

ELITE ELECTRONIC ENGINEERING INC.
1516 CENTRE CIRCLE
DOWNERS GROVE, ILLINOIS 60515-1082

ELITE PROJECT: 31552 DATES TESTED: October 14 and 18, 2002

TEST PERSONNEL: Richard E. King

TEST SPECIFICATION: FCC "Code of Federal Regulations" Title 47 Part
15, Subpart C, Section 15.247 for Frequency
Hopping Spread Spectrum Intentional Radiators
Operating within the 902MHz - 928MHz band

ENGINEERING TEST REPORT NO. 31552-01

MEASUREMENTS OF RF EMISSIONS

FROM THE RF KEYPAD TRANSMITTER

FOR: Badger Meter
Milwaukee, Wisconsin

PURCHASE ORDER NO.: 527402

Report By:

Richard E. King
Richard E. King

Approved By:

Raymond J. Klonda
Raymond J. Klonda
Registered Professional
Engineer of Illinois - 44894

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Frequency Hopping Spread Spectrum
Transmitter

MODEL NO. : RF Keypad Transmitter SERIAL NO.: None Assigned

FCC ID NO. :

MANUFACTURER: Badger Meter

APPLICABLE

SPECIFICATION: FCC "Code of Federal Regulations", Title 47, Part 15,
Subpart C, Sec. 15.247

TEST PERFORMED BY: ELITE ELECTRONIC ENGINEERING INC.
Downers Grove, Illinois 60515

DATES TESTED: October 14 and 18, 2002

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):

WITNESS: No Badger Meter personnel were present during the
testing.

ELITE ELECTRONIC: Richard E. King

ELITE JOB NO.: 31552

ABSTRACT: The model RF Keypad Transmitter meets the requirements of
the FCC "Code of Federal Regulations", Title 47, Part 15, Subpart C,
Section 15.247 for frequency hopping spread spectrum transmitters. The
carrier frequency separation, number of hopping frequencies, time of
occupancy (dwell time), 20 dB bandwidth, peak output power, band-edge
compliance, spurious emissions and power spectral density were
measured and found to comply with the requirements.

See the test results and data pages for more details.

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MEASUREMENT OF RF EMISSIONS
FROM A HAND-HELD TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: This report presents the results of the RF emissions measurements performed for the model RF Keypad spread spectrum transmitter, (hereinafter referred to as the test item). The tests were performed for Badger Meter located in Milwaukee, Wisconsin.

The test item is a frequency hopping spread spectrum transceiver used for wireless meter reading applications. It operates in the frequency band 902 to 928MHz.

1.2 PURPOSE: The test series was performed to determine if the test item would meet the selected requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for intentional radiators.

1.3 DEVIATIONS, ADDITIONS AND EXCLUSIONS: There were no deviations from the test requirements.

1.4 APPLICABLE DOCUMENTS: The following documents of the exact issue designated form part of this document to the extent specified herein:

Federal Communications Commission (FCC) "Code of Federal Regulations", Title 47, Part 15, dated 1 October 2001

FCC Public Notice, DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems", Released March 30, 2000

1.5 SUBCONTRACTOR IDENTIFICATION: This series of tests was performed by the Elite Electronic Engineering Inc., of Downers Grove,

Illinois.

2.0 TEST ITEM SETUP AND OPERATION:

For all tests the test item was placed on a 0.8 meter high non-conductive table. The 6VDC was supplied to the test item from a 6VDC power supply . The test item is supplied with an external antenna. The test item was directly connected to the spectrum analyzer for Power Line Conducted Emissions, Carrier Frequency Separation, Number of Hopping Frequencies, Time of Occupancy (Dwell Time), 20 dB Bandwidth, Peak Output Power and Band-edge Compliance tests. The spurious radiated emissions were performed with the antenna connected to the test item.

3.0 TEST SITE AND INSTRUMENTATION:

3.1 TEST SITE: All tests were performed at Elite's facility in Downers Grove, Illinois. All tests were performed in a hybrid anechoic/ferrite tile shielded enclosure.

3.2 TEST INSTRUMENTATION: A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 POWERLINE CONDUCTED EMISSIONS:

4.1.1 REQUIREMENTS: All radio frequency voltages on the power lines of a Class B device shall be below 250uV (quasi-peak) over the frequency range from 0.45MHz to 30MHz. It is also to be noted that if emitted levels in the peak detector function do not exceed the above limits, the test item does meet the intent of these requirements.

4.1.2 PROCEDURES: The interference on each power lead was measured by connecting the measuring equipment to the appropriate meter terminal of the LISN. The meter terminal of the LISN not under test was terminated with 50 ohms. Measurements were first made over the entire frequency range from 450kHz through 30MHz with a peak detector and the results were automatically plotted. The data thus obtained was then searched by the computer for the highest levels. Quasi-peak measurements were automatically performed at the frequencies selected from the highest peak measurements, and the results printed.

4.1.3 RESULTS: The plots of the peak preliminary conducted voltage levels on each power line are presented on data pages 19 and 20. The conducted limit for the Class B category is shown as a reference. The final quasi-peak results are presented on data pages 21 and 22.

4.2 CARRIER FREQUENCY SEPARATION:

4.2.1 REQUIREMENTS: Per section 15.247 (a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

4.2.2 PROCEDURES: The test item was setup inside the chamber. The output of the test item was connected to the spectrum analyzer through a 20dB pad. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to $\geq$ to 1% of the span.

The peak detector and 'Max-Hold' function was engaged. The span was set wide enough to capture the peaks of at least two adjacent channels. When the trace had stabilized after multiple scans. The marker-delta function was used to determine the separation between the peaks of the adjacent channels. The analyzer's display was plotted using a 'screen dump' utility.

4.2.3 RESULTS: Data page 23 shows the carrier frequency separation. As can be seen from this plot, the separation is 201kHz which is greater than the 20dB bandwidth (116kHz).

4.3 NUMBER OF HOPPING FREQUENCIES:

4.3.1 REQUIREMENTS: Per section 15.247(a)(1)(i), frequency hopping systems shall use at least 50 hopping frequencies.

4.3.2 PROCEDURE: The test item was setup inside the chamber. The output of the test item was connected to the spectrum analyzer through a 20dB pad. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to $\geq$ to 1% of the span. The peak detector and 'Max-Hold' function was engaged. The span was set wide enough to capture the entire frequency band of operation.

When the trace had stabilized after multiple scans. The number of hopping frequencies was counted. The analyzer's display was plotted using a 'screen dump' utility.

4.3.3 RESULTS: Data page 24 shows the number of hopping frequencies. As can be seen from this plot, the number of frequencies is 67 which is greater than the minimum required of 50.

4.4 TIME OF OCCUPANCY (DWELL TIME):

4.4.1 REQUIREMENTS: Per section 15.247(a)(1)(i), the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

4.4.2 PROCEDURE: The test item was setup inside the chamber. The output of the test item was connected to the spectrum analyzer through a 20dB pad. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to 1 MHz. The peak detector and 'Max-Hold' function was engaged. With the span set to 0Hz, the sweep time was adjusted to capture a single event in order to measure the dwell time per hop. Then, the sweep time was expanded to capture the average time between hops. When the trace had stabilized after multiple scans, the time between hops was measured. The analyzer's display was plotted using a 'screen dump' utility.

The dwell time in a 10 second period was then calculated from dwell time per hop divided by time between hops then multiplied by 10 seconds. The dwell time in a 10 second period was then divided by the number of frequency hopping channels to give the dwell time of a single frequency hopping channel.

4.4.3 RESULTS: Data pages 25 and 26 show the plots for the time of occupancy (dwell time). As can be seen from the plots, the time of occupancy can be determined by a 4.6 msec burst every 333.5 msec in a 10 Second period divided by the number of the hopping frequencies. This calculated value is equal to 0.14 seconds which is less than the 0.4 seconds allowed.

4.5 20 dB BANDWIDTH:

4.5.1 REQUIREMENTS: Per section 15.247(a)(1)(i), the maximum 20dB bandwidth of the hopping channel is 500kHz.

4.5.2 PROCEDURE: The test item was setup inside the chamber. The output of the test item was connected to the spectrum analyzer through a 20dB pad. With the hopping function disabled, the test item was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to $\geq$ to 1% of the 20 dB BW.

The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility.

4.5.3 RESULTS: The plots on pages 27 through 29 show that the maximum 20 dB bandwidth was 116kHz. The 20 dB bandwidth was less than the 500kHz maximum requirement.

4.6 PEAK OUTPUT POWER:

4.6.1 REQUIREMENTS: This requirement applies only to the transmit mode of operation. Per section 15.247(b)(2) the maximum peak output power of the transmitter shall not exceed 1 Watt. If transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

4.6.2 PROCEDURES: The output of the test item was connected to the power meter through a 20dB pad. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high hopping frequencies.

4.6.3 RESULTS: The results are presented on data page 30. The maximum peak power output was measured from the transmitter was 10.2dBm. Therefore, the transmitter meets the 30dBm limit.

4.7 BAND-EDGE COMPLIANCE:

4.7.1 REQUIREMENTS: Per section 15.247(c), the emissions at the band-edges must be at least 20dB below the highest level measured within the band. In addition, any radiated emissions which fall in restricted bands must meet the general limits of 15.209

4.7.2 PROCEDURE: The same data recorded for the low and high hopping frequencies from the 20 dB bandwidth measurements was used to demonstrate compliance with the 20 dB band-edge requirements.

For the radiated emissions which fall in the restricted band the "marker-delta" method described in Public Notice DA 00-705 was used. Initially radiated measurements were performed at the fundamentals of the highest hopping frequencies using 1 MHz bandwidth. For the measurements the "delta" required to meet the general limit was calculated.

Next, the band-edge emissions were plotted using peak detector and 100 kHz bandwidth. The "delta" limit was applied to this plot to determine compliance at the band-edge.

4.7.3 RESULTS: Data pages 31 through 34 show the band-edge compliance results using the marker-delta method. As can be seen from this plot, the emissions at the band-edge in the restricted band are within the general limits.

4.8 ANTENNA CONDUCTED EMISSIONS:

4.8.1 REQUIREMENTS: Per section 15.247(c), the spurious

emissions in any 100 kHz BW outside the frequency band must be at least 20dB below the highest 100 kHz BW level measured within the band.

4.8.2 PROCEDURES: The measuring equipment was connected to the test item's antenna port. The emissions in the frequency range from 30MHz to 10GHz were observed and plotted separately with the test item transmitting at 908.8MHz, 915.0MHz, and 921.4MHz.

4.8.3 RESULTS: The results of the antenna conducted emissions levels were plotted. These plots are presented on Data Pages 35 through 43. This plot shows that the spurious emissions were at least 20 dB below the level of the fundamental.

4.9 RADIATED SPURIOUS EMISSIONS:

4.9.1 REQUIREMENTS: Per section 15.247(c), the spurious emissions in any 100 kHz BW outside the frequency band must be at least 20dB below the highest 100 kHz BW level measured within the band. In addition, the radiated emissions which fall in the restricted bands must meet the general limits of 15.209.

4.9.2 PROCEDURES: Since the test item was supplied with a permanently attached antenna, the spurious emissions compliance was evaluated against the radiated emissions levels for unrestricted bands as well as the restricted bands.

The radiated tests were performed in a 32ft. x 20ft. x 18ft. hybrid absorber lined semi-anechoic test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. The floor of the chamber is used as the ground plane. The chamber complies with ANSI

63.4 and CISPR 16 requirements for site attenuation.

Preliminary radiated measurements are performed to determine the frequencies where the significant emissions might be found. With the test item at one set position and the measurement antenna at a set height (i.e. without maximizing), the radiated emissions were measured using peak detection with 100 kHz BW. This data was then automatically plotted up through 10 Ghz.

Next, the harmonic or spurious emissions falling in the restricted bands were measured up through the 10th harmonic. For these measurements, the measurement bandwidths were set to 1 MHz RBW. The analyzer was set to **linear mode** with 10 Hz VBW in order to simulate an average detector. A pre-amplifier was used to increase the receiver sensitivity.

4.9.3 RESULTS: The preliminary emissions levels were plotted. These plots are presented on Data Pages 44 through 49. The harmonics and any other emissions that fall in the restricted frequency bands were then re-measured manually. This data is shown in the tables on data Pages 50 through 52. Since the dwell time per channel was less than 100mSeconds, the average measurements were further adjusted using a duty cycle correction factor derived from $20\log(\text{dwell time (4.8mSec)}/100\text{mSec})$. The field intensities levels for the harmonics were within the limit.

A block diagram of the test item orientation position is shown in Figure 1.

5.0 CONCLUSION:

The Badger Meter RF Keypad Transmitter does meet the limits imposed by the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for frequency hopping spread spectrum transmitters.

6.0 CERTIFICATION:

Elite Electronic Engineering Inc. certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specification.

The data presented in this test report pertains to the test item at the test date. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

ENGINEERING TEST REPORT NO. 3/552-01

TABLE 1: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC.

Page: 1

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XLJN	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	24	DC-2GHZ	06/12/02	12	06/12/03
XZG3	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2421A03059	---		N/A	
Equipment Type: AMPLIFIERS								
APK1	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A01243	1-26.5GHZ	02/22/02	12	02/22/03
APK3	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01593	1-26.5GHZ	05/09/02	12	05/09/03
Equipment Type: ANTENNAS								
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	01/10/02	12	01/10/03
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	06/25/02	12	06/25/03
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	08/25/02	12	08/25/03
Equipment Type: ATTENUATORS								
T1K1	10DB, 2.5W LIMITER	HEWLETT PACKARD	11947A	3107A01737	0.009-200MHZ	03/15/02	12	03/15/03
T2DC	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BH5448	DC-18GHZ	11/28/01	12	11/28/02
Equipment Type: CONTROLLERS								
CDD2	COMPUTER	HEWLETT PACKARD	D4171A#ABA	US61654645	---		N/A	
Equipment Type: METERS								
MPA0	POWER METER	HEWLETT PACKARD	432A	1141A08696	0.01-40GHZ	06/27/02	12	06/27/03
MPAA	THERMISTOR MOUNT	HEWLETT PACKARD	8478B	1144A08340	0.01-18GHZ	09/04/02	12	09/04/03
Equipment Type: PROBES; CLAMP-ON & LISNS								
PLL9	50UH LISN 462D	ELITE	462D/70A	010	0.01-400MHZ	02/27/02	12	02/27/03
PLLA	50UH LISN 462D	ELITE	462D/70A	011	0.01-400MHZ	02/27/02	12	02/27/03
Equipment Type: PRINTERS AND PLOTTERS								
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USH8061052	---		N/A	
Equipment Type: RECEIVERS								
RAC2	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3638A08770	100HZ-22GHZ	02/21/02	12	02/21/03

Cal. Interval: Listed in Months I/O: Initial Only N/A: Not Applicable

Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

14 0652

ENGINEERING TEST REPORT NO. 31552-01

TABLE 1: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC.

Page: 2

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
RACC	RF PRESELECTOR	HEWLETT PACKARD	85685A	2648A00507	20HZ-2GHZ	01/17/02	12	01/17/03
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	02/21/02	12	02/21/03
RAE5	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2532A02136	100HZ-22GHZ	05/09/02	12	05/09/03
RAF4	QUASIPeAK ADAPTER	HEWLETT PACKARD	85650A	2043A00320	0.01-1000MHZ	06/13/02	12	06/13/03
RAKG	RF SECTION	HEWLETT PACKARD	85462A	3549A00284	0.009-6500MHZ	02/18/02	12	02/18/03
RAKH	RF FILTER SECTION	HEWLETT PACKARD	85460A	3448A00324	---	02/18/02	12	02/18/03

Cal. Interval: Listed in Months I/O: Initial Only N/A: Not Applicable

Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

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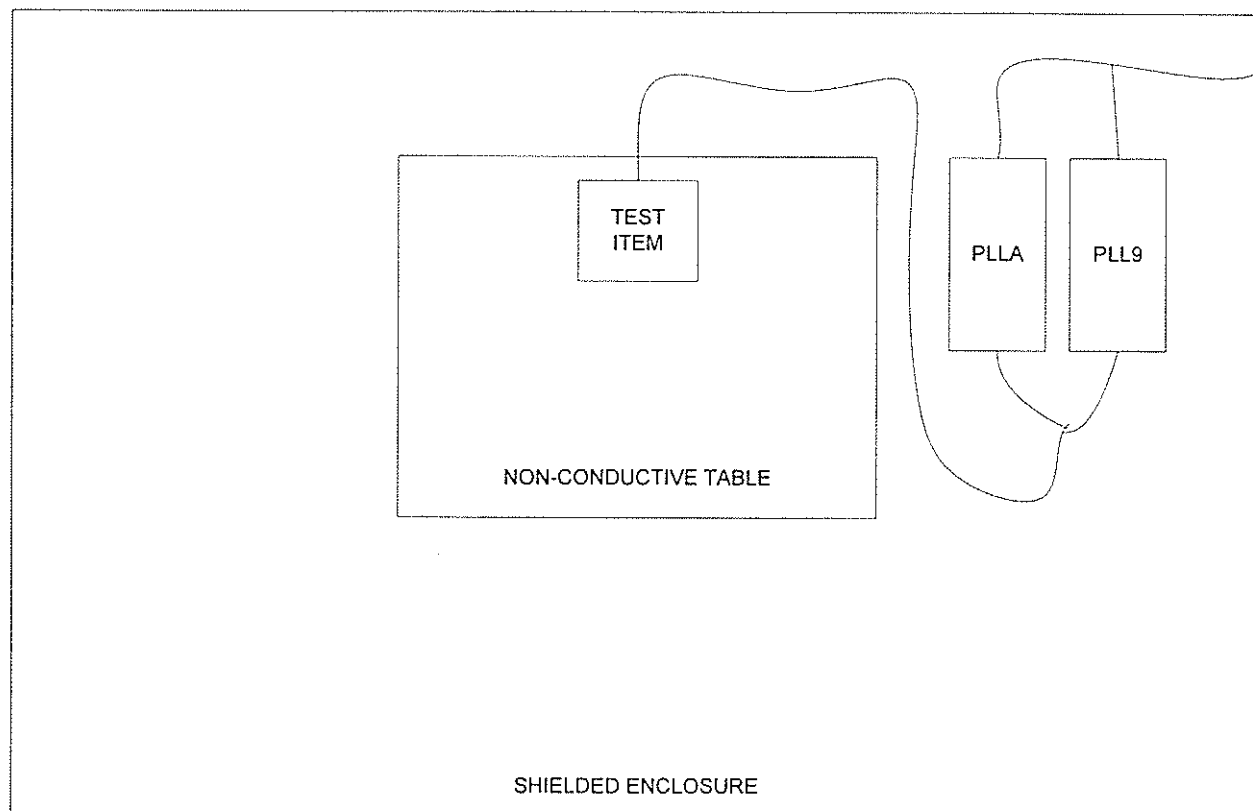
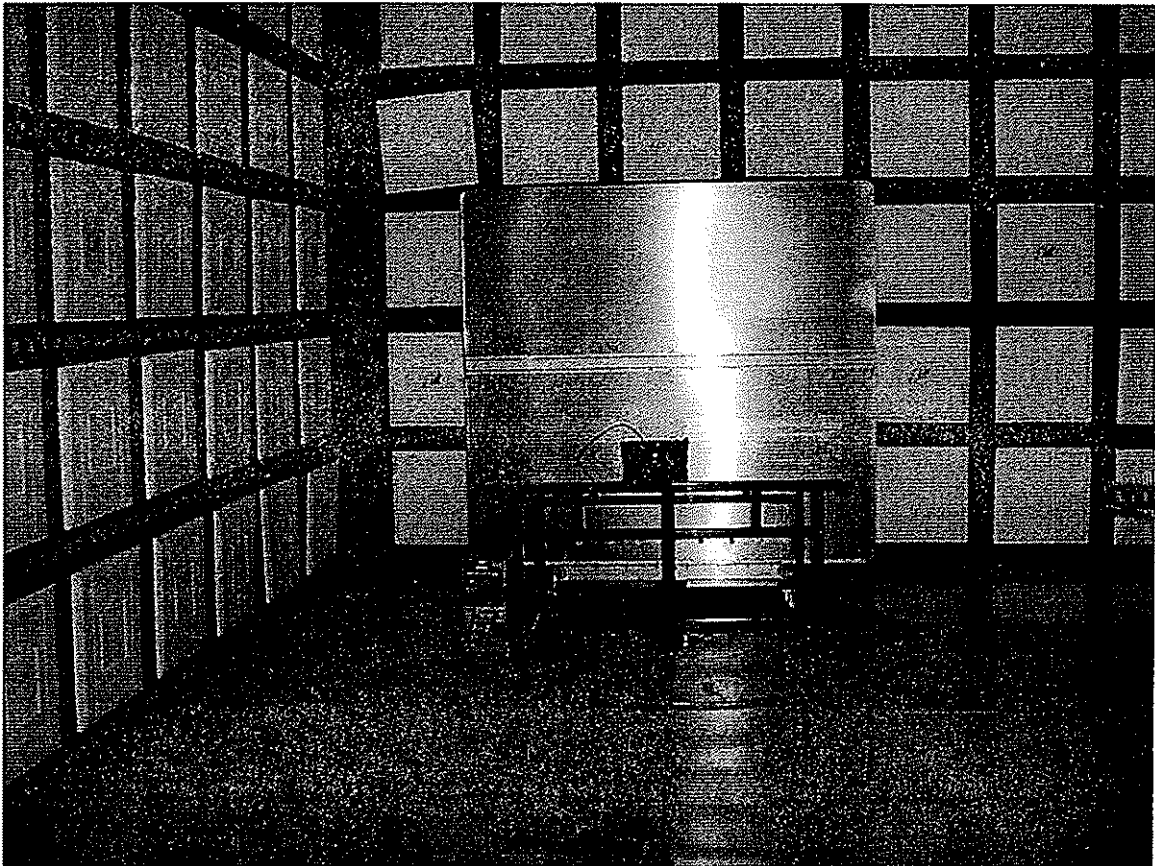
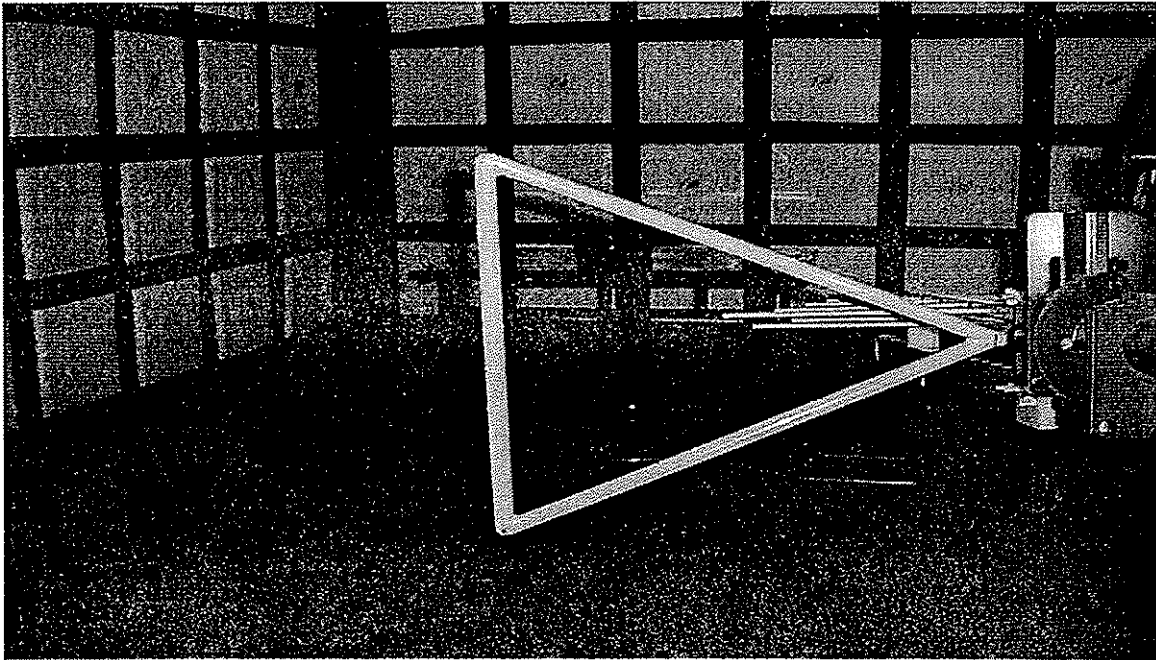
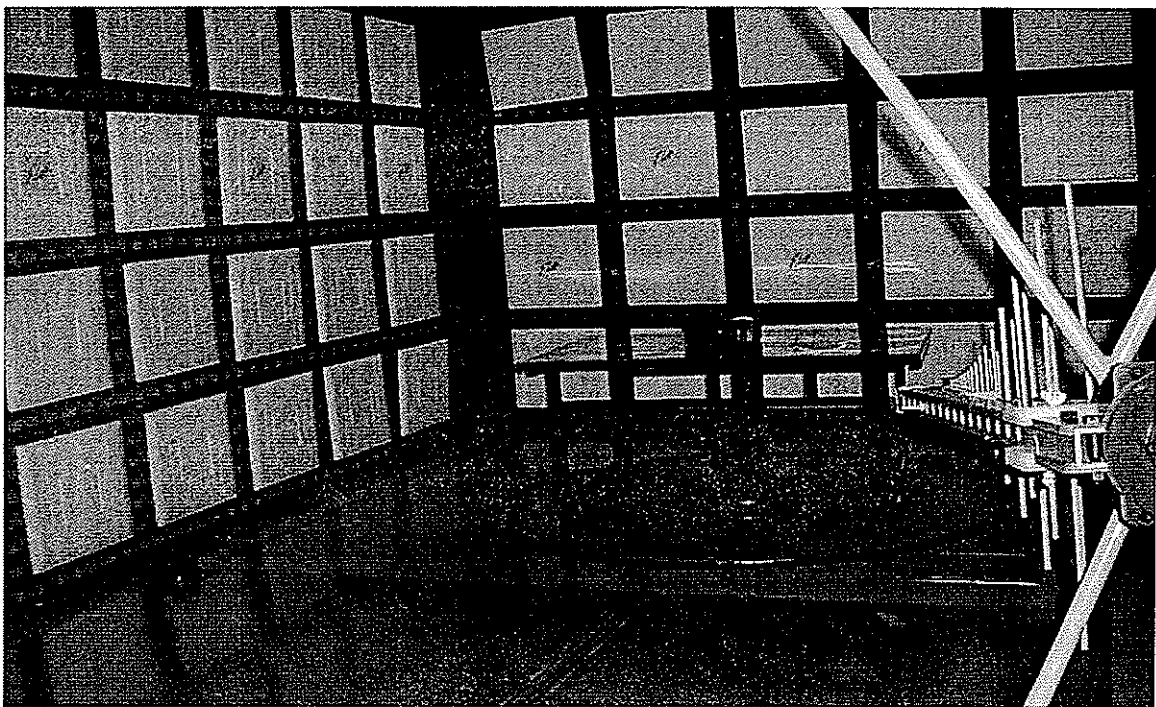


FIGURE 1





Radiated Emissions Worst Case Horizontal Polarization



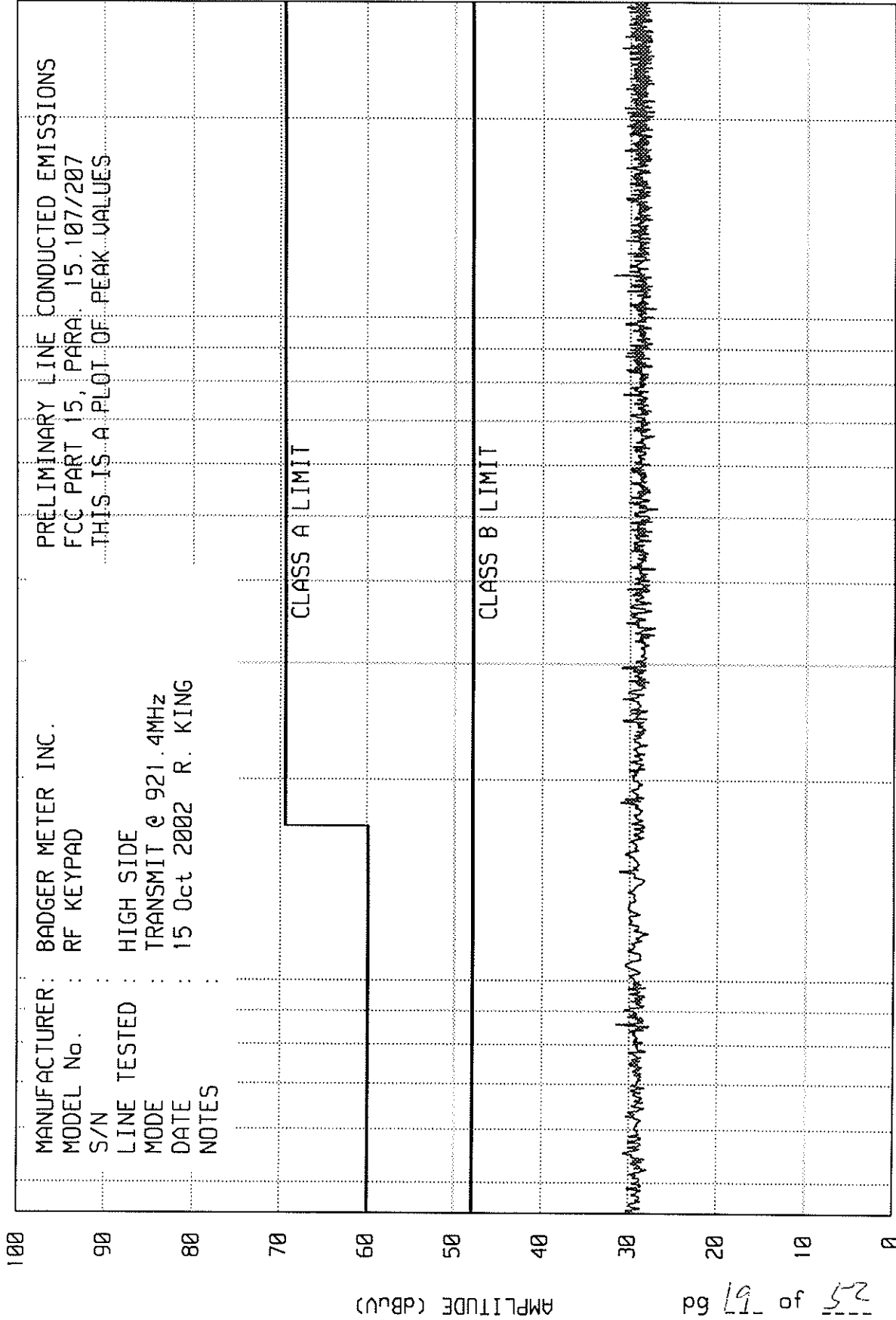
Radiated Emissions Worst Case Vertical Polarization

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

FCC15 CE RUN 6

WEAB 07/15/02



START = .45

FREQUENCY - MHz

10

STOP = 30

ELITE ELECTRONIC ENGINEERING Inc.

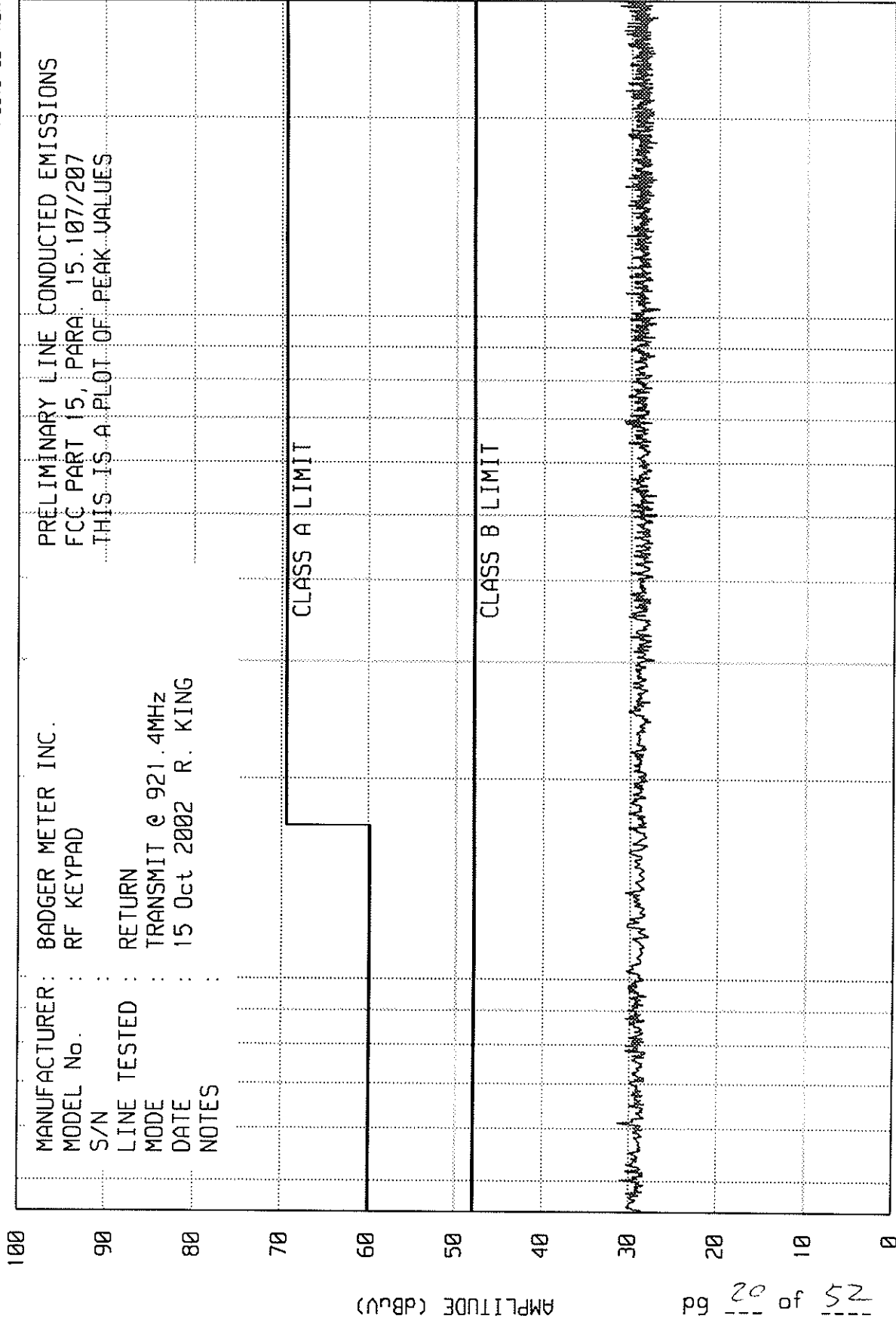
Downers Grove, Ill. 60515

FCC15 CE RUN 5

WEA0 07/15/02

MANUFACTURER: BADGER METER INC.
MODEL No. : RF KEYPAD
S/N :
LINE TESTED : RETURN
MODE : TRANSMIT @ 921.4MHz
DATE : 15 Oct 2002 R. KING
NOTES :

PRELIMINARY LINE CONDUCTED EMISSIONS
FCC PART 15, PARA. 15.107/207
THIS IS A PLOT OF PEAK VALUES



AMPLITUDE (dBu)

25 of 52
pg 02

START = .45

1

FREQUENCY - MHz

10

STOP = 30

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
S/N :
SPECIFICATION : FCC DIGITAL EQUIPMENT, CLASS B
TEST : LINE CONDUCTED EMISSIONS
LINE TESTED : HIGH SIDE
MODE : TRANSMIT @ 921.4MHz
DATE : 15 Oct 2002
NOTES :
RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. uV	LIMIT uV
.549	18.1	250
.638	18.4	250
.849	18.1	250
1.451	18.1	250
1.830	18.1	250
2.952	18.1	250
3.086	18.1	250
3.429	18.1	250
4.426	18.1	250
5.246	18.1	250
7.119	18.1	250
7.685	18.4	250
8.791	18.4	250
11.569	18.1	250
13.143	18.4	250
13.813	18.1	250
15.237	18.4	250
17.908	18.1	250
19.495	18.4	250
19.801	18.1	250
20.736	18.1	250
22.117	18.1	250
24.623	18.1	250
25.538	18.4	250
27.711	18.1	250
29.493	25.8	250

MANUFACTURER : BADGER METER INC.
 MODEL : RF KEYPAD
 S/N :
 SPECIFICATION : FCC DIGITAL EQUIPMENT, CLASS B
 TEST : LINE CONDUCTED EMISSIONS
 LINE TESTED : RETURN
 MODE : TRANSMIT @ 921.4MHz
 DATE : 15 Oct 2002
 NOTES :
 RECEIVER : HP 8566 w/ HP85650A QP ADAPTOR
 VALUES MEASURED WITH QP DETECTOR USING 9kHz BANDWIDTH

FREQUENCY MHz	METER RDG. uV	LIMIT uV
.601	18.4	250
.778	18.6	250
.878	18.6	250
1.332	18.4	250
1.683	18.4	250
2.518	18.1	250
2.942	18.1	250
3.487	18.1	250
4.108	18.4	250
4.306	18.4	250
5.055	18.1	250
6.950	18.6	250
7.569	18.4	250
9.885	18.4	250
9.956	18.4	250
10.743	18.4	250
10.844	18.4	250
13.213	18.4	250
14.708	18.4	250
15.776	18.4	250
17.270	18.4	250
18.946	18.4	250
19.422	18.1	250
21.573	18.4	250
22.005	18.4	250
22.276	18.4	250
24.003	20.1	250
25.895	18.4	250
27.095	18.6	250
29.493	27.1	250

ELITE ELECTRONIC ENGINEERING Inc.

MKR ^ 198 kHz
0.20 dB

hp

REF 137.0 dBuV ATTN 30 dB + 20 dB Exr

10 dB/

OFFSET

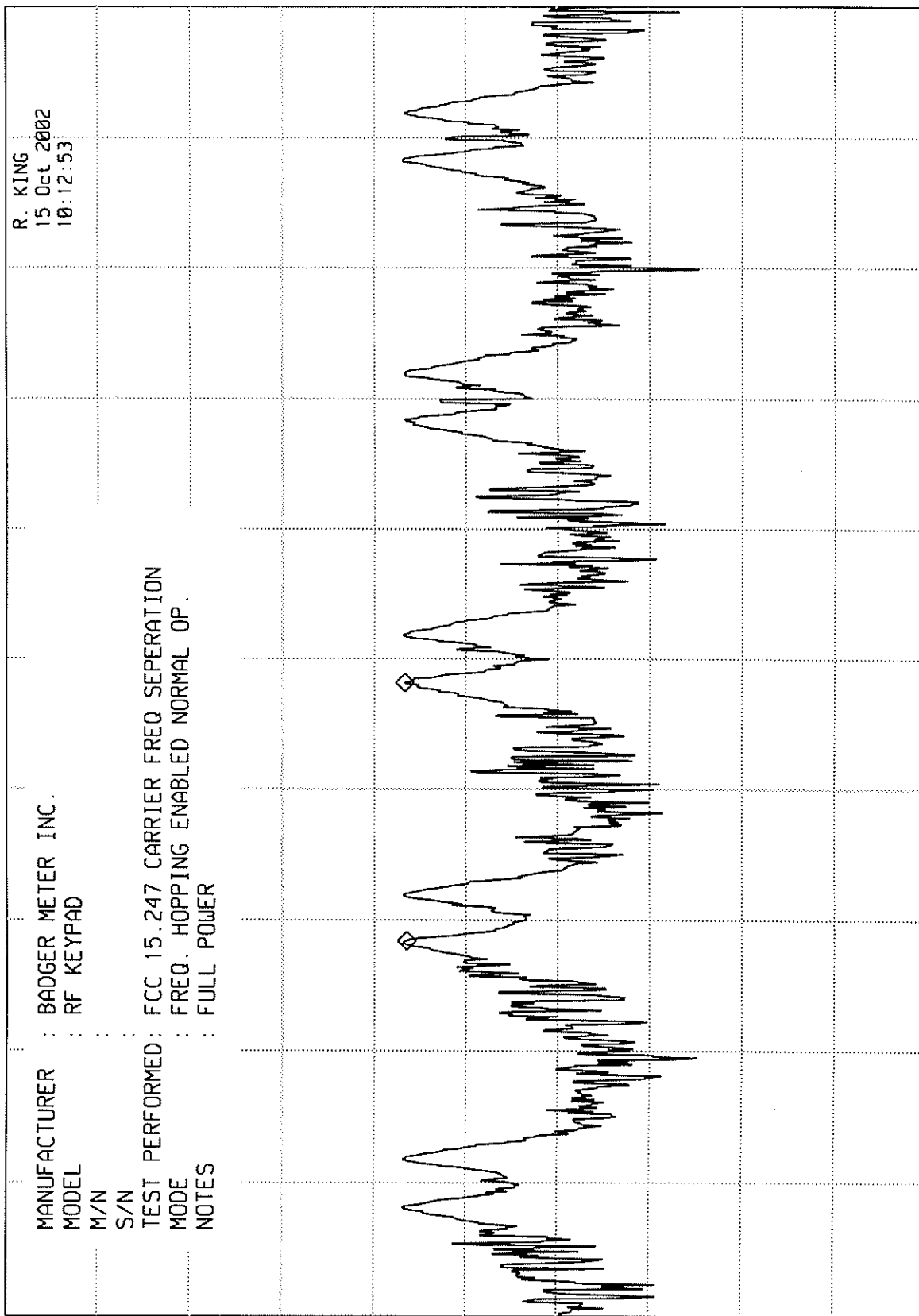
10.0

dB

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
M/N :
S/N :

TEST PERFORMED: FCC 15.247 CARRIER FREQ SEPERATION
MODE : FREQ. HOPPING ENABLED NORMAL OP.
NOTES : FULL POWER

R. KING
15 Oct 2002
10:12:53



ETD 3552-01

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CENTER 915.00 MHz

RES BW 10 kHz(i)

VBW 100 kHz

SPAN 1.00 MHz
SWP 75.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 908.76 MHz
94.20 dBuV

REF 137.0 dBuV ATTEN 40 dB + 20 dB EXT

hp

10 dB/

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
M/N :
S/N :

TEST PERFORMED : FCC 15.247 NUMBER OF HOP FREQ.
MODE : FREQ. HOPPING ENABLED NORMAL OP.
NOTES : FULL POWER

R. KING
15 Oct 2002
09:55:57

ETR 31552-01

of Channels = 67

START 902.0 MHz
RES BW 300 kHz (1)
UBW 3 MHz
STOP 928.0 MHz
SWP 20.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR ^ 4.640 msec

-16.70 dB

hp

REF 127.0 dBuV

ATTEN 30 dB+20dB EXY

10 dB/

MANUFACTURER : BADGER METER INC.

MODEL : RF KEYPAD

M/N :

S/N :

TEST PERFORMED : FCC 15.247 DWELL TIME

MODE : FREQ. HOPPING ENABLED NORMAL OP.

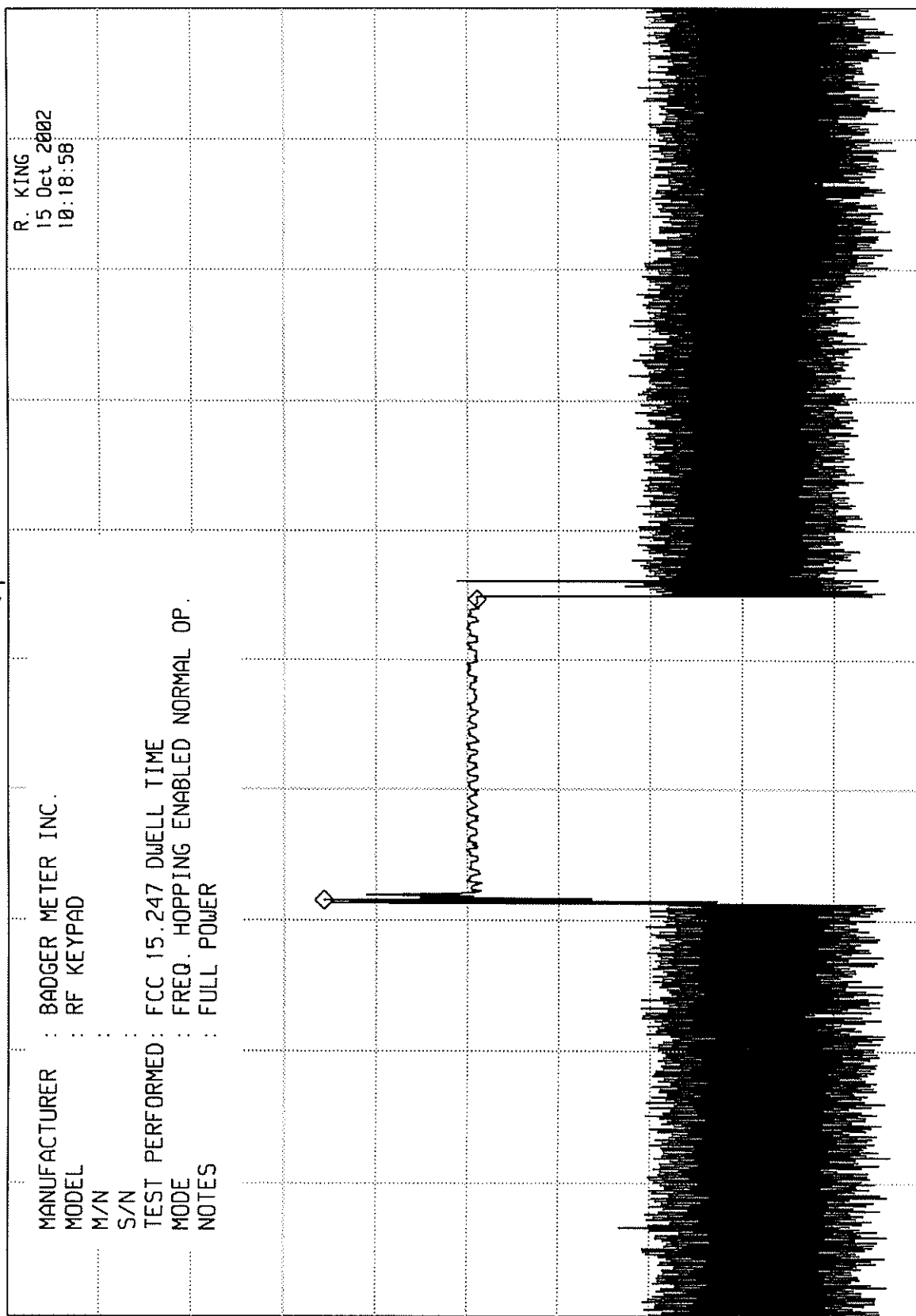
NOTES : FULL POWER

R. KING

15 Oct 2002

10:18:58

ETR 31552-01



CENTER 915.000 000 MHz

RES BW 1 MHz (1)

VBW 3 MHz

SPAN 0 Hz

SWP 20.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR ^ 333.5 msec
-0.90 dB

hp

REF -20.0 dBm

ATTEN 10 dB

10 dB/

OFFSET

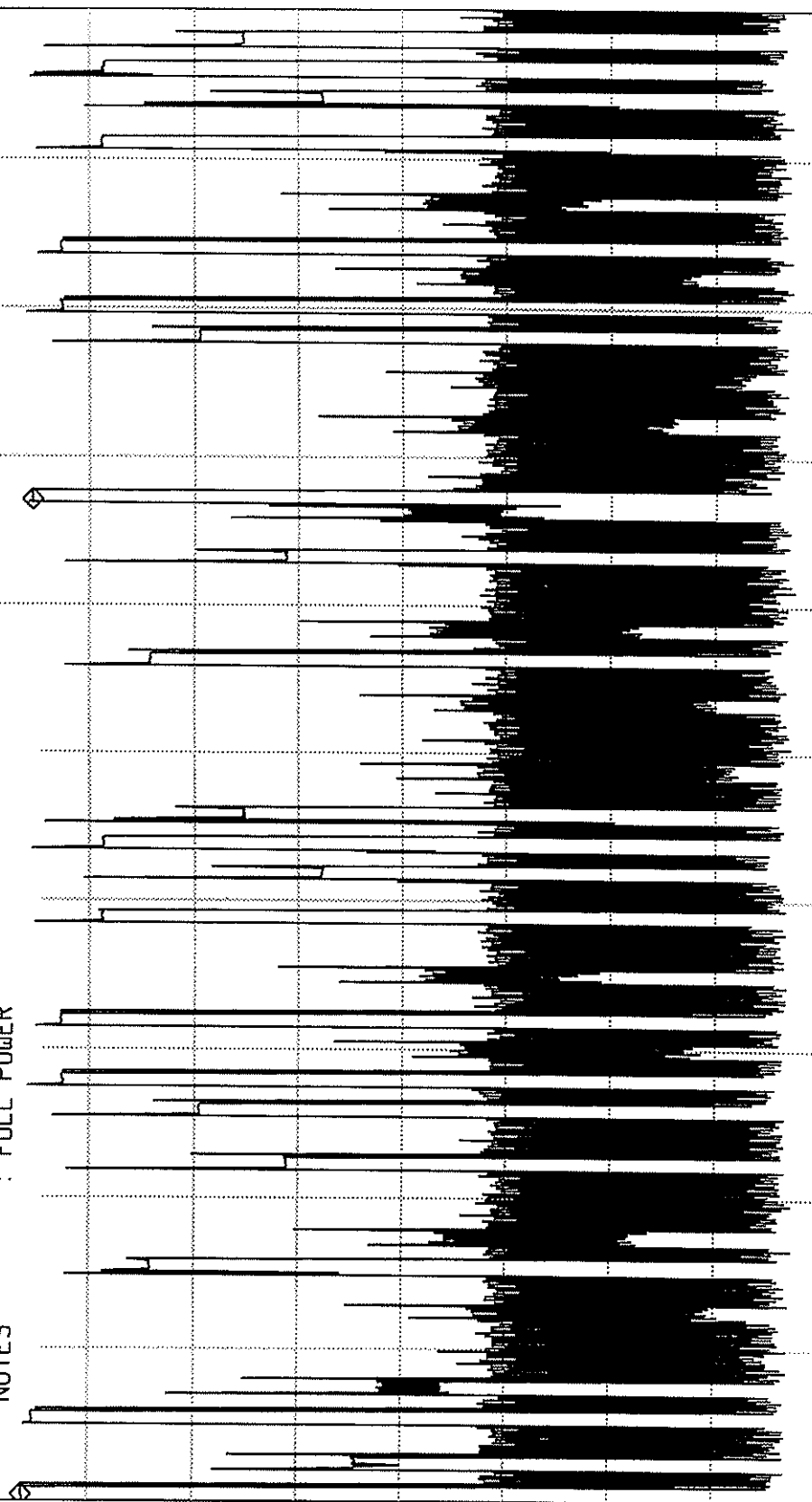
-20.0

dB

MANUFACTURER : BADGER METER INC.
MODEL : HAND-HELD TRANSMITTER / RF KEYPAD
M/N : RF EPM
S/N :

TEST PERFORMED : FCC 15.247 DWELL TIME
MODE : FREQ. HOPPING ENABLED NORMAL OP.
NOTES : FULL POWER

R. KING
9 Oct 2002
13:31:41



CENTER 909.360 000 MHz

RES BW 1 MHz (i)

VBW 3 MHz

SPAN 0 Hz

SUP 500 msec

ETR 31552-01

ELITE ELECTRONIC ENGINEERING INC.

MKR ^ 346 kHz
-0.20 dB

REF 107.0 dBuV ATTN 10 dB + 20 dB Ext

hp

10 dB/

MANUFACTURER

MODEL

M/N

S/N

TEST PERFORMED:

MODE

NOTES

: BADGER METER INC.

: RF KEYPAD

:

:

FCC 15.247 20dB BANDWIDTH

: TRANSMIT @ 908.8MHz

: DELTA MARKER METHOD

R. KING

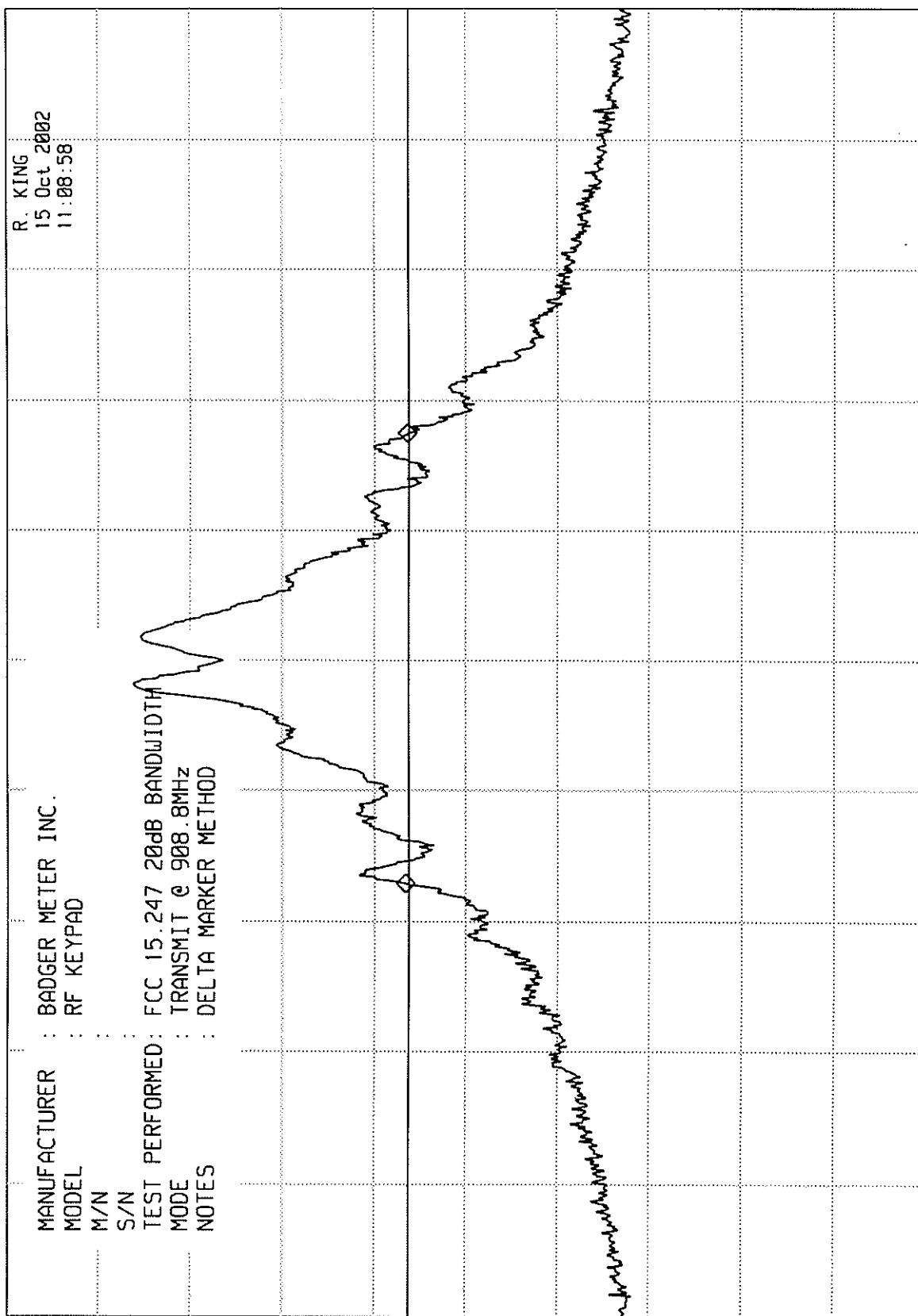
15 Oct 2002

11:08:58

DL

63.2
dBuV

ETR 31552-01



CENTER 908.80 MHz

RES BW 10 kHz(i)

VBW 100 kHz

SPAN 1.00 MHz

SWP 75.0 msec

ELITE ELECTRONIC ENGINEERING INC.

MR ^ 299 kHz
0.40 dB

hp

REF 107.0 dBuV

ATTEN 10 dB + 20 dB EXT

10 dB/

MANUFACTURER

: BADGER METER INC.

MODEL

: RF KEYPAD

M/N

S/N

TEST PERFORMED: FCC 15.247 20dB BANDWIDTH

MODE : TRANSMIT @ 915.0MHz

NOTES

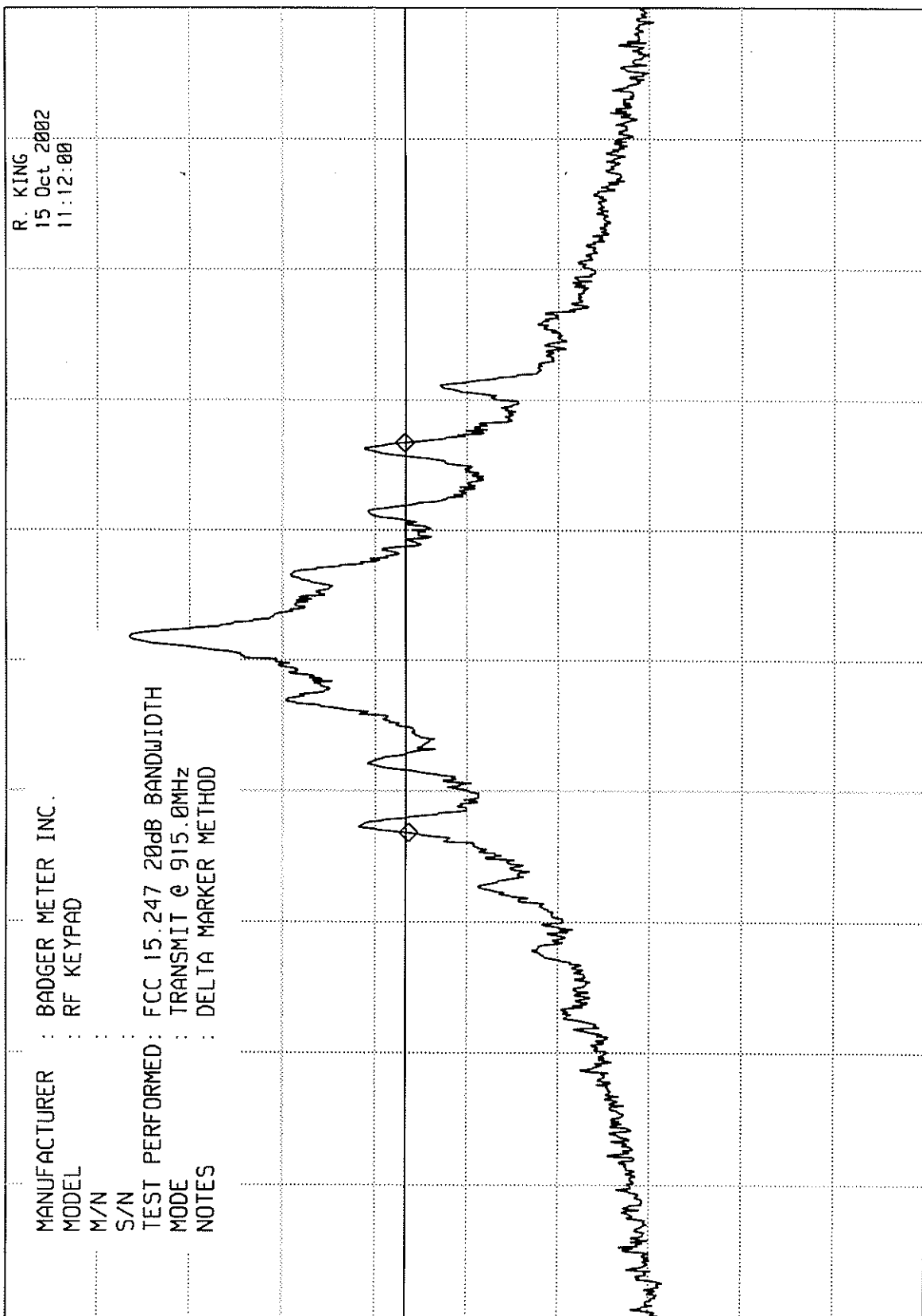
: DELTA MARKER METHOD

R. KING
15 Oct 2002
11:12:00

DL

63.6
dBuV

ETD 31552-01



CENTER 915.00 MHz

RES BW 10 kHz(i)

VBW 100 kHz

SPAN 1.00 MHz

SWP 75.0 msec

28 of 52

ELITE ELECTRONIC ENGINEERING INC.

MKR ^ 340 kHz
-0.70 dB

hp

REF 107.0 dBuV

ATTEN 10 dB + 20 dB Ext

10 dB/

MANUFACTURER

MODEL

M/N

S/N

TEST PERFORMED:

MODE

NOTES

: BADGER METER INC.

: RF KEYPAD

FCC 15.247 20dB BANDWIDTH

: TRANSMIT @ 921.4MHz

: DELTA MARKER METHOD

R. KING

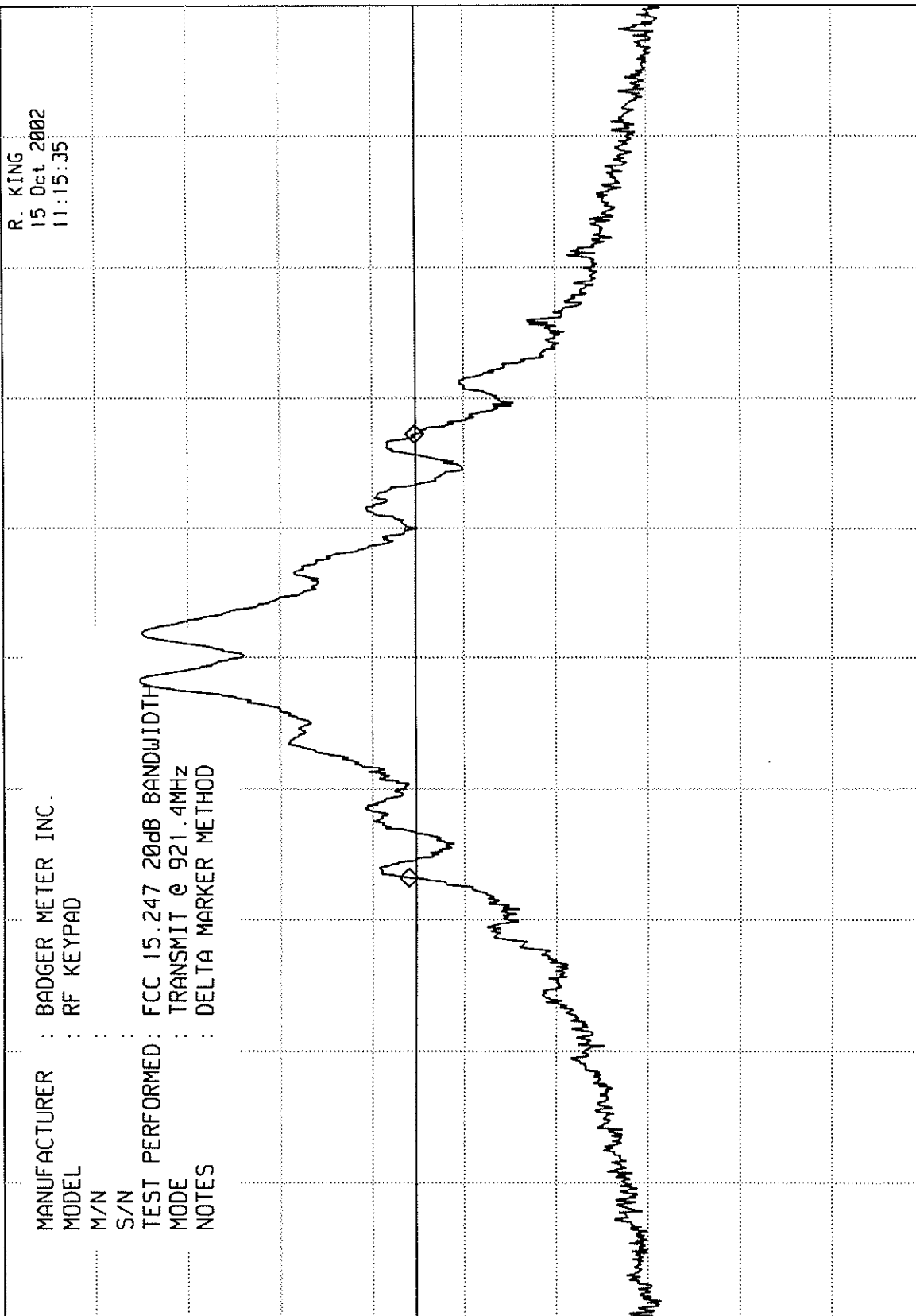
15 Oct 2002

11:15:35

DL

62.2
dBuV

ETR 31552-01



CENTER 921.40 MHz

RES BW 10 kHz(i)

VBW 100 kHz

SPAN 1.00 MHz

SWP 75.0 msec

29 of 52



ETR No. 31552-01
DATA SHEET

PEAK OUTPUT POWER

SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : RF KEYPAD
SERIAL NO. : NONE GIVEN
NOTES : TRANSMITTING AT FULL POWER
TEST DATE : OCTOBER 14 - 18, 2002
TEST DISTANCE : 3m

Freq. (MHz)	Mtr Rdg dBm	Pads dB	Total (dBm)	Limit (dBm)
908.0	-10.0	20	10.0	30
915.0	-9.8	20	10.2	30
921.4	-9.9	20	10.1	30

CHECKED BY: Richard King
page ____ of ____

30 of 52

ELITE ELECTRONIC ENGINEERING Inc.

MR 908.78 MHz
94.20 dBu

hp

REF 107.0 dBu ATTN 10 dB + 20 dBc

10 dB/

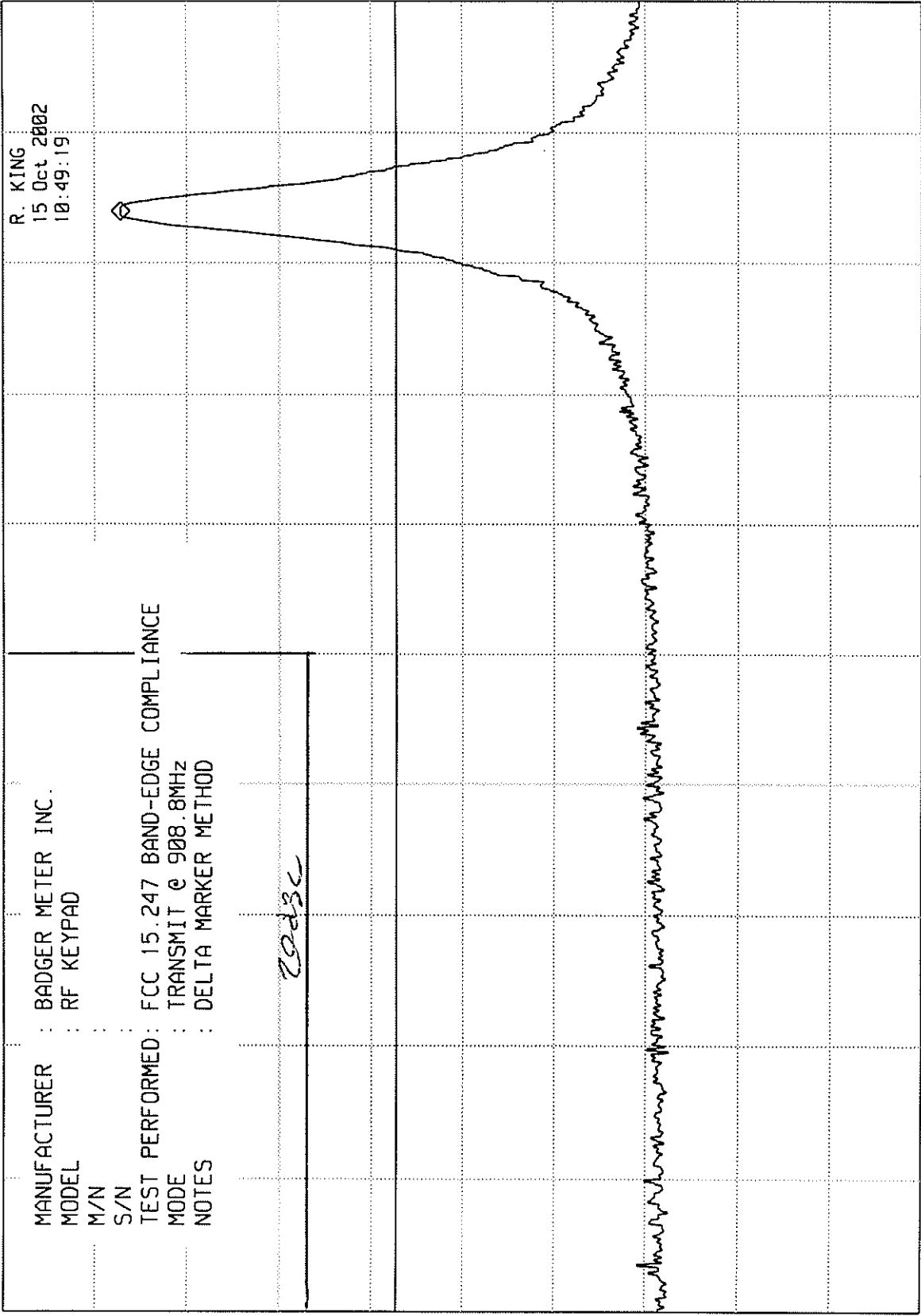
MANUFACTURER
MODEL
M/N
S/N

: BADGER METER INC.
: RF KEYPAD

TEST PERFORMED: FCC 15.247 BAND-EDGE COMPLIANCE
MODE : TRANSMIT @ 908.8MHz
NOTES : DELTA MARKER METHOD

DL 64.2
dBu

20dBc



ETR 31552-01

31 of 52

CENTER 902.0 MHz SPAN 20.0 MHz
RES BW 300 kHz(i) UBW 3 MHz SWP 20.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 909.14 MHz
94.20 dBuV

hp

10 dB/

DL

64.2
dBuV

REF 107.0 dBuV ATTN 10 dB

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
M/N :
S/N :

TEST PERFORMED: FCC 15.247 BAND-EDGE COMPLIANCE
MODE : FREQ. HOPPING ENABLED
NOTES : DELTA MARKER METHOD

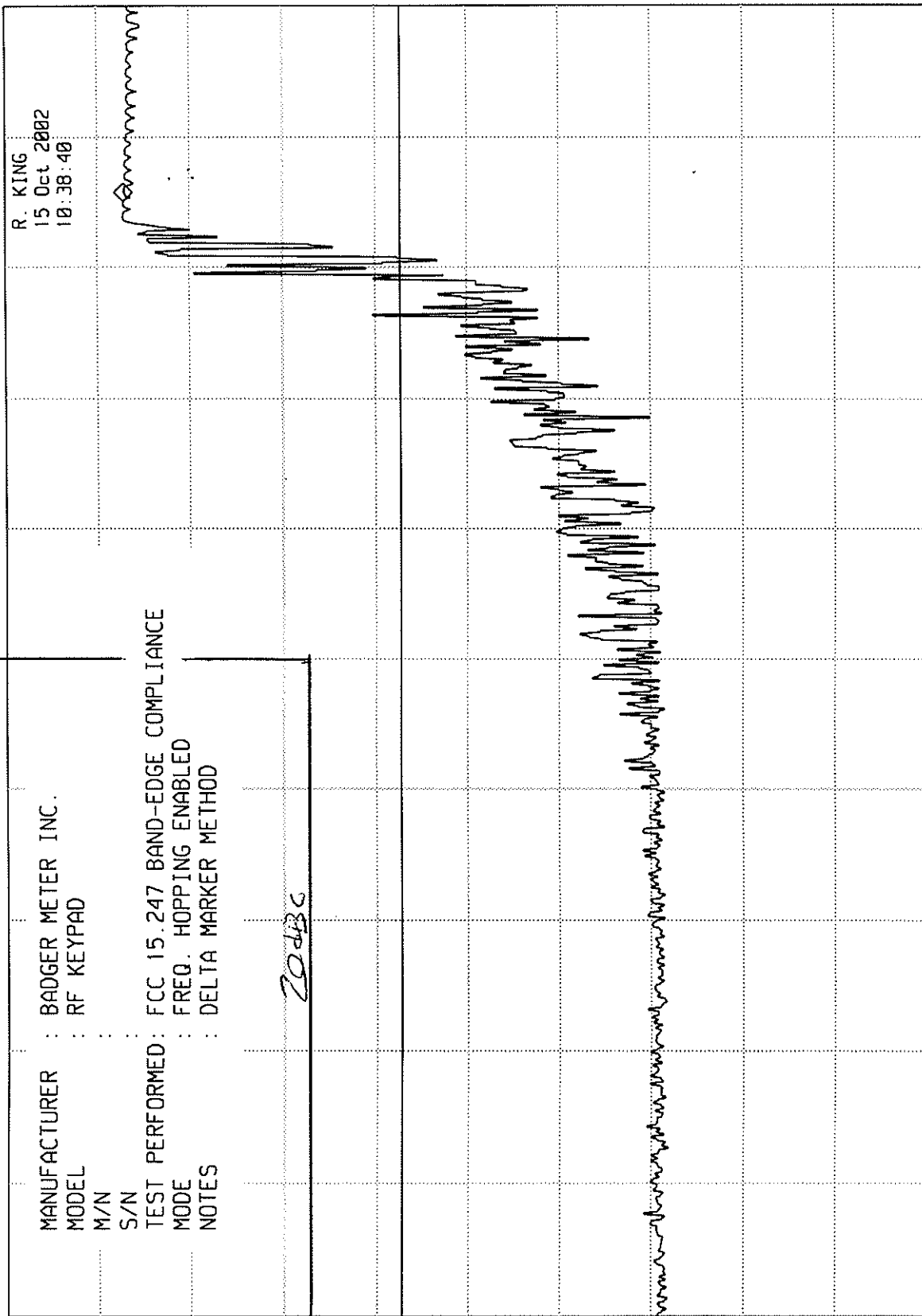
20dBc

R. KING

15 Oct 2002

10:38:40

ETR 31552-01



CENTER 902.0 MHz

RES BW 300 kHz(i)

UBW 3 MHz

SPAN 20.0 MHz

SWP 20.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MR 921.32 MHz
94.20 dBuV

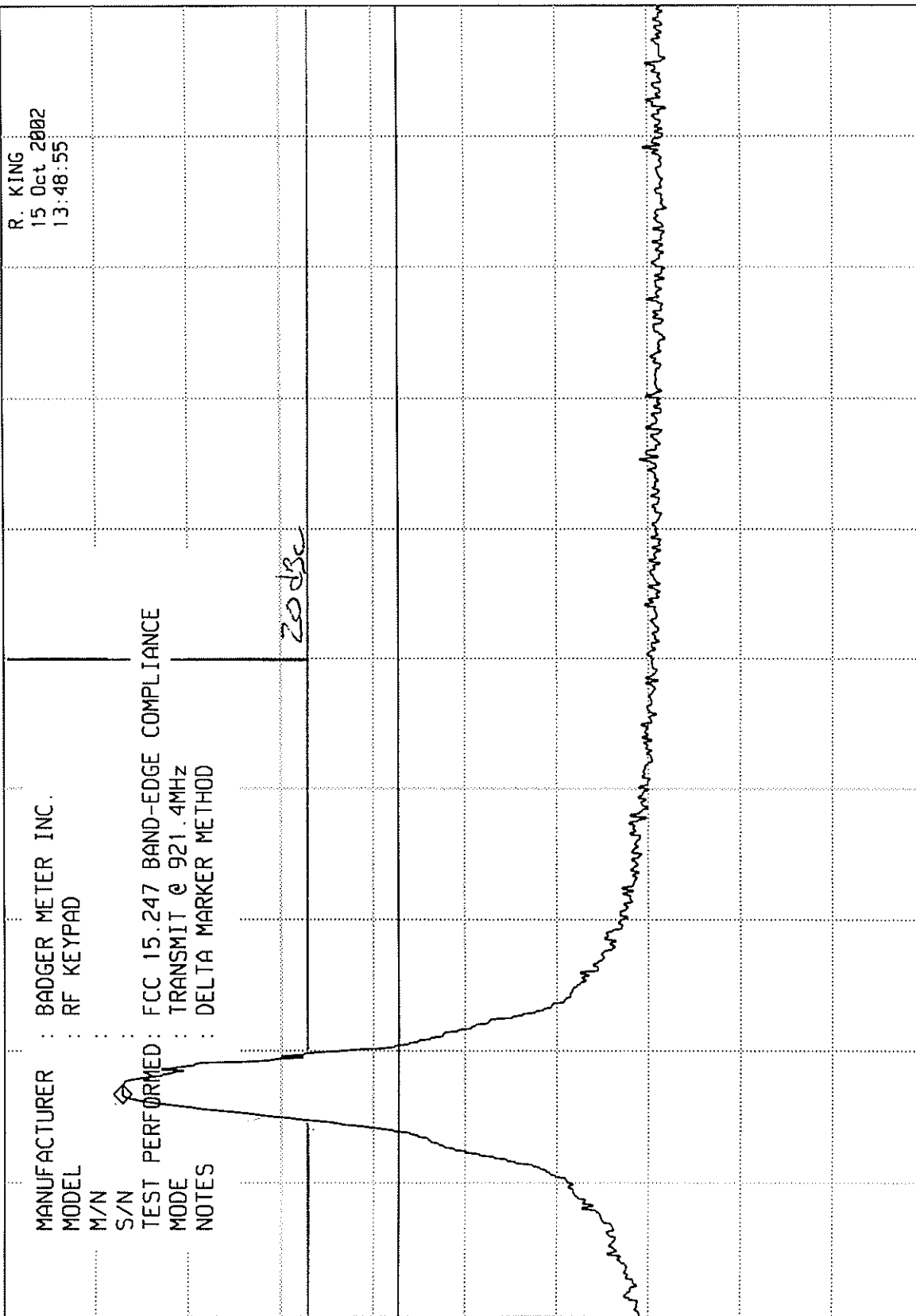
hp

10 dB/

DL

64.2
dBuV

REF 107.0 dBuV ATTN 10 dB + 20 dB EXT



ETR 31552-01

33 of 52

CENTER 928.0 MHz SPAN 20.0 MHz
RES BW 300 kHz (i) UBW 3 MHz SWP 20.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 918.00 MHz
93.40 dBuV

REF 127.0 dBuV ATTN 30 dB + 20 dB ATT

hp

10 dB/

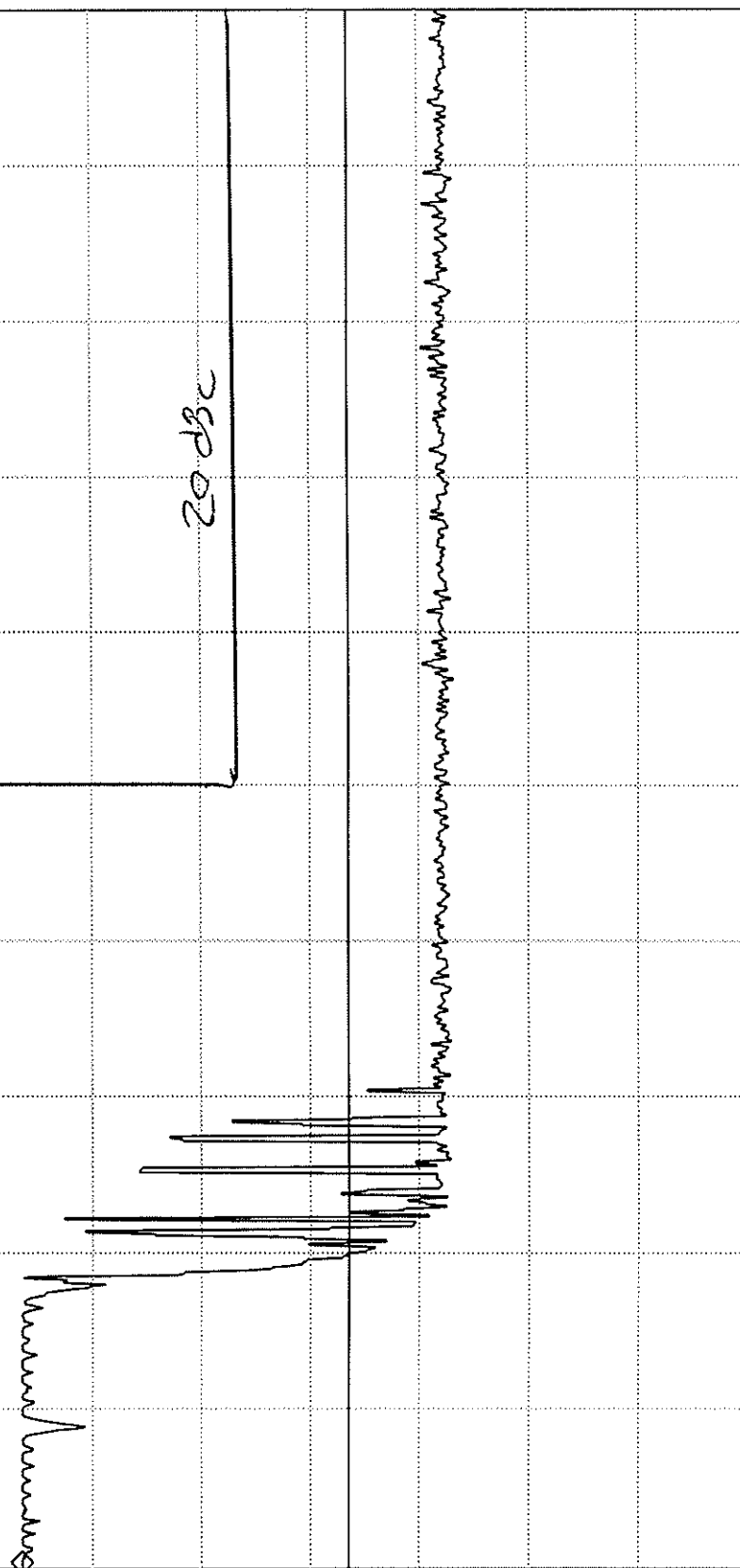
MANUFACTURER :
MODEL :
M/N :

BADGER METER INC.
RF KEYPAD

R. KING
15 Oct 2002
10:43:43

S/N :
TEST PERFORMED : FCC 15.247 BAND-EDGE COMPLIANCE
MODE : FREQ. HOPPING ENABLED
NOTES : DELTA MARKER METHOD

DL 63.4
dBuV



ETR 31552-01

34 of 52

CENTER 928.0 MHz RES BW 300 kHz(i) VBW 3 MHz SPAN 20.0 MHz SUP 20.0 msec

ELITE ELECTRONIC ENGINEERING Inc.

MR 909.8 MHz
-13.00 dBm

hp

REF 0.0 dBm ATTN 10 dB + 20 dB EXT

10 dB/

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
M/N :
S/N :

TEST PERFORMED : FCC 15.247 SPURIOUS RF CE
MODE : TRANSMIT @ 908.8MHz
NOTES : 30MHz-1GHz

R. KING

15 Oct 2002
13:37:24

DL

-33.4
dBm

20 dB

ETR-31852-01

35 of 52

START 30 MHz

RES BW 100 kHz (i)

VBW 1 MHz

STOP 1.000 GHz

SWP 728 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 1.818 GHz
-58.30 dBm

hp

REF 0.0 dBm

ATTEN 10 dB + 20 dB EXT

10 dB/

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
M/N :
S/N :

TEST PERFORMED : FCC 15.247 SPURIOUS RF CE
MODE : TRANSMIT @ 908.8MHz
NOTES : 1GHZ-2GHZ

R. KING
15 Oct 2002
13:38:37

DL
-33.4
dBm

20dBc

ETM 31552-01

36 of 52

START 1.00 GHz

RES BW 100 kHz (i)

UBW 1 MHz

STOP 2.00 GHz

SWP 750 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 2.712 GHz
-66.90 dBm

hp

REF 0.0 dBm

ATTEN 10 dB + 20 dB Ext

10 dB/

MANUFACTURER

MODEL

M/N

S/N

TEST PERFORMED: FCC 15.247 SPURIOUS RF CE

MODE : TRANSMIT @ 908.8MHz

NOTES : 2GHZ-10GHZ

: BADGER METER INC.

: RF KEYPAD

R. KING

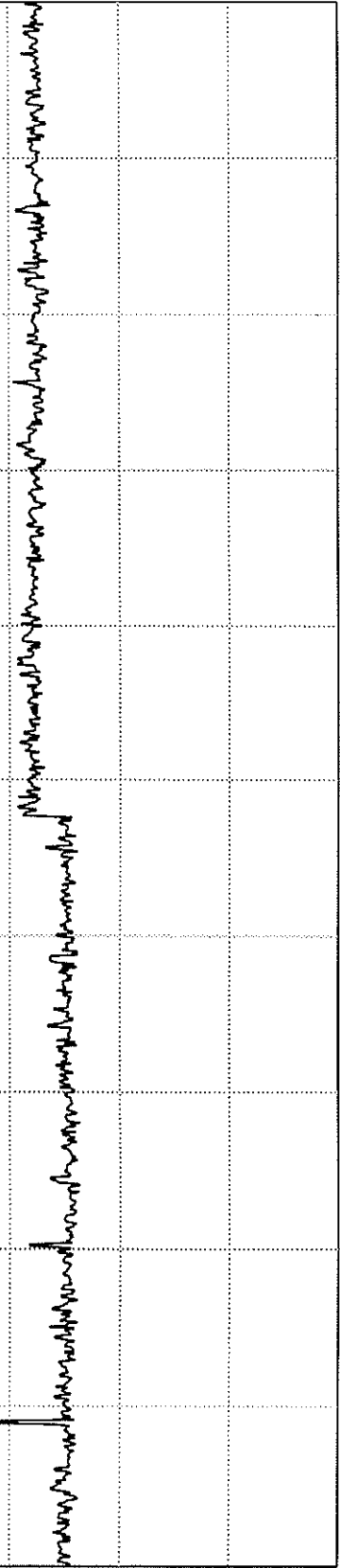
15 Oct 2002

13:40:21

DL

-33.4
dBm

20dBc



37 of 52

ETD 31552-01

START 2.00 GHz

RES BW 100 kHz (i)

VBW 1 MHz

STOP 10.00 GHz

SWP 6.00 sec

ELITE ELECTRONIC ENGINEERING Inc.

MR 916.6 MHz
-13.70 dBm

hp

REF 0.0 dBm

ATTEN 10 dB + 20 dB EXT

10 dB/

MANUFACTURER

: BADGER METER INC.

MODEL

: RF KEYPAD

M/N

S/N

TEST PERFORMED: FCC 15.247 SPURIOUS RF CE

MODE : TRANSMIT @ 915.0MHz

NOTES : 30MHz-1GHz

R. KING

15 Oct 2002

13:32:06

DL

-33.4
dBm

20 dBc

ETL 31552-01



38.652

START 30 MHz

RES BW 100 kHz (i)

VBW 1 MHz

STOP 1.000 GHz

SWP 728 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 1.830 GHz
-57.10 dBm

REF 0.0 dBm

ATTEN 10 dB + 20dB EXT

MANUFACTURER : BADGER METER INC.
MODEL : RF KEYPAD
M/N :
S/N :

TEST PERFORMED : FCC 15.247 SPURIOUS RF CE
MODE : TRANSMIT @ 915.0MHZ
NOTES : 1GHZ-2GHZ

R. KING
15 Oct 2002
13:33:38

DL
-33.4
dBm

20dBc

ETM 31552-01



39.452

START 1.00 GHz
RES BW 100 kHz (i)
STOP 2.00 GHz
SWP 750 msec
VBW 1 MHz

ELITE ELECTRONIC ENGINEERING Inc.

MKR 2.728 GHz
-66.40 dBm

hp

REF 0.0 dBm

ATTEN 10 dB + 20 dB EXT

10 dB/

MANUFACTURER

: BADGER METER INC.

MODEL

: RF KEYPAD

M/N

S/N

TEST PERFORMED: FCC 15.247 SPURIOUS RF CE

MODE : TRANSMIT @ 915.0MHZ

NOTES : 2GHZ-10GHZ

R. KING

15 Oct 2002

13:34:50

DL
-33.4
dBm

20dBc

ETR 31552-01



Handwritten notes in the right margin: "Power level 10 dBm at 2.728 GHz" and "Power level 10 dBm at 2.728 GHz" repeated twice.

40,452

START 2.00 GHz

RES BW 100 kHz (i)

UBW 1 MHz

STOP 10.00 GHz

SWP 6.00 sec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 922.4 MHz
-13.60 dBm

ATTEN 10 dB + 20 dB EXT

REF 0.0 dBm

hp

10 dB/

MANUFACTURER : BADGER METER INC.

MODEL : RF KEYPAD

M/N

S/N

TEST PERFORMED: FCC 15.247 SPURIOUS RF CE

MODE : TRANSMIT @ 921.4MHz

NOTES : 30M-1GHZ

R. KING

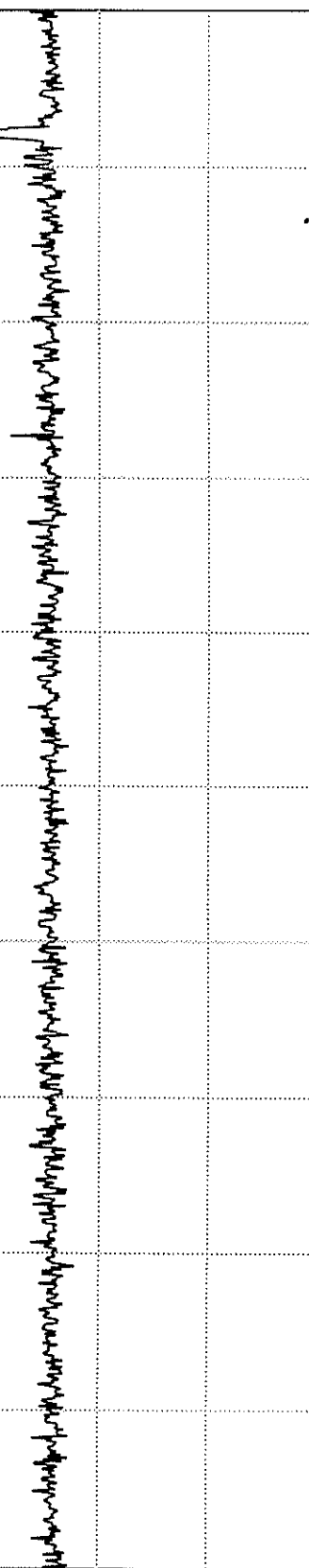
15 Oct 2002

13:21:51

DL
-33.4
dBm

20 dBc

ETL 31552-01



START 30 MHz

RES BW 100 kHz (i)

UBW 1 MHz

STOP 1.000 GHz

SWP 728 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 1.842 GHz
-57.20 dBm

ATTEN 10 dB + 20 dB Ext

REF 0.0 dBm

hp

10 dB/

MANUFACTURER
MODEL

: BADGER METER INC.
: RF KEYPAD

M/N

S/N

TEST PERFORMED: FCC 15.247 SPURIOUS RF CE
MODE : TRANSMIT @ 921.4MHZ
NOTES : 1GHZ-2GHZ

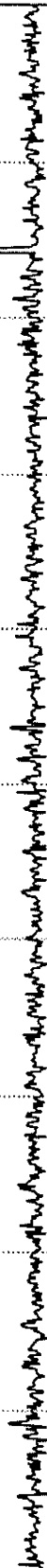
R. KING

15 Oct 2002
13:24:20

DL
-33.3
dBm

20 dBc

ETR 31552-01



42 of 52

START 1.00 GHz

RES BW 100 kHz(i)

UBW 1 MHz

STOP 2.00 GHz

SWP 750 msec

ELITE ELECTRONIC ENGINEERING Inc.

MKR 2.752 GHz
-65.60 dBm

hp

REF 0.0 dBm ATTN 10 dB + 20 dB EXT

10 dB/

MANUFACTURER : BADGER METER INC.

MODEL : RF KEYPAD

M/N

S/N

TEST PERFORMED : FCC 15.247 SPURIOUS RF CE

MODE : TRANSMIT @ 921.4MHZ

NOTES : 2GHZ-10GHZ

R. KING

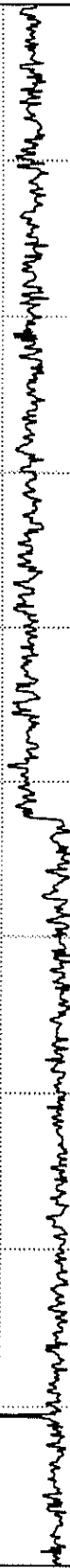
15 Oct 2002

13:30:09

DL

-33.4
dBm

20 dB c



43 of 52

START 2.00 GHz

RES BW 100 kHz (1)

UBW 1 MHz

STOP 10.00 GHz

SWP 6.00 sec

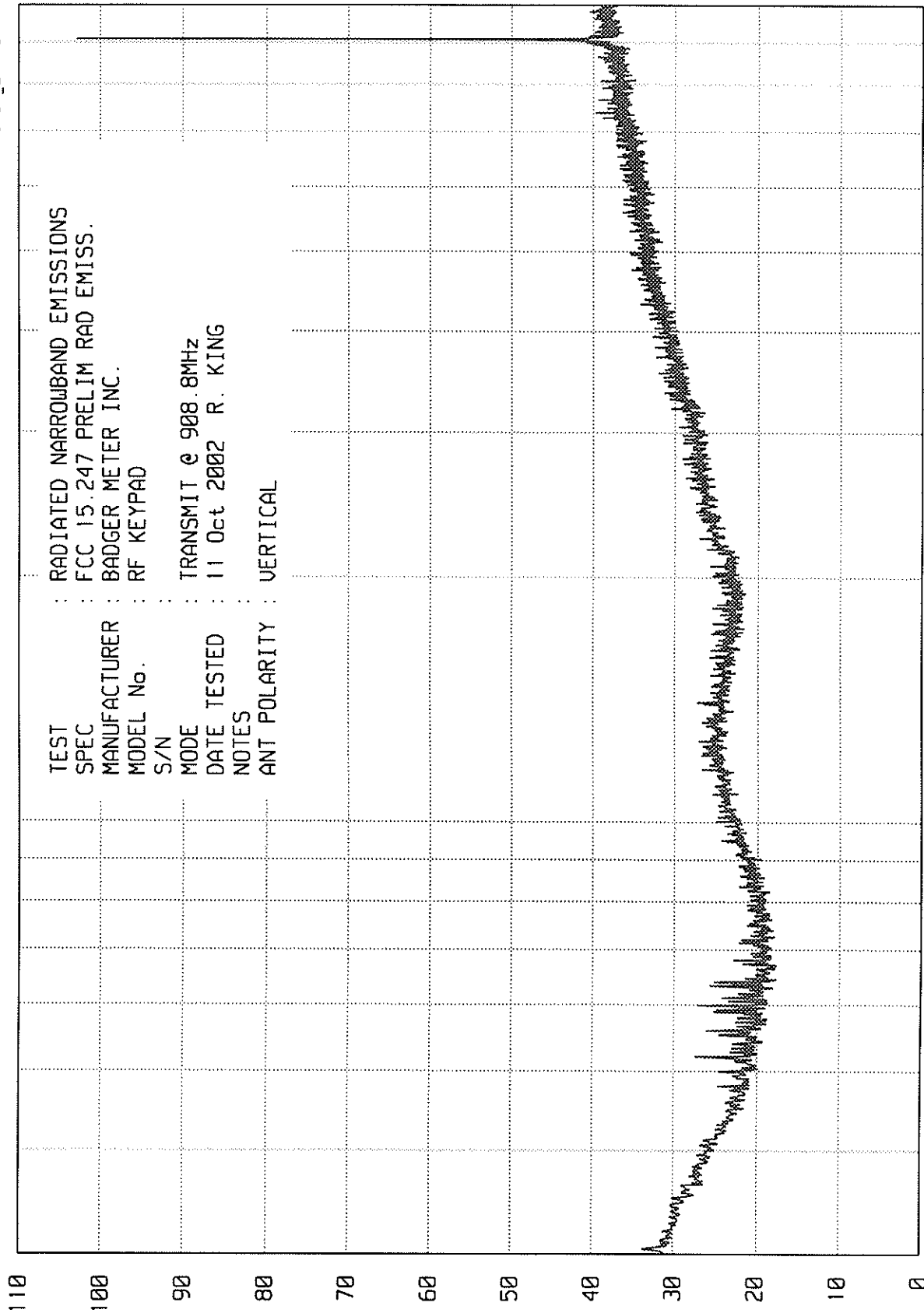
EPR 31552-01

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

WKA0 06/18/02

UNIT EM RUN RUN 2



TEST : RADIATED NARROWBAND EMISSIONS
 SPEC : FCC 15.247 PRELIM RAD EMISS.
 MANUFACTURER : BADGER METER INC.
 MODEL No. : RF KEYPAD
 S/N :
 MODE : TRANSMIT @ 908.8MHz
 DATE TESTED : 11 Oct 2002 R. KING
 NOTES :
 ANT POLARITY : VERTICAL

RADIATED NARROWBAND EMISSIONS - dBu/m

25 of 52

START = 30

FREQUENCY - MHz

STOP = 1000

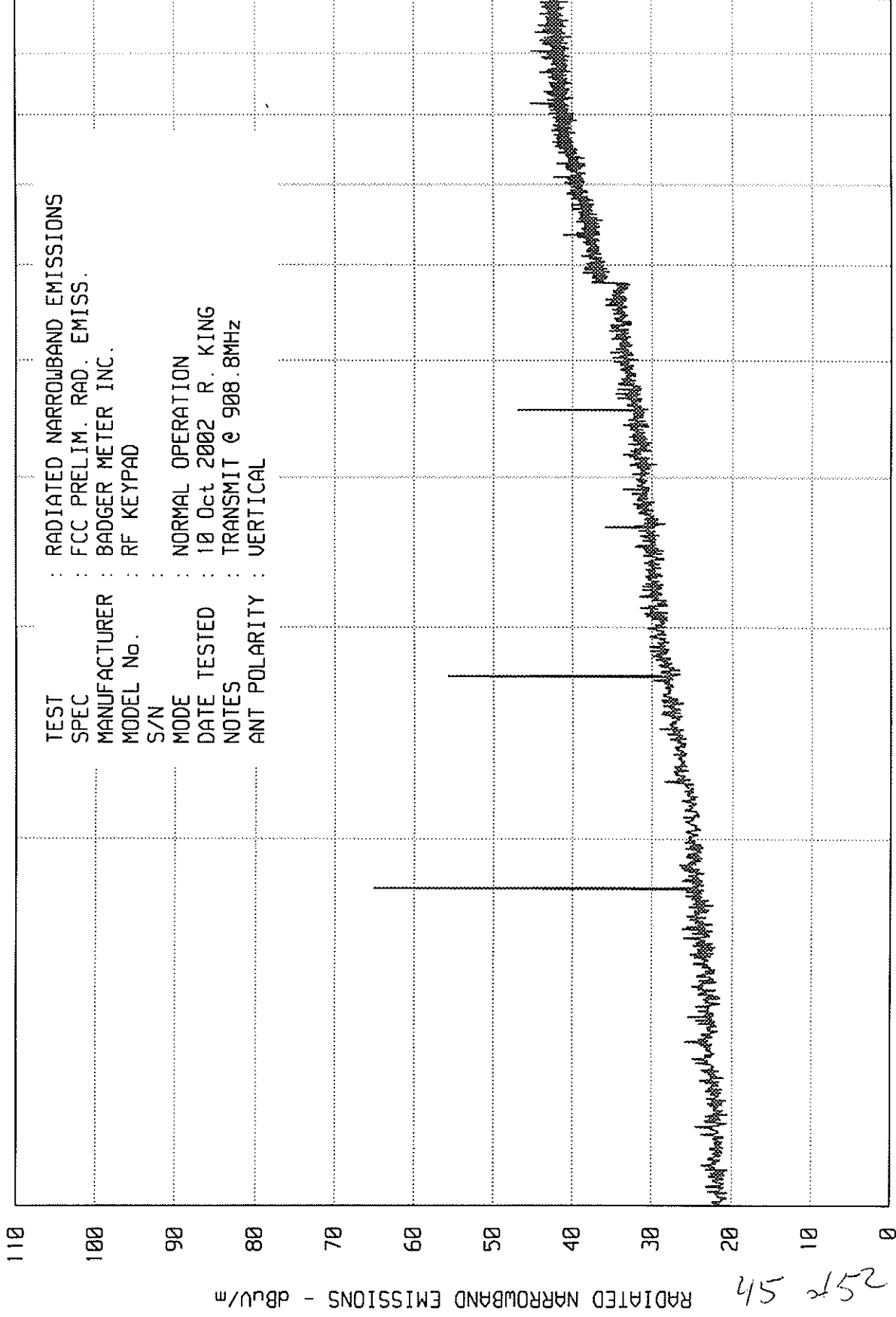
ETR 31552-01

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

UNIV_EM RUN RUN 2

UKA0 06/18/02



STOP = 10000

FREQUENCY - MHz

START = 1000

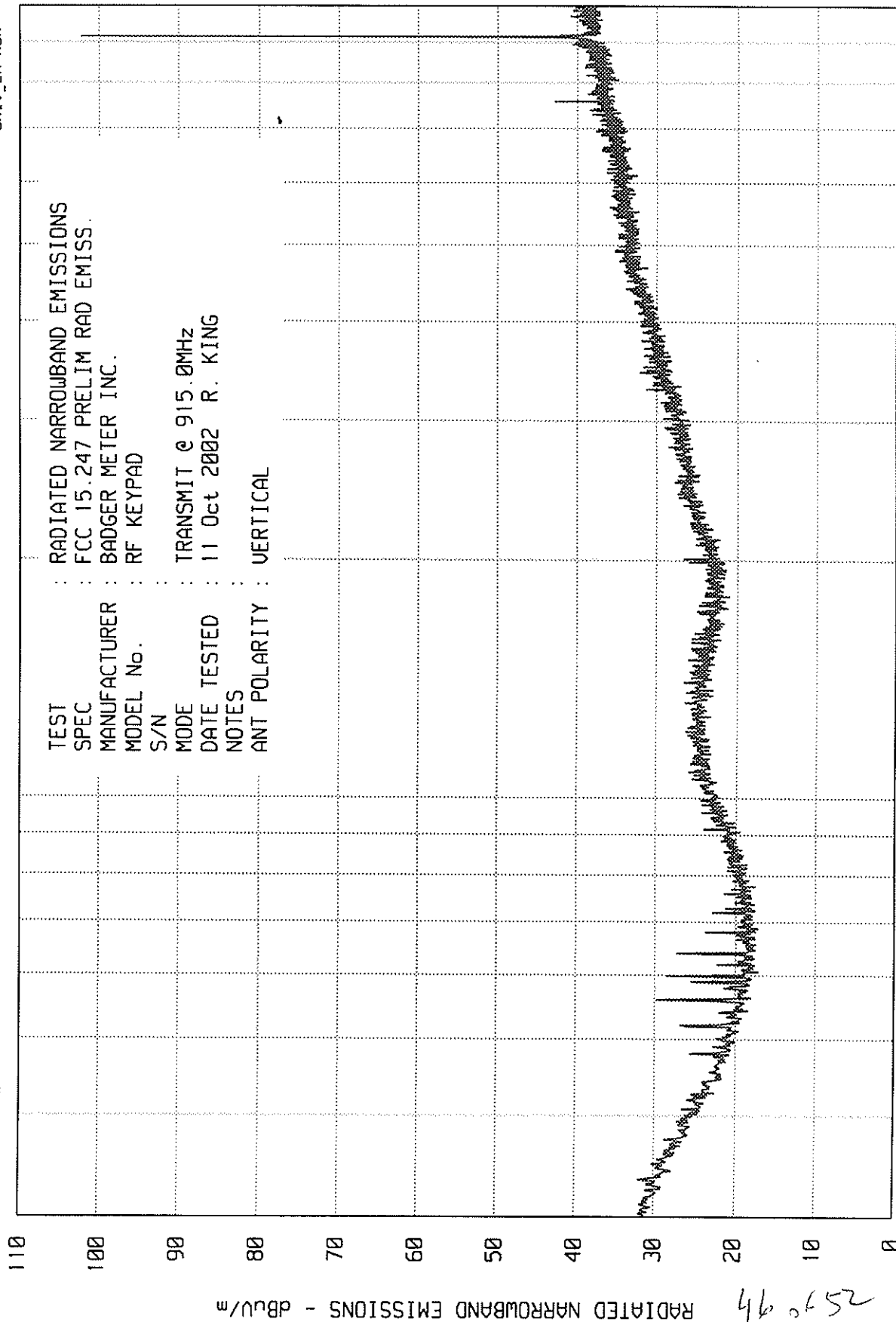
ERR31552-01

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

UNIT EM RUN RUN 2

WKAB 06/18/02



START = 30

FREQUENCY - MHz

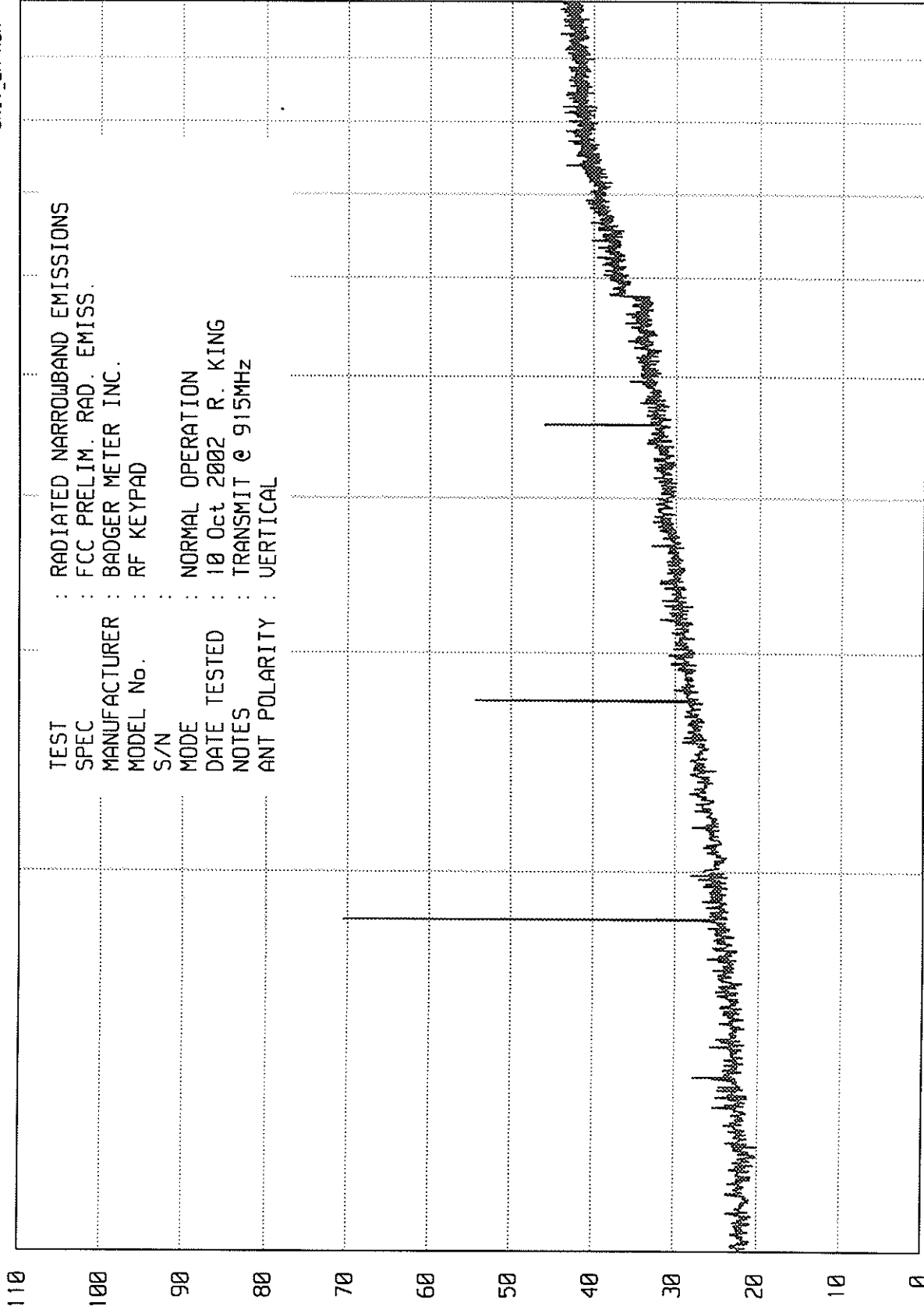
STOP = 1000

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

UNIV_EM RUN RUN 2

UKA8 06/18/02



TEST : RADIATED NARROWBAND EMISSIONS
 SPEC : FCC PRELIM. RAD. EMISS.
 MANUFACTURER : BADGER METER INC.
 MODEL No. : RF KEYPAD
 S/N :
 MODE : NORMAL OPERATION
 DATE TESTED : 18 Oct 2002 R. KING
 NOTES : TRANSMIT @ 915MHz
 ANT POLARITY : VERTICAL

RADIATED NARROWBAND EMISSIONS - dBuV/m

25 f 47

START = 1000

FREQUENCY - MHz

STOP = 10000

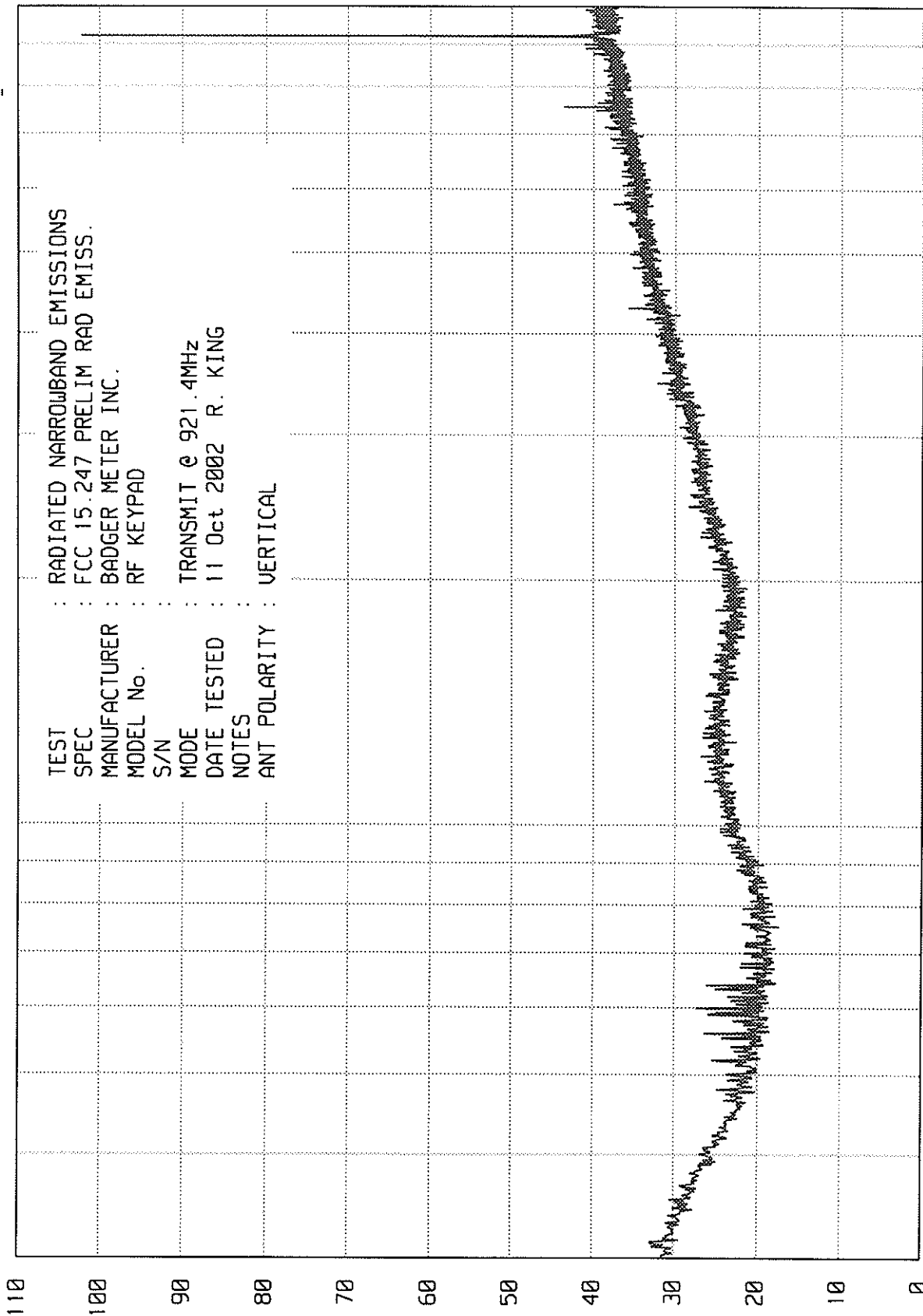
EIR 31552-01

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

UNIT EM RUN RUN 2

UKA0 06/18/02



TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC 15.247 PRELIM RAD EMISS.
MANUFACTURER : BADGER METER INC.
MODEL No. : RF KEYPAD
S/N :
MODE : TRANSMIT @ 921.4MHz
DATE TESTED : 11 Oct 2002 R. KING
NOTES :
ANT POLARITY : VERTICAL

RADIATED NARROWBAND EMISSIONS - dBu/m

251,84

START = 30

100

FREQUENCY - MHz

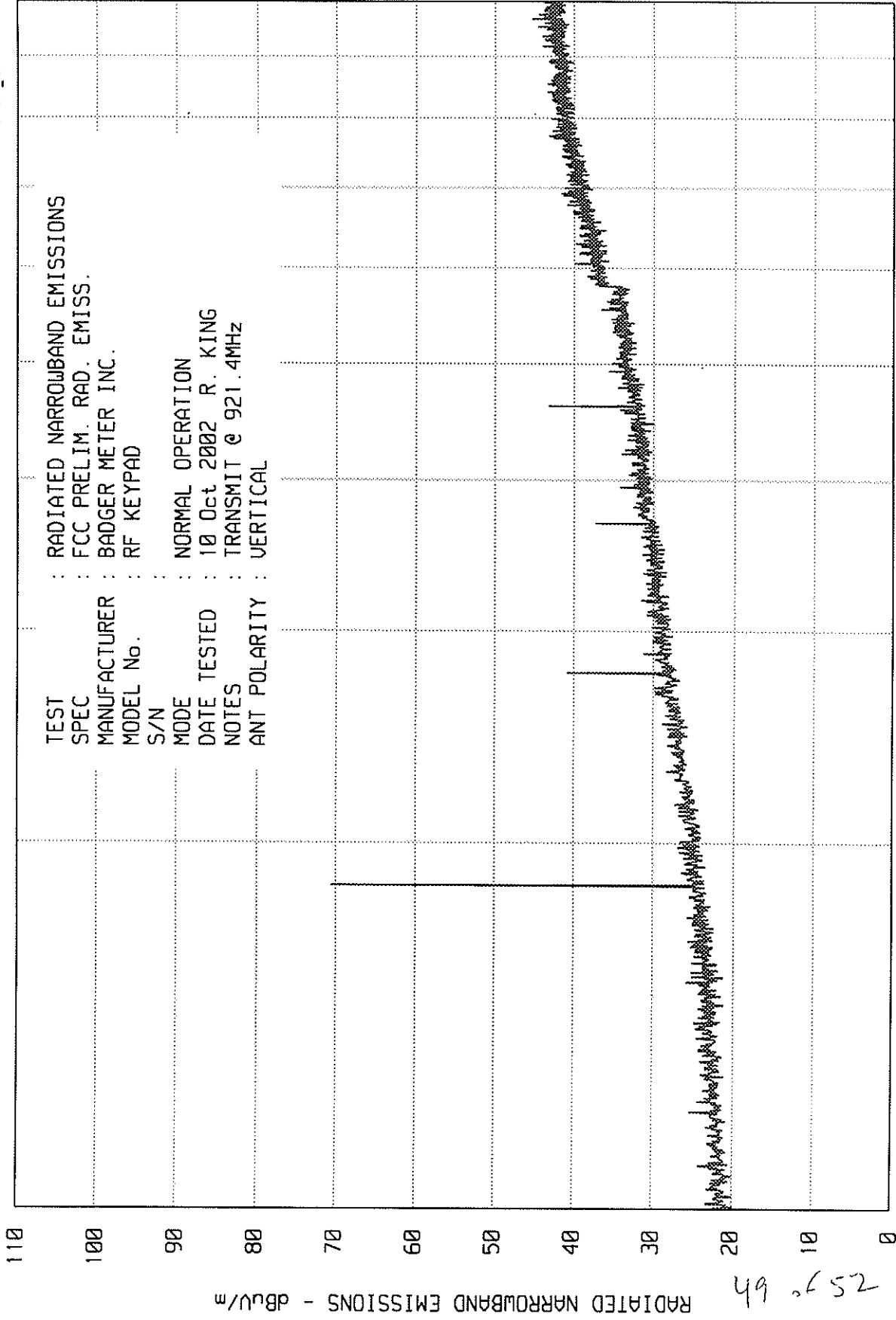
STOP = 1000

ELITE ELECTRONIC ENGINEERING Inc.

Downers Grove, Ill. 60515

UKA0 06/18/02

UNIU_EM RUN RUN 2



START = 1000

FREQUENCY - MHz

STOP = 10000

ETDZ 31552-01



ETR No. 31522-01
DATA SHEET

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM

SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : RF KEYPAD
SERIAL NO. : NONE GIVEN
NOTES : TRANSMIT AT LOW CHANNEL 908.8MHz
TEST DATE : OCTOBER 14 - 18, 2002
TEST DISTANCE : 3m

FREQ	ANT	MTR			ANT	CABLE	PRE	TOTAL	TOTAL	LIMIT
MHz	POL	RDG		BW	FAC	LOSS	AMP	dBuV/m	uV/m	uV
2724.8	H	60.1	-26.6	1M/10	28.0	3.2	-36.6	28.1	25.5	500.0
	V	76.2	-26.6	1M/10	28.0	3.2	-36.6	44.2	162.2	500.0
3633.6	H	52.5	-26.6	1M/10	32.7	4.3	-36.5	26.4	20.9	500.0
	V	59.8	-26.6	1M/10	32.7	4.3	-36.5	33.7	48.4	500.0
4542.4	H	58.4	-26.6	1M/10	33.5	4.3	-36.4	33.2	45.7	500.0
	V	53.4	-26.6	1M/10	33.5	4.3	-36.4	28.2	25.7	500.0
5451.2	H	36.8	-26.6	1M/10	35.2	5.4	-36.0	14.8	5.5	500.0
	V	38.8	-26.6	1M/10	35.2	5.4	-36.0	16.8	6.9	500.0
7268.8	H	34.0	-26.6	1M/10	37.4	6.5	-36.3	15.0	5.6	500.0
	V	33.8	-26.6	1M/10	37.4	6.5	-36.3	14.8	5.5	500.0
8177.6	H	35.2	-26.6	1M/10	37.9	7.6	-36.3	17.7	7.7	500.0
	V	36.0	-26.6	1M/10	37.9	7.6	-36.3	18.6	8.5	500.0
9086.4	H	34.6	-26.6	1M/10	38.4	7.6	-36.7	17.3	7.3	500.0
	V	34.6	-26.6	1M/10	38.4	7.6	-36.7	17.3	7.3	500.0

CHECKED BY:

Richard E. King

page 50 of 52



ETR No. 31522-01
DATA SHEET

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM

SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : RF KEYPAD
SERIAL NO. : NONE GIVEN
NOTES : TRANSMIT AT LOW CHANNEL 915MHz
TEST DATE : OCTOBER 14 - 18, 2002
TEST DISTANCE : 3m

FREQ	ANT	MTR	Duty		ANT	CABLE	PRE	TOTAL	TOTAL	LIMIT
MHz	POL	RDG dBuV	Cycle	BW	FAC	LOSS	AMP	dBuV/m	uV/m	uV
2745.0	H	57.6	-26.6	1M/10	28.0	3.2	-36.6	25.6	19.1	500.0
	V	77.4	-26.6	1M/10	28.0	3.2	-36.6	45.4	186.2	500.0
3660.0	H	48.7	-26.6	1M/10	32.7	4.3	-36.5	22.6	13.5	500.0
	V	56.4	-26.6	1M/10	32.7	4.3	-36.5	30.3	32.7	500.0
4575.0	H	57.1	-26.6	1M/10	33.5	4.3	-36.4	31.9	39.4	500.0
	V	52.4	-26.6	1M/10	33.5	4.3	-36.4	27.2	22.9	500.0
7320.0	H	34.2	-26.6	1M/10	37.4	6.5	-36.3	15.2	5.8	500.0
	V	34.1	-26.6	1M/10	37.4	6.5	-36.3	15.1	5.7	500.0
8235.0	H	34.6	-26.6	1M/10	37.9	7.6	-36.3	17.2	7.2	500.0
	V	34.4	-26.6	1M/10	37.9	7.6	-36.3	17.0	7.0	500.0
9150.0	H	34.7	-26.6	1M/10	38.4	7.6	-36.7	17.4	7.4	500.0
	V	34.5	-26.6	1M/10	38.4	7.6	-36.7	17.2	7.2	500.0

CHECKED BY: Richard E. King
page 51 of 52



ETR No. 31552-01
DATA SHEET

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM

SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : RF KEYPAD
SERIAL NO. : NONE GIVEN
NOTES : TRANSMIT AT LOW CHANNEL 921.4MHz
TEST DATE : OCTOBER 14 - 18, 2002
TEST DISTANCE : 3m

FREQ	ANT	MTR	Duty		ANT	CABLE	PRE	TOTAL	TOTAL	LIMIT
MHz	POL	RDG dBuV	Cycle	BW	FAC	LOSS	AMP	dBuV/m	uV/m	uV
2764.0	H	59.1	-26.6	1M/10	28.0	3.2	-36.6	27.1	22.8	500.0
	V	72.7	-26.6	1M/10	28.0	3.2	-36.6	40.7	108.4	500.0
3685.5	H	49.2	-26.6	1M/10	32.7	4.3	-36.5	23.1	14.3	500.0
	V	53.7	-26.6	1M/10	32.7	4.3	-36.5	27.6	24.0	500.0
4606.9	H	55.3	-26.6	1M/10	33.5	4.3	-36.4	30.1	32.0	500.0
	V	55.2	-26.6	1M/10	33.5	4.3	-36.4	30.0	31.6	500.0
7371.1	H	34.4	-26.6	1M/10	37.4	6.5	-36.3	15.4	5.9	500.0
	V	34.1	-26.6	1M/10	37.4	6.5	-36.3	15.1	5.7	500.0
8292.5	H	34.6	-26.6	1M/10	37.9	7.6	-36.3	17.2	7.2	500.0
	V	35.1	-26.6	1M/10	37.9	7.6	-36.3	17.7	7.6	500.0
9213.9	H	34.5	-26.6	1M/10	38.4	7.6	-36.7	17.2	7.2	500.0
	V	34.2	-26.6	1M/10	38.4	7.6	-36.7	16.9	7.0	500.0

CHECKED BY:

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