REPORT NUMBER 1513 DEC 1999

# RADIO PERFORMANCE MEASUREMENTS

on the TOP-K2220 Hand Portable Transceiver

# FCC ID: CASTEL0032

Serial N$^{o}$ 14034155

in accordance with

FCC 47 CFR Part 90

PREPARED BY: Garry Pringle
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FCC ID: CASTEL 0032

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NAME OF TEST: TRANSMITTER OUTPUT POWER (CONDUCTED)

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.046 (a)

GUIDE: TIA/EIA-603 2.2.1

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The load used has an impedance of 50Ω.
3. The unmodulated output power was measured by means of an RF Power meter.

MEASUREMENT RESULTS:

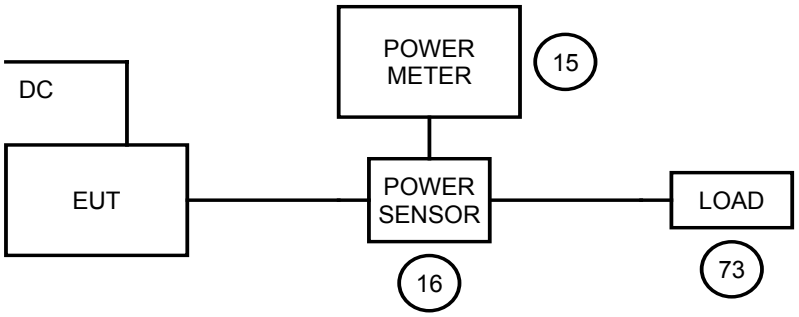
Manufacturers rated output power: Selectable 1W or 3 W

| 918.1MHz | 1W nominal | 3 W nominal |
|---|---|---|
| Watts | 1.07 | 3.16 |
| Variation from nom (%) | +7 | +5.3 |
| Measurement uncertainty (dB) | +0.63<br>-0.68 | |

LIMIT CLAUSE: FCC 47 CFR 90.205

Radio Type: Hand Portable Transceiver
Frequency Band: 896 MHz – 941 MHz;
(n) "The output power shall not exceed by more than 20% the manufacturers rated output power for the particular transmitter."

TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: AUDIO FREQUENCY FILTER RESPONSE

TEST CONDITIONS: Ambient temperature °C
Relative humidity %
Standard Voltage VDC

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603 2.2.15

MEASUREMENT PROCEDURE:

This test was not carried out as the EUT meets the emission limitations specified in §90.210.

MEASUREMENT RESULTS:

See Occupied Bandwidth tests on Page 11

LIMIT CLAUSE: 90.211 (a)

"Transmitters utilizing analog transmissions that are equipped with an audio low-pass filter must meet the emission limitations specified in §90.210….."

TEST SETUP: See page 11 - Occupied Bandwidth.

NAME OF TEST: TRANSMITTER AUDIO FREQUENCY RESPONSE
PRE-EMPHASIS

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603 2.2.6

MEASUREMENT PROCEDURE:

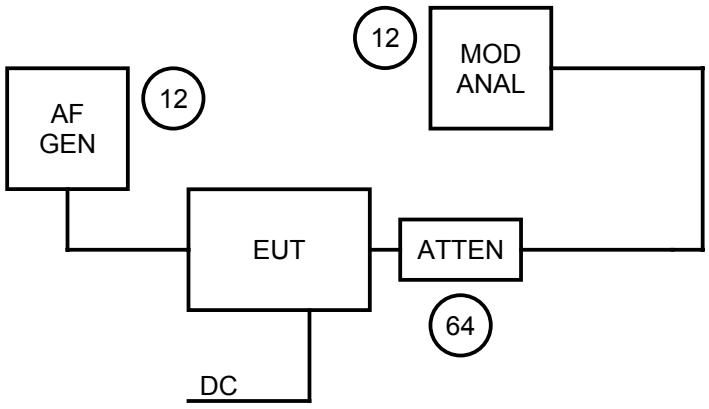
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. An audio input tone of 1000Hz was applied, the level set to obtain 20% max deviation. This was used as the 0dB reference point.
3. The AF frequency was varied, while the deviation level was held constant,
4. The response in dB relative to 1000Hz was measured.

MEASUREMENT RESULTS:

See the plot on the following page.

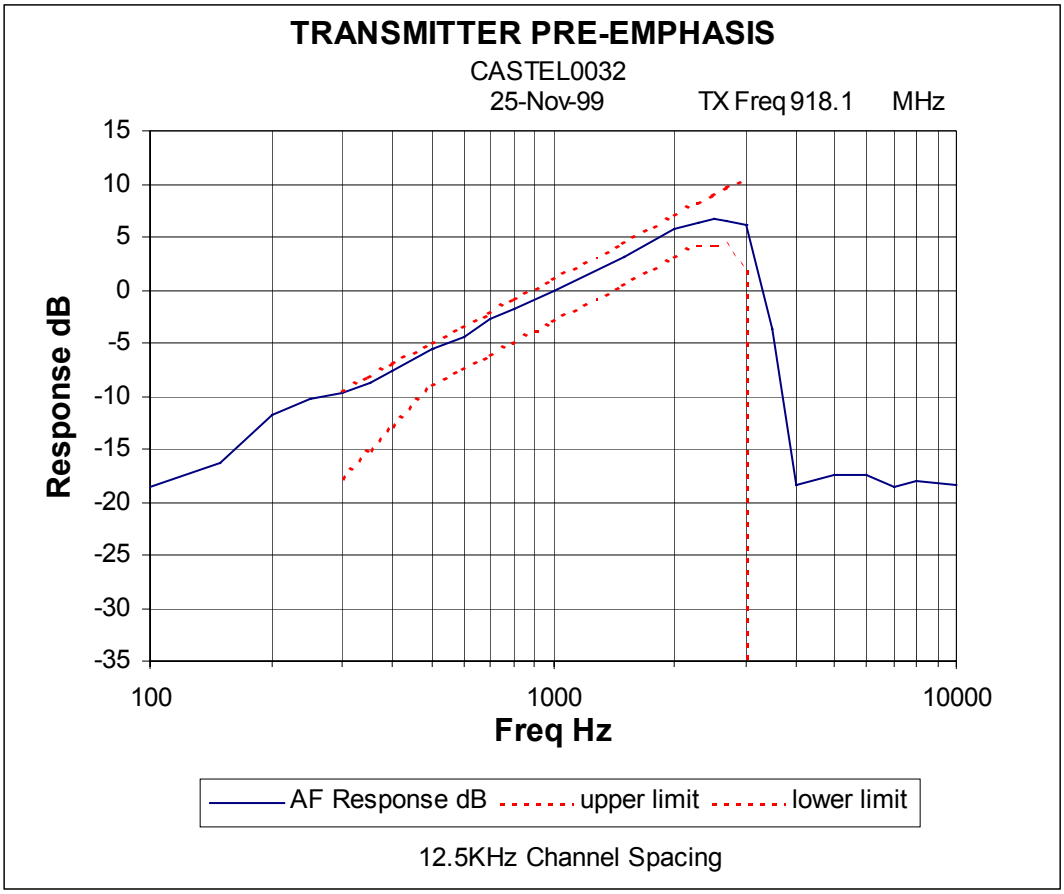
LIMIT CLAUSE: TIA/EIA-603 2.2.6

TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: TRANSMITTER AUDIO FREQUENCY RESPONSE PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)



NAME OF TEST: TRANSMITTER MODULATION LIMITING

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603 2.2.3

MEASUREMENT PROCEDURE:

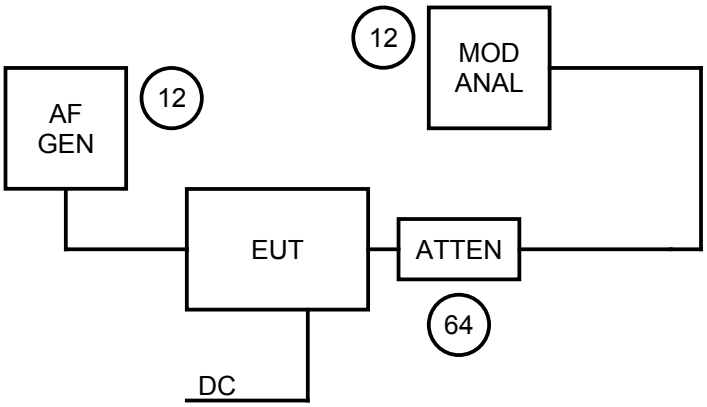
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The modulation response was measured at three audio frequencies, varying the input level.
3. Measurements were made for both positive and negative deviation.

MEASUREMENT RESULTS:

See the plots on the following page.

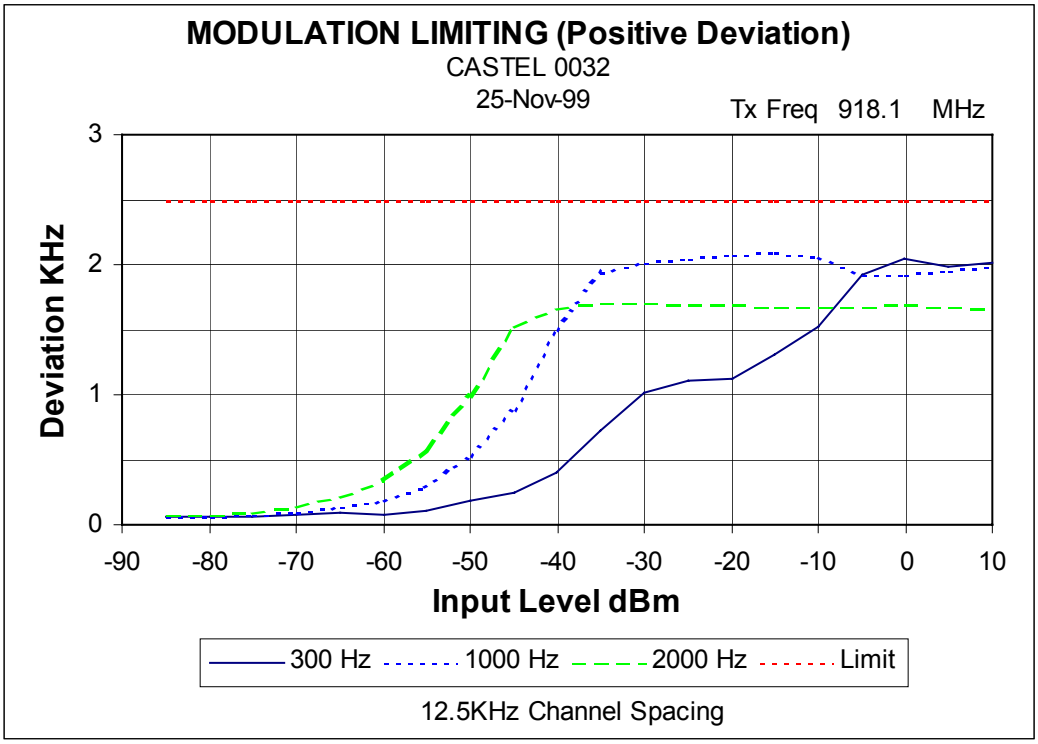
LIMIT CLAUSE: FCC 47 CFR 90.211(a)
2.1047 (b)

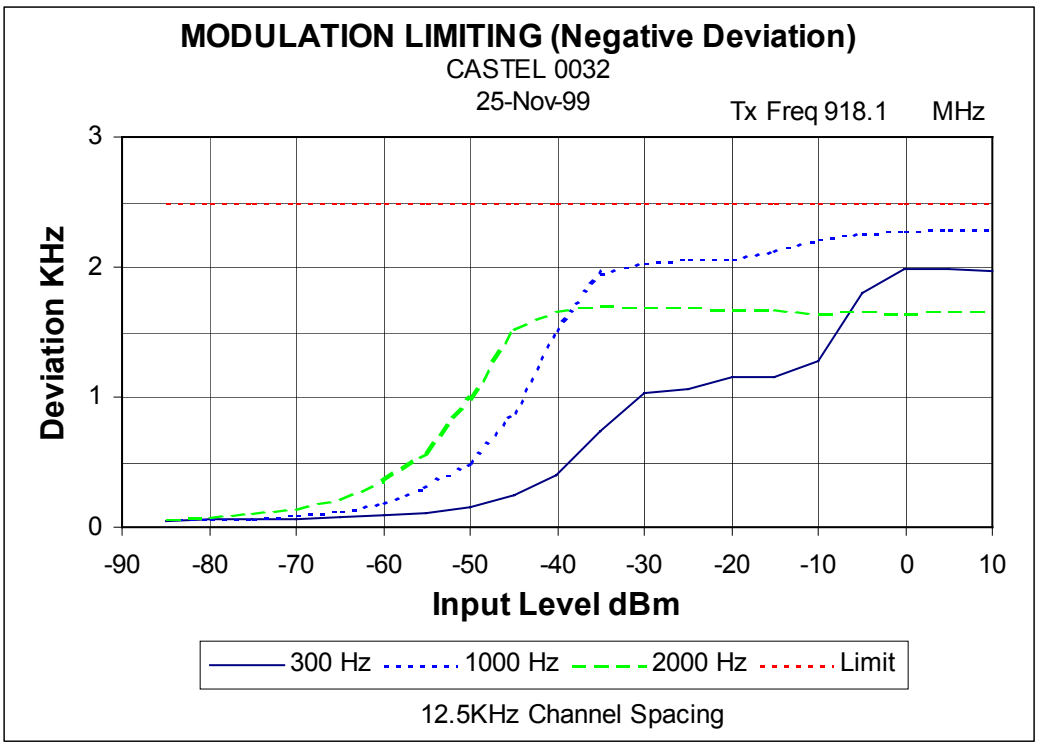
TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047(b)



NAME OF TEST: TRANSMITTER MODULATION LIMITING
STEADY STATE AND INSTANTANEOUS

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603 2.2.3

MEASUREMENT PROCEDURE:

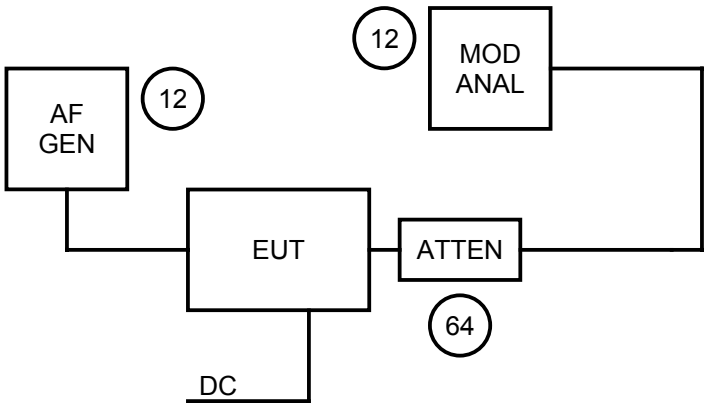
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The modulation response was measured with the level stepped 20dB above the level required to obtain 60% Deviation at 1000Hz AF.
3. Measurements were made for both positive and negative deviation.

MEASUREMENT RESULTS:

See the plots on following page.

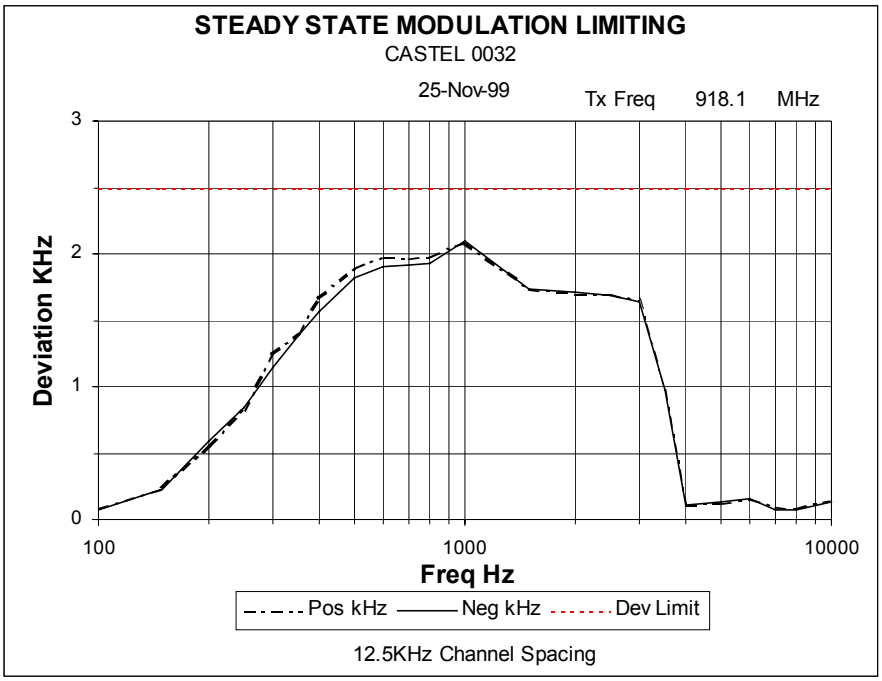
LIMIT CLAUSE: FCC 47 CFR 90.211(a)
2.1047 (b)

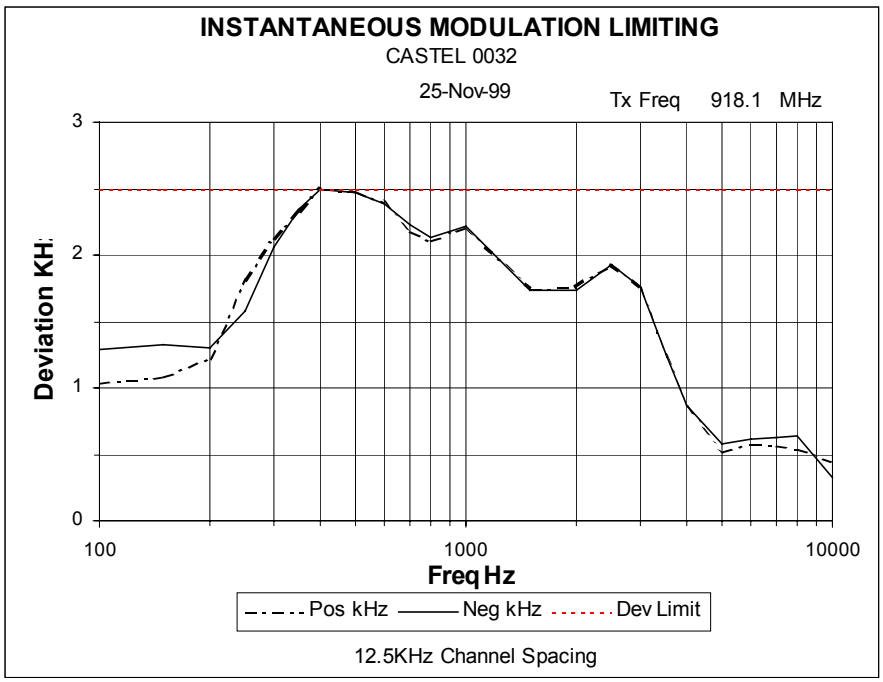
TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: TRANSMITTER MODULATION LIMITING
STEADY STATE AND INSTANTANEOUS

SPECIFICATION: FCC 47 CFR 2.1047 (b)



FCC ID: CASTEL 0032

NAME OF TEST: OCCUPIED BANDWIDTH

TEST CONDITIONS: Ambient temperature 20 °C
Relative humidity 60 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1049(c)(1)

GUIDE: TIA/EIA-603 Para 2.2.11

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was modulated by a 2500Hz tone at an input level 16dB above a level that produced 50% deviation. The input level was established at the frequency of maximum response of the audio modulating circuit.
3. The Occupied Bandwidth was measured on the Spectrum Analyser with the controls set as shown on the following plots.

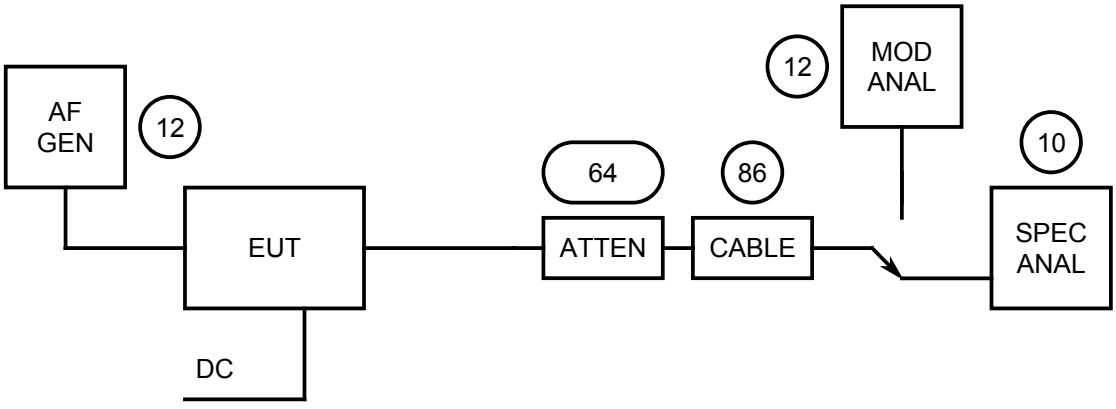
MEASUREMENT RESULTS:

See the plots on following pages.

LIMIT CLAUSE: FCC 47 CFR 90.210

| Emission Mask "I" | ATTENUATION (dBc) | |
|---|---|---|
| | 1 W | 3 W |
| Fc ± 6.8 kHz To ± 9 kHz | 25 | 25 |
| Fc ± 9 kHz To ± 15 kHz | 35 | 35 |
| Fc > ± 15 kHz | 43 | 47.77 |

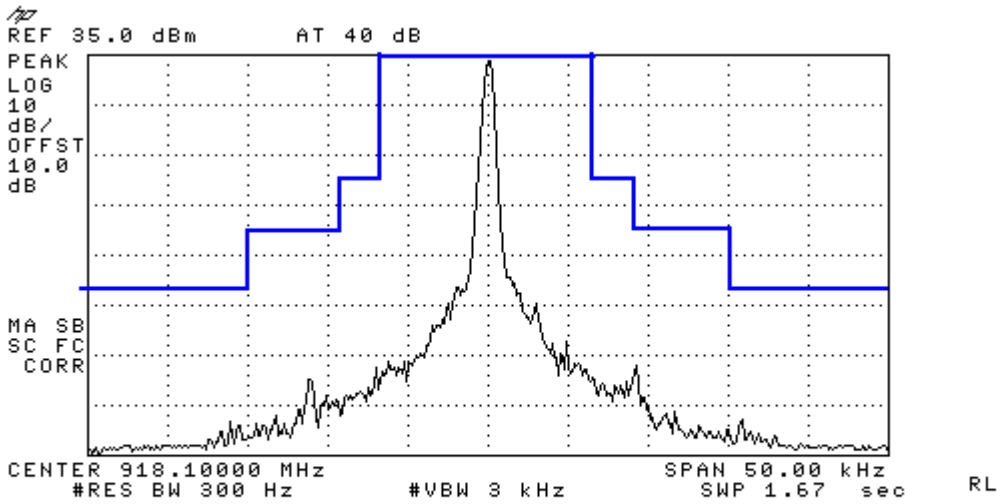
TEST SETUP: See page 23 for test equipment information.



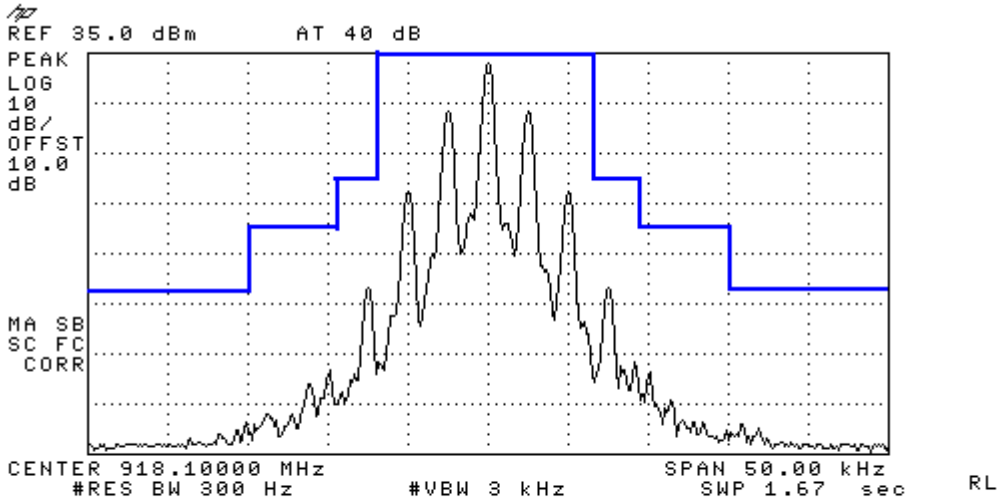
NAME OF TEST: OCCUPIED BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.1049(c) (1)

MASK "I"
HIGH POWER 3 W Unmodulated



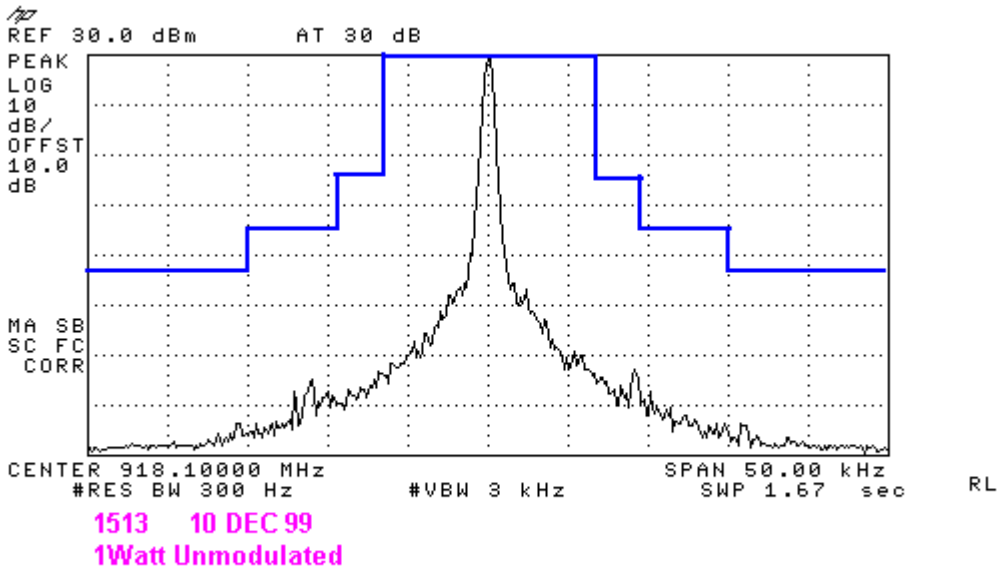

MASK "I"
HIGH POWER 3 W Modulated



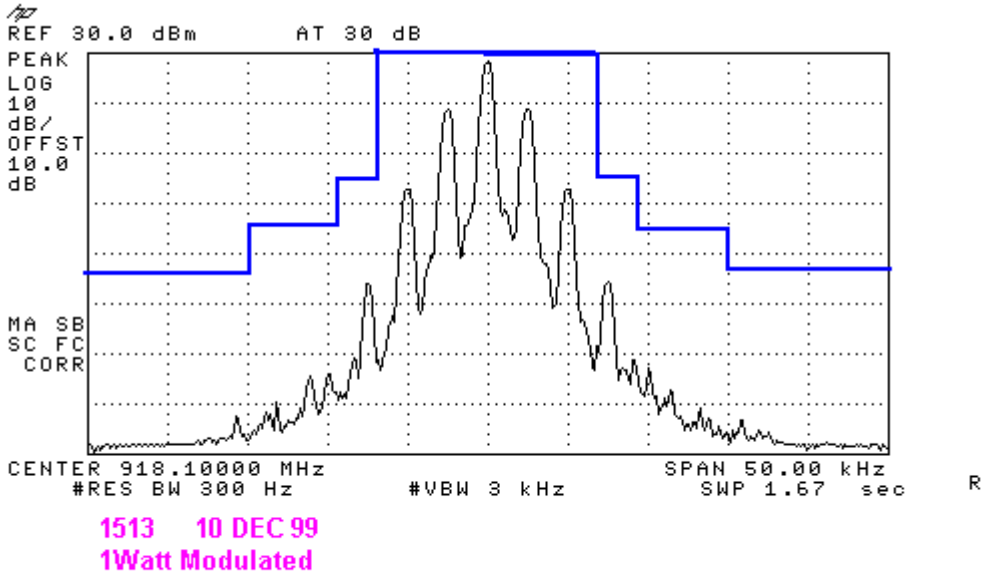
NAME OF TEST: OCCUPIED BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.989(c) (1)

MASK "I"
LOW POWER 1W Unmodulated




MASK "I"
LOW POWER 1W Modulated



NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1051

GUIDE: TIA/EIA-603 2.2.13

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The frequency range examined was from the lowest frequency generated within the EUT to a frequency higher than the 10th harmonic: 100KHz to Fc-BW
Fc+BW to 10GHz
3. Spurious emissions which were attenuated more than 20dB below the limit were not recorded

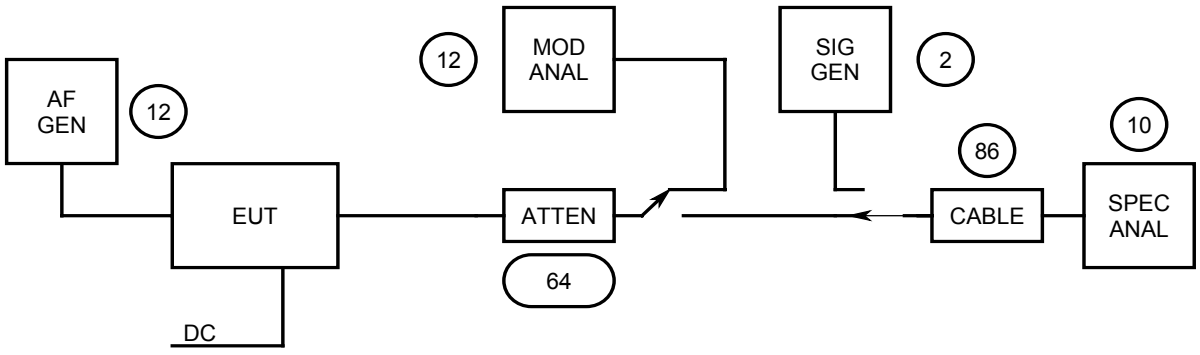
MEASUREMENT RESULTS:

See the tables on following pages.

LIMIT CLAUSE: FCC 47 CFR 90.210

See the tables on following pages.

TEST SETUP: See page 23 for test equipment information.



FCC ID: CASTEL 0032

NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1051

| 918.1MHz @ 3 W Emission Mask "I" | | |
|---|---|---|
| Emission Freq MHz | Level dBm | Level dBc |
| ~ | ~ | ~ |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| No emissions were detected at a level greater than 20 dB below the limit | | |

LIMITS:

| Carrier output power P Watts | Emission Mask "I" $43+10Log_{10}(P_{Watts})$ | |
|---|---|---|
| 3 W | 47.77 dBc | -13dBm |
| 1W | 43 dBc | -13dBm |

FCC ID: CASTEL 0032

NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1051

| 918.1 MHz @ 1 W Emission Mask "I" | | |
|---|---|---|
| Emission Freq MHz | Level dBm | Level dBc |
| ~ | ~ | ~ |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| No emissions were detected at a level greater than 20 dB below the limit | | |

LIMITS:

| Carrier output power P Watts | Emission Mask "I" $43+10Log_{10}(P_{Watts})$ | |
|---|---|---|
| 3 W | 47.77 dBc | -13dBm |
| 1 W | 43 dBc | -13dBm |

NAME OF TEST: SPURIOUS EMISSIONS (RADIATED)

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 60 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1053(a)

GUIDE: TIA/EIA-603 2.2.12

MEASUREMENT PROCEDURE:
1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was placed on a wooden turntable at a distance of three metres from the test antenna. The output terminal was connected to an RF dummy load.
3 The frequency range examined was from the lowest frequency generated within the EUT to a frequency higher than the 10th harmonic: 100KHz to Fc-BW
Fc+BW to 10GHz
4. The turntable was rotated through 360° to obtain the maximum response of each spurious emission. Valid emissions were determined by switching the EUT on and off.
5. The EUT was replaced by a signal generator and substitution antenna to make measurements by the substitution method.

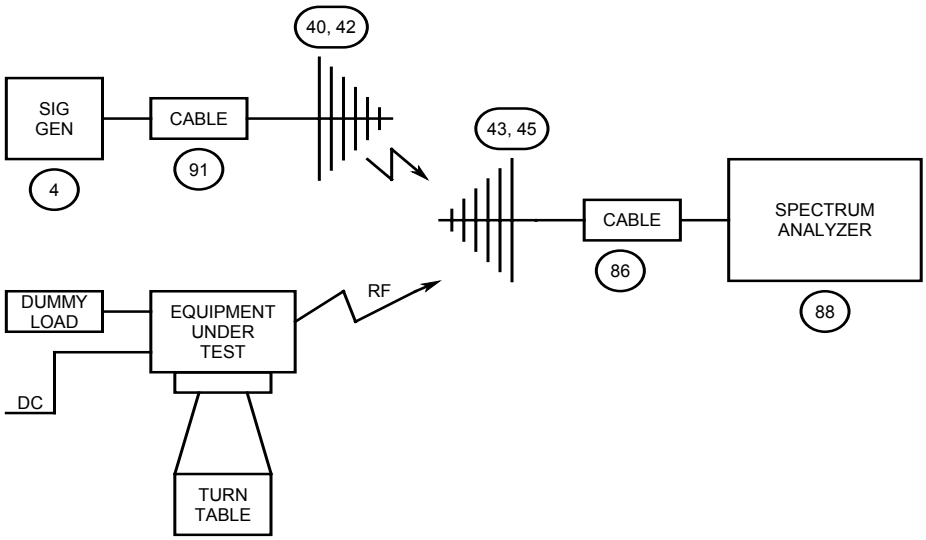
MEASUREMENT RESULTS:

See the tables on following pages.

LIMIT CLAUSE: FCC 47 CFR 90.210

See the tables on following pages

TEST SETUP: See page 23 for test equipment information.



FCC ID: CASTEL 0032

NAME OF TEST: SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053(a)

| 918.1 MHz @ 3 W Emission Mask "I" | | |
|---|---|---|
| Emission Freq MHz | Level dBm | Level dBc |
| ~ | ~ | ~ |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| No emissions were detected at a level greater than 20 dB below the limit | | |

LIMITS:

| Carrier output power P Watts | Emission Mask "I" $43+10Log_{10}(P_{Watts})$ | |
|---|---|---|
| 3 W | 47.77 dBc | -13dBm |
| 1 W | 43 dBc | -13dBm |

FCC ID: CASTEL 0032

NAME OF TEST: SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053 (a)

| 918.1 MHz @ 1 W Emission Mask "I" | | |
|---|---|---|
| Emission Freq MHz | Level dBm | Level dBc |
| ~ | ~ | ~ |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| No emissions were detected at a level greater than 20 dB below the limit | | |

LIMITS:

| Carrier output power P Watts | Emission Mask "I" $43+10Log_{10}(P_{Watts})$ | |
|---|---|---|
| 3 W | 47.77 dBc | -13dBm |
| 1 W | 43 dBc | -13dBm |

NAME OF TEST: TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1055 (a) (1)

GUIDE: TIA/EIA-603 2.2.2

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was tested for frequency error from -30°C to +50°C in 10°C increments.
3. The frequency error was recorded in parts per million (PPM)

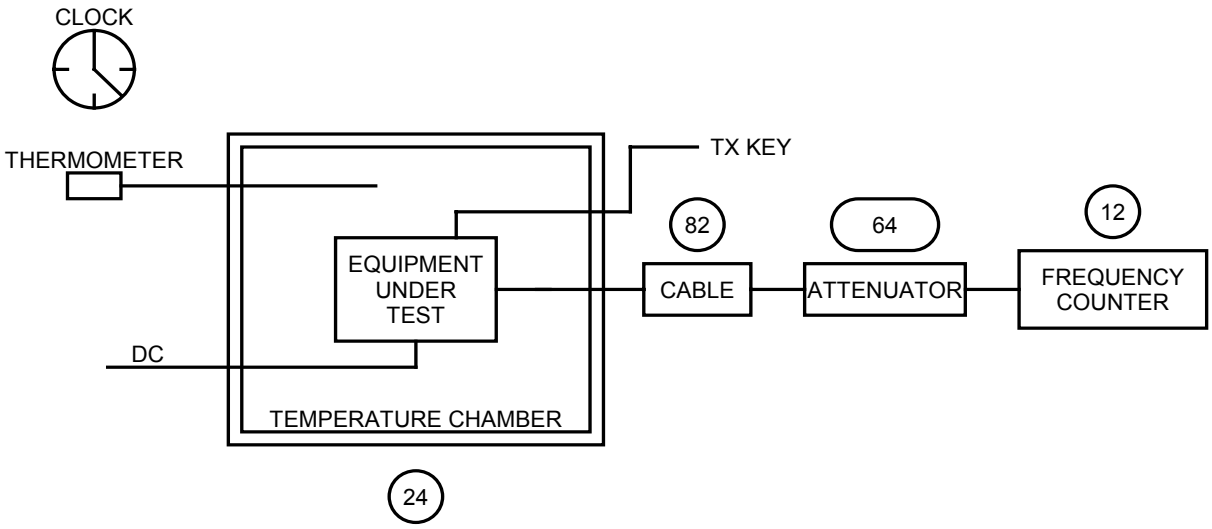
MEASUREMENT RESULTS:

See the plot on the following page.

LIMIT CLAUSE: FCC 47 CFR 90.213

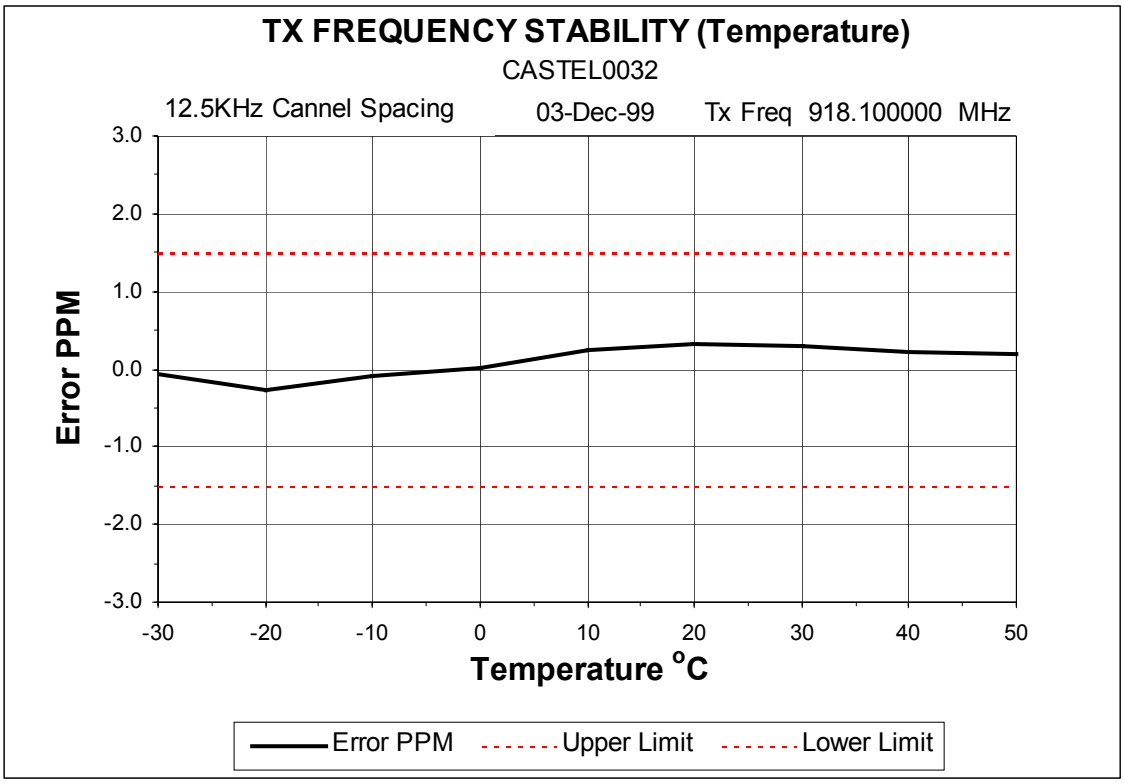
| Frequency Range | Frequency Error (PPM) |
|---|---|
| 896 MHz to 941 MHz | 1.5 |

TEST SETUP: See page 23 for test equipment information.



NAME OF TEST: TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

SPECIFICATION: FCC 47 CFR 2.1055(a)(1)



NAME OF TEST: TRANSMITTER FREQUENCY STABILITY (VOLTAGE)

TEST CONDITIONS: Ambient temperature 19 °C
Relative humidity 65 %
Standard Voltage 7.50 VDC

SPECIFICATION: FCC 47 CFR 2.1055 (d) (2)

GUIDE: TIA/EIA-603 2.2.2

MEASUREMENT PROCEDURE:

1. The Equipment Under Test (EUT) was set up as shown on the following diagram.
2. The EUT was tested for frequency error at a nominal battery voltage, and at battery end point voltage (6.30 VDC).
3. The frequency error was recorded in parts per million (PPM)

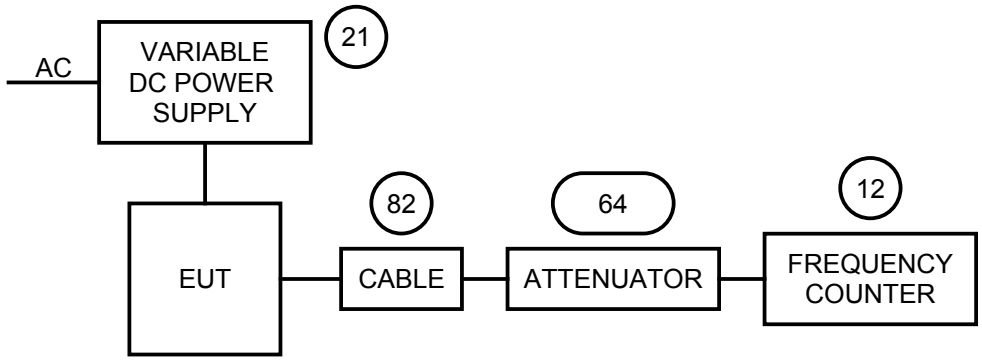
MEASUREMENT RESULTS:

| Channel Frequency (MHz) | Frequency Error (PPM) | |
|---|---|---|
| | 7.50 VDC | 6.30 VDC |
| 918.1 | +0.23 | +0.25 |

LIMIT CLAUSE: FCC 47 CFR 90.213

| Frequency Range | Frequency Error (PPM) |
|---|---|
| 896 MHz to 941 MHz | 1.5 |

TEST SETUP: See page 23 for test equipment information.



TEST EQUIPMENT LIST

To facilitate inclusion on each page, the test equipment used is identified (numbered) and listed against the related test in the report.

| No | Equipment Type | Model number | Serial Number | Tait ID: |
|---|---|---|---|---|
| 01 | Signal Generator | HP 8642B (Opt 001) | 2512A00176 | E3064 |
| 02 | Signal Generator | HP8648A | 3430U00344 | E3579 |
| 03 | Signal Generator | HP8656A | 2142A02103 | E3063 |
| 04 | Signal Generator | HP8648C | 3443U00543 | E3558 |
| 05 | Signal Generator | SMY01 1062.5502.11 | 841736/019 | E3553 |
| 10 | Spectrum Analyser | HP8596E (Opt 140) | 3346A00213 | E3427 |
| 11 | Modulation Analyser | HP8901B (Opt 002) | 2441A00393 | E3073 |
| 12 | Modulation Analyser | FMA 0852.8500.52 | 842541/001 | E3554 |
| 13 | Audio Analyser | HP8903A | 2308A02597 | E3074 |
| 14 | Power Head | HP11722A | 2320A00688 | E3307 |
| 15 | Power Meter | NRVS 1020.1809.02 | 841954/005 | E3555 |
| 16 | Power Sensor | URV5-Z4 395.1619.55 | 841.498/003 | E3557 |
| 20 | Power Supply | HP6032A | 2441A-0041 | E3075 |
| 21 | Power Supply | NGSM32/10 192.0810.31 | Fnr 434 | E3556 |
| 22 | Oscilloscope | Tektronics TDS 340 | B013611 | E3585 |
| 23 | Universal Counter | Goldstar FC-2015U | 600801 | E3550 |
| 24 | Environmental Chamber | Contherm Spatial Cal | E3397 | E3397 |
| 24 | Environmental Chamber | Contherm Temp Control | E3397 | E3397 |
| 25 | Portable Hygrometer (ASL) | Rotronic A1 | 2070300/38 | N/A |
| 25 | Whirling Hygrometer | Casella 3156 / 82 | TA004 | TA004 |
| 30 | Directional Coupler | HP778D-012 | 1144 07392 | E3292 |
| 31 | 4 Port Combiner (CAST) | DVU4, ¼W 201.4018.03 | 300729/47 | E3623 |
| 32 | 4 Port Combiner | DVU4, ¼W 201.4018.03 | 300971/28 | E3572 |
| 33 | 3 Port Combiner | Weinschel 1506A, 1W | LD858 | E3672 |
| 34 | Mixer Spurious Emission | Tait (3.2G≤ Rfx≤ 4.0G) | E3661 | E3661 |
| 35 | Mixer Transient ACP | Minicircuits ZAD-11 | 77031 | E3394 |

TEST EQUIPMENT LIST (Cont.)

| No | Equipment Type | Model number | | Serial Number | Tait ID: |
|---|---|---|---|---|---|
| 36 | Voltmeter | HP3478A | | 2545A25838 | E1559 |
| 37 | Variac | Yamabishi S-260-5 | | TX-533 | E1737 |
| 38 | RX and TX, RF Paths | Tait CAST Interface | | E3067 | E3067 |
| 40 | Reference Dipoles | Emco 3121C-DB1 | | 9510-1164 | E3559 |
| 41 | Antenna | Biconical | | 9307-1680 | E3033 |
| 42 | Reference Horn Antenna | Emco DRG 3115 | | 9512-4638 | E3560 |
| 43 | Horn Antenna | Emco DRG 3115 | | 2084 | E3076 |
| 44 | Corner 175-420 MHz | Ailtech DM 105A-T2 | | J1417-103 | E3031 |
| 45 | Corner 400-1000 MHz | Ailtech DM 105A-T3 | | J1418-108 | E3036 |
| 46 | S-LINE TEM CELL | 1089.9296.02 | | 338232/003 | E3636 |
| 50 | Amplifier AR 1M-1000M | 25W1000A | | 20444 | E3637 |
| 51 | Amplifier AR 10K-250M | 25A250 | | 16373 | E3570 |
| 52 | Amplifier +21.7 dB | Tait ZFL-1000LN | | E3660 | E3360 |
| 53 | RF Filter 21.4M (CAST) | Tait NDK 21G-6DT | | E3069 | E3069 |
| 54 | RF Filter 21.4M (ACP) | Tait NDK 21G-6DT | | RA-7' | E3249 |
| 55 | Filter Notch | Tait | | N/A | ? |
| 56 | Filter High Pass | Tait | Mhz | N/A | ? |
| 57 | Filter Low Pass | Tait | Mhz | N/A | ? |
| 60 | RF Attenuator 250W | Weinschel 45-30-34 | | JW663 | E3386 |
| 61 | RF Attenuator 150W | Weinschel 40-20-33 | | CJ404 | E3387 |
| 62 | RF Attenuator 150W | Weinschel 57-10-34 | | LB590 | E3674 |
| 63 | RF Attenuator 150W | Weinschel 40-06-34 | | KV457 | E3561 |
| 64 | RF Attenuator 50W | Weinschel 24-10-34 | | AL0401 | E3388 |
| 65 | RF Attenuator 50W | Weinschel 24-20-44 | | AW1266 | E3562 |

TEST EQUIPMENT LIST (Cont.)

| No | Equipment Type | Model number | Serial Number | Tait ID: |
|---|---|---|---|---|
| 66 | RF Attenuator 25W | Weinschel 33-20-33 | BD5871 | E3673 |
| 67 | RF Attenuator150W(CAST) | Weinschel 40-20-33 | CJ405 | 3366/82 |
| 70 | RF Load 150W | Byrd 8166 | 524 | E3625 |
| 71 | RF Load 50 W | Weinschel F1426 | BF0487 | E3675 |
| 72 | RF Load 50 W | Weinschel F1426 | AE2490 | E3624 |
| 73 | RF Termination 20W | Deltec | 118.001 | E3626 |
| 74 | RF Termination ½ W | MCL NTRM-50 | 951215 | E3574 |
| 75 | RF Termination ½ W | MCL NTRM-50 | 954214 | E3575 |
| 76 | RF Termination ½ W | MCL NTRM-50 | 954214 | E3576 |
| 80 | 20 M Coax Cable | RG214/U 50 (Ext Cal) | CBL01 | E3659 |
| 81 | 2 M Coax Cable | RG213/U 50 (Ext Cal) | CBL02 | E3658 |
| 82 | 3 M Coax Cable (BLUE) | Suhner Sucoflex 104A | 25033 / 4A | E3694 |
| 83 | 1 M Coax Cable (BLUE) | Suhner Sucoflex 104A | 25006 / 4A | E3693 |
| 84 | 1 M Coax Cable (BLUE) | Suhner Sucoflex 104A | 25005 / 4A | E3692 |
| 85 | 1 M Coax Cable (BLUE) | Suhner Sucoflex 104A | 25004 / 4A | E3691 |
| 86 | 1 M Coax Cable (BLUE) | Suhner Sucoflex 104A | 25003 / 4A | E3690 |
| 87 | Audio Analyser | HP8903B | 2818A04275 | E3710 |
| 88 | Spectrum Analyser | HP8562E | 3821A00799 | E3715 |
| 89 | Field Strength Meter | Holaday HI-422 | 95661 | E3630 |
| 90 | Power Supply | HP6012B | 2524A00616 | E3712 |
| 91 | 20 M Coax Cable | RG214/U 50 (Ext Cal) | 3404 | 24/08/99 |
| 92 | LISN | EMCO 3825/2 | 9204-1961 | E3040 |
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