



# GainMaker Amplifiers and Nodes QAM AGC Application Note

## Overview

A quadrature amplitude modulation automatic gain control (QAM AGC) module is available for use in GainMaker® amplifiers and nodes.

This application note provides information on:

- QAM AGC system requirements
- QAM AGC setup procedures
- QAM AGC pad selection
- Switch 1 (S1) functions with AGC installed

## System Requirements

As its name implies, the QAM AGC is intended to operate with a QAM carrier serving as the pilot carrier. While the QAM AGC operates similarly to the standard single pilot AGCs (which required either a CW or NTSC modulated carrier as the pilot), optimum system performance is achieved when the following guidelines are followed:

- The pilot carrier must be a QAM carrier. (Typically 64QAM or 256QAM - with approximately 6 MHz occupied bandwidth.)
- The QAM pilot carrier's RF level must be set properly at the headend or hub site.
- The QAM pilot carrier should always be modulated. (If changed to CW mode, the AGC may detect a slight power change and alter RF levels.)
- Channels adjacent to the pilot should also be present. (If they are empty channel slots that are filled later, the AGC may detect a slight power change and alter RF levels.)





- 6 Install the design value AGC pad. Refer to **QAM AGC Pad Selection** in this document for pad selection procedures.
- 7 Follow your system's standard balancing procedure for adjusting the amplifier for design RF output levels, using either Thermal set-up procedures or Manual set-up procedures.
- 8 Record the balanced amplifier's RF output levels.
- 9 Move Switch 1 (S1) to position 3 - AGC Operational Mode.
- 10 Slowly adjust the AGC Gain pot to match the RF output levels recorded in step 8. Once this is done the AGC setup is complete.  
**Note:** When adjusting, allow a little time for the AGC to settle as there is some delay between pot adjustment and the associated RF level change.
- 11 If the RF output levels in position 3 - AGC Operational Mode cannot be made to match the levels recorded in step 8 by adjusting the AGC Gain pot, the AGC pad value may need to be changed. In that case, go to step 12. Note that this should only be necessary if the actual amplifier output level of the QAM pilot carrier deviates by more than 2 dB to 3 dB from its design output level, which is possible due to frequency response characteristics of the plant.
- 12 With Switch 1 (S1) in either position 1 or 2 (the position you used for initial balancing) and the amplifier output levels adjusted properly, measure (see note below), and record the output level of the QAM pilot carrier at the main output port. Subtract the appropriate AGC reference level from the measured level to determine the AGC pad value required. Refer to **QAM AGC Pad Selection** in this document for AGC reference levels and pad selection formulas.  
**Note:** When measuring the QAM pilot carrier output level, be sure the meter used is capable of measuring QAM carrier levels accurately. Some earlier meters were only designed to accurately measure CW or NTSC modulated carriers, and may provide erroneous readings when tuned to a QAM carrier.
- 13 Change the AGC pad value based upon the calculation in step 12.
- 14 Repeat step 9.
- 15 Repeat step 10.
- 16 After ensuring that the RF output levels in position 3 - AGC Operational Mode are the same as those in the position used for initial balancing (position 1 or 2), the AGC setup is complete.

## QAM AGC Pad Selection

### QAM AGC Pad Value Formula

The QAM AGC pad value is calculated using the following formula:

$$\begin{aligned}
 & \text{[Design output level of QAM pilot carrier]} \\
 & - \text{[QAM AGC reference value]} \\
 & \text{-----} \\
 & = \text{[QAM AGC pad design value]}
 \end{aligned}$$

#### Example

If the design output level of the QAM pilot carrier is 39 dBmV and the QAM AGC reference value is 27 dBmV (since the amp is a Line Extender), then the design value AGC pad is 12 dB, as follows:

$$\begin{aligned}
 & 39 \text{ dBmV} \\
 & - 27 \text{ dBmV} \\
 & \text{-----} \\
 & = 12 \text{ dB}
 \end{aligned}$$

### QAM AGC Reference Values

The following table provides the QAM AGC reference values.

GainMaker Amplifier Type	QAM AGC Reference Value	Associated RF Port
Line Extender	27 dBmV	Output port
Unbalanced Triple System Amplifier	26 dBmV	Main output port *
All other System Amps: (High Gain Dual, High Gain Balanced Triple, Low Gain Dual)	34 dBmV	Main output port *

**\*Note:** In the system amplifiers, the coupler that directs signal to the AGC is tied into the Main port RF path. It is best to calculate the pad value based upon that port's design output level for the QAM pilot carrier.

### QAM AGC Pilot Carrier Design RF Output Level Determination

If the design output level of the QAM carrier that will serve as the AGC pilot has not been provided (e.g., by a system design group), it can be calculated. The calculation provided in this document assumes the amplifier output tilt is a linear tilt.

You must know the following to determine the QAM AGC pilot carrier's design output level for a given amplifier:

- The lowest and highest frequencies used for system design
- The associated analog equivalent design output levels at the lowest and highest frequencies
- The frequency of the QAM AGC pilot carrier
- The number of dB "down" that the QAM carrier levels are relative to analog (QAM to analog carrier level ratio - typically 6 dB for 256QAM)

Once these items are known, complete these steps to calculate the design output level of the QAM pilot carrier.

- 1 Subtract the lowest design frequency from the highest design frequency, to determine the total bandwidth used in the design (in MHz).
- 2 Subtract the design output level associated with the lowest design frequency from the design output level associated with the highest design frequency, to determine the total output tilt for the amplifier (in dB).
- 3 Subtract the lowest design frequency from the QAM pilot frequency.
- 4 Divide the result from step 3 by the total design bandwidth (the step 1 result).
- 5 Multiply the result from step 4 by the total output tilt (the step 2 result).
- 6 Add the result from step 5 to the design output level at lowest frequency. This will yield the "analog equivalent" pilot carrier output level.
- 7 Subtract the number of dB down from analog that the QAM's are run from the result in step 6 to determine the design output level for the QAM pilot carrier.

### Example

Refer to the following example and the illustration that follows.

Items that must be known:

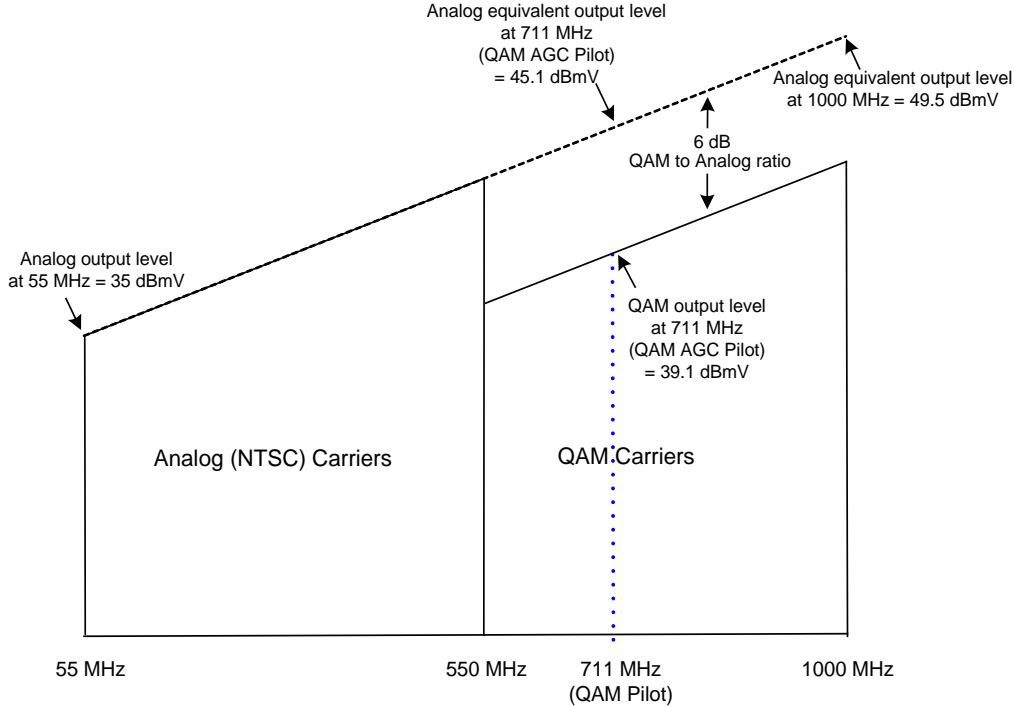
- Design low frequency is 55 MHz and high frequency is 1000 MHz
- Design output level at low frequency is 35 dBmV and at high frequency is 49.5 dBmV
- QAM AGC pilot carrier is at 711 MHz
- QAM carriers are 6 dB down from analog

Calculation procedure steps:

- 1  $1000 \text{ MHz} - 55 \text{ MHz} = 945 \text{ MHz}$  (total design bandwidth)
- 2  $49.5 \text{ dBmV} - 35 \text{ dBmV} = 14.5 \text{ dB}$  (total output tilt)
- 3  $711 \text{ MHz} - 55 \text{ MHz} = 656 \text{ MHz}$
- 4  $656 \text{ MHz} / 945 \text{ MHz} = 0.697$
- 5  $0.697 \times 14.5 \text{ dB} = 10.1 \text{ dB}$  (tilt from low frequency to pilot frequency)

QAM AGC Pad Selection

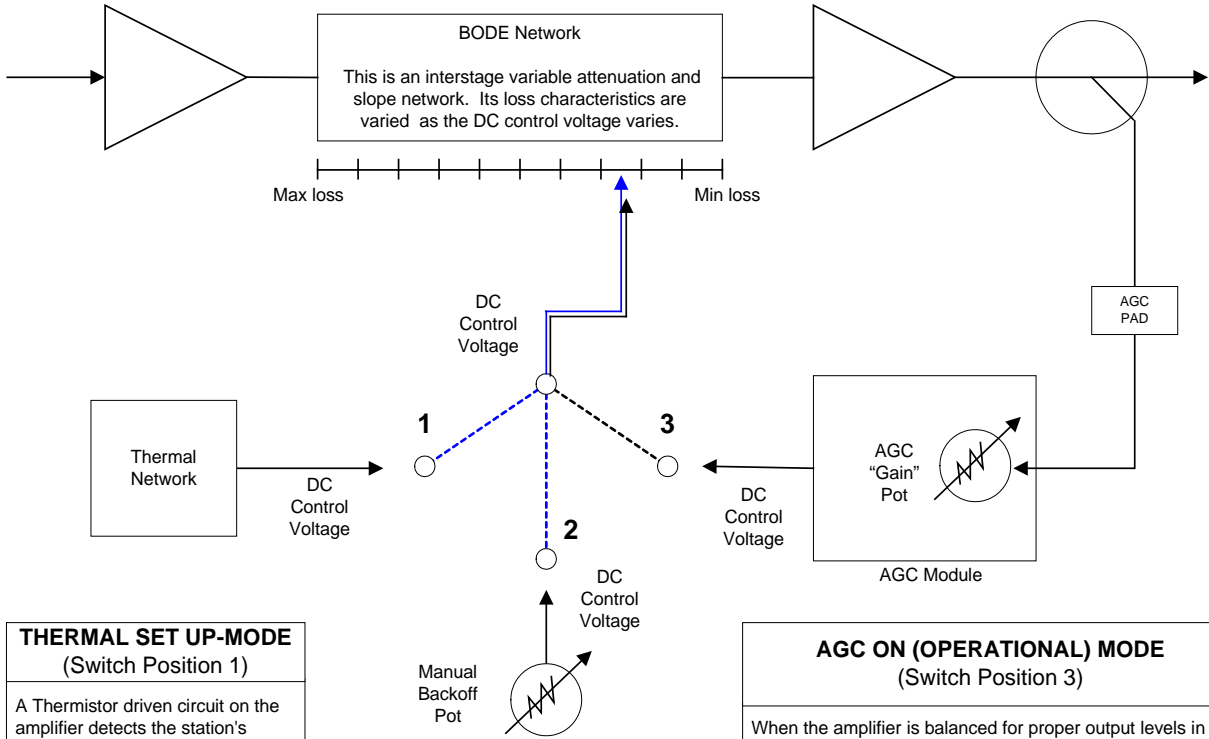
- 6  $10.1 \text{ dB} + 35 \text{ dBmV} = 45.1 \text{ dBmV}$  (analog equivalent pilot output level)
- 7  $45.1 \text{ dBmV} - 6 \text{ dB} = 39.1 \text{ dBmV}$  (QAM pilot output level)





# Switch 1 (S1) Functions With AGC Installed

The following information explains how Switch 1 (S1) functions with AGC installed.



**THERMAL SET UP-MODE**  
(Switch Position 1)

A Thermistor driven circuit on the amplifier detects the station's internal temperature, and generates a related DC control voltage.

This serves to set the proper loss characteristics of the Bode, with respect to the current outdoor temperature.

Prior to initial balancing of the amplifier, either the switch must be in Position 1 (Thermal set-up mode), or the Manual Backoff must be set while the switch is in Position 2 (Manual set-up mode).

*This is the same as the "Thermal" toggle switch position on most prior AGC's.*

**MANUAL SET UP-MODE**  
(Switch Position 2)

By manually adjusting the "Manual Backoff" potentiometer (pot), the DC control voltage that drives the Bode is varied accordingly. This serves to set the proper loss characteristics of the Bode, with respect to the current outdoor temperature.

Prior to initial balancing of the amplifier, either the Manual Backoff must be set with the switch in Position 2 (Manual set-up mode), or the switch must be in Position 1 (Thermal set-up mode).

When in Manual set-up mode, the station RF output level is monitored and the pot adjusted to reduce the gain "x" dB from the full gain (min. loss) pot setting.

The amount of "backoff" (gain reduction) required is determined by consulting a "balance temperature vs. dB of backoff" chart.

*This is the same as the "Manual" toggle switch position found on some prior AGC's.*

**AGC ON (OPERATIONAL) MODE**  
(Switch Position 3)

When the amplifier is balanced for proper output levels in the desired set up mode (Thermal or Manual), the DC control voltage that drives the Bode is set so that the Bode will have appropriate loss characteristics with respect to the current temperature.

For AGC set-up, the Switch must be moved to Position 3 (AGC On) and the AGC Pad and/or AGC Gain pot must be adjusted so that the Bode is set to the same spot in its range as it was during Thermal or Manual set up. It is easy to verify this has been accomplished by monitoring the RF output of the amplifier and switching between the original set up Position (1 or 2), and Position 3. When the output levels in both the original set up position and in Position 3 are the same, the AGC is set properly (the loss characteristic of the Bode is the same for both cases). It is important to note that the exact AGC Pad value and/or relative position of the AGC Gain Pot (min, middle, max etc.) is unimportant in this process. Once matched, the AGC will have full range of operation over temperature.

For AGC operation, the switch must be left in position 3 (AGC On). The AGC pilot carrier level at the input to the AGC module is monitored by the AGC detector circuit. Detected level variations due to temperature cause proportional variation to the DC control voltage driving the Bode. The AGC and Bode combination create offsetting gain and slope variations to occur as needed, holding the actual amplifier output stable.

*This is the same as the "Auto" toggle switch position found on all prior AGC's.*

For Information

## For Information

### Support Telephone Numbers

If you have technical questions, call Cisco Services for assistance. Follow the menu options to speak with a service engineer.





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August 2012 Printed in USA

Part Number 4015992 Rev D