4.14 Diagnostic Tool Communication Function

This section defines the unique ECU requirements by using the diagnostic tool communication that is based on "Unified diagnostic services (UDS)" including ECU flash reprogramming code.

4.14.1 Applied Specifications

Specifications	Document number	Issuing department
Diagnostic Service Specification switch net diag spec COO8	PD2145319	SCANIA
Requirements on diagnostic services in Scania ECUs	TB1524	SCANIA
Technical Regulation SESAMM Design Guideline Software downloading End of Line parameters	TB4151	SCANIA
Technical Regulation SCANIA ECU requirements for UDS	TB4061	SCANIA
Technical Regulation Scania ECU software download service specification	TB4193	SCANIA
Technical Regulation Requirements for software download in Scania ECUs	TB4194	SCANIA
Road vehicles--Unified diagnostic services(UDS) --Part 1: Specification and requirements	ISO 14229-1	ISO
Road vehicles--Diagnostic communication over Controller Area Network(DoCAN) --Part 2: Transport protocol and network layer services	ISO 15765-2	ISO
Road vehicles--Diagnostics on Controller Area Networks (CAN) --Part 3: Implementation of unified diagnostic services(UDS on CAN)	ISO 15765-3	ISO

4.14.2 System Clock and Watchdog for Flash Boot Loader

The watchdog timer shall be set in PBL under high-speed clock mode. To monitor the watchdog cancellation timing, a pulse wave that toggles every watchdog cancellation shall be output to P5_6.

Item		Specifications
System clock		16MHz±0.3% (Stabilization time is equal to 1ms or less.)
Clock for watchdog timer		Low-speed on chip oscillator (Min112.5kHz, typ125kHz, Max137.5kHz)
Watchdog reset time		Min. 59.5ms, Typ. 65.5 ms; Max. 72.9 ms
Watchdog cancel timing	During Flash Reprogramming (High-speed clock mode)	Between 10 to 25 ms (It should be cyclic.)
	Waiting for the request to flash	20ms interval (It has to be cyclic.)
	During initialization process (High-speed clock mode)	The cancel shall be less than 10 ms. (It doesn't have to be cyclic.)

4.14.3 Diagnostic Communication Protocol including flash reprogramming

Item	Specifications
Baud rate	500kbps
Message format	CAN Specification 2.0 PART B : Extended format (29bit ID)
Data transfer direction	MSB First
Communication byte order	Little-endian
Data length	Fixed to 8 bytes (unless otherwise specified)
Padding data for unused bit	Set to "0" (This is used only in the response message with ASCII characters.)
	Set to "1" except the above response messages.
Configuration Parameter	Unified Diagnostic Service (UDS)
2 Separation Time Minimum (STmin)	0ms
1 Sampling point	75% - 88% at one point
1 Synchronization Jump Width	2

Note: See ISO15765-3 for timing parameter definitions for diagnostic communication except Rx timeout.

4.14.4 CAN message IDs for flash reprogramming

	Message Name	Identifier	Message Type	PGN	Default Priority	DP ext	DP	PF	Desti-nation	Source Addrss	Standard/ proprietary
Tx	Module Configuration – CPEL2->Sender	1 18AAxx37	Event	0xAA00	6	0	0	AA	xx	37	Standard
Rx	Module Configuration - Any -> CPEL2	1 18AA37xx	Event	0xAA00	6	0	0	AA	37	xx	Standard

Note :
1. Node address for CPEL2 = 0x37
2. "xx" in ID can be any numbers and it means that CPEL2 shall receive diagnostic request messages from any ECUs.
3. The source address "xx" in ID for Rx messages shall be used as the destination in the ID for the response messages.
4. The Tx ID0x18AAxx37 shall be used for the flash reprogramming and also the response messages for SID0x11, SID0x22 and SID0x2E.

4.14.5 Protocol Control Information(PCI) for CAN Reprogramming

The following table shows the protocol control information(PCI) used for CAN reprogramming.

N_PDU	Information for PCI Byte and Data Byte				
	Byte1		Byte2	Byte3	Byte4
	Upper Nibble	Lower Nibble			
Single Frame (SF)	0x0	Single Frame Data Length (SF_DL)	Service ID	Sub Parameter	Data1
First Frame (FF)	0x1	First Frame Data Length (FF_DL)		Service ID	Sub Parameter
Consecutive Frame (CF)	0x2	Sequence Number (SN)	Data1	Data2	Data3
Flow Control (FC)	0x3	Flow Status (FS)	Block Size (BS)	Separation Time min (STmin)	N/A

Note : 1. N_PDU stands for Network Protocol Data Unit.

N_PDU	Information for Frame Specific Parameters				
	Byte1		Byte2		Byte3
	Lower Nibble	Definition			
Single Frame (SF)	SF_DL	Valid : 0x1-0x7 Invalid : 0x0, 0x8-0xF	-		-
First Frame (FF)	FF_DL	Valid : 0x008-0xFFF Invalid : 0x0-0x7			-
Consecutive Frame(CF)	SN	Valid : 0x0-0xF Invalid : unexpected SN	-		-
Flow Control (FC)	FS	Valid : 0x0-0x2 Invalid : 0x3-0xF	BS	0x01-0xFF	Valid : 0x0A or bigger Invalid: Less than 0x0A

6

Note :
1. If CPEL2 receives a single frame with 0x0 or greater than or equal to 0x8 for SF_DL, it shall be ignored. ~~and a negative response with NRC 0x13 shall be transmitted.~~
2. CPEL2 shall use the received data until the byte position indicated by SF_DL. If a signal frame includes more data than SF_DL, they should be unused bytes and CPEL2 shall ignore these data.
3. If CPEL2 receives a first frame with 0x07 or less for FF_DL, it shall be ignored. ~~and a negative response with NRC 0x13 shall be transmitted.~~
4. Once CPEL2 received an FF, CPEL2 shall wait for a corresponding CF with the same CAN ID used in FF for 1000ms. If CPEL2 receives it within 1000ms, CPEL2 shall accept the request. However, if CPEL2 does not receive it for 1000ms, it causes timeout and CPEL2 shall ignore this message. ~~reply a negative response with NRC0x10.~~ If CPEL2 received a CF with a different CAN ID from FF, it shall be ignored. If CPEL2 receives another pair of FF and CF with a different CAN ID before receiving CF, CPEL2 shall also ignore them. (CPEL2 shall not reply a negative response.)
5. The maximum segmented message length supported is equal to 100 bytes of user data.

6

4.14.6 Flow control

Flow control shall not be used in Default session and Extended Diagnostic session, but it can be used in Programming session. If CPEL2 receives Flow control in Default session, CPEL2 shall ignore it. ~~send a negative response with 0x22 (ConditionNotCorrect).~~

6

4.14.7 Single Frame

If CPEL2 receives an SF with SF_DL equal to zero then the network layer shall ignore the received SF.
If CPEL2 receives an SF with SF_DL greater than seven the network layer shall ignore the received SF.

4.14.8 Service IDs for Diagnostic messages

The following table shows the service IDs that CPEL2 shall support in each diagnostic session.

Service ID (SID)		Service Name	Diagnostic Sessions for APP			Diagnostic Sessions for PBL		
			Default Session	Ext. Diag Session	Programng Session	Default Session	Ext. Diag Session	Programng Session
CPEL2 Rx	0x10	DiagnosticSessionControl	O	O	X	O	O	O
	0x11	ECUReset	O 1	O	X	~~X~~ O 4	O	O
	0x22	ReadDataByIdentifier	O	O	X	O	O	X
	0x27	SecurityAccess	O	O	X	O	O	X
	0x28	CommunicationControl	X	O	X	X	O	X
	0x2E	WriteDataByIdentifier	O	X	X	X	X	X
	0x31	RoutineControl	X	X	X	X	X	O
	0x34	RequestDownload	X	X	X	X	X	O
	0x36	TransferData	X	X	X	X	X	O
	0x37	TransferExit	X	X	X	X	X	O
	0x3E	TesterPresent	O	O	X	O	O	O
	0xA5 1	OnChipMemoryControl	O	X	X	X	X	X
	~~0xB1~~	~~Programming~~	~~O~~	~~X~~	~~X~~	~~O~~	~~X~~	~~O~~
CPEL2 Tx	(SID+0x40)	Positive Response	O	O	X	O	O	O
	0x7F	Negative Response	O	O	X	O	O	O

O : The service shall be supported in the session.
X : The service shall NOT be supported in the session.

Note :

1 1. During Extended Diagnostic Session and Programming Session, CPEL2 shall never go into sleep by "NoWakeUp" messages from other ECUs since Rotary switch is at either Position Light or Driving at that time. Even if the switch is turned to either OFF or AUTO, CPEL2 shall not go to Sleep state until the session returns to Default Session.
2. All the SIDs in Extended Diagnostic Session can be accessed only after CPEL2 can unlock the corresponding security level successfully.
3. All the SIDs in Programming Session can be accessed only after CPEL2 can unlock the corresponding security level successfully.
4. Negative Response Code 0x7F shall be used when a requested diagnostic service is not supported in the session currently active but it is supported in another session(s).
   ~~E.g. If Tester requests ECUReset in Default session, CPEL2 sends a negative response with 0x7F.~~
   E.g. If Tester requests ControlDTCSetting (SID0x85) in any sessions, CPEL2 sends a negative response with 0x11.
5. None of SIDs used only for flash programming shall be supported in the application because flash reprogramming shall be handled only by PBL and the application doesn t support the flash reprogramming function.

6 6. If Tester requests a SID that is not listed in the table above and the range of SID is from 0x10 to 0x3E, the negative response code 0x11 shall be replied in the negative response.
   If a requested SID is not from 0x10 to 0x3E, CPEL2 shall ignore this message.

4.14.9 Magic Number

1 Magic Number located at 0x1FFFC through 0x1FFFF shall be a 4 byte-long data with 0x545223DE. It is used to check if application software exists or flash reprogramming has been completed successfully. 2 s compliment of Magic Number located at 0x08000 through 0x08003 is used only to cancel out Magic Number for ROM check. PBL shall hold both Magic Number and the 2 s compliment as constant values within PBL and they are written to 0x1FFFC through 0x1FFFF and 0x08000 through 0x08003 respectively after consistency check(checksum) requested by RoutineControl(SID0x31) is successfully completed at the end of

flash reprogramming.

4.14.10 Negative Response Codes

The following table shows the negative response codes (NRC) that CPEL2 shall support.

Negative Response Code	Description
0x10	**GeneralReject** This response code shall be used when the CAN ID for the first frame is different from the CAN ID for the consecutive frame. E.g. CAN IDs of the first frame and the consecutive frame for SID0x2E is different. Also, it shall be used CPEL2 does not receive Consecutive Frames within the timeout period of 1000ms.
0x11	**ServiceNotSupported** ECU shall send this response code in case Tester has sent a request message with a service identifier which is either unknown or not supported by ECU.
0x12	**SubFunctionNotSupported** This is sent if either the sub-function parameter or the service specific parameters in the requested message is not supported.
0x13	**IncorrectMessageLengthOrInvalidFormat** This code shows the length of received diagnostic request message doesn't match the predefined length of the request or format of the parameters doesn't match the predefined format.
0x22	**ConditionNotCorrect** This response code shall be sent if the prerequisite conditions for ECU are not met.
0x24	**RequestSequenceError** This code is sent when ECU's expected process sequence differs from the one sent by Tester. For example, SecurityAccess(SID0x27) with SendKey is received before SecurityAccess with RequestSeed.
0x31	**RequestOutOfRange** This code is used when the service identifier is supported but none of the requested data parameters(sub function parameters, DIDs, Routine IDs, etc) are supported by the Tester's request message.
0x33	**SecurityAccessDenied** This indicates the required message sequence isn't met or Tester has sent a request message that requires to unlock the security in ECU.
0x35	**InvalidKey** This indicates that the key sent by Tester doesn't match with the key that ECU has and ECU couldn't give security access.
0x36	**ExceedNumberOfAttempt** This shows that a security access attempt to unlock by Tester gets failed even once.
0x37	**RequestTimeDelayNotExpired** Tester's attempt to unlock security access was requested before 10 second delay time had elapsed.
0x70	**UploadDownloadNotAccepted** This is used to respond when an attempt to download to a non-volatile memory can't achieved due to a failure occurrence.
0x71	**TransferDataSuspended** This indicates that a data transfer operation(SID0x34) was stopped due to a fault or the download module length doesn't match with the memory size parameter sent in the request message of RequestDownload.
0x72	**GeneralProgrammingFailure** This code shall be sent if ECU detects any type of error when erasing or writing to a non-volatile memory location.
0x73	**WrongBlockSequenceCounter** This is used when ECU detected a fault in the sequence of the BlockSequenceCounter values. Even if the counter value in a consecutive frame is same the one included in the previous, it shall be accepted.
0x78	**RequestCorrectlyReceived-ResponsePending** This shall be sent when CPEL2 isn't ready to receive further request messages. Negative Response is repeatedly sent until CPEL2 is ready to receive another request messages. First, Positive/Negative response for a request message shall be sent before receiving another request messages.
0x7F	**ServiceNotSupportedInActiveSession** This shall be used when Tester requests a diagnostic service that is not supported in the current active session; however, it is supported in another session(s).
0x92	**VoltageTooHigh** This indicates that ECU detects Overvoltage at power supply during TransferData sequence.
0x93	**VoltageTooLow** This indicates that ECU detects Undervoltage at power supply during TransferData sequence.

Note : 1. If SecurityAccess(SID0x27) is requested in Programming Session, CPEL2 shall respond with 0x0000 as the seed in the positive response.

2. NRC 0x78 shall be transmitted once before starting to erase flash area or to calculate the checksum. It shall be also transmitted arbitrarily within 1000ms to avoid the communication lost with Tester by Rx timeout with 1000ms.

4.14.11 Data Identifier

The following table shows the data identifiers (DIDs) that ReadDataByIdentifier (SID0x22) and WriteDataByIdentifier (SID0x2E) use as a part of their diagnostic request messages. The procedure for access to the data flash ROM addressed from 0x7000 to 0x7FFF and data assurance logic is specified separately.

3 If data for DID0xF198, 0xF199 and 0xFD05 through 0xFD08 is updated by SID0x2E, the updated data shall be available only after software reset by SID0x11 or reset by Voltage Monitor 0 (3.80 V set by VDSEL bits in OFS register) or after +B is reconnected or from the next WakeUp cycle. If SID0x22 for them is requested in the same WakeUp cycle after they were updated, their ~~previous~~ latest values in Data Flash shall be replied in the response message.

5

If DID0xFDA0 is updated, the updated data shall be available for the system behaviors soon after written in Data Flash successfully.

6

When WriteDataByIdentifier(SID0x2E) is requested, CPEL2 shall check the range of values to be written. If the values are out of range, CPEL2 shall reply a negative response message with NRC 0x31.

Data Identifier	Data Type	Description 6	Range	Default Value
0xF187	One-time Programmable 1	**ScaniaSparePartNumberDataIdentifier** This indicates to report the Scania part number for complete unit(ECU Assy) with 7 byte ASCII characters.	–	3 None
0xF18A	Constant	**SupplierIdentifierDataIdentifier** This requests to report the system supplier name with 10 byte ASCII characters. There is no space between "Tokai " and "Rika " as shown in Default value column. The 10th byte shall be filled with NULL(0x00 in ASCII). 1	–	TokaiRika
0xF18B	One-time Programmable 1	**ECUManufacturingDataIdentifier** This requests to report the ECU manufacturing date information(YYMMDD) with 6 byte ASCII characters decided by Tokai Rika. 1	–	2 None
0xF18C	One-time Programmable 1	**ECUSerialNumberDataIdentifier** This requests to report the ECU serial number with ~~7~~ 8 byte ASCII characters. 2	–	2 None
0xF193	One-time Programmable 1	**SupplierECUHardwareVersionNumberDataIdentifier** This requests to send the information of the hardware version number with 7 byte ASCII characters decided by Tokai Rika. 1	–	2 None
0xF195	Constant 1	**SupplierECUSoftwareVersionNumberDataIdentifier** This requests to send the information of the software version number with 7 byte ASCII characters decided by Tokai Rika.	–	CPL1010 2 3 4 5
2 0xF197	One-time Programmable ~~3~~	**SystemNameDataIdentifier** This requests to send the information of the system name with 8 byte ASCII characters.	–	CPEL0000 (See 3.4.3)

Data Identifier	Data Type	Description	5 Range	Default Value
0xF198 (FingerPrintData)	Programmable	**TesterSerialNumberDataIdentifier** This is used to respond Finger Print Data(10bytes) defined by Scania consist of Tester serial number data identifier. See the definition table on the next page.	–	1 0x00 for all 10 bytes
0xF199 (FingerPrintData)	Programmable	**ProgrammingDateDataIdentifier** This is used to respond Finger Print Data(6bytes) defined by Scania consist of Programming date data identifier. See the definition table on the next page.	5 0x20 – 0x7E	1 0x00 for all 6 bytes
1 0xFD05	Programmable	**PWMOutputLights** The 10 different threshold values ~~from 10% to 100% with 10% interval~~ shall be stored in non-volatile memory and shall be able to be reprogrammed by WriteDataByID. They shall be read out from the non-volatile memory to a RAM area ~~during WakeUp Preparation state~~ before entering Normal Operation mode and used for the linear interpolation to calculate the PWM duty cycle for symbol illumination based on the "Switch BacklightIlluminationBrightnessPercent "signal in Cab Illumination with either P2P or Broadcast. The value more than the threshold value for 100% shall be treated as 100%. See the example of the calculation for PWM duty cycle by the linear interpolation on the next page. 1	0 - 250	Illumination Level 5 : ~~6~~ 2 4 10 : ~~16~~ 12 20 : ~~45~~ 25 5 35 : 100 60 55 : ~~115~~ 105 7 80 : ~~130~~ 160 110 : ~~150~~ 215 145 : ~~175~~ 250 190 : ~~200~~ 250 250 : ~~225~~ 250
1 0xFD06 1	Programmable	**PWMOutputLEDIndicators** The 10 different threshold values ~~from 10% to 100% with 10% interval~~ shall be stored in non-volatile memory and shall be able to be reprogrammed by WriteDataByID. They shall be read out from the non-volatile memory to a RAM area ~~during WakeUp Preparation state~~ before entering Normal Operation mode and used for the linear interpolation to calculate the PWM duty cycle for the intensity of Indicators ~~during the night mode~~ based on the "Switch Indication Illumination Brightness Percent" in Cab Illumination with either P2P or Broadcast. The value more than the threshold value for 100% shall be treated as 100%. See the example of the calculation for PWM duty cycle by the linear interpolation on the next page. 1	0 - 250	Illumination Level 4 5 : ~~6~~ 1 10 : ~~16~~ 2 5 20 : ~~45~~ 3 35 : 100 8 7 55 : ~~115~~ 14 80 : ~~130~~ 22 110 : ~~150~~ 32 145 : ~~175~~ 45 190 : ~~200~~ 64 250 : ~~225~~ 90
2 0xFD07 2 3	Programmable	**LightSensorOffsetPWMOutput** The 10 different threshold values from 1 lux to 130000 lux shall be stored in non-volatile memory and shall be able to be reprogrammed by WriteDataByID. They shall be read from the non-volatile memory to a RAM area during WakeUp Preparation state and used for the linear interpolation to calculate the offset value added to/subtracted from PWM duty cycle for the intensity of Indicators based on the "Switch Indication Illumination Brightness Percent "in Cab Illumination with either P2P or Broadcast. 1	0 - 250	Offset Value 2 7 1 lux 125 50 lux 125 100 lux 125 500 lux 125 1000 lux 125 5000 lux 125 10000 lux 200 50000 lux 250 80000 lux 250 130000lux: 250
0xFD08	Programmable	**NumberOfSamplesForLightSensorCompensation** The value shows how many last transmitted "AmbientLightDriverSide" values shall be used to calculate an average value used as an offset value for the intensity of LED indicator.	from 1 to 100	10
0xFDA0	Programmable	**CalibrationCoefficientForLightSensorValue** The coefficient is used to calibrate ambient illuminance average values. The stored coefficient shall have a valid range between ~~500~~ 200and ~~1500~~ 5000.	–	1000 (0x03E8)

5

Example: PWM calculation by the linear interpolation.

CAN Rx value = 0x8C (140 in dec)

Wake-up Bus 'HI' threshold $= \frac{(175 - 150)}{145 - 110}$ KI0 threshold voltage

$=171.4286$

PWM duty cycle = 171.4286 x (0x4%/bit) x 100

= 68.5714

≒ 68%

1 Data format of finger print data in response message

Byte	Tester serial number data ID (DID:0xF198)	Programming Date Data Identifier (DID:0xF199)
1	User ID in ASCII code (Highest Byte)	YY in ASCII code
2	User ID in ASCII code	YY in ASCII code
3	User ID in ASCII code	MM in ASCII code
4	User ID in ASCII code (Lowest Byte)	MM in ASCII code
5	ID for Application tool used to modify data in ASCII code	DD in ASCII code
6	YY in ASCII code	DD in ASCII code
7	MM in ASCII code	
8	DD in ASCII code	
9-10	0xFF (Reserved for future use)	

1 Note : 1. YYMMDD for Tester serial number data ID shows the date in BCD code that the most recent data writing for DID0xF198 in data flash has done by requested WriteDataByIdentifier with DID0xF198.
e.g. 2013/2/14 -> 13/2/14 -> 130214 -> **0x13 0x02 0x14**

2. YYMMDD for Programming Date Data Identifier indicates the date in ASCII code that the most recent flash reprogramming has done to ROM area.
e.g. 2013/2/14 -> 13/2/14 -> 130214 -> **0x31 0x33 0x30 0x32 0x31 0x34**

ASCII Code Table

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0x20	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
0x30	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
0x40	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
0x50	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
0x60	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
0x70	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	

Example : Tokai Rika -> T:0x54 o:0x6F k:0x6B a:0x61 i:0x69 R:0x52 i:0x69 k:0x6B a:0x61

3 ***4.14.11.1 Response to Diagnostic Request Message for Scania Part Number***

When CPEL2 receives the diagnostic request message WriteDataByIdentifier (SID0x2E) with ScaniaSparePartNumberDataIdentifier (DID0xF18 7), it shall need to record the received "SCANIA Part number" data into Data Flash. The data shall be writable only once. If the data has been already written in Data when requested the SID0x2E with DID0xF187, CPEL2 shall reply the negative response with NRC 0x22. Since new part numbers may be added later, CPEL2 does not have to check if a received "SCANIA Part number" is any one of the expected part numbers before writing a received part number into Data Flash.

When CPEL2 received ReadDataByIdentifier (SID0x22) with ScaniaSparePartNumberDataIdentifier (DID0xF187), CPEL2 shall need to read out and reply the "SCANIA Part number" recorded in Data Flash. If there is no data for the part number available in Data Flash when CPEL2 received the request message, CPEL2 shall reply the negative response with NRC 0x22. If any one of errors in Data Flash is detected when the SID0x22 with DID0xF187 was requested, CPEL2 shall reply the negative response with NRC 0x22.

4.14.12 Diagnostic Service Identifier

4.14.12.1 DiagnosticSessionControl (SID0x10)

This SID enables to shift diagnostic sessions in CPEL2 when CPEL2 receives a correct formatted message with a correct sub function parameter. During Programming Session and Extended Diagnostic Session, CPEL2 shall not go into "Sleep state". If the sub parameter is 0x8*, then CPEL2 shall not send a positive response. However, a negative response shall be sent even if the sub parameter is 0x8*.

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session, Extended Diagnostic Session		
	PBL	Default Session, Extended Diagnostic Session, Programming Session		
Prerequisite Condition(s)		None		

Byte	Description	Values(hex) of each Byte on request message			
1	Upper Nibble : PCI Type	0	**0x02**		
	Lower Nibble : Data Length	2			
2	Request Service ID	**0x10**			
3	Sub Function Parameter	**0x01**	**0x02**	**0x03**	0x00, 0x04 – 0x7F
		Default Session	Programming Session	Extended Diagnostic Session	Not Supported
4-8	Unused Byte	-			

Note:
1. Default Session: Diagnostic session always starts from this session.
2. Programming Session: This session supports the memory programming such as flash reprogramming.
3. Extended Diagnostic Session: This session supports the preconditions to change the session to Programming session.

Response message definition for SID0x10

Network Protocol Data Unit	Single Frame

Byte	Description	Values(hex) of each Byte on response message							
		Positive Response			Negative Response				
1	Upper Nibble : PCI Type	0	**0x02**		0	**0x03**			
	Lower Nibble : Data Length	2			3				
2	Response Service ID	**0x50**			**0x7F**				
3	Sub Function Parameter / Echo of Request Service ID	**0x01**	**0x02**	**0x03**	**0x10**				
4	Unused Byte / Response code	**0xFF**			**0x12**	**0x13**	**0x22**	**0x33**	**0x78**
5-8	Unused Byte	**0xFF**			**0xFF**				

Response Code 0x22: When Tester requests to shift to Extended Diagnostic session in Programming Session, this is used.

Possibility of session transitions and the conditions

		Current Session		
		Default Session	Programming Session	Extended Diag Session
Next Session	Default Session	O	O	O
		DiagnosticSessionControl (Security for Ext. Diag Session shall be locked.)	1. ECUReset 2. Rx Timeout 3. DiagnosticSessionControl	1. ECUReset 2. Rx Timeout 3. DiagnosticSessionControl
	Programming Session	X		O
		-		CPEL2 accepted a key for programming session Tester sent.
	Extended Diagnostic Session	O	X	
		CPEL2 accepted a key for Extended Diagnostic Session Tester sent.	-	

O: Possible to shift X: Impossible to shift

4.14.12.2 ECUReset (SID0x11)

1 When CPEL2 receives this SID with one of the sub function parameters 0x01 (HardReset) ~~or 0x02 (KeyOffOnReset)~~, CPEL2 first sends a positive response message only if a consistency check (checksum) has been already succeeded. Then the control shall jump to 0x0C000 by software reset and the initialization from PowerOn shall be started. After the software reset, T-WakeUp line shall be set to Hi for 5 seconds if ROM/RAM errors in PBL aren't detected and also RAM error in APP isn't detected. Even if Rotary switch is not at Position Light or Driving Light, T-WakeUp line shall be set to Hi for 5 seconds to show that reprogramming has been completed in APP. If ROM/RAM error in PBL is detected AND no correct Magic Number is available, the control stays in PBL and T-WakeUp line shall be set to high for 5 seconds in PBL and keep sending "Internal Error" signal with 0x01 to show that a fatal error has been detected in PBL. When PBL received this SID during "stays in PBL" or APP received this SID in Normal Operation Mode, ROM check in PBL or APP shall be stopped even on the way toward the end address and the control shall jump to 0x0C000 again by the reset indicated in the sub function parameter.

If CPEL2 receives this SID with 0x05 (Factory Reset) when any two of the 6 momentary switches are pressed, all the programmable DIDs except DID0xFDA0 shall be set back to their default values and then the software reset shall be issued. Only after the software reset, the written default values shall be valid. Leveling switch ~~and the switch stuck status~~ shall not be considered as "switch press" to accept "Factory Reset". If none, one, three or more of the momentary switches are pressed when CPEL2 receives the diagnostic request, CPEL2 shall reply the negative response with NRC0x22. If all the programmable DIDs except DID0xFDA0 are successfully written back to their default values, a positive response shall be sent and then the software reset shall be issued. T-WakeUp line behavior depends on the status of Rotary switch after the software reset. If failed to write default values, CPEL2 shall retry to write the default value twice.

6 Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session, Extended Diagnostic Session		
	PBL	Extended Diagnostic Session, Programming Session		
Prerequisite Condition(s)		Consistency check has successfully completed (RoutineControl with **0x01** and **0xFF01**)		

Byte	Description	Values(hex) of each Byte on request message			
1	Upper Nibble : PCI Type	0	**0x02**		
	Lower Nibble : Data Length	2			
2	Request Service ID	**0x11**			
3	Sub Function Parameter	**0x01**	**~~0x02~~**	**0x05**	0x00, 0x02, 0x03, 0x04, 0x06 - 0x7F
		HardReset	~~KeyOffOnReset~~	FactoryReset	Not Supported
4-8	Unused Byte	-			

Note: 1. HardReset: It shall be treated as software reset and the initialization from Power ON should be done.
(The initialization from Wakeup shouldn't be executed instead of the one from Power ON.)
~~2. KeyOffOnReset: It shall be treated as software reset and the initialization from Power ON is used.~~

Response message definition for SID0x11

Network Protocol Data Unit	Single Frame

Byte	Description	Values(hex) of each Byte on response message					
		Positive Response			Negative Response		
1	Upper Nibble : PCI Type	0	**0x02**		0	**0x03**	
	Lower Nibble : Data Length	2			3		
2	Response Service ID	**0x51**			**0x7F**		
3	Echo of Sub Function Parameter / Echo of Request Service ID	**0x01**	**~~0x02~~**	**0x05**	**0x11** 2		
4	Unused Byte / Response Code	**0xFF**			**0x12**	**0x13**	
					0x22	**-**	
5-8	Unused Byte	**0xFF**					

2 ~~Response Code 0x22: This is used when ROM/RAM error has been detected in any sessions.~~
2 ~~Response Code 0x7F: This is used when CPEL2 receives SID0x11 in Default Session.~~

3 Note: 1. If SID0x11 is requested in Application under the condition of ROM/RAM error, please reply a positive response and invoke reset.
4 2. If SID0x11 is requested in any of diagnostic sessions of PBL under the condition of ROM/RAM error, please reply a positive response and invoke reset.

4.14.12.3 ReadDataByIdentifier (SID0x22)

This is used when CPEL2 needs to provide information indicated by data identifier (DID) in positive response. This diagnostic request message from Tester always includes only one DID. Please see the section 4.14.11 "Data Identifier" for the detail of DIDs. The unused byte(s) shall be filled up with 0xFF. 2

Diagnostic request message definition

Addressing Type	Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session, Extended Diagnostic Session	
	PBL	Default Session, Extended Diagnostic Session	
Prerequisite Condition(s)		-	

Byte	Description	Values(hex) of each Byte on request message	
1	Upper Nibble : PCI Type	0	**0x03**
	Lower Nibble : Data Length	3	
2	Request Service ID	**0x22**	
3	Data Identifier	**0xF187, 0xF18A-0xF18C, 0xF193, 0xF195, 0xF197, 0xF198, 0xF199, 0xFD05-0xFD08, 0xFDA0** 1 2 4 3	all the other 2 byte data
4		See the section «Data Identifier» for the detail	Not Supported
5-8	Unused Byte	-	

Response message definition for SID0x22

Network Protocol Data Unit	First Frame and Consecutive Frame for Positive response, Single Frame for Negative response

Byte	Description	Values(hex) of each Byte on response message				
		Positive Response		Negative Response		
1	Upper Nibble : PCI Type	First Frame	1	**0x10**	Single Frame	0 **0x03**
	Lower Nibble : Data Length		0			3
2	Data Length/Response Service ID		**0x08 - 0x64**			**0x7F**
3	Response Service ID / Echo of Request Service ID		**0x62**			**0x22**
4	Echo of Higher DID / Response Code		**0xF187, 0xF18A-0xF18C, 0xF193, 0xF195, 0xF197, 0xF198, 0xF199, 0xFD05-0xFD08, 0xFDA0** 1 2 3 4			**0x13** / **0x31** | **0x22** / **0x7F**
5	Echo of Lower DID / Unused byte					**0xFF**
6-8	Response Data / Unused byte		**Response Data0 - 2**			**0xFF**
9	Upper Nibble : PCI Type	CF	2	**0x21 -> 0x22 ... 0x2F -> 0x20 -> 0x21 ...**	N/A	
	Lower Nibble : Sequence Number		1-0			
10-n	Response Data / NA		**Response Data3 - m**			

6 Note : 1. Unused byte(s) in the last first frame shall be filled up with 0xFF.
2. The maximum size of transmitting data shall be ~~100~~ 50 bytes.
3. Sequence Number in consecutive frame counts from 0x1 up to 0xF and rolls back to 0x0 after 0xF.
4. For Response Data 0-2 and 3-m, please refer to the table "Data Identifier".

2 3 Response Code 0x22 : Whether this NRC shall be replied depends on DID when no data/no valid is available in Data Flash. See the table below for this NRC in the response message.
Response Code 0x7F : This is used when CPEL2 receives SID0x22 in Programming Session.

1 If no valid data for a requested DID is stored in DF, the response message shall have the following format.

Data Identifier	Response Message	Response Code or Data	Remarks
0xF187	Negative Response	NRC0x22. See the section~~1.6~~ 4.14.11.1 for the detail.	If SID0x22 is requested during "stay in PBL", PBL shall reply a negative response with NRC0x22 except the response for DID0xF18A. The response for DID0xF18A shall be 10 byte constant value unless otherwise ROM error is detected.
0xF18A	Positive Response	10 byte constant value	
0xF18B	Negative Response	NRC0x22	
0xF18C	Negative Response	NRC0x22	
0xF193	Negative Response	NRC0x22	
0xF195	Positive Response	7 byte constant value	
0xF197	Positive Response	~~NRC0x22~~ 8 byte default value	
0xF198	Positive Response	10 byte default value	
0xF199	Positive Response	6 byte default value	
0xFD05	Positive Response	10 byte default value	
0xFD06	Positive Response	10 byte default value	
0xFD07	Positive Response	10 byte default value	
0xFD08	Positive Response	1 byte default value	
0xFDA0	Positive Response	~~NRC0x22~~ 1000(0x03E8) default value	

4.14.12.4 SecurityAccess (SID0x27)

This request is used to unlock for a particular security level. CPEL2 shall transmit "seed" (2 bytes) after "RequestSeed" (2 bytes) has received. "Seed" shall be a random number generated in CPEL2. To generate a random number, any standard library functions shall not be used. Based on the "seed", a key is calculated in both Tester and CPEL2 by using the formula mentioned below. If the "key" transmitted by Tester matches with the "key" calculated in CPEL2, the particular security level shall be unlocked. Only if the "key" transmitted from Tester is incorrect, 10 seconds delay time is applied and rejects all the "RequestSeed" request messages during the time delay by Negative Response with NRC "0x37". CPEL2 shall send a negative response with NRC 0x36 to a further "RequestSeed" request during the same "wake up" cycle or the same "Power On" cycle after CPEL2 receives an incorrect key three times. Once CPEL2 sleeps or the power is OFF, CPEL2 should be able to receive the "RequestSeed" request message again as its 1st trial. The delay time should not be cleared by software reset or watchdog reset. The time delay shall be applied only to SecurityAccess for RequestSeed and shall not disturb all the other diagnostic response messages to their request messages. The SecurityAccess for Extended Diagnostic Session shall be accepted only when the security for Default Session has been already unlocked.

Diagnostic request message definition for RequestSeed

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session, Extended Diagnostic Session		
	PBL	Default Session, Extended Diagnostic Session		
Prerequisite Condition(s)		DiagnosticSessionControl(SID0x10)		

Byte	Description	Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	0	**0x02**	
	Lower Nibble : Data Length	2		
2	Request Service ID	**0x27**		
3	Sub Function Parameter	**0x01**	**0x03**	0x00, 0x02, 0x04 –0x7F
		Request Seed for Extended Diagnostic Session	Request Seed for Programming Session	Not Supported
4-8	Unused Byte	-		

Note:
1. Programming Session: This session supports the memory programming such as flash reprogramming.
2. Extended Diagnostic Session: This session supports the preconditions to change the session to Programming session.

Response message definition for SecurityAccess (SID0x27) - RequestSeed

Network Protocol Data Unit		Single Frame					
Byte	Description	Values(hex) of each Byte on response message					
		Positive Response			Negative Response		
1	Upper Nibble : PCI Type	0	**0x04**		0	**0x03**	
	Lower Nibble : Data Length	4			3		
2	Response Service ID	**0x67**			**0x7F**		
3	Echo of Sub Function Parameter / Echo of Request Service ID	**0x01**	**0x03**		**0x27**		
4	Seed(High byte) / Response Code	**0x0001-0xFFFF** **0x0000 if the requested security level has been already unlocked.**			**0x12**	**0x13**	**0x24**
					0x36	**0x37**	
5	Seed(Low byte)				**0xFF**		
6-8	Unused Byte	**0xFF**					

The following is the formula to calculate "key" based on "seed".

"key" = 2's complement of "seed".

Diagnostic request message definition for SendKey

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session, Extended Diagnostic Session		
	PBL	Default Session, Extended Diagnostic Session		
Prerequisite Condition(s)		SecurityAccess(SID0x27) – "RequestSeed"		

Byte	Description	Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	0	**0x04**	
	Lower Nibble : Data Length	4		
2	Request Service ID	**0x27**		
3	Sub Function Parameter	**0x02**	**0x04**	0x00, 0x01, 0x03, 0x05 – 0x7F
		Send Key for Extended Diagnostic Session	Send Key for Programming Session	Not Supported
4	SendKey(High byte)	**0x0000-0xFFFF**		
5	SendKey(Low byte)			
6-8	Unused Byte	-		

Response message definition for SecurityAccess (SID0x27) - SendKey

Network Protocol Data Unit		Single Frame			
Byte	Description	Values(hex) of each Byte on response message			
		Positive Response		Negative Response	
1	Upper Nibble : PCI Type	0	**0x02**	0	**0x03**
	Lower Nibble : Data Length	2		3	
2	Response Service ID	**0x67**		**0x7F**	
3	Sub Function Parameter / Request Service ID	**0x02**	**0x04**	**0x27**	
4	Unused Byte / Response Code	**0xFF**		**0x12**	**0x13**
				0x24	**0x35**
5-8	Unused Byte	**0xFF**			

Response Code 0x24: If CPEL2 receives SecurityAccess– SendKey without receiving SecurityAccess – RequestSeed, this NRC is used. If CPEL2 receives any other request messages in between SendKey and RequestSeed, this is also used.

4.14.12.5 CommunicationControl (SID0x28)

This request message shall be used to enable/disable ECU(s) to transmit a type of CAN messages by a sub function parameter. A control type represents to enable/disable both or either normal (application) messages like switch status and/or network management messages like sleep/wakeup message. This SID is used only in Extended Diagnostic session. When one of the following conditions is met, CPEL2 enables to receive and transmit messages again.

1. Received SessionControl (SID0x10) with sub parameter "defaultSession"
2. 1 second session timeout in Programming Session and Extended Diagnostic session
6 3. ECUReset(SID0x11) – HardReset ~~or KeyOffOnReset~~

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Extended Diagnostic Session		
	PBL	Extended Diagnostic Session		
Prerequisite Condition(s)		DiagnosticSessionControl(SID0x10), SecurityAccess(SID0x27)		

Byte	Description	Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	0	**0x03**	
	Lower Nibble : Data Length	3		
2	Request Service ID	**0x28**		
3	Control Type	**0x00**	**0x01**	0x02 – 0x7F
		Enable Rx and enable Tx	Enable Rx and disable Tx	Not Supported
4	Communication Type	**0x01**	**0x02**	**0x03**
		Normal Communication messages	NM Communication messages	Both Normal and NM com. messages
		All the other byte data		
		Not Supported		
5-8	Unused Byte	-		

Note: The combination of sub parameter and communication type shows what type of messages shall be enabled/disabled to Tx/Rx.
1 Normal Communication Tx messages: DriveLightingRequest - CPEL2, ECUID without transport protocol - CPEL2, Software Identification - CPEL2, Cab Information Proprietary 1 - CPEL
NM Communication Tx messages: AuxiliaryWakeUpVisibility - CPEL2

Response message definition for SID0x28

Network Protocol Data Unit		Single Frame						
Byte	Description	Values(hex) of each Byte on response message						
		Positive Response			Negative Response			
1	Upper Nibble : PCI Type	0	**0x02**		0	**0x03**		
	Lower Nibble : Data Length	2			3			
2	Response Service ID	**0x68**			**0x7F**			
3	Echo of Control Type / Echo of Request Service ID	**0x01**	**0x02**	**0x03**	**0x28**			
4	Unused Byte / Response Code	**0xFF**			**0x12**	**0x13**	**0x22** 1	
					0x31	**0x7F**		
5-8	Unused Byte	**0xFF**						

Response Code 0x22: If CPEL2 requested to enable Tx during "disabled Tx by DM13," 0x22 is used in the response message.
Response Code 0x7F: This is used when CPEL2 receives SID0x28 in either Default Session or Programming Session.

1 2 Priority of message status between DM13 and Communication Control (SID0x28)

DM13	Communication Control	Action to be taken	Rx Timeout Monitor
Disable Tx	Don't care	Disable all CAN Tx	Enabled
Enable Tx	Disable Normal Msg	Disable Normal Msg	Enabled
	Disable NM Msg	Disable NM Msg	Enabled
	Enable Normal Msg	Enable all CAN Tx	Enabled
	Enable NM Msg		Enabled

4.14.12.6 WriteDataByIdentifier (SID0x2E)

This request consists of a DID and the related reprogramming data. Tester sends this when CPEL2 needs to reprogram the stored data indicated by data identifier (DID). Data length depends on a requested DID which has the defined data size. Please see the section 4.14.11 "Data Identifier "for the detail of DIDs including data length of each DID. No sub parameter is used on this request message.

5 Diagnostic request message definition for DID0xFD08 and DID0xFDA0 with Single Frame

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session		
	PBL	N/A		
Prerequisite Condition(s)		None		

Byte	Description	Values(hex) of each Byte on request message			
1	Upper Nibble : PCI Type	0	**0x04**	0	**0x05**
	Lower Nibble : Data Length	4		5	
2	Request Service ID	**0x2E**		**0x2E**	
3	Data ID(High byte)	**0xFD**		**0xFD**	
4	Data ID(Low byte)	**0x08**		**0xA0**	
5	DataRecord1	**0x0A**		**0x03**	
6	Unused Byte/ DataRecord2	**-**		**0xE8**	
7-8	Unused Byte	**-**		**-**	

Diagnostic request message definition for First Frame and Consecutive Frame

Addressing Type	Physical	Network Protocol Data Unit	First Frame and Consecutive Frame
Applicable Session	APP	Default Session	
	PBL	N/A	
Prerequisite Condition(s)		None	

Byte	Description		Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	First Frame	1	**0x10**	
	Lower Nibble : Data Length		0		
2	Data Length		**0x09 - 0x****		
3	Request Service ID		**0x2E**		
4	Data Identifier		**0xF187, ~~0xF18A~~ 0xF18B, 0xF18C, 0xF193,** 0xF195 **0xF197, 0xF198, 0xF199, 0xFD05-0xFD08, 0xFDA0** 1 3 4	all the other DIDs except the ones in the right cell	
5			See the section "Data Identifier ".	Not Supported	
6-8	Reprogramming Data		**Data0 – 2**		
9	Upper Nibble : PCI Type	CF	2	**0x21 -> 0x22 -> … -> 0x2F -> 0x20 -> 0x21 -> …**	
	Lower Nibble : Sequence Number		1-0		
10-n	Reprogramming Data / Unused Byte		**Data3 – m**		

Note: 1. Sequence Number shall first set to 0x1 and count up to 0xF. Then it shall roll back to 0x0.
2. Unused byte(s) in the last CF shall be filled up with 0xFF if there are some.

1 2 To reprogram the threshold levels for each percentage in DID0xFD05 through 0xFD08, the diagnostic request message with the following data format has been defined as follows.

Data Format for DID0xFD05 and 0xFD06

Msg Type	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
FF	0x10	2 0x0D	0x2E	0xFD	1 0x05 or 0x06	Thrsh val for 10%	Thrsh val for 20%	Thrsh val for 30%
CF	0x21	Thrsh val for 40%	Thrsh val for 50%	Thrsh val for 60%	Thrsh val for 70%	Thrsh val for 80%	Thrsh val for 90%	Thrsh val for 100%

For example, the received data "Thrsh val for 30%" at Byte8 in FF is 77 in decimal value, then the corresponding threshold level shall be rewritten to 77. If the default value is still used for 30%, 45 shall be rewritten to 77.

1 Data Format for DID0xFD07

Msg Type	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
FF	0x10	2 0x0D	0x2E	0xFD	0x07	Thrsh val for 1 lx	Thrsh val for 10 lx	Thrsh val for 50 lx
CF	0x21	Thrsh val for 100 lx	Thrsh val for 500 lx	Thrsh val for 1000 lx	Thrsh val for 5000 lx	Thrsh val for 10000 lx	Thrsh val for 50000 lx	Thrsh val for 100000 lx

~~Note: When the table data for 0xFD05 through 0xFD07 are updated, the updated threshold values shall be used to calculate a PWM duty from the next PWM duty cycle.~~

5 2 Data Format for DID0xFD08

Msg Type	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
SF	0x04	0x2E	0xFD	0x08	Number of Sampling	0xFF	0xFF	0xFF

Note: When the data for 0xFD08 is updated, the updated number of sampling shall be applied from the next average calculation using the values for "AmbientLightDriverSide" signal before resolution adjustment.

4 Note: If the requested "Number of Sampling" is 0x00 or a value more than 0x64 (100), CPEL2 shall reply Negative Response with NRC 0x22.

Response message definition for SID0x2E

Network Protocol Data Unit		Single Frame						
Byte	Description	Values(hex) of each Byte on response message						
		Positive Response			Negative Response			
1	Upper Nibble : PCI Type	0	1 **0x03**		0	**0x03**		
	Lower Nibble : Data Length	3			3			
2	Response Service ID	**0x6E**			**0x7F**			
3	Echo of Data Identifier Upper Byte / Echo of Request Service ID	1 **0xF187, ~~0xF18A~~ 0xF18B, 0xF18C, 0xF193, ~~0xF195~~ 0xF197, 0xF198, 0xF199, 0xFD05-0xFD08, 0xFDA0**			1 **0x2E**			
4	Echo of Data Identifier Lower Byte / Response Code				2 **0x13** 3 4 **0x72**	**0x22** **0x78**		**0x31** **0x7F**
5-8	Unused Byte	**0xFF**						

~~Response Code 0x13: This is used when a received data length doesn't match with a defined data length for the received DID.~~
Response Code 0x31: This is used when CPEL2 receives a DID which CPEL2 doesn't support.
Response Code 0x78: This is transmitted once before starting to erase flash area or to calculate the checksum and then shall be transmitted arbitrarily within 1000ms before Tester detects the Rx timeout with 1000ms.

1

Note: Since Flow Control is not permitted for this SID, the communication sequence for SID0x2E is that First Frame is sent first and Consecutive Frame follows after First Frame. If CPEL2 receives a DID on First Frame that CPEL2 doesn't support, CPEL2 shall send the negative response after the first Consecutive Frame.

1

3 Note: If SID0x2E is requested during "stay in PBL", PBL shall reply a negative response with NRC0x7F.

4.14.12.7 RoutineControl (SID0x31)

This SID is used to request CPEL2 to start a routine specified by Routine Identifier either memory erase routine or consistency check in a part of flash reprogramming sequence. If the requested memory erase is failed due to an error, a negative response with NRC 0x72 is replied. If the requested consistency check is failed, CPEL2 shall send a negative response message with NRC0x72 back to Tester and stay in PBL. If the consistency check is successfully completed, PBL writes Magic Number 0x545223DE and the 2's compliment to 0x1FFFC through 0x1FFFF and 0x08000 through 0x08003 respectively before sending a positive response. The Magic Number is held in PBL.

1

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	N/A		
	PBL	Programming Session		
Prerequisite Condition(s)		SecurityAccess service(SID0x27) – "SendKey" for Programming Session		

Byte	Description	Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	0	**0x04**	
	Lower Nibble : Data Length	4		
2	Request Service ID	**0x31**		
3	Sub Function Parameter	**0x01**	**0x03**	0x00, 0x02, 0x04 –0x7F
		Start Routine specified by Routine Identifier	Request Routine Results specified by Routine ID	Not Supported
4	Routine Identifier(High byte)	**0xFF00** EraseMemory	**0xFF01** CalculateChecksum	
5	Routine Identifier(Low byte)			
6-8	Unused Byte	-		

Response message definition for SID0x31

Network Protocol Data Unit	Single Frame

Byte	Description	Values(hex) of each Byte on response message				
		Positive Response		Negative Response		
1	Upper Nibble : PCI Type	0	**0x04**	0	**0x03**	
	Lower Nibble : Data Length	4		3		
2	Response Service ID	**0x71**		**0x7F**		
3	Echo of Sub Function Parameter / Request Service ID	**0x01**	**0x03**	**0x31**		
4	Echo of RoutineID(High byte) / Response Code	**0xFF00** RequestToEraseMemory		**0x12**	**0x13**	**0x31**
				0x72	**0x78**	**0x7F**
5	Echo of Routine ID(Low byte) / Unused Byte	**0xFF01** RequestToCalculateChecksum		**0xFF**		
6-8	Unused Byte	**0xFF**				

Response Code 0x31: This is used when CPEL2 doesn't support the received routine identifier.
Response Code 0x72: This is used when CPEL2 failed to write flash memory area, erase flash memory area or detected a checksum error in PBL.
Response Code 0x78: This is transmitted once before starting to erase flash area or to calculate the checksum and then shall be transmitted arbitrarily within 1000ms before Tester detects the session timeout (1000ms).

1

4.14.12.8 RequestDownload(SID0x34)

This service is used to trigger a data transfer and indicate a starting address that the transferred data shall be flashed and a memory size to be transferred from the starting address. The response shall include the information of how many data bytes CPEL2 can receive in the parameter "MaxNumberOfBlockLength." This is used every time when Tester sends a segmented data to CPEL2.

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	First Frame and Consecutive Frame
Applicable Session	APP	N/A		
	PBL	Programming Session		
Prerequisite Condition(s)		SecurityAccess service(SID0x27) – "SendKey" for Programming Session		

Byte	Description		Values(hex) of each Byte on request message	
1	Upper Nibble : PCI Type	First Frame	1	**0x10**
	Lower Nibble : Data Length		0	
2	Data Length		**0x09**	
3	Request Service ID		**0x34**	
4	Data Format Identifier		**0x00**	
5	Upper Nibble : Memory Size Parameter		3	**0x33**
	Lower Nibble : Memory Address Parameter		3	
6	Starting Address (Most Significant Byte)		**0x****	
7	Starting Address		**0x****	
8	Starting Address (Least Significant Byte)		**0x****	
9	Upper Nibble : PCI Type	Consecutive Frame	2	**0x21**
	Lower Nibble : Sequence Number		1	
10	Memory Size (Most Significant Byte)		**0x****	
11	Memory Size		**0x****	
12	Memory Size (Least Significant Byte)		**0x****	
13-16	Unused Byte		**-**	

Memory Size Parameter: The number with 4 bit length is used as the data length for Starting Address.
E.g. Memory Size Parameter = 3 -> Starting Address = 0x00 40 00
E.g. Memory Size Parameter = 2 -> Starting Address = 0x 40 00
Memory Address Parameter: The number with 4 bit length is used as the data length for Memory Size.
E.g. Memory Address Parameter = 4 -> Starting Address = 0x00 00 01 FF
E.g. Memory Address Parameter = 2 -> Starting Address = 0x 01 FF

Response message definition for SID0x34

Network Protocol Data Unit	Single Frame

Byte	Description	Values(hex) of each Byte on response message				
		Positive Response		Negative Response		
1	Upper Nibble : PCI Type	0	**0x04**	0	**0x03**	
	Lower Nibble : Data Length	4		3		
2	Response Service ID	**0x74**		**0x7F**		
3	Length Format Parameter / Request Service ID	**0x20**		**0x34**		
4	MaxNumberOfBlockLength(High) / Response Code	**0x** (Most Significant Byte)**		**0x13**	**0x22**	**0x31**
				0x33	**0x70**	**0x7F**
5	MaxNumberOfBlockLength(Low) / Unused Byte	**0x** (Least Significant Byte)**		**0xFF**		
6-8	Unused Byte	**0xFF**				

"MaxNumberOfBlockLength" means the max data size CPEL2 can receive by one transfer sequence including "Service ID" 1(byte) and "BlockSequenceNumber" (1 byte).
E.g. "MaxNumberOfBlockLength" = 1026 bytes = "Rx buffer of CPEL2 is 1024 bytes" + "Service ID" and "BlockSequenceNumber".
△5 Response Code 0x22: This is used when CPEL2 receives SID0x34 in any sessions ~~in APP~~ other than Programming Session in PBL.
Response Code 0x33: This is used when CPEL2 receives SID0x34 without unlocking programming session.
Response Code 0x70: This is used when CPEL2 failed to download received data to flash memory area.
△5 Response Code 0x7F: This is used when CPEL2 receives SID0x34 ~~other than Programming Session in PBL~~ in APP.

4.14.12.9 TransferData (SID0x36)

This is used to transfer data segments from Tester to CPEL2. This service includes a Block Sequence Counter and it is used as a sequence number of multiple TransferData requests (Consecutive Frame). It always starts counting up from 0x01. After CPEL2 received a segmented reprogramming data, it shall first check if Over/Undervoltage occurs or not. If detected, CPEL2 shall send a negative response with 0x92/0x93. Otherwise, it sends a negative response with 0x78 once before starting flash reprogramming. Then, after reprogrammed the segmented data, CPEL2 shall send either a positive response with echo of the received Block Sequence Counter or a negative response with a negative response code. 1

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	First Frame and Consecutive Frame
Applicable Session	APP	N/A		
	PBL	Programming Session		
Prerequisite Condition(s)		SecurityAccess service(SID0x27) – "SendKey" for Programming Session		

Byte	Description			Values(hex) of each Byte on request message
1	Upper Nibble : PCI Type	First Frame	1	**0x1***
	Lower Nibble : Data Length		*	
2	Data Length			**0x****
3	Request Service ID			**0x36**
4	Block Sequence Counter			**0x01 -> 0x02 -> ... -> 0xFE -> 0xFF -> 0x00 -> 0x01 -> ...**
5-8	Transferring Data 0-3			**0x****
9	Upper Nibble : PCI Type	CF	2	**0x21 -> 0x22 ... 0x2F -> 0x20 -> 0x21 ...**
	Lower Nibble : Sequence Number		1 - 0	
10-n	Transferring Data 4-m			**0x****

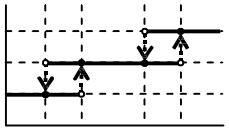
Note:
1. The size of transferring data m at Byte n depends on the data length on First Frame.
2. Block Sequence Counter shall always be 0x01 for the first transfer sequence and be incremented at the next of transfer sequence. When it reaches 0xFF, it shall roll back to 0x00.
3. Unused byte(s) in the last CF shall be filled up with 0xFF if applicable.

Response message definition for SID0x36

Network Protocol Data Unit		Single Frame					
Byte	Description	Values(hex) of each Byte on response message					
		Positive Response		Negative Response			
1	Upper Nibble : PCI Type	0	**0x02**	0	**0x03**		
	Lower Nibble : Data Length	2		3			
2	Response Service ID	**0x76**		**0x7F**			
3	Echo of Block Sequence Counter / Request Service ID	**0x01 -> 0x02 -> ... -> 0xFF -> 0x00 -> 0x01 -> ...**		**0x36**			
4	Unused byte / Response Code	**0xFF**		**0x13**	**0x22**	**0x24**	**0x72**
				0x73	**0x78**	**0x7F**	**0x92**
				0x93			
5-8	Unused Byte	**0xFF**					

Response Code 0x24: This is used when CPEL2 receives SID0x36 before receiving RequestDownload (SID0x34).
Response Code 0x72: This is used when CPEL2 failed to reprogram the received data to flash memory area.
Response Code 0x73: This is used when CPEL2 received an incorrect Block Sequence Counter. It has to be in sequence.
Response Code 0x7F: This is used when CPEL2 receives SID0x36 in any sessions in APP.
Response Code 0x92: This is used when CPEL2 detects overvoltage range error during flash reprogramming.
Response Code 0x93: This is used when CPEL2 detects undervoltage range error during flash reprogramming.

Power Supply Voltage Conditions		Threshold voltage	A/D value 1 2
Under Voltage	X1	Detected at 10V or less	~~262~~ 254
	X2	Recovered at 11.5V or more	~~301~~ 292
Over Voltage	X3	Recovered at 34V or less	~~892~~ 865
	X4	Detected at 35.5V or more	~~932~~ 903



A/D software filter time: 2ms x 11 times

4.14.12.10 TransferExit (SID0x37)

This is sent by Tester to terminate a sequence of a data transfer after SBL data transferring or a segment of flash reprogramming data has been completed without any errors.

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	N/A		
	PBL	Programming Session		
Prerequisite Condition(s)		SecurityAccess service(SID0x27) – "SendKey" for Programming Session		

Byte	Description	Values(hex) of each Byte on request message	
1	Upper Nibble : PCI Type	0	**0x01**
	Lower Nibble : Data Length	1	
2	Request Service ID	**0x37**	
3-8	Unused Byte	**-**	

Response message definition for SID0x37

Network Protocol Data Unit		Single Frame					
Byte	Description	Values(hex) of each Byte on response message					
		Positive Response		Negative Response			
1	Upper Nibble : PCI Type	0	**0x01**	0	**0x03**		
	Lower Nibble : Data Length	1		3			
2	Response Service ID	**0x77**		**0x7F**			
3	Unused Byte / Request Service ID	**0xFF**		**0x37**			
4	Unused Byte / Response Code	**0xFF**		**0x13**	**0x24**	**0x71**	**0x7F**
5-8	Unused Byte	**0xFF**					

Response Code 0x24: This is used if CPEL2 has not completed reprogramming when SID0x37 is requested or if this service is requested before RequestDownload (SID0x34).

Response Code 0x71: This is used if CPEL2 has not received all the segmented data block for reprogramming when SID0x37 is requested.

Response Code 0x7F: This is used when CPEL2 receives SID0x37 in any sessions in APP.

4.14.12.11 TesterPresent (SID0x3E)

This is used to prevent from a communication lost between CPEL2 and Tester. If CPEL2 doesn't receive this service ID within every 1000ms in Extended Diagnostic Session or Programming session, all the diagnostic services shall be deactivated and go back to Default session (Session Timeout). A negative response for 1000ms timeout shall be transmitted with the response code 0x10. If the sub parameter is 0x80, then CPEL2 shall not send a positive response. However, a negative response can be sent even if the sub parameter is 0x80.

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session, Extended Diagnostic Session		
	PBL	Default Session, Extended Diagnostic Session, Programming Session		
Prerequisite Condition(s)		None		

Byte	Description	Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	0	**0x02**	
	Lower Nibble : Data Length	2		
2	Request Service ID	**0x3E**		
3	Sub Function Parameter		**0x80**	0x01 – 0x7F
			No response is required	Not Supported
4-8	Unused Byte	-		

Response message definition for SID0x3E

Network Protocol Data Unit	Single Frame

Byte	Description	Values(hex) of each Byte on response message		
		Positive Response	Negative Response	
1	Upper Nibble : PCI Type		0	**0x03**
	Lower Nibble : Data Length		3	
2	Response Service ID		**0x7F**	
3	Sub Function Parameter / Request Service ID		**0x3E**	
4	Unused Byte / Response Code		**0x12**	**0x13**
5-8	Unused Byte		**0xFF**	

4.14.12.12 OnChipMemoryControl (SID0xA5)

1 This is used to erase either the fixed or rotational blocks in the data flash area. Only when the password Tester sent is correct, the requested block shall be erased. ~~All the rotational blocks shall not be erased by this SID.~~ Normally, it takes 200ms to 300ms to erase the fixed block with 1K bytes. The response message shall be transmitted after the block erase has been completed successfully or failed.

Diagnostic request message definition

Addressing Type		Physical	Network Protocol Data Unit	Single Frame
Applicable Session	APP	Default Session		
	PBL	-		
Prerequisite Condition(s)		-		

Byte	Description	Values(hex) of each Byte on request message		
1	Upper Nibble : PCI Type	0	**0x06**	
	Lower Nibble : Data Length	6 1		
2	Request Service ID	**0xA5**		
3	Sub Function Parameter	**0x10**	**0x20** 1	all the other 1 byte data
		EraseFixedBlock	EraseRotationalBlock	Not Supported
4	Password	For 0x10 2	**0x54**	For 0x20 2 **0xDE**
5			**0x52**	**0x23**
6			**0x23**	**0x54**
7			**0xDE**	**0x52**
8	Unused Byte	-		

Response message definition for SID0xA5

Network Protocol Data Unit		Single Frame				
Byte	Description	Values(hex) of each Byte on response message				
		Positive Response		Negative Response		
1	Upper Nibble : PCI Type	0	**0x02**	0	**0x03**	
	Lower Nibble : Data Length	2 2		3		
2	Response Service ID	**0xE5**		**0x7F**		
3	Sub Function Parameter / Request Service ID 1	**0x10**	**0x20**	**0xA5**		
4	Unused Byte / Response Code	**0xFF**		**0x11** 1	**0x12**	**0x13** **0x22**
				0x35 2	**0x72**	**0x7F** 1 **0x78** 5
5-8	Unused Byte	**0xFF**				

Response Code 0x11: This is used if PBL receives the password is incorrect and this shall not be used in APP.

5 Response Code 0x22: This is used ~~if the received password is incorrect.~~ when unsupported sub function parameter is received, DataFlash is busy or Data Flash rejected the erase request.

Response Code 0x72: This is used if the fixed block erase has failed.

5 Response Code 0x35: This is used if the received password ~~for all the sub parameters~~ is incorrect.

4.15 Flash Reprogramming Function

This section defines the flash reprogramming method.

4.15.1 Requirement for Flash Reprogramming

1. File format to be flash-reprogrammed (downloaded) shall be Motorola S-format with S2 data record type (24 bit address).
2. Unused byte(s) in a response message shall be filled up with 0xFF.
3. The downloading file must include a checksum data and 2's compliment of the checksum data at a specific address for consistency check after downloaded.
4. During reprogramming, only reprogramming related CAN messages shall be transmitted on the bus.
5. For consistency check, a checksum calculated by reprogrammed data in ROM area, a checksum calculated by reprogramming data and a checksum data at 0x1FFF0 are compared each other.
6. The system must be able to communicate with a diagnostic communication for the next flash reprogramming even after flash reprogramming has been failed.(e.g. Rx Timeout, Bus off, Power shut down)
7. The system must be able to reset by diagnostic messages with a defined communication sequence.
8. The system shall support 500kbps for flash reprogramming.

4.15.2 Performance Parameters/results to be submitted to Tokai Rika

The following requirements/parameters with worst and regular cases shall be monitored.

1. Flow chart for software download with service IDs and sub parameters between Tester and CPEL2.
2. Communication sequence (log) with comments for each services IDs and the responses from CPEL2.
3. Time interval to be able to access to a diagnostic service in Inactive Mode after power-on.
4. Time interval to be able to access to a diagnostic service in Inactive Mode after wake up.
5. Time interval to be able to access to a diagnostic service in Normal Operation Mode after wake up.
6. Time interval from "received ECUReset" to "the end of initialization" after wake up.
7. Memory Erase rate (kbyte/s) and time to erase required ROM area (Block2-5).
8. Data download rate (kbyte/s)
9. Duration time for ECU checksum verification at the end of download process.
10. Response time for each diagnostic message from the completion of a message reception to the settings on registers to transmit a positive/negative message.
11. Duration time for the entire download process from Rx of DiagnosticSessionControl until just before software reset.
12. CAN baud rate (kbps) used for the above performance test.
13. Every time software is downloaded, all the recorded DTCs shall be erased by the end of reprogramming.

4.15.3 Structure of Flash Boot Loader (PBL)

Flash boot loader is composed of Primary Boot Loader (PBL) and Secondary Boot Loader (SBL). PBL shall be located in flash ROM memory from 0x0C000 to 0x0FFFF and shall never be erased in the system lifetime. SBL shall be transferred from Tester to CPEL2 via CAN communication and located in RAM memory from 0x00460 up to 0x013FF.

4.15.4 Function of Primary Boot Loader and Secondary Boot Loader

PBL has a function to receive diagnostic service messages, erases flash ROM area from 0x08000 to 0x1FFFF except the area for itself, stores SBL data separated in a few different CAN segment messages and stores one of segmented blocks of the entire reprogramming data to their designated RAM memory. Once PBL has received one of segmented blocks, the control jumps from PBL to SBL. SBL has a function to reprogram the transferred data to flash ROM memory. Once SBL completed to reprogram a data block, the control jumps from SBL back to PBL to receive the next segmented data blocks of reprogramming data. To reprogram entire flash ROM memory, the control jumps back and forth between PBL and SBL several times.