

TV TechCheck

The Weekly NAB Newsletter for TV Broadcast Engineers



CEA Submits DTV Receiver Interference Study to the FCC

On May 22 the Consumer Electronics Association (CEA) filed a technical report with the FCC on laboratory testing regarding the susceptibility of recent consumer DTV receivers to DTV and LTE interference. The tests were performed by the firm of Meintel, Sgrignoli, and Wallace (MSW) on ATSC flat-screen consumer digital television (DTV) receivers that have been on the market in the period 2012 - 2013. CEA states in their filing that “The report is intended to inform the commission staff as it continues its important work regarding the upcoming TV broadcast spectrum incentive auctions.”

According to the report, the main goal of the tests was to evaluate overall receiver performance in the presence of simple impairments and with various configurations of co-channel and adjacent channel DTV and LTE interference. Important guideposts for this testing are the receiver performance guidelines contained in ATSC [A/74:2010](#), and the report on a DTV receiver study published by the FCC’s office of Engineering and Technology in 2007([Martin 2007](#)).

CEA provided twelve recent-model (2012 and 2013) and two older-model (2006) DTV receivers of various screen sizes. These receivers were all production units (or pre-production in one case), from the top ten brands as ranked by U.S. market share in unit volume. The report states that, based on market data and manufacturer interviews, CEA estimates that the twelve recent-model receivers represent about 85 percent of DTV shipments in the U.S. market during 2012 and 2013. A subset of six of these receivers was selected by CEA for detailed DTV-into-DTV adjacent channel interference testing, and another single unit was selected from the subset of 6 for LTE-into-DTV interference testing. CEA estimates that the six recent-model receivers represent about 75 percent of DTV shipments in the U.S. market during 2012 and 2013. Additionally, the two older-model DTV sets were included in the sliding LTE interference tests to provide some performance information on older DTV sets; both older units were earlier models from brands represented in the subset of six.

The tests performed included general tests (sensitivity, overload, added white noise threshold, co-channel interference) as well as adjacent channel interference tests for both DTV-into-DTV and LTE-into-DTV. The desired (D) signal was always a typical 6 MHz ATSC DTV signal on UHF channel 30, the undesired (U) interference signals were either one or two DTV signal (6 MHz ATSC 8-VSB signal in a 6 MHz RF channel) or one LTE signal (5 MHz or 10 MHz 3GPP OFDMA signal) or one LTE and one DTV signal. The interference performance metric for these laboratory tests was the ratio of the desired (D) average signal power level to the undesired (U) average signal power level, referred to as D/U. Each D/U measurement was taken at a threshold of video (TOV) error point; depending on the test. The following tests were performed:

- Sensitivity
- Overload

- Added White Gaussian Noise Impairment Threshold
- Co-channel Interference (DTV-into-DTV and LTE-into-DTV)
- Multi-Signal Overload Interference: N+2/N+3 pair (DTV-into-DTV and LTE-into-DTV)
- Single Interferer Interference: N±10, N±8, N±7, N±6, N±5, N±4, N±3, N±2, N±1, N+13, N+14, N+15 (DTV-into-DTV and LTE-into-DTV)
- IM3-Generating Interference Pairs: Equal Power: N+k = N+2k (DTV-into-DTV and LTE-into-DTV)
- IM3-Generating Interference Pairs: Unequal Power: N+k > N+2k (DTV-into-DTV and LTE-into-DTV)
- IM3-Generating Interference Pairs: Unequal Power: N+k < N+2k (DTV-into-DTV and LTE-into-DTV)
- Sliding 5 MHz and 10 MHz LTE Signal Interference (where the interfering signal was moved in 1MHz increments to investigate required guard band)

| DUT # | Test Description | Screen Size | Model Year |
|-------|-------------------------------------|-------------|-------------|
| 1 | General, DTV-into-DTV, LTE-into-DTV | 39" | 2012 - 2013 |
| 2 | General, DTV-into-DTV, LTE-into-DTV | 32" | 2012 - 2013 |
| 3 | General, DTV-into-DTV, LTE-into-DTV | 32" | 2012 - 2013 |
| 4 | General, DTV-into-DTV, LTE-into-DTV | 46" | 2012 - 2013 |
| 5 | General, DTV-into-DTV, LTE-into-DTV | 32" | 2012 - 2013 |
| 6 | General, DTV-into-DTV, LTE-into-DTV | 32" | 2012 - 2013 |
| 7 | General | 23" | 2012 - 2013 |
| 8 | General | 32" | 2012 - 2013 |
| 9 | General | 32" | 2012 - 2013 |
| 10 | General | 26" | 2012 - 2013 |
| 11 | General | 32" | 2012 - 2013 |
| 12 | General | 32" | 2012 - 2013 |
| 13 | Sensitivity, AWGN, LTE-into-DTV | 40" | 2006 |
| 14 | Sensitivity, AWGN, LTE-into-DTV | 52" | 2006 |

Device Under Test (DUT) receivers and their respective performance testing

The report shows that the DTV receivers performed extremely well to A/74 guidelines and in the presence of single interferers, but receiver performance was impaired in the presence of intermodulation effects from N+k/N+2k interference pairs.

| Statistical Parameter | Sensitivity Threshold | Overload Threshold | Dynamic Range | AWGN Threshold | Noise Figure | D-into-D Co-CH | LTE1-into-D Co-CH | LTE2-into-D Co-CH |
|-----------------------|-----------------------|--------------------|---------------|----------------|--------------|----------------|-------------------|-------------------|
| (*) | (dBm) | (dBm) | (dB) | (dB) | (dB) | (dB) | (dB) | (dB) |
| Mean | -86.6 | > +5.0 | ----- | 14.8 | 4.8 | 14.7 | 15.5 | 13.7 |
| Median | -86.2 | > +5.0 | ----- | 14.8 | 5.4 | 14.4 | 15.3 | 13.7 |
| Minimum | -89.4 | > +5.0 | >90.1 | 14.6 | 2.0 | 14.2 | 15.0 | 13.3 |
| Maximum | -85.1 | ----- | ----- | 14.9 | 6.3 | 16.1 | 16.5 | 14.3 |
| Std Dev | 1.3 | 0.0 | ----- | 0.1 | 1.3 | 0.6 | 0.4 | 0.3 |

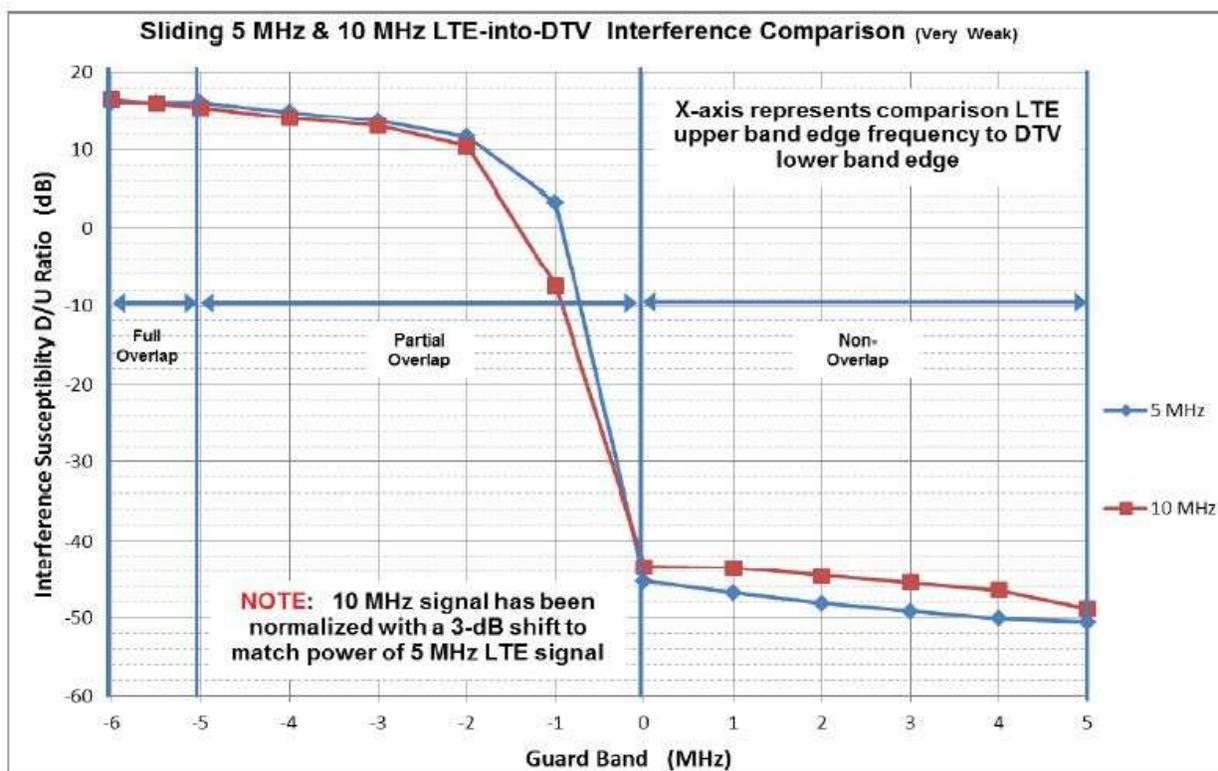
Summary of general performance test results for 12 recent-model consumer receivers

With DTV co-channel interference, receivers again exceeded A/74 guidelines; with median performance of 14.4 dB D/U required (vs. 15.5 dB per A/74) in the presence of an undesired DTV signal co-channel. With a single DTV interferer, all six receivers tested met the D/U ratio targets in A/74. Again, it is

important to note that the testing was performed without the first adjacent DTV splatter; this splatter must be considered before applying these results to spectrum allocation.

This testing also investigated the required guard band between a DTV channel and an LTE interferer.

- DTV tuners exhibited co-channel-like behavior when the spectrum overlap between DTV and LTE was from 3 to 5 MHz (i.e., -3 to -5 MHz guard band), with some 15 dB D/U ratio required.
- Tuners transitioned to something like adjacent channel behavior when there was near or at zero guard band, but with 15 – 20 dB less robustness as compared to the true single channel interferer curves.
- There was a transition region 2 – 3 MHz wide between these two regions, and in this transition region the D/U ratios fluctuated about 1 – 2 dB. The root cause of this effect is not known, but as long as there is a guard band between LTE and DTV in the field, the effect can be avoided.



Median comparison of sliding 5 MHz and 10 MHz LTE1 interference results at weak desired signal for 6 DTV sets.

The report cautions, however,

“...it is imperative to note that these tests used ideal desired and undesired test signals under ideal test conditions, thus not simulating typical conditions found in the field, such as adjacent channel transmitter splatter. Desired DTV signals were high quality and had no impairments while DTV and LTE interferer signals were also high quality, with no non-linearity-induced adjacent channel splatter. Therefore, care must be taken in applying these laboratory test results directly to any planning in the spectrum allocation process.”

The report is available [here](#).



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