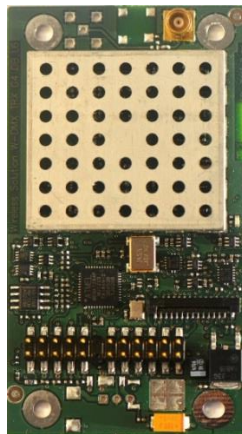WIRELESS SOLUTION
MADE IN SWEDEN

W-DMX TRX

IMPLEMENTATION GUIDE L6 GENERATION 4S

REV. 4

Pro L6

W-DMX TRX

Author: Anders Zellén
Date: 14/11/2014
Document revision: 4
Document Status: Company Confidential

This document describes the mechanical and electrical properties, as well as the electrical interface, of the W-DMX TRX G4 Pro L6 card.

The W-DMX system is the most advanced wireless lighting control system on the market today. With over 250,000 units sold, and over 45 OEM customers worldwide, the W-DMX wireless protocol has become the world's unofficial standard for Wireless DMX and RDM control. The G4S line contains the following key features:

1. Support for Adaptive Frequency Hopping Spread Spectrum technology. This technology allows the system to dynamically avoid other users of the radio spectrum, in order to ensure that we do not cause interference with other radio users i.e. WLAN. All radio cards come with this functionality as standard, with zero-configuration required.
2. RDM support, with a full managed proxy implementation. All RDM devices, when connected through the supporting W-DMX models will be exposed through the system to an upstream controller automatically.
3. DataSafe and InvisiWire technologies, which collectively ensure that data is more redundant to interference, and the system responds just as a wire would respond.

This document is valid for L6 Pro hardware with G4S firmware.

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Warning ! ESD sensitive device

The W-DMX PCB is sensitive to ESD.

Follow proper ESD control procedures when handling the W-DMX PCB.

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1 Standards Compliance

1.1 FCC Compliance Statement

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

To assure continued compliance, any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:

• Reorient or locate the receiving antenna.
• Increase the separation between the equipment and receiver.
• Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
• Consult the dealer or an experienced radio/TV technician for help.

When the device is installed in the carrier equipment, included label "Contains FCC ID: NY2-WDMXTRXDB" must be fastened on product label on the bottom of the unit.

The module will be installed by Wireless Solution during production of host equipment or by Wireless Solution trained service technicians.

RF Exposure Warning for North America

RF Exposure: This device complies with part 2.1091 of the FCC rules for an uncontrolled environment. This equipment shall be installed and operated with a minimum distance of 20cm (7.9 in.) between the antenna and the user.

1.2 Usage of this device

This device is certified to be used together with the following units and antennas from Wireless Solution
Host products:
BlackBox F-1, A40001G4MK2-X
WhiteBox F-1, A40002G4-X
WhiteBox F-2, A40004G4-X
BlackBox F-2, A40005G4MK2-X
ProBox F-2500, A40007G4-X
WhiteBox R-512, A40101G4-X
BlackBox R-512, A40102G4MK2-X

Antennas:
A40511G4, omnidirectional antenna with 4.0dBi gain

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1.3 USITT DMX-512 A Compliance

This device complies with the USITT DMX-512A standard as described in ANSI E1.11-2008. See section 6.1 for details.

1.4 Product Marking

The following text must be added to the host product for the USA market:
"Contains FCC ID: NY2-WDMXTRXDB"

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2 Mechanical Dimensions

Transceiver cards are equipped with a metal shield over the radio to conform to international standards. The receiver cards do not emit any significant amount of RF energy and are thus not equipped with this shield.

Auto Cad DXF files with file with relevant dimensions are available on request from Wireless Solution. The total height of Pro cards is 11 mm, the highest point it the pin header, take into consideration the receptacle that you choose.

2.1 Pro L6 model

S2, S3 and S4 is M3 holes
S1 is a slot 3.9 x 3.1 mm
X2 is the antenna connector

3 Antennas

Note that several aspects, including physical placement, should to be considered with external antennas.

W-DMX installations use W-DMX supplied RP-SMA cable and ship with the standard dual band indoor 4dBi antenna.

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4 Power Supply Considerations for Receivers and Transceivers

Transceivers and receivers have very different power requirements. Please read the following information carefully together with the electrical specifications at the end of this document.

4.1 Receivers

For a receiver only implementation a simple linear voltage regulator such as the common 7805 series is sufficient. Be sure to choose a package with sufficient cooling capabilities. A TO-220 or D-Pak is usually a good choice.

4.2 Transceivers

As transceivers can draw high currents when transmitting, a more sophisticated solution is generally required. It is especially important to make sure the supply can handle the brief peaks.
The W-DMX cards have built in under voltage detection which protects the system from permanent electrical damage, but data loss might still occur.
If the transceiver card is used as an RDM receiver, then you also need to take into consideration the current used during transmission.

4.3 Power Indicator

The W-DMX card is equipped with an on-board green Power Indicator LED, which is lit when the card is powered properly.

5 Interface Connectors, J1 and J3

The connectors J1 and J3 provide pins for power, DMX data, control signals and user interface.

Pin 1, 2, and 3 of J1 will function as a DMX/RDM input on a Transmitter card and as a DMX/RDM output on a Receiver card.

No provisions are made on the W-DMX TRX card for the secondary DMX data connections, or any other form of data, that is sometimes carried by Pin 4 & 5 on 5 pin DMX XLR connectors, and as such these two extra pins should never be connected to any pin on the radio card.

5.1 Connector Types

J1 and J3 are both commonly available standard dual row 2.54mm (0.1") pitch pin headers
J1 and J3 are located in such way so that they together fit in a 24 pin header.

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5.2 Pin out for the W-DMX Pro card

J1

Tx/Rx Sel In	10	9	LED Mode (L6)
Pwr, non reg.	8	7	Gnd
+5V	6	5	LED Status
Button	4	3	RS485+/TTL Tx
RS485-/TTL Rx	2	1	Gnd

J3 (only available on L6)

RS485/TTL Sel.	12	11	RS485 Ext. Dir
MOSI	10	9	MISO
SCK	8	7	Slave CS
Overlay CS	6	5	Slave IRQ
Inter B	4	3	Inter A
Tx/Rx Out	2	1	Reset

Pin		Name	Dir	Description	Notes
J1	10	Tx/Rx Sel In	I/O	Select/Indicate Transceiver Direction (On L5, only used for input)	330ohm series resistor
J1	9	LED Mode	O	Indicates G3/G4L/G4H mode (On L5, internal usage)	Active High
J1	8	Pwr, Non. Reg.	P	Unregulated power in, only on select models	
J1	7	Gnd	P	Ground	
J1	6	+5V	P	Regulated 5V	
J1	5	LED Status	O	Status Led	Active High
J1	4	Button	I	Function Button, Internal Pullup	Active Low
J1	3	RS485+/TTL Tx	I/O	RS485 Positive or TTL level Tx	
J1	2	RS485-/TTL Rx	I/O	RS485 Negative or TTL level Rx	
J1	1	Gnd	P	Ground	
J3	12	RS485/TTL Sel.	I	Select RS485/TTL level. Internally pulled low to select RS485	
J3	11	RS485 Ext. Dir.	O	RS485 direction for external driver	
J3	10	MOSI	O	SPI Data Out	
J3	9	MISO	I	SPI Data In	
J3	8	SCK	O	SPI Clock	
J3	7	OSP CS#	O	Chip Select for slave MCU Interface	Active Low
J3	6	Overlay CS	O	Chip Select for Overlay Interface	Active High
J3	5	OSP IRQ#	I	Slave interrupt request	Active Low
J3	4	Inter B	I/O	Reserved, Do not connect	
J3	3	Inter A	I/O	Reserved, Do not connect	
J3	2	Tx/Rx Out	O	Signals transceiver mode	Active High
J3	1	Reset	I	MCU reset, internally pulled high	Active Low

6 DMX Interface and Specification

The transceiver provides a non-isolated RS-485 signal interface that is used in the R-512 unit in parallel with an TTL level interface used in the other units where the carrier board implement an isolated RS-485 interface.

To select TTL levels instead of RS485, pull the **RS485/TTL Sel.** pin (J3:12/Slot In:16) high. Refer to the connector description for pin numbering.

Note that all normal DMX/RDM timing requirements apply regardless of signal levels.

6.1 Conformity to ANSI E1.11-2008

The W-DMX G4S conforms to the USITT DMX-512A standard with the following specifications:

6.1.1 §10.5.3 Loss of data handling procedure.

6.1.1.1 Loss of DMX or Radio Link

Recovery of DMX at the receiving end after loss and resumption of DMX signal at the transmitter is within 5 ms.

Recovery after complete loss of the radio link is less than 50ms when there are normal reception conditions.

A W-DMX TRX receiver card will turn its DMX/RDM output into high impedance state upon loss of DMX at the transmitter, or loss of radio link at the receiver.

The W-DMX G4S radio protocol employs what is known as Data Safe which has redundancy on the packets sent over the air and send each DMX slot at least twice, and distributes them on different frequencies, thereby greatly improving reliability and data fidelity, and greatly reducing the chance of data loss caused by spurious interference when compared to other Wireless DMX products. However, no radio system is 100% noise proof and if higher data reliability where no bytes can be allowed to be wrong, the user needs to implement some kind of error correction scheme above the DMX layer.

6.1.1.2 Loss of Power

Configuration information is stored in non-volatile memory and will not be lost upon loss of power to the card. This information includes system setup and settings for power level and frequency hopping pattern, as well as connection information for the previous transmitter the unit was connected to. The non-volatile memory will retain its information for a minimum of 10 years without power.

Upon loss of power to the card the RS-485 DMX ports of the device will go into a high impedance state, as mandated by the DMX standard.

Resumption of wireless transmission and reception of data takes place within a second after power is reapplied to the card, depending on configuration.

6.1.2 §10.5.4 Packet processing latency.

The W-DMX systems have an average latency of 3ms from when data comes in to the radio transmitter to when data is transmitted from the radio receiver when running in G4S radio mode.

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6.1.3 §10.5.5. NULL START Code functionality.

The W-DMX system forwards all packets regardless of start code in G4S mode, with the exception of RDM start codes, which are processed internally on RDM enabled devices. In other radio modes only NULL START Code packages is forwarded.

6.1.4 §10.5.6 Slot footprint.

The W-DMX system has a slot footprint of zero.

7 User Interface

The W-DMX system offers the following user interface options:
1. A push button (called function switch) and one or more status LEDs.
2. Overlay Interface
3. RDM interface

IMPORTANT! The Function Switch and the LED Indicator are the minimum requirement for a working implementation. Without a way to interact with the system the user may be left with an inoperable device.

7.1 Function Switch

The function switch can be a simple momentary push button connected between pin J1:4 and ground or a transistor controlled by a micro controller. Refer to the table below for exact timings required.

7.1.1 Link

When the button is pressed for a brief period of time the transmitter will link unlinked receivers within range.

7.1.2 Unlink

On a transmitter holding the button for more than 3s and then releasing it will cause any linked receivers to unlink.
On a receiver holding the button for more than 3s will cause that receiver to unlink.

7.1.3 Transceiver direction

Cards read the state of pin J1:4 at start up and will, if the pin is low, switch mode. A receiver becomes a transmitter and vice versa. When J1:4 is held low at boot, the boot loader will be bypassed, giving control to the main program immediately. Thus the pin only has to be held low for a very short period of time.

7.1.4 Function Switch Timing

The functionality provided by the Function Switch input and its timing parameters are described in the table below.

	Time min	Time max
Transceiver		
Idle / Normal Operation	-	-
Link Receivers	100ms	3s

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Unlink all Receivers	3s	10s
Toggle direction at boot (Flex Button Mode only)	100ms	-
Receiver		
Idle / Normal Operation	-	-
Unlink from a Transmitter	3s	

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7.1.5 Status Indicator LED

The Status LED indicates the current status of the wireless connection and the presence of DMX data. The status is valid after start-up process has finished after ~1.7s (worst case) from power on

The LED is active high, and should be connected between J1:5 and ground, for example J1:7 via a series resistor.

The LED output can deliver a maximum of 15mA. For the average LED a series resistor of 330ohms will work well.

The indications below are valid during steady state, that is in normal running mode after the boot loader has finished.

☐ / "Off" denotes a dark LED and ■ / "On" denotes a lit LED.

7.1.5.1 LED Indication - Receiver:
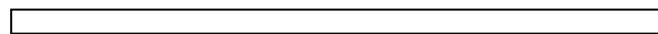
Continuously Off = not assigned to a transmitter

On 900ms / Off 100ms = assigned to a transmitter, but no DMX present

Continuously On = assigned to a transmitter and DMX present

On 100ms / Off 100ms = link to transmitter lost or linking to transmitter

7.1.5.2 LED Indication - Transmitter:

On 900ms / Off 100ms = no DMX present

Continuously On = DMX present

On 100ms / Off 100ms = linking receivers

On 500ms / Off 500ms = unlinking all receivers

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7.1.6 Mode Indicator LED, L6 only

The Mode LED indicates whether the W-DMX device is currently operating in G3, G4, G4S 2.4GHz or G4S 5.8GHz mode.

G4S 5.8 GHz mode: on 500ms / Off 500ms

The LED is active high, and should be connected between pin J1:9 and ground, for example at pin J1:7, via a series resistor.

The LED output can deliver a maximum of 15mA. For the average LED a series resistor of 330ohms will work well.

7.2 LED Overlay Interface, L6 only

This interface is implemented on the W-DMX BlackBox/WhiteBox range.
The overlay interface consists of an SPI interface that shifts out data for the LEDs as described below. To avoid flicker a latched shift register is recommended.
The SPI speed is 2.5MHz and Overlay CS is pulled high before the output start and pulled low after the SPI output has ended.
.

7.2.1 LED order

Name	Bit	Text	Color	Description
Signal 5	0		Green	Signal strength
Signal 4	1		Green	Signal strength
Signal 3	2		Green	Signal strength
Signal 2	3		Yellow	Signal strength
Signal 1	4		Red	Signal strength, G4/G4S indication on transmitter
Transmit Mode	5	TX	Green	Radio transmitter
Control Mode	6	CTRL	Red	In control mode
Link	7	LINK	Green	Link established
Data	8	DATA	Green	DMX Data present
Power	9	PWR	Blue	Power on indication
Reserved	10-11			
Receiver Mode	12	RX	Green	Radio receiver
G4 Mode	13	G4	Green	Mode indication
RDM	14	RDM	Green	RDM on/off
Reserved	15			

7.2.2 SPI Settings

Parameter	Min	Typ.	Max	Unit	Comment
SPI Mode					0. Clock idles low. Data valid on leading clock edge
Data Bit Rate		2.5		MHz	
Bit order					Most Significant Bit first

7.3 W-DMX RDM Interface

The W-DMX transceivers can act as a managed RDM proxy. Please see the separate document "W-DMX RDM Manual" for details.

8 In System Software updates (Boot Loader Support)

The W-DMX device is equipped with a so called boot loader which allows the end user to upgrade the device to a new software version even when installed in a fixture.
When power is applied to the W-DMX device the boot loader is entered and the Status LED is lit as an indication. In this mode it waits for a sync signal from a W-DMX USB Dongle. If no signal is received within 0.5s normal operation is resumed and the system enters the main program.

If no valid program is found on the W-DMX card, for example because of an interrupted upgrade, the Status LED will blink slowly to indicate this.
During software upgrade the Status LED blinks once for every valid packet received.

When software update is performed, configuration settings on the device is not affected and therefore the software lock that disable 2.4 functionality is not affected.

8.1 Design considerations

Designing for boot loader compatibility requires a few considerations that might not normally be included in a simple receiver setup:

8.1.1 Bidirectional connection

In a simple fixture external DMX ports might not be present. For the boot loader to be able to communicate with the USB Dongle a bi-directional connection is required between the DMX terminals of the W-DMX device and an external connector.
Some fixtures offer an external XLR connector for DMX input, often to a separate UART on the uC. This will not work as the boot loader requires unhindered control of the data lines.
Also, most repeaters/splitters will not work as the boot loader protocol uses the non-DMX data rate of 57.6kbps.

8.1.2 A means of resetting the device

Since the W-DMX device enters the boot loader at start up, some way to restart the device is required in order for upgrades to work. This can be done either by power cycling the W-DMX card or by pulling the RESET pin low on an L6 card.
If the fixture controls the power state of the W-DMX device care must be taken to ensure that the data lines are available to the device at start up.

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9 Installation Guidelines

The PCB is installed on the carrier board.
The box is opened by unscrew 4 screws from the bottom of the unit, the screws is hidden by rubber feet's.
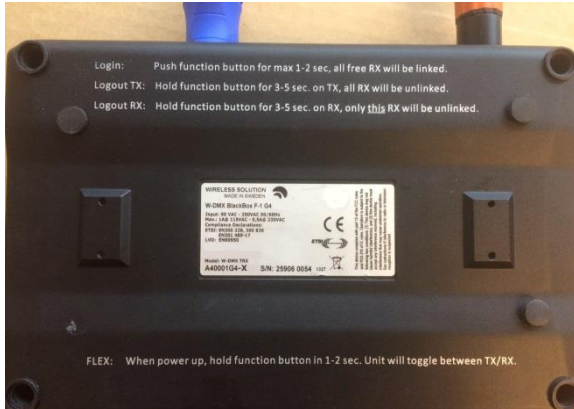
The electrical installation includes two parts:
Push out the plug for the antenna connector and then fasten the antenna cable in the chassis

Connect the MCX connector on the antenna cable on the radiocard

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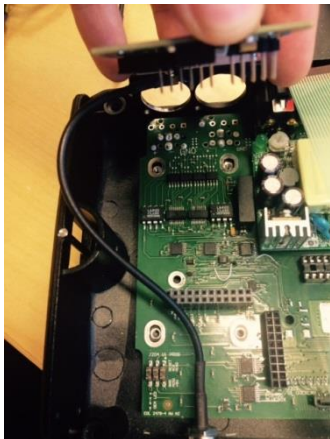
Connect the pin header on the radiocard to the carrier board and fixate with four screws.

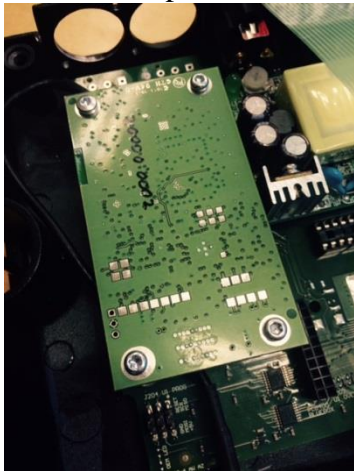To close the unit, close the LID and fasten the 4 screws in the bottom, put back the rubber feet.

Connect the antenna to the SMA connector on the box

Finally when the installation is completed, take the label
"Contains FCC ID: NY2-WDMXTRXDB" and fasten it on the product label on the bottom of the unit.

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The radio card is detected by signal level on pin J1.5 that is driven to GND or 5V depending on card status, normal this pin is floating to ~2.5V. Therefore no further installation is needed.

By this detection, the host product is initialized for use of the radiocard.

10 Specifications

Exceeding the values specified in the tables below will cause permanent damage and void any warranty.

10.1 Electrical Specifications

Parameter	Min.	Typ.	Max.	Unit
DC Supply				
5V DC input	4.9	5.0	5.1	V
LED Pin output source current			20	mA
DMX interface				
Maximum number of units on the DMX/RS-485 bus	As per the DMX Standard			
DMX data rate[1]		250		kbps
ESD protection, human body model		None		kV
RF characteristics (5.8GHz)				
Maximum Output Power	-		27.0	dBm
Actual limit depends on local regulations	-		500	mW
Frequency Range of operation	5744		5821	MHz
Channel bandwidth		1		MHz
Sensitivity at 0.1% BER		-96		dBm
Range with standard 4dBi antenna (measured)		400		m

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[1] Slew rate limited for minimum of EMI in un-terminated networks.

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DC current consumption

Code[1]	Typ.[2] (mA)	Max[2] (mA)	Antenna	Operating Mode	Typ. input power (W)	Max input power (W)
WDMX-TRX	470	850	MCX	Tx		
WDMX-TRX	80	95	MCX	Rx		

Environmental requirements

Parameter	Min.	Typ.	Max.	Unit
Ambient Operating Temperature	-20		45[3]	°C
Relative Humidity[4]	20		80	%
Option: coated Relative Humidity[4]	20		95	%

---

[1] Refer to Appendix 1 for Order Codes and a detailed description.

[2] Measured with no DMX on input/output and no LEDs.

[3] Consult with Wireless Solution for temperatures exceeding 45°C.

[4] Non-condensing.

Appendix 1.   Ordering Codes for Radio Cards

Order Code	Name	Input Voltage	Band (GHz)	Direction Selector	Ant.	RDM	Notes
WDMX-TRX	PRO G4, Transceiver, MCX Connector. DMX/RDM. 5,8GHz US Market only	5V	5.8	J1:4	MCX	Yes	Transceiver, 5.8GHz only

11 Notes