



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:

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Date of test: August 20-21, 2001

Report No.: FC01-059

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CKC Laboratories, Inc. has received Certificates of Accreditation from the following agencies:

A2LA (USA); DATech (Germany); BSMI (Taiwan); Nemko (Norway); and GOST (Russia).

CKC Laboratories, Inc has received test site Registration Acceptance from the following agencies:

FCC (USA); VCCI (Japan); and Industry Canada.

CKC Laboratories, Inc. has received Letters of Acceptance through an MRA for the following agencies:

ACA/NATA (Australia); SABS (South Africa); SWEDAC (Sweden); Radio Communications Agency (RA); HOKLAS (Hong Kong); Bakom (Swiss); BIPT (Belgium); Denmark Teletyrelsen; RvA (Netherlands); SEE (Luxembourg) SITTEL (Bolivia); and UKAS (UK).

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 2345 Turner Road SE Salem, OR 97302
REPRESENTATIVE:	George Cooley
TEST LOCATION:	CKC Laboratories, Inc. 22105 Wilson River Hwy 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:

A handwritten signature in black ink that reads "Dennis Ward".

Dennis Ward, Quality Manager

TEST PERSONNEL:

A handwritten signature in black ink that reads "Mike Wilkinson".

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)
= $500 \times 94 \times 116 \times 500E-9 \Rightarrow 2.726$ watts long mode S replies
+ $500 \times 31 \times 60 \times 500E-9 \Rightarrow 0.465$ watts short mode S replies
+ $500 \times 500 \times 14 \times 450E-9 \Rightarrow 1.575$ 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 $T=50\text{ns}$, the DRVR_MOD signal is brought up and propagates DC voltage to the driver transistor collector at $T=100\text{ nS}$ and stays on for the entire pulse group.

Pulses are formed as follows. At $T=300\text{ nS}$ the BUFR_MOD comes up, and the HL MOD starts up and reaches full voltage at $T=400\text{ nS}$. At $T=350\text{nS}$, 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 $T=750\text{nS}$, causing HL_MOD voltage to ramp down between $T=850\text{ns}$ and $T=1000\text{ns}$, thus forming the trailing edge of the RF output pulse. At $T=1100\text{ns}$ BUFR_MOD, GATE_MOD1, and Gate MOD2 are shut down. This sequence is repeated beginning at $T=300\text{nS}$ 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 = $(387.25 \text{ watts}) \times (94 \text{ groups/sec}) \times (116 \text{ pulses/group}) \times (511.6 \text{ nS/pulse}) = 2.16 \text{ Watts}$ Mode S short = $(387.25 \text{ watts}) \times (31 \text{ groups/sec}) \times (60 \text{ pulses/group}) \times (511.6 \text{ nS/pulse}) = 0.37 \text{ Watts}$ ATCRABS = $(387.25 \text{ watts}) \times (500 \text{ groups/sec}) \times (14 \text{ pulses/group}) \times (457.9 \text{ nS/pulse}) = 1.24 \text{ Watts}$ Total Average power = Mode S long + Mode S short + ATCRABS = 3.77 watts. The 250 % spurious limit is $43 + 10\log(\text{average power}) = -49 \text{ dBc} = 113.9 \text{ dBuV}$. 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	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 = $(462.38 \text{ watts}) \times (94 \text{ groups/sec}) \times (116 \text{ pulses/group}) \times (511.6 \text{ nS/pulse}) = 2.58 \text{ Watts}$ Mode S short = $(462.38 \text{ watts}) \times (31 \text{ groups/sec}) \times (60 \text{ pulses/group}) \times (511.6 \text{ nS/pulse}) = 0.45 \text{ Watts}$ ATCRABS = $(462.38 \text{ watts}) \times (500 \text{ groups/sec}) \times (14 \text{ pulses/group}) \times (457.9 \text{ nS/pulse}) = 1.48 \text{ Watts}$ Total Average power = Mode S long + Mode S short + ATCRABS = 4.51 watts. The 250 % spurious limit is $43 + 10\log(\text{average power}) = -50 \text{ dBc} = 113.7 \text{ dBuV}$. 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		1.5 G dB	Coupl dB	Dist Table	Corr dBμV	Spec dBμV	Margin dB	Polar Ant
			dB	dB							
1	1089.150M	132.1	+1.9		+0.0	+29.6	+0.0	163.6	163.6	+0.0	None

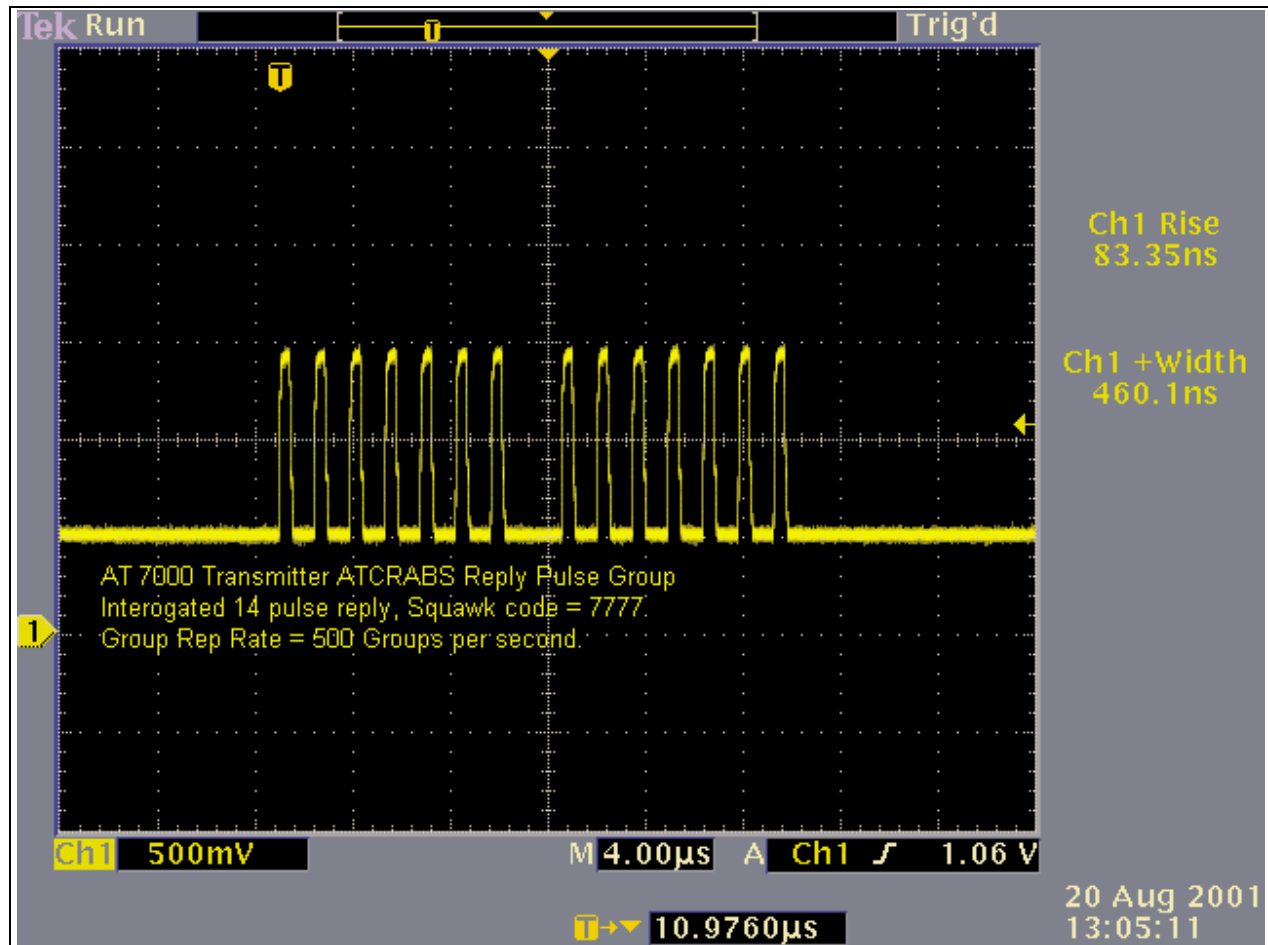


Test Setup - Front View

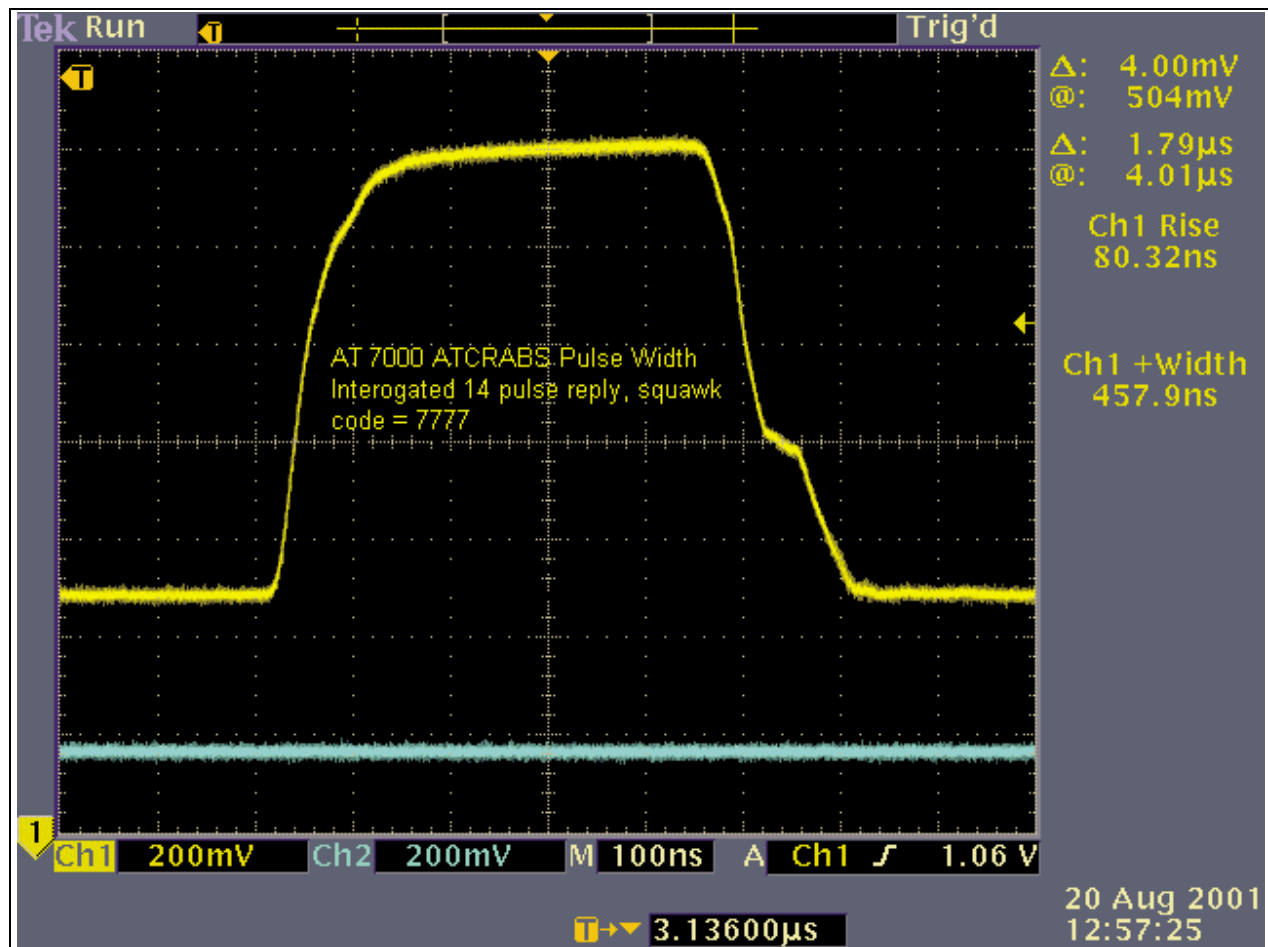


Test Setup – Back View

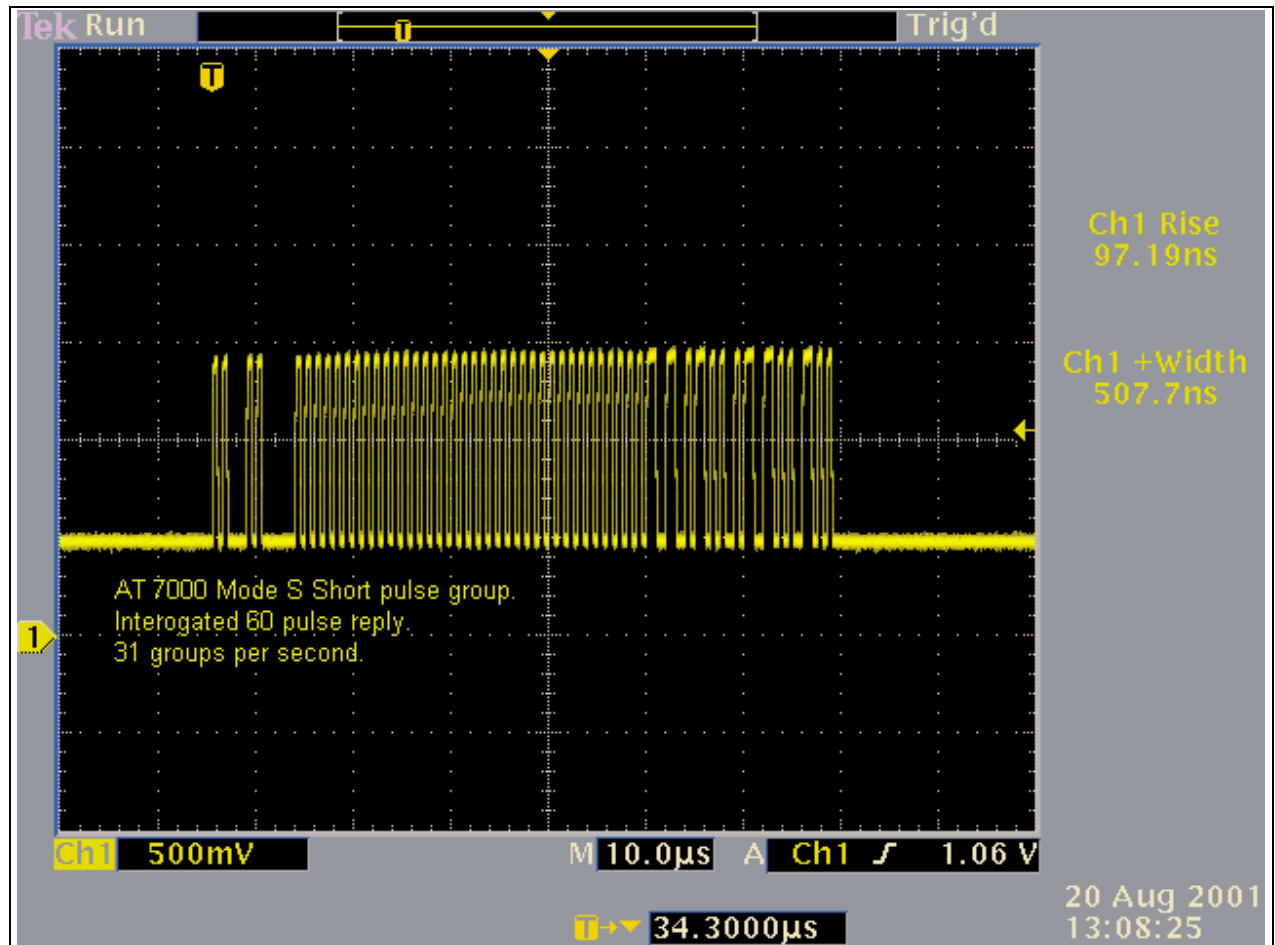
ATCRABS GROUP



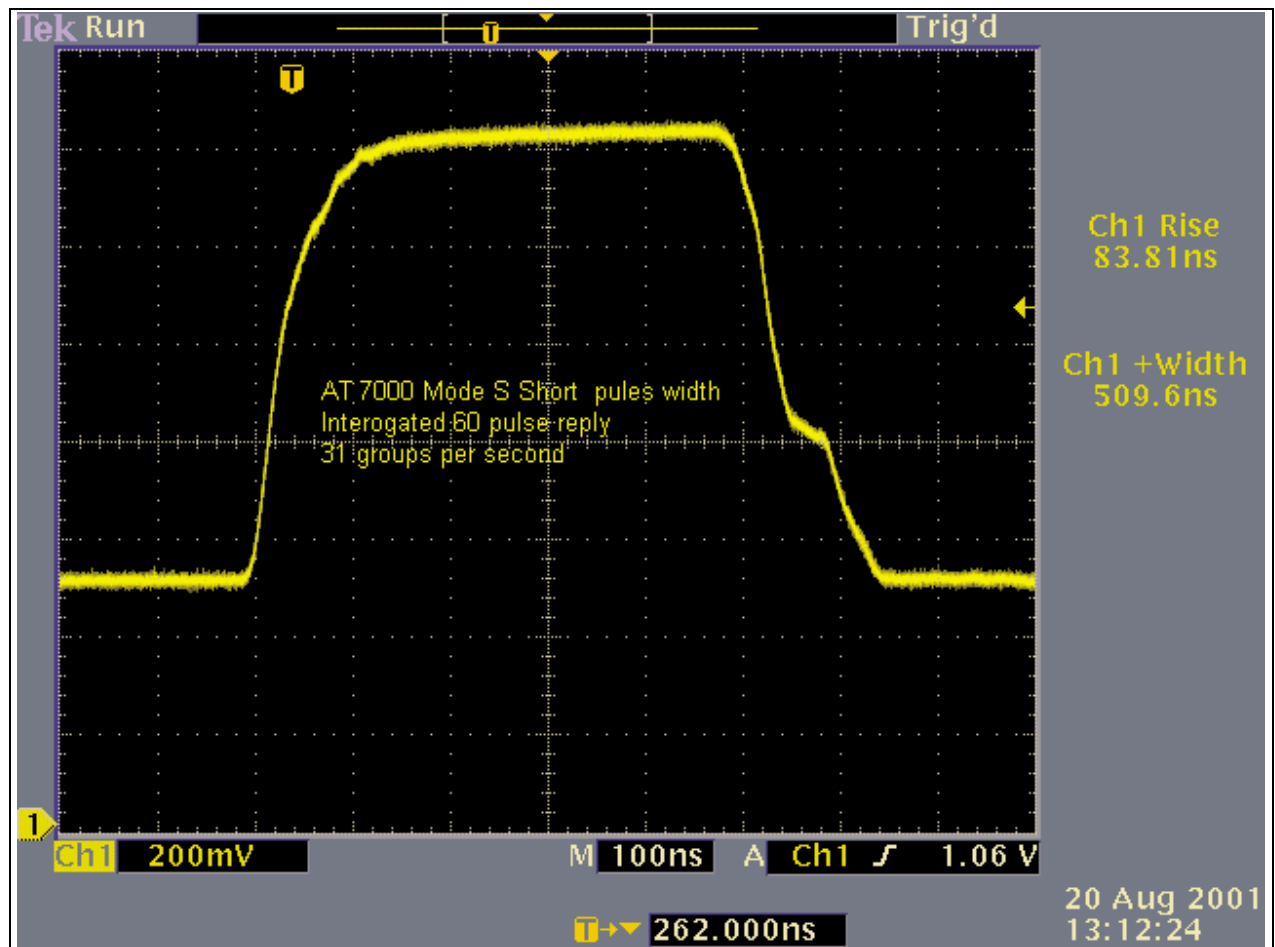
ATCRABS PULSE



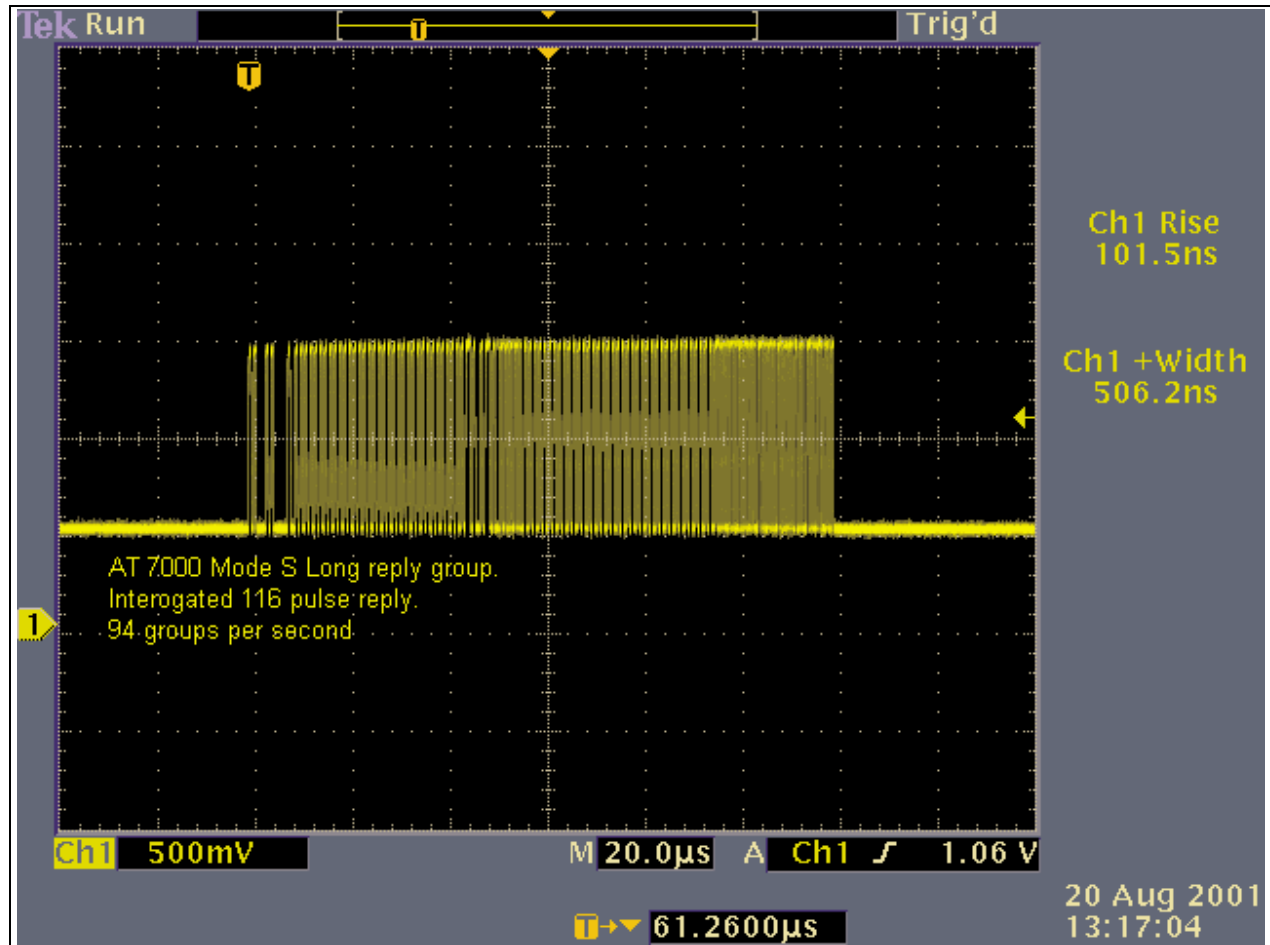
MODE S SHORT GROUP



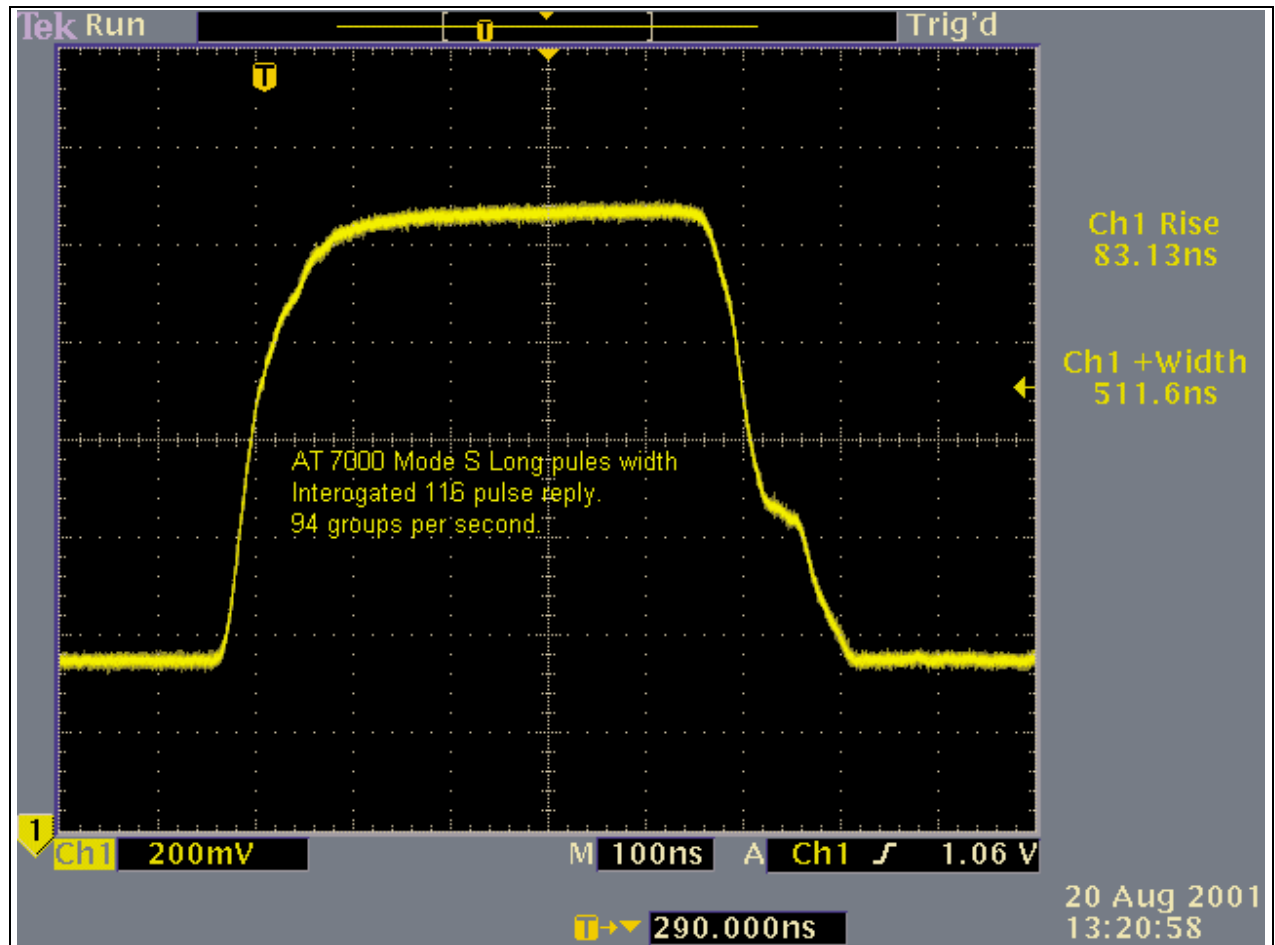
MODE S SHORT PULSE



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

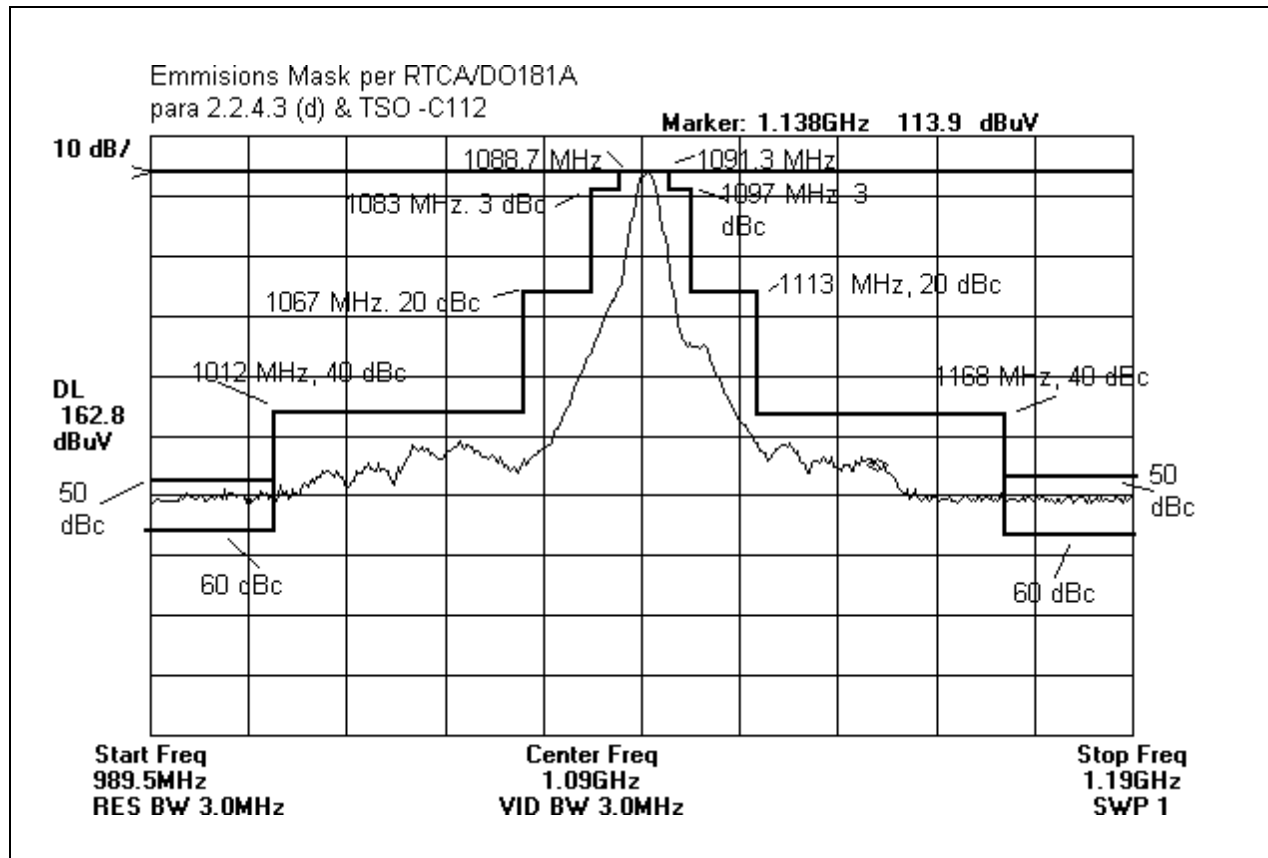


Test Setup - Front View



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

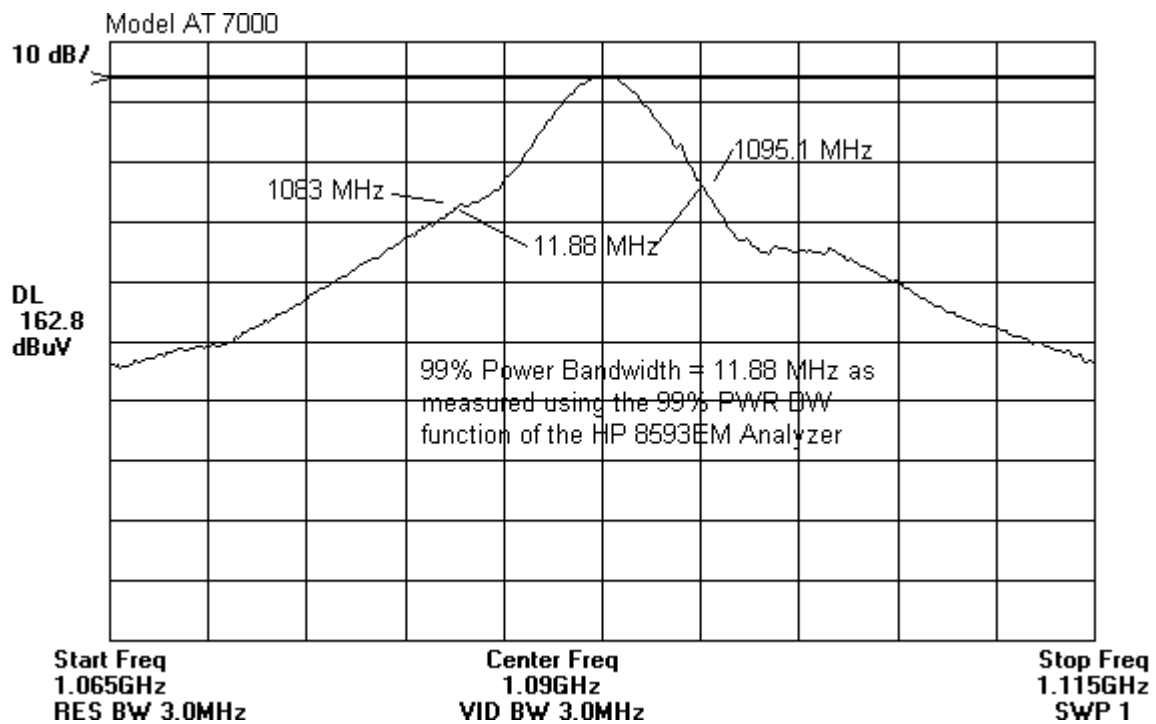


Test Setup - Front View



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 = $(387.25 \text{ watts}) \cdot (94 \text{ groups/sec}) \cdot (116 \text{ pulses/group}) \cdot (511.6 \text{ nS/pulse}) = 2.16 \text{ Watts}$ Mode S short = $(387.25 \text{ watts}) \cdot (31 \text{ groups/sec}) \cdot (60 \text{ pulses/group}) \cdot (511.6 \text{ nS/pulse}) = 0.37 \text{ Watts}$ ATCRABS = $(387.25 \text{ watts}) \cdot (500 \text{ groups/sec}) \cdot (14 \text{ pulses/group}) \cdot (457.9 \text{ nS/pulse}) = 1.24 \text{ Watts}$ Total Average power = Mode S long + Mode S short + ATCRABS = 3.77 watts. The 250 % spurious limit is $43 + 10\log(\text{average power}) = -49 \text{ dBc} = 113.9 \text{ dBuV}$. 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 #
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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**
 Test Type: **Maximized Emissions**
 Equipment: **Mode S Data Link Transponder**
 Manufacturer: **UPS Aviation Technologies**
 Model: **AT-7000**
 S/N: **P0008**

Date: 08/21/2001
 Time: 11:39:58
 Sequence#: 2
 Tested By: Mike Wilkinson

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	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 = $(462.38 \text{ watts}) \times (94 \text{ groups/sec}) \times (116 \text{ pulses/group}) \times (511.6 \text{ nS/pulse}) = 2.58 \text{ Watts}$ Mode S short = $(462.38 \text{ watts}) \times (31 \text{ groups/sec}) \times (60 \text{ pulses/group}) \times (511.6 \text{ nS/pulse}) = 0.45 \text{ Watts}$ ATCRABS = $(462.38 \text{ watts}) \times (500 \text{ groups/sec}) \times (14 \text{ pulses/group}) \times (457.9 \text{ nS/pulse}) = 1.48 \text{ Watts}$ Total Average power = Mode S long + Mode S short + ATCRABS = 4.51 watts. The 250 % spurious limit is $43 + 10\log(\text{average power}) = -50 \text{ dBc} = 113.7 \text{ dBuV}$. 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:

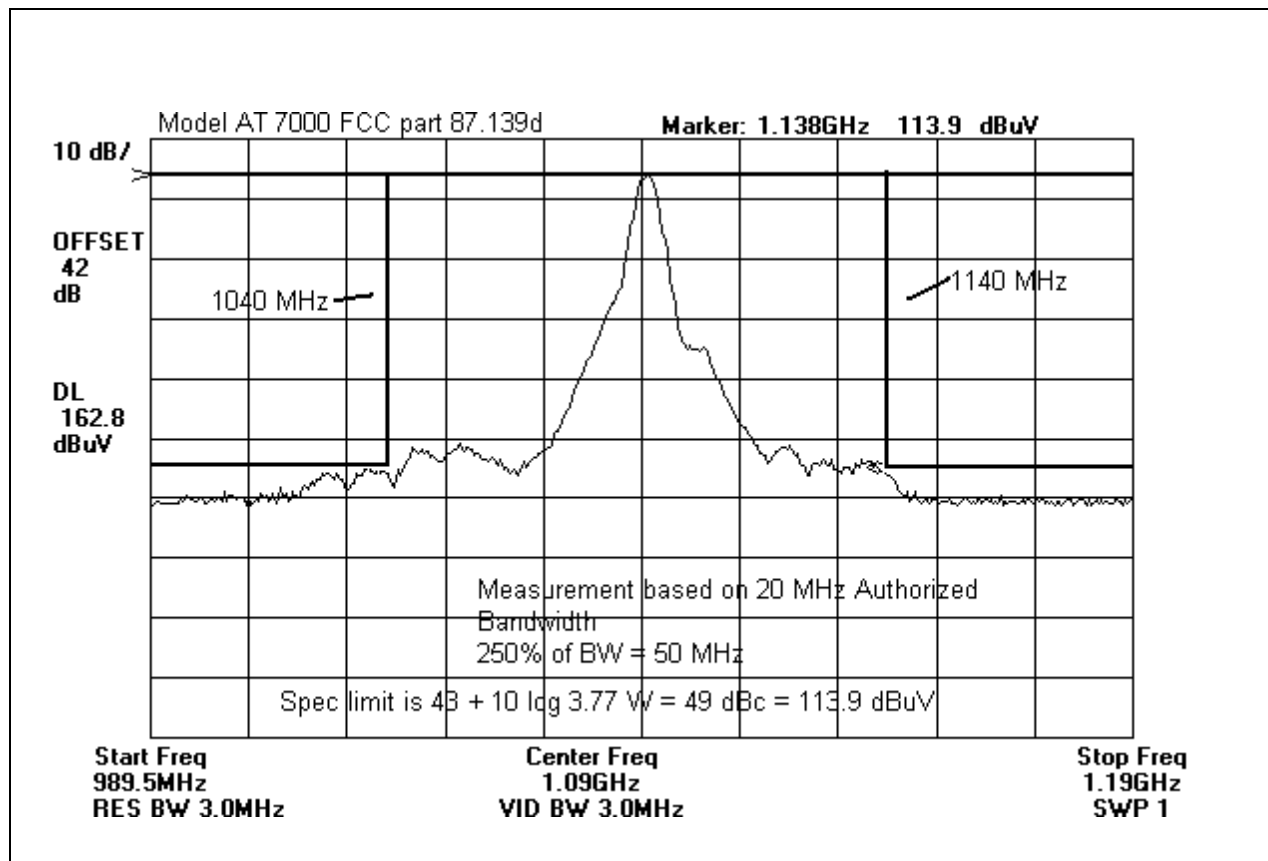
Reading listed by margin.

Test Distance: None

#	Freq MHz	Rdng dBμV	Cable dB	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 $10 \log (462.38W/1mW) = 56.65 \text{ dBm}$ $56.6 \text{ dBm} - 50 \text{ dBc} = 6.6 \text{ dBm}$ $\text{Inv Log } (6.6 \text{ dBm}/10) = 4.57 \text{ mW}$ 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 $[\text{invlog}(\text{Reading in dBuV/m}/20)]*0.000001 = \text{V/m}$											

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

Calculations:

The mode S (TSO-C112) spec requires the reply frequency to be within ± 1 MHz 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