# UPS AVIATION TECHNOLOGIES TEST REPORT

# FOR THE

# MODE S DATA LINK TRANSPONDER, AT7000

# FCC PART 87 SUBPART D COMPLIANCE

**DATE OF ISSUE: SEPTEMBER 5, 2001**

**PREPARED FOR:**

UPS Aviation Technologies
2345 Turner Road SE
Salem, OR 97302

P.O. No.: 220750
W.O. No.: 77446

**PREPARED BY:**

Joyce Walker
CKC Laboratories, Inc.
5473A Clouds Rest
Mariposa, CA 95338

Date of test: August 20-21, 2001

**Report No.: FC01-059**

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## ADMINISTRATIVE INFORMATION

| | |
|---|---|
| **DATE OF TEST:** | August 20-21, 2001 |
| **DATE OF RECEIPT:** | August 20, 2001 |
| **PURPOSE OF TEST:** | To demonstrate the compliance of the Mode S Data Link Transponder, AT7000 with the requirements for FCC Part 87 Subpart D devices. |
| **TEST METHOD:** | FCC Part 87 |
| **MANUFACTURER:** | UPS Aviation Technologies<br>2345 Turner Road SE<br>Salem, OR 97302 |
| **REPRESENTATIVE:** | George Cooley |
| **TEST LOCATION:** | CKC Laboratories, Inc.<br>22105 Wilson River Hwy<br>Tillamook, OR 97141 |

## SUMMARY OF RESULTS

As received, the UPS Aviation Technologies Mode S Data Link Transponder, AT7000 was found to be fully compliant with the following standards and specifications:

**United States**

- FCC Part 87 Subpart D

The results in this report apply only to the items tested, as identified herein.

## MODIFICATIONS REQUIRED FOR COMPLIANCE

No modifications were necessary for compliance.

## APPROVALS

**QUALITY ASSURANCE:**

Dennis Ward, Quality Manager

**TEST PERSONNEL:**

Mike Wilkinson, Test Engineer

## EQUIPMENT UNDER TEST (EUT) DESCRIPTION

The Mode S Transponder tested by CKC Laboratories was a pre-production unit conformed to production drawings.

## EQUIPMENT UNDER TEST

**Mode S Data Link Transponder**
Manuf: UPS Aviation Technologies
Model: AT7000
Serial: P0008
FCC ID: EOJAT7000

**AT7000 Install Kit**
Manuf: UPS Technologies
Model: TBD
Serial: None
FCC ID: NA

## PERIPHERAL DEVICES

The EUT was tested with the following peripheral device(s):

**DC Power Supply**
Manuf: Astron
Model: RS-12M
Serial: 98110031
FCC ID: DoC

**Transponder I/O Test Interface**
Manuf: II Morrow
Model: None
Serial: None
FCC ID: None

**Computer**
Manuf: BSI
Model: TANY385F11
Serial: 1006943
FCC ID: MQMTD86125P

## TEMPERATURE AND HUMIDITY DURING TESTING

The temperature during testing was within +15°C and + 35°C.
The relative humidity was between 20% and 75%.

**2.1033(c)(1) MANUFACTURER**

UPS Aviation Technologies
A Subsidiary of United Parcel Service
2345 Turner Road
Salem, OR 97302

**2.1033(c)(2) IDENTIFICATION**

Model: AT7000
FCC ID: EOJAT7000

**2.1033(c)(3) USER'S MANUAL**

The necessary information is contained in a separate document, 560-0405-00 AT7000 Mode S Data Link Transponder Installation Manual.

**2.1033(c)(4) TYPE OF EMISSIONS**

20MO M1D

**2.1033(c)(5) FREQUENCY RANGE**

1090 MHz

**2.1033(c)(6) OPERATING POWER**

No means are provided for varying the operating power level.

**2.1033(c)(7) MAXIMUM POWER RATING**

Maximum $P_o$: 500 Watts PEP (4.766 W Avg.)

500 W PEP Max.
Average Power = $P_o$ PEP x (no. Pulse groups/ sec) x (pulses / group) x (pulse width)
= 500 x 94 x 116 x 500E-9 => 2.726 watts long mode S replies
+ 500 x 31 x 60 x 500E-9 => 0.465 watts short mode S replies
+ 500 x 500 x 14 x 450E-9 => 1.575 watts ATCRABS replies
= 4.766 watts total average power

## 2.1033(c)(8) DC VOLTAGES

The DC voltage to the final stage is 50 volts.

## 2.1033(c)(9) TUNE-UP PROCEDURE

There are no tune-up procedures required by the operator. The transmitter is tuned-up during the manufacturing process and requires no adjustments by the user.

## 2.1033(c)(10) SCHEMATICS AND CIRCUITRY DESCRIPTION

Schematics are contained in a separate document.

(a) Frequency Stabilization

A 20MHz oscillator is used as the reference oscillator for the time base for the synthesizers. The oscillator, #S125-0024-016, is a 100ppm part rated for operation over the temperature range of -40°C to +85°C. At 100ppm, the reply frequency falls within 109KHz of 1090MHz. This is well within the +/- 1 MHz limits required by TSO-C112. Reference oscillator schematics are on SCH3070 page 6.

(b) Spurious Radiation Suppression

Spurious emissions are suppressed by controlling the rise-times and fall times of the pulse by a high level modulator. The modulator schematics are depicted on SCH3070 page 7. Low pass filters between the transmitter output and the two antenna ports (top and bottom) further attenuates harmonics. Low Pass Filter schematics, one for each port, are shown on SCH3071 page 2.

(c) Modulation Limiting

Pulse Position modulation is used. The modulator is described in the sections below and is depicted in SCH-3070 page 7.

(d) Power limiting

The modulator limits the power. The +50V supply voltage that is controlled by the PA mod signal, depicted in SCH-3070 page 7, sets final output power.

## 2.1033(c)(11) LABEL AND PLACEMENT

The necessary information is contained in a separate document.

## 2.1033(c)(12) SUBMITTAL PHOTOS

The necessary information is contained in a separate document.

## 2.1033(c)(13) MODULATION INFORMATION

Six circuits are used synergistically to modulate the pulse train: 1) LO GATE, 2) BUFR_MOD, 3) GATE_MOD1, 4) GATE_MOD2, 5) DRVR_MOD, and 6) HL_MOD. All the circuits are located on the main receiver board assembly, and are depicted in schematic SCH-3070 page 7.

The LO Gate and DRVR_MOD are turned on during the entire reply pulse train. Individual pulses are gated on and off by the BUFR_MOD, GATE_MOD1, Gate_MOD2, and HL_MOD pulses.

The start-up sequence of events during a transmission is as follows. At T=0, the LO GATE is brought up and stays on for the entire pulse group. At T=50ns, the DRVR_MOD signal is brought up and propagates DC voltage to the driver transistor collector at T=100 nS and stays on for the entire pulse group.

Pulses are formed as follows. At T=300 nS the BUFR_MOD comes up, and the HL MOD starts up and reaches full voltage at T=400 nS. At T=350nS, GATE MOD 1 and GATE MOD 2 become active applying RF drive to the driver transistor and in turn to the final PA transistor, thus forming the leading edge of the RF output pulse. The drive signal is removed from the HL_MOD at T=750nS, causing HL_MOD voltage to ramp down between T=850ns and T=1000ns, thus forming the trailing edge of the RF output pulse. At T=1100ns BUFR_MOD, GATE_MOD1, and Gate MOD2 are shut down. This sequence is repeated beginning at T=300nS for each pulse in the train. Note: The trailing edge of the RF 50% point occurs at approximately 925 nS. The leading edge of the RF 50% point occurs at approximately 425 nS.

The LO GATE and DRVR_MOD are turned off after the entire pulse train is transmitted.

## 2.1033(c)(14)/2.1046/87.139 - RF POWER OUTPUT

***Test Conditions / Notes:***

The EUT is placed in an install kit and connected to the test equipment through cable harnesses. The losses of the harnesses, directional coupler, and attenuator were characterized. Interrogating the EUT with the 3 modulation modes in interlaced mode. The computer is used to setup the EUT operation, and then is not active. The Top antenna port of the EUT (AT7000) is connected to the ATC 1400A through a 3 meter cable and directional coupler, having a 1.6 dB and 0.3 dB loss respectively. The total loss is 1.9 dB. Peak power is measured on the ATC1400A and the cable loss is factored in to get the power at the EUT's terminals. Peak power was measured at 250 watts, which translates to 53.98 dBm. Factoring in the cable loss, actual power at the EUT's terminals is 55.88 dBm, which translates to 387.25 watts. Next we convert the unit's peak power out by adding 107 to 55.88 dBm to get 162.88 dBuV. We then take the average power output with 500 ATCRABS replies, and 125 mode S replies that are split between 94 long replies and 60 short replies, the average power calculation is as follows: Mode S long = (387.25 watts)*(94 groups/sec)*(116 pulses/group)*(511.6 nS/pulse) = 2.16 Watts Mode S short = (387.25 watts)*(31 groups/sec)*(60 pulses/group)*(511.6 nS/pulse) = 0.37Watts ATCRABS = (387.25 watts)*(500 groups/sec)*(14 pulses/group)*(457.9 nS/pulse) = 1.24 Watts Total Average power = Mode S long + Mode S short + ATCRABS = 3.77 watts. The 250 % spurious limit is 43 + 10log (average power) = -49 dBc = 113.9 dBuV. The EUT is then coupled to the spectrum analyzer through the 3 meter cable, incident port of the directional coupler and a 10 dB attenuator. The Spectrum Analyzer is adjusted to reflect the signal level of 162.88 dBuV measured with the ATC 1400A. The spec limit in the data sheet is adjusted for each RF port reading using the above. The temperature was 69°F. and the humidity was 40%. Investigated frequencies 20 MHz through 11 GHz.

***Test Equipment*:**

| Function | S/N | Calibration Date | Cal Due Date | Asset # |
|---|---|---|---|---|
| HP 8574A EMI Receiver | 3010A01076 | 07/12/2001 | 07/12/2002 | 42 |
| HP 84300-80037 1.5 GHz High Pass Filter | 3643A00027 | 06/08/2001 | 06/08/2002 | 2116 |
| Tektronix Oscilloscope TDS 3034 | B018922 | 08/02/2001 | 08/02/2002 | 0 |
| IFR S-1403A Mode S Test Set | 6558 | 11/08/2000 | 11/08/2001 | 0 |
| IFR ATC 1400A Mode A & C Test Set | 204006626 | 11/08/2000 | 11/08/2001 | 0 |
| HP 778D Directional Coupler | 13454 | 08/20/2001 | 08/20/2002 | 0 |
| 10 dB Attenuator | None | 09/21/2000 | 09/21/2001 | 2221 |

Test Location: CKC Laboratories, Inc. • 22105 Wilson River Hwy • Tillamook, Or 97141 • 503 842-5577

Customer: **UPS Aviation Technologies, Inc**
Specification: **FCC 87.139 Top Port**
Work Order #: **77446** Date: 08/21/2001
Test Type: **Maximized Emissions** Time: 11:39:58
Equipment: **Mode S Data Link Transponder** Sequence#: 2
Manufacturer: UPS Aviation Technologies Tested By: Mike Wilkinson
Model: AT-7000
S/N: P0008

***Equipment Under Test* (* = EUT):**

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| Mode S Data Link Transponder* | UPS Aviation Technologies | AT-7000 | P0008 |
| AT-7000 Install Kit | UPS Technologies | TBD | None |

***Support Devices:***

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| DC Power Supply | Astron | RS-12M | 98110031 |
| Transponder I/O Test Interface | II Morrow | None | None |
| Computer | BSI | TANY385F11 | 1006943 |

***Measurement Data:*** Reading listed by margin. Test Distance: None

| # | Freq MHz | Rdng dBµV | dB | Cable dB | 1.5 G dB | Coupl dB | Dist Table | Corr dBµV | Spec dBµV | Margin dB | Polar Ant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1089.830M | 131.6 | | +1.7 | +0.0 | +29.6 | +0.0 | 162.9 | 162.9 | +0.0 | None |

***Test Conditions / Notes:***

The EUT is placed in an install kit and connected to the test equipment through cable harnesses. The losses of the harnesses, directional coupler, and attenuator were characterized. Interrogating the EUT with the 3 modulation modes in interlaced mode. The computer is used to setup the EUT operation, and then is not active. The Bottom antenna port of the EUT (AT7000) is connected to the ATC 1400A through a 3 meter cable and directional coupler, having a 1.8 dB and 0.3 dB loss respectively. The total loss is 2.1 dB. Peak power is measured on the ATC1400A and the cable loss is factored in to get the power at the EUT's terminals. Peak power was measured at 285 watts, which translates to 54.55 dBm. Factoring in the cable loss, actual power at the EUT's terminals is 56.65 dBm, which translates to 462.38 watts. Next we convert the unit's peak power out by adding 107 to 56.65 dBm to get 163.65 dBuV. We then take the average power output with 500 ATCRABS replies, and 125 mode S replies that are split between 94 long replies and 60 short replies, the average power calculation is as follows: Mode S long = (462.38 watts)*(94 groups/sec)*(116 pulses/group)*(511.6 nS/pulse) = 2.58 Watts Mode S short = (462.38 watts)*(31 groups/sec)*(60 pulses/group)*(511.6 nS/pulse) = 0.45Watts ATCRABS = (462.38 watts)*(500 groups/sec)*(14 pulses/group)*(457.9 nS/pulse) = 1.48 Watts Total Average power = Mode S long + Mode S short + ATCRABS = 4.51 watts. The 250 % spurious limit is 43 + 10log (average power) = -50 dBc = 113.7 dBuV. The EUT is then coupled to the spectrum analyzer through the 3 meter cable, incident port of the directional coupler and a 10 dB attenuator. The Spectrum Analyzer is adjusted to reflect the signal level of 163.65 dBuV measured with the ATC 1400A. The spec limit in the data sheet is adjusted for each RF port reading using the above. The temperature was 69°F. and the humidity was 40%. Investigated frequencies 20 MHz through 11 GHz.

Test Location: CKC Laboratories, Inc. • 22105 Wilson River Hwy • Tillamook, Or 97141 • 503 842-5577

| | | | |
|---|---|---|---|
| Customer: | **UPS Aviation Technologies, Inc** | | |
| Specification: | **FCC 87.139 Bottom Port** | | |
| Work Order #: | **77446** | Date: | 08/21/2001 |
| Test Type: | **Maximized Emissions** | Time: | 16:38:54 |
| Equipment: | **Mode S Data Link Transponder** | Sequence#: | 1 |
| Manufacturer: | UPS Aviation Technologies | Tested By: | Mike Wilkinson |
| Model: | AT-7000 | | |
| S/N: | P0008 | | |

***Equipment Under Test* (* = EUT):**

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| Mode S Data Link Transponder* | UPS Aviation Technologies | AT-7000 | P0008 |
| AT-7000 Install Kit | UPS Technologies | TBD | None |

***Support Devices:***

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| DC Power Supply | Astron | RS-12M | 98110031 |
| Transponder I/O Test Interface | II Morrow | None | None |
| Computer | BSI | TANY385F11 | 1006943 |

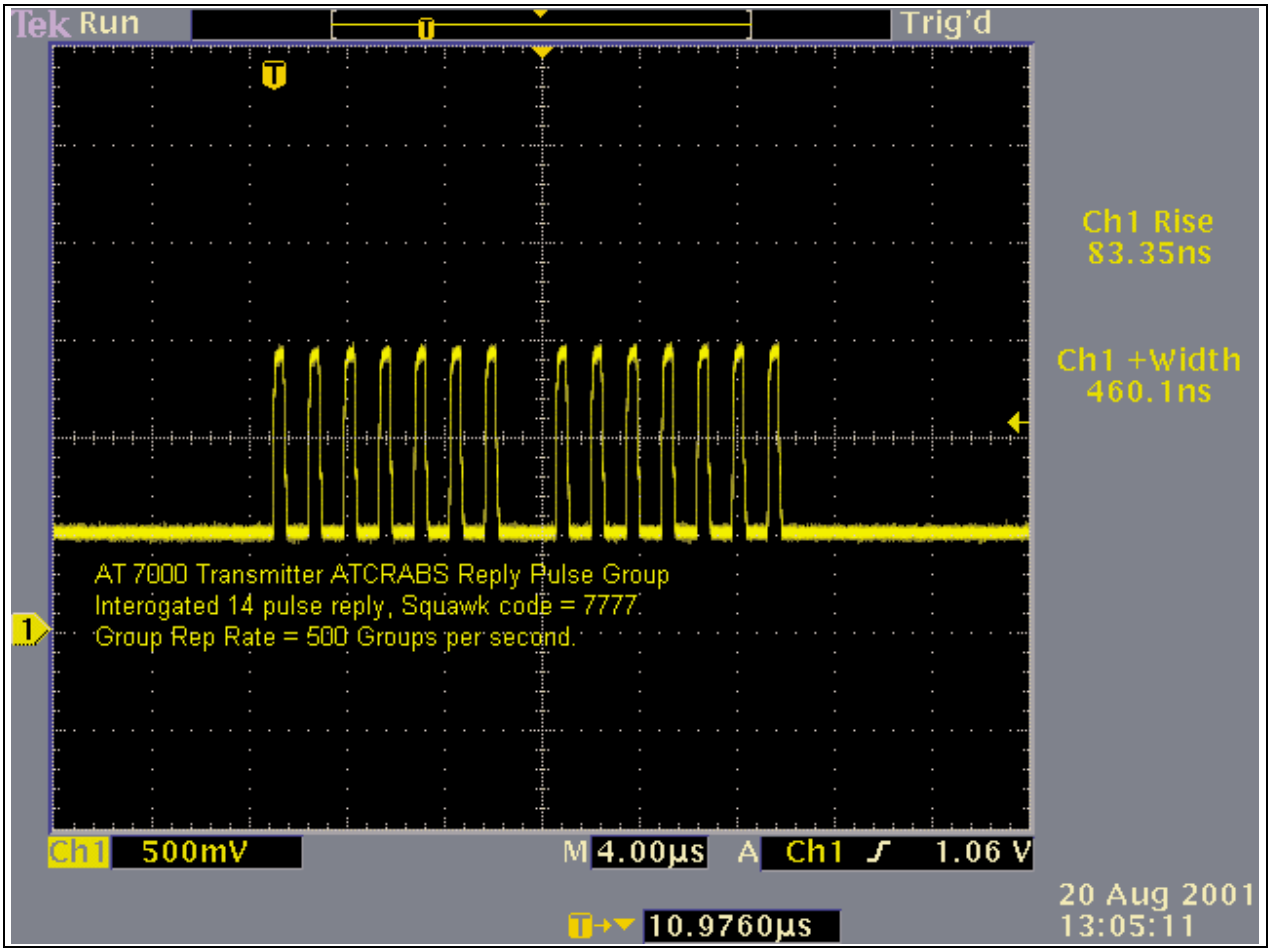
***Measurement Data:*** Reading listed by margin. Test Distance: None

| # | Freq | Rdng | Cable | | 1.5 G | Coupl | Dist | Corr | Spec | Margin | Polar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MHz | dBµV | dB | dB | dB | dB | Table | dBµV | dBµV | dB | Ant |
| 1 | 1089.150M | 132.1 | +1.9 | | +0.0 | +29.6 | +0.0 | 163.6 | 163.6 | +0.0 | None |

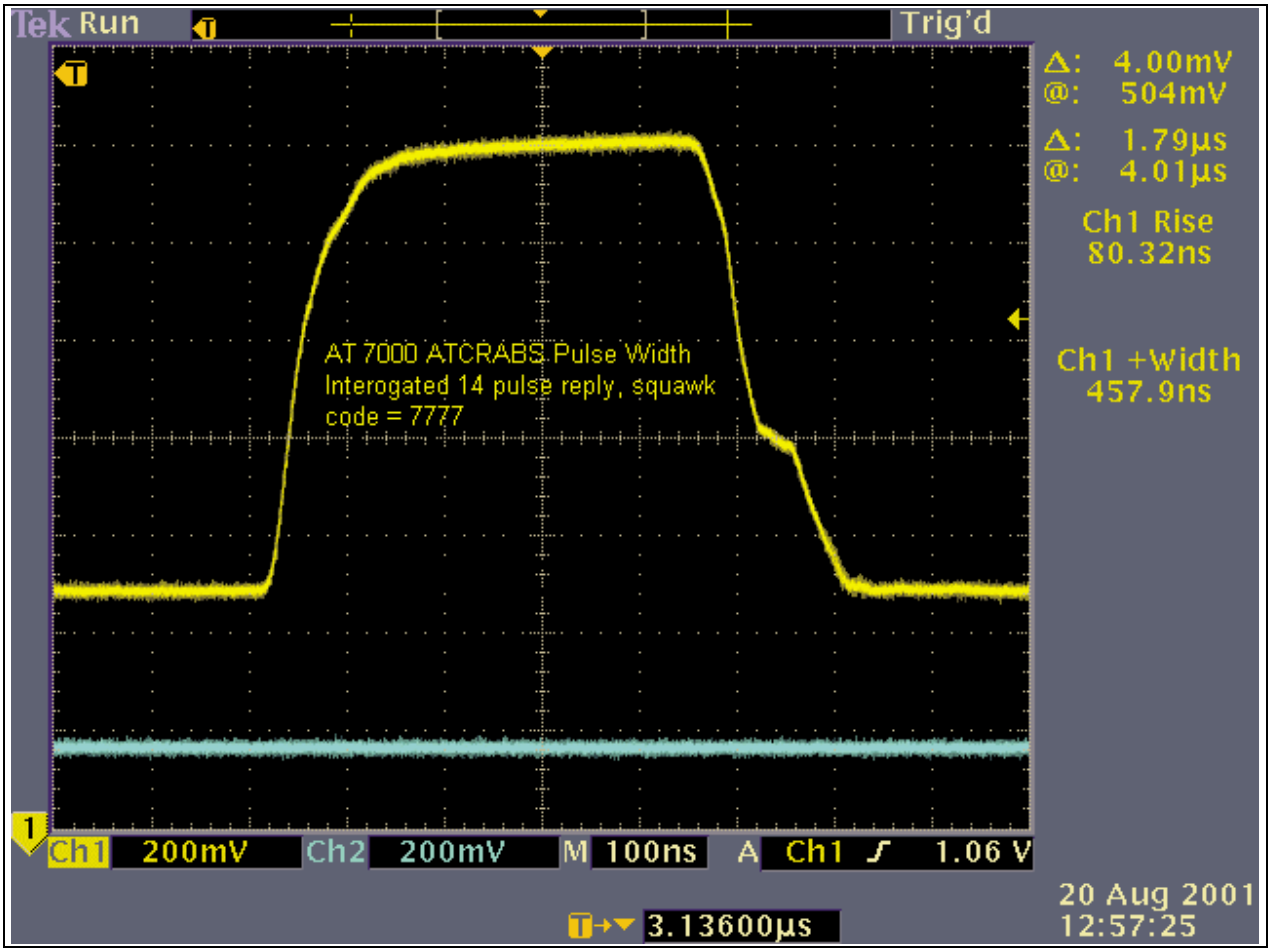
Test Setup - Front View

Test Setup – Back View

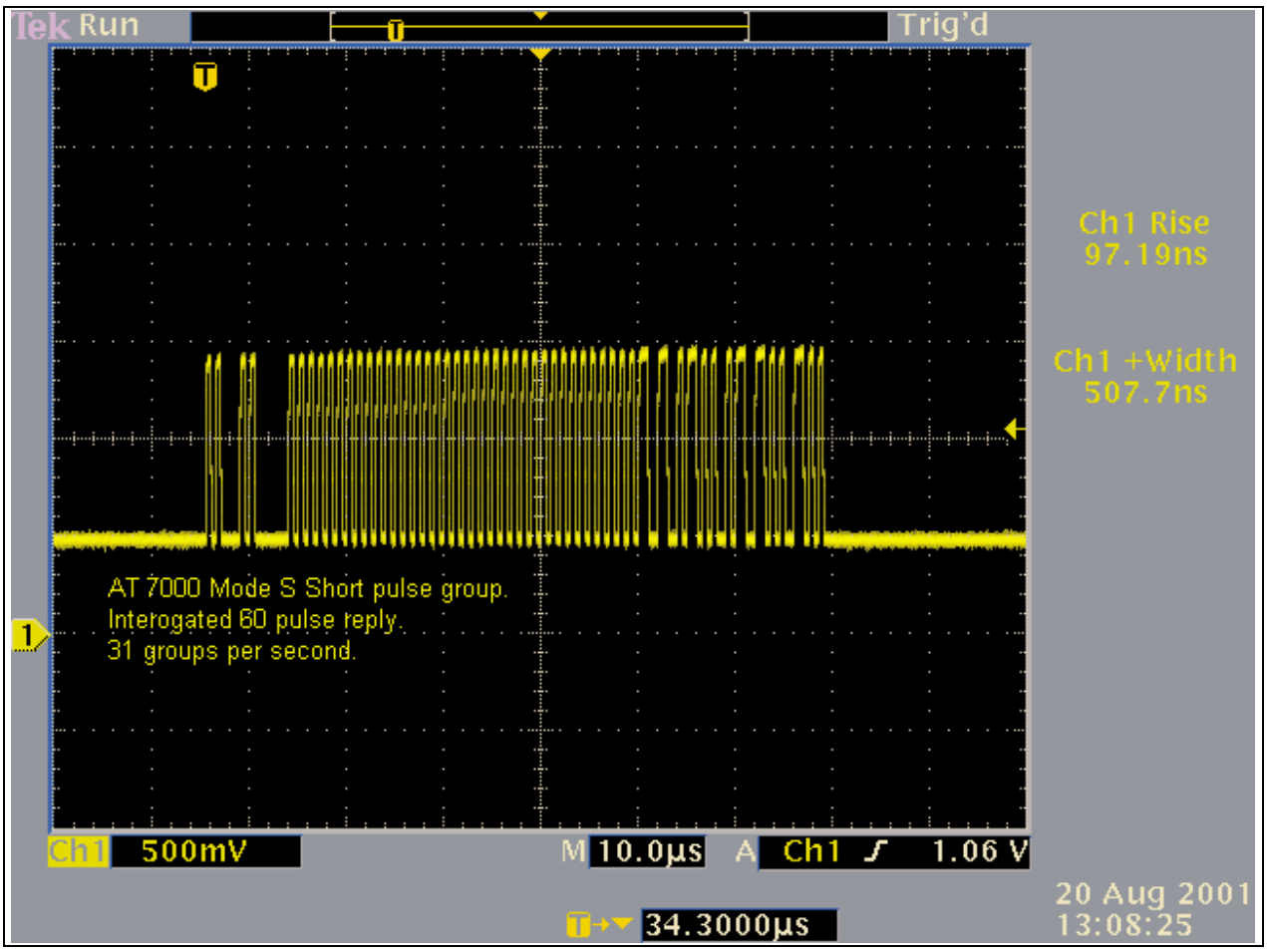
**ATCRABS GROUP**



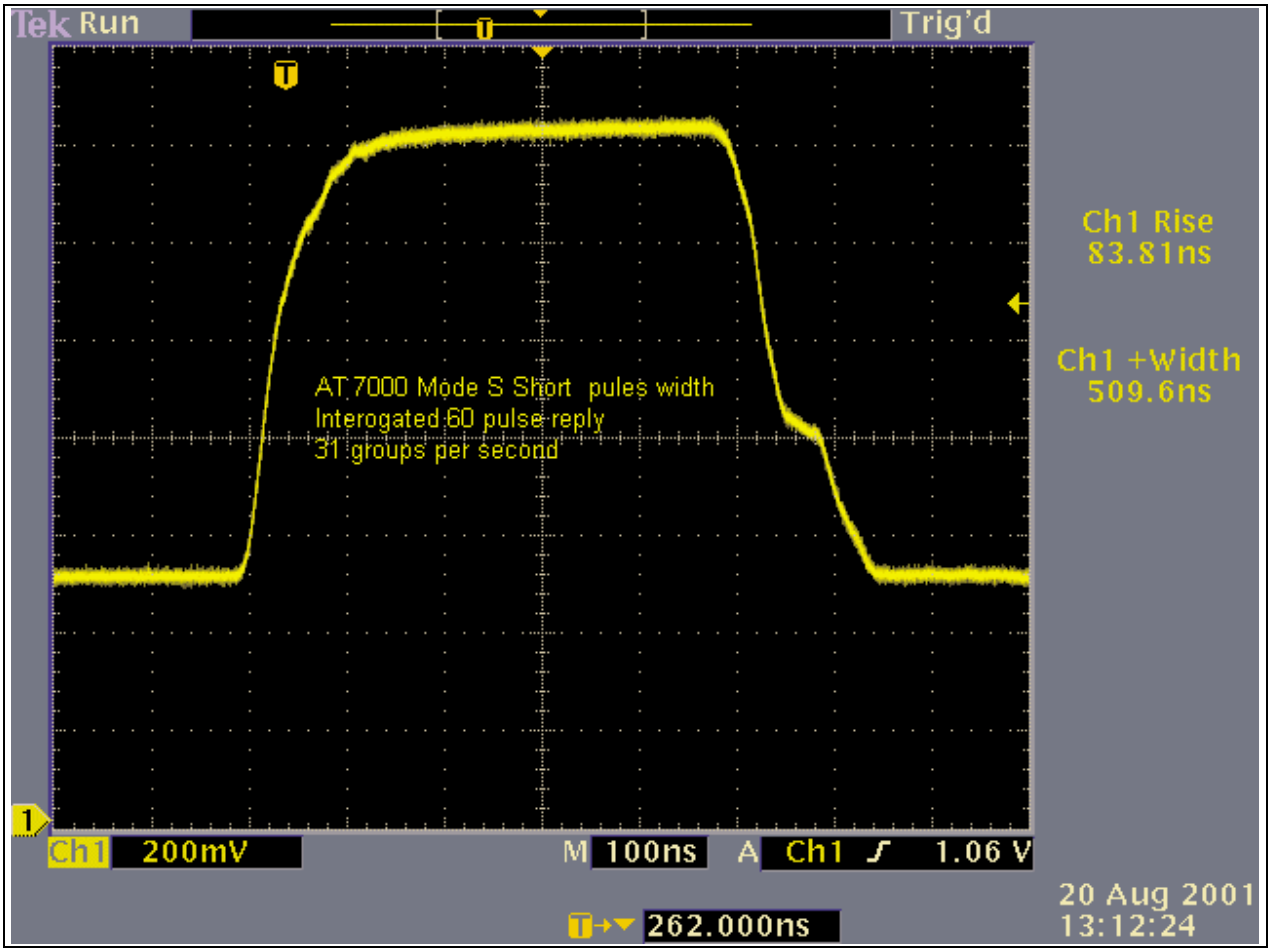
**ATCRABS PULSE**



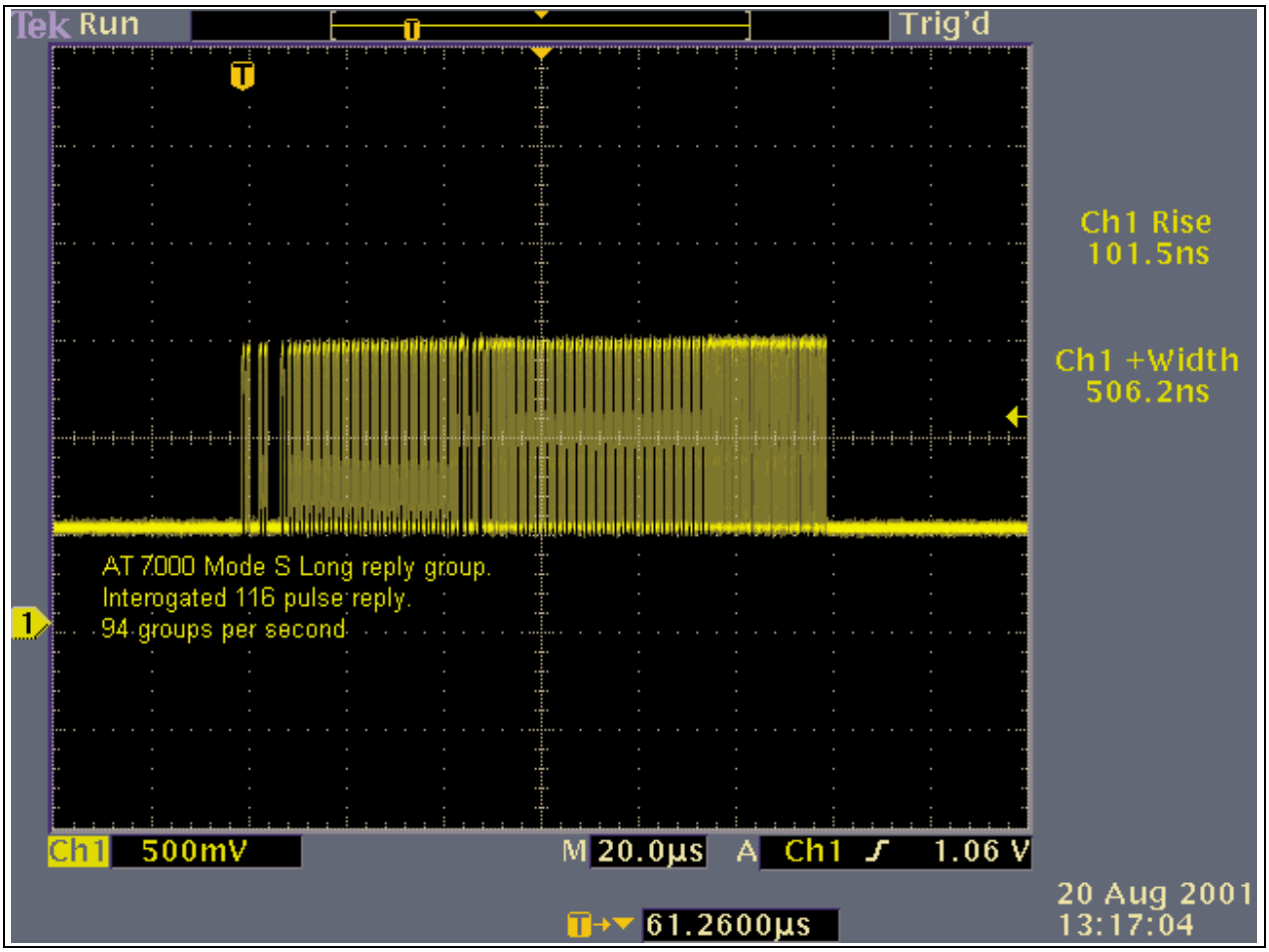
## MODE S SHORT GROUP



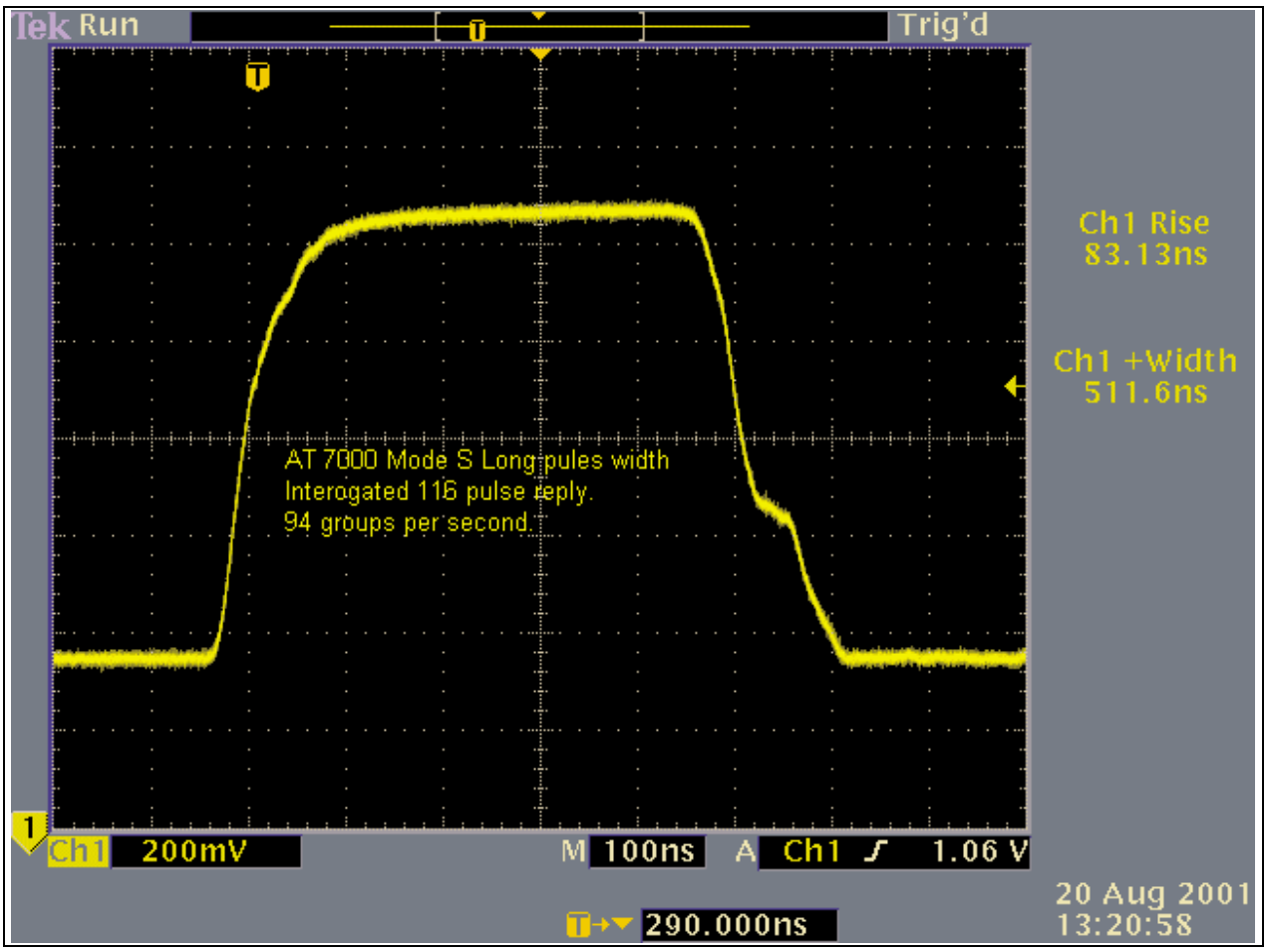
**MODE S SHORT PULSE**



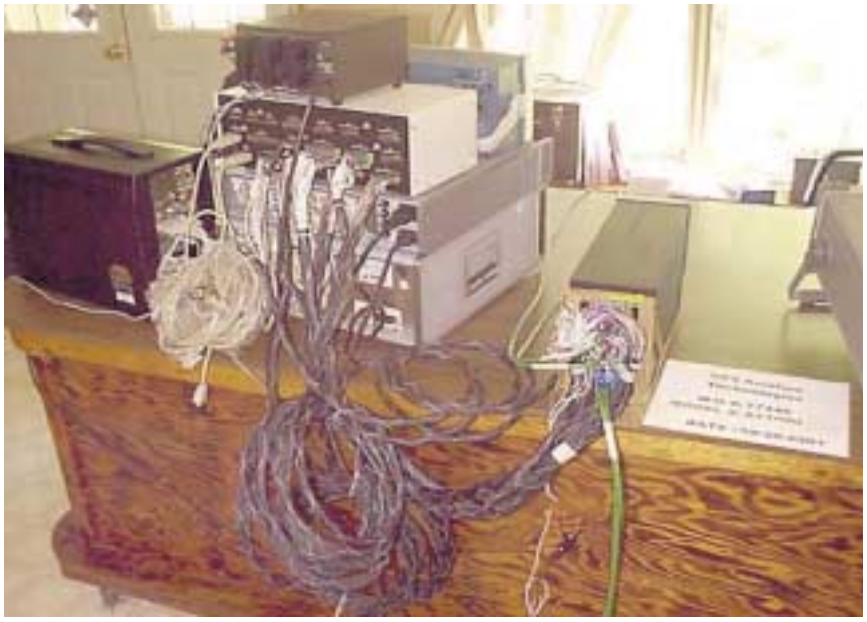
## MODE S LONG GROUP



**MODE S LONG PULSE**



Test Setup of Pulse Width – Front View



Test Setup of Pulse Width – Back View

## 2.1033(c)(14)/2.1047/ - MODULATION CHARACTERISTICS -

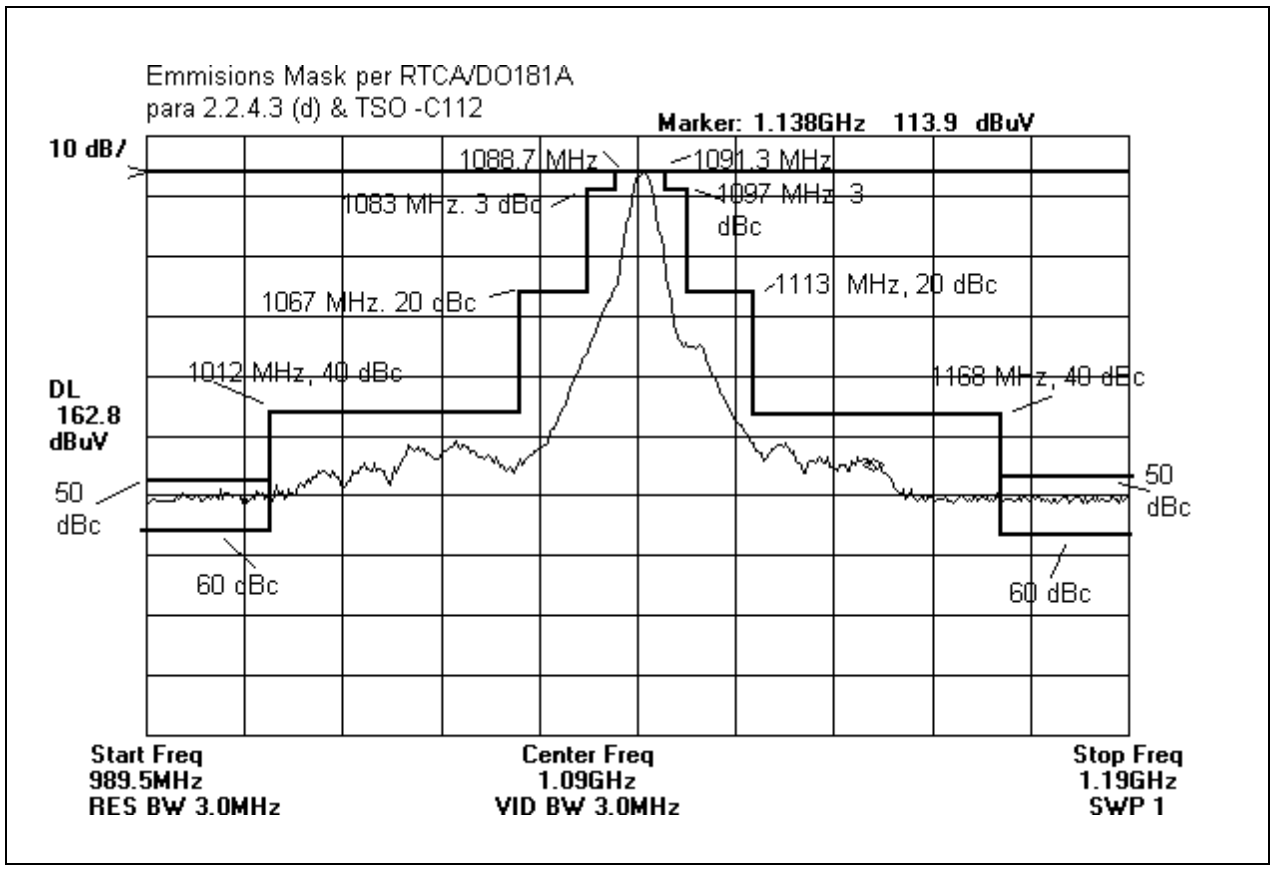
***Test Equipment*:**

| Function | S/N | Calibration Date | Cal Due Date | Asset # |
|---|---|---|---|---|
| HP 8574A EMI Receiver | 3010A01076 | 07/12/2001 | 07/12/2002 | 42 |
| HP 84300-80037 1.5 GHz High Pass Filter | 3643A00027 | 06/08/2001 | 06/08/2002 | 2116 |
| IFR S-1403A Mode S Test Set | 6558 | 11/08/2000 | 11/08/2001 | 0 |
| IFR ATC 1400A Mode A & C Test Set | 204006626 | 11/08/2000 | 11/08/2001 | 0 |
| HP 778D Directional Coupler | 13454 | 08/20/2001 | 08/20/2002 | 0 |
| 10 dB Attenuator | none | 09/21/2000 | 09/21/2001 | 2221 |
| Chase CBL6111C Bilog Antenna | 2455 | 02/09/2001 | 02/09/2002 | 1992 |
| HP 8447D Amplifier | 2727A05392 | 08/17/2001 | 08/17/2002 | 10 |
| EMCO 3115 1-18 GHz Horn Antenna | 9006-3413 | 06/07/2001 | 06/07/2002 | 327 |
| HP 83017A Amplifier 26GHz | 0000009002 | 01/18/2001 | 01/18/2002 | 2114 |

Test Setup - Front View

Test Setup - Back View

## TSO-C112 EMISSIONS MASK



## 2.1033(c)(14)/2.1049(i)/87.135- OCCUPIED BANDWIDTH

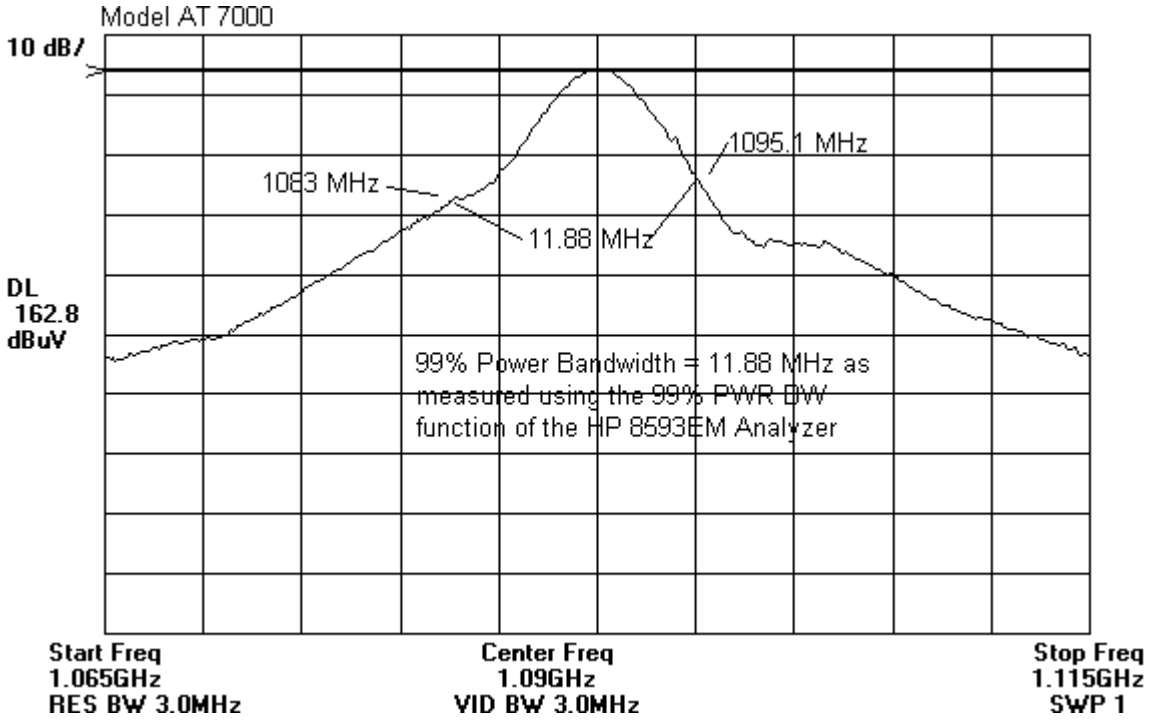
***Test Equipment*:**

| Function | S/N | Calibration Date | Cal Due Date | Asset # |
|---|---|---|---|---|
| HP 8574A EMI Receiver | 3010A01076 | 07/12/2001 | 07/12/2002 | 42 |
| HP 84300-80037 1.5 GHz High Pass Filter | 3643A00027 | 06/08/2001 | 06/08/2002 | 2116 |
| Tektronix Oscilloscope TDS 3034 | B018922 | 08/02/2001 | 08/02/2001 | 0 |
| IFR S-1403A Mode S Test Set | 6558 | 11/08/2000 | 11/08/2001 | 0 |
| IFR ATC 1400A Mode A & C Test Set | 204006626 | 11/08/2000 | 11/08/2001 | 0 |
| HP 778D Directional Coupler | 13454 | 08/20/2001 | 08/20/2002 | 0 |

Test Setup - Front View

Test Setup – Back View

## 99% BANDWIDTH



## 2.1033(c)(14)/2.1051/87.139 - SPURIOUS EMISSIONS AT ANTENNA TERMINAL

***Test Conditions / Notes:***

The EUT is placed in an install kit and connected to the test equipment through cable harnesses. The losses of the harnesses, directional coupler, and attenuator were characterized. Interrogating the EUT with the 3 modulation modes in interlaced mode. The computer is used to setup the EUT operation, and then is not active. The Top antenna port of the EUT (AT7000) is connected to the ATC 1400A through a 3 meter cable and directional coupler, having a 1.6 dB and 0.3 dB loss respectively. The total loss is 1.9 dB. Peak power is measured on the ATC1400A and the cable loss is factored in to get the power at the EUT's terminals. Peak power was measured at 250 watts, which translates to 53.98 dBm. Factoring in the cable loss, actual power at the EUT's terminals is 55.88 dBm, which translates to 387.25 watts. Next we convert the unit's peak power out by adding 107 to 55.88 dBm to get 162.88 dBuV. We then take the average power output with 500 ATCRABS replies, and 125 mode S replies that are split between 94 long replies and 60 short replies, the average power calculation is as follows: Mode S long = (387.25 watts)*(94 groups/sec)*(116 pulses/group)*(511.6 nS/pulse) = 2.16 Watts Mode S short = (387.25 watts)*(31 groups/sec)*(60 pulses/group)*(511.6 nS/pulse) = 0.37Watts ATCRABS = (387.25 watts)*(500 groups/sec)*(14 pulses/group)*(457.9 nS/pulse) = 1.24 Watts Total Average power = Mode S long + Mode S short + ATCRABS = 3.77 watts. The 250 % spurious limit is 43 + 10log (average power) = -49 dBc = 113.9 dBuV. The EUT is then coupled to the spectrum analyzer through the 3 meter cable, incident port of the directional coupler and a 10 dB attenuator. The Spectrum Analyzer is adjusted to reflect the signal level of 162.88 dBuV measured with the ATC 1400A. The spec limit in the data sheet is adjusted for each RF port reading using the above. The temperature was 69°F. and the humidity was 40%. Investigated frequencies 20 MHz through 11 GHz.

***Test Equipment*:**

| Function | S/N | Calibration Date | Cal Due Date | Asset # |
|---|---|---|---|---|
| HP 8574A EMI Receiver | 3010A01076 | 07/12/2001 | 07/12/2002 | 42 |
| HP 84300-80037 1.5 GHz High Pass Filter | 3643A00027 | 06/08/2001 | 06/08/2002 | 2116 |
| Tektronix Oscilloscope TDS 3034 | B018922 | 08/02/2001 | 08/02/2001 | 0 |
| IFR S-1403A Mode S Test Set | 6558 | 11/08/2000 | 11/08/2001 | 0 |
| IFR ATC 1400A Mode A & C Test Set | 204006626 | 11/08/2000 | 11/08/2001 | 0 |
| HP 778D Directional Coupler | 13454 | 08/20/2001 | 08/20/2002 | 0 |
| 10 dB Attenuator | none | 09/21/2000 | 09/21/2001 | 2221 |

### VIDEO BANDWIDTH AND RESOLUTION BANDWIDTH SETTINGS:

| BEGINNING FREQUENCY | ENDING FREQUENCY | BANDWIDTH SETTING |
|---|---|---|
| 20 MHz | 30 MHz | 9 kHz |
| 30 MHz | 1000 MHz | 120 kHz |
| 1000 MHz | 11 GHz | 3 MHz |

Test Location: CKC Laboratories, Inc. • 22105 Wilson River Hwy • Tillamook, Or 97141 • 503 842-5577

Customer: **UPS Aviation Technologies, Inc**
Specification: **FCC 87.139 Top Port**
Work Order #: **77446** Date: 08/21/2001
Test Type: **Maximized Emissions** Time: 11:39:58
Equipment: **Mode S Data Link Transponder** Sequence#: 2
Manufacturer: UPS Aviation Technologies Tested By: Mike Wilkinson
Model: AT-7000
S/N: P0008

***Equipment Under Test* (* = EUT):**

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| Mode S Data Link Transponder* | UPS Aviation Technologies | AT-7000 | P0008 |
| AT-7000 Install Kit | UPS Technologies | TBD | None |

***Support Devices:***

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| DC Power Supply | Astron | RS-12M | 98110031 |
| Transponder I/O Test Interface | II Morrow | None | None |
| Computer | BSI | TANY385F11 | 1006943 |

***Measurement Data:*** Reading listed by margin. Test Distance: None

| # | Freq MHz | Rdng dBµV | dB | Cable dB | 1.5 G dB | Coupl dB | Dist Table | Corr dBµV | Spec dBµV | Margin dB | Polar Ant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1089.830M | 131.6 | | +1.7 | +0.0 | +29.6 | +0.0 | 162.9 | 162.9 | +0.0 | None |
| 2 | 2178.730M | 77.0 | | +2.2 | +0.5 | +30.2 | +0.0 | 109.9 | 113.9 | -4.0 | None |
| 3 | 4359.530M | 69.8 | | +4.1 | +0.3 | +30.1 | +0.0 | 104.3 | 113.9 | -9.6 | None |
| 4 | 5449.580M | 66.6 | | +4.1 | +0.2 | +30.2 | +0.0 | 101.1 | 113.9 | -12.8 | None |
| 5 | 7629.680M | 50.3 | | +4.0 | +0.2 | +32.9 | +0.0 | 87.4 | 113.9 | -26.5 | None |
| 6 | 8719.680M | 47.8 | | +4.7 | +0.7 | +30.2 | +0.0 | 83.4 | 113.9 | -30.5 | None |
| 7 | 3270.530M | 49.4 | | +2.5 | +0.3 | +29.8 | +0.0 | 82.0 | 113.9 | -31.9 | None |
| 8 | 6539.030M | 47.7 | | +4.2 | +0.1 | +27.9 | +0.0 | 79.9 | 113.9 | -34.0 | None |
| 9 | 9809.330M | 44.4 | | +5.2 | +1.4 | +28.1 | +0.0 | 79.1 | 113.9 | -34.8 | None |

***Test Conditions / Notes:***

The EUT is placed in an install kit and connected to the test equipment through cable harnesses. The losses of the harnesses, directional coupler, and attenuator were characterized. Interrogating the EUT with the 3 modulation modes in interlaced mode. The computer is used to setup the EUT operation, and then is not active. The Bottom antenna port of the EUT (AT7000) is connected to the ATC 1400A through a 3 meter cable and directional coupler, having a 1.8 dB and 0.3 dB loss respectively. The total loss is 2.1 dB. Peak power is measured on the ATC1400A and the cable loss is factored in to get the power at the EUT's terminals. Peak power was measured at 285 watts, which translates to 54.55 dBm. Factoring in the cable loss, actual power at the EUT's terminals is 56.65 dBm, which translates to 462.38 watts. Next we convert the unit's peak power out by adding 107 to 56.65 dBm to get 163.65 dBuV. We then take the average power output with 500 ATCRABS replies, and 125 mode S replies that are split between 94 long replies and 60 short replies, the average power calculation is as follows: Mode S long = (462.38 watts)*(94 groups/sec)*(116 pulses/group)*(511.6 nS/pulse) = 2.58 Watts Mode S short = (462.38 watts)*(31 groups/sec)*(60 pulses/group)*(511.6 nS/pulse) = 0.45Watts ATCRABS = (462.38 watts)*(500 groups/sec)*(14 pulses/group)*(457.9 nS/pulse) = 1.48 Watts Total Average power = Mode S long + Mode S short + ATCRABS = 4.51 watts. The 250 % spurious limit is 43 + 10log (average power) = -50 dBc = 113.7 dBuV. The EUT is then coupled to the spectrum analyzer through the 3 meter cable, incident port of the directional coupler and a 10 dB attenuator. The Spectrum Analyzer is adjusted to reflect the signal level of 163.65 dBuV measured with the ATC 1400A. The spec limit in the data sheet is adjusted for each RF port reading using the above. The temperature was 69°F. and the humidity was 40%. Investigated frequencies 20 MHz through 11 GHz.

Test Location: CKC Laboratories, Inc. • 22105 Wilson River Hwy • Tillamook, Or 97141 • 503 842-5577

| | | | |
|---|---|---|---|
| Customer: | **UPS Aviation Technologies, Inc** | | |
| Specification: | **FCC 87.139 Bottom Port** | | |
| Work Order #: | **77446** | Date: | 08/21/2001 |
| Test Type: | **Maximized Emissions** | Time: | 16:38:54 |
| Equipment: | **Mode S Data Link Transponder** | Sequence#: | 1 |
| Manufacturer: | UPS Aviation Technologies | Tested By: | Mike Wilkinson |
| Model: | AT-7000 | | |
| S/N: | P0008 | | |

***Equipment Under Test* (* = EUT):**

| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| Mode S Data Link Transponder* | UPS Aviation Technologies | AT-7000 | P0008 |
| AT-7000 Install Kit | UPS Technologies | TBD | None |

***Support Devices:***

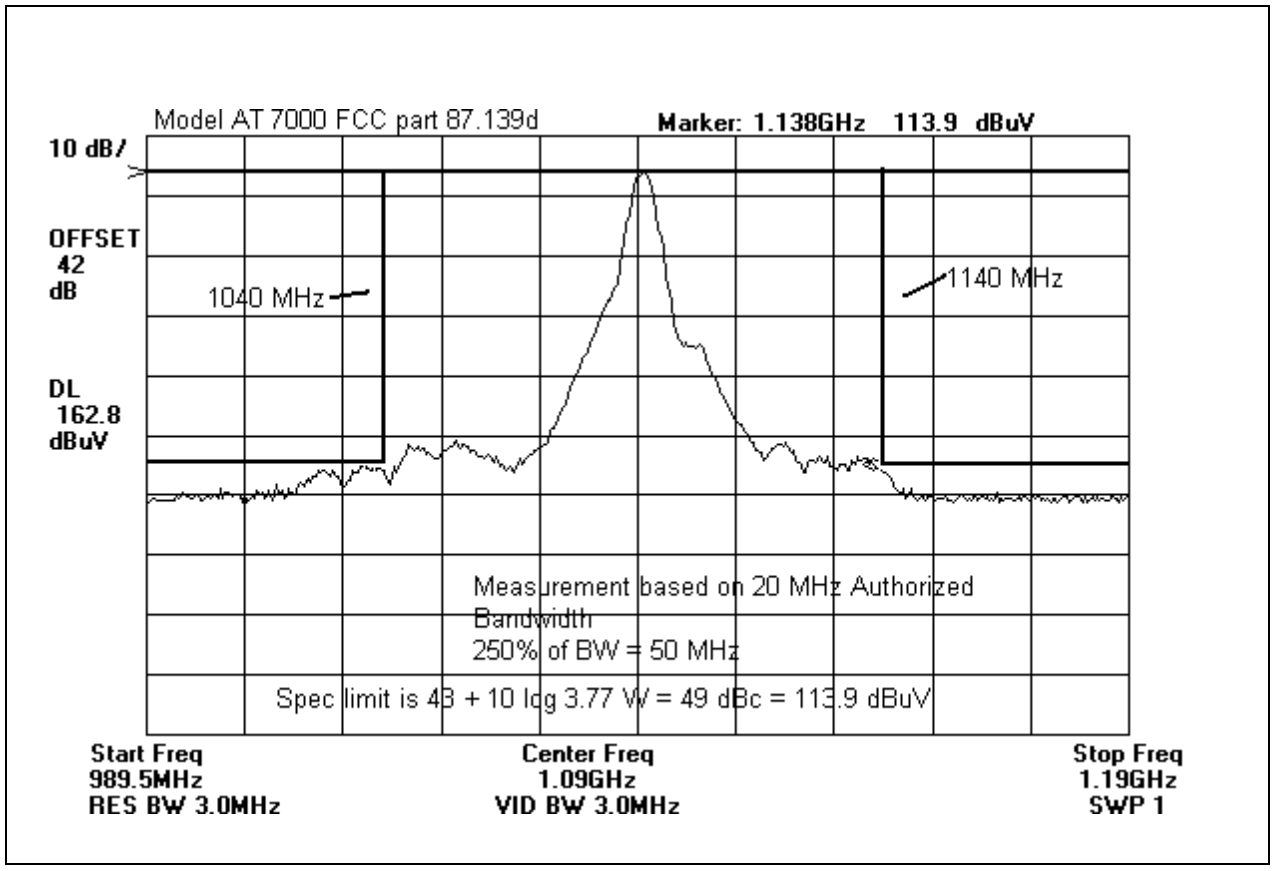
| Function | Manufacturer | Model # | S/N |
|---|---|---|---|
| DC Power Supply | Astron | RS-12M | 98110031 |
| Transponder I/O Test Interface | II Morrow | None | None |
| Computer | BSI | TANY385F11 | 1006943 |

***Measurement Data:*** Reading listed by margin. Test Distance: None

| # | Freq MHz | Rdng dBµV | Cable dB | dB | 1.5 G dB | Coupl dB | Dist Table | Corr dBµV | Spec dBµV | Margin dB | Polar Ant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1089.150M | 132.1 | +1.9 | | +0.0 | +29.6 | +0.0 | 163.6 | 163.6 | +0.0 | None |
| 2 | 2179.400M | 78.6 | +2.3 | | +0.5 | +30.2 | +0.0 | 111.6 | 113.7 | -2.1 | None |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 4360.150M | 72.0 | +3.7 | +0.3 | +30.1 | +0.0 | 106.1 | 113.7 | -7.6 | None |
| 4 | 5449.780M | 57.9 | +3.9 | +0.2 | +30.2 | +0.0 | 92.2 | 113.7 | -21.5 | None |
| 5 | 7630.650M | 52.3 | +4.1 | +0.2 | +32.9 | +0.0 | 89.5 | 113.7 | -24.2 | None |
| 6 | 6540.400M | 57.3 | +4.1 | +0.1 | +27.9 | +0.0 | 89.4 | 113.7 | -24.3 | None |
| 7 | 3268.400M | 56.4 | +2.6 | +0.3 | +29.8 | +0.0 | 89.1 | 113.7 | -24.6 | None |
| 8 | 8720.279M | 45.0 | +4.8 | +0.7 | +30.2 | +0.0 | 80.7 | 113.7 | -33.0 | None |

## PART 87.139 EMISSIONS



Test Setup - Front View

Test Setup – Back View

## 2.1033(c)(14)/2.1053/87.139- FIELD STRENGTH OF SPURIOUS RADIATION

***Test Conditions:***

The EUT is placed on the OATS and in an install kit that is connected to the support equipment through cable harnesses. The support equipment is located under the ground plane. Interrogating the EUT with the 3 modulation modes in interlaced mode. The computer is used to setup the EUT operation, and then is not active. The Bottom antenna port of the EUT (AT7000) is connected to the ATC 1400A through a 3 meter cable and directional coupler. The Top antenna Port is connected to S-1403A through a 3 meter cable. The temperature was 69°F. and the humidity was 40%. Investigated frequencies 20 MHz through 11 GHz.

***Test Equipment*:**

| Function | S/N | Calibration Date | Cal Due Date | Asset # |
|---|---|---|---|---|
| HP 8574A EMI Receiver | 3010A01076 | 07/12/2001 | 07/12/2002 | 42 |
| HP 84300-80037 1.5 GHz High Pass Filter | 3643A00027 | 06/08/2001 | 06/08/2002 | 2116 |
| IFR S-1403A Mode S Test Set | 6558 | 11/08/2000 | 11/08/2001 | 0 |
| IFR ATC 1400A Mode A & C Test Set | 204006626 | 11/08/2000 | 11/08/2001 | 0 |
| HP 778D Directional Coupler | 13454 | 08/20/2001 | 08/20/2002 | 0 |
| 10 dB Attenuator | none | 09/21/2000 | 09/21/2001 | 2221 |
| Chase CBL6111C Bilog Antenna | 2455 | 02/09/2001 | 02/09/2002 | 1992 |
| HP 8447D Amplifier | 2727A05392 | 08/17/2001 | 08/17/2002 | 10 |
| EMCO 3115 1-18 GHz Horn Antenna | 9006-3413 | 06/07/2001 | 06/07/2002 | 327 |
| HP 83017A Amplifier 26GHz | 0000009002 | 01/18/2001 | 01/18/2002 | 2114 |

Test Setup - Front View

Test Setup - Back View

## VIDEO BANDWIDTH AND RESOLUTION BANDWIDTH SETTINGS:

| BEGINNING FREQUENCY | ENDING FREQUENCY | BANDWIDTH SETTING |
|---|---|---|
| 10 MHz | 30 MHz | 9 kHz |
| 30 MHz | 1000 MHz | 120 kHz |
| 1000 MHz | 11 GHz | 3 MHz |

FCC Part 2.1053 Measurements required: Field strength of spurious radiation & FCC part 87.139(d)

| Polarity | Freq(MHz) | Reading in dBuV/m | PreAmp Factor | Cable Factor | Horn Antenna | High Pass Filter | Corrected E (dBuV/M) | V/M | ERP (Watts) | Spec Limit Watts | Pass or Fail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vertical | 2179.73 | 75.70 | -42.00 | 7.70 | 29.20 | 0.5 | 71.1 | 0.003589219 | 0.000002357 | 0.00457W | Pass |
| Horizontal | 2179.73 | 75.00 | -42.00 | 7.70 | 29.20 | 0.5 | 70.4 | 0.003311311 | 0.000002006 | 0.00457W | Pass |
| Horizontal | 4359.85 | 56.50 | -37.40 | 13.50 | 32.60 | 0.3 | 65.5 | 0.001883649 | 0.000000649 | 0.00457W | Pass |
| Vertical | 4360.30 | 49.90 | -37.40 | 13.50 | 32.60 | 0.3 | 58.9 | 0.000881049 | 0.000000142 | 0.00457W | Pass |
| Horizontal | 6539.70 | 45.80 | -38.30 | 15.90 | 34.50 | 0.1 | 58.0 | 0.000794328 | 0.000000115 | 0.00457W | Pass |
| Vertical | 6539.43 | 45.50 | -38.30 | 15.90 | 34.50 | 0.1 | 57.7 | 0.000767361 | 0.000000108 | 0.00457W | Pass |
| Vertical | 5449.73 | 47.70 | -39.00 | 14.0 | 33.80 | 0.2 | 56.7 | 0.000683912 | 0.000000086 | 0.00457W | Pass |
| Horizontal | 5449.50 | 47.50 | -39.00 | 14.0 | 33.80 | 0.2 | 56.5 | 0.000668344 | 0.000000082 | 0.00457W | Pass |
| Vertical | 3270.13 | 46.20 | -39.30 | 10.10 | 31.60 | 0.3 | 48.9 | 0.000278612 | 0.000000014 | 0.00457W | Pass |
| Horizontal | 3270.60 | 44.30 | -39.30 | 10.10 | 31.60 | 0.3 | 47.0 | 0.000223872 | 0.000000009 | 0.00457W | Pass |
| Vertical | 1035.25 | 54.70 | -43.00 | 5.40 | 25.50 | 0.0 | 42.6 | 0.000134896 | 0.000000003 | 0.00457W | Pass |
| Vertical | 60.01 | 47.50 | -27.20 | 1.90 | 5.90 | 0.0 | 28.1 | 0.000025410 | 0.000000000 | 0.00457W | Pass |
| Horizontal | 179.98 | 38.80 | -26.80 | 3.20 | 8.90 | 0.0 | 24.1 | 0.000016032 | 0.000000000 | 0.00457W | Pass |

Notes: Frequency range investigated was from 10MHz to 11.0GHz. All spurious and harmonic emissions were investigated. All emissions detected that were less than 20dB below the permissible value were reported. Rated Power output of transmitter at 462.38 Watts.

**CALCULATIONS**

Note: The data taken is relative to the radiated power of each spurious emission with reference to the rated mean power output of the

10 log (462.38W/1mW) = 56.65 dBm

56.6 dBm - 50 dBc = 6.6 dBm

Inv Log (6.6 dBm/10) = 4.57 mW

**Spec Limit = 0.00457 Watts**

**ERP = $(Ed)^2/30(G)$**

E = V/m

d= distance

G = Gain of Antenna ( numerical gain of half wave dipole antenna 1.64)

**Conversion of dBuV/m to V/m**

**[invlog(Reading in dBuV/m/20)]*.000001 = V/m**

## 2.1033(c)(14)/2.1055/87.133- FREQUENCY STABILITY

**Calculations:**

The mode S (TSO-C112) spec requires the reply frequency to be within ± 1MHz of 1090 MHz, or 917ppm, for operations above 15,000 feet and within +/- 3 MHz of 1090 MHz for operations not exceeding 15,000 feet.

Paragraph 87.133 (d) of the FCC regulations requires that, " the frequency at which maximum emission occurs must be within the authorized frequency band and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where T is the pulse duration in microseconds."

If the nominal 450 ns pulse width for the transponder is used, the frequency stability of the transmitter should be 3.33 MHz or less.

The maximum change in frequency observed over temperature and voltage variation was 30 kHz. This is within the 3.33 MHz FCC limit and the 1 MHz limit called out by TSO C112/DO181A.

***Test Equipment*:**

| Function | S/N | Cal Date | Cal Due | Asset # |
|---|---|---|---|---|
| HP 34970A Data Acquisition Meter/Thermocoupler | 34970A-04 | 12/14/00 | 12/14/01 | |
| IFR Model S-1403DL Mode S Test Set | 6558, II Morrow # A00049134 | 11/8/00 | 11/8/01 | |
| IFR Model ATC 1400A Mode A & C Test Set | 204006626, II Morrow # A00049134 | 11/8/00 | 11/8/01 | |
| Thorton Temp Chamber | | 9/15/00 | 9/15/01 | 1878 |

Test Setup

| Temperature(°C) | Frequency(MHz) Vnominal 28.0 VDC | Frequency(MHz) Vminimum 23.8 VDC | Frequency(MHz) Vmaximum 32.2 VDC |
|---|---|---|---|
| -20°C | 1089.94 | 1089.94 | 1089.94 |
| -10°C | 1089.94 | 1089.94 | 1089.94 |
| 0°C | 1089.93 | 1089.93 | 1089.93 |
| 10°C | 1089.92 | 1089.92 | 1089.92 |
| 20°C | 1089.92 | 1089.92 | 1089.92 |
| 30°C | 1089.91 | 1089.91 | 1089.91 |
| 40°C | 1089.91 | 1089.91 | 1089.91 |
| 50°C | 1089.91 | 1089.91 | 1089.91 |