

HDX RFID Reader System

Microreader RI-STU-MRD2

Reference Guide



Literature Number: SCBU049

August 2012

| | | |
|----------|--|------------|
| 1 | Introduction | 7 |
| 2 | References | 8 |
| 3 | Definitions | 8 |
| | 3.1 Abbreviations | 8 |
| 4 | Product Description | 9 |
| | 4.1 Hardware SMD Module | 10 |
| | 4.2 Hardware DIL Module | 12 |
| | 4.3 Power Supply | 15 |
| | 4.4 Synchronization | 15 |
| | 4.5 Serial Port and USB Communication | 15 |
| | 4.6 Handshake | 16 |
| | 4.7 Trigger Mode | 16 |
| | 4.8 Continuous Mode | 16 |
| | 4.9 Demonstration Circuit | 17 |
| 5 | Antenna Construction | 18 |
| | 5.1 Q-Factor | 18 |
| | 5.2 Adapting the Inductance Range | 19 |
| 6 | Communication Between Host and Reader | 19 |
| | 6.1 Legacy Microreader Protocol (LMP) | 20 |
| | 6.2 Bit Sequence Protocol BSP | 33 |
| | 6.3 Easy Code Mode (ECM) | 36 |
| | 6.4 Setup Mode | 67 |
| 7 | Operating Conditions | 99 |
| 8 | Transponder Downlink Timings | 99 |
| 9 | External Power Reader Module (RFM) | 100 |

List of Figures

| | | |
|----|--|----|
| 1 | RI-STU-MRD2 Module | 7 |
| 2 | Overview | 9 |
| 3 | Top View With Pin Numbers of the Microreader 2 SMD Module | 10 |
| 4 | SMD Module Pin Configuration | 11 |
| 5 | Top, Front, and Side View Measurements of DIL Module | 12 |
| 6 | Microreader 2 Demonstration Circuit With USB Interface..... | 17 |
| 7 | BCC Field Example | 20 |
| 8 | LMP Command Byte Field 1 Example..... | 21 |
| 9 | LMP Command Byte Field 2 Example..... | 21 |
| 10 | BCC Field Example | 22 |
| 11 | Read Only Command Format..... | 24 |
| 12 | Read-Only Response Data Format | 24 |
| 13 | Programming Data Format of the 64-bit Read/Write Transponder | 25 |
| 14 | General Read Data Formats of MPT Transponders | 26 |
| 15 | Programming Data Format of the MPT Transponders | 27 |
| 16 | Lock Page Data Format of MPT Transponder..... | 28 |
| 17 | Response Data Format of MPT Transponder | 29 |
| 18 | Data Format of the Selective Read Page | 30 |
| 19 | Data Format of the Selective Program Page Function | 31 |
| 20 | Data Format of the Selective Lock Page Function..... | 32 |
| 21 | STAT Signal Mode | 92 |

List of Tables

| | | |
|----|--|----|
| 1 | Mechanical Data of SMD Module | 10 |
| 2 | SMD Module Pin Functions | 10 |
| 3 | Mechanical Data of DIL Module | 12 |
| 4 | Pin Functions DIL Module | 13 |
| 5 | Antenna Parameters | 18 |
| 6 | Transmit Stage Parameters | 18 |
| 7 | LMP Command Format (Full) | 20 |
| 8 | LMP Command Byte Field 1 Bit Format | 20 |
| 9 | LMP Command Byte Field 2 Bit Format | 21 |
| 10 | LMP Data Field Bit Format | 22 |
| 11 | LMP Command Response Format (Full) | 22 |
| 12 | LMP Status Byte Bit Format | 23 |
| 13 | LMP Response Data Bit Format | 23 |
| 14 | LMP Charge Only Read for Read-Only Transponder | 24 |
| 15 | LMP Program Command Format for R/W Transponder | 25 |
| 16 | General Read Page Command Format for MPT Transponder | 26 |
| 17 | LMP Program Page Command Format for MPT Transponder | 27 |
| 18 | LMP Command Format for Lock Page of MPT Transponder | 28 |
| 19 | LMP General Read Data Format of MPT 16/17 | 30 |
| 20 | LMP Program Page data Format of SAMPT Transponder | 31 |
| 21 | LMP Lock Page data Format of SAMPT Transponder | 32 |
| 22 | BSP Command Format (Full) | 33 |
| 23 | Command Byte CMD1 | 34 |
| 24 | Command Byte CMD2 | 34 |
| 25 | CMD2 Downlink Timing Coding | 34 |
| 26 | Command Byte CMD3 | 34 |
| 27 | Special TX Mode | 35 |
| 28 | BSP Command Response Format | 35 |
| 29 | Raw Data Bit Sequence | 35 |
| 30 | ECM Command Format | 36 |
| 31 | ECM Device Codes | 37 |
| 32 | ECM Command Codes Overview | 37 |
| 33 | ECM Command Response Format | 38 |
| 34 | Status Byte Definition for Host to Reader Protocol Status | 38 |
| 35 | Status Byte Definition for Reader to Transponder Protocol Status | 39 |
| 36 | Coding of Status Byte 2 | 40 |
| 37 | Device Commands Read Only Transponder | 41 |
| 38 | ECM Charge only Read Command Format | 41 |
| 39 | Device Commands Read Write Transponder R/W | 42 |
| 40 | ECM Charge Only Read Command Format | 42 |
| 41 | ECM Program Command Format for R/W | 43 |
| 42 | ECM Command Format Program(CRC Calc) Command Format for R/W | 43 |
| 43 | Device Commands Multipage Transponder MPT 16/17 | 44 |
| 44 | ECM Charge Only Read Command Format for MPT | 44 |
| 45 | ECM Read Page Command Format for MPT | 45 |
| 46 | ECM Program Page Command Format for MPT | 45 |
| 47 | ECM Program Page (CRC Calc) Command Format for MPT | 46 |

| | | |
|----|---|----|
| 48 | ECM Lock Page Command Format for MPT | 46 |
| 49 | Device Commands for HDX+ Transponder | 47 |
| 50 | ECM Charge Only Read Command Format for HDX+ | 47 |
| 51 | ECM Read UID Command Format for HDX+ | 48 |
| 52 | ECM General Read Command Format for HDX+ | 48 |
| 53 | ECM Selective Read Command Format for HDX+ | 49 |
| 54 | ECM Read Multi Block Command Format for HDX+ | 49 |
| 55 | ECM Selective Read Multi Block Command Format for HDX+ | 50 |
| 56 | ECM Program Command Format for HDX+ | 50 |
| 57 | ECM Selective Program Command Format for HDX+ | 51 |
| 58 | ECM Program Multi Block Command Format for HDX+ | 51 |
| 59 | ECM Selective Program Multi Block Command Format for HDX+ | 52 |
| 60 | ECM Lock Block Command Format for HDX+ | 52 |
| 61 | ECM Program Selective Lock Block Command Format for HDX+ | 53 |
| 62 | ECM Read Config Command Format for HDX+ | 53 |
| 63 | ECM Write Config Command Format for HDX+ | 54 |
| 64 | ECM Write AID Command Format for HDX+ | 54 |
| 65 | ECM Program C-Trim Switches Command Format for HDX+ | 55 |
| 66 | ECM Stay Quiet Command Format for HDX+ | 55 |
| 67 | ECM Write TI R/W Command Format for HDX+ | 56 |
| 68 | Device Commands PaLFI | 57 |
| 69 | ECM General Read Command Format for PaLFI | 57 |
| 70 | Byte Order of Response Data | 57 |
| 71 | ECM Selective Read Command Format for PaLFI | 58 |
| 72 | ECM Program Command Format for PaLFI | 58 |
| 73 | ECM Program Command Format for PaLFI | 59 |
| 74 | ECM Selective Program Command Format for PaLFI | 59 |
| 75 | ECM Selective Program Command Format for PaLFI | 60 |
| 76 | ECM Lock Command Format for PaLFI | 60 |
| 77 | ECM Selective Lock Command Format for PaLFI | 61 |
| 78 | ECM Protect Command Format for PaLFI | 61 |
| 79 | ECM Selective Protect Command Format for PaLFI | 62 |
| 80 | ECM MSP Access Command Format for PaLFI | 62 |
| 81 | ECM Battery Check Command Format for PaLFI | 63 |
| 82 | ECM Battery Charge Command Format for PaLFI | 63 |
| 83 | Relation Between PaLFI Read Address and MRD2 Status Bytes | 64 |
| 84 | Device Command Raw Data Response | 66 |
| 85 | ECM Raw Data Response Command Format | 66 |
| 86 | Raw Data Bit Sequence | 67 |
| 87 | Setup Mode Command Byte 2 | 67 |
| 88 | Setup Command Format | 68 |
| 89 | Setup Command Response Format | 69 |
| 90 | Setup Get Firmware Version Command Format | 69 |
| 91 | Setup Get Protocol Version Command Format | 70 |
| 92 | Setup Get Hardware Type Command Format | 71 |
| 93 | Setup Get Serial Number Command Format | 71 |
| 94 | Setup Get PWM Timing Command Format | 72 |
| 95 | Setup Set PWM Timing Command Format | 73 |
| 96 | Setup Get PWM Timing Command Format | 74 |

| | | |
|-----|--|-----|
| 97 | Setup Set PWM Timing Command Format | 75 |
| 98 | Get PPM Timing Command Format | 76 |
| 99 | Set PPM Timing Command Format..... | 77 |
| 100 | Setup Get BLC Timing Command Format | 78 |
| 101 | Setup Set BLC Timing Command Format | 79 |
| 102 | Setup Get BLC (Automotive) Timing Command Format | 80 |
| 103 | Set BLC (Automotive) Timing Command Format | 81 |
| 104 | Setup Set Duration Power Burst 1 Command Format..... | 82 |
| 105 | Setup Get Duration Power Burst 1 Command Format | 82 |
| 106 | Setup Set Duration Power Burst 2 Command Format..... | 83 |
| 107 | Setup Get Duration Power Burst 2 Command Format | 83 |
| 108 | Set Downlink CRC Command Format | 84 |
| 109 | Setup Set Uplink CRC Command Format | 84 |
| 110 | Set or Check R/W Data CRC Command Format | 85 |
| 111 | Setup Check MPT CRC Command Format..... | 86 |
| 112 | Setup Start 1-Slot Inventory Process Command Format | 87 |
| 113 | Set Serial Port Com Speed Command Format..... | 88 |
| 114 | Speed Byte Data Format | 88 |
| 115 | Setup Get Last Measured Low Bit Freq Command Format | 89 |
| 116 | Setup Execute C-Trim Command Format..... | 90 |
| 117 | Device Code Values | 90 |
| 118 | Status Byte | 90 |
| 119 | Carrier On or Off Command Format | 91 |
| 120 | OKT Signal Timing Command Format..... | 91 |
| 121 | Setup STAT Signal Mode Command Format..... | 92 |
| 122 | Setup Get Status of SIG_IN_0 Command Format | 93 |
| 123 | Setup Get Status of SIG_IN_1 Command Format | 93 |
| 124 | Setup Set Status of SIG_OUT_0 Command Format | 94 |
| 125 | Setup Set Status of SIG_OUT_1 Command Format | 94 |
| 126 | Setup Set Demodulation Threshold Mode Command Format..... | 95 |
| 127 | Setup Set External Power Reader Command Format..... | 96 |
| 128 | Setup save Setting to Flash Command Format | 97 |
| 129 | Status Bit | 97 |
| 130 | Setup Restore Settings to Factory Default Command Format | 98 |
| 131 | Status Bit | 98 |
| 132 | Operating Conditions..... | 99 |
| 133 | Transponder Downlink Timings..... | 99 |
| 134 | Default Power Burst Values..... | 99 |
| 135 | Microreader RFM Connections..... | 100 |

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.

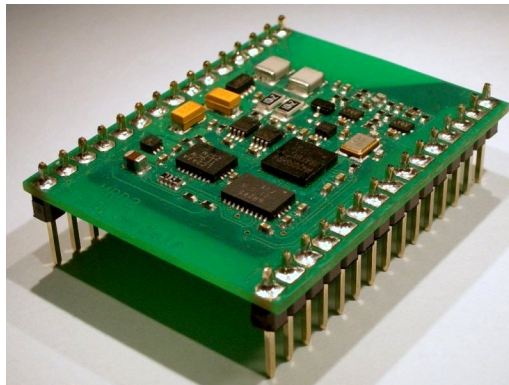


Figure 1. RI-STU-MRD2 Module

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 | PaLFI: Passive Low Frequency Interface |
| BCC: Block Check Character | PCB: Printed Circuit Board |
| BLC: Bit Length Coding | PPM: Pulse Position Modulation |
| BSP: Bit Sequence Protocol | PWM: Pulse Width Modulation |
| CDC: Communication Device Class | RFM: Radio Frequency Power Module |
| DIL: Dual in Line | RFU: Reserved for Future Use |
| ECM: Easy Code Mode | RO: Read Only (Transponder) |
| EOF: End of Frame | R/W: Read/Write (Transponder) |
| FBCC: Frame Block Check Character | RX: Receive |
| FSK: Frequency Shift Keying | SM: Setup Mode |
| HDX: Half Duplex | SMD: Surface Mounted Device |
| HDX+: Half Duplex Plus | SOF: Start of Frame |
| LMP: Legacy Microreader Protocol | TX: Transmit |
| MCU: Micro Controller Unit | WLSC: Wireless Synchronization |
| MPT: Multipage Transponder | SCI: Serial Communication Interface |
| MRD1: Microreader 1 (RI-STU-MRD1) | 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.

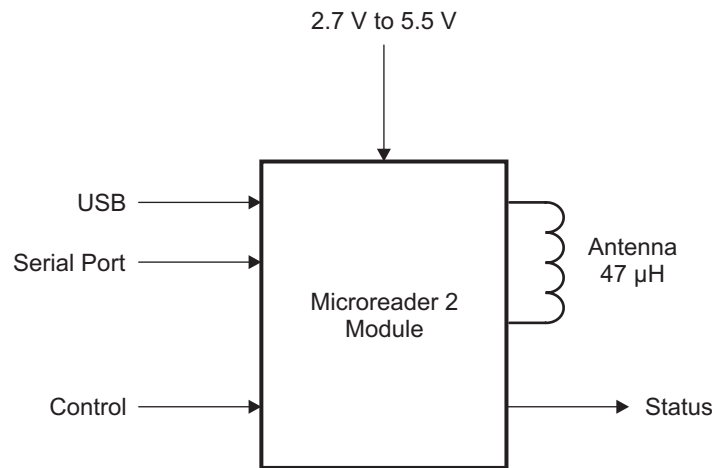


Figure 2. Overview

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.

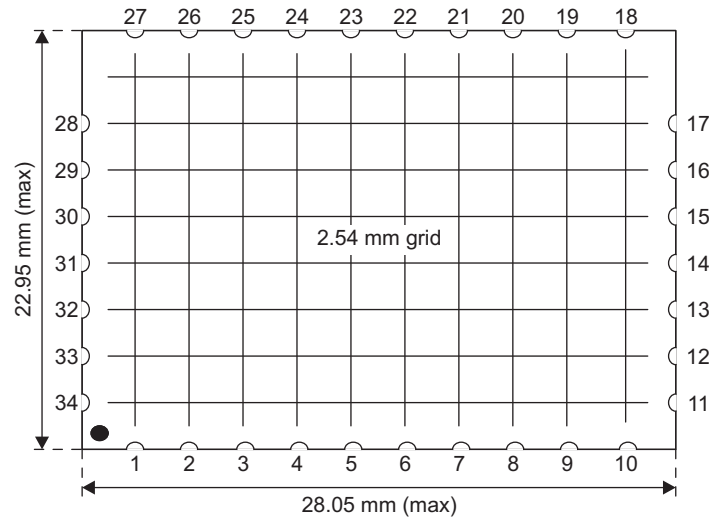


Figure 3. Top View With Pin Numbers of the Microreader 2 SMD Module

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.

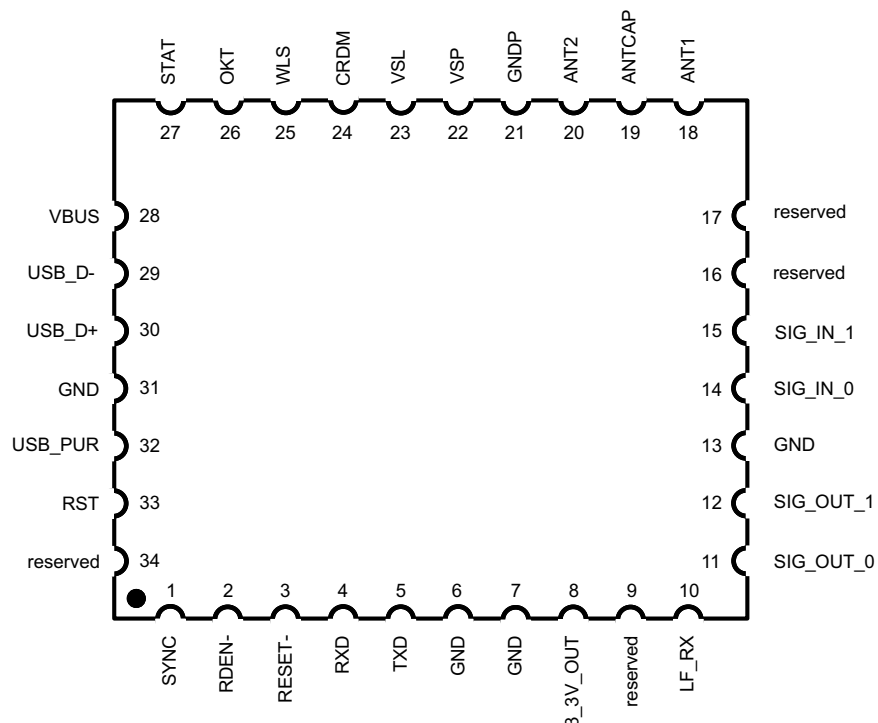


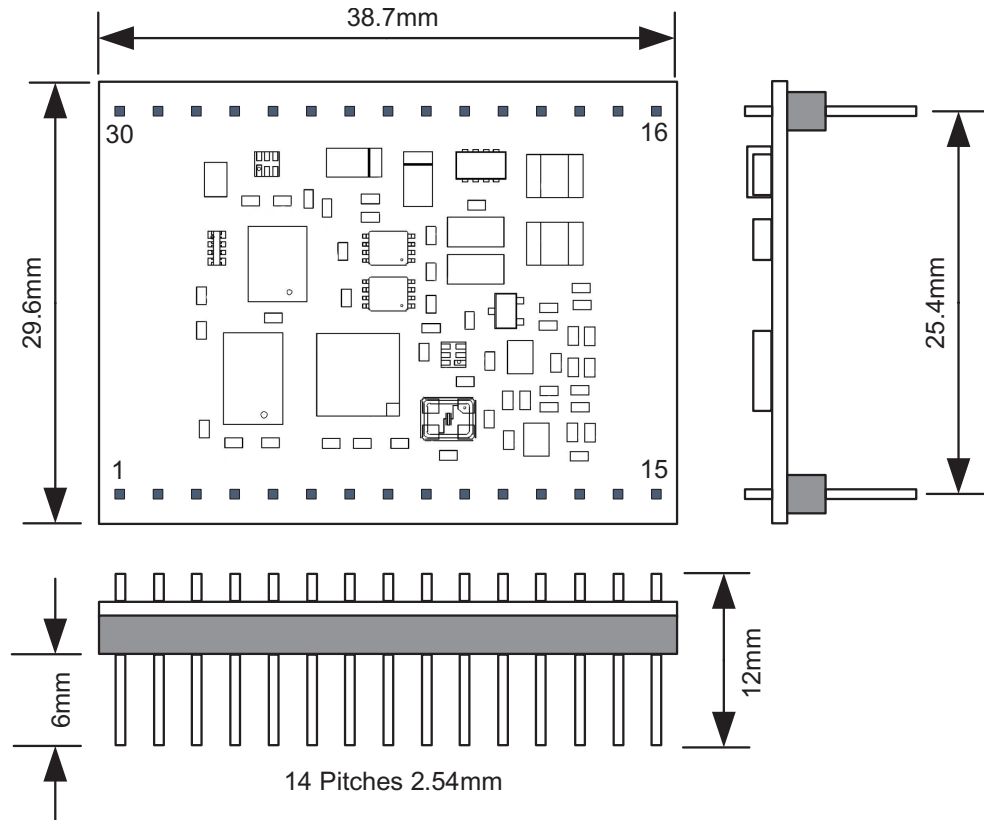
Figure 4. SMD Module Pin Configuration

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- μ H 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- μ H 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 k Ω).

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 k Ω). 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 μ s 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 μ s. The single read starts on the falling edge of the 100- μ s 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.

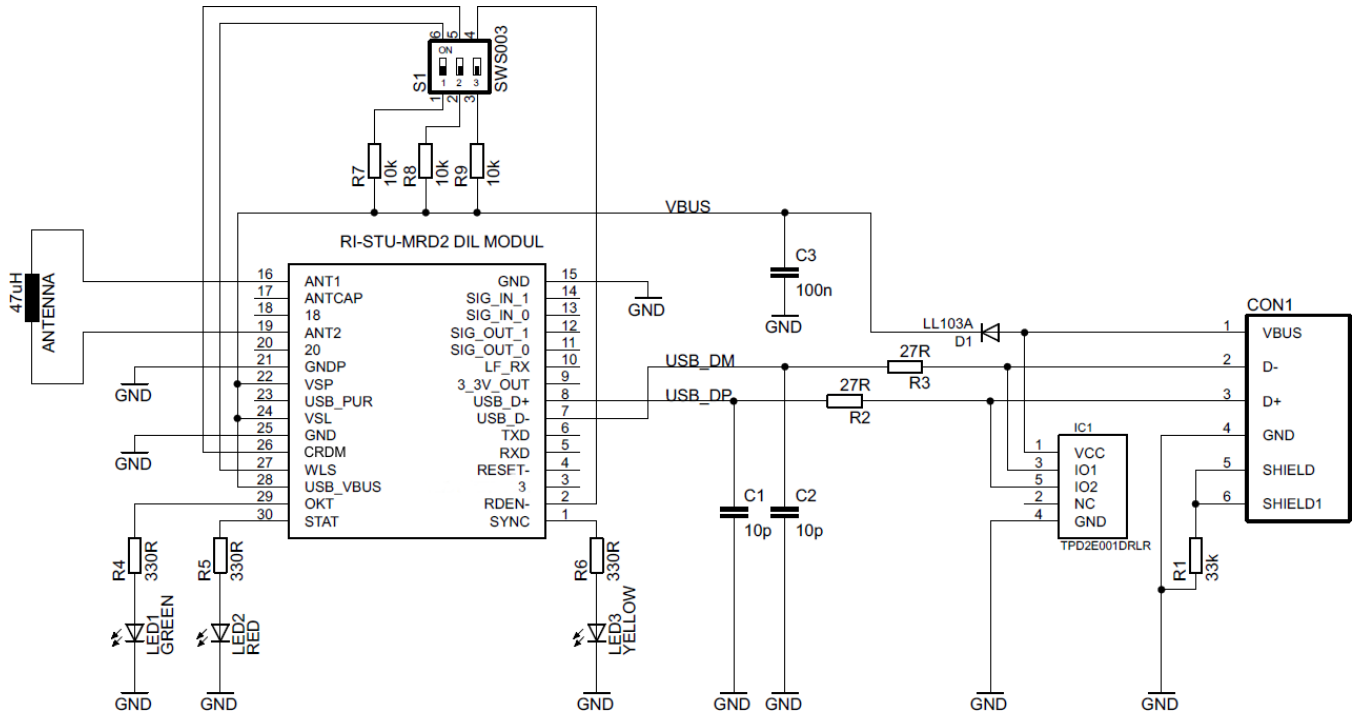


Figure 6. Microreader 2 Demonstration Circuit With USB Interface

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 | $\text{k}\Omega$ |
| 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:

$$Q = \frac{2\pi fL}{R} \quad (1)$$

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

$$\begin{aligned}
 Q &= \frac{2 \times \pi \times 134200 \times 0.000047}{2.2} \\
 &= \frac{39.636}{2.2} \\
 &= 18
 \end{aligned} \quad (2)$$

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.

$$C_{\text{tot}} = \frac{1}{4\pi^2 L_{\text{Ant}} f^2} \quad (3)$$

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.

$$C_{\text{ext}} = C_{\text{tot}} - 30 \text{ nF} \quad (4)$$

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.

$$\frac{1}{C_{\text{ext}}} = \frac{1}{C_{\text{tot}}} - \frac{1}{30 \text{ nF}} \quad (5)$$

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 to 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 -----
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

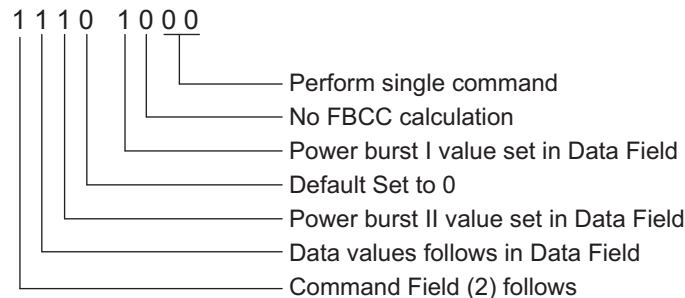


Figure 8. LMP Command Byte Field 1 Example

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

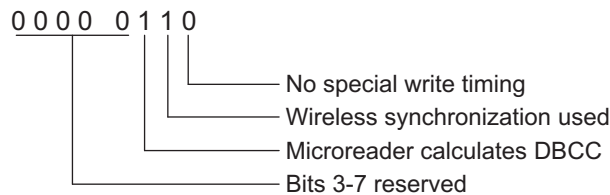


Figure 9. LMP Command Byte Field 2 Example

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

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

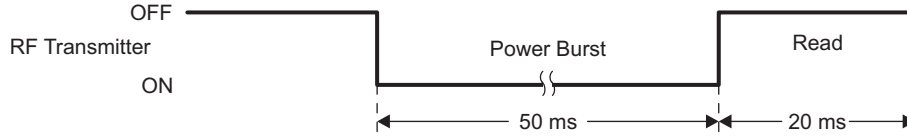


Figure 11. Read Only Command Format

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 Burst 1 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

| <i>Command</i> | | | | |
|--|----------------|-------------|----------------------|-----|
| 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 |
| <i>Response</i> | | | | |
| 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 |

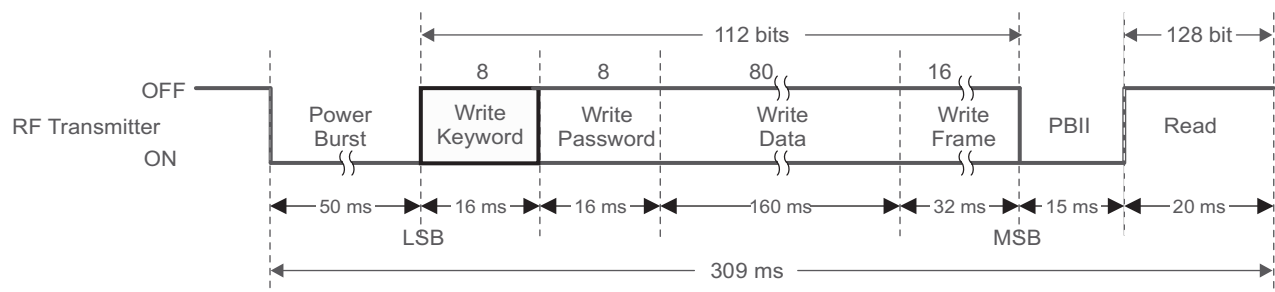


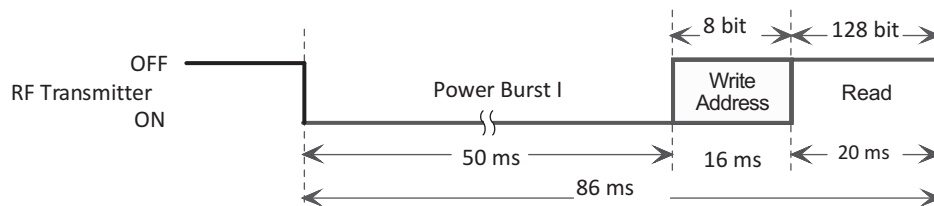
Figure 13. Programming Data Format of the 64-bit Read/Write Transponder

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

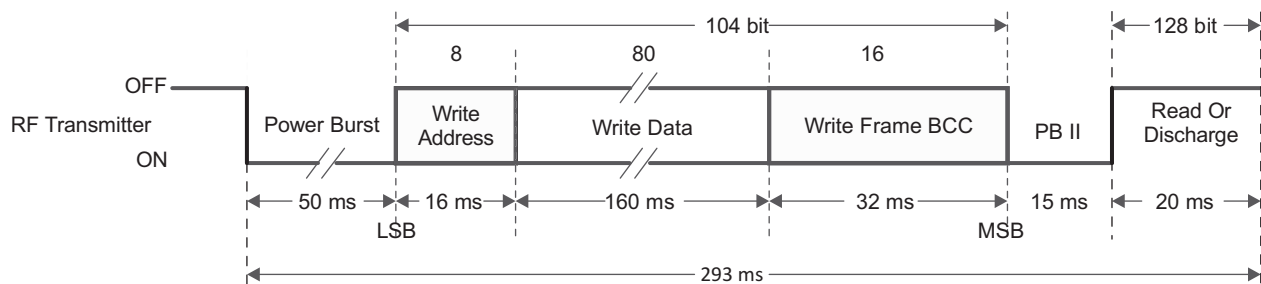
| <i>Command</i> | | | | |
|--|----------------|-------------|----------------------|-----|
| Parameter | Length (Bytes) | Byte Number | Data (MSB...LSB) | |
| Start Byte | 1 | 0 | 01 | hex |
| Length | 1 | 1 | 04 | hex |
| CMD 1 (Perform Single command, send Power Burst I with data) | 1 | 2 | 48 | hex |
| 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 |
| <i>Response</i> | | | | |
| 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 |

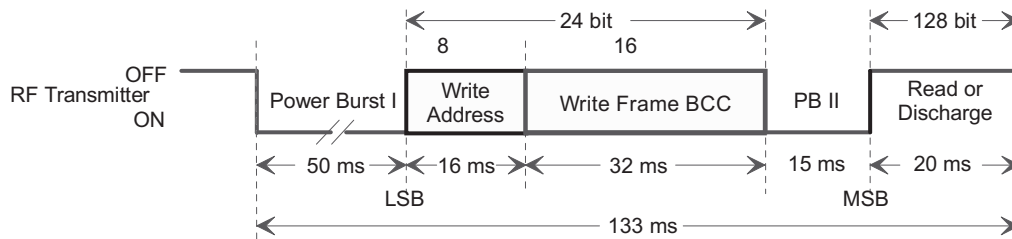
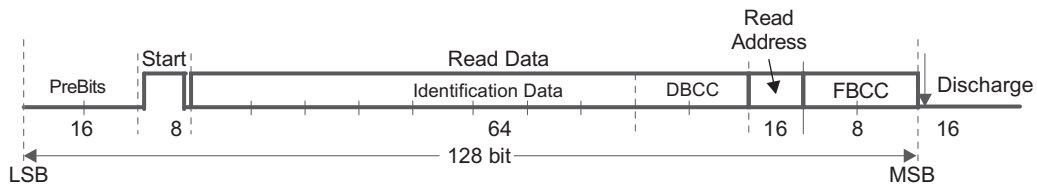


Figure 16. Lock Page Data Format of MPT Transponder

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.



Read Address

| | | | | | | | | | | | |
|--|-----|------|---|---|---|---|---|---------|---|---|-----|
| | MSB | P | P | P | P | P | P | P | C | C | LSB |
| | | ↑ | | | | | | ↑ | | | |
| | | Page | | | | | | Command | | | |

| | | | |
|---------|--------|----|---|
| Page 1 | 000001 | 00 | Read unlocked page |
| Page 2 | 000010 | 01 | Programming done |
| ⋮ | ⋮ | 10 | Read locked page |
| Page 16 | 010000 | 11 | Reserved (see Note A) |
| Page 17 | 010001 | | |
| | 000000 | 00 | Read unlocked page, locking not correctly executed |
| | 000000 | 01 | Programming done, but possibly not reliable |
| | 000000 | 10 | Read locked page, but locking possibly not reliable |

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

Figure 17. Response Data Format of MPT Transponder

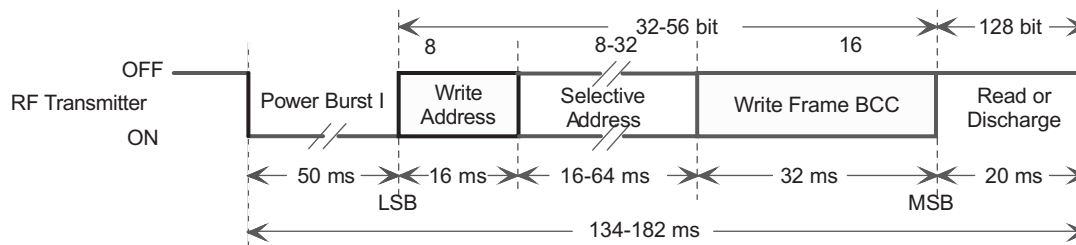
6.1.6 Device Commands Selective Address Multipage Transponder (SAMPT)

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 |

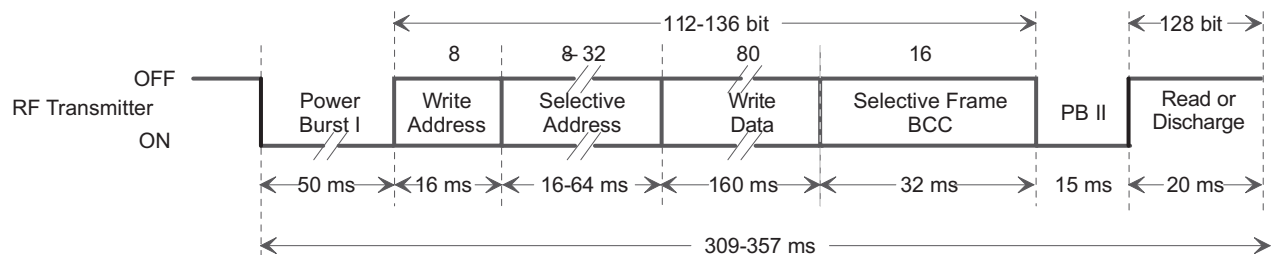
Response format is the same as for the General Read of MPT 1 6/17 (see [Section 6.1.5.1](#)).


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](#)).

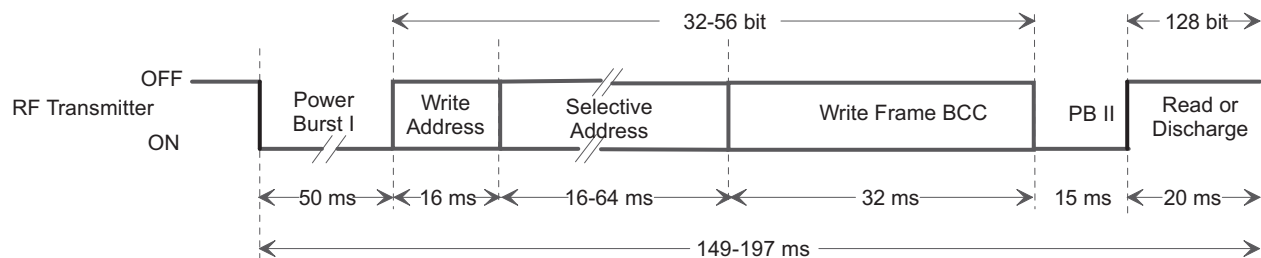

Figure 19. Data Format of the Selective Program Page Function

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 | 0xnxxx |

| 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 |
| 0xnxxx | 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 than 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.

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 | |
| 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 | |
| RFU | | 0 | 0 | 0 | 0 | | | | | |
| 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 | |
| Programming not successful (or unreliable) | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | |
| Programming not successful (field strength too low) | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | |
| RFU | | 0 | 0 | 0 | 1 | | | | | |
| 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 | |
| Locking not successful (or unreliable) | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | |
| Locking not successful (field strength too low) | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | |
| RFU | | 0 | 0 | 1 | 0 | | | | | |
| 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 | |
| RFU | | 0 | 0 | 1 | 1 | | | | | |
| Raw data received from transponder to follow | 0 | 1 | X | X | X | X | X | X | X | |
| Unknown | 1 | 0 | X | X | X | 1 | 1 | 1 | 1 | |

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) | | | | |
|--|----------------|-------------|--------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx xxxxxxx | 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) | | | | |
|--|----------------|-------------|--------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx xxxxxxx | 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 | xxxxxxx xxxxxxx | 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 | xxxxxxx xxxxxxx | 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) | | | | |
|--|----------------|-------------|--------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx xxxxxxx | 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|------------------------------------|----------------|-------------|----------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|---|----------------|-------------|--------------------|-----|
| <i>Command</i> | | | | |
| 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 | xxxxxxx xxxxxxx | 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) | | | | |
|---------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|--------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx xxxxxxx | 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) | | | | |
|--------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx | 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx | 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|-------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | xxxxxxx | hex |
| BCC | 1 | 10 | calculated | hex |
| <i>Response</i> | | | | |
| 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | xxxxxxx | 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | xxxxxxx | 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | xxxxxxx | hex |
| Write Data Second Block | 4 | 16-19 | xxxxxxx | 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) | | | | |
|----------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|---------------------------------|----------------|-------------|--------------------|-----|
| <i>Command</i> | | | | |
| 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 | xxxxxxx xxxxxxx | hex |
| BCC | 1 | 13 | calculated | hex |
| <i>Response</i> | | | | |
| 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 | xxxxxxx xxxxxxx | 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|----------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|----------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|-------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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. (É Page 3 is factory locked)

Table 74. ECM Selective Program Command Format for PaLFI

| Selective Program (Device Command 0x12) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|--------------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|-------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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) | | | | |
|-------------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|--------------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | | Error Status 1 Bit 7 | Status Byte 2 | Comment |
|-------------|-------------------------------|--------------|-----------|----------------------|---------------|--|
| | | Bit [7:2] | Bit [1:0] | | | |
| 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 | | Error Status 1 Bit 7 | Status Byte 2 | Comment |
|----------------|-------------------------------|--------------|-----------|----------------------|--|--|
| | | Bit [7:2] | Bit [1:0] | | | |
| 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 | | Error Status 1 Bit 7 | Status Byte 2 | Comment |
|-------------|------------|--------------|-----------|----------------------|---------------|-----------------------------|
| | | Bit [7:2] | Bit [1:0] | | | |
| 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 | | | | |
|--------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 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) | | | | |
|-----------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|-----------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|--------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|-------------------------------|----------------|-------------|----------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|-----------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | | |
|-----------------------|-----------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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) | | | | |
|-------------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | | |
|-------------------------------------|-----------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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) | | | | |
|-----------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| Parameter | Length (Bytes) | Byte Number | Data (MSB...LSB) | |
| Start Byte | 1 | 0 | 01 | hex |
| Length | 1 | 1 | 08 | hex |
| toffLow (μ s) | 2 | 2-3 | xxxx | hex |
| tonLow (μ s) | 2 | 4-5 | xxxx | hex |
| toffHigh (μ s) | 2 | 6-7 | xxxx | hex |
| tonHigh (μ s) | 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) | | | | | |
|-----------------------|-----------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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) | | | | |
|------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| Parameter | Length (Bytes) | Byte Number | Data (MSB...LSB) | |
| Start Byte | 1 | 0 | 01 | hex |
| Length | 1 | 1 | 10 | hex |
| SOFoff (μ s) | 2 | 2-3 | xxxx | hex |
| SOFon (μ s) | 2 | 4-5 | xxxx | hex |
| toffLow (μ s) | 2 | 6-7 | xxxx | hex |
| tonLow (μ s) | 2 | 8-9 | xxxx | hex |
| toffHigh (μ s) | 2 | 10-11 | xxxx | hex |
| tonHigh (μ s) | 2 | 12-13 | xxxx | hex |
| EOFOff (μ s) | 2 | 14-15 | xxxx | hex |
| EOFOon (μ s) | 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 (μ s) | 298 μ s | 2 | 4-5 | xxxx | hex |
| SOFon (μ s) | 499 μ s | 2 | 6-7 | xxxx | hex |
| toffLow (μ s) | 149 μ s | 2 | 8-9 | xxxx | hex |
| tonLow (μ s) | 171 μ s | 2 | 10-11 | xxxx | hex |
| toffHigh (μ s) | 149 μ s | 2 | 12-13 | xxxx | hex |
| tonHigh (μ s) | 238 μ s | 2 | 14-15 | xxxx | hex |
| EOFOff (μ s) | 149 μ s | 2 | 16-17 | xxxx | hex |
| EOFon (μ s) | 373 μ s | 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 (μ s) | | 2 | 2-3 | xxxx | hex |
| SOFon (μ s) | | 2 | 4-5 | xxxx | hex |
| toffLow (μ s) | | 2 | 6-7 | xxxx | hex |
| tonLow (μ s) | | 2 | 8-9 | xxxx | hex |
| toffHigh (μ s) | | 2 | 10-11 | xxxx | hex |
| tonHigh (μ s) | | 2 | 12-13 | xxxx | hex |
| EOFOff (μ s) | | 2 | 14-15 | xxxx | hex |
| EOFon (μ s) | | 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) | | | | |
|------------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| Parameter | Length (Bytes) | Byte Number | Data (MSB...LSB) | |
| Start Byte | 1 | 0 | 01 | hex |
| Length | 1 | 1 | 10 | hex |
| SOFoff (μ s) | 2 | 2-3 | xxxx | hex |
| SOFon (μ s) | 2 | 4-5 | xxxx | hex |
| toffLow (μ s) | 2 | 6-7 | xxxx | hex |
| tonLow (μ s) | 2 | 8-9 | xxxx | hex |
| toffHigh (μ s) | 2 | 10-11 | xxxx | hex |
| tonHigh (μ s) | 2 | 12-13 | xxxx | hex |
| EOFOff (μ s) | 2 | 14-15 | xxxx | hex |
| EOFon (μ s) | 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) | | | | | |
|------------------------------|-----------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 (μ s) | 170 μ s | 2 | 4-5 | xxxx | hex |
| SOFon (μ s) | 460 μ s | 2 | 6-7 | xxxx | hex |
| toffLow (μ s) | 170 μ s | 2 | 8-9 | xxxx | hex |
| tonLow (μ s) | 230 μ s | 2 | 10-11 | xxxx | hex |
| toffHigh (μ s) | 170 μ s | 2 | 12-13 | xxxx | hex |
| tonHigh (μ s) | 350 μ s | 2 | 14-15 | xxxx | hex |
| EOFOff (μ s) | 170 μ s | 2 | 16-17 | xxxx | hex |
| EOFon (μ s) | 580 μ s | 2 | 18-19 | xxxx | hex |
| BCC | | 1 | 20 | calculated | |
| <i>Response</i> | | | | | |
| Parameter | | Length (Bytes) | Byte Number | Data (MSB...LSB) | |
| Start Byte | | 1 | 0 | 01 | hex |
| Length | | 1 | 1 | 10 | hex |
| SOFoff (μ s) | | 2 | 2-3 | xxxx | hex |
| SOFon (μ s) | | 2 | 4-5 | xxxx | hex |
| toffLow (μ s) | | 2 | 6-7 | xxxx | hex |
| tonLow (μ s) | | 2 | 8-9 | xxxx | hex |
| toffHigh (μ s) | | 2 | 10-11 | xxxx | hex |
| tonHigh (μ s) | | 2 | 12-13 | xxxx | hex |
| EOFOff (μ s) | | 2 | 14-15 | xxxx | hex |
| EOFon (μ s) | | 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) | | | | | |
|-----------------------------------|-----------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response (n+1 times)</i> | | | | | |
| 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) | | | | | |
|-----------------------------------|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 |
| <i>Response (n+1 times)</i> | | | | | |
| 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) | | | | | |
|-----------------------------------|-----------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response (n+1 times)</i> | | | | | |
| 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) | | | | | |
|-----------------------------------|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | | |
| 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 |
| <i>Response (n+1 times)</i> | | | | | |
| 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) | | | | | |
|-------------------------------------|-----------------|----------------|-------------|-------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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) | | | | | |
|-------------------------------------|-----------------|----------------|-------------|-------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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) | | | | |
|---------------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | |
| <i>Response (n+1 times)</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | |
| <i>Response</i> | | | | |
| 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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 | xxxxxxx | 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 return 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 | |

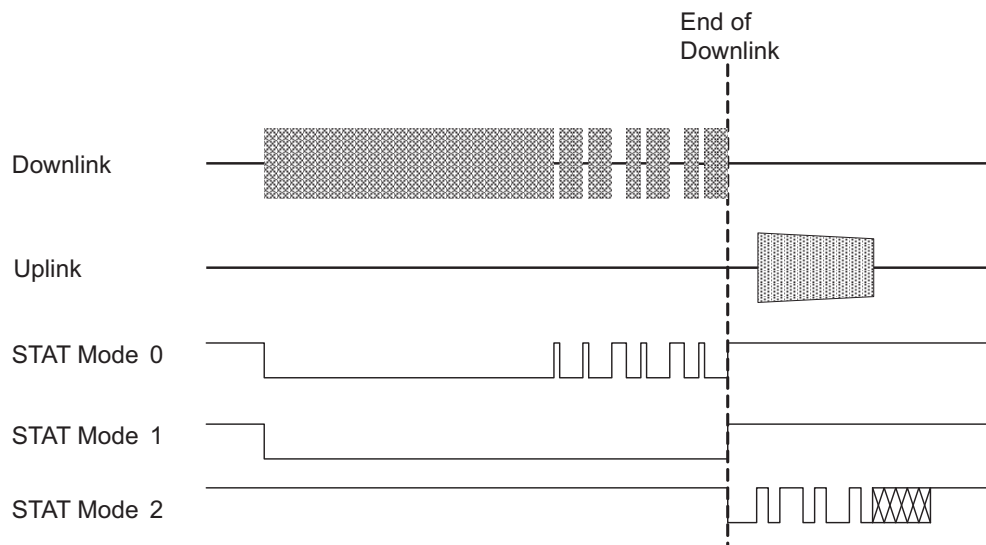


Figure 21. STAT Signal Mode

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) | | | | |
|-------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|-------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | |
| <i>Response</i> | | | | |
| 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) | | | | |
|--------------------------------|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 | |
| <i>Response</i> | | | | |
| 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) | | | | | |
|--|-----------------|----------------|-------------|-----------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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 reader's 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 (TXCT-) and two for receive (RXCK and RXDT). When the RFM mode is enabled, 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) | | | | | |
|--|-----------------|----------------|-------------|-------------------|-----|
| <i>Command</i> | | | | | |
| 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 | |
| <i>Response</i> | | | | | |
| 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) | | | | |
|---|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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) | | | | |
|--|----------------|-------------|------------------|-----|
| <i>Command</i> | | | | |
| 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 |
| <i>Response</i> | | | | |
| 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

| Modulation | Bit H | | Bit L | | SOF | | EOF | |
|-------------------|------------|-----------|------------|-----------|--------------|-------------|--------------|-------------|
| | 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

WARNING

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.

WARNING

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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46C and to discontinue any product or service per JESD48B. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

Products

| | |
|------------------------|--|
| Audio | www.ti.com/audio |
| Amplifiers | amplifier.ti.com |
| Data Converters | dataconverter.ti.com |
| DLP® Products | www.dlp.com |
| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
| Logic | logic.ti.com |
| Power Mgmt | power.ti.com |
| Microcontrollers | microcontroller.ti.com |
| RFID | www.ti-rfid.com |
| OMAP Mobile Processors | www.ti.com/omap |
| Wireless Connectivity | www.ti.com/wirelessconnectivity |

Applications

| | |
|-------------------------------|--|
| Automotive and Transportation | www.ti.com/automotive |
| Communications and Telecom | www.ti.com/communications |
| Computers and Peripherals | www.ti.com/computers |
| Consumer Electronics | www.ti.com/consumer-apps |
| Energy and Lighting | www.ti.com/energy |
| Industrial | www.ti.com/industrial |
| Medical | www.ti.com/medical |
| Security | www.ti.com/security |
| Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Video and Imaging | www.ti.com/video |

TI E2E Community e2e.ti.com