



ENGINEERING REPORT OF ATSC
TELEVISION TRANSMITTER PERFORMANCE CHARACTERISTICS

FOR

WRAZ-DT
Raleigh North Carolina

ULXTED-100

Capital Broadcasting
Raleigh
North Carolina

Measured by:



September 11-15, 2020

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FACILITIES AUTHORIZED IN CONSTRUCTION PERMIT:

Name of applicant: : Capital Broadcasting
Call letters: : WRAZ-DT
Channel number: : CH-15
File number of license or CP: : BLANK-0000143683
Center frequency: : 479 MHz
Pilot frequency: : 476.309441 MHz

TRANSMITTER LOCATION:

State: : North Carolina
Country: : United States of America
City: : Garner
Street: : 3201D Transmitter Rd
GPS : 35° 40' 29" N 78° 31' 39" W (NAD 83)

TRANSMITTER MANUFACTURER:

Manufacturer : GatesAir
Type: : ULXTED-100
Serial Number: : TE10004070-002
Type Acceptance File Number: : 
Exciter Type: : XTE (x2)

TRANSMITTER POWER SUMMARY: (Average, Digital Power)

Amplifier (s) rated power : 0.627 kW (*100= 62.7 kW)
Transmitter system rated power (Pre-filter) : 61.52 kW
Transmitter power output (TPO-Post filter) : 57.81 kW
Transmission line loss : -1.73 dB
Antenna input power : 38.82 kW
Antenna power gain (Max) : 13.17 dB
ERP (Ave.) : 805.4 kW

FILTER MANUFACTURER:

: ERI 8-pole, dual-reflective

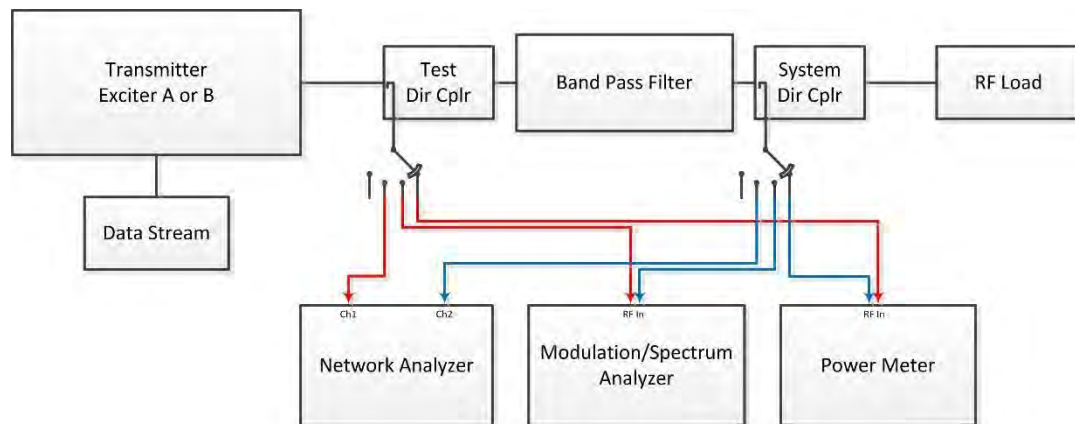
ANTENNA MANUFACTURER:

: Electronics Research Inc. ATW25H4-ETO-15M

*Link to FCC Data <https://www.fccinfo.com/>

** Customer supplied power level (if applicable)

SIGNAL BLOCK DIAGRAM



TEST EQUIPMENT LIST:

<u>Test Equipment</u>	<u>Make</u>	<u>Model</u>	<u>S/N</u>
Network Analyzer	Copper Mountain	S5048	18097093
Spectrum Analyzer	Rohde & Schwarz	ETL	100682
Power Meter	Rohde & Schwarz	NRP-Z51 +10dB pad	100260

METHOD FOR DETERMINING POWER OUTPUT

This describes the method of power output determining, as described in the FCC rules and Regulations.

TPO measurement: With the transmitter adjusted to produce 100% (TPO); Average Power, was measured using a calibrated RF power meter connected to a precision directional coupler.

TPO *post filter* **57.81 kW** /-59.94 dB (coupler value)

- A Precision “Average” Power meter was used to calibrate output power & verify pre-filter levels.
- Pre & Post filter, forward and reflected data recorded & displayed in this report.

Efficiency measurement: a calibrated RF power meter was used to measure precision directional coupler(s) before the Mask filter in the RF system. In multi filter systems, the pre-filter power is additive as can be seen below.

- PRE-Filter Coupling value(s) & Power: TX 1 50.17 dB; 29.9 kW / TX 2 50.48 dB; 29.6 kw

Average pre-filter power displayed from the power meter reading(s): 59.5 kW

PA EFFICIENCY

Total PA power supply current: 2922.6A

Average PA power supply voltage: 43.9V

Transmitter power in Watts: 59.5 kW

PA Efficiency = Cabinet Average output power/input power X 100	
Total PA Current	2922.6
Average PA power supply voltage	43.9
Power in watts	59500
Transmitter efficiency	46.37%

Screen capture below showing transmitter power display & POST-filter Forward power.



Screen capture showing transmitter power display & POST-filter Reflected power.

- NOTE Reflected power must be > 0 and less than 5% of forward power.
 - If reflected power is not within the above parameters further investigation is required. Test load, and all interconnecting coaxial line to be measured & investigated.
- Reflected power / Forward power * 100 = Reflected percentage.

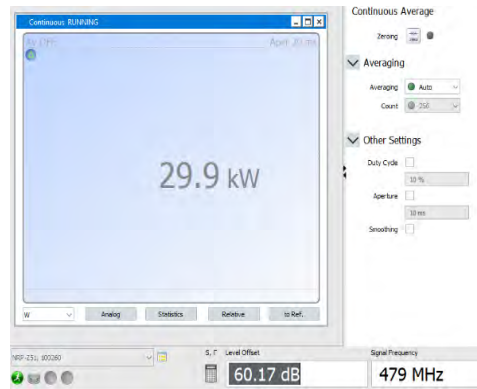
Reflected Power %	
Forward power	57800.00
Reflected power	259.00
Reflected power % < 5%	0.45
VSWR	1.14



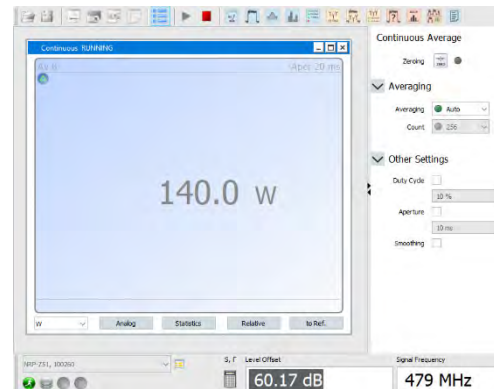
Pre-Filter Power Meter Readings.

NOTE; Prefilter requires a set of power meter measure for each Cabinet and/or filter.
Reflected power to be > 0 and less than 5% of forward power.

Screen capture showing PRE-filter Forward & Reflected TX-1

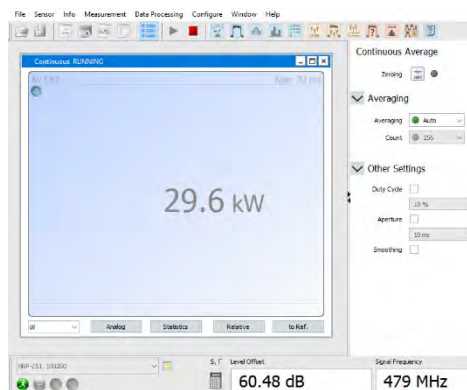


TX-1 Forward

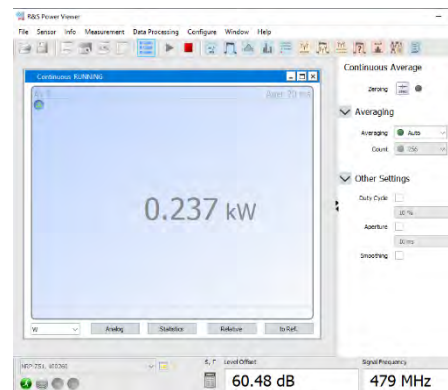


TX-1 Reflected

Screen capture showing PRE-filter Forward & Reflected TX-2



TX-2 Forward



TX-2 Reflected

FREQUENCY MEASUREMENT OF DIGITAL PILOT; POST FILTER-EXCITER A & B

FREQUENCY MEASUREMENTS OF THE DIGITAL CARRIER.

[Section 73.1545 © (1) and (2)] Frequency measurements were made of the pilot carrier frequency using the following equipment;
Rohde & Schwarz ETL, SN: 100682

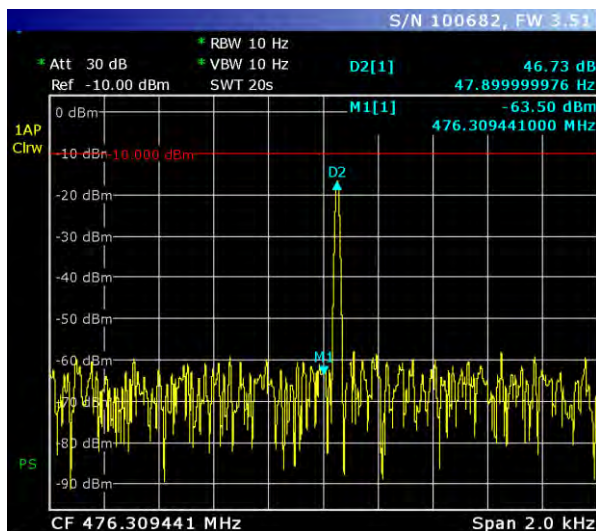
Pilot Frequency= Lower 6 MHz side band plus 0.309441 MHz
Example Ch-27 548-554 MHz: Pilot=548.309441 MHz

*Set parameters as listed below;

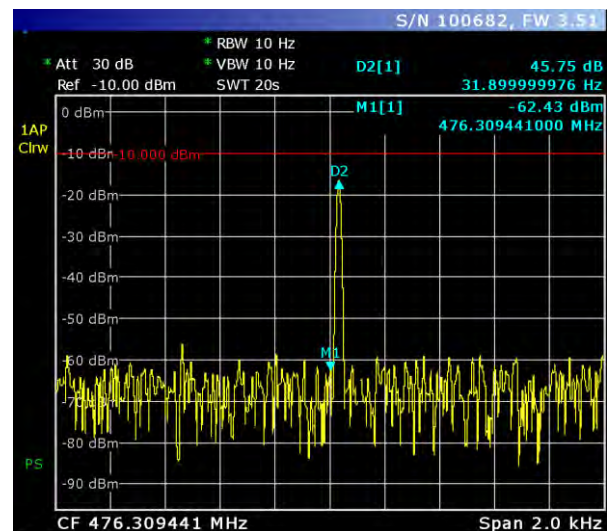
- Span=2 kHz, RBW=10HZ, VBW=10 HZ for N-1
- Span=100HZ, RBW=10 HZ, VBW=10 HZ for DTV-DTV & N+1
 - (10mhz EXT reference should be used for 100HZ span)

*Place center frequency and marker 1, on Pilot; For Marker 2 use peak search to find peak.

****NOTE** the pilot can be adjusted from each exciter “FTR OCXO, OCXO%” for the System Reference “manual” mode.



Exciter A: 476309489 Hz



Exciter B: 476309472 Hz

FCC limit +/- 1000 Hz from assigned carrier frequency. (N-1) typical
FCC limit +/- 10 Hz from assigned carrier frequency. (DTV to DTV) Close Channel
FCC limit +/- 3 Hz from assigned carrier frequency. (N+1) SFN type network

HARMONIC MEASUREMENTS-POST FILTER--EXCITER A

The capacitive samples were connected to the spectrum analyzer through a notch filter or high pass filter tuned to reduce the carrier, to prevent overloading.

The characteristics of the cable used is accounted for at each required frequency. The characteristics of the high pass filter(s), or notch filter(s), used are accounted for at each required frequency.

Copper Mountain: S5048 Network Analyzer, SN: 18097093

Spectrum analyzer model: Rohde & Schwarz ETL, SN: 100682

Cable type: Mini Circuits Armored Cable Length: 15 ft. Filter used: (2) NHP-1000+ High Pass filters

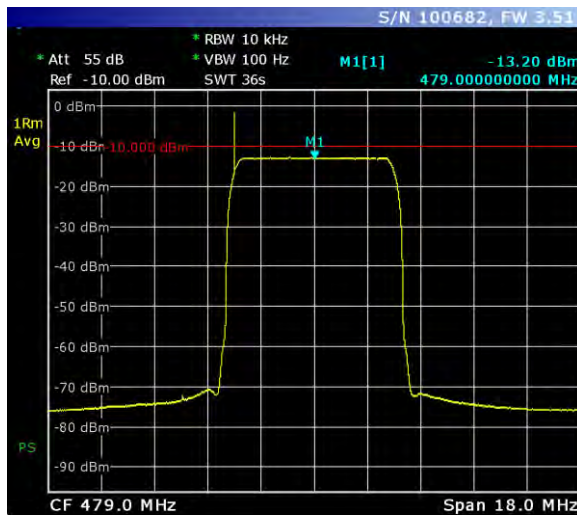
*****NOTE; review document "Harmonic Measurement Instructions-ATSC-Rev B" prior to measure"***
Measurements to be taken with Spectrum Analyzer set for 10 kHz resolution bandwidth, and 10 kHz or less video bandwidth. *** Set span to 20- 30 MHz***

****NOTE, only required to measure to the 3rd harmonic due to moding****

****GatesAir, Inc. Moding document attached at the end of this report.***

WRAZ ULXTED Harmonic Measurements Exciter A												
Frequency	Measured Level	Losses (dB)				Loss Correction	Measurement RBW (kHz)	RBW Correction	TPO Reference Measurement After Corrections	dBc	FCC Limit	FCC Margin
		Coupler	Cable	Signal Pad	Inline Filter							
479.00MHz	-13.200dBm	-59.940dB	-1.105dB	0.000dB		61.045dB	10kHz	27.782dB	75.626dBm	0.0dBc	0.000dBc	0.0dB
958.00MHz	-122.630dBm	-54.650dB	-1.618dB	0.000dB	-1.548dB	57.816dB	10kHz	16.990dB	-47.825dBm	-123.5dBc	-110.000dBc	13.5dB
1437.00MHz	-119.700dBm	-48.660dB	-2.037dB	0.000dB	-0.862dB	51.559dB	10kHz	16.990dB	-51.151dBm	-126.8dBc	-110.000dBc	16.8dB

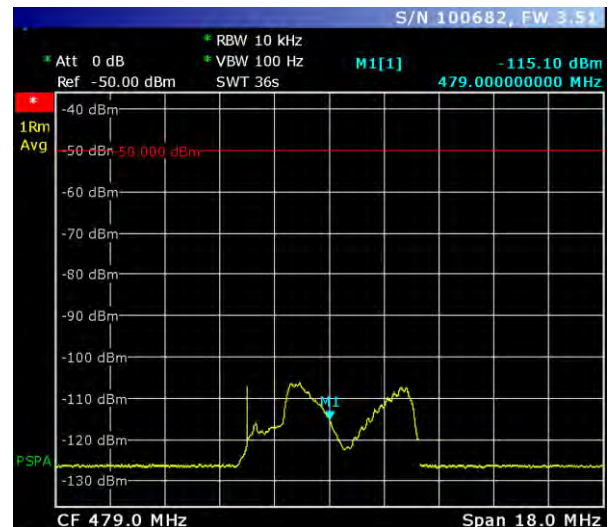
Exciter A:



Date: 14.SEP.2020 16:48:42

Exciter A:

Input level verified below 30dBm using external power meter, internal attenuation set at 50dB

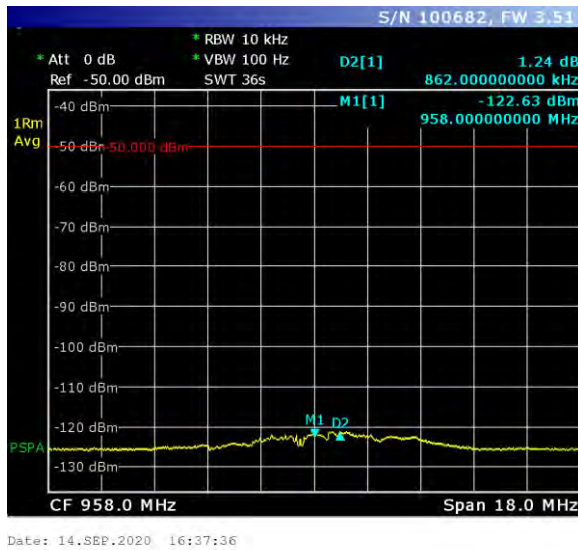


Date: 14.SEP.2020 16:39:00

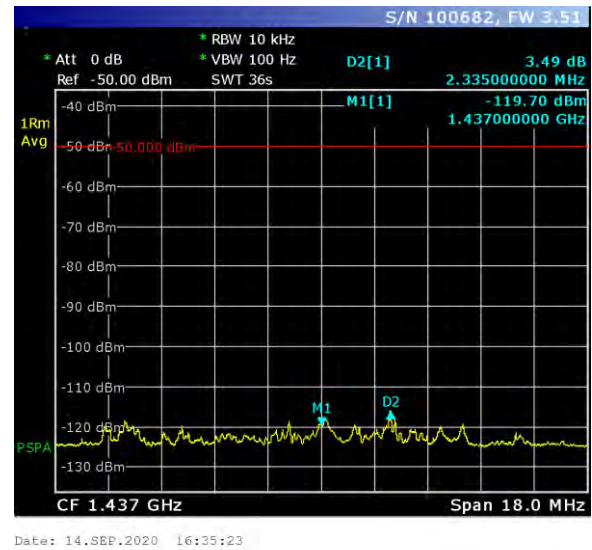
Exciter A:

2 High Pass filters added to system, internal attenuation set at 0dB, pre-amp turned on.

HARMONIC MEASUREMENTS-POST FILTER--EXCITER A



Exciter A:
2nd harmonic with 2 HP filters in series



Exciter A:
3rd harmonic with 2 HP filters in series

Notes:

HARMONIC MEASUREMENTS-POST FILTER--EXCITER B

The capacitive samples were connected to the spectrum analyzer through a notch filter or high pass filter tuned to reduce the carrier, to prevent overloading.

The characteristics of the cable used is accounted for at each required frequency. The characteristics of the high pass filter(s), or notch filter(s), used are accounted for at each required frequency.

Copper Mountain: S5048 Network Analyzer, SN: 18097093

Spectrum analyzer model: Rohde & Schwarz ETL, SN: 100682

Cable type: Mini Circuits Armored Cable Length: 15 ft. Filter used: (2) NHP-1000+ High Pass filters

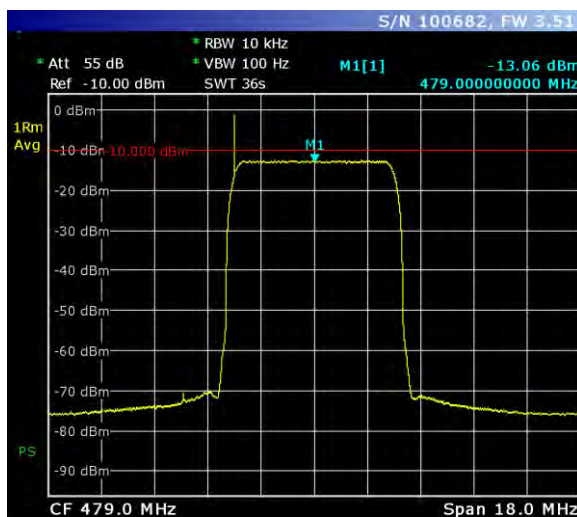
*****NOTE; review document "Harmonic Measurement Instructions-ATSC-Rev B" prior to measure"***
Measurements to be taken with Spectrum Analyzer set for 10 kHz resolution bandwidth, and 10 kHz or less video bandwidth. *** Set span to 20-30 MHz***

****NOTE, only required to measure to the 3rd harmonic due to moding****

****GatesAir, Inc. Moding document attached at the end of this report.***

WRAZ ULXTED Harmonic Measurements Exciter B												
Frequency	Measured Level	Losses (dB)				Loss Correction	Measurement RBW (kHz)	RBW Correction	Measurement After Corrections	dBc	FCC Limit	FCC Margin
		Coupler	Cable	Signal Pad	Inline Filter							
479.00MHz	-13.060dBm	-59.940dB	-1.105dB	0.000dB		61.045dB	10kHz	27.782dB	75.766dBm	0.0dBc	0.000dBc	0.0dB
958.00MHz	-122.890dBm	-54.650dB	-1.618dB	0.000dB	-1.548dB	57.816dB	10kHz	16.990dB	-48.084dBm	-123.9dBc	-110.000dBc	13.9dB
1437.00MHz	-117.180dBm	-48.660dB	-2.037dB	0.000dB	-0.862dB	51.559dB	10kHz	16.990dB	-48.631dBm	-124.4dBc	-110.000dBc	14.4dB

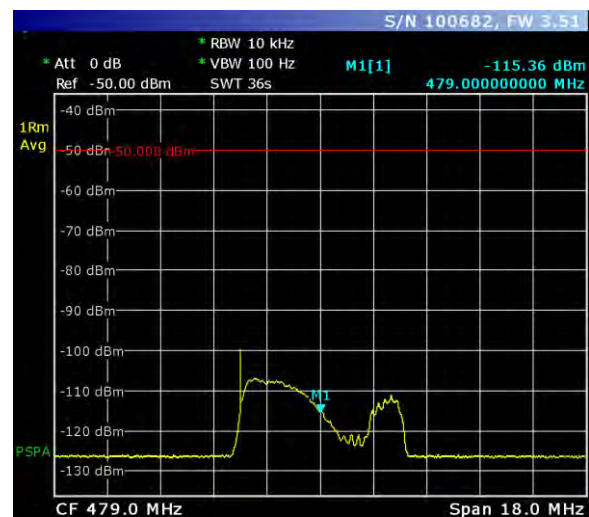
Exciter B:



Date: 15.SEP.2020 10:23:49

Exciter B:

Input level verified below 30dBm using external power meter, internal attenuation set at 55dB

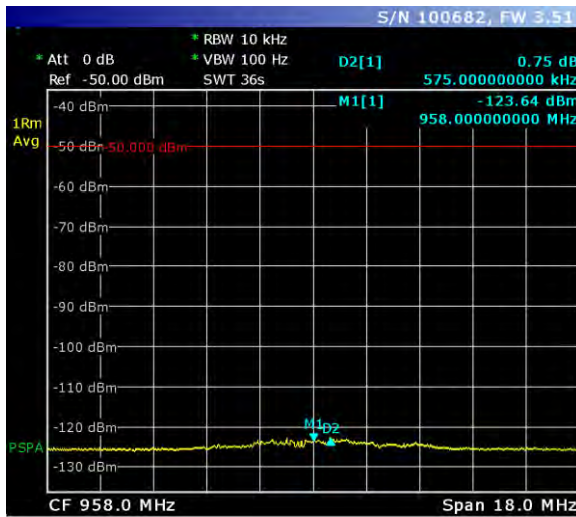


Date: 15.SEP.2020 10:26:48

Exciter B:

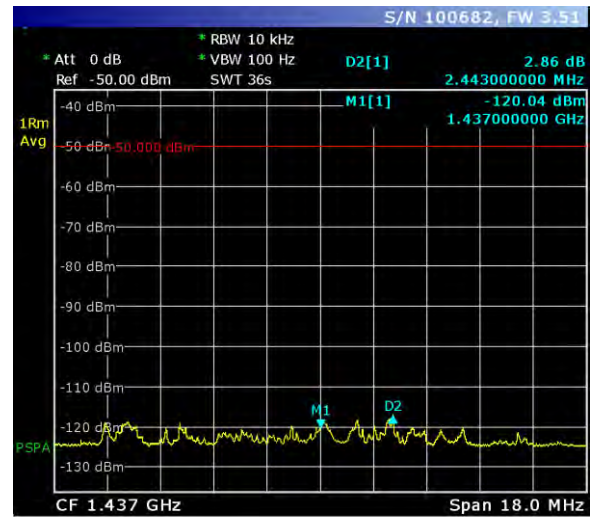
2 High Pass filters added to system, internal attenuation set at 0dB, pre-amp turned on.

HARMONIC MEASUREMENTS-POST FILTER--EXCITER B



Date: 15.SEP.2020 10:33:44

Exciter B:
2nd harmonic with 2 HP filters in series



Date: 15.SEP.2020 10:31:24

Exciter B:
3rd harmonic with 2 HP filters in series

Notes:

RESPONSE AND GROUP DELAY-POST FILTER-EXCITER A & B

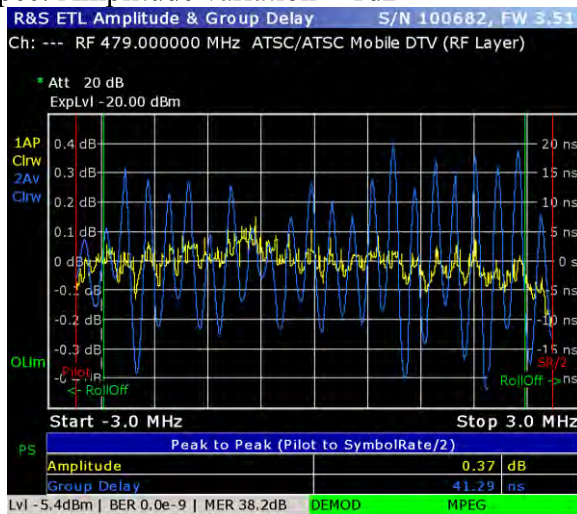
The Response and Group Delay was measured using the “Rhode and Swartz ETL Television Analyzer”. *Channel Analysis for ETL*

*Note if Amplitude is skewed, often can be adjusted via the exciter (typically not required).
RTAC>Calibration>Down Converter Tilt Compensation Enabled “yes”>

- Tilt factor .5 dB Steps (+/- 3 dB adjustment range) if more is required contact service.
- NOTE from this same screen PROFLE allows access for critical filter profile (i.e. Ch-14)

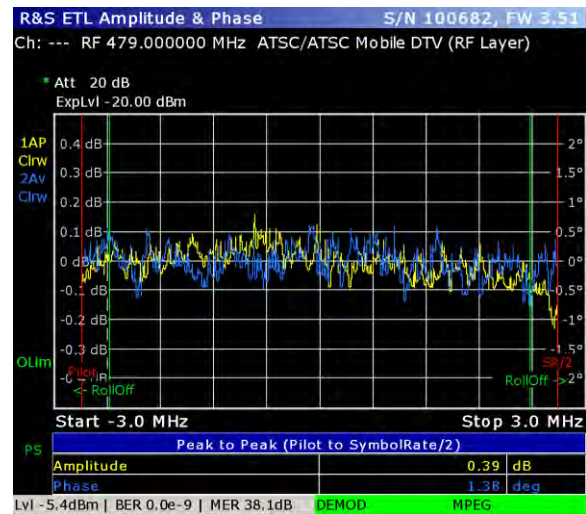
Rohde & Schwarz ETL, SN: 100682

*Spec: Amplitude variation < 1dB



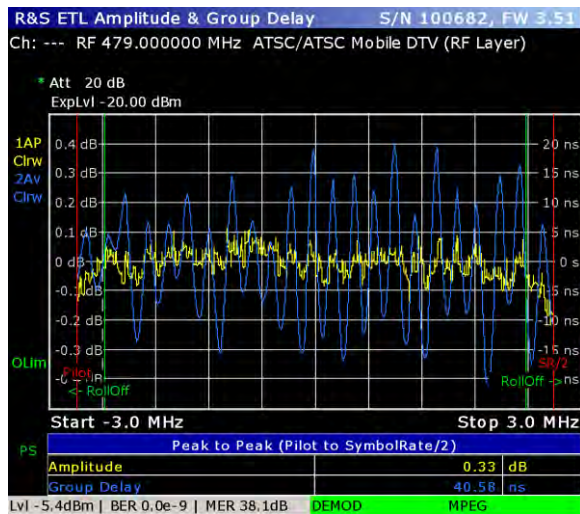
Date: 15.SEP.2020 11:53:34

Exciter A – Amplitude & Group Delay



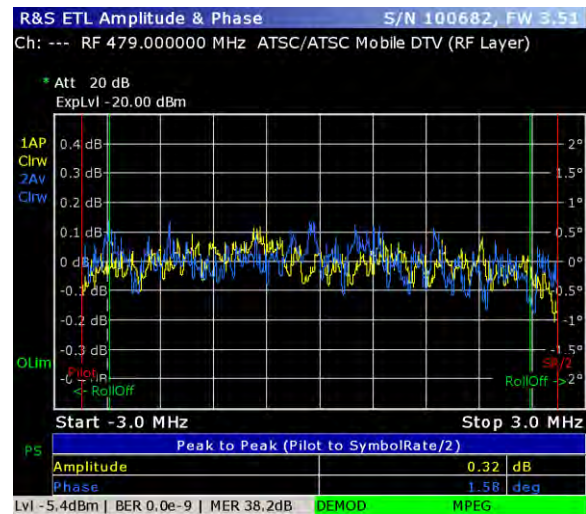
Date: 15.SEP.2020 11:52:53

Exciter A – Amplitude & Phase



Date: 15.SEP.2020 11:48:23

Exciter B – Amplitude & Group Delay



Date: 15.SEP.2020 11:49:14

Exciter B – Amplitude & Phase

ERROR VECTOR MAGNITUDE-POST FILTER-EXCITER A

The Error Vector Magnitude was measured using the Rhode and Swartz ETL Television analyzer

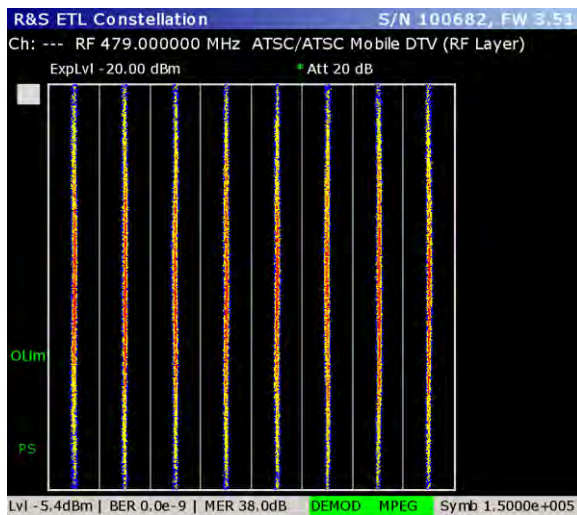
menu-digital TV for ETL* *Zoom-select EVM for overview screen

Rohde & Schwarz ETL, SN: 100682

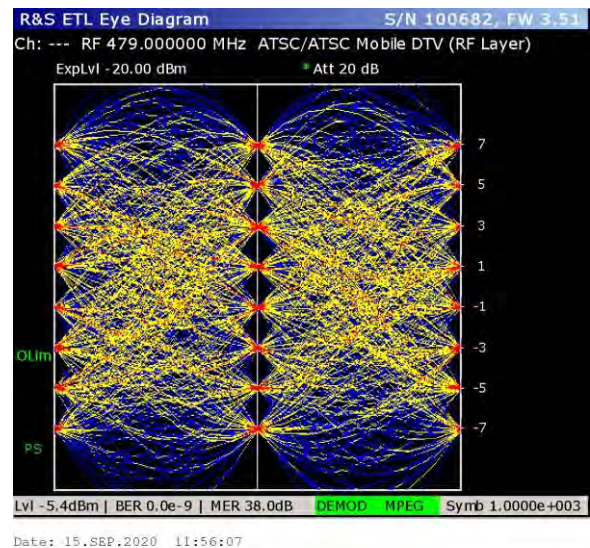


Date: 15.SEP.2020 11:55:17

Overview *EVM Spec <4%*



Exciter A: Constellation



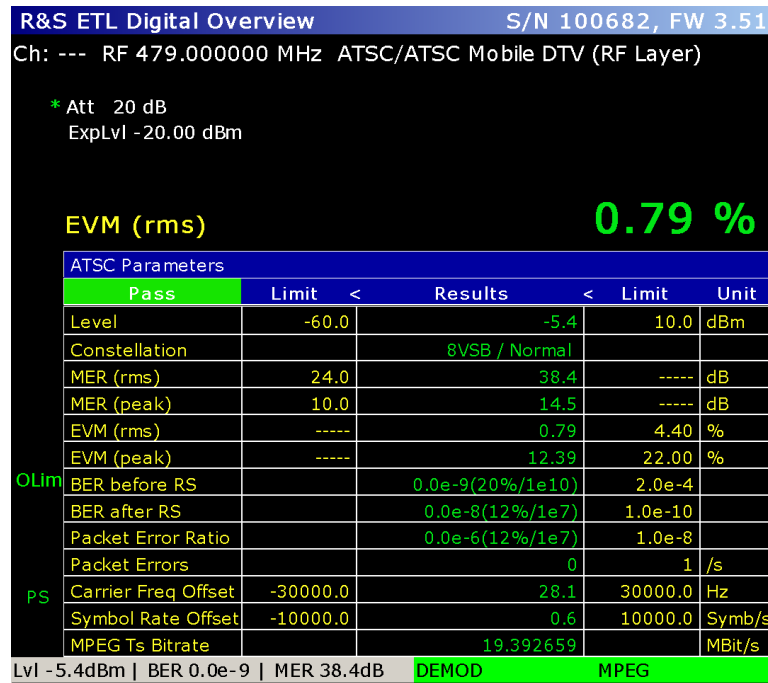
Exciter A: Eye Pattern

ERROR VECTOR MAGNITUDE-POST FILTER-EXCITER B

The Error Vector Magnitude was measured using the Rhode and Swartz ETL Television analyzer

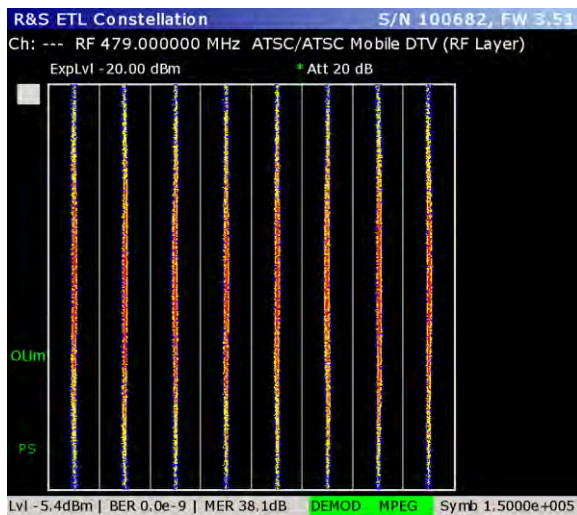
menu-digital TV for ETL* *Zoom-select EVM for overview screen

Rohde & Schwarz ETL, SN: 100682



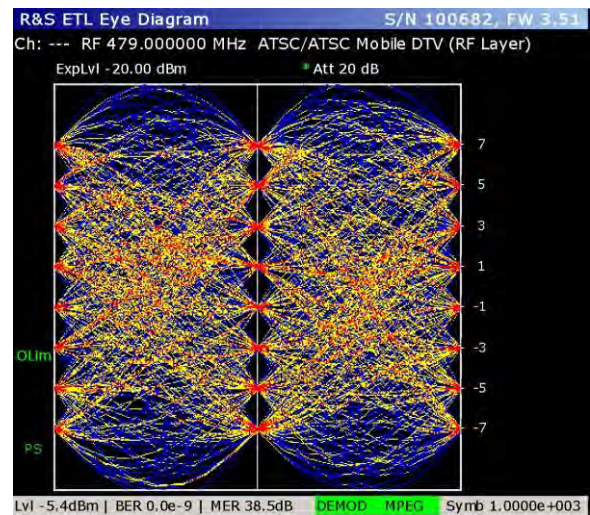
Date: 15.SEP.2020 11:58:02

Overview *EVM Spec <4%*



Date: 15.SEP.2020 11:57:45

Exciter B: Constellation



Date: 15.SEP.2020 11:57:20

Exciter B: Eye Pattern

SYSTEM SIDEBAND ENERGY +/- 3.25 MHz FROM CENTER, POST-FILTER-EXCITER A

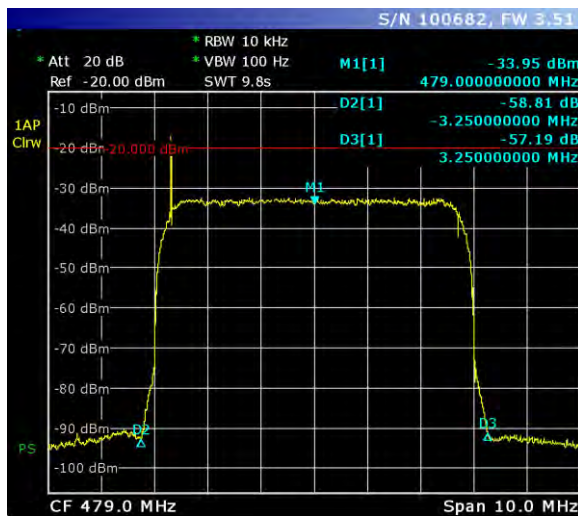
Specification= -37 dB.*

*Note for standard spectrum analyzers, -10.63 dB will need to be added to the spectrum analyzer marker values. Adding -10.63 dB accounts for the {flat portion or “head” of an ideal 8-VSB signal “IEEE P1631”}. The marker delta, plus the “flat portion” -10.63 value, must be less than -47 dB to meet specification. Note screen below to the left.

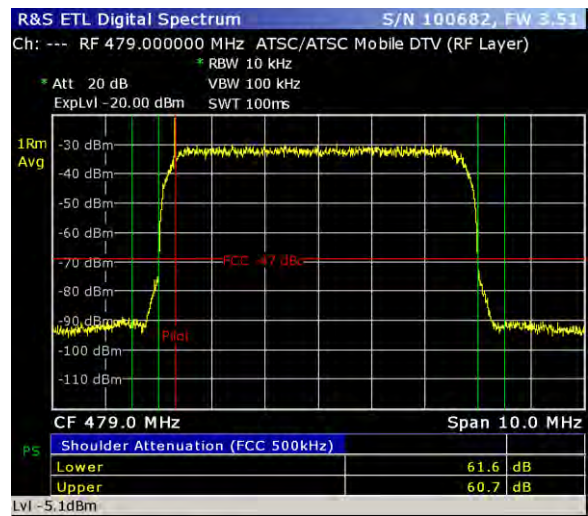
*Some analyzers have built in software that automatically adds the -10.63dB {flat portion or head of an ideal 8-VSB signal} to the overall measurement such as an ETL. Screen below to the right shows a pre-configured screen. (when using pre-configured screens, it is typically not required to add the -10.63 value).

Measurements to be taken with Spectrum Analyzer set for 10 kHz resolution bandwidth, and 10 kHz or less video bandwidth, 10MHz span. Post-Filter. *NOTE, if Spectrum Analyzer does not have the preconfigured set up, those screen shots can be omitted.

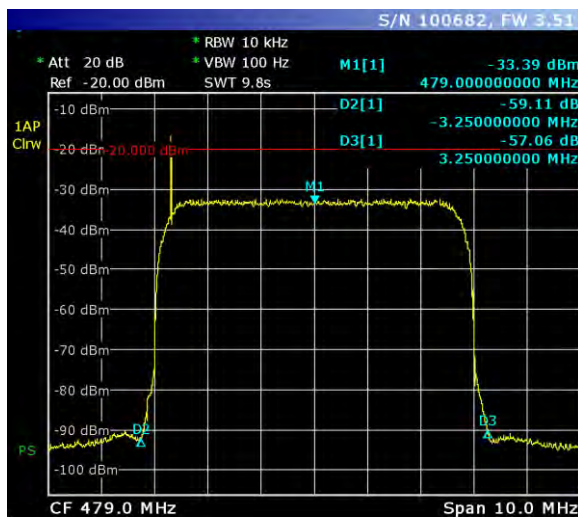
Rohde & Schwarz ETL, SN: 100682



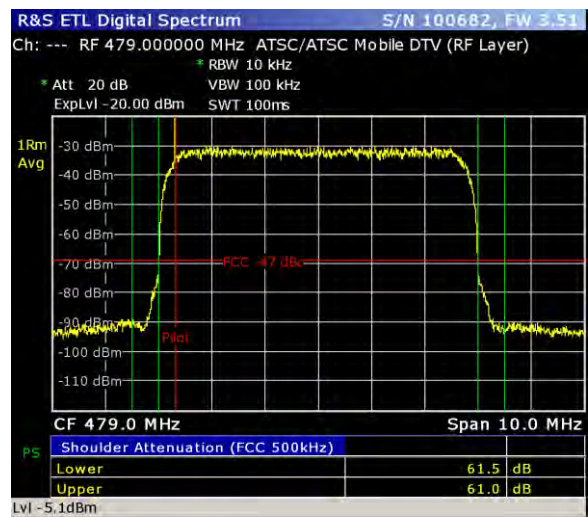
Exciter A: Standard Spectral Screen



Exciter A: ETL Pre-Configured Screen



Exciter B: Standard Spectral Screen



Exciter B: ETL Pre-Configured Screen

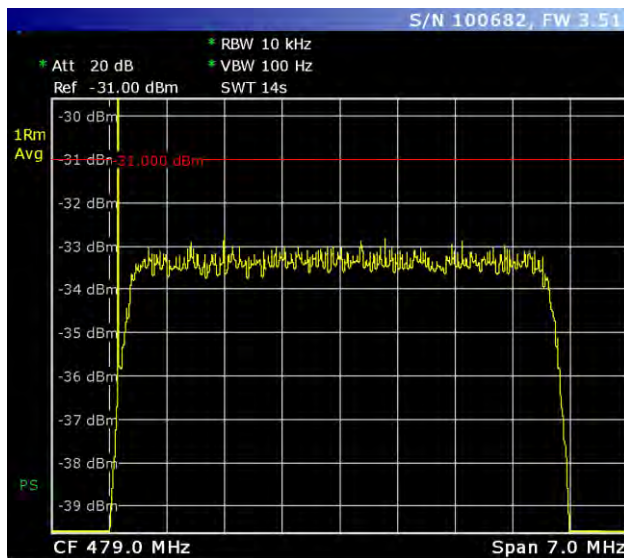
DIGITAL TRANSMITTER AMPLITUDE RESPONSE: IN-BAND, 7 MHZ-EXCITER A & B

The test equipment was connected as shown in the Block Diagram. The response was measured Post Filter, after the band pass filter on the transmitter output. The results are recorded below.

Measurements to be taken with Spectrum Analyzer set for 10 kHz resolution bandwidth, and 10 kHz or less video bandwidth. Picture to be 7 MHz and 1 dB per division.

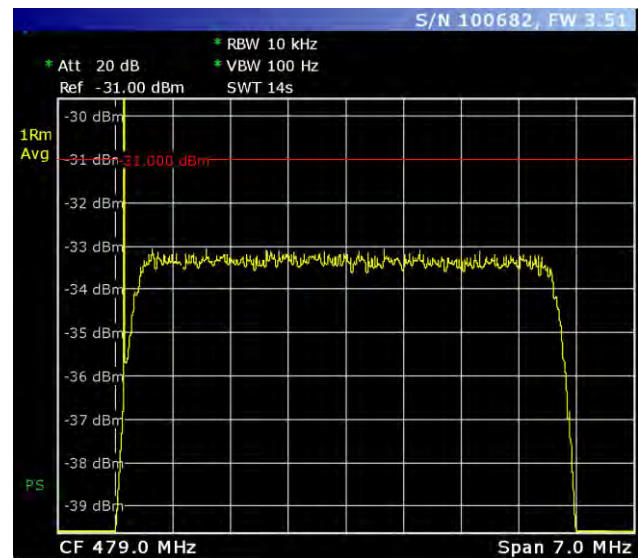
Rohde & Schwarz ETL, SN: 100682

*Spec is 1dB variation. Plot must have enough resolution to demonstrate.



Date: 15.SEP.2020 15:41:42

Exciter A:



Date: 15.SEP.2020 15:39:46

Exciter B

DIGITAL TRANSMITTER AMPLITUDE RESPONSE --EXCITER A

The following chart shows the addition of the Band Pass Filter and the Transmitter response, (Net Response). The Net Response is then compared to the FCC Mask. A negative number in the last column indicates exceeding the FCC specifications. References for these measurements are from the ATSC Standard Document A64.

*Screen capture below is a summary sheet (Net Response). Proof folder must include excel work sheet with all values for each filter sweep and pre-filter coupler measurements to validate compliance.

****NOTE, The Filter response is measured passively with a network analyzer. The transmitter response is measured PRE-FILTER at full TPO.**

Summary Bandpass Data Calculated (WRAZ Exciter A)									
Summary Filter Response			Transmitter Response before filter				Net Response	FCC Mask Response	Negative # Is out of FCC Specifications
Frequency	Analyzer Reading	Center Freq. Reference	Filter Response	Analyzer Reading	Center Freq. Reference	Transmitter Response			
470.00	-84.361	-0.185	-84.18	-45.035	0.000	-45.04	-129.21	-99.40	29.81
471.00	-71.250	-0.185	-71.06	-44.300	0.000	-44.30	-115.36	-88.60	26.76
472.00	-61.118	-0.185	-60.93	-42.755	0.000	-42.76	-103.69	-77.10	26.59
473.00	-50.013	-0.185	-49.83	-43.345	0.000	-43.35	-93.17	-65.60	27.57
474.00	-38.226	-0.185	-38.04	-43.095	0.000	-43.10	-81.14	-54.10	27.04
474.50	-31.926	-0.185	-31.74	-42.950	0.000	-42.95	-74.69	-48.40	26.29
475.00	-25.479	-0.185	-25.29	-42.235	0.000	-42.24	-67.53	-42.60	24.93
475.50	-21.450	-0.185	-21.26	-42.090	0.000	-42.09	-63.35	-36.40	26.95
475.75	-35.759	-0.185	-35.57	-42.135	0.000	-42.14	-77.71	-36.40	41.31
482.25	-18.230	-0.185	-18.04	-41.185	0.000	-41.19	-59.23	-36.40	22.83
482.50	-26.972	-0.185	-26.79	-41.265	0.000	-41.27	-68.05	-36.40	31.65
483.00	-27.157	-0.185	-26.97	-41.265	0.000	-41.27	-68.24	-42.60	25.64
483.50	-33.093	-0.185	-32.91	-42.695	0.000	-42.70	-75.60	-48.40	27.20
484.00	-39.274	-0.185	-39.09	-42.465	0.000	-42.47	-81.55	-54.10	27.45
485.00	-51.233	-0.185	-51.05	-43.150	0.000	-43.15	-94.20	-65.60	28.60
486.00	-62.738	-0.185	-62.55	-43.165	0.000	-43.17	-105.72	-77.10	28.62
487.00	-75.175	-0.185	-74.99	-44.845	0.000	-44.85	-119.83	-88.60	31.23
488.00	-85.708	-0.185	-85.52	-45.085	0.000	-45.09	-130.61	-99.40	31.21

ETL or Spectrum Mask Markers

Center Frequency =		479.00	MHz				
<u>Markers</u>				<u>Lower</u>		<u>Upper</u>	
Adj	= ±	3.25	MHz	475.75	MHz	482.25	MHz
Alt01	= ±	3.50	MHz	475.50	MHz	482.50	MHz
Alt02	= ±	4.00	MHz	475.00	MHz	483.00	MHz
Alt03	= ±	4.50	MHz	474.50	MHz	483.50	MHz
Alt04	= ±	5.00	MHz	474.00	MHz	484.00	MHz
Alt05	= ±	6.00	MHz	473.00	MHz	485.00	MHz
Alt06	= ±	7.00	MHz	472.00	MHz	486.00	MHz
Alt07	= ±	8.00	MHz	471.00	MHz	487.00	MHz
Alt08	= ±	9.00	MHz	470.00	MHz	488.00	MHz

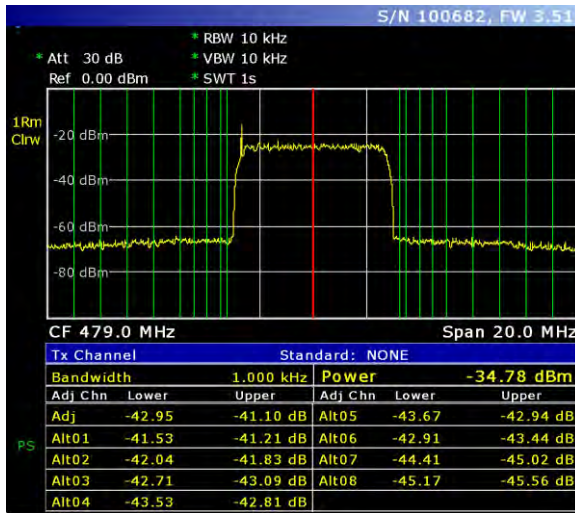
DIGITAL TRANSMITTER AMPLITUDE RESPONSE--EXCITER A

The test equipment was connected as shown in the Block Diagram. The response was measured **at the pre-filter coupler** on the transmitter output. The results are recorded below.

*Example below is multi/chart-screen, other screens or chart type data is acceptable as well.

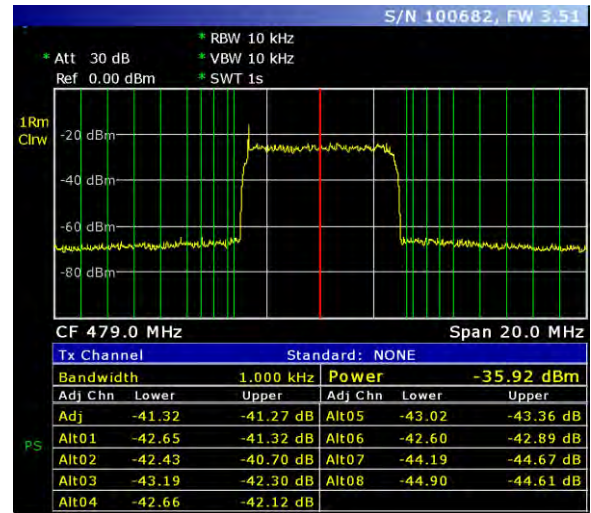
*Measurements to be taken with Spectrum Analyzer set for **10 kHz resolution bandwidth, and 10 kHz or less video bandwidth. Span to be set to 20 MHz***

Rohde & Schwarz ETL, SN: 100682



Date: 15.SEP.2020 15:50:26

TX 1 Pre Filter



Date: 15.SEP.2020 15:51:46

TX 2 Pre Filter

DIGITAL TRANSMITTER AMPLITUDE RESPONSE --EXCITER B

The following chart shows the addition of the Band Pass Filter and the Transmitter response, (Net Response). The Net Response is then compared to the FCC Mask. A negative number in the last column indicates exceeding the FCC specifications. References for these measurements are from the ATSC Standard Document A64.

*Screen capture below is a summary sheet (Net Response). Proof folder must include excel work sheet with all values for each filter sweep and pre-filter coupler measurements to validate compliance.

****NOTE, The Filter response is measured passively with a network analyzer. The transmitter response is measured *PRE-FILTER* at full TPO.**

Summary Bandpass Data Calculated (WRAZ Exciter B)									
Summary Filter Response			Transmitter Response before filter				Net Response	FCC Mask Response	Negative # Is out of FCC Specifications
Frequency	Analyzer Reading	Center Freq. Reference	Filter Response	Analyzer Reading	Center Freq. Reference	Transmitter Response			
470.00	-84.361	-0.185	-84.18	-44.280	0.000	-44.28	-128.46	-99.40	29.06
471.00	-71.250	-0.185	-71.06	-43.200	0.000	-43.20	-114.26	-88.60	25.66
472.00	-61.118	-0.185	-60.93	-43.060	0.000	-43.06	-103.99	-77.10	26.89
473.00	-50.013	-0.185	-49.83	-42.515	0.000	-42.52	-92.34	-65.60	26.74
474.00	-38.226	-0.185	-38.04	-41.630	0.000	-41.63	-79.67	-54.10	25.57
474.50	-31.926	-0.185	-31.74	-42.375	0.000	-42.38	-74.12	-48.40	25.72
475.00	-25.479	-0.185	-25.29	-42.645	0.000	-42.65	-67.94	-42.60	25.34
475.50	-21.450	-0.185	-21.26	-41.610	0.000	-41.61	-62.87	-36.40	26.47
475.75	-35.759	-0.185	-35.57	-41.655	0.000	-41.66	-77.23	-36.40	40.83
482.25	-18.230	-0.185	-18.04	-41.430	0.000	-41.43	-59.47	-36.40	23.07
482.50	-26.972	-0.185	-26.79	-42.210	0.000	-42.21	-69.00	-36.40	32.60
483.00	-27.157	-0.185	-26.97	-41.970	0.000	-41.97	-68.94	-42.60	26.34
483.50	-33.093	-0.185	-32.91	-42.055	0.000	-42.06	-74.96	-48.40	26.56
484.00	-39.274	-0.185	-39.09	-42.345	0.000	-42.35	-81.43	-54.10	27.33
485.00	-51.233	-0.185	-51.05	-42.270	0.000	-42.27	-93.32	-65.60	27.72
486.00	-62.738	-0.185	-62.55	-42.855	0.000	-42.86	-105.41	-77.10	28.31
487.00	-75.175	-0.185	-74.99	-43.235	0.000	-43.24	-118.22	-88.60	29.62
488.00	-85.708	-0.185	-85.52	-44.905	0.000	-44.91	-130.43	-99.40	31.03

ETL or Spectrum Mask Markers

Center Frequency =		479.00	MHz				
Markers				Lower		Upper	
Adj	= ±	3.25	MHz	475.75	MHz	482.25	MHz
Alt01	= ±	3.50	MHz	475.50	MHz	482.50	MHz
Alt02	= ±	4.00	MHz	475.00	MHz	483.00	MHz
Alt03	= ±	4.50	MHz	474.50	MHz	483.50	MHz
Alt04	= ±	5.00	MHz	474.00	MHz	484.00	MHz
Alt05	= ±	6.00	MHz	473.00	MHz	485.00	MHz
Alt06	= ±	7.00	MHz	472.00	MHz	486.00	MHz
Alt07	= ±	8.00	MHz	471.00	MHz	487.00	MHz
Alt08	= ±	9.00	MHz	470.00	MHz	488.00	MHz

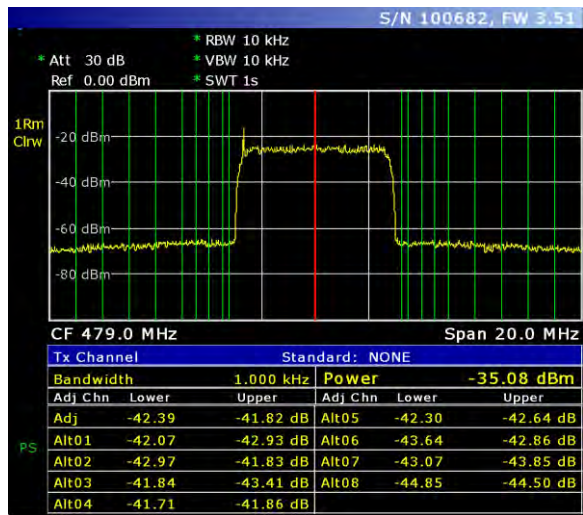
DIGITAL TRANSMITTER AMPLITUDE RESPONSE--EXCITER B

The test equipment was connected as shown in the Block Diagram. The response was measured at the pre-filter coupler on the transmitter output. The results are recorded below.

*Example below is multi/chart-screen, other screens or chart type data is acceptable as well.

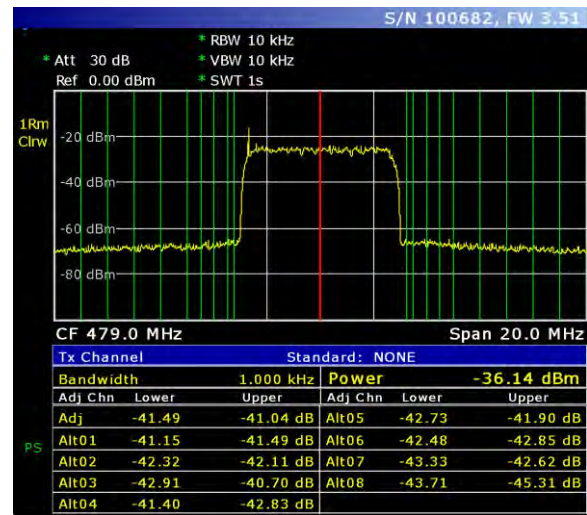
*Measurements to be taken with Spectrum Analyzer set for **10 kHz resolution bandwidth, and 10 kHz or less video bandwidth. Span to be set to 20 MHz***

Rohde & Schwarz ETL, SN: 100682



Date: 15.SEP.2020 15:55:19

TX 1 Pre Filter



Date: 15.SEP.2020 15:53:11

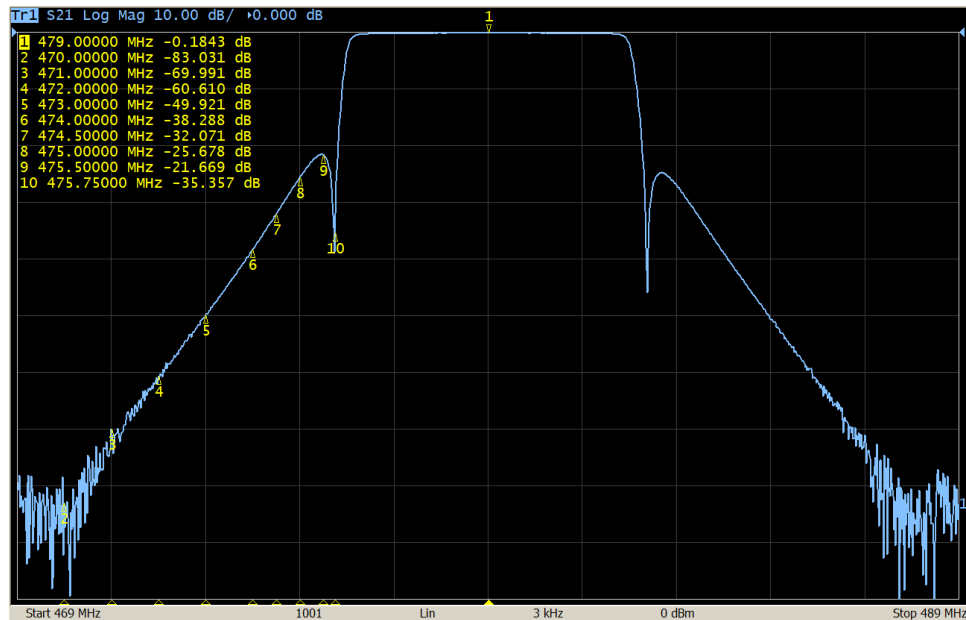
TX 2 Pre Filter

DIGITAL TRANSMITTER AMPLITUDE RESPONSE -BANDPASS FILTER TX 1

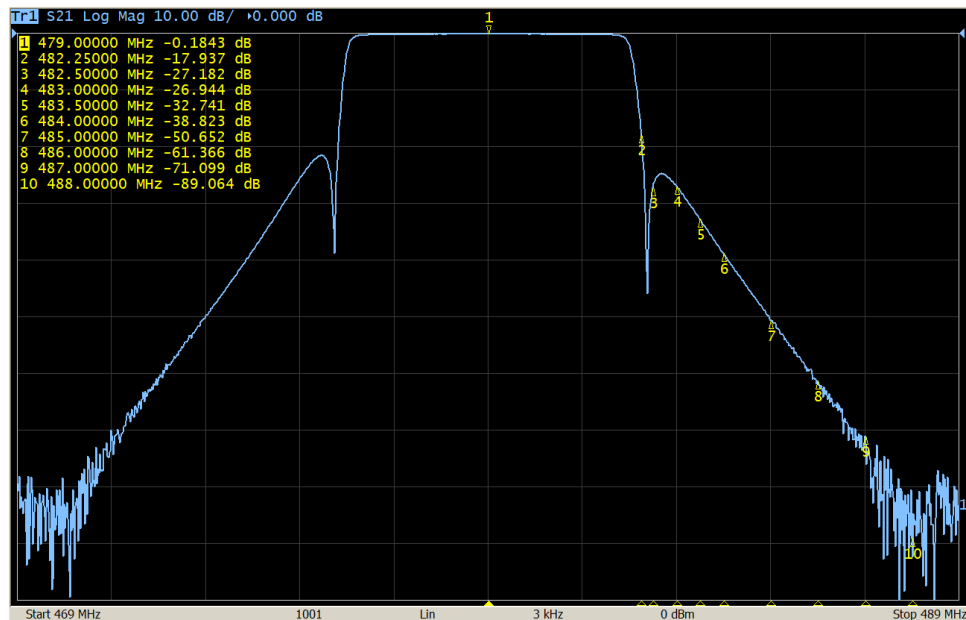
The response of the Band Pass Filter was measured using S21 parameters, the results are recorded below.

*Span to be a minimum of 18 MHz, no more than 30 MHz
Points of measure to align with amplitude response chart.*

Copper Mountain: S5048 Network Analyzer, SN: 18097093



TX 1 Lower



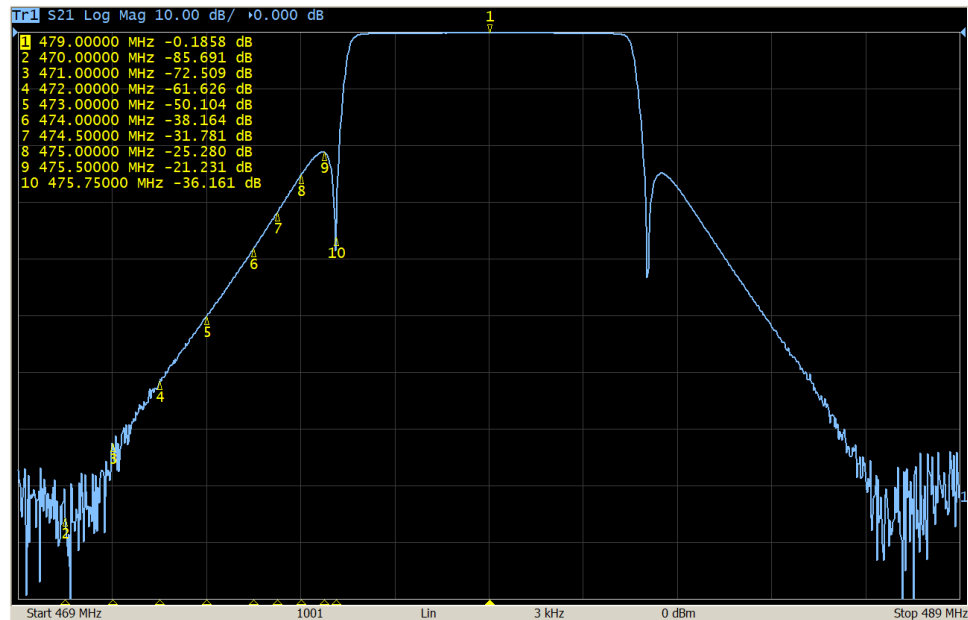
TX 1 Upper

DIGITAL TRANSMITTER AMPLITUDE RESPONSE -BANDPASS FILTER TX 2

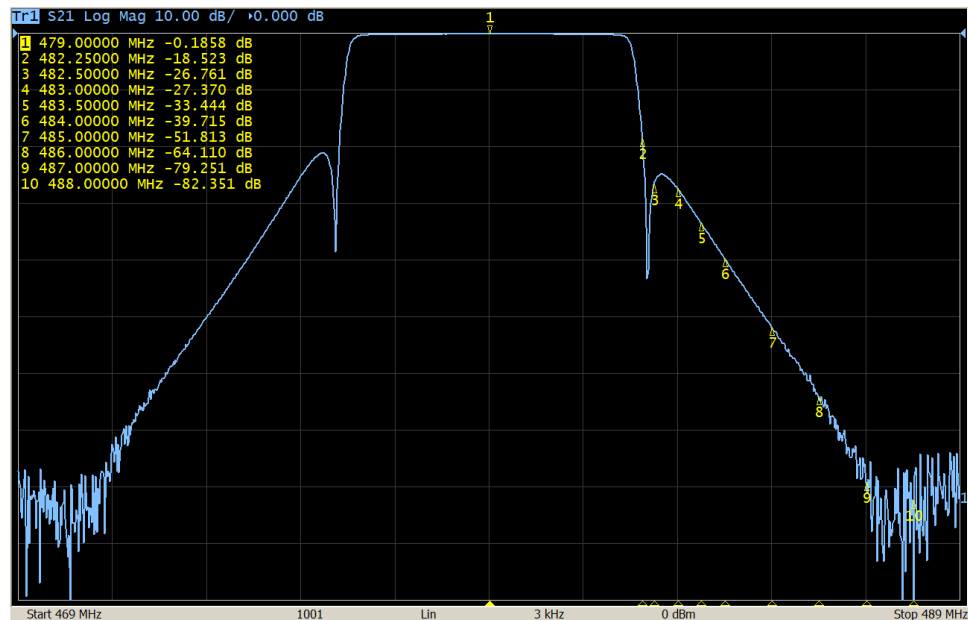
The response of the Band Pass Filter was measured using S21 parameters, the results are recorded below.

*Span to be a minimum of 18 MHz, no more than 30 MHz
Points of measure to align with amplitude response chart.*

Copper Mountain: S5048 Network Analyzer, SN: 18097093



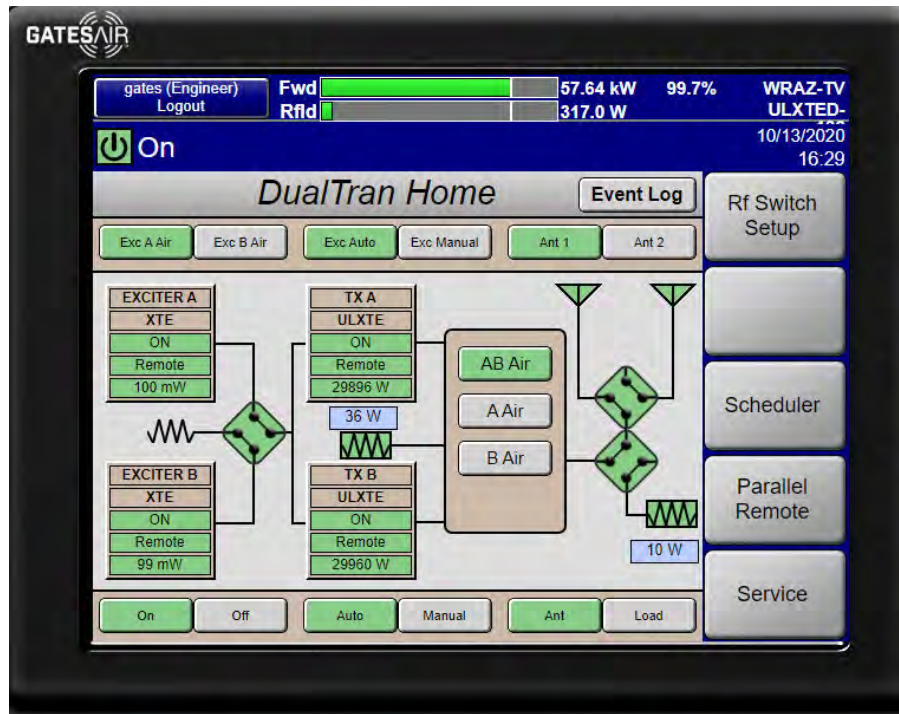
TX 2 Lower



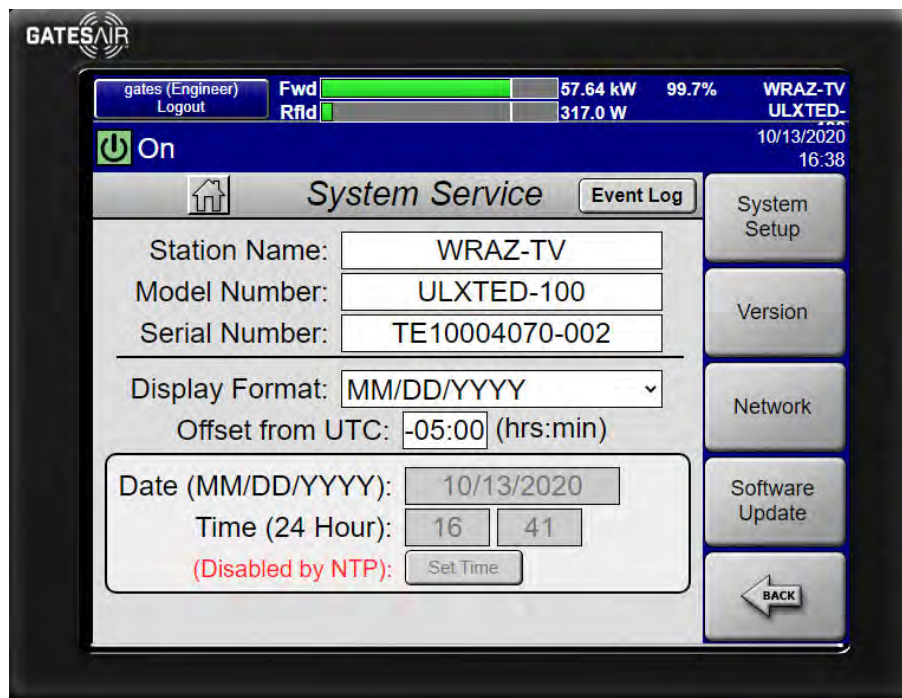
TX 2 Upper

TRANSMITTER MSC SCREENS

System Home Screen




System Service



The System Service screen displays configuration options for the transmitter. At the top, the status bar is identical to the DualTran Home screen. Below the title 'System Service' is an 'Event Log' button and a 'System Setup' button. The main area contains several input fields and buttons: 'Station Name: WRAZ-TV', 'Model Number: ULXTED-100', 'Serial Number: TE10004070-002', 'Display Format: MM/DD/YYYY' (dropdown), 'Offset from UTC: -05:00 (hrs:min)', 'Date (MM/DD/YYYY): 10/13/2020', 'Time (24 Hour): 16 41', and a red text label '(Disabled by NTP):' with a 'Set Time' button. On the right, there are buttons for 'System Setup', 'Version', 'Network', 'Software Update', and a 'BACK' button with a left arrow.

System Version



gates (Engineer) Logout Fwd 57.64 kW 99.7% WRAZ-TV
Rfid 317.0 W ULXTED-
On 10/13/2020 16:43


Software Version Event Log

MSC Part Number:	861-1151-162 AP	TX 1:	01.00.0007
PCM Software Ver:	06.00.0032	TX 2:	01.00.0007
MSC Software Ver:	03.00.0004		
Web App Ver:	01.00.0356		
Dual Controller:	02.00.0002		
LCD:	01.00.0428		
SNMP:	01.00.0686		
DMAP:	01.00.0002		
Harris Protocol:	01.10.0076		
Rf Switch:	02.00.0185		
Par Remote:	01.00.0251		

PCM Patches

BACK

System Network



gates (Engineer) Logout Fwd 57.64 kW 99.7% WRAZ-TV
Rfid 317.0 W ULXTED-
On 10/13/2020 16:45

Network Event Log

Hostname:	WRAZ
MAC:	00:D0:69:4D:9D:F0
DHCP:	Disabled
IP Address:	172.16.58.219
Netmask:	255.255.255.0
Gateway:	172.16.58.1
DNS Source:	Manual
DNS 1:	8.8.8.8
DNS 2:	

Save Cancel

System Setup

System Setup

Device Type: Dual Tran
 Detector Type: Average
 Number of Excs: 2
 Combiner Type: Switchless
 Combiner Num of Sws: 2
 Combiner AB to Load: Disable
 Combiner Sw Travel Time: 20
 Ant/Load: Enable Switch
 Ant1/Ant2: Enable Switch
 Ant Rf Sw Travel Time: 30
 Switch Cmd Delay Time: 2

Combiner Config
 Power Calibration
 Thresholds

BACK

Combiner Config

Combiner Config

Mode	SW1	SW2	SW3	SW4
	PSH1	PSH2		
AB Air	1	1	None	None
A Air	1	2	None	None
B Air	2	1	None	None
AB Test	None	None	None	None
Sw Pos	1	1	0	0

Event Log

BACK

System Thresholds

GATESAIR

gates (Engineer) Logout Fwd 57.64 kW 99.7% WRAZ-TV ULXTED-100
 RfId 317.0 W

On 10/13/2020 16:42

System Thresholds

Event Log

System Nominal Power:	57810	(W)
System High Warning Lvl:	60000	(W)
System Low Warning Lvl:	15000	(W)
Low Pwr Md Low Warning Lvl:	0	(W)
Low Pwr 2 Md Low Warning Lvl:	0	(W)
System Low Trip Lvl:	10000	(W)
Low Pwr Md Low Trip Lvl:	0	(W)
Low Pwr 2 Md Low Trip Lvl:	0	(W)
System Trip Time:	60	(S)
Exciter Low Warning Lvl:	90	(mW)
Exciter Low Trip Lvl:	50	(mW)
Exciter Trip Time:	2	(S)

BACK

Power Calibration Screen

GATESAIR

gates (Engineer) Logout Fwd 57.64 kW 99.7% WRAZ-TV ULXTED-100
 RfId 317.0 W

On 10/13/2020 16:41

Power Calibrate

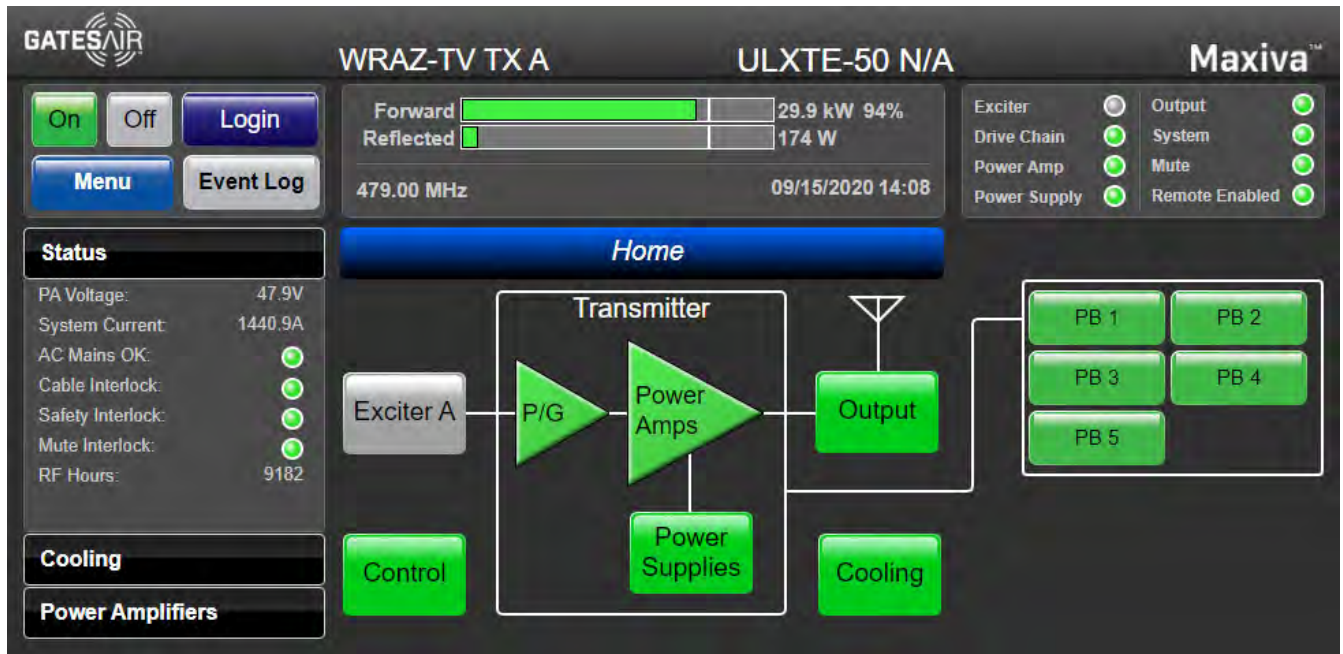
Event Log

	Rf Det Pwr	Cal	Detector 2.5VMax
Sys Fwd:	57639 W	57810	2.003 V
Sys RefId:	317 W	180	1.593 V
Reject Load:	36 W	10000	0.899 V
Test Fwd:	10 W	26000	0.016 V

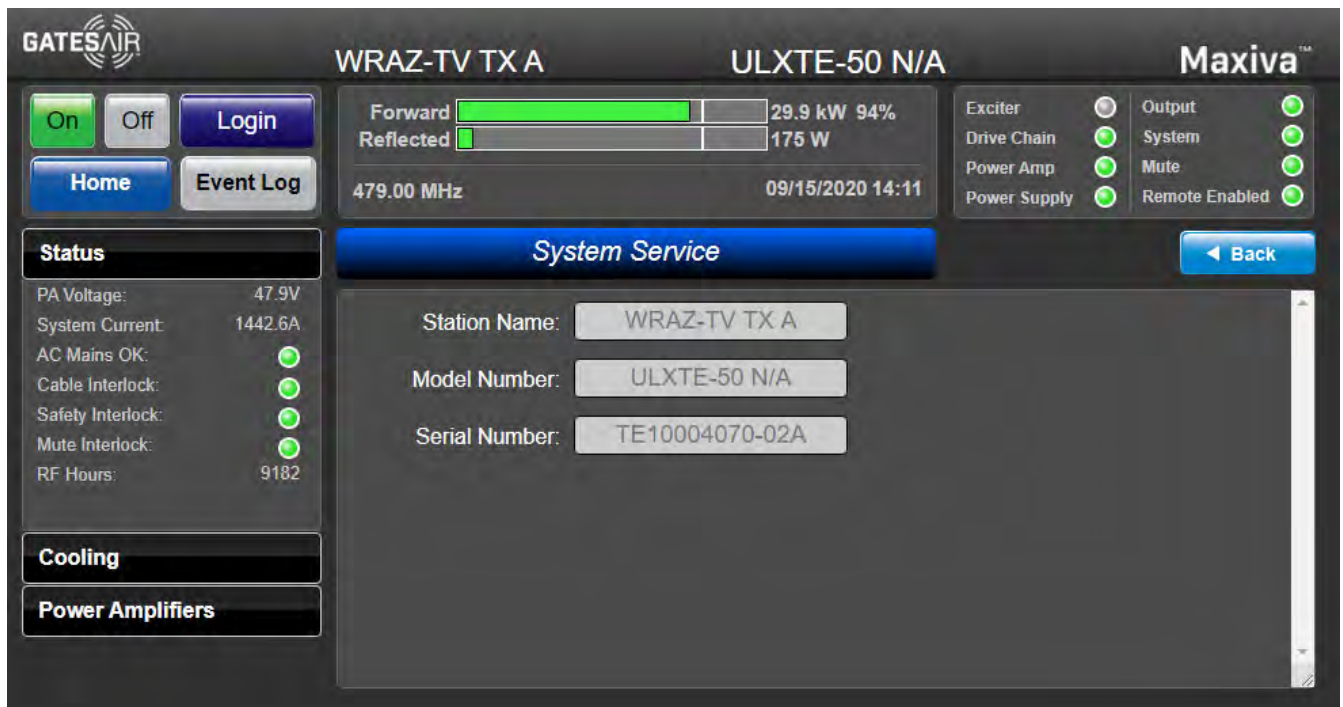
BACK

TRANSMITTER A STM SCREENS

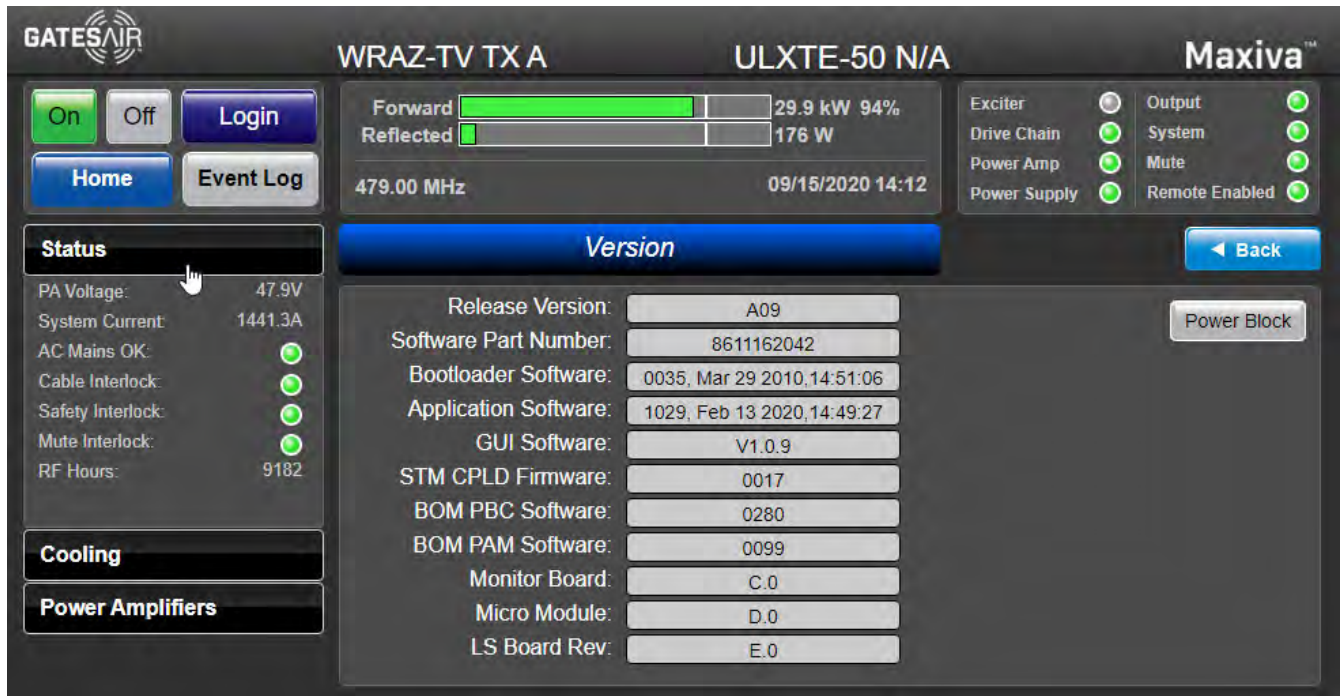
System Home Screen



System Service



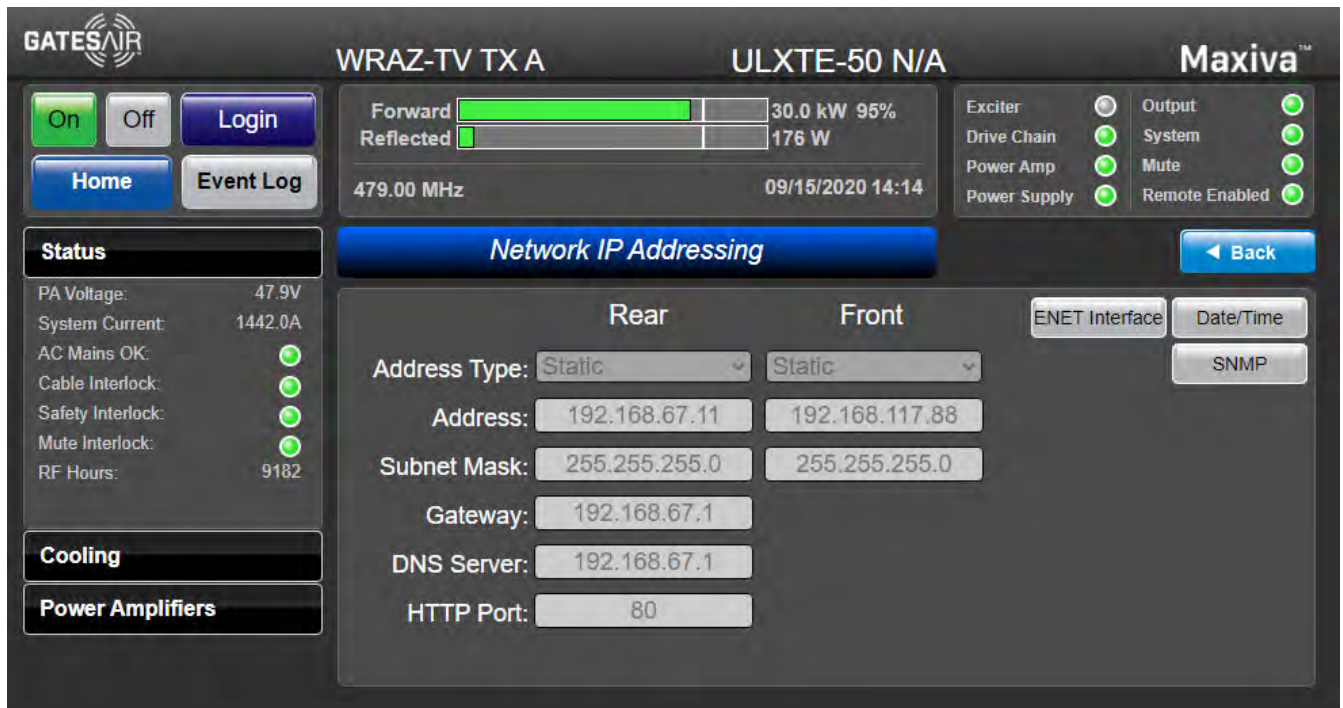
System Version



The screenshot shows the 'System Version' page of the Maxiva™ interface. The top bar includes the GATESAIR logo, station call letters 'WRAZ-TV TX A' and 'ULXTE-50 N/A', and the Maxiva™ logo. On the left, there are buttons for 'On', 'Off', 'Login', 'Home', and 'Event Log'. The 'Status' section on the left lists: PA Voltage: 47.9V, System Current: 1441.3A, AC Mains OK: (green circle), Cable Interlock: (green circle), Safety Interlock: (green circle), Mute Interlock: (green circle), and RF Hours: 9182. Below this are 'Cooling' and 'Power Amplifiers' sections. The main area is titled 'Version' and contains a table of software and hardware versions. A 'Power Block' button is on the right. The bottom right has a 'Back' button.

Release Version:	A09
Software Part Number:	8611162042
Bootloader Software:	0035, Mar 29 2010, 14:51:06
Application Software:	1029, Feb 13 2020, 14:49:27
GUI Software:	V1.0.9
STM CPLD Firmware:	0017
BOM PBC Software:	0280
BOM PAM Software:	0099
Monitor Board:	C.0
Micro Module:	D.0
LS Board Rev:	E.0

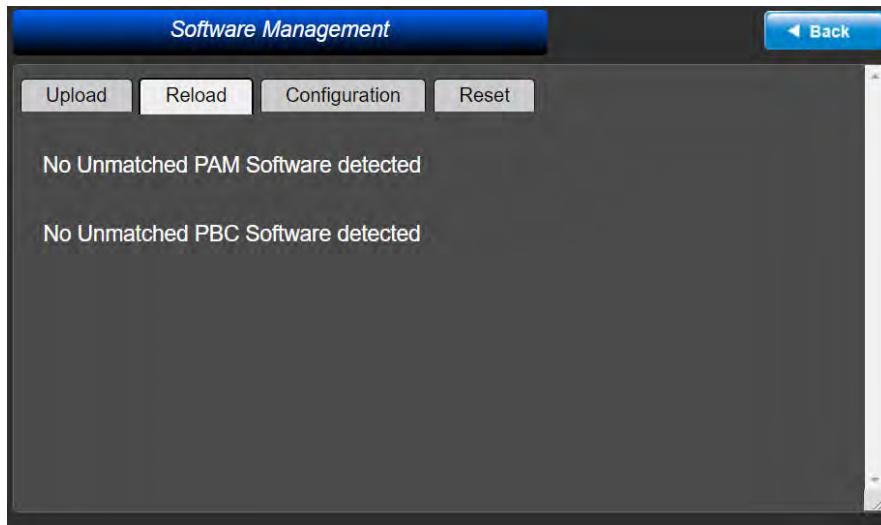
System Network



The screenshot shows the 'System Network' page of the Maxiva™ interface. The top bar is identical to the previous screenshot. The 'Status' section on the left is identical. The main area is titled 'Network IP Addressing' and contains a table for 'Rear' and 'Front' network configurations. A 'Back' button is on the right. The bottom right has buttons for 'ENET Interface', 'Date/Time', and 'SNMP'.

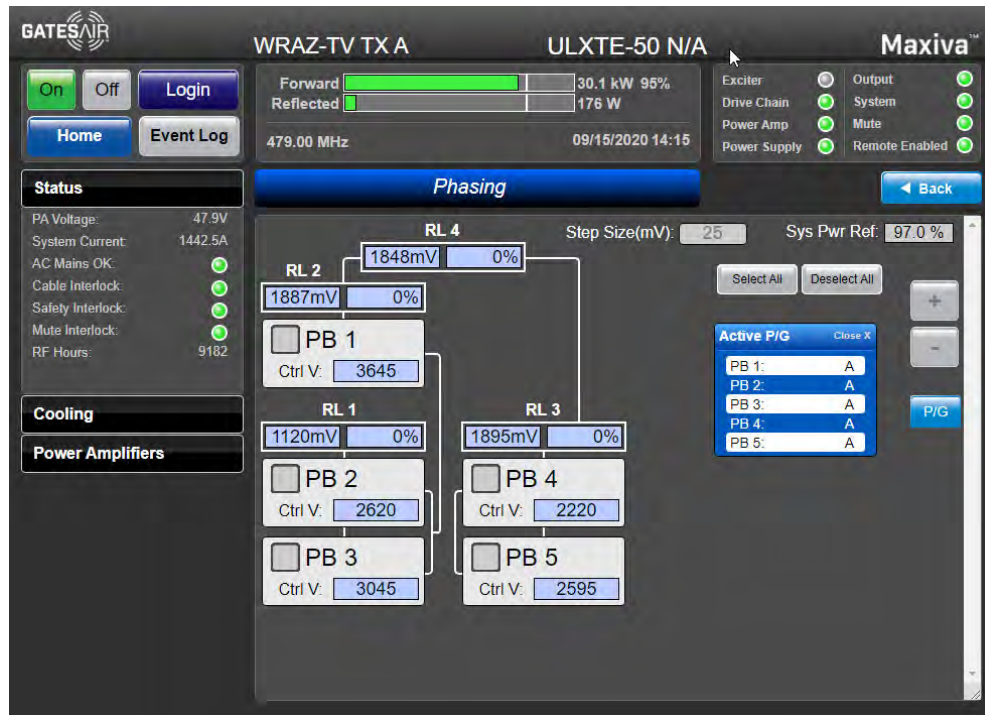
	Rear	Front
Address Type:	Static	Static
Address:	192.168.67.11	192.168.117.88
Subnet Mask:	255.255.255.0	255.255.255.0
Gateway:	192.168.67.1	
DNS Server:	192.168.67.1	
HTTP Port:	80	

Software Management Reload Page

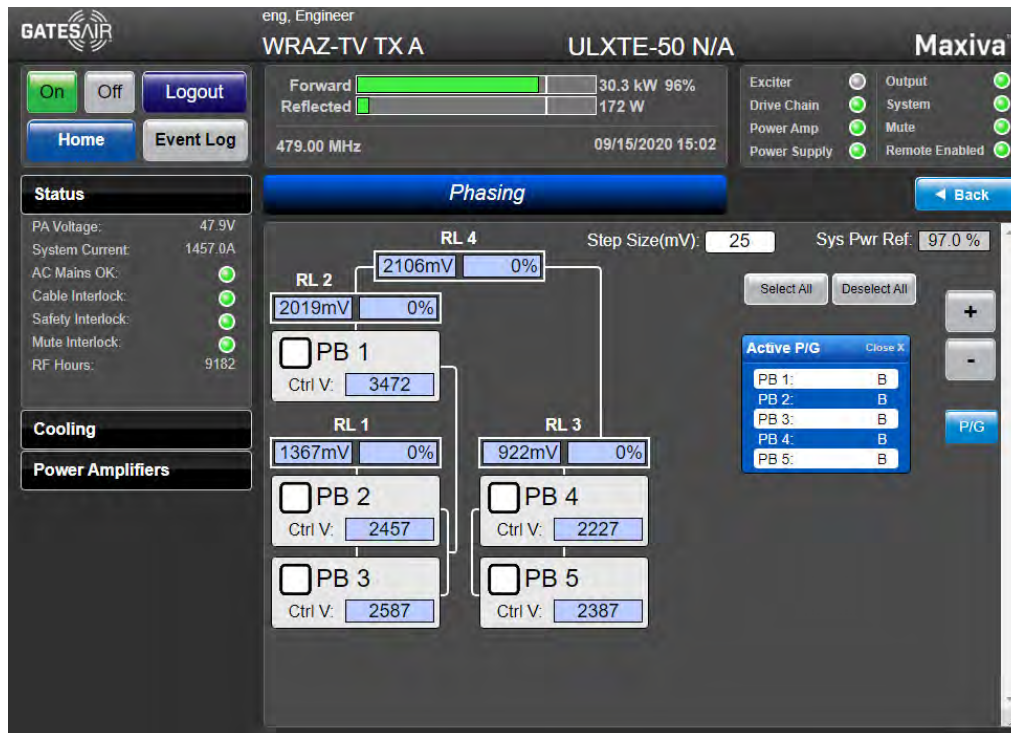


The screenshot shows a web interface for 'Software Management'. At the top, there is a blue header bar with the text 'Software Management' and a 'Back' button. Below the header, there are four buttons: 'Upload', 'Reload', 'Configuration', and 'Reset'. The 'Reload' button is highlighted. The main content area is dark gray and contains two lines of text: 'No Unmatched PAM Software detected' and 'No Unmatched PBC Software detected'.

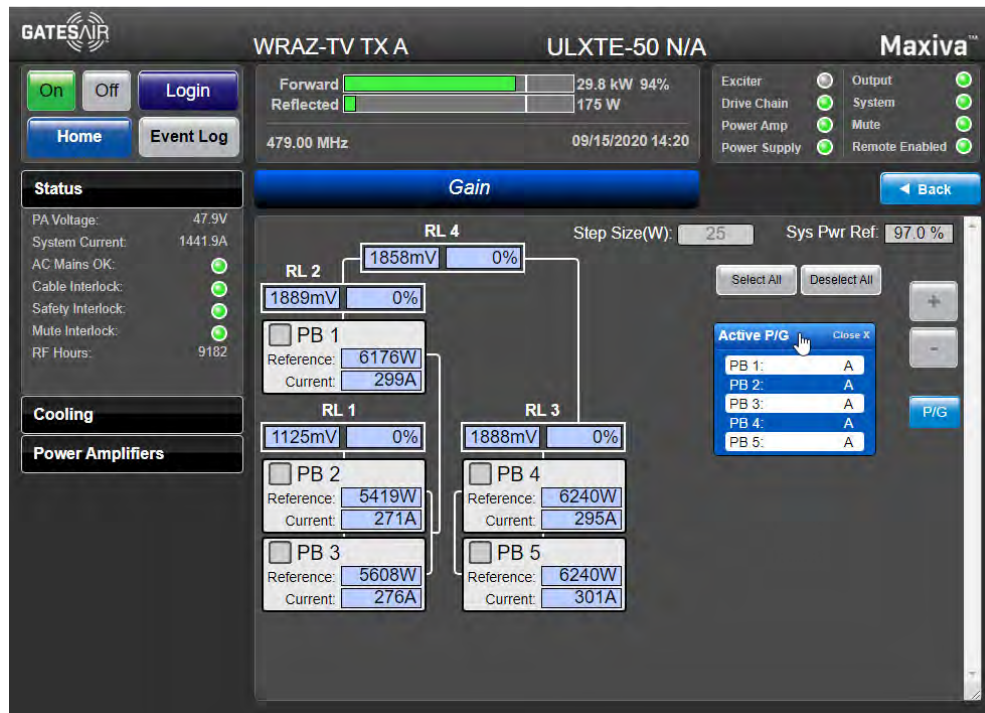
Tx A System Phase A



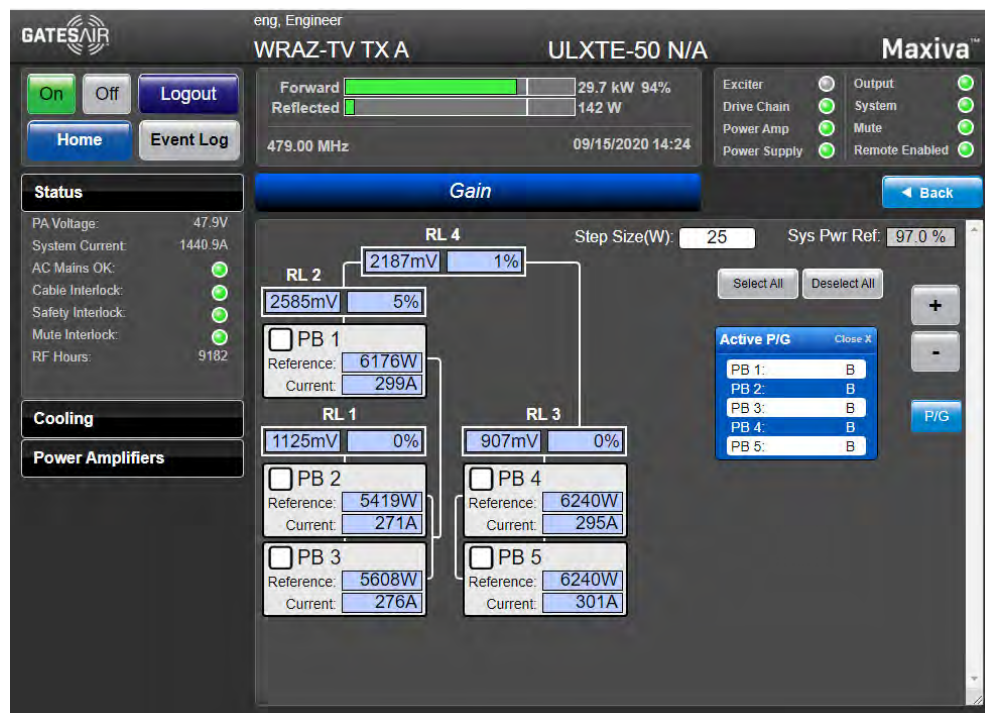
TX A System Phase B



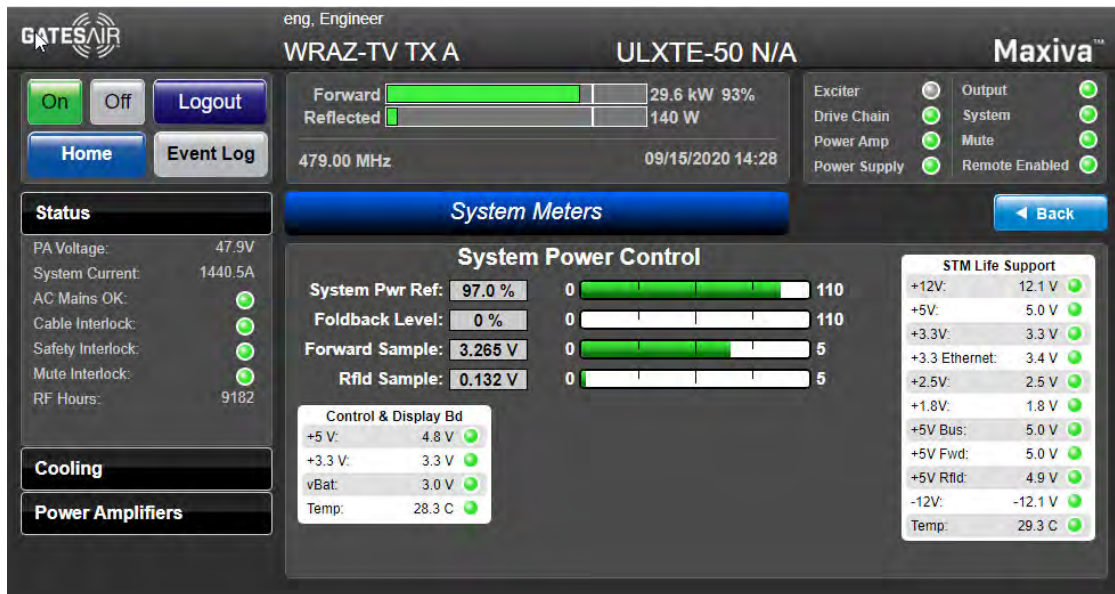
TX A System Gain A



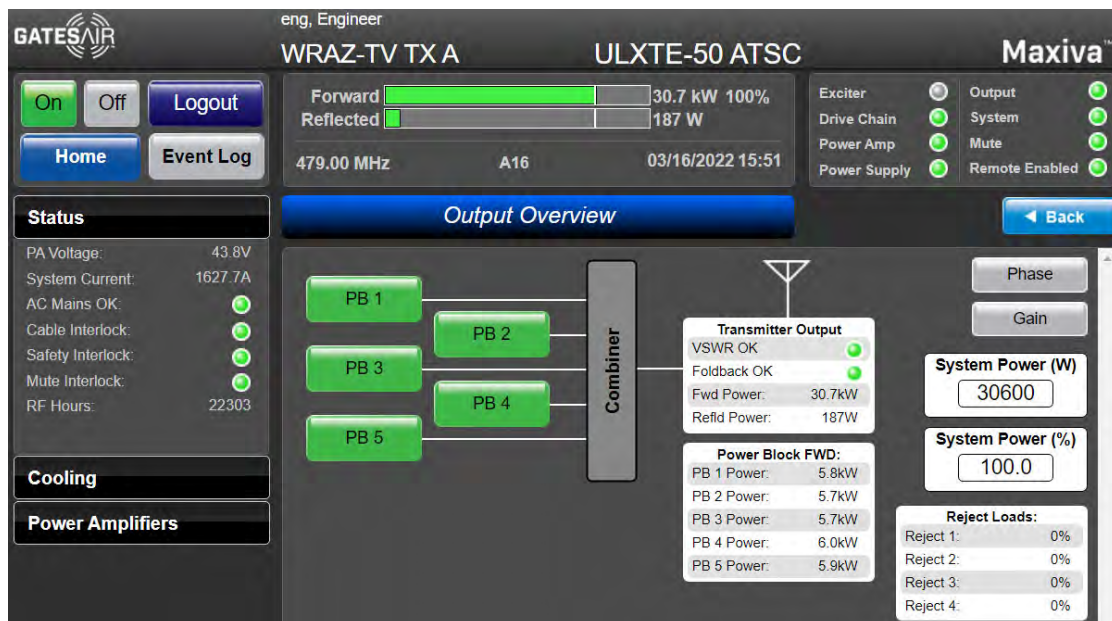
TX A System Gain B



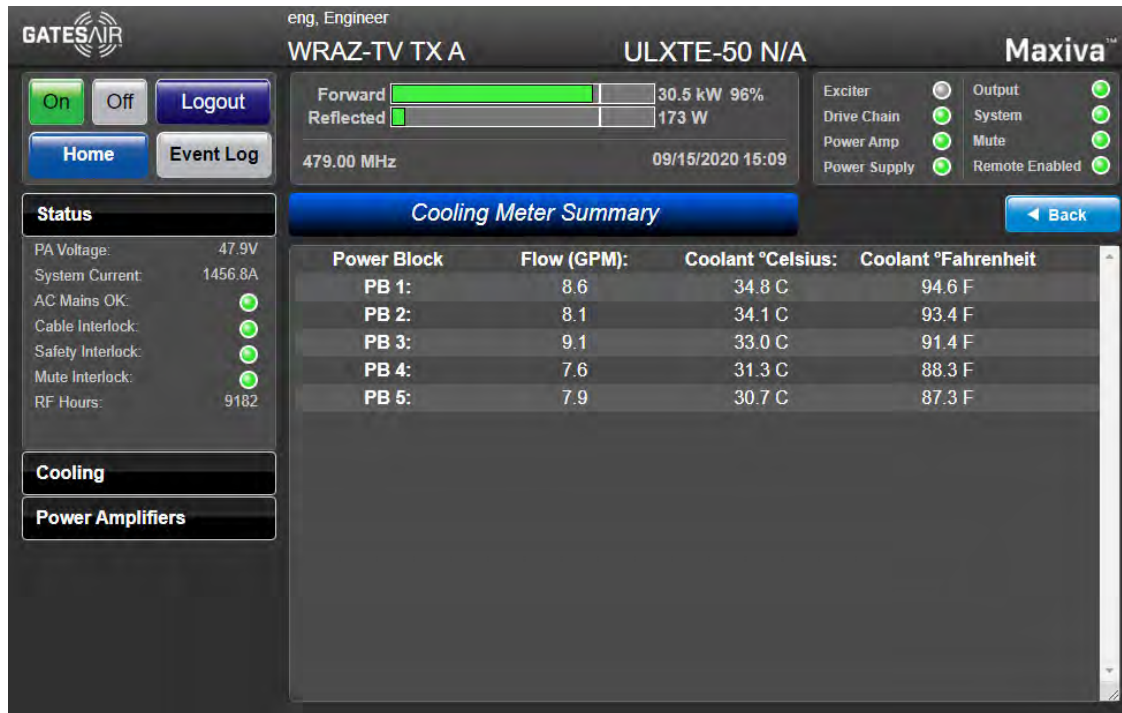
TX A System Meters



Overview

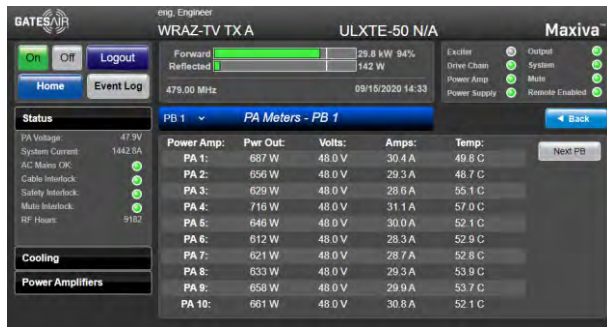


Cooling Meter Summary

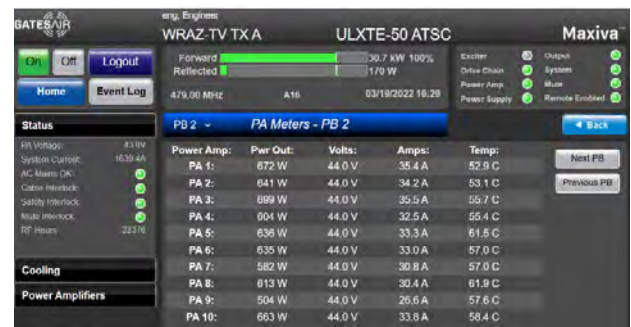


GatesAir, Inc. Proof of performance WRAZ ULXTED-100 Raleigh, NC

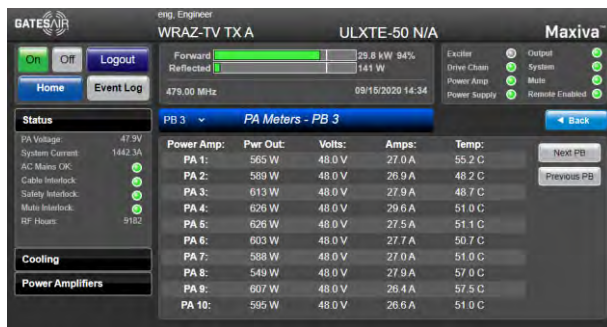
TX A Block PA Meters



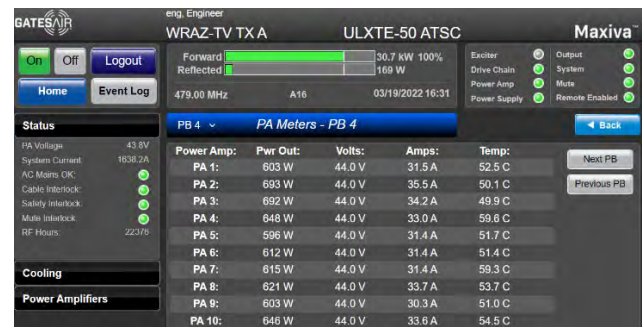
Power Block 1



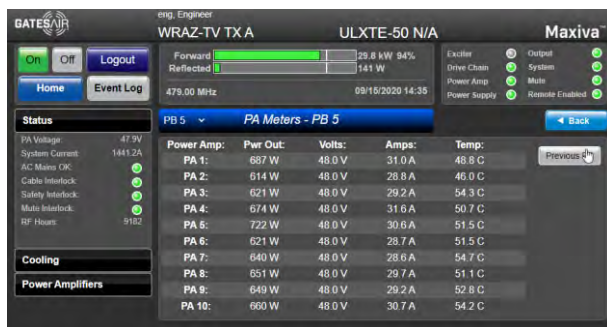
Power Block 2



Power Block 3



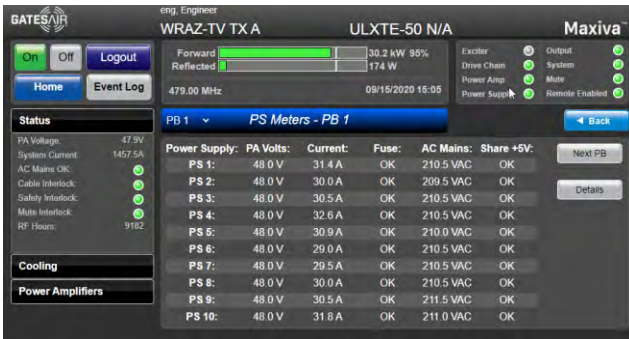
Power Block 4



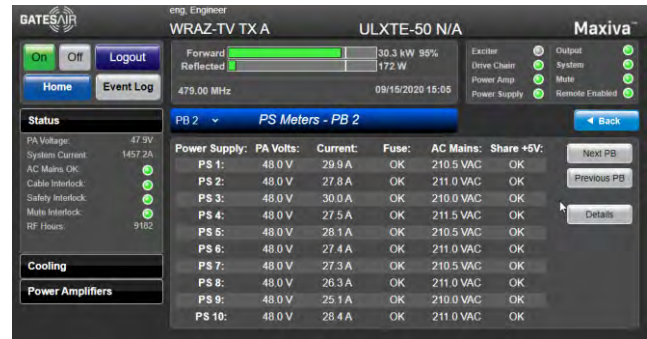
Power Block 5

GatesAir, Inc. Proof of performance WRAZ ULXTED-100 Raleigh, NC

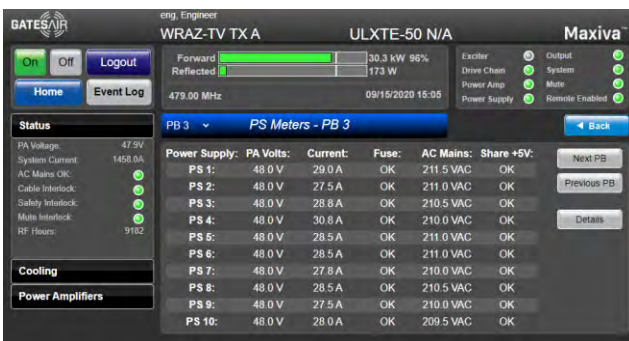
TX A Power Block PS Meters



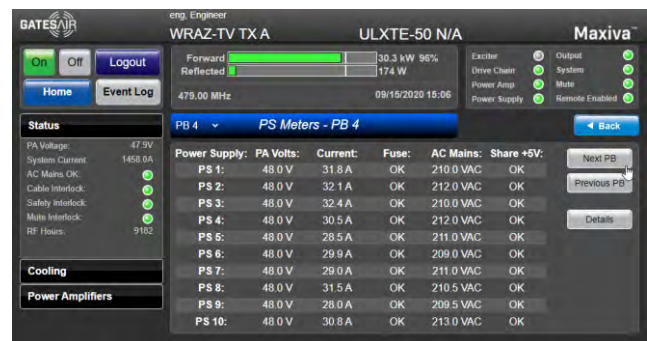
Power Block 1



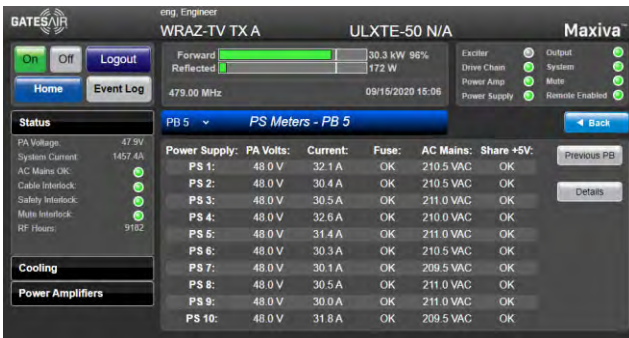
Power Block 2



Power Block 3



Power Block 4



Power Block 5

TX A Power Block P/G Meters A



Power Block 1



Power Block 2



Power Block 3



Power Block 4



Power Block 5

GatesAir, Inc. Proof of performance WRAZ ULXTED-100 Raleigh, NC

TX A Power Block P/G Meters B



Power Block 1



Power Block 2



Power Block 3



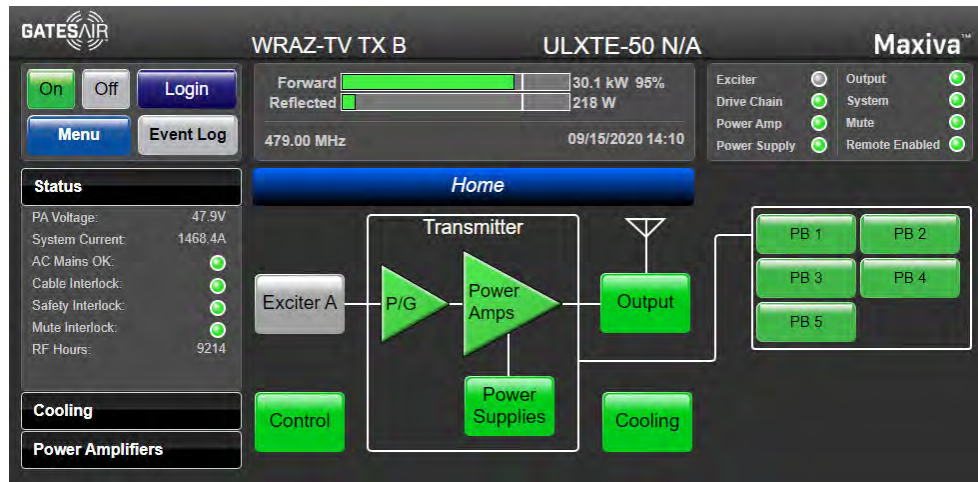
Power Block 4



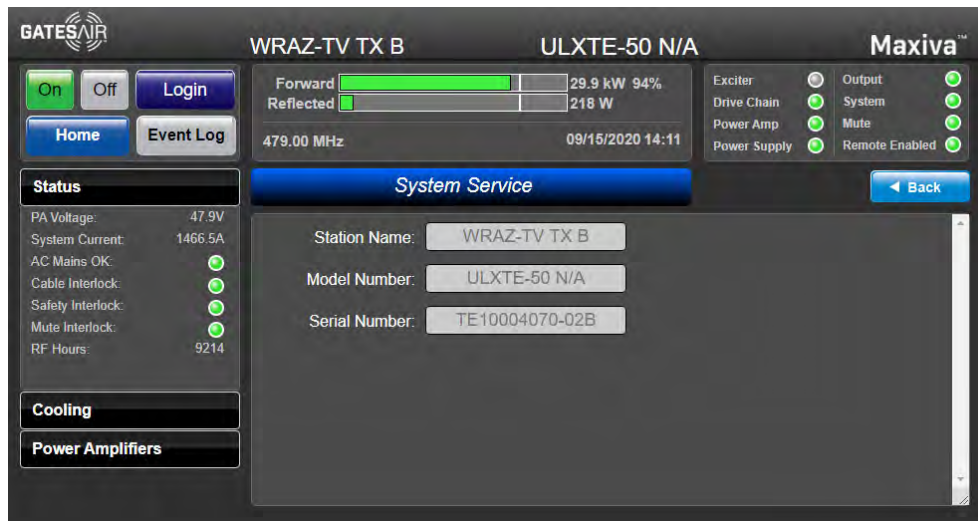
Power Block 5

TRANSMITTER B STM SCREENS

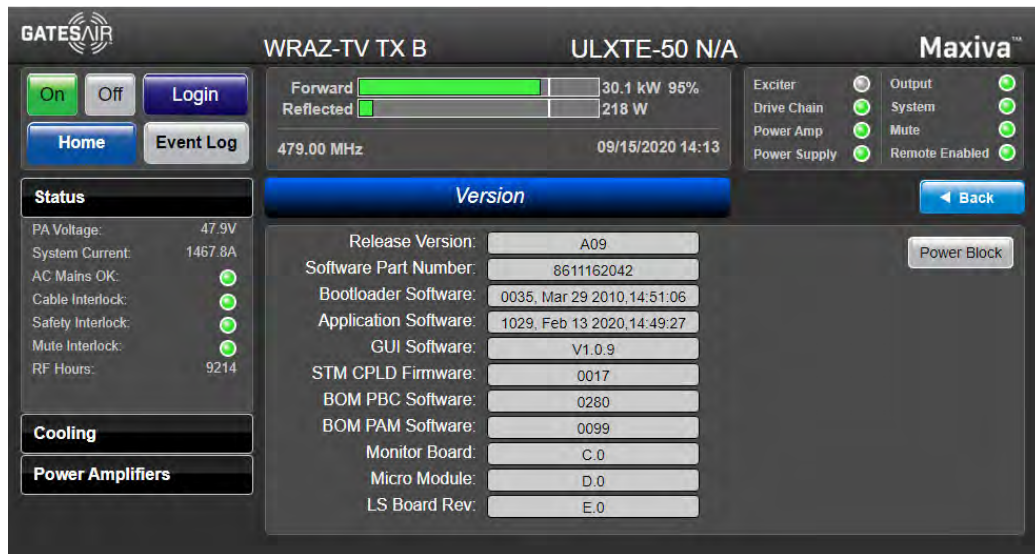
TX B System Home Screen



TX B System Service



TX B System Version



GATESAIR WRAZ-TV TX B ULXTE-50 N/A Maxiva™

On Off Login

Home Event Log

Status

PA Voltage: 47.9V
System Current: 1467.8A
AC Mains OK: ☒
Cable Interlock: ☒
Safety Interlock: ☒
Mute Interlock: ☒
RF Hours: 9214

Cooling

Power Amplifiers

Forward ☒ 30.1 kW 95%
Reflected ☒ 218 W

479.00 MHz 09/15/2020 14:13

Version

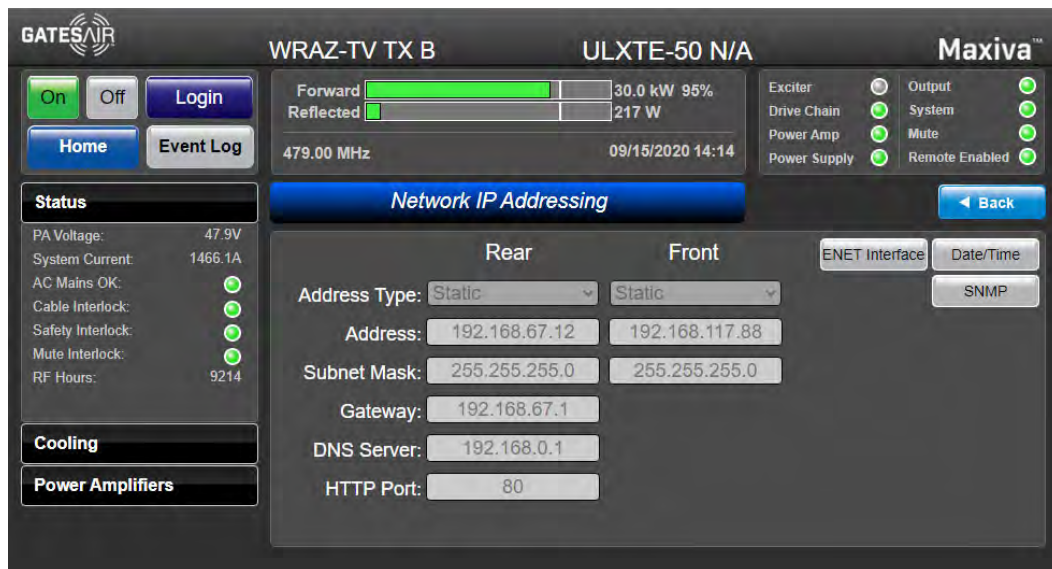
Release Version: A09
Software Part Number: 8611162042
Bootloader Software: 0035, Mar 29 2010, 14:51:06
Application Software: 1029, Feb 13 2020, 14:49:27
GUI Software: V1.0.9
STM CPLD Firmware: 0017
BOM PBC Software: 0280
BOM PAM Software: 0099
Monitor Board: C.0
Micro Module: D.0
LS Board Rev: E.0

Exciter ☒ Output ☒
Drive Chain ☒ System ☒
Power Amp ☒ Mute ☒
Power Supply ☒ Remote Enabled ☒

Power Block

Back

TX B System Network



GATESAIR WRAZ-TV TX B ULXTE-50 N/A Maxiva™

On Off Login

Home Event Log

Status

PA Voltage: 47.9V
System Current: 1466.1A
AC Mains OK: ☒
Cable Interlock: ☒
Safety Interlock: ☒
Mute Interlock: ☒
RF Hours: 9214

Cooling

Power Amplifiers

Forward ☒ 30.0 kW 95%
Reflected ☒ 217 W

479.00 MHz 09/15/2020 14:14

Network IP Addressing

Rear Front

Address Type: Static Static

Address: 192.168.67.12 192.168.117.88

Subnet Mask: 255.255.255.0 255.255.255.0

Gateway: 192.168.67.1

DNS Server: 192.168.0.1

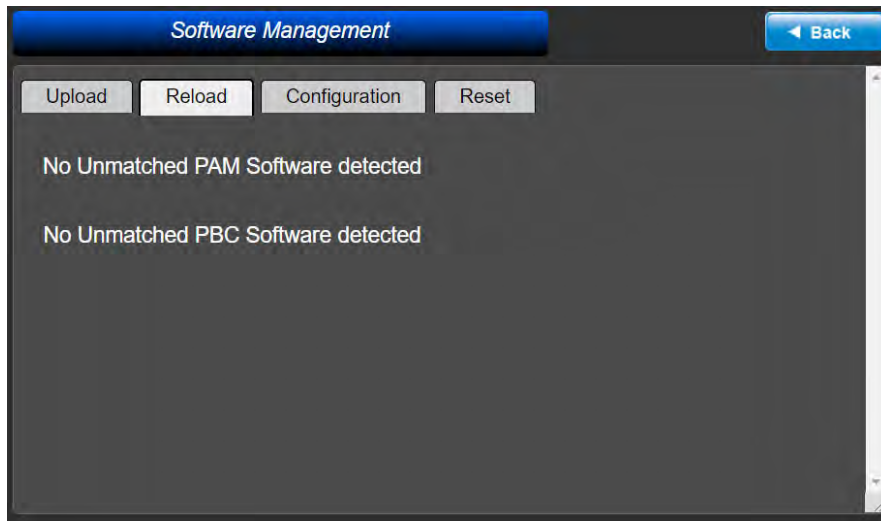
HTTP Port: 80

ENET Interface Date/Time

SNMP

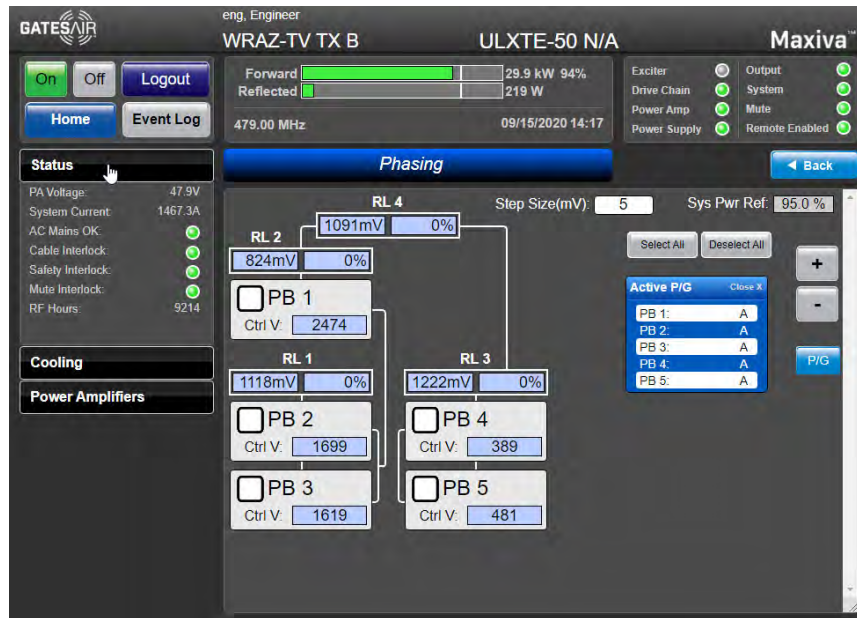
Back

TX B Software Management Reload Page

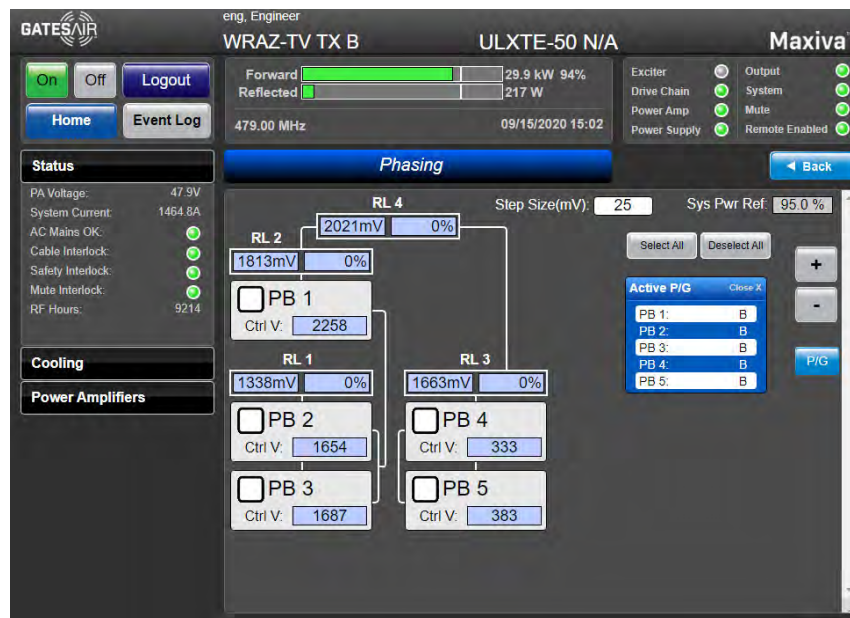


The screenshot shows a web interface for 'Software Management'. At the top, there is a blue header bar with the text 'Software Management' and a 'Back' button. Below the header, there are four buttons: 'Upload', 'Reload', 'Configuration', and 'Reset'. The main content area is dark gray and contains two lines of text: 'No Unmatched PAM Software detected' and 'No Unmatched PBC Software detected'.

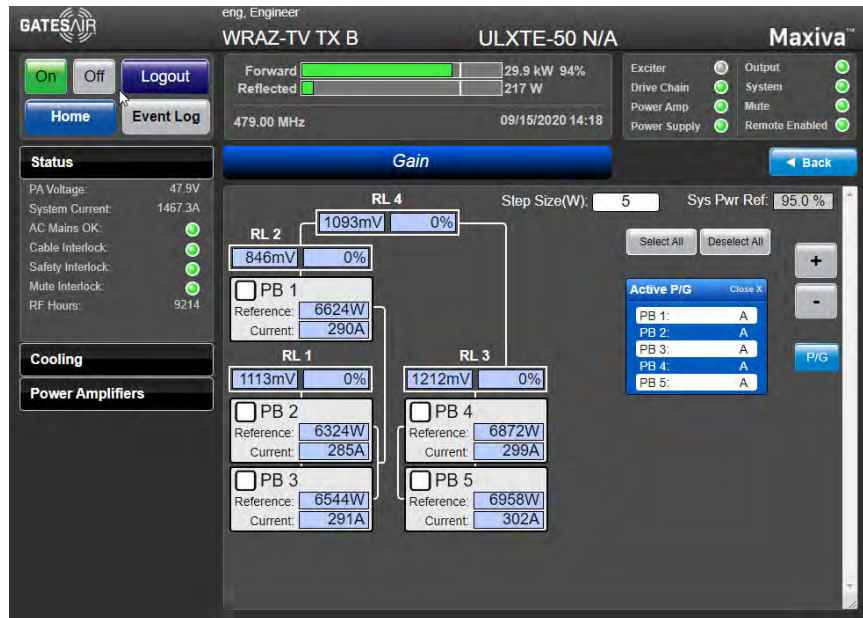
TX B System Phase A



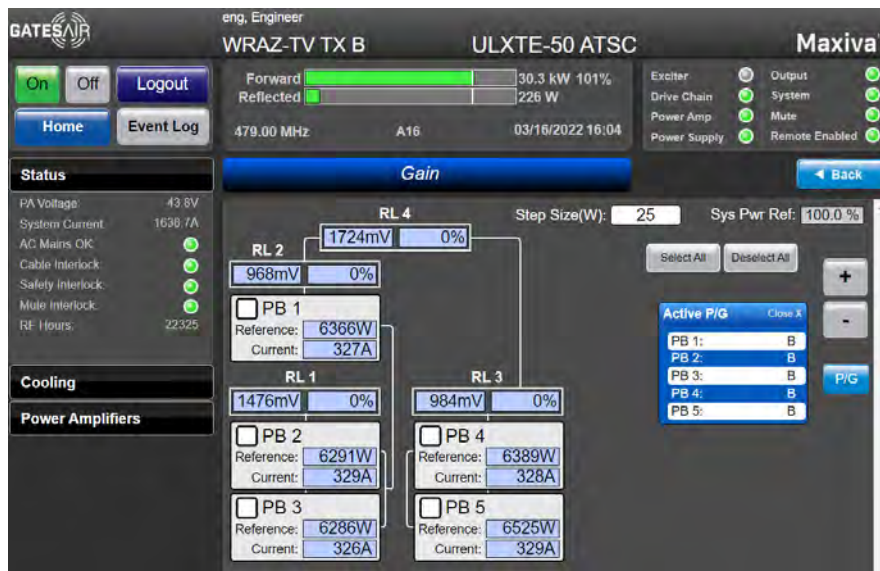
TX B System Phase B



TX B System Gain A

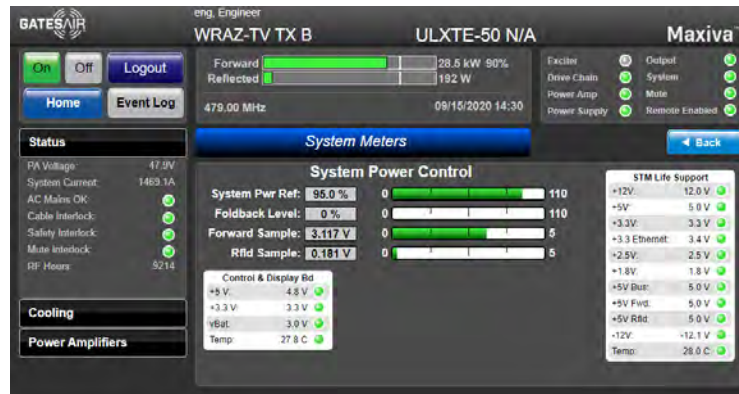


TX B System Gain B

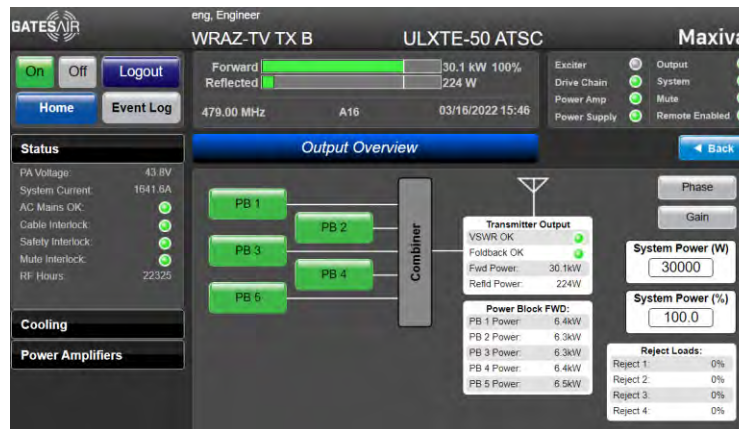


GatesAir, Inc. Proof of performance WRAZ ULXTED-100 Raleigh, NC

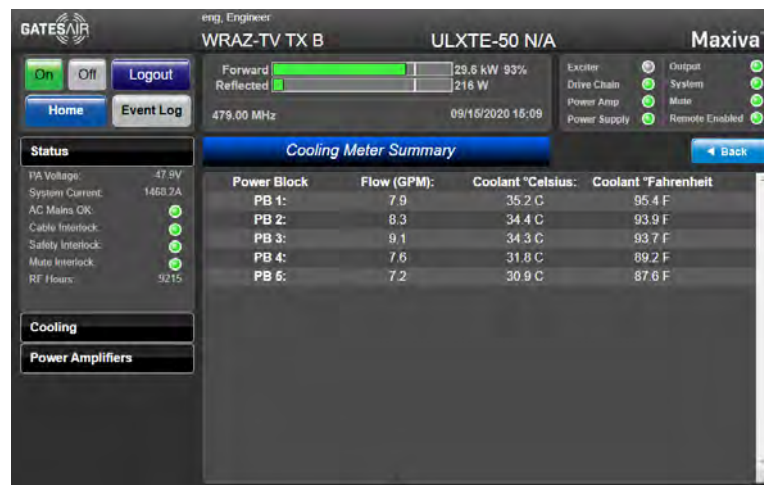
TX B System Meters



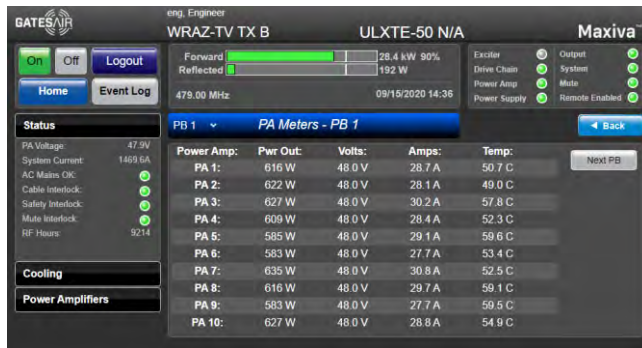
TX B System Output Overview



TX B Cooling Meter Summary



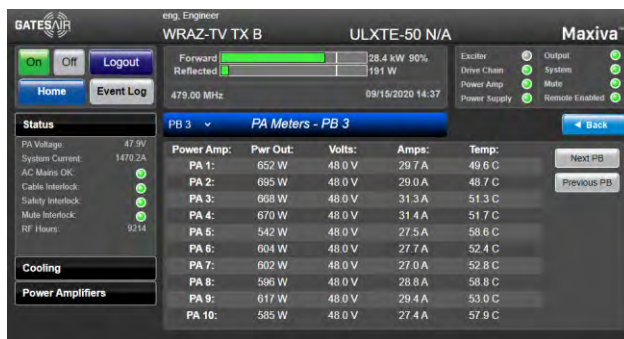
TX B Power Block PA Meters



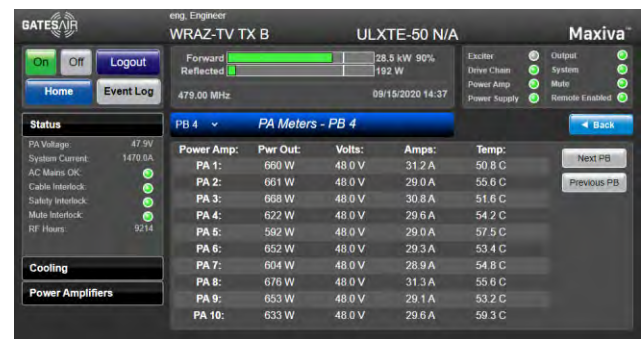
Power Block 1



Power Block 2



Power Block 3

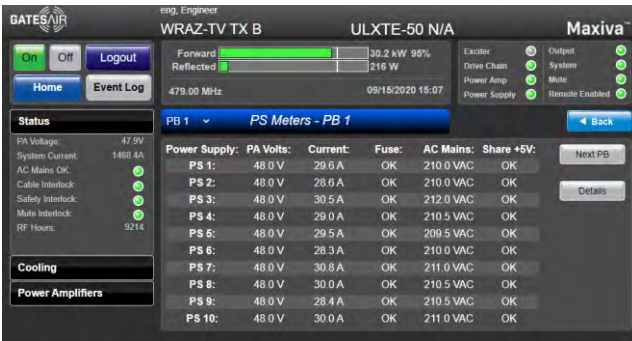


Power Block 4

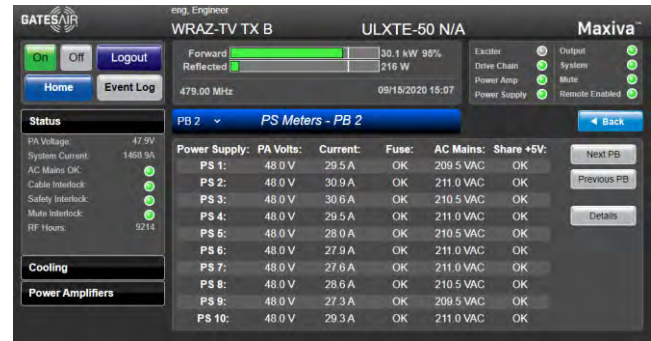


Power Block 5

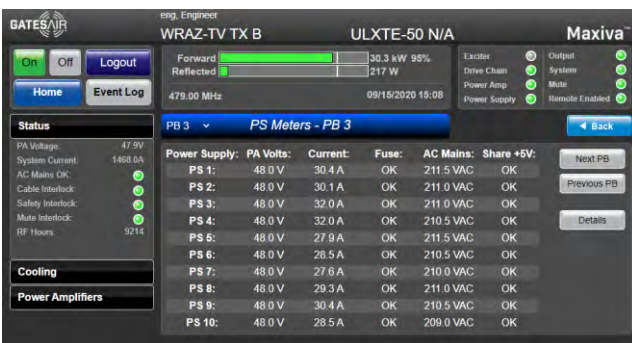
TX B Power Block PS Meters



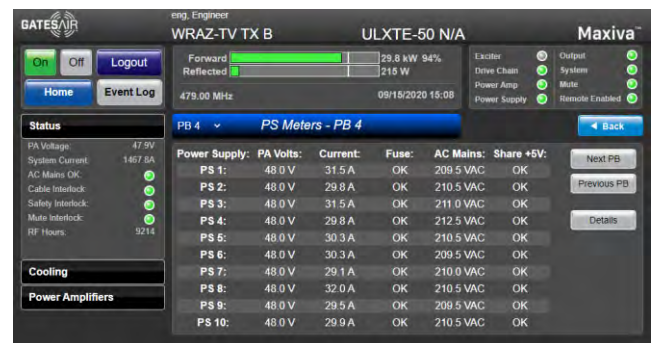
Power Block 1



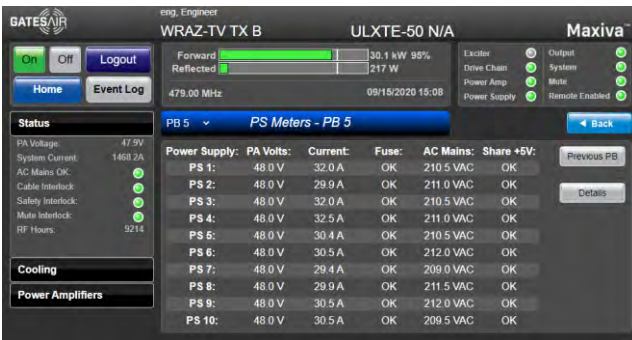
Power Block 2



Power Block 3



Power Block 4



Power Block 5

TX B Power Block P/G Meters A



Power Block 1



Power Block 2



Power Block 3



Power Block 4



Power Block 5

GatesAir, Inc. Proof of performance WRAZ ULXTED-100 Raleigh, NC

TX B Power Block P/G Meters B



Power Block 1



Power Block 2



Power Block 3

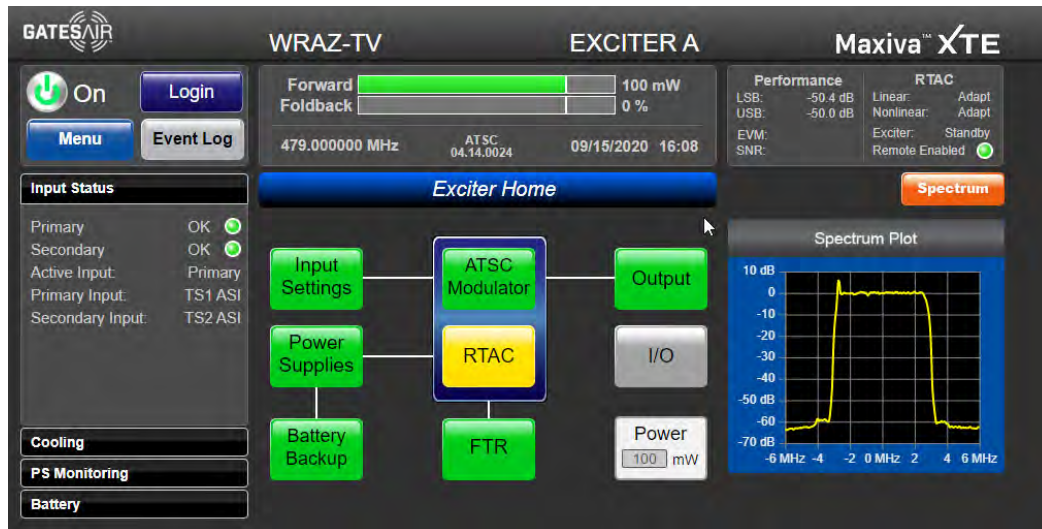


Power Block 4

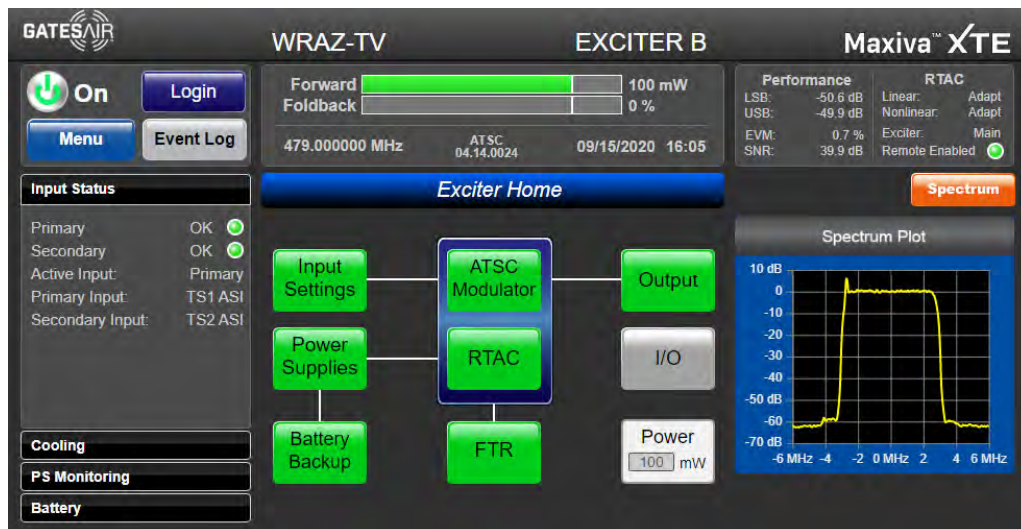


Power Block 5

Exciter Home Screen



Exciter A



Exciter B

Exciter Software Version



WRAZ-TV **EXCITER A** **Maxiva™ XTE**

Forward  100 mW
Foldback  0 %

479.000000 MHz ATSC 04.14.0024 10/21/2020 15:23

Software Version

Software P/N:	861-1161-032 N1
Software Rev:	04.14.0024
U-Boot Rev:	2014.01.0016
WebBoot Rev:	04.10.0002
Xtmod Setup Rev:	0102
Linux Rev:	4.1.15-01.01.2002
Dev Tree Rev:	02.01.0000 D1
FPGA1 Flash Rev:	0xb2
FPGA1 Rev:	0x0000B2 (ATSC)
CPLD Rev:	0x5
Power Supply SW:	E3 V01_15

Input Status

Primary	OK
Secondary	OK
Active Input:	Primary
Primary Input:	TS1 ASI
Secondary Input:	TS2 ASI

Cooling

PS Monitoring

Battery

Performance

LSB:	-50.7 dB
USB:	-50.0 dB
EVM:	0.6 %
SNR:	40.3 dB

RTAC

Linear:	Adapt
Nonlinear:	Adapt
Exciter:	Main
Remote Enabled:	Yes

Back **Spectrum**

Exciter A



WRAZ-TV **EXCITER B** **Maxiva™ XTE**

Forward  100 mW
Foldback  0 %

479.000000 MHz ATSC 04.14.0024 10/21/2020 15:29

Software Version

Software P/N:	861-1161-032 N1
Software Rev:	04.14.0024
U-Boot Rev:	2014.01.0016
WebBoot Rev:	04.10.0002
Xtmod Setup Rev:	0102
Linux Rev:	4.1.15-01.01.2002
Dev Tree Rev:	02.01.0000 D1
FPGA1 Flash Rev:	0xb2
FPGA1 Rev:	0x0000B2 (ATSC)
CPLD Rev:	0x5
Power Supply SW:	E3 V01_15

Input Status

Primary	OK
Secondary	OK
Active Input:	Primary
Primary Input:	TS1 ASI
Secondary Input:	TS2 ASI

Cooling

PS Monitoring

Battery

Performance

LSB:	-50.3 dB
USB:	-50.6 dB
EVM:	
SNR:	

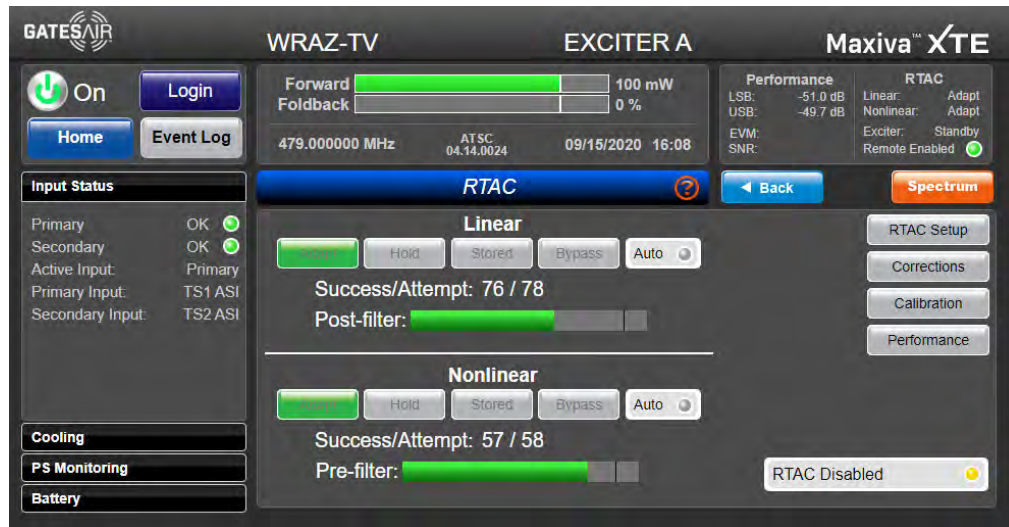
RTAC

Linear:	Adapt
Nonlinear:	Adapt
Exciter:	Standby
Remote Enabled:	Yes

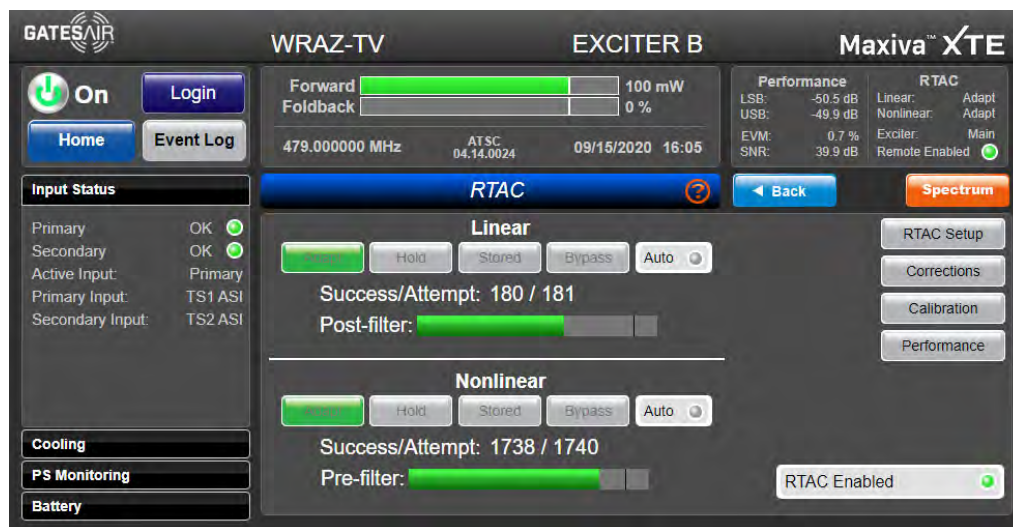
Back **Spectrum**

Exciter B

Exciter Home RTAC Screen

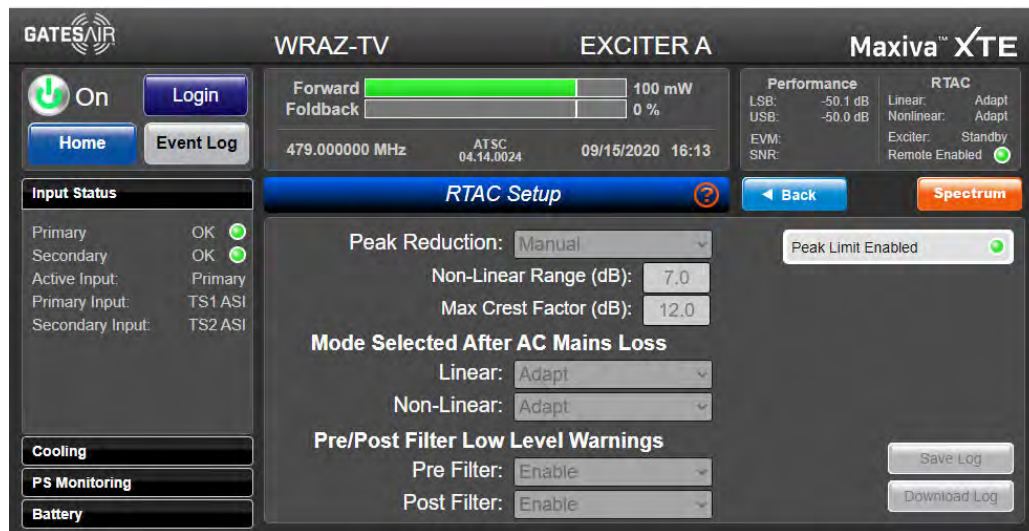


Exciter A



Exciter B

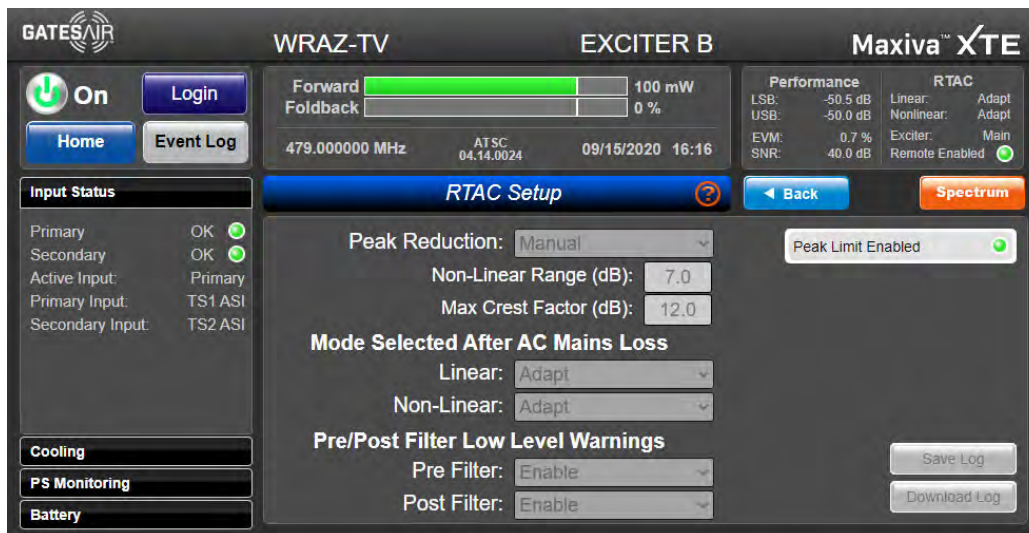
Exciter RTAC Setup



The screenshot shows the 'Exciter A' RTAC Setup interface. The top header includes the GATESAIR logo, 'WRAZ-TV', 'EXCITER A', and 'Maxiva™ XTE'. The interface is divided into several sections:

- Top Left:** Power status (On), Login button, Home button, and Event Log button.
- Top Center:** Forward and Foldback power levels (100 mW, 0 %), frequency (479.000000 MHz), ATSC version (04.14.0024), and date/time (09/15/2020 16:13).
- Top Right:** Performance metrics (LSB: -50.1 dB, USB: -50.0 dB, EVM: 0.7 %, SNR: 40.0 dB) and RTAC settings (Linear: Adapt, Nonlinear: Adapt, Exciter: Standby, Remote Enabled).
- Left Sidebar:** Input Status (Primary: OK, Secondary: OK, Active Input: Primary, Primary Input: TS1 ASI, Secondary Input: TS2 ASI), Cooling, PS Monitoring, and Battery status.
- Main Content Area:** 'RTAC Setup' title, Peak Reduction (Manual), Non-Linear Range (7.0 dB), Max Crest Factor (12.0 dB), Mode Selected After AC Mains Loss (Linear: Adapt, Non-Linear: Adapt), and Pre/Post Filter Low Level Warnings (Pre Filter: Enable, Post Filter: Enable). A 'Peak Limit Enabled' toggle is also present.
- Bottom Right:** 'Save Log' and 'Download Log' buttons.

Exciter A

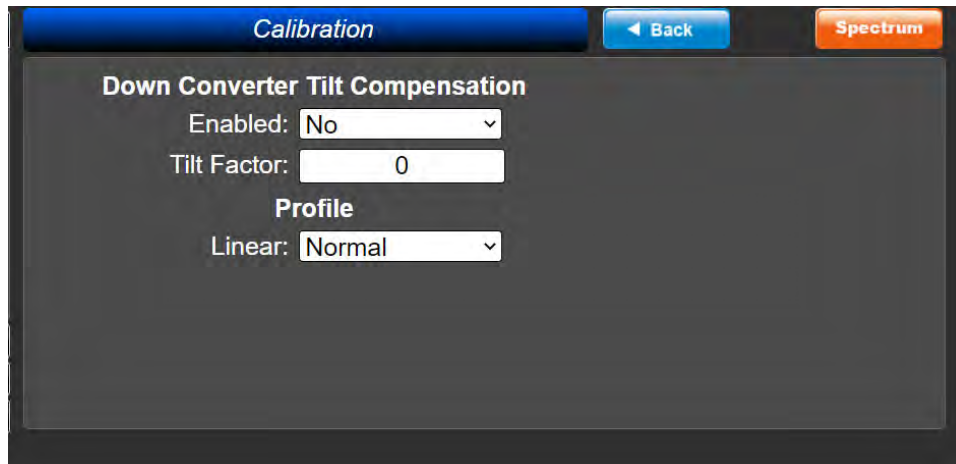


The screenshot shows the 'Exciter B' RTAC Setup interface, which is identical in layout to the Exciter A interface. The top header includes the GATESAIR logo, 'WRAZ-TV', 'EXCITER B', and 'Maxiva™ XTE'. The interface is divided into several sections:

- Top Left:** Power status (On), Login button, Home button, and Event Log button.
- Top Center:** Forward and Foldback power levels (100 mW, 0 %), frequency (479.000000 MHz), ATSC version (04.14.0024), and date/time (09/15/2020 16:16).
- Top Right:** Performance metrics (LSB: -50.5 dB, USB: -50.0 dB, EVM: 0.7 %, SNR: 40.0 dB) and RTAC settings (Linear: Adapt, Nonlinear: Adapt, Exciter: Main, Remote Enabled).
- Left Sidebar:** Input Status (Primary: OK, Secondary: OK, Active Input: Primary, Primary Input: TS1 ASI, Secondary Input: TS2 ASI), Cooling, PS Monitoring, and Battery status.
- Main Content Area:** 'RTAC Setup' title, Peak Reduction (Manual), Non-Linear Range (7.0 dB), Max Crest Factor (12.0 dB), Mode Selected After AC Mains Loss (Linear: Adapt, Non-Linear: Adapt), and Pre/Post Filter Low Level Warnings (Pre Filter: Enable, Post Filter: Enable). A 'Peak Limit Enabled' toggle is also present.
- Bottom Right:** 'Save Log' and 'Download Log' buttons.

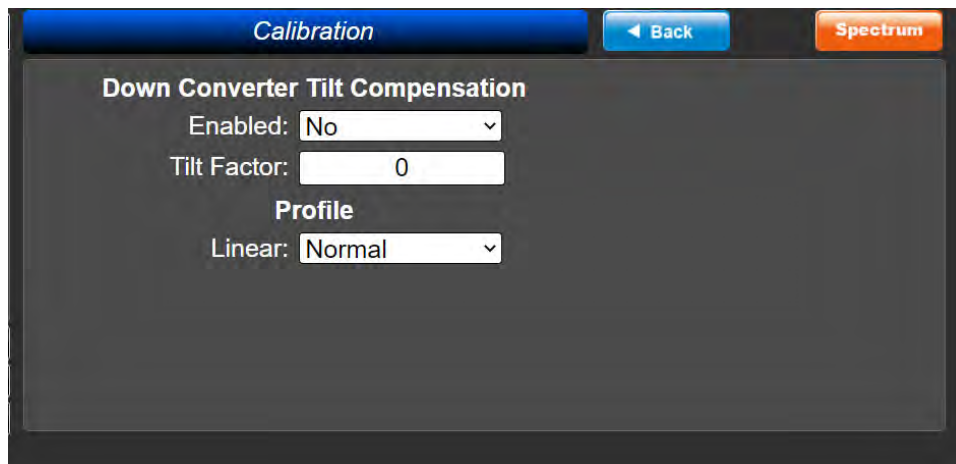
Exciter B

Exciter RTAC Calibration



The screenshot shows the 'Calibration' screen for Exciter A. At the top, there is a blue bar with the word 'Calibration' in white. To the right of this bar are two buttons: a blue 'Back' button with a left arrow and an orange 'Spectrum' button. Below the bar, the title 'Down Converter Tilt Compensation' is displayed. Under this title, there are three settings: 'Enabled:' with a dropdown menu showing 'No', 'Tilt Factor:' with a text input field containing '0', and 'Profile' with a dropdown menu showing 'Linear: Normal'.

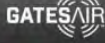
Exciter A



The screenshot shows the 'Calibration' screen for Exciter B. It has the same layout as the Exciter A screen. At the top, there is a blue bar with the word 'Calibration' in white. To the right of this bar are two buttons: a blue 'Back' button with a left arrow and an orange 'Spectrum' button. Below the bar, the title 'Down Converter Tilt Compensation' is displayed. Under this title, there are three settings: 'Enabled:' with a dropdown menu showing 'No', 'Tilt Factor:' with a text input field containing '0', and 'Profile' with a dropdown menu showing 'Linear: Normal'.

Exciter B

Exciter Network Routes



On

Login

Home

Event Log

Input Status

Primary OK

Secondary OK

Active Input: Primary

Primary Input: TS1 ASI

Secondary Input: TS2 ASI

Cooling

PS Monitoring

Battery

WRAZ-TV

EXCITER A

Maxiva™ XTE

Forward

Foldback

100 mW

0 %

479.000000 MHz

ATSC 04.14.0024

09/15/2020 16:09

Performance

LSB: -50.4 dB

USB: -49.9 dB

EVM:

SNR:

RTAC

Linear: Adapt

Nonlinear: Adapt

Exciter: Standby

Remote Enabled

Network Route Table


Back

Spectrum

Destination Address	Netmask	Gateway	Interface	Type
10.10.1.0	255.255.255.0	0.0.0.0	ts0ip1	System
10.10.2.0	255.255.255.0	0.0.0.0	ts0ip2	System
192.168.67.0	255.255.255.0	0.0.0.0	lan	System
192.168.117.0	255.255.255.0	0.0.0.0	service	System

Result:

Exciter A



On

Login

Home

Event Log

Input Status

Primary OK

Secondary OK

Active Input: Primary

Primary Input: TS1 ASI

Secondary Input: TS2 ASI

Cooling

PS Monitoring

Battery

WRAZ-TV

EXCITER B

Maxiva™ XTE

Forward

Foldback

100 mW

0 %

479.000000 MHz

ATSC 04.14.0024

09/15/2020 16:06

Performance

LSB: -50.2 dB

USB: -50.2 dB

EVM: 0.7 %

SNR: 40.0 dB

RTAC

Linear: Adapt

Nonlinear: Adapt

Exciter: Main

Remote Enabled

Network Route Table

Back

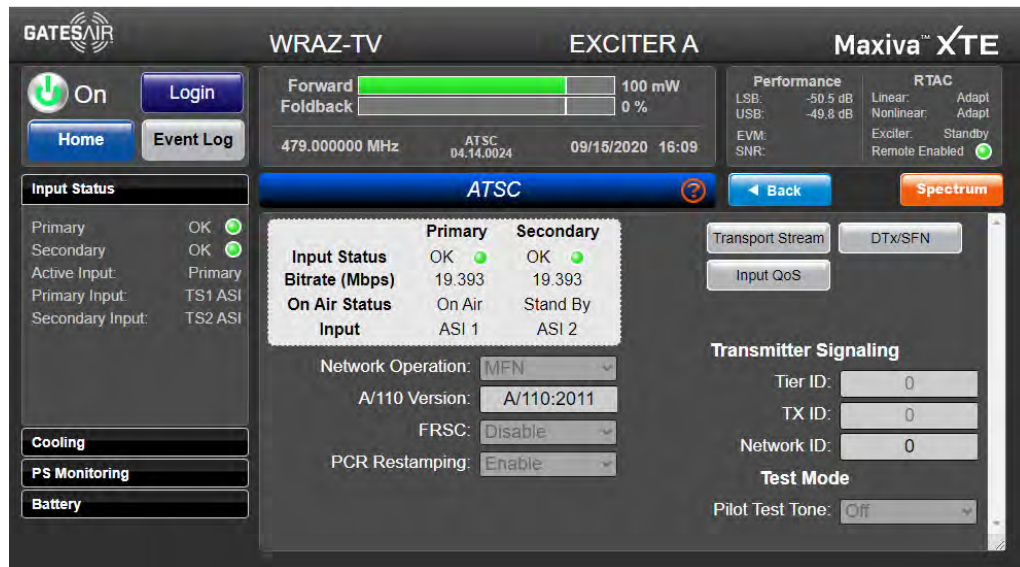
Spectrum

Destination Address	Netmask	Gateway	Interface	Type
10.10.1.0	255.255.255.0	0.0.0.0	ts0ip1	System
10.10.2.0	255.255.255.0	0.0.0.0	ts0ip2	System
192.168.67.0	255.255.255.0	0.0.0.0	lan	System
192.168.117.0	255.255.255.0	0.0.0.0	service	System

Result:

Exciter B

Exciter Modulator ATSC Setup



GATESAIR **WRAZ-TV** **EXCITER A** **Maxiva™ XTE**

On Login Home Event Log

Forward Foldback

479.000000 MHz ATSC 04.14.0024 09/15/2020 16:09

Performance: LSB: -50.5 dB, USB: -49.8 dB, EVM: , SNR: , RTAC: Linear: Adapt, Nonlinear: Adapt, Exciter: Standby, Remote Enabled: ☒

Input Status: Primary OK, Secondary OK, Active Input: Primary, Primary Input: TS1 ASI, Secondary Input: TS2 ASI

Cooling PS Monitoring Battery

ATSC Back Spectrum

	Primary	Secondary
Input Status	OK	OK
Bitrate (Mbps)	19.393	19.393
On Air Status	On Air	Stand By
Input	ASI 1	ASI 2


Transport Stream DTX/SFN Input QoS

Transmitter Signaling: Tier ID: 0, TX ID: 0, Network ID: 0

Test Mode: Pilot Test Tone: Off

Network Operation: MFN A/110 Version: A/110:2011 FRSC: Disable PCR Restamping: Enable

Exciter A



GATESAIR **WRAZ-TV** **EXCITER B** **Maxiva™ XTE**

On Login Home Event Log

Forward Foldback

479.000000 MHz ATSC 04.14.0024 09/15/2020 16:07

Performance: LSB: -50.0 dB, USB: -49.8 dB, EVM: 0.7 %, SNR: 39.8 dB, RTAC: Linear: Adapt, Nonlinear: Adapt, Exciter: Main, Remote Enabled: ☒

Input Status: Primary OK, Secondary OK, Active Input: Primary, Primary Input: TS1 ASI, Secondary Input: TS2 ASI

Cooling PS Monitoring Battery

ATSC Back Spectrum

	Primary	Secondary
Input Status	OK	OK
Bitrate (Mbps)	19.393	19.393
On Air Status	On Air	Stand By
Input	ASI 1	ASI 2

Transport Stream DTX/SFN Input QoS

Transmitter Signaling: Tier ID: 0, TX ID: 0, Network ID: 0

Test Mode: Pilot Test Tone: Off

Network Operation: MFN A/110 Version: A/110:2011 FRSC: Disable PCR Restamping: Enable

Exciter B

Exciter Input Settings



GATESAIR WRAZ-TV EXCITER A Maxiva™ XTE

On Login Home Event Log

Forward 100 mW
Foldback 0 %

479.000000 MHz ATSC 04.14.0024 09/15/2020 16:10

Performance: LSB: -50.8 dB, USB: -49.7 dB, EVM: , SNR: , RTAC: Linear: Adapt, Nonlinear: Adapt, Exciter: Standby, Remote Enabled: ●

Input Status

Primary	OK ●
Secondary	OK ●
Active Input:	Primary
Primary Input:	TS1 ASI
Secondary Input:	TS2 ASI

Cooling PS Monitoring Battery

Input Settings

	Primary	Secondary
Input Status	OK ●	OK ●
Bitrate (Mbps)	19.393	19.393

Power On Input: Current
Active Input: Primary
Primary Input: TS1 ASI
Secondary Input: TS2 ASI
TS Monitor Output: Follow Input
Mute on Loss of TS: No

Switch

Mode: Auto-Return
Timeout (s): 5
Elapsed Time (s): 0
Max Count: 0
Count: 0
SSW State: Off
SSW Buffer Depth (s): 0.000
SSW Actual Delay (s): 0.000

Switch Reset DTI-IP Settings

Exciter A



GATESAIR WRAZ-TV EXCITER B Maxiva™ XTE

On Login Home Event Log

Forward 100 mW
Foldback 0 %

479.000000 MHz ATSC 04.14.0024 09/15/2020 16:08

Performance: LSB: -50.3 dB, USB: -49.7 dB, EVM: 0.7 %, SNR: 39.8 dB, RTAC: Linear: Adapt, Nonlinear: Adapt, Exciter: Main, Remote Enabled: ●

Input Status

Primary	OK ●
Secondary	OK ●
Active Input:	Primary
Primary Input:	TS1 ASI
Secondary Input:	TS2 ASI

Cooling PS Monitoring Battery

Input Settings

	Primary	Secondary
Input Status	OK ●	OK ●
Bitrate (Mbps)	19.393	19.393

Power On Input: Current
Active Input: Primary
Primary Input: TS1 ASI
Secondary Input: TS2 ASI
TS Monitor Output: Follow Input
Mute on Loss of TS: No

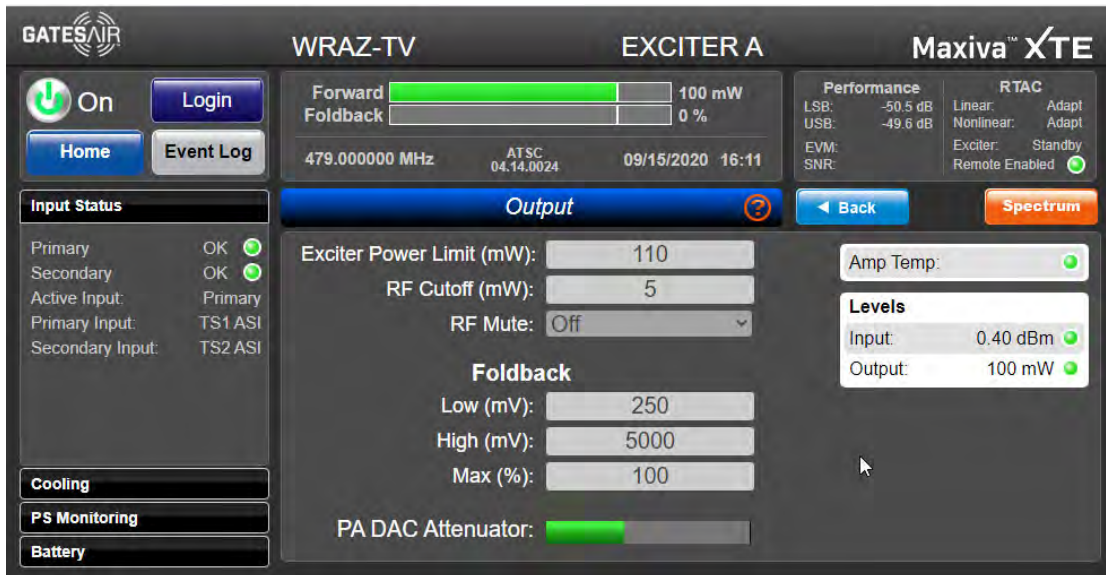
Switch

Mode: Auto-Return
Timeout (s): 5
Elapsed Time (s): 0
Max Count: 0
Count: 0
SSW State: Off
SSW Buffer Depth (s): 0.000
SSW Actual Delay (s): 0.000

Switch Reset DTI-IP Settings

Exciter B

Exciter Output Config



GATESAIR **WRAZ-TV** **EXCITER A** **Maxiva™ XTE**

On **Login** **Home** **Event Log**

Forward **Foldback** 100 mW 0 %

479.000000 MHz ATSC 04.14.0024 09/15/2020 16:11

Performance **RTAC**

LSB: -50.5 dB Linear: Adapt
USB: -49.6 dB Nonlinear: Adapt
EVM: Exciter: Standby
SNR: Remote Enabled

Input Status

Primary OK
Secondary OK
Active Input: Primary
Primary Input: TS1 ASI
Secondary Input: TS2 ASI

Output

Exciter Power Limit (mW): 110
RF Cutoff (mW): 5
RF Mute: Off

Foldback

Low (mV): 250
High (mV): 5000
Max (%): 100

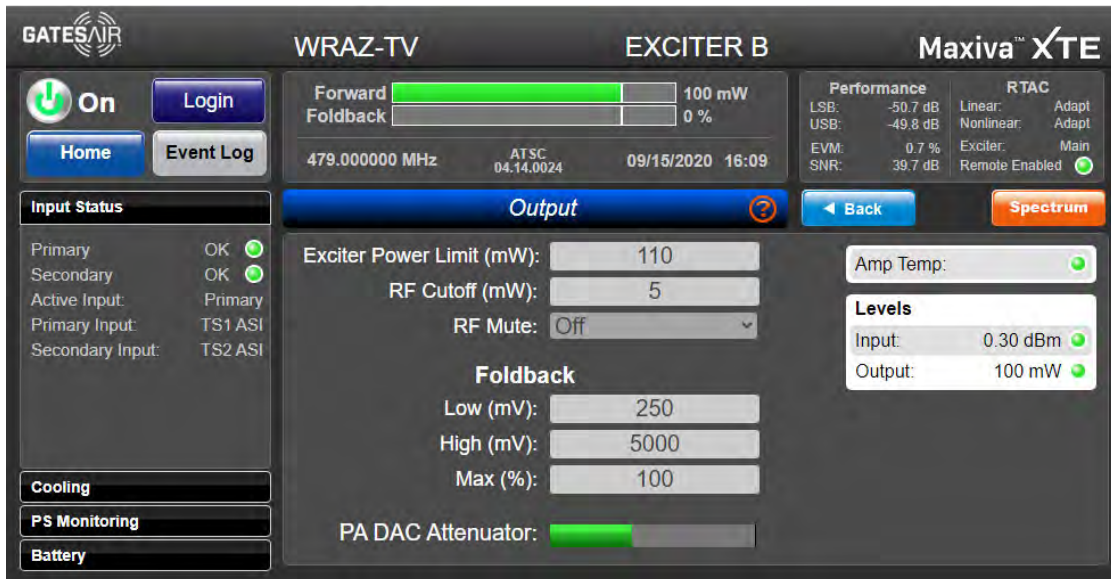
PA DAC Attenuator:

Levels

Input: 0.40 dBm
Output: 100 mW

Cooling
PS Monitoring
Battery

Exciter A



GATESAIR **WRAZ-TV** **EXCITER B** **Maxiva™ XTE**

On **Login** **Home** **Event Log**

Forward **Foldback** 100 mW 0 %

479.000000 MHz ATSC 04.14.0024 09/15/2020 16:09

Performance **RTAC**

LSB: -50.7 dB Linear: Adapt
USB: -49.8 dB Nonlinear: Adapt
EVM: 0.7 % Exciter: Main
SNR: 39.7 dB Remote Enabled

Input Status

Primary OK
Secondary OK
Active Input: Primary
Primary Input: TS1 ASI
Secondary Input: TS2 ASI

Output

Exciter Power Limit (mW): 110
RF Cutoff (mW): 5
RF Mute: Off

Foldback

Low (mV): 250
High (mV): 5000
Max (%): 100

PA DAC Attenuator:

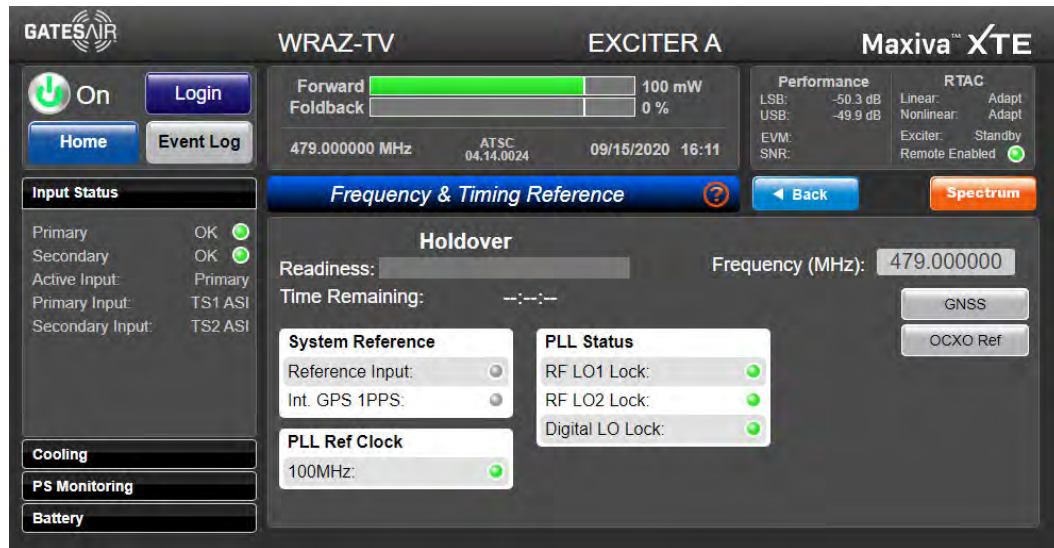
Levels

Input: 0.30 dBm
Output: 100 mW

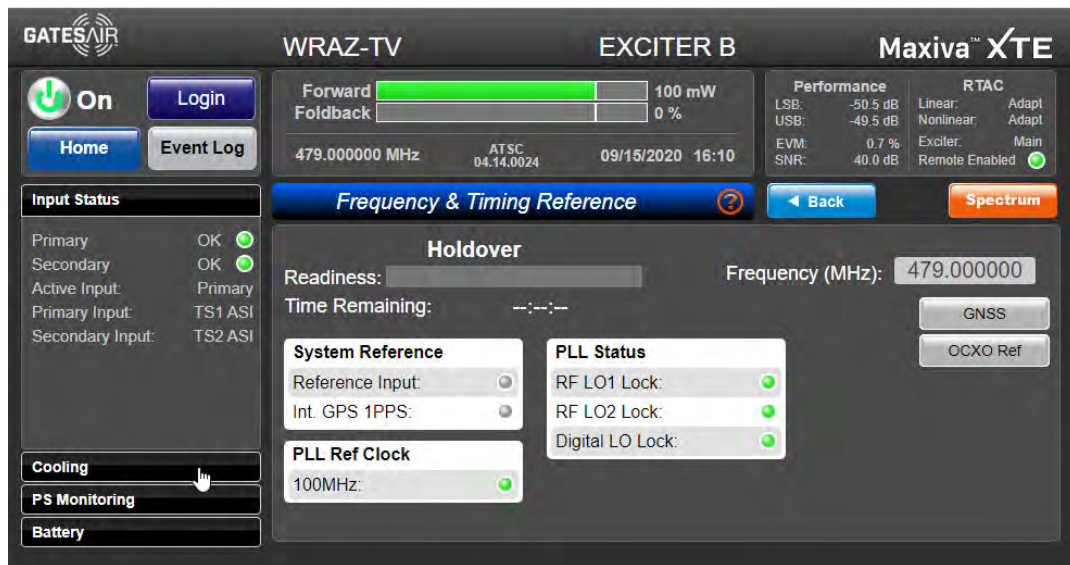
Cooling
PS Monitoring
Battery

Exciter B

Exciter FTR Reference Config

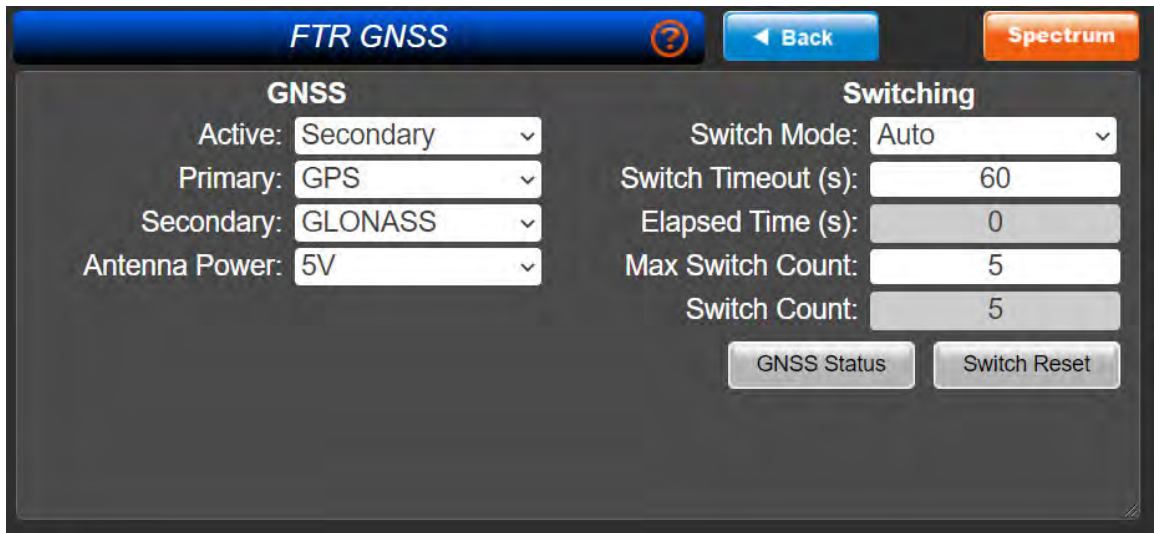


Exciter A



Exciter B

Exciter FTR GNSS



FTR GNSS ? Back Spectrum

GNSS

Active: Secondary ▾

Primary: GPS ▾

Secondary: GLONASS ▾

Antenna Power: 5V ▾

Switching

Switch Mode: Auto ▾

Switch Timeout (s): 60

Elapsed Time (s): 0

Max Switch Count: 5

Switch Count: 5

GNSS Status Switch Reset

Exciter A



FTR GNSS ? Back Spectrum

GNSS

Active: Secondary ▾

Primary: GPS ▾

Secondary: GLONASS ▾

Antenna Power: 5V ▾

Switching

Switch Mode: Auto ▾

Switch Timeout (s): 60

Elapsed Time (s): 0

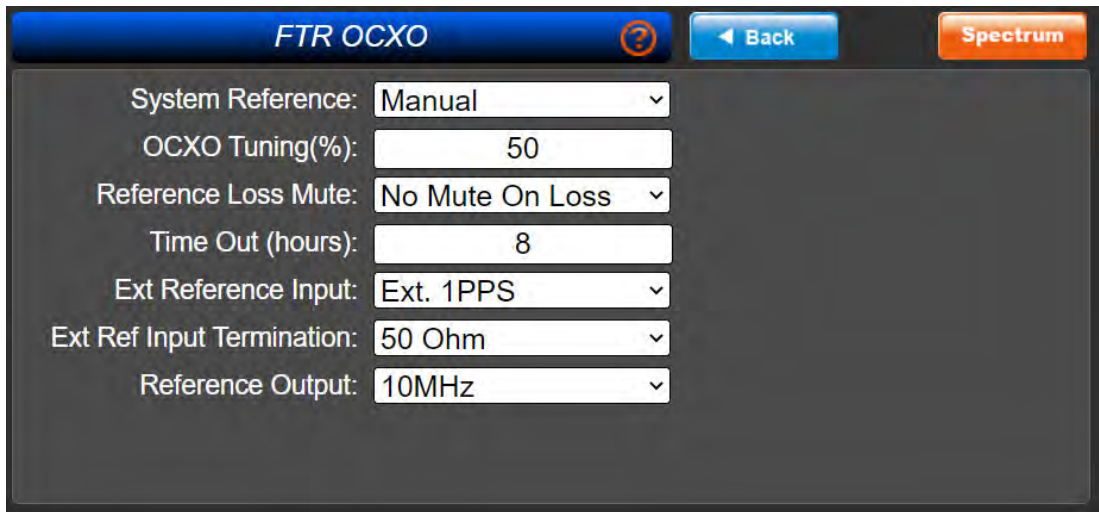
Max Switch Count: 5

Switch Count: 5

GNSS Status Switch Reset

Exciter B

Exciter FTR OCXO



FTR OCXO ? Back Spectrum

System Reference: Manual ▾

OCXO Tuning(%): 50

Reference Loss Mute: No Mute On Loss ▾

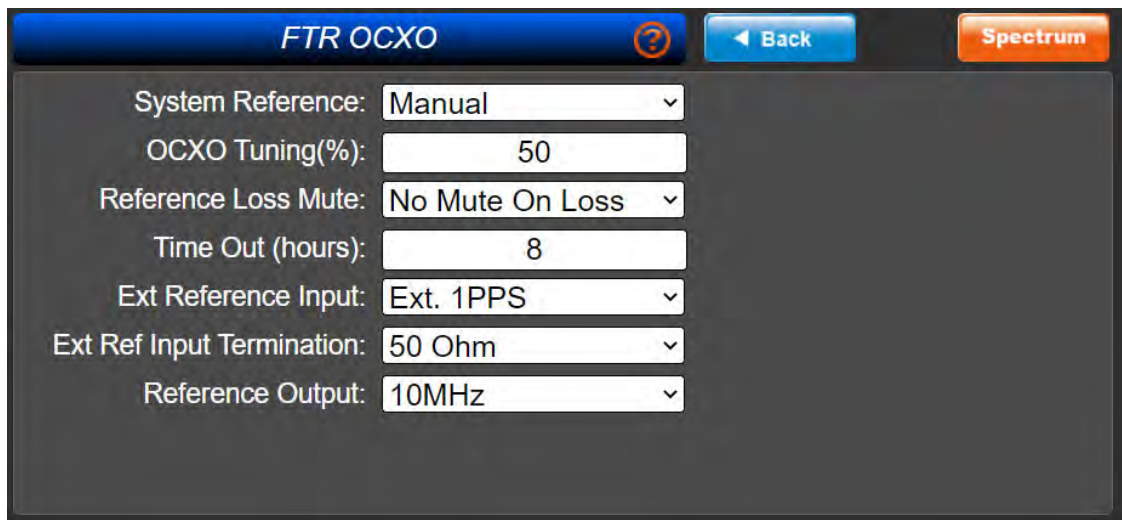
Time Out (hours): 8

Ext Reference Input: Ext. 1PPS ▾

Ext Ref Input Termination: 50 Ohm ▾

Reference Output: 10MHz ▾

Exciter A



FTR OCXO ? Back Spectrum

System Reference: Manual ▾

OCXO Tuning(%): 50

Reference Loss Mute: No Mute On Loss ▾

Time Out (hours): 8

Ext Reference Input: Ext. 1PPS ▾

Ext Ref Input Termination: 50 Ohm ▾

Reference Output: 10MHz ▾

Exciter B

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ANNEX: Harmonics and Spurious Emissions Measurement Anomalies

Higher order spurious emissions and harmonics measurements are distorted by the propagation of higher order waveguide modes within the couplers and diameter size of low pass filters used within the system. These modes result in anomalous responses and impedance mismatches which cannot be accurately accounted for by a calculated offset from the coupler and the low pass filter characterizations. Because of the moding anomalies, the amplitude accuracy versus frequency response has specific upper bound frequency measurement relative to transmission line sizes. Typical behavior for common transmission line sizes are as such:

Line Size	Calculated Cut-off, MHz	Useful Cut-Off, MHz	Outer I.D. (in)	Inner O.D. (in)
7/8" 50Ω	6658.749	6000	0.785	0.341
1 5/8" 50Ω	3422.068	3000	1.527	0.664
3 1/8" 50Ω	1726.797	1600	3.027	1.315
4 1/16" 50Ω	1327.976	1262	3.935	1.711
6 1/8" 50Ω	873.762	806	5.981	2.600
6 1/8" 75Ω	974.747	830	5.981	1.711
7 3/16" 75Ω	833.083	752	7.000	2.000
8 3/16 75Ω	728.644	704	8.000	2.290
9 3/16" 50Ω	580.771	552	9.000	3.910
9 3/16 75Ω	647.474	615	9.000	2.5

The TEM cutoff frequency happens at the frequency in which the circumference at midpoint inside the dielectric equals a wavelength.

The above statement in equation form:

$$\lambda_c = \pi \left(\frac{D+d}{2} \right)$$

Then:

$$f_c = \frac{c}{\lambda_c} = \frac{c}{\pi \left(\frac{D+d}{2} \right)}$$

Simplifying the equation, it can be approximated to:

$$f_c = \frac{7500}{(D+d)}$$

Where

- f_c is the cutoff frequency in MHz
- D is the diameter of the outer conductor, in inches
- d is the diameter of the inner conductor, in inches

Referencing EIA RS225, the standard defines Upper-Frequency limit as: "The UPPER-FREQUENCY LIMIT is determined by the cut-off frequency of higher order "waveguide" modes of propagation, and the effect, which they have on the impedance and transmission characteristics of the normal TEM coaxial transmission line mode. The lowest cut-off frequency occurs with the TE_{11} mode, and this cut-off frequency in air dielectric line is the upper-



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frequency limit of a practical transmission line. How closely the TE₁₁ mode cut-off frequency can be approached depends on the application.”

Above the cutoff frequency, the TE₁₁ higher order mode is allowed to propagate and has a different propagation velocity than the base TEM mode, which, in turn, interferes with it. When below the cutoff frequency, the TE₁₁ rapidly disappears along the transmission line. When propagating beyond the cutoff frequency, the effect is unpredictable, based on a complex set of factors, most notably, line length, variable impedance and positioning of the directional coupler feeds relative to the phase of the line.

GatesAir has analyzed this ongoing phenomenon and has characterized/verified our power amplifier/transmitter output independent of these factors. Under controlled lab conditions, we have characterized the raw harmonic energy out of the transmitter and have quantified that the RF energy produced does not exceed -110dBc from 1.907GHz and beyond throughout the rest of the band. We then can use the indirect method to calculate the harmonic response of the transmitter after the low pass filter.

When performing proofs at the broadcasting installation site for FCC compliance, the above technique is not practical, due to mostly installation/infrastructure restraints. So, the spurious measurement must be taken with a directional coupler after all of the appropriate filters. Great care must be taken to have the directional coupler and the low pass filters characterized to show where the TE₁₁ mode is most prevalent in the system. Due to added transmission line lengths and different positions of added transitions, the exact TE₁₁ modes are an unknown variable. These points, therefore, distort the real output measurement of the spectrum to make the actual harmonic or spurious emission look greater than what is emanating from the transmitter. Therefore, the measured result at the broadcast facility yields erroneous values past the useable cutoff frequency.

Looking at the response of a typical 1/4-wave directional coupler – (in this case a $3\frac{1}{8}$ " diameter), the TE₁₁ interaction is evident in Figure 1.

Figures 2a-c are plots made from raw network analyzer data from the same ¼ wave directional coupler sweep.



Figure 1. Broadband plot from ¼ wave Coupler



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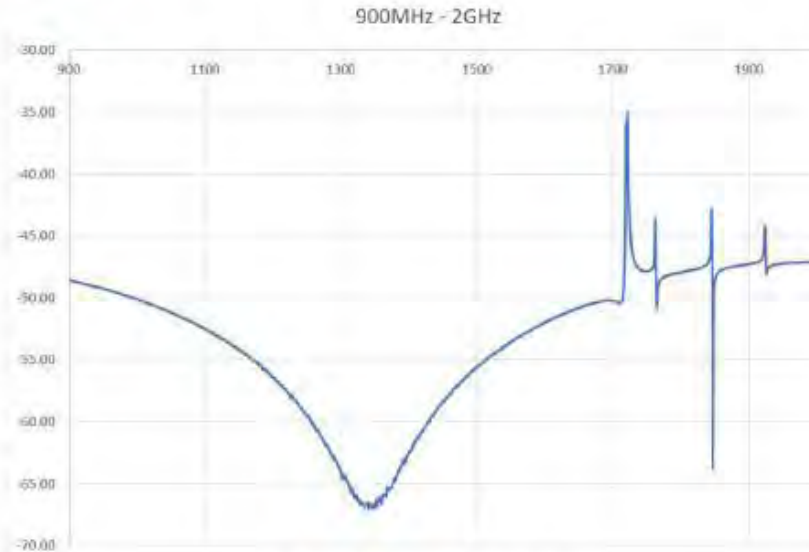


Figure 2a. 900Mhz - 2GHz sweep

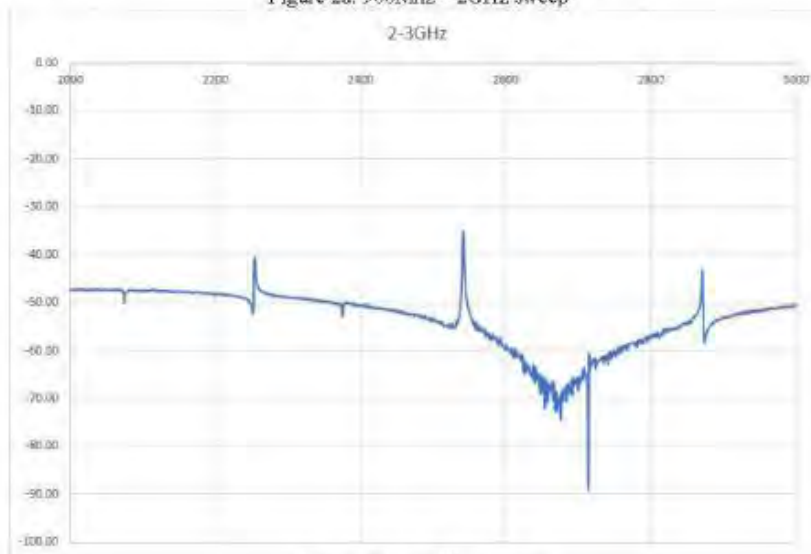


Figure 2b. 2 - 3GHz sweep



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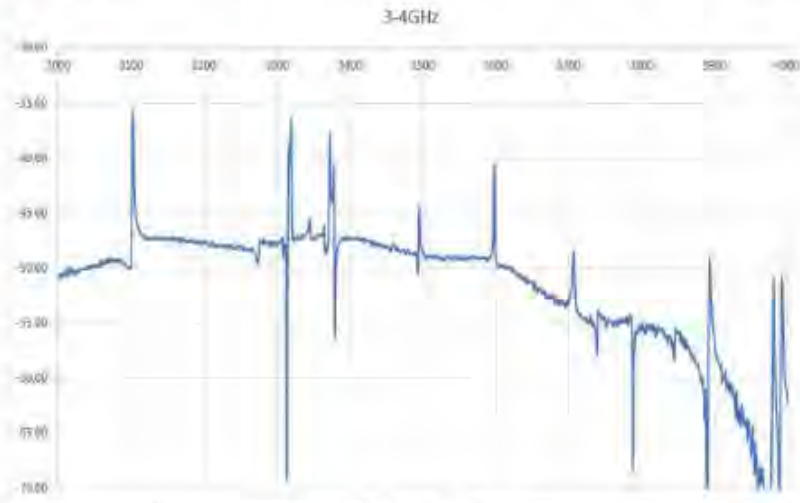


Figure 2c. 3 - 4GHz sweep

The data shows a worst-case measurement uncertainty of +20/-30dB. Therefore, there is no accurate directional coupler correction above the transmission line cut-off frequency that can be applied for an accurate measurement that fully characterizes the transmitter's spectral output for compliance when using directional couplers. This phenomenon is also addressed in the European standard, ETSI EN 302 296 V2.1.1, and the EIA RS225 transmission line standard for frequency cutoff. If further clarification is needed, data from this investigation can be obtained from GatesAir directly.