The University of Michigan
Radiation Laboratory
3228 EECS Building
Ann Arbor, MI 48109-2122
Tel: (734) 647-1792

Measured Radio Frequency Emissions
From

Lamson Plug-In Doorbell
(Receiver)
Model: 3730R

Report No. 415031-911
April 17, 1998

For:
Lamson Home Products
25701 Science Park Drive
Cleveland, OH 44122

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Measurements made by:
Daliang Shi
Valdis Liepa

Tests supervised by:
Report approved by:
Valdis V. Liepa
Research Scientist

Summary

Tests for compliance with FCC Regulations subject to Part 15, Subpart B, were performed on Lamson Model 3730R superregenerative receiver. This device is subject to Rules and Regulations as a Receiver. As a Digital Device it is exempt, but such measurements were made to assess the receiver's overall emissions.

In testing performed on April 1, 1997, the device tested in the worst case met the specifications for radiated emissions by 9.6 dB (see p. 6). The line conductive emission limits (Class B) were met by 4.0 dB.

1. Introduction

Lamson Doorbell Receiver, Model 3730R, was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-1992 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland. (FCC file 31040/SIT)

2. Test Procedure and Equipment Used

The test equipment commonly used in our facility is listed in Table 2.1 below. The second column identifies the specific equipment used in these tests. The HP 8593E spectrum analyzer is used for primary amplitude and frequency reference.

Table 2.1. Test Equipment.

Test Instrument	Eq'nt Used	Manufacturer/Model	Cal. Date/By
Spectrum Analyzer (9kHz-22GHz)		Hewlett-Packard 8593A SN: 3107A01358	July 1997/HP
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E SN: 3107A01131	June 1997/HP
Spectrum Analyzer (0.1-1500 MHz)	X	Hewlett-Packard 182T/8558B SN: 1529A01114/543592	August 1996/U of M Rad Lab
Preamplifier (5-1000MHz)	X	Watkins-Johnson A11 -1 plus A25-1S	May 1997/U of M Rad Lab
Preamplifier (5-4000 MHz)	X	Avantek	Nov. 1992/ U of M Rad Lab
Power Meter w/ Thermistor		Hewlett-Packard 432A Hewlett-Packard 478A	August 1989/U of M Rad Lab August 1989/U of M Rad Lab
Broadband Bicone (20-200 MHz)	X	University of Michigan	July 1996/U of M Rad Lab
Broadband Bicone (200-1000 MHz)	X	University of Michigan	June 1996/U of M Rad Lab
Dipole Antenna Set (25-1000 MHz)		University of Michigan	June 1996/U of M Rad Lab
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C SN: 992	June 1996/U of M Rad Lab
Active Loop Antenna (0.090-30MHz)		EMCO 6502 SN: 2855	December 1993/ EMCO
Active Rod (30Hz-50 MHz)		EMCO 3301B SN: 3223	December 1993/EMCO
Ridge-horn Antenna (0.5-5 GHz)	X	University of Michigan	February 1991/U of M Rad Lab
LISN Box		University of Michigan	May 1994/U of M Rad Lab
Signal Cables	X	Assorted	January 1993/U of M Rad Lab
X-Y Plotter		Hewlett-Packard 7046A	During Use/U of M Rad Lab
Signal Generator (0.1-990 MHz)	X	Hewlett-Packard 8656A	January 1990/U of M Rad Lab
Printer	X	Hewlett-Packard 2225A	August 1989/HP

3. Configuration and Identification of Device Under Test

The DUT was a 315.0 MHz superregenerative receiver developed by Lamson to perform like a conventional doorbell when activated by companion transmitter. Its dimensions are approximately 4 x 3 x 1.3 inches, and antenna is internal For power, it plugs in the wall. There is no micro; decoding is done in analog circuitry.

The DUT was designed and manufactured by Lamson Home Products, 25701 Science Park Drive, Cleveland, OH 44122. It is identified as:

Lamson Plug-In Doorbell Receiver
Model 3730R
SN: FCCTEST
FCC ID: DE43730R
CANADA: to be provided by IC

3.1 Modifications Made

There were no modifications made to the DUT by this laboratory.

4. Emission Limits

The DUT tested falls under Part 15, Subpart B, "Unintentional Radiators". The pertinent test frequencies, with corresponding emission limits, are given in Tables 4.1 and 4.2 below and Section 4.3.

4.1 Radiated Emission Limits

Table 4.1. Radiated Emission Limits (Ref: 15.33, 15.35, 15.109).

Freq. (MHz)	Elim (3m) µV/m	Elim dB(µV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Quasi-Peak readings apply to 1000 MHz (120 kHz BW)
Average readings apply above 1000 MHz (1 MHz BW)

4.2 Line Conducted Emission Limits

Table 4.2. Conducted Emission Limits (Ref: 15.107).

Freq. (MHz)	µV	dB(µV)
0.450 - 1.705	250	48.0
1.705 - 30.0	250	48.0

Note: Quasi-Peak readings apply here

4.3 Antenna Power Conduction Limits
Ref: 15.111(a). Pmax = 2 nW; for frequency range see Table 4.1.

5. Emission Tests and Results

NOTE: Even though the FCC and/or Industry Canada specify that both the radiated and conductive emissions be measured using the Quasi-Peak and/or average detection schemes, we normally use peak detection since especially the Quasi-Peak is cumbersome to use with our instrumentation. In case the measurement fails to meet the limits, or the measurement is near the limit, it is remeasured using appropriate detection. We note, that since the peak detected signal is always higher or equal to the Quasi-Peak or average detected signal, the margin of compliance may be better, but not worse, than indicated in this report. The type of detection used is indicated in the data table, Table 5.1.

5.1 Anechoic Chamber Radiated Emission Tests
To familiarize with the radiated emission behavior of the DUT, it was studied and measured in the shielded anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with turntable, antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

To study and test for radiated emissions, the DUT was powered by a laboratory power supply at 13.6 VDC. A 315 MHz CW signal was injected (radiated) from a nearby signal generator using a short wire antenna. The DUT was placed on the test table on each of its three axis. For each placement, the table was rotated to obtain maximum signal for vertical and horizontal emission polarizations. This sequence was repeated throughout the required frequency range.

In the chamber we studied and recorded all the emissions using a ridge-horn antenna, which covers 200 MHz to 5000 MHz, up to 2 GHz. In scanning from 30 MHz to 2.0 GHz, there were no spurious emissions observed other than the LO, the injection signal, and the LO harmonics. Figures 5.1 and 5.2 show emissions measured 0-1000 MHz and 1000-2000 MHz, respectively. These measurements are made with a ridge-horn antenna at 3m, with spectrum analyzer in peak hold mode and the receiver rotated in all orientations. The measurements up to 1000 MHz (Fig. 5.1) are used for initial evaluation only, but those above 1000 MHz (Fig. 5.2) are used in final assessment for compliance.

5.2 Open Site Radiated Emission Tests
The DUT was then moved to the 3 meter Open Field Test Site where measurements were repeated up to 1000 MHz using a dipole. The DUT was excersized as described in Sec. 5.1 above. The measurements were made with a spectrum analyzer using 120 kHz IF bandwidth and peak detection mode, and, when appropriate, using Quasi-Peak or average detection (see 5.0). Figure 5.3 shows the close-up of the DUT on the test table, and figure 5.4 shows the overview of the site.

The emissions from digital circuitry were measured on the Open Site using a standard dipole. These results are also given in Table 5.1.

5.3 Computations and Results for Radiated Emissions
To convert the dBm's measured on the spectrum analyzer to dB(μV/m), we use expression

$$E_3(dB\mu V/m) = 107 + P_R + K_A - K_G$$

where P_R = power recorded on spectrum analyzer, dB, measured at 3m
K_A = antenna factor, dB/m
K_G = pre-amplifier gain, including cable loss, dB

When presenting the data, at each frequency the highest measured emission under all of the possible orientations is given. Computations and results are given in Table 5.1. There we see that the DUT meets the limit by 9.6 dB.

5.4 Conducted Emission Tests
Standard FCC/IC measurement procedures were used and the dominant emissions are presented in Table 5.1. From there we see that the DUT meets the Class B limits by 4.0 dB.

6. Other Measurements

6.1 Emission Spectrum Near Fundamental

Near operating frequency the emission spectrum is measured typically over 50 MHz span with and without injection signal. These data are taken with the DUT close to antenna and, hence, amplitudes are relative. The plots are shown in Figure 6.1.

6.2 Effect of Supply Voltage Variation

The DUT has been designed to operate from 115 VAC power. Using a spectrum analyzer, relative radiated emissions were recorded at the "fundamental" (316 MHz) as voltage was varied from 60 to 140 VAC. Figure 6.2 shows the emission variation.

6.3 Operating Voltage and Current

V = 115 VAC
I = 44.4 mA

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(734) 647-1792

Table 5.1 Highest Emissions Measured

Radiated Emission - RF — Lamson 3730R RX; FCC

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	313.6	SBic	H	-66.7	Pk	18.9	23.0	36.1	46.0	9.9	side
2	313.6	SBic	H	-65.1	Pk	18.9	23.0	37.7	46.0	8.3	end
3	313.6	SBic	V	-67.2	Pk	18.9	23.0	35.6	46.0	10.4	side
4	313.6	SBic	V	-66.7	Pk	18.9	23.0	36.1	46.0	9.9	end
5	627.2	SBic	H	-78.3	Pk	25.2	19.7	34.2	46.0	11.8	end
6	627.2	SBic	V	-79.8	Pk	25.2	19.7	32.7	46.0	13.3	end
7	940.8	SBic	H	-82.1	Pk	28.8	17.3	36.4	46.0	**9.6**	end
8	940.8	SBic	V	-85.8	Pk	28.8	17.3	32.7	46.0	13.3	side
9	1260.0	Horn	H	-67.0	Pk	20.4	28.0	32.4	54.0	21.6	max. of all
10	1575.0	Horn	H	-69.0	Pk	20.6	28.0	30.6	54.0	23.4	max. of all, noise
11	1890.0	Horn	H	-68.0	Pk	20.8	28.2	31.6	54.0	22.4	max. of all, noise
12											
13											
14											
15											
16											
17											
18											

Radiated Emission - Digital (Class B)

1											
2	Digital Emissions more than 20 dB below Class B limits										
3											

Conducted Emissions (Class B)

#	Freq. MHz	Line Side	Det. Used	Vtest dBµV	Vlim dBµV	Pass dB	Comments
1	0.52	Lo	Pk	41	48	7.0	
2	1.50	Lo	Pk	40.5	48	7.5	
3	1.95	Lo	Pk	41.0	48	7.0	
4	2.50	Lo	Pk	43.0	48	5.0	
5	16.70	Lo	Pk	42.0	48	6.0	
6	1.05	Hi	Pk	41.0	48	7.0	
7	1.50	Hi	Pk	44.0	48	**4.0**	
8	1.80	Hi	Pk	42.5	48	5.5	
9	2.50	Hi	Pk	43.0	48	5.0	
10							
11							
12							
13							
14							
15							

Meas. 4/1/97; U of Mich.

Figure 5.1. Emissions measured at 3 meters in anechoic chamber, 0-1000 MHz.
(top) Receiver plus ambient
(bottom) Ambient

Figure 5.2. Emissions measured at 3 meters in anechoic chamber, 1000-2000 MHz.
(top) Receiver plus ambient
(bottom) Ambient

Figure 6.1. Relative receiver emissions in stand-by and "locked-in" modes. The final emission measurements were made with the receiver in "locked-in" mode.

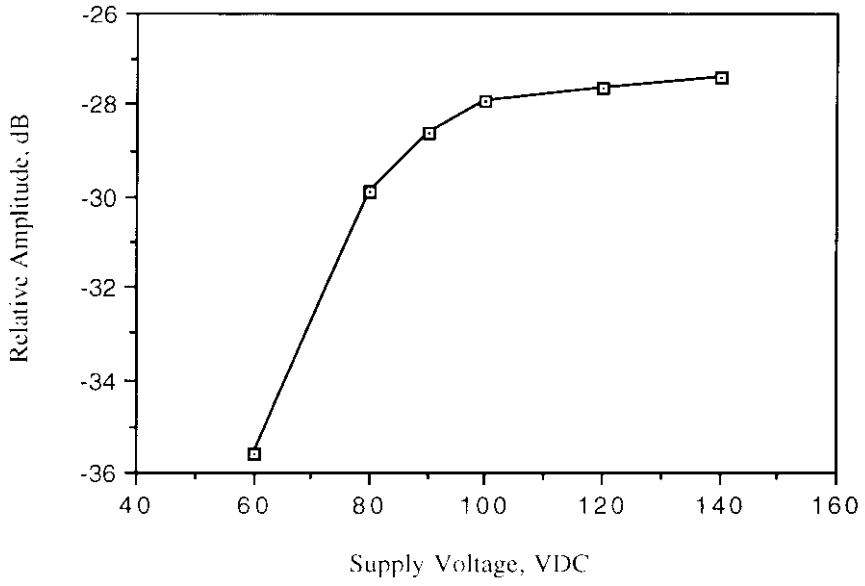


Figure 6.2. Relative emission at "fundamental" vs. supply voltage.

Product Description 3730R Plug-In Doorbell Receiver

I Introduction

The 3730R receiver is designed to mimic a conventional (wired) doorbell is both function and appearance. The receiver operates in a system consisting of a chime button and the 3730R. Typically, the chime button is placed at the entrance of a home and the 3730R receiver is placed inside. When the button is depressed the 3730R receiver makes a pleasant sound alerting the occupants of the building of the presence of a visitor. The chime button and receiver communicate with each other using an AM modulated UHF radio signal.

II System Description

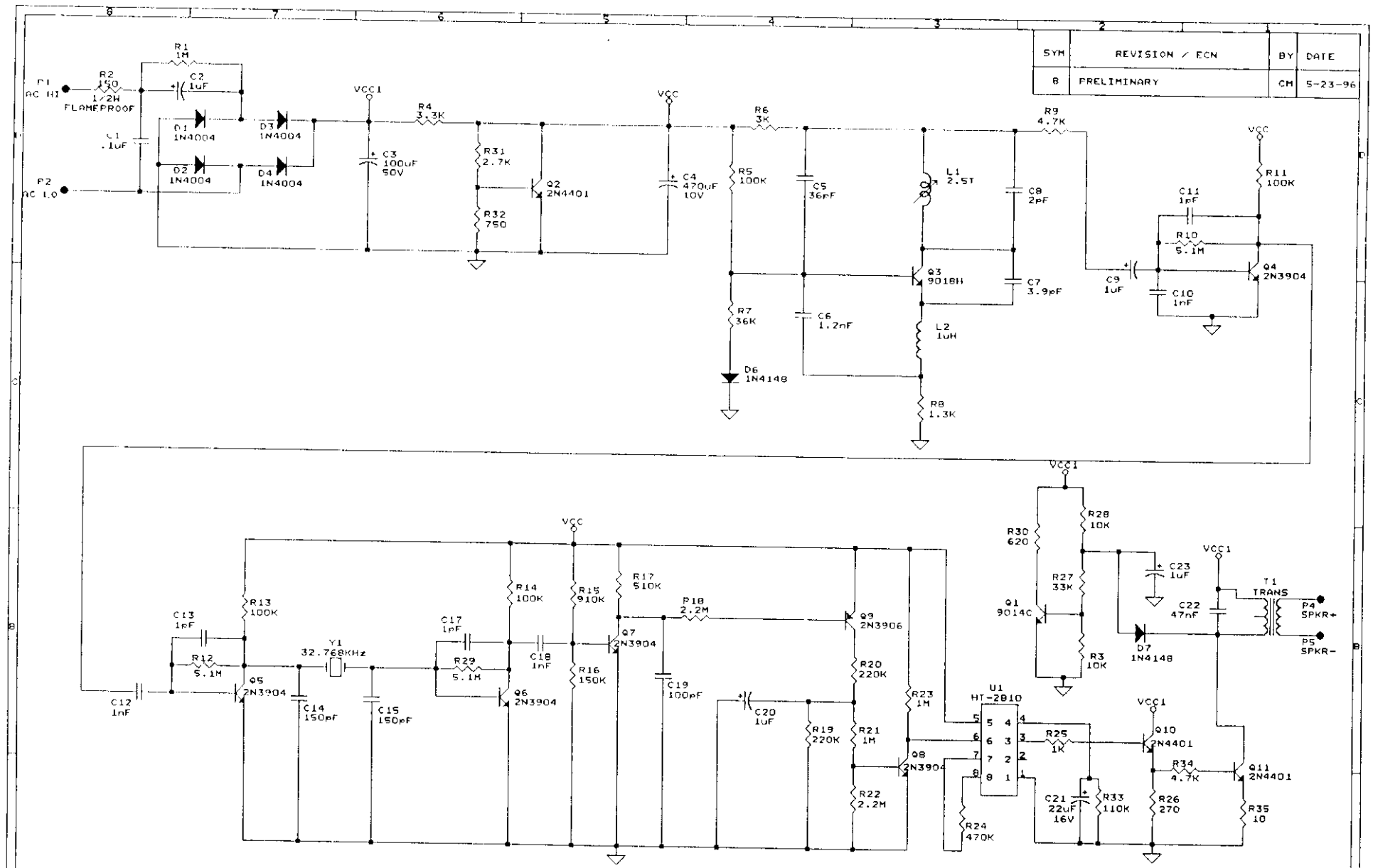
The chime button transmits an ASK modulated 315 MHz signal. The modulating signal is a 32 kHz pulse train. This 32 kHz signal is produced by a crystal oscillator.

An RF superregenerative receiver, tuned to 315 MHz is used to detect and demodulate the ASK signals from the chime button. The demodulated signal is further filtered by a crystal filter that uses a crystal that matches the one in the button. The bandwidth of the filter is quite small (50 Hz). If a signal is present at the output of the filter, then a sound making IC is activated.

III Detailed Description

Referring to the schematic. AC is applied between P1 and P2. D1,2,3,4 form a bridge rectifier. Q2 is a voltage regulator.

Q3 and associated circuitry form the superregenerative detector.to production. Q4 is a baseband amplifier. Q5, Y1, Q6 and associated circuitry form the crystal filter. This filter is tuned to 32.768kHz the same frequency that modulates the transmitter. Q7 rectifies the amplified 32 kHz signal from the output of the crystal filter. Q9 and C20 form a timer. If an uninterrupted 32 kHz signal is present for more than 250msec, then collector of Q8 goes to ground. This timer prevents the receiver from responding to noise or other false signals. When Q11 goes low, the sound chip, U1 produces a chime sound. The audio signal is amplified by Q10 and Q11. Q1 is used to sense the presence of the audio signal. If the audio is not active, then it adds a load to the power supply at VCC1 to minimize the power dissipated in Q2.



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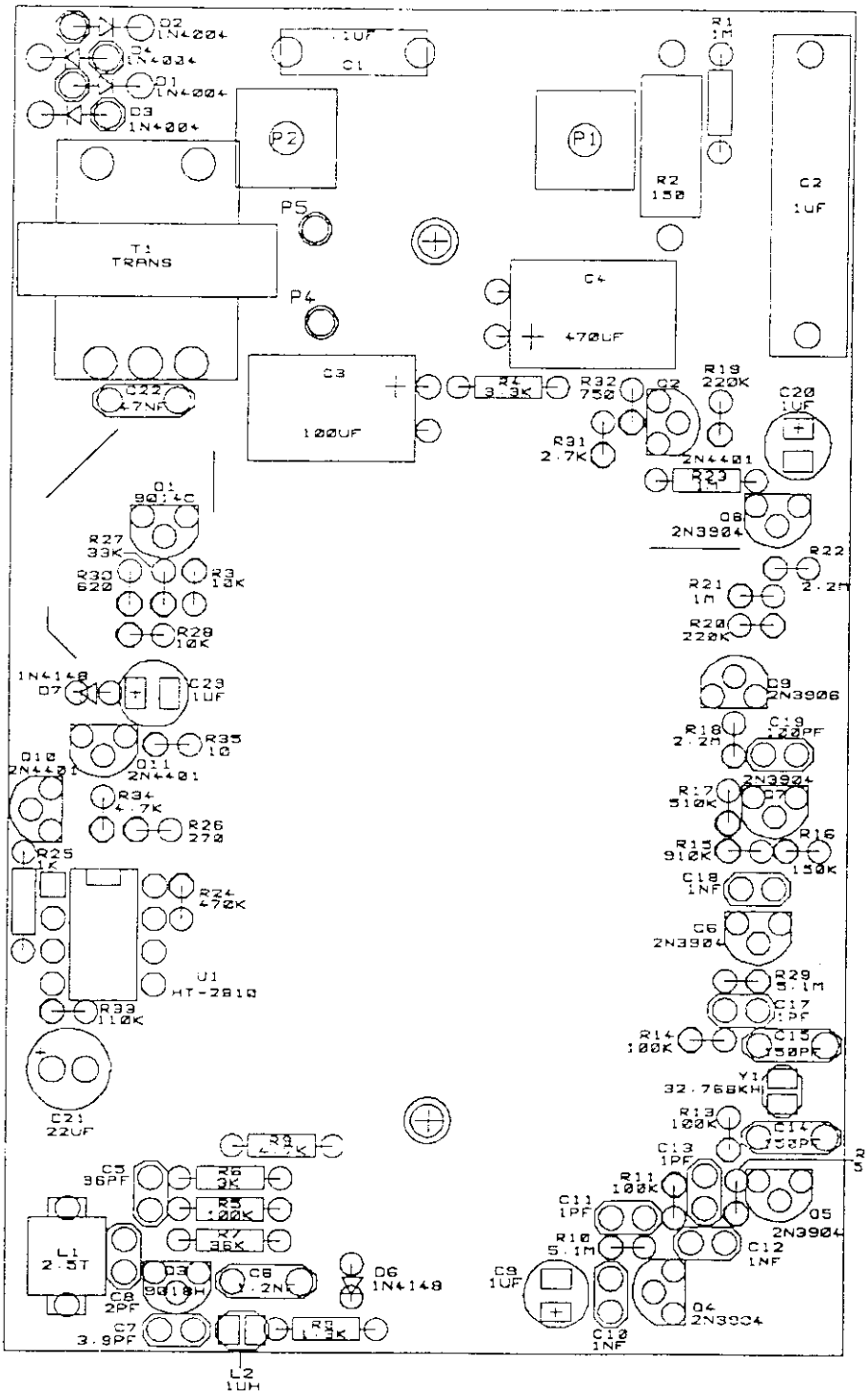
DIMANGO PRODUCTS CORPORATION
7258 Kensington Rd. Brighton, MI 48116
(313) 486-0770 FAX (313) 486-2967

Name: PLUG-IN DOORBELL

Drawn | Check

Size: B | Document Number: Z3730R-02-8(SC) | REV: B

Date: May 23, 1996 | Sheet 1 of 1



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				NAME	PLUG-IN DOORBELL		
				DRAWN CA	DATE 5-24-96	SCALE	SHEET 1 OF 1
				Q.C.	DRAWING NO.		
				ENG.	Z3730R-02-8(AD)		
8	PRELIMINARY	CM	5-24-96	DIMANGO PRODUCTS CORPORATION 7258 KENSINGTON ROAD, BRIGHTON, MI 48116 (310) 486-0770 FAX (810) 486-2967			REV. 8
SYM	DESCR.	BY	DATE				

3730R(BM) Bill of Materials
Plug-in Doorbell

Preliminary: June 3, 1996
Released: June 25, 1996
Revised: August 15, 1996 *

Line	Qty	Drawing No.+	Reference	Part Name
1	1	3730R-01-A(C)		Cover
2	1	3730R-02-A0		Printed Circuit Board Assembly (See 3730R-02-A0(AB))
3		3730R-07		Base Assembly, consisting of:
*	1	3730R-03-D(C)		Base
		3730R-05-A(A)		Etched Label,Product,UL and FCC (Artwork)
4	2	3300R-04-A(A)		Blade, A. C.
5	1	QC001-02-B(A)		QC/Date Code Label. 13mm Diameter
6	2			Eyelets,3mm
7	2			Screw,Flat Head,Cross Recess, 3mm X 16mm Long, Self Threading

+ IF THE NUMBER LISTED UNDER "DRAWING NO. +" CONTAINS NO SUFFIX IN BRACKETS ( ) THEN IT IS A PART NUMBER WITHOUT A DRAWING ON FILE.

Note: For Bulk Shipping

1	Bubble Bag
1	Bulk Shipping Carton

EXHIBIT
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Z3730R-02-8(AB) Bill of Materials
Plug-In Doorbell

Preliminary: May 16, 1996
Released:
Revised:

Line	Qty	Drawing No.+	Reference	Part Name
1	1		C1	.1uF,250VDC or 160VAC,+/-10% Polyester Capacitor
2	1	Tung Shin# MPK105-2ESD	C2	1uF,160VAC,+/-10%,Polyester Capacitor
3	1		C3	100uF,50V,+/-20%, Electrolytic Capacitor
4	1		C4	470uF,50V,+/-10%, Electrolytic Capacitor
5	1		C5	36pF,50V,+/-5%,Ceramic Disc Capacitor
6	1		C6	1.2nF,50V,+/-5%,Ceramic Disc Capacitor
7	1		C7	3.9pF,50V,+/-.25pF,NPO,Ceramic Disc Capacitor
8	1		C8	2pF,50V,+/-.25pF,NPO,Ceramic Disc Capacitor
9	2		C9,C20	1uF,16V,+/-20%,Electrolytic Capacitor
10	3		C10,C12,C18	1nF,50V,+/-20%,GP,Ceramic Disc Capacitor
11	3		C11,C13,C17	1pF,50V,+/-.25pF,NPO,Ceramic Disc Capacitor
12	2		C14,C15	150pF,50V,+/-20%,GP,Ceramic Disc Capacitor
13	1		C19	100pF,50V,+/-20%,GP,Ceramic Disc Capacitor
14	1		C21	22uF,16V,+/-20%,Electrolytic Capacitor
15	1		C22	47nF,50V,+/-20%,Polyester Capacitor
16	1		C23	1uF,50V,+/-20%,Electrolytic Capacitor
17	4		D1,D2,D3 D4	1N4004,Rectifier Diode 1A,400 PIV
18	2		D6,D7	1N4148,Switching Diode

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Line	Qty	Drawing No.+	Reference	Part Name
19	5			Jumper,22 Gauge Buss Wire (D12) Component Layout is now a Jumper
20	1 1		L1	Coil,21/2 turn,Red in color Slug,Aluminum
21	1		L2	1uH,RF Choke
22	1		P4	Speaker Wire, Red, UL 1015,105 Celcius, 600V,22gauge, 51mm Long
23	1		P5	Speaker Wire, Blue, UL 1015,105 Celcius, 600V,22gauge, 51mm Long
24	1		Q1	9014C,NPN Transistor
25	3		Q2,Q10,Q11	2N4401,NPN Transistor
26	1		Q3	9018H,NPN,RF Transistor
27	5		Q4,Q5,Q6 Q7,Q8	2N3904,NPN Transistor
28	1		Q9	2N3906,PNP Transistor
29	3		R1,R21,R23	1M,1/4W,5%,Carbon Film Resistor
30	1		R2	150 Ohm,1/2W,5%,Carbon Film Resistor Flameproof
31	2		R3,R28	10K,1/4W,5%,Carbon Film Resistor
32	1		R4	3.3K,1/4W,5%,Carbon Film Resistor
33	4		R5,R11,R13 R14	100K,1/4W,5%,Carbon Film Resistor
34	1		R6	3K,1/4W,5%,Carbon Film Resistor
35	1		R7	36K,1/4W,5%,Carbon Film Resistor
36	1		R8	1.3K,1/4W,5%,Carbon Film Resistor

Z3730R-02-8(AB) Bill of Materials
Plug-In Doorbell

Preliminary: May 16, 1996
Released:
Revised:

Line	Qty	Drawing No.+	Reference	Part Name
37	2		R9,R34	4.7K,1/4W,5%,Carbon Film Resistor
38	3		R10,R12,R29	5.1M,1/4W,5%,Carbon Film Resistor
39	1		R15	910K,1/4W,5% Carbon Film Resistor
40	1		R16	150K,1/4W,5% Carbon Film Resistor
41	1		R17	510K,1/4W,5%,,Carbon Film Resistor
42	2		R18,R22	2.2M,1/4W,5%,,Carbon Film Resistor
43	2		R19,R20	220K,1/4W,5%,,Carbon Film Resistor
44	1		R24	470K,1/4W,5%,,Carbon Film Resistor
45	1		R25	1K,1/4W,5%,,Carbon Film Resistor
46	1		R26	270 Ohm,1/4W,5%,,Carbon Film Resistor
47	1		R27	33K,1/4W,5%,,Carbon Film Resistor
48	1		R30	620 Ohm,1/4W,5%,Carbon Film Resistor
49	1		R31	2.7K,1/4W,5%,Carbon Film Resistor
50	1		R32	750 Ohm,1/4W,5%,Carbon Film Resistor
51	1		R33	110K,1/4W,5%,Carbon Film Resistor
52	1		R34	10 Ohm,1/4W,5%,Carbon Film Resistor
53	1		T1	Transformer, Z=1400/8 Ohm, Center Tap, 200mV @ 1KC Audio
54	1	Holtek HT-2810	U1	HT-2810, Sound Generator, IC
55	1			32.7KHz, Crystal
56				Solder and Flux

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Z3730R-02-8(AB) Bill of Materials
Plug-In Doorbell

Preliminary: May 16, 1996
Released:
Revised:

Line	Qty	Drawing No.+	Reference	Part Name

DOCUMENTATION

Z3730R-02-8(AW)	PCB Artwork
Z3730R-02-8(SC)	PCB Schematic
Z3730R-02-8(AD)	PCB Component Layout
Z3730R-02-8(AB)	PCB Bill of Materials

+ If the number listed under "Drawing No. contains no suffix in brackets () then we have used the part number.

EXHIBIT H
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Re: Certification for Lamson
Superregenerative Receiver
Model: 3730R
FCC ID: DE43730R
CANADA: to be provided by IC

LIST OF PHOTOGRAPHS

EXHIBIT 5

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