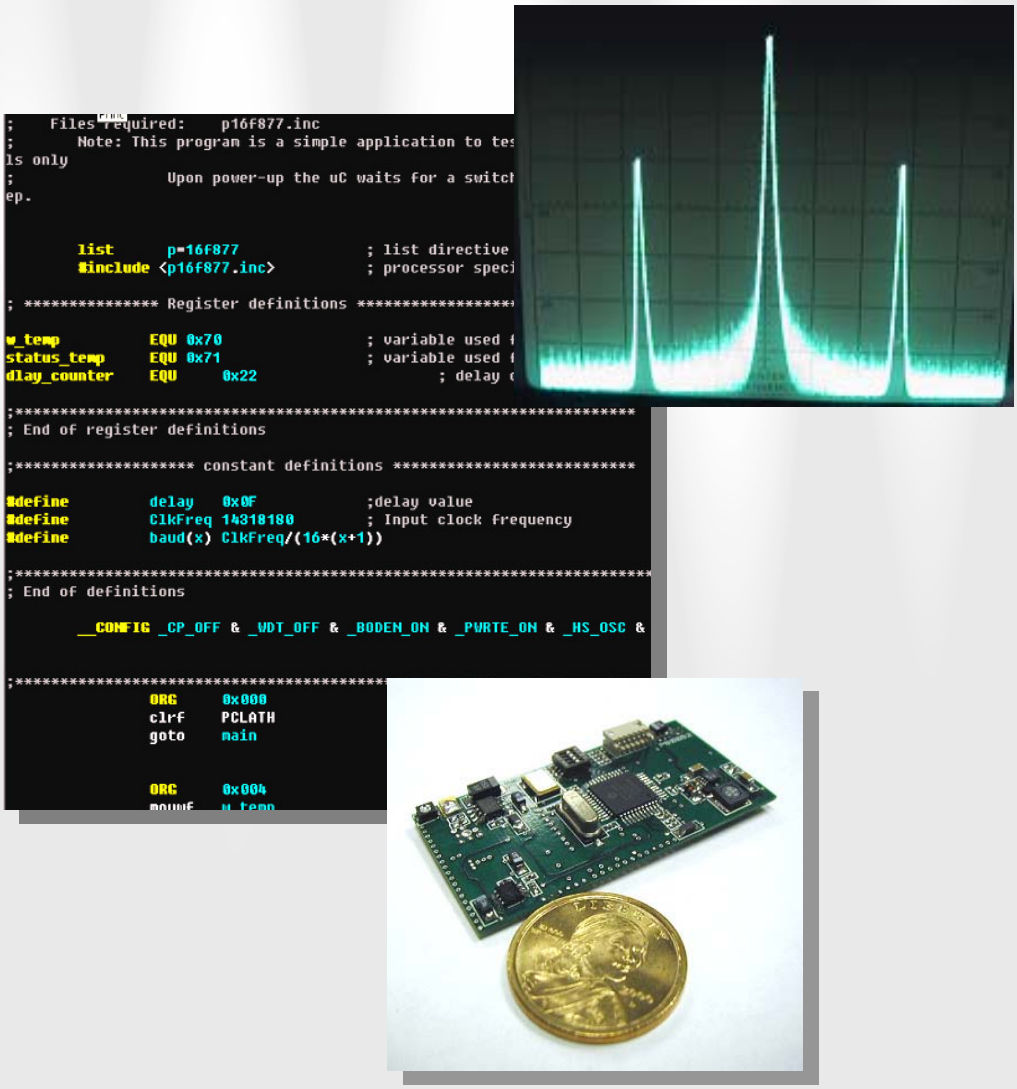
Datawave Technologies, LLC.

M1700 Ultra High Power FM Video Transmitter
User's Manual
Revision A
Oct 2003



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1.0 Document Information

1.1 Copyright Information

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1.2 Revision Listing

Revision Number	Description
1.00	Initial Release

Table 1

1.3 Agency Approval

Identification	Agency
Q4N1700	US- FCC

Table 2

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2.0 FCC Labeling and Documentation

2.1 FCC Notice

Warning: This product complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) The device may not cause harmful interference and (2) This device must accept any interference received, including interference that may cause undesired operation.

Figure 1

2.2 Antenna Notice

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

- Reorient or relocate 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.

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Figure 2

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2.3 Antenna Listing

Part Number	Antenna Gain	Manufacturer
WXE	2.15dBi	Centurion Rubber Duck
A1654	2.15dBi/4dBi	Datawave Technologies
A1655	2.15dBi	Datawave Technologies

Table 3

2.4 FCC Labeling

Warning:

All original equipment manufacturers (OEM) integrating this device within their products must comply with FCC labeling requirements. A clearly visible label must be displayed on the outside of the OEM enclosure specifying that the device contains the FCC identifier listed on the FCC label shown below.

Figure 3

2.5 RF Exposure

Warning:

All original equipment manufacturers (OEM) integrating this device within their products must maintain a minimum distance of 20cm between the installed antenna and the user or general population. For applications requiring handheld or body worn operations OEMS must submit their product to the FCC for Specific Absorption Rate (SAR) testing.

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Figure 4

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2.6 FCC Label

FCCID: Q4NM1700

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.

Figure 5

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3.0 Overview

3.1 Introduction

This manual contains information regarding the hardware and operational aspects of the DataWave M1700 series transmit modules. This information includes theory of operation and integration guidelines to aid the OEM during installation.

The M1700 is designed to operate in the 2450MHz- 2483.5MHz license free ISM frequency band. The module can be ordered in a 2 channel configuration and when used with the R1701 can cover ranges of up to 7000ft L.O.S. The M1700 is ideal for intermediate range communication links requiring full resolution video transmission.

3.2 Applications

The M1700 is designed to be embedded within OEM product such as a hand held camera, PTZ surveillance pod or any other fixed mast mounted camera system. Below is a picture of the M1700 within a thermal imaging camera from ISG Thermal Systems.

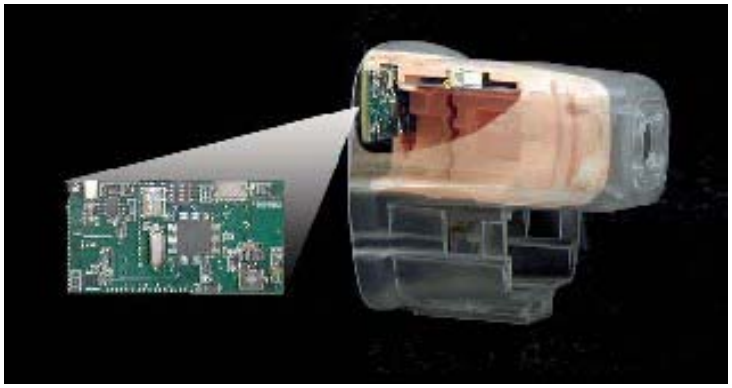

Figure 6

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4.0 Electrical Specifications

4.1 Electrical Characteristics

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Operating Voltage	8	12	16	Volts	
Curent Consumption	540	560	580	mA	Pout=950-1000mW
Max RF Output Power		750		mW	±50mW
RF Bandwidth	7.75	8	8.25	MHz	
First Harmonic Rej.	-57	-60	-65	dBc	Reference to Carrier Power
Frequency Range	2450		2483	MHz	
Channel 1		2458		MHz	
Channel 2		2474		MHz	
Power Output Adj.	1		950mW	mW	±50mW
Operating Temp.	-40		85	°C	
Modulation Type	Frequency Modulation				
Dimensions	2.5" x 1.4" x .25"				
Antenna Interface	MMCX **see approved antenna listing				
Weight	3 oz				
VSWR Antenna Port	2:1 @ 50Ω				

Table 4

4.2 Power Requirements

The transmit module can operate with supply voltages ranging from 8 to 16Vdc that can provide 5W of continuous power. The graph below shows typical power consumption vs. RF output power levels.

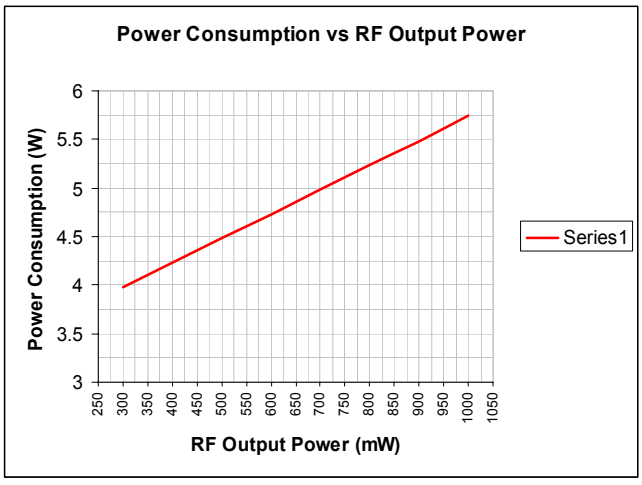

Figure 7

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4.3 Antenna port Impedance

The output stage of the M1700 provides the best efficiency and performance when its antenna port impedance matches the plot of Figure 8. Transmitters whose antenna impedance differs from the graph can be expected to exhibit poor range and/or power consumption.

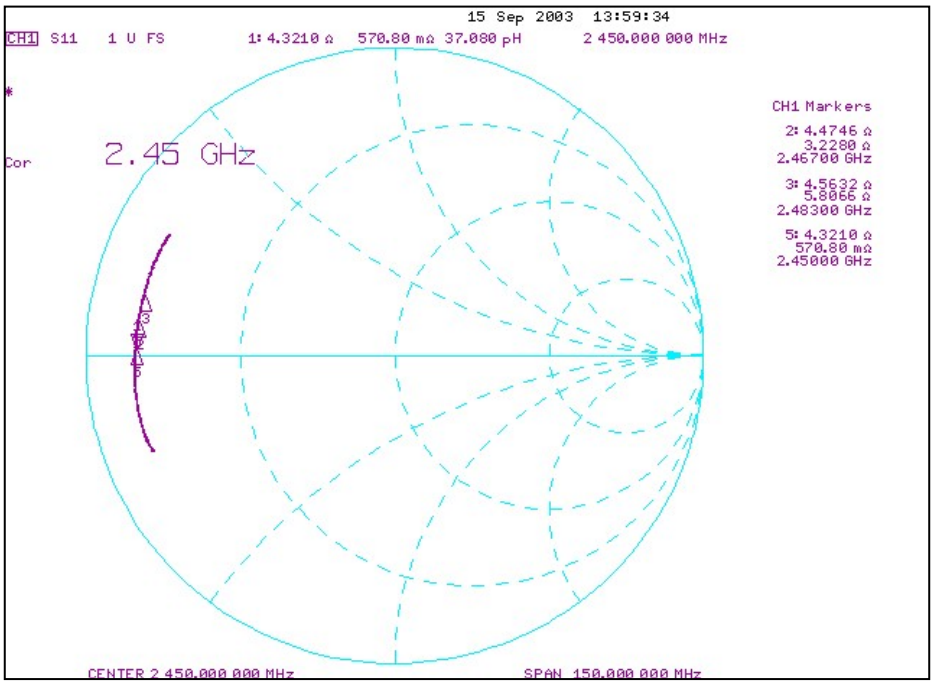

Figure 8

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5.0 Operation and Installation

5.1 Module Connections

The transmit module wire harness requires seven connections which are listed in Table 3.

Pin	Name	Function
1	Power	Supply Voltage source
2	Ground	Supply Voltage ground
3	TXD	RS-232 TX
4	RXD	RS-232 RX
5	Ground	RS-232 ground
6	Video	NTSC 1Vp-p across 75Ω
7	Ground	Video return

Table 5

5.2 Integration and EMC Issues

In order to minimize the effects of RFI/EMI the following items should be taken into consideration as in all cases of radio frequency product integration.

5.3 Interconnection and Wiring

For standalone applications in which the transmitter is supplied with and external power and video source, operation typically involves nothing more than setup and applying power.

For application requiring integration into a host environment, it is best to avoid cascading ground planes through multiple PCBs. If for some reason cascading ground planes can not be avoided, minimize the amount of parasitic inductance to ground. As an example, insure that the leads on pins 1&2 exist as a twisted pair in order to minimize "antenna like" effects generated by such parasitic inductances.

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5.4 Proximity and Cavity Effects

Care should also be given in the placement of host components with respect to the transmit module. Switching power supplies and high voltage supply lines should be routed or shielded from the area where the transmit module is expected to reside. If at all possible a separate cavity should be designed specifically to house and shield the transmitter. This would greatly minimize all RFI/EMI problems and ease the production planning and processes.

5.5 Standard and Non-Standard Video Signals

The M1700 is design to accept NTSC video levels in accordance with ANSI/SMPTE 170M – 1999. For non-compliant video levels, a modulation adjustment will be needed in order comply with FCC spectral mask requirements and visual video performance.

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6.0 Transmitter Adjustments

6.1 Modulation Adjustment

Transmitter modulation adjustments are required when non-standard video signals are transmitted. Figure 9 shows a video signal (with averaging on) that contains NTSC standard timing but non-standard video levels. The red line marker shows a .34Vdc shift for blanking, and sync tip amplitude is only .18Vdc as indicated by the blue line marker. In order to maintain proper video scaling between sync tip and maximum video level the maximum peak to peak voltage of video would be .64V. Any voltage over this value would result in an over-white condition and over-modulation would occur which would result in white streaks or tearing in the video image.

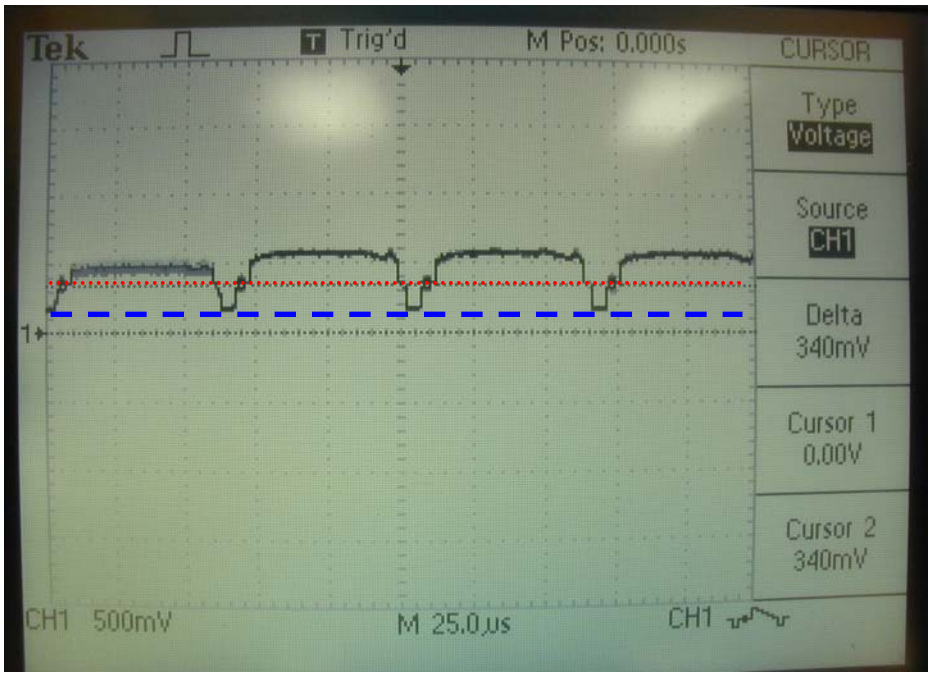

Figure 9 Non-Standard Video Level Output

The M1700 modulation circuit is based off of a monolithic VCO with a tuning sensitivity of 140MHz/V. Through software and passive circuit design the tuning sensitivity is reduced to about 25MHz/V. That means that .1V over a .64Vp-p video signal will change the RF bandwidth from 8MHz to 10.5MHz. Since the receiver is set for an 8MHz RF channel you will lose the modulated video

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information that exists outside this 8MHz channel. The result will be white steaks or tearing in video when over-modulation[1] is present.

To adjust the modulation level to accommodate the video signal in Figure 9, you will need the following items.

1. Function generator capable of a DC offset square wave at 1.5 KHz.
2. Oscilloscope capable of viewing line video information.
3. Spectrum Analyzer with a RBW of 30kHz and capable of measuring an RF signal up to 2.5GHz

Step1

Setup the function generator to output a 1.5 KHz .64Vp-p square wave and add a plus .34Vdc shift.

Step2

Power up the transmitter and apply the test signal to the video input port of the transmitter. Be mindful of the impedance mismatch possibility between the function generator and the video port on the transmitter. If there is a mismatch you will need to adjust the amplitude of the test signal back to .64Vp-p.

Step3

Using a spectrum analyzer measure the deviation from the nominal carrier frequency and adjust this deviation until you have a deviation of .5 MHz.

At this point all that is left is to apply the actual signal in Figure 9 to test the adjustment and you're done. Verifying this measurement insures that the spectral mask is within the limitations defined by Part 90 of the FCC Rules and Regulations (Fig. 11**). <u>Failure to do so will void the transmitter's FCC compliance and it will be unlawful to operate the unit in the United States.</u>**

For situations where the above mentioned test equipment is not available and jurisdiction allows, simple comparative measurements can be made between non-transmitted and transmitted images.

[1] Over-modulation in FM occurs when the deviation exceeds the maximum allowable for the desired RF channel.

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As a baseline, apply the video signal of the target video source directly to a display device and carefully observe the image in terms of resolution and brightness. Next, apply the video source to the transmitter and observe the received video image and adjust the modulation input until the received image matches the baseline image in resolution and brightness. Typically, attention is given to the brightness level as this is what is affected most by non-standard video levels. Once the modulation level is adjusted for a matching picture a "black to white" test needs to be performed in order to insure that an over-white condition does not tear the video image. "White streaks" in the image usually is a result of over-modulation. "Black streaks" or "a dim image" can be attributed to under-modulation[2]. Moving a soldering iron in and out of the scene several times works well for this test. The image should not tear upon white out. If it does, continue to adjust the modulation level until the over-modulation or under-modulation condition stops.

It should be made aware that this is an approximate method for setting the deviation level of the transmitter and is subject to the display device, FM receiver and video source levels being known good constants if this is to become the chosen method of adjustment for production. **This procedure is not recommended for transmitters being used in the United States and doing so will void FCC compliance.**

6.2 RF Power Output Adjustment

The M1700 is adjustable for power levels from 1mW up to 1000mW. The adjustment can be achieved by manually rotating the adjustment potentiometer. It is important to remember that increasing the RF power output also increase the power required to operate the transmitter and careful consideration should be given to the power supply circuits selected. Please refer to Section 4.2 for more information.

The modulation and power adjustments are made prior to installation into an end user device. **Once the radio module is installed these adjustments can not be modified.**

[2] Under-modulation in FM occurs when the maximum deviation is 20% or more below the maximum allowable for the desired RF channel.

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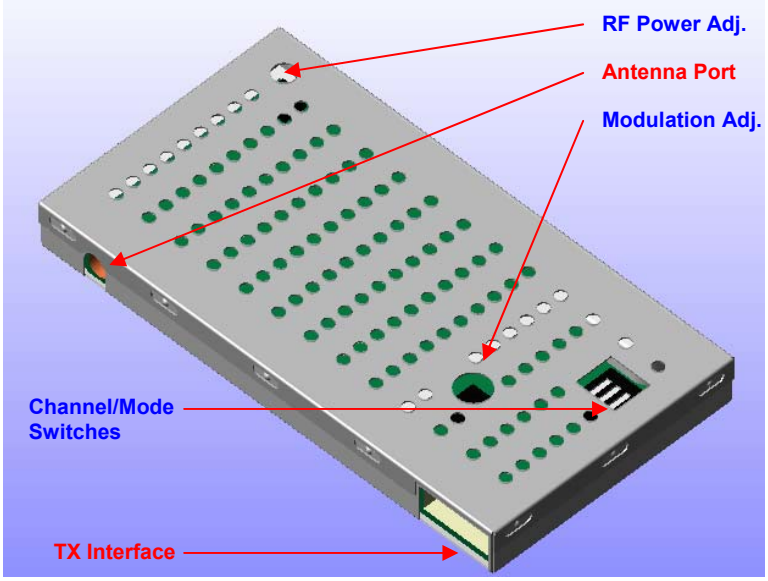

Figure 12 Transmitter Diagram

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7.0 Channel Selection and Programming

7.1 Channel Selection

The MPFM-2450 can operate in either STD or RS232 communication modes. This is determined by the dip switch first-position setting. The "off" position places the transmitter in STD mode and the "on" position places the transmitter in RS232 mode communicating at 9600 bps.

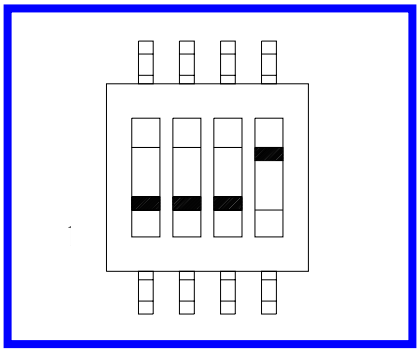

Figure 13 Dip switch setting for RS-232

	SW1	SW2	SW3	SW4
RS232	ON	XX	XX	XX
STD2CH1	OFF	ON	ON	ON
STD2CH2	OFF	ON	OFF	OFF
STD4CH1	OFF	OFF	ON	ON
STD4CH2	OFF	OFF	OFF	ON
STD4CH3	OFF	OFF	ON	OFF
STD4CH4	OFF	OFF	OFF	OFF

Table 6 Dip switch setting for all operations

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7.2 RS-232 Programming

For RS232 operation, set SW 1 as indicated and power up the transmitter. In this mode only the radio controller is powered and all the RF circuitry is disabled. At this point the radio is ready to receive commands. The host controller can configure the following:

- Number of Channels
- Active Channel
- Active Status of the Power Amp
- Active Status of the RF Modulator

Number of Channels and Channel Selection

The transmitter can be configured to operate in two system configurations, 2-Channel or 4-Channel.

	Device	Argument
2-Channel	0x02	0x33
4-Channel	0x02	0xCC

Table 7 Channel mode command value

Channel Configuration Command string:

< WRITE >< DEVICE > < ARGUMENT >
< 0x55 >< 0x02 >< 0x33 | 0xCC >

The 2-Channel configuration is standard and allocates the US-ISM band as shown below.

	Carrier	BW	Device	Argument
Channel 1	2.458 GHz	8 MHz	0x03	0x10
Channel 2	2.474 GHz	8 MHz	0x03	0x20

Table 8 Channel mode – active channel commands

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The 4-Channel configuration is new and the frequency allocation is shown below.

	Carrier	Bandwidth	Device	Argument
Channel 1	2.454 GHz	8 MHz	0x03	0x10
Channel 2	2.462 GHz	8 MHz	0x03	0x20
Channel 3	2.470 GHz	8 MHz	0x03	0x30
Channel 4	2.478 GHz	8 MHz	0x03	0x40

Table 9 Channel mode – active channel commands

Active Channel Command string:

< WRITE > < DEVICE > < ARGUMENT >
< 0x55 > < 0x03 > < 0x10 | 0x20 | 0x30 | 0x40 >

Power Amplifier/RF Modulator Status Control

The host can also control when the RF modulator and power amplifier are enabled.

	Device	Argument-on	Argument-off
Power Amp	0x00	0x0F	0xF0
RF Modulator	0x01	0x0F	0xF0

Table 10 Enable status commands

Enable Command string:

<WRITE> <DEVICE> <ARGUMENT>
< 0x55 > < 0x00 | 0x01 > < 0x0F | 0xF0 >

7.3 Transmitter Status

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The transmitter will respond to a query command (0xAA). This command will return the following:

- Power amp enable status
- RF modulator status
- Channel configuration
- Active Channel
- Transmitter serial number
- Transmitter software version

Query Command string:

<COMMAND>
<0xAA>

Response string:

<CH CONFIG.><SEP> <ACT CHAN><SEP> <PA STATUS><SEP> <RF Mod STATUS>

< 0x33 | 0x CC><0x2F> <0x10 | 0x20 | 0x30 | 0x40><0x2F> <0xF0 | 0x0F ><0x2F> <0xF0 | 0x0F>

7.4 Command String Examples

After power up: 4-channel operation, transmit on channel three:

< 0x55 > < 0x01 > < 0x0F >	*(turn modulator on)*
< 0x55 > < 0x02 > < 0xCC >	*(configure for 4 channels of operation)*
< 0x55 > < 0x03 > < 0x30 >	*(make channel 3 active)*
< 0x55 > < 0x00 > < 0x0F >	*(turn on power amp)*

Change from Channel 3 to Channel 1 after the above command:

< 0x55 > < 0x03 > < 0x10 >	*(make channel 1 active)*

Change from 4-channel to 2-channels and activate Channel 2 at 2474 MHz:

< 0x55 > < 0x02 > < 0x33 >	*(configure for 2 channels of operation)*
< 0x55 > < 0x03 > < 0x20 >	*(make channel 2 active)*

Things to Remember

1. The RF modulator must be enabled before the power amp. This is a protection justification within the transmitter. Sending a power amp

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enable command, without enabling the RF modulator **first**, will be viewed as an ignored command from the perspective of the host.

2. Raw binary commands are used for transmission (LSB first). Do not send carriage return values or EOL bytes. Doing so will corrupt the command string.

3. Requesting CH3 or CH4 operation from a transmitter configured for 2 channel operation will be viewed as an ignored command from the perspective of the host.

4. If you were to change channel configurations but stay on the same channel, you still need to send the active channel command. This will reload the new frequency information.

Development Notes:

1. Software version 1.00 does not contain provisions to check for power on sequencing (Note #1 under "Things to Remember").

2. Software version 1.00 does not contain provisions to check for identifying a valid channel selection for a specified system configuration (Note #3 under "Things to Remember").

3. These items will be corrected in the version 1.01.

7.5 Software Interface

The interface software is provided for testing/evaluation purposes only. The software can be used to generate the correct bit streams through a

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PC serial port. Outgoing as well as incoming data streams can be view as well as the transmitter serial number and software version.

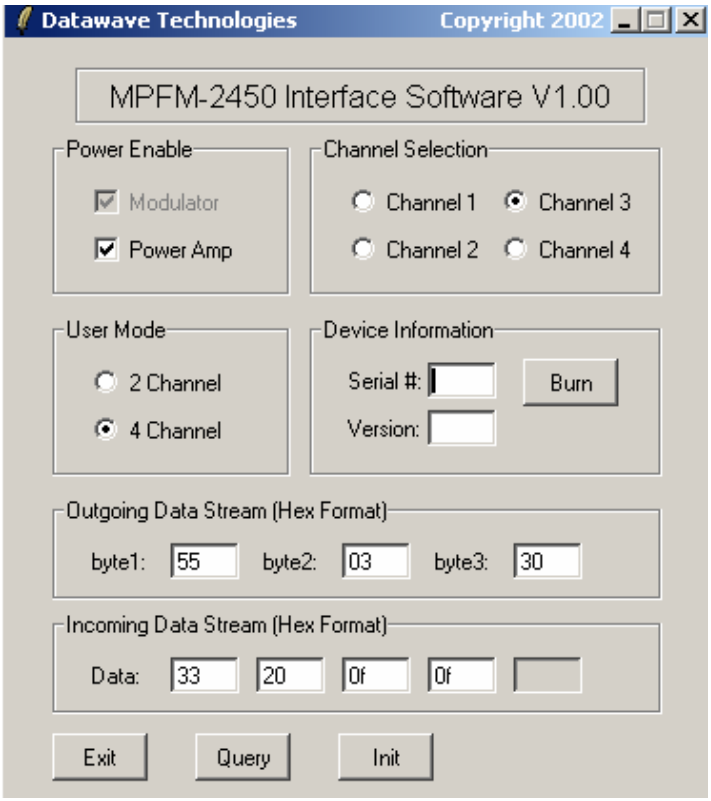

Figure 14 Test software interface

Buttons

1. Init – Configures the transmitter to activate channel 1 as a two channel transmitter with the RF Modulator and Power Amp enabled (Default).
2. Query – Sends the query command string (0xAA) and displays the received string.
3. Exit – Exits the utility.
4. Burn – factory use only

7.6 Operating Modes

The *Power Enable, Channel Selection* and *User Mode* sections of the software are direct action functions. Once you make a selection it immediately sends the

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command string for that selection. All direct actions begin with a command <*write*> (0x55) followed by the device and argument commands. This arrangement creates the command string needed to talk to the transmitter.

By selecting a direct action function the command string is placed in the *Outgoing Data Stream* section of the GUI. Likewise when the query command is sent, the response string is displayed in the *Incoming Data Stream* section. The device serial number and software version will be displayed in the *Device Information* window.

The data stream windows are read by the user left to right with the first byte in or out being the left most value.

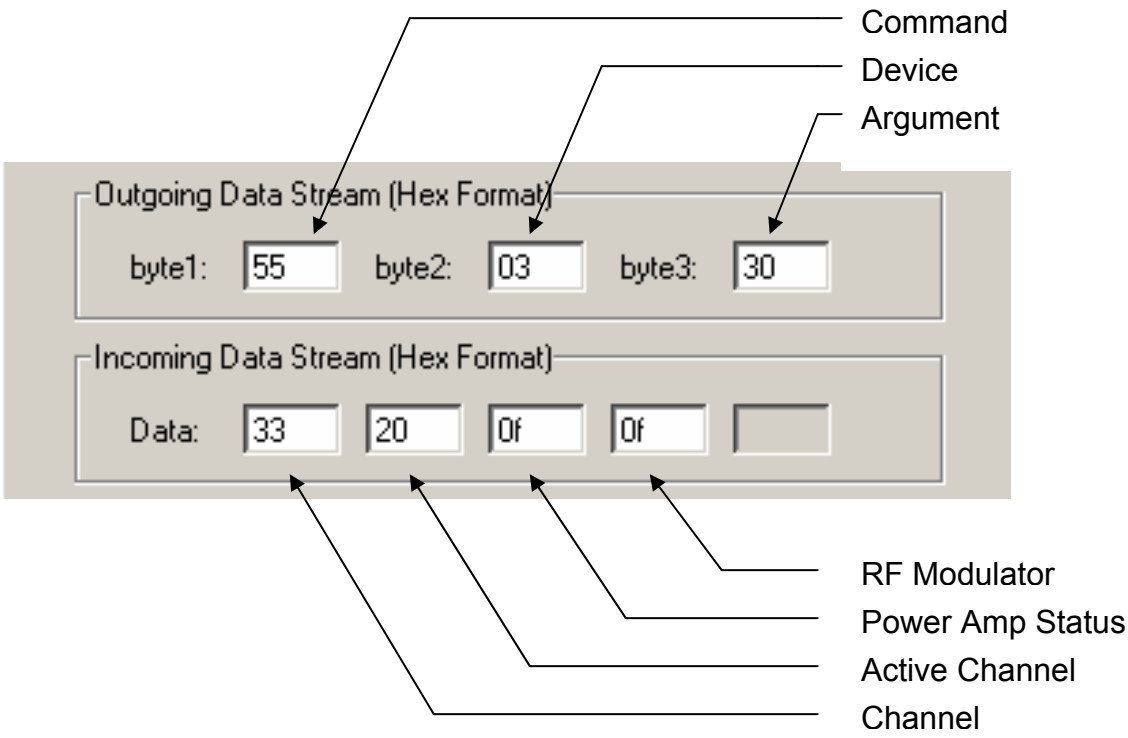

Figure 15 PCB Data Stream sequence

8.0 Hardware Interface

The transmitter PCB RS-232 interface will be configured to operate from TTL levels for direct access to a host microprocessor or microcontroller. Should the

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user wish to connect the transmitter to a PC, then a level converter can be ordered from the factory.

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