

RETLIF TESTING LABORATORIES  
TEST REPORT R-4155N  
September 24, 2003

FCC COMPLIANCE TEST REPORT  
ON

RADIANSE, INC.  
INDOOR POSITIONING TRANSMITTER  
FCC ID: Q9V-100-A

APPLICANT	MANUFACTURER
Radianse, Inc. 439 South Union Street, Suite 401 Lawrence, MA 01843	SAME

TEST SPECIFICATION: FCC Rules and Regulations Part 15, Subpart C, Para. 15.231 (e)

TEST PROCEDURE: ANSI C63.4:1992

#### TEST SAMPLE DESCRIPTION

BRANDNAME: LightPak MODEL: 100A  
 TYPE: Indoor positioning/asset location tracking transmitter  
 POWER REQUIREMENTS: 3VDC via internal battery  
 FREQUENCY OF OPERATION: 433.92MHz  
 TYPE OF TRANSMISSION: Pulsed emission containing manchester encoded data bits  
 FCC ID: Q9V-100-A  
 APPLICABLE RULE SECTION: Part 15, Subpart C, Section 15.231 (e)

#### TESTS PERFORMED

Spurious Emissions (30MHz to 4.4GHz)  
 Field Strength of Fundamental  
 Occupied Bandwidth, 0.25% of Fundamental Frequency  
 Duty Cycle Determination

#### TEST SAMPLE OPERATION

The EUT is powered by 3VDC, internal battery. The device is normally automatically operated but can also be manually operated. The device transmits location data for personnel/asset tracking applications. Operation of the EUT complies with the parameters required in Part 15, Subpart C, Section 15.231 (e) for devices which will transmit data and with the general requirements of 15.231 for both automatic and manual operated devices. For testing purposes only the EUT was configured to continuously transmit.

## TEST SAMPLE / TEST PROGRAM

- When manually activated the transmitter automatically ceases transmission within five seconds after activation per the requirements of 15.231 a (1).
- In automatic mode the transmitter ceases transmission within 5 seconds after activation per the requirements of 15.231 a (2).
- In automatic mode operation is limited so that the duration of each transmission is less than one second (8.016msec) and the silent period between transmissions is more than 30 times the duration of the transmission and over ten seconds per the requirements of 15.231 (e) .
- The device is not employed for RC purposes involving fire, security and safety of life.
- The fundamental field strength at 433.92MHz did not exceed  $4398\mu\text{V/M}$  (Average) at a test distance of 3 meters.
- The peak value of fundamental emissions did not exceed a peak field strength limit corresponding to 20dB above the maximum permitted average limit.
- The field strength of harmonic and spurious emissions did not exceed  $439\mu\text{V/M}$  as specified in 15.231 (e) for a fundamental frequency of 433.92MHz.
- The device operates at a single frequency of 433.92MHz The bandwidth of emissions did not exceed 0.25% of the operating frequency as specified in 15.231 (c) and was determined as follows:

Fundamental Frequency	=	433.92MHz
0.25% of Center Frequency	=	1.0848MHz
1.0848 divided by 2	=	0.542MHz
Bandwidth Range	=	Fundamental Frequency + and - 0.542MHz
433.92MHz - 0.542MHz	=	433.378MHz
433.92MHz + 0.542MHz	=	434.462MHz
<b>Bandwidth Range</b>	=	<b>433.378MHz - 434.462MHz</b>

- The device uses an internal loop antenna
- Radiated Emissions from the EUT were measured in all three axis. The attached Radiated Emissions test data is representative of the worst case orientation.

## DETERMINATION OF FIELD STRENGTH LIMITS

The field strength limits shown below were calculated as instructed in Section 15.231 (e).

### **Fundamental Frequency: 433.92MHz**

Where F is the frequency in MHz, the formula for calculating the maximum permitted fundamental field strength for the band 260-470MHz,  $\mu$ V/m at 3 meters is as follows:

$$\begin{aligned} 16.6667(F) - 2833.3333 &= \text{Field Strength Limit } (\mu\text{V/m}) \\ 16.6667 \times 433.92 &= 7232 \\ 7232 - 2833.3333 &= 4398 \\ \text{Field Strength Limit} &= 4398 \mu\text{V/m} = 72.8\text{dBuV/M} \end{aligned}$$

The maximum permitted unwanted emission level is 20dB below the maximum permitted fundamental level which equals  $439.8 \mu\text{V/m} = 52.8\text{dBuV/M}$ .

## DETERMINATION OF DUTY CYCLE

The transmitter controls were adjusted to maximize the transmitted duty cycle. The analyzer was set for a frequency span of 0Hz. The sweep time was then adjusted in order to display one full pulse train. The transmitter on time was then summed and compared to the time for one full cycle in order to obtain the duty cycle. As the pulse train was less than 100msec in duration the worst case duty cycle was determined by measuring/calculating the duration of the pulse train and then the “on time” within the pulse train. The on times were determined as follows:

The individual pulse widths within the pulse train were measured and summed in order to obtain the total “on time” within the train.

### **Fundamental Frequency: 433.92MHz**

$$\begin{aligned} \text{Transmitter On Time} &= 4.0865 \text{ milliseconds} \\ \text{Transmitter Cycle Time} &= 8.016 \text{ milliseconds} \\ \text{Transmitter Duty Cycle} &= 50.98 \% \\ \text{On Time divided by Cycle Time} &= \text{Duty Cycle Factor} \\ 4.0865 \text{ divided by } 8.016 &= 0.5096 \\ 0.5096 \text{ converted to dB } (\text{LOG}_{10} .05096)20 &= -5.85\text{dB} \\ \textbf{Duty Cycle Factor} &= \textbf{-5.85dB} \end{aligned}$$

Duty Cycle Factor Determination Plots are included with this application as a separate attachment.

## TEST SAMPLE / TEST PROGRAM (continued)

### SPECTRUM ANALYZER

Due to the nature of the emissions being measured, care was taken to ensure that the resolution bandwidth of the spectrum analyzer was adequate to provide accurate measurements.

### GENERAL NOTES

1. All readings were taken utilizing a peak detector function at a test distance of 3 meters.
2. The duty cycle factor was applied to the peak readings in order to determine the average value of the emissions.

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## EQUIPMENT LIST

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### Fundamental Field Strength & Spurious Emissions

EN	Type	Manufacturer	Description	Model No.	Cal Date	Due Date
3258	Double Ridge Guide	EMCO	1 - 18 GHz	3115	05/14/2003	05/14/2004
4029B	Test Site Attenuation	Retlif	3 / 10 Meters	RNH	07/30/2003	07/30/2004
4202	Biconilog	EMCO	26 MHz - 2 GHz	3142	07/25/2003	08/25/2003
4895	Spectrum Analyzer	Hewlett Packard	9kHz - 22GHz	8593EM	03/18/2003	03/18/2004
713	EMI Test Receiver	Rohde & Schwarz	20 Hz - 26.5 GHz	ESI26	01/29/2003	01/29/2004

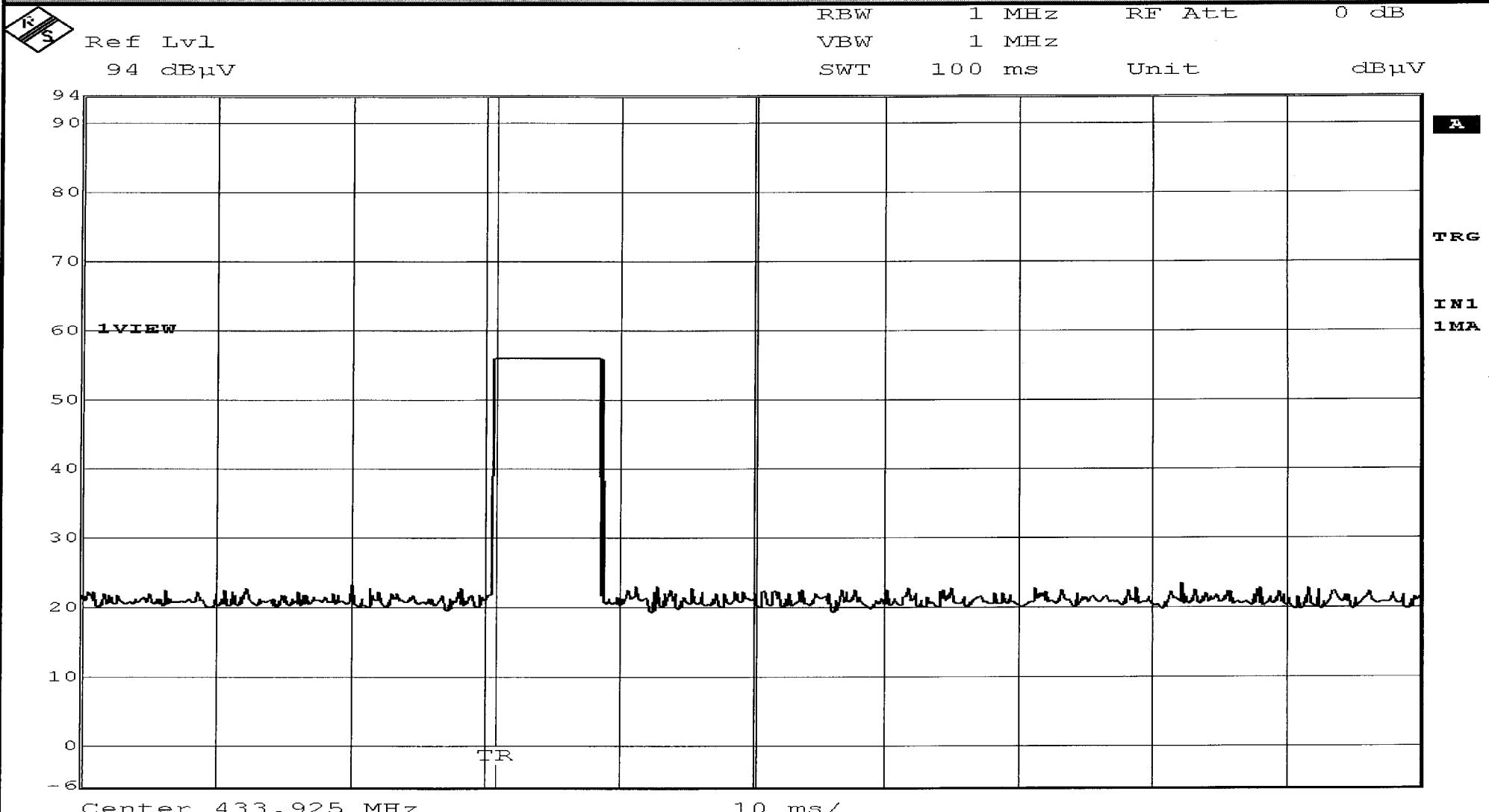
### Occupied Bandwidth/Duty Cycle

EN	Type	Manufacturer	Description	Model No.	Cal Date	Due Date
4895	Spectrum Analyzer	Hewlett Packard	9kHz - 22GHz	8593EM	03/18/2003	03/18/2004
713	EMI Test Receiver	Rohde & Schwarz	20 Hz - 26.5 GHz	ESI26	01/29/2003	01/29/2004

# RETLIF TESTING LABORATORIES

## EMISSIONS DATA SHEET

Test Method:	Duty Cycle Plots		
Customer:	Radianse, Inc.	Test Sample:	Transmitter
Model No.:	100A	Serial No.:	n/a
Test Specification:	FCC Part 15 Paragraph: 15.231(e)		
Operating Mode:	Transmitting Data Bursts		
Notes:			



Date: 24 . JUL . 2003 10 : 41 : 06

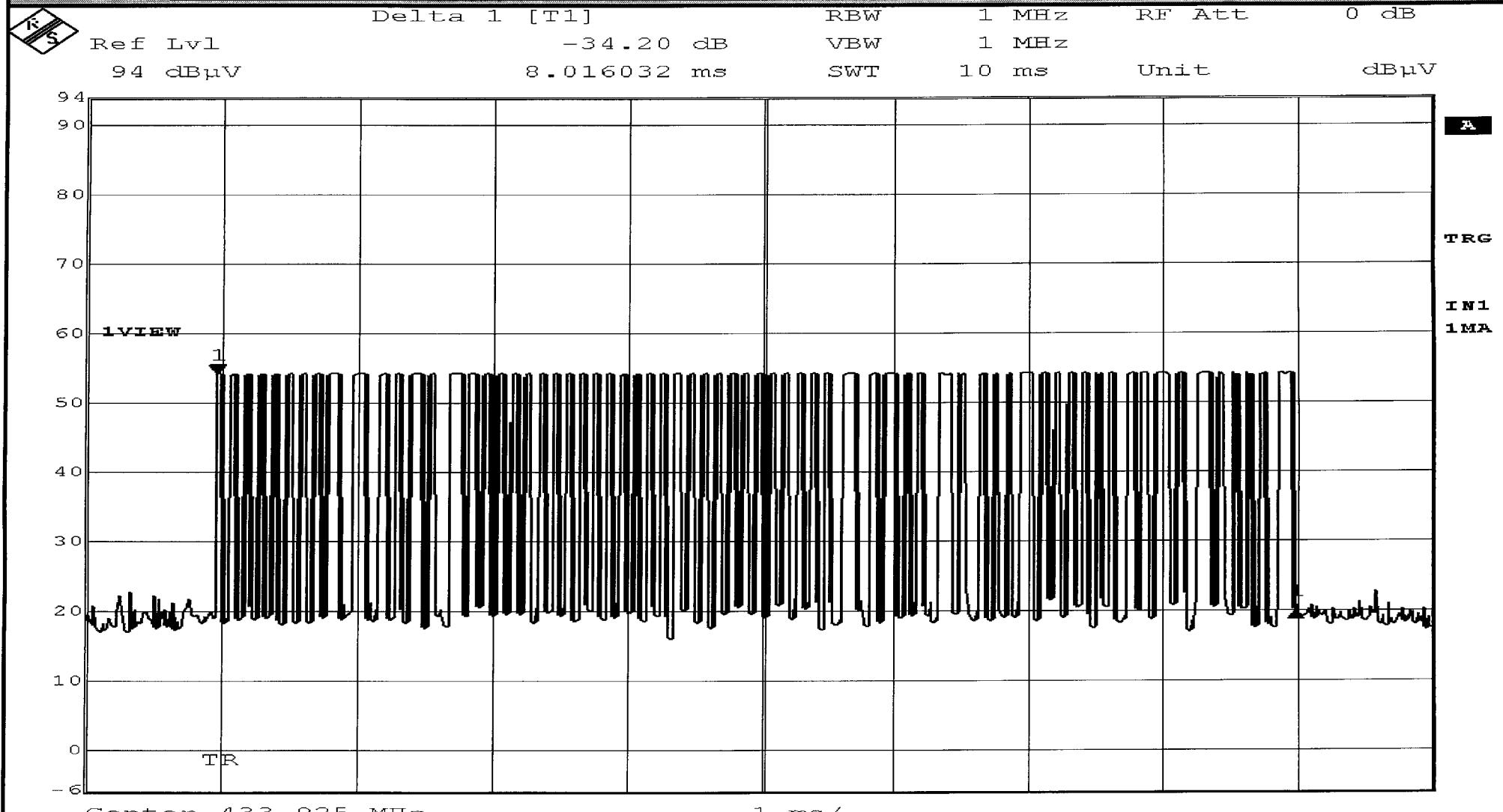
Data Sheet 1 of 5

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# RETLIF TESTING LABORATORIES

## EMISSIONS DATA SHEET

Test Method:	Duty Cycle Plots		
Customer:	Radianse, Inc.	Test Sample:	Transmitter
Model No.:	100A	Serial No.:	n/a
Test Specification:	FCC Part 15 Paragraph: 15.231(e)		
Operating Mode:	Transmitting Data Bursts		
Notes:			



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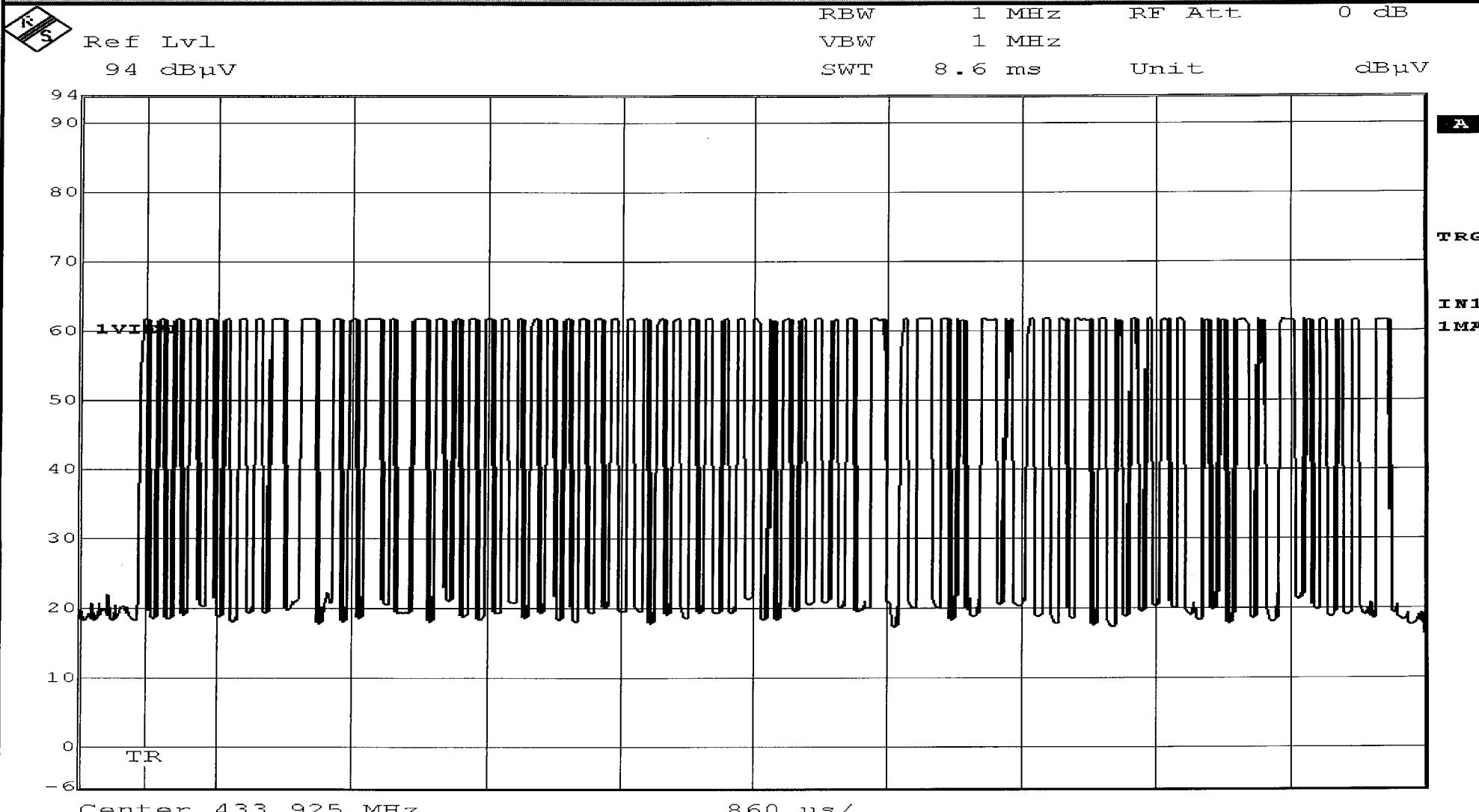
Data Sheet 2 of 5

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# RETLIF TESTING LABORATORIES

## EMISSIONS DATA SHEET

Test Method:	Duty Cycle Plots		
Customer:	Radianse, Inc.	Test Sample:	Transmitter
Model No.:	100A	Serial No.:	n/a
Test Specification:	FCC Part 15 Paragraph: 15.231(e)		
Operating Mode:	Transmitting Data Bursts		
Notes:			



Date: 24.JUL.2003 12:48:28

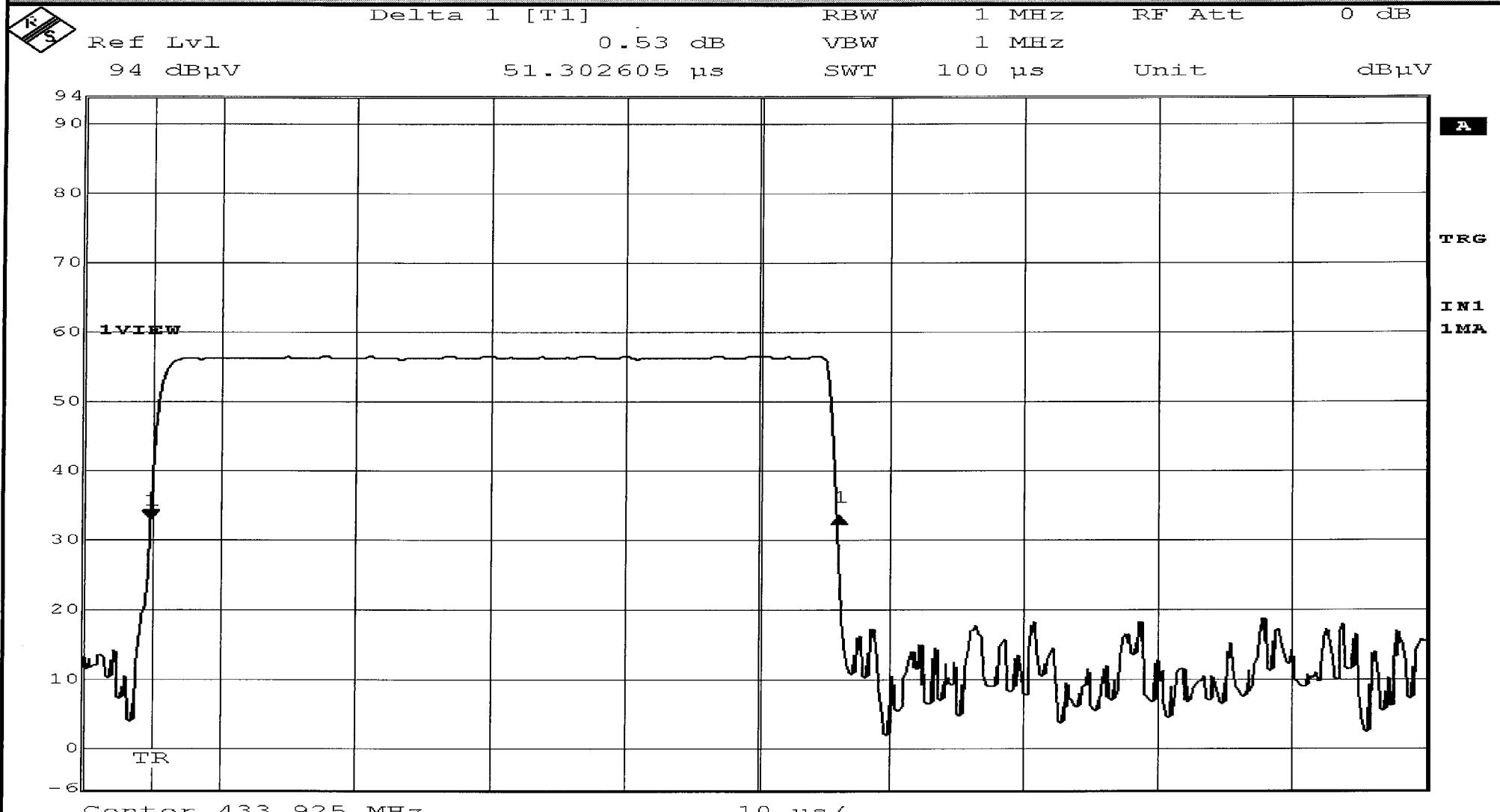
Data Sheet 3 of 5

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# RETLIF TESTING LABORATORIES

## EMISSIONS DATA SHEET

Test Method:	Duty Cycle Plots		
Customer:	Radianse, Inc.	Test Sample:	Transmitter
Model No.:	100A	Serial No.:	n/a
Test Specification:	FCC Part 15 Paragraph: 15.231(e)		
Operating Mode:	Transmitting Data Bursts		
Notes:			



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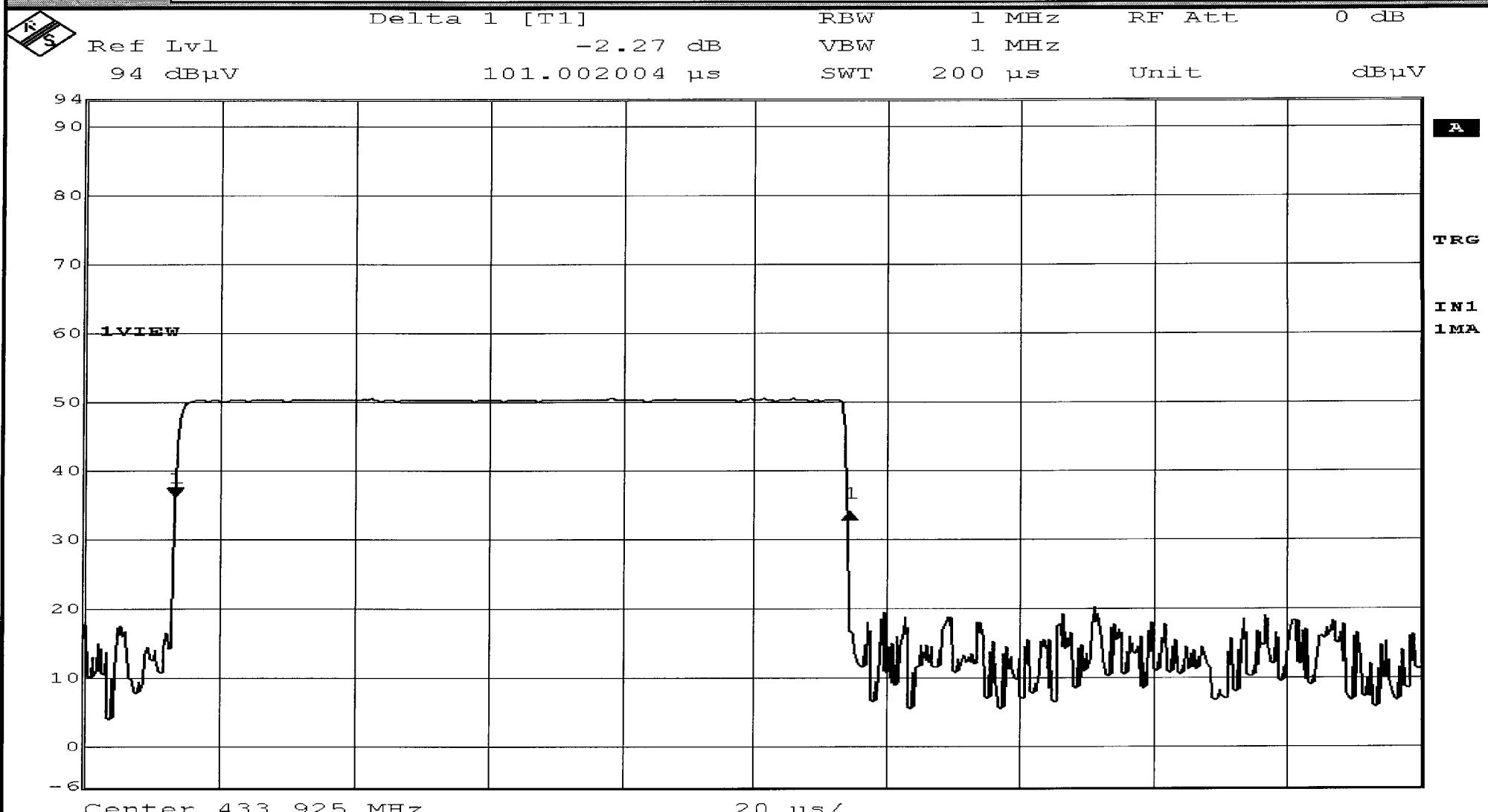
Data Sheet 4 of 5

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# RETLIF TESTING LABORATORIES

## EMISSIONS DATA SHEET

Test Method:	Duty Cycle Plots		
Customer:	Radianse, Inc.	Test Sample:	Transmitter
Model No.:	100A	Serial No.:	n/a
Test Specification:	FCC Part 15	Paragraph:	15.231(e)
Operating Mode:	Transmitting Data Bursts		
Notes:			



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Data Sheet 5 of 5

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# RETLIF TESTING LABORATORIES

## TABULAR DATA SHEET

Test Method:	Fundamental Field Strength & Spurious Emissions 30 MHz - 4.4 GHz									
Customer:	Radianse, Inc.			Job No:	R-4155N					
Test Sample:	Transmitter									
Model No.:	100A			Serial No.:	n/a					
Test Specification:	FCC Part 15 Paragraph: 15.231 (e)									
Operating Mode:	Transmitting Data Bursts									
Technician:	T. Firkowski			<input checked="" type="checkbox"/>	Date:	07/31/2003				
Notes:										
Transmit Frequency	Test Frequency	Antenna/EUT Position	Meter Reading	Correction Factor	Duty Cycle Correction	Corrected Reading			Converted Reading	Limit at 3 Meters
MHz	MHz	Polarization/Axis	dBuV	dB	dB	dBuV/m			uV/m	uVm
433.92	30.00	-	-	-	-	-			-	439.88
		-	-	-	-	-			-	
		-	-	-	-	-			-	
		-	-	-	-	-			-	439.88
	433.92	V/X	51.62	26.22	-5.85	71.99			3976.04	4398.76
		-	-	-	-	-			-	439.88
		-	-	-	-	-			-	
	867.84	-	-	-	-	-			-	
	1301.76	V/Z	27.76	25.23	-5.85	47.14			227.63	
	1735.68	-	-	-	-	-			-	
	2169.60	-	-	-	-	-			-	
	2603.52	-	-	-	-	-			-	
	3037.44	-	-	-	-	-			-	
	3471.36	-	-	-	-	-			-	
	3905.28	-	-	-	-	-			-	
	4339.20	-	-	-	-	-			-	
		-	-	-	-	-			-	
		-	-	-	-	-			-	
		-	-	-	-	-			-	
433.92	4400.00	-	-	-	-	-			-	439.88
EUT emissions observed throughout the given frequency spectrum were recorded and evaluated. Emission levels closest to the limit are listed on this data sheet.										

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# RETLIF TESTING LABORATORIES

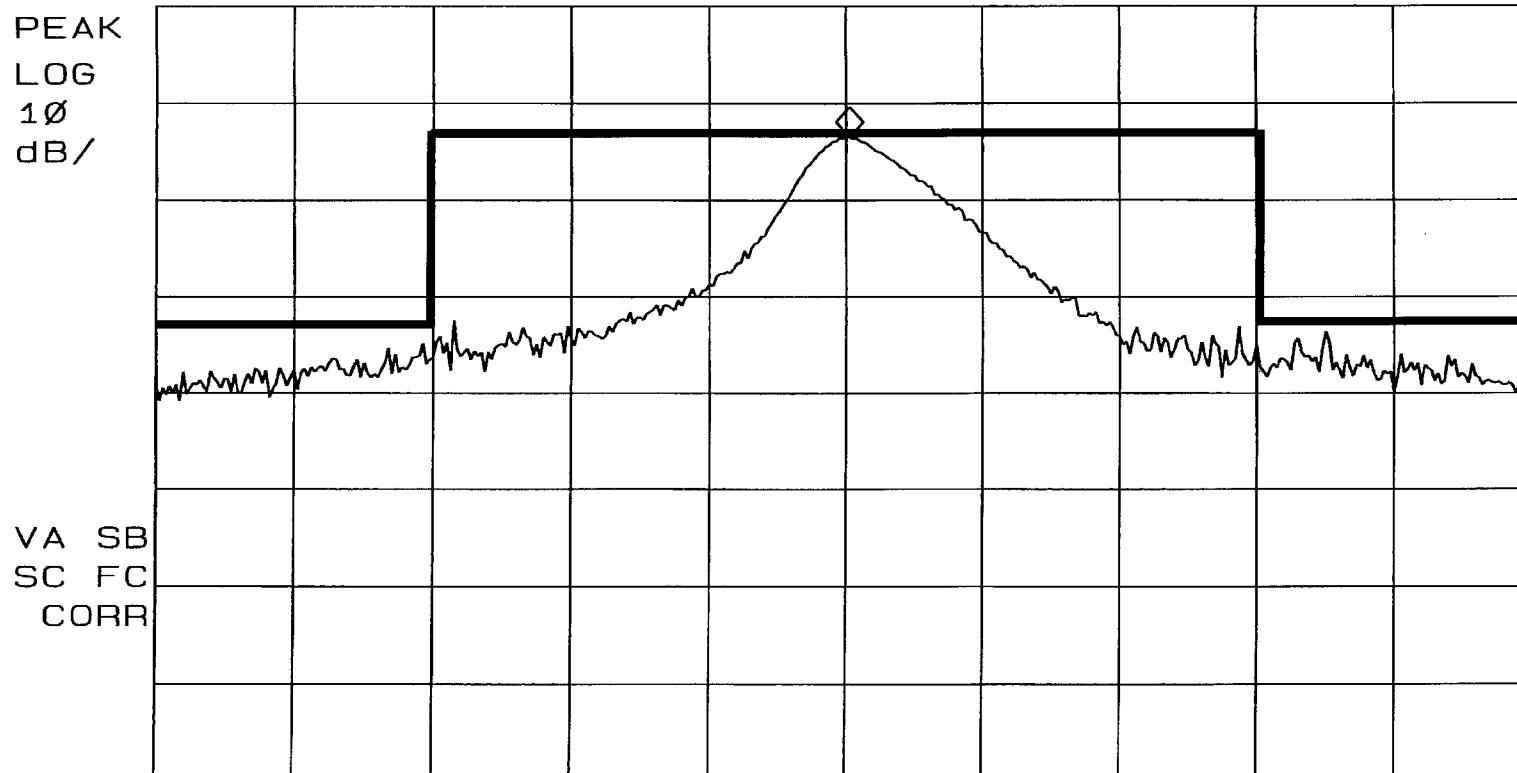
## EMISSIONS DATA SHEET

Test Method:	Occupied Bandwidth		
Customer:	Radianse, Inc.	Test Sample:	Transmitter
Model No.:	100A	Serial No.:	n/a
Test Specification:	FCC Part 15		
Operating Mode:	Transmitting Data Bursts		
Notes:			

12: 55: 53 JUL 31, 2003

REF 87.Ø dB  $\mu$ V #AT Ø dB

MKR 433.925 MHz  
73.45 dB  $\mu$ V



CENTER 433.92Ø MHz  
#RES BW 1ØØ kHz

VBW 3ØØ kHz

SPAN 1.8ØØ MHz  
SWP 2Ø.Ø msec