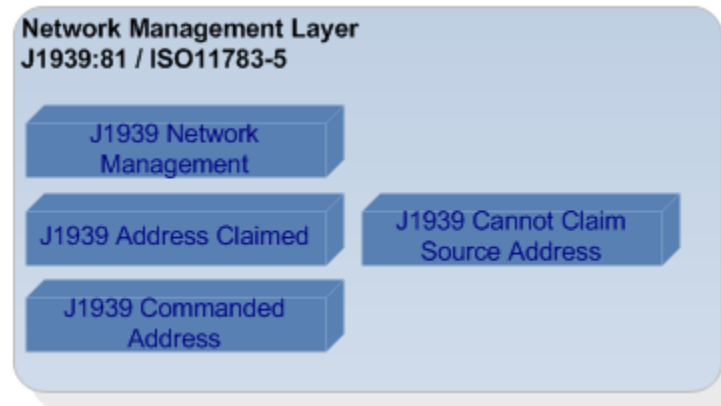
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J1939:81 : Network Management Layer

The Network Management Layer will define:

- The NAME of the "Controller Application" (CA Name)
- The Address Claim procedure

The J1939 frames defined in the Network Management Layer are :

- Address Claimed
- Cannot Claim Source Address
- Commanded Address

Network Management Layer
J1939:81 / ISO11783-5

- J1939 Network Management
- J1939 Address Claimed
- J1939 Cannot Claim Source Address
- J1939 Commanded Address

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J1939:81 : Network Management Layer
CA Name

CA NAME							
Bit 8 (MSB)	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1 (LSB)
Byte 1	Identity Number (8-1)						
Byte 2	Identity Number (16-9)						
Byte 3	Manufacturer Code (3-1)			Identity Number (21-17)			
Byte 4	Manufacturer Code (11-4)						
Byte 5	Function Instance				Ecu Instance		
Byte 6	Function						
Byte 7	Vehicle System						R
Byte 8	Arb Address	Industry Group		Vehicle System Instance			

Identify Number : Assigned by the manufacturer (SBZ), this 21 bits field is unique incremental number.

Manufacturer Code : Assigned by SAE : 0x147 for Sonceboz

ECU Instance : Indicates the ECU number on which the application controller is used in the case of several ECUs

Function Instance : Identifies the occurrence of the application controller (having the same function) on the CAN bus

Function : Defines the function of the actuator (Auxiliary Valve Control, Hitch Control, etc)
Default value is 129d (0x81 - auxiliary valves control).

Vehicle System : Must be associated with the industry group to define the sub-group Ex: Tractor, Harvester, etc.
Default value for tractor auxiliary valves control is 1.

Vehicle Instance : Identifies the occurrence of the "Vehicle System" on the CAN bus

Industry group : Type of industry in which the actuator is used
Ex : On-Highway equipment, agricultural, construction, marine, industrial.
By default the ACU group is 2 for "agricultural and forestry" (industry group n°2).

Arbitrary Address Capable : capability to select another address in case of address conflicts

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J1939:81 : Network Management Layer
Source Address Range for S42 products

➢ Valid address ranges are generally from 0x80 to 0x8F, but some customers use the range 0xA0 - 0xAF.
➢ The function instance is used to determine the valve number which determines the supported PGN for actuator control.
➢ The ECU Type will define the protocol to use : "Auxiliary Valve" or "General Purpose Valve"

Type of valve	ECU Type	Source Address (ex 0x80-0x8F)	Function Instance (valve number)	Command message PGN	Estimated Flow message PGN
Auxiliary Valve 0	'A'	0x80	0	FE30	FE10
Auxiliary Valve 1	'A'	0x81	1	FE31	FE11
Auxiliary Valve 2-14	'A'	0x82-0x8E	2-14	FE32-FE3E	FE12-FE1E
Auxiliary Valve 15	'A'	0x8F	15	FE3F	FE1F
General Purpose Valve	'G'	0x80-0x8F	0-15	C400	C600

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ISO11783-7 : Implement Messages Application layer Auxiliary Valve Command

The Auxiliary Valve Command message must be send with a period from 10 to 100ms.

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
	Auxiliary Valve Command (PGN 65072 - 65087 / 0x00FE30 - 0x00FE3F)							
ID	0C FE 3 "Valve Number" "SA"							
Byte 1	Standard Flow [0-100%]							
Byte 2	Reserved							
Byte 3	Fail Safe Mode		Reserved			Valve State		
Byte 4	Reserved							
Byte 5	Reserved							
Byte 6	Reserved							
Byte 7	Reserved							
Byte 8	Reserved							

Standard Flow: The percentage of flow [0-250] for [0-100%]
Valve State: Define the actuator command (Neutral, Extend, Retract, Float, Safety)
Fail Safe Mode : Ignored by the Actuator

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ISO11783-7 : Implement Messages Application layer General Purpose Valve Command

The General Purpose Valve Command message must be send with a period from 10 to 100ms.

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
	General Purpose Valve Command (PGN 50176 / 0x00C400)							
ID	0C C4 "DA" "SA"							
Byte 1	Standard Flow [0-100%]							
Byte 2	Reserved							
Byte 3	Fail Safe Mode		Reserved			Valve State		
Byte 4	Extended Flow [LSB]							
Byte 5	Extended Flow [MSB]							
Byte 6	Reserved							
Byte 7	Reserved							
Byte 8	Reserved							

Standard Flow: The percentage of flow [0-250] for [0-100%]
Valve State: Define the actuator command (Neutral, Extend, Retract, Float, Safety)
Fail Safe Mode : Ignored by the Actuator
Extended Flow : The percentage of flow encoded on 16bits [0-64000] for [0-100%]

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ISO11783-7 : Implement Messages Application layer Auxiliary Valve Estimated Flow

The Auxiliary Valve Estimated Flow message is send every 100ms

	Auxiliary Estimated Flow (PGN 65040 - 65055 / 0x00FE10 - 0x00FE1F)							
	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
ID	0C FE 1 "Valve Number" "SA"							
Byte 1	Extend Estimated Flow - Standard							
Byte 2	Retract Estimated Flow - Standard							
Byte 3	Fail Safe Operation		Reserved		Valve State			
Byte 4	Limit (unused 111)			Reserved				
Byte 5	Reserved		Exit/Reason Code (unused 11111)					
Byte 6	Reserved							
Byte 7	Reserved							
Byte 8	Reserved							

Extend Estimated Flow: Extend Flow [25-225] for [-100%;100%]
Retract Estimated Flow : Retract Flow [25-225] for [-100%;100%]
Fail Safe Operation : Not used (filled with '0')
Valve State: Define the Valve State (Neutral, Extend, Retract, Float, Error)
Limit: Not used (filled with '1')
Exit/Reason Code: Not used (filled with '1')

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ISO11783-7 : Implement Messages Application layer
General Purpose Valve Estimated Flow

The General Purpose Valve Estimated Flow message is send every 100ms

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
	General Purpose Estimated Flow (PGN 50688 / 0x00C600)							
ID	0C C6 "DA" "SA"							
Byte 1	Extend Estimated Flow - Standard							
Byte 2	Retract Estimated Flow - Standard							
Byte 3	Fail Safe Operation		Reserved		Valve State			
Byte 4	Limit (unused 111)			Reserved				
Byte 5	Extend Estimated Flow - Extended [LSB]							
Byte 6	Extend Estimated Flow - Extended [MSB]							
Byte 7	Retract Estimated Flow - Extended [LSB]							
Byte 8	Retract Estimated Flow - Extended [MSB]							

Extend Estimated Flow: Extend Flow [25-225] for [-100%;100%]
Retract Estimated Flow : Retract Flow [25-225] for [-100%;100%]
Fail Safe Operation : Not used (filled with '0')
Valve State: Define the Valve State (Neutral, Extend, Retract, Float, Error)
Limit: Not used (filled with '1')
Exit/Reason Code: Not used (filled with '1')
Extend Estimated Flow - Extended : Extend Flow [6250-56250] for [-100%;100%]
Retract Estimated Flow - Extended : Retract Flow [6250-56250] for [-100%;100%]

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J1939:73 : Diagnostics Layer
DM1 Active Diagnostic Trouble Codes

The DM1 message is send every 1sec and when a DTC becomes active or inactive.

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
	DM1 (PGN 65226 / 0x00FECA)							
ID	18 FE CA "SA"							
Byte 1	SAE Lamp Status (Malfunction Indicator, Red Stop, Amber Warning, Protect Lamp)							
Byte 2	SAE Flash Lamp (Malfunction Indicator, Red Stop, Amber Warning, Protect Lamp)							
Byte 3	SPN (1..8)							
Byte 4	SPN (9..16)							
Byte 5	SPN (17..19)			FMI				
Byte 6	CM = 0	Occurrence Count						
Byte 7	Reserved							
Byte 8	Reserved							

SAE Lamp Status: Not used (filled with 0x00)

SAE Flash Lamp: Not used (filled with 0xFF)

SPN : « Suspect Parameter Number » First part of the error code

FMI: « Failure Mode Identifier » 2nd part of the error code

SPN Conversion Method : Always set to 0.

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J1939:73 : Diagnostics Layer
DM1 Active Diagnostic Trouble Codes

Example of SPN :
- SPN 158: Power Supply
- SPN 628 : Program Memory

SPN 158	
FMI 18	DTC 0x9E0012

FMI value:

FMI = 0 : Data Valid but Above Normal Operation Range – Most Severe Level

FMI = 1 : Data Valid but Below Operation Range – Most Severe Level

FMI = 2 : Data Erratic, Intermittent or Incorrect

FMI = 3 : Voltage Above Normal or Shorted to High Source

FMI = 4 : Voltage Below Normal or Shorted to Low Source

FMI = 5 : Current Above Normal or Open Circuit

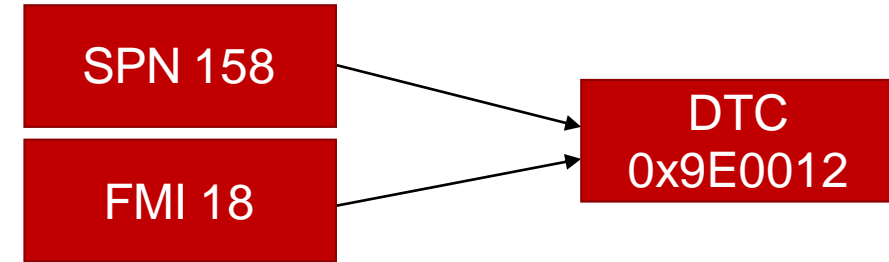FMI = 6 : Current Below Normal or Grounded Circuit

FMI = 7 : Mechanical System not Responding or Out of Adjustment

FMI = 8 : Abnormal Frequency or Pulse Width or Period

FMI = 9 : Abnormal Update Rate

FMI = 10 : Abnormal Rate of Change

FMI = 11 : Root Cause Not Known

FMI = 12 : Bad Intelligent Device or Component

FMI = 13 : Out of Calibration

FMI = 14 : Special Instructions

FMI = 15 : Data Valid but Above Normal Operation Range – Least Severe Level

FMI = 16 : Data Valid but Above Normal Operation Range – Moderately Severe

FMI = 17 : Data Valid but Below Normal Operation Range – Least Severe Level

FMI = 18 : Data Valid but Below Normal Operation Range – Moderately Severe
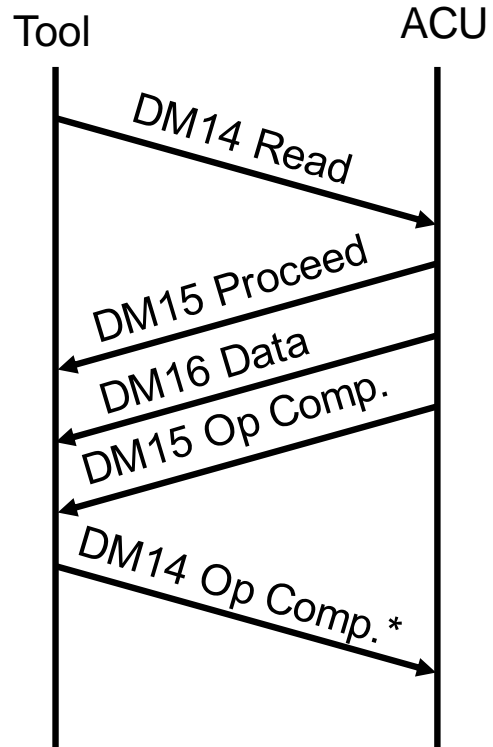
FMI = 19 : Received Network Data In Error

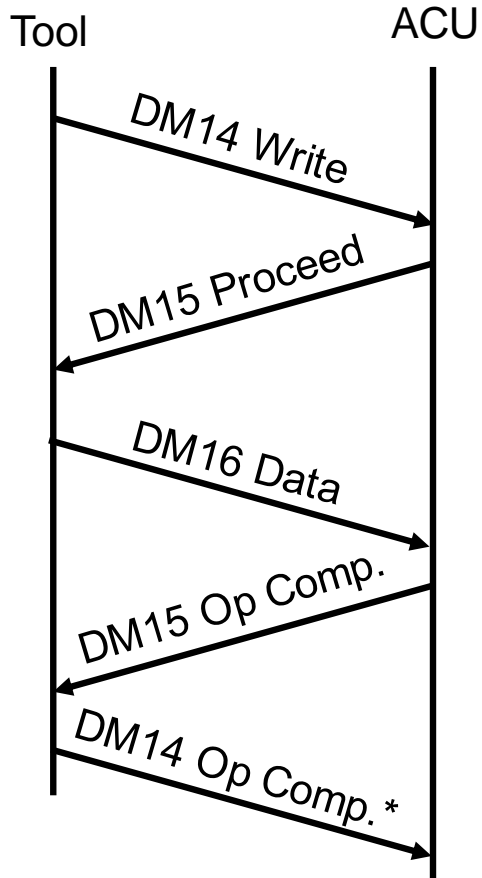FMI = 20 : Data Drifted High

FMI = 21 : Data Drifted Low

FMI = 31 : Not Available or Condition reported by the SPN exists

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J1939:73 : Diagnostics Layer
Memory Access Process

Process to read data

Tool → ACU

- DM14 Read (Tool → ACU)
- DM15 Proceed (ACU → Tool)
- DM16 Data (ACU → Tool)
- DM15 Op Comp. (ACU → Tool)
- DM14 Op Comp. * (Tool → ACU)

Process to write data

Tool → ACU

- DM14 Write (Tool → ACU)
- DM15 Proceed (ACU → Tool)
- DM16 Data (Tool → ACU)
- DM15 Op Comp. (ACU → Tool)
- DM14 Op Comp. * (Tool → ACU)

* This message is defined in the J1939 standard but is optional because the actuator has already completed its Memory Access session

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J1939:73 : Diagnostics Layer
DM14 Memory Access Request

The Memory Access Request message will initiate or end a Memory Access session

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
	DM14 (PGN 55552 / 0x00D900)							
ID	18 D9 "DA" "SA"							
Byte 1	Length / Number requested LSB							
Byte 2	Length / Number requested MSB			Pointer Type	Command			Reserved
Byte 3	Pointer (LSB)							
Byte 4	Pointer (mSB)							
Byte 5	Pointer (MSB)							
Byte 6	Pointer extension							
Byte 7	Key / User level (LSB)							
Byte 8	Key / User level (MSB)							

Length / Number requested : Number of byte to read or to write
Pointer Type : Set to '0' for Sense42
Command : Command for Memory Access (Read, Write, Op Complete, Op Failed)
Pointer : Address to read / write
Pointer Extension : Set to '1' for EEPROM access
Key / User level: Key value for Write Memory Access (0x2505)

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J1939:73 : Diagnostics Layer
DM14 Memory Access Request

Command for Memory Access Request :

Bits Command	Description
01	Read
02	Write
04	Operation Completed
05	Operation Failed

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J1939:73 : Diagnostics Layer
DM15 Memory Access Response

The message DM15 is the response to the message DM14 to define if the actuator can perform the Memory Access request:

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
	DM15 (PGN 55296 / 0x00D800)							
ID	18 D8 "DA" "SA"							
Byte 1	Length / Number allowed LSB							
Byte 2	Length / Number allowed MSB			Reserved	Status			Reserved
Byte 3	Error Indicator / EDC parameter (LSB)							
Byte 4	Error Indicator / EDC parameter (mSB)							
Byte 5	Error Indicator / EDC parameter (MSB)							
Byte 6	EDCP extension							
Byte 7	Seed (LSB)							
Byte 8	Seed (MSB)							

Length / Number allowed : Number of byte allowed to read / write
Status : Define the status of the Memory Access (Proceed, Busy, Op Complete, Op Failed)
Error indicator: Filled with 0xFF (not used)
EDCP Extension : Filled with 0xFF (not used)
Seed: Filled with 0xFF (not used)

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J1939:73 : Diagnostics Layer
DM15 Memory Access Response

DM15 Status value :

Bits Status	Description
00	Proceed
01	Busy
04	Operation Completed
05	Operation Failed

J1939:73 : Diagnostics Layer
DM16 Memory Access Data

The DM16 message will contain the data to be written or read by Memory Access

	Bit8 (MSB)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1 (LSB)
DM16 (PGN 55040 / 0x00D700)								
ID	18 D7 "DA" "SA"							
Byte 1	Number of occurrences							
Byte 2	Raw Binary data							
Byte 3	Raw Binary data							
Byte 4	Raw Binary data							
Byte 5	Raw Binary data							
Byte 6	Raw Binary data							
Byte 7	Raw Binary data							
Byte 8	Raw Binary data							

Number of occurrences : Number of byte read / write in the DM16 message
Raw Binary Data: Data byte read or to write

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J1939:73 : Diagnostics Layer
Example with Read Memory Access

ID	Data	Description
0x18D98022	02 03 73 00 00 01 05 25	DM14 message, Command Read, 2 bytes, Address 0x73
0x18D82280	02 00 FF FF FF FF FF FF	DM15 message, Proceed, 2 bytes
0x18D72280	02 BC 02 FF FF FF FF FF	DM16 message, read 2 bytes with value : 0x02BC (700 in decimal)
0x18D82280	00 08 FF FF FF FF FF FF	DM15 message, Operation Completed

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J1939:73 : Diagnostics Layer
Example with Write Memory Access for Sensor Zero

ID	Data	Description
0x18D98022	01 05 83 02 00 01 05 25	DM14 message, Command Write, 1 byte, Address 0x283
0x18D82280	01 00 FF FF FF FF FF FF	DM15 message, Proceed, 1 byte
0x18D78022	01 00 00 00 00 00 00 00	DM16 message, write 1 byte with value : 0x00
0x18D82280	00 08 FF FF FF FF FF FF	DM15 message, Operation Completed

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J1939:73 : Diagnostics Layer
Example with Read Memory Access for Sensor Zero

ID	Data	Description
0x18D98022	01 03 83 02 00 01 05 25	DM14 message, Command Read, 1 byte, Address 0x283
0x18D82280	01 00 FF FF FF FF FF FF	DM15 message, Proceed, 1 byte
0x18D72280	01 01 FF FF FF FF FF FF	DM16 message, read 1 byte with value : 0x01
0x18D82280	00 08 FF FF FF FF FF FF	DM15 message, Operation Completed

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Merci…thank you…danke…grazie…gracias…谢谢…ありがとうございます

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