

# **CITY THEATRICAL**

**NEW YORK • LONDON**

## **RadioScan™ Spectrum Analyzer**

**P/N 5988**

### **User's Manual** Rev 1.0

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Made in USA

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# 1 Foreword

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## 1.1 Safety Notice

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This product is designed for use in dry locations only. Exposure to rain or moisture may cause damage.

# 2 Compliance Requirements

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The 5988 is compliant to the following standards:

CE: EMC Directive of EU 2014/30/EU  
Low Voltage Directive of EU 2014/35/EU  
FCC: CFR 47 Part 15 Subpart B, Class B  
IC: ICES-003 (Issue 6), Class B

## 2.1 FCC Compliance Statement (United States)

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This device complies with Part 15 of the Federal Communications Commission (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.

## 2.2 IC Statement

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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.

### 3 Introduction

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RadioScan is a 900MHz and 2.4GHz spectrum analyzer (includes a RadioScan hardware dongle and accompanying free RadioScan software) that enables you to easily visualize radio energy that is otherwise invisible to you. Using RadioScan helps you to create a broadcast plan that optimizes available spectrum in your area, and helps prevent interference with other mission critical radio devices near you.

RadioScan shows all radio activity near you in your chosen frequency, including frequency hopping gear like wireless DMX, as well as Wi-Fi networks, Bluetooth, wireless headsets, video transmitters, cordless phones, baby monitors, and microwave ovens. RadioScan can view spectrum data either in Spectrogram view or Waterfall view, notes can be added, and snapshots can be taken and saved. Scans of any length can be recorded, saved, and emailed, and can be played back and reviewed by others with just the free RadioScan software, without the need for the RadioScan hardware dongle.

By identifying SSIDs, broadcast channel, and the signal strength of wireless networks, RadioScan can help IT departments setup, maintain, and troubleshoot their wireless installations.

For users of City Theatrical Multiverse® wireless DMX/RDM products, RadioScan will guide you in creating the optimum broadcast plan for your production by helping choose the best SHoW ID based on the number of universes being broadcast and the best area of the spectrum on which to broadcast.



RadioScan is compatible with both Windows and macOS computers. RadioScan software is available as a free download at: <http://www.citytheatrical.com/Products/radioscan> (Scroll down to the Downloads tab)

#### 3.1 Features

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- 900MHz and 2.4GHz spectrum analyzer with dual band antenna
- Finds all radio activity nearby in chosen spectrum
- Identifies SSID (network name) and RSSI (signal strength) of Wi-Fi networks
- Shows either Spectrogram or Waterfall view
- Records and play back scans of unlimited length using free RadioScan software
- Takes and saves snapshots
- Records notes onto scans
- Guides users in choosing Multiverse SHoW IDs
- Compatible with Windows and macOS computers (USB-A to USB-C cable provided)

## 5988 RadioScan Spectrum Analyzer

### 3.2 Part Number

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*Table 1: Part Number*

Part #	Description
5988	RadioScan™ Spectrum Analyzer

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## 3.3 Product Detail

Top/bottom diagram shown to scale.



Figure 1: Product Top, Bottom and Side

## 4 Specifications

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*Table 2: Physical Characteristics*

Specifications	Description
Frequency	902-928MHz and 2.4-2.483GHz
Size (not including antenna)	Length: 2.0" (50mm) Width: 2.0" (50mm) Height: 0.5" (12.7mm)
Antenna	Detachable external omnidirectional broadband, 2dBi 900MHz, 4dBi 2.4GHz
Construction	NEMA 4 IP20 ABS Plastic
Power/Data Connector	USB-C with 1m (39.37") USB-A to USB-C cable

Computer Requirements	
Operating System	Windows 10 / Mac OS 10.15 or higher
Display resolution	800x600
Wi-Fi Radio	Internal or USB Wi-Fi adaptor
USB Port	1.1 or higher
RAM	4GB

Product Information	
Configuration	City Theatrical RadioScan software program
Use Environment	Indoor
Warranty	One year
Compliance	FCC / IC / CE / RoHS

## 5 Using RadioScan

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### 5.1 Download RadioScan Software

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Go to <http://www.citytheatrical.com/Products/radioscan> (Scroll down to the Downloads tab) to download the free RadioScan software program.

### 5.2 Plug In RadioScan Dongle

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Attach the 1m USB-A to USB-C cable from the RadioScan dongle to your computer.

### 5.3 Run RadioScan Software

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Find and open the RadioScan software program on your computer. It will recognize your RadioScan dongle and will begin a 2.4GHz scan.

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## 5.4 RadioScan Dongle Indicator Lights

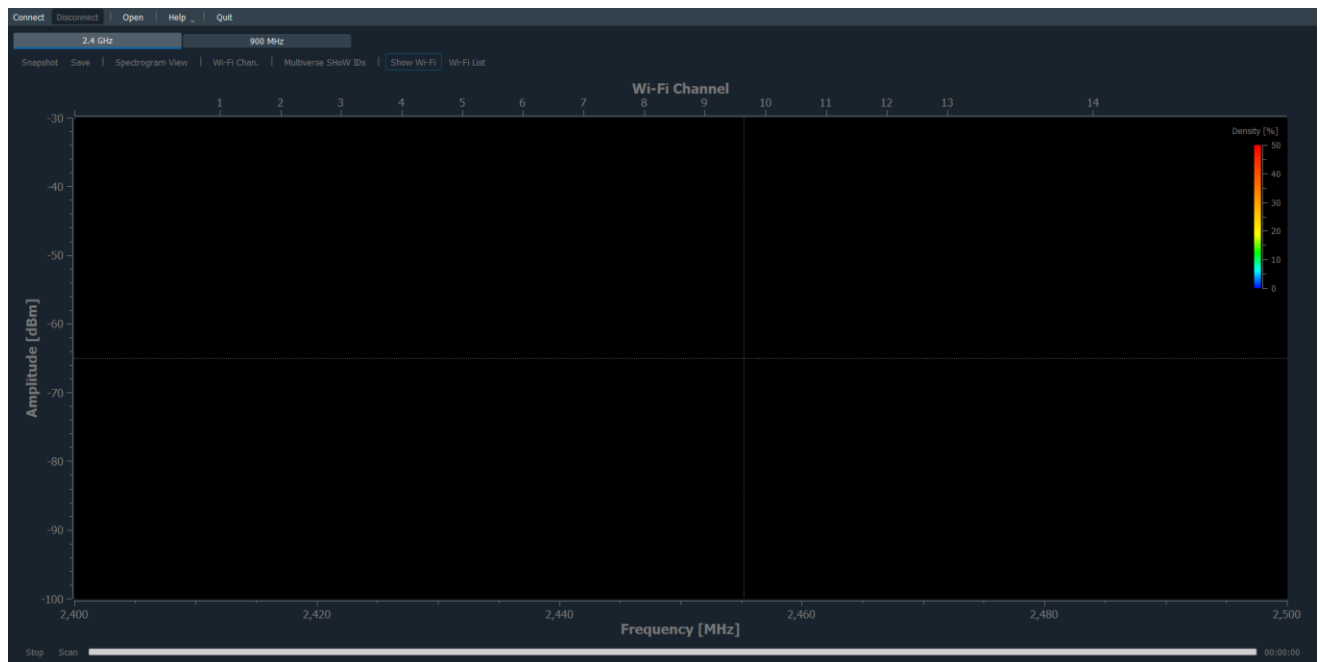
The RadioScan dongle has one multicolor LED indicator light that can inform you of various functions, as follows.

**Table 3: LED Indicator Light Colors**

<b>Red</b>	Powered, no connection to computer
<b>Green</b>	Powered, connected to computer
<b>Blue</b>	Powered, connected, and application is connected
<b>Flashing Blue</b>	Powered, connected, application is connected and scanning
<b>Magenta</b>	Dongle is updating firmware

## 5.5 Screen View

By default, when you open the RadioScan software application, you will see Spectrogram view:



Frequency is shown on the X-axis on the bottom of the screen, and Wi-Fi channels are shown on the X-axis on the top of the screen. Amplitude is shown on the Y-axis on the left side of the screen.

A cross hair travels with the cursor showing frequency, amplitude, and density data at any point on the screen.

A 2.4GHz scan starts automatically when the program is opened and a RadioScan dongle is found, and Wi-Fi networks are displayed by default.

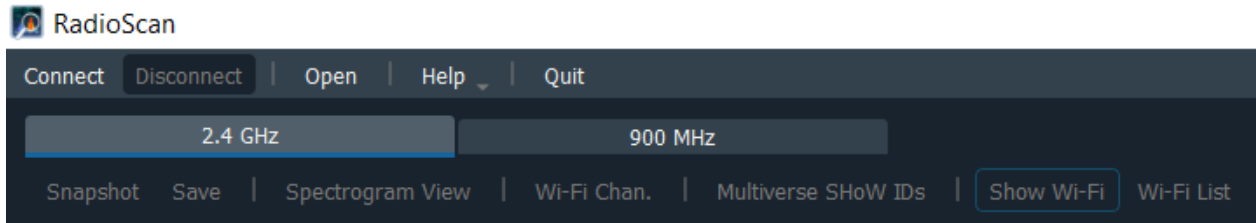


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## 5.6 Other Controls

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Top of screen controls:



### Connect

Connects RadioScan dongle to RadioScan program.

### Disconnect

Disconnects RadioScan dongle from RadioScan program.

### Open

Opens a saved RadioScan recording.

### Help

**-User Manual** Provides a link to the 5988 RadioScan product manual

**-City Theatrical website** Provides a link to the CTI website

**-Update Firmware** Updates the firmware in the RadioScan dongle. Note: The latest RadioScan software application can be found on the Downloads tab of the RadioScan webpage on the City Theatrical website.

**-About** Provides License Information related to the RadioScan program and the current version of the software.

### Quit

Quits the RadioScan software program.

### 2.4GHz

Selects the 2.40-2.483GHz portion of the spectrum to scan.

### 900MHz

Selects the 902-928MHz portion of the spectrum to scan.

### Snapshot

Takes a snapshot of the current screen, and prompts for a location to save. Scan does not need to stop to take a snapshot.

### Save

Saves a recording of the current scan, and prompts for a location to save. Scan does not need to stop before saving.

### Spectrogram View/Waterfall View

Toggles between Spectrogram view and Waterfall view of the chosen frequency band.

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### Wi-Fi Chan./Zigbee Chan.

Toggles the X axis at the top of the screen between Wi-Fi channels and Zigbee channels.

### Multiverse SHoW IDs

Opens a table that shows the relationship of Multiverse SHoW IDs to the spectrum, and helps to choose the optimum area of the band on which to broadcast. See pages 13-15 for complete information.

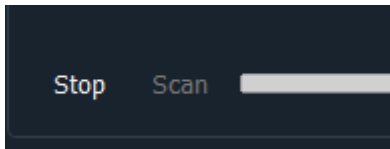
### Show Wi-Fi

Shows the frequency range of Wi-Fi networks nearby and identifies their SSID (name). Note: your computer must have Wi-Fi hardware installed for this feature to be available.

### Wi-Fi List

Displays a table of Wi-Fi networks found, including their Wi-Fi channel, SSID (name) and RSSI (signal strength). List can be undocked, dragged to another location, and expanded.

### Bottom of Screen

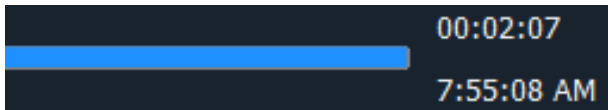


### Scan

Starts a new scan.

### Stop

Stops a scan. After stopping, scans can't be restarted, so save the scan if a record is required.



### Scan Time

Scan time is shown in the lower right hand corner of the screen in both elapsed time and clock time. After each 24 hour period, scan time resets to zero and starts again, while preserving all previous scan data and timings.



### Scan Bar

The Scan Bar tracks the course of the scan across the screen after the first two minutes of data collection. The scan can be rewound to view previous events by pulling the Scan Bar to the left (the scan continues to record), and the scan resumed by pulling it back to the right.

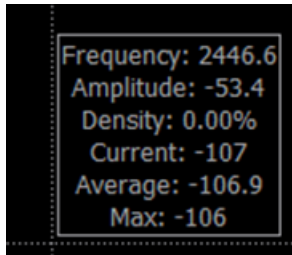
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### 5.7 Spectrogram View

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The default view of the RadioScan program is the Spectrogram view. The Y axis represents the amplitude of the radio energy on any frequency across the X axis.

The cross hair cursor shows information as you move it around the screen.



The crosshairs of the cursor show the frequency across the X axis, the amplitude of the point where the cursor is on the Y axis, the density of that frequency, the current amplitude reading of that frequency, and the average, and maximum amplitudes over the previous two minutes, for that frequency.

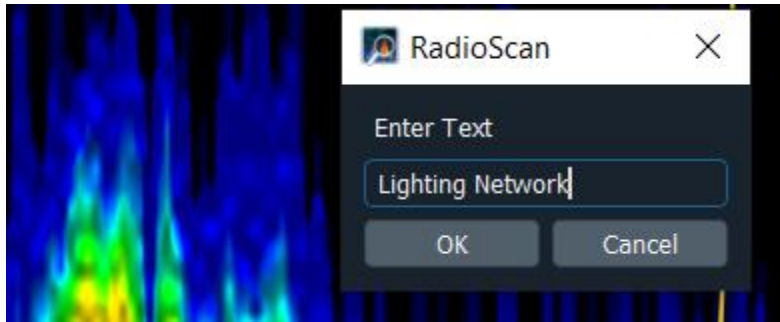
Although the Spectrogram is two dimensional, color provides a third dimension of analysis. The color of the Spectrogram describes the density of radio energy on each frequency. Density is described as the percentage of time a specific amplitude of radio energy was measured on a specific frequency during the immediately preceding two-minute period. Density can be expressed as colors, like the chart on the upper right side of the RadioScan Spectrogram View screen. Density is an important tool in analysis of the broadcast spectrum.

Blue designates a radio signal of short duration, like a frequency hopping radio, and means the frequency has been utilized less than 6.25% of the time during the last two minutes. This may signify a radio signal of high amplitude, but very short duration, like wireless DMX. Cyan designates the frequency was used slightly more of the time, with green, yellow, and orange progressing to higher usages of time over until reaching red, which shows the frequency was used more than 50% of the time over the two previous two minutes. This is a rolling two-minute calculation that updates automatically as conditions change.

Generally, when looking for a suitable place to put a broadcast, look for areas with more blue and less red. Areas of high amplitude and high density should be avoided. An area of low amplitude and high density represents a noise floor that your signal would need to overcome to be successful.

Spectrogram view often changes over time. By dragging the scan bar at the bottom of the screen, you can scroll back through your scan to quickly see changes in the environment. This is valuable in diagnosing the source of broadcast problems.

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Notes can be added in Spectrogram view. Place your cursor at the spot you want to add a note (anywhere on the screen) and left click your mouse. Enter a note of unlimited length. Click OK and the note will be pinned to the screen starting at the point of your mouse click.

Multiple notes can be added this way at various locations on the screen. If a recording of the scan is saved, the note will appear in the entire recording. Left click on an existing note to edit. Right click on an existing note to delete.

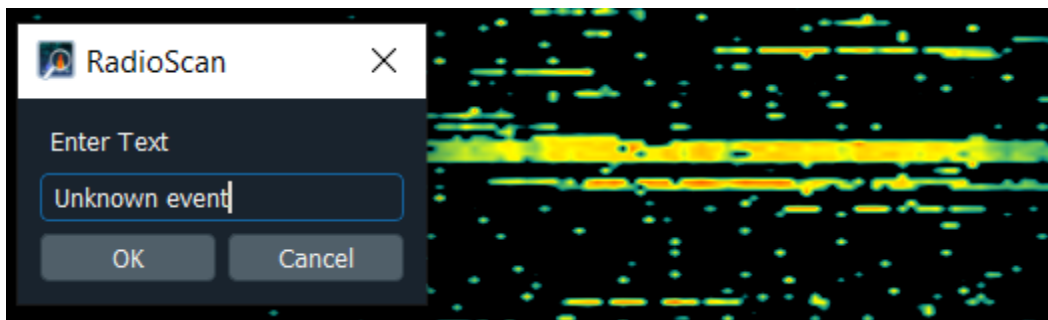
### 5.8 Waterfall View

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Waterfall view gives a different look at radio energy. Devices around you that are controlled by others can affect your own radio signal. Using Waterfall View allows you to roll back time to see the moment a device is turned on or off. This can help to track down sources of interference.

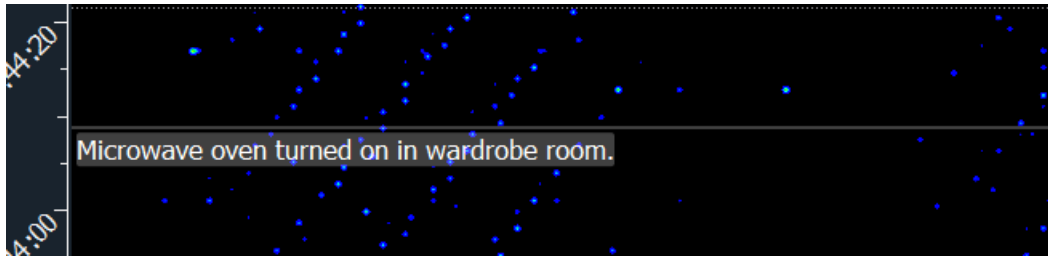
The X axis again represents frequency, while the Y axis represents real time, showing the previous two minutes on the screen. Each colored mark on the screen represents radio energy on a given frequency at a particular moment. The amplitude of the radio signal is denoted by its color, with blue representing low amplitude signals, and red representing high amplitude signals.

Whereas Spectrogram view collects elapsed time on the scan bar, Waterfall view uses actual clock time (adjusted automatically for your location) and allows you to roll back time to see the moment a device is turned on or off. This can help to track down sources of interference.



Notes can be added in Waterfall view. Place your cursor at the spot you want to add a note and left click your mouse. Enter a note of unlimited length. Click OK and the note will be pinned to the left margin of the screen at that point in time and a line will be drawn across the screen. Left click on an existing note to edit. Right click on an existing note to delete the note and the horizontal line.

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### 5.9 Multiverse IDs

The Multiverse IDs feature is for users of City Theatrical Multiverse wireless DMX, and will describe the SHoW IDs that may be selected for various areas of the band (either 2.4GHz or 900MHz).

Multiverse SHoW IDs are a descriptive number that designates the portion of the spectrum on which to broadcast (900MHz or 2.4GHz), the data rate (this determines the number of universes of DMX that can be broadcast, the distance of the broadcast, and the degree of broadcast fidelity that can be expected), the portion of the broadcast band (full, adaptive, low, mid, high, and max), and the actual hopping pattern. See the SHoW ID chart on page 15 to see this explained graphically.

When the Multiverse IDs button is selected, a table appears showing examples of SHoW IDs available. These SHoW IDs are a function of the number of universes needed (the “X” axis of the table), and the relative position in the band (the “Y” axis of the table).

Multiverse SHoW IDs			
	1	2	5
Adaptive	24150	24250	24350
Full	24100	24200	24300
Low	24110	24210	24310
Mid	24120		
High	24130	24230	24330
Max	24140	24240	24340

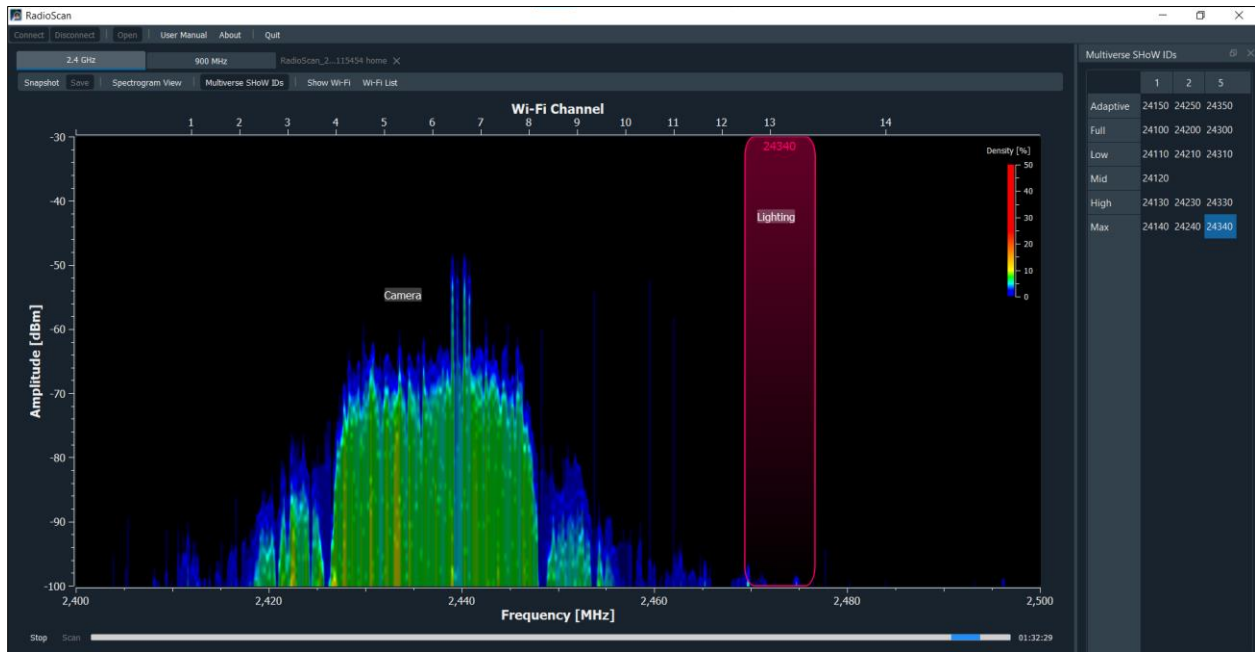
Hovering over each individual SHoW ID reveals more information about it.

Additionally, when hovering over a SHoW ID, an overlay will appear over the scan that shows the portion of the band that the broadcast will reach while using the selected SHoW ID. Below, SHoW ID 24340 has been selected (a “Max” bandwidth selection that will broadcast in the area of Wi-Fi channels 13-14, outside of the normal Wi-Fi range in the U.S.).

Clicking on any SHoW ID button will lock the overlay to the screen where it will appear in all recordings and screen shots.

SHoW ID Details	
SHoW ID:	24340
Universes:	5
Frequency Range:	2469.39 - 2476.64 MHz
Type:	Max
Indoor Range:	100 ft
Outdoor Range:	1000 ft

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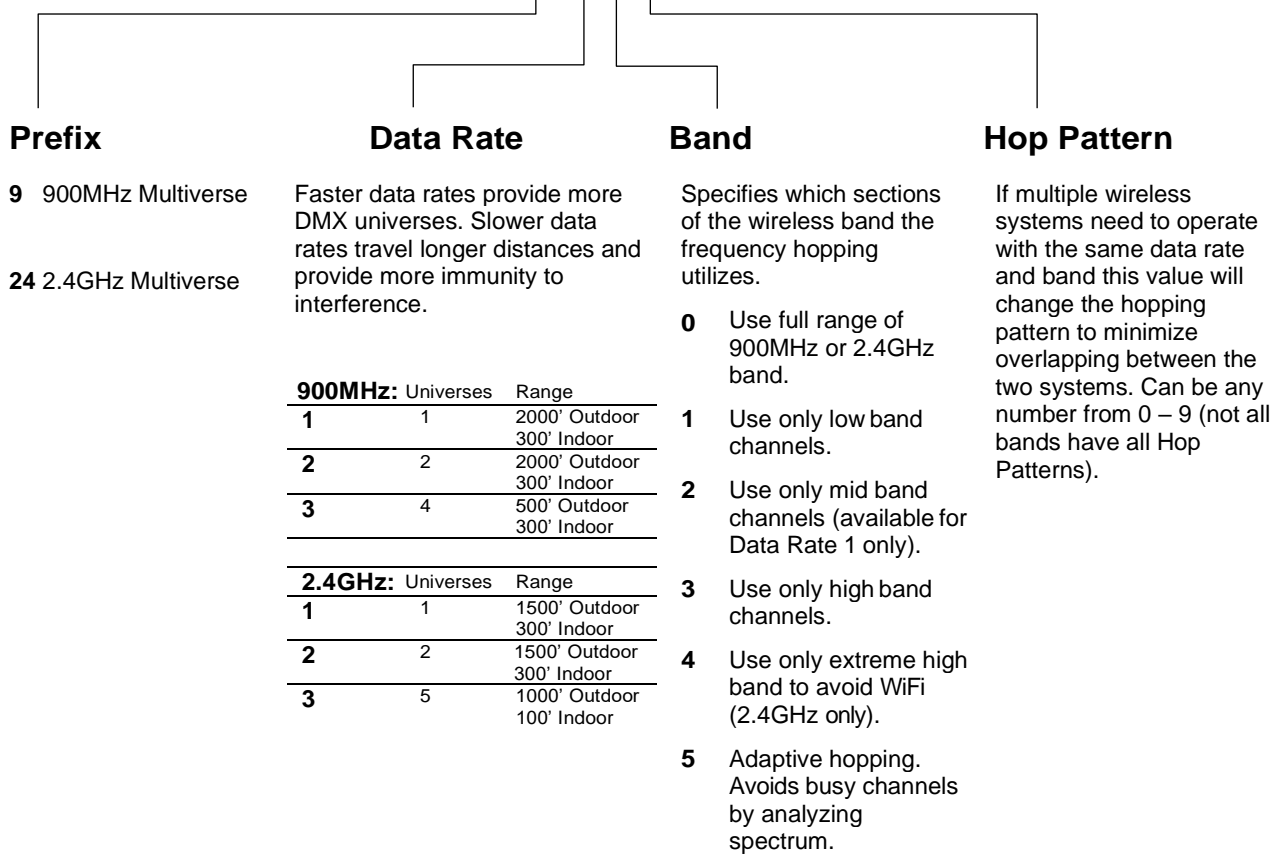
Begin your thought process of creating a broadcast plan by deciding how many universes need to be transmitted. SHoW IDs that carry fewer universes travel longer distances and often have more perfect fidelity than SHoW IDs that carry more universes. A good rule of thumb is to choose SHoW IDs with lower universe capacity whenever possible, and spread out your broadcast over more than one radio when possible, such as splitting your broadcast between the 2.4GHz and 900MHz radios on a 5910 Multiverse Transmitter.

The most challenging shows for wireless DMX often involve direct view LED pixel chases and they require careful planning and the use of SHoW IDs that carry a low universe count for perfect operation. Nearly any other combination of equipment including moving lights, LED fixtures, and conventional dimmers will operate well on SHoW IDs that can carry multiple universes.

If longer distance broadcasts or direct view LED pixel chases of more universes are needed (such as nine or 10 universe broadcasts from one 5910 or 5911 Multiverse Transmitter), performance can often be improved by the use of a specialized antenna such as a panel or Yagi.

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## Multiverse SHoW ID Example: **24302**



Note: Not all combinations of digits are possible and unused numbers are reserved for future use.

Note: SHoW ID, SHoW Key (if used) and Universe must match between Transmitter and Receiver Cards.

**Figure 2: Multiverse SHoW ID**

### 5.10 Software Updates

City Theatrical issues software updates occasionally to add features or to fix bugs. The software version in use on your RadioScan dongle is found on the Help/About section of the RadioScan software program. Software updates are found on the CTI website on the 5988 Downloads tab.

## 6 Troubleshooting

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*Table 4: Troubleshooting Guide*

Symptom	Solution(s)
Unable to find any RadioScan device error.	Check for working USB data cable and not charging cable
	Verify that a USB Serial port was added to computer system.
LED is red	Device has not enumerated on the USB bus, check cable and computers USB port.
No Wi-Fi access points are show	Make sure your computer has Wi-Fi hardware and it is turned on.

## 7 Customer Service

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