LumenRadio

CRMX™

TiMo RX RDM 200-1502 – specifications

Revision A – October 2, 2014

CONFIDENTIALITY NOTE

GENERAL

CRMX™ is the future of wireless DMX distribution – a wireless system that communicates reliably with perfect fidelity. CRMX is the most powerful wireless lighting control system on the market, with groundbreaking features to ensure unrivalled reliability. CRMX distributes DMX and RDM, with full frame integrity and provides range and reliability that surpass all other systems available today. This document describes the function and specifications of the TiMo RX RDM receiver module.

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Introduction

CRMX™[1] is an acronym for Cognitive Radio MultipleXer and is the first smart wireless system to automatically and continuously adapt to its surroundings in real time. CRMX was specifically developed to meet the demand for reliable, easy to use, and cost effective wireless lighting controls.
LumenRadio launched its unique CRMX wireless technology for sale on an OEM basis in April of 2009. CRMX has since then been the only smart radio that automatically adapts to its surroundings in a smart way.
CRMX has been developed by veterans in the wireless lighting control business with years of experience of the high demands of the entertainment and architainment businesses.

CRMX is now also available for OEM implementations as an even more cost effective and space effective surface mounted solution providing wireless DMX receiving capabilities to the most cost and/or space sensitive applications.

The TiMo RX RDM receiver is a highly integrated wireless DMX receiver module and is compatible with all LumenRadio CRMX transmitter as well as W-DMX™[2] G2, G3, G4 and G4Stransmitters (G4 and G4S in 2.4 GHz mode only).

Features

- Supports ANSI E1.11 - DMX512-A and ANSI E1.20 - RDM
- Cognitive coexistence – dynamically avoids occupied frequencies
- DMX fidelity and frame integrity
- DMX frame rate and frame size auto sensing
- Fixed 5 ms end-to-end latency
- Automatic legacy (W-DMX G3, G4 and G4S) compatibility mode
- Small footprint 18.5 mm x 33.5 mm
- Integral chip antenna and U.FL/IPEX external antenna connector
- All configuration data is stored in non-volatile memory, 20 years data retention
- TiMo RX RDMcontains upgradeable drivers for future proofing
- Over-the-air driver upgrades

[1] CRMX is a trademark of LumenRadio AB
Other trademarks and trade names are the property of their respective holder

[2] W-DMX is a trademark of Wireless Solution Sweden AB

Pin assignments and functions

This section describes the pin assignments and pin functions.

Pin assignments

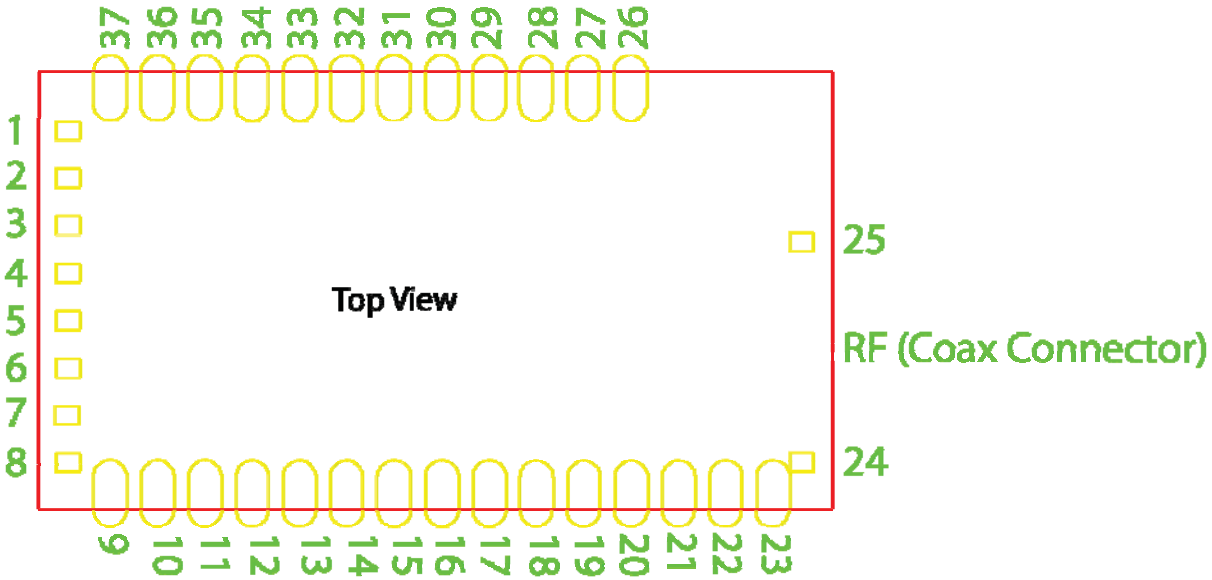

Figure 1: TiMo RX RDM pinout.

Pin functions

Pin	Name	Function	Description
1	VSS	Power	Ground (0V)
2	/IRQ	Digital output	Interrupt signal, active low
3	/CS	Digital input	Chip select, active low
4	SCK	Digital input	SPI clock
5	MOSI	Digital input	SPI Master Out, Slave In
6	MISO	Digital output	SPI Master In, Slave Out
7	VSS	Power	Ground (0V)
8	DMX_TXD	Digital output	DMX TXD
9	VSS	Power	Ground (0V)
10	RS485_DE	Digital output	RS485 driver control signal
11	/RS485_RE	Digital output	RS485 driver control signal
12	DMX_RXD	Digital input	DMX RXD (3.3 V max)
13	RDI_LVL0	Digital output	Radio level LED
14	RDI_LVL1	Digital output	Radio level LED
15	RDI_LVL2	Digital output	Radio level LED
16	RDI_LVL3	Digital output	Radio level LED
17	RDI_LVL4	Digital output	Radio level LED
18	RDM	Digital output	RDM LED
19	DMX	Digital output	DMX LED
20	N.C.	No connection	Do not connect
21	N.C.	No connection	Do not connect
22	VSS	Power	Ground (0V)
23	VSS	Power	Ground (0V)
24	VSS	Power	Ground (0V)
25	VSS	Power	Ground (0V)
26	VSS	Power	Ground (0V)
27	VSS	Power	Ground (0V)
28	VSS	Power	Ground (0V)
29	VSS	Power	Ground (0V)
30	VSS	Power	Ground (0V)
31	ANT_SEL	Digital input	RF Antenna select
32	LINK_SW	Digital input	Link control switch input
33	STATUS_LED	Digital output	Status LED
34	LINKED	Digital output	Linked to transmitter LED
35	RF_LINK	Digital output	RF link LED
36	VDD	Power	Power supply (3.3V)
37	VSS	Power	Ground (0V)
ANT	RF ANT	RF	Antenna connector

Typical application circuit

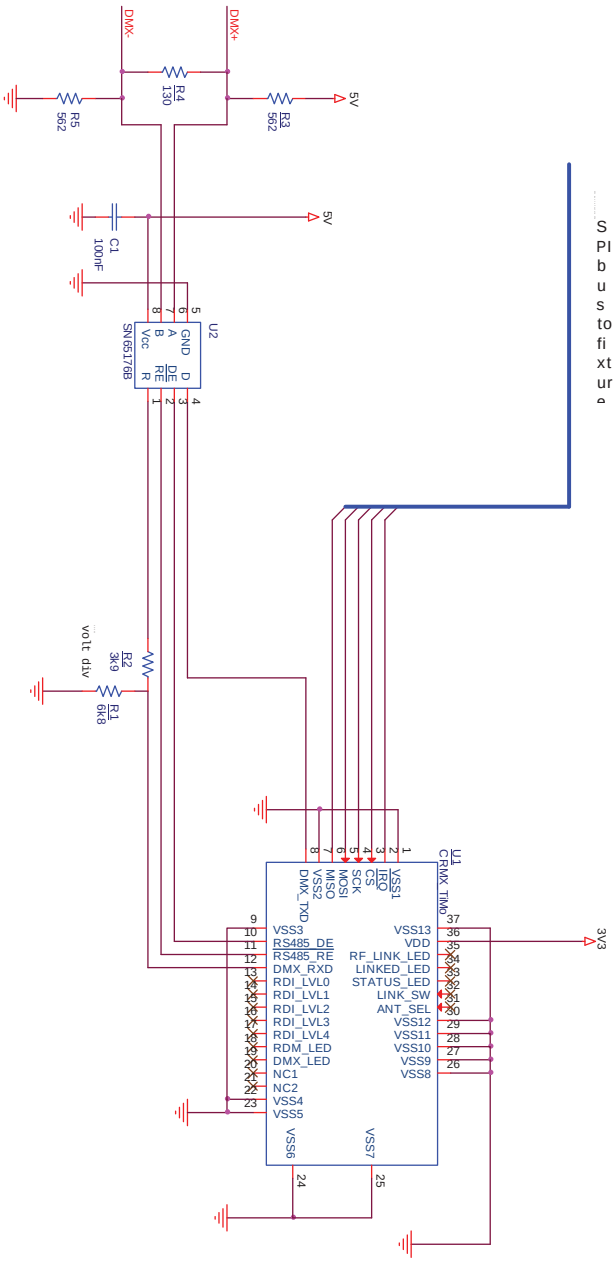

Figure 2: Typical application circuit for TiMo RX RDM

Reference design files

A complete reference design including PCB layout and PCB design guidelines is available from LumenRadio to make integration easier. Please send your inquiry to LumenRadio for details.

PCB mounting

Internal or External Antenna?

For short distances the modules´ internal antenna will perform well. But if the design is to be placed inside a metal enclosure, or if there is a need to cover large distances, an external antenna is necessary. An external antenna MUST at least be designed for operation between 2.4 – 2.48GHz

Always use external antennas with a 50Ω characteristic impedance.

Internal Antenna

If the internal antenna is considered, the product case needs to be of a RF transparent plastic material. The circuit board that will hold TiMo needs to be designed so that the internal chip antenna radiates efficiently. Avoid any ground planes near the antenna chip.

When placing TiMo on a circuit board:

- Place the module as close to the host circuit board edge as possible with the antenna pointing outward.
- Note the absence of ground plane near the chip antenna on the modules´ circuit board.
- Remove any copper from the main board as specified in section "*Layout Example~~Layout Example~~s*"
- Avoid using metal structures such as mounting hardware close to the antenna chip.

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Layout considerations for the main (Customer) board.

TiMo has been specifically designed in order to achieve good RF performance. In order to maintain this, there are some guidelines that we would like to stress:

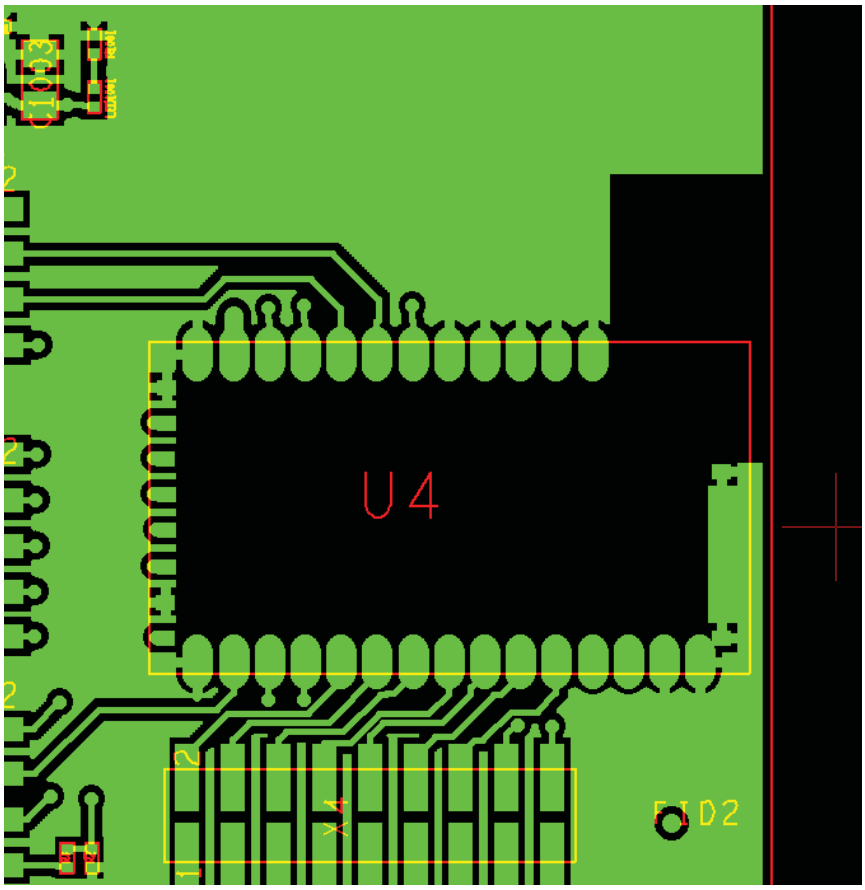
The use of ground planes also on the main board cannot be overemphasized. Good decoupling of any high speed digital circuitry is a must. Many embedded type microprocessors today has clock frequencies with clocks or over tones that reaches well into the GHz range. It is perfectly possible for an embedded design to pass any EMC certification and still cause disturbances that will block the RF reception of the TiMo module. The sensitivity of the TiMo receiver is -96dBm therefore it is recommended to keep disturbances below -100dBm in the frequency range of operation

A near field probe connected to a spectrum analyzer will show if there are any disturbances present on the 2.45 GHz band generated by the microprocessor or any other device that is placed on the main board. Pay special attention to readymade LAN-products "Server in a RJ connector". They pass EMC certifications, but some of them radiates badly on 2.45 GHz. If disturbances can be seen on a spectrum analyzer - then the TiMo module will have impaired reception.

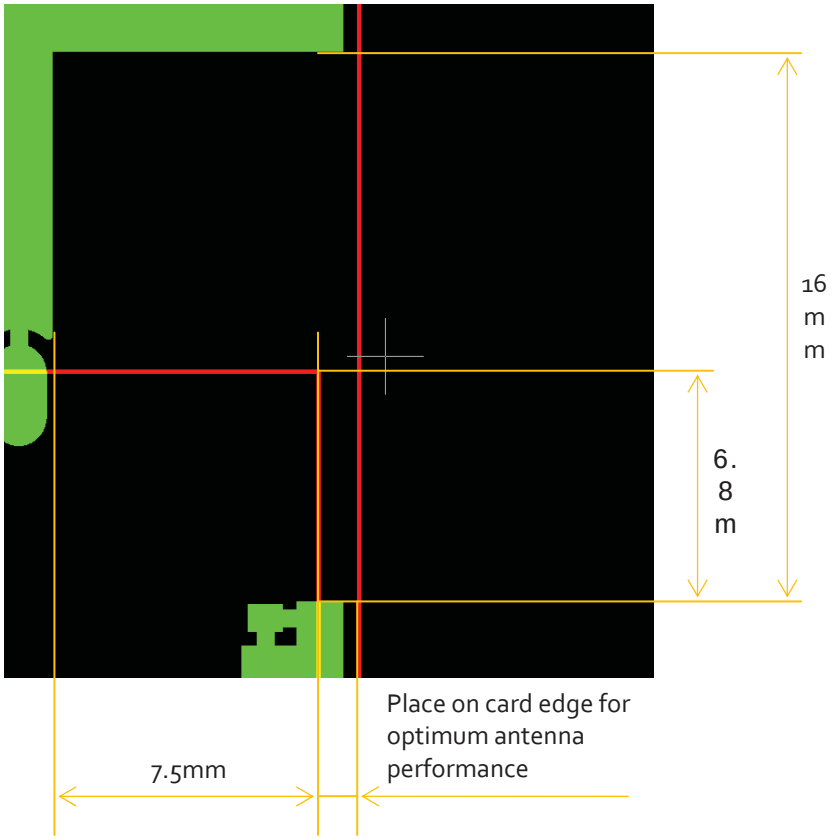
TiMo has a supply voltage decoupling on the circuit board. The supply voltage still needs to be adequately filtered. If any disturbance or intermittent communication failures occur, as one of the trouble shooting steps - check the supply voltage for drop-outs, switch supply ripple etc.

Layout Example

1. The TOP layer inside the footprint must be free from copper. There is a ground plane on TiMo, but there are also supply lines. It is an unnecessary risk to rely on solder mask lacquer for isolation.
2. The area around the antenna must be kept clear from copper on all layers. This is shown in the picture below. This shows inner layer 1 (next to TOP)

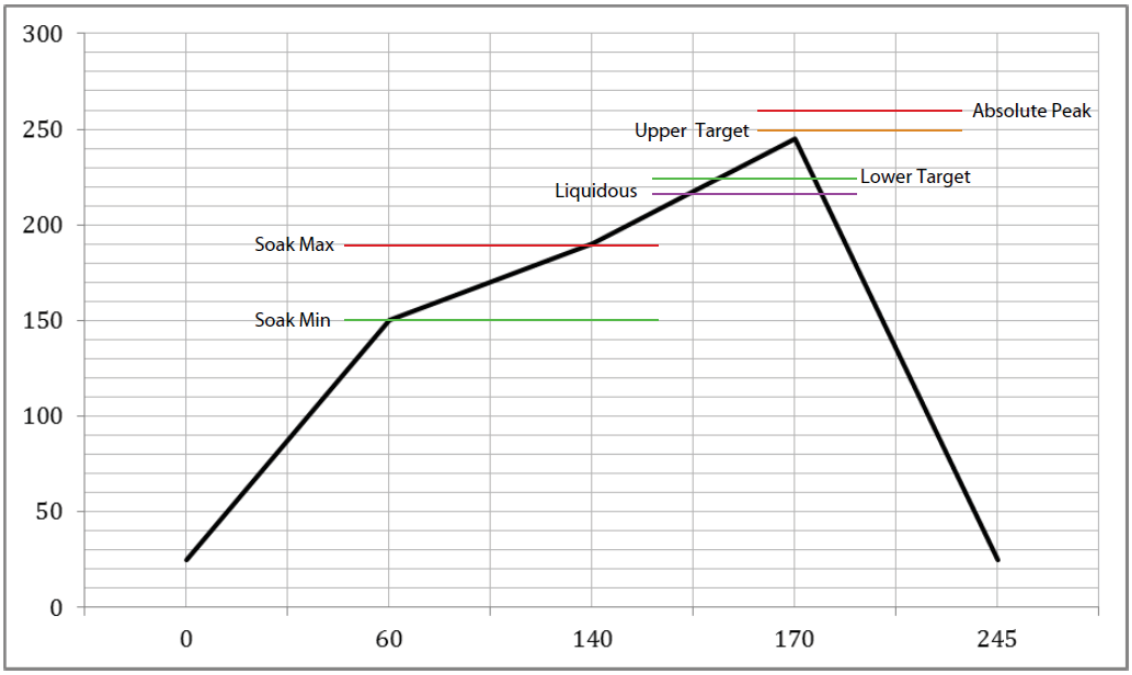


Minimum dimensions for ground plane clearance for optimum antenna performance are shown below:



TiMo reflow soldering specification

TiMo is a surface mount device (SMD) designed to be easily manufactured including reflow soldering to a PCB.It isultimately theresponsibility of the customer to choose the appropriate solder paste and to ensure oventemperatures during reflow meet the requirements of the solder paste. TiMo surface mount module conforms to JSTD-020D1 standards for reflow temperatures.



Temperatures should not exceed the minimums or maximums presented in table below:

Specification	Value	Unit
Temperature Inc./Dec. Rate (max)	1~3	°C / sec
Temperature Decrease rate (goal)	2-4	°C / sec
Soak Temp Increase rate (goal)	.5 - 1	°C / sec
Flux Soak Period (min)	70	sec
Flux Soak Period (max)	120	sec
Flux Soak Temp (min)	150	°C
Flux Soak Temp (max)	190	°C
Time Above Liquidous (max)	70	sec
Time Above Liquidous (min)	50	sec
Time In Target Reflow Range (goal)	30	sec
Time At Absolute Peak (max)	5	sec
Liquidous Temperature (SAC305)	218	°C
Lower Target Reflow Temperature	225	°C
Upper Target Reflow Temperature	250	°C
Absolute Peak Temperature	260	°C

LED outputs

Status

The status LED (*STATUS_LED*) indicates the status of the TiMo RX RDM. The LED indicator pin is an output pin capable of sourcing 5mA at the V_{DD} voltage. An appropriate current limiting resistor must be connected in series with the LED.

Constant off (0V): Not linked to any transmitter

Flashing: off (0V) 100 ms / on (V_{DD}) 100 ms: linked to a transmitter, but no active radio link

Flashing: off (0V) 900 ms / on (V_{DD}) 100 ms: Active radio link, no DMX present

Constant on (V_{DD}): Active radio link, DMX data present

Linked

The Linked LED (*LINKED*) indicates whether the TiMo RX RDM is linked to a transmitter or if it's available to be linked. High level (V_{DD}) on this pin indicates a linked state; low level (0V) indicates that the TiMo RX RDM is not linked.

RF Link

A high level (V_{DD}) on the RF Link LED output (*RF_LINK*) indicates that the TiMo RX RDM is within range from the transmitter it is linked to and that an active radio link from the transmitter is present.

DMX

The DMX LED (*DMX_LED*) indicates if a valid DMX stream is received from the transmitter. A high level (V_{DD}) indicates that DMX is present, a low level (0V) indicates that no valid DMX is present.

RDM LED

A high level (V_{DD}) on the RDM LED output (*RDM_LED*) indicates that the TiMo RX RDM is performing RDM activity.

Radio level

TiMo RX RDM has 5 output signals for controlling radio level LEDs in the form of a bar graph (*RDI_LVL0 - RDI_LVL4*). Operation of these, and suggestion of LED colors, can be found in the table below.

Signal name	Suggested LED color	On when signal quality
RDI_LVL0	Red	below ~10%
RDI_LVL1	Amber / Yellow	above ~20%
RDI_LVL2	Green	above ~40%
RDI_LVL3	Green	above ~60%
RDI_LVL4	Green	above ~80%

Link switch input

The link switch input can be used to interface with a momentary closing push button to facilitate a simple user interface when not using the SPI interface to integrate into a host device's menu system.
Please refer to the example schematic for details on how to connect the push button.
This signal shall be pulled to V_{DD} using an external 4.7kΩ-10kΩ resistor, when used, to ensure proper function.
The switch input has two functions: unlink the receiver from a transmitter or to force driver update mode. Please see the table below for details about the functions of the switch input.

Function	Conditions
Unlink from transmitter	Hold signal low (button pressed) for >3 seconds.
Force driver update mode	Hold signal low (button pressed) during power on.

Antenna selection

The antenna selection input can be used to select the required RF antenna for use on TiMo RX RDM. This pin is internally pulled high. This pin can be overridden by writing the ANTENNA register.

State	Conditions
High Level (Logical 1)	External U.FL/IPEX connector
Low Level (Logical 0)	Internal Chip Antenna

SPI interface

The SPI interface gives access to all features of the TiMo RX RDM. The interface consist of five digital signals (V_{DD} max):

- **IRQ** – Interrupt signal. Active low, configurable through the interrupt mask register.
- **CS** – SPI Chip select, active low.
- **SCK** – SPI clock input
- **MOSI** – SPI data input
- **MISO** – SPI data output

Interface description

Bit and byte order

The data on the SPI bus is clocked with most significant bit first. All multi-byte register data are sent in big-endian byte order.

Clock polarity

Data is valid in the low-to-high transition of SCK. This is also known as the clock being active high with valid data on the leading clock edge.

Maximum clock speed

The maximum clock speed supported by TiMo RX RDM is 2MHz. Clock speeds above this limit may result in unexpected behavior.

Setup time

The SPI slave unit has a setup time of 4 µs after the high-to-low transition of the CS signal.

SPI operation

SPI transactions

All SPI transactions start with a high-to-low transition on the CS pin. The CS pin must be held low during the entire SPI transaction.
The IRQ_FLAGS register is always shifted out as the first byte of each transaction.

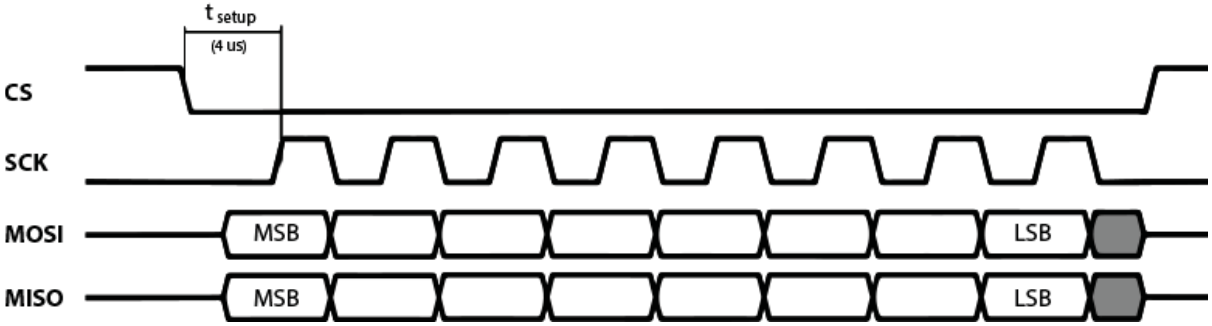


Figure 3: Example SPI transaction

SPI commands

All SPI command sequences, except for the NOP command, consist of two SPI transactions. The first transaction shall be one byte long, this is the command byte. The second transaction is the payload. The second transaction must not be started until the TiMo RX RDM has confirmed the command by a high-to-low transition on the IRQ pin. The first byte being sent to TiMo RX RDM in the second transaction will be ignored, however it is suggested this byte is being sent as 0xFF. See below for an example full SPI command sequence.
NOTE: Bit 7 in the IRQ flags register MUST be observed. A '1' in this bit means that the SPI slave module is unable to process the current transaction, and the full command sequence MUST be restarted – this means sending the command transaction again.

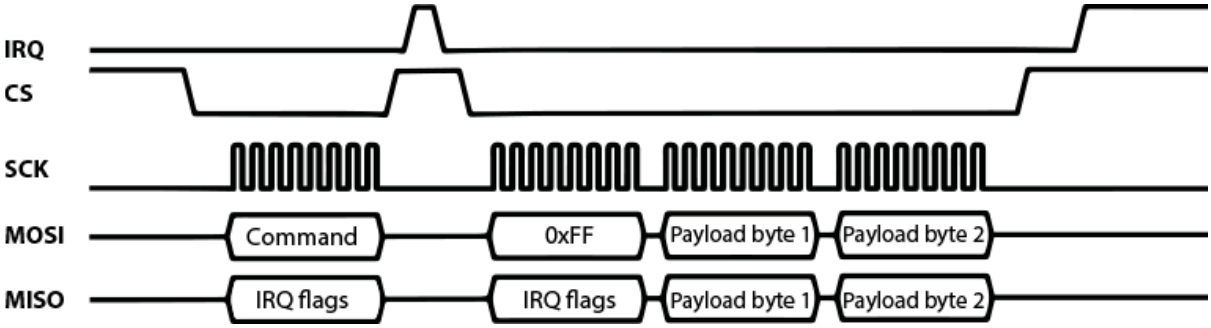


Figure 4: Example SPI command sequence with a pending IRQ when sequence started

The available SPI commands are listed in the table below.

Command	Binary value	Comment
WRITE_REG	01AA AAAA	Write to a register. AAAAAA = 6 bit register address
READ_REG	00AA AAAA	Read from a register. AAAAAA = 6 bit register address
READ_DMX	1000 0001	Read the latest received DMX values from the window set up by the DMX_WINDOW register.
READ_ASC	1000 0010	Read the latest received ASC frame.
NOP	1111 1111	No operation. Can be used as a shortcut to read the IRQ_FLAGS register.

Register map

All undefined bits in the table below shall be considered reserved for future use - don't care when read, write as 0.
Do not read or write undefined registers – doing so could result in undefined behavior.

Address (hex)	Mnemonic	Bit #	Type	Reset value	Description
00	**CONFIG**				**Configuration register**
	UART_EN	0	R/W	1	Enable UART output of DMX frames (required for RDM)
	Reserved	1-6	-	-	Reserved for future use
	RX_ENABLE	7	R/W	1	Enable wireless DMX reception
01	**STATUS**				**Status register**
	LINKED	0	R/W	-	0 = Not linked, 1 = Linked to TX (or pairing) Write 1 to unlink