HDX RFID Reader System

Microreader RI-STU-MRD2

Reference Guide

Texas Instruments

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Microreader RI-STU-MRD2

> ## WARNING
>
> **The terminals across the antenna connectors ANT1 and ANT2 operate at potentially hazardous voltages. Effective safety application procedures and knowledge are required to minimize risk of electrical shock hazard when using this EVM. The user should be technically qualified to operate this EVM, including having full knowledge of risks associated in working with electrically live and hazardous voltages commonly found in development platforms. Careful review of** *General Texas Instruments High Voltage Evaluation Module (TI HV EVM) User Safety Guidelines* **at the end of this document is required prior to using this EVM.**

1   Introduction

The Microreader RI-STU-MRD2 is a reader module with advanced features that is backward compatible with the RI-STU-MRD1 module. It features new protocols and commands to communicate with TI low-frequency (LF) half-duplex (HDX), and advanced transponders for programming and tuning after the production phase. In addition to the DIL module size, which is compatible with the RI-STU-MRD1, the reader is also available in a smaller SMD module RI-SMD-MRD2. Both modules can be used as direct drop-in replacements for the RI-STU-MRD1.

This document describes the hardware and communication protocols of the RI-STU-MRD2 module.

Figure 1. RI-STU-MRD2 Module

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2 References

1. 2000 Reader System: Microreader RI-STU-MRD1 Reference Guide (SCBU027)
2. Reference Guide for 32-mm Glass Transponder (Read Only, Read/Write) (SCBU019)
3. Multipage, Selective Addressable and Selective Addressable (Secured) Transponders (SCBU020)
4. TMS37157 PaLFI data sheet (SWRS083)
5. ISO/IEC 18000-2:2004, Information technology – Radio frequency identification for item Management – Part 2: Parameters for air interface communications below 135 kHz
6. ISO 14223-1:2003, Radio frequency identification of animals – Advanced transponders – Part 1: Air interface
7. ISO 14223-2:2010, Radio frequency identification of animals – Advanced transponders – Part 2: Code and command structure

3 Definitions

3.1 Abbreviations

AID: Animal Identification Code

BCC: Block Check Character

BLC: Bit Length Coding

BSP: Bit Sequence Protocol

CDC: Communication Device Class

DIL: Dual in Line

ECM: Easy Code Mode

EOF: End of Frame

FBCC: Frame Block Check Character

FSK: Frequency Shift Keying

HDX: Half Duplex

HDX+: Half Duplex Plus

LMP: Legacy Microreader Protocol

MCU: Micro Controller Unit

MPT: Multipage Transponder

MRD1: Microreader 1 (RI-STU-MRD1)

PaLFI: Passive Low Frequency Interface

PCB: Printed Circuit Board

PPM: Pulse Position Modulation

PWM: Pulse Width Modulation

RFM: Radio Frequency Power Module

RFU: Reserved for Future Use

RO: Read Only (Transponder)

R/W: Read/Write (Transponder)

RX: Receive

SM: Setup Mode

SMD: Surface Mounted Device

SOF: Start of Frame

TX: Transmit

WLSC: Wireless Synchronization

SCI: Serial Communication Interface

SMPS: Switched-Mode Power Supply

4   Product Description

The Microreader module is available as a dual in line (DIL) module or a surface-mount device (SMD) module that can be plugged into or soldered onto an application-specific adapter board. The Microreader supports serial and USB data communications between a PC and TI transponders. The Microreader supports TTL data communications through its serial communications interface (SCI), which allows communication to a standard interface when using an additional communications driver (for example, RS232 or RS422). In addition, a USB interface is available and requires only a few external components. For easy access to the USB port from the PC side, the reader is managed as a COM port.

The Microreader can be controlled remotely either by providing certain inputs with the corresponding voltage level or by sending commands to the SCI or USB. The Microreader can be driven either with or without synchronization. Synchronization can be either wireless or wired to enable reliable operation in multi-reader environments. Two outputs show the reader status and inform the user about a successful command execution. The Microreader supports all available TI LF HDX transponders.

The supply voltage can vary between 2.7 V and 5.5 V. A voltage regulator and level shifters are implemented to maintain the specified supply range.

A microcontroller generates the transmit signal, demodulates the receive signal, and manages the two host interfaces.

Figure 2. Overview

4.1 Hardware SMD Module

The following sections describe the SMD module hardware and pin functions.

4.1.1 SMD Module Product Dimensions

Figure 3 shows the SMD module with single-sided component placement, and Table 1 shows the product dimensions. The size and shape of the pads are designed to make assembly and soldering of the module in an automated production process as easy as possible.

Figure 3. Top View With Pin Numbers of the Microreader 2 SMD Module

Table 1. Mechanical Data of SMD Module

Parameter	Min	Typ	Max	Unit
Length	27.8	27.9	28.05	mm
Width	22.7	22.8	22.95	mm
Height	3.0		3.5	mm
Weight		2.0		g

4.1.2 SMD Module Pin Functions

Table 2. SMD Module Pin Functions

Pin	Pin Name	Function[1]	Description
1	SYNC	O	Output for wired synchronization (yellow LED)
2	RDEN-	I	Input for wired synchronization and single read trigger
3	RESET-	I	Reset of the Microreader
4	RXD	I	Receive data signal input of serial interface
5	TXD	O	Transmit data signal output of serial interface
6	GND		
7	GND		
8	3_3V_OUT	P	Do not connect
9	Reserved		
10	Reserved	O	
11	SIG_OUT_0	O	Programmable signal output 0
12	SIG_OUT_1	O	Programmable signal output 1 or TXCT- in RFM mode

[1] B = Bidirectional, I = Input, O = Output, P = Power

Table 2. SMD Module Pin Functions (continued)

13	GND		
14	SIG_IN_0	I	Programmable signal input 0 or RXDT in RFM mode
15	SIG_IN_1	I	Programmable signal input 1 or RXCK in RFM mode
16	Reserved		
17	Reserved		
18	ANT1		Antenna terminal 1
19	ANTCAP		Antenna capacitor terminal
20	ANT2		Antenna terminal 2
21	GNDP		Ground for output stage
22	VSP	P	Supply voltage output stage
23	VSL	P	Supply voltage for logic
24	CRDM	I	Input for continuous read mode
25	WLS	I	Input to turn wireless synchronization on
26	OKT	O	Read of valid transponder ID (green LED)
27	STAT	O	Status of RF transmitter control (red LED) (see Section 6.4.3.31)
28	USB_VBUS	P	+5 V from USB port
29	USB_D-	B	USB data
30	USB_D+	B	USB data
31	GND		
32	USB_PUR	O	USB pullup resistor
33	Reserved		
34	Reserved		

4.1.3 SMD Module Pin Configuration

Figure 4 shows the pin configuration of the SMD module.

Figure 4. SMD Module Pin Configuration

4.2 Hardware DIL Module

The following sections describe the DIL module hardware and pin functions.

4.2.1 Product Dimensions

Figure 5 and Table 3 show the layout and dimensions of the DIL module.

Note: Pin size: 0.64 x 0.64 mm

Note: Contact plating: Gold

Note: Recommended pin hole size diameter: 1 mm

Figure 5. Top, Front, and Side View Measurements of DIL Module

Table 3. Mechanical Data of DIL Module

Parameter	Min	Typ	Max	Unit
Length	37.9	38.3	38.7	mm
Width	28.8	29.3	29.6	mm
Height including pins	11.5	12	12.5	mm
Weight		5.0		g

4.2.2 DIL Module Pin Functions

Table 4. Pin Functions DIL Module

Pin	Pin Name	Function[1]	Description
1	SYNC	O	Output for wired synchronization (yellow LED)
2	RDEN-	I	Input for wired synchronization and single read trigger
3	Reserved		Do not connect
4	RESET-	I	Reset of the Microreader
5	RXD	I	Receive data signal input of serial interface
6	TXD	O	Transmit data signal output of serial interface
7	USB_D-	B	USB data
8	USB_D+	B	USB data
9	3_3V_OUT	P	Do not connect
10	Reserved		Do not connect
11	SIG_OUT_0	O	Programmable signal output 0
12	SIG_OUT_1	O	Programmable signal output 1 or TXCT- in RFM mode
13	SIG_IN_0	I	Programmable signal input 0 or RXDT in RFM mode
14	SIG_IN_1	I	Programmable signal input 1 or RXCK in RFM mode
15	GND		
16	ANT1		Antenna terminal 1
17	ANTCAP		Antenna capacitor terminal
18	Reserved		Do not connect
19	ANT2		Antenna terminal 2
20	Reserved		Do not connect
21	GNDP		Ground for output stage
22	VSP	P	Supply voltage output stage
23	USB_PUR	O	USB pullup resistor
24	VSL	P	Supply voltage logic
25	GND		Ground for logic
26	CRDM	I	Input for continuous read mode
27	WLS	I	Input to turn wireless synchronization on
28	USB_VBUS	P	+5 V from USB port
29	OKT	O	Read of valid transponder ID (green LED)
30	STAT	O	Status of RF transmitter control (red LED)

[1] B = Bidirectional, I = Input, O = Output, P = Power

4.2.3 DIL Module Pin Functional Description

SYNC (1)

Output for wired synchronization. This output is at GND level until the Microreader starts its read cycle, at which time it goes to VSL until the read, program, or lock cycle is finished.

RDEN- (2)

Input for wired synchronization. Pull this pin to VSL to prevent the Microreader output stage from transmitting. Pull this pin to GND to enable transmitting. The Microreader samples this input at the start of its own read, program, or lock cycle; therefore, if the input goes to VSL after a cycle is started, the cycle is not interrupted. RDEN- is a high-impedance input and must be tied to GND via a suitable resistor (27 kΩ) when not in use.

To trigger a single read when the Microreader is idle, pull the RDEN- pin logic high for 100 μs. The single read starts on the falling edge of the 100-μs pulse.

RESET- (4)

Pull this pin to GND to hold the Microreader in reset. If the reset pin is not used, it can be left disconnected (it is internally pulled up). Minimum pulse duration to perform a reset is 1 ms. After a reset, the processor requires between 28 ms and 132 ms (typically 72 ms) before it can receive new instructions via the serial communications interface.

RXD (5)

Input configured to receive serial data at 9600 Baud (default, configurable up to 115k Baud), 1 start bit, 8 data bits, no parity, and 1 stop bit.

TXD (6)

Output configured to transmit serial data at 9600 Baud (default, configurable up to 115k Baud), 1 start bit, 8 data bits, no parity, and 1 stop bit.

USB_D-, USB_D+ (7, 8)

USB data transmit and receive

USB_VBUS (28)

USB power voltage

GND (15, 25)

Pins 15 and 25 are ground for the logic part.

ANT1 (16)

Antenna pin for the connection of a 47-µH low-Q antenna.

ANTCAP (17)

To use an antenna of lower inductance, connect a suitable capacitor between ANT1 and ANTCAP. This additional capacitor (ceramic, 100 VDC) is in parallel with the 30-nF resonance capacitor on the Microreader.

ANT2 (19)

Antenna pin (GND) for the connection of a 47-µH low-Q antenna.

GNDP (21)

Ground for the output stage.

VSP (22)

Positive supply voltage (2.7 V to 5.5 V, same as VSL) for the output stage.

VSL (24)

Positive supply voltage (2.7 V to 5.5 V, same as VSP) for the logic part.

CRDM (26)

Apply a logic high signal to run the Microreader in a continuous charge-only read mode. When the CRDM pin is logic low, the Microreader is in an idle state waiting for commands via the serial interface or for a trigger signal (RDEN-) to start a single read out cycle. CRDM is a high-impedance input and must be tied to either VSL or GND via a suitable resistor (27 kΩ).

WLSC (27)

Enables or disables wireless synchronization. To enable the wireless synchronization, pin 27 must be pulled to VSL. When wireless synchronization is enabled, the Microreader tries to synchronize its transmit signals with any other readers in range. To disable wireless synchronization, pull pin 27 to GND. Pin 27 is a high-impedance input and must be tied to either VSL or GND via a suitable resistor (27 kΩ). Wireless synchronization can also be turned on or off by a command on the serial interface. This command has priority over the WLSC input.

OKT (29)

This output is set to logic high for approximately 60 ms if a valid transponder was read. It can be connected externally to an LED to indicate the result of the read cycle (see Section 6.4.3.30).

STAT (30)

Pin 30 is set to logic low when the RF transmitter is activated. Supplying an external LED with this signal makes the status of the Microreader visible (see Section 6.4.3.31).

4.3 Power Supply

There are two separate (2.7 V to 5.5 V) supplies to the Microreader, one for the output stage (VSP) and the other for the logic (VSL). Both supplies, VSP and VSL, must have the same voltage. On power up, VSL should rise faster than 0.1 V/ms to ensure reliable operation.

To avoid problems with noise conducted by the supply lines if a single supply is used, use separate connections from a common decoupling capacitor to the Microreader.

> **NOTE:** The RF module must not be supplied by most switched mode power supplies (SMPS). This is because most SMPS operate at frequencies near 50 kHz. The harmonics of the generated field can interfere with the receiver. Therefore, use linear regulated power supplies. An SMPS with a fundamental operating frequency of 200 kHz or higher can be used.

4.4 Synchronization

There are two possible methods of wired synchronization:

- Connect a pulse waveform to all RDEN- input pins of the Microreaders to be synchronized. Hold the pulse at VSL and drop it to GND for 100 µs every 200 ms.
- Connect all SYNC outputs to an OR gate and then connect the output of the OR gate as an input to the RDEN- of each Microreader to be synchronized.

Wireless synchronization of the Microreader is very effective at synchronizing to adjacent readers; however, problems can occur if the antennas are positioned so that a transponder is within range of two readers at the same time. In this situation, one reader could synchronize with the transponder instead of with the other reader.

When the WLSC input is active, the Microreader is in wireless synchronization mode. Wireless synchronization can also be turned on or off by a corresponding command via the serial interface. During execution of this command, it has priority over the WLSC input. After the command execution, the status of the WLSC input is considered again.

> **NOTE:** It is not recommended to have both wired and wireless synchronization on, because the synchronization could be unreliable. It is recommended to use bus drivers for wired synchronization with other Microreaders and to prevent ESD damage. Wired or wireless synchronization prolongs the cycle time by 20 ms (typical).

4.5 Serial Port and USB Communication

Communication between host and reader is done by either the serial port or the USB port. Both ports can accept commands. No setup or switch between these ports is necessary. Each response is sent to the port from which the command was received. If the CRDM pin is active, the response is sent to the serial port, but when a USB connection is established the response is sent to the USB port.

The factory default for both interfaces is 9600 Baud, 1 start bit, 8 data bits, no parity, and 1 stop bit; they can be connected directly to a communications driver to allow a half duplex communication with a PC via its serial communications interface (for example: RS232 or RS422)or USB Interface.

See Section 6 for details on the communication protocols.

4.6 Handshake

The Microreader accepts handshake commands Xon and Xoff. When it receives an Xoff (0x13) the Microreader stops its current operation and stops transmitting data via the serial port. It stays in idle mode until Xon (0x11) is received when it continues with the previous mode or command. During this idle period, the Microreader accepts commands via the serial port, however, it waits for its execution until Xon is received. In this idle period, the Microreader can store only one command.

> **NOTE:** While receiving a command protocol from the serial port, Xon or Xoff is interpreted as normal data without affecting the serial communication.

4.7 Trigger Mode

When the Microreader is in idle mode, it is possible to trigger a single charge-only read with a power burst duration of 50 ms by taking the RDEN- pin to logic high for 100 µs. The single read starts on the falling edge of the 100-µs pulse.

If a transponder command is sent to the Microreader via the SCI while RDEN- is in a logic high state (waiting position), a falling edge on RDEN- triggers execution of the command. In waiting position the Microreader can only store one command. This means that if two commands were to be sent to the Microreader while it is in the waiting position, the second command overwrites the first one.

4.8 Continuous Mode

When the CRDM input is active, the Microreader enters a continuous charge-only read mode using power burst duration of 50 ms. The serial data input takes priority over the CRDM input such that if a serial command is received, it is executed regardless of the state of the CRDM input. After the execution of the serial data command, the Microreader continues with the previous read mode.

In the default continuous read mode, only those valid RO, R/W, or MPT IDs that differ from the previously read ID, or valid IDs read after a NO READ, are transferred via the SCI (Normal Mode). The Microreader can be set to transfer all valid IDs that are read (Line Mode) by means of a corresponding serial data command.

Without synchronization the Microreader has a reading frequency of approximately ten readouts per second using power burst duration of 50 ms.

4.9 Demonstration Circuit

Figure 6 shows a demonstration circuit. Pin numbers are shown for the DIL module.

Figure 6. Microreader 2 Demonstration Circuit With USB Interface

5 Antenna Construction

The Microreader has been designed for use with a 47-µH antenna with a Q of 10 to 20 to generate the exciter frequency of 134.2 kHz. Because of the low Q, the system does not need to be tuned.

Table 5 shows the typical parameters for a circular air coil antenna.

Table 5. Antenna Parameters

Inner diameter of transmit antenna	A	75	mm
Outer diameter of transmit antenna	B	78	mm
Radius of transmit antenna	r_{tx}	0.03825	m
Inductance	L_{tx}	47	µH
Turns	N_{tx}	15	
Diameter of wire	d_w	0.2	mm
Antenna quality factor (134.2 kHz)	Q_{ant}	16	
Antenna resistance (134.2 kHz)	R_{ant}	2.5	Ω

Table 6 shows the Microreader 2 transmitter stage parameters.

Table 6. Transmit Stage Parameters

Supply voltage	U_{sup}	2.7 - 5.5	V
Bridge drain-source resistance	R_{onPx}, R_{onNx}	0.25, 0.1	Ω
Damping resistor	R_{dmp}	2	kΩ
Resonance capacitor	C_{res}	30	nF

5.1 Q-Factor

If the antenna's Q factor exceeds 20:

- The output capacitors are overloaded and long-term damage could result.
- The antenna may still be resonating when the response from the transponder is received. Without built-in damping, the data may not be correctly received.
- The antenna may be detuned if there is any metal in the area.

The following formula provides a method of calculating the approximate Q factor of the antenna:

$$Q = \frac{2\pi fL}{R} \tag{1}$$

Where,

    f = 134200 Hz (Frequency = 134.2 kHz)
    L = Inductance (H)
    R = Series resistance (Ω)

Equation 2 shows an example for:

    Inductance (L) = 47 µH
    Resistance (R) = 2.2 Ω

$$Q = \frac{2 \times \pi \times 134200 \times 0.000047}{2.2}$$

$$= \frac{39.636}{2.2}$$

$$= 18 \tag{2}$$

5.2   *Adapting the Inductance Range*

If the antenna is outside of the required inductance range of 46 to 48 µH, adapt it to work with the Microreader by adding an external capacitor to it, either in series or in parallel. This external capacitor can change the inductance range by 5 µH.

Equation 3 shows the formula to calculate the total resonance capacity.

$$C_{tot} = \frac{1}{4\pi^2 L_{Ant} f^2}$$

(3)

If the antenna inductance is less than 46.1 µH, add an extra capacitor (externally) to the antenna between pin ANT1 and pin ANTCAP. Equation 4 shows the formula for the value of this capacitor.

$$C_{ext} = C_{tot} - 30 \text{ nF}$$

(4)

If the antenna inductance is more than 47.9 µH, add an extra capacitor in series with the antenna between pin ANT2 and the antenna. Equation 5 shows the formula for the value of this capacitor.

$$\frac{1}{C_{ext}} = \frac{1}{C_{tot}} - \frac{1}{30 \text{ nF}}$$

(5)

6   **Communication Between Host and Reader**

Communication between host and reader is done either by the serial port or the USB port. Both ports can accept commands. No setup or switch between these ports is necessary. Response is sent to the port from which the command was received.

The USB port is configured as CDC (Communication Device Class). If connected to a PC, no special driver is required, but an INF file is required, which can be downloaded from the Microreader product folder on the TI web page. If the port is installed by the host, it is accessible as COM port.

Data transfer is done in a binary format. No ASCII characters interpretation is done. Therefore, the use of the ASCII carriage return (CR) or line feed (LF) for the command termination is not possible. The reader assumes a command as terminated if the number of bytes specified after the 0x01 start byte is received, or if no new byte is received for 10 ms.

The Microreader can process different communication protocols:

It can interpret the protocol defined for the previous Microreader RI-STU-MRD1 with no restrictions. This protocol is referred to as Legacy Microreader Protocol (LMP).

Based on this protocol, expansions are defined to support new functionality. These expansions are:
- Bit Sequence Protocol (BSP) allows specification of a transponder downlink at bit level.
- Easy Code Mode (ECM) Protocol allows specification of a transponder downlink with a minimum of parameters based on the specification of the device that is in use and the associated command.
- Setup Mode Protocol (SM) is used to set up reader parameters or to manage functionality such as the inventory process.

NOTE: It is recommended that all users take advantage of the Easy Code Mode (ECM) Protocol when possible. The use of the Legacy Microreader Protocol (LMP) should be restricted to users who migrate from the RI-STU-MRD1 module and have software already available. For special purposes, when the user wants do define a transponder protocol at bit level, the Bit Sequence Protocol (BSP) can be used.

6.1 Legacy Microreader Protocol (LMP)

6.1.1 LMP Command Format

Table 7 shows the LMP command format.

Table 7. LMP Command Format (Full)

Start Byte	Length	CMD1	CMD2 (optional)	Data Field (1...)	Data Field (N)	BCC
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 (3)...	Byte ...n+3 (2)	Byte n+4 (3)
0x01	0xyy	0xyy	0xyy	0xyy	0xyy....	calculated

- The Start Byte has a fixed value of 0x01 and marks the beginning of the command.
- The Length byte indicates the length in bytes of the following command and data fields.
- CMD1 command code description is in Section 6.1.1.1.
- CMD2 is the optional command code; description is in Section 6.1.1.1.
- The presence of the Data Field is optional; whether or not it is included and the number of bytes depend on the command codes. This is described in Section 6.1.1.2.
- The BCC Field is a one-byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole command excluding the Start Byte.

```
Example: 02 08 32

02     0000 0010
08     0000 1000
XOR    0000 1010
32     0011 0010
XOR    0011 1000  = 38h
```

Figure 7. BCC Field Example

NOTE: The total number of bytes sent within a protocol frame (including Start Mark and BCC) is limited to 41 bytes.

6.1.1.1 LMP Command Codes

The Command Fields define the mode in which the Microreader operates and determines the operation that is to be carried out in the transponder. The value of the Command Codes determine whether or not information specified in the Data Fields is sent to the transponder.

Table 8. LMP Command Byte Field 1 Bit Format

Command Field (1) Bit	Use	Setting	Comment
0, 1	Mode, Command	00 (MSB, LSB)	Perform single command (for example: single read, program, lock)
		01	Read in continuous Normal Mode
		10	Read in continuous Line Mode
		11	Send Microreader S/W version
2	FBCC Calculation	1/0	If set, Microreader calculates FBCC of the MPT protocol
3	Power Burst I	1/0	If set, needs to be determined in Data Field (see Section 6.1.1.2)
4	Power Pause Duration	1/0	If set, needs to be determined in Data Field
5	Power Burst II	1/0	If set, needs to be determined in Data Field
6	Data	1/0	If set, needs to be determined in Data Field
7	Cmd Expansion Field	1/0	If set, Command Field (2) follows

If bit 5 (Power Burst II; for example, for programming and locking) is set, the Microreader automatically operates in single read mode. Thus the application can validate the programming or lock response before a further cycle is started.

If bit 2 (FBCC calculation) and bit 6 (Data) are set, the Microreader automatically calculates a two byte BCC over the data to be sent to the transponder and adds it to the protocol. When bits 2 and 6 are set, the PC must not send the 2 byte FBCC to the Microreader.

Bit 4 (Power Pause Duration) is for future use and must not be set when addressing standard transponders.

Example: E8h = 1110 1000b

Figure 8. LMP Command Byte Field 1 Example

Table 9. LMP Command Byte Field 2 Bit Format

Bit	Use	Setting	Comment
0	Special Write Timing	1 or 0	If set, needs to be determined in Data Field
1	Wireless Synchronization	1 or 0	If set, wireless synchronization is used
2	DBCC calculation	1 or 0	If set, Microreader calculates DBCC of the R/W and MPT write data
3-7	Reserved		

Example: 06h = 0000 0110b

Figure 9. LMP Command Byte Field 2 Example

If Command Field (2) is not present, standard write timings are used and wireless synchronization is turned on or off according to the status of input line WLSC.

NOTE: The settings specified in Command Field (1) and (2) are only valid during the execution of the current command.

6.1.1.2 LMP Data Field

The presence of the data field depends on the setting of the Command Field.

If a command bit that requires the data field is set to 1 (for example, Command bit 3 "Power Burst I"), then Data Field 1 is present defining the Power Burst length. If the relevant bit in the Command Field is set to 0 the consequent Data Field is omitted, this results in the following data field being moved forward (decremented) by one.

Table 10. LMP Data Field Bit Format

Data Field	Use	Range (dec)	Comment
1	Power Burst I	1 to 255 (ms)	If bit 3 of Command Field(1) is set
2	Power Pause Duration	1 to 255 (ms)	If bit 4 of Command Field(1) is set
3	Power Burst II	1 to 255 (ms)	If bit 5 of Command Field(1) is set
4/5	Toff Low (LSByte/MSByte)	28 to 2044 (ms)	If bit 0 of Command Field(2) is set
6/7	Ton Low (LSByte/MSByte)	28 to 2044 (ms)	If bit 0 of Command Field(2) is set
8/9	Toff High (LSByte/MSByte)	28 to 2044 (ms)	If bit 0 of Command Field(2) is set
10/11	Ton High (LSByte/MSByte)	28 to 2044 (ms)	If bit 0 of Command Field(2) is set
12	# of Data Fields that follow	See [1]	If bit 6 of Command Field(1) is set
13...	Data Fields	LSByte first	

[1] The number of Data Fields must not cause an infringement of the total number of bytes allowed within a protocol frame.

Transponder command protocols are described in detail in Section 6.1.3.

6.1.2 LMP Command Response Format

Table 11. LMP Command Response Format (Full)

Start Byte	Length	Status	Data	BCC
Byte 0	Byte 1	Byte 2	Byte 4...n	Byte n + 1
0x01	0xyy	0xyy	0xyy...	calculated

- The Start Byte has a fixed value of 0x01 and marks the beginning of the command.
- The Length byte indicates the length in bytes of the following command and data fields.
- Status description is in Section 6.1.2.1.
- The Response Data Format is described in Section 6.1.2.2.
- The BCC Field is a one-byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole command excluding the Start Byte.

```
Example: 02 08 32

02     0000 0010
08     0000 1000
-----------------
XOR    0000 1010
32     0011 0010
-----------------
XOR    0011 1000  = 38h
```

Figure 10. BCC Field Example

6.1.2.1   Status Byte Format

The Status byte provides feedback from the preceding read or program operation (see Table 12).

Table 12. LMP Status Byte Bit Format

Status Bits	Setting	Comment
0, 1	00 (MSB, LSB)	Transponder type: RO
	01	Transponder type: R/W
	10	Transponder type: MPT/SAMPT
	11	Other
2	1 or 0	If set, Start byte detected
3	1 or 0	If set, DBCC OK
4	1 or 0	If set, FBCC OK
5	1 or 0	If set, Microreader S/W version follows
6–7	Reserved	

6.1.2.2   Response Data Format

Table 13. LMP Response Data Bit Format

Type	Bytes in Data Field	Comment
RO	8	Identification Data (LSByte first), see Section 6.1.3
R/W	8	Identification Data (LSByte first)), see Section 6.1.4
MPT, SAMP	9	Identification Data (LSByte first), plus Read Address, see Section 6.1.5 and Section 6.1.6
Other	14	Complete transponder protocol without pre-bits provided that a valid RO or R/W start byte was detected
No read	0	No Data Fields, not even transponder start byte was detected, status 0x03
Software version	1	For example: 0x15 indicates software version 1.5

6.1.3 Device Commands Read-Only Transponder RO

6.1.3.1 *Charge Only Read*

Rea- only transponders support a command called Charge Only Read. The response data contain a 16-bit checksum and a 64-bit ID.

Figure 11. Read Only Command Format

Table 14. LMP Charge Only Read for Read-Only Transponder

Charge Only Read				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD (Power Burst 1 + Single Command)	1	2	08	hex
Data Field(Power Burst1 with 50 ms Duration)	1	3	32	hex
BCC	1	4	38	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	09	hex
Status (Valid RO, Start byte detected, DBCC OK)	1	2	0C	hex
ID	8	3-10	xxxxxxxx xxxxxxxx	hex
BCC	1	11	calculated	hex

Figure 12. Read-Only Response Data Format

6.1.4   Device Commands Read/Write Transponder

6.1.4.1   Charge Only Read

Command and Respond formats are the same as for the Charge Only Read (see Section 6.1.3.1).

6.1.4.2   Program/Configuration

Table 15. LMP Program Command Format for R/W Transponder

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	11	hex
CMD 1 (no FBCC calculation, send Power Burst I and II with Data Command Field (2) follows)	1	2	E8	hex
CMD2 (wireless synchronization, calculate DBCC of the R/W and MPT write data)	1	3	06	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	4	32	hex
Data Field 2 (Power Burst II with 15 ms duration (Program burst))	1	5	0F	hex
Data Field 3 (12 Data Fields follow)	1	6	0C	hex
Data Field 4 (Keyword)	1	7	BB	hex
Data Field 5 (Password)	1	8	EB	hex
ID (LSB...MSB)	8	9-16	xxxxxxxx xxxxxxxx	hex
Data Field 14 (Write Frame)	1	17	xx	hex
Data Field 15 (Write Frame)	1	18	xx	hex
BCC	1	19	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	09	hex
Status (Valid R/W, Start byte detected, DBCC OK)	1	2	0D	hex
ID	8	3-10	xxxxxxxx xxxxxxxx	hex
BCC	1	11	calculated	hex

Figure 13. Programming Data Format of the 64-bit Read/Write Transponder

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6.1.5 Device Commands Multipage Transponder MPT 16/17

6.1.5.1 General Read Page

Table 16. General Read Page Command Format for MPT Transponder

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1 (Perform Single command, send Power Burst I with data)	1	2	48	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	3	32	hex
Data Field 2 (One Data Field follows)	1	4	01	hex
Data Field 3 (Write Address specifying General Read Page 2)	1	5	08	hex
BCC	1	6	77	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
Status	1	2	xx	hex
Data	10	3-10	xxxxxxxx xxxxxxxx	hex
Read Address (specifying successful Read of page 2)	1	11	09	hex
BCC	1	12	calculated	hex

Figure 14. General Read Data Formats of MPT Transponders

6.1.5.2 Program Page

Table 17. LMP Program Page Command Format for MPT Transponder

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0F	hex
CMD 1 (Perform Single command, calculate FBCC, send Power Burst I and II with Data)	1	2	6C	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	3	32	hex
Data Field 2 (Power Burst II with 15 ms duration (Program burst))	1	4	0F	hex
Data Field 3 (1 Data Fields follow)	1	5	0B	hex
Data Field 4 (Write Address specifying Program Page 2)	1	6	0B	hex
Write Data (LSB...MSB)	8	7-14	xxxxxxxx xxxxxxxx	hex
DBCC (LSByte)	1	15	calculated	hex
DBCC (MSByte)	1	16	calculated	hex
BCC	1	17	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
Status (Valid MPT, Start byte detected, DBCC OK, FBCC OK)	1	2	1E	hex
Data	10	3-10	xxxxxxxx xxxxxxxx	hex
Read Address (specifying successful program of page 2)	1	11	09	hex
BCC	1	12	calculated	hex

Figure 15. Programming Data Format of the MPT Transponders

6.1.5.3 Lock Page

Table 18. LMP Command Format for Lock Page of MPT Transponder

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	05	hex
CMD 1 (Perform Single command, calculate FBCC, send Power Burst I and II with Data)	1	2	6C	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	3	32	hex
Data Field 2 (Power Burst II with 15 ms duration (Program burst))	1	4	07	hex
Data Field 3 (1 Data Fields follow)	1	5	01	hex
Data Field 4 (Write Address specifying Program Page 2)	1	6	0A	hex
BCC	1	7	5F	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
Status (Valid MPT, Start byte detected, DBCC OK, FBCC OK)	1	2	1E	hex
Data	10	3-10	xxxxxxxx xxxxxxxx	hex
Read Address (Specifying successful Lock of page 2)	1	11	0A	hex
BCC	1	12	calculated	hex

Figure 16. Lock Page Data Format of MPT Transponder

The Read Address consists of a 2-bit status field and a 6-bit page field. The status field provides information about the function the multipage transponder has executed and the page field shows which page was affected.

Note A: If the status indicates 'Reserved', the read data cannot be interpreted as identification data.

Figure 17. Response Data Format of MPT Transponder

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6.1.6   Device Commands Selective Address Multipage Transponder (SAMPT)

6.1.6.1   *Selective Read Page*

Table 19. LMP General Read Data Format of MPT 16/17

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	07	hex
CMD 1 (Perform Single command, calculate FBCC, send Power Burst I with Data)	1	2	4C	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	3	32	hex
Data Field 2 (4 Data Fields follow)	1	4	04	hex
Data Field 3 (Write Address specifying selective Read Page 2)	1	5	0B	hex
Data Field 4 (Selective Address LSB)	1	6	56	hex
Data Field 5 (Selective Address)	1	7	34	hex
Data Field 6 (Selective Address MSB)	1	8	12	hex
BCC	1	9	06	hex

Response format is the same as for the General Read of MPT 1 6/17 (see Section 6.1.5.1).

Figure 18. Data Format of the Selective Read Page

6.1.6.2 Selective Program Page

Table 20. LMP Program Page data Format of SAMPT Transponder

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	12	hex
CMD 1 (Perform Single command, calculate FBCC, send Power Burst I and II with Data)	1	2	6C	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	3	32	hex
Data Field 2 (Power Burst II with 15 ms duration (Program burst))	1	4	0F	hex
Data Field 3 (14 Data Fields Follow)	1	5	0E	hex
Data Field 4 (Write Address specifying Program Page 2)	1	6	09	hex
Data Field 5 (Selective Address LSB)	1	7	56	hex
Data Field 5 (Selective Address)	1	8	34	hex
Data Field 6 (Selective Address MSB)	1	9	12	hex
Programming Data (LSB...MSB)	8	10-17	xxxxxxxx xxxxxxxx	hex
Data Field 16 (DBCC LSByte)	1	18	9F	hex
Data Field 17 (DBCC MSByte)	1	19	BD	hex
BCC	1	20	34	hex

Response format is the same as for the Program Page of MPT 1 6/17 (see Section 6.1.5.2).

Figure 19. Data Format of the Selective Program Page Function

6.1.6.3 Selective Lock Page

Table 21. LMP Lock Page data Format of SAMPT Transponder

Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	08	hex
CMD 1 (Perform single command, calculate FBCC, send Power Burst I and II with Data)	1	2	6C	hex
Data Field 1 (Power Burst I with 50 ms duration (charge-up))	1	3	32	hex
Data Field 2 (Power Burst II with 15 ms duration (Program. burst))	1	4	0F	hex
Data Field 3 (4 Data fields follow)	1	5	04	hex
Data Field 4 (Write address specifying Lock Page 2)	1	6	0A	hex
Data Field 5 (Selective Address LSB)	1	7	56	hex
Data Field 5 (Selective Address)	1	8	34	hex
Data Field 6 (Selective Address MSB)	1	9	12	hex
BCC	1	20	27	hex

Response format is the same as for the Lock Page of MPT 1 6/17 (see Section 6.1.5.3).

Figure 20. Data Format of the Selective Lock Page Function

6.2 Bit Sequence Protocol BSP

The Bit Sequence Protocol is similar to the Legacy Microreader Protocol LMP but has some enhancements. It can be used for transponders that are not implemented in the Easy Code Mode ECM or if special features are required. Using this protocol requires deep knowledge about the used transponder because the downlink to the transponder must be defined bitwise.

The response to a BSP command is the raw data received from the transponder including the Start Byte but without the Pre-Bits.

6.2.1 BSP Command Format

Table 22 shows the BSP command format.

Table 22. BSP Command Format (Full)

Start Byte	Length	CMD1	CMD2	CMD3	Power Burst 1
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5-6
0x01	0xnn	1nnn nnnn bin	1nnn nnnn bin	0nnn nnnn bin	0xnnnn

Power Burst 2	Number of TX Bits	Data	Number of RX Bytes	BCC
Byte 7-8	Byte 9	Byte 10...n	Byte n + 1	Byte n + 2
0xnnnn	0xnn	0xnn.....	0xnn	calculated

- Start Byte is always 0x01.
- The Length byte indicates the length in bytes of the following command and data fields.
- CMD1 to CMD3 are command bytes that are used to configure the behavior of the downlink, such as Power Bursts or Timing. Bit 8 of CMD1 and CMD2 must be 1, and Bit 8 of CMD3 must be 0.
- Power Burst 1 is an optional 16-bit value that defines the length of the Power Burst 1 in milliseconds (65 seconds maximum)
- Power Burst 2 is an optional 16-bit value that defines the length of the Power Burst 2 in milliseconds (65 seconds maximum)
- Number of TX Bits defines the length of the downlink to the transponder in bits. This value must be equal to or less then the number of data bits available in the Data section. If no Data is specified, this field is omitted.
- Data contains the data that is sent as downlink to the transponder. LSByte comes first. LSBit of LSByte is transmitted first.
- Number of RX Bytes is the number of bytes that are expected from the transponder during the uplink. Count starts at the first bit of the Start Byte.
- BCC is a 1-byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole command excluding the Start Byte.

The fields Power Burst 1, Power Burst 2, Number of TX Bits, and Data are optional, depending on the value of CMD1.

6.2.1.1   *Command Bytes CMD1, CMD2, CMD3*

Command bytes are used to configure the downlink protocol to the transponder; for example, it can be specified if a power burst is needed, if data should be sent to the transponder, the duration of a power burst, or the downlink timing that should be used. Finally, special handling of the transmit mode, for instance if the carrier stays on after the data is transmitted, can be set.

Table 23. Command Byte CMD1

CMD1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	Data	Power Burst 2	0	Power Burst 1	0	0	0

- Bit 3: Power Burst 1 must be set if the command has a value for the duration of the Power Burst 1 specified (Charge Burst).
- Bit 5: Power Burst 2 must be set if the command has a value for the duration of the Power Burst 2 specified (Program Burst).
- Bit 6: Data indicates that the command contains a Data field and also the Number of TX Bits field.

Table 24. Command Byte CMD2

CMD2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	Downlink Timing				0	Wireless Synchronization	0

- Bit 1: Enables the Wireless Synchronization.
- Bit 3-6: Downlink Timing specifies the timing used for the downlink to the transponder (see Table 25).

Table 25. CMD2 Downlink Timing Coding

Downlink Timing	Bit 6	Bit 5	Bit 4	Bit 3
PWM (R/W and MPT)	0	0	0	0
PWM (Auto)	0	0	0	1
PPM	0	0	1	0
BLC (HDX+)	0	0	1	1
BLC (Auto) with SOF, EOF	0	1	0	0
BLC (Auto) with SOF without EOF	0	1	0	1
RFU	.	.	.	.

Table 26. Command Byte CMD3

CMD3							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	RFU	RFU	RFU		Send Ton first	Special TX Mode	

- Bit 0 and 1: Special TX Mode are used to set special behavior of the TX signal (carrier). See table 28
- Bit 2: Send Ton first reverses, if set, the timing specification of the downlink. One single bit of the downlink is composed of a time where the carrier is off (Toff) and a time where the carrier is on (Ton). Normally the carrier off (Toff) comes first. This can be changed to Ton first by setting this bit.

Table 27. Special TX Mode

Mode	Bit 1	Bit 0
Normal	0	0
Keep TX on after downlink	0	1
Set TX on again after uplink is received	1	0
RFU	1	1

6.2.2 BSP Command Response Format

The response to a BSP command contains, besides the standard protocol information, two Status Bytes and the raw data received from the transponder.

Table 28. BSP Command Response Format

Start Byte	Length	Status 1	Status 2	Raw Data	BCC
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4...n	Byte n + 1
0x01	0xnn	0xnn	0xnn...	0xnn...	calculated

- The Start Byte has a fixed value of 0x01 and marks the beginning of the response.
- The Length byte indicates the length in bytes of the following status and data fields.
- Status 1 and Status 2 are used to show the status of the host to reader communication and the reader to transponder communication
- The length of the Raw Data depends on the Number of RX Bytes specified in the command. If a transponder uplink was detected the first data byte (byte number 4) contains in bit 0 the first bit of the Start Byte received from the transponder.
- The BCC Field is a one byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole response excluding the Start Byte.

The Raw Data contains the bit sequence receive from the transponder. Byte number 4 of the response, which is the first byte of the raw data, contains in bit 0 the first data bit received from the transponder. This is the first bit of the Start Byte.

The following table shows the bit sequence in the Raw Data.

Table 29. Raw Data Bit Sequence

Byte Number 4								Byte Number 5								Byte Number 6							
7	6	5	4	3	2	1	0 [(1)]	15	14	13	12	11	10	9	8								16

[(1)] Bit 0 of Byte Number 4 is the first bit received.

6.3 Easy Code Mode (ECM)

This protocol was implemented so that user does not need deep knowledge of the device used. It should free the user from knowing the timings, meanings of all of the bits, the sequence in which they must be sent, or how they are received from the transponder.

Only a minimum of information is necessary to construct an ECM reader command. This includes the device that is used in form of a device code, the command that should be sent to the device and, if any, the parameters that belongs to the command.

The reader's response will contain status information and also data, if data was requested with the command.

The raw structure of an ECM command is:

Device Code	Command	Parameters and Data

The raw structure of an ECM response is:

Status Information	Data

6.3.1 ECM Command Format

To fit into the Microreader's protocol structure, an ECM reader command needs additional byte fields. Table 30 shows an ECM reader command in detail.

Table 30. ECM Command Format

Start Byte	Length	CMD1	CMD2 Device Code	Device Command	Parameter, Data (optional)	BCC
Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5...n**	**Byte 5 or Byte n + 1**
0x01	0xnn	0x80	0xnn	0xnn	0xnn....	calculated

- The Start Byte has a fixed value of 0x01 and marks the beginning of the command.
- The Length byte indicates the length in bytes of the following command and data fields.
- CMD1 has a value of 0x80 (single command)
- CMD2 is the device code (see Section 6.3.1.1)
- Device Command (see Section 6.3.1.2)
- The Parameter and Data Field is optional; whether or not it is present, as well as the number of bytes, depends on the device command.
- The BCC Field is a one byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole command excluding the Start Byte.

6.3.1.1 ECM Device Codes

Table 31 shows the implemented devices and their corresponding Device Codes.

Table 31. ECM Device Codes

Device	Device Type	Device Code (6 Bits)
Read Only Transponder	TMS3719	0x00
Read Write Transponder	TMS37124	0x01
Multipage MPT 16/17	TMS3789 / TMS37159	0x02
HDX+	TMS37190	0x03
RFU		⋮
PaLFI	TMS37157	0x07
RFU		⋮
Raw Data of Last Command		0x2F

The last Device Code is added for debug purpose. With this code (0x2F) the reader does not initiate a downlink to the transponder but instead respond with the raw data received from the transponder at the last cycle.

6.3.1.2 ECM Command Codes

Command Codes are divided into four groups:
- Read
- Program
- Lock and Protect
- Special

Table 32 shows the valid Command Codes for each device type.

Table 32. ECM Command Codes Overview

Group	Command	Command Code	Valid for Device				
			RO	R/W	MPT	HDX+	PaLFI
Read	Charge only Read	0x00	X	X	X	X	
	General Read	0x01			X	X	X
	Selective Read	0x02				X	
	Read Multi Block	0x03				X	
	Selective Read Multi Block	0x04				X	
	Read UID	0x05				X	
	Read Configuration	0x06				X	
	....	.....					
Program	RFU	0x10					
	Program	0x11		X	X	X	X
	Selective Program	0x12				X	X
	Program Multi Blocks	0x13				X	
	Selective Prog. Multi Blocks	0x14				X	
	Program (CRC by Reader)	0x15		X	X		
	Write Configuration	0x16				X	
	Write AID (CRC by Reader)	0x17				X	
	Write TI R/W Transponder	0x18				X	
	Write C-Trim Value	0x19				X	
	....	.....					

Table 32. ECM Command Codes Overview (continued)

Lock And Protect	Lock	0x20			X	X	X
	....	.....					
	Selective Lock	0x22				X	X
	Protect	0x23					X
	Selective Protect	0x24					X
	....	.....					
Special	RFU	0x30					
	RFU	0x31					
	RFU	0x32					
	Battery Check	0x33					X
	Battery Charge	0x34					X
	MSP Access	0x35					X
	Successive Approximation C-Trim	0x36				X	
	Stay Quiet	0x37				X	

6.3.2 ECM Command Response Format

Table 33. ECM Command Response Format

Start Byte	Length	Status 1	Status 2	Data	BCC
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4...n	Byte n + 1
0x01	0xnn	0xnn	0xnn.....	0xnn.....	calculated

- The Start Byte has a fixed value of 0x01 and marks the beginning of the response.
- The Length byte indicates the length in bytes of the following status and data fields.
- Status 1 and Status 2 are used to show the status of the host to reader communication and the reader to transponder communication
- The presence of the Data Field is optional and depends, as well as the number of bytes, on the ECM command.
- The BCC Field is a one byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole response excluding the Start Byte.

6.3.2.1 Status Byte Format

The Status Bytes, Status 1 and Status 2, are used to show the status of the host to reader communication and the reader to transponder communication.

Bit 0 of Status 1 is used to distinguish between host to reader and reader to transponder. If Bit 0 of Status 1 has a value of 1 host to reader protocol status is shown. In this case Status 2 has a value of 0x00.

Table 34. Status Byte Definition for Host to Reader Protocol Status

Status Byte 1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	Parameter Error	Unknown Device Code	Unknown Command Code	1
Status Byte 2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	0

- Bit 1 "Unknown Command Code" of Status 1 is set to 1 if a Command code is sent to the reader that is not defined.
- Bit 2 "Unknown Device Code" of Status 1 is set to 1 if a Device code is sent to the reader that is not defined.
- Bit 3 "Parameter Error" of Status 1 is set to 1 if the length of the Parameter and Data field does not match with the Device and Command combination or if one of the Parameters is out of the allowed bounds.

If any of these errors occurred, no downlink is sent to the transponder.

The response has the Length Byte set to 0x02, because no Data is returned.

If Bit 0 of Status 1 has a value of 0 reader to transponder protocol status is shown.

If no Error occurred or no status information is available, Status Bytes 1 and Status Byte 2 have a value of 0x00, which means the last command was executed successfully.

If the Status Byte 1 has a value of 0x00 and Status Byte 2 has a value that is not equal 0x00, then Status Byte 2 shows not an error condition but only additional status information. For example, this could happen when reading a page from a MPT transponder and get the status that the read page is a locked page, which is not an error condition.

Table 35. Status Byte Definition for Reader to Transponder Protocol Status

Status Byte 1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Error shown in Status Byte 2	0	No Start Byte detected	Frame BCC Error	Data BCC (CRC) Error	Tag to Reader Protocol Error	Wrong Start Byte detected	0
Status Byte 2							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Raw Data follows	Command Groups			Error Codes			

- Bit 1 of Status Byte 1 "Wrong Start Byte detected" is set to 1 if a Start Byte is received by the reader that does not match the Device Code used in the reader command.
- Bit 2 of Status Byte 1 "Tag to Reader Communication Error" is set to 1 if no or a wrong Stop Byte is received by the reader. This can happen if the received data is incomplete. The bit is also set if wrong trailing bits are received.
- Bit 3 of Status Byte 1 "Data BCC (CRC) Error" is set to 1 if the BCC (CRC) received from the transponder does not match with the transponder ID.
- Bit 4 of Status Byte 1 "Frame BCC Error" is set to 1 if the frame sent by the transponder has a BCC error. Frame BCC are not available at all transponders. MPT and HDX+ can have a frame BCC
- Bit 5 of Status Byte 1 "No Start Byte Detected" is set to 1 if no valid Start Byte is detected.
- Bit 6 of Status Byte 1 is always 0
- Bit 7 of Status Byte 1 indicates that Status Bytes 2 shows an error condition.

In error cases (Status Byte 1 not equal 0x00) no transponder data is responded.

The ECM command with device code 0x2F can be used to get the received raw data.

The following Table shows the error coding in Status Byte 2.

Bit 7 of Status Byte 1 indicates if Status Byte 2 shows an error or if only additional status information is available (i.e. read of locked page).

The status information in Status Byte 2 is organized into two sections. The first section, bits 0 to 3 show the actual error code. Bits 4 to 6 indicate the command groups as Reader, Program, Lock and Special commands.

Table 36. Coding of Status Byte 2

Description	Error		Command Groups			Error Codes				
	Status 1 Bit Number	Status Byte 2 Bit Number								
	7	7	6	5	4	3	2	1	0	
No error	0	0	0	0	0	0	0	0	0	
Read locked page	0	0	0	0	0	0	0	0	1	Read
Page not available	1	0	0	0	0	0	0	1	0	Read
RFU		0	0	0	0					Read
Page is locked	1	0	0	0	1	0	0	0	1	Program
Page not available	1	0	0	0	1	0	0	1	0	Program
Programming not successful (or unreliable)	1	0	0	0	1	0	0	1	1	Program
Programming not successful (field strength too low)	1	0	0	0	1	0	1	0	0	Program
RFU		0	0	0	1					Program
Page is locked	1	0	0	1	0	0	0	0	1	Lock and Protect
Page not available	1	0	0	1	0	0	0	1	0	Lock and Protect
Locking not successful (or unreliable)	1	0	0	1	0	0	0	1	1	Lock and Protect
Locking not successful (field strength too low)	1	0	0	1	0	0	1	0	0	Lock and Protect
RFU		0	0	1	0					Lock and Protect
SPI programming failed	1	0	0	1	1	0	0	0	1	Special
MSP access execution failed	1	0	0	1	1	0	0	1	0	Special
RFU		0	0	1	1					Special
Raw data received from transponder to follow	0	1	X	X	X	X	X	X	X	Special
Unknown	1	0	X	X	X	1	1	1	1	Special

6.3.3   Device Commands Read Only Transponder

Table 37. Device Commands Read Only Transponder

Device	TMS3719 Based
Device Code	0x00
Downlink Timing	none

6.3.3.1   Charge Only Read

Read Only Transponders support a command called "Charge Only Read". The response data contain a 16-bit checksum and a 64-bit ID.

Table 38. ECM Charge only Read Command Format

Charge Only Read (Device Command 0x00)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	00	hex
Device Command	1	4	00	hex
BCC	1	5	83	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
CRC	2	4,5	xxxx	hex
ID	8	6-13	xxxxxxxx xxxxxxxx	hex
BCC	1	14	calculated	hex

6.3.4 Device Commands Read Write Transponder R/W

Table 39. Device Commands Read Write Transponder R/W

Device	TMS37124
Device Code	0x01
Downlink Timing	PWM (R/W and MPT)

Three different commands are supported for the R/W transponders which all have the same response format.

6.3.4.1 Charge Only Read

Table 40. ECM Charge Only Read Command Format

Charge Only Read (Device Command 0x00)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	01	hex
Device Command	1	4	00	hex
BCC	1	5	82	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
CRC	2	4,5	xxxx	hex
ID	8	6-13	xxxxxxxx xxxxxxxx	hex
BCC	1	14	calculated	hex

6.3.4.2 Program/Configuration

For the configuration, an additional Keyword and Password is needed (see description of TMS37124 device).

Table 41. ECM Program Command Format for R/W

Program Read/Write (Device Command 0x11)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0F	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	01	hex
Device Command	1	4	11	hex
Keyword	1	5	xx	hex
Password	1	6	xx	hex
CRC	2	7,8	xxxx	hex
ID	8	9-16	xxxxxxxx xxxxxxxx	hex
BCC	1	17	calculated	hex

Response format is the same as for the Charge Only Read (see Section 6.3.4.1).

6.3.4.3 Program/Configuration With CRC Calculated by Reader

For the configuration an additional Keyword and Password is needed (see description of TMS37124 device). The CRC for the ID is calculated by the reader.

Table 42. ECM Command Format Program(CRC Calc) Command Format for R/W

Program Read/Write with CRC calculation (Device Command 0x15)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0D	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	01	hex
Device Command	1	4	15	hex
Keyword	1	5	xx	hex
Password	1	6	xx	hex
ID	8	7-14	xxxxxxxx xxxxxxxx	hex
BCC	1	15	calculated	hex

Response format is the same as for the Charge Only Read (see Section 6.3.4.1).

6.3.5 Device Commands Multipage Transponder MPT 16/17

**Table 43. Device Commands Multipage Transponder
MPT 16/17**

Device	TMS3789, TMS37159
Device Code	0x02
Downlink Timing	PWM (R/W and MPT)

Five different commands are supported for the MPT transponders,. All commands have the same response format. The response to the "Charge Only Read" is different for the MPT16 and MPT17 transponders. The MPT16 transponder responds with the content of page 1 in the RO transponder format which has a Start Byte and a Stop Byte of 0x7E. The MPT17 transponder responds with the content of page 1 but in the MPT format with the "Read Address" instead of a fixed Stop Byte.

6.3.5.1 Charge Only Read

Table 44. ECM Charge Only Read Command Format for MPT

Charge Only Read (Device Command 0x00)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	02	hex
Device Command	1	4	00	hex
BCC	1	5	81	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0D	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Data	10	4-13	xxxxxxxx xxxxxxxx	hex
Read Address	1	14	xx	hex
BCC	1	15	calculated	hex

6.3.5.2   General Read Page

This command reads one page with 80 bits of data from a MPT transponder.

Table 45. ECM Read Page Command Format for MPT

General Read Page (Device Command 0x01)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	02	hex
Device Command	1	4	01	hex
Page Number	1	5	xx	hex
BCC	1	6	calculated	hex

Response format is the same as for the Charge Only Read (see Section 6.3.4.1).

6.3.5.3   Program Page

This command programs a page of a MPT transponder with 80 bits of data.

Table 46. ECM Program Page Command Format for MPT

Program Page (Device Command 0x11)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0E	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	02	hex
Device Command	1	4	11	hex
Page Number	1	5	xx	hex
Write Data	10	6-15	xxxxxxxx xxxxxxxx	hex
BCC	1	16	calculated	hex

Response format is the same as for the Charge Only Read (see Section 6.3.4.1).

6.3.5.4 *Program Page 64 Bits, CRC Calculated by Reader*

This command programs one page of a MPT transponder with 80 bits of data. With the command 64 bits are specified and the reader adds 16 bits of CRC to the data.

Table 47. ECM Program Page (CRC Calc) Command Format for MPT

Program Page, CRC by Reader (Device Command 0x15)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	02	hex
Device Command	1	4	15	hex
Page Number	1	5	xx	hex
Write Data	8	6-13	xxxxxxxx xxxxxxxx	hex
BCC	1	15	calculated	hex

Response format is the same as for the Charge Only Read (see Section 6.3.4.1).

6.3.5.5 *Lock Page*

This command locks one page of a MPT transponder.

Table 48. ECM Lock Page Command Format for MPT

Lock Page (Device Command 0x20)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	02	hex
Device Command	1	4	20	hex
Page Number	1	5	xx	hex
BCC	1	6	calculated	hex

Response format is the same as for the Charge Only Read (see Section 6.3.4.1).

6.3.6   Device Commands for HDX+ Transponder

Table 49. Device Commands for HDX+ Transponder

Device	TMS37190 (HDX+)
Device Code	0x03
Downlink Timing	BLC (HDX+)

17 different commands are defined for the HDX+ transponders. Because HDX+ transponders are configurable, some commands work only with a specific transponder configuration.

6.3.6.1   Charge Only Read

The response to the "Charge Only Read" is the same as for a RO transponder.

Table 50. ECM Charge Only Read Command Format for HDX+

Charge Only Read (Device Command 0x00)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	00	hex
BCC	1	5	80	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
CRC	2	4-5	xxxx	hex
ID	8	6-13	xxxxxxxx xxxxxxxx	hex
BCC	1	14	calculated	hex

6.3.6.2 Read UID

The command reads the 48 bit UID of the transponder.

Table 51. ECM Read UID Command Format for HDX+

Read UID (Device Command 0x05)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	05	hex
BCC	1	5	85	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	08	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
UID	6	4-9	xxxx xxxxxxxx	hex
BCC	1	10	calculated	hex

6.3.6.3 General Read (Memory Read Single Block)

This command reads a 32-bit block from the transponder memory.

Table 52. ECM General Read Command Format for HDX+

General Read (Single Block) (Device Command 0x01)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	01	hex
Block Number (0x00-0x0F)	1	5	xx	hex
BCC	1	6	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	08	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Memory Data	4	4-7	xxxxxxxx	hex
BCC	1	8	calculated	hex

6.3.6.4 Selective Read (Memory Read Single Block Addressed)

This command reads a 32-bit block from the transponders memory if the specified UID matches the transponders UID.

Table 53. ECM Selective Read Command Format for HDX+

Selective Read (Single Block Addressed) (Device Command 0x02)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	02	hex
UID	6	5-10	xxxx xxxxxxxx	hex
Block Number (0x00-0x0F)	1	11	xx	hex
BCC	1	12	calculated	hex

Response format is the same as for the General Read (Memory Read Single Block) command (see Section 6.3.6.3).

6.3.6.5 Read Multi Block (Memory Read Two Blocks)

This command reads two 32-bit blocks from the transponders memory.

Table 54. ECM Read Multi Block Command Format for HDX+

Read Multi Block (Device Command 0x03)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	03	hex
Start Block Number (0x00-0x0E)	1	5	xx	hex
BCC	1	6	calculated	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	08	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Memory Data First Block	4	4-7	xxxxxxx	hex
Memory Data Second Block	4	8-11	xxxxxxxx	hex
BCC	1	12	calculated	hex

6.3.6.6 Selective Read Multi Block

This command reads two 32-bit block from the transponders memory if the specified UID matches the transponders UID.

Table 55. ECM Selective Read Multi Block Command Format for HDX+

Selective Read Multi Block (Device Command 0x04)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	04	hex
UID	6	5-10	xxxx xxxxxxxx	hex
Start Block Number (0x00-0x0E)	1	11	xx	hex
BCC	1	12	calculated	hex

Response format is the same as for the Read Multi Block command (see Section 6.3.6.5).

6.3.6.7 Program (Memory Write Single Block)

This command writes a 32-bit block to the transponders memory.

Table 56. ECM Program Command Format for HDX+

Program (Device Command 0x11)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	08	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	11	hex
Block Number (0x00-0x0F)	1	5	xx	hex
Write Data	4	6-9	xxxxxxxx	hex
BCC	1	10	calculated	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
BCC	1	4	calculated	hex

6.3.6.8   Selective Program (Memory Write Single Block Addressed)

This command writes a 32-bit block to the transponders memory if the specified UID matches the transponders UID.

Table 57. ECM Selective Program Command Format for HDX+

Selective Program (Device Command 0x12)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0E	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	12	hex
UID	6	5-10	xxxx xxxxxxxx	hex
Block Number (0x00-0x0F)	1	11	xx	hex
Write Data	4	12-15	xxxxxxxx	hex
BCC	1	16	calculated	hex

Response format is the same as for the Program command (see Section 6.3.6.7).

6.3.6.9   Program Multi Blocks (Memory Write two Blocks)

This command writes two 32-bit blocks to the transponders memory.

Table 58. ECM Program Multi Block Command Format for HDX+

Program Multi Blocks (Device Command 0x13)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	13	hex
First Block Number (0x00-0x0E)	1	5	xx	hex
Write Data First Block	4	6-9	xx	hex
Write Data Second Block	4	10-13	xxxxxxxx	hex
BCC	1	14	calculated	hex

Response format is the same as for the Program command (see Section 6.3.6.7).

6.3.6.10 Selective Program Multi Blocks (Memory Write two Blocks Addressed)

This command writes two 32-bit blocks to the transponders memory if the specified UID matches the transponders UID.

Table 59. ECM Selective Program Multi Block Command Format for HDX+

Selective Program Multi Blocks (Device Command 0x14)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	12	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	14	hex
UID	6	5-10	xxxx xxxxxxxx	hex
First Block Number (0x00-0x0E)	1	11	xx	hex
Write Data First Block	4	12-15	xxxxxxxx	hex
Write Data Second Block	4	16-19	xxxxxxxx	hex
BCC	1	20	calculated	hex

Response format is the same as for the Program command (see Section 6.3.6.7).

6.3.6.11 Lock Block

This command locks a 32-bit block of the transponders memory.

Table 60. ECM Lock Block Command Format for HDX+

Lock Block (Device Command 0x20)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	20	hex
Block Number (0x00-0x0F)	1	5	xx	hex
BCC	1	6	calculated	hex

Response format is the same as for the Program command (see Section 6.3.6.7).

6.3.6.12 Selective Lock Block

This command locks a 32-bit block of the transponders memory if the specified UID matches the transponders UID.

Table 61. ECM Program Selective Lock Block Command Format for HDX+

Selective Lock Block (Device Command 0x22)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	22	hex
UID	6	5-10	xxxx xxxxxxxx	hex
Block Number (0x00-0x0F)	1	11	xx	hex
BCC	1	12	calculated	hex

Response format is the same as for the Program command (see Section 6.3.6.7).

6.3.6.13 Read Configuration

This command reads the configuration bytes "Config Byte 1" and "Config Byte 2" from the transponders memory.

Table 62. ECM Read Config Command Format for HDX+

Read Configuration (Device Command 0x06)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	06	hex
BCC	1	5	86	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Config Byte 1	1	4	xx	hex
Config Byte 2	1	5	xx	hex
BCC	1	6	calculated	hex

6.3.6.14 Write Configuration

This command writes the configuration bytes "Config Byte 1" and "Config Byte 2" to the transponders memory.

Table 63. ECM Write Config Command Format for HDX+

Write Configuration (Device Command 0x16)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	05	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	16	hex
Config Byte 1	1	5	xx	hex
Config Byte 2	1	6	xx	hex
BCC	1	7	calculated	hex

Response format is the same as for the Read Configuration command (see Section 6.3.6.13).

6.3.6.15 Write AID

This command writes the AID to the transponder. The CRC that belongs to this AID is calculated by the reader and also written to the transponder.

Table 64. ECM Write AID Command Format for HDX+

Write AID (Device Command 0x17)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0B	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	17	hex
AID	8	5-12	xxxxxxxx xxxxxxxx	hex
BCC	1	13	calculated	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
CRC	2	4,5	xxxx	hex
AID	8	6-13	xxxxxxxx xxxxxxxx	hex
BCC	1	14	calculated	hex

6.3.6.16 Program C-Trim Switches

This command programs a 6-bit value to the transponder C-Trim switches for the trimming of the resonance frequency.

Table 65. ECM Program C-Trim Switches Command Format for HDX+

Program C-Trim Switches (Device Command 0x19)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	19	hex
Trim Value (0x00-0x3F)	1	5	xx	hex
BCC	1	6	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Trim Value	1	5	xx	hex
BCC	1	6	calculated	hex

6.3.6.17 Stay Quiet

This command sets the transponder to the "Quiet" state if the sent UID matches the transponder UID. Do to the fact that there is no response from the transponder to this command the status will always show ok.

Table 66. ECM Stay Quiet Command Format for HDX+

Stay Quiet (Device Command 0x37)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	09	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	37	hex
UID	6	5-10	xxxx xxxxxxxx	hex
BCC	1	11	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	2	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
BCC	1	4	calculated	hex

6.3.6.18 Write TI R/W Transponder

This command programs a HDX+ transponder that is configured to be TI R/W transponder with 80 bits of data.

Table 67. ECM Write TI R/W Command Format for HDX+

Program TI R/W Transponder (Device Command 0x18)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0D	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	03	hex
Device Command	1	4	18	hex
Write Data	10	5-14	xxxxxxxx xxxxxxxx	hex
BCC	1	15	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	0C	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Data	10	4-13	xxxxxxxx xxxxxxxx	hex
BCC	1	14	calculated	hex

6.3.7 Device Commands PaLFI

Table 68. Device Commands PaLFI

Device	TMS37157
Device Code	0x07
Downlink Timing	PPM

6.3.7.1 General Read

This command reads a page with 6 bytes of data from the PaLFI memory. Valid page numbers are 1 to 3, 8 to 15, and 40 to 55.

Table 69. ECM General Read Command Format for PaLFI

General Read (Device Command 0x01)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	01	hex
Page Number (1-3, 8-15, 40-55)	1	5	xx	hex
BCC	1	6	calculated	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	08	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Data (see byte order in Table 70)	6	4-9	xxxx xxxxxxxx	hex
BCC	1	10	calculated	hex

Table 70 describes the byte order of the response data.

Table 70. Byte Order of Response Data

Response Data Byte Order						
Page	Byte					
	5	4	3	2	1	0
1-3[1]	Serial Number	Serial Number	Serial Number	Manufacturer	Data Page 2	Selective Address
8-15	Data 4	Data 3	Data 2	Data 1	Data 0	Data Page 2
40-55	Data 4	Data 3	Data 2	Data 1	Data 0	Data Page 2
8-15	Data 4	Data 3	Data 2	Data 1	Data 0	Data Page 2
40-55	Data 4	Data 3	Data 2	Data 1	Data 0	Data Page 2

[1] A read to pages 1 to 3 responds with the same data for all three pages.

6.3.7.2   Selective Read

This command reads a page with 6 bytes of data from the PaLFI memory when the specified Selective Address matches the Selective Address of the transponder (data in page 1). Selective addressing is enabled when page 1 contains a value other than 0xFF.Valid page numbers are 1 to 3.

Table 71. ECM Selective Read Command Format for PaLFI

Selective Read (Device Command 0x02)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	05	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	02	hex
Selective Address	1	5	xx	hex
Page Number (1-3)	1	6	xx	hex
BCC	1	7	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.3   Program (Pages 1-2)

This command writes a page with 1 byte of data to the PaLFI memory.Valid page numbers are 1 and 2.Page 1 contains the Selective Address. Any value other than 0xFF enables selective addressing. Page 2 contains 1 byte of user data.

Table 72. ECM Program Command Format for PaLFI

Program (Device Command 0x11)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	09	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	11	hex
Page Number (1, 2)	1	5	xx	hex
Data	1	6	xx	hex
BCC	1	7	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.4   Program (Pages 8-15, 40-55)

This command writes a page with 5 bytes of data to the PaLFI memory.Valid page numbers are 8 to 15 and 40 to 55.

Table 73. ECM Program Command Format for PaLFI

Program (Device Command 0x11)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	09	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	11	hex
Page Number (8-15, 40-55)	1	5	xx	hex
Data	5	6-10	xxxxxxxxxx	hex
BCC	1	11	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.5   Selective Program (Pages 1-2)

This command writes a page with 1 byte of data to the PaLFI memory when the specified Selective Address matches the Selective Address of the transponder (data in page 1).Selective addressing is enabled when page 1 contains a value other than 0xFF.Valid page numbers are 1 and 2. (Ê Page 3 is factory locked)

Table 74. ECM Selective Program Command Format for PaLFI

Selective Program (Device Command 0x12)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	12	hex
Selective Address	1	5	xx	hex
Page Number (1, 2)	1	6	xx	hex
Data	1	7	xx	hex
BCC	1	8	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.6 Selective Program (Pages 8-15, 40-55)

This command writes a page with 5 bytes of data to the PaLFI memory when the specified Selective Address matches the Selective Address of the transponder (data in page 1).

Selective addressing is enabled when page 1 contains a value other than 0xFF.

Valid page numbers are 8 to 15 and 40 to 55 (page 3 is factory locked).

Table 75. ECM Selective Program Command Format for PaLFI

Selective Program (Device Command 0x12)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0A	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	12	hex
Selective Address	1	5	xx	hex
Page Number (8-15, 40-55)	1	6	xx	hex
Data	5	7-11	xxxxxxxxxx	hex
BCC	1	12	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.7 Lock

This command locks a page of the PaLFI memory. Valid page numbers are 1 to 2, 8 to 15 and 40 to 55 (Page 3 is factory locked).

NOTE: Locked pages cannot be programmed.

Locked pages cannot be unlocked.

Table 76. ECM Lock Command Format for PaLFI

Lock (Device Command 0x20)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	20	hex
Page Number (1,2, 8-15, 40-55)	1	5	xx	hex
BCC	1	6	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.8 Selective Lock

This command locks a page of the PaLFI memory if the specified Selective Address matches the Selective Address of the transponder (data in page 1). Selective addressing is enabled when page 1 contains a value other than 0xFF. Valid page numbers are 1, 2, 8 to 15 and 40 to 55.

> **NOTE:** Locked pages cannot be programmed.
>
> Locked pages cannot be unlocked.

Table 77. ECM Selective Lock Command Format for PaLFI

Selective Lock (Device Command 0x22)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	05	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	22	hex
Selective Address	1	5	xx	hex
Page Number	1	6	xx	hex
BCC	1	7	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.9 Protect

This command protects a page of the PaLFI memory.

Protected pages can only be reprogrammed via SPI. The protection is irreversible!

Valid page numbers are 8 to 15 and 40 to 55.

Table 78. ECM Protect Command Format for PaLFI

Protect (Device Command 0x23)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	23	hex
Page Number (8-15, 40-55)	1	5	xx	hex
BCC	1	6	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.10   Selective Protect

This command protects a page of the PaLFI memory if the specified Selective Address matches the Selective Address of the transponder (data in page 1).

Selective addressing is enabled when page 1 contains a value other than 0xFF.

Protected pages can only be reprogrammed via SPI. The protection is irreversible!

Valid page numbers are 8 to 15 and 40 to 55.

Table 79. ECM Selective Protect Command Format for PaLFI

Selective Protect (Device Command 0x24)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	05	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	24	hex
Selective Address	1	5	xx	hex
Page Number (8-15, 40-55)	1	6	xx	hex
BCC	1	7	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.11   MSP Access

This command starts a SPI cycle and sends 6 bytes of data to the device connected to the SPI interface. When the "MSP Access Time" is elapsed the data received at the SPI interface is sent back to the reader. Set the "MSP Access Time" to 0x0000 if no response is expected.

Table 80. ECM MSP Access Command Format for PaLFI

MSP Access (Device Command 0x35)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	0B	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	35	hex
Data	6	5-10	xxxx xxxxxxxx	hex
MSP Access Time (ms)	2	11-12	xxxx	hex
BCC	1	13	calculated	hex

Response format is the same as for the General Read command (see Section 6.3.7.1).

6.3.7.12 Battery Check

This command gives information about the charge condition of the battery.

Table 81. ECM Battery Check Command Format for PaLFI

Battery Check (Device Command 0x33)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	33	hex
BCC	1	5	B7	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Data	1	4	xx	hex
BCC	1	5	calculated	hex

6.3.7.13 Battery Charge

This command starts a charge of the battery.

The transponder does not respond to this command. Any following command that initiates a downlink to the device stops the charge cycle.

Table 82. ECM Battery Charge Command Format for PaLFI

Battery Charge (Device Command 0x34)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	07	hex
Device Command	1	4	34	hex
BCC	1	5	B0	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
BCC	1	4	calculated	hex

6.3.7.14 Relation Between PaLFI Read Address and MRD2 ECM Status Bytes

The TMS37157 device has a Read Address defined in the response protocol. This is a one byte value that holds in bit 7 to 2 the page address of the page that was address by the command. If no error occurs, this is the address that was specified in the Write Address part of the command that was sent to the transponder. The bits 1 and 0 are used to give status information about the last executed command.

Table 83 shows the relationship between this status information and the Status Byte 1 and 2 that is return by the reader when using the ECM protocol.

Table 83. Relation Between PaLFI Read Address and MRD2 Status Bytes

Page Number	Command	Read Address Bit [7:2]	Read Address Bit [1:0]	Error Status 1 Bit 7	Status Byte 2	Comment
1-3	Read and Selective Read	> 0	00	0	0x00	Read unlocked page
			01	1	0x0F	Unknown
			10	0	0x01	Read locked page
			11	1	0x0F	Unknown
		0	00	1	0x0F	Unknown
			01	1	0x0F	Unknown
			10	1	0x0F	Unknown
			11	1	0x0F	Unknown
	Program and Selective Program	> 0	00	1	0x14	Programming not executed; field strength too low
			01	0	0x00	Done
			10	1	0x11	Page is locked
			11	1	0x1F	Unknown
		0	00	1	0x1F	Unknown
			01	1	0x13	Programming possibly not reliable
			10	1	0x1F	Unknown
			11	1	0x1F	Unknown
	Lock and Selective Lock	> 0	00	1	0x24	Lock not executed; field strength too low
			01	1	0x2F	Unknown
			10	0	0x21	Done
			11	1	0x2F	Unknown
		0	00	1	0x23	Locking possibly not reliable
			01	1	0x2F	Unknown
			10	1	0x23	Locking possibly not reliable
			11	1	0x2F	Unknown

Table 83. Relation Between PaLFI Read Address and MRD2 Status Bytes (continued)

Page Number	Command	Read Address Bit [7:2]	Read Address Bit [1:0]	Error Status 1 Bit 7	Status Byte 2	Comment
8-15 and 40-55	Read	> 0	00	0	0x00	Read unlocked page
			01	1	0x0F	Unknown
			10	0	0x01	Page is locked
			11	1	0x0F	Unknown
		0	00	1	0x0F	Unknown
			01	1	0x0F	Unknown
			10	1	0x0F	Unknown
			11	1	0x0F	Unknown
	Program and Selective Program	> 0	00	1	0x14	Programming not executed; field strength too low
			01	0	0x00	Done
			10	1	0x11	Page is locked
			11	1	0x1F	Unknown
		0	00	1	0x1F	Unknown
			01	1	0x13	Programming possibly not reliable
			10	1	0x1F	Unknown
			11	1	0x1F	Unknown
	Lock And Selective Lock	> 0	00	1	0x24	Lock not executed; field strength too low
			01	1	0x2F	Unknown
			10	0	0x21	Done
			11	1	0x2F	Unknown
		0	00	1	0x23	Locking possibly not reliable
			01	1	0x2F	Unknown
			10	1	0x23	Locking possibly not reliable
			11	1	0x2F	Unknown
	Protect and Selective Protect	> 0	00	1	0x24	Protection not set; field strength too low (unlocked page)
			01	1	0x2F	Unknown
			10	1	0x24	Protection not set; field strength too low (locked page)
			11	0	0x00	Done
		0	00	1	0x2F	Unknown
			01	1	0x2F	Unknown
			10	1	0x2F	Unknown
			11	1	0x23	Protection set but possibly not reliable
19	Battery Check	> 0	00	0	0x00	Read unlocked page
			01	1	0x3F	Unknown
			10	1	0x3F	Unknown
			11	1	0x3F	Unknown
		0	00	1	0x3F	Unknown
			01	1	0x3F	Unknown
			10	1	0x3F	Unknown
			11	1	0x3F	Unknown

Table 83. Relation Between PaLFI Read Address and MRD2 Status Bytes (continued)

Page Number	Command	Read Address Bit [7:2]	Read Address Bit [1:0]	Error Status 1 Bit 7	Status Byte 2	Comment
31	MSP Access	> 0	00	1	0x31	SPI Programming failed
			01	0	0x3x	MSP Access execution ok
			10	1	0x3F	Unknown
			11	1	0x3F	Unknown
		0	00	1	0x32	MSP Access execution failed
			01	1	0x32	MSP Access execution failed
			10	1	0x3F	Unknown
			11	1	0x3F	Unknown

6.3.7.15 Device Command Raw Data Response

Table 84. Device Command Raw Data Response

Device	All
Device Code	0x2F
Downlink Timing	Not applicable

For debug purpose a special device code is defined. If this device code is used, the reader responds with the raw data that was received from the transponder during the last command. The length of the response depends on the number of bits received.

Table 85. ECM Raw Data Response Command Format

Raw Data Response				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	80	hex
Device Code (CMD2)	1	3	2F	hex
Don't care	1	4	00	hex
BCC	1	5	AC	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	xx	hex
Status 1	1	2	xx	hex
Status 2	1	3	xx	hex
Raw Data	n	4-n	xx ... xx	hex
BCC	1	n + 1	calculated	hex

The Raw Data contains the bit sequence receive from the transponder. Byte number 4 of the response, which is the first byte of the raw data, contains in bit 0 the first data bit receive from the transponder. This the first bit of the Start Byte. The following table shows the bit sequence in the Raw Data.

Table 86. Raw Data Bit Sequence

Byte Number 4								Byte Number 5								Byte Number 6							
7	6	5	4	3	2	1	0 [1]	15	14	13	12	11	10	9	8								16

[1] Bit 0 in Byte Number 4 is the first bit received.

6.4 Setup Mode

The current Microreader protocol specification has no setup mode defined.

The RI-STU-MRD2 protocols are extended with a setup mode to maintain the following functionality:

- Get firmware / protocol version and hardware type
- Get serial number
- Get and set timing parameter
- Carrier on or off for field-strength measurements
- Get last measured low bit frequency
- Set up serial port baud rate
- Save to flash setting and restore to factory defaults
- Automated determination of the C-Trim value
- Initiation of the inventory process
- Protocol specific settings

The new defined setup mode commands are specified within the Command Field 2.

> **NOTE:** All values that are altered are temporary and are lost after a reset or power down of the reader. Use the "Save Settings" command to store the settings in the reader's flash memory.

Table 87. Setup Mode Command Byte 2

CMD2	Description	Influence on Protocol[1]		
		LMP	BSP	ECM
0x00	Get firmware version			
0x01	Get protocol version			
0x02	Get hardware type			
0x03	Get serial number			
0x04	Get PWM timing		•	•
0x05	Set PWM timing		•	•
0x06	Get PWM (R/W and MPT) timing		•	•
0x07	Set PWM (R/W and MPT) timing		•	•
0x08	Get PPM timing		•	•
0x09	Set PPM timing		•	•
0x0A	Get BLC (HDX+) timing		•	•
0x0B	Set BLC (HDX+) timing		•	•
0x0C	Get BLC (Auto) timing		•	•
0x0D	Set BLC (Auto) timing		•	•
...	RFU (new timing specs)			
0x10	Set Duration Power Burst I (Charge)	•[2]	•[2]	•
0x11	Get Duration Power Burst I (Charge)			•
0x12	Set Duration Power Burst II (Program)	•[2]	•[2]	•
0x13	Get Duration Power Burst II (Program)			•

[1] LMP = Legacy Microreader Protocol, BSP = Bit Sequence Protocol, ECM = Easy Code Mode
[2] If Power Burst in Protocol defined as 0.

Table 87. Setup Mode Command Byte 2 (continued)

....	RFU			
0x20	Set downlink CRC in HDX+ protocol (on or off)			•
0x21	Set uplink CRC in HDX+ protocol (on or off)			•
0x23	Set check R/W Data CRC (on or off)			•
0x24	Set check MPT Data CRC (on or off)			•
....	RFU			
0x30	Start Inventory (1-slot)			
....	RFU			
0x40	Set serial port communication speed (baud rate)	•	•	•
0x41	Get low bit frequency of last uplink			
0x43	Execute C-trimming			
0x44	Carrier (on or off)			
0x45	OKT pin timing	•		•
0x46	STAT pin mode	•	•	•
0x47	Get status of SIG_IN_0			
0x48	Get status of SIG_IN_1			
0x49	Set output SIG_OUT_0			
0x4A	Set output SIG_OUT_1			
0x4B	RFU			
0x4C	Set demodulation threshold mode	•	•	•
0x4D	Power Reader (RFM) connected (on or off)	•	•	•
0x50	Save settings to flash			
0x51	Restore settings to defaults (needs additional keyword)			

6.4.1   Setup Command Format

Table 88. Setup Command Format

Start Byte	Length	CMD1	CMD2	Data (optional)	BCC
Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4...n**	**Byte 4 or Byte n + 1**
0x01	0xnn	0x83	0xnn	0xnn.....	calculated

- Start Byte has a fixed value of 0x01 and marks the beginning of the command.
- Length indicates the length in bytes of the following command and data fields.
- CMD1 has a fixed value of 0x83 for setup mode commands.
- CMD2 represents the command.
- The presence of the Data Field is optional; whether or not it is included and its number of bytes depends on the command specified as CMD2.
- BCC Field is a one-byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole command excluding the Start Byte.
- An unknown Setup Command returns 0x01 0x00 0x00.

6.4.2   Setup Command Response Format

Table 89. Setup Command Response Format

Start Byte	Length	Data	BCC
Byte 0	**Byte 1**	**Byte 2...n**	**Byte n + 1**
0x01	0xnn	0xnn...	calculated

• Start Byte has a fixed value of 0x01 and marks the beginning of the response.

• Length indicates the length in bytes of the following data fields.

• The length of the Data Field depends on the command that was sent.

• BCC is a one-byte value of the Longitudinal Redundancy Check calculation (XORed bytes) for the preceding message. The calculation is performed on the whole response excluding the Start Byte.

6.4.3   Setup Commands

The following section is a detailed description of all available setup mode commands.

6.4.3.1   Get Firmware Version (Command 0x00)

Response is the version of the firmware in a two-byte format. Each byte can be 0 to 99 (decimal).

The minor version byte is always interpreted as two digits.

Examples:
    Major byte = 0x01 and Minor Byte = 0x02 indicates version 1.02.
    Major byte = 0x01 and Minor Byte = 0x14 indicates version 1.20.

Table 90. Setup Get Firmware Version Command Format

Get Firmware Version (0x00)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	00	hex
BCC	1	4	81	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Firmware Version Major	1	2	xx	hex
Firmware Version Minor	1	3	xx	hex
BCC	1	4	calculated	

6.4.3.2 Get Protocol Version (Command 0x01)

The protocol version is incremented if changes relevant to the protocol are made in the firmware; for example, if a new device is implemented.

Response is the version of the protocol in a two-byte format. Each byte can range from 0 to 99 (decimal). The minor version byte is always interpreted as two digits.

Examples:

Major byte = 0x01 and Minor Byte = 0x02 indicates version 1.02.
Major byte = 0x01 and Minor Byte = 0x14 indicates version 1.20.

Table 91. Setup Get Protocol Version Command Format

Get Protocol Version (0x01)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	01	hex
BCC	1	4	80	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Protocol Version Major	1	2	xx	hex
Protocol Version Minor	1	3	xx	hex
BCC	1	4	calculated	

6.4.3.3   Get Hardware Type (Command 0x02)

If hardware changes made that are relevant for the user, for instance added new features, the hardware type information is changed. Response is the hardware type of the reader in a two byte format. Both bytes can range from 0 to 99 (decimal). The minor hardware type byte is always interpreted as two numbers.

Examples:

Major byte = 0x01 and Minor Byte = 0x02 indicates type 1.02.
Major byte = 0x01 and Minor Byte = 0x14 indicates type 1.20.

Table 92. Setup Get Hardware Type Command Format

Get Hardware Type (0x02)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	02	hex
BCC	1	4	83	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Hardware Type Major	1	2	xx	hex
Hardware Type Minor	1	3	xx	hex
BCC	1	4	calculated	

6.4.3.4   Get Serial Number (Command 0x03)

This command can be used for a unique identification of a reader module.

Table 93. Setup Get Serial Number Command Format

Get Serial Number (0x03)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	03	hex
BCC	1	4	82	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	08	hex
MSP430 Wafer Lot and Position	8	2-9	xxxxxxxx xxxxxxxx	hex
BCC	1	10	calculated	

6.4.3.5 Get PWM Timing (Command 0x04)

The currently active parameters for the PWM downlink timing are reported with this command. Each of the four timing parameters is reported as two bytes which represents the timing in microseconds.

Table 94. Setup Get PWM Timing Command Format

Get PWM Timing (0x04)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	04	hex
BCC	1	4	85	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	08	hex
toffLow (µs)	2	2-3	xxxx	hex
tonLow (µs)	2	4-5	xxxx	hex
toffHigh (µs)	2	6-7	xxxx	hex
tonHigh (µs)	2	8-9	xxxx	hex
BCC	1	10	calculated	

6.4.3.6   Set PWM Timing (Command 0x05)

This command can be used to change the PWM downlink timing parameters. Each of the four timing values must be specified as two bytes and represents the timing in microseconds. If any timing value is set to zero, the complete PWM timing is set to factory default values.

Table 95. Setup Set PWM Timing Command Format

Set PWM Timing (0x05)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	0A	hex
CMD 1		1	2	83	hex
CMD 2		1	3	05	hex
toffLow (µs)	170 µs	2	4,5	xxxx	hex
tonLow (µs)	330 µs	2	6,7	xxxx	hex
toffHigh (µs)	480 µs	2	8,9	xxxx	hex
tonHigh (µs)	520 µs	2	10,11	xxxx	hex
BCC		1	12	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	08	hex
toffLow (µs)		2	2,3	xxxx	hex
tonLow (µs)		2	4,5	xxxx	hex
toffHigh (µs)		2	6,7	xxxx	hex
tonHigh (µs)		2	8,9	xxxx	hex
BCC		1	10	calculated	

6.4.3.7 Get PWM (R/W and MPT) Timing (Command 0x06)

The currently active parameters for the PWM downlink timing, which is used for R/W and MPT transponders, are reported with this command. Each of the four timing parameters is reported as two bytes that represent the timing in microseconds.

Table 96. Setup Get PWM Timing Command Format

Get PWM (R/W and MPT) Timing (0x06)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	06	hex
BCC	1	4	87	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	08	hex
toffLow (µs)	2	2-3	xxxx	hex
tonLow (µs)	2	4-5	xxxx	hex
toffHigh (µs)	2	6-7	xxxx	hex
tonHigh (µs)	2	8-9	xxxx	hex
BCC	1	10	calculated	

6.4.3.8   Set PWM (R/W and MPT) Timing (Command 0x07)

This command can be used to change the PWM downlink timing parameters, which are used for R/W and MPT transponders. Each of the four timing parameters is reported as two bytes that represent the timing in microseconds. If any timing value is set to zero the complete PWM (R/W and MPT) timing is set to factory default values.

Table 97. Setup Set PWM Timing Command Format

Set PWM (R/W and MPT) Timing (0x07)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	0A	hex
CMD 1		1	2	83	hex
CMD 2		1	3	07	hex
toffLow (µs)	300 µs	2	4-5	xxxx	hex
tonLow (µs)	1700 µs	2	6-7	xxxx	hex
toffHigh (µs)	1000 µs	2	8-9	xxxx	hex
tonHigh (µs)	1000 µs	2	10-11	xxxx	hex
BCC		1	12	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	08	hex
toffLow (µs)		2	2-3	xxxx	hex
tonLow (µs)		2	4-5	xxxx	hex
toffHigh (µs)		2	6-7	xxxx	hex
tonHigh (µs)		2	8-9	xxxx	hex
BCC		1	10	calculated	

6.4.3.9 Get PPM Timing (Command 0x08)

The currently active parameters for the PPM downlink timing are reported with this command. Each of the four timing values is specified as two bytes that represent the timing in microseconds.

Table 98. Get PPM Timing Command Format

Get PPM Timing (0x08)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	08	hex
BCC	1	4	89	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	08	hex
toffLow (µs)	2	2-3	xxxx	hex
tonLow (µs)	2	4-5	xxxx	hex
toffHigh (µs)	2	6-7	xxxx	hex
tonHigh (µs)	2	8-9	xxxx	hex
BCC	1	10	calculated	

6.4.3.10   Set PPM Timing (Command 0x09)

This command can be used to change the PPM downlink timing parameters. Each of the four timing values must be specified as two bytes that represent the timing in microseconds. If any timing value is set to zero, the complete PPM timing is set to factory default values.

Table 99. Set PPM Timing Command Format

Set PPM Timing (0x09)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	0A	hex
CMD 1		1	2	83	hex
CMD 2		1	3	09	hex
toffLow (µs)	170µs	2	4-5	xxxx	hex
tonLow (µs)	230µs	2	6-7	xxxx	hex
toffHigh (µs)	170µs	2	8-9	xxxx	hex
tonHigh (µs)	350µs	2	10-11	xxxx	hex
BCC		1	12	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	08	hex
toffLow (µs)		2	2-3	xxxx	hex
tonLow (µs)		2	4-5	xxxx	hex
toffHigh (µs)		2	6-7	xxxx	hex
tonHigh (µs)		2	8-9	xxxx	hex
BCC		1	10	calculated	

6.4.3.11 Get BLC (HDX+) Timing (Command 0x0A)

The currently active parameters for the BLC downlink timing are reported with this command. Each of the eight timing parameters is reported as two bytes that represent the timing in microseconds.

Table 100. Setup Get BLC Timing Command Format

Get BLC (HDX+) Timing (0x0A)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	0A	hex
BCC	1	4	8B	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	10	hex
SOFoff (µs)	2	2-3	xxxx	hex
SOFon (µs)	2	4-5	xxxx	hex
toffLow (µs)	2	6-7	xxxx	hex
tonLow (µs)	2	8-9	xxxx	hex
toffHigh (µs)	2	10-11	xxxx	hex
tonHigh (µs)	2	12-13	xxxx	hex
EOFoff (µs)	2	14-15	xxxx	hex
EOFon (µs)	2	16-17	xxxx	hex
BCC	1	18	calculated	

6.4.3.12 Set BLC (HDX+) Timing (Command 0x0B)

This command can be used to change the BLC (HDX+) downlink timing parameters.

Each of the eight timing values must be specified as two bytes that represent the timing in microseconds.

If any timing value is set to zero the complete BLC (HDX+) timing is set to factory default values.

Table 101. Setup Set BLC Timing Command Format

Set BLC (HDX+) Timing (0x0B)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	12	hex
CMD 1		1	2	83	hex
CMD 2		1	3	0B	hex
SOFoff (µs)	298 µs	2	4-5	xxxx	hex
SOFon (µs)	499 µs	2	6-7	xxxx	hex
toffLow (µs)	149 µs	2	8-9	xxxx	hex
tonLow (µs)	171 µs	2	10-11	xxxx	hex
toffHigh (µs)	149 µs	2	12-13	xxxx	hex
tonHigh (µs)	238 µs	2	14-15	xxxx	hex
EOFoff (µs)	149 µs	2	16-17	xxxx	hex
EOFon (µs)	373 µs	2	18-19	xxxx	hex
BCC		1	20	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	10	hex
SOFoff (µs)		2	2-3	xxxx	hex
SOFon (µs)		2	4-5	xxxx	hex
toffLow (µs)		2	6-7	xxxx	hex
tonLow (µs)		2	8-9	xxxx	hex
toffHigh (µs)		2	10-11	xxxx	hex
tonHigh (µs)		2	12-13	xxxx	hex
EOFoff (µs)		2	14-15	xxxx	hex
EOFon (µs)		2	16-17	xxxx	hex
BCC		1	18	calculated	

6.4.3.13 Get BLC (Automotive) Timing (Command 0x0C)

The currently active parameters for the BLC (Automotive) downlink timing are reported with this command. Each of the 8 timing parameters is reported as 2 bytes which represents the timing in microseconds.

Table 102. Setup Get BLC (Automotive) Timing Command Format

Get BLC (Automotive) Timing (0x0C)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	0C	hex
BCC	1	4	8D	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	10	hex
SOFoff (µs)	2	2-3	xxxx	hex
SOFon (µs)	2	4-5	xxxx	hex
toffLow (µs)	2	6-7	xxxx	hex
tonLow (µs)	2	8-9	xxxx	hex
toffHigh (µs)	2	10-11	xxxx	hex
tonHigh (µs)	2	12-13	xxxx	hex
EOFoff (µs)	2	14-15	xxxx	hex
EOFon (µs)	2	16-17	xxxx	hex
BCC	1	18	calculated	

6.4.3.14 Set BLC (Automotive) Timing (Command 0x0D)

This command can be used to change the BLC (Automotive) downlink timing parameters.

Each of the eight timing values must be specified as two bytes and represents the timing in microseconds. If any timing value is set to zero the complete BLC (Automotive) timing is set to factory default values.

Table 103. Set BLC (Automotive) Timing Command Format

Set BLC (Auto) Timing (0x0D)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	12	hex
CMD 1		1	2	83	hex
CMD 2		1	3	0D	hex
SOFoff (µs)	170 µs	2	4-5	xxxx	hex
SOFon (µs)	460 µs	2	6-7	xxxx	hex
toffLow (µs)	170 µs	2	8-9	xxxx	hex
tonLow (µs)	230 µs	2	10-11	xxxx	hex
toffHigh (µs)	170 µs	2	12-13	xxxx	hex
tonHigh (µs)	350 µs	2	14-15	xxxx	hex
EOFoff (µs)	170 µs	2	16-17	xxxx	hex
EOFon (µs)	580 µs	2	18-19	xxxx	hex
BCC		1	20	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	10	hex
SOFoff (µs)		2	2-3	xxxx	hex
SOFon (µs)		2	4-5	xxxx	hex
toffLow (µs)		2	6-7	xxxx	hex
tonLow (µs)		2	8-9	xxxx	hex
toffHigh (µs)		2	10-11	xxxx	hex
tonHigh (µs)		2	12-13	xxxx	hex
EOFoff (µs)		2	14-15	xxxx	hex
EOFon (µs)		2	16-17	xxxx	hex
BCC		1	18	calculated	

6.4.3.15 *Set Duration of Power Burst 1 (Command 0x10)*

This command can be used to change the duration of the Power Burst 1.

If the duration is set to zero, the duration is set to the factory default value.

Table 104. Setup Set Duration Power Burst 1 Command Format

Set Duration Power Burst 1 (0x10)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	04	hex
CMD 1		1	2	83	hex
CMD 2		1	3	10	hex
Duration (ms)	50 ms	2	4-5	xxxx	hex
BCC		1	6	calculated	
Response (n+1 times)					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	02	hex
Duration		2	2,3	xxxx	hex
BCC		1	4	calculated	

6.4.3.16 *Get Duration of Power Burst 1 (Command 0x11)*

The currently active parameter for the Power Burst 1 duration is reported with this command.

Table 105. Setup Get Duration Power Burst 1 Command Format

Get Duration Power Burst 1 (0x11)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	11	hex
BCC	1	4	90	hex
Response (n+1 times)				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Duration	2	2-3	xxxx	hex
BCC	1	4	calculated	

6.4.3.17   Set Duration of Power Burst 2 (Command 0x12)

This command can be used to change the duration of the Power Burst 2.

If the duration is set to zero, the duration is set to the factory default value.

Table 106. Setup Set Duration Power Burst 2 Command Format

Set Duration Power Burst 2 (0x12)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	04	hex
CMD 1		1	2	83	hex
CMD 2		1	3	12	hex
Duration (ms)	17 ms	2	4-5	xxxx	hex
BCC		1	6	calculated	
Response (n+1 times)					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	02	hex
Duration		2	2,3	xxxx	hex
BCC		1	4	calculated	

6.4.3.18   Get Duration of Power Burst 2 (Command 0x13)

The currently active parameter for the Power Burst 2 duration is reported with this command.

Table 107. Setup Get Duration Power Burst 2 Command Format

Get Duration Power Burst 2 (0x13)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	13	hex
BCC	1	4	93	hex
Response (n+1 times)				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
Duration	2	2-3	xxxx	hex
BCC	1	4	calculated	

6.4.3.19 Set Downlink CRC in HDX+ Protocol (Command 0x20)

HDX+ transponders can use a CRC in the downlink protocol. This command can be used to turn this function on or off.

Set the parameter to 0x00 to turn off this function, or set to 0x01 to turn on this function. Any other value does not change the setting but instead the current setting is returned.

Table 108. Set Downlink CRC Command Format

Set-Downlink CRC in HDX+ protocol on or off (0x20)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	20	hex
Data	on	1	4	0 = off 1 = on	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (returns current setting)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.20 Set-Uplink CRC in HDX+ Protocol (Command 0x21)

HDX+ transponders can use a CRC in the uplink protocol. This command can be used to turn this function on or off.

Set the parameter to 0x00 to turn off this function, or set to 0x01 to turn on this function. Any other value does not change the setting but instead the current setting is returned.

Table 109. Setup Set Uplink CRC Command Format

Uplink CRC in HDX+ Protocol On or Off (0x21)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	21	hex
Data	off	1	4	0 = off 1 = on	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (returns current setting)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.21   Set or Check R/W Data CRC (Command 0x23)

R/W transponders provide 80-bit data. This data can be handled as 80-bit data or as 64-bit data and 16-bit CRC. When using the ECM protocol, this CRC is checked and the result is reported in the status byte. This check can be turned on or off with this command.

Set the parameter to 0x00 to turn off this function, or set to 0x01 to turn on this function. Any other value does not change the setting but instead the current setting is returned.

Table 110. Set or Check R/W Data CRC Command Format

Check R/W Data CRC On or Off (0x23)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	23	hex
Data	on	1	4	0 = off 1 = on	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (returns current setting)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.22　Set or Check MPT Data CRC (Command 0x24)

MPT transponders have 80-bit data in each memory page. This data can be handled as 80-bit data or as 64-bit data and 16-bit CRC. When using the ECM protocol, this CRC is checked and the result is reported in the status byte. This check can be turned on or off with this command.

Set the parameter to 0x00 to turn this function off, or set to 0x01 to turn it on. Any other value does not change the setting but instead the current setting is returned.

Table 111. Setup Check MPT CRC Command Format

Check MPT Data CRC On or Off (0x24)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	24	hex
Data	off	1	4	0 = off 1 = on	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (returns current setting)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.23   Start 1-Slot Inventory Process (Command 0x30)

Execution of this command start the 1-slot inventory process for HDX+ advanced Transponders. Reader responds with every found UID. A timeout in seconds must be specified for this process.

Status Byte is 01 for the first valid UID that is returned and is incremented for each new responded UID.

Status Byte is 00 if inventory has finished (UID in response is invalid).

Status Byte is FF if timeout has occurred (UID in response is invalid).

Table 112. Setup Start 1-Slot Inventory Process Command Format

Start 1-Slot Inventory Process (0x30)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	83	hex
CMD 2	1	3	30	hex
Timeout (s)	1	4	xx	hex
BCC	1	5	calculated	
Response (n+1 times)				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	07	hex
Status Byte	1	2	xx	hex
UID	6	3-8	xxxx xxxxxxxx	hex
BCC	1	9	calculated	

6.4.3.24   Set Serial Port Communication Speed (Command 0x40)

The communication speed of the serial port can be set with this command.

All other communication parameters are set fix to 1 stop bit, 8 data bits, no parity, and no handshake (XON and XOFF software handshake is used with a Microreader-specific functionality). Response to command is done with the same baud rate as the command was sent.

Valid values range from 1 to 6. Any other value sets the baud rate to 9600 baud.

A value of 0xFF does not change the setting; instead, the current setting is returned.

Table 113. Set Serial Port Com Speed Command Format

Set Serial Port Communication Speed (0x40)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	83	hex
CMD 2	1	3	40	hex
Baud rate setup value (see Table 114)	1	4	xx	hex
BCC	1	5	calculated	
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Baud rate setup value (see Table 114)	1	2	xx	hex
BCC	1	3	calculated	

Table 114. Speed Byte Data Format

Value	Baud Rate	Remark
0 or 1	9600	Factory default
2	14400	
3	19200	
4	38400	
5	57600	
6	115200	
>6 to 0xFE	9600	Factory default
0xFF	Keeps current setting	Returns current setting

6.4.3.25 Get Last Measured Low-Bit Frequency (Command 0x41)

Returns the low-bit frequency of the last transponder response in Hertz. For example, a return value of 01 03 02 0C 38 xx equals 134.2 kHz.

Table 115. Setup Get Last Measured Low Bit Freq Command Format

Read Last Measured Low-Bit Frequency (0x41)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	41	hex
BCC	1	4	C0	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	03	hex
Low Bit Frequency (Hz)	3	2-4	xxxxxx	hex
BCC	1	5	calculated	

6.4.3.26 *Execute C-Trimming (Command 0x43)*

This command starts a C-trimming sequence to adjust the transponder resonance frequency to a given target frequency. Because this procedure is device-dependent, the additional specification of the device is necessary. The target frequency must be specified in Hertz. For example, a target frequency of 02 0C 38 equals 134.2 kHz.

This command does not work when using an external RFM module (power reader).

Table 116. Setup Execute C-Trim Command Format

Execute C-Trimming (0x43)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	06	hex
CMD 1	1	2	83	hex
CMD 2	1	3	43	hex
Device Code (see Table 117)	1	4	xx	hex
Target Frequency	3	5-7	xxxxxxxx	hex
BCC	1	8	calculated	
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	05	hex
Status Byte	1	2	xx	hex
Programmed C-Trim Value	1	3	xx	hex
Measured Low-Bit Frequency	3	4-6	xxxxxx	hex
BCC	1	7	calculated	

Table 117. Device Code Values

Device	Device Code	
TMS37190 (HDX+)	0x03	

Table 118 shows the description of the status byte. A successful trimming procedure returns a status byte value of 0x00.

Table 118. Status Byte

	Bit	Description
Common	0	Unknown device code
	1	Target frequency out of range
	2	No or wrong transponder
	3	Trim value reached limit
Device Specific	Device 0x03 (HDX+)	Device 0xxx (RFU)
	4	Wrong transponder life cycle
	5	No or wrong response to C-trim command
	6	
	7	

6.4.3.27 Carrier On or Off (Command 0x44)

For field strength measurements this command can be used to turn on the 134.2-kHz carrier signal. A data value of zero turns off the carrier; any other value turns on the carrier. After a timeout of 65 seconds, the carrier is turned off.

Following commands, that generate a transponder downlink, will turn the carrier off.

Table 119. Carrier On or Off Command Format

Carrier On or Off (0x44)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	83	hex
CMD 2	1	3	44	hex
Data	1	4	0 = off ≠ 0 = on	hex
BCC	1	5	calculated	
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Data (repeat value from command)	1	2	xx	hex
BCC	1	3	calculated	

6.4.3.28 OKT Signal Timing (Command 0x45)

A successful read of a transponder sets the OKT signal active for 60 ms. This command can be used to reduce this time in 1-ms steps down to 0 ms. Reducing this time can send successive commands more quickly. Maximum is 60 ms.

Data set to 0xFF does not change the setting but does returns the current setting.

Table 120. OKT Signal Timing Command Format

OKT Signal Timing (0x45)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	45	hex
Data	0x3C (60ms)	1	4	xx	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (repeated from Command)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.29 *STAT SIgnal Mode (Command 0x46)*

Two different behaviours of the STAT signal pin are selectable.

If Data is set to 0x00, the STAT signal toggles at every change of the carrier signal and represents the downlink data (TXCT signal).

If Data is set to 0x01, the STAT signal toggle only at the end of the downlink and can be used for synchronisation purposes.

If Data is set to 0x02, the STAT signal represents the demodulated uplink data. In this mode the STAT signal is set to 1 after all uplink data is received or the receive process times out.

If Data is set to 0xFF, no changes are made to the setting; instead, the current setting is returned.

Table 121. Setup STAT Signal Mode Command Format

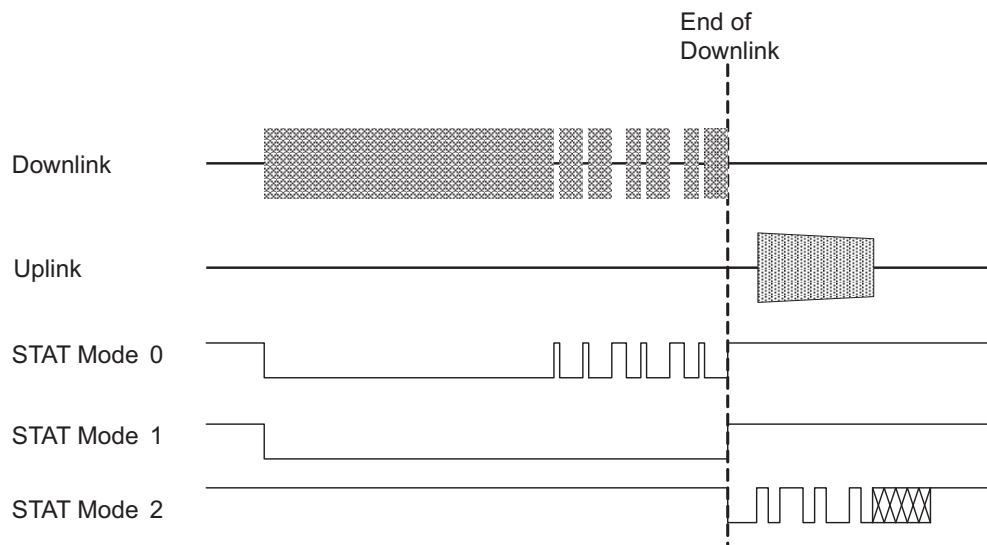| STAT Signal Mode (0x46)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	46	hex
Data	0x00	1	4	xx	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (repeated from Command)		1	2	xx	hex
BCC		1	3	calculated	

Figure 21. STAT Signal Mode

6.4.3.30 Get Status of SIG_IN_0 (Command 0x47)

Get the status of the general purpose input signal SIG_IN_0.

If external RFM is selected this signal is used as receive data (RXDT) and cannot be used for other functions (see Section 9).

Table 122. Setup Get Status of SIG_IN_0 Command Format

Get Status of SIG_IN_0 (0x47)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	47	hex
BCC	1	4	C6	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Data (0 or 1)	1	2	xx	hex
BCC	1	3	calculated	

6.4.3.31 Get Status of SIG_IN_1 (Command 0x48)

Get the status of the general purpose input signal SIG_IN_1.

If an external RFM is used, this signal is used as the receive clock (RXCK) and cannot be used for other functions (see Section 9).

Table 123. Setup Get Status of SIG_IN_1 Command Format

Get Status of SIG_IN_1 (0x48)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	48	hex
BCC	1	4	C9	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Data (0 or 1)	1	2	xx	hex
BCC	1	3	calculated	

6.4.3.32 Set Signal SIG_OUT_0 (Command 0x49)

Set the level of the general purpose output signal SIG_OUT_0.

A Data of 0 sets the pin to low, and a value of 1 sets the pins to high. Any other value does not change the pin state but instead returns the current state.

Table 124. Setup Set Status of SIG_OUT_0 Command Format

Set Signal SIG_OUT_0 (0x49)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	83	hex
CMD 2	1	3	49	hex
Data	1	4	0 or 1	hex
BCC	1	5	calculated	
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Data (repeated from Command)	1	2	xx	hex
BCC	1	3	calculated	

6.4.3.33 Set Signal SIG_OUT_1 (Command 0x4A)

Set the level of the general purpose output signal SIG_OUT_1.

A data of 0 set the pin to low, a value of 1 sets the pins to high. Any other value will not change the pin state but returns the current state.

If external RFM is selected this signal is used as transmit control (TXCT-) and cannot be used for other functions (see Section 9).

Table 125. Setup Set Status of SIG_OUT_1 Command Format

Set Status of SIG_OUT_1 (0x4A)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	03	hex
CMD 1	1	2	83	hex
CMD 2	1	3	4A	hex
Data	1	4	0 or 1	hex
BCC	1	5	calculated	
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Data (repeated from Command)	1	2	xx	hex
BCC	1	3	calculated	

6.4.3.34 Set Demodulation Threshold Mode (Command 0x4C)

Sets the mode for the demodulation of the uplink.

If Data is set to 0x00, the mode is set to automatic, which means that the low-bit frequency is measured and the threshold is set based on the measured frequency.

If Data is set to 0x01, the threshold is set to a fixed value of 130.2 kHz.

If Data is set to 0xFF, no settings are changed; instead the the current setting is returned.

This setting is ignored when using an external RFM module (power reader) (see Section 9).

Table 126. Setup Set Demodulation Threshold Mode Command Format

Set Demodulation Threshold Mode (0x4C)					
Command					
Parameter	**Factory Default**	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	4C	hex
Data	auto	1	4	0 = auto 1 = fixed	hex
BCC		1	5	calculated	
Response					
Parameter		**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (repeated from Command)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.35 Set External Power Reader (RFM) On or Off (Command 0x4D)

Instead of using the readers internal transmit and receive stage, it is possible to use an RFM module to extend the reader's operating range. The RFM module uses three control signals, one for transmit (TXTCT-) and two for receive (RXCK and RXDT). When the RFM mode is enables, the reader module signal SIG_IN_1 is used as RXCK, SIG_IN_0 as RXDT, and SIG_OUT_1 as TXCT- (see Section 9).

The transmit and receive stages of the reader are disabled in this case.

The measurement of the low-bit frequency is not possible when the RFM is used.

Table 127. Setup Set External Power Reader Command Format

Set External Power Reader (RFM) (0x4D)					
Command					
Parameter	Factory Default	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte		1	0	01	hex
Length		1	1	03	hex
CMD 1		1	2	83	hex
CMD 2		1	3	4D	hex
Data	off	1	4	0 = off 1 = on	hex
BCC		1	5	calculated	
Response					
Parameter		Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte		1	0	01	hex
Length		1	1	01	hex
Data (repeated from Command)		1	2	xx	hex
BCC		1	3	calculated	

6.4.3.36 Save Settings to Flash (Command 0x50)

Save temporary settings to the flash memory. After a reset or a power up, the saved settings are used.

Table 128. Setup save Setting to Flash Command Format

Save Settings to Flash (0x50)				
Command				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	02	hex
CMD 1	1	2	83	hex
CMD 2	1	3	50	hex
BCC	1	4	D1	hex
Response				
Parameter	**Length (Bytes)**	**Byte Number**	**Data (MSB...LSB)**	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Status (see Table 129)	1	2	xx	hex
BCC	1	3	calculated	

Table 129. Status Bit

Status	Description
0	OK
1	Save not OK

6.4.3.37 *Restore Settings to Factory Default (Command 0x51)*

This command sets back all parameters to factory defaults. To prevent accidentally restore of the settings to factory defaults an additional 2 bytes "keyword" of 0x55AA is added to the command.

Table 130. Setup Restore Settings to Factory Default Command Format

Restore Settings to Factory Default (0x51)				
Command				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	04	hex
CMD 1	1	2	83	hex
CMD 2	1	3	51	hex
Keyword	2	4-5	55AA	hex
BCC	1	6	29	hex
Response				
Parameter	Length (Bytes)	Byte Number	Data (MSB...LSB)	
Start Byte	1	0	01	hex
Length	1	1	01	hex
Status (see Table 131)	1	2	xx	hex
BCC	1	3	calculated	

Table 131. Status Bit

Status	Description
0	OK
1	Restore not OK

7   Operating Conditions

Table 132 shows the recommended operating conditions for the RI-STU-MRD2.

Table 132. Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
T_oper	Operating free-air temperature	-40		85	°C
T_store	Storage temperature	-40		85	°C
V_VSP	Supply voltage for power stage [1]	2.7	-	5.5	V
V_VSL	Supply voltage for logic [1]	2.7	-	5.5	V
I_VSP	Supply current for power stage at 5 V	-	100	-	mA
I_VSL	Supply current for logic at 5 V	-	30	-	mA
I_su	Output current sunk an output pin	-	-	15	mA
I_so	Output current sourced by an output pin	-	-	15	mA
I_sutot	Output current sunk by all output pins	-	-	60	mA
I_sotot	Output current sourced by all output pins	-	-	60	mA
V_ret	VSP start voltage to ensure power on reset	-	-	GND	-
Vrise_ret	VSP rise rate to ensure power on reset	0.1	-	-	V/ms
I_idle	Supply current when reader is idle	-	-	2	mA
I_USB_VBUS	Supply current when reader is idle and connected to USB	-	-	8	mA
I_act	Supply current when reader is active at 5 V	-	100	-	mA
ViH	Input high voltage	0.8 VSL	-	VSL	-
ViL	Input low voltage	GND	-	0.2 VSL	-
VoH	Output high voltage	VSL – 0.7	-	VSL	-
VoL	Output low voltage	GND	-	0.6	V
Q_Ant	Antenna quality factor	10	15	20	-
L_Ant	Antenna inductance value	46.1	47	47.9	µH
f_carrier	Carrier frequency	134.1	134.2	134.3	kHz

[1]   VSP and VSL supplies must have the same voltage.

8   Transponder Downlink Timings

Table 133 shows the default values for the different transponder downlink modulation types. All values can be modified by Setup Mode commands.

Table 133. Transponder Downlink Timings

	Bit H		Bit L		SOF		EOF	
Modulation	toffH (µs)	tonH (µs)	toffL (µs)	tonL (µs)	toffSOF (µs)	tonSOF (µs)	toffEOF (µs)	tonEOF (µs)
PWM (R/W and MPT)	1000	1000	300	1700	-	-	-	-
PWM (Auto)	480	520	170	330	-	-	-	-
PPM	170	350	170	230	-	-	-	-
BLC (HDX+)	149	238	149	171	298	499	149	373
BLC (Auto)	170	350	170	230	170	460	170	580

Table 134 shows the default values for Power Burst 1 and Power Burst 2.

Table 134. Default Power Burst Values

Power Burst 1 (Charge)	50 ms
Power Burst 2 (Program)	17 ms

9 External Power Reader Module (RFM)

To extend the readers operating distance an external power reader module (RFM) type numbers RI-RFM-007B, RI-RFM-008B can be connected to the RI-STU-MRD2.

Table 135 shows the signals that should be connected with the RFM module.

Table 135. Microreader RFM Connections

Microreader 2	DIL Pin	SMD Pin	RFM	Description
GND	15	13	GND	Ground
SIG_OUT_1	12	12	TXCT-	Transmit control (active low)
SIG_IN_0	13	14	RXDT	Receive data
SIG_IN_1	14	15	RXCK	Receive clock

Use Setup Mode function 0x4D (see Section 6.4.3.35) to enable the RFM module.

The measurement of the low-bit frequency is not possible in this mode. This means that automatic C-Trimming (Setup Mode 0x43) and the automatic detection of the demodulation threshold do not work in combination with the RFM module.

General Texas Instruments High Voltage Evaluation Module (TI HV EVM) User Safety Guidelines

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> # <u>WARNING</u>

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and the safety of those working around you. Contact TI's Product Information Center http://support.ti.com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitable qualified, you should immediately stop further use of the TI HV EVM.

1. Work Area Safety:
   (a) Keep work area clean and orderly.
   (b) Qualified observer(s) must be present any time circuits are energized.
   (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
   (e) Use a stable and nonconductive work surface.
   (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

2. Electrical Safety:

   As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.

   (a) De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   (c) Once EVM readiness is complete, energize the EVM as intended.

> # <u>WARNING</u>
>
> **While the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.**

---

3. Personal Safety:
   (a) Wear personal protective equipment; for example, latex gloves or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use: EVMs are not to be used as all or part of a production unit.

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