Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the matter of:

Amendment of Parts 73 and 74 of the	**)**	**MB Docket No. 03-185**
Commission's Rules to Establish Rules for Digital	**)**	
Low Power Television, Television Translator, and	**)**	
Television Booster Stations and to Amend Rules	**)**	
For Digital Class A Television Stations	**)**	

To the Commission:

SUPPLEMENTAL ENGINEERING FIELD STUDY

R. Kent Parsons here respectfully submits the attached "Supplemental Engineering Field Study" for inclusion in the record of the above rule making proceeding. The date for comments and reply comments has passed. On March 22, 2004, the undersigned presented at the Commission's offices in Washington, D.C. a tutorial and report of field investigations. These were based on extensive tests using digital and conventional facilities for TV translator transmissions in several locations in the "Back-Bone" Translator System of Utah.

In comments filed herein, and especially through discussions at the tutorial and after, questions were raised as to possible destructive interference to GPS users, from the second and third harmonics of future DTV translator emissions. This issue was not squarely raised in the Notice of Proposed Rule Making here and to this date had not been investigated in the field. Such interference, if it posed a realistic possibility, could require a re-examination of the proposed technical standards for digital translators.

In view of this I immediately made plans to supplement the tests we had conducted, to make actual measurements and determine whether this problem existed and, if so, it's apparent magnitude.

Actual 2nd and 3rd harmonics field measurements were performed from early May to May 27. These results are now submitted. As indicated in the title page and summary attached, this was a collaborative effort throughout. The tests and analysis were made possible by the hard work and diligence of myself, Mauri Parsons, Johnny Parsons, Reggie Parsons, Gary Sgrignoli, John Tremblay and others.

We conclude that even though existing TV translators would meet the out-of-band spurious products with our suggested reduced power levels, an additional low-pass filter would further insure no interference to any GPS reception would occur.

The low-pass filter can be installed within a new filter or added externally. In many instances, older existing equipment can be used with the addition of an external low-pass filter, and nothing further should be required.

Where it is necessary to mandate a low-pass filter, low-cost equipment is available now ($275.00 - $475.00) and these prices can be expected to drop in the future.

In conclusion, I am pleased to report that, where this problem was measurable, an economical solution is at hand, well within the state of art. Certainly this issue should in no way delay the Commission in bringing forward rules for digital service using LPTV and translators.

Respectfully Submitted,

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A DOCUMENTED FIELD TEST CONCERNING THE POSSIBILITY OF 2nd and 3rd HARMONICS OF A TYPICAL TELEVISION TRANSLATOR STATIONS CAUSING INTERFERENCE TO GLOBAL POSITIONING SATELLITE (GPS) RECEPTION

EXECUTIVE SUMMARY

The University of Utah is the licensee of primary station KUES-DT Channel 19 located approximately four miles east of Monroe, Utah on Cove Mountain (38 38' 5.8" North Latitude – 112.03' 34.1" West Longitude) at 2672 meters AMSL. This station is operating with a transmitter output power (TPO) of 25 Watts and an effective radiated power (ERP) of 330 Watts. The station was proofed for compliance of a full power primary DTV station on March 31, 2003.

While the station is authorized for primary service, its 8-VSB programming is delivered 60 miles via a Broadcast Auxiliary Service (BAS) microwave channel (6.9875 GHz) from the Levan relay site, which is 83 miles from the originating KUED-DT (CH 42) station in Salt Lake City, Utah (Farnsworth Peak). It is received on an 8' Cable Wave parabolic dish transferred through wave-guide to a Microwave Radio Corporation DAR receiver with a 70 MHz IF output. It is then distributed to the VSB transmitter using a Zenith Transcoder (digital regenerator), which performs tuning, synchronization, and equalization (ghost canceling) before performing its error correction (trellis deciding and Reed-Solomon decoding). The perfectly replicated MPEG transport stream is modulated according to the ATSC's 8-VSB standard before being upconverted in a LARCAN up-converter, and amplified in a LARCAN model MX100/u high power solid-state amplifier. The final output signal passes through a Telewave isolator and a Teracom six-section emission mask band-pass filter before carried to the Scala Corporation model SL-8 transmit antenna, via 95 feet of 7/8" Heliax coaxial cable. It is expected that this combination of components will be a model for many digital television translators across America in the future. The center of radiation of the transmit antenna is 60 feet above ground level.

Extensive tests have been made using this particular Cove Mountain DTV station site for recording and documenting out-of-band emissions in the first adjacent channel as well as those resulting from the 2nd and 3rd harmonics of the translators. There has been a concern within the FCC and other groups regarding the possibility of causing interference to both terrestrial receiver and satellite GPS receiver reception. Translator licensees have equal concern regarding these issues and extensive field tests were needed to identify the actual out-of-band emissions, especially into GPS bands. While the 2nd and 3rd harmonics of channel 19 do not fall within the GPS band, the measured results are indicative of those DTV channels whose 2nd or 3rd harmonics do fall with the protected GPS bands (L1, L2, and L5). Likewise, the measurement techniques being used will serve as a model for future FCC compliance measurements.

Initial attempts to measure and calculate 2nd and 3rd harmonics radiating from this station were affected by ambient EMI radiation from the DTV transmitter rack itself, although the 10 μWatt limit was met. A final test on May 20, 2004 was performed to reduce the spurious EMI pickup, and resulted in even better GPS harmonic results. This indicated that DTV translator stations can be properly measured for compliance of the *proposed* 10 μWatt ERP limit (see supplemental NPRM comments by Sgrignoli dated April 16, 2004).

Using the *proposed* DTV translator standards that were originally established for *full* power television stations, and considering the relatively low power typically radiated by TV translator stations, existing standards can be met and in many cases exceeded. A 10 μWatt interference power (in a 500 kHz band) is currently used in full power station requirements. This is determined by the fact that the maximum ERP for a full power primary station is 1 MW (average power in 6 MHz) and the mandatory GPS interference requirement is 110 dB down from this total in-band power. This calculates to a 10-μWatt radiation level (in a 500 kHz bandwidth).

With the power reduction TV translators use, the 10 μWatt limitation can be easily achieved by good engineering practices such as use of an additional low-pass filter that is either built within the mask filter or an external low-pass filter. An additional attenuation of 50 dB can be achieved at the GPS frequencies with the addition of a low pass filter, helping even those transmitters with moderate 2nd and 3rd harmonic energy to meet the proposed 10-μWatt interference limitation. However, measuring significantly below the 10-μWatt limit may impose some problems with test methodology.

Finally, DTV translator operator education is essential to the success of the DTV transition in rural areas, and should be undertaken immediately.

DETAILS

Overview

Tests were performed on May 17th, 18th, and 20th at the Cove Mountain DTV transmitter site (38 38' 5.8" North Latitude – 112.03' 34.1" West Longitude and an altitude of 2672 meters above mean sea level, i.e. AMSL), which is 143 miles south of the originating site of Salt Lake City. However, the Cove site is fed from Levan Peak, which is a relay site about 83 miles south of Salt Lake City and about 60 miles north of the Cove Mountain site. Therefore the output of the Cove Mountain site used in this testing is the 2nd hop in a multi-hop system. The translator site is a small building next to the 40' tower as shown in **Figure 1a.** Note the transmitter building is immediately adjacent to the tower.

The following description is of the equipment that is installed in the Cove translator site, as shown in **Figure 2**.

An 8' parabolic antenna (with *no* low-noise pre-amplifier) mounted on the side of the local 40' tower (about 30' above the ground, i.e. AGL) is used to receive the 6.9875 GHz BAS microwave signal from the Levan Peak relay site. The signal was transported to the Microwave Receiver Corporation's DAR receiver by a transverse waveguide, where it was then downconverted to a 70 MHz IF signal (terrestrial television channel 4 was used, i.e., 66-72 MHz).

This signal, after some attenuation pads, is inserted into the Zenith transcoder, a digital regenerator using a 4th generation VSB decoding chip that demodulates and decodes the channel 4 RF signal. The incoming signal is above threshold, therefore, the transcoder reduces any multipath and interference present, and creates an error-free MPEG transport signal that is re-modulated to a pristine 8-VSB signal IF signal at the transcoder output.

The 44 MHz IF output is upconverted to RF Channel 19 (500 - 506 MHz, with a center frequency of 503 MHz) by a LARCAN upconverter. This relatively low-level exciter output signal is then amplified to its final average output power level (in 6 MHz bandwidth) of 30 Watts by a LARCAN MX100/u transmitter.

This 30-Watt VSB RF output is inserted to a 10-inch long 50-Ohm coaxial cable; which then feeds a Telewave, Inc. "narrow-band" isolator (circulator) tuned to channel 19. The purpose of this isolator is to provide constant impedance (over at least three channels) to the solid-state LARCAN amplifier that the narrow-band emission mask band-pass filter does not do. The linear and non-linear performance of the transmitter is improved due to this isolation of the transmitter output from the non-constant bandpass filter impedance. The isolator was directly connected to the input of the six-section Teracom filter with a male bullet (transmitter output power from the filter is 25 Watts, producing an ERP of 330 Watts/6 MHz at the antenna output) for the first test, and then subsequently connected to the three-section Television Technology Corporation (TTC) filter. A performance comparison of the two filters is discussed later in this document.

In the *first* test, the 30-dB directional coupler that is permanently mounted in the system was used to measure a portion of the output signal for splatter and harmonic content. Following the directional coupler is 95 feet of 7/8" Andrew Heliax cable that supplies the Scala single-channel 19 omni-slot antenna (Model SL-8) with narrow-band characteristics (e.g. one-channel wide).

In the *second* test, the feed-line cable to the Scala antenna was disconnected, and a 20 foot long Beldon 8214 (RG8 foam), with a *single*- copper-braid coaxial cable was connected to the filter output. The other end of this cable was then connected to a 50-Ohm, 20-dB high-power Tenuline Coaxial Attenuator (Model 8340-200 – SN 4798) that is capable of handling the full 25 Watts of digital signal power (power at the attenuator output is 0.25 Watts).

Figure 1b shows the terrestrial translator equipment with the test equipment sitting on a table just in front. The two spectrum analyzers used in these tests are shown. The first is an expensive IFR Systems Inc. laboratory unit, Model AN1820 (Serial # 2026), that is often used in laboratory testing scenarios while the second is a smaller, light-weight battery-operated portable Rhode & Schwarz, Model FSH-3 (Serial #100110) that is easy to carry around to remote locations. Data was taken with both of these units in order to verify transmitter measurement results with multiple pieces of test equipment.

TEST METHODOLOGY (Test #1)

The test methodology used during the first test (May 17, 2004) followed some simple procedures presented at the NTA conference held in Salt Lake City, UT on May 14-16 by Gary Sgrignoli. It covers three (3) basic measurements of compliance testing.

1) Absolute in-band average transmitter power output (TPO) within 6 MHz, from which the effective radiated power (ERP) is calculated.
2) Relative 1st adjacent channel splatter energy (within 500 kHz sub-bands) compared to the desired FCC's rigid emission mask.
3) Absolute harmonic energy with the GPS band (500 kHz compared to total in-band power) using a high pass filter to remove the fundamental energy

The procedure begins with calibrating the directional coupler, the test cable, any attenuation pads inserted to optimize spectrum analyzer dynamic range, and the high pass filter that is used to reject the fundamental DTV signal when measuring the harmonic content. **Figure 3** illustrates the calibration measurement results.

The first measurement is that of the fundamental in-band TPO signal power. That was measured to be +8.3 dBm. When taking into account the directional coupler tap loss (30.1 dB) and its "through" loss (0.5 dB), the test cable loss (1.4 dB), and the attenuator pads (4 dB), the TPO is found to be +44.3 dBm, or about 27 Watts. Using the line loss and the antenna gain, the ERP is calculated to be 330 Watts.

The second measurement is to view the 1st adjacent channel splatter to see if it meets the desired FCC rigid emission mask. **Figure 4** illustrates the spectrum measured on the CH 19 transmitter. Note that the dynamic range on the unit is shown at about 61 dB, which covers the proposed simple mask (60 dB from in-band "flat-top" to edge of 1st adjacent channel). This was achieved by using an external 4 dB pad since the spectrum analyzer's internal attenuator changes in 10 dB steps. If the proposed stringent mask were required, a few more dB would have been added in front of the analyzer since 65 dB of dynamic range is needed for the this emission mask.

The third measurement is to measure the absolute 2nd and 3rd harmonic energy of the transmitter output. In order to increase the dynamic range of the spectrum analyzer to easily view and measure the harmonic energy, the spectrum analyzer sensitivity must be increased by lowering its input attenuator. However, the DTV's fundamental signal power will overload the front end of the analyzer and cause harmonic energy of its own. Therefore, a high pass filter is employed to remove any lower frequency energy (primarily the fundamental signal). **Figure 5** illustrates the transfer function of the Mini-Circuits high-pass filter used in this test.

The harmonic content was measured in a 500 kHz bandwidth. The harmonic content is shown in **Figure 6** and **Figure 7**. Note that the harmonic content, as seen in Figure 6, is not a flat spectrum across a 6 MHz bandwidth, and is "rounded". Also, the harmonic spectral energy stretches either 12 MHz (2nd harmonic) or 18 MHz (3rd harmonic). It can be observed that the 3rd harmonic is within the noise floor of the spectrum analyzer.

Table 1 contains the summary of the measurements and the calculations for Test #1. Note that the calculated interference into a 500 kHz sub-band within the 2nd and 3rd harmonic region is less than the proposed 10 uWatts. This calculation assumes that the transmission line loss and the antenna gain are equal to the values known for the fundamental frequency, which is believed to be a pseudo-worst case scenario. In many cases, there will be some attenuation at the GPS frequencies (1.1 – 1.6 GHz), which will help to reduce any harmonic interference into GPS devices. To measure equivalent harmonic energy interference much below 10 uWatts can be challenging at best due to the required instrumentation and operator skills.

TABLE 1 Test #1 with 6-Section Filter & Directional Coupler/Cable/4 dB Pad

Component	503 MHz	1006 MHz	1509 MHz
Test Point Measurement	+8.2 dBm/6 MHz	-77.2 dBm/500 kHz	-84.5 dBm/500 kHz
30 dB Directional Coupler "Thru" Loss	0.5 dB	0.5 dB	0.5 dB
30 dB Directional Coupler Tap Loss 8.4' Coaxial Test Cable Loss 4 dB Attenuator Pads	-36.1 dB	-36.2 dB	-36.7 dB
NHP-700 High Pass Filter Loss (no filter/with filter)	0 dB / 32.7 dB	-3.2 dB	-3.0 dB
Calculated TPO (log)	+43.8 dBm	-38.3 dBm	-45.3 dBm
Calculated TPO (linear)	24.0 Watts	0.15 uWatts	0.03 uWatts
Coaxial Line Loss	0.9 dB	0.9 dB *	0.9 dB *
Antenna Gain	12.3 dBd	12.3 dBd *	12.3 dBd *
ERP (log)	+55.2 dBm/6 MHz	-26.9 dBm/500 kHz	-33.9 dBm/500 kHz
ERP(linear)	331	2.04 uWatts/500 kHz	0.41 uWatts/500 kHz
Power Relative to In-Band Signal Power	0.0 dB	-82.1 dB	-89.1 dB

* Note: Assume that transmission line loss and antenna gain are same at GPS frequencies as that at fundamental frequency.

TEST METHODOLOGY (Test #2)

After the initial testing was completed, another subsequent test at the Cove Mountain site was run later the same week on May 20, 2004. A different high pass filter (actually, a *bandpass* filter) prototype was used to reduce the fundamental (in-band) signal frequency during the harmonic measurements. The R&S FSH-3 spectrum analyzer was no longer available, so only the IFR spectrum analyzer was used.

Once again, the same results were obtained. However, it was observed that the amount of 2^{nd} harmonic energy would vary as the equipment was moved around the room. It was determined that there was some signal leakage (EMI) reaching the spectrum analyzer due to the fact that all the test equipment was in near proximity to the transmitter. The EMI signal could have come from the transmitter itself, the “accessories” (isolator, filter, directional coupler), the heliax cable carrying the signal to the antenna, antenna radiation itself, or any combination of the previous items. Not enough time was available to determine the exact cause of the EMI. However, it was determined that if the equipment were situated in the next room (separated by sold concrete walls and a metal door), the small levels of harmonic energy that were previously measured would decrease totally below the spectrum noise floor. **Figure 8** is a block diagram of the setup for Test #2 that was used.

To make this special measurement, the transmitter was taken off the air for a time. The output of the emission mask bandpass filter was connected through a 20-foot Beldon 8214 coaxial cable (signal copper-braided shield) to a 20-dB high-power attenuator in order to reduce the 25 Watts/6 MHz signal output for insertion into the IFR spectrum analyzer. The cable loss was measured and calibrated at the fundamental (0.9 dB) and the 2^{nd} (1.6 dB) and 3^{rd} harmonic (2.1 dB) frequencies. This attenuated output of 0.25 Watts (+24 dBm) was directly connected, with a second male bullet, to a custom-built ($500 prototype) band-pass filter from Pacific Millimeter Products, Inc., in Golden CO. This filter attenuated the fundamental channel 19 frequencies by a minimum of 50 dB while passing the GPS frequencies with an insertion loss of 1.8 dB as shown in see **Figure 9**. The output of the GPS band-pass filter was directly connected to the IFR spectrum analyzer for the harmonic measurements with a third male bullet.

Harmonic measurements were first made using a six-section filter, and then a three-section filter, all within a one hour time frame as indicated on the spectrum printout plots. **Figure 10** is a plot of the six-section filter transfer function and **Figure 11** is a plot of the 3-section filter transfer function. Note how the 3-section filter (an older design) has a self-resonance effect at its 3^{rd} harmonic (but not the 2^{nd} harmonic). Therefore, it will allow any 3^{rd} harmonic present in the transmitter output due to non-linearities to pass through it with only about 3 dB of attenuation. On the other hand, the 6-section filter did not have any self-resonant behavior, and thus filter had about 80 dB of attenuation (compared to the pass-band). This explains why the 3^{rd} harmonic performance is so much better than the 3-section filter.

Figure 12 and **Figure 13** show the transmitter’s fundamental (in-band) and harmonic signal power at the 3-section and 6-section emission mask filter outputs, respectively. The 6-section filter was measured by monitoring the 30-dB directional coupler (with the through leg connected to the antenna), where the tapped output was connected via the 20’ coaxial test cable to the IFR spectrum analyzer. The 3-section filter was measured using a 20-dB high-power attenuator to feed the same 20’ test cable that was connected to the IFR spectrum analyzer**.** This accounts for the approximate10 dB difference in the two readings (30 dB directional coupler versus the 20-dB attenuator. Note that, when taking into account the 10-dB difference in test points used, the in-band power at the output of each filter is within 1 dB of each other, the difference coming from the slightly different insertion loss for each filter. The 3-section filter has slightly less insertion loss (0.5 dB) than the 6-section filter (0.8 dB). The noise floor of the analyzer (with 0-dB attenuation at the front end) is around –90 dBm. Only the 3^{rd} harmonic was measurable (above the spectrum analyzer noise floor) when using the 3-section filter.

As previously described, it was observed that the second harmonic that was just above the noise floor when measured in the same room as the transmitter was sensitive to position of the measurement devices (e.g. cable and spectrum analyzer). Therefore, to make accurate harmonic measurements, isolation of 15 feet from the transmitter in an adjacent room with the metal door either open or closed was found to work well to reduce the ambient RF energy in the immediate vicinity of the transmitter. Any remnant of harmonic energy was below the noise floor of the analyzer. Measuring these very low signal levels could not be made accurately when the test equipment was located closer to the transmitter.

Table 2 and **Table 3** summarize the results from the 6-section filter and 3-section filter measurements.

TABLE 2 Test #2 with 6-Section Filter & Directional Coupler/Cable

Component	503 MHz	1006 MHz	1509 MHz
Test Point Measurement	-7 dBm/120 kHz	-90dBm/500 kHz	-90 dBm/500 kHz
Test Point Measurement Correction	+11.9 dBm/6 MHz	-71.1 dBm/500 kHz	-66.7 dBm/500 kHz
30 dB Directional Coupler "Thru" Loss	0.5 dB	0.5 dB	0.5 dB
30 dB Directional Coupler Tap Loss	-30.0 dB	-30.0 dB	-30.0 dB
20' Coaxial Test Cable Loss	-0.9 dB	-1.6 dB	-2.1 dB
0 dB Attenuator Pads	0 dB	0 dB	0 dB
Pacific Millimeter BandPass Filter Loss (no filter/with filter)	0 dB / > 50 dB	-1.8 dB	-1.8 dB
Calculated TPO (log)	+42.3dBm	-51.3 dBm	-50.8 dBm
Calculated TPO (linear)	17.0 Watts	< 0.007 uWatts/500 kW	< 0.008 uWatts/500 kW
Coaxial Line Loss	0.9 dB	0.9 dB *	0.9 dB *
Antenna Gain	12.3 dBd	12.3 dBd *	12.3 dBd *
ERP (log)	+53.7 dBm/6 MHz	-39.9 dBm/500 kHz	-39.4 dBm/500 kHz
ERP (linear)	234	<0.10 uWatts/500 kHz	<0.11 uWatts/500 kHz
Power Relative to In-Band Signal Power	0.0 dB	-93.6 dB	-93.1 dB

* Note: Assume that transmission line loss and antenna gain are same at GPS frequencies as that at fundamental frequency.

TABLE 3 Test #2 with 3-Section Filter & 20-dB Attenuation

Component	503 MHz	1006 MHz	1509 MHz
Test Point Measurement	+4 dBm/120 kHz	< -90dBm/500 kHz	-74 dBm/500 kHz
Test Point Measurement Correction	+22.9 dBm/6 MHz	< -71.1 dBm/500 kHz	-55.1 dBm/500 kHz
20 dB Attenuator "Thru" Loss	NA	NA	NA
20 dB Attenuator Loss	-20.0 dB	-19.9 dB	-18.9 dB
20' Coaxial Test Cable Loss	-0.9 dB	-1.6 dB	-2.1 dB
0 dB Attenuator Pads	0.0 dB	0.0 dB	0.0 dB
Pacific Millimeter BandPass Filter Loss (no filter/with filter)	0 dB / > 50 dB	-1.8 dB	-1.8 dB
Calculated TPO (log)	+43.3 dBm	< -61.4 dBm	-45.9 dBm
Calculated TPO (linear)	21.4 Watts	< 0.0007 uWatts	0.026 uWatts
Coaxial Line Loss	0.9 dB	0.9 dB *	0.9 dB *
Antenna Gain	12.3 dBd	12.3 dBd *	12.3 dBd *
ERP (log)	+54.7 dBm/6 MHz	-50.0 dBm/500 kHz	-34.5 dBm/500 kHz
ERP (linear)	295 Watts/6 MHz	<0.01 uWatts/500 kHz	0.36 uWatts/500 kHz
Power Relative to In-Band Signal Power	0.0 dB	-104.7 dB	-89.2 dB

- Note: Assume that transmission line loss and antenna gain are same at GPS frequencies as that at fundamental frequency.

It should be noted that the 2nd harmonic measurements for the 6-section filter and the 3-section filter were in the noise floor of the spectrum analyzer. However, because the test signal was 10 dB stronger for the 3-section filter than the 6-section filter, a larger dynamic range was achieved.

Note that the harmonic content is reduced due to the location of the test equipment being farther away from the transmitter. Also note that the 3rd harmonic of the 3-section filter is greater than with the 6-section filter due to its resonant response at the 3rd harmonic. Of course, an external low pass filter can reduce harmonic content above 1 GHz by more than 50 dB, and will probably be used in implementations that use older, existing resonant cavity filters. Newer designs will reduce or eliminate the resonant behavior at the harmonics of the DTV channel frequency.

Summary

The test results above indicate that DTV translators can be measured for basic FCC compliance in a straightforward manner. The in-band average DTV power in 6 MHz (TPO) can be easily measured with a spectrum analyzer (with or without band-power markers) as can the adjacent channel splatter energy compliance with a rigid FCC emission mask. Likewise, harmonic energy can be measured, with the use of a high-pass test filter, to verify that any energy beyond 1 GHz is below the proposed equivalent 10-uWatt limit. However, care must be exercised when making these harmonic measurements so as to not measure direct pickup from the transmitter cabinet or other transmission components (coaxial cable or directly from the antenna). Therefore, the accuracy of the measurement can become compromised if too small a limit is placed on the allowed harmonic content. Note that these measurements were made by highly experienced translator technicians using moderately accurate spectrum analyzers and other test equipment.

The above example of a "typical" DTV translator relay site showed that the 10- uWatt limit can be met and measured in a straightforward manner with a spectrum analyzer. Even in the close proximity of the transmitter unit itself (with EMI present in the form of direct pickup), the 2^{nd} and 3^{rd} harmonic content was measured as 2 and 0.5 uWatts, respectively. A lower harmonic content value was measured only when the measurement equipment was moved to a distance of 15 feet or greater away from the transmitter hardware.

The importance of DTV translator operator education is absolutely imperative in the coming months and years. Education on the basic measurements for FCC compliance and required test equipment is essential, which can readily equip the translator operators for their transition into this new digital world. Education can come from the classroom, the laboratory, or it can even occur in the field, as shown in **Figure 14** where Gary Sgrignoli provided an on-site tutorial to those participating in these field test measurements.

Acknowledgments

I would like to thank Mauri Parsons, Johnny Parsons, and Reggie Parsons along with Gary Sgrignoli and John Tremblay for participating with me in the on-site measurements on Cove mountain as well as the data analysis and proofreading of this text.

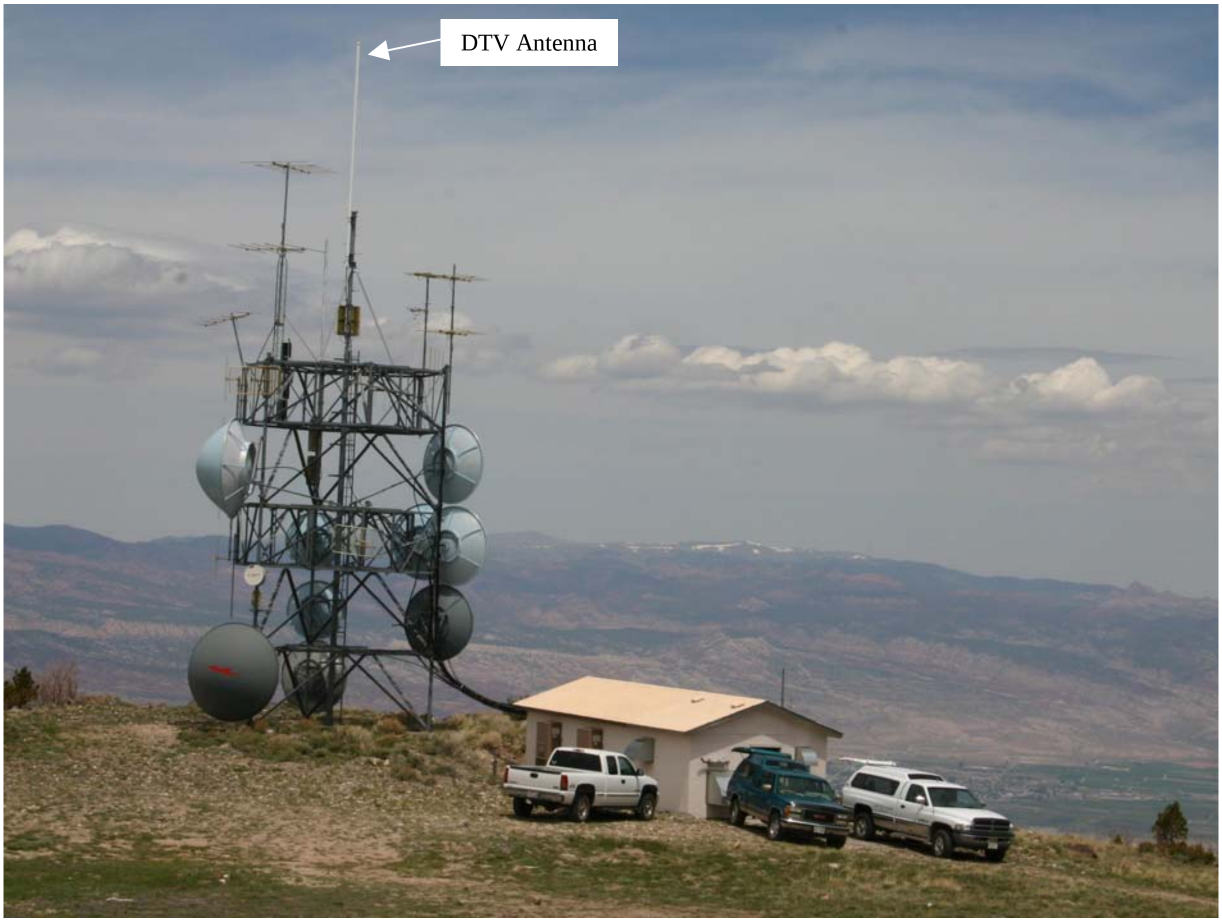

Figure 1a Cove Mountain DTV translator site (3.5 miles east of Monroe, UT): tower & building

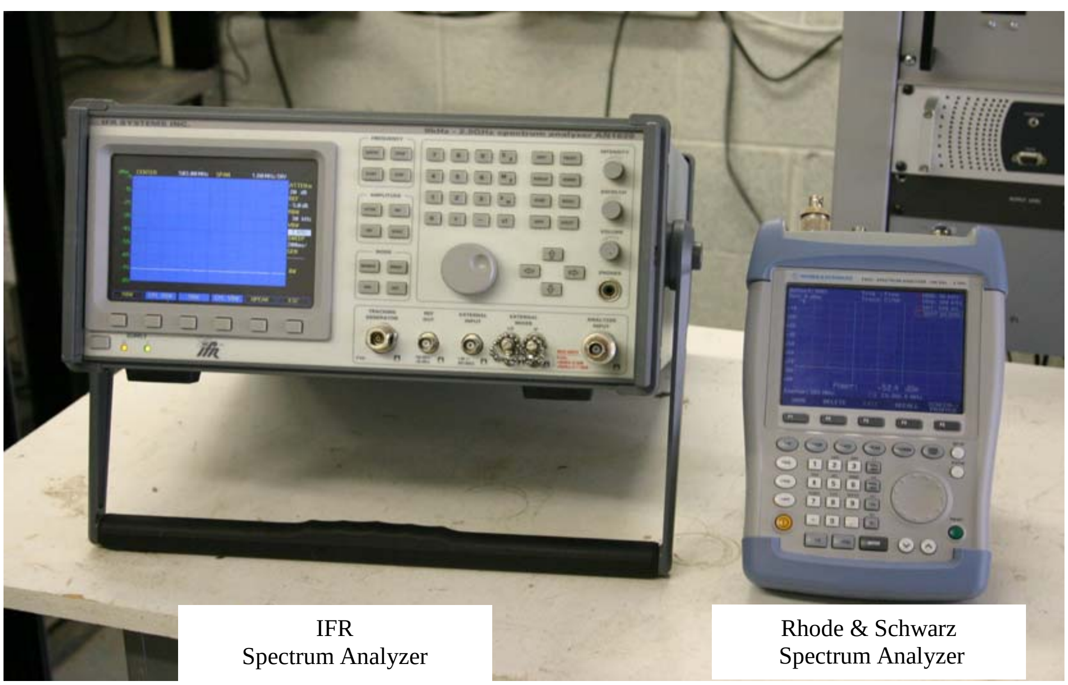

Figure 1b Cove Mountain DTV translator site internal view: test equipment in front of transmitter

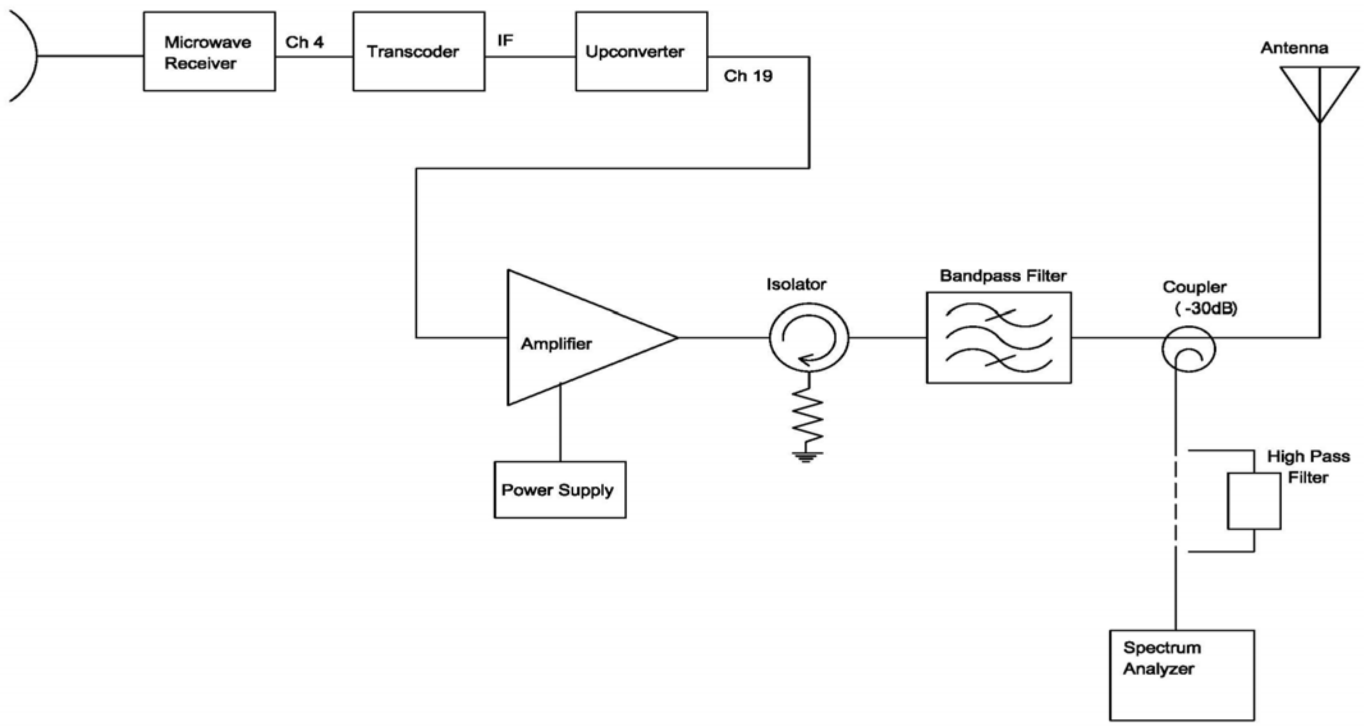

Figure 2 Cove Mountain translator block diagram for Test #1

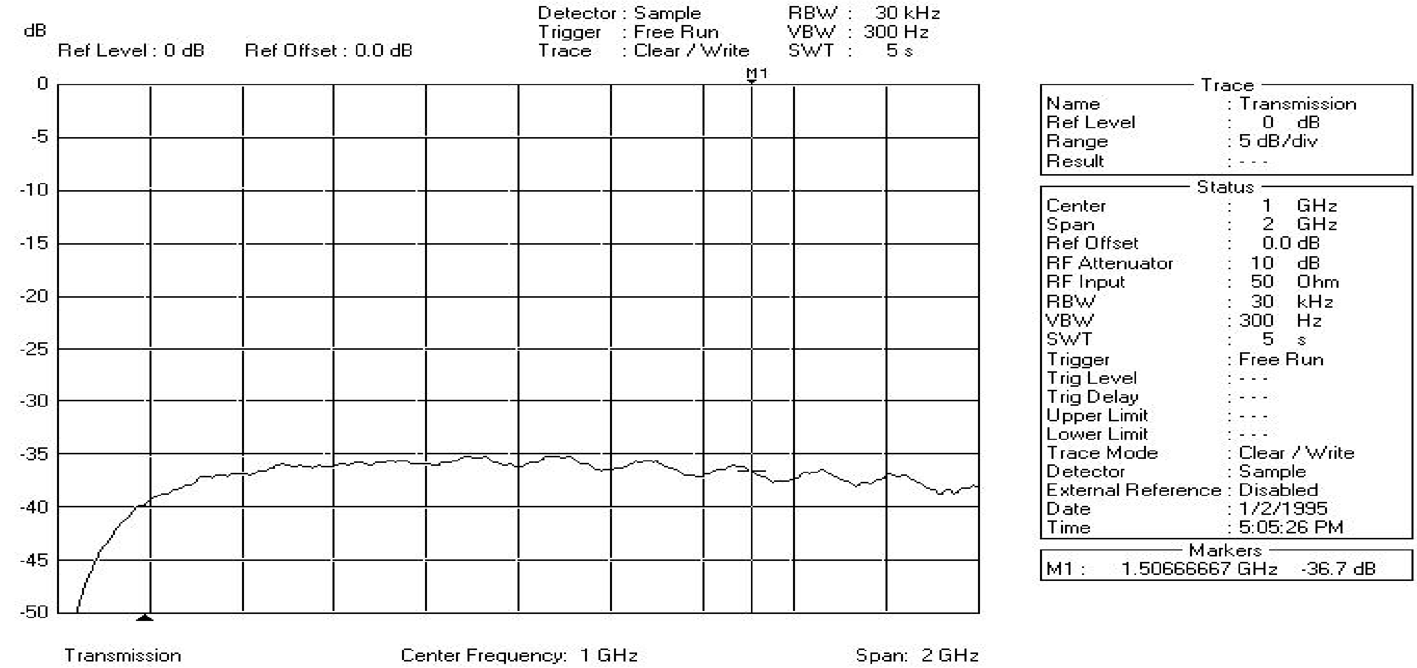

Figure 3 Directional coupler, test cable, and 4 dB pad filter transfer function calibrationmeasurement (from FSH-3)

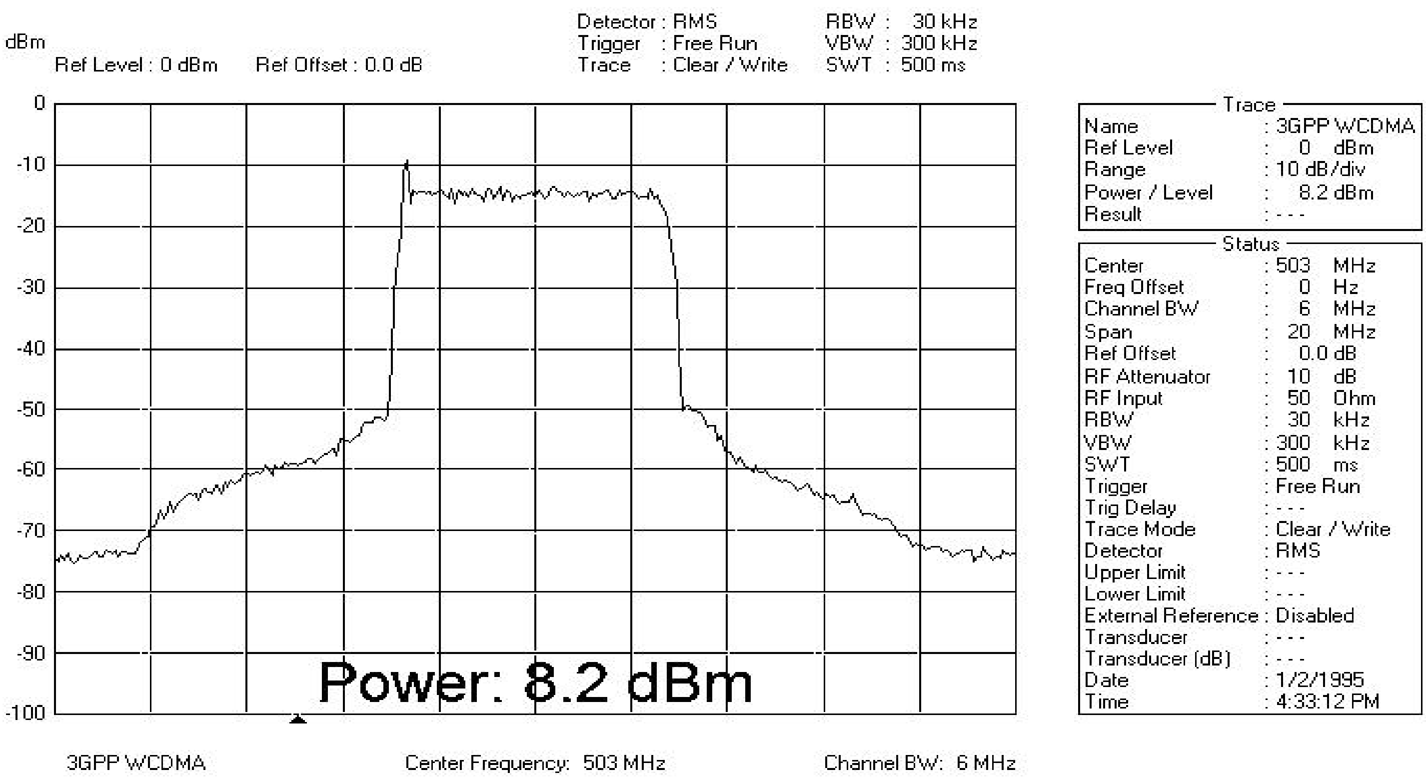

Figure 4 Fundamental DTV signal at test point output (from FSH-3)

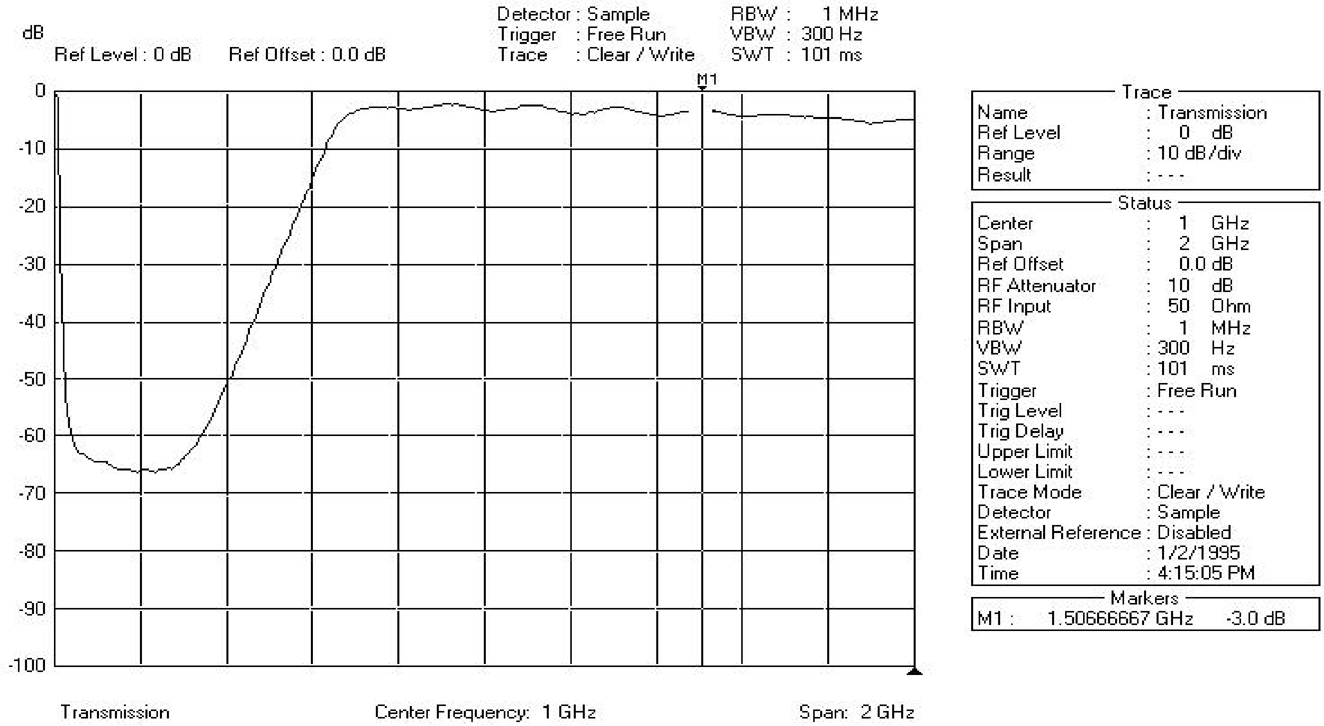

Figure 5 Mini Circuits High Pass Filter (NHP-700) calibration transfer function (from FSH-3)

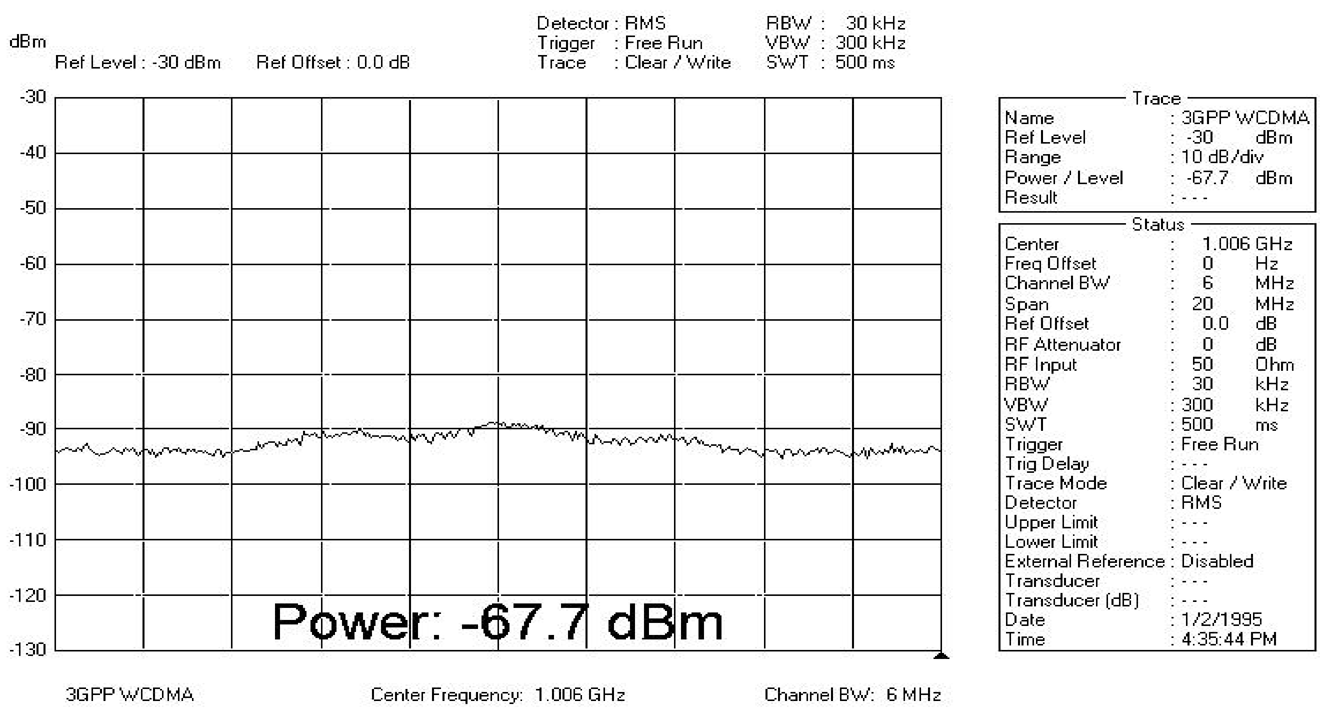

Figure 6 2nd Harmonic output from transmitter (from FSH-3)

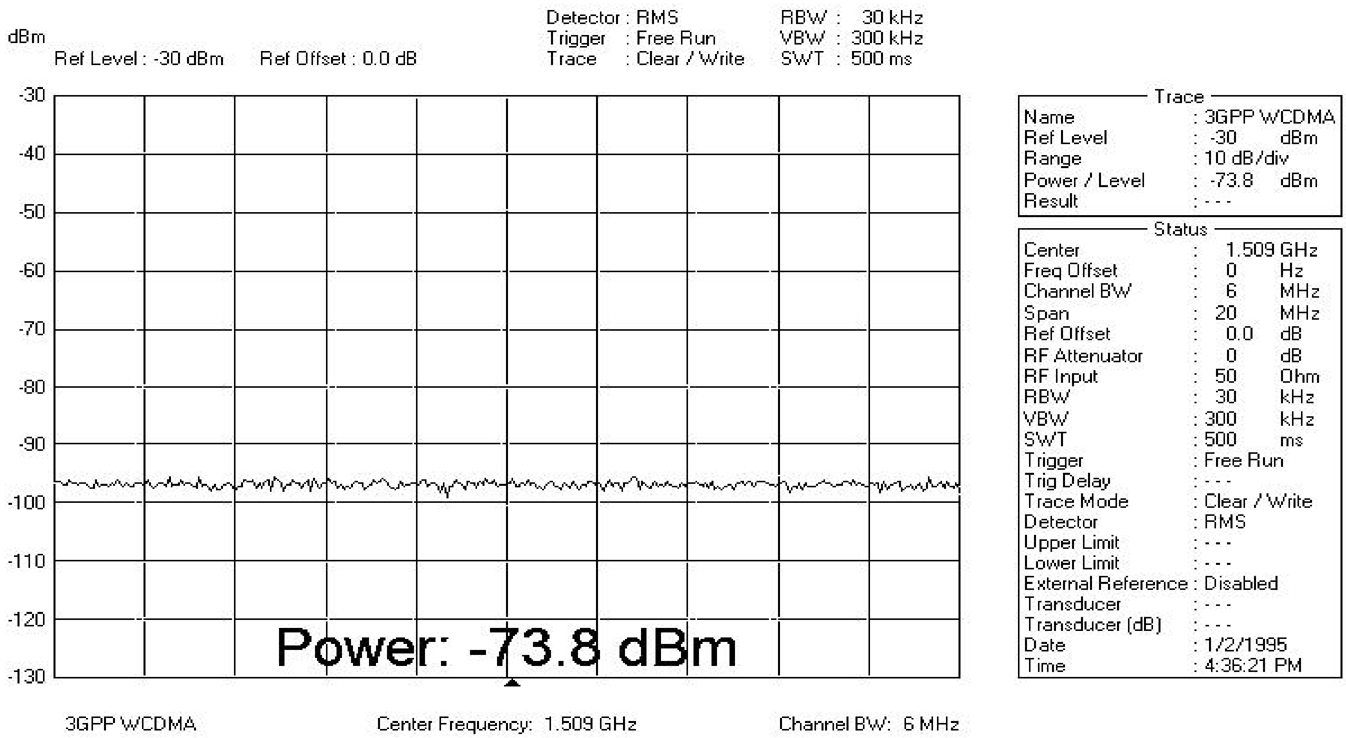

Figure 7 3rd harmonic energy from transmitter output (from FSH-3)

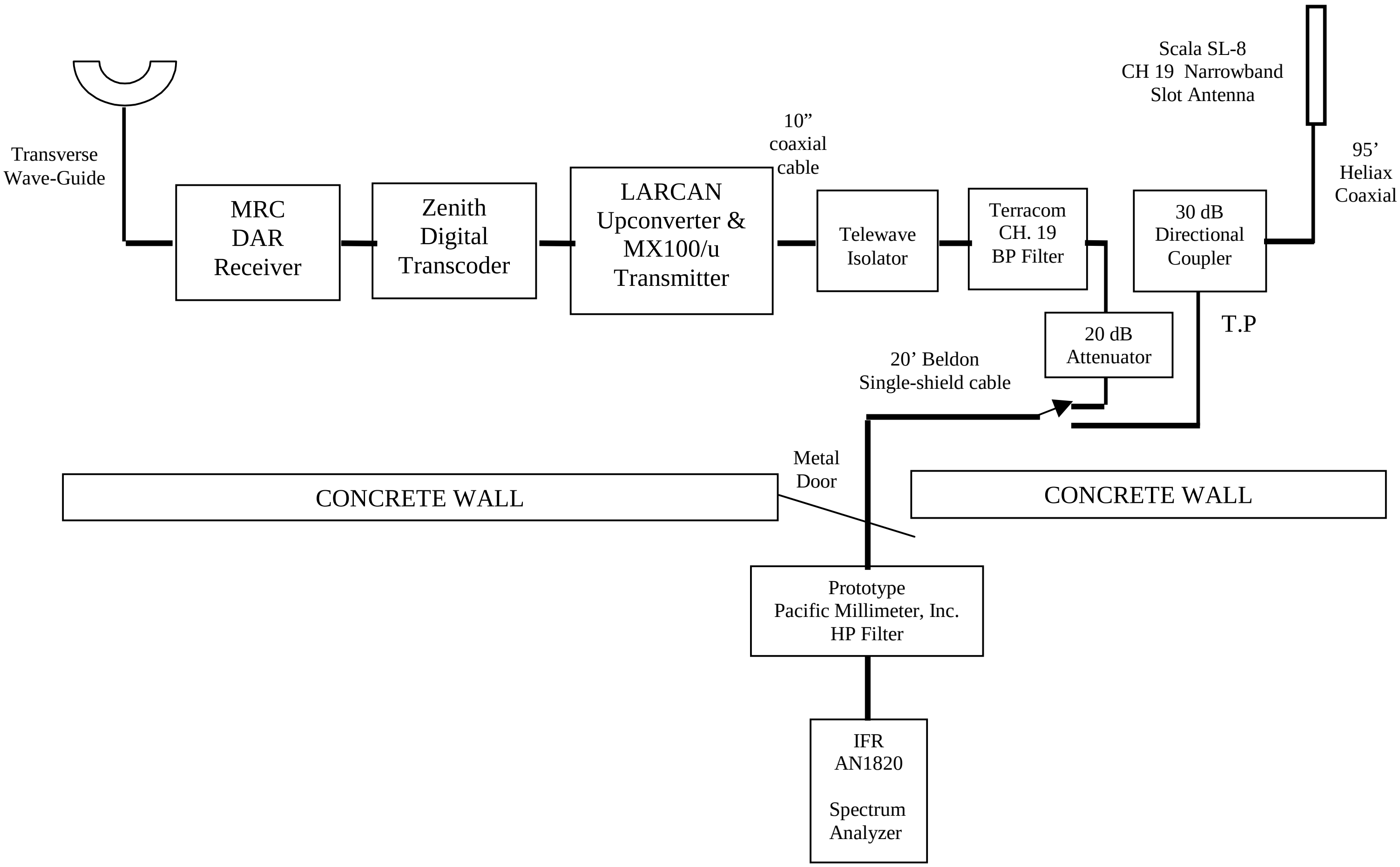

Figure 8 System block diagram of the Cove Mountain translator site: TEST #2

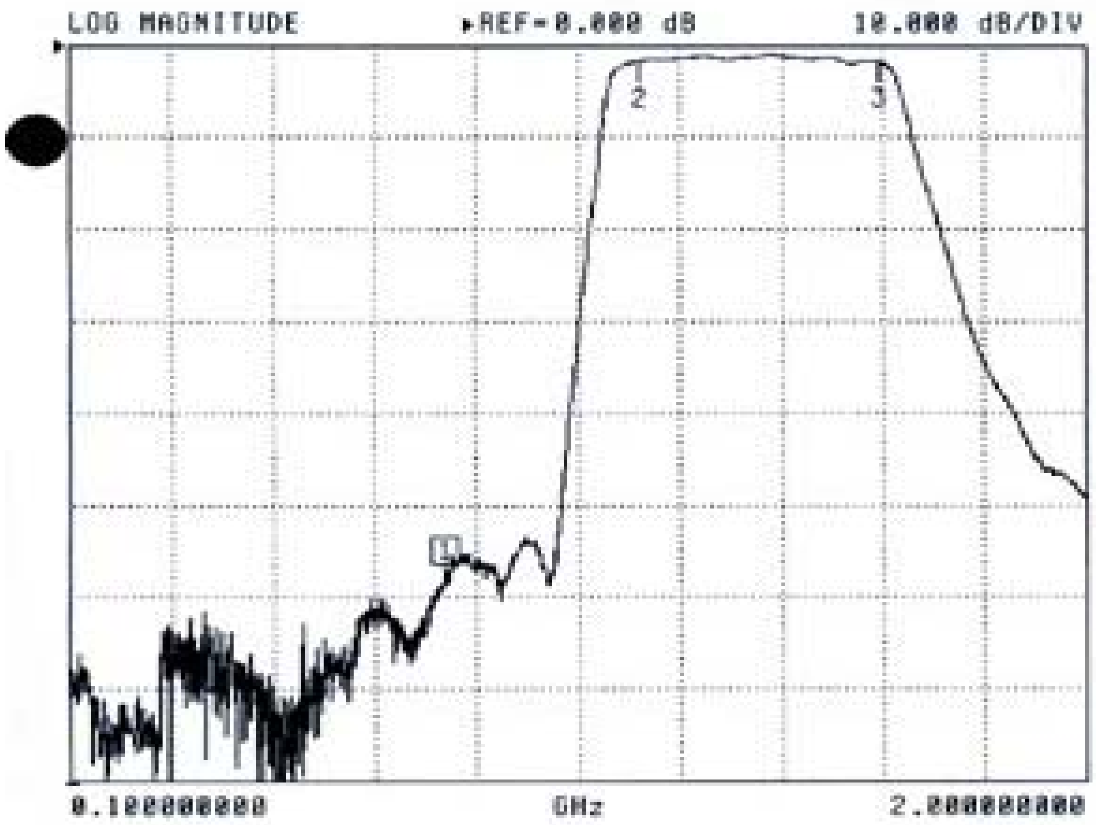

Figure 9 Pacific Millimeter Products, Inc., band-pass filter transfer function

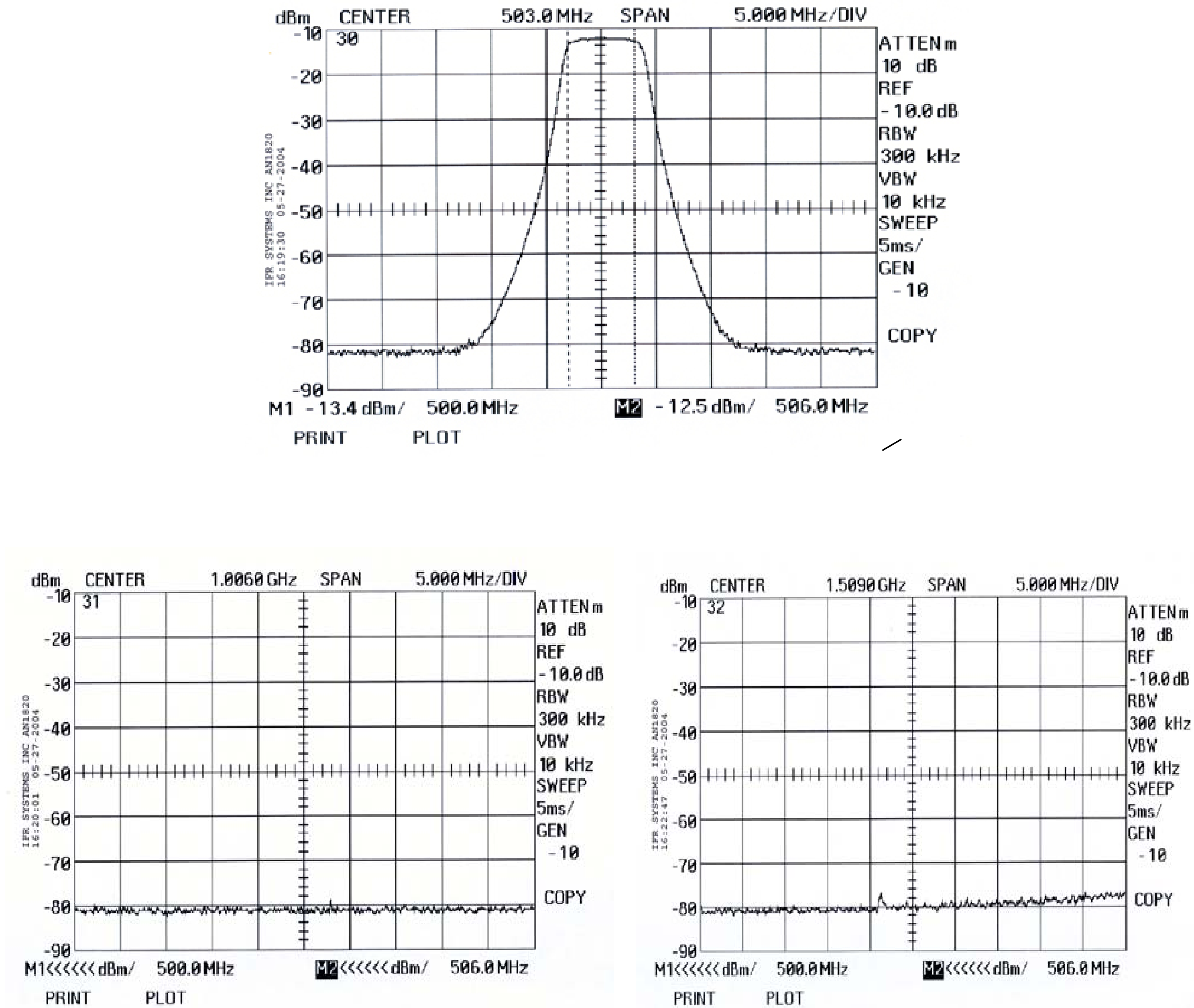

Figure 10 6-section e-mission mask band-pass filter transfer function at its fundamental and 2nd/3rd harmonics (from IFR)

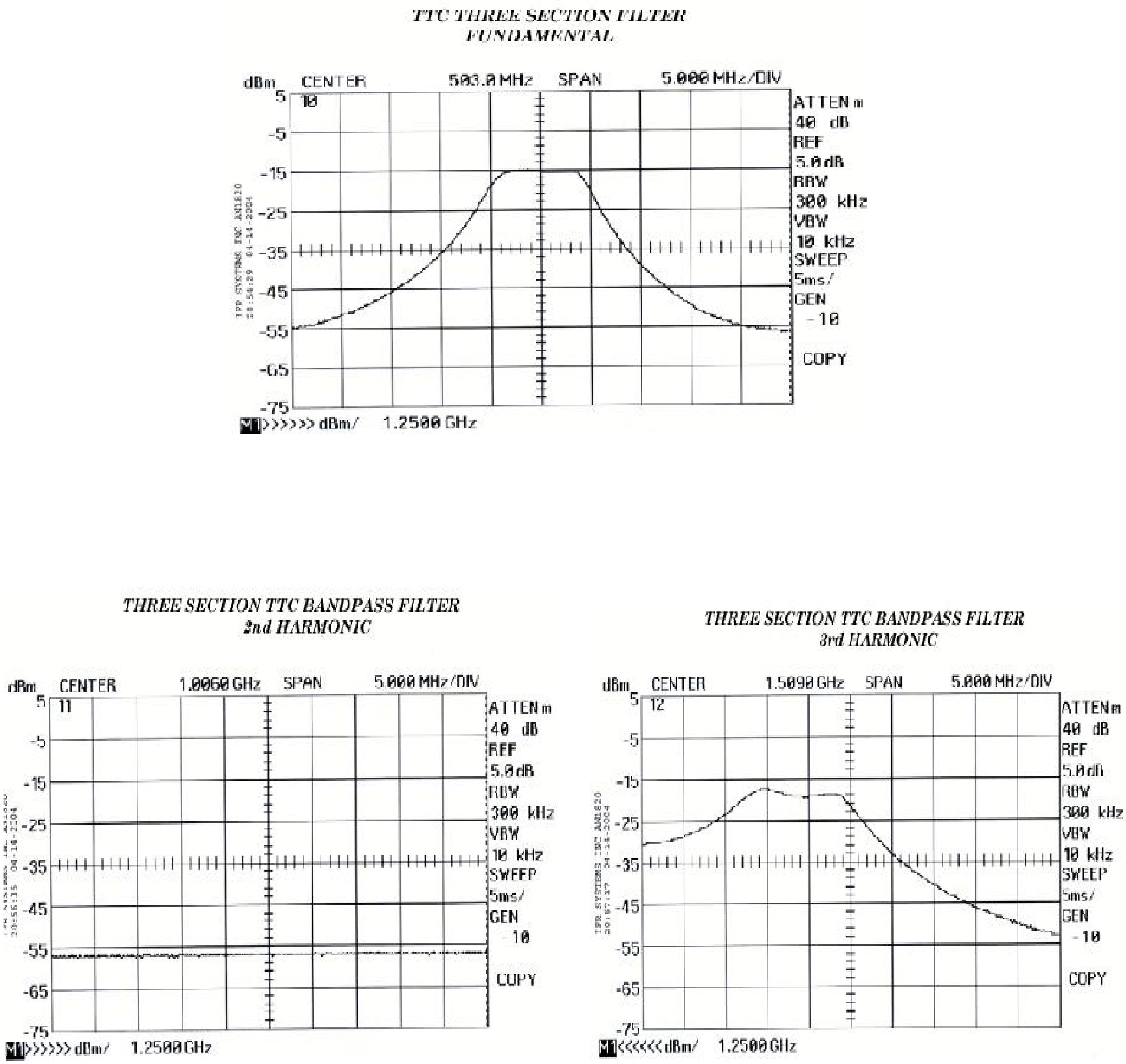

Figure 11 3-section e-mission mask band-pass filter transfer function at its fundamental and $2^{nd}/3^{rd}$ harmonics (from IFR). Note that 2nd harmonic filter response is not at –85 dB due to analyzer attenuation set to 40 dB.

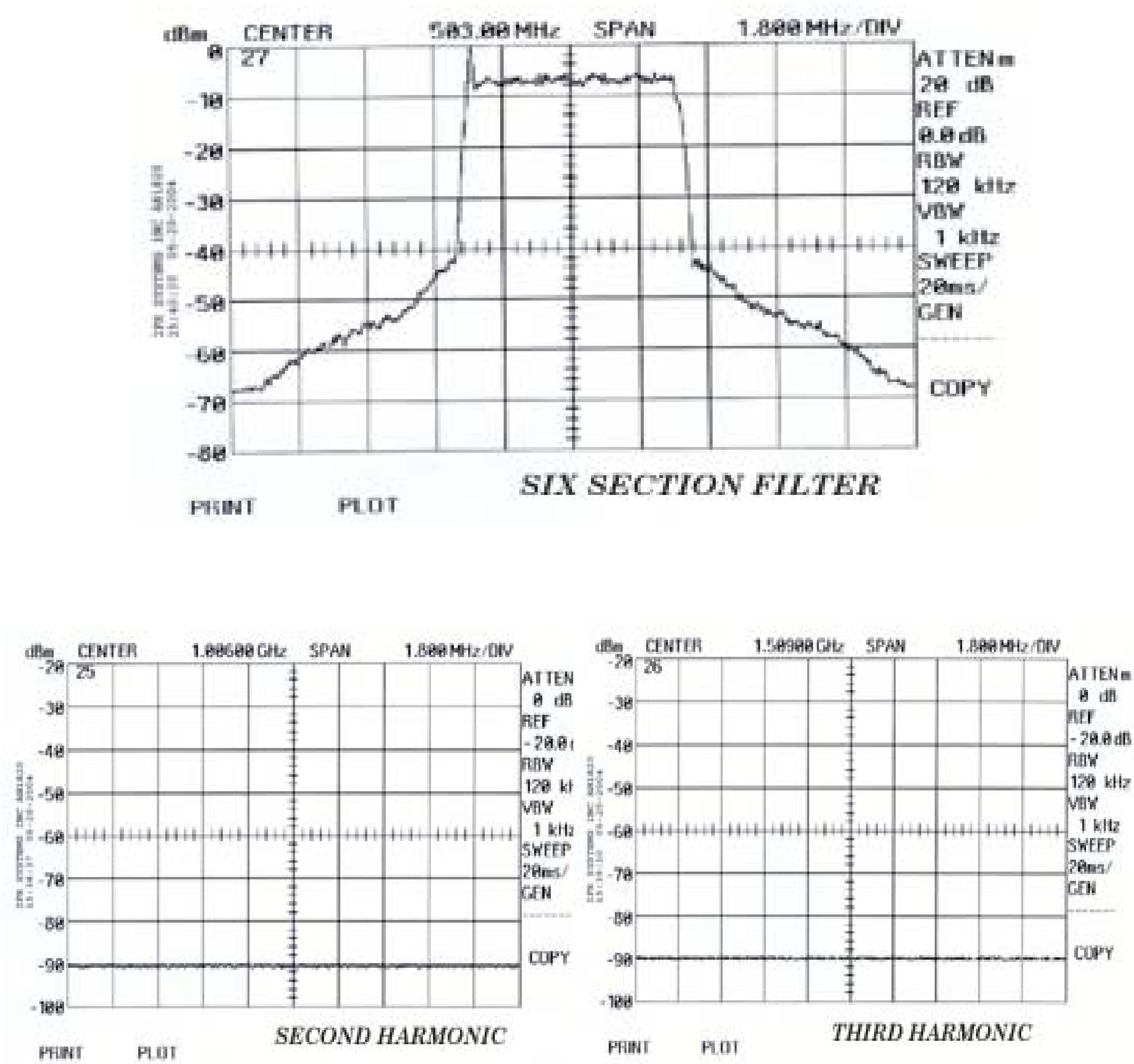

Figure 12 CH 19 transmitter output signal harmonic spectrum after 6-section filter through 30-dB directional coupler (from IFR)

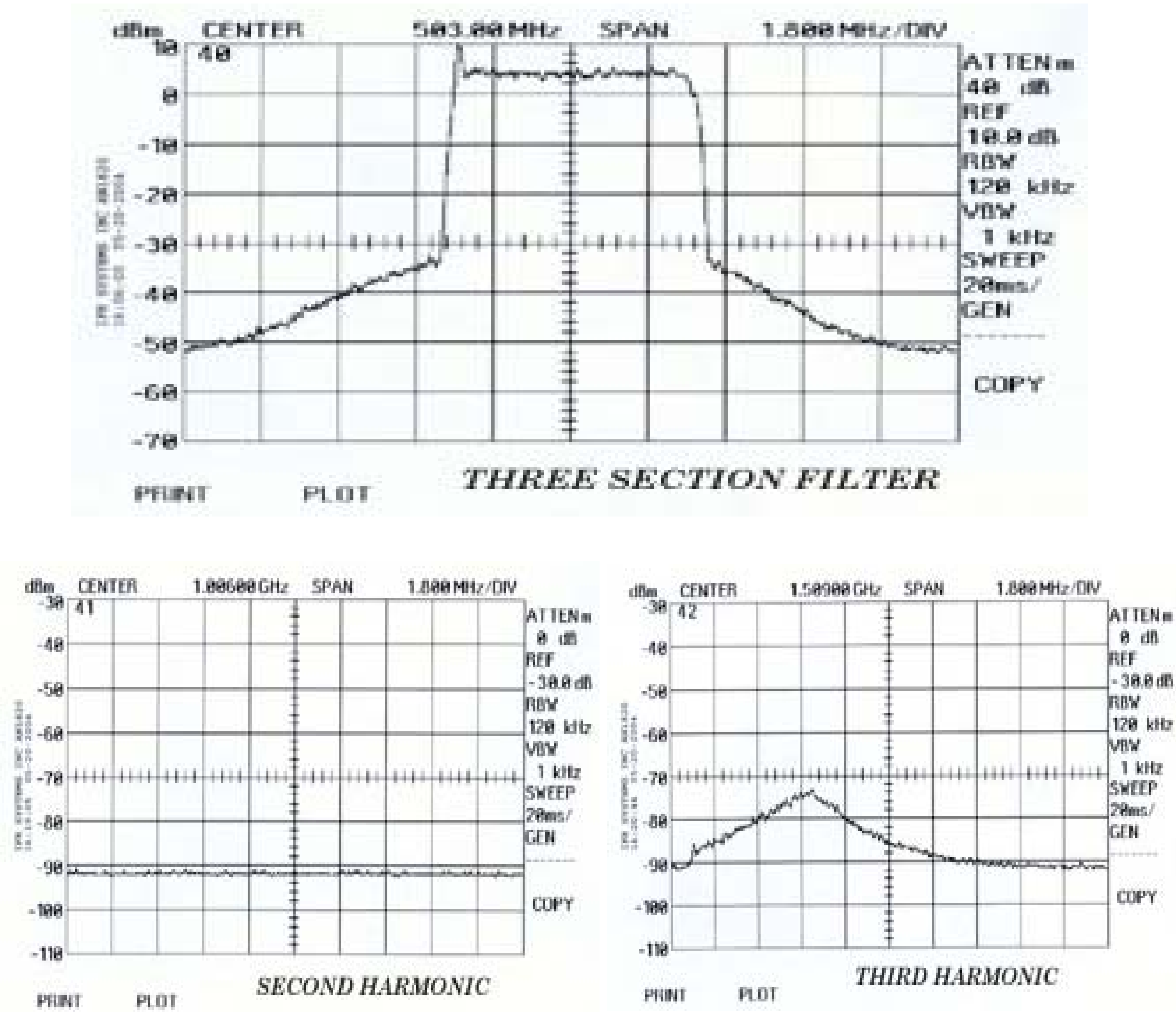

Figure 13 CH 19 Transmitter harmonic output signal spectrum after 3-section filter and through 20-dB attenuator (from IFR)

Figure 14 Gary Sgrignoli holding an impromptu tutorial at the DTV translator site on Cove Mountain. From left to right: Reggi Parsons, Maury Parsons, Gary Sgrignoli (seated), Kent Parsons, and Johnny Parsons. Not shown (taking the picture) is John Tremblay.