A. DEVICE UNDER TEST

The product is remote control transmitter used as a safety alarm on cranes to indicate a hazardous condition. This device works in conjunction with a receiver (NFA-L20D) that was previously certified. This product is designed to operate in two states under the provisions of Part 15.231, both (a) and (e), of the FCC rules. The rational is explained in the Operational Description that accompanies this application.

The transmit frequency is 418.000 MHz. nominal. The modulation mode is on/off keying using a pulse position scheme. This device only transmits command codes and is not used for data transmission. Power for the device is provided by an internal "C" size 3.6 volt lithium battery.

The rf section consists of a Linx Technologies TXM-418-LC transmitter module, a four element antenna matching network and a detachable steel spring antenna. The antenna is custom manufactured by the applicant and is connected by a unique three part assembly that is not compatible with any standard electrical connector.

B. MEASUREMENT PROCEDURE: RADIATED EMISSIONS

Testing of this device was conducted at the Hyak Laboratory test facility located in Spotsylvania, Virginia.

Transmitter field strength measurements were conducted according to the procedures set forth in ANSI C63.4 (1992). Testing was conducted with a fresh battery and monitored periodically to insure that the battery voltage (under load) was maintained at 95% of nominal or better.

The device under test was placed on a rotating turntable 0.8 meters high, centered at 3 meters distant from the measurement antenna. The device was placed in the center of the turntable and tested in two positions shown in the test setup photographs.

For the purpose of testing, the micro-controller in the test sample was set to transmit a constant 1 kHz. pulse stream continuously.

The field strength measurements were taken using a Tektronix 494P spectrum analyzer, EMCO 3121C dipole set, an EMCO 3115 double ridge guide horn and an Avantek UJ210 preamp. The device was scanned from 30 MHz. to 5 GHz. and all emissions were noted. In this case, the only emissions detected were those harmonically related to the fundamental transmit frequency.

Two sets of radiated emissions measurements were taken for this device. One set for the 15.231(e), low power state and one for the 15.231(b), high power state. For both tests, at each frequency of emission, the device was measured by rotating the turntable and adjusting the antenna height over a range of 1 to 4 meters to obtain the maximum output level. This procedure was performed with both horizontal and vertical antenna polarizations for both of the setup positions shown in the test setup photos. The peak reading for each frequency was recorded in the second column on the data sheets.

Measurements taken for weak emissions were performed by reducing the distance from the measurement antenna to 1 meter and factoring –9.54dB into the calculation. For the low power state this procedure was used for the 5^{th} and 6^{th} harmonics. For the high power state this done for the 6^{th}, 7^{th} and 8^{th} harmonics.

C. DUTY CYCLE AND PERIODIC INTERVAL CALCULATIONS

The occupied bandwidth and duty cycle measurements were made using an HP8596E spectrum analyzer and plotted with an HP7475A pen plotter. While the computations below were drawn from the timing diagram, the plots verify the computations and indicate that the duty cycle taken from the sample is slightly less than one derived from the timing diagram.

The code format for this device is a three packet burst, pulse position scheme that comprises 16 data bit frames and 1 start bit frame for each packet The packets are asymmetrically spaced with a period of 347.456ms. from the rising edge of the first packet pulse to the falling edge of the last pulse of the third packet.

The frame windows are divided into 4 sectors of 0.488ms. each, giving a frame window of 1.952ms. This gives a total packet length of 33.184ms. Except for the start frame, the on time of any data bit is equal to 25% of the frame window or 0.488ms. The start frame has an on time equal to 75% of the frame or 1.464ms.

Referring to the timing diagram:
1) the start frame is high in the 1^{st}, 2^{nd} and 4^{th} frame sectors
2) a logic “one” is high in the 1^{st} sector and,
3) a logic “zero” is high in the 3^{rd} sector

This gives a total on time of:
1 start frame (1.464ms.) + 16 bit frames (16 X 0.488ms. = 7.808ms.) = 9.272ms.

The time from the start frame of the first packet to the start frame of the second packet is 197.152ms. The time from the start frame of the second packet to the start frame of the third packet is 117.120ms. This spacing insures that not more than one packet is issued in any 100ms. time frame. The duty cycle correction factor derived from this is:

20log (9.272ms./100ms.) = - 20.66dB

As provided in Part 15.35 of the FCC rules, a correction factor of –20dB is used for the calculations on the data sheets.

The provisions of 15.231(e) require the silent period for this device to be 10.424 sec.

(30 X 347.456ms. = 10.42368 sec.)

As shown in time domain plot 6, the repeat rate from this sample was 13.650 seconds giving a silent period of 13.303 seconds. (13.650 – 0.347456 = 13.302544). The repeat rate varies between 11 and 16 seconds and is independent of the frame and packet timing. This is done for collision avoidance where multiple systems are used in close proximity.

RADIATED EMISSIONS	FCC ID: NFA-L25RS	page 1 of 2
client Liftek Corp.	model L25 RAT Switch	project # 0678
device control transmitter (periodic power limit)		Test date 12-13-00
CFR V47 15.231(e)	antenna Dipoles/DRG horn	temp. = 4C

Frequency Radiated MHz.	Peak Reading dBm	Ant Factor dB	Ant Polar	Field 1 Intensity uV/m @ 3m	Duty Cycle -dB	Field 2 Intensity uV/m @ 3m	FCC Limit
417.070	-39.01	22.8	H	34634	-20	3463	4133
836.140	-86.22	27.3	V	254	-20	25	500
1254.210	-102.11	25.8	H	34	-20	3	500
1672.281	-98.07	27.7	V	68	-20	7	500
2090.351	-112.06	29.4	V	16	-20	2	500
2508.421	-122.39*	30.9	H	6	-20	1	500

This device is pulse code modulated according to the format described in the test report.

* noise = -127.08 dBm

RADIATED EMISSIONS	FCC ID: NFA-L25RS	page 2 of 2
client Liftek Corp.	model L25 RAT Switch	project # 0678
device control transmitter (alarm power limit)		Test date 12-13-00
CFR V47 15.231(a)	antenna Dipoles/DRG horn	temp. = 4C

Frequency Radiated MHz.	Peak Reading dBm	Ant Factor dB	Ant Polar	Field 1 Intensity uV/m @ 3m	Duty Cycle -dB	Field 2 Intensity uV/m @ 3m	FCC Limit
417.070	-32.65	22.8	H	72028	-20	7203	10333
836.140	-77.06	27.3	V	728	-20	73	1033
1254.210	-90.12	25.8	V	136	-20	14	1033
1672.281	-93.03	27.7	V	121	-20	12	500
2090.351	-94.21	29.4	H	129	-20	13	1033
2508.421	-102.74	30.9	V	57	-20	6	1033
2964.491	-110.60	31.7	H	25	-20	3	1033
3344.562	-119.43*	32.6	H	10	-20	1	1033

This device is pulse code modulated according to the format described in the test report.

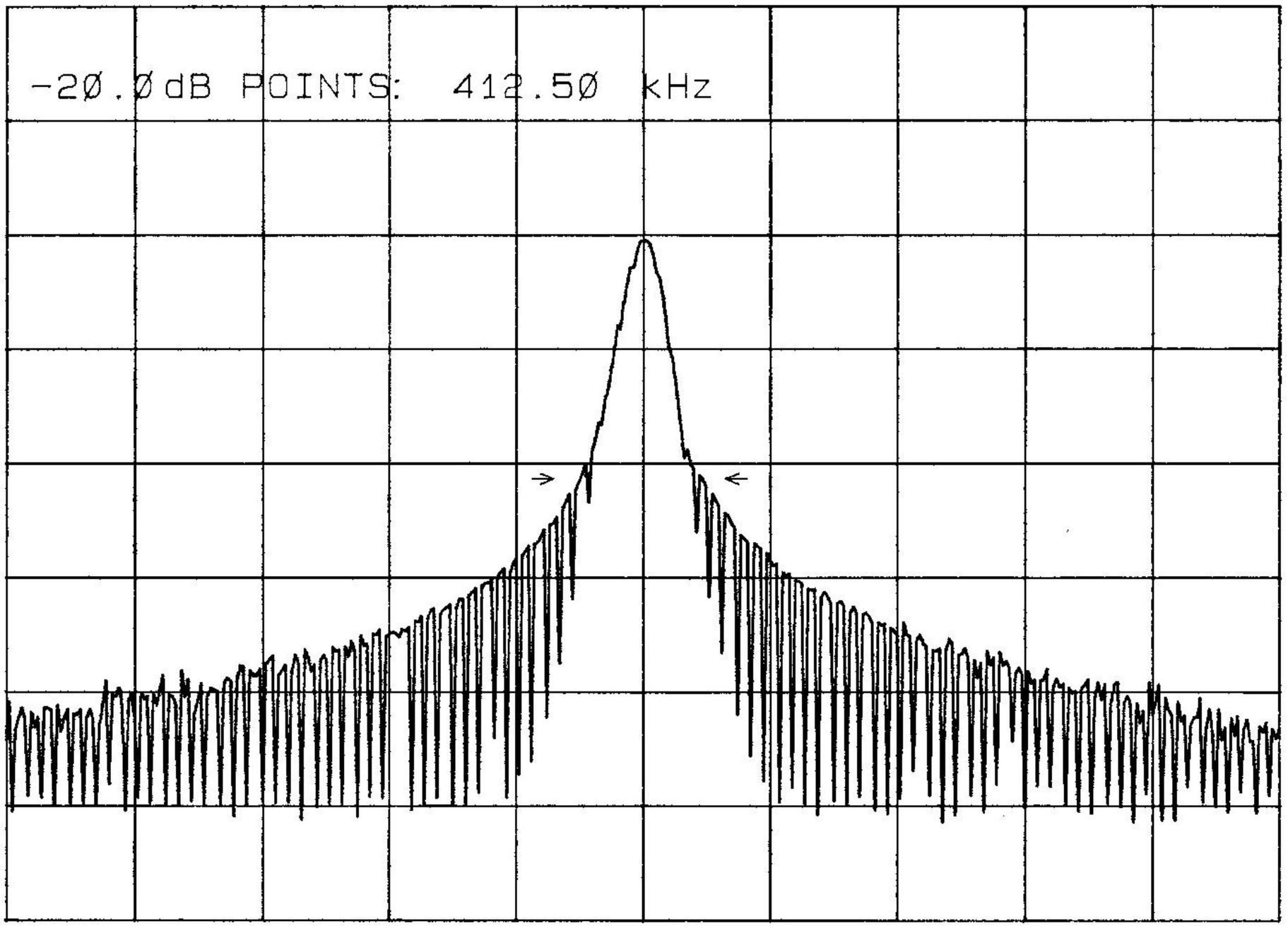
* noise = -126.43 dBm

12: 22: 30 DEC 12, 2000

REF -10.0 dBm #AT 10 dB OCCUPIED BANDWIDTH (HIGH POWER)

PEAK
LOG
10
dB/

-20.0dB POINTS: 412.50 kHz



WA SB
SC FS
CORR

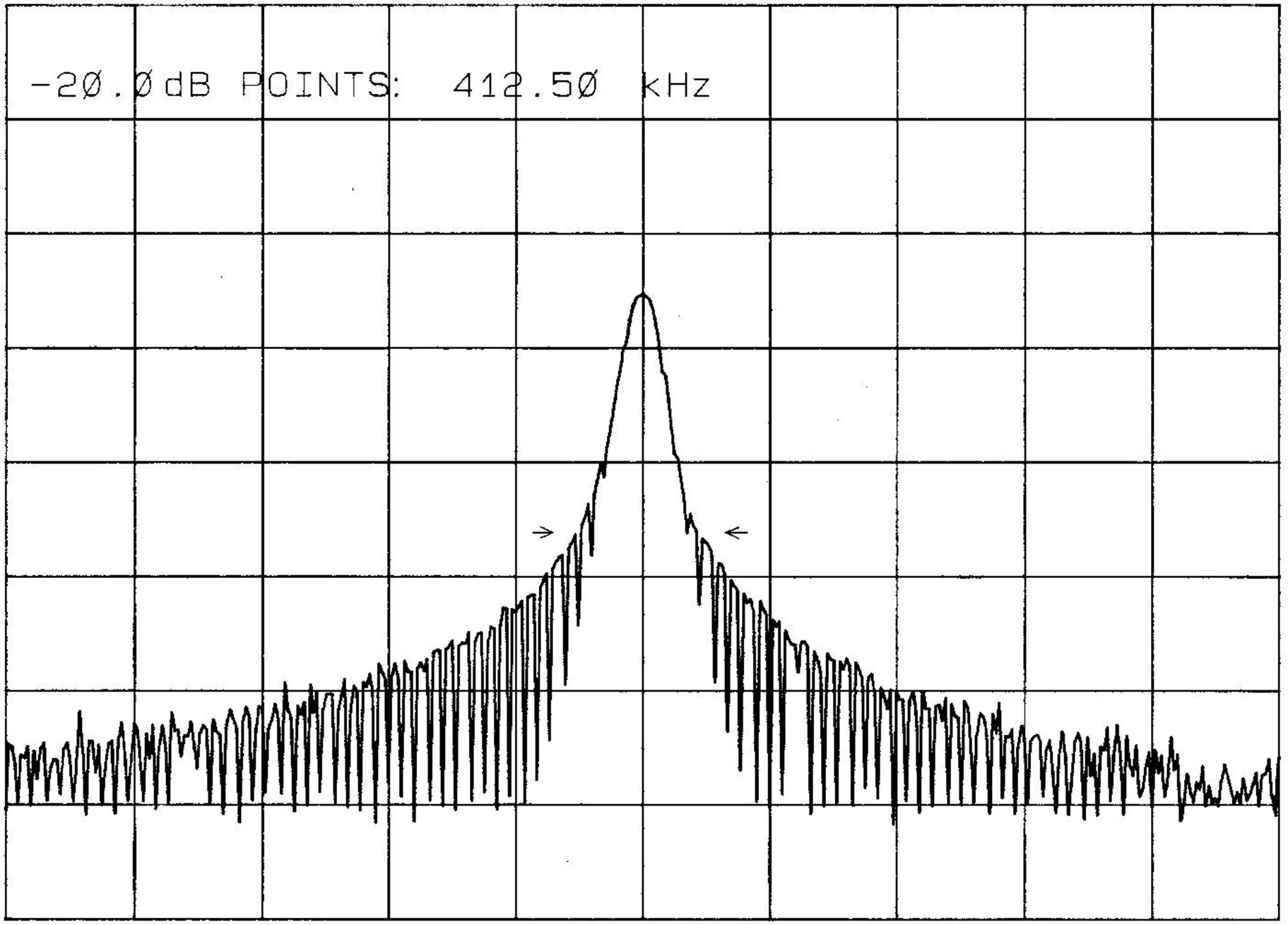
CENTER 418.071 MHz
#RES BW 100 kHz
#VBW 100 kHz
SPAN 5.000 MHz
#SWP 300 msec

11: 46: 26 DEC 12, 2ØØØ

REF -1Ø.Ø dBm #AT 1Ø dB OCCUPIED BANDWIDTH (LOW POWER)

PEAK
LOG
1Ø
dB/

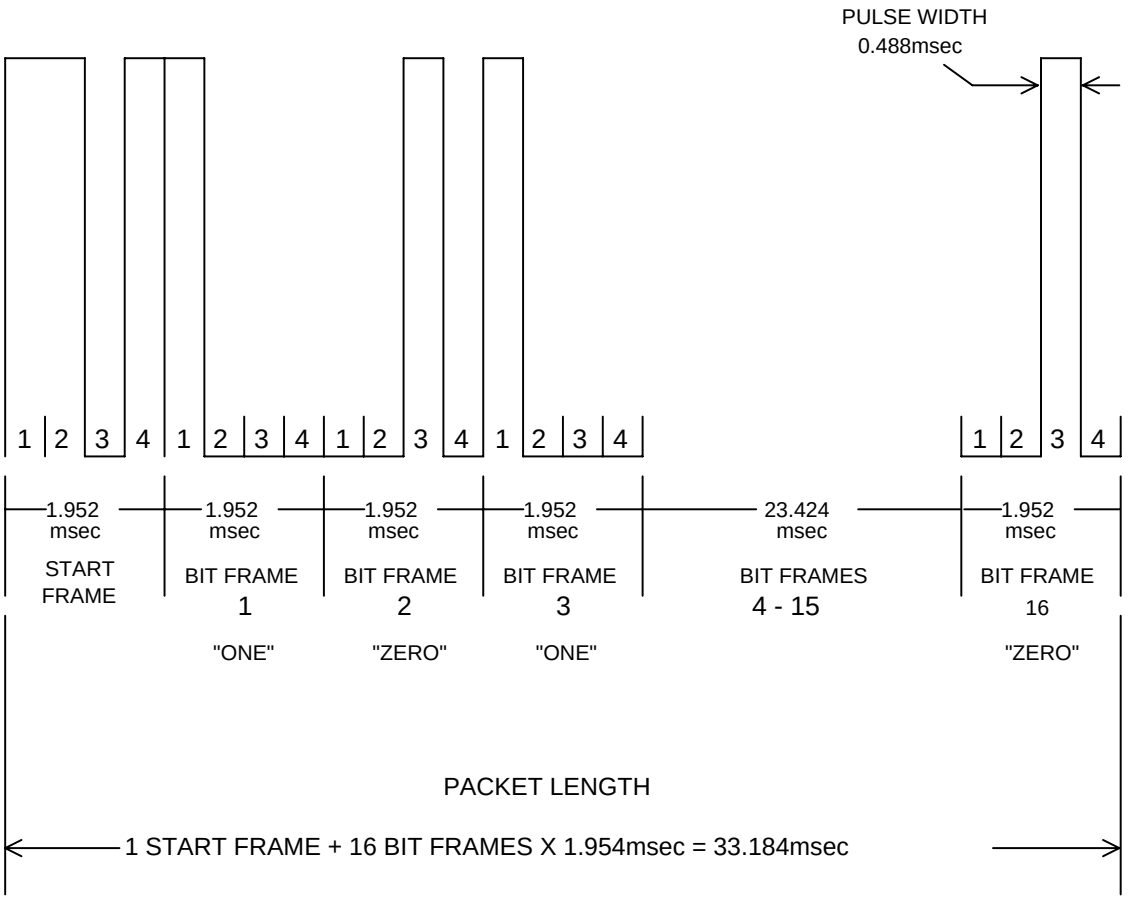
-2Ø.Ø dB POINTS: 412.5Ø kHz

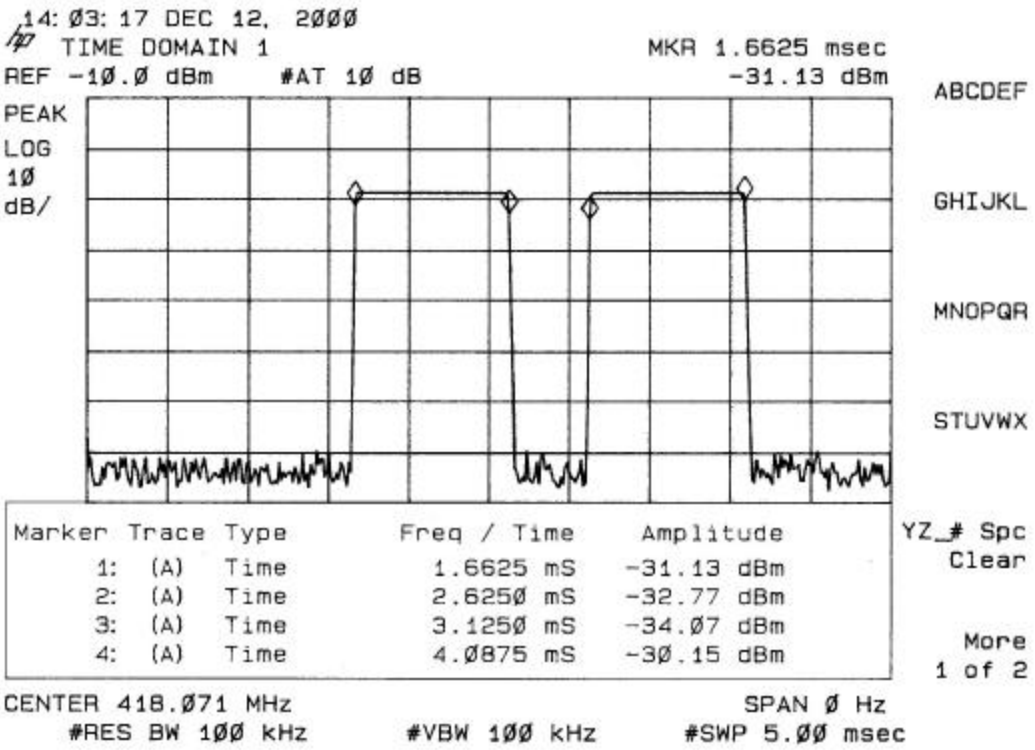


WA SB
SC FS
CORR

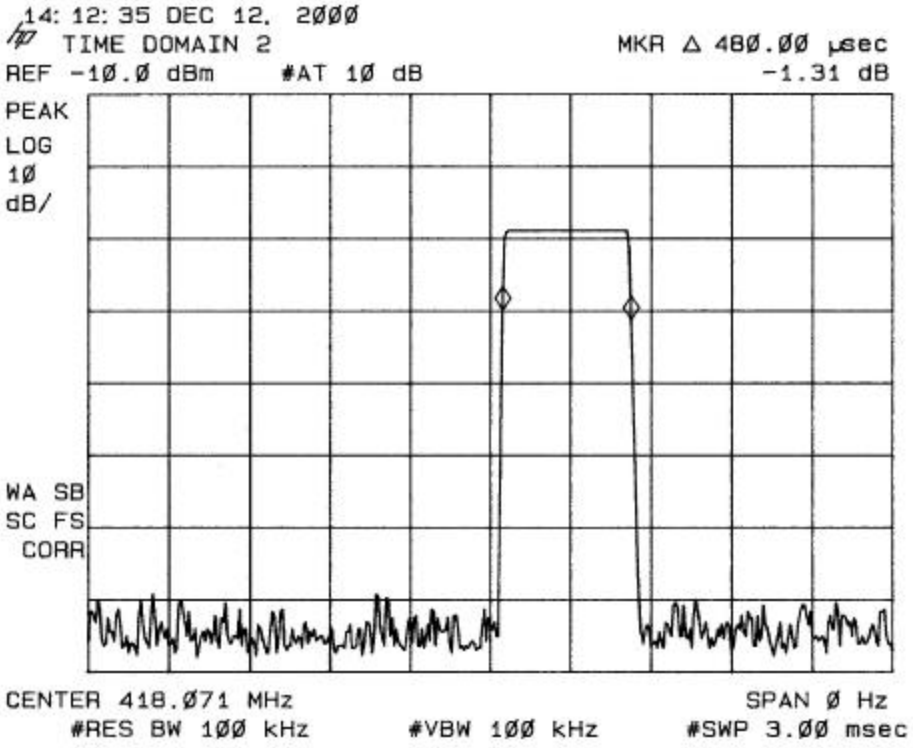
CENTER 418.Ø71 MHz
SPAN 5.ØØØ MHz
#RES BW 1ØØ kHz
#VBW 1ØØ kHz
#SWP 3ØØ msec

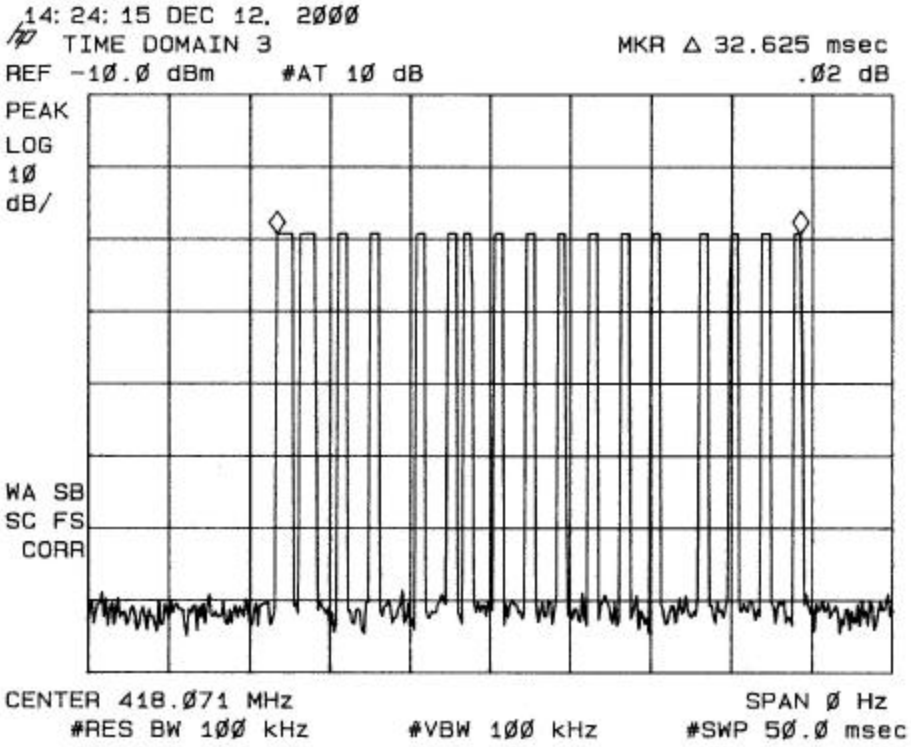
TIMING DIAGRAM



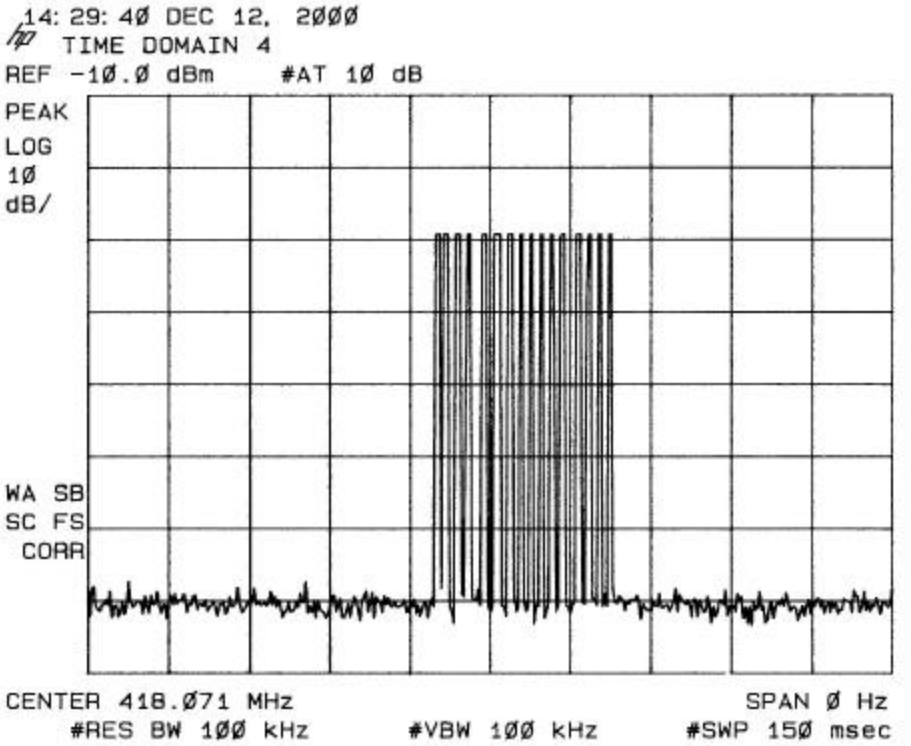

14: Ø3: 17 DEC 12, 2ØØØ
TIME DOMAIN 1
MKR 1.6625 msec
REF -1Ø.Ø dBm
#AT 1Ø dB
-31.13 dBm
ABCDEF
PEAK
LOG
1Ø
dB/
GHIJKL
MNOPQR
STUVWX
Marker Trace Type Freq / Time Amplitude
1: (A) Time 1.6625 mS -31.13 dBm
2: (A) Time 2.625Ø mS -32.77 dBm
3: (A) Time 3.125Ø mS -34.Ø7 dBm
4: (A) Time 4.Ø875 mS -3Ø.15 dBm
YZ_# Spc
Clear
More
1 of 2
CENTER 418.Ø71 MHz
SPAN Ø Hz
#RES BW 1ØØ kHz
#VBW 1ØØ kHz
#SWP 5.ØØ msec

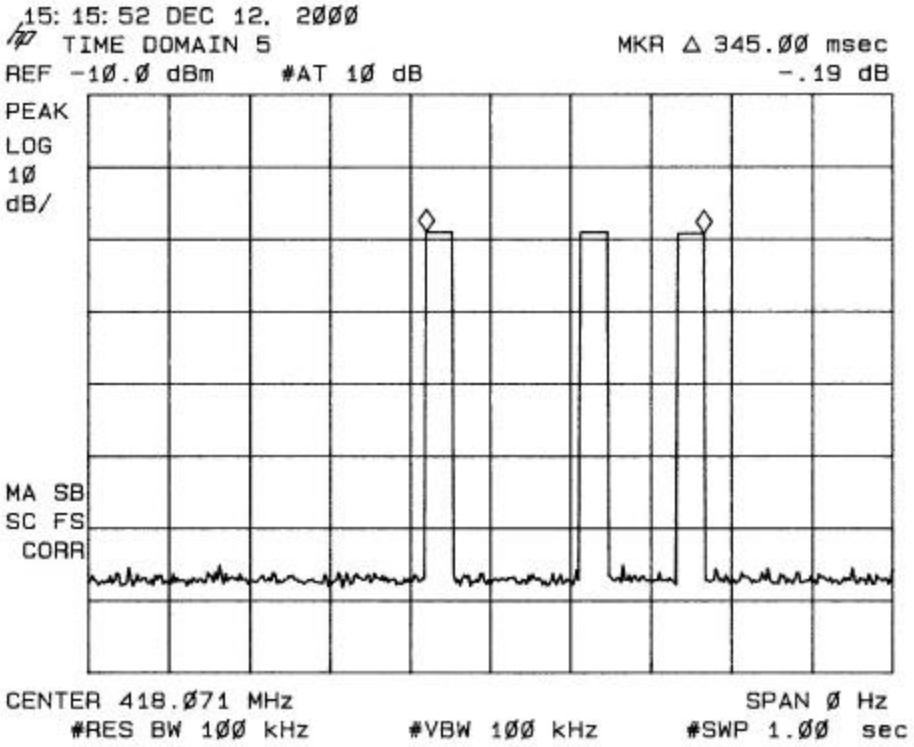
NFA-L25RS


14: 12: 35 DEC 12, 2ØØØ
TIME DOMAIN 2
MKR Δ 48Ø.ØØ µsec
REF -1Ø.Ø dBm
#AT 1Ø dB
-1.31 dB
PEAK
LOG
1Ø
dB/
WA SB
SC FS
CORR
CENTER 418.Ø71 MHz
SPAN Ø Hz
#RES BW 1ØØ kHz
#VBW 1ØØ kHz
#SWP 3.ØØ msec

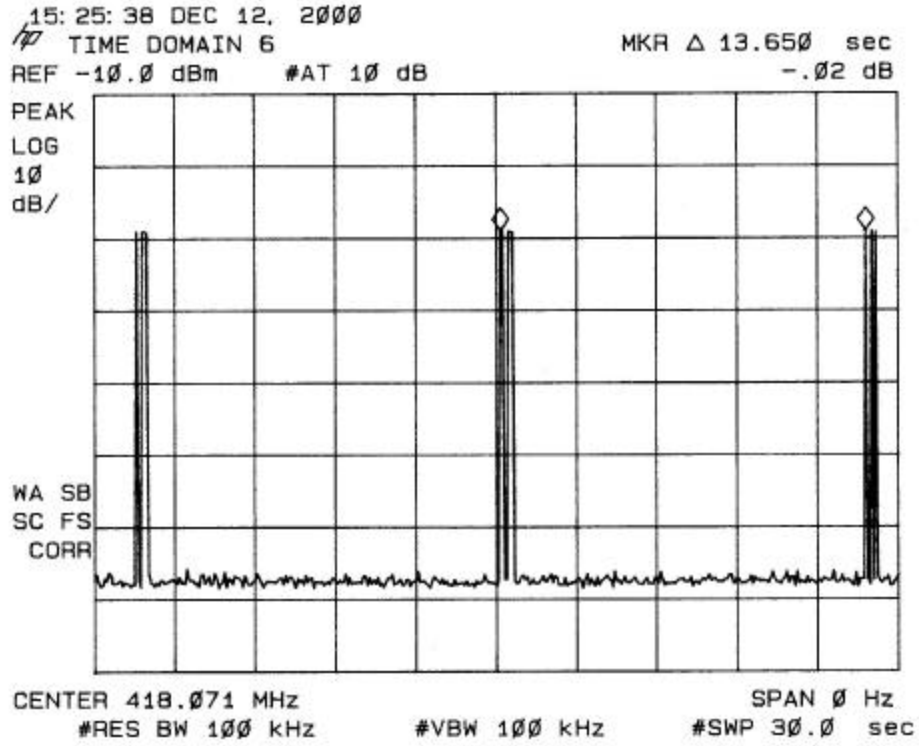

14: 24: 15 DEC 12, 2000
TIME DOMAIN 3
MKR Δ 32.625 msec
REF -10.0 dBm
#AT 10 dB
.02 dB
PEAK
LOG
10
dB/
WA SB
SC FS
CORR
CENTER 418.071 MHz
SPAN 0 Hz
#RES BW 100 kHz
#VBW 100 kHz
#SWP 50.0 msec

NFA-L25RS


14: 29: 40 DEC 12, 2000
TIME DOMAIN 4
REF -10.0 dBm
#AT 10 dB
PEAK
LOG
10
dB/
WA SB
SC FS
CORR
CENTER 418.071 MHz
SPAN 0 Hz
#RES BW 100 kHz
#VBW 100 kHz
#SWP 150 msec


15: 15: 52 DEC 12, 2000
TIME DOMAIN 5
MKR Δ 345.00 msec
REF -10.0 dBm
#AT 10 dB
-.19 dB
PEAK
LOG
10
dB/
MA SB
SC FS
CORR
CENTER 418.071 MHz
SPAN 0 Hz
#RES BW 100 kHz
#VBW 100 kHz
#SWP 1.00 sec

NFA-L25RS


15: 25: 38 DEC 12, 2000
TIME DOMAIN 6
MKR Δ 13.650 sec
REF -10.0 dBm
#AT 10 dB
-.02 dB
PEAK
LOG
10
dB/
WA SB
SC FS
CORR
CENTER 418.071 MHz
SPAN 0 Hz
#RES BW 100 kHz
#VBW 100 kHz
#SWP 30.0 sec