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Engineering Report

Commissioned by and prepared for:

WBGN 1340 – BOWLING GREEN, KY

Test date: 8/24/2023

AM Broadcast Bandwidth
& Emissions Compliance Tests
in accordance with §73.44

AM Bandwidth, Harmonic, and Intermodulation Measurements

List of Attachments

Spectral plot(s)

LP-3 Antenna Calibration

Station Data

WBGN operates at 1000 watts on a frequency of 1340 kilohertz.

The transmitting antenna is located at 37 00 34 North latitude, and 86 27 09 West longitude. These tests were conducted at a test site location within one Kilometer. The results of these tests show that the station is **passing**.

Results summary for WBGN - 1340 kHz

Category	FCC Limit	Results	
Bandwidth – 0 to 25 kHz	Per NRSC Mask	Passing	
Bandwidth – 25 to 75 kHz	Per NRSC Mask	Passing	
Bandwidth – 75 kHz +	73 dB	Passing	
Spurious Emissions	73 dB	Passing	
2nd Harmonic	73 dB	91 / Passing	
3rd Harmonic	73 dB	80 / Passing	
(Diplexed Only) F1- F2	73 dB	NA	
(Diplexed Only) F1+ F2	73 dB	NA	
(Diplexed Only) 2F1 - F2	73 dB	NA	
(Diplexed Only) 2F2 – F1	73 dB	NA	

Introduction to Measurements

§73.44 sets forth performance standards for all AM broadcast stations, to be measured yearly. These tests characterize the potential of the transmitter to interfere with other broadcast stations, or other radio-frequency services including those associated with public safety and aeronautical, but are not necessarily indicative of a station's on-air audio quality or signal coverage. Often the results of these tests provide the licensee with early warning of serious transmission system problems. These tests include occupied bandwidth, harmonic radiation, spurious energy, and for diplexed stations, intermodulation (mixing) products. This report contains the results of these tests, conducted in accordance with currently accepted engineering practice. A maximum of 14 months may elapse until the station must again repeat these tests.[1]

[1] Per § 73.1590(a)(6). A 12-month interval is most cost effective.

Engineer's Certification

I, Christopher R. Scott, CPBE, certify:

That my qualifications as a radio engineer are on record with the Federal Communications Commission, having been presented and accepted repeatedly in the past, That I have been examined and am currently certified as a Professional Broadcast Engineer by the Society of Broadcast Engineers; That I am Chief Broadcast Engineer, retired, after 28 years at Western Kentucky University; That I have made significant contributions to the science of AM Bandwidth measurement instrumentation and methodology;[1]

That the tests, measurements and accompanying technical analysis presented in this document were either supervised by, or personally conducted by myself, and that all information presented is true and accurate to the best of my knowledge and belief.

/s/______________________ 9/16/23

Christopher Robinson Scott ("Chris Scott")

Subscribed and sworn to before me: _______________ date.

Chris Scott & Associates Bowling Green, KY USA

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Notary Public

My commission expires:

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[1] *Radio World*, Sept 7, 1994. The engineer designed and commercially produces a calibrated shielded loop antenna and notch filter used to conduct AM bandwidth & harmonic tests. This antenna is now an industry standard, used by the FCC, and is referenced in both the NAB Engineering Handbook and standards document NRSC-G201 *Measurement Methods and Practice*.

Instrumentation List

1. Anritsu model 2721b spectrum analyzer SN 845216.

2. LP-3 Shielded loop antenna, serial number "LAB REF".

3. AM frequency tunable notch filter (CSA commercial manufacture). Attenuation is less than .8 dB at 2f, less than 1.5 dB at 3f. This attenuation data is used in combination with the antenna factor in determining harmonic and IM attenuation levels.

4. BLP-10.7 low-pass filter, used in the presence of FM transmitting antennas.

Calibration

All instruments were tested and calibrated prior to their use to ensure compliance with manufacturers' specifications. The LP-3 shielded loop antenna is the actual laboratory reference transfer standard used for comparison against units in commercial production, and was calibrated in accordance with the attached detail, using procedures similar to those recommended by NIST to calibrate AM field strength meters.[1]

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[1] See LP-3 calibration detail attachment.

Harmonic Attenuation

This data was obtained using the spectrum analyzer, a fundamental frequency notch filter, and the LP-3 laboratory reference loop antenna which has a calibrated field intensity / output voltage relationship from .1 to 10 MHz. The spectrum analyzer is used as the calibrated level indicator, with cross-modulation-free indication assured with the selectivity enhanced by the notch filter. The estimation of uncertainty is within plus or minus 3 dB when the entire system is considered.[1] Numerous comparisons to calibrated Potomac Instruments FIM-41 instruments have produced agreement well within plus or minus 2 dB.[2] Similar methods were used for the measurement of intermodulation product levels in the case of diplexed stations feeding a common radiator.

Measurement Site Selection

Unless indicated otherwise, site selection was based upon accessibility, freedom from electrical noise and re-radiation structures, at approximately 1-kilometer distance or closer, as required to produce an acceptable signal-to-noise ratio. Where a directional antenna array was being measured, this location was within the angular 3 dB area produced by the main lobe. In the case where the measurements were made near fm or television broadcast antennas, a 10 Megahertz low-pass filter was used to prevent spectrum analyzer overload from the interfering transmitter. Harmonic radiation values were in all cases measured far enough outside the induction field to prevent transmitter cabinet radiation and that from impedance matching network components from contaminating the actual far-field ratios.

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1. Data from model 2721b spectrum analyzer users manual, root-sum-squared ("RSS") method.
2. The Engineer's empirical laboratory data.

Occupied Bandwidth Measurement

Bandwidth measurements were made in accordance with §73.44, using the peak-recording mode of the spectrum analyzer in conjunction with the standard NRSC mask described below. Generally, measurements were conducted at the same site as used to collect the harmonic data. In all cases, air-chain adjustment and programming were the same as used during standard operation. Where a mode change is used, tests were conducted in both modes. If the mode switch was unavailable, the highest power mode is documented. In some measurement environments, a common problem with bandwidth testing develops when the ratio between the subject's received carrier and those of other broadcast stations is less than the prescribed attenuation; this produces ambiguity and invites subjective judgment. In order to minimize this, one or more of several techniques were used:

1. The azimuthal orientation of the shielded loop antenna was adjusted to null the subject station, noting whether the questionable spectra reduced by a similar amount.

2. Individual interfering carriers were individually nulled, obtaining a bearing from each source.

3. The measurement location was moved closer to increase signal-to-noise ratio.

4. In extreme cases, corroborating measurements were taken with the shielded loop antenna placed well within the induction field. By whichever means required, satisfactory spectra attribution was obtained.

> **"Mask" described in §73.44(b):** Emissions 10.2 kHz to 20 kHz removed from the carrier must be attenuated at least 25 dB below the unmodulated carrier level, emissions 20 kHz to 30 kHz removed from the carrier must be attenuated at least 35 dB below the unmodulated carrier level, emissions 30 kHz to 60 kHz removed from the carrier must be attenuated at least [5 + 1 dB/kHz] below the unmodulated carrier level, and emissions between 60 kHz and 75 kHz of the carrier frequency must be attenuated at least 65 dB below the unmodulated carrier level. Emissions removed by more than 75 kHz must be attenuated at least 43 + 10 Log (Power in watts) or 80 dB below the unmodulated carrier level, whichever is the lesser attenuation, except for transmitters having power less than 158 watts, where the attenuation must be at least 65 dB below carrier level.

The following page shows the actual spectral plots, normally one wide and one narrow, with the §73.44 upper limit "mask" depicted as appropriate for the transmitter power level. All emissions from the station under test must fall beneath the mask line. If signals from other stations penetrate above the mask line, they are identified.

CALIBRATION of LP-3 series antennas

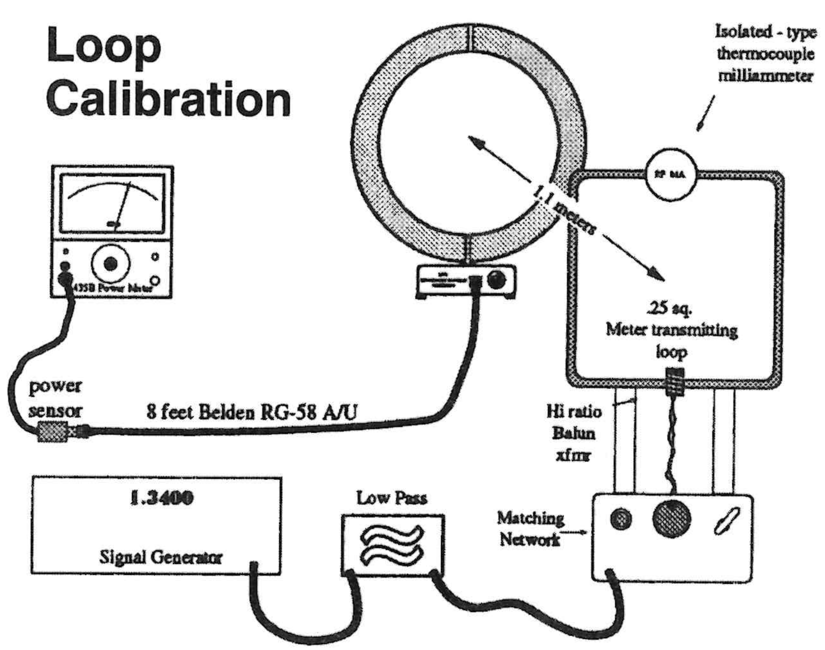
CS & A maintains a standard field for frequencies between .25 and 5 MHz, for calibrating loop antennas. This standard field is generated by a constant current loop antenna that has stable characteristics, metered by an accurate NIST traceable thermocouple milliammeter. This field is periodically audited by a NIST traceable transfer standard and kept in agreement to NIST within 5%. The methodology for this calibration system was originally published with a refined algorithm by Frank Greene of NIST (then NBS).

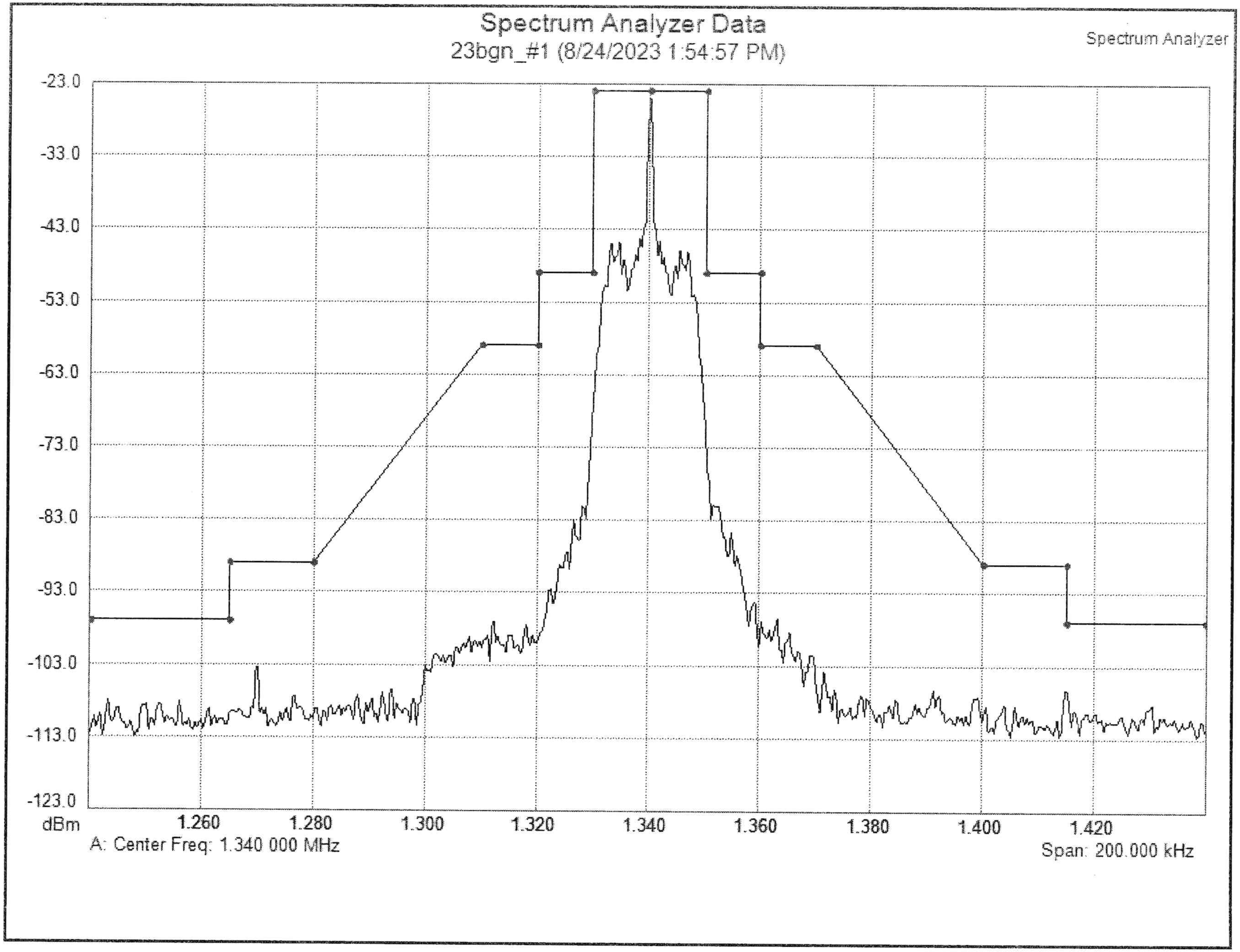
The formula predicting the near electromagnetic field in equivalent volts per meter units when two loop antennas are aligned coaxially is:

$$Ro := \sqrt{\left(d^2 + r1^2 + r2^2\right)} \qquad VM := \left[\left(\frac{I \cdot S1}{2 \cdot \pi \cdot Ro^3}\right) \cdot \left[\left[1 + 1.875 \cdot \left(\frac{r1 \cdot r2}{Ro^2}\right)^2 + 4.922 \cdot \left(\frac{r1 \cdot r2}{Ro^2}\right)^4\right] \cdot \sqrt{\left(1 + \beta^2 \cdot Ro^2\right)}\right]\right] \cdot ZoFS$$

$MHz := 1$	Frequency	$I := .2$	Transmit loop current
$d := 1.1$	Axial spacing between loops: M	$\beta := \frac{2 \cdot \pi}{\lambda}$	$ZoFS := 376.7304$
$r1 := .282$	Radius of transmit loop: M		
$S1 := .2488$	Area of transmit loop: sq. M	$r2 := .2222$	Radius of receive loop: M

This calculation of the standard field is inherently accurate to within .2%. Due however to errors in physical measurements, and limits of RF current metrology, 6% is our standard. Our entire calibration system when considered in its entirety, results in an estimation of uncertainty of 1.2 dB. The accuracy specification for LP-3 series loop antennas is + / - 1.5 dB.

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-113.0
-123.0
dBm
1.260
1.280
1.300
1.320
1.340
1.360
1.380
1.400
1.420
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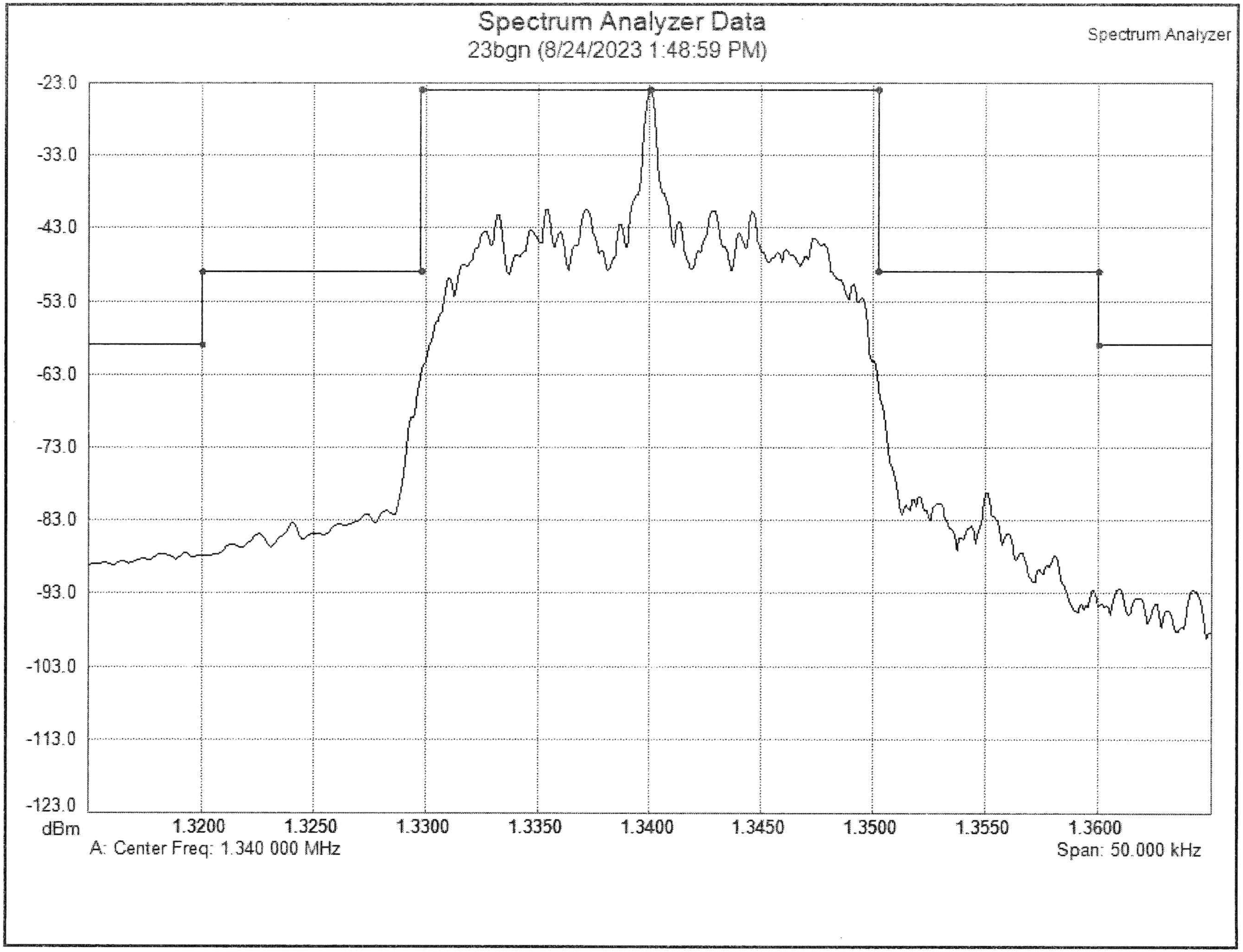
Span: 200.000 kHz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-113.0
-123.0
dBm
1.3200
1.3250
1.3300
1.3350
1.3400
1.3450
1.3500
1.3550
1.3600
A: Center Freq: 1.340 000 MHz
Span: 50.000 kHz