

Figure 27: 200 – 400 MHz Frequency Span

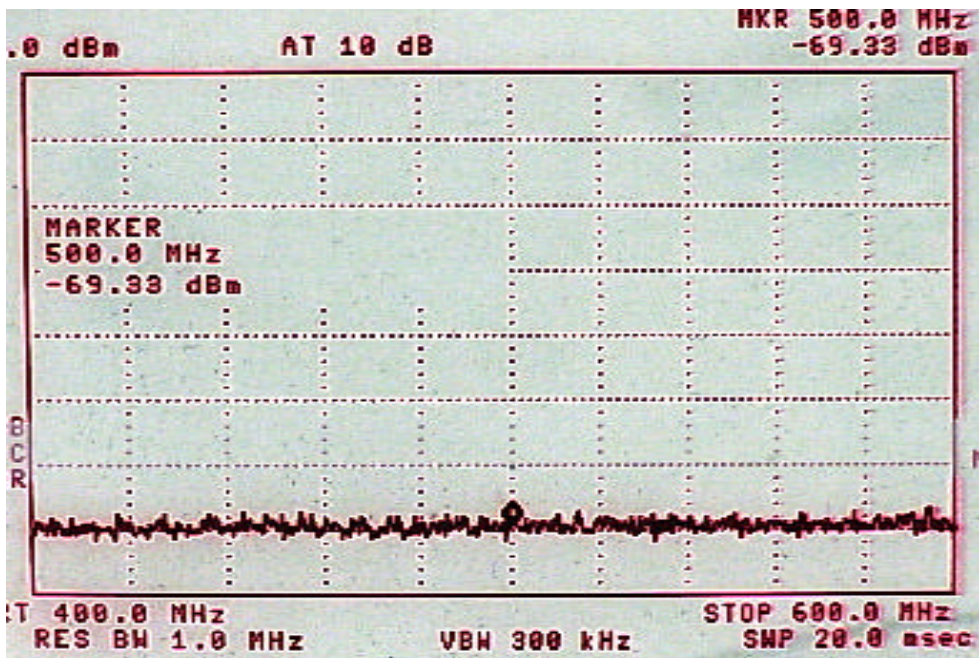


Figure 28: 400 – 600 MHz Frequency Span

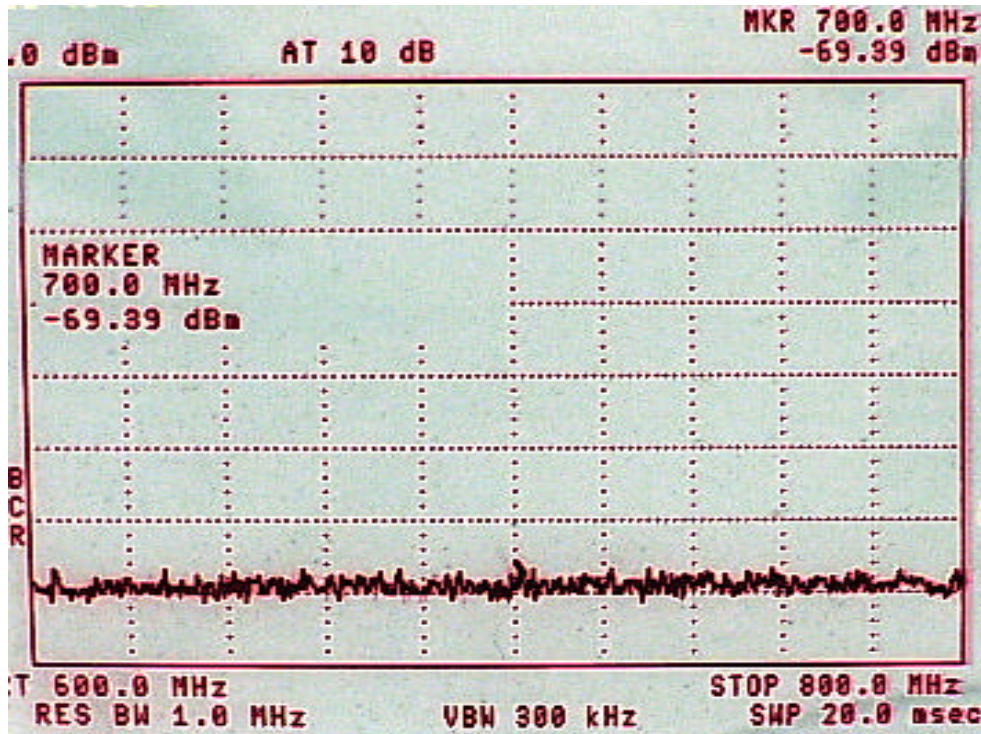


Figure 29: 600 – 800 MHz Frequency Span

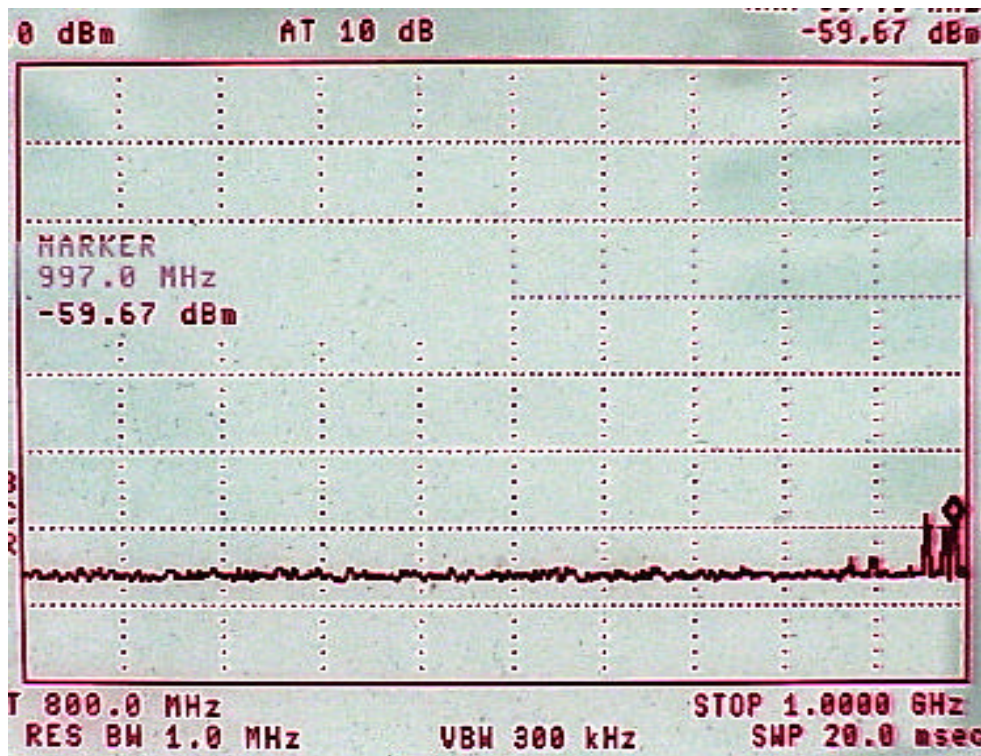


Figure 30: 800 – 1000 MHz Frequency Span

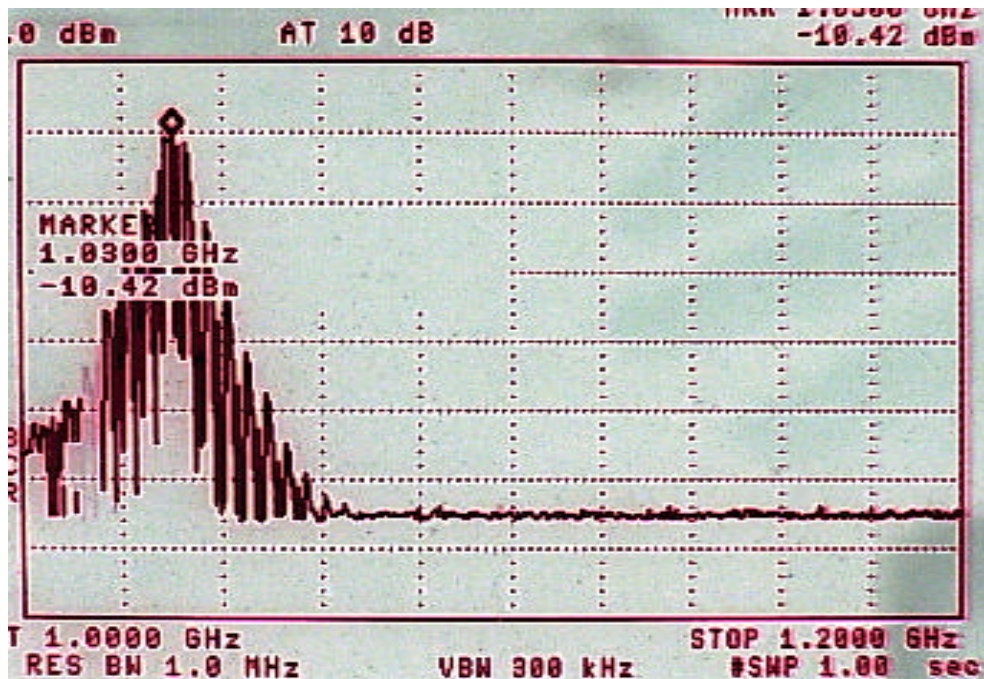


Figure 31: 1000 – 1200 MHz Frequency Span

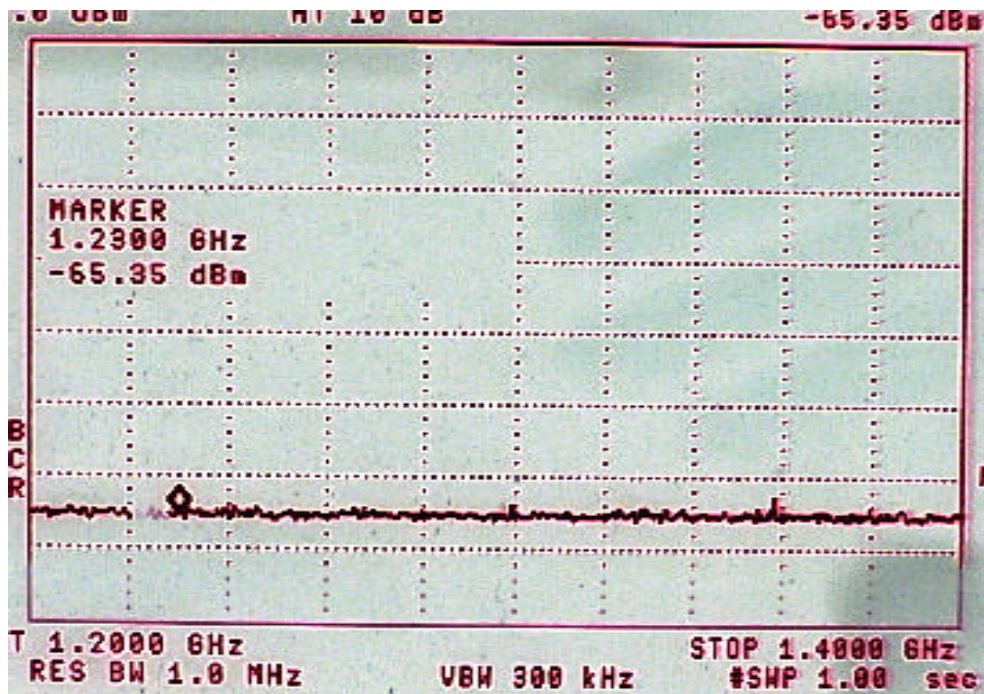


Figure 32: 1200 – 1400 MHz Frequency Span

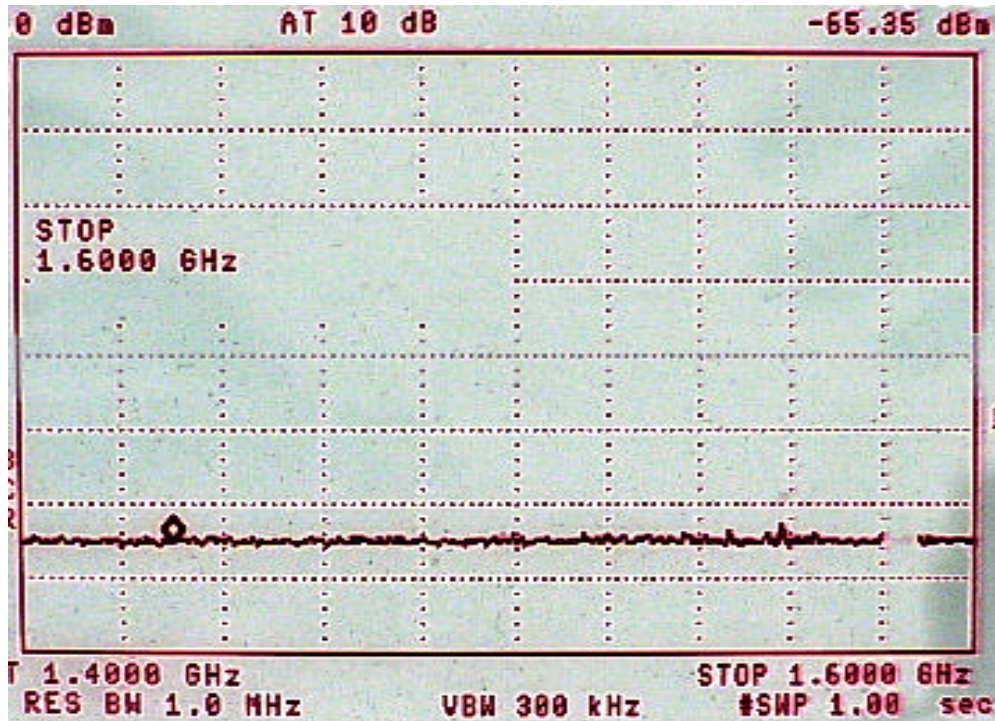


Figure 33: 1400 – 1600 MHz Frequency Span

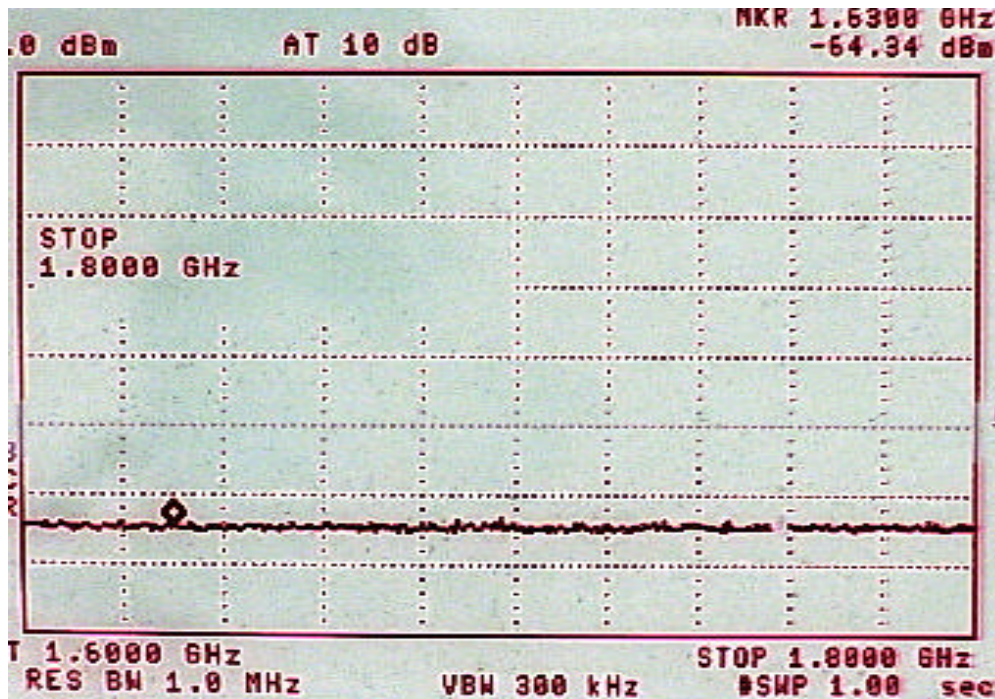


Figure 34: 1600 – 1800 MHz Frequency Span

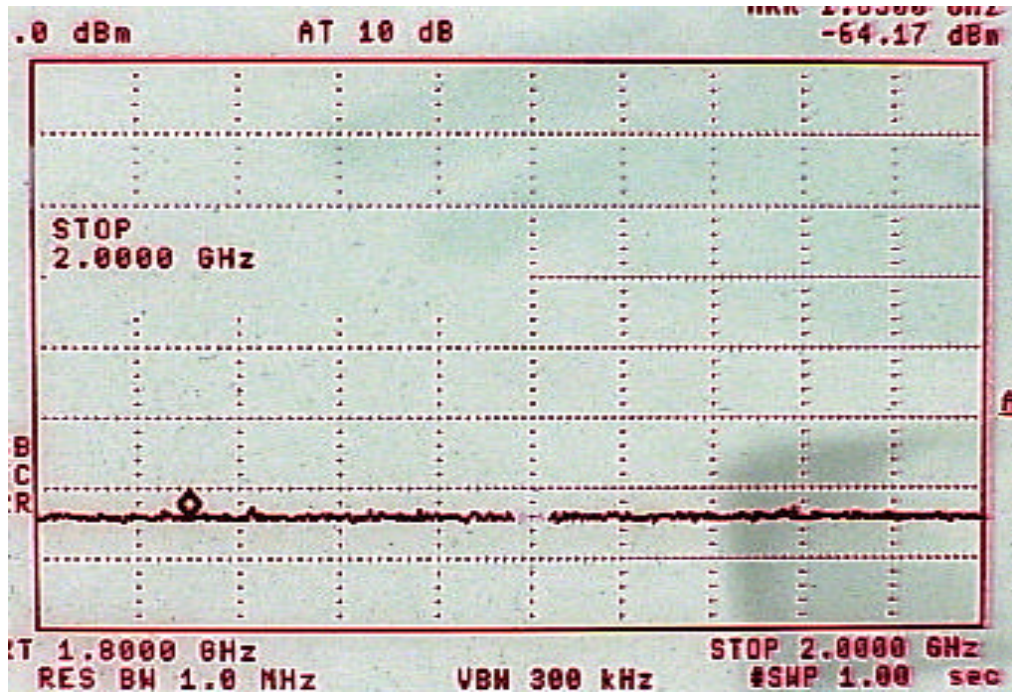


Figure 35: 1800 – 2000 MHz Frequency Span

8.4.2 Spurious Emissions at Antenna Terminals (2000 - 11330 MHz) Test Equipment Required

| Block Diagram Reference | Type | Manufacturer | Model | Asset # | Cal Date |
|-------------------------|------------------------|-----------------|-------------|---------|----------|
| A | T2CAS Computer | ACSS | RT-952 | NA | |
| B | TCAS 2000 System Panel | ACSS | 9000121-001 | NA | |
| C | Attenuator | Narda | 765-20 | NA | |
| D | Hi-Pass Filter | Microlab/FXR | HD-20N | NA | |
| E | Hi-Pass Filter | Microlab/FXR | HD-40N | NA | |
| F | Hi-Pass Filter | Microlab/FXR | HD-60N | NA | |
| G | Attenuator | Narda | 765-6 | NA | |
| H | Spectrum Analyzer | Hewlett-Packard | HP8592L | 418 | 6/11/03 |

Table 12: Spurious Emissions at Antenna Terminals (2000 – 11330 MHz) Test Equipment Required

8.4.2.1 Spurious Emissions at Antenna Terminals (2000 - 11330 MHz) Test Setup

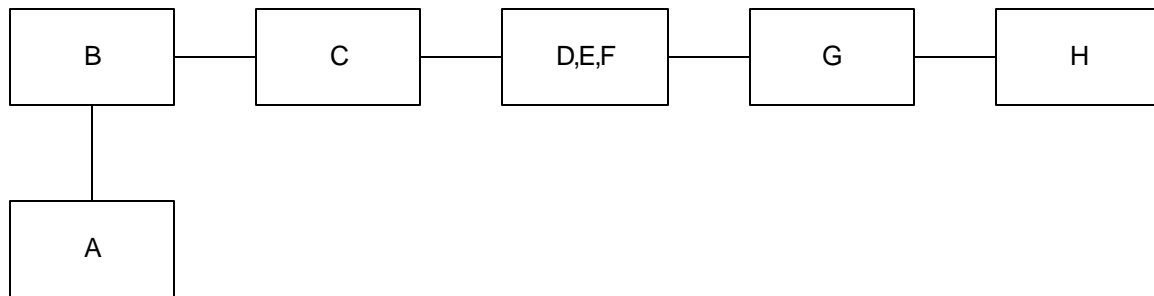


Figure 36: Spurious Emissions at Antenna Terminals (2000 - 11330 MHz) Test Setup

8.4.2.2 Spurious Emissions at Antenna Terminals (2000 - 11330 MHz) Test Procedure

1. Connect the equipment as shown in Figure 36 above.
2. Configure the TCAS 2000 System Panel to invoke Test Mode 2 (Mode S, Long P6, DPSK Modulation, Test Mode Program switches on System Panel to DDUD).
3. Adjust the Spectrum Analyzer so that no signal exceeds the dynamic range of the analyzer. Set the resolution bandwidth to 3 MHz.
4. Measure and record all spurious emissions between 2 Ghz and 4 Ghz using the 2 Ghz high pass filter.
5. Measure and record all spurious emissions between 4 Ghz and 8 Ghz using the 4 Ghz high pass filter.
6. Measure and record all spurious emissions between 8 Ghz and 12 Ghz using the 6 Ghz high pass filter.
7. Measure and record Attenuator/filter/cable calibration factor for each harmonic.

8.4.2.3 Spurious Emissions at Antenna Terminals (2000 - 11330 MHz) Test Data

| FREQUENCY (MHz) | CALIBRATION FACTOR (dB) | TOP ANTENNA SPURIOUS LEVEL (dB) | BOTTOM ANTENNA SPURIOUS LEVEL (dB) | TOP ANTENNA SPURIOUS LEVEL CORRECTED (dB) | BOTTOM ANTENNA SPURIOUS LEVEL CORRECTED (dB) | SPURIOUS OUTPUT LIMIT |
|-----------------|-------------------------|---------------------------------|------------------------------------|---|--|-----------------------|
| 2060 | 17.86 | -37.78 | -39.19 | -19.92 | -21.33 | 12.5 dBm |
| 3090 | 18.32 | -47.18 | -46.64 | -28.86 | -28.32 | 12.5 dBm |
| 4120 | 18.52 | -47.70 | -48.66 | -29.18 | -30.14 | 12.5 dBm |
| 5150 | 19.20 | -64.93 | -65.16 | -45.73 | -45.96 | 12.5 dBm |
| 6180 | 20.87 | -65.82 | -65.20 | -44.95 | -44.33 | 12.5 dBm |
| 7210 | 20.68 | -60.88 | -60.56 | -40.20 | -39.88 | 12.5 dBm |
| 8240 | 22.06 | -60.45 | -60.65 | -38.39 | -38.59 | 12.5 dBm |
| 9270 | 22.29 | -61.66 | -61.28 | -39.37 | -38.99 | 12.5 dBm |
| 10300 | 23.18 | -59.76 | -59.89 | -36.58 | -36.71 | 12.5 dBm |
| 11330 | 28.42 | -58.65 | -58.49 | -30.23 | -30.07 | 12.5 dBm |

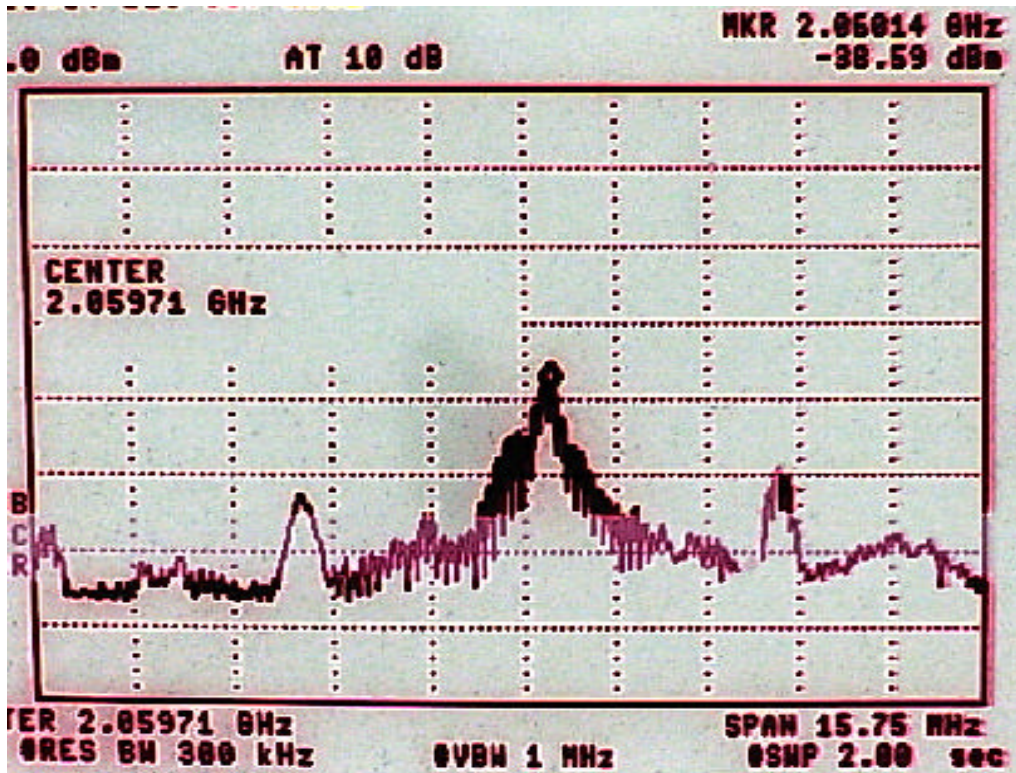


Figure 37: 2nd Harmonic

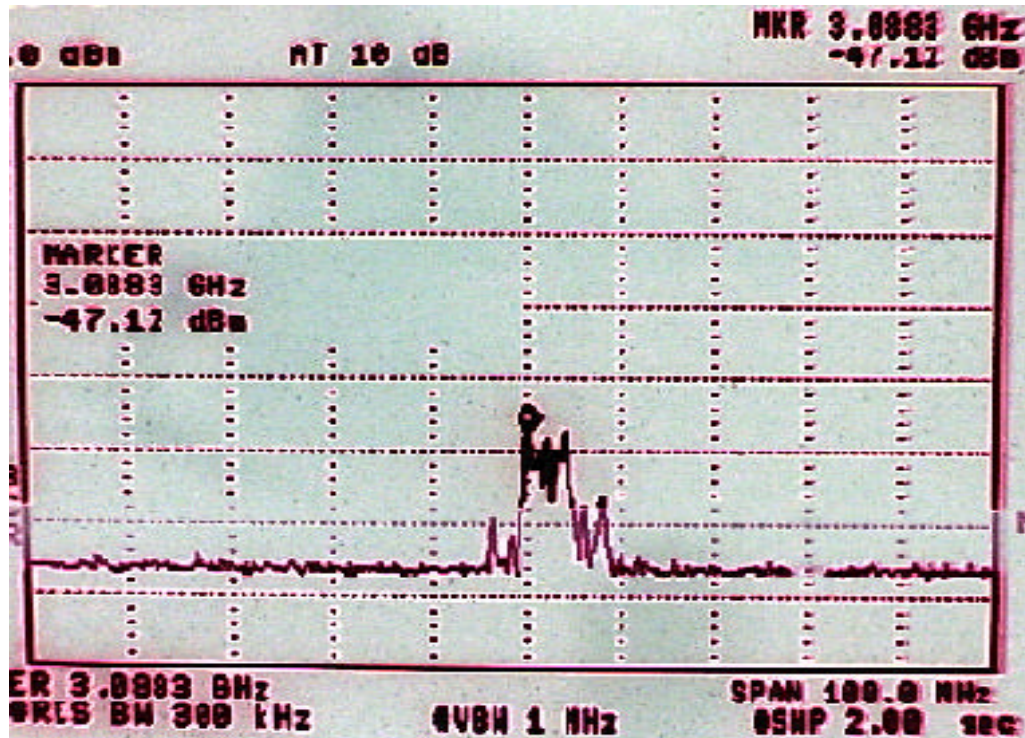


Figure 38: 3rd Harmonic

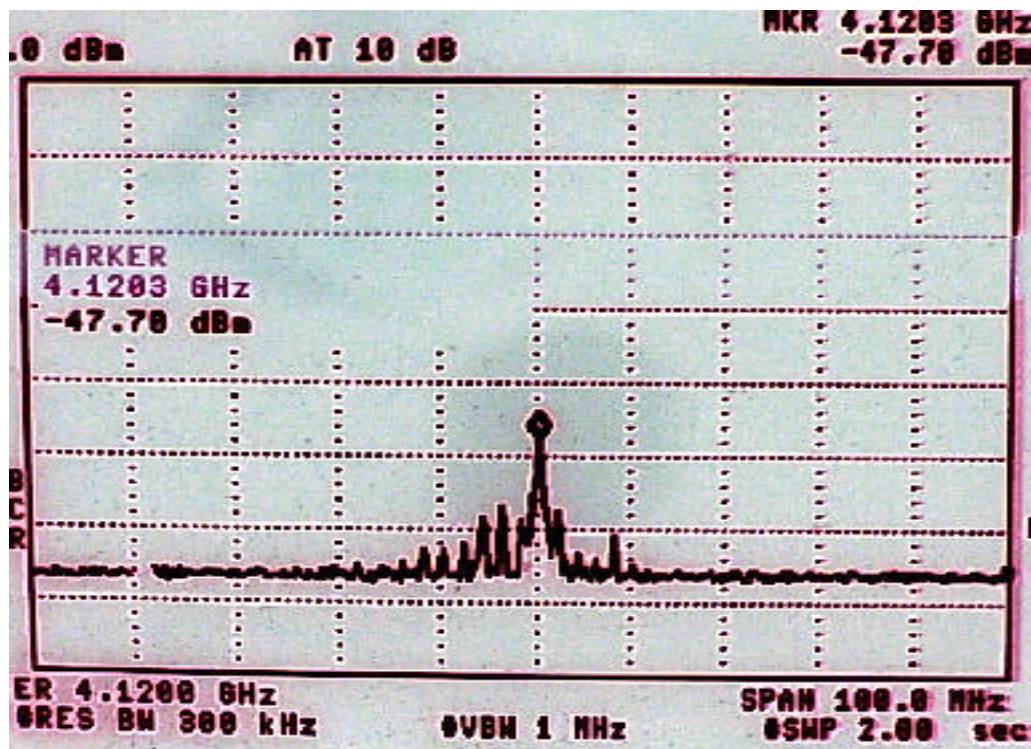


Figure 39: 4th Harmonic

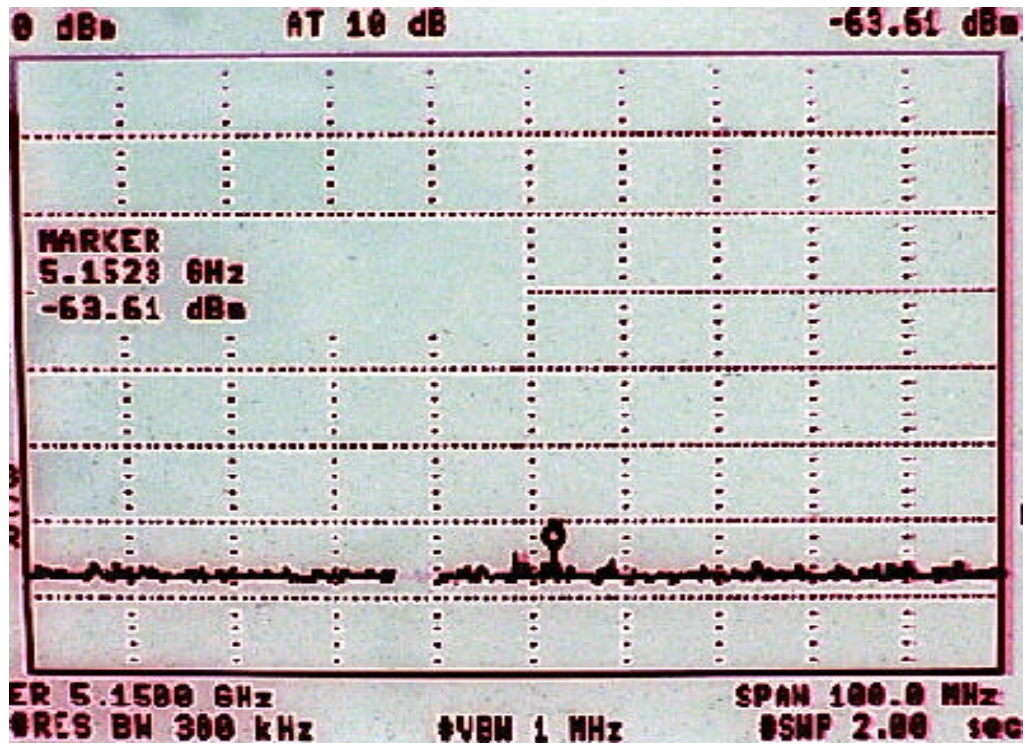


Figure 40: 5th Harmonic

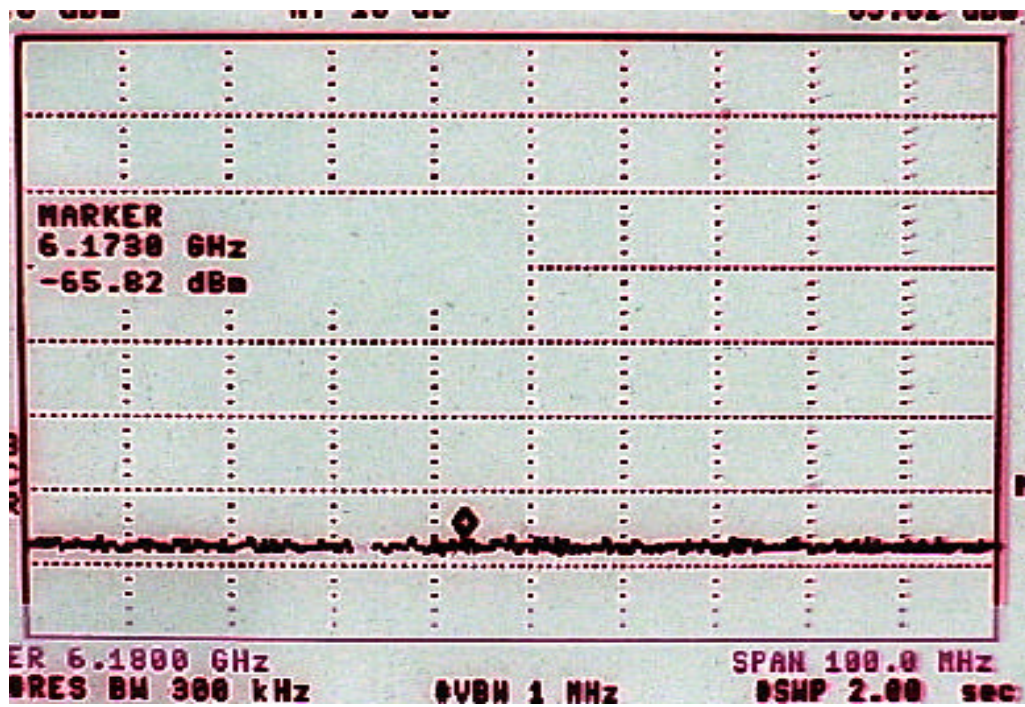


Figure 41: 6th Harmonic

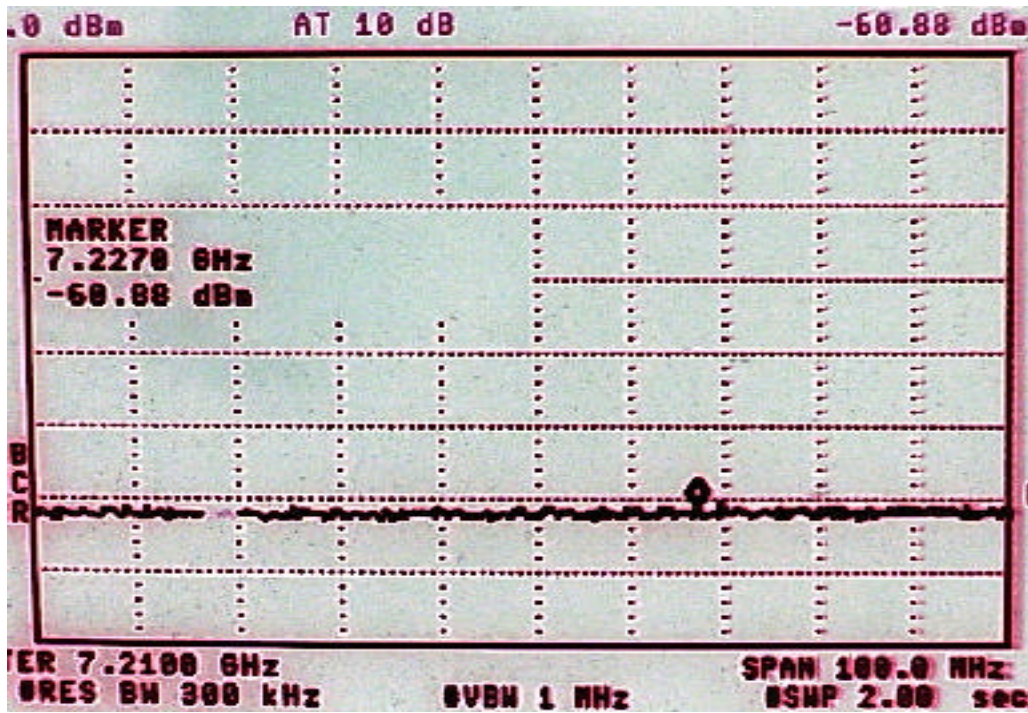


Figure 42: 7th Harmonic

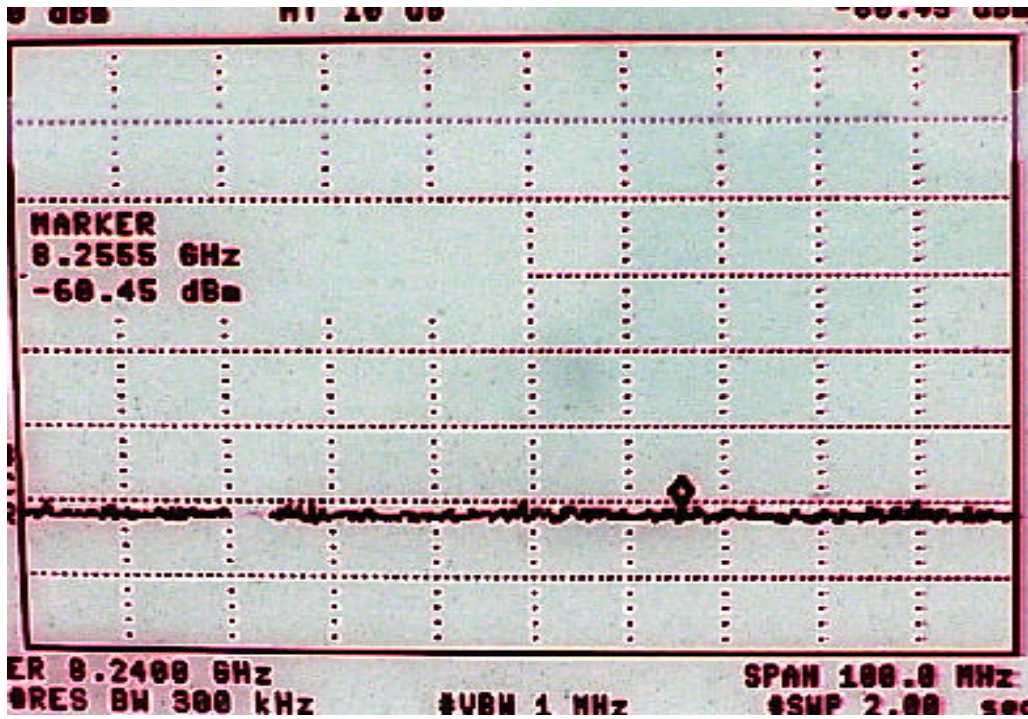


Figure 43: 8th Harmonic

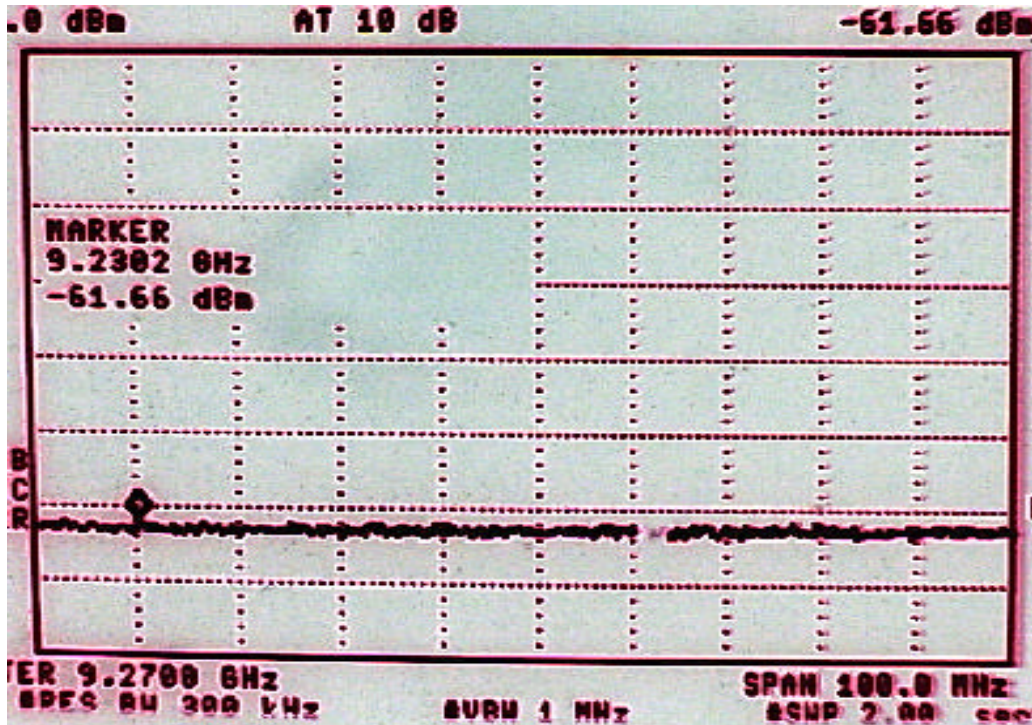


Figure 44: 9th Harmonic

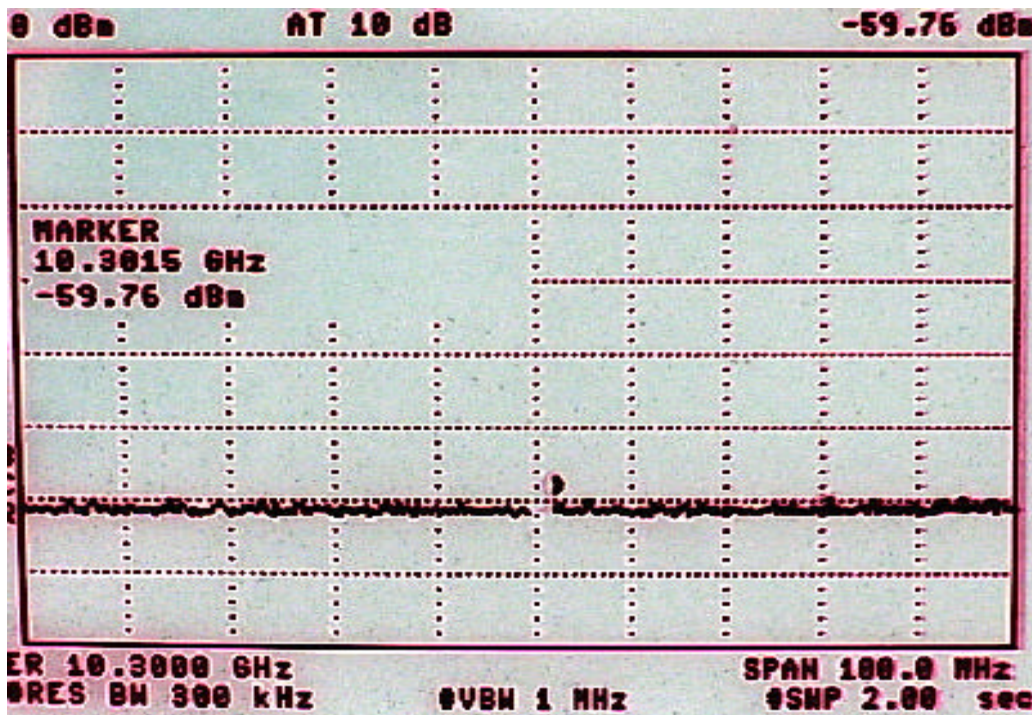


Figure 45: 10th Harmonic

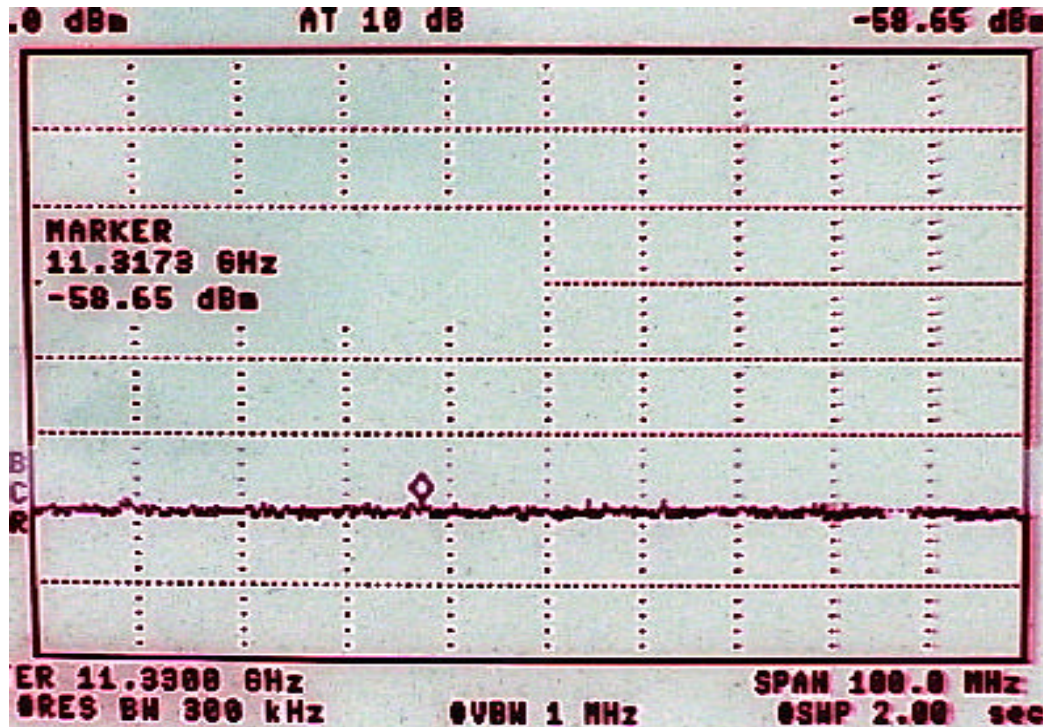


Figure 46: 11th Harmonic

8.4.3 Spurious Emissions at Antenna Terminals Local Oscillator Leakage (1030 MHz)

8.4.3.1 Spurious Emissions at Antenna Terminals L.O. Leakage (1030 MHz) Test Equipment Required

| Block Diagram Reference | Type | Manufacturer | Model | Asset # | Cal Date |
|-------------------------|------------------------|-----------------|-------------|---------|----------|
| A | T2CAS Computer | ACSS | RT-952 | NA | |
| B | TCAS 2000 System Panel | ACSS | 9000121-001 | NA | |
| C | Peak Power Analyzer | Hewlett-Packard | HP8990A | 418 | 23/7/03 |

Table 13: Spurious Emissions at Antenna Terminals L.O. Leakage (1030 MHz) Test Equipment Required

8.4.3.2 Spurious Emissions at Antenna L.O. Leakage (1030 MHz) Test Setup

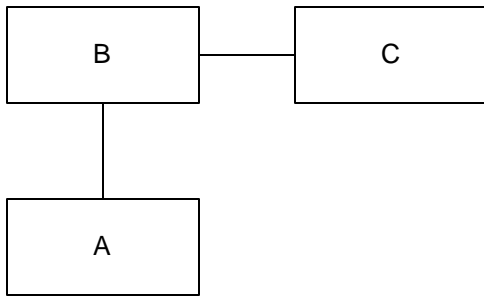


Figure 47: Spurious Emissions at Antenna Local Oscillator Leakage (1030 MHz) Test Setup

8.4.3.3 Spurious Emissions at Antenna L.O. Leakage (1030 MHz) Test Procedure

- 1 Connect the equipment as shown in Figure 47 above.
- 2 Configure the TCAS 2000 System Panel to invoke the No-Interrogation Test Mode (transmitter in standby, no interrogations, Test Mode Program switches on System Panel to DUUD).
- 3 Measure and record the L.O. leakage out of the top and bottom ports.

8.4.3.4 Spurious Emissions at Antenna L.O. Leakage (1030 MHz) Test Data

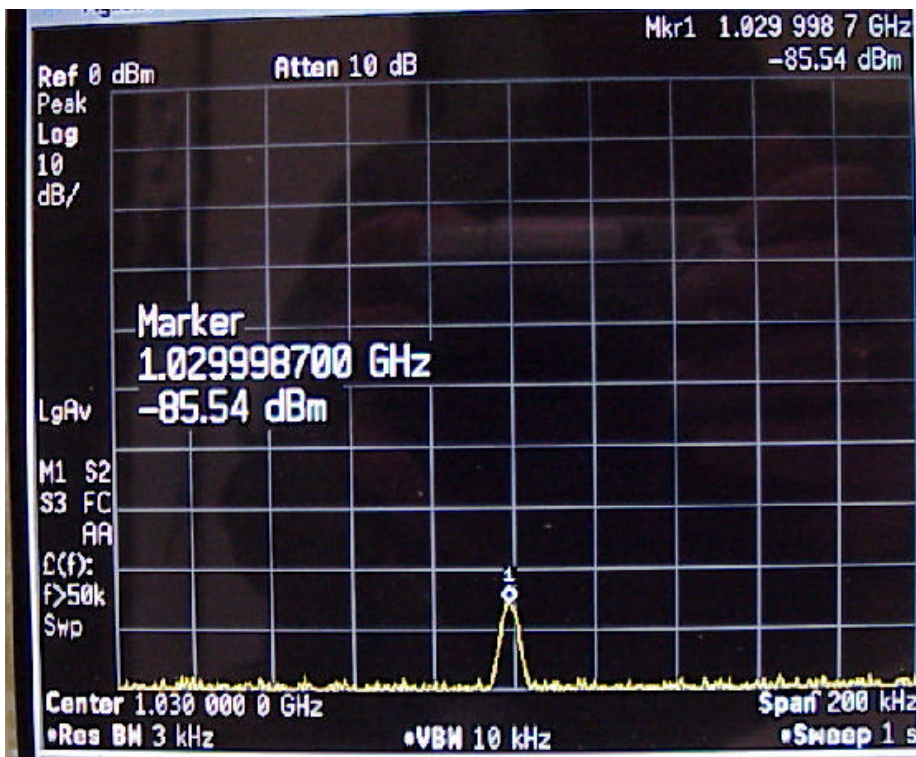


Figure 48: Top Antenna L.O. Leakage

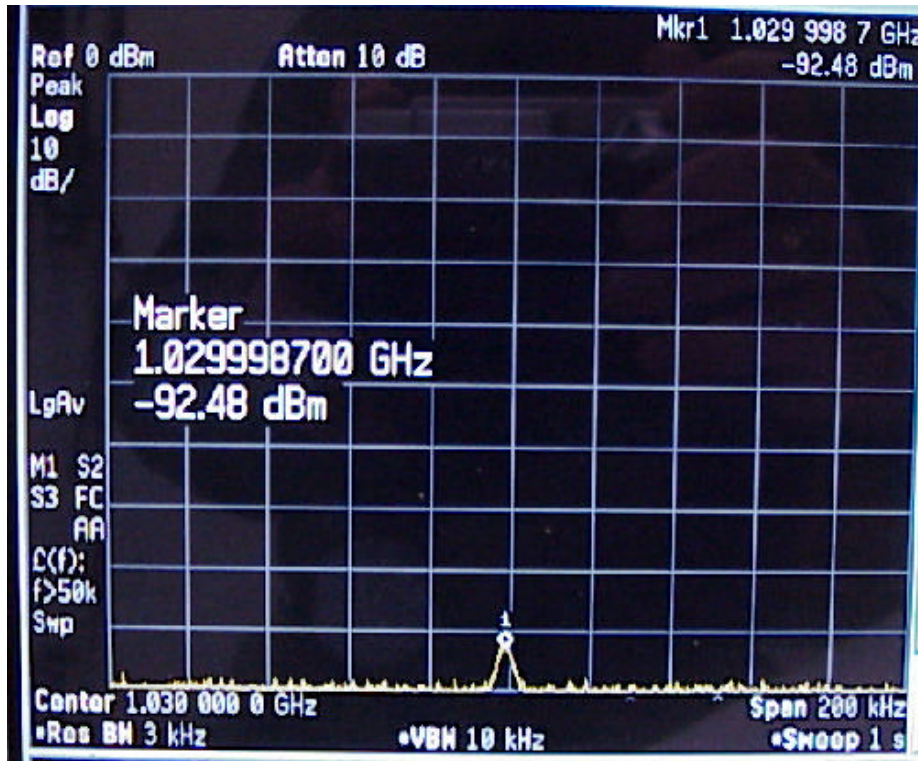


Figure 49: Bottom Antenna L.O. Leakage

8.5 Field Strength of Spurious Radiation

47CFR References:

- 2.1053, Field Strength of Spurious Radiation
- 15.109, Radiated Emission Limits
- 15.31, Measurement Standards
- 15.33, Frequency Range of Radiated Measurements
- 87.139, Emissions Limitations

Per 47CFR15.109, the following limits on radiated emissions apply to T²CAS because it contains digital devices:

| Frequency (MHz) | Field Strength (microvolts/meter) | ** Measurement Distance (meters) |
|-----------------|-----------------------------------|----------------------------------|
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

** Measurements will be taken at 3m.

Table 14: Allowable radiated emissions levels for units containing digital devices per 47CFR15.109

47CFR15.31 para (i) states that the emission tests shall be performed with the device and accessories configured in a manner that tends to produce maximized emissions within the range of variations that can be expected under normal operating conditions. In order to accomplish this, the T²CAS will be operated in Test Mode 2 (Mode S, long P6, DPSK modulation, Test Mode Program switches on System Panel to UUDU) during the emissions tests.

Per 47CFR15.33 para (a) (1), because T²CAS operates below 10 Ghz, the 10th harmonic of the highest frequency or to 40 Ghz, whichever is lower, shall be used for the upper frequency of the measurement range.

47CFR15.33 para (b) (3) states that receivers employing superheterodyne techniques controlled by digital devices shall be investigated up to the higher of the 2nd harmonic of the highest local oscillator frequency generated in the device or the upper frequency of the measurement range of the digital device. Thus, a check for emissions at the first two harmonics of the fundamental frequency (1030 Mhz) will be done with the TCAS portion of the T²CAS unit in an idle (non-transmitting) state.

8.5.1 Field Strength of Spurious Radiation

The T²CAS model TT-952 unit will be subjected to the full suite of FCC compliance tests. The T²CAS model TT-951 unit will be subjected to an unofficial Field Strength of Spurious Radiation test to verify that its smaller 4MCU chassis with a fan does not alter emissions characteristics.

8.5.1.1 Field Strength of Spurious Radiation Test Equipment Required

| Block Diagram Reference | Type | Manufacturer | Model |
|-------------------------|------------------------|-----------------|-------------|
| A | T2CAS Computer | ACSS | RT-950 |
| B | TCAS 2000 System Panel | ACSS | 9000121-001 |
| C | Termination | ATTA | N4425-10 |
| D | Antenna, Biconical | Emco | 3109 |
| E | Antenna, Log Per. | Apral | AL-2001 |
| F | Antenna, Horn | Apral | AH-118 |
| G | Spectrum Analyzer | Hewlett-Packard | HP8566B |
| H | Preselector | Hewlett-Packard | 85685A |
| I | Quasi-Peak | Hewlett-Packard | 85650A |

Table 15: Field Strength of Spurious Radiation Test Equipment Required

8.5.1.2 Field Strength of Spurious Radiation Test Setup

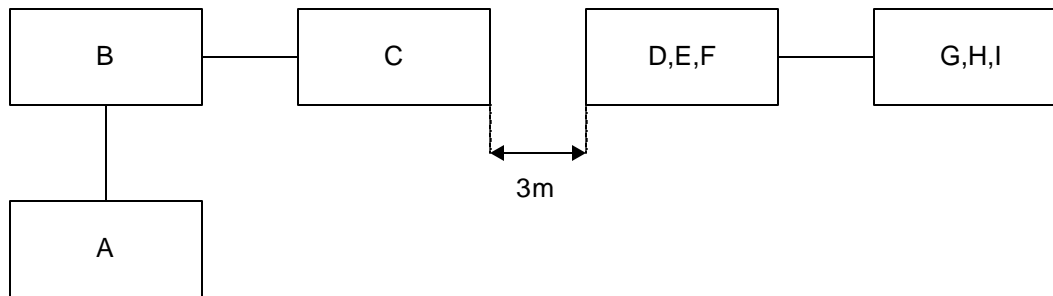


Figure 50: Field Strength of Spurious Radiation Test Setup

8.5.2 Field Strength of Spurious Radiation Test Procedure

1. Connect the equipment as shown in Figure 50 above.
2. Configure the TCAS System Panel to invoke Test Mode 2 (Mode S, long P6, DPSK modulation, Test Mode Program switches on System Panel to DDUD).
3. Measure and record all spurious emissions using the appropriate antenna in the frequency ranges indicated in Table 14 at a distance of 3 meters.
4. Calculate the field strength at 3m using the recorded power measurement, antenna factor and cable loss for each frequency.

8.5.3 Field Strength of Spurious Radiation Test Data

8.5.3.1 TT-951 (4MCU) Radiated Test Data

Refer to Appendix A for the test data and plots for the TT-951.

8.5.3.2 TT-951 (4MCU) Conducted Test Data

Refer to Appendix B for the test data and plots for the TT-951.

8.6 Frequency Stability

8.6.1 Frequency Stability (Temperature Variation)

47CFR Reference:

2.1055, Frequency Stability

15.31, Measurement Standards

87.133, Frequency Stability

8.6.1.1 Frequency Stability (Temperature Variation) Test Equipment Required

| Block Diagram Reference | Type | Manufacturer | Model | Asset# | Cal Date |
|-------------------------|------------------------|--------------|-------------|--------|----------|
| A | T2CAS Computer | ACSS | RT-952 | NA | |
| B | TCAS 2000 System Panel | ACSS | 9000121-001 | NA | |
| C | Attenuator | Narda | 765-20 | NA | |

| | | | | | |
|---|---------------------|-----------------|---------|------|---------|
| D | Attenuator | Narda | 765-20 | NA | |
| E | Peak Power Analyzer | Hewlett-Packard | HP8990A | 418 | 23/7/03 |
| F | Spectrum Analyzer | Hewlett-Packard | HP8592L | 1025 | 6/11/03 |

Table 16: Frequency Stability (Temperature Variation) Test Equipment Required

8.6.1.2 Frequency Stability (Temperature Variation) Test Setup

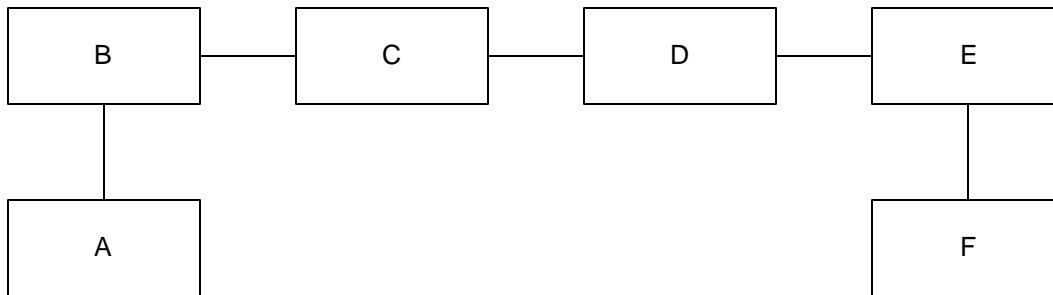


Figure 51: Frequency Stability (Temperature Variation) Test Setup

8.6.1.3 Frequency Stability (Temperature Variation) Test Procedure

- 1 Connect the equipment as shown in Figure 51 above.
- 2 Configure the TCAS 2000 System Panel to invoke Test Mode 3 (Mode S, Long P6, No DPSK Modulation, Test Mode Program switches on System Panel to DDUU).
- 3 Set the temperature chamber to - 50°C and allow the transmitter (non-operating) temperature to stabilize.
- 4 Apply power to the unit and record the transmission frequency for both the top and bottom antennas.
- 5 Repeat steps 3 and 4 at -40°C, -30°C, -20°C, -10°C, 0°C, +10°C, +20°C, +30°C, +40°C,+50°C, +60°C, +70°C, and +80°C. Perform the test for both +28VDC and +115VAC power.
- 6 Record results in tables similar to **Error! Reference source not found.** below.

| TEMP C | 28VDC POWER SUPPLY | | | | FREQ LIMIT | POWER LIMIT |
|-----------|----------------------|-----------|----------------------|-----------|---------------|----------------|
| | TOP 0 DEGREE ANTENNA | | BOT 0 DEGREE ANTENNA | | | |
| | POWER OUT | FREQUENCY | POWER OUT | FREQUENCY | | |
| -50 | 55.204 | 1.0300013 | 55.235 | 1.0299976 | <.01MHz | >54dBm |
| -40 | 55.267 | 1.0300000 | 55.298 | 1.0299978 | <.01MHz | >54dBm |
| -30 | 55.268 | 1.0300016 | 55.282 | 1.0299995 | <.01MHz | >54dBm |
| -20 | 55.251 | 1.0300005 | 55.283 | 1.0299984 | <.01MHz | >54dBm |
| -10 | 55.204 | 1.0300016 | 55.220 | 1.0299995 | <.01MHz | >54dBm |
| 0 | 55.218 | 1.0300005 | 55.204 | 1.0299995 | <.01MHz | >54dBm |
| 10 | 55.142 | 1.0300022 | 55.111 | 1.0299995 | <.01MHz | >54dBm |
| 20 | 55.157 | 1.0300022 | 55.126 | 1.0299995 | <.01MHz | >54dBm |
| 30 | 55.157 | 1.0300016 | 55.095 | 1.0299995 | <.01MHz | >54dBm |
| 40 | 55.111 | 1.0300011 | 55.079 | 1.0299992 | <.01MHz | >54dBm |
| 50 | 55.064 | 1.0300011 | 55.017 | 1.0299989 | <.01MHz | >54dBm |

| | | | | | | |
|----|--------|-----------|--------|-----------|---------|--------|
| 60 | 55.111 | 1.0300027 | 54.986 | 1.0300022 | <.01MHz | >54dBm |
| 70 | 55.097 | 1.0300016 | 54.928 | 1.0300012 | <.01MHz | >54dBm |
| 80 | 55.064 | 1.0300022 | 54.889 | 1.0300011 | <.01MHz | >54dBm |

Table 17: Frequency Stability (Temperature Variation, +28 VDC Power Supply) Test Results Example Table

8.6.2 Frequency Stability (Primary Power Variation)

47CFR Reference:
 2.1055, Frequency Stability
 15.31, Measurement Standards
 87.133, Frequency Stability

47CFR15.31 (e) states that measurements of the radiated signal level of the fundamental frequency component of the emission shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

For the 28 vdc power, 85%/115% = 23.8 vdc/32.2 vdc,. and 23 vdc & 33 vdc will be used.

8.6.2.1 Frequency Stability (Primary Power Variation) Test Equipment Required

| Block Diagram Reference | Type | Manufacturer | Model | Asset# | Cal Date |
|-------------------------|------------------------|-----------------|-------------|--------|----------|
| A | T2CAS Computer | ACSS | RT-952 | NA | |
| B | TCAS 2000 System Panel | ACSS | 9000121-001 | NA | |
| C | Attenuator | Narda | 765-20 | NA | |
| D | Attenuator | Narda | 765-20 | NA | |
| E | Peak Power Analyzer | Hewlett-Packard | HP8990A | 418 | 23/7/03 |
| F | Spectrum Analyzer | Hewlett-Packard | HP8592L | 1025 | 6/11/03 |

Table 18: Frequency Stability (Primary Power Variation) Test Equipment Required

8.6.2.2 Frequency Stability (Primary Power Variation) Test Setup

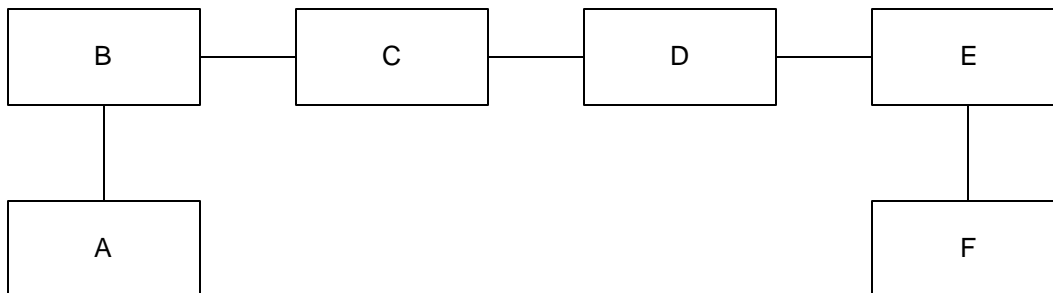


Figure 52: Frequency Stability (Primary Power Variation) Test Setup

8.6.2.3 Frequency Stability (Primary Power Variation) Test Procedure

- 1 Connect the equipment as shown in the block diagram above.
- 2 Configure the TCAS 2000 System Panel to invoke Test Mode 3 (Mode S, Long P6, No DPSK Modulation, Test Mode Program switches on System Panel to DDUU).
- 3 Apply +28VDC power to the unit and vary the primary power by +/-15% to the values shown in Table 19. Record the transmission frequency and power out for both the top and bottom antennas in a table similar to Table 19 shown below.

| Frequency Stability (Primary Power Variation) +28 VDC | | | | | |
|---|--|--------------------------------------|--|--------------------------------------|------------------|
| Power Supply Voltage (VDC) | Measured Frequency Top 0 Degree Ant Port | Measured Power Top 0 Degree Ant Port | Measured Frequency Bot 0 Degree Ant Port | Measured Power Bot 0 Degree Ant Port | Limits Frequency |
| 23 | 1.0299986 | 55.189 | 1.0299991 | 54.939 | 1.03 +/- .01 GHZ |
| 28 | 1.0299989 | 55.230 | 1.0299986 | 54.988 | 1.03 +/- .01 GHZ |
| 33 | 1.0300003 | 55.251 | 1.0299986 | 55.001 | 1.03 +/- .01 GHZ |

Table 19: Frequency Stability (Primary Power Variation) Test Results Example Table

9 APPENDIX A: TT-951 (4MCU) RADIATED EMISSIONS

9.1 Class B Spurious Emissions (Radiated)

9.1.1 Class B Spurious Emissions (Radiated) Mode 2 (Transmitting)

All data was taken in mode #2, transmitting into a dummy load. The tables below reflect the measured data and the limit. The pass/fail results for the measured data were calculated on the following methods:

- 10KHz - 150 KHz: Averaged Measurement
- 150KHz – 1GHz: Quasi-Peak Measurement
- 1- 10GHz: Average Measurement

000 Deg Vertical

| Emissions Level (MHz) | Level @ 3 Meters dBuV/m | Calculated Level @ 3 Meters dBuV/m | Limit dBuV/m | Peak Or Average |
|-----------------------|-------------------------|------------------------------------|--------------|-----------------|
| 1030.00 | 100.8 | 84.6 | | Peak |
| 1030.00 | 59.2 | 53.4 | 54 | Average |
| 2060.00 | 86.5 | 81.4 | | Peak |
| 2060.00 | 51.2 | 49.6 | 54 | Average |
| 3090.00 | 66.37 | 63.9 | | Peak |
| 3090.00 | 48.6 | 46.3 | 54 | Average |
| 4120.00 | 73.4 | 64.7 | | Peak |
| 4120.00 | 40.6 | 39.6 | 54 | Average |
| 5150.00 | 53.0 | 39.2 | | Peak |
| 5150.00 | 46.7 | 43.8 | 54 | Average |

000 Deg Horizontal

| Emissions Level (MHz) | Level @ 3 Meters dBuV/m | Calculated Level @ 3 Meters dBuV/m | Limit dBuV/m | Peak Or Average |
|-----------------------|-------------------------|------------------------------------|--------------|-----------------|
| 1030.00 | 98.6 | 81.6 | | Peak |
| 1030.00 | 63.3 | 52.8 | 54 | Average |
| 2060.00 | 85.1 | 78.6 | | Peak |
| 2060.00 | 56.4 | 51.6 | 54 | Average |
| 3090.00 | 63.5 | 59.1 | | Peak |
| 3090.00 | 52.6 | 48.7 | 54 | Average |
| 4120.00 | 58.8 | 54.9 | | Peak |
| 4120.00 | 40.3 | 38.4 | 54 | Average |
| 5150.00 | 57.4 | 39.7 | | Peak |
| 5150.00 | 41.4 | 40.2 | 54 | Average |

180 Deg Vertical

| Emissions Level (MHz) | Level @ 3 Meters dBuV/m | Calculated Level @ 3 Meters dBuV/m | Limit dBuV/m | Peak Or Average |
|-----------------------|-------------------------|------------------------------------|--------------|-----------------|
| 1030.00 | 84.6 | 76.1 | | Peak |
| 1030.00 | 68.4 | 53.1 | 54 | Average |
| 2060.00 | 75.6 | 67.3 | | Peak |
| 2060.00 | 55.8 | 52.7 | 54 | Average |
| 3090.00 | 55.9 | 51.8 | | Peak |
| 3090.00 | 48.9 | 44.6 | 54 | Average |
| 4120.00 | 63.7 | 58.4 | | Peak |
| 4120.00 | 39.8 | 34.7 | 54 | Average |

180 Deg Horizontal

| Emissions Level (MHz) | Level @ 3 Meters dBuV/m | Calculated Level @ 3 Meters dBuV/m | Limit dBuV/m | Peak Or Average |
|-----------------------|-------------------------|------------------------------------|--------------|-----------------|
| 1030.00 | 86.7 | 74.3 | | Peak |
| 1030.00 | 67.9 | 49.8 | 54 | Average |
| 2060.00 | 80.7 | 72.4 | | Peak |
| 2060.00 | 53.6 | 49.5 | 54 | Average |
| 3090.00 | 55.9 | 49.3 | | Peak |
| 3090.00 | 48.9 | 42.4 | 54 | Average |
| 4120.00 | 63.7 | 56.9 | | Peak |
| 4120.00 | 41.8 | 34.5 | 54 | Average |

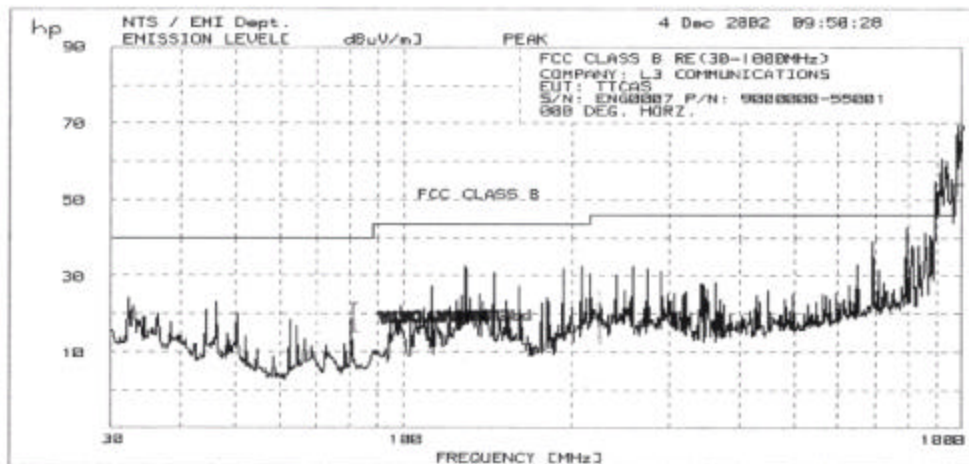


Figure 53: 4MCU, Radiated, Mode 2, 30MHz-1GHz, 000 Deg, Horizontal

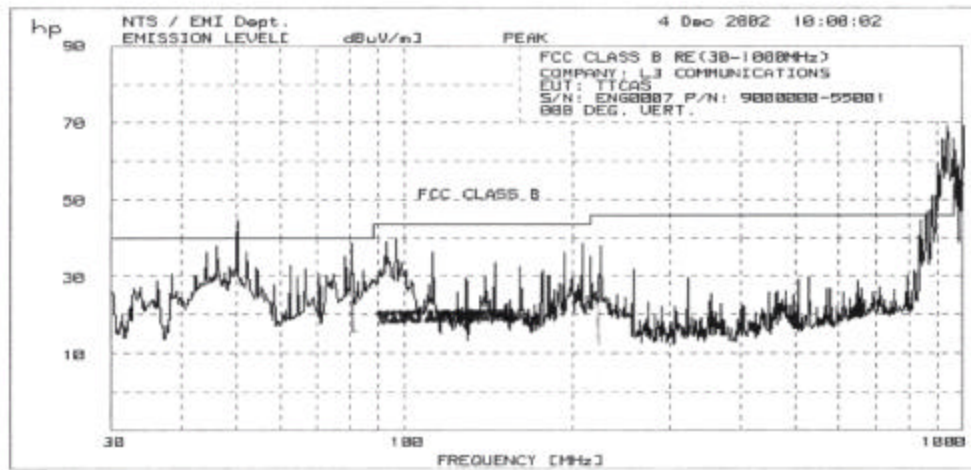


Figure 54: 4MCU, Radiated, Mode 2, 30MHz-1GHz, 000 Deg, Vertical

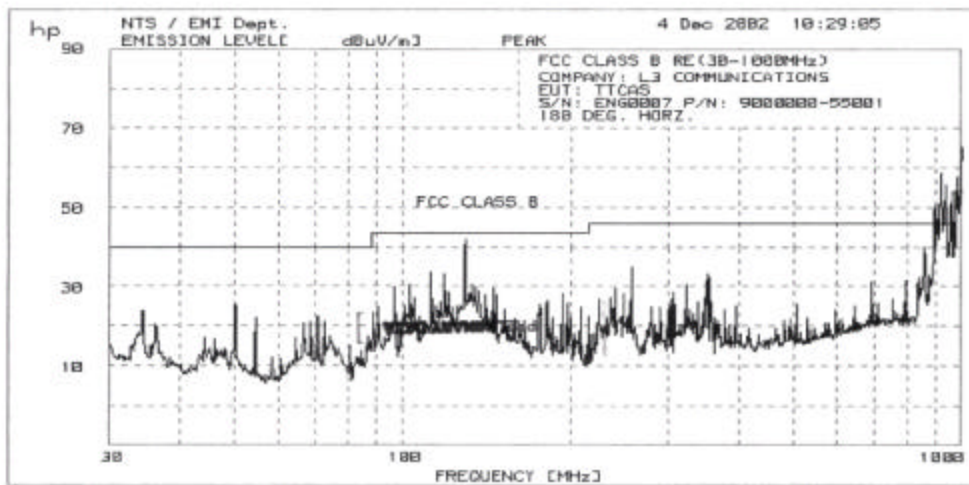


Figure 55: 4MCU, Radiated, Mode 2, 30MHz-1GHz, 180 Deg, Horizontal

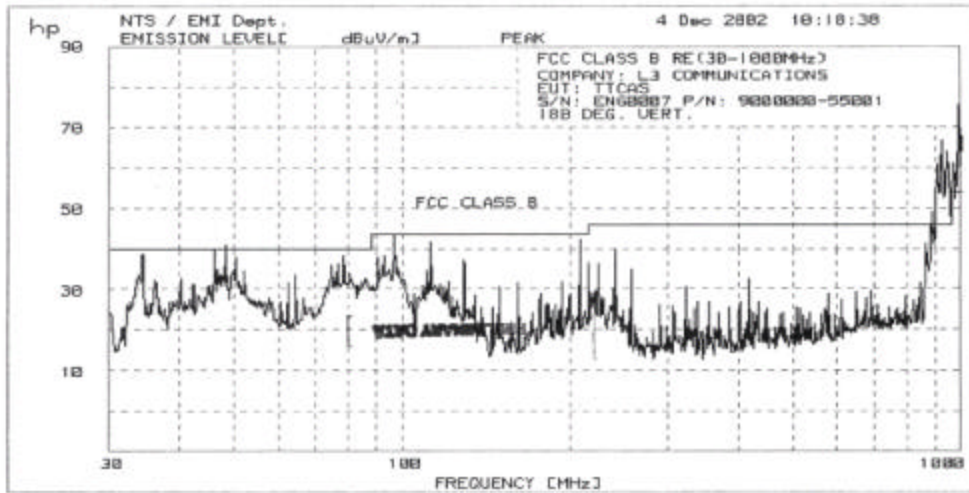


Figure 56: 4MCU, Radiated, Mode 2, 30MHz-1GHz, 180 Deg, Vertical

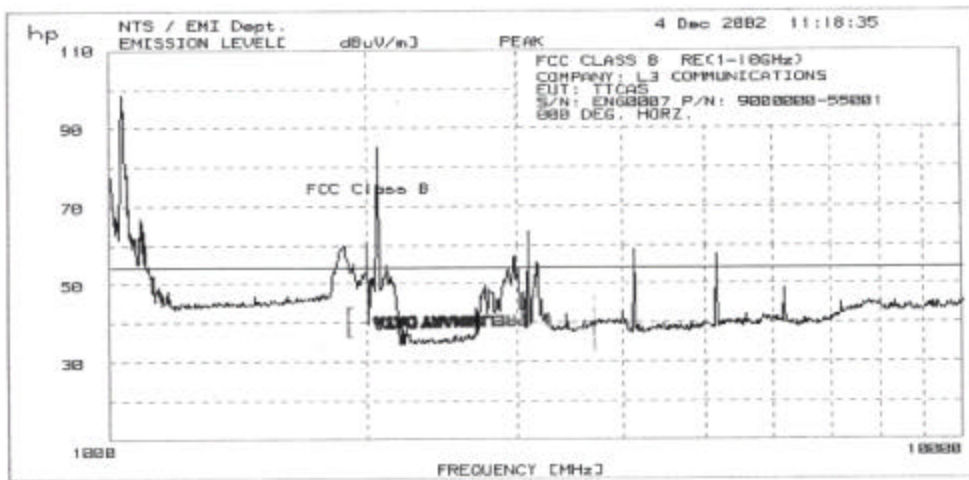


Figure 57: 4MCU, Radiated, Mode 2, 1-10GHz, 000 Deg, Horizontal