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1. SAE J1939-Standard CAN Messages

The following messages are described in the standard SAE J1939.
SAE-J1939/21
SAE-J1939/71
SAE-J1939-73
DIN ISO 11898

All send messages are available on the Bus also after switching Ignition Key off till EMR3 resets itself. The Period between switching Ignition Key Off and the reset of the EMR3 takes about 15 Seconds depending on load, engine state … etc.

1.1. EEC1:

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Status EEC1</td>
<td>Bits 1 to 4 Engine / Retarder torque mode Bits 5 to 8 not defined</td>
</tr>
<tr>
<td>Byte 2</td>
<td>Requested engine torque in %</td>
<td>1% /Bit, Offset -125%, indicated torque, i.e. 0xCDh means 205-125 = 80% of M\text{d}_{\text{max}}</td>
</tr>
<tr>
<td></td>
<td>related to M\text{d}_{\text{max}}</td>
<td></td>
</tr>
<tr>
<td>Byte 3</td>
<td>Actual Engine torque in %</td>
<td>1% /Bit, Offset -125%, indicated torque, i.e. 0xCDh means 205-125 = 80% of M\text{d}_{\text{max}}</td>
</tr>
<tr>
<td></td>
<td>related to M\text{d}_{\text{max}}</td>
<td></td>
</tr>
<tr>
<td>Byte 4-5</td>
<td>Engine speed</td>
<td>0,125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 6</td>
<td>Source address of the controlling</td>
<td>0x00h if EMR3 controls the engine torque else the source address of the</td>
</tr>
<tr>
<td></td>
<td>device for engine torque</td>
<td>TSC1 message identifier which is controlling the torque</td>
</tr>
<tr>
<td>Byte 7</td>
<td>Engine starter mode</td>
<td>s. separate list</td>
</tr>
<tr>
<td>Byte 8</td>
<td>Engine demand percent torque</td>
<td>The limiting torque of the gearbox is used. TSC1-TE message is the source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1% /Bit Offset -125% i.e. 0xCDh means 205-125 = 80% of M\text{d}_{\text{max}}</td>
</tr>
</tbody>
</table>
**Byte 1:** Engine torque mode:

<table>
<thead>
<tr>
<th>Output Value Bits 1-4</th>
<th>Active Mode</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0</td>
<td>Low Idle Governor / Overrun</td>
<td>Overrun means no injection</td>
</tr>
<tr>
<td>0x1</td>
<td>Accelerator Pedal</td>
<td></td>
</tr>
<tr>
<td>0x2</td>
<td>Cruise Control</td>
<td>with positive torque</td>
</tr>
<tr>
<td>0x3</td>
<td>Power Take Off</td>
<td>PTO control active via MSS (multiple state switch) or MFLv (multifunction control unit)</td>
</tr>
<tr>
<td>0x4</td>
<td>Road Speed Limiter</td>
<td></td>
</tr>
<tr>
<td>0x5</td>
<td>ASR Control</td>
<td></td>
</tr>
<tr>
<td>0x6</td>
<td>Transmission Control</td>
<td>Speed control / torque control</td>
</tr>
<tr>
<td>0x7</td>
<td>ABS Control</td>
<td>not used</td>
</tr>
<tr>
<td>0x8</td>
<td>Torque Limitation</td>
<td>not for fuel limitation (s. 0xC) engine is working at limited torque (max. torque curve)</td>
</tr>
<tr>
<td>0x9</td>
<td>High Speed Governor</td>
<td></td>
</tr>
<tr>
<td>0xA</td>
<td>Engine Retarder Control / Break System</td>
<td>only positive torque or speed request</td>
</tr>
<tr>
<td>0xB</td>
<td>Remote Acceleration</td>
<td>not used</td>
</tr>
<tr>
<td>0xC</td>
<td>Fuel Limitation</td>
<td></td>
</tr>
<tr>
<td>0xD</td>
<td>PTO Active</td>
<td>PTO activation via CAN or VCU torque request</td>
</tr>
<tr>
<td>0xE</td>
<td>VCM Control</td>
<td>Vehicle Control Mode (drivability) Then Byte 2 is set to 0xFFh</td>
</tr>
<tr>
<td>0xF</td>
<td>Not available</td>
<td>not used</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Byte 3:**
The value of Byte 3 is the actual engine torque in percent of the reference engine torque of the message engine configuration.
The torque values of Byte 3, TSC1 and the points 1 to 5 of the message engine configuration are directly comparable to each other because of the same reference value $M_{dmax}$.

**Byte 7:** Engine starter mode values:

<table>
<thead>
<tr>
<th>Output value</th>
<th>Start Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xF0</td>
<td>start not requested</td>
</tr>
<tr>
<td>0xF1</td>
<td>cranking active, gear not engaged</td>
</tr>
<tr>
<td>0xF2</td>
<td>cranking active, gear engaged</td>
</tr>
<tr>
<td>0xF3</td>
<td>cranking finished</td>
</tr>
<tr>
<td>0xF4</td>
<td>cranking inhibited due to engine is already running</td>
</tr>
<tr>
<td>0xF5</td>
<td>cranking inhibited due to engine is not ready for start</td>
</tr>
<tr>
<td>0xF6</td>
<td>cranking inhibited due to drive train engaged</td>
</tr>
<tr>
<td>0xF7</td>
<td>cranking inhibited due to immobilizer is locked</td>
</tr>
<tr>
<td>0xFC</td>
<td>cranking inhibited due to unknown reason (blind meshing, max. duration is over etc.)</td>
</tr>
<tr>
<td>0xFE</td>
<td>error condition (not supported)</td>
</tr>
<tr>
<td>0xFF</td>
<td>crank control is not available</td>
</tr>
</tbody>
</table>

If there is no "gear engaged switch" information available, the value 0xF2h will not be sent. Instead of this value 0xF1h will be sent if cranking is active.
0xF6h, "drive train engaged" is the clutch state for EMR3.
1.2. EEC2:

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Status EEC2</td>
<td></td>
</tr>
<tr>
<td>Byte 2</td>
<td>Accelerator Pedal Position</td>
<td>0.4 % / Bit, 0xFEh if pedal is in error state, 0xFFh if pedal is not available</td>
</tr>
<tr>
<td>Byte 3</td>
<td>Percent Load at current speed</td>
<td>1% / Bit, indicated torque, 0xFEh if percent load can not be calculated, i.e. because of injection path errors.</td>
</tr>
<tr>
<td></td>
<td>= Engine torque related to max. engine torque at engine speed</td>
<td></td>
</tr>
<tr>
<td>Byte 4-8</td>
<td></td>
<td>= 0xFFh - not available</td>
</tr>
</tbody>
</table>

**Byte 1: Status EEC2:**

<table>
<thead>
<tr>
<th>Output Value Bits</th>
<th>Status</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits 8, 7</td>
<td>Not defined</td>
<td>= 11</td>
</tr>
<tr>
<td>Bits 6, 5</td>
<td>Road Speed Limit State</td>
<td>00 = active, 01 = not active</td>
</tr>
<tr>
<td>Bits 4, 3</td>
<td>Status of Accelerator Pedal Kick-Down switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available, (Kick down switch not enabled)</td>
</tr>
<tr>
<td>Bits 2, 1</td>
<td>Low idle switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available, (Low idle switch not enabled)</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Byte 3**

The value of Byte 3 is the actual engine torque in percent of the maximal available engine torque at the actual engine speed. The maximal available engine torque depends on the limiting torque curve and engine protection values. Notice that the limiting torque curves are selectable by switches or CAN (protection messages). This includes the influence of the boost pressure.TSC1 limits are not considered in this Byte!

The maximal available engine torque is like considered in torque points 1 to 5 of the engine configuration message.
1.3. **Engine Temperature:**

Defaults values for transmission rate and CAN Identifier CAN Code Specification.

If any data isn't available the corresponding Bytes will be set to \(0xFF_{h}\).

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Coolant temperature</td>
<td>(1^\circ C /\text{Bit}, \text{Offset} -40^\circ C)</td>
</tr>
<tr>
<td>Byte 2</td>
<td>Fuel temperature</td>
<td>(1^\circ C /\text{Bit}, \text{Offset} -40^\circ C)</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Engine oil temperature</td>
<td>(0.03125^\circ C /\text{Bit}, \text{Offset} -273^\circ C)</td>
</tr>
<tr>
<td>Byte 5-8</td>
<td></td>
<td>(= 0xFF_{h} - \text{not available})</td>
</tr>
</tbody>
</table>
1.4. **Engine Fluid Level / Pressure:**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

It depends on the application which sensors and data are available.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Fuel delivery pressure</td>
<td>4 kPa/Bit, 1/25 bar /Bit</td>
</tr>
<tr>
<td>Byte 3</td>
<td>Oil level</td>
<td>0xFFh - not available</td>
</tr>
<tr>
<td>Byte 4</td>
<td>Oil pressure</td>
<td>4 kPa/Bit, 1/25 bar /Bit, not in receive msg,</td>
</tr>
<tr>
<td>Byte 5, 6</td>
<td>Crankcase pressure not available</td>
<td>0xFFh - not available</td>
</tr>
<tr>
<td>Byte 8</td>
<td>Coolant level</td>
<td>0.4%/Bit, Offset 0%</td>
</tr>
<tr>
<td>Bytes 2, 7</td>
<td></td>
<td>0xFFh - not available</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Byte 1:**
The fuel delivery pressure is measured by the low fuel pressure sensor which is located between the main fuel filter and the Fuel Control Unit (FCU).
1.5. **Inlet / Exhaust Conditions**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

It depends on the application which sensors and data are available.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Boost pressure</td>
<td>2 kPa/Bit = 1/50 bar/Bit</td>
</tr>
<tr>
<td>3</td>
<td>Intake manifold temperature</td>
<td>1°C /Bit, Offset -40 °C</td>
</tr>
<tr>
<td></td>
<td>i.e. boost temperature</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Air filter differential pressure</td>
<td>0.05 kPa / Bit, range 0 to 12.5 kPa</td>
</tr>
<tr>
<td>6,7</td>
<td>Exhaust gas temperature</td>
<td>= 0xFFh - not available</td>
</tr>
<tr>
<td>8</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!
1.6. **Ambient Conditions**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

It depends on the application which sensors and data are available.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Barometric pressure (absolute)</td>
<td>0,5 kPa/Bit = 1/200 Bar/Bit</td>
</tr>
<tr>
<td>Byte 4, 5</td>
<td>Ambient air temperature</td>
<td>don't care!</td>
</tr>
<tr>
<td>Bytes 2, 3, 6, 7, 8</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

1.7. **Vehicle Electrical Power**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

It depends on the application which sensors and data are available.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 3, 4</td>
<td>Alternator potential (voltage)</td>
<td>= 0xFFh - not available</td>
</tr>
<tr>
<td>Byte 7, 8</td>
<td>Battery potential (voltage) , supplied through switched device</td>
<td>0,05 V /Bit</td>
</tr>
<tr>
<td>Bytes 1, 2, 5, 6</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
</tbody>
</table>

1.8. **Fuel Economy**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

It depends on the application which sensors and data are available.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1, 2</td>
<td>Fuel rate</td>
<td>0,05 L/h /Bit</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Instantaneous fuel economy km/l</td>
<td>1/512 km/L /Bit</td>
</tr>
<tr>
<td>Bytes 5, 6, 7, 8</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!
1.9. Engine Hours, Revolutions

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1 to 4</td>
<td>Total engine hours</td>
<td>0.05h/Bit; Byte 1 is LSB, Byte 4 is MSB</td>
</tr>
<tr>
<td>Byte 5 to 8</td>
<td>Total engine revolutions</td>
<td>don’t Care</td>
</tr>
</tbody>
</table>

Total engine hours are only be accumulated when the engine is running!

1.10. EEC3

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Nominal friction percent torque</td>
<td>1% / Bit, Offset = −125%, range 0 to 125 %</td>
</tr>
<tr>
<td>Byte 2, 3</td>
<td>Engine’s desired operating speed</td>
<td>0.125 rpm/Bit</td>
</tr>
<tr>
<td>Byte 4</td>
<td>Engine’s operating speed asymmetry adjustment</td>
<td>1 ratio/Bit</td>
</tr>
<tr>
<td>Bytes 5, 6, 7, 8</td>
<td>= 0xFFh - not available</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Byte 1**

This data is a percentage value related to reference max. torque value Md\(\text{max}\) defined in the message engine configuration.
The nominal friction depends on the engine speed and the engine temperature.
1.11. Cruise Control / Vehicle Speed

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Measured SW1</td>
<td></td>
</tr>
<tr>
<td>Byte 2, 3</td>
<td>Wheel based vehicle speed</td>
<td>1 / 256 km/h = 1 / 412 mph</td>
</tr>
<tr>
<td>Byte 4</td>
<td>Measured_CC_SW1</td>
<td></td>
</tr>
<tr>
<td>Byte 5</td>
<td>Measured_CC_SW2</td>
<td></td>
</tr>
<tr>
<td>Byte 6</td>
<td>Cruise Control set speed</td>
<td>1km/h / Bit</td>
</tr>
<tr>
<td>Byte 7</td>
<td>State CC</td>
<td></td>
</tr>
<tr>
<td>Byte 8</td>
<td>Measured idle SW1</td>
<td></td>
</tr>
</tbody>
</table>

The binary value 11, indicating not available for a switch state will also be sent, when the switch is disabled by configuration parameters for a special application.
Gray displayed information are actually not available – ignore these data!

**Byte 1: Measured SW1:**

<table>
<thead>
<tr>
<th>Output Value Bits</th>
<th>Status</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits 4, 3</td>
<td>Parking brake switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available</td>
</tr>
<tr>
<td>Bits 8, 7, 6, 5, 2, 1</td>
<td>all set to 1 = not available</td>
<td></td>
</tr>
</tbody>
</table>

**Byte 4: Measured CC_SW1:**

<table>
<thead>
<tr>
<th>Output Value Bits</th>
<th>Status</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits 8, 7</td>
<td>Clutch switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available</td>
</tr>
<tr>
<td>Bits 6, 5</td>
<td>Brake switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available</td>
</tr>
<tr>
<td>Bits 4, 3</td>
<td>Cruise control enable switch</td>
<td>00 = CC not enabled by parameter, 01 = CC enabled by parameter, 11 = not available</td>
</tr>
<tr>
<td>Bits 2, 1</td>
<td>Cruise control active</td>
<td>00 = CC is not active, 01 = CC is active</td>
</tr>
</tbody>
</table>

**Byte 5: Measured CC_SW2:**

<table>
<thead>
<tr>
<th>Output Value Bits</th>
<th>Status</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits 8, 7</td>
<td>Cruise control accelerator switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available</td>
</tr>
<tr>
<td>Bits 6, 5</td>
<td>Cruise control resume /hold switch</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available</td>
</tr>
<tr>
<td>Bits 4, 3</td>
<td>Cruise control coast switch (decelerate)</td>
<td>00 = not active, 01 = active, 10 = error, 11 = not available</td>
</tr>
<tr>
<td>Bits 2, 1</td>
<td>Cruise control set switch</td>
<td>11 = not available</td>
</tr>
</tbody>
</table>
### Byte 7: State_CC:

<table>
<thead>
<tr>
<th>Output Value</th>
<th>Status</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits 6 to 8</td>
<td>Cruise control state (of the cruise controller)</td>
<td>000 = off/disabled, 001 = hold, 010 = accelerating, 011 = decelerating, 100 = resuming, 101 = set (use actual vehicle speed), 110 = accelerator override, 111 = not available</td>
</tr>
<tr>
<td>Bits 1 to 5</td>
<td>PTO (Power takeoff) state</td>
<td>PTO function is on, if constant speed is selected or PTO functionality is usable by the switches (Same, up-down and hold switches for engine speed), 00000 = off/disabled, 00001 = hold, 00101 = set, 00110 = decelerate, 00111 = resume, 01000 = accelerate, 01010 = constant speed 1, 01011 = constant speed 2, 01100 = constant speed 3, 01101 = constant speed 4</td>
</tr>
</tbody>
</table>

### Byte 8: Measured_Idle_SW1:

<table>
<thead>
<tr>
<th>Output Value</th>
<th>Status</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bits 8, 7</td>
<td>Engine shut down override switch</td>
<td>00 = not active, 01 = active, 10 = error, 11= not available</td>
</tr>
<tr>
<td>Bits 6, 5</td>
<td>Engine test mode switch</td>
<td>Indicates, that the test mode parameter setting is actual used, i.e. for EOL tests, specification for EMR3 programming. It is a parameter of the data set, 00 = not active, 01 = active, 10 = error, 11= not available</td>
</tr>
<tr>
<td>Bits 4, 3</td>
<td>Idle decrement switch</td>
<td>Even if there is no switch, these bits will be set if the EMR3 is decrementing the low idle value, 00 = not active, 01 = active, 10 = error, 11= not available</td>
</tr>
<tr>
<td>Bits 2, 1</td>
<td>Idle increment switch</td>
<td>Even if there is no switch, these bits will be set if the EMR3 is incrementing the low idle value, 00 = not active, 01 = active, 10 = error, 11= not available</td>
</tr>
</tbody>
</table>
1.12. Software ID

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Number of software identification fields</td>
<td>Each field delimited by ASCII &quot;*&quot;</td>
</tr>
<tr>
<td>Byte 2-8</td>
<td>Software Identification</td>
<td>ASCII formatted</td>
</tr>
</tbody>
</table>

**Byte 2-8:**
The format is XXXVYYYY
  - X = Main software identifier.
  - V = ASCII char "v"
  - Y = Software version identifier.

*Example:*

<table>
<thead>
<tr>
<th>ID</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWID (18FEDA00)</td>
<td>01</td>
<td>34</td>
<td>39</td>
<td>31</td>
<td>56</td>
<td>32</td>
<td>31</td>
<td>32</td>
</tr>
</tbody>
</table>

ASCII: 4 9 1 v 2 1 2

Software Version: 491v212

*End of Example*
1.13. Engine Configuration

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification. EMR3 uses mode 2 of the engine configuration message, defined in SAE-J1939-71 chapter 5.4.1

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 1,2   | Engine speed at idle (point 1) | 0.125 rpm /Bit  
point 1 = idle |
| 3     | Percent torque at idle (point 1) | 1% /Bit, Offset = –125% |
| 4,5   | Engine speed (point 2) | 0.125 rpm /Bit  
point 2 = rated speed |
| 6     | Percent torque (point 2) | 1% /Bit, Offset = –125% |
| 7,8   | Engine speed (point 3) | 0.125 rpm /Bit  
point 3 = maximal engine torque |
| 9     | Percent torque (point 3) | 1% /Bit, Offset = –125% |
| 10,11 | Engine speed (point 4) | 0.125 rpm /Bit  
point 4 = high idle |
| 12    | Percent torque (point 4) | 1% /Bit, Offset = –125% |
| 13,14 | Engine speed (point 5) | 0.125 rpm /Bit  
point 5 = maximal engine torque |
| 16    | Percent torque (point 5) | 1% /Bit, Offset = –125% |
| 18,19 | Engine speed at high idle  
engine torque = 0 (point 6) | 0.125 rpm /Bit  
point 6 = high idle |
| 20,21 | Reference engine torque  
(maximum torque of engine torque map) | 1 Nm /Bit  
This is a configuration parameter in EMR3 |
| 22,23 | Maximum momentary engine override  
speed | 0.125 rpm /Bit |
| 24    | Maximum momentary engine override  
time limit | 0.1s /Bit |
| 25    | Requested speed control range lower limit | 10 rpm /Bit  
Min. engine speed value for TSC1 messages |
| 26    | Requested speed control range upper limit | 10 rpm /Bit  
Max. engine speed value for TSC1 messages |
| 27    | Requested torque control range lower limit | 1% /Bit, Offset = –125%  
Min. engine torque value for TSC1 messages |
| 28    | Requested torque control range upper limit | 1% /Bit, Offset = –125%  
Max. engine torque value for TSC1 messages |

Byte 18,19 Droop:

\[
\text{Droop} = \frac{(n_{\text{max}} - n_{\text{rated}})}{n_{\text{rated}}} \times 100 \% \quad n = \text{speed}, \text{resolution droop} \ (0.0122\% /\text{Bit})
\]
Bytes 20, 21: Reference torque
This parameter is the 100% reference value for all defined indicated engine torque parameters. It's only defined once and doesn't change if a different engine torque map becomes valid.

Data update
The values will be modified in following cases
- the torque map has been changed
- Gain has been modified / a new droop is selected
- power reduction (engine protection) is active.

Boost pressure (smoke limiter), road speed limits or limits set in TSC1 will not modify the data values.

This message uses more than 8 data bytes, therefore the Multipacket Transport (Appendix 1) will be used.

The message will be transmitted periodically.
1.14. **TSC1 Message**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Control Bits SAE J1939/71, Parameter 3.3.1</td>
<td></td>
</tr>
<tr>
<td>Bit 1, 2</td>
<td>Override control mode</td>
<td></td>
</tr>
<tr>
<td>Bit 3, 4</td>
<td>Requested speed control condition</td>
<td></td>
</tr>
<tr>
<td>Bit 5, 6</td>
<td>Override control priority</td>
<td></td>
</tr>
<tr>
<td>Bit 7, 8</td>
<td>Not defined</td>
<td></td>
</tr>
<tr>
<td>Byte 2,3</td>
<td>Requested speed / speed limit</td>
<td>0.125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 4</td>
<td>Requested torque / torque limit</td>
<td>1% /Bit, Offset –125%</td>
</tr>
<tr>
<td>Byte 5-8</td>
<td>Not defined</td>
<td></td>
</tr>
</tbody>
</table>

**Byte 1 Bits 1, 2 Override Control Mode:**

- **00** Override disabled – disable any existing control commanded by the source of this command.
- **01** speed control, no limits will be changed
  - Bytes 2 and 3 for requested speed
  - Byte 4 will be ignored
- **10** torque control, no limits will be changed
  - Bytes 2 and 3 will be ignored
  - Byte 4 for requested torque
- **11** set limits
  - Bytes 2 and 3 are the limit of speed control.
  - Byte 4 contents the limit for torque control

**Byte 1 Bits 5, 6 Priority Bits**

- **00** Highest Priority
- **01** High Priority
- **10** Low Priority
- **11** Lowest Priority

**Byte 4**

Torque ranges are shown in the following table:

| Message | Torque set point range | Torque limit range | |
|---------|------------------------|--------------------|
| TSC1_TE | 0% to 125%             | 0% to 125 %        | incoming Values < 0 set to 0 |
Set point calculation
The requested speed value is the set point engine speed at full load. Without load the engine speed will be higher and calculated using the droop.

Example
- Requested speed 2000 rpm, \( \text{droop} = 5\% \)
- then speed without load \( n = 2000 \times (1 + \text{droop}) = 2100 \text{ rpm} \)
End of example

Control mode selection
For switching from speed control mode to torque control mode the engine has to operate at low idle speed \( \pm 100 \text{ 1/min} \) and engine torque value has to be less than 10%.

For switching from torque control mode to speed control mode the engine has to operate at low idle speed \( \pm 100 \text{ 1/min} \).

Priority Bits
The data process regarding to the priority bits of TSC1 messages is shown in Fig. 7 of the SAE-J1939/71 document.

Limitation
All incoming TSC1 limits are proofed for validity and only messages with valid data will be checked for their priority. The values are stored into a priority table. This table is necessary to search for the limit with the highest priority. If the higher priority is assigned to more than one limit, EMR3 will compare the limits and use the lowest limit. If a TSC1 message with new valid limit has been received, the corresponding memory place in the table will be overridden. If a TSC1 message fails, goes to time out error, doesn’t give new valid limits or includes control mode set to zero, then the previous valid data (limits and priority) are used for searching the lowest limit of messages with highest priority.
When limitations are sent via the TSC1 message, then both limits in the message must be valid. The engine speed limit bytes must be less or equal 0xFAFFh and the engine torque limit must be less or equal 0xFAh.
Limitations can be deactivated by using high values, i.e. 0xFAFFh for engine speed limit or 0xFAh for engine torque limit.

Example for set point speed operation in a standard Can Function:

<table>
<thead>
<tr>
<th>ID</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSC1 (0C00003x)</td>
<td>01</td>
<td>80</td>
<td>25</td>
<td>00</td>
<td>FF</td>
<td>FF</td>
<td>FF</td>
<td>FF</td>
</tr>
</tbody>
</table>

Engine set point speed = 1200 rpm
End of Example
2. Diagnostic Messages

These messages are specified in SAE-J1939-73. There are 12 messages described, but not all messages are supported from EMR3. A request for a non-available message will be answered by EMR3 with a negative acknowledgment (NACK). The negative and positive acknowledgment are shown in Appendix 3.

Messages that require more than 8 data bytes have to be transferred with the „Multipacket Transport Protocol“ (SAE-J1939-21) - see Appendix 1.

2.1. Diagnostic Readiness (DM5) / Number of faults

The number of faults are transmitted on request. There are two kind of faults displayed in this message - active and previously active faults (= passive faults).

Active faults are faults that are currently active. Passive faults (= previously active faults) are faults which have been active in the past and are not currently active.

Request for reading DM5 (Standard Request)
EMR3 receives this messages as a request to send the number of faults, which have occurred at least once and are active or passive at that moment.

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

Data Length: 3 Bytes
Data Page: 0
PDUF: 234
PDUS: EMR3 Device Nr
Parameter group number: 00EA00

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1-3</td>
<td>00 FE CE</td>
<td>PGN-Nr. Of message DM5, LSB first</td>
</tr>
</tbody>
</table>
### Answer DM5

Data Length: 8 Bytes  
Data Page: 0  
PDUF: 254  
PDUS: 206  
Parameter group number: 65230 (00 FE CE)

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Number of active faults</td>
<td></td>
</tr>
</tbody>
</table>
| Byte 2 | Mode1: Count of passive faults stored in the error memory of EMR3  
Mode2: Count of all faults (active faults + passive faults) stored in the error memory | Deutz standard is Mode1  
Applications which have to be compatible with EMR2 Controllers use Mode2 |
| Byte 3 | OBD Compliance | Identifies the OBD compliance of the responding controller |
| Byte 4-8 | not defined | don’t care |

**Example:**

<table>
<thead>
<tr>
<th>ID</th>
<th>Byte 1</th>
<th>Byte 2</th>
<th>Byte 3</th>
<th>Byte 4</th>
<th>Byte 5</th>
<th>Byte 6</th>
<th>Byte 7</th>
<th>Byte 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM5 (18FECE00)</td>
<td>00</td>
<td>01</td>
<td>05</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
</tr>
</tbody>
</table>

*Byte 1: 00 - no active faults  
Byte 2: 01 - 1 passive fault stored in the error memory  
Byte 3: 05 - "Not intended to meet OBD II compliance”*  

*End of Example*
2.2. Active faults (DM 1)

The transmission rate is according to SAE-J1939. That means:
1. The standard update rate is 1s, if at least one active faults exists.
2. The message will be transmitted immediately, if a fault becomes active or inactive.
3. Within one second only the first change of state of the fault will be transmitted immediately. If the fault changes his state (active / passive) more than one time within a second, the DM1-message will be transmitted at the end of the second with the actual state of the fault.

The following messages will be transmitted if there is only one active fault.

DM1:

Transmission rate: see above
Data Length: variable
Data Page: 0
PDUF: 254
PDUS: 202
Priority: s. Appendix 3
Parameter group number: 65226 (00FECA)

<table>
<thead>
<tr>
<th>Byte 1</th>
<th>Lamp state (LS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 2</td>
<td>Lamp state (LS) reserved =FF</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Suspect Parameter Number (SPN)</td>
</tr>
<tr>
<td>Byte 5</td>
<td>Bit 6 to 8 SPN</td>
</tr>
<tr>
<td>Bit 1 to 5 Failure mode identifier (FMI)</td>
<td></td>
</tr>
<tr>
<td>Byte 6</td>
<td>Bit 8 not defined</td>
</tr>
<tr>
<td>Bit 1 to 7 Occurrence counter (OC)</td>
<td></td>
</tr>
<tr>
<td>Byte 7, 8</td>
<td>= 0xFFh - not defined</td>
</tr>
</tbody>
</table>

LS: see Appendix 2
SPN: see Appendix 3 Error codes
FMI: see Appendix 3 Error codes
OC: The Occurrence Counter displays how often a fault got active since the fault memory has been cleared the last time.

The following data will be send once, if the last active fault switched passive and there is no active fault in the error memory left:
(according to standard SAE-J1939/21 Juli94)
LS=0, SPN= 0, FMI = 0, OC = 0

The Multipacket Transport (SAE-J1939/21 July 94) will be used if there is more than one active fault. The data stream is:
LS, SPN, FMI, OC, SPN, FMI, OC, SPN, FMI, OC .....etc.
2.3. Passive Faults (DM2)

Passive faults (= previously active faults) are faults which have been active in the past and are not currently active. They are transmitted on request.

Request for reading DM2 (Standard Request)

Data Length: 3 Bytes  
Data Page: 0  
PDUF: 234  
PDUS: EMR3 Device Nr  
Parameter group number: 00EA00

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1-3</td>
<td>00 EA 00</td>
<td>PGN-Nr. Of message DM2, LSB first</td>
</tr>
</tbody>
</table>

Answer passive Faults (Standard DM2)

If there is only one fault stored:

Data length: 8 Bytes  
Data Page: 0  
PDUF: 254  
PDUS: 203  
Parameter group number: 65227 (00FECB)

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Lamp state (LS)</td>
</tr>
<tr>
<td>Byte 2</td>
<td>Lamp state (LS) reserved = FF</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Suspect Parameter Number (SPN)</td>
</tr>
</tbody>
</table>
| Byte 5 | Bit 6 to 8 SPN  
|        | Bit 1 to 5 Failure Mode Identifier (FMI)      |
| Byte 6 | Bit 8 = CM = 1  
|        | Bit 1 to 7 Occurrence counter (OC)            |
| Byte 7, 8 | not defined, value is 0xFFh                |

LS: see Appendix 2  
SPN: see Appendix 3 Error codes  
FMI: see Appendix 3 Error codes  
CM: SPN Conversation Method  
OC: The Occurrence Counter displays how often a fault got active since the fault memory has been cleared the last time.

The Multipacket Transport (SAE-J1939/21 July 94) is used, if the count of passive faults in the error memory is higher than one. The format of the data stream is:

LS, SPN, FMI, CM, OC, SPN, FMI, CM, OC, SPN, FMI, CM, OC, ...  

The following data will be send, if there is no fault stored  
SPN = 0, FMI = 0, OC= 0, LS according to actual lamp state.
2.4. Freeze Frame Parameters (DM4)

A Freeze Frame is defined as the list of parameters recorded at the time a diagnostic trouble code was captured. They are also described in the error memory specification. Due to its size on every request only one Freeze Frame will be transmitted. For the first request for DM4, ECU transmits the freeze frame parameters of the first fault entry of the error memory. On the second request for DM4, the freeze frame parameters for the second fault entry will be transmitted and so on.

Freeze Frames aren't available for all kind of faults.

Request for reading DM4 (Standard Request)

Data Length: 3 Bytes  
Data Page: 0  
PDUF: EAh = 234d  
PDUS: EMR3 Device Nr (00)  
Parameter group number: 00EA00

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1-3</td>
<td>00 EA 00</td>
<td>PGN-Nr. Of message DM4, LSB first</td>
</tr>
</tbody>
</table>

Answer DM4 : Freeze Frame Parameter

A Freeze Frame contains more than 8 data bytes, therefore the Multipacket Transport will be used.

Data length  
Data Page: 0  
PDUF: 254  
PDUS: 205  
Parameter group number: 65229 (00FECD)  
Source Address: EMR2 Device Nr. (00)
## Byte 1
Number of the following data bytes | 0x10h

## Byte 2
DTC (Diagnostic trouble code) Byte1 | Suspect parameter number SPN

## Byte 3
DTC (Diagnostic trouble code) Byte2 | Suspect parameter number SPN

## Byte 4
DTC (Diagnostic trouble code) Byte3 | Bits 6 to 8: SPN
Bits 1 to 5 Failure Mode (FMI) Bit5 MSB

## Byte 5
DTC (Diagnostic trouble code) Byte4 | Bit 8 Conversion Method
Bits 1 to 7 Occurrence counter (OC)

## Byte 6
=FF not available

## Byte 7
Boost pressure | 2 kPa/Bit = 1/50 bar/Bit

## Bytes 8, 9
Engine Speed | 0,125 rpm / Bit

## Byte 10
Engine % Load at current speed | Actual Engine load indicated 1% / Bit s. EEC2 Byte 3

## Byte 11
Engine coolant temperature | 1°C /Bit, Offset –40 °C

## Bytes 12, 13
Vehicle speed | 1/256 km/h/ Bit
if data is not available 0xFFh will be transmitted

## Bytes 14
Applicable value 1

## Bytes 15
Applicable value 2

## Bytes 16
Applicable value 3

## Bytes 17
Applicable value 4

## Bytes 2 to 5: DTC
DTC and SPN are described in the appendix

**Timestamps of minimum and maximum values**
A timer starts when an error becomes active. The minimum and maximum values will be build in the time when the error is still active, no matter if the override button has been pressed or not. The absolute time off a minimum or maximum value is the occurrence time plus the time of the stamp.

**If no fault present:**
The message above is used too, if there are no fault entry and freeze data available. In that case the 8 data bytes( no Multipacked Transport necessary then) filled as follow: Number = 0, DTC = 0, Bytes 6 to 8 = 0xFFh.

## Byte 1
Number of the following data bytes | Byte 1 = 0x00h if no fault is present

## Byte 2 to 5
DTC | DTC = 0

## Byte 6 to 8
| = 0xFFh
2.5. Diagnostic Data Clear (DM3 Replacement, DM11)

DM3 Replacement:
Request for DM3 (Standard Request)

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

On request for DM3 all passive faults (and the depending Freeze Frames) stored in the error memory will be cleared.

Request message:

| Data Length: | 3 Bytes |
| Data Page:   | 0       |
| PDUF:        | 234     |
| PDUS:        | EMR3 Device Nr |
| Parameter group number: | 00EA00 |

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1-3</td>
<td>00 FE CC</td>
<td>PGN-Nr. Of message DM3, LSB first</td>
</tr>
</tbody>
</table>

Answer for DM3 request
The answer of EMR3 will be a positive Acknowledgment.

Example for clearing passive Errors (DM3):

ID  Request (18EA0003)  CC  FE  00  00  00  FF  FF

Answer EMR3 (positive Acknowledgment): Delete passive Error is done
Acknowledgment  00  FF  FF  FF  FF  FF  CC  FE  00 (18E8FF00)

The result may be checked with DM2:

Reading passive Errors:
Request (18EA0003)  CB  FE  00

Answer EMR3: no passive Error
Request (18FECB00)  xx  FF  00  00  00  00  FF  FF

End of Example
DM11: Request for reading DM11 (Standard Request)

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

When the EMR3 receives the standard request message, using the PGN of the diagnostic message DM11 in the data area, only the active errors will be cleared in the error memory 1, including their freeze frame parameters. The entries of the passive faults will be left untouched.

- Data Length: 3 Bytes
- Data Page: 0
- PDUF: 234
- PDUS: EMR3 Device Nr
- Parameter group number: 00EA00

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>00 FE D3</td>
<td>PGN-Nr. Of message DM11, LSB first</td>
</tr>
</tbody>
</table>

**Answer for DM11 request**

The answer of EMR3 will be a positive Acknowledgment.
Proprietary EMR3 Specific CAN Messages based on SAE - J1939

There is only a small range available in the standard for proprietary messages. Therefore the receivers of the messages should use the complete identifier including the source address as a filter for the input buffers of the CAN controller.

2.6. Measured Data 1
Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Preheat information</td>
<td></td>
</tr>
<tr>
<td>Byte 2-3</td>
<td>Engine speed</td>
<td>0,125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 4</td>
<td>Boost pressure</td>
<td>2 kPa/ Bit = 1/50 Bar /Bit</td>
</tr>
<tr>
<td>Byte 5</td>
<td>Pedal position 0 to 100%</td>
<td>0,4% / Bit</td>
</tr>
<tr>
<td>Byte 6</td>
<td>Coolant temperature</td>
<td>1°C /Bit, -40°C Offset</td>
</tr>
<tr>
<td>Byte 7</td>
<td>Oil pressure</td>
<td>4 kPa/ Bit = 1/25 Bar /Bit</td>
</tr>
<tr>
<td>Byte 8</td>
<td>Can set point status</td>
<td></td>
</tr>
</tbody>
</table>

Byte 1: Preheat information

<table>
<thead>
<tr>
<th>Bit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preheat active</td>
</tr>
<tr>
<td>2</td>
<td>Ready for start</td>
</tr>
<tr>
<td>3</td>
<td>Post heat active</td>
</tr>
<tr>
<td>4</td>
<td>Glow plugs active</td>
</tr>
<tr>
<td>5</td>
<td>Flame glow plugs active</td>
</tr>
<tr>
<td>6</td>
<td>Flame fuel valve active</td>
</tr>
<tr>
<td>7</td>
<td>Push button active</td>
</tr>
<tr>
<td>8</td>
<td>Status preheat sense line (1= preheat active, 0 = preheat not active)</td>
</tr>
</tbody>
</table>

Byte 8: Can set point status

<table>
<thead>
<tr>
<th>Value</th>
<th>Can set point status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Initialization after power on</td>
</tr>
<tr>
<td>1 or 2</td>
<td>engine not started, waiting for start</td>
</tr>
<tr>
<td>3</td>
<td>engine starts (is cranking)</td>
</tr>
<tr>
<td>4</td>
<td>engine has started, is running, waiting for Can messages with speed or torque demand</td>
</tr>
<tr>
<td>5*</td>
<td>engine is running, CAN messages for speed or torque control used</td>
</tr>
<tr>
<td>6</td>
<td>CAN messages for speed or torque demand failed (timeout) - EMR uses substitute input source for setpoint i.e. accelerator pedal</td>
</tr>
<tr>
<td>7</td>
<td>Push button active</td>
</tr>
<tr>
<td>8</td>
<td>Status preheat sense line (1= preheat active, 0 = preheat not active)</td>
</tr>
</tbody>
</table>

*1) depending on the software version 0xFFh will be send instead of 0x05h.
### 2.7. Measured Data 2

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Droop</td>
<td>1% / bit</td>
</tr>
<tr>
<td>Bytes 2-3</td>
<td>set point data engine speed, droop calculated</td>
<td>0,125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 4</td>
<td>source of set point data engine speed</td>
<td></td>
</tr>
<tr>
<td>Byte 5, 6</td>
<td>engine speed, sensor 1 (crank shaft)</td>
<td>0,125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 7, 8</td>
<td>engine speed, sensor 2 (cam shaft) calculated as crank shaft speed</td>
<td>0,125 rpm /Bit</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Byte 1: Droop**

\[
\text{Droop} = \frac{(n_{\text{max}} - n_{\text{rated}})}{n_{\text{rated}}} * 100 \%
\]

\(n = \text{engine speed}\)

**Bytes 2, 3: Set point data engine speed, droop calculated ( =engine set point at no load )**

This is a data inside EMR3 after selection of the source of requested speed at the input of the speed governor, calculated with droop.

**Byte 4: Source of set point data engine speed:**

This value shows, which signal is the source of the actual set point data.

0  No set point data
1  Pedal input ( Analog / PWM input)
2  Hand throttle lever
3  Error value used
4  TSC1.TE
5  reserved ( for TSC1.xx)
6  reserved ( for SAE-J1587 PID 91 accelerator pedal)
7  Constant speed 1
8  Constant speed 2
9  Frozen engine speed (actual engine speed saved)
10 Frozen engine speed (set point speed saved)
11 special function ( hold)
12 special function ( min)
13 special function ( max)
14 reserved (for PTO)
15 idle calibration mode
16 reserved (for VP2 pedal data)
### 2.8. Measured Data 3

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Power reduction</td>
<td>1% / bit</td>
</tr>
<tr>
<td>Byte 2</td>
<td>Maximum available engine torque at current speed</td>
<td>1% / bit</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Maximum available engine speed</td>
<td>0.125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 5, 6</td>
<td>Hold engine speed</td>
<td>0.125 rpm /Bit</td>
</tr>
<tr>
<td>Byte 7, 8</td>
<td>Rail Fuel Pressure</td>
<td>1 Mpa/ Bit, range 0 to 251 Mpa</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Power reduction**
This is the actual value of the power reduction, calculated by the internal engine protection functions and the CAN message engine protection. The limits set by the message TSC1 have no influence on this value.
The value of no power reduction is 100%

**Maximum available engine torque at current speed**
The maximum available indicated engine torque at current speed in percent of the actual torque curve.
Engine protection functions and CAN messages, i.e. TSC1, can limit this data to a lower value. In that case not 100% of the torque is available.
If there are no limitations or power reductions active, the available engine torque is given by the torque curve. In that case the value of maximum available engine torque at current speed will be 100%.

**Maximal available engine speed**
The maximal available engine speed varies because of engine protection functions and other CAN messages.

**Hold engine speed**
Is one of the following data, depending on which data is actual used:

- Frozen engine speed (actual engine speed saved)
- Frozen engine speed (set point speed saved)

If none of both data is actual used the value will be 0xFFh.
### 2.9. Measured Data 4

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Switch status 1</td>
<td>Bit 1, 2: Water in fuel indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 3, 4: Engine break switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 5, 6: Engine stop switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 7, 8: Engine start switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Values: On = 1, Off = 0, not available/ enabled = 11</td>
</tr>
<tr>
<td>Byte 2</td>
<td>Switch status 2</td>
<td>Bit 1, 2: Low idle switch throttle 2 (hand gas lever)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On = 1, Off = 0, not available/ enabled = 11</td>
</tr>
<tr>
<td>Byte 3</td>
<td>Throttle 2 (hand gas lever)</td>
<td>Range 0 to 100%, 0.4 % / Bit,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFEh if throttle is in error state,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFFh if throttle is not available</td>
</tr>
<tr>
<td>Byte 4</td>
<td>PWM throttle value</td>
<td>Range 0 to 100%, 0.4 % / Bit,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFEh if PWM throttle is in error state (SRC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFFh if PWM throttle is not available</td>
</tr>
<tr>
<td>Byte 5</td>
<td>Multiply State Switches</td>
<td>Bits 1,2,3: Network speed set point number</td>
</tr>
<tr>
<td></td>
<td>Additional Set Point Input Switches</td>
<td>Values = 0 to 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 7: not available (disabled by parameter or out of range)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bits 4,5,6: Network torque/droop line number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 to 4 = number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 = not available (disabled by parameter or out of range)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bits 7, 8: 0xFFh = not defined</td>
</tr>
<tr>
<td>Bytes 6, 7</td>
<td>Customer pressure</td>
<td>resolution depends on application output of sensor input curve</td>
</tr>
<tr>
<td>Byte 8</td>
<td>Multiply State Switches 2</td>
<td>Bits 1,2,3: Network PID parameter selection number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 to 4 = number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 = not available (disabled by parameter or out of range)</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!
### 2.10. Measured Data 5

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1, 2</td>
<td>Customer Temperature 1</td>
<td>0.03125 °C / Bit, Offset –273°C</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Customer Temperature 2</td>
<td>0.03125 °C / Bit, Offset –273°C</td>
</tr>
<tr>
<td>Byte 5, 6</td>
<td>Cylinder head temperature</td>
<td>0.03125 °C / Bit, Offset –273°C</td>
</tr>
<tr>
<td>Byte 7</td>
<td>Oil level status information</td>
<td>If the oil level sensor measurement is analog:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 0: oil level to too low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>oil level ≤ low limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 1: refill request</td>
</tr>
<tr>
<td></td>
<td></td>
<td>oil level ≤ refill request limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 2: refill stop request</td>
</tr>
<tr>
<td></td>
<td></td>
<td>refill stop request limit ≤oil level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 3: = oil level too high</td>
</tr>
<tr>
<td></td>
<td></td>
<td>oil level ≥ max limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 7 = oil level measurement not possible,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>because engine is running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 8 = oil level measurement not possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>because of timer for oil flow back to pan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>time is running / hasn't already elapsed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 4 to 6 = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All bits are zero if level is ok.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the oil level sensor is digital:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 0=1 and Bit 1=1 if oil level is too low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 0=0 and Bit 1=0 if oil level is ok</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFEh = Sensor signal error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFFh = oil level measurement disabled by parameter</td>
</tr>
<tr>
<td>Byte 8</td>
<td>Oil level (extended range)</td>
<td>1% / Bit, range 0 to 150%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Too high level detection can set values more than 100%. This data is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>also available when the engine is running. Byte 7 gives information if</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the content of Byte 3 is valid or not.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFEh = Sensor error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0xFFh = Sensor not enabled by parameter</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!
### 2.11. Measured Data 8

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bytes 1</td>
<td>Lamp commands 1</td>
<td>useful if lamp controller of the dashboard are controlled by the CAN bus. It is not an output pin state of EMR3. This information is always available, no matter if lamps are at the output pins or not.</td>
</tr>
<tr>
<td>Bit 1</td>
<td>engine protection lamp demand (engine limits exceeded)</td>
<td>ச. also Appendix Lamp Status for details</td>
</tr>
<tr>
<td>Bit 2</td>
<td>warning lamp (malfunction lamp) for all faults, that means system faults i.e. broken wires, memory problems and so on, and if physical engine parameter exceed limits</td>
<td></td>
</tr>
<tr>
<td>Bit 3</td>
<td>stop lamp (for engine protection, and systems faults)</td>
<td></td>
</tr>
<tr>
<td>Bit 4</td>
<td>OBD lamp demand not in all applications available</td>
<td></td>
</tr>
<tr>
<td>Bit 5</td>
<td>Maintenance lamp demand</td>
<td></td>
</tr>
<tr>
<td>Bit 6</td>
<td>Warning Temperature Lamp</td>
<td></td>
</tr>
<tr>
<td>Bit 7</td>
<td>Warning Oil Lamp</td>
<td></td>
</tr>
<tr>
<td>Bit 8</td>
<td>Charge indicator lamp demand (on if D+ pin is low)</td>
<td></td>
</tr>
<tr>
<td>Values on= 1, off or not available= 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Byte 2</td>
<td>Lamp commands 2</td>
<td>useful if lamp controller of the dashboard are controlled by the CAN bus. It is not an output pin state of EMR3. This information is always available, no matter if lamps are at the output pins or not.</td>
</tr>
<tr>
<td>Bits 1,2</td>
<td>Preheat lamp demand</td>
<td>Values on= 01, off = 00, blinking = 10 not available = 11</td>
</tr>
<tr>
<td>Bits 3 to 8</td>
<td>= 0</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!
| Bytes 3, 4 | Actual limp home status / Engine protection (only for monitoring functions, not for system faults) | The actual limp home 1/2 status bits show the actual valid status. Also DM4 for freezing in fault condition.  
| Bit 1,2: limp home (i.e. constant engine speed)  
| Bit 3,4: power reduction  
| Bit 5,6: forced idle  
| Bit 7,8: shutdown  
| Bit 9,10: shutdown demand  
| Bit 11,12: engine shutdown by driver in time during shutdown demand: yes = 1, no = 0  
| Bit 13,14: engine start protection  
| Bit 15,16: rail pressure estimating  
| Values: active = 1, passive = 0, not available = 11 |
| Byte 5 | Status of engine protection override (only for monitoring functions, not for system faults) | Bit 1: power reduction override  
| Bit 2: force low idle timer override  
| Bit 3: forced low idle override  
| Bit 4: engine shutdown timer override  
| Bit 5: engine start protection override  
| Values: active = 1, passive = 0, not available = 11 |
| Bytes 6 | Engine protection phase (only for monitoring functions, not for system faults) | Values see separate list |
| Byte 7 | Engine running status | Bits 1 to 4, values:  
| 0h: engine is not running  
| 1h: engine is cranking  
| 2h: engine is running  
| Bit 8: if a fault is active it is set to 1 else to 0  
| Bits 5 to 7: 0, not used. |
| Bytes 8 | Controller status | Bit 1,2: EMR3 stops CAN Bus operating  
| 00: EMR 3 intends not to stop CAN Bus operating  
| 01: EMR 3 intends to stop CAN Bus operating  
| 11: this function is disabled by configuration parameter  
| If EMR3 gets the command to be switched off, it will send this message one time with Bit 1 set to 0  
| Bit 8: actual use of data set  
| 0: customer data set active  
| 1: Test bench data set active  
| Bit 3 to 7: 11, not available |

Gray displayed information are actually not available – ignore these data!
Byte 6 Engine protection phase:

<table>
<thead>
<tr>
<th>Engine not running</th>
<th>Engine running</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = no protection</td>
<td>0 = no protection</td>
</tr>
<tr>
<td>1 = start protection active (starter disabled)</td>
<td>3 = warning active</td>
</tr>
<tr>
<td>2 = start protection override active (phase 1 override)</td>
<td>4 = warning and power reduction active</td>
</tr>
<tr>
<td>3 = warning active</td>
<td>5 = power reduction override in warning state active</td>
</tr>
<tr>
<td>14 = engine shutdown done by the protection function, start fuel amount is still set zero, Diagnosis lamp blinks quickly</td>
<td>6 = low idle force pre warning (timer)</td>
</tr>
<tr>
<td>15 = engine shutdown done in time by the driver during engine shutdown demand or signal in shutdown range and shutdown demand set after T15 on</td>
<td>7 = override of low idle force timer in low idle force pre warning state, delays forced idle, engine is in forced low idle state</td>
</tr>
<tr>
<td>8 = forced low idle active,</td>
<td></td>
</tr>
<tr>
<td>9 = override of forced low idle state</td>
<td></td>
</tr>
<tr>
<td>10 = shut down pre warning (timer) running</td>
<td></td>
</tr>
<tr>
<td>11 = override of shut down timer, in shut down pre warning state, delays shut down</td>
<td></td>
</tr>
<tr>
<td>12 = shutdown demand to the driver</td>
<td></td>
</tr>
<tr>
<td>13 = no reaction of the driver to engine shutdown demand</td>
<td></td>
</tr>
<tr>
<td>17 = engine running due to 16 override and engine start command and 2</td>
<td></td>
</tr>
</tbody>
</table>
2.12. **Measured Data 9 (fan data)**
Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1, 2</td>
<td>Fan speed</td>
<td>1 rpm / bit</td>
</tr>
<tr>
<td>Byte 3</td>
<td>Fan speed clutch value</td>
<td>0.4 %, range 0 to 100 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>only if PWM is sent to clutch else 0xFFh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This is the clutch input value.</td>
</tr>
<tr>
<td>Byte 4</td>
<td>Fan speed range</td>
<td>If Linnig clutch is used</td>
</tr>
<tr>
<td>Byte 5</td>
<td>PWM Load limiting</td>
<td>0.4 % / Bit</td>
</tr>
<tr>
<td>Byte 6,7,8</td>
<td>not available</td>
<td>not available, value is 0xFFh</td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!
2.13. **Engine Protection (receive message)**

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
</table>
| Byte 1 | Power reduction               | 1% /Bit, range 0% to 100%
0% = engine stop |
| Byte 2 | Start Lock                    | Lock status (Engine Start Lock 1):
0x00h = no engine start prohibition
0x01h = engine stops and engine start prohibition will be active
0xFFh = not defined (no protection) |
| Byte 3 | Engine protection demands     | values
0 = no engine protection, no action
1 = force idle
2 = release forced idle caused by command 1
3 = engine shutdown immediately
4 = engine shutdown procedure timer, override possible etc.
5 = normal engine stop procedure
6 = special engine stop procedure
i.e. used to reduce load before engine stop or to cool down the engine
7 = override engine protection same procedure like override push button |
| Byte 4to8 |                               | not defined, value is 0xFFh |

Gray displayed information are actually not available – ignore these data!

Depending on the application, ignition key has to be switched off to release start prohibition.

Not all engine protection functions are available in every applications, i.e. engine shutdown is not allowed for some applications.

**Byte 1: Power reduction:**
Reduces the max. engine torque.
The base for the percentage value is the max. torque curve 1

0% causes the EMS to switch off the engine.
100% means no power reduction.

If there is more than one source for power reduction active, i.e. internal power protection by temperature and this message, the lowest value (= the highest reduction) will be used. If there is a timeout of a message the last valid data will be used furthermore for the calculation.
Byte 2 Start Lock
As long as the start is forbidden, the value 0x01h has to be sent. Sending the 0x00h will release the start lock. This value is used for normal operation with no start prohibition. It can not release a start prohibition which is caused by other sources, i.e. internal engine protection functions or other CAN bus messages.

Start lock Actuators
If the starter is controlled by EMR3 then start prevention means also not cranking, else cranking is possible. The injection fuel mass will be set to zero.

Example:

<table>
<thead>
<tr>
<th>No Limiting or shut off demand:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>EngPrt (0CFF0303x)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shut off demand if engine running or start lock demand if engine not running:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>EngPrt (0CFF0303x)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>50% Limiting demand:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>EngPrt (0CFF0303x)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Start Lock demand:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
</tr>
<tr>
<td>EngPrt (0CFF0303x)</td>
</tr>
</tbody>
</table>

End of Example
2.14. Engine Stop request (receive message)

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Engine stop demand</td>
<td>01 H = engine will be stopped immediately</td>
</tr>
<tr>
<td>Byte 2</td>
<td>Start Lock</td>
<td>Lock status (Engine Start Lock 2):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x00h = no engine start prohibition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x 01h = engine stops and engine start</td>
</tr>
<tr>
<td></td>
<td></td>
<td>prohibition will be active</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x FFh = not defined ( no protection)</td>
</tr>
<tr>
<td>Byte 3-8</td>
<td></td>
<td>Not Defined = 0xFFh</td>
</tr>
</tbody>
</table>

To release the engine stop demand, ignition key has to be switched off and the after-run time has to elapse before switching ignition key on again.

**Byte 1 Engine stop demand**

This message allows an engine shutoff additional to the message engine protection. Each CAN-bus node is able to stop the engine independent from the source address of the message. This message should not be send periodically.

If at least one engine stop demand has been received the engine will be stopped.

If the engine is not running and EMR 3 is receives an engine stop demands, then the engine will not be able to start (start prevention). In that case it is necessary to send the engine stop command as long as the start is forbidden.

**Byte 2 Start Lock**

This data is as defined in the engine protection message. Here each CAN-bus node is able to set the start prohibition.

When EMR3 has received a start lock command, it stores the source address of the node which has activated the start lock, because only the same can bus node can release the start lock. If more than 1 node has forced a start lock, then all these nodes has to release the start lock to allow EMR3 to reset the engine start lock 2.

The value 00h is used on two ways. The first way is to use normal operation with no start prohibition and the other way is to release a start lock which was caused by this command (byte 2).

It can not release a start prohibition which is caused by other sources, i.e. internal engine protection functions or other CAN bus messages.

**Start lock actuators**

If the starter is controlled by EMR3 then start prevention means also not cranking, else cranking is possible. The injection fuel mass will be set to zero.
2.15. Limitation

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

In this section the possibility will describe for limitation or engine shut off. If an limitation will be send depends on the Function of he engine

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Active limitation 1</td>
<td></td>
</tr>
<tr>
<td>Byte 2</td>
<td>Active limitation 2</td>
<td></td>
</tr>
<tr>
<td>Byte 3</td>
<td>Actual torque map</td>
<td></td>
</tr>
<tr>
<td>Byte 4</td>
<td>Engine speed limit</td>
<td></td>
</tr>
<tr>
<td>Byte 5</td>
<td>Engine torque limit</td>
<td></td>
</tr>
<tr>
<td>Byte 6</td>
<td>Source of power reduction</td>
<td></td>
</tr>
<tr>
<td>Byte 7</td>
<td>Engine stop</td>
<td></td>
</tr>
<tr>
<td>Byte 8</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Active limitation 1**
- Bit 8 Max. torque curve reached
- Bit 7 Max. engine speed limit reached (Engine speed limit)
- Bit 6 Engine speed limit TSC1 reached ( TSC1 Engine speed limit)
- Bit 5 Engine torque limit TSC1 reached (TSC1 Engine torque limit)
- Bit 4 Power reduction active
- Bit 3 engine shutdown protection / start prevention active
- Bit 2 limp home function active
- Bit 1 Road speed limitation active (configured limit reached )

A bit will only be set, when the depending function is limiting the engine at this moment.
If there is a limit set, but the engine is working at a point below this limit, the corresponding bit will not be set.

**Active Limitation 2**
- Bit 1,2,7, 8 reserved = 0
- Bit 6 Rail limp home
- Bit 5 overrun condition
- Bit 4 smoke limitation
- Bit 3 limitation by barometric pressure
Actual torque map
This is the number of the selected max. torque curve, even when the engine is actually not working at this limit
1 = max. torque curve 1
2 = max. torque curve 2
3 = max. torque curve 3
4 = max. torque curve 4
5 = max. torque curve 5
6 = kick down curve
7 = power boost torque curve

Engine speed limit
1 normal speed limit (configuration parameter)
2 TSC1.AE
3 TSC1.DE
4 TSC1.PE
5 TSC1.TE
6 TSC1.VE

This is the number of the actual lowest engine speed limit, even when the engine is actually not working at this limit

Engine torque limit
1 normal limitation by max. torque curve
2 TSC1.AE
3 TSC1.AR
4 TSC1.DE
5 TSC1.DR
6 Reserved
7 Minimum Torque Limit
8 TSC1.PE
9 TSC1.TE
10 TSC1.TR
11 TSC1.VE
12 TSC1.VR
13 minimum torque limit is torque max
14 Reserved
15 limit by engine protection

This is the number of the actual lowest engine torque limit, even when the engine is actually not working at this limit.
Source of power reduction
0 = no power reduction
1 = Boost Air Temperature Monitoring
2 = Coolant Temperature Monitoring
3 = Fuel Temperature Monitoring
4 = Oil Temperature Monitoring
5 = Oil Pressure High Monitoring
6 = Oil Pressure Low Monitoring
7 = Boost Pressure Monitoring
9 = Coolant Level Monitoring
12 = Misfire Detection
13 = Rail pressure Monitoring by metering unit
14 = Rail pressure sensor Monitoring
16 = Low Fuel Pressure Monitoring
18 = Gearbox Oil Temperature Monitoring
19 = Hydraulic Oil Temperature Monitoring
20 = Air Filter Monitoring

The number of the signal that sets the highest reduction will be send in this byte.
The engine mustn't work at the limit to get a value different from zero. It is sufficient that
a limit is set.

Example:

Power reduction 20% of max. torque curve because of coolant temperature is too high,
that means 80% of power is available. The engine may work at 10% of max. power, but
the value of the byte will be 2.

End of Example
Engine stop

1  = no special engine stop, normal engine stop
2  = Engine shutdown for engine protection
3  = CAN Message Engine Stop Request
4  = Boost Air Temperature too High
5  = Coolant temperature too high
6  = Fuel Temperature too high
7  = Oil Temperature too high
8  = Oil Pressure too low
9  = Boost Air Pressure
10 = Boost Air Pressure deviation
11 = Coolant level too low
13 = shut down is due to injection
14 = Rail Pressure
15 = Rail Pressure Sensor
16 = Low Fuel Pressure
17 = Fan Control
18 = Customer Temperature 1
19 = Customer Temperature 2
20 = Air Filter
21 = Fuel Filter
22 = Oil Level
23 = Preheat
24 = Battery Voltage
25 = Reserved
26 = Engine Speed
27 = Engine Stop Switch

The value of this byte shows the reason, why EMR3 has shut off the engine.
2.16. State of Inputs 1

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

These data give information about the input pins, regardless for what they used for, that means independent from the output pin assignment.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Digital Input Pins 1</td>
<td>Measured at the hardware inputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 1: override switch input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 2: droop choice input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 3: EMR3-S: controller mode input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMR3-E: = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 4: EMR3-S: power boost input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMR3-E: = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 5: manual heating or reserve1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 6: speed switch (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 7: speed switch (-)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bit 8: speed switch (hold/resume)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Values: high = 1, low = 0</td>
</tr>
</tbody>
</table>

| Byte 2 | Digital Input Pins 2 | Measured at the hardware inputs |
| Byte 3 | Network controller mode / power boost |
|        | 0,05 V / Bit, 0 to 5V |
|        | Only for EMR3-E available, EMR3-S controller sets this byte to 0xFFh and uses Byte1 - Bits3 and 4 instead. |

| Byte 4 | Network speed set point voltage |
|        | 0,05 V / Bit, 0 to 5V |

| Byte 5 | Network torque / droop line voltage |
|        | 0,05 V / Bit, 0 to 5V |

| Byte 6 | Pre control input |
|        | 0,05 V / Bit, 0 to 5V |

| Byte 7, 8 | Reserve Pulse Input (EMR3-E) |
|           | = 5 rpm /Bit |
|           | Pulses / rpm is a parameter |

Gray displayed information are actually not available – ignore these data!
### 2.17. State of Outputs

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>External EGR output, PWM / Switch</td>
<td></td>
</tr>
<tr>
<td>Byte 2</td>
<td>Internal EGR output PWM / Switch</td>
<td></td>
</tr>
<tr>
<td>Byte 3</td>
<td>Reserve 1 PWM / Switch</td>
<td></td>
</tr>
<tr>
<td>Byte 4</td>
<td>Reserve 2 (only EMR3-E) PWM / Switch</td>
<td></td>
</tr>
<tr>
<td>Byte 5</td>
<td>Torque PWM / Switch</td>
<td></td>
</tr>
<tr>
<td>Byte 6</td>
<td>Fan Control PWM / Switch</td>
<td></td>
</tr>
<tr>
<td>Byte 7</td>
<td>Digital outputs1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 1,2: engine running output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 3,4: OBD Lamp output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 5,6: Starter output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 7,8: Fuel valve for flame start</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Values: on = 01, off = 00, 10 = error of output, 11 = disabled output</td>
<td></td>
</tr>
<tr>
<td>Byte 8</td>
<td>Digital outputs 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 1,2: warning temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 3,4: warning oil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 5,6: preheat lamp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit 7,8: engine brake flap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Values: on = 01, off = 00, 10 = error of output, 11 = disabled output</td>
<td></td>
</tr>
</tbody>
</table>

Gray displayed information are actually not available – ignore these data!

**Data format for PWM / Switch Outputs**
- if PWM: 0% to 100%, 1% / Bit
- if Switch: on = 100, off = 0
- Error = 0xFEh
- Disabled by parameter = 0xFFh
### 2.18. Function mode control (receive message)

Defaults values for transmission rate and CAN Identifier s. CAN Code Specification.

This message allows to switch to different modes without using external switches. It depends on the application which options are enabled by configuration parameters. Each single value for selection can be disabled (i.e. number of selectable constant speeds).

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1</td>
<td>Number of engine torque map</td>
<td></td>
</tr>
<tr>
<td>Byte 2</td>
<td>Droop selection, number of droop engine speed governor</td>
<td></td>
</tr>
<tr>
<td>Byte 3</td>
<td>Engine speed mode</td>
<td></td>
</tr>
<tr>
<td>Byte 4</td>
<td>Controller mode</td>
<td></td>
</tr>
<tr>
<td>Byte 5</td>
<td>Droop value</td>
<td>0.25% / bit, range 0% to 50%</td>
</tr>
<tr>
<td>Byte 6</td>
<td>PID selection for engine speed governor</td>
<td></td>
</tr>
<tr>
<td>Byte 7</td>
<td>Droop selection, number of droop high idle governor</td>
<td></td>
</tr>
<tr>
<td>Byte 8</td>
<td>Pedal choice</td>
<td></td>
</tr>
</tbody>
</table>

**Number of engine torque map:**
- 0 = no modification of torque map
- 1 = switch to torque map 1
- 2 = switch to torque map 2
- 3 = switch to torque map 3
- 4 = switch to torque map 4
- 5 = switch to torque map 5

**Droop selection**
- 0 = no modification of droop
- 1 = selects engine speed depended droop 1
- 2 = selects engine speed depended droop 2
- 3 = selects engine speed depended droop 3
- 4 = use byte 5 as droop value

**Engine speed mode**
- 0 = no modification of speed mode
- 1 = freeze and use the actual engine speed
- 2 = freezes the requested engine speed
- 3 = switches to variable engine speed (TSC1,

**Pedal..**
- 4 = switches to constant speed 1 (Genset)
- 5 = switches to constant speed 2 (Genset)
- 6 = switches to constant speed 1
- 7 = switches to constant speed 2
- 8 = switches to constant speed 3
- 9 = switches to constant speed 4
| Controller mode   | 0 = no modification of controller mode  
|                  | 1 = engine speed governor  
|                  | 2 = engine torque governor |
| PID engine speed governor | 0 = no modification of PID  
|                      | 1 = PID set 1 selected  
|                      | 2 = PID set 2 selected |
| Droop selection (high idle governor) | 0 = no modification of droop  
|                                      | 1 = High idle droop 1  
|                                      | 2 = High idle droop 2 |
| Pedal choice     | 0 = no modification of pedal choice  
|                  | 1 = Pedal 1  
|                  | 2 = Pedal 2 |

**Default status**

Default value for droop is "droop 1".

Default status for controller mode is a configuration parameter.

**Limp home status**

If the primary setpoint source fails (i.e. TSC1 Message due to timeout) then the secondary one (depending on priority order i.e. accelerator pedal or constant speed) will be used for setpoint calculation. In that case it depends on the application which droop will be used.

**Example:**

*Droop1 and Torque map 1 demand:*

<table>
<thead>
<tr>
<th>ID</th>
<th>Byte1</th>
<th>Byte2</th>
<th>Byte3</th>
<th>Byte4</th>
<th>Byte5</th>
<th>Byte6</th>
<th>Byte7</th>
<th>Byte8</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMC (18FF0203x)</td>
<td>01</td>
<td>01</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>01</td>
<td>00</td>
</tr>
</tbody>
</table>

*End of Example*
### 2.19. Controller Configuration

Defaults values for transmission rate and CAN Identifiers. CAN Code Specification.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Data</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 1, 2</td>
<td>Rated engine power</td>
<td>0,5 KW/Bit; No Offset; Range: 0 to 32,127.5 kW</td>
</tr>
<tr>
<td>Byte 3, 4</td>
<td>Rated engine speed</td>
<td>0,125 rpm / Bit</td>
</tr>
<tr>
<td>Byte 5 to 8</td>
<td>not defined</td>
<td>not defined = 0xFFh</td>
</tr>
</tbody>
</table>
3. CAN Bus Diagnosis

CAN Bus start operation
After switching the system on, the diagnostic functions for the CAN bus starts after a configurable waiting time ECU_INIT (~ 10s). If a receive message is still missing after this time elapsed, then the message is in the time out condition.

After the waiting time ECU_INIT elapsed, the normal timeout monitoring starts. In this mode the waiting time is different from the above one (~8 * standard transmission rate).

Engine start condition
While starting the engine, the supply voltage usually drops down. To avoid faults due to low supply voltages there is another configurable waiting time where CAN Bus monitoring is disabled. This time starts when engine starts cranking and ends when low idle speed has been reached plus a configurable time delay.
If a receive message is still missing when this time elapsed, then the message is in the time out condition.
After this waiting time elapsed, the normal timeout monitoring starts. In this mode the waiting time is different from the above one (~8 * standard transmission rate).

Supply voltage
Even when the engine is already running and the supply voltage decreases below a minimal threshold (configurable), the normal timeout monitoring will be disabled. It will be enabled again, after the voltage raised to normal values (configurable) again and a configurable waiting time elapsed.
If a receive message is still missing after this time elapsed, then the message is in the time out condition.
After this waiting time elapsed, the normal timeout monitoring starts. In this mode the waiting time is different from the above one (~8 * standard transmission rate).

Setpoint sources
If the CAN Bus is the source of the engine speed or torque setpoint and a pedal is also connected to the EMR3, the CAN setpoint has higher priority and the pedal is the redundant source. The following functions will be used:

If the CAN Bus message which delivers the setpoint is in the timeout condition, then the redundant source will be used. Once switched over to the redundant value no return to the CAN bus setpoint is possible till the engine has been stopped.

CAN BUS stops operation
All members of the CAN Bus must be switched on/off at the same time, else receive messages could be missing and faults might be generated.
The DEUTZ experience is, that the fault message "receive message is missing" is not sufficient if they occur seldom, because nobody knows if this is caused by indeterminate switch off conditions or by CAN Bus disturbances.
Therefore EMR3 will set a data before it ends stopping the CAN Bus messages.
All other nodes can decide if they need the CAN BUS messages from EMR3 furthermore.

Receive Messages missing, time out
Defaults values for transmission rate, timeout and CAN Identifier s. CAN Code Specification.

Not valid data
Not valid data, (i.e. caused by a short circuit of a sensor), have to be set to 0xFEh according to the standard SAE-J1939.

Missing or not valid data of a CAN-Bus will be replaced by error values inside the EMR3. These error values are configuration parameters, which can be normal error values in the normal operation range or error values outside the operation range. Error values in the normal operation range are used like valid data for the other functions of EMR3, but error messages will be generated.

EMR functions will not work with data set to error values outside the normal operation range. Alternative function will be used to get a proper operation of the system, i.e. limp home function. If a data becomes valid again, this valid value will be used again for normal operation, if not other specified in the function specification. Set point values for engine speed or engine torque will not get valid again after a fault detection.

Error Memory
Faults of the CAN-bus are transmitted via CAN-Bus and the ISO9141 Bus and will be stored into the error memory of EMR3. The diagnostic lamp will be activated. The reason for a fault must be unambiguously determinable.

Engine protection message
If an engine protection message fails, the last valid value will be used and the error messages will be generated.
Appendix 1: Multipacket Transport

If more than 8 data bytes must be send they have to be separated in different packets. The first message is the Broadcast Announce Message (BAM), which tells the receiver which message will be send in packages. After that the data packets will be send.

BAM:
Transmission rate: s. below.
Data length: 8
Data Page: 0
PDUF: 236
PDUS: 255
Priority: 6
Parameter group number: 60416
Source Address: Device- Nr. EMR
ID:

<table>
<thead>
<tr>
<th>Byte 1</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 2, 3</td>
<td>Number of used data bytes of all packets without the byte of packet number</td>
</tr>
<tr>
<td>Byte 4</td>
<td>number of Packets</td>
</tr>
<tr>
<td>Byte 5</td>
<td>reserved FF</td>
</tr>
<tr>
<td>Byte 6 to 8</td>
<td>Parameter group number</td>
</tr>
</tbody>
</table>

Die „parameter group number“ and the transmission rate are the same as in the message specified, which data are transferred with the Multipacket Transport (i.e. DM 1, DM 2)

The data packets:
Transmission rate: see above
Data length: 8
Data Page: 0
PDUF: 235
PDUS: External Device Nr
Priority: 6
Parameter group number: 00Ebxxh
Source Address: Device- Nr. EMR
ID:

<table>
<thead>
<tr>
<th>Byte 1</th>
<th>Packet Nr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 2 to 8</td>
<td>Data</td>
</tr>
</tbody>
</table>

There may be less than 8 useful data bytes in the last data packet, so the rest of the data bytes are set to FF. The External Device No. is global (255) if the message is send cyclically, else it is the Device No. of the device which made a request.
Appendix 2: Lamp status

Malfunction Lamp status
consist of 2 Bit values:
00 not active (not lightened)
01 active (lightened)
7 not defined

Bit 1,2 Engine Protection Lamp
• is active, if a valid data is out of normal operating range, i.e. in warning range, power reduction range, engine shutdown demand range, start protection range or shutdown range.
• is not active, if the data value is coming back out of the warning range and is below the recovery limit.

Bit 3,4 Warning Lamp
is active, if the diagnostic lamp of EMR is continuously lightened, otherwise it is inactive. That means it is active not only if a data value is in the warning range, it is also set, if an electronic part of the EMR System has a fault which does not causes an automatically shut off of the engine, i.e. broken wire.

Bit 5,6 Stop lamp (for engine protection)
active, if the EMR diagnostic lamp is blinking to show an critical fault. That means an engine shut off is necessary.

Bit 7,8 Emission Related Lamp

DM1 and DM2 have a second Byte for Lamp Status, but the contents are not specified (=FF)

After switching power supply the EMR diagnostic lamp is lightened for a test, but the bits defined above will not be set active for that reason.
Appendix 3: Error codes, SPN, DTC

The diagnostic trouble code DTC consist on the SPN (suspect parameter number) to see which parameter is faulty, and the FMI (failure mode identifier), which shows the kind of error.

DTC consist on 19 Bits SPN, 5 Bits FMI, 1 bit conversation method CM and 7 Bits Occurrence Counter

The SPN (suspect parameter number) values are the same values as described in the standard.
For special faults, not defined in the standard, the SPN values are configurable.
Each error message can be enabled separately by a configuration parameter.
The error codes SPN and FMI are listed in a separate document.

There are 4 different ways to interpret the SPN Bytes as defined in SAE-J1939-73 OCT1998. 5.7.1.7

The following example shows how to interpret the received bytes of message DM1, using version 1, for a test tool connected to EMR3.

**EXAMPLE DM1 Received, Version 1 EMR1 and EMR2 compatible:**

DM1 Bytes 3 to 6: 00 17 CB 83

This is binary: 0000 0000 0001 0111 1100 1011 1000 0011

SPN = 0 0 0 0 0 0 0 0 1 0 1 1 1 1 1 0

FMI = 01011 = 11d

OC = 0000011 = 3

CM = 0x00BEh = 190d = Engine Speed Error

So the fault 190 with kind of error 11 has occurred 3 times.

Software routine for SPN: Read Bytes 3 to 5 and shift right 5 times, or equivalent: Read Bytes 3 to 5 and divide by 20h = 32d

0017CB / 20h = BE = 190d
Appendix 4: Acknowledgment

according to SAE-J1939-21

Transmission rate: Once, after receiving a message which needs an Acknowledge.
Data length: 8 Bytes
Data Page: 0
PDUF: 232
PDUS: 255
Priority: 6
Parameter group number: 59647 (E8FF)
Source Address: EMR Device Nr.
ID:

| Byte 1 | 0 for positive Acknowledge  
|        | 1 for negative Acknowledge  |
| Byte 2 to 5 | not defined             |
| Byte 6 to 8 | parameter group number of the message, which needs an Acknowledge |

Appendix 5: Hardware Information CAN

Terminal Resistor:
On both ends of the CAN Bus terminate resistors are necessary. They must external of the EMR3 controller, because EMR3 does not provide internal CAN BUS termination resistors.

EMR3 switched off
EMR3 will not influence the CAN BUS data transfer, when EMR3 is switched off by the power supply.
That means EMR 3 will not influence the p physical can bus parameter.