



HPQI-2 QAM Pilot Generator Users Guide

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This document details how to setup and configure the Arcom Digital HPQI-2 Headend QAM Pilot Generator



Table of Contents

Overview	3
The Arcom QAM Pilots	3
Back Panel Illustrations	4
110 - 240 VAC, 50/50 Hz	4
-48 VDC	4
Installation	4
PilotGenerator.exe	5
Connect a USB cable and Driver Installation.....	5
The PilotGenerator.exe Control Panel	6
The Low and High Bands	6
The On/Off Button	6
The Leakage Detection Code	7
Output Level	7
Customized Output Frequencies.....	8
600 MHz Low Pass Filter	8
Setting the Pilot Levels	9
Measuring QAM Power using a Spectrum Analyzer	9
Setting the Pilot Levels	12
RF Surge Protection.....	13
FCC.....	14
HPQI-2 QAM Pilot Generator S/N <300 Specifications	15
HPQI-2 QAM Pilot Generator S/N ≥300 Specifications	16

Overview

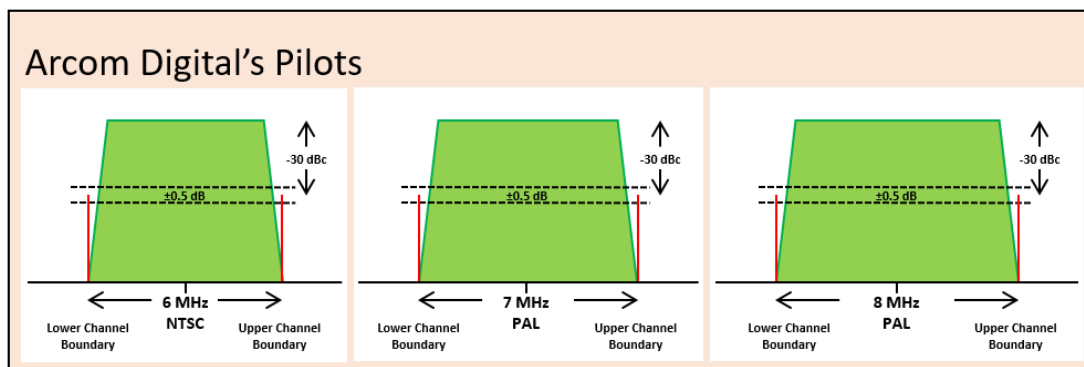
The rapid implementation of Remote-PHY Devices presents a challenge to the Arcom QAM Snare Leakage Detection when there are no QAM samples available for the detector to correlate. This can be easily overcome by programming the RPD to insert pilots in the guard bands surrounding a QAM channel. However, this presents new challenges to QAM Snare Server hub arrangements, that will require continuous boundary and global channel adjustments as new R-PHY Devices are activated.



The Arcom HPQI-2 QAM Pilot Generator is a headend device packaged in a 1 /U chassis that inserts QAM pilots in one or two bands. Installed in legacy hubs, the QAM Pilot Generator will allow for seamless leakage detection as RPD nodes begin to break up larger legacy hubs without a need to continuously update hub boundaries.

The Arcom QAM Pilots

The Arcom Pilot/QAM detection feature is used to create a leakage test signal comprised of a pair of low-level CW carriers separated by 6 MHz, with one of the carriers injected at the channel boundary on the lower edge of a Single Carrier QAM (SC-QAM) signal, and the second CW carrier injected at the channel boundary on the upper edge of the same SC-QAM signal. The Pilot/QAM carriers, or “QAM Pilots”, are typically -30 dBc (QAM), and are precisely placed at the QAM band edge, ± 5 kHz for both NTSC and PAL standards.





Arcom Pilot/QAM “Tagging” is accomplished by the accuracy of the pilot carriers. Carrier frequency tolerance is ± 5 ppm, and separation tolerance is ± 50 Hz. Anything outside those limits will not be detected. This speaks for the accuracy of the HPQI-2 and protects against the confusion of overbuilds.

Back Panel Illustrations

110 - 240 VAC, 50/50 Hz



-48 VDC



Installation

Install the Arcom HPQI-2 QAM Pilot Generator in an equipment rack that is close to a system combiner input. Connect power, ground, and a coaxial connection between the HPQI-2 RF output port and a system combiner input.

PilotGenerator.exe

PilotGenerator.exe is a windows compatible app used for setting the Pilot Generator Operating Parameters. The latest revision can be found on the Arcom Digital Website Resources page at <https://www.arcomdigital.com/resources-info/>.

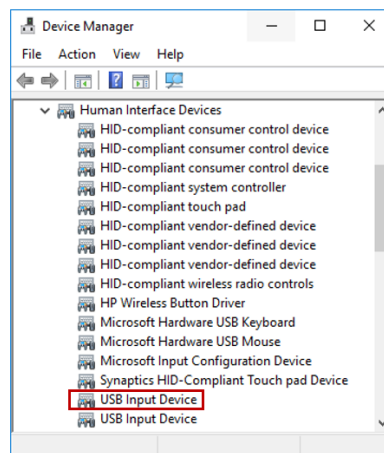
There are two HPQI-2 hardware versions, thus two versions of PilotGenerator.exe. The correct PilotGenerator program must be used with the HPQI-2 Generator listed below to achieve matching output levels.

- PilotGenerator 1.4.0.5.exe is to be used for any HPQI-2 serial number below 300
- PilotGenerator 1.4.0.8.exe is to be used with HPQI-2 serial number 300 and above

PilotGenerator.exe is an independent application that can be run in any authorized Windows folder.

Connect a USB cable and Driver Installation.

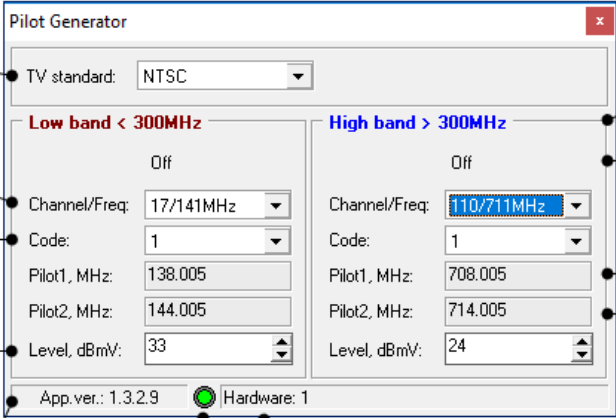
With power applied to your HPQI-2, connect a USB cable between the HPQI-2 and your PC and wait for the drivers to install. The Pilot Generator uses standard Human Interface Device (HID) drivers - no special drivers need to be installed. The Device Manager Entry should list as “USB Input Device”



The PilotGenerator.exe Control Panel

Launch PilotGenerator.exe after the driver has installed. The Pilot Generator control panel will appear. The control panel shows the current state of the QAM Pilot Generator.

If a pilot in either band is ON, then please turn them OFF at this time.



TV Standard: Choose the desired TV Standard, NTSC, PAL-B/G, or PAL-D/K.

Channel/Freq: Pull-Down selection of the pilot channel.

Detection Code: Pull-Down selection of the pilot frequency detection code.

Output Level: Selects the RF Output Level in 0.5 dB steps. Output Range:

- S/N < 300, +15 dBmV to +40 dBmV
- S/N ≥ 300, +10 dBmV to +30 dBmV

App ver.: PilotGenerator.exe software revision number.

LED: Pilot Generator USB connection indicator, Green is connected, Red is not connected.

Hardware Revision: Displays the Pilot Generator Firmware Revision number.

High and Low Bands: One control Panel for each band.

On/Off Button: Turns the pilot carriers ON or OFF in each band.

Pilot Frequencies: Shows the actual pilot frequencies per the Channel/Freq and Detection Code selections.

The Low and High Bands

Each Pilot Generator can output up to two sets of QAM Pilots. One set of pilots in the 120 MHz to 300 MHz (Low) band, and a second set of pilots in the 300 MHz to 1100 MHz (High) band.

The On/Off Button

Each band has one On/Off button to enable or disable the RF output for that band.

The Leakage Detection Code

To simplify the setup of specific pilot frequencies, PilotGenerator.exe presents codes for the operator when selecting a desired pair of frequencies. To set the actual QAM Pilot detection frequency code, pull-down and select the code that represents the desired pilot frequency.

There are four possible channel codes used by Arcom, intended to provide flexibility in overbuild situations. The table below illustrates the frequencies associated with each code. F1 and F2 represent the QAM guard band frequencies.

Code # vs Pilot Carrier Frequencies

Code #	Pilot 1, MHz	Pilot 2, MHz
1	$F1^* + 0.005$	$F2^* + 0.005$
2	$F1^* - 0.005$	$F2^* - 0.005$
3	$F1^* + 0.005$	$F2^* - 0.005$
4	$F1^* - 0.005$	$F2^* + 0.005$
*F1 and F2 = SC-QAM band edge frequencies		

Actual frequencies are displayed in the PilotGenerator.exe “Pilot Frequencies” fields shown above.

Output Level

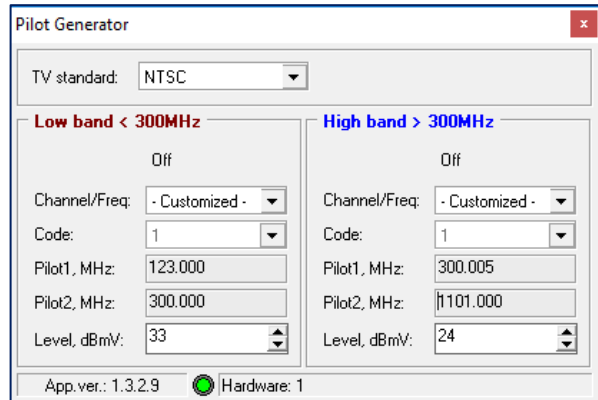
RF Output levels are controlled in 0.5 dB steps using the up/down arrows for each band. Each Output Range:

S/N < 300, +15 dBmV to +40 dBmV

S/N ≥ 300, +10 dBmV to +30 dBmV

Customized Output Frequencies

Although the Pilot Generator output frequencies are normally menu selected, the generator is also capable of producing specific operator selectable output frequencies in 1 KHz increments. Simply pull down “Channel/Freq” in the desired band and select “Customized” at the top of the list. Next, enter the desired frequencies within band ranges; Low Band = 123.000 MHz to 300.000 MHz, High Band = 300.005 MHz to 1101.000 MHz.



600 MHz Low Pass Filter

Any time a High Band frequency is 600 MHz or less is used, it is important to install the FLP-600 supplied with your Pilot Generator. The FLP-600 will eliminate any eliminate harmonics generated by the High Band Synthesizer. Be sure the FLP-600 is removed when output frequencies are above 600 MHz.

The FLP-600 is not required for Low Band operation.



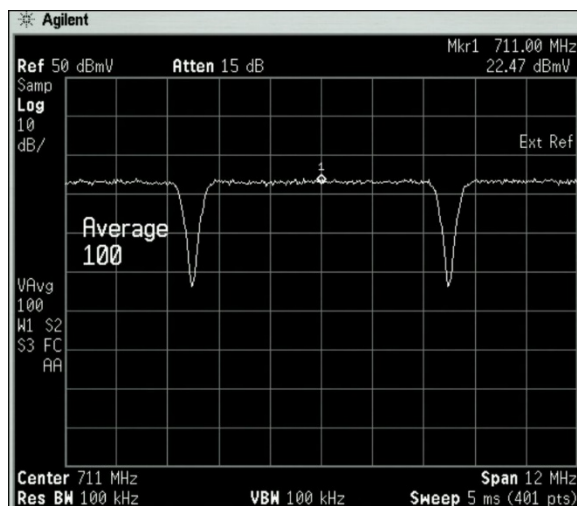
Setting the Pilot Levels

Measuring QAM Power using a Spectrum Analyzer

Note: The following document procedures assumes a basic knowledge of Spectrum Analyzer Operation. Also refer to your spectrum analyzers operation manual.

1. Set your spectrum analyzer as follows:
 - a. Center frequency = the QAM Channel of interest Center Frequency. (For this example, we will use channel 110 with a center frequency of 711 MHz.)
 - b. Span = 12 MHz
 - c. ResBW = 100 KHz (preferred). 30 KHz, 300 KHz, and 1 MHz are also acceptable.
 - d. VidBW \geq ResBW
 - e. Ref Level = 50 dBmV. (adjust at the user's discretion)
 - f. Scale = 10 dB/div
 - g. Averaging = ON, 100 Sweeps

Your analyzer display should look like this:



The typical QAM haystack should average out with a flat top. You can increase the number of averaging sweeps to make the top flatter if desired.



2. Use a marker or display line to measure the haystack peak. In the example above the peak haystack = 22.47 dBmV.
3. To determine the actual QAM channel power, add the following QAM Power Correction [QPC] factor:
 - a. For 30 KHz ResBW add 25.0 dB
 - b. For 100 KHz ResBW add 19.8 dB
 - c. For 300 KHz ResBW add 15.0 dB
 - d. For 1 MHz ResBW add 9.8 dB

Using our example, the Ch-110 QAM Channel Power = 22.47 dBmV + 19.8 dB = 42.27 dBmV.

Why add a QAM Power Correction factor to the QAM haystack to determine the actual channel power?

First, under normal circumstances a Spectrum Analyzer is not capable of displaying true QAM power, simply because data occurs and changes faster than the Analyzer can display. An analyzer that has unlimited Resolution Bandwidth (RBW) can display actual QAM power using a peak hold function. However, since Resolution bandwidths are not usually unlimited, and are only available in common steps, we must apply the Bandwidth Correction Factor (BWC) to the peak haystack to arrive at the actual power measurement.

$$BWC[dB] = 10 \log_{10} \left(\frac{SWB [MHz]}{RBW [MHz]} \right)$$

256 QAM television channels have a symbol rate of 5.361 million symbols per second. This corresponds to a Signal Bandwidth (SBW) of 5.361 MHz.



Second, a QAM transmission produces a signal with the characteristics of noise. When measuring signals ‘noise like’ in nature, with averaging, the logarithmic result will incur an “under-response”, which is typically 2.51 dB. [1].

The final QAM Power Correction factor now becomes:

$$QPC[dB] = BWC[dB] + 2.51[dB]$$

$$QPC[dB] = 10 \log_{10} \left(\frac{SWB [MHz]}{RWB [MHz]} \right) + 2.51$$

When using a 100 KHz Resolution Bandwidth like our example:

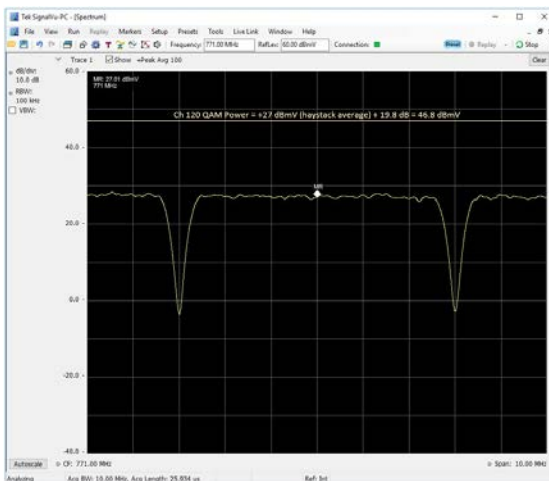
$$QPC[dB]_{100\text{ KHz}} = 10 \log_{10} \left(\frac{5.361 [MHz]}{0.100 [MHz]} \right) + 2.51 = 19.8[dB]$$

[1] "Agilent spectrum and signal analyzer measurements and noise", § Measuring the power of noise with a log-envelope scale.

Setting the Pilot Levels

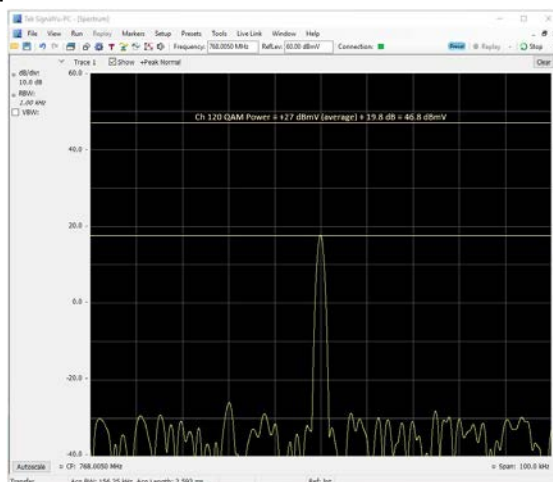
Now that the Pilot Generator Is installed, connected to the System Combiner, and PilotGenerator.exe is running, adjusting the pilot frequencies and levels is easy:

1. Connect a Spectrum Analyzer after the combiner and measure the QAM Power. For this example, we will use channel 120 with a center frequency of 771 MHz, and a QAM channel power of 46.8 dBmV.



$F_c = 771 \text{ MHz}$
 Span = 10 MHz
 ResBW = 100 KHz
 Averaging = ON

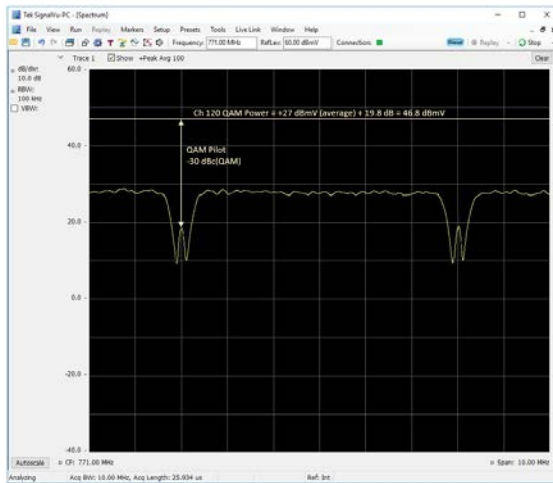
2. Determine the output level of your Pilot carriers. In this case the QAM power is +46.8 dBmV. We will place our carriers -30 dBc(QAM), or 16.8 dBmV.
3. Change your analyzer center frequency to the lower QAM Pilot frequency and using the additional settings below.
4. Now use PilotGenerator.exe to set the pilot carrier as close to 16.8 dBmV as possible.



$F_c = 768.005 \text{ MHz}$
 Span = 100 KHz
 ResBW = Auto, or 1 KHz
 Averaging = OFF

Note - the actual carrier level displayed on the Spectrum Analyzer will not be the same as the RF output level showing on PilotGenerator.exe because the analyzer is connected after the combiner.

- Finally, you can view the entire QAM channel to see both the QAM Pilots and Haystack. QAM Pilots may appear higher in this view because of noise and averaging.



$f_c = 771 \text{ MHz}$
 Span = 10 MHz
 ResBW = 30 KHz or 100 KHz
 Averaging = ON

RF Surge Protection.

Pilot Generators below Serial No 300 do not contain any protection against a surge that appears on the RF port. If you desire surge protection for the HPQI-2 or HPQI-2-48V then Arcom Digital Part Number HESURGEKIT “Headend Surge Protection Kit” can be installed. It is not recommended to use this protection kit with serial numbers below 300.

HESURGEKIT includes a model DK-F-N surge protection device and model FLP-100 High Pass Filter. Together the ability to withstand IEEE C62.41 combination wave surge events of 2,000 volts peak amplitude.

To install simply screw the FLP-100 Male port to the Pilot Generator RF Output, followed by the DK-F-N surge protection device. Ground bonding via crimp connection is optional but is recommended to be used if the cable system is not bonded to ground.



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 manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.



HPQI-2 QAM Pilot Generator S/N <300 Specifications

Model Numbers

Model HPQI-2 = 115 - 230 VAC, 50/60 Hz, 9 Watts @119 VAC. Typ.

Model HPQI-2-48V = (-)36 to (-)65 VDC, 4.5 Watts @-48 VDC. Typ.

Physical

Dimensions = 19.000in X 1.750in X 9.000in (48.260cm x 4.445cm x 22.860cm).

Weight = 2.95 lb (1.34 kg).

Environmental

Operating Temperature 0°C to +40C.

Operating Humidity 0 to 95 RH.

Interfaces

Power:

110 - 240 VAC = IEC 60320-1 C14.

(-)48 VDC = 5.00mm Pitch Eurostyle Horizontal PCB Header, 2 Circuits.

RF Output = F-Type.

USB 2.0 type B.

Operating Specifications

Frequency Standards:

NTSC

PAL B/G

PAL D/K

Other (Individual In-Band Custom Frequencies at 1Khz Increments)

RF Output:

Band 1 = Two (2) CW carriers 123-300 MHz,

Band 2 = Two (2) CW carriers 300.005 - 1104.00 MHz

RF Output Level

123 - 900 MHz = +15dBmV to +40 dBmV (± 3 dB)

900 - 1000 MHz = +10dBmV to +35 dBmV (± 3 dB)

1000 - 1104 MHz = +5 dBmV to +30 dBmV (± 3 dB)

Custom Frequency Adjustment = 1KHz

Spurious <70 dBc max (<100 dBc QAM)



HPQI-2 QAM Pilot Generator S/N ≥ 300 Specifications

Model Numbers

Model HPQI-2 = 115 - 230 VAC, 50/60 Hz, 9 Watts @119 VAC. Typ.

Model HPQI-2-48V = (-)36 to (-)65 VDC, 4.5 Watts @-48 VDC. Typ.

Physical

Dimensions = 19.000in X 1.750in X 9.000in (48.260cm x 4.445cm x 22.860cm).

Weight = 2.95 lb (1.34 kg).

Environmental

Operating Temperature 0°C to +40C.

Operating Humidity 0 to 95 RH.

Interfaces

Power:

110 - 240 VAC = IEC 60320-1 C14.

(-)48 VDC = 5.00mm Pitch Eurostyle Horizontal PCB Header, 2 Circuits.

RF Output = F-Type.

USB 2.0 type B.

Operating Specifications

Frequency Standards:

NTSC

PAL B/G

PAL D/K

Other (Individual In-Band Custom Frequencies at 1Khz Increments)

RF Output:

Band 1 = Two (2) CW carriers 123-300 MHz,

Band 2 = Two (2) CW carriers 300.005 - 1104.00 MHz

RF Output Level

123 - 1104 MHz = +10 dBmV to +30 dBmV (± 3 dB)

Custom Frequency Adjustment = 1KHz

Spurious <70 dBc max (<100 dBc QAM)