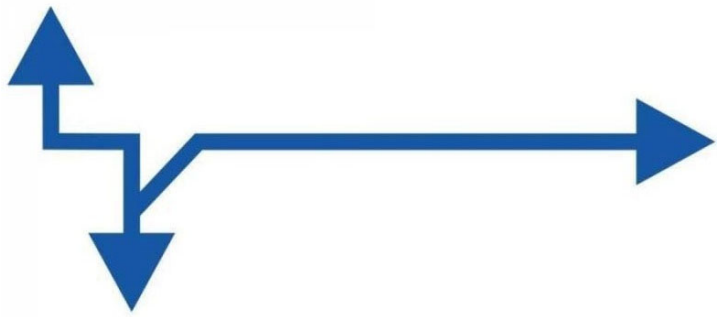
JetCat serial interface description
V12-ECU and PRO-engines
<< Binary protocol >>



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General

The JetCat ECU can support two types of serial protocols. The standard ASCII protocol (since 1998) and the new binary protocol (2019).
This document describes the binary protocol.
Which protocol is used by the ECU can be set in the Limits menu under parameter “Serial Protocol type” .

Bus topology

The serial interface of the JETCAT ECU facilitates remote access of all controller functions as well as readout and change of all system parameters.

A special daisy chaining feature facilitates chaining multiple ECU’s via their serial interfaces only through one Host-interface.

To set-up a daisy-chain, the transmit line (TxD) of the host is connected to the receive line (RxD) of the first ECU. The transmit line of this ECU is then connected to the receive line of the next ECU in the chain. The transmit line of the last ECU in the chain is returned to the receive line of the host, which closes the link and forms the ring connection.

To address a specific ECU in a daisy-chain, each ECU carries a so-called Slave Address, which can be any number from 1 to 255 (default setting: 1). The slave address “0” is the general call address on which all ECU´s would respond.

Although possible, it is recommended that daisy chained ECU´s will be set to different slave addresses for easy identification by the host.

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Baud rate, data format

The Baud rate of the serial interface can be user set to baud rates ranging from 4800 to 115200

Depending on hardware setup, the serial interface works on 3,3V TTL level or RS232 level (+/-12V).

Default is 3,3V TTL level (5V TTL compatible)

Parameters of the serial interface:

baud rate:	4800-115000 baud	(9600 default)
data bits:	8	
parity:	none	
stop bits:	1	
default slave address:	1	

Slave address, baud rate and protocol type can be set with the GSU in the Limits menu.

Important:
When using the binary protocol type, the baud rate should be set at least to **115000** baud, otherwise bandwidth might be too small!

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Control Modes

The ECU allows engine control (start/stop/rpm commanding) via several control sources:

- PWM: Servo PWM signal (Throttle and AUX channels).
- GSU: Ground support unit, if connected.
- COM: Serial interface (described in this document)
- CAN: CAN-BUS interface

Therefore, different control modes are defined as follows:
PWM control mode: Default when engine is not running or is controlled via PWM signals.
EXT control mode: Default when engine has been commanded to start either via a GSU keyboard command or a command sent via the serial interface (COM), or via a command sent via the CAN-bus interface.
COM control mode: In this mode, commands will only be accepted via the COM serial interface and GSU.
CAN control mode: In this mode, commands will only be accepted via the CAN-Bus interface and GSU.
GSU control mode: In this mode engine control is only possible through the ground support unit.

Table 1, Control Modes:

	Matrix for allowed control sources, depending on control mode and engine state (=not running/running or starting up)			
Control mode	**Engine Start** (engine not yet started or running)	**Engine Stop** (engine was started or is running)	**Engine setpoint control** (engine running)	**Change of control mode after engine has been started**
PWM control (2)	PWM, GSU, COM, CAN	PWM, GSU	PWM	GSU, COM, CAN
EXT control (3)	Not defined	GSU, COM, CAN	GSU, COM, CAN	GSU, COM, CAN
COM control (4)	Not defined	COM, GSU	COM, GSU	COM, GSU
CAN control (5)	Not defined	CAN, GSU	CAN, GSU	CAN, GSU
GSU control (6)	Not defined	GSU	GSU	GSU

Whenever the engine is off/not running, the control mode is automatically set to “PWM control mode”. This basically allows all control sources to take engine control by starting the engine.
Depending on the source from which the engine start command came in first, the system would either stay in PWM control mode (when engine start has been commanded via valid PWM signal/sequence) or will switch into EXT control mode if the engine has been started via commands given by either GSU, COM or CAN interface.
Once in EXT control mode, there are commands available to switch to COM control mode, which would actively disable any commanding coming in via the CAN-Bus interface.
For basic serial communication applications, this command mode switching however is not required, as in EXT control mode, commands coming in via the serial interface would also be processed.

In all control modes manual GSU override control is possible.
GSU control mode can be activated/switched by a special key sequence on the GSU keyboard

CAN control mode can only be activated through the CAN-Bus interface with dedicated commands.

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JetCat Data Link Layer protocol definition

All data which is sent or received through the serial interface is sent in packets.

Each data packet is framed according to Point-to-Point Protocol (PPP, data link layer protocol)

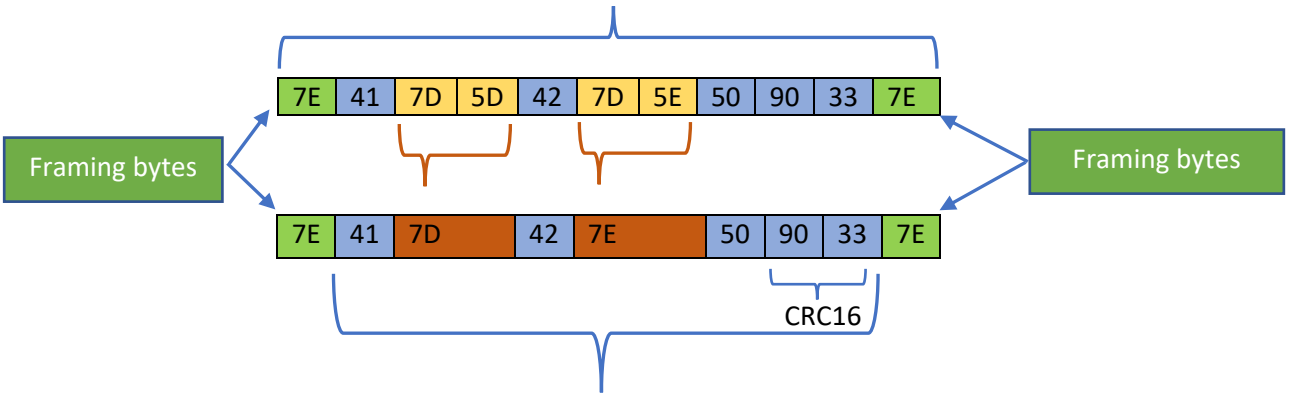
With this, each data packet is framed with fixed framing characters. The framing character is defined as **0x7E**. For this reason, the framing character itself must not be present in the data packet itself!
To achieve this, a simple encoding / encoding algorithm of the data stream is done via “byte stuffing” further explained in appendix A).

Typically, a receiving task on the user side would scan the raw data received until a framing character has been detected. This is the signal that a data packet is finished, and the prior received data can be processed. All other bytes received up to this point (except the framing character) had been decoded and stored into an input buffer according to the scheme explained in appendix A).

Once a data packet has been received, it can be checked for correct CRC. For this a CRC16 checksum is added into the last two bytes of a data packet. The CRC16 checksum is calculated from byte(1) to byte(x-2), whereas “x” is the number of bytes received in a data packet (x= number of bytes between the framing characters). The calculation of the checksum is according to CCITT and described in appendix B).

Example:

Raw data bytes received or sent from ECU (all data in hexadecimal format).



This is the final data packet, after unstuffing, with x=7 bytes. The last two bytes are the CRC16 checksum which was calculated over Byte1 to Byte5.

Once a data packet is received, CRC checksum can be calculated over the received data and then verified against the checksum which was received in the data packet. If checksums are matching the data packet is valid and can be forwarded for further decoding.

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Network Layer packet definition

Data types/data interpretation

Name	Size (Bit)	Size (Bytes)	Sign	Range min	Range max	Decimals
int8_t	8	1	Signed	-128	127	3
uint8_t	8	1	Unsigned	0	255	3
int16_t	16	2	Signed	-32768	32767	5
uint16_t	16	2	Unsigned	0	65535	5
int32_t	32	4	Signed	-2147483648	2147483647	10
uint32_t	32	4	Unsigned	0	4294967295	10

Network Layer Data packet structure

	Byte No	Description	Data type	Range	Note
Header	1	Engine Address (Slave Address)	uint8_t	0-255	Address of engine to be accessed
	2-3	Message Descriptor	uint16_t	0x0000-0xFFFF	See table with available/valid descriptors
	4	Sequence No	uint8_t	0-255	Used for simple handshaking, data flow checking
	5	Data byte count/length	uint8_t	0-249	Number of data bytes (n) in packet.
Payload	6	Data Byte 1	Depends on MessageType		
	7	Data Byte 2	Depends on MessageType		
	8	Data Byte 3	Depends on MessageType		
	…	…			
	5+n	Data Byte n	Depends on MessageType		
Checksum	6+n and 7+n	CRC16	uint16_t	0… 0xFFFF	CRC 16 CCITT; Calculated over Byte(1) through Byte(n+5)

With this format, a valid data packet at least contains a minimum of 7 Bytes(for n=0) and up to a maximum of 255 Bytes (for n=248).

The sequence number (Byte #4) can be used by the host to identify and match responses of the ECU to send messages. Typically, the host would increment the sequence number with every message sent. The ECU would copy this number into its own messages sent back on a frequent basis. By this the host can easily verify that messages are decoded and passing through to the ECU, without adding other means of more complex handshaking.

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Messages emitted by ECU

The ECU will emit message packets on a fixed rate defined with the message descriptor.

Per default messages with message descriptor ranging from 0x0001 to 0x0006 are enabled to be emitted after ECU boot up. If this is not desired, individual (or all) messages can be turned on/off via command message **0x010D.**

Engine live data message 1

Message descriptor	Rate	Description	No of data bytes in message	
0x0001	10Hz	ECU-Real data message #1	46	Turned off by default
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Setpoint rpm	uint16_t	10x RPM	0-300000 RPM
3-4	Setpoint in %	uint16_t	0.01 %	0..100.00%
5-6	Actual rpm	uint16_t	10x RPM	0-300000 RPM
7-8	Actual rpm in %	uint16_t	0.01 %	0..100.00%
9-10	Exhaust Temp (EGT)	int16_t	0.1 x °C	-30.0°C to +1100°C
11-12	Pump Volts (setpoint)	int16_t	0.01 x V	-30.00 to +30.00 V Negative values reflect pump reverse operation
13-14	Pump Volts (real)	int16_t	0.01 x V	-30.00 to +30.00 V Neg. values= reverse operation
15-16	Fuel Flow	uint16_t	1 x ml/min	0… 65535 ml/min
17-18	FuelConsumed	uint16_t	10 x ml	0-655350 ml
19	Remain Fuel%	uint8_t	0.5%	0..100.0%
20-21	Thrust corrected	int16_t	0.1x N	0-6553.5 N
22	Thrust%	uint8_t	0.5%	0..100.0%
23	State	uint8_t	1	Engine state according to table 2
24-25	Battery Volts	uint16_t	0.01 x V	0-35.00V
26	Battery Volt level %	uint8_t	0.5%	0..100.0%
27-28	BattCapa mAh	uint16_t	1 x mAh	0-65535mAh
29	BattCapa level %	uint8_t	0.5%	0..100.0%
30-31	Battery current	int16_t	0.01 x A	-80.00 to +80.00A Negative values reflect battery discharge; Positive values battery charge
32-33	Generator Volts	uint16_t	0.01 x V	0-120.00V
34-35	Generator Amps	uint16_t	0.01 x A	0-80.00A
36-37	Airspeed	uint16_t	0.1 km/h	0-650.0 km/h
38-39	Pressure Altitude	int16_t	0.1m	-500.0 to +12000.0m
40-41	Ambient pressure	uint16_t	0.02 mbar	0-1300.00mbar
42	Command Mode	uint8_t	1	Tells from which source setpoint is controlled. See table3
43-44	PWM-THR channel	uint16_t	0.1 x µs	0-3000µs
45-46	PWM-AUX channel	uint16_t	0.1 x µs	0-3000µs

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Engine live data message 1

Message descriptor	Rate	Description		No of data bytes in message	
0x0001	10Hz	ECU-Real data message #1		26	Turned on by default
Data Byte #	**Parameter**		**Data interpretation**	**Scale**	**Range**
1-2	Setpoint rpm		uint16_t	10x RPM	0-300000 RPM
3-4	Setpoint in %		uint16_t	0.01 %	0..100.00%
5-6	Actual rpm		uint16_t	10x RPM	0-300000 RPM
7-8	Actual rpm in %		uint16_t	0.01 %	0..100.00%
9-10	Exhaust Temp (EGT)		int16_t	0.1 x °C	-30.0°C to +1100°C
11-12	Pump Volts (setpoint)		int16_t	0.01 x V	-30.00 to +30.00 V Negative values reflect pump reverse operation
13-14	Pump Volts (real)		int16_t	0.01 x V	-30.00 to +30.00 V Neg. values= reverse operation
15	State		uint8_t	1	Engine state according to table 1
16-17	Battery Volts		uint16_t	0.01 x V	0-35.00V
18	Battery Volt level %		uint8_t	0.5%	0..100.0%
19-20	Battery current		int16_t	0.01 x A	-80.00 to +80.00A Negative values reflect battery discharge; Positive values battery charge
21-22	Airspeed		uint16_t	0.1 km/h	0-650.0 km/h
23-24	PWM-THR channel		uint16_t	0.1 x µs	0-3000µs
25-26	PWM-AUX channel		uint16_t	0.1 x µs	0-3000µs

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Engine live data message 2

Message descriptor	Rate	Description		No of data bytes in message	
0x0002	1Hz	ECU-Real data message #1		20	Turned off by default
Data Byte #	**Parameter**		**Data interpretation**	**Scale**	**Range**
1-2	Fuel Flow		uint16_t	1 x ml/min	0… 65535 ml/min
3-4	FuelConsumed		uint16_t	10 x ml	0-655350 ml
5	Remain Fuel%		uint8_t	0.5%	0..100.0%
6-7	Thrust corrected		int16_t	0.1x N	0-6553.5 N
8	Thrust%		uint8_t	0.5%	0..100.0%
9-10	BattCapa mAh		uint16_t	1 x mAh	0-65535mAh
11	BattCapa level %		uint8_t	0.5%	0..100.0%
12-13	Generator Volts		uint16_t	0.01 x V	0-120.00V
14-15	Generator Amps		uint16_t	0.01 x A	0-80.00A
16-17	Pressure Altitude		int16_t	0.1m	-500.0 to +12000.0m
18-19	Ambient pressure		uint16_t	0.02 mbar	0-1300.00mbar
20	Command Mode		uint8_t	1	Tells from which source setpoint is controlled. See table3

Engine live data message 3, two-shaft engines only (Turboprops/Turboshafts)

Message descriptor	Rate	Description		No of data bytes in message	
0x0003	5Hz	ECU-Real data message #2, Two-Shaft engines only!		14	Turned off by default
Data Byte #	**Parameter**		**Data interpretation**	**Scale**	**Range**
1-2	Setpoint rpm2		uint16_t	2 x RPM	0-130000 RPM
3-4	Setpoint rpm2 in %		uint16_t	0.01 %	0..100.00%
5-6	Internal Setpoint rpm2		uint16_t	2 x RPM	0-130000 RPM
7-8	Actual rpm2		uint16_t	2 x RPM	0-130000 RPM
9-10	Actual rpm2 in %		uint16_t	0.01 %	0..100.00%
11-12	Rotor/Prop RPM		uint16_t	0,5 x Rpm	0.. 32767 RPM
13-14	Tail rotor Rpm		uint16_t	1 x Rpm	0… 65535 RPM

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Engine health check / warnings message

Message descriptor	Rate	Description		No of data bytes in message	
0x0004	0,5Hz	Engine status message		11	Turned off by default
Data Byte #	**Parameter**		**Data interpretation**	**Scale**	**Range**
1	Starter Health Flag		uint8_t	1	Bitfield
2	MainV Health Flag		uint8_t	1	Bitfield
3	GasV Health Flag		uint8_t	1	Bitfield
4	RpmSns Health Flag		uint8_t	1	Bitfield
5	Pump Health Flag		uint8_t	1	Bitfield
6	Ignitor Health Flag		uint8_t	1	Bitfield
7	EGT Health Flag		uint8_t	1	Bitfield
8-9	Warnings		uint16_t	1	Bitfield
10-11	Expansion		uint16_t	1	For later use

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Message with Last-Off Condition information

Message descriptor	Rate	Description		No of data bytes in message	
0x0005	1Hz	Last Off Conditions		10	Turned off by default
Data Byte #	**Parameter**		**Data interpretation**	**Scale**	**Range**
1	Last OFF Condition		uint8_t	1	Off condition according to table
2-3	Last Run Time		uint16_t	1 x seconds	0-65535s
4-5	Last OFF Rpm		uint16_t	10x RPM	0-300000 RPM
6-7	Last OFF EGT		int16_t	0.1 x °C	-30.0°C to +1100°C
8-9	Last Off Pump		int16_t	0.01 x V	-30.00 to +30.00 V Negative values reflect pump reverse operation
10	LastOffState		uint8_t	1	State according to table 1

Message with engine information, statistics

Message descriptor	Rate	Description		No of data bytes in message	
0x0006	0,25Hz	Engine information		22	Turned off by default
Data Byte #	**Parameter**		**Data interpretation**	**Scale**	**Range**
1-2	Firmware number		uint16_t	0.01	Firmware release code
3-4	Serial number		uint16_t	1	Serial number
5	Engine Type		uint8_t	1	Code identifying engine type
6	Engine OEM code		uint8_t	1	Code identifying OEM type
7-8	Hardware code		uint16_t	1	Code hardware definition
9-10	Total RunTime		uint16_t	1 x minutes	0-65535minutes
11-12	Runs OK		uint16_t	1	
13-14	Runs aborted		uint16_t	1	
15-16	Ignitions ok		uint16_t	1	
17-18	Ignitions failed		uint16_t	1	
19-20	Starts failed		uint16_t	1	
21-22	LoBattCutOut's		uint16_t	1	

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Special message for OEMs

Message descriptor	Rate	Description	No of data bytes in message	
0x000A	10Hz	ECU-Real data message, special version for customer	18	Turned off by default

Data Byte #	Parameter	Data interpretation	Scale	Range
1-2	Setpoint rpm	uint16_t	10x RPM	0-300000 RPM
3-4	Actual rpm	uint16_t	10x RPM	0-300000 RPM
5-6	Exhaust Temp (EGT)	int16_t	0.1 x °C	-30.0°C to +1100°C
7-8	Pump Volts (real)	int16_t	0.01 x V	-30.00 to +30.00 V Neg. values= reverse operation
9-10	Battery Volts	uint16_t	0.01 x V	0-35.00V
11	State	uint8_t	1	Engine state according to table 1
12	Starter Health Flag	unit8_t	1	Bitfield
13	MainV Health Flag	unit8_t	1	Bitfield
14	GasV Health Flag	unit8_t	1	Bitfield
15	RpmSns Health Flag	unit8_t	1	Bitfield
16	Pump Health Flag	unit8_t	1	Bitfield
17	Ignitor Health Flag	unit8_t	1	Bitfield
18	EGT Health Flag	unit8_t	1	Bitfield

#

Above message is disabled for emission per default!

To enabled, use command message **0x010D** !

#

#

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Table 1: Engine states

State	Description
0	OFF (engine can be started)
1	WAIT for RPM (Stby/Start)
2	Ignite
3	Accelerate
4	Stabilize
5	Not used
6	Learn LO
7	OFF, cooling (engine can be started)
8	Slow Down, cooling (engine cannot be started)
9	Not used
10	AutoOff
11	Run (reg.)
12	Acceleration delay
13	SpeedReg (Speed Ctrl)
14	Two-Shaft-Regulate (only for turbines with secondary shaft)
15	PreHeat1 (only for direct Kerosene start-up mode)
16	PreHeat2 (only for direct Kerosene start-up mode)
17	Not used
18	Not used
19	Keros.FullOn (only for direct Kerosene start-up mode)

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Table 2: Off-Conditions

Off-Condition code	Description
0	No Off-Condition defined
1	Shut down via RC; Off via Throttle – PWM channel
2	Over temperature
3	Ignition timeout
4	Acceleration time out
5	Acceleration too slow
6	Over RPM
7	Low Rpm Off
8	Low Battery
9	Auto Off
10	Low temperature Off
11	Hi Temp Off
12	Glow Plug / Igniter defective
13	Watch Dog Timer
14	Fail Safe Off
15	Manual Off (via GSU)
16	Power fail (Battery fail)
17	Temp Sensor fail (only during startup)
18	Fuel fail
19	Prop fail (only two shaft engines)
20	2nd engine fail
21	2nd engine differential to high
22	2nd engine no communication
23	No oil (only on engines with separate oil reservoir)
24	Over current

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Off-Condition code	Description
25	No fuel pump connected/found
26	Wrong fuel pump connected
27	Fuel pump communication error
28	Out of fuel shut down (only on engines with fuel sensor, like RXi types)
29	Low Rpm shutdown, possibly due to Pump failure
30	Low Rpm shutdown, possibly due to front board failure
31	Clutch fail (starter motor clutch is not decoupling)
32	ECU reboot due to re-matching of new engine connected
33	Engine shut down, due to not receiving valid messages via the CAN interface for longer than the time defined in parameter “CAN-Timeout” (Limits menu) This shut down would only be triggered if the engine was commanded to start/run via a command given through the CAN interface ahead. Furthermore, engine must be in either in EXT- or CAN-command mode! If engine is off, or e.g. commanded via PWM or RS232, this shut down will not be triggered. This function allows to verify that the CAN communication link is working. In case this function is not desired, leave the value of the parameter “CAN timeout” set to zero. If set unequal to zero, the system expects to receive valid commands sent via the serial interface within the timeout period. If this is not happening the engine will be shut down. Per default this supervision function is set to 15 which means 1.5 seconds timeout. (“CAN-Timeout” =0). The number given for the Timeout value is in multiples of 0,1 seconds. Therefore, a value of 15 would define a 1.5second timeout period. Only available in firmware 12.53 or higher.
34	NO_RC_PULSE; Only applies for engines controlled via RC-PWM signal and if engine was started via RC-PWM control.
35	ROTORBLOCKED Engine rotor blocked, not turning.
36	SAFETY PIN signal; connection to GND removed
37	Restart aborted by user
38	Engine off commanded via PWM-AUX channel

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Off-Condition code	Description
39	Engine off commanded via RS232-Off command
40	Engine off commanded via CAN-Bus Off command
41	Test Mode Off command
42	COM Timeout. Engine shut down, due to not receiving valid messages via the main serial interface for longer than the time defined in parameter “COMM-Timeout” (Limits menu) This shut down would only be triggered if the engine was commanded to start/run via a command given through the serial interface ahead. Furthermore, engine must be in either in EXT- or COM-command mode! If engine is off, or e.g. commanded via PWM or CAN-Bus, this shut down will not be triggered. This function allows to verify that the serial communication link is working. In case this function is not desired, leave the value of the parameter “COMM timeout” set to zero. If set unequal to zero, the system expects to receive valid commands sent via the serial interface within the timeout period. If this is not happening the engine will be shut down. Per default this supervision function is disabled. (“COMM-Timeout” =0). The number given for the Timeout value is in multiples of 0,1 seconds. Therefore, a value of 20 would define a 2second timeout period. Only available in firmware 12.33 or higher.
43	Preheat Timeout; preheat function timed out; only on engine with this function enabled
44	Oilpump disconnected
45	Oilpump rotor blocked
46	Oil level low

Remark:
Off Conditions 20-22 are only for multiengine communication setup (engine interlinkage via serial interface)
Off Conditions 38 only available in firmware 12.33 or higher; before, this off condition resulted in code 2.
Off Conditions 39-41 only available in firmware 12.33 or higher; before these off conditions resulted in code 15.

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Table 4: Health check results

After power up all flags will report “0” (=not tested). To perform health check the “DHC” command needs to be issued for the flags to be set. The “DHC” command initially also would set the flags to zero. Health check is completed once all flags are reported unequal to zero!

Bit state in return value	Return value Bit 0	Bit1	Bit2	Bit3
Starter “ok”	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	0: ok 1: No current /open circuit (Motor defective or cable/ connector interruption)	0: ok 1: No starter motor rpm detected, possibly rotor of starter motor blocked
Main valve “ok	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	0: ok 1: No current /open circuit (valve defective or cable/ connector interruption)	Not defined
Starter valve “ok”	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	0: ok 1: No current /open circuit (valve defective or cable/ connector interruption)	Not defined
RPM Sensor “ok	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	Not defined	0: ok 1: No rpm detected; bad rpm sensor; or engine rotor stuck
Pump “ok”	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	0: ok 1: No current /open circuit (pump defective or cable/ connector interruption)	0: ok 1: No pump rpm; Pump rotor blocked
Glow Plug “ok”	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	0: ok 1: No current /open circuit (ignitor defective or cable/ connector interruption)	0: ok 1: Current too low/ out of range, Bad glow element!
EGT Sensor	0: not tested 1: Ok, system works All other values define error code (Bit 1 to Bit 3 set in return value)	0: Driver ok 1: Driver error	0: ok 1: open circuit, possibly bad thermocouple / broken connection	Not defined

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Engine Control Commands

For engine control/commanding there are the following commands defined

Command Message for engine Start/Stop control

Message descriptor	Description		No of data bytes in message	
0x0101	Engine Start/Stop control		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Engine control	uint16_t	---	0 : Engine Off 1 : Engine Start/Run. If engine should already run or be started, command has no effect. In addition, PWM-engine control would be disabled. 2… 6: See table 1 !

Command Message for engine Rpm control/demand

Message descriptor	Description		No of data bytes in message	
0x0102	Engine Rpm demand This command would also disable the governor mode for 2-shaft engines, if applicable. In addition, PWM-engine control would be disabled.		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Engine rpm demand	uint16_t	10x RPM	0-300000 RPM If demanded RPM should be out of allowed range of engine, value would be automatically limited to possible/allowed range!

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Command Message for engine "thrust percent" demand

Message descriptor	Description		No of data bytes in message	
0x0103	Engine thrust % demand This command would also disable the governor mode for 2-shaft engines, if applicable. In addition, PWM-engine control would be disabled.		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Engine thrust % demand	uint16_t	0.01 %	0..100.00% 0% reflects engine idle 100% reflects full power

Command Message for alternator control

Message descriptor	Description		No of data bytes in message	
0x0104	Generator control		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Generator control	uint16_t	---	0: Generator function Off 1: Generator function On

Command Message for Test functions

Message descriptor	Description		No of data bytes in message	
0x0105	Test functions		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Test functions	uint16_t	---	**Function code** **1:** Test run fuel pump, main fuel valve would be opened automatically. Second parameter defines the pump voltage (range: -7.0…+7.0). Positive values run the pump forward, negative values run the pump reverse, zero stops the pump. **2:** Test run fuel pump, gas/ignition valve would be opened automatically, main valve closed. Second parameter defines the pump voltage (range: -7.0…+7.0). Positive values run the pump forward, negative values run the pump reverse, zero stops the pump. **3:** Test run fuel pump, both valves would stay closed.

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				Second parameter defines the pump voltage (range: -7.0…+7.0). Positive values run the pump forward, negative values run the pump reverse, zero stops the pump. **4:** Open/close the main fuel valve. Second parameter defines the valve position. A value of 1 opens the valve, all other values close the valve. **5:** Open/close the gas/ignition valve. Second parameter defines the valve position. A value of 1 opens the valve, all other values close the valve. **6:** Test the starter motor. A value of 1 engages the motor, all other values stop the motor. If motor is not commanded off within 10 seconds, motor will be disengaged by system. **7:** Test the ignition device/glow plug. A value of 1 engages the igniter, all other values disable the ignitor If igniter is not commanded off within 10 seconds, igniter will be disengaged by system. **8:** Activate the "Auto bleed function". The second parameter given defines the max. allowed time in seconds for the bleeding process. The allowed range for the second parameter is: 0...50 seconds. In case a value of zero is sent for the timeout, a possibly running bleed process will be terminated.

Command Message for executing health check

Message descriptor	Description		No of data bytes in message	
0x0106	Execute Health check		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Health check trigger	uint16_t	---	1: Execute health check

Command Message for 2-shaft engines, rpm setpoint demand 2nd shaft rpm

Message descriptor	Description		No of data bytes in message	
0x0107	Setpoint for 2nd shaft rpm This command would also engage the governor mode for 2-shaft engines		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Setrpm for second shaft	uint16_t	2 x RPM	0-130000 RPM If demanded RPM should be out of allowed range of engine, value would be automatically

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				limited to possible/allowed range!

Command Message for 2-shaft engines, percent power demand 2nd shaft rpm

Message descriptor	Description		No of data bytes in message	
0x0108	Power% demand for 2nd shaft This command would also engage the governor mode for 2-shaft engines		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Setrpm for second shaft	uint16_t	0.01 %	0..100.00% 0% reflects 2nd shaft idle 100% reflects 2nd shaft max rpm

Command Message for switching to ASCII protocol mode / baud rate set

Message descriptor	Description		No of data bytes in message	
0x0109	Switch to ASCII protocol		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Switch to ASCII protocol	uint16_t	---	0: Stay with binary protocol 1: Switch to ASCII protocol

Command Message for baud rate set

Message descriptor	Description		No of data bytes in message	
0x010A	Baud rate select		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Set baud rate	uint16_t		Code for Baud rate (0..8) **0: 2400** **1: 2400** **2: 4800** **3: 9600** **4: 19200** **5: 38K4** **6: 38K4** **7: 57K6** **8: 115K2**

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Command Message for Set/Change of slave address

Message descriptor	Description		No of data bytes in message	
0x010B	Change/Set Slave Address		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	New Slave Address	uint16_t	---	1-255

Command Message for set of COM timeout

Message descriptor	Description		No of data bytes in message	
0x010C	Timeout value		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Timeout value	uint16_t	---	1-255 sec

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Command Message for activating/deactivating messages sent/emitted via ECU

Message descriptor	Description		No of data bytes in message	
0x010D	Message On/Off control		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1	LowByte of Message descriptor	unit8_t	---	0x00 – 0x0A Example: ~~0x00 defines all messages~~ 0x01 defines message 0x0001 0x02 defines message 0x0002…
2	Message On/Off control	unit8_t	---	0: turns message off 1: turns message on

After power up, messages 0x0001 to 0x0006 are enabled by default!

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Command Message for transmission of Set levels from external control system to ECU

Message descriptor	Description		No of data bytes in message	
0x010E	Voltage regulator (optional) Transfer Set voltage setpoint to ECU from external system		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Setpoint in V	uint16_t	0,01V	0 - 655.00V

A value of 0 for the setpoint will disable the regulator!

After power up, the setpoint is set to zero and therefore the regulator system is disabled.

Command Message for transmission real voltage levels from external control system to ECU

Message descriptor	Description		No of data bytes in message	
0x010F	Voltage regulator (optional) Transfer real measured voltage to ECU from external system		2	
Data Byte #	**Parameter**	**Data interpretation**	**Scale**	**Range**
1-2	Measured voltage in V	uint16_t	0,01V	0 - 655.00V

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Example on building a data packet for commanding thrust in %

Let us assume a “Throttle %” command should be sent to ECU with Slave Address=**0x05**

For this command the message ID is defined to be **0x0103** (=Engine thrust% demand). This command uses 0x02 Bytes for defining the commanded throttle value.

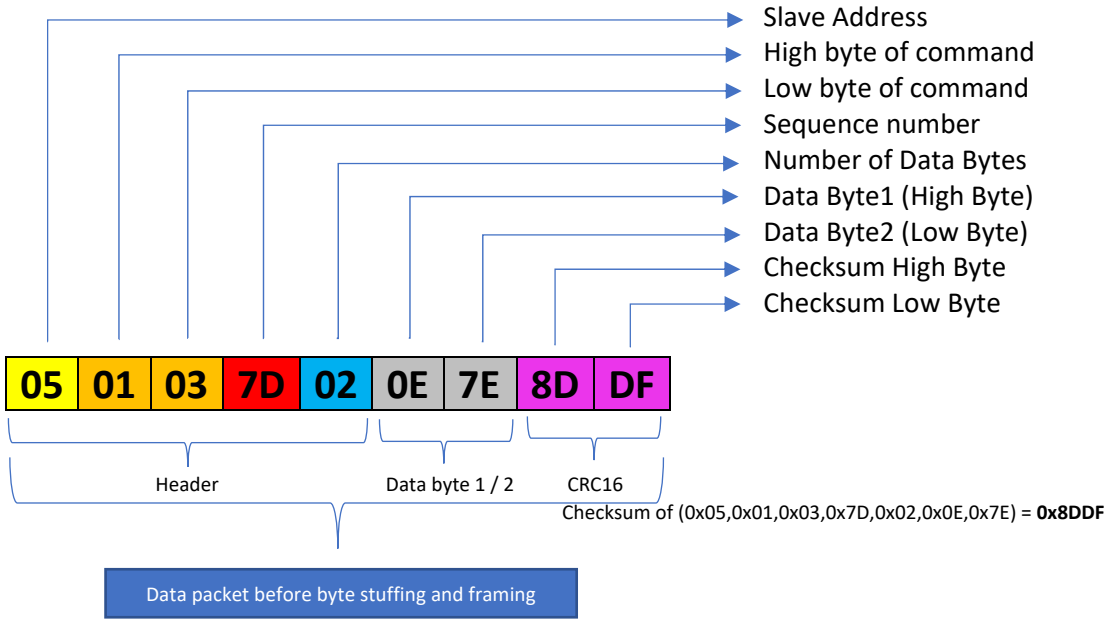
The throttle command in this example should be set to **37.10%**

As the scale factor for this command is defined to be **0.01,** we need to divide: 37.10 / 0.01 = 3710

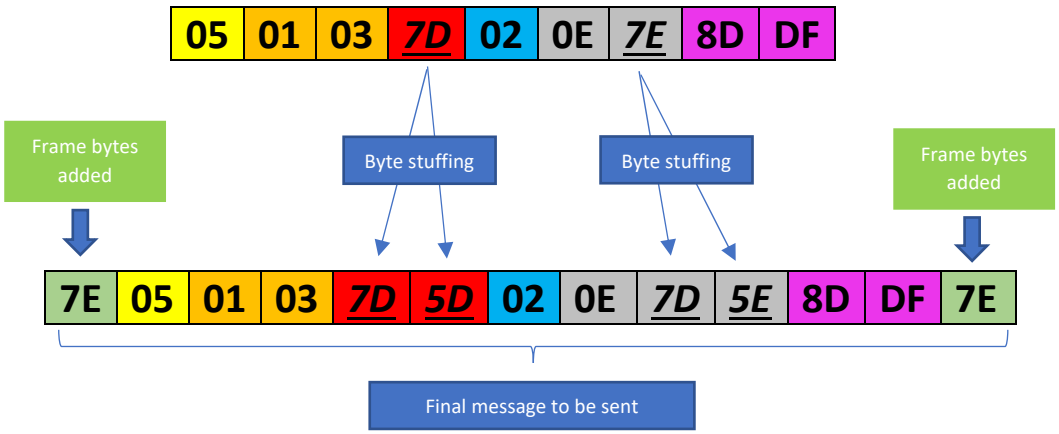
3710 in hex format is equal to **0x0E7E**

Let us further assume we want to use **0x7D** as the current sequence number.

With this information we can start building the data packet:



Next step is to send the message with leading and ending frame bytes and to perform byte stuffing were needed (→replace 0x7D with 0x7D/0x5D and 0x7E with 0x7D / 0x5E sequences)



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Appendix A), Point-to-Point Protocol (PPP), data link layer protocol

Definitions:

Frame character (Flag): **0x7E** (01111110)

Escape character: **0x7D** (01111101)

Sending data treatment, byte stuffing method (encoding algorithm):

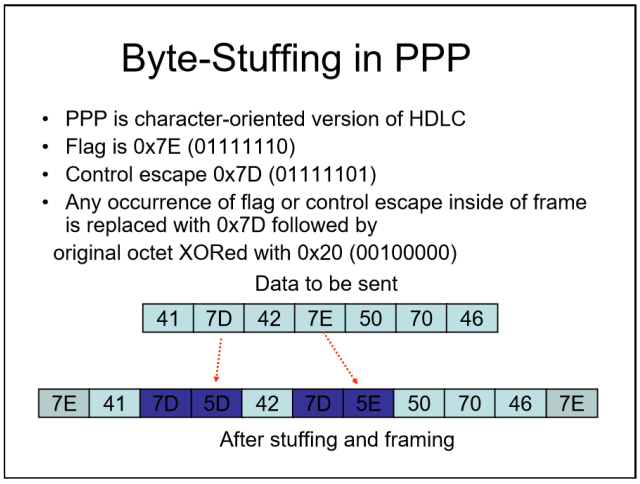
0x7D → 0x7D, 0x5D ;

0x7E → 0x7D, 0x5E ;

This means:
If 0x7D should be transmitted, transmit two bytes: 0x7D and 0x5D instead.

If 0x7E should be transmitted, transmit two bytes 0x7D and 0x5E instead.

Example:



Before and after each data packet 0x7E is used as framing characters

Treatment of received data (decoding algorithm):

If 0x7D is received: omit/skip this byte/data (→ do not put into receive buffer) and XOR next incoming byte with 0x20 before putting it into receive buffer! All other bytes are directly put in receive buffer, without modification.

Data frames are enclosed by leading/ending 0xFE framing bytes. These bytes are only for framing and do not belong to the payload data!

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Appendix B), CRC16 calculation, C-Code example

The checksum is a 16-bit, type CCITT. The checksum calculation starts with the first byte of a data packet and goes till n-2 of the bytes received in a packet.

Sample code to calculate the CRC16-CCITT in the C language:

```
// ------------------------------------------------------------//
// Subroutine used by get_crc16z function
uint16_t crc16_update ( uint16_t crc, uint8_t data )
{

uint16_t ret_val;

      data ^= (uint8_t)(crc) & (uint8_t)(0xFF);
      data ^= data << 4;
      ret_val = ((((uint16_t)data << 8) | ((crc & 0xFF00) >> 8))
      ^ (uint8_t)(data >> 4)
      ^ ((uint16_t)data << 3));
      return ret_val;
}
// ------------------------------------------------------------//



// ------------------------------------------------------------//
// Function to compute CRC16:
// *p : pointer to first data byte
// len: Number of data bytes
// return value is CRC16 over source data p[0]… p[len-1]
uint16_t get_crc16z(uint8_t *p, uint16_t len)
{

uint16_t crc16_data=0;

      while(len--)
      {
            crc16_data = crc16_update(crc16_data, p[0]);
            p++;
      }
      return(crc16_data);
}
// ------------------------------------------------------------//
```


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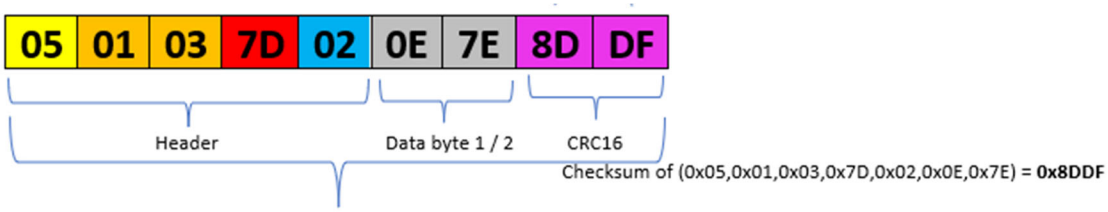
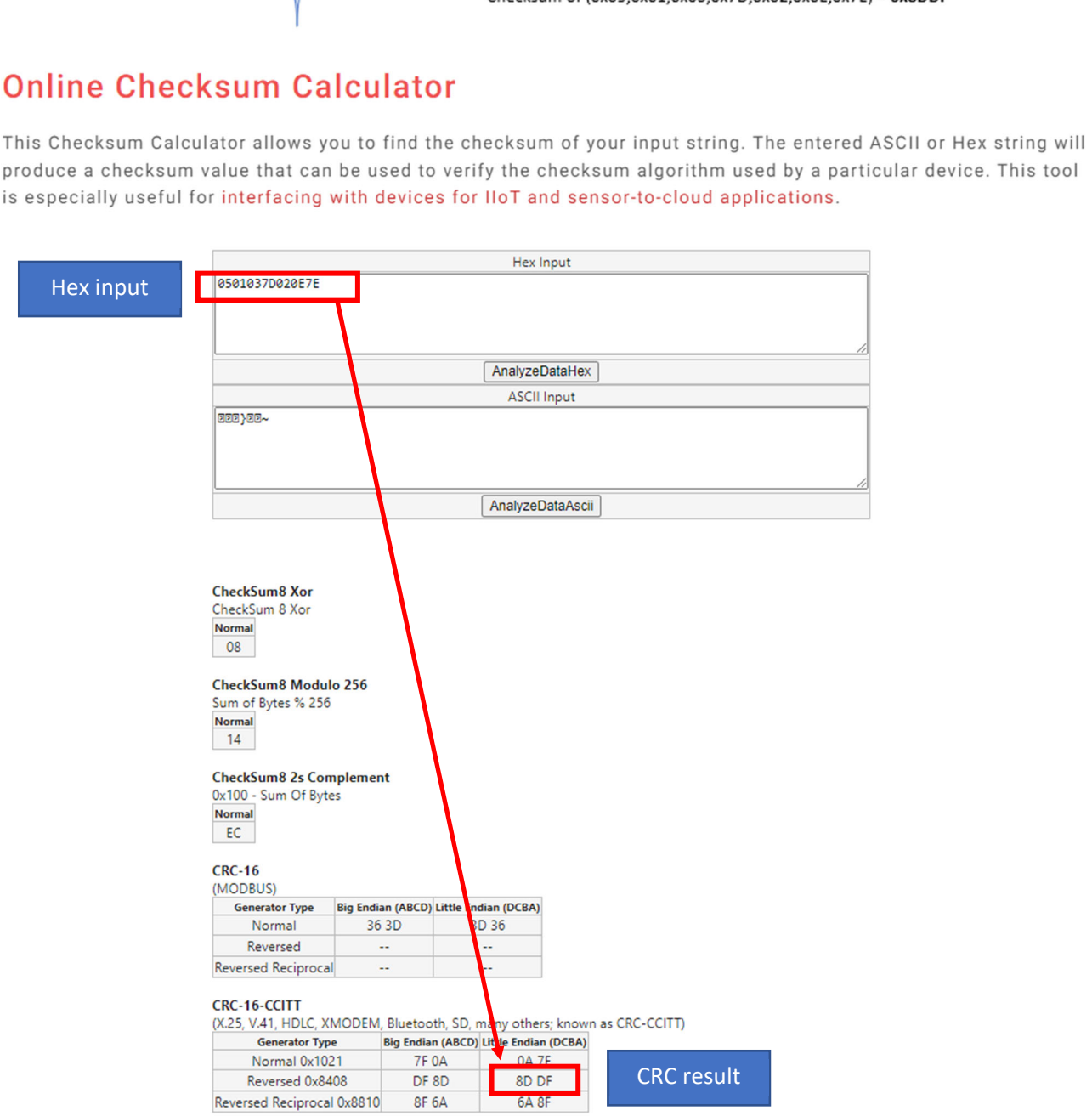
Appendix C), CRC16 calculation via online tool
https://www.scadacore.com/tools/programming-calculators/online-checksum-calculator/

Below screenshot illustrates CRC output of example data:





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