QAM Marker™

User Guide

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CSI Doc. 101623-004 eRev. 1.0.2

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2013-12-18 jv

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Electrical Safety

 This symbol is used to alert users of possible hazard or risk in operating this equipment.

- **Read the instructions fully before operating this equipment for the first time.**
- Do NOT expose this equipment to rain or moisture!
- Do not disassemble the equipment or interfere with the internal components; this will void the warranty and create the possibility of electric shock.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- Only use the provided mains lead as using other types may cause damage to the equipment, which will void the warranty and may cause electric shock.
- Clean only with a soft dry cloth.

 **AC Mains.**

This equipment does not have a power switch. It is turned on when the power cord is plugged in.

 **This equipment must be grounded.**

The AC power input is Double-Pole Fused, also known as Neutral Fused, and requires this equipment to be grounded as follows:

- AC input - Connect to an electrical outlet provided with a protective ground connection.
- DC input - Connect the protective ground to the designated external terminal on the equipment rear panel.

 **This equipment has no internal user serviceable or replaceable parts.**

The rear panel fuses and screw connection adapters are the only user replaceable parts. Use only the original factory rated fuse types; otherwise safety of the equipment may be impaired.

Introduction

The ComSonics' QAM Sniffer is a system which allows detection of CATV leakage in an all-digital system without reserving any bandwidth for a discrete leakage carrier.

- It is a CATV leakage detection system made up of two parts. The first part is a QAM Marker Signal Source which is installed at a headend or hub of a CATV system. The second part is the handheld/mobile QAM Sniffer unit or the GENACIS QS mobile unit.
- The QAM Marker Signal Source, typically centered at 138 MHz or 612 MHz, uses a unique modulation frequency for each CATV system to allow the QAM Sniffer units to detect leaks only from the CATV system to which they are matched. The QAM Marker Signal Source can be configured differently for up to three CATV systems in an overbuild area to distinguish leaks between the CATV systems. The QAM Sniffer units must be configured to match the appropriate QAM Marker Signal Source.
- The QAM Sniffer unit is a handheld cable leakage detector with vehicle mounting capability. It is an attractive and easy to use tool. Five buttons on the display panel and a multifunction trigger type control, integrated into the handle, blend with the ergonomic contours of the device. The buttons allow control of the settings needed in normal use, such as; power, operational functions, backlight, and the loudness of our famous historic Sniffer warble tone. The unit has a built-in folding dipole antenna for handheld use.
- The GENACIS QS mobile unit is a GPS Enabled Automatic Cable Integrity System delivering unmatched leakage location and management technology. It makes cable plant optimization automatic and affordable. This hands free solution mounts easily in the cable operator's vehicles, detecting system leaks in real time as the technician performs their regular duties. Leak intensity and location are recorded and uploaded by cell phone GPRS technology to the central server allowing the cable operator to view their leaks, manage work orders and monitor results. GENACIS QS gives the ability to proactively manage the cable plant to optimize performance and customer satisfaction.
- The QAM Sniffer and the GENACIS QS units use sophisticated methods to detect and measure QAM Marker Signal Source leaks from the CATV system. They can differentiate a true leak from general noise or signals originated by another marker in a co-located CATV system.
- The QAM Marker Signal Source can be configured through the internet using a standard web browser. An Ethernet network internet connection is required.

Unpacking - The QAM Marker Signal Source and any ordered accessories are included in a shipping container designed to provide the maximum protection during shipment. Upon receipt, inspect the container and contents for signs of physical damage. Notify the freight forwarder of any damage detected.

Please dispose of the cardboard packaging carefully and recycle where possible.

Power - The QAM Marker is powered by a standard AC detachable power cord.
Allow 15 seconds for the QAM Marker to initialize after applying power.

Components

Front Panel

The QAM Marker front panel has two indicators, a reset switch, and a marker selector. Refer to Figure 1 for locations.

Figure 1 QAM Marker Front Panel Indicators and Controls

1. Power LED: Indicates unit is connected to and receiving 115 VAC or 48 VDC power.
2. Alarm LED: Indicates a marker output fault.
3. 612 LED: Indicates marker output frequency set to 612 MHz.
4. 138 LED: Indicates marker output frequency set to 138 MHz.
5. Reset Switch: Press to reset fault conditions when Alarm indicator is on OR when directed during QAM Marker configuration.
6. Marker Identifier/Selector Switches: The standard marker setting is 1 for monitoring QAM Marker Leakage signals. Using the Selector Switches the Marker output can be set to 1, 2, or 3. The QAM Sniffer Receivers in use in the field must be set to the same Marker setting.

Back Panel

The QAM Marker back panel provides for power, control, and signal connections. Refer to Figure 2 for locations.

Figure 2 QAM Marker Back Panel

1. AC Power Connection with built in (internal) fuse: Accepts standard IEC power cord.
2. DC Power fuses (2 each): Provide protection for 48 VDC power (Optional).
3. *DC Power Connection: Optional Dual 48 VDC power input. Screw connection adapter included.
4. Alarm Remote Connection: Connects to internal relay contacts to provide remote monitoring. Screw connection adapter included.
5. LAN Connection: RJ45 Ethernet network connector for use during QAM Marker configuration.
6. Ground Binding Post: Provides chassis ground point. *Required if using DC Power.*
7. Combined RF IN: Reference input for adjacent QAM signals combined with QAM Marker output.
8. USB Connection: For factory calibration use only.
9. Marker Out Connection: QAM Marker output signal.

*NOTE: DC Power Connection is optional. Not available on all models. Contact ComSonics Technical Support for additional information.

Headend/Hub Installation

Important!
For automatic mode operation at least one of the adjacent QAM signals from the applicable pair (channel 16 or 17 for 138 MHz operation or channel 88 or 89 for 612 MHz operation) and the QAM Marker signal must be present at the 'Combined RF IN' (❼) before powering on the QAM Marker unit. The QAM 'Marker OUT' (❾) is connected to a headend/hub combiner port.

The QAM Marker Signal Source uses 1 3/4 inches of rack space and should have free air space of at least 1/2 inch above and to the ends of the chassis for ventilation. It needs power from the AC (❶) or DC (❷) supply mains, a connection (❾) to the headend/hub combiner network, and a connection (❼) to headend/hub signals at test point levels (consisting of at least the available adjacent QAM channel/s and the QAM Marker signal).

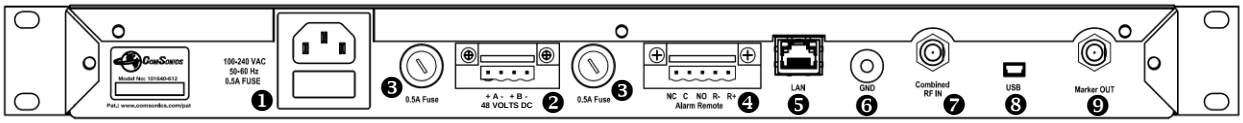

Figure 3 Back Panel Connections

❶ AC Power with built-in fuse - Accepts standard IEC power cord.
⚠ Refer to the Electrical Safety section on page 4.

❷ *DC Power – Optional Dual 48 volt power, screw connection adapter included.
⚠ Refer to the DC Powering section on the next page.

❸ DC Power Fuse (2) - Protection for 48 volt power (Optional).

❹ Alarm Remote - Connects to internal relay contacts, screw connection adapter included.

❺ LAN - RJ45 Ethernet network connector.

❻ Ground Binding Post - Chassis ground point.
⚠ Unit must be grounded if using DC Power.

❼ Combined RF IN - Input for adjacent reference QAM signals with Marker signal.

❽ USB - Service port, factory use only.

❾ Marker OUT - QAM Marker signal output.

*NOTE: DC Power connection is optional. Not available on all models. Contact ComSonics Technical Support for additional information.

DC Powering

 **Optional Dual 48 Volt DC Powering Recommendations.**

Observe the following guidelines for using the 48 Volt DC Power option.
(DC power cables are not supplied with the equipment.)

- Only use wiring rated to safely handle 48 VDC/0.5A.
- Use the provided Phoenix 4-position pluggable terminal block (Phoenix MSTB 2.5/4 - STF - 5.08).
- Each terminal connection of the Phoenix plug can only accept one 24 to 12 AWG stranded wire.
- Do not exceed the rated capacity.
- Use the shortest possible wire length.
- Always use a continuous length of wire.
- Do not splice wires to attain the needed length.
- Use a larger wire size (within the recommended range of 24 AWG min to 12 AWG max) to minimize voltage drops when wires must run a long distance.
- Always use similar wire size for both the '+' and the '-' sections.
- Use wire trays for routing where possible.
- Avoid running wires near high energy or AC wiring.

Power and Alarm Indicators

Allow 15 seconds for the QAM Marker to initialize after applying power.

After initialization the front panel indicators will flash based on the current configuration. Refer to Figure 4 for description of LED indications.

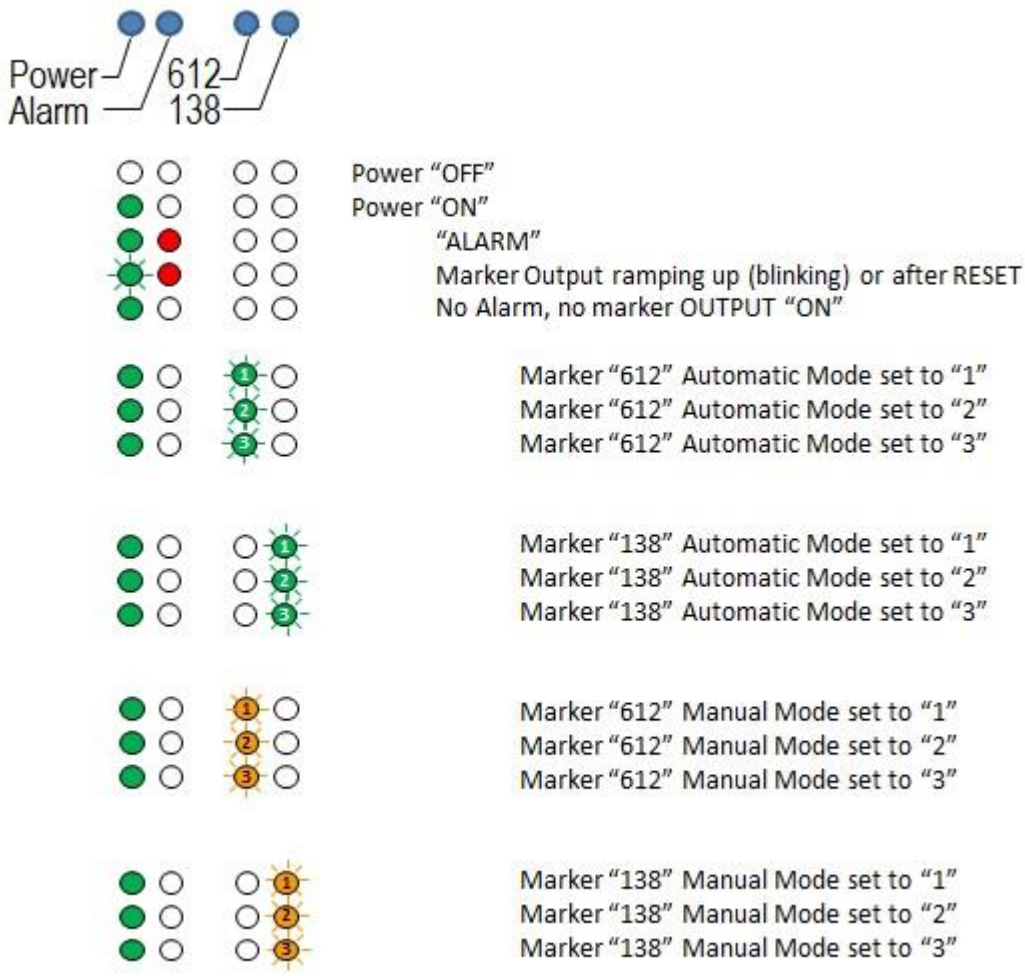

Figure 4 Front Panel LED Indications

Broadcast Insertion Considerations

For maintaining maximum plant-wide shielding effectiveness, the QAM Marker signal must be available throughout the coaxial distribution network. For that reason, installation strategy is important.

1. A single QAM Marker may serve, if the plant is configured to optically transport the broadcast spectrum from a single location (the headend) with no further electrical conversion before each fiber node.
2. Multiple QAM Marker units may be needed, if the headend optical output serves multiple hub locations with recombined signaling or remapped channel plans. The QAM Marker output signal must be combined with all other broadcast signals at the input to the final laser.

Directions in the document are based on the assumption that channels adjacent to the QAM Marker (16 and 17 for 138 MHz operation and 88 and 89 for 612 MHz operation) are QAM channels. If either of the adjacent channels is an analog carrier the QAM Marker must be operated in manual mode. Manual mode configuration is covered later in this document.

In the automatic mode, the QAM Marker adjusts the marker signal level relative to the RMS power level of an adjacent QAM channel. When the difference in power levels between the adjacent QAM channels is less than 3 dB, the QAM Marker will use the channel with the lower RMS power level as a reference. When the difference in power is greater than 3 dB, the QAM Marker will use the channel with the higher power level as the reference.

The QAM Marker automatic leveling feature references on its Combined Input port the simultaneous availability of the QAM Marker output signal, and either one or both QAM signals adjacent to the selected output frequency. **IMPORTANT: The Marker OUT port of the QAM Marker is limited to ONLY the Marker test signal. The QAM Marker only references the adjacent QAM signals and does NOT forward the payload of the adjacent QAM signals.**

Where this combination (Marker output signal and either or both adjacent QAM signal) is available at an open combiner port feeding the broadcast laser, or where that combination is available on the laser output test point, the QAM Marker can be operated in the automatic leveling mode. Note that the Combined Input port QAM signal level must be between -20 and +30 dBmV. If the input levels are too low, an amplifier with an appropriate gain may be used and if the input levels are too high, an attenuator may be used.

If the headend configuration cannot supply the required combination, it is quite likely that the automatic leveling feature cannot be used and the QAM Marker output level will fall within the unused laser output spectrum above the broadcast channels. The QAM Marker level must be set manually based upon the nearest adjacent QAM signal amplitude.

The manual output range is -10 dBmV to +35 dBmV. After installation of the QAM Marker the output level should be checked relative to the adjacent QAM channel levels at a convenient field test point, such as a node electrical output. If the QAM Marker is not 30 dB (+0.0, -2.0 dB) below the adjacent QAM signals the output should be adjusted. Care taken at the headend during initial set-up will minimize any further adjustment.

The following table and text condenses and consolidates different headend/hub/node configurations.

Type	Headend Output	Hub	Fiber Node
1	Optical	N/A	Optical > RF
2	Optical	Optical > Optical	Optical > RF
3	Optical	Optical > RF > Optical	Optical > RF
4	Optical	Optical > RF > Optical	Optical > RF
5	IP	IP > RF > Optical	Optical > RF

Type 1: Broadcast analog and QAM signals are combined at the headend location, fed to one or more lasers and transported optically to one or more fiber nodes. A QAM Marker for each frequency monitored operated in Automatic Leveling mode can be used for system-wide distribution.

Type 2: Broadcast analog and QAM signals are combined at the headend location and transported to one or more hub locations, then split and transported to one or more fiber nodes. A single QAM Marker may serve system-wide distribution depending upon the combining method. Operation in Automatic Leveling mode requires a single RF port with the presence of both the inserted QAM Marker signal and either or both adjacent QAM channels. This may only be available at the final laser output test point.

Type 3: Broadcast analog and QAM signals are partially combined at the headend location and transported optically to one or more hub locations. At the hub location, the optical signals are converted to RF and recombined with locally generated signaling or remapped to form a desired channel plan. The new combination is supplied to the output laser and transported optically to one or more fiber nodes. A single QAM Marker may serve system-wide distribution depending upon the combining method. Operation in Automatic Leveling mode requires a single RF port with the presence of both the inserted QAM Marker signal and either or both adjacent QAM channels. This may only be available at the final laser output test point.

Type 4: Broadcast analog signals are combined for input to the broadcast laser and transported to one or more hub locations. Digital baseband signals are streamed to hub locations on a high speed fiber ring where they are recovered, converted to QAM, and combined with locally generated signaling. A single QAM Marker may serve system-wide distribution depending upon the combining method. Operation in Automatic Leveling mode requires a single RF port with the presence of both the inserted QAM Marker signal and either or both adjacent QAM channels. This may only be available at the final laser output test point.

Type 5: Individual hubs receive input in IP format from a central location. All RF signals (analog and QAM) are generated and combined at each hub and transmitted optically to nodes. QAM Marker(s) will be required at each hub. Operation in Automatic Leveling mode requires a single RF port with the presence of both the inserted QAM Marker signal and either or both adjacent QAM channels. This may only be available at the final laser output test point.

Configuration Manager Introduction (web based)

NOTE: Reference this section when performing the QAM Marker Manual Level Set Up Procedure described in the following sections.

To configure the QAM Marker by direct connection, use a shielded cross-over type Cat 5 Ethernet cable between the computer and the LAN port on the back panel of the unit. Make sure the computer's Ethernet configuration has DHCP turned OFF. Use the option that allows the user to enter in a manual IP Address such as "Use the following address". Enter in an address that does not conflict with the Marker address. A recommended address is: **192.168.0.49** Also ensure the subnet mask is set to: 255.255.255.0. Remaining settings do not need to be altered.

To configure the QAM Marker on your existing network, connect it to a network switch or hub using a shielded straight-through Cat 5 Ethernet cable. Make sure the QAM Marker default address of 192.168.0.50 will not conflict in the existing network. If so, use the direct connection method to change the unit address under Network Settings and then click on Apply Settings. Once that operation completes, *press the Reset button on the front panel.*

Open a web browser and enter **192.168.0.50** (or the current IP address) in the address bar. *Recommended browsers are IE, Firefox, and Chrome. Note that the windows may appear differently with different browsers.* Reference Figure 5.

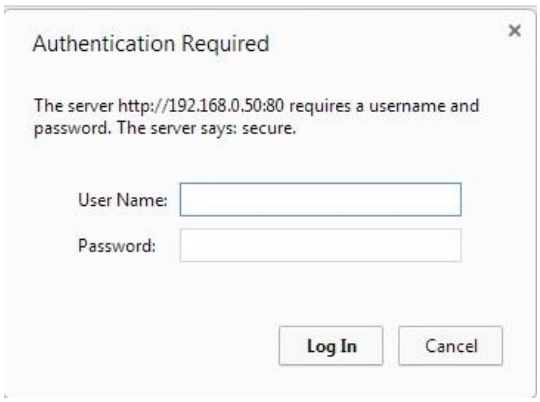

Figure 5 Authentication Window

Click "Log In" on the Authentication window to continue. *The Authentication window varies per operating system and web browser.*

Leave the fields blank. The Authentication window shows the first time the unit is addressed as long as the browser remains open.

The Home page (Figure 6) shows the QAM Marker's Firmware Version, MAC Address, and the Marker Configuration Manager Version. Menu items are available in the left column. Note: The first time connecting to the QAM Marker an error screen may be shown. Click any of the tabs in the left column to clear. This does not affect Marker operation.

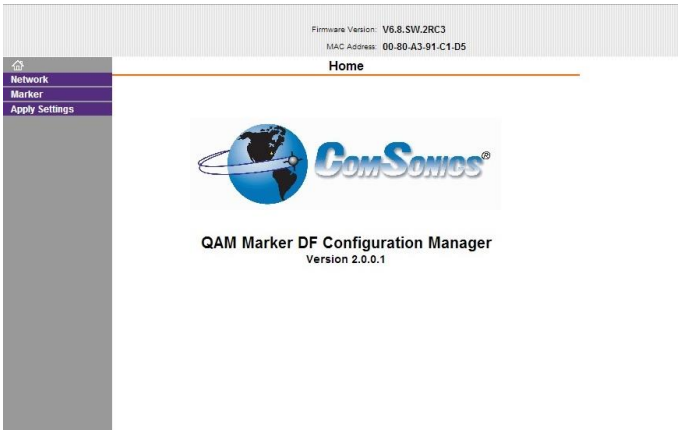

Figure 6 Home Page

Network

Select “Network” from the left column menu bar to display the Network setting screen (Figure 7).

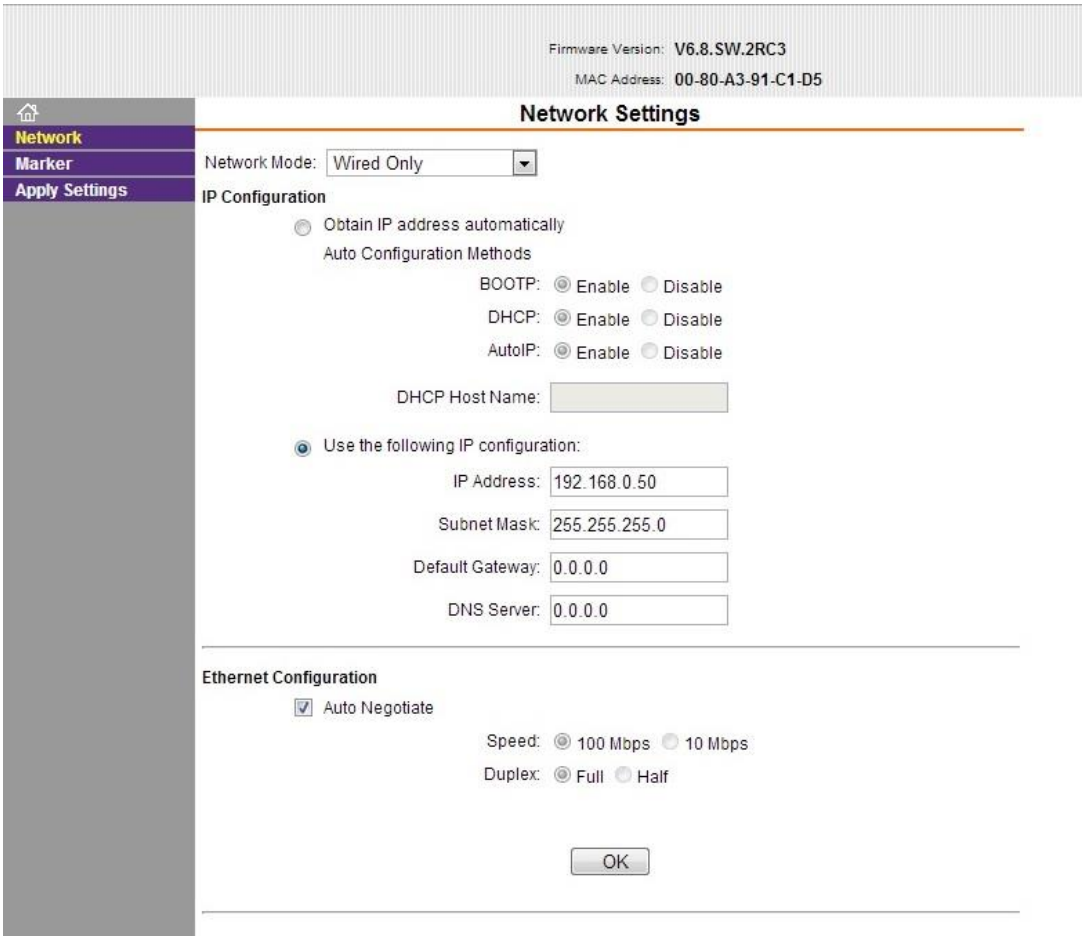

Figure 7 Network Settings Screen

If not connecting QAM Marker to a local network do not change default settings. If connecting to local network, enter desired network information and click “OK”. Note this saves settings on page but *DOES NOT* send settings to QAM Marker. Click Apply Settings to send the settings to the

QAM Marker unit.

Apply Settings

When the desired Network Settings are set click the OK button. This must be done as an intermediate process. Once all settings are entered, click on Apply Settings in the left panel to complete the process (Figure 8). The QAM Marker reboots and Configuration Manager returns to the Home screen.

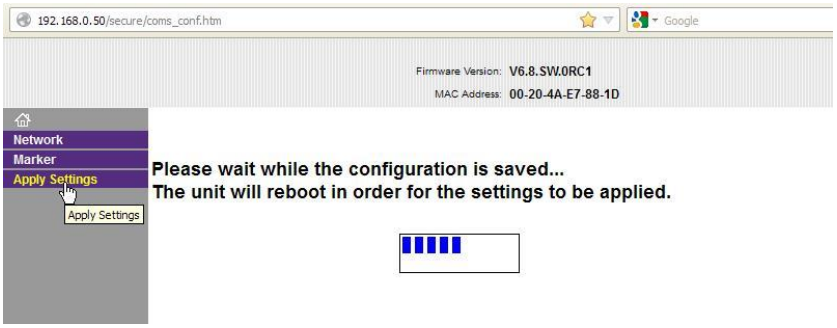

Figure 8 Apply Settings

Important:

When the *Apply Settings* function is used, the QAM Marker must be locally reset by pressing the front panel Reset button. *(This step must be done in order to access the Marker Settings screen after the Apply Settings function is used.)*

Marker

Click on “Marker” in the left column to access the Default Marker set up screen (Figure 9).

When the System Mode is set to *Automatic*, the *Manual Level* field is grayed out and not available.

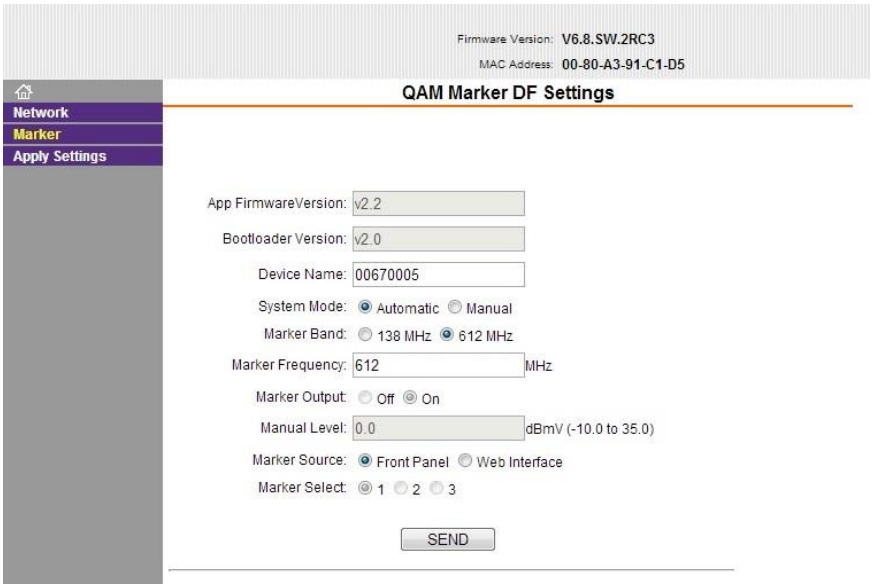

Figure 9 Default Marker Set Up

Enabling *Manual* in the System Mode allows entering an output level in the *Manual Level* field (Figure 10).

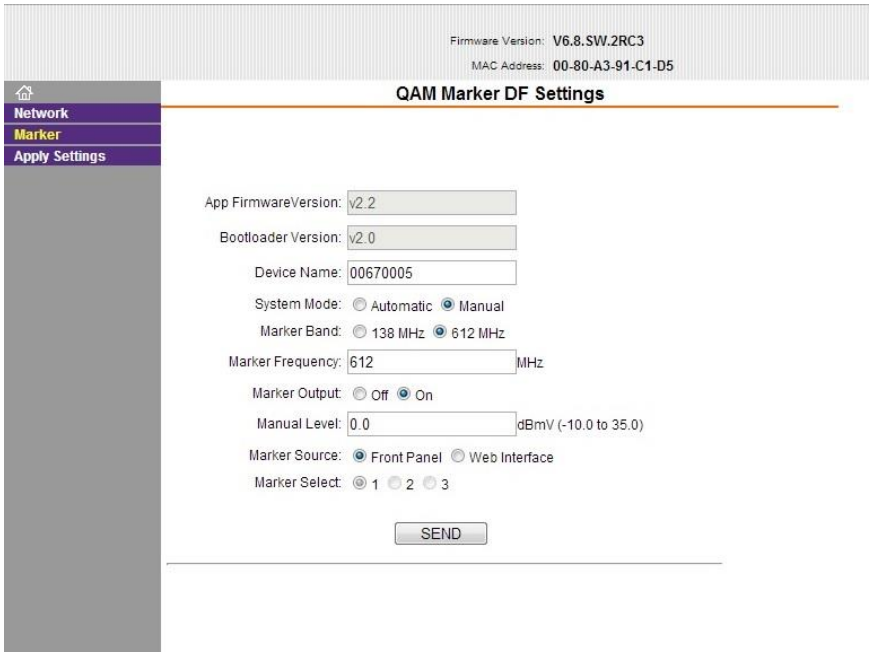

Figure 10 Manual Level Set Up

The *Marker Output* can only be set to Off in the *Manual* mode. Selecting the *Automatic* mode locks the *Marker Output* to On.

The *Marker Frequency* is set in MHz. Ranges are 136.5 to 138.5 MHz and 607 to 615 MHz.

Click the **SEND** button to immediately change the QAM Marker's settings. No reboot is needed.

Note: If the *Marker Frequency* or the *Manual Level* is not within range, an invalid value warning is shown.

If using *Manual* mode, the required marker level may be determined by a procedure in the next section of this document. Enter the desired output in the *Manual Level* box and click **Send** to immediately change the QAM Marker output. No reboot is needed.

The QAM Marker Identifier defaults to the front panel control. It may be changed using the Web Interface by selecting the "Web Interface" option and selecting the desired Marker Identifier (1,2, or 3). Changing the Front Panel Marker Identifier switch reverts control back to "Front Panel".

Exit

Close the browser tab to exit the Configuration Manager. *(No log-out function is needed.)*

QAM Marker Manual Level Setup Procedure

Spectrum Analyzer

This section contains information to assist in the setup of the QAM Marker when configured to operate in manual mode. Power measurements will be made on both the QAM television channels in the CATV system and on the output from the QAM Marker unit itself.

A familiarity with the operation of the QAM Marker web-based user interface and operation of a spectrum analyzer is required. The spectrum analyzer used for this document is an Agilent N9342C. Other spectrum analyzers may have similar functions and settings.

Section 1 - QAM Power Measurements using a Spectrum Analyzer

When measuring signals having a bandwidth greater than that of the resolution bandwidth of the instrument used to make the measurement, a measurement bandwidth correction factor must be applied.

256-QAM television channels have a symbol rate of 5.361 million symbols per second for a 6 MHz bandwidth and 6.952 million symbols per second for a 8 MHz bandwidth. This corresponds to a Signal Bandwidth (SBW) of 5.361 MHz and 6.952 MHz respectively.

A Spectrum Analyzer has a number of Resolution Bandwidth (RBW) settings. The setting selected when measuring power must be used to calculate the Bandwidth Correction factor. This is because the amount of power measured on the Spectrum Analyzer is restricted to the resolution bandwidth (RBW), thus it must be adjusted to obtain the correct measurement.

The Bandwidth Correction factor (BWC) is calculated with the following equation:

$$BWC\ (in\ dB) = 10 * Log10\left(\frac{SBW\ (in\ MHz)}{RWB\ (in\ MHz)}\right)$$

When using Quadrature Amplitude Modulation, the signal produced has characteristics of noise. When measuring signals 'noise like' in nature and averaging the resulting logarithmic output on the screen of a spectrum analyzer, an under-response of 2.51 dB is incurred. To compensate, add 2.51 dB to the measurement obtained, altering the formula to:

$$BWC\ (in\ dB) = 10 * Log10\left(\frac{SBW\ (in\ MHz)}{RWB\ (in\ MHz)}\right) + 2.51\ dB$$

It is possible that the spectrum analyzer uses an FFT type detector to make the power measurement. In this case, the 2.51 dB correction does NOT apply. The correction is only for the case where a log-type detector, usually called "sweep", is used to measure signals "noise-like" in nature, such as QAMs.

The instructions contained in this document for the spectrum analyzer control are specifically for the **Agilent N9342** (Figure 11), however many of the menu/command structures from spectrum analyzer to spectrum analyzer are similar.

Figure 11 Spectrum Analyzer

The key functions used for the measurements in this document are as follows:

- SPAN controls the amount of bandwidth shown on the display indicated and/or set by the start, center, and stop frequency.
- RBW (Resolution Bandwidth) is an important function. It is a band pass filter before the power measurement is taken. It impacts the measurement in three important ways:
  1) The measured power at the marker point is constrained to the band pass limits,
  2) the noise floor decreases as the band pass range is narrowed, and
  3) frequency signals close together (the QAM Marker is a good example) cannot be resolved unless the RBW is set low enough to discriminate between them.
- VBW (Video Bandwidth) determines the capability to discriminate between two different power levels. A narrower VBW setting removes more noise in the detector output and ‘smooths’ the envelope display. Set the VBW to be 3x RBW for QAM Marker measurements.
- Sweep mode has a lower RBW of 1 kHz. For a lower RBW, set the sweep mode to ‘FFT’ or ‘Auto’. Auto mode changes settings as needed.

Section 2 - Measuring the QAM Channel Power Level

Use the following steps to measure and calculate the total QAM Power Level:

1) Set the spectrum analyzer to a 15 MHz span centered at the Marker Frequency to be used (138 MHz or 612 MHz). This should be a resolution bandwidth (RBW) of **100 kHz** (30 kHz for FFT mode). Set the video bandwidth filter (VBW) bandwidth at least three times the RBW. The VBW setting is expressed as a ratio to the RBW; i.e. 3:1. These settings appear on the bottom of the display as RBW and VBW. For a 15 MHz span, use the SPAN and BW functions. Adjust the Reference level and the Amplitude scale, if needed, using Amptd function.

2) Enable trace averaging mode and adjust to collect 100 samples. Wait a few seconds for the display to stabilize. The two QAM signals adjacent to the desired frequency should be within 1 dB of each other. Record the power level of the QAM channel having the lower level as indicated on the spectrum analyzer. In Figure 12, the QAM power is measured at 16.02 dBmV. Use the Trace function to set averaging. Use the 'more' menu under Trace.

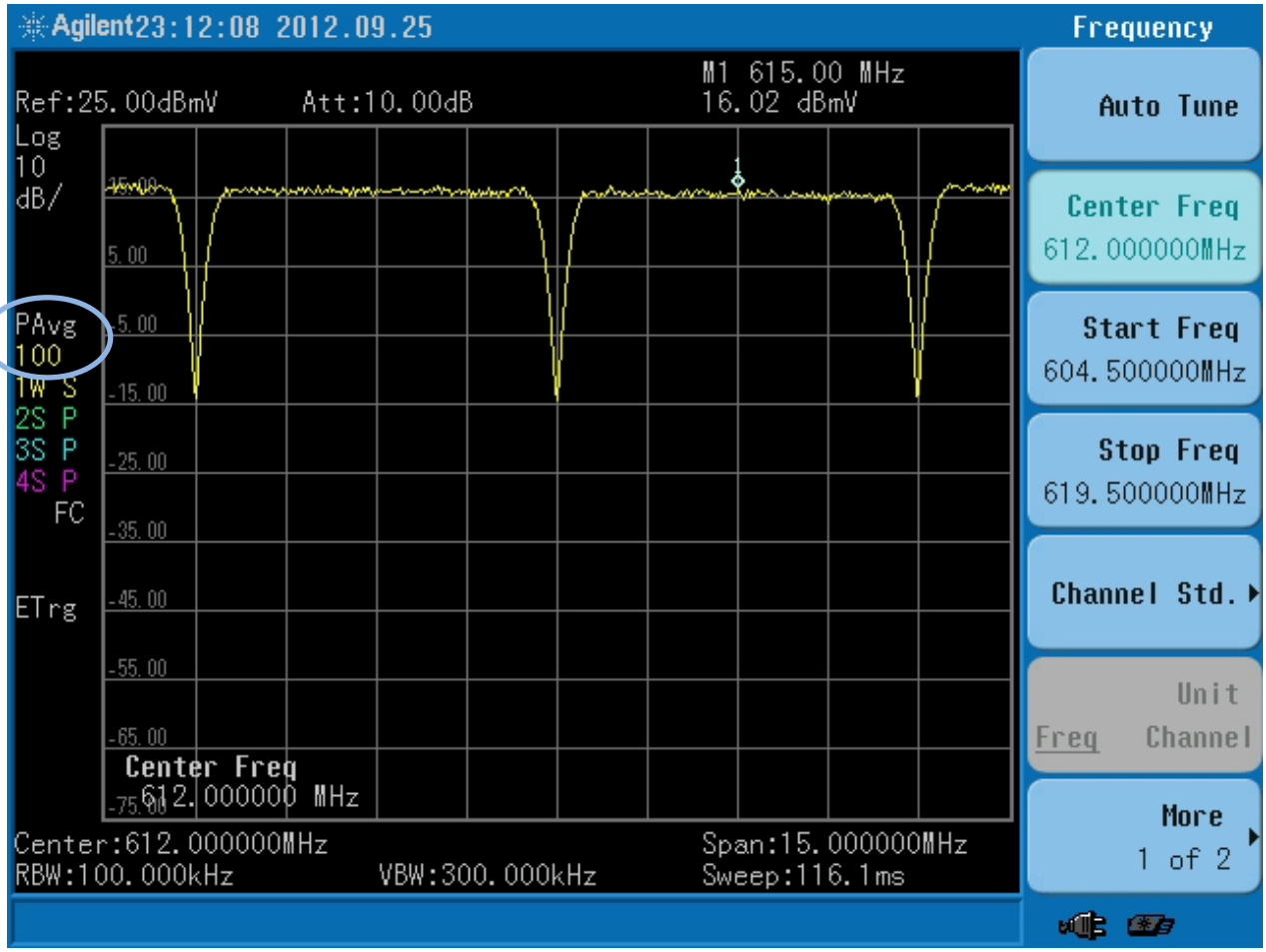

Figure 12 Measuring Adjacent QAM Channels

3) Calculate the bandwidth correction factor based on the resolution bandwidth (RBW) selected on the spectrum (100 kHz). **BWC = 10 * Log10 (5.361 / 0.1) = 17.29 dB** (for 6 MHz QAM).

4) Add the measurement bandwidth correction factor of **17.29 dB** to the number obtained in step 2: **16.02 + 17.29 = 33.31 dBmV**.

5) The logarithmic output is averaged on the display and the correction factor of **2.51 dB** must be applied. For this example: 33.31 dBmV + 2.51 dB = QAM Power Level of **35.82 dBmV**.

Section 3 - Calculate the Required QAM Marker Power Level

The **total marker power** is set to a level **30 dB less** (± 0.5 dB) than the calculated total QAM power level.

Example: Total QAM Power Level calculated: 35.82 dBmV. Subtract 30 dB and set the marker power to this level. 35.82 dBmV - 30 dB = 5.82 dBmV (± 0.5 dB)

Section 4 - Measuring the QAM Marker Power

1) The QAM Marker Signal is comprised of a signal in a double sideband, suppressed carrier, modulation scheme.
2) Set the spectrum analyzer to a 5 kHz span centered at the QAM Marker output frequency. For best results, use a RBW setting between 1 kHz and 30 Hz with 100Hz or 30Hz providing the best results. Disable the trace averaging mode.
3) As illustrated in Figure 13, the two marker sidebands and perhaps some leakage of the suppressed carrier at the center frequency will be visible on the spectrum. Use the peak search function to measure the power level of one of the sidebands (they both should be equal) and add 3 dB to this value for the total marker power. In this example: **2.82 dBmV + 3 dB = 5.82 dBmV**. If the spectrum analyzer does not have a RBW small enough to resolve the two sidebands, you will see a single 'haystack' type trace. In this case, all of the marker power is indicated by the single trace and the 3 dB correction factor is not applied.

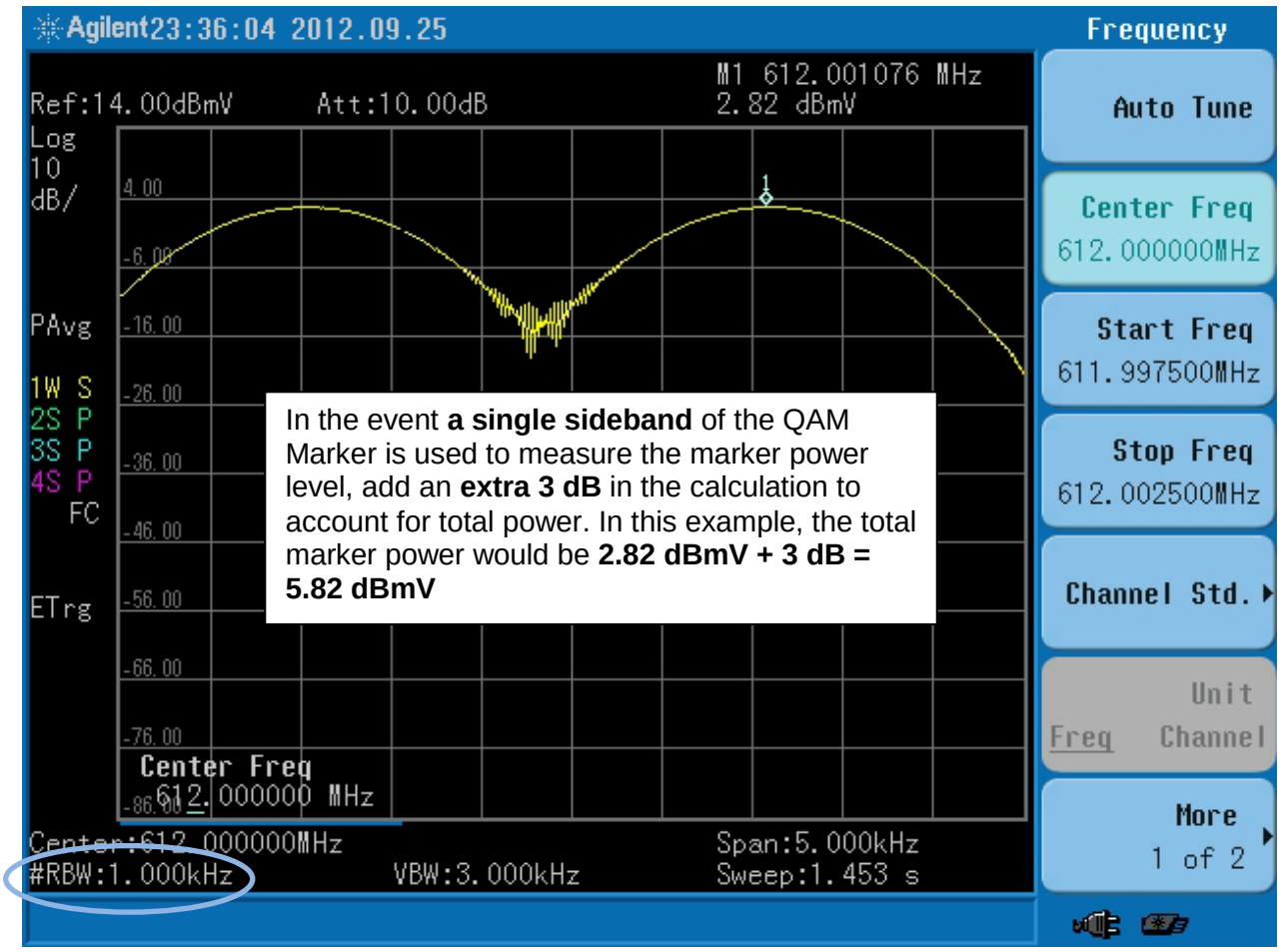

Figure 13 Measuring QAM Marker Output

4) If the spectrum has a selectable Sweep/FFT mode, the resolution bandwidth may be further reduced by selecting the FFT mode. The result in Figure 14 is still at a 5 kHz span **but** at a RBW of 30Hz. Important to note, the indicated level of 2.31 dBmV is less than measured at the previous RBW setting. This is an artifact of the measuring process. More accurate results are obtained if the span is set to a lower value thus increasing the number of data points used to represent the signal on the screen, refer to Figure 14. FFT mode is set using the Sweep function. If the sweep mode is set to 'Auto' this self-adjusts.

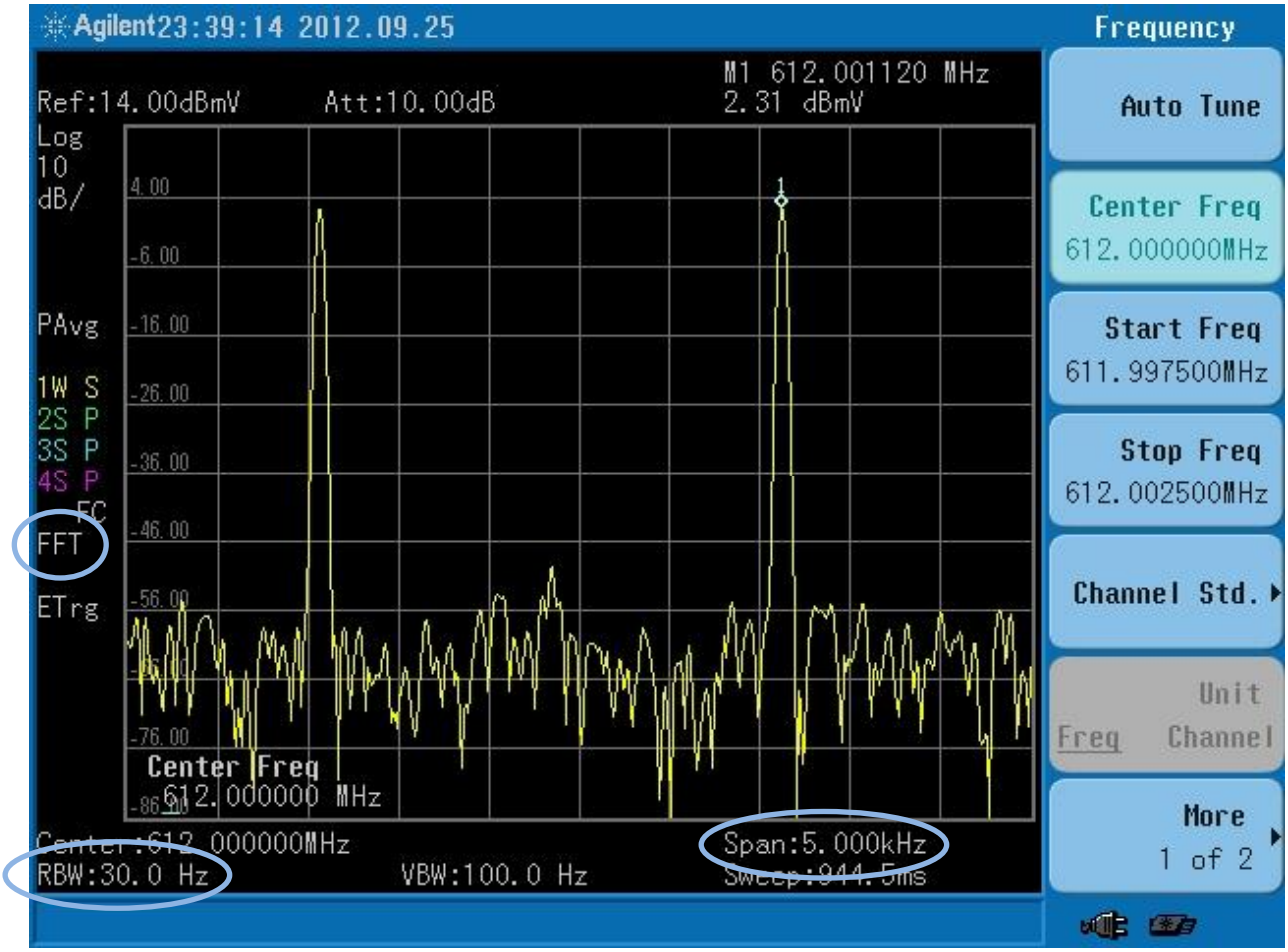

Figure 13 QAM Marker

In this figure the accuracy of the marker measurement is affected by the span setting (5 kHz) being set too wide. Additional resolution is needed to accurately detect to the true peak. Reduce the Span setting.

5) In Figure 15, the marker frequency from the measurement above was transferred to the center frequency of the spectrum analyzer and the span was decreased to 500 Hz. The measured level increased by approximately 0.5 dB, to the expected level of 2.82 dBmV. **Note:** Use the Peak Search function, then 'To Center' to move center frequency to marker point.

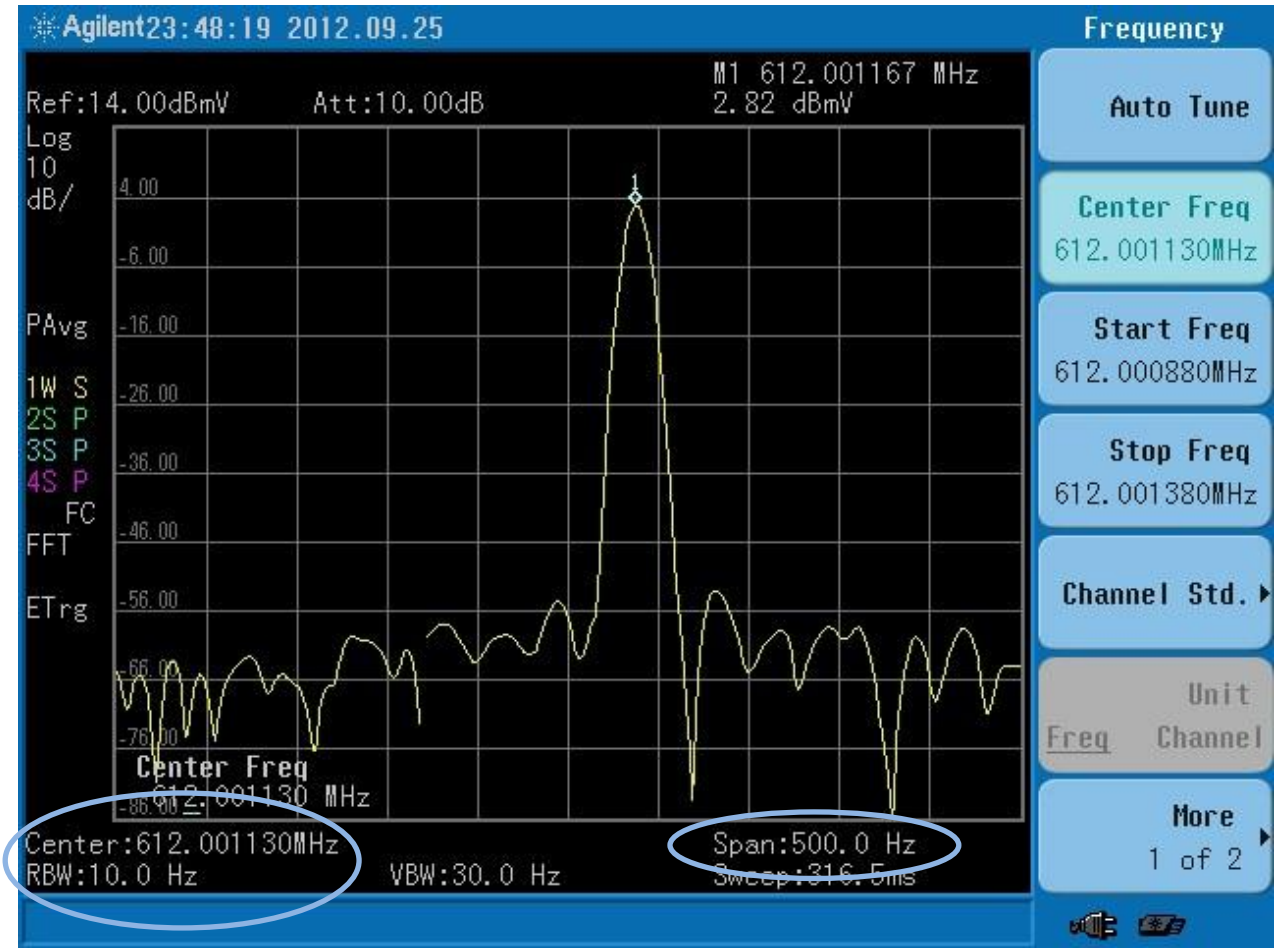

Figure 145 QAM Marker Output

Section 5 - Modulation Error Ratio Measurements

The QAM Marker installation should be verified not to cause interference nor signal degradation to the adjacent channels in the system. A MER measurement should be performed on the adjacent channels both before and after the QAM Marker has been installed.

As an example:

1) Locate a system test point where the adjacent QAM signals, and the QAM Marker signal can be observed.
2) Perform a MER measurement on the adjacent QAM signals and record the levels.
3) Install the QAM Marker unit.
4) Using the same system test point as above, verify the correct QAM Marker level.
5) Repeat and record the MER measurements on the adjacent QAM signals.

QAM Channel Measurement Reference Notes

If the system utilizes a frequency plan other than Standard, adjust the center frequencies of the QAM Marker and test equipment accordingly. These are the published/calculated center frequencies:

	Standard	Incremental	Harmonic
Channel 16	135 MHz	135 MHz	133.75 MHz
QAM Marker (Low Freq Output)	138 MHz	138.0125 MHz	136.7569 MHz
Channel 17	141 MHz	141 MHz	139.75 MHz
Channel 88	609.0000 MHz	609.0125 MHz	607.7803 MHz
QAM Marker (High Freq Output)	612.0000 MHz	612.0125 MHz	610.7806 MHz
Channel 89	615.0000 MHz	615.0125 MHz	613.7806 MHz

QAM Signal Bandwidth:

	6 MHz QAM	8 MHz QAM
64 QAM	5.057 MHz	6.952 MHz
256 QAM	5.361 MHz	6.952 MHz

Common Measurement Bandwidth Correction Factors for 256 QAM:

RBW	6 MHz QAM Correction Factor	8 MHz QAM Correction Factor
3 MHz	10 * log10 (5.361 / 3.0) = 2.52 dB	10 * log10 (6.952 / 3.0) = 3.65 dB
1 MHz	10 * log10 (5.361 / 1.0) = 7.29 dB	10 * log10 (6.952 / 1.0) = 8.42 dB
300 kHz	10 * log10 (5.361 / 0.3) = 12.52 dB	10 * log10 (6.952 / 0.3) = 13.65 dB
100 kHz	10 * log10 (5.361 / 0.1) = 17.29 dB	10 * log10 (6.952 / 0.1) = 18.42 dB

QAM Signal Power = Measured QAM Level + RBW Correction + Log Averaging Correction

Additional Spectrum Analyzer Settings:
Detector Type - Sampling

References:
[1] Agilent - Spectrum Analyzer Basics - Application Note 150
[2] Agilent - Spectrum and Signal Analyzer Measurements and Noise - Application Note
[3] QAM Marker User Guide

Worksheet for Manual Level Mode Setup

Calculate QAM Marker level when measuring **Total Marker power**
[both sidebands combined; RBW =>5,000 Hz]

QAM Channel Level	+	BWC	+	Log Averaging Correction	=	QAM Channel Power	-	30 dB	=	QAM Marker Level
_____ dBmV	+	____ dB	+	___2.51__ dB	=	_____ dBmV	-	**30 dB**	=	_____ dBmV

Measure MER before and after QAM Marker installation

MER	Channel 88	Channel 89
Pre QAM Marker Install	_____ dB	_____ dB
Post QAM Marker Install	_____ dB	_____ dB

Note:
Subtract 30 dB for combined sideband level

Calculate QAM Marker level when measuring **One Marker sideband only (Preferred Method)**
[two sideband peaks visible; RBW = 30Hz]

QAM Channel Level	+	BWC	+	Log Averaging Correction	=	QAM Channel Power	-	33 dB	=	QAM Marker Level
_____ dBmV	+	____ dB	+	2.51 dB	=	_____ dBmV	-	**33 dB**	=	_____ dBmV

Measure MER before and after QAM Marker installation

MER	Channel 88	Channel 89
Pre QAM Marker Install	_____ dB	_____ dB
Post QAM Marker Install	_____ dB	_____ dB

Note:
Subtract 33 dB for one sideband only level

Example: QAM Signal Power at RBW=100kHz; Marker power at RBW=30Hz

6 MHz QAMs

QAM Channel Level	+	BWC+ Log Correction	=	QAM Channel Power	-	33 dB	=	Single QAM Marker Level
_____ dBmV	+	19.80 dB	=	_____ dBmV	-	33 dB	=	_____ dBmV

8 MHz QAMs

QAM Channel Level	+	BWC+ Log Correction	=	QAM Channel Power	-	33 dB	=	Single QAM Marker Level
_____ dBmV	+	20.93 dB	=	_____ dBmV	-	33 dB	=	_____ dBmV

Example: 17.29 dB (BWC for 100 kHz)
+ 2.51 dB (Log Avg Correction)
= **19.80 dB** (BWC + Log Correction)

Example: 18.42 dB (BWC for 100 kHz)
+ 2.51 dB (Log Avg Correction)
= **20.93 dB** (BWC + Log Correction)

Specifications

Output	
Frequency	User selected: 138 MHz (136.5 to 138.5) OR 612 MHz (607.0000 to 615.0000 MHz)
Accuracy	±1 kHz
Marker Output Signal	DSB-SC (Double Sideband, Suppressed Carrier)
Marker Spacing *(front panel setting)*	Low Freq (138 MHz) Operation: 1 = 1131 Hz 2 = 1432 Hz 3 = 1809 Hz High Freq (612 MHz) Operation: 1 = 1283 Hz 2 = 1511 Hz 3 = 1663 Hz
Accuracy	±2 Hz
Marker Output Level	Automatic Mode Marker level is automatically fixed at a level 30 dB below the adjacent QAM channel with minimum RMS Power
	Manual Mode -10 dBmV to 35 dBmV
Output Level Accuracy	+0.0, -1.0 dB
Input	
RF Input	Combined RF (Lower adjacent QAM, Marker, Upper adjacent QAM)
Mechanical	
Connectors	RF Input: Type “F”; Combined RF Input RF Output: Type “F”; Marker Output Fault Alarm Remote Access: C, NO, NC, Reset, Ground Phoenix MSTB 2,5/5-STF-5.08 (1 plug provided)
Indicators	Power Applied / ON Fault Alarm Tripped 612 MHz 138 MHz
Dimensions	1U - 19” rack mount; 16.75” W x 6.75” D x 1.75” H
Weight	less than 6 lbs
Environmental	
AC Power	100 ~ 240 VAC, 50 ~ 60 Hz, <15 Watts (IEC 350 6 foot power cord included)
DC Power (OPTIONAL: Contact ComSonics Technical Support	48 VDC, <15 Watts Phoenix MSTB 2,5/4-STF-5.08 (1 plug provided)

for additional details)	
Operating Temperature Range	+50°F to +90°F
Storage Temperature Range	-20°F to +140°F

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- Use of the product with any non-recommended device or service if such device or service causes the problem.

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