KTL Test Report:	0R02527
Applicant:	EXI Wireless Systems Inc. Suite 100-13551 Commerce Parkway Richmond, BC V6V 2L1
Equipment Under Test: (E.U.T.)	ASSET TAG
FCC ID:	HE7 ATG
In Accordance With:	**FCC Part 15, Subpart C** For Low Power Transmitters Operating Periodically In The Band 40.66 - 40.77 MHz And Above 70 MHz
Tested By:	KTL Ottawa Inc. 3325 River Road, R.R. 5 Ottawa, Ontario K1V 1H2
Authorized By:	
	R. Grant, Wireless Group Manager
Date:	
Total Number of Pages:	25

Table of Contents

Section 1. Summary of Test Results

General

All measurements are traceable to national standards.

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.231. All tests were conducted using measurement procedure ANSI C63.4-1992. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-Production Unit

D	S	C

Equipment Code

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.
See " Summary of Test Data".

NVLAP LAB CODE: 100351-0

TESTED BY: _____ DATE: _____
Kevin Carr, Technologist

Summary Of Test Data

Name of Test	Para. Number	Results
Transmission Requirements	15.231(a)	Complies
Radiated Emissions	15.231(b)	Not Applicable
Occupied Bandwidth	15.231(c)	Complies
Frequency Tolerance	15.231(d)	Not Applicable
Periodic Alternate Field Strength Requirements	15.231(e)	Complies
Powerline Conducted Emissions	15.207	Not Applicable

Footnotes For N/A's:

- Applicant filing under Clause 15.231(e)
- Applicant does not transmit within the band specified by Clause 15.231(d)

Test Conditions:

Indoor	Temperature:	24 °C
	Humidity:	35 %
Outdoor	Temperature:	24 °C
	Humidity:	35 %

Section 2. Equipment Under Test (E.U.T.)

General Equipment Information

Manufacturer:	EXI Wireless Systems Inc.
Model No.:	ASSET TAG
Serial No.:	None
Date Received In Laboratory:	May 25, 2000
KTL Identification No.:	Item #1
Frequency Range:	434 MHz
Operating Frequency(ies) of Sample:	433.9 MHz
Type of Emission:	PCM
Emission Designator:	66K7L1D
Supply Power Requirement:	Battery
Duty Cycle Calculation:	$20 \text{ Log} \left(\frac{25x0.35 + 4x0.5}{100} \right) = -19.4\text{dB}$

Section 3. Transmission Requirements

Para. No.: 15.231(a)

Test Performed By: Kevin Carr	**Date of Test:** June 6, 2000

Minimum Standard:

15.231(a) Continuous transmissions such as voice, video or data transmissions are not permitted.

15.231(a)(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds after being released.

15.231(a)(2) A transmitter activated automatically shall cease transmission within 5 seconds of activation.

15.231(a)(3) Periodic transmissions at regular pre-determined intervals are not permitted. However polling or supervisory transmissions to determine system integrity of transmitters used in security or safety applications are allowed if the periodic rate of transmission does not exceed one transmission of not more than one second duration per hour for each transmitter.

15.231(a)(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm.

Test Results: Complies.

Test Data: Compliance was determined by verification of technical specifications and a functional test on the equipment.

Rationale for Compliance with Transmission Requirements

15.231(a)(1) : The E.U.T. is not intended for manual operation.

15.231(a)(2) : The E.U.T. transmits periodically while in the 307 kHz field. Reference Customer Technical Information – Attached.

15.231(a)(3) : This equipment has no provision for periodic transmission.

15.231(a)(4) : Not applicable.

WIRELESS SYSTEMS INC.

Technical Memo

TO: KTL
FM: Chris Chattaway

Date: May 29, 2000
Subject: Technical Description of the Halo Asset Tag
Document Number: 970-000014-000

1 Introduction

The purpose of this memo is to give a top-level technical description of the Asset tag. The Asset tag is used with the EXI Assetrac Asset protection system. The following sections describe the form and operation of the Asset tag.

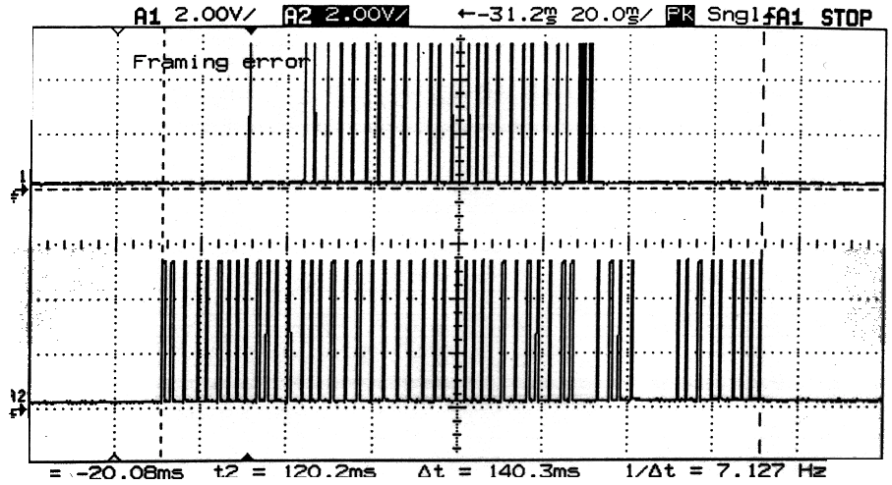
2 Operation

The Asset tag has two modes of operation, in field and tag initiated. First and foremost the Asset tag is an RF transceiver that receives a 307 KHz signal and replies with a 433.92 MHz signal. The tag upon entering a 307 KHz field wakes up and communicates its serial number to the controller (base station). The controller, over the 307 KHz field (channel), transmits wakeup and respond commands to the tag and also initiates and controls the serial number interrogation. The second mode of operation is initiated by the tag's tamper circuitry. The tag is able to transmit to the nearest controller or receiver a message that indicates that the tag is being removed from the device it is protecting. This mode of operation is called Tag Initiated Communications (TIC).

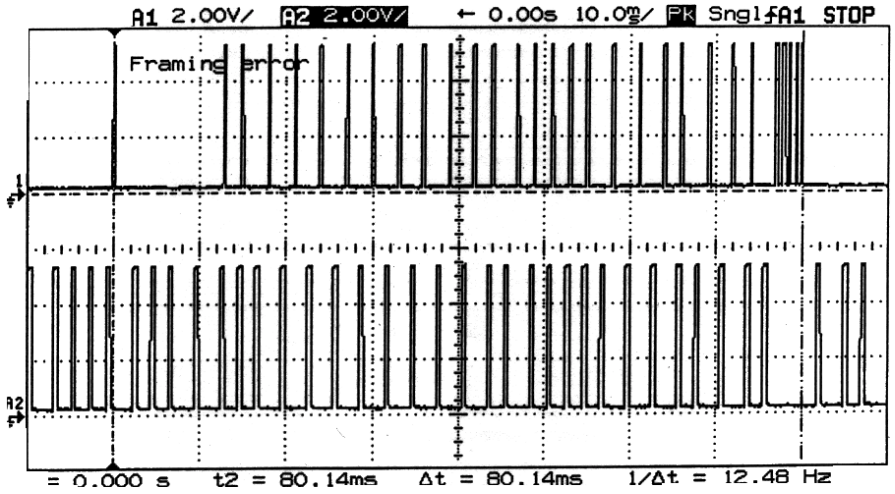
2.1 In field Performance

The Asset tag operates when in the 307 KHz field. When a tag enters the field it is prompted to power up by the wake up word that is transmitted by the controller (over 307 KHz field). Once powered up the tag will respond to the next wake up word with a 350µs pulse. This pulse prompts the controller to issue the serial number interrogation protocol command (bit by bit) and the serial number is extracted from the tag by the controller. Figure 1and Figure 2 illustrate this communication. The top traces show the output from the tag (433.92 MHz) and the bottom traces show the transmissions from the controller (307 KHz). The entire communication takes approximately 120ms (this time varies slightly from tag to tag based on the serial number). Figure 2 illustrates that the tag transmitter is working for approximately 80 ms of these 120 ms. For more information on the bit by bit protocol please refer to document "Bit-by-Bit Interrogation: Protocol Description" document number 970-000001-000.

Now that the tag in the field is identified, the controller must periodically check to see if the tag is still in the field. Approximately every 12 sec. the tag will wake up and respond with a 350µs pulse when it sees the controller transmit a respond command. This communication is shown in Figure 3 and Figure 4. Figure 3 shows a bit by bit communication followed by a respond 11.47 seconds later and Figure 4 illustrates in detail the respond communication pulse. The respond communication will continue until the controller issues a reset command and re-interrogates all the tags in the field. The reset and re-interrogation occurs once per minute. Once again this behavior is detailed in the document "Halo communication Protocol" document number 970-000002-000.



igur Bit by ommu ication pie



ig 2: by Bit unication example

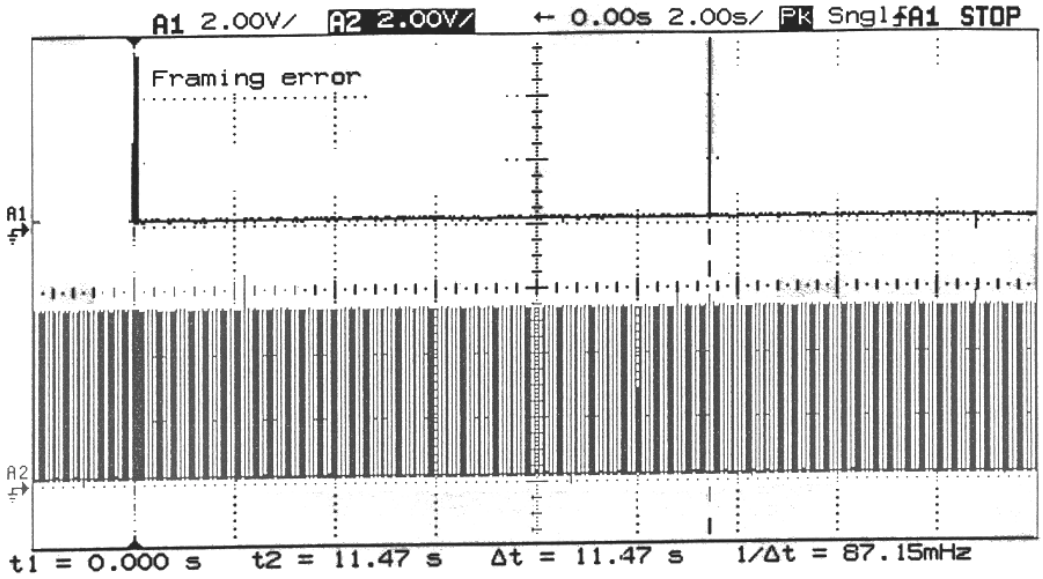


Figure 3: Bit By Bit communication followed by first respond

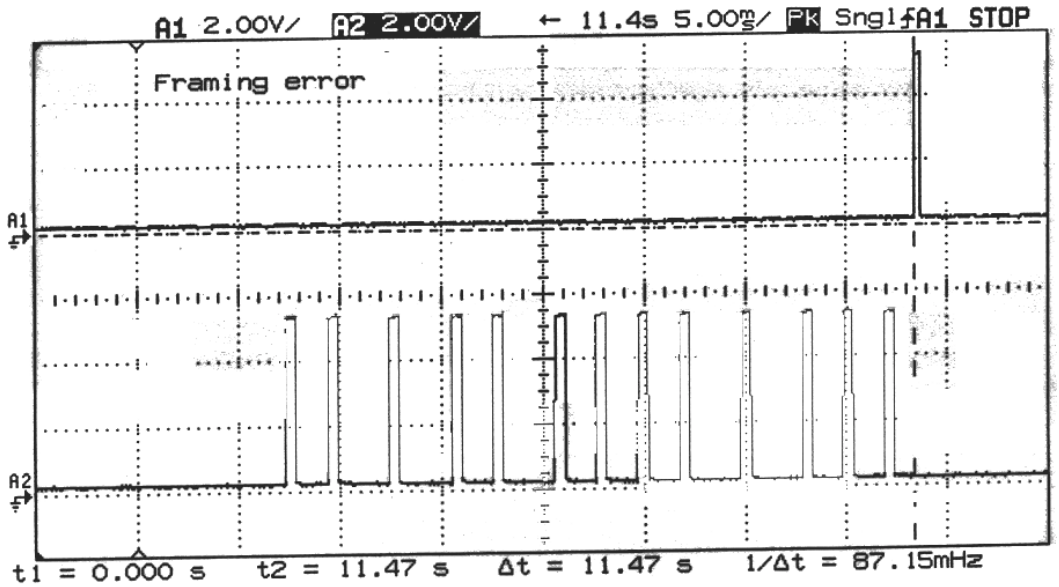


Figure 4: Respond Communication Example

2.2 TIC performance

A TIC alarm is transmitted any time the tamper switch is closed. The switch protrudes from the bottom of the case and is intended to close when the tag is removed form the device it is protecting. Typically the tag will be adhered to a device and if the tag is tamper with or removed the switch will close. This switch closure powers up the tag and causes it to transmit its serial number to any/all controllers or receivers that are in range. The nature of the transmission is

shown in Figure 5. This waveform shows that the transmitter is in use for approximately 48 ms (this varies slightly with serial number). The transmitter will then turn off for approximately 12 seconds and then, assuming the tamper switch is still closed, will transmit the signal shown in Figure 5 again. This sequence will continue with the time between TICs doubling each time as long as the tamper switch remains closed. Figure 6 and Figure 7 show three consecutive TIC transmissions and show the time between TICs 1 and two (13.59 sec.) and TICs 2and 3 (26.53 sec.) respectively.

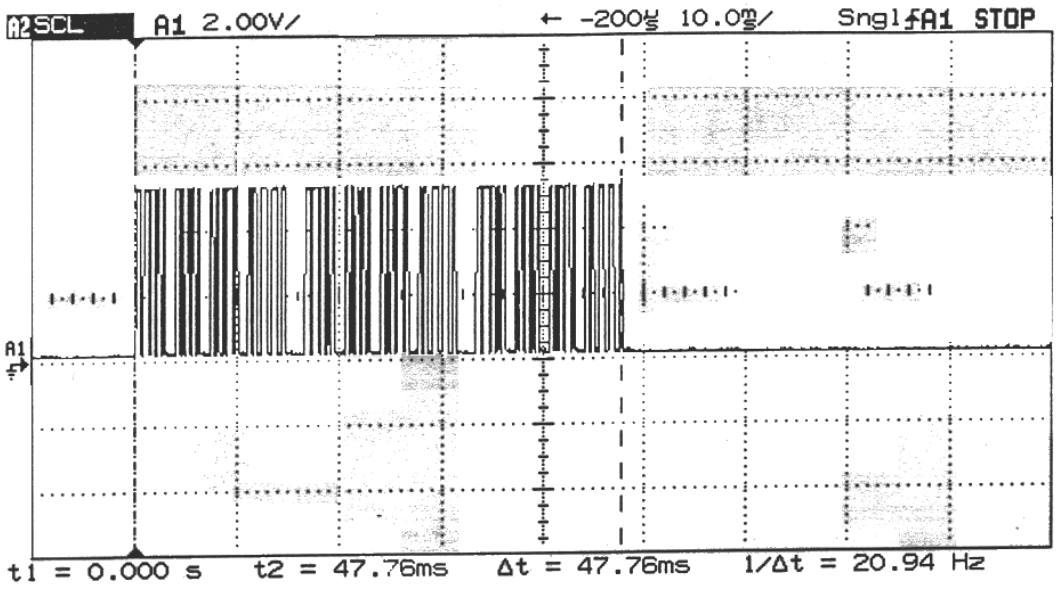


Figure 5: Waveform for single TIC Transmission

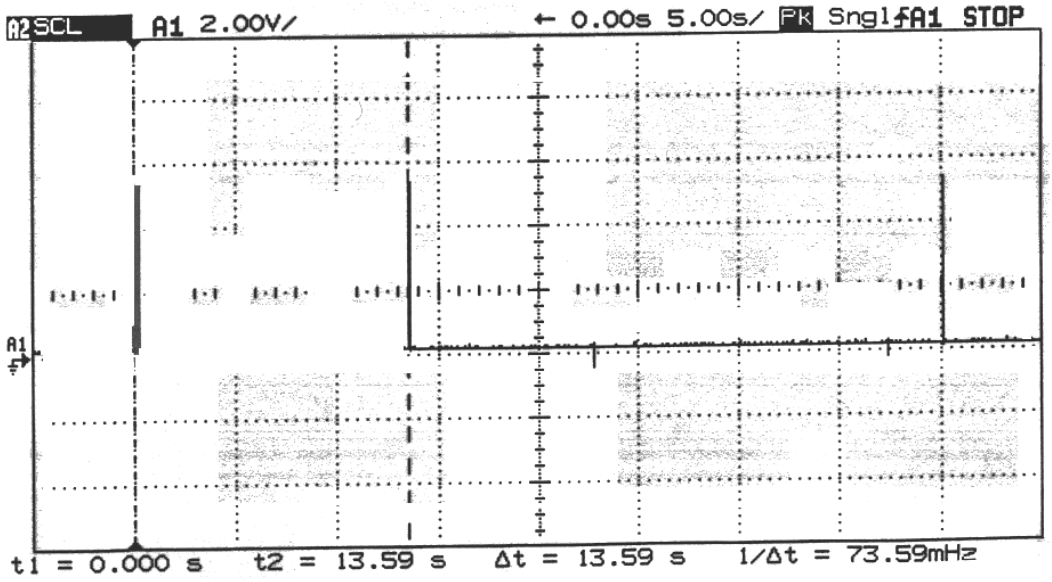


Figure 6: TIC example - Time Between First and Second TIC Transmission

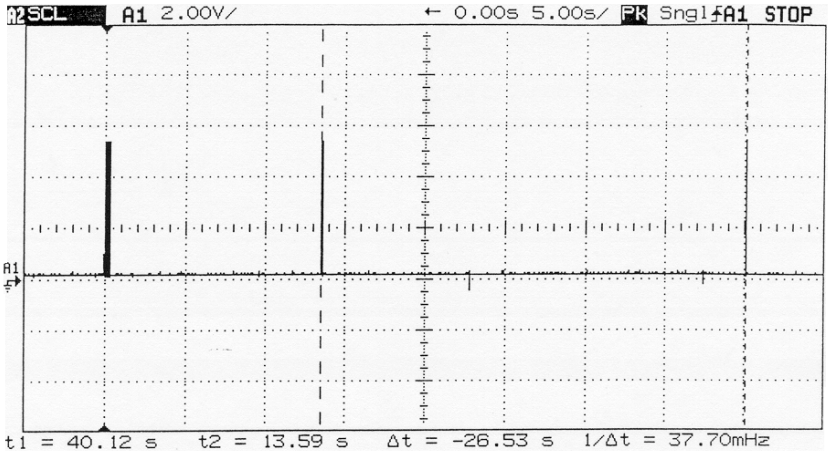


Figure 7: TIC example - Time Between Second and Third TIC Transmission

3 Cases and markings

Figure 8 illustrates the case design that will be used for the Asset tag. The diagram shows where the FCC identification will appear.

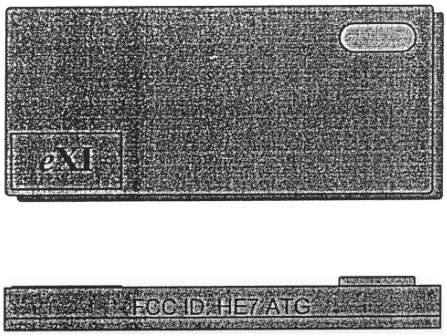
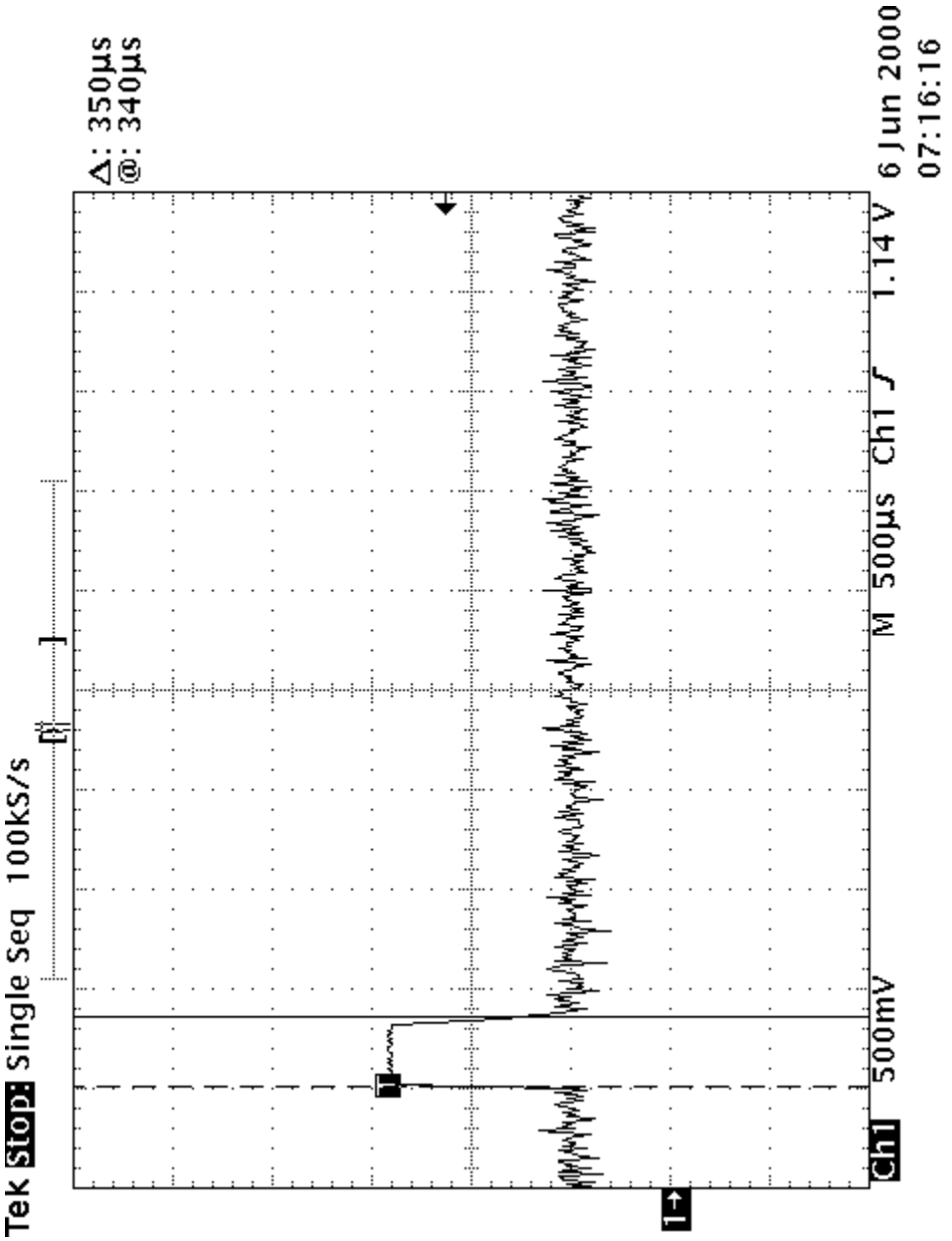
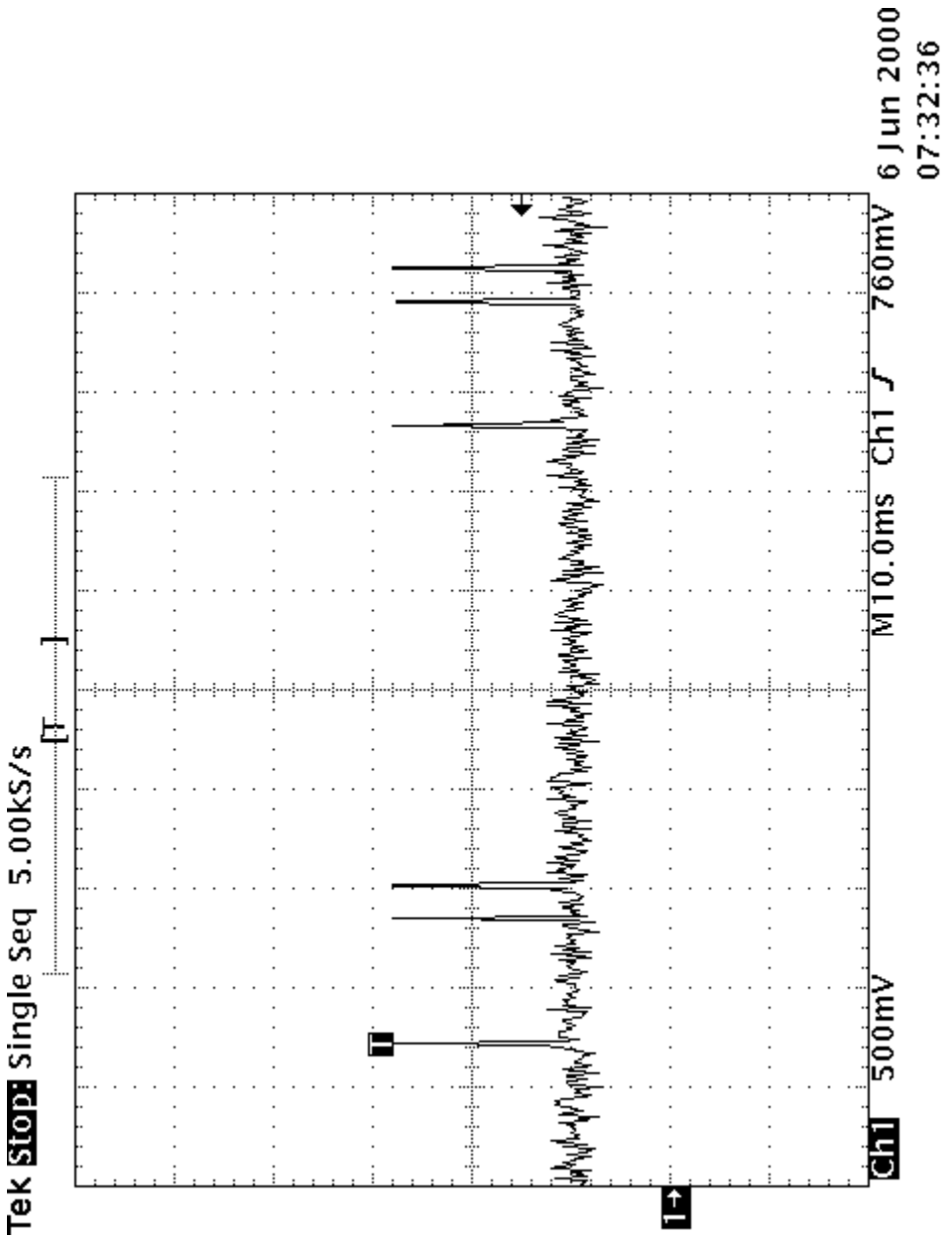


Figure 8: Case and Markings for the Asset tag


Δ: 350µs
@: 340µs
6 Jun 2000
07:16:16
Tek Stop: Single Seq 100kS/s
M 500µs Ch1 ƒ 1.14 V
Ch1 500mV


Tek Stop: Single Seq 5.00kS/s
6 Jun 2000
07:32:36
M10.0ms Ch1 ƒ 760mV
Ch1 500mV

Section 4. Occupied Bandwidth & Duty Cycle

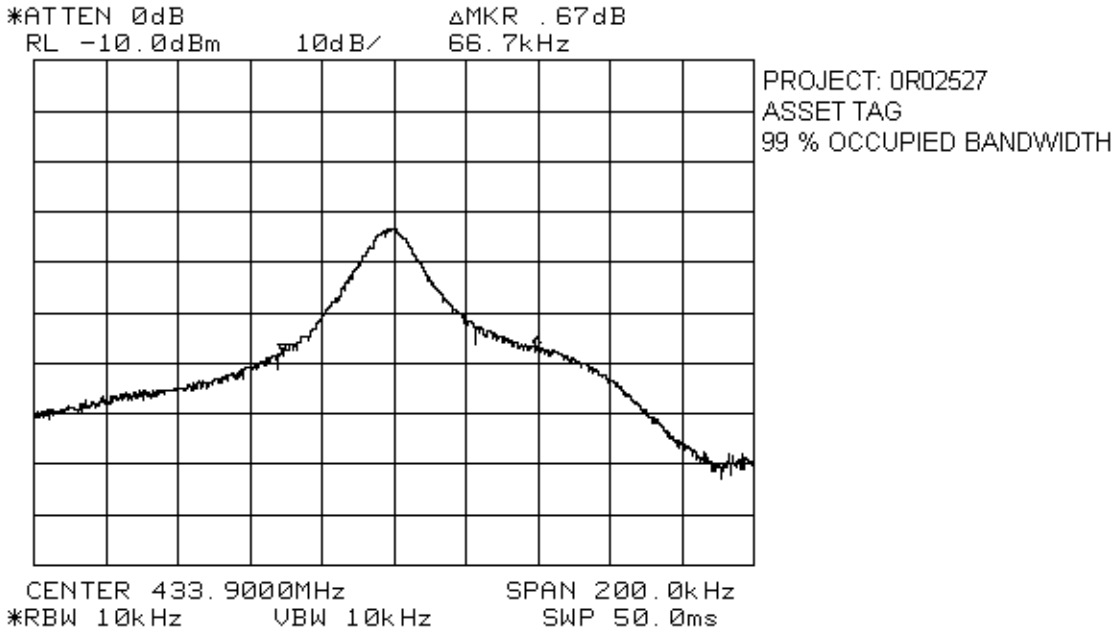
Para. No.: 15.231(c)

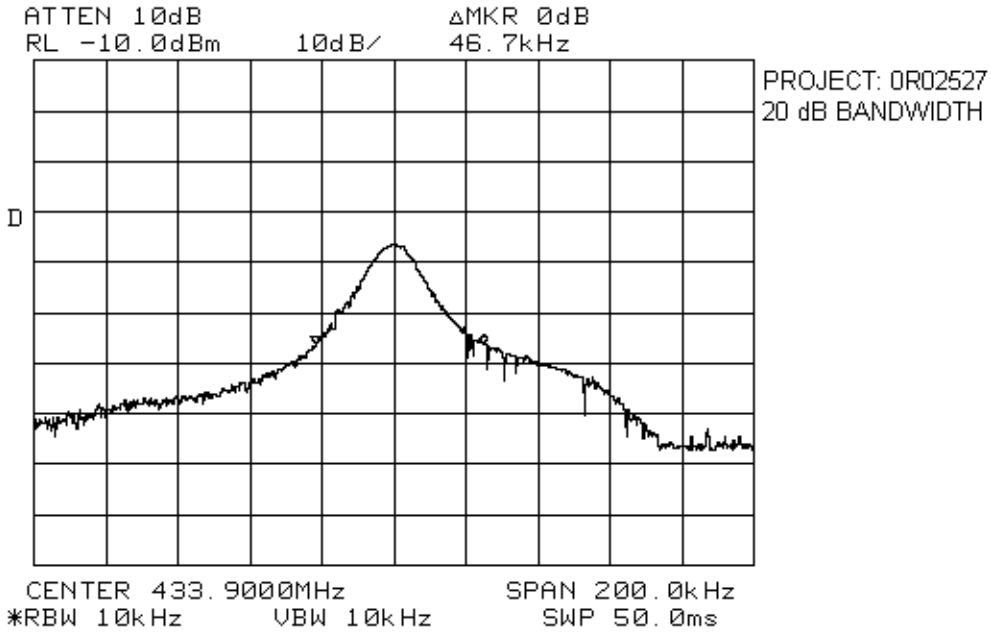
Test Performed By: Kevin Carr	**Date of Test:** June 6, 2000

Minimum Standard: 15.231(c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Test Results: Complies. See attached graph.

Test Data: See attached graph.


*ATTEN 0dB
ΔMKR .67dB
RL -10.0dBm
10dB/
66.7kHz
PROJECT: 0R02527
ASSET TAG
99 % OCCUPIED BANDWIDTH
CENTER 433.9000MHz
SPAN 200.0kHz
*RBW 10kHz
VBW 10kHz
SWP 50.0ms


ATTEN 10dB
RL -10.0dBm
10dB/
ΔMKR 0dB
46.7kHz
PROJECT: 0R02527
20 dB BANDWIDTH
D
CENTER 433.9000MHz
SPAN 200.0kHz
*RBW 10kHz
VBW 10kHz
SWP 50.0ms

Section 5. Periodic Alternate Field Strength Requirements

Para. No.: 15.231(e)

Test Performed By: Kevin Carr	**Date of Test:** June 6, 2000

Minimum Standard:

15.231(e) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation, including operation prohibited in paragraph (a) of this section, provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this section, except the field strength table in paragraph (b) of this section is replaced by the following.

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	1,000	100
70 - 130	500	50
130 - 174	500 to 1,500	50 to 150
174 - 260	1,500	150
260-470	1,500 to 5,000	150 to 500
Above 470	5,000	500

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

Test Results: Complies. The worst case emission is 65.9 dBµV/m at 3m at 433.86 MHz. This is 7.0dB below the specification limit.

Test Data: See attached table.

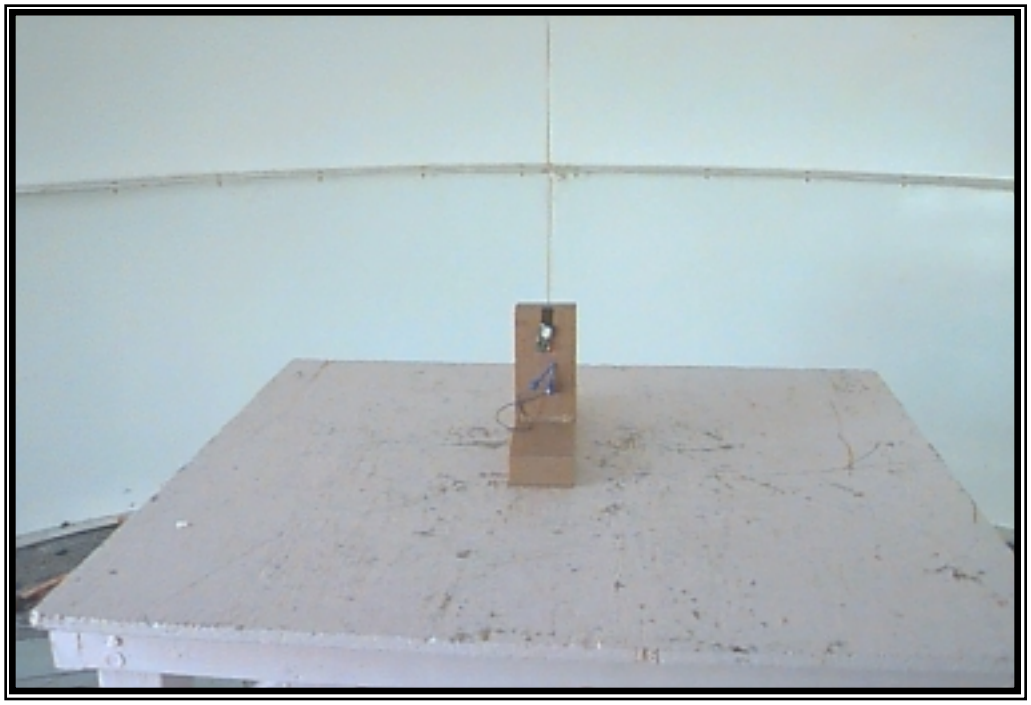
Test Data - Periodic Alternate Field Strength Requirements

Test Distance (meters) : 3		Range: A Tower		Receiver: HP8564E		RBW: 100 kHz/1 MHz		Detector: PEAK	
Freq. (MHz)	Ant. *	Pol. (V/H)	RCVD Signal (dBµV/m)	Ant. Factor (dB)**	Amp. Gain (dB)***	Duty Cycle Corr. (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
433.86	E/D4	V	59.4	25.9		-19.4	65.9	72.9	7.0
433.86	E/D4	H	53.8	25.9		-19.4	60.3	72.9	12.6
867.79	E/D4	V	17.8	33.7		-19.4	32.1	52.9	20.8
867.72	E/D4	H	20.8	33.7		-19.4	35.1	52.9	17.8
1301.59	H2	V	16.5	29.4		-19.4	26.5	52.9	26.4
1301.58	H2	H	14.1	29.4		-19.4	24.1	52.9	28.8
1735.45	H2	V	10.5	10.5		-19.4	1.6	52.9	51.3
1735.45	H2	H	11.8	11.8		-19.4	9.2	52.9	48.7
2169.3	H2	V	63.0	35.6	-57.9	-19.4	21.3	52.9	31.6
2169.3	H2	H	63.1	35.6	-57.9	-19.4	21.4	52.9	31.5
2603.17	H2	V	61.0	37.3	-60.0	-19.4	18.9	52.9	34.0
2603.17	H2	H	62.3	37.3	-60.0	-19.4	20.2	52.9	32.7
3037.03	H2	V	60.8	38.8	-59.4	-19.4	20.8	52.9	32.1
3037.02	H2	H	60.8	38.8	-59.4	-19.4	20.8	52.9	32.1
3470.88	H2	V	74.0	40.8	-57.0	-19.4	38.4	52.9	14.5
3470.88	H2	H	75.8	40.8	-57.0	-19.4	40.2	52.9	12.7
3904.75	H2	V	72.0	42.0	-57.7	-19.4	36.9	52.9	16.0
3904.75	H2	H	73.0	42.0	-57.7	-19.4	37.9	52.9	15.0
4338.6	H2	V	55.9	43.5	-55.0	-19.4	25.0	52.9	27.9
4338.61	H2	H	57.5	43.5	-55.0	-19.4	26.6	52.9	26.3

Notes:
B/C = Biconical, B/L = Biconilog, L/P = Log-Periodic, H = Horn, D/P = Dipole
* Re-measured using dipole antenna.
** Includes cable loss when amplifier is not used.
*** Includes cable loss.
( ) Denotes failing emission level.
N.D. = Not Detected

Photographs (Worst Case Configuration)

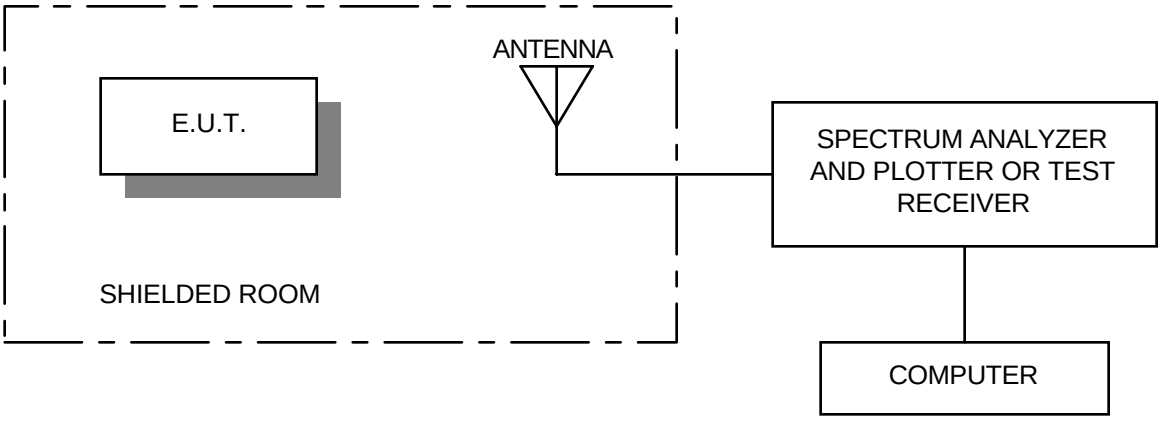
Front View



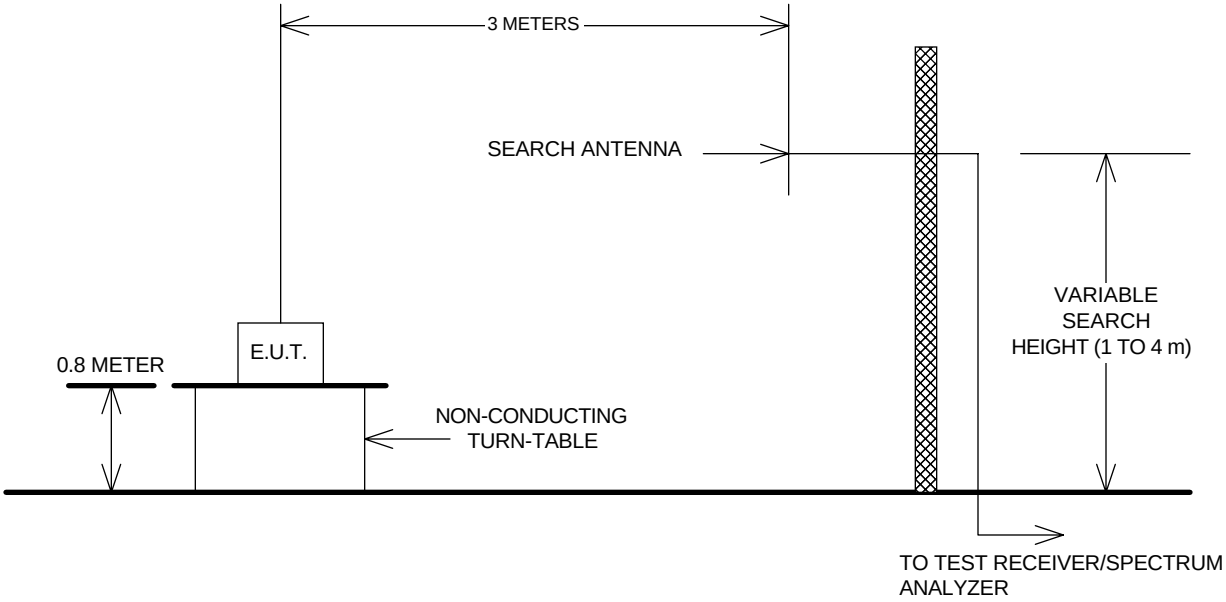
The E.U.T. was tested on 3 axis in order to determine the strongest emission level.

Section 6. Block Diagrams

Radiated Prescan

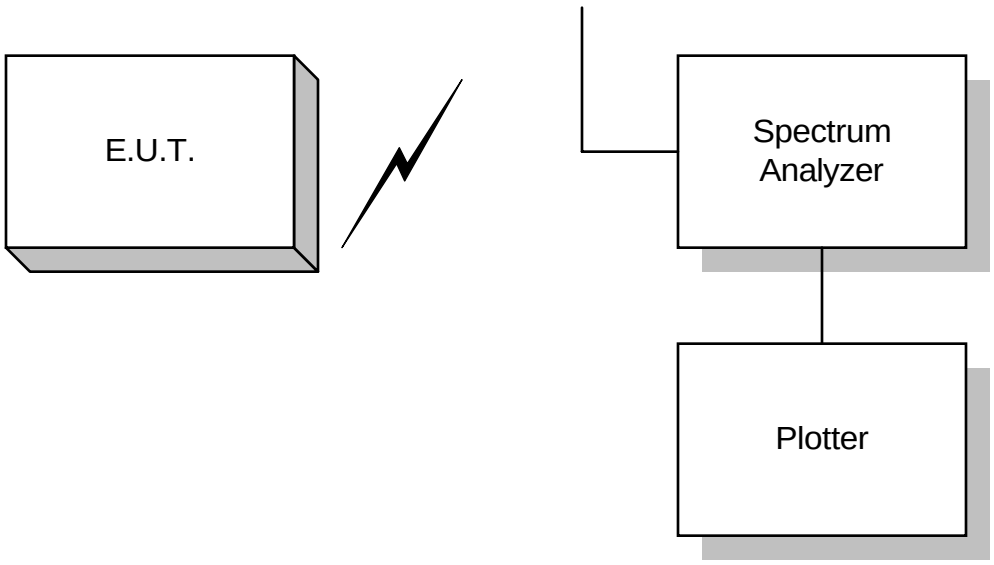


Outdoor Test Site For Radiated Emissions



The spectrum was searched up to the 10th harmonic of the fundamental frequency of operation.

Occupied Bandwidth



Section 7. Test Equipment List

Equipment List - Conducted Emissions - Shielded Room #1

CAL Cycle	Equipment	Manufacturer	Model #	Serial/Asset #	Last Cal.	Next Cal.
1Year	LISN	Rohde & Schwarz	ESH2-Z5	890485/017	Aug. 24/99	Aug. 24/00
1Year	Receiver	Rohde & Schwarz	ESH3	892473/002	Nov. 23/99	Nov. 23/00

Equipment List - Radiated Emissions

CAL Cycle	Equipment	Manufacturer	Model #	Serial/Asset #	Last Cal.	Next Cal.
2 Year	Active Loop Antenna	Rohde & Schwarz	HFH2-Z2	FA000631	Feb. 9/00	Feb. 9/02

Cal Cycle	Equipment	Manufacturer	Model	Serial	Last Cal.	Next Cal.
1 Year	Spectrum Analyzer	Hewlett Packard	8564E	3846A01407	May 31/99	May 31/00
1 Year	Spectrum Analyzer-**1**	Hewlett Packard	8566B	2311A02238	Nov. 6/99	Nov. 6/00
1 Year	Spectrum Analyzer Display-**1**	Hewlett Packard	8566B	2314A04759	Nov. 6/99	Nov. 6/00

NA: Not Applicable
NCR: No Cal Required
COU: CAL On Use

Annex A

Restricted Bands

Section A Restricted Bands of Operation

(a) Except as shown in paragraph (d) of this section , only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42-16.423	399.9-410	4.5-5.15
0.49 - 0.51	16.69475-16.69525	608-614	5.35-5.46
2.1735 - 2.1905	16.80425-16.80475	960-1240	7.25-7.75
3.020 - 3.026	25.5-25.67	1300-1427	8.025-8.5
4.125 - 4.128	37.5-38.25	1435-1626.6	9.0-9.2
4.17725 - 4.17775	73-74.6	1645.5-1646.5	9.3-9.5
4.20725 - 4.20775	74.8-75.2	1660-1710	10.6-12.7
6.215 - 6.218	108-121.94	1718.8-1722.2	13.25-13.4
6.31175 - 6.31225	123-138	2220-2300	14.47-14.5
8.291 - 8.294	149.9-150.05	2310-2390	15.35-16.2
8.362 - 8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625 - 8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425 - 8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29 - 12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975 - 12.52025	240-285	3345.8-3358	36.43-36.5
12.57675 - 12.57725	322-335.4	3600-4400	Above 38.6
13.36 - 13.41			