

CITY THEATRICAL

NEW YORK • LONDON



Multiverse[®] Module OEM User Manual

Rev 1.9

© 2017 City Theatrical, Inc.

Multiverse devices are covered by U.S. patent #7,432,803.

Other patents pending.

Table of Contents

1	Revision History	6
2	Introduction	7
2.1	Features	7
2.2	Part Numbers	8
3	Specifications	9
3.1	Regulatory Specifications	11
3.1.1	FCC Part 15	11
3.1.2	Radio Frequency Notifications	11
3.1.3	FCC Notifications	11
3.1.4	Industry Canada Notification	12
4	OEM Installation	13
4.1	OEM Labeling Requirements	13
4.1.1	FCC Compliance Statement (United States)	13
4.1.2	IC Statement	13
4.2	Approved Antennas	14
5	Recommended Layout Decals	15
5.1	Layout Notes	16
6	Signal Pinout	17
7	OEM Interfaces	18
7.1	I2C	18
7.1.1	I2C Accessible Data	20
7.1.2	I2C Protocol	20
7.1.2.1	Strings	20
7.1.2.2	Termination and Overrun	20
7.1.2.3	Repeated Reads	21
7.1.2.4	Repeated Writes	21
7.1.2.5	Slot Array	21
7.1.2.6	Timing diagrams	21
7.1.3	I2C Register Descriptions	21
7.1.3.1	(0x0046) I2C Attention Register	21
7.1.3.2	(0x0047) I2C RDM Proxy Traffic Enable	22

www.citytheatrical.com

7.1.3.3	(0x0049) I2C RDM Response	22
7.1.3.4	(0x004A) I2C RDM PD	23
7.2	SPI	23
7.2.1	SPI Protocol	23
7.3	UART	24
7.4	Recommended Configurations	24
7.4.1	Minimal	24
7.4.2	Basic.....	25
7.4.3	Advanced	26
8	Tape and Reel Information	28
9	Reflow Profile.....	29

List of Tables

Table 1: Revision History	6
Table 2: Part Numbers	8
Table 3: Absolute Maximum Ratings	9
Table 4: Physical Characteristics	9
Table 5: ESD Ratings	9
Table 6: Recommended Operating Conditions	9
Table 7: Power Consumption Summary	10
Table 8: DC Characteristics	10
Table 9: RF Characteristics	10
Table 10: Interfaces	10
Table 11: Timing Characteristics	10
Table 12: Approved Antennas	14
Table 13: Pinout Descriptions	17
Table 14: I2C Addresses	18
Table 15: I2C Accessible Data	20
Table 16: I2C Attention Data Bytes	22
Table 17: I2C Attention Reason Codes	22
Table 18: I2C RDM Response Data Bytes	22
Table 19: Synchronous Serial Interface (SSI) Characteristics	23

List of Figures

Figure 1: 5990 Decal	15
Figure 2: 5994 Decal	15
Figure 3: 5991/5995 Decal	16
Figure 4: 5990 Side View	16
Figure 5: 5994 Side View	16
Figure 6: 5991/5995 Side View	16
Figure 7: Example Board Layout	16
Figure 8: Example Stencil Design	16
Figure 9: I2C Specification	21
Figure 10: SSI Timing	23
Figure 11: Minimal Configuration Block Diagram	25
Figure 12: Basic Configuration Block Diagram	25
Figure 13: Advanced Configuration Block Diagram	26

1 Revision History

Table 1: Revision History

Revision	Date	Description	Author/Changed
1.0	May 8 th , 2017	Preliminary release of Footprint and pin info	P. Kleissler
1.1	August 15 th 2017	Added Electrical Characteristics and Protocol	D. Smith/P. Kleissler
1.2	August 24 th 2017	Updated Table 4 packaging	P. Kleissler
1.3	November 6 th 2017	Added ID 7&8 to Table 12	A. Joo
1.4	November 6 th 2017	Added text to Introduction	P. Kleissler
1.4	November 6 th 2017	Updates to cover page; revised intro for naming consistency	J. Morreale
1.5	November 13 th 2017	Updated Table 12 ID8 gain to 11dBi	A. Joo
1.6	December 4 th 2017	Updated Table 14 and added I2C Attention	P. Kleissler
1.7	December 6 th 2017	Added Integration block diagrams Added more I2C register descriptions Added Configuration Block Diagrams	P. Kleissler
1.8	December 19 th 2017	Added required OEM wording on antenna	P. Kleissler
1.9	January 23 rd 2018	Added OEM requirements as per FCC review	P. Kleissler

2 Introduction

City Theatrical's newest version of the Multiverse® Modules provides unprecedented levels of data transmission in a tiny package, and at the lowest cost yet seen in the entertainment lighting industry for professional quality wireless DMX.

Multiverse Modules are best suited for lighting equipment manufacturers who are interested in adding wireless DMX to their products. Due to low cost, increased data transport, and ease of design integration, the Multiverse Module marks the first time that the implementation of a wireless DMX chip in every DMX device is possible.

The Multiverse Module is available in two frequency ranges, 900MHz (for use in the Americas) and 2.4GHz (for use worldwide). Each frequency version can include a PCB trace antenna or not. All versions have a U.FL connector to connect to external antennas. Consult Table 2 for part numbers.

The implementation of Multiverse Modules is simple because they are available on reels for surface mounting. The engineer can opt to integrate in one of three ways: Minimal, Basic or Advanced.

The Minimal Integration Method replaces the DMX input circuitry with the module. The Multiverse module will deliver DMX/RDM directly via TTL UART signals. In this configuration, the Multiverse module will appear as a separate RDM device from the OEM product. This method provides an easy path to add the Multiverse module to existing products without major re-design of the product.

The Basic Integration Method replaces the DMX/RDM input circuitry, provides a DMX and RDM stack and appears as a single integrated OEM RDM device. This configuration also allows for seamless DMX wired and wireless operation without any additional hardware to be implemented. This is the recommended integration method because it provides the most benefit to the end user with the lowest implementation cost.

The Advanced Integration Method provides all of the features of the other two methods, but enables multiple universes to be processed. This method of integration is required when you need access to more than a single universe, or need to transport alternate start code (ASC) data.

2.1 Features

- Supports ANSI E1.11 DMX512-A and E1.20 RDM
- Supports unidirectional alternate start codes
- Up to 2,560 DMX slots
- Non-Interfering RDM
- Adaptive frequency hopping modes
- Low Latency < 7ms

- Source frame size/rate matching
- Backwards compatible with SHoW DMX Neo, Neo Max systems
- With or without PCB trace antenna
- External antenna supported via U.FL/IPEX antenna connector on all models
- 900MHz and 2.4GHz models
- I2C Slave configuration from OEM host
- SPI interface
- Small footprint (900MHz, 18x34mm; 2.4GHz, 18x26.2mm; 900/2.4 No PCB Antenna 18x21mm)
- Same pinout for all models, design for largest, install any
- Firmware updatable over air or by OEM system via I2C

2.2 Part Numbers

Table 2: Part Numbers

Model #	Description	FCC ID:	IC:	Size
5990	900MHz Multiverse Module Internal & External Antenna (DTS)	VU65990	7480A-5990	18mm x 34mm
5991	900MHz Multiverse Module External Antenna Only (DTS)	VU65991	7480A-5991	18mm x 21mm
5994	2.4GHz Multiverse Module Internal & External Antenna (FHSS)	VU65994	7480A-5994	18mm x 26.2mm
5995	2.4GHz Multiverse Module External Antenna Only (FHSS)	VU65995	7480A-5995	18mm x 21mm

3 Specifications

Table 3: Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)¹

	MIN	MAX	UNIT
Supply Voltage	-0.3	VCC + 0.3, max3.6	V
Voltage on any pin	-0.3	VCC + 0.3, max3.6	V
Storage Temperature	-40	150	°C

Table 4: Physical Characteristics

		UNIT
Size	5990: 18 x 34 x 2.8 5991: 18 x 21 x 2.8 5994: 18 x 26.2 x 2.8 5995: 18 x 21 x 2.8	mm
OEM Interface	PCB SMD 2 x 12 castellated edge	
Antenna Connector	U.FL/IPEX	
Moisture Sensitivity Level	3	
Packaging	5990: Tape & Reel 13" 56mm, 780/reel 5994: Tape & Reel 13" 44mm, 780/reel 5991/5995: Tape & Reel 13" 32mm, 780/reel	

Table 5: ESD Ratings

			VALUE	UNIT
V _{ESD} Electrostatic Discharge	Human body Model (HBM) ²	All Pins	±3500	V
	Charged device model (CDM) ³	All Pins	±1250	

Table 6: Recommended Operating Conditions

Over operating free-air temperature range

	MIN	MAX	UNIT
Ambient Temperature	-40	85	°C
Operating Supply Voltage (VCC)	3.10	3.36	V
Rising Supply voltage slew rate	0	100	mV/μs
Falling Supply voltage slew rate	0	20	mV/μs

¹ Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the module. There are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

² Per ANSI/ESDA/JEDEC JS001.

³ Per JESD22-C101

Table 7: Power Consumption Summary

Transmit and receive measurements made with maximum power settings. Different RF modes will affect power consumption.

PARAMETER	TEST CONDITIONS	MODULE	TYP	UNIT
Current Consumption	Sleep	5990/5991	?	mA
		5994/5995	?	mA
	Transmitter	5990/5991	30	mA
		5994/5995	80	mA
	Receiver	5990/5991	25	mA
		5994/5995	25	mA

Table 8: DC Characteristics

		MIN	MAX	UNIT
VOH at 4mA Load		2.72		V
VOL at 4mA Load		0.28		V
VIH	Lowest interface input voltage reliably interpreted as a <i>High</i>		0.8	V
VIL	Highest interface input voltage reliably interpreted as a <i>Low</i>	0.2		V

Table 9: RF Characteristics

TRANSMITTER CHARACTERISTICS			UNIT
Frequency Range	5990/5991: 902 ~ 928 5994/5995: 2.40 ~ 2.483		MHz GHz
Rated Transmit Power	17 +0.25		dBm
Encryption	AES-128		
Security	User Password		
RECEIVER CHARACTERISTICS			
Sensitivity			dBm
Error Checking	CRC32		
Forward Error Correction	Cross-Packet		
Modulations			
5990 / 5991	DTS		
5994 / 5995	FHSS		

Table 10: Interfaces

OEM INTERFACE		SPEED
SPI	4 Wire Slave	4Mbps max
I2C	2 Wire Slave	400Kbps max
UART	DMX TTL with Driver control	250Kbps

Table 11: Timing Characteristics

	MIN	MAX	UNIT
--	-----	-----	------

nReset low duration	1	μs
Active → Sleep		μs
Sleep → Active		μs

3.1 Regulatory Specifications

3.1.1 FCC Part 15

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 to correct the interference by one or more of the following measures:

- Re-orient or re-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.

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 UNDESIRE OPERATION.

3.1.2 Radio Frequency Notifications

3.1.3 FCC Notifications

RF Radiation: The Product is an intentional radiator of Radio Frequency (RF) energy. In order to limit RF exposure to personnel in the immediate area, the Product should be located and installed such that a separation of at least 20 centimeters is maintained between the Product's antenna and personnel in the vicinity of the device. The antenna used for this transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

Modification warning: Caution - changes or modifications to this equipment, not expressly approved by City Theatrical, Inc. could void the user's authority to operate the equipment.

3.1.4 Industry Canada Notification

This Class B digital apparatus complies with Canadian ICES-003. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

4 OEM Installation

These modules are limited to OEM installations only.

The OEM integrator is responsible for ensuring that the end user has no manual instructions to remove or install the modules.

The modules are limited to installation in mobile or fixed applications, according to Part 2.1091(b)

Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations.

4.1 OEM Labeling Requirements

The OEM integrator is required to have the following statements in the end product's user's manual.

4.1.1 FCC Compliance Statement (United States)

This device complies with Part 15 of the Federal Communications Commission (FCC) Rules. Operation is subject to the following two conditions:

This device may not cause harmful interference.

This device must accept any interference received, including interference that may cause undesired operation.

CAUTION:

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

4.1.2 IC Statement

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause interference; and
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

FCC/IC Labeling Instruction for 900MHz Multiverse Module #5991

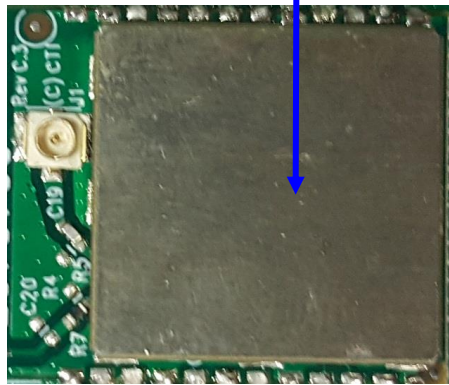
On Modular

City Theatrical
900MHZ MULTIVERSE MODULE
Model No.: 5991
FCC ID: VU65991 IC: 7480A-5991

This device complies with FCC Part 15C & IC RSS-247 Rules. Operating 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.

(statement shown in the manual)

Product Sticker with FCC/IC ID



FCC/IC Label on Hosting/Finished Products:

Brand Name Product Marketing Name / Model No.

Contains FCC ID:VU65991 IC:7480A-5991

FCC /IC Statements

This device complies with FCC Part 15C & IC RSS-247 Rules. Operating 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.

4.2 Approved Antennas

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that required for successful communication. This device has been designed to operate with the antennas listed in Table 12 below. Antennas not included in this list are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

The OEM integrator must provide the ability to select an antenna in the end product and provide the following antenna information as to its use in the product's user manual.

The modules can be configured ONLY with any one of the approved antennas listed in Table 12 for fixed, point-to-point (one transmitter and one receiver) configuration. When the device is configured for point-to-multipoint (one transmitter and multiple receivers, receivers talk to transmitter only one at a time) configuration, the receiver can use any of the approved antennas, the transmitter can use any approved antenna listed in Table 12 except ID5 and ID8 Yagi directional antennas.

When antennas ID4 and ID7 are used, the antenna register must be selected to "Panel" mode.

When antennas ID5 and ID8 are used, the antenna register must be selected to "Yagi" mode.

The OEM must include instructions in the product's user manual as to the setting of this register. The setting of this register can be either thru the local UI or RDM. For example:

"When using a panel antenna, you must select "Panel Antenna" in the antenna options"

Table 12: Approved Antennas

ID	Manufacture	Model	Type	Connector	Gain (dBi)	Freq. Hz
1	Nearson	S141AH-2450	Omni Whip	RP-SMA	2	2.4G
2	TekFun	M35-SR	Omni Whip Tilt	RP-SMA	2	2.4G
3	TekFun	W50-SR-V4	Omni Whip Tilt	RP-SMA	2/3	900M/2.4G
4	TekFun	PL-M24-08X	Panel	N Female	8	2.4G
5	TekFun	YG-M04-14X	Yagi	N Female	14	2.4G
6	Microchip	TRF1001	Omni Whip	U.FL on 150mm cable	2	2.4G
7	Tekfun	PL-W26-08M	Panel	N Female	6.5/8.5	900M/2.4G
8	Tekfun	LP-W28-110	Yagi	N Female	11	900M/2.4G

[illegible]

Figure 3: 5991/5995 Decal

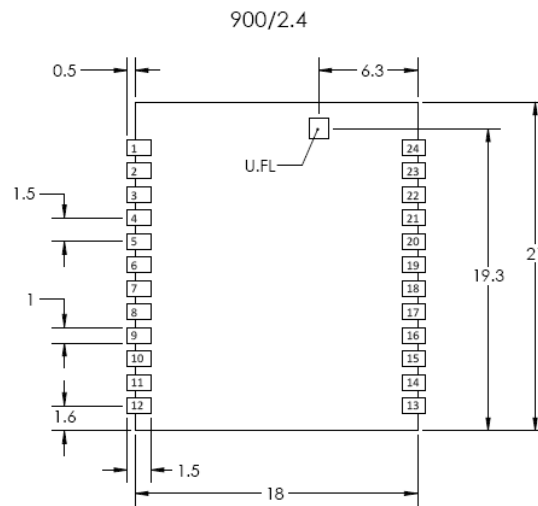


Figure 4: 5990 Side View

Figure 5: 5994 Side View

Figure 6: 5991/5995 Side View

Figure 7: Example Board Layout

Figure 8: Example Stencil Design

5.1 Layout Notes

- Place the module at an edge of the OEM PCB with the antenna overhanging or at the edge.
- There should be no copper directly under the module on the OEM's top layer.
- There should be no ground/power planes within 10mm of PCB trace antenna
- Avoid metal structures near the PCB trace antenna

6 Signal Pinout

Table 13: Pinout Descriptions

Pin	Type	Signal Name	Function	Notes
1	GND	GND	Signal Ground	
2	VCC	VCC	+3V3DC Module Power	
3	VCC	VCC	+3V3DC Module Power	
4	GND	GND	Signal Ground	
5	I/O	JTAG_TMS	JTAG Test Mode Select	
6	I	JTAG_TCK	JTAG Clock	
7	I	nRESET	Module Hard Reset	Active Low
8	GND	GND	Signal Ground	
9	O	UART_TXE	DMX Driver Transmit enable	
10	I	UART_RX	Receive Data from DMX driver	
11	O	UART_TX	Transmit Data to DMX driver	
12	GND	GND	Signal Ground	
13	GND	GND	Signal Ground	
14	I	I2C_SCL	I2C Clock	Open-drain, 2K Ω internal pull-up
15	I/O	I2C_SDA	I2C Data	Open-drain, 2K Ω internal pull-up
16	O	I2C_nATTN	I2C Attention	Active Low
17	GND	GND	Signal Ground	
18	I	SPI_nSS	SPI Slave Select	Active Low
19	I	SPI_MOSI	SPI Master output, slave input	
20	O	SPI_MISO	SPI Master input, slave output	
21	I	SPI_CLK	SPI Clock	Idle Low, Sample on Falling Edge
22	O	SPI_nATTN	SPI Attention	Active Low
23	GND	GND	Signal Ground	
24	GND	GND	Signal Ground	

7 OEM Interfaces

The module has three interfaces to OEM systems, SPI, I2C and DMX TTL. Not all interfaces are required to be connected to the OEM CPU. In this section, each interface will be described followed by the three implementation examples.

7.1 I2C

The I2C bus provides bidirectional data transfer through a 2-wire interface, a serial data line (SDA), and a serial clock line (SCL). An Attention line is included that is active low to notify the OEM CPU that data is available to be read. The SDA and SCL lines each have 2K Ω internal pull-up resistors. Additional pull up resistors may be needed depending on OEM's circuit board design.

Do not apply a 5 volt logic signal to the I2C bus.

You can have a maximum of one module on each I2C bus. Other I2C devices are allowed on the same buss, but may impact performance and should be evaluated.

The Multiverse I2C chip address is 0x43.

The I2C interface can operate up to fast mode (400 Kbps).

The I2C interface is the only interface for configuring the module. All configurable parameters are read or written to this interface.

Access any to all slot data can be obtained thru this interface. Care should be taken to not attempt to retrieve more slot data than the interface speed can support for the DMX refresh rate currently being transmitted if loss of data is intolerable.

For devices that wish to have a single RDM presence for the integrated device, RDM messages addressed to the OEM's UID will come from this interface.

Addressing registers is accomplished by supplying a 2 byte address after the I2C address. The register addresses are defined below in Table 14.

Table 14: I2C Addresses

ADDRESS (HEX)	DESCRIPTION	# BYTES	READ/WRITE
0x0000	Product Name Length (Auto-increment on Read)	1	Read
0x0001	Product Name (String)	<= 255	Read
0x0002	Manufacturer Name Length (Auto-increment on Read)	1	Read
0x0003	Manufacturer Name (String)	<= 255	Read
0x0004	Serial Number Length (Auto-increment on Read)	1	Read
0x0005	Serial Number (String)	<= 255	Read
0x0006	Hardware Revision Length (Auto-increment on Read)	1	Read
0x0007	Hardware Revision (String)	<= 255	Read

www.citytheatrical.com

0x0008	Software Revision Length (Auto-increment on Read)	1	Read
0x0009	Software Revision (String)	<= 255	Read
0x000A	Software Build Info Length (Auto-increment on Read)	1	Read
0x000B	Software Build Info (String)	<= 255	Read
0x0010	Manufacturer ID	2	Read
0x0011	Product ID	2	Read
0x0012	RDM UID	6	Read/Write
0x0013			
0x0014	Hardware Binary Revision	2	Read
0x0015	Software Binary Revision	4	Read
0x0018	Operating Mode (0 = Off, 1 = Node, 2 = Hub, 0xff = Not Ready)	1	Read/Write
0x0019	Antenna Mode (0 = Auto, 1 = PCB, 2 = External)	1	Read/Write
0x001A	Modulation (xMbps)	1	Read/Write
0x001B	Modulation Minimum	1	Read
0x001C	Modulation Maximum	1	Read
0x001D	Hop Mode	1	Read/Write
0x001E	Hop Mode Minimum	1	Read
0x001F	Hop Mode Maximum	1	Read
0x0020	Hop Sub Mode	1	Read/Write
0x0021	Hop Sub Mode Minimum	1	Read
0x0022	Hop Sub Mode Maximum	1	Read
0x0023	Number of Hop Channels	1	Read
0x0024	Hop Sequence	1	Read/Write
0x0025	Hop Sequence Minimum	1	Read
0x0026	Hop Sequence Maximum	1	Read
0x0027	Transmit Power	2	Read/Write
0x0028	Transmit Power Minimum	2	Read
0x0029	Transmit Power Maximum	2	Read
0x002A	Transmit Power Code	2	Read
0x002B	Cluster ID	2	Read/Write
0x002C	RF Encoding (0 = Direct, 2 = Cross Packet)	1	Read/Write
0x002D	RF Encoding Minimum	1	Read
0x002E	RF Encoding Maximum	1	Read
0x002F	Front End Bypass (2.4GHz only)	1	Read/Write
0x0030	Receiver Status	1	Read
0x0031	Receiver RSSI	1	Read
0x0032	Clear Stats	1	Write
0x0033	Transmitter Total Packet Count	4	Read
0x0034	Receiver Total Packet Count	4	Read
0x0035	Receiver Good Packet Count	4	Read
0x0036	Receiver Repaired Packets	4	Read
0x0037	Receiver Bad Packets	4	Read
0x0038	Receiver Missed Packets	4	Read
0x0039	Max Packet Size	2	Read/Write
0x003A	Max Packet Size Minimum	2	Read
0x003B	Max Packet Size Maximum	2	Read
0x003C	Hop Period	4	Read
0x003D	FEC Sub-Blocks	1	Read/Write
0x003E	Debug Terminal Enable	1	Read/Write
0x0040	Slot Count (Size of supported slot-array)	2	Read
0x0041	Slot Interface (0 = None, 1 = SPI, 2 = DMX In, 3 = DMX Out)	1	Read/Write
0x0042	DMX Stream	1	Read/Write

0x0043	DMX Length	2	Read/Write
0x0044	DMX Present	1	Read
0x0046	I2C Attention	8	Read
0x0047	RDM Proxy Traffic Enable	1	Read/Write
0x0048	RDM External Parser	1	Read/Write
0x0049	RDM Response	237	Write
0x004A	RDM PD	231	Read
0x4000 – 0x49FF	DMX Slot Array, address auto-increments	1	Read/Write

7.1.1 I2C Accessible Data

The I2C Interface supports access to the types of data in Table 15.

Table 15: I2C Accessible Data

Type	Comments
Slot Data	Any slot data from any stream being sent over the wireless/wired link
RDM	RDM messages that are directed to the OEM CPU
Configuration	Configuration registers

ASC data for a universe is stored in a different stream than the universe that it was received on. See ??? for more information on streams.

7.1.2 I2C Protocol

7.1.2.1 Strings

Strings use 2 registers. The first contains the 1-byte length (0-255) of the string while the second contains the string itself. When the length register is read the register address auto-increments to the string address which means if reading continues the string will clock out after the length. Note that the auto-increment behavior only applies from the length address to the string address. Once the string address is read the address remains at the string address and a subsequent read will clock out the string again.

7.1.2.2 Termination and Overrun

If reading attempts to continue beyond the length of a register zeros will be clocked out indefinitely. Zero will also provide an automatic termination for strings.

If writing continues beyond the length of a register then extra bytes are discarded.

If writing is terminated by a Stop condition before the specified number of bytes have been written then the entire operation is discarded. A write may be suspended and re-commenced by a repeat-Start, but this is not a common use-case.

7.1.2.3 Repeated Reads

The read/write logic is reset by an I2C Stop condition. Following a Stop a repeated read with no register address write will read the same register again, except in special cases where the register address auto-increments (string-length registers and slot array). If a read occurs with no intervening Stop (repeated Start condition) then reading continues from the previous position.

7.1.2.4 Repeated Writes

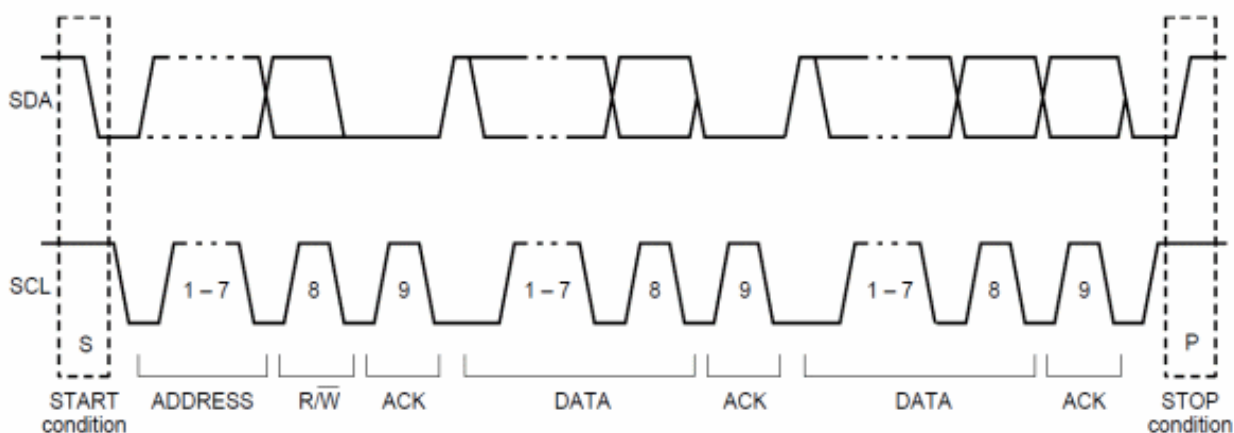
Following a Stop condition, the first two bytes written are always interpreted as a register address. If a write operation begins with a repeated Start condition then it will continue from the previous position.

7.1.2.5 Slot Array

Registers 0x4000 through 0x49FF are individual 1 byte registers at consecutive addresses. Address auto-increments on read or write. Slots are readable in both hub and node modes. Slots are only writeable in hub mode.

7.1.2.6 Timing diagrams

Figure 9: I2C Specification



7.1.3 I2C Register Descriptions

7.1.3.1 (0x0046) I2C Attention Register

Whenever the radio module needs to read/write data from/to the OEM CPU, it will assert the I2C Attention line.

The OEM CPU will read this register to determine the attention reason. Reason codes are defined in Table 17. When reading this register, there will be eight bytes returned. The first byte is the reason, followed by 7 bytes of data. Table 16 defines the data bytes returned.

www.citytheatrical.com

After reading the I2C Attention register, a read of the RDM PD register is required to get the message data. If the PD length reported in the I2C Attention register is less 2 bytes or less, the needed data for the RDM command will be included in the attention register and a read of the RDM PD register is not necessary.

Table 16: I2C Attention Data Bytes

Byte	Definition
0	Attention Reason Code
1	Length of data in RDM PD register (0 – 230 bytes)
2-3	RDM PID in network byte order
4-5	RDM Sub-device number in network byte order
6-7	First 2 bytes of PD if length of PD <= 2, else random value

Table 17: I2C Attention Reason Codes

Code	Reason
0x00	Null
0x01	RDM Get message received
0x02	RDM Set message received
0x03	RDM Set Broadcast message received
0x04	Slot Value Change

7.1.3.2 (0x0047) I2C RDM Proxy Traffic Enable

7.1.3.3 (0x0049) I2C RDM Response

This write only register is used to send RDM responses back to the radio module.

The radio module will generate an ACK_TIMER with a value of 1 in the case where the OEM CPU does not answer the RDM message within the RDM timing requirements. In order to avoid the ACK_TIMER, the OEM CPU needs to have the complete response transferred back to the radio module within 2ms.

When the ACK_TIMER expires and the RDM controller tries to retrieve the response and the OEM CPU still has not supplied the response, the radio module will respond with a NACK NR_BUFFER_FULL and consider the message cycle complete.

If the RDM controller sends a message other than Get:QUEUED_MESSAGE before or after the ACK_TIMER and the OEM CPU writes a new response to the RDM Response register, the old message is overwritten.

Table 18: I2C RDM Response Data Bytes

Byte	Definition
0	Length of the response message
1	RDM Response type as defined in E1.20

2-3	RDM PID in network byte order
4-5	Sub-Device number in network byte order
6-236	RDM PD

7.1.3.4 (0x004A) I2C RDM PD

The read only register contains the RDM PD of the message received when the PDL of the message is greater than 2 bytes.

When the I2C Attention register is read and the PD byte is greater than 2, this register must be read to get the RDM messages payload.

7.2 SPI

The SPI interface is used for slot data and RDM messages external to the OEM product.

The interface has an attention signal to notify the OEM CPU that the interface has data available to be read.

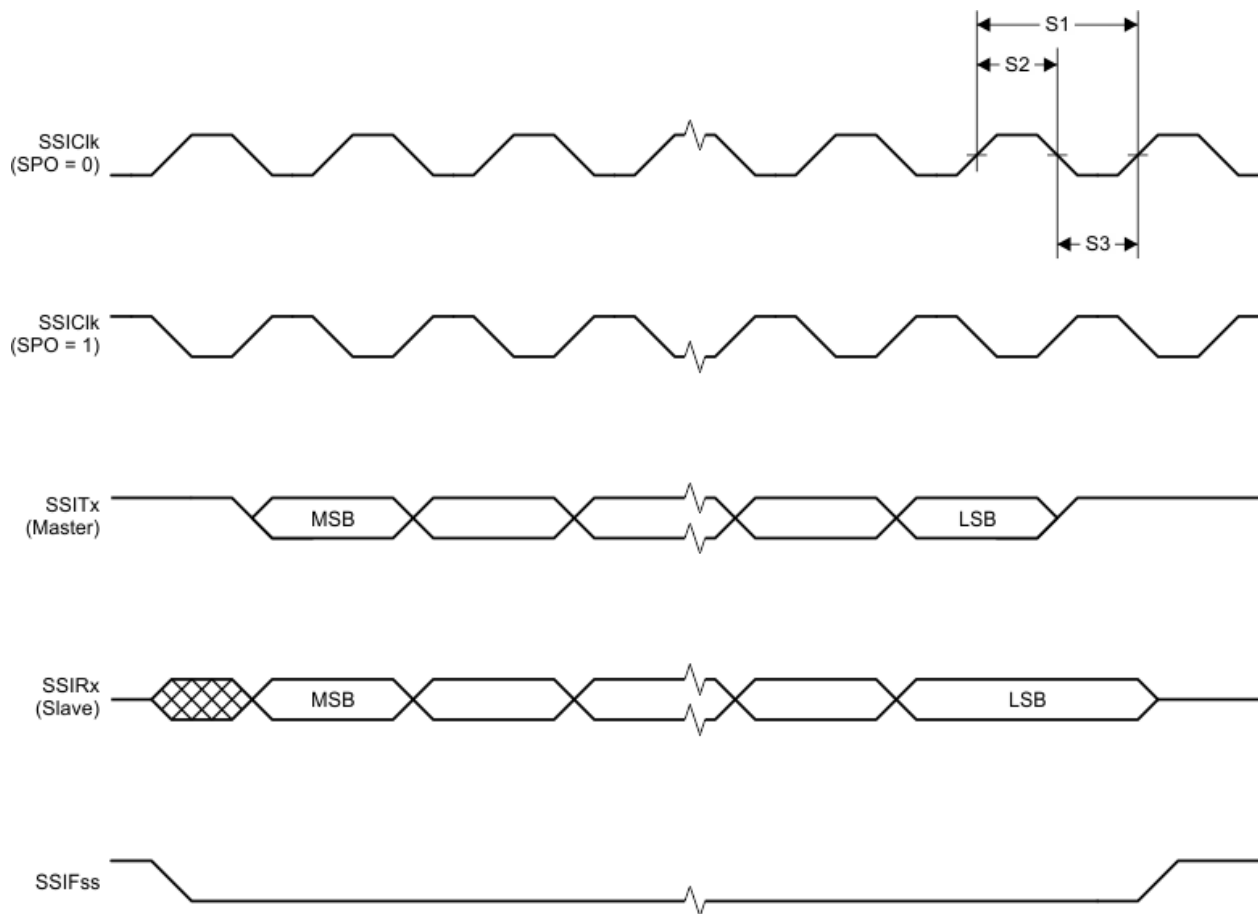
This interface is mutually exclusive with the UART interface. If you use the UART for a DMX interface, SPI is disabled. If you enable the SPI interface, the UART is disabled.

7.2.1 SPI Protocol

Table 19: Synchronous Serial Interface (SSI) Characteristics

PARAMETER NO.	PARAMETER	MIN	TYP	MAX	UNIT
S1	t_{clk_per} SSIClk cycle time	12		????	system clocks
S2	t_{clk_high} SSIClk high time		0.5		t_{clk_per}
S3	t_{clk_low} SSIClk low time		0.5		t_{clk_per}

Figure 10: SSI Timing



7.3 UART

The UART interface is used to handle a single universe of DMX/RDM data. It is capable of proxying a limited number of RDM devices.

7.4 Recommended Configurations

The interfaces that are connected to the OEM CPU should fall into one of three setups. These setups are based on what your data needs are and whether you intend to appear as a unified RDM device or not.

7.4.1 Minimal

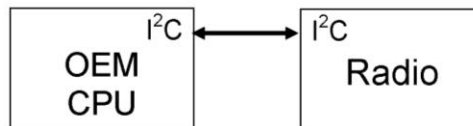
This configuration has the following features:

- DMX is not intended to be sent from module
- Consumed DMX slots are retrieved via the I2C interface
- All configuration operations set via I2C interface

- OEM CPU stores and sets configuration data
- OEM provides user interface
- OEM CPU answers unicast RDM messages thru I2C interface
- Your device will show as one RDM devices

In this configuration, the OEM only needs to supply power and provide an I2C interface connection.

Figure 11: Minimal Configuration Block Diagram



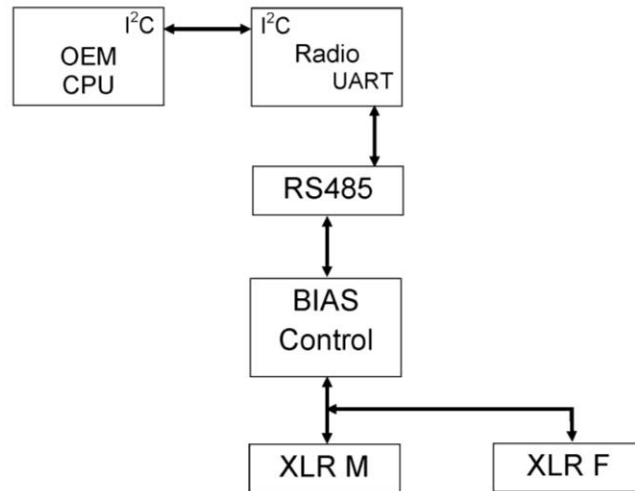
7.4.2 Basic

This configuration has the following features:

- One universe of DMX/RDM is handled by the module
 - Can receive wired DMX/RDM (Does not transmit wirelessly)
 - Can send wirelessly received DMX/RDM
- Consumed DMX slots can be retrieved via the I2C interface
 - In both wired and wireless directions
- All configuration operations are set via I2C interface
- OEM stores and sets configuration data
- OEM provides user interface
- OEM answers unicast RDM messages thru I2C interface
- OEM device will show as one RDM devices
- Can proxy up to 50 end devices on DMX/RDM UART interface

In this configuration, the OEM supplies power and connects to the I2C interface. The UART interface is connected to a DMX driver and associated RDM line bias network.

Figure 12: Basic Configuration Block Diagram



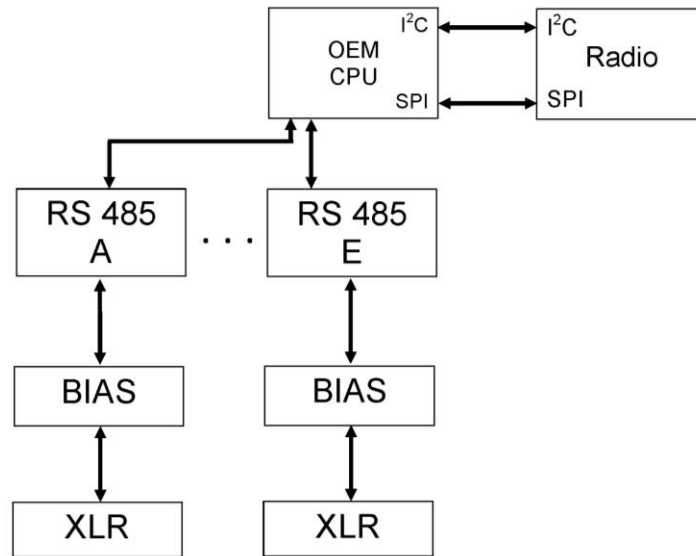
7.4.3 Advanced

This configuration has the following features:

- All configuration operations are set via I2C interface
- OEM stores and sets configuration data
- OEM provides user interface
- OEM device will show as one RDM devices
- Up to 5 universes of slot data is accessed thru the SPI interface
- Proxied RDM messages are handled thru the SPI interface
- OEM is responsible for generating DMX/RDM ports, if required
- OEM is responsible for providing RDM proxy services
- OEM maintains the RDM proxy list

In this configuration, the OEM supplies power and connects to the SPI and I2C interfaces. If the design requires DMX/RDM ports on the product, the OEM has to generate those ports from the SPI data and provide RDM proxy services.

Figure 13: Advanced Configuration Block Diagram



8 Tape and Reel Information

9 Reflow Profile

Information and graph for reflow profile