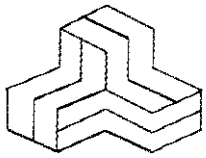
ENGINEERING TEST REPORT



Digital Cordless Telephone
MODEL NO.: TS101

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, SEC. 15.247
Direct Sequence Spread Spectrum Transmitters operating in the frequency band 904.2 - 925.8 MHz

UltraTech's FILE NO.: DAE2-FTX

Tested for:

DAEWOO TELECOM LTD.
265-3,4 Seohyun-Dong Pundang-Gu
Sungnam, 463-050
Korea

Tested by:

UltraTech - Group of Labs
3000 Bristol Circle
Oakville, Ontario
Canada L6H 6G4

Report Prepared by: Dan Huynh

DATE: April 25, 1999

TABLE OF CONTENTS

1. EXHIBIT 1 - SUMMARY OF TEST RESULTS & GENERAL STATEMENT OF CERTIFICATION

FCC PARAGRAPH.	TEST REQUIREMENTS	COMPLIANCE (YES/NO)
15.247(a)(2)	Spectrum Bandwidth of a Direct Sequence Spread Spectrum System	Yes
15.247(b) & 1.1310	Maximum Peak Power and RF Exposure Limits	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
15.247(d)	Transmitted Power Density of a Direct Sequence Spread Spectrum System	Yes
15.247(e)	Processing Gain of Direct Sequence Spread Spectrum System	Yes
15.107, 15.109	AC Power Conducted Emissions & Radiated Emissions for Receiver and Digital Circuit Portions	Yes (Note 1)

Note 1: The digital circuits portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and Radio Receivers. The engineering test report can be provided upon FCC requests.

TESTIMONIAL AND STATEMENT OF CERTIFICATION

THIS IS TO CERTIFY:

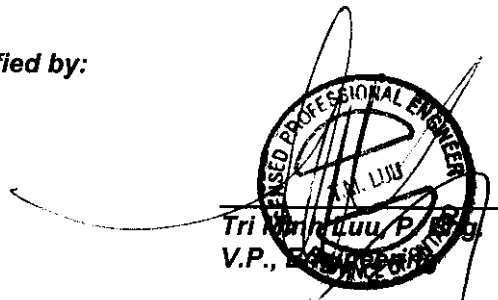
1) *THAT the application was prepared either by, or under the direct supervision of the undersigned.*

2) *THAT the measurement data supplied with the application was taken under my direction and supervision.*

3) *THAT the data was obtained on a representative production unit.*

4) *THAT, to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct.*

Certified by:



Tri Minh Luu, P. Eng.
V.P., Engineering

DATE: April 25, 1999

INPUT SUPPLY:	Handset: 3.6V DC 550mA Base: 9V DC 300mA
ASSOCIATED DEVICES:	DVE AC/DC Adaptor, Model No.: DV-9300S
FCC ID:	DTSTS101
INTERFACE PORTS:	(1) Telephone Jack Interface (2) Power Jack Interface (3) Pulse/Tone Switch Interface

2.4. RELATED SUBMITTAL(S)/GRANT

Not applicable

2.5. TEST METHODOLOGY

These tests were conducted on a sample of the equipment for the purpose of certification compliance with Code of Federal Regulations (CFR47-1991), Part 15, Subpart C, Para. 15.247, Direct Sequence Spread Spectrum Transmitters operating in the Frequency Band 904.2 - 925.8 MHz.

Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4-1992 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz.

2.6. TEST FACILITY

AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

Radiated Emissions were performed at the UltraTech's 3-10 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: September 20, 1998.

The above test site is also filed with Interference Technology International Ltd (ITI - An EC Directive on EMC).

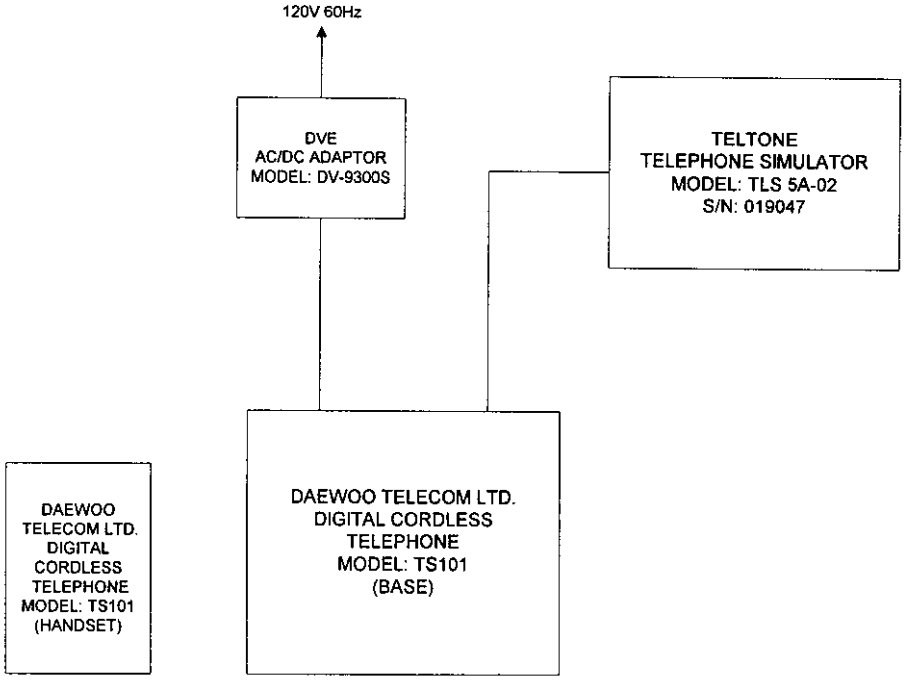
2.7. UNITS OF MEASUREMENTS

Measurements of conducted emissions are reported in units of dB referenced to one microvolt [dB(μV)].

Measurements of radiated emissions are reported in units of dB referenced to one microvolt per meter [dB(μV)/m] at the distance specified in the report, wherever it is applicable.

3. EXHIBIT 3 - SYSTEM TEST CONFIGURATION

3.1. BLOCK DIAGRAMS FOR CONDUCTED & RADIATED EMISSION MEASUREMENTS



3.3. JUSTIFICATION

No deviation, in both configuration and operation manners, different from normal operation were required.

3.4. EUT OPERATING CONDITION

Software provided by DAEWOO TELECOM LTD. to set the EUT to transmit or receive at various channel frequencies.

3.5. SPECIAL ACCESSORIES

No special accessories were required.

3.6. EQUIPMENT MODIFICATIONS

To achieve compliance, the following change(s) were made by UltraTech's test house during compliance testing:

a. Handset: Removed L12 – 1.5nH Chip inductor from PCB.
Closed (short) pin3 and pin4 of U5_RF106 24Pin IC by solder.
b. Base set: Removed L3 – 1.5nH Chip inductor from PCB.
Closed (short) pin3 and pin4 of U5_RF106 24Pin IC by solder.

4. EXHIBIT 4 - TEST DATA

4.1. 6 DB BANDWIDTH @ FCC 15.247(A)(2)

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

FCC REQUIREMENTS:

For a direct sequence spread spectrum system, the minimum 6 dB bandwidth shall be at least 500 KHz.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT: 3.6V DC 550mA (Handset), 9V DC 300mA (Base)

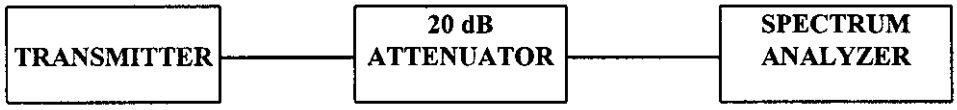
TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT

METHOD OF MEASUREMENTS:

The transmitter output was connected to the spectrum analyzer through an attenuator. the bandwidth of the fundamental frequency was measured with the spectrum analyzer using 100 KHz RBW, VBW = 100 KHz,. The 6 dB bandwidth was measured and recorded.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hung Trinh, EMI/RFI Technician

DATE: April 20, 1999

MEASUREMENT DATA:

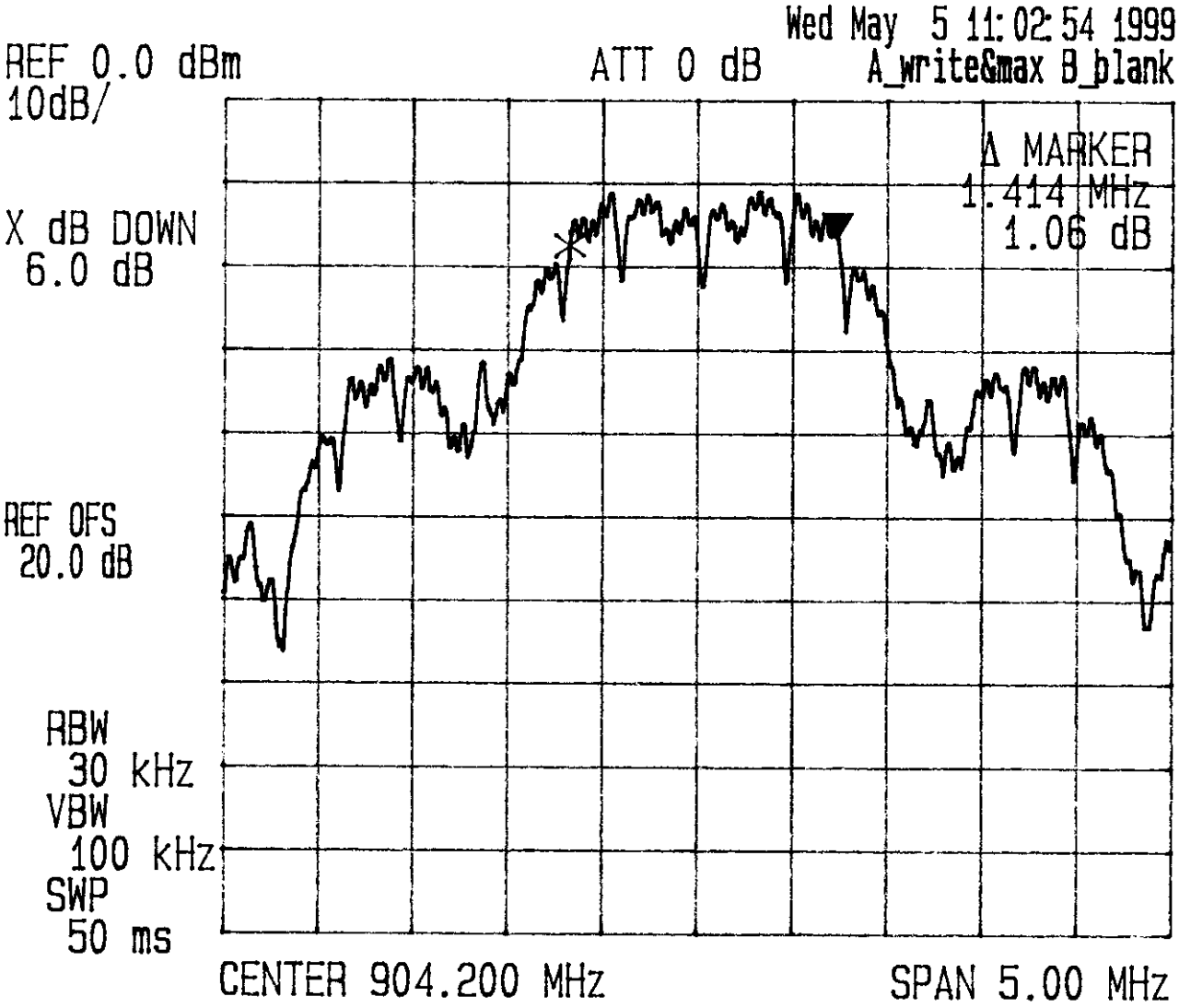
HANDSET			
CHANNEL FREQUENCY (MHz)	6 dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS/FAIL
904.2	1.414	0.5	PASS
914.4	1.414	0.5	PASS
925.8	1.414	0.5	PASS

BASE			
CHANNEL FREQUENCY (MHz)	6 dB BANDWIDTH (MHz)	MINIMUM LIMIT (MHz)	PASS/FAIL
904.2	1.407	0.5	PASS
914.4	1.400	0.5	PASS
925.8	1.400	0.5	PASS

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [V] Handset Transmitter, [ ] Base Transmitter
Channel #: 1 (LOWEST), Tx Frequency:_____

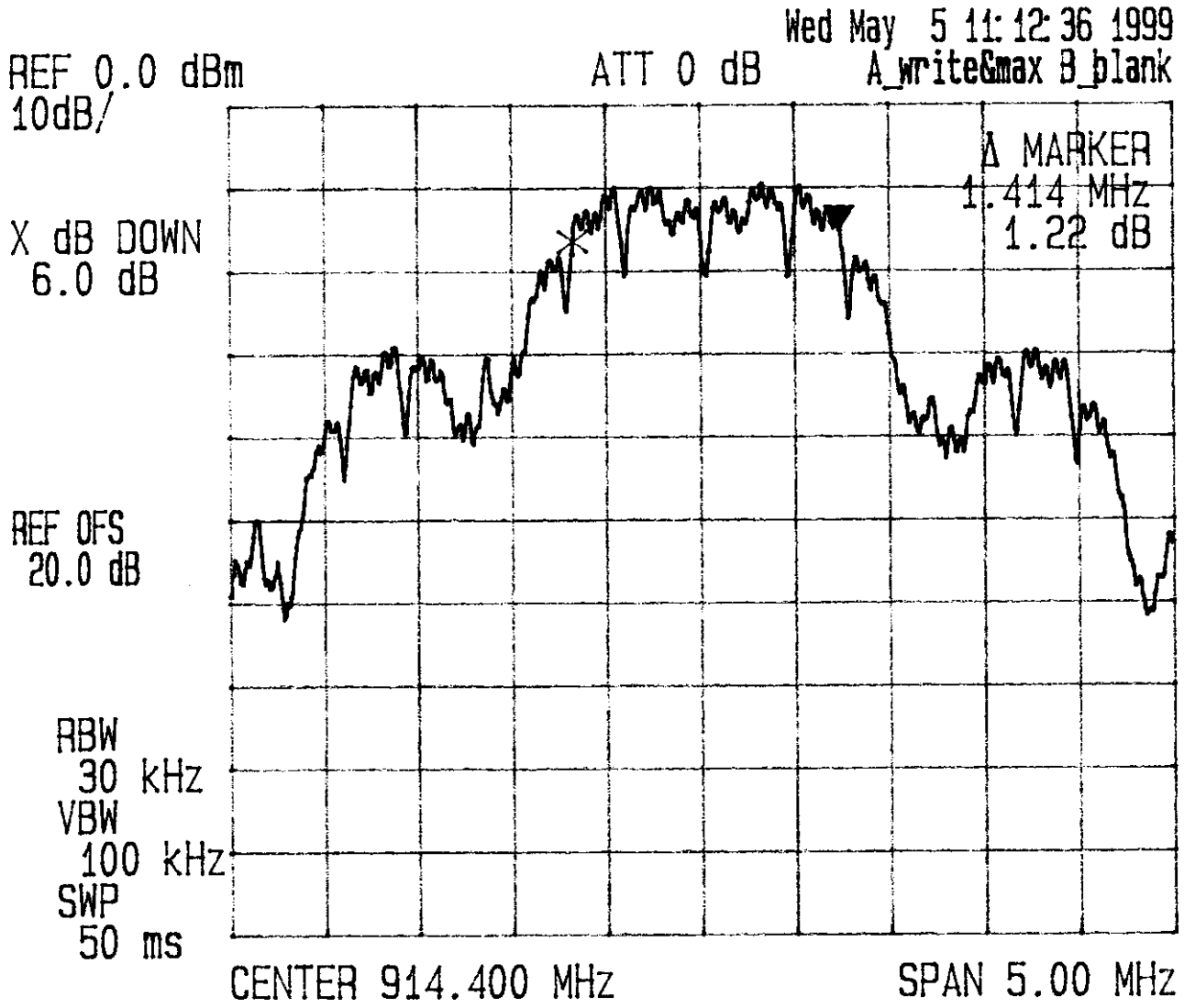
Date: May 05, 1999
Tested by: Hung Trinh



UltraTech
Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [✓] Handset Transmitter, [ ] Base Transmitter
Channel #: 10 (MIDDLE), **Tx Frequency:** 914.4 MHz.

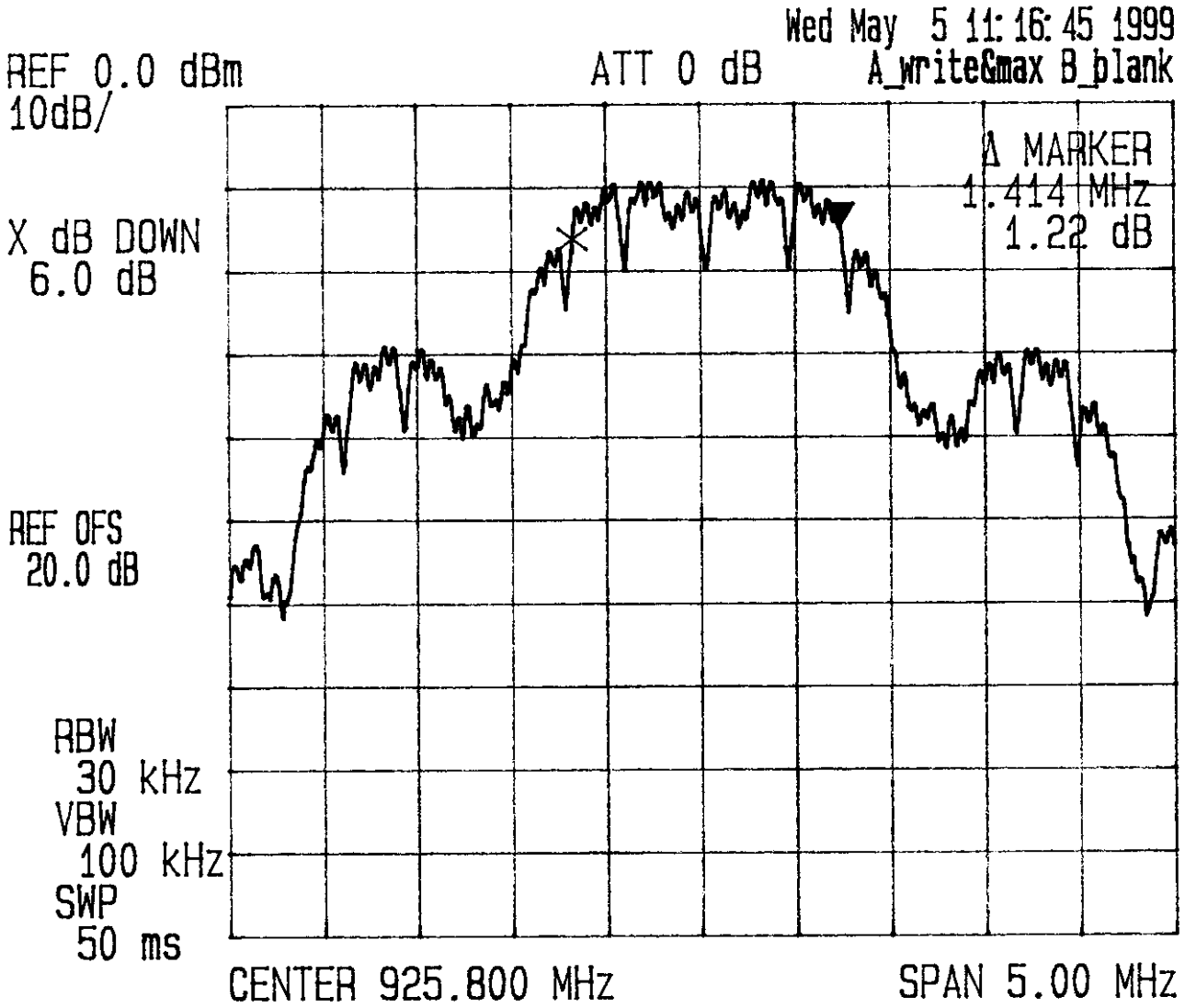
Date: May 05, 1999
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [✓] Handset Transmitter, [ ] Base Transmitter
Channel #: 20 (HIGHEST) **Tx Frequency:** 925.8 MHz

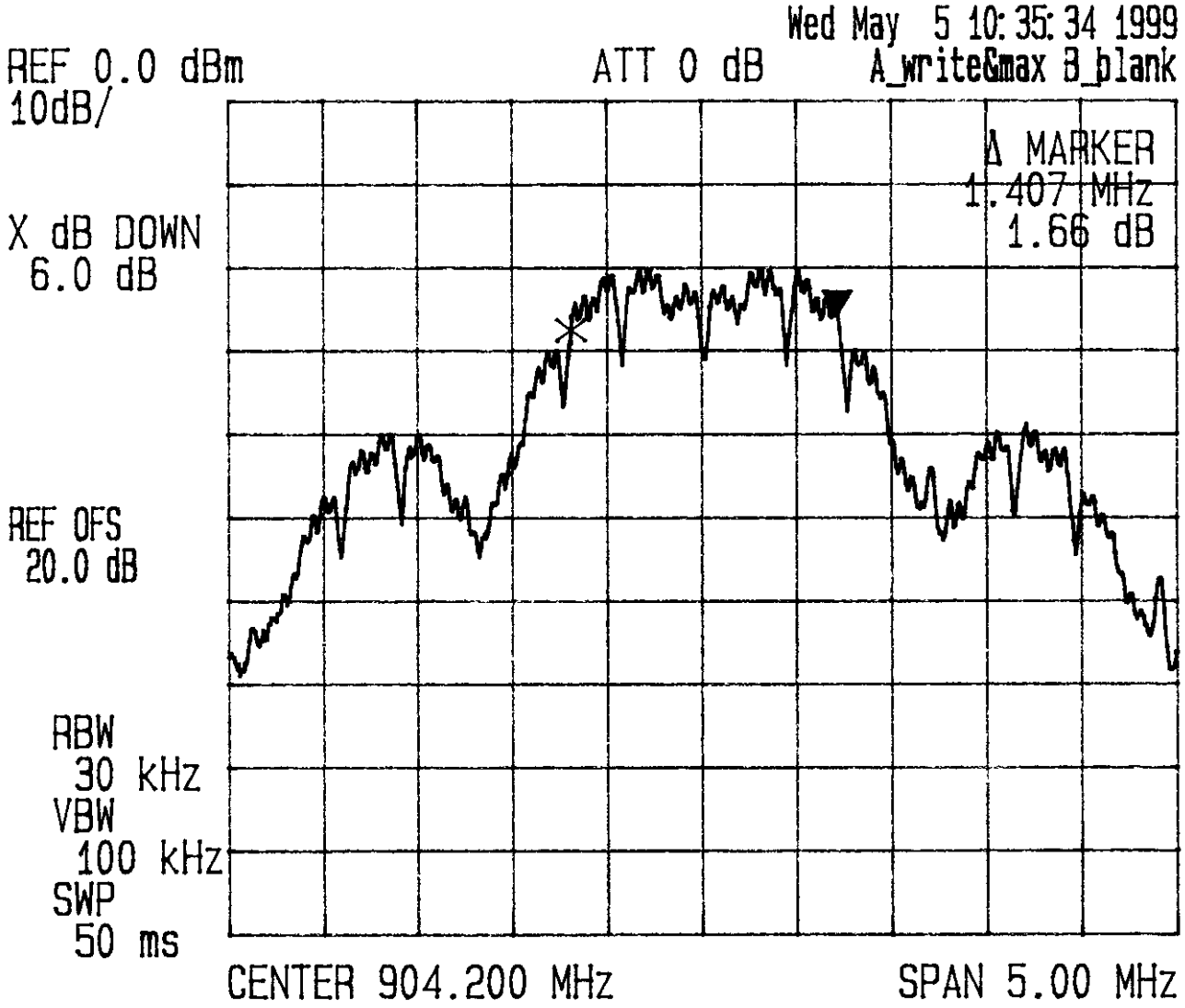
Date: May 05, 1999
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 1 (LOWEST), **Tx Frequency:** 904.20 MHz

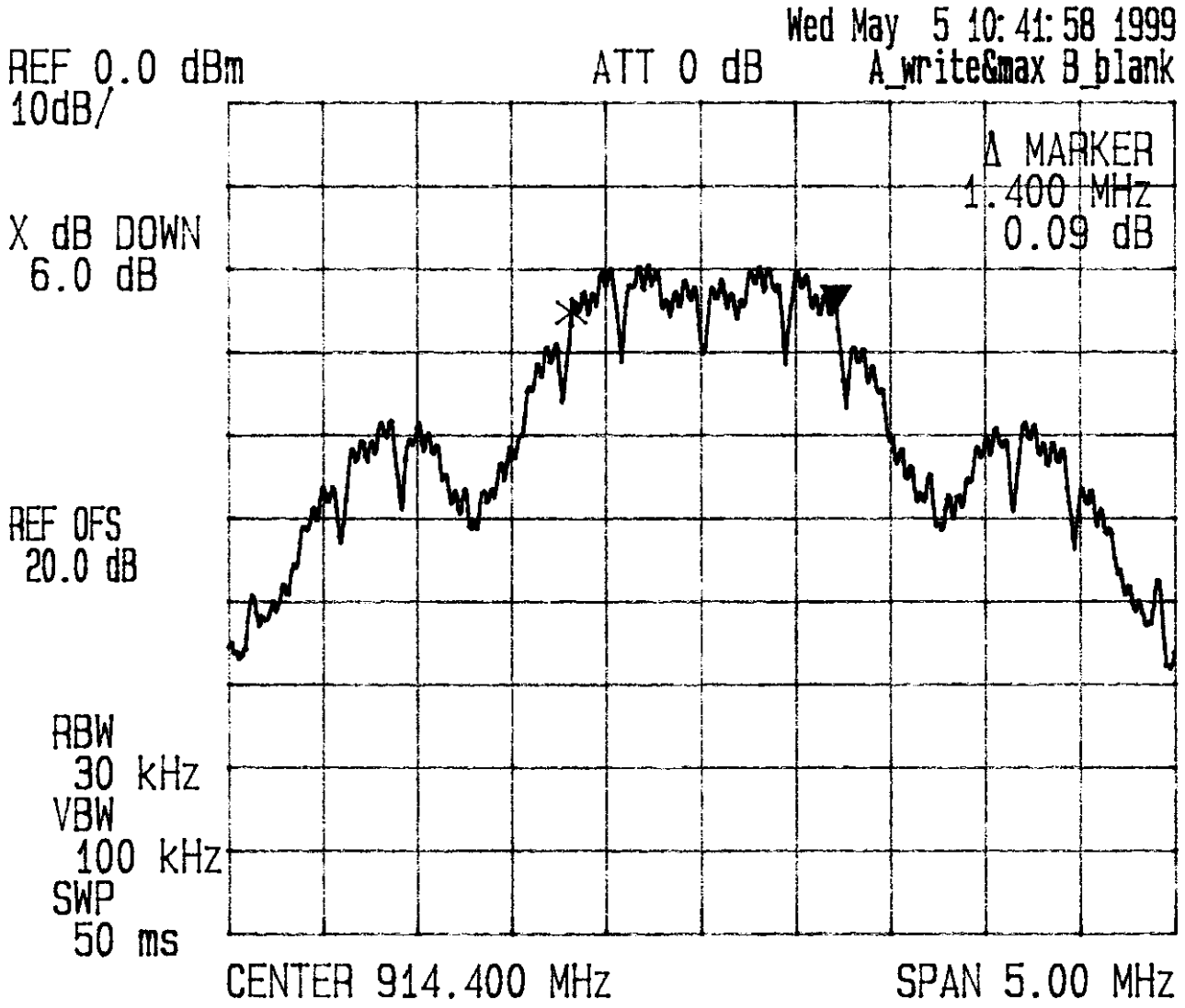
Date: May 05 1999
Tested by: Hung Trinh



UltraTech
Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 10 (MIDDLE), **Tx Frequency:** 914.40 MHz

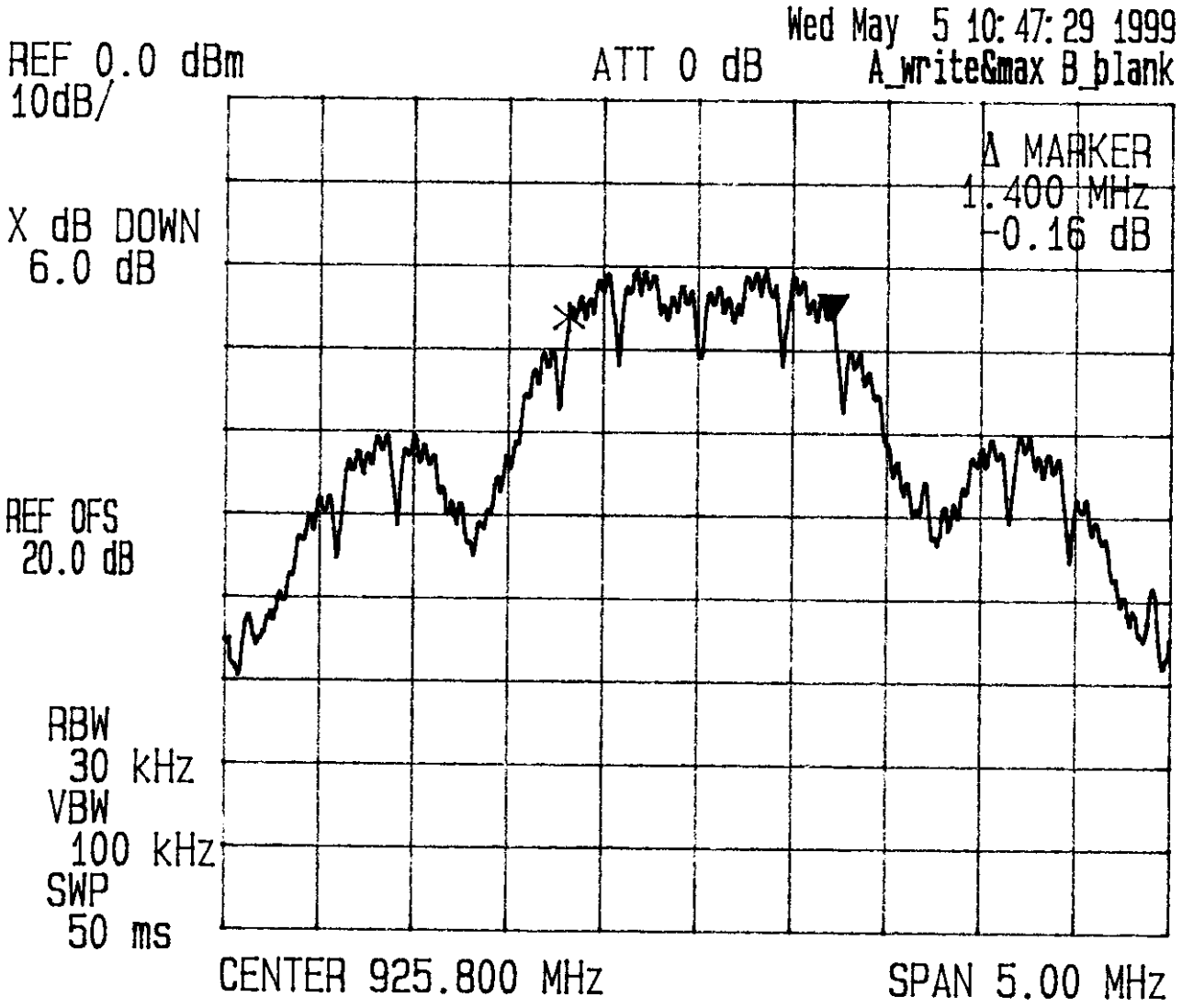
Date: May 05 1999
Tested by: Hung Trinh



UltraTech
Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 20 (HIGHEST) **Tx Frequency:** 925.80 MHz

Date: May 05 1999
Tested by: Hung Trinh



4.2. MAXIMUM PEAK OUTPUT POWER @ FCC 15.247(B) AND RF EXPOSURE LIMIT FCC 1.1310

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

FCC REQUIREMENTS:

FCC 15.247(b):- Maximum peak output power of the transmitter shall not exceed 1 Watt.

FCC 1.1310:- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
300-1500	...	...	F/300	6
1500-100,000	...	...	5	6
(B) Limits for General Population/Uncontrolled Exposure				
300-1500	...	...	F/1500	6
1500-100,000	...	...	1.0	30

F = Frequency in MHz

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

3.6V DC 550mA (Handset), 9V DC 300mA (Base)

TEST EQUIPMENT:

- HP RF Peak Power Meter, Model 8900, S/N: 2131A00124, Measuring Freq. Range: 01 - 18 GHz, 50 Ohm IN.
- HP RF Peak Power Sensor, Model 8481A, S/N: 2551A01965, Measuring Freq. Range: 0.1 - 18 GHz, 50 Ohm IN/OUT

METHOD OF MEASUREMENTS:

FCC @ 1.1310 & OST Bulletin No. 65-October 1985

$S = PG/4\Pi r^2 = EIRP/4\Pi r^2$

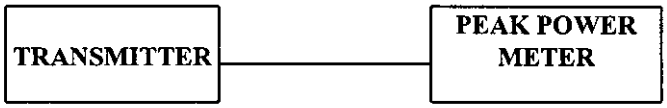
Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

$$r = \sqrt{PG/4\Pi S}$$

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hung Trinh, EMI/RFI Technician

DATE: April 19, 1999

MEASUREMENT DATA:

PEAK POWER MEASUREMENT

ANTENNA GAIN: 1 numeric

DIRECT PEAK POWER MEASUREMENTS AT THE ANTENNA TERMINAL WITH THE ANTENNA REPLACED BY A SMA CONNECTOR

HANDSET				
TRANSMITTER CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	MEASURED PEAK TOTAL POWER (mW)	PEAK POWER LIMIT (mW)
Lowest	904.2	85.3 Kbps/DBPSK	2.3	1000.0
Middle	914.4	85.3 Kbps/DBPSK	2.5	1000.0
Highest	925.8	85.3 Kbps/DBPSK	2.7	1000.0

BASE				
TRANSMITTER CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	MEASURED PEAK TOTAL POWER (mW)	PEAK POWER LIMIT (mW)
Lowest	904.2	85.3 Kbps/DBPSK	1.1	1000.0
Middle	914.4	85.3 Kbps/DBPSK	1.2	1000.0
Highest	925.8	85.3 Kbps/DBPSK	1.3	1000.0

EFFECTIVE ISOTROPIC RADIATED POWER (EIRP) MEASURED AT 3 METER DISTANCE
(Substitution Method)

HANDSET							
TX CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	Tx Antenna Gain (Numeric)	Max. Field Strength Level @ 1 MHz BW At 3 m (dBuV/m)	(1) Max. EIRP POWER @ 1 MHz BW (mW)	(2) Max. EIRP POWER In a full BW (mW)	PEAK POWER LIMIT (mW)
Lowest	904.2	85.3 Kbps/ DBPSK	1	99.54	2.7	4.4	4000.0
Middle	914.4	85.3 Kbps/ DBPSK	1	100.38	3.3	5.2	4000.0
Highest	925.8	85.3 Kbps/ DBPSK	1	99.94	3.0	4.7	4000.0

BASE							
TX CHANNEL OUTPUT	FUNDAMENTAL FREQUENCY (MHz)	DATA RATE / MODULATION	Tx Antenna Gain (Numeric)	Max. Field Strength Level @ 1 MHz BW At 3 m (dBuV/m)	(1) Max. EIRP POWER @ 1 MHz BW (mW)	(2) Max. EIRP POWER In a full BW (mW)	PEAK POWER LIMIT (mW)
Lowest	904.2	85.3 Kbps/ DBPSK	1	98.75	2.3	3.7	4000.0
Middle	914.4	85.3 Kbps/ DBPSK	1	98.31	2.0	3.3	4000.0
Highest	925.8	85.3 Kbps/ DBPSK	1	96.19	1.3	2.0	4000.0

Remarks:

(1) EIRP power measured in 1 MHz BW

(2) Conversion of power measured in 1MHz BW using the EMI receiver to power in full BW using HP8900 peak power meter:

1MHz BW-Full BW power conversion factor = (peak power level measured using the HP peak power meter) - (peak power level measured using EMI receiver in 1 MHz BW) = 3.62dBm – 1.46 dBm = 2.16 dB

(3) The differences between the radiated power measurement and direct peak power measurements are due to the approximation of the conversion from 1MHz-BW power to full-BW power, the linearity of the antenna gain at different frequencies and effect of packaging and installation of the internal integrated antenna inside the case..

RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$
$S = 0.6 mW/cm^2$, $G = 1$ numeric

HANDSET				
TRANSMITTER CHANNEL OUTPUT	**FUNDAMENTAL FREQUENCY (MHz)**	**DATA RATE / MODULATION**	**MEASURED EIRP FULL POWER (mWatts)**	**MNIMUM ALLOWABLE DISTANCE (r) FROM SKIN (Centi-Meter)**
Lowest	904.2	85.3 Kbps/DBPSK	4.4	0.6
Middle	914.4	85.3 Kbps/DBPSK	5.2	0.7
Highest	925.8	85.3 Kbps/DBPSK	4.7	0.6
Since the power density of 0.6 mW/cm^2 is at a very short distance from the radiating antenna, RF exposure limit warning or SAR tests are not necessary.				

BASE				
TRANSMITTER CHANNEL OUTPUT	**FUNDAMENTAL FREQUENCY (MHz)**	**DATA RATE / MODULATION**	**MEASURED EIRP FULL POWER (mWatts)**	**MNIMUM ALLOWABLE DISTANCE (r) FROM SKIN (Centi-Meter)**
Lowest	904.2	85.3 Kbps/DBPSK	3.7	0.5
Middle	914.4	85.3 Kbps/DBPSK	3.3	0.5
Highest	925.8	85.3 Kbps/DBPSK	2.0	0.4
Since the power density of 0.6 mW/cm^2 is at a very short distance from the radiating antenna, RF exposure limit warning or SAR tests are not necessary.				

4.3. RF CONDUCTED EMISSIONS AT THE TRANSMITTER ANTENNA TERMINAL, FCC CFR 47, PARA. 15.247(C)

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

FCC REQUIREMENTS:

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

3.6V DC 550mA (Handset), 9V DC 300mA (Base)

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT
- Microphase Highpass Filter, P/N: CR220HIB, S/N: 1301, Cut-off Freq. 1.8 GHz. (Optional)

METHOD OF MEASUREMENT:

A scan was made by using a spectrum analyzer with the detector function set to PEAK mode.

Set RBW = 100 KHz, VBW = 100 KHz.

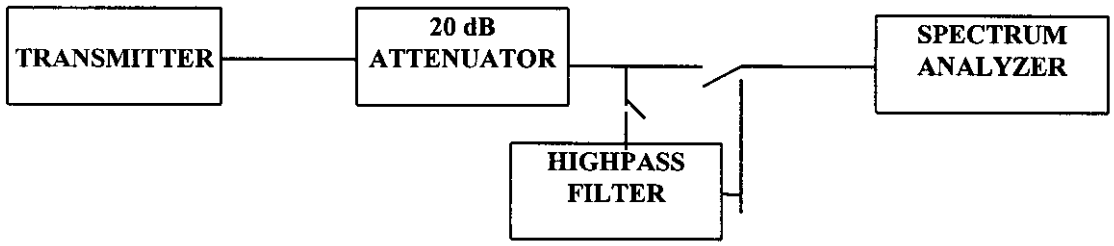
FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated

The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.991 - Spurious Emissions at Antenna Terminal

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.989 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hung Trinh, EMI/RFI Technician

DATE: April 20, 1999

MEASUREMENT DATA

SPURIOUS & HARMONIC EMISSIONS AT THE TRANSMITTER ANTENNA TERMINAL

TEST CONFIGURATION

- *The transmitter was coupled to the Spectrum Analyzer through a 20 dB attenuator.*
- *The insertion loss between the transmitter output terminal and the spectrum analyzer was measured to be 20 dB*
- *The channel frequencies were established on the extreme edges (both upper and lower) and middle of the 904.2 - 925.8 MHz band at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Part 15.247(c)*

HANDSET				
Channel Frequency: 904.2MHz **Full Rated Power: 2.3 mW**		**Power Level in 100 KHz BW: -1.31dBm** **Limit = -1.31dBm - 20 dB = -21.31dBm**		
FREQUENCY (MHz)	**RF LEVEL 100 kHz BW (dBm)**	**LIMIT (dBm)**	**MARGIN (dB)**	**PASS/ FAIL**
904.2	-1.31	--	--	--
495	-60.91	-21.31	-39.78	PASS
1808	-58.38	-21.31	-37.25	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details				

HANDSET				
Channel Frequency: 914.2MHz **Full Rated Power: 2.5 mW**		**Power Level in 100 KHz BW: -1.34 dBm** **Limit =-1.34 dBm - 20 dB = -21.34dBm**		
FREQUENCY (MHz)	**RF LEVEL 100 kHz BW (dBm)**	**LIMIT (dBm)**	**MARGIN (dB)**	**PASS/ FAIL**
914.2	-1.34	--	--	--
495	-61.66	-21.34	-40.32	PASS
1822	-55.88	-21.34	-34.54	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details				

HANDSET				
Channel Frequency: 925.8MHz **Full Rated Power: 2.7 mW**		**Power Level in 100 KHz BW: -1.56 dBm** **Limit = -1.56 dBm - 20 dB = -21.56dBm**		
FREQUENCY (MHz)	**RF LEVEL 100 kHz BW (dBm)**	**LIMIT (dBm)**	**MARGIN (dB)**	**PASS/ FAIL**
925.8	-1.56	--	--	--
495	-59.00	-21.56	-37.44	PASS
1837	-56.91	-21.56	-35.35	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details				

BASE				
Channel Frequency: 904.2 MHz **Full Rated Power: 1.1 mW**		**Power Level in 100 KHz BW: -10.34 dBm** **Limit = -10.34 dBm - 20 dB = -30.34 dBm**		
FREQUENCY (MHz)	**RF LEVEL 100 kHz BW (dBm)**	**LIMIT (dBm)**	**MARGIN (dB)**	**PASS/ FAIL**
904.2	-10.34	--	--	--
524	-63.19	-30.34	-32.85	PASS
1808	-61.34	-30.34	-31.00	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details				

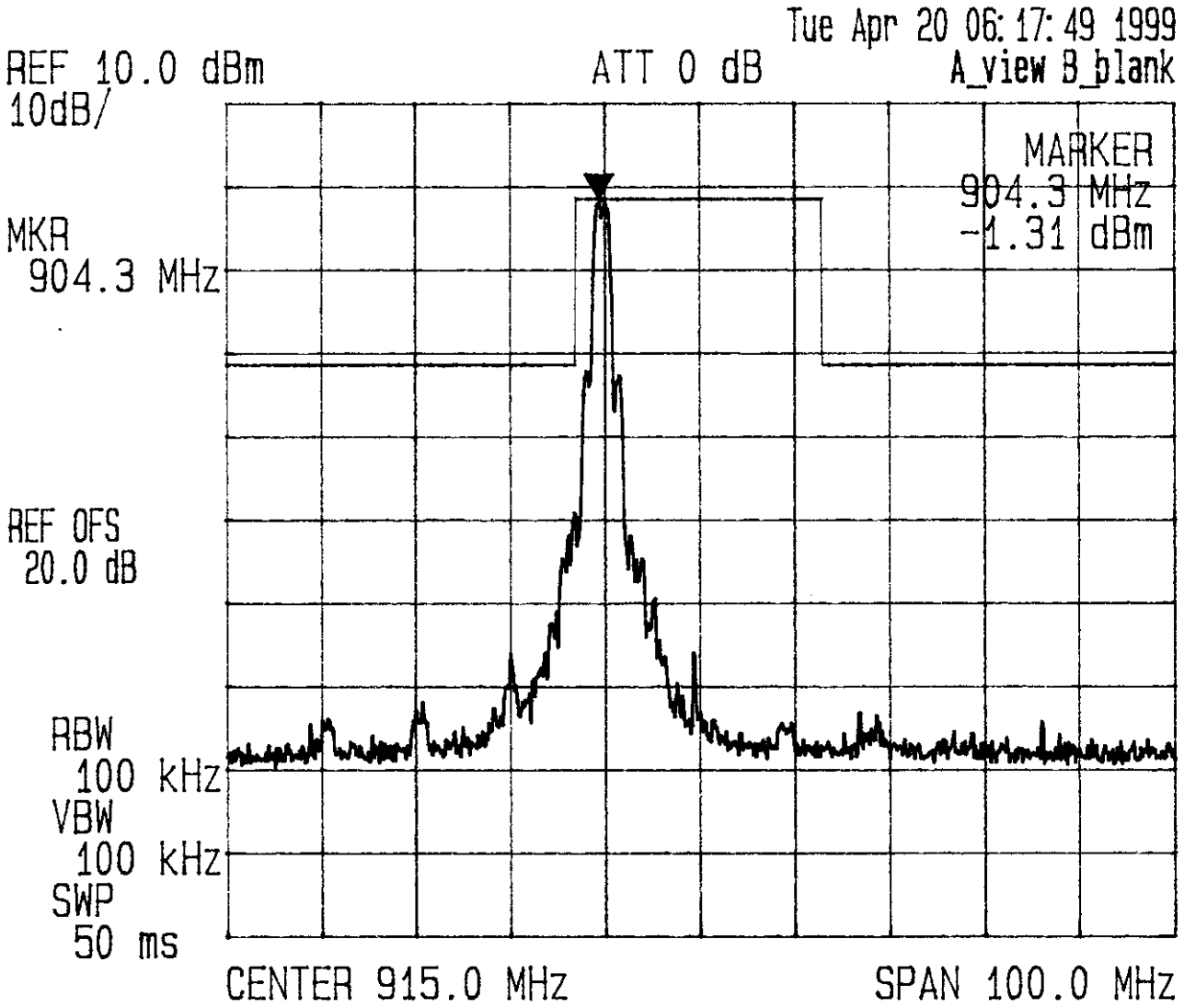
BASE				
Channel Frequency: 914.4 MHz **Full Rated Power: 1.2 mW**		**Power Level in 100 KHz BW: -11.69 dBm** **Limit = -11.69 dBm - 20 dB = -31.69 dBm**		
FREQUENCY (MHz)	**RF LEVEL 100 kHz BW (dBm)**	**LIMIT (dBm)**	**MARGIN (dB)**	**PASS/ FAIL**
914.4	-11.69	--	--	--
524	-64.19	-31.69	-32.50	PASS
1808	-60.41	-31.69	-28.72	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details				

BASE				
Channel Frequency: 925.8 MHz **Full Rated Power: 1.3 mW**		**Power Level in 100 KHz BW: -12.66 dBm** **Limit = -12.66 dBm - 20 dB = -32.66 dBm**		
FREQUENCY (MHz)	**RF LEVEL 100 kHz BW (dBm)**	**LIMIT (dBm)**	**MARGIN (dB)**	**PASS/ FAIL**
925.8	-12.66	--	--	--
524	-61.41	-32.66	-28.75	PASS
1851	-60.63	-32.66	-27.97	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details				

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 1 (LOWEST), **Tx Frequency:** 904.20 MHz.

Date: April 20**,1999**
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

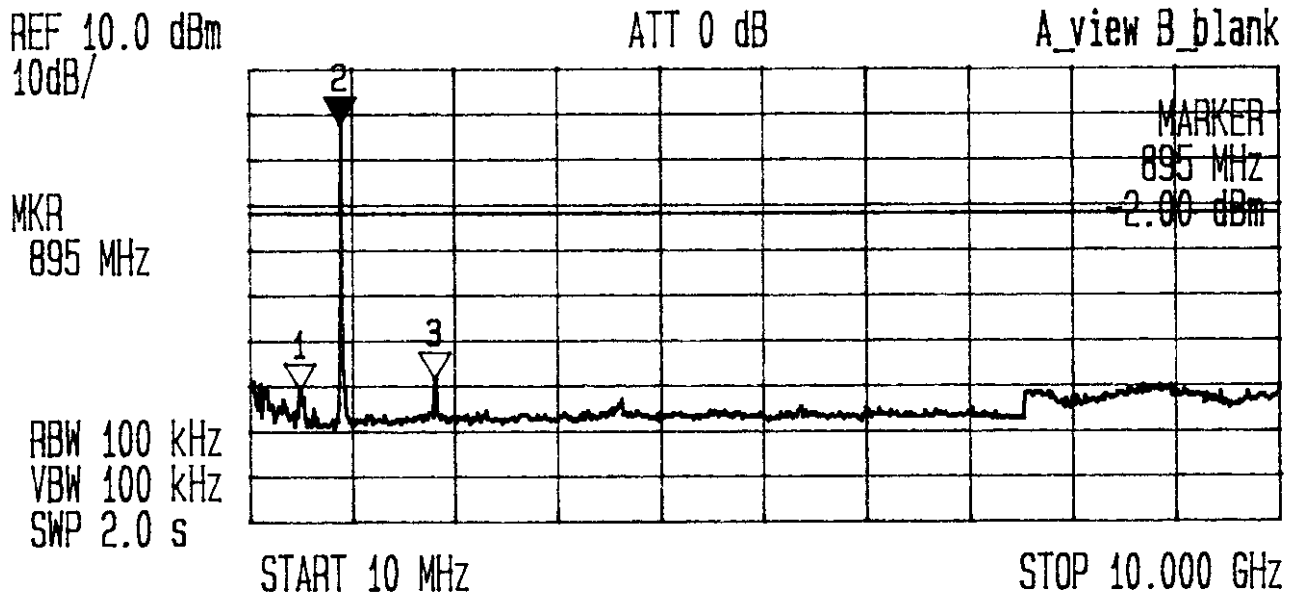
DAEWOO TELECOM LTD.

TS-101 CORDLESS TELEPHONE

Tested Component: [M] Handset Transmitter, [ ] Base Transmitter

Channel #: 1 (LOWEST), **Tx Frequency:** 902.20 MHz

Date: April 20,1999
Tested by: Hung Trinh



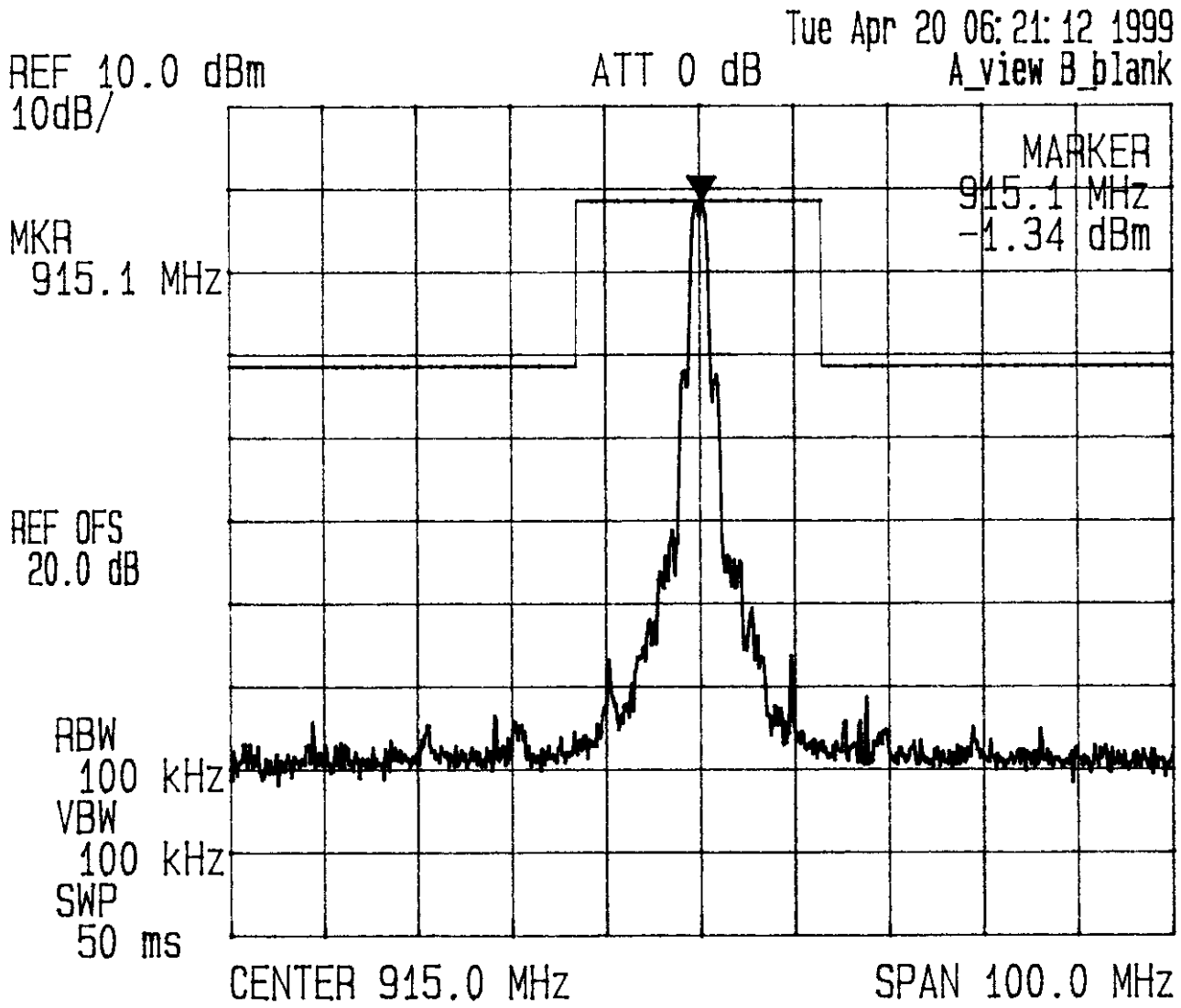
*** Multi Marker List ***

No.1:	495 MHz	-60.91 dBm	A
No.2:	895 MHz	-2.00 dBm	A
No.3:	1.808 GHz	-58.38 dBm	A
No.4:			
No.5:			
No.6:			
No.7:			
No.8:			
Δ:			

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 10 (MIDDLE). **Tx Frequency:** 914.40 MHz

Date: April 20**,1999**
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

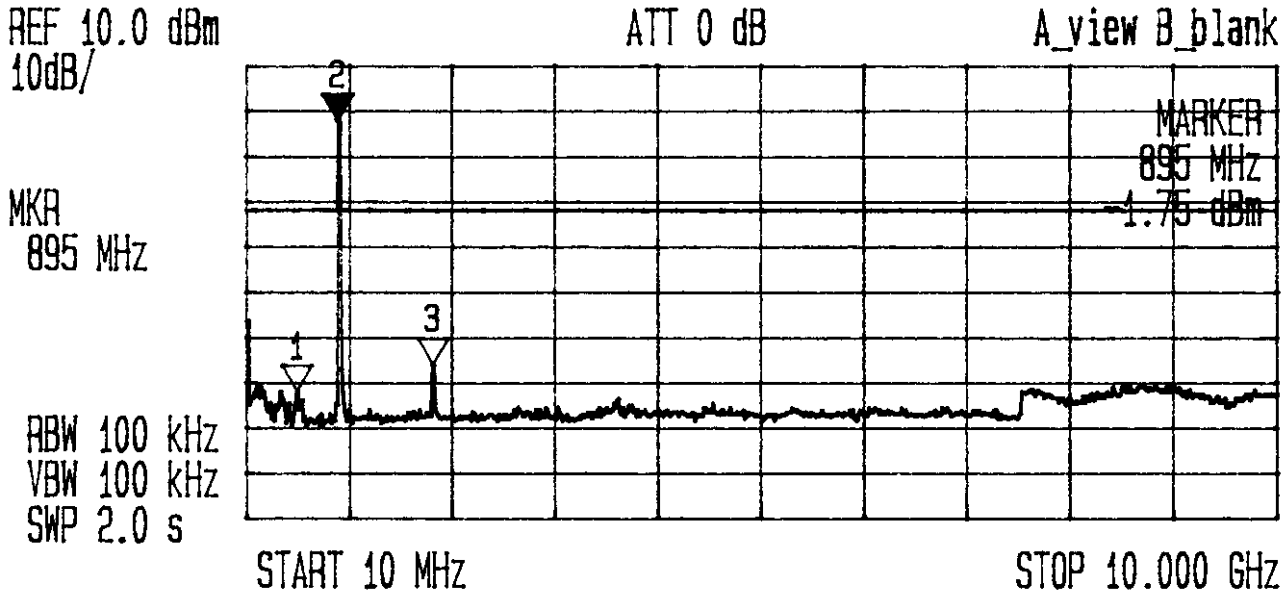
DAEWOO TELECOM LTD.

TS-101 CORDLESS TELEPHONE

Tested Component: [M] Handset Transmitter, [ ] Base Transmitter

Channel #: 10 (MIDDLE), **Tx Frequency:** 914.40

Date: April 20, 1999
Tested by: Hung Trinh



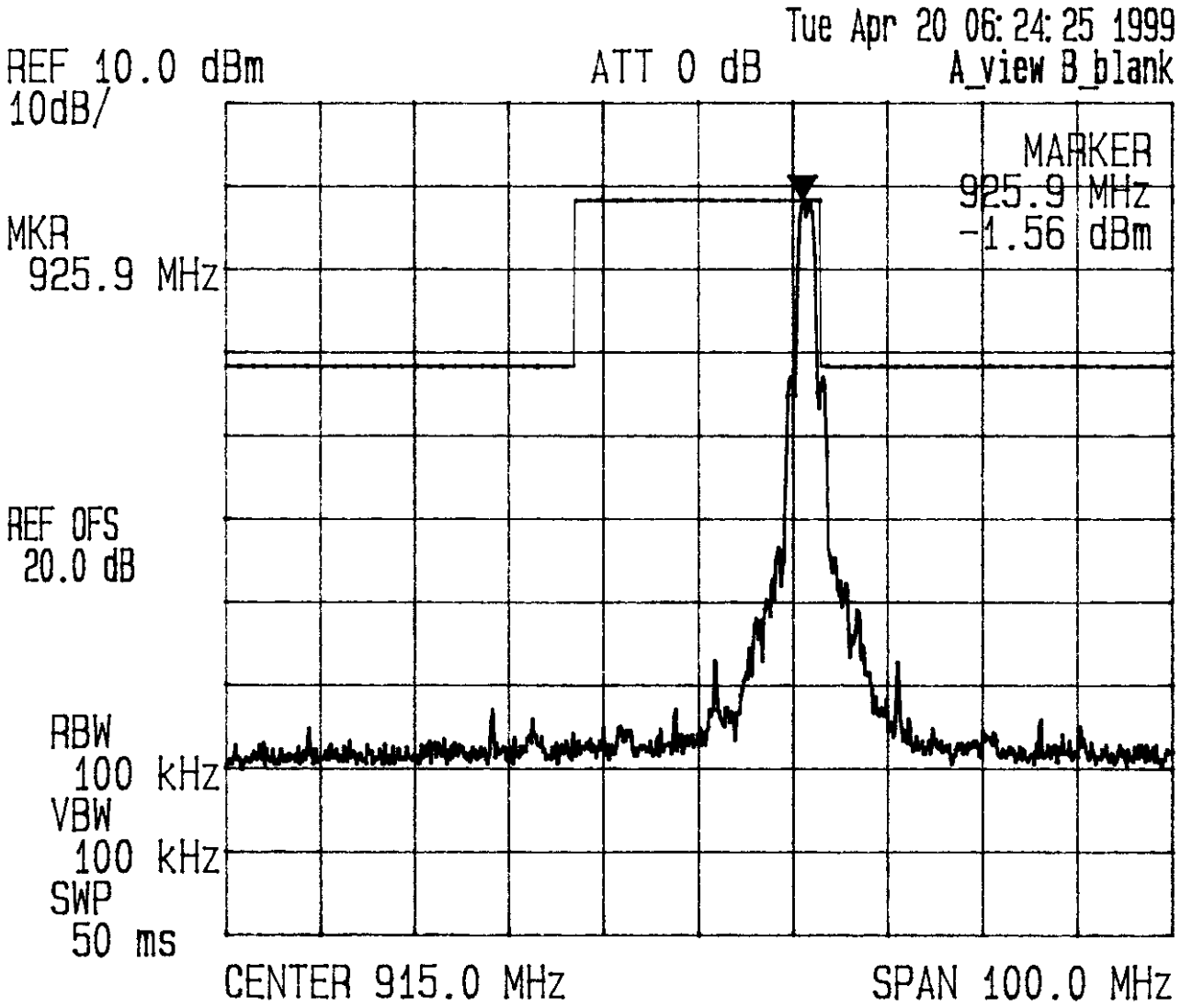
*** Multi Marker List ***

No.1:	495 MHz	-61.66 dBm	A
No.2:	895 MHz	-1.75 dBm	A
No.3:	1.822 GHz	-55.88 dBm	A
No.4:			
No.5:			
No.6:			
No.7:			
No.8:			
Δ:			

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 20 (HIGHEST) Tx Frequency: 925.80 MHz

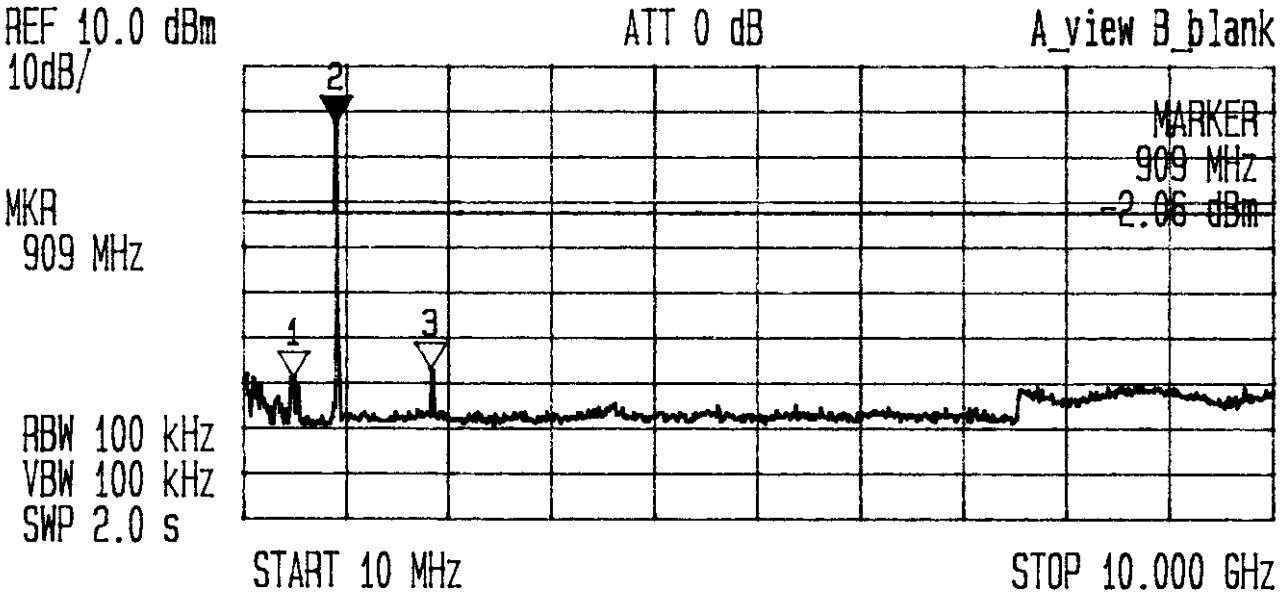
Date: April 20,1999
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 20 (HIGHEST) **Tx Frequency:** 925.80 MHz

Date: April 20, 1999
Tested by: Hung Trinh



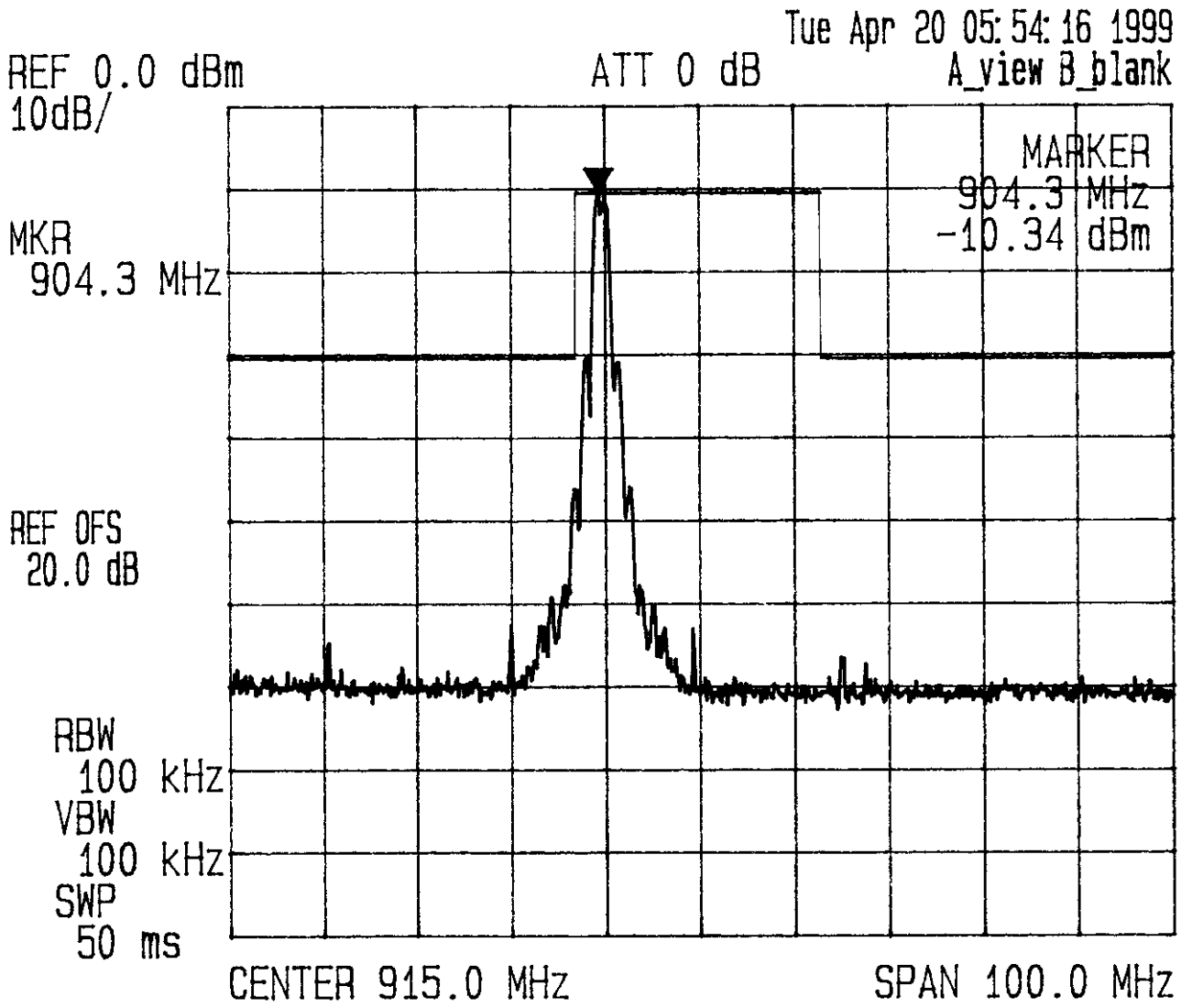
*** Multi Marker List ***

No.1:	495 MHz	-59.00 dBm	A
No.2:	909 MHz	-2.06 dBm	A
No.3:	1.837 GHz	-56.91 dBm	A
No.4:			
No.5:			
No.6:			
No.7:			
No.8:			
Δ:			

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 1 (lowest) **Tx Frequency:** 904.20 MHz

Date: April 20, 1999
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

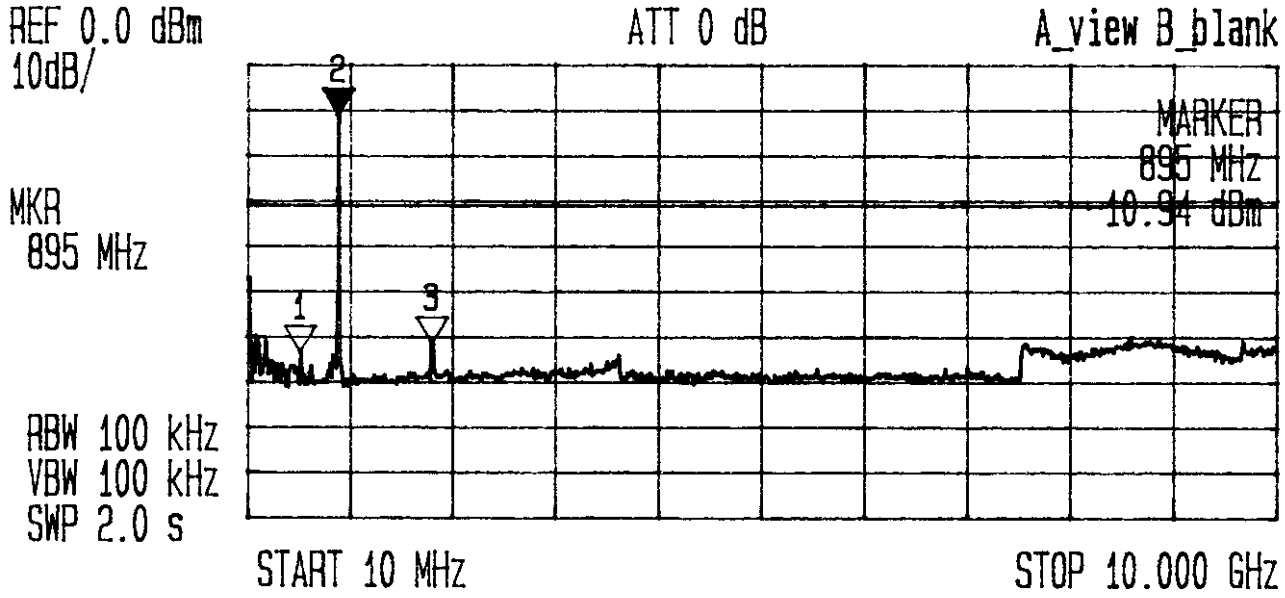
DAEWOO TELECOM LTD.

TS-101 CORDLESS TELEPHONE

Tested Component: [ ] Handset Transmitter, [M] Base Transmitter

Channel #: 1 (LOWEST), **Tx Frequency:** 902.20 MHz

Date: April 20, 1999
Tested by: Hung Trinh



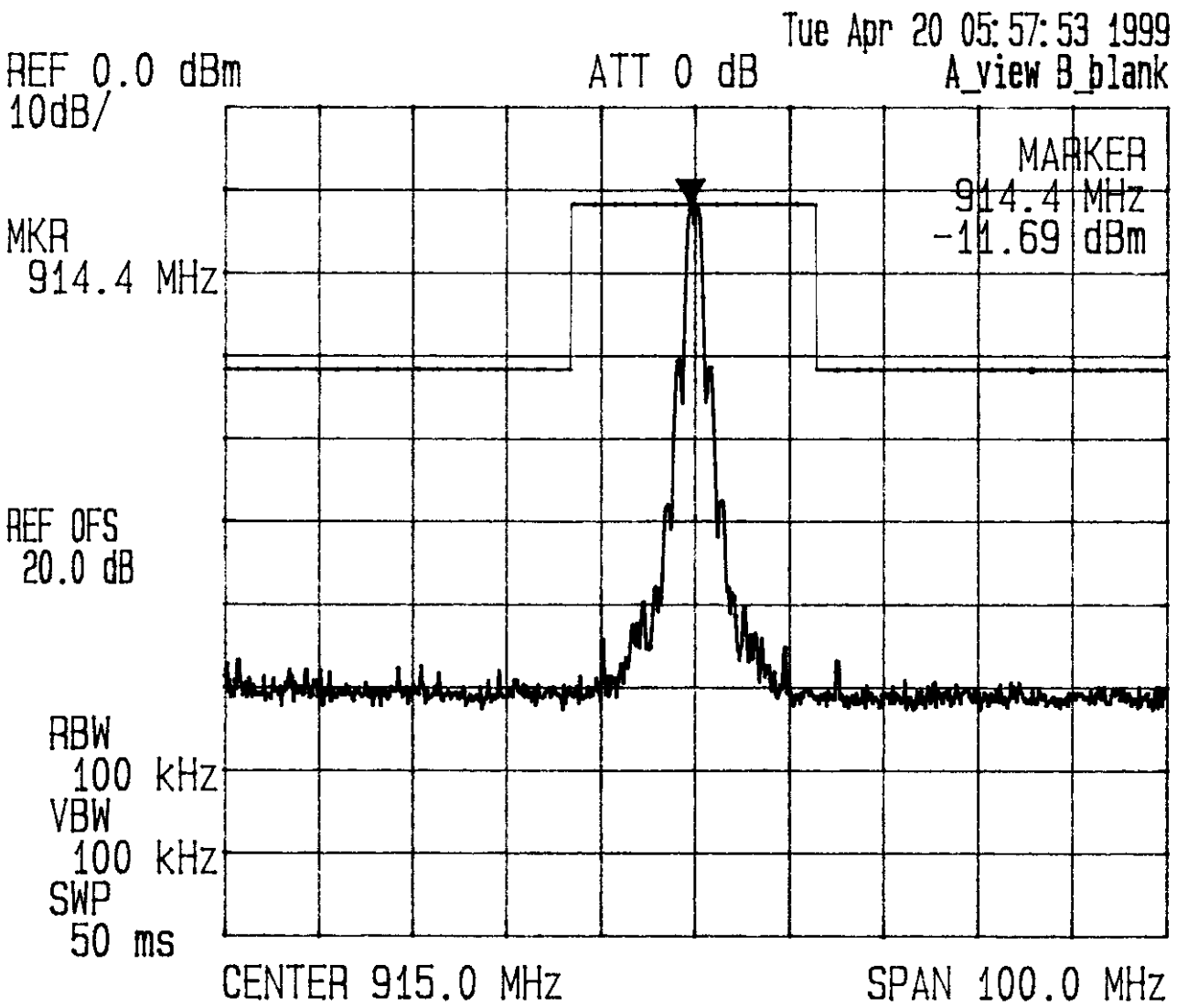
*** Multi Marker List ***

No.1:	524 MHz	-63.19 dBm	A
No.2:	895 MHz	-10.94 dBm	A
No.3:	1.808 GHz	-61.34 dBm	A
No.4:			
No.5:			
No.6:			
No.7:			
No.8:			
Δ:			

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 10 (MIDDLE) **Tx Frequency:** 914.40 MHz

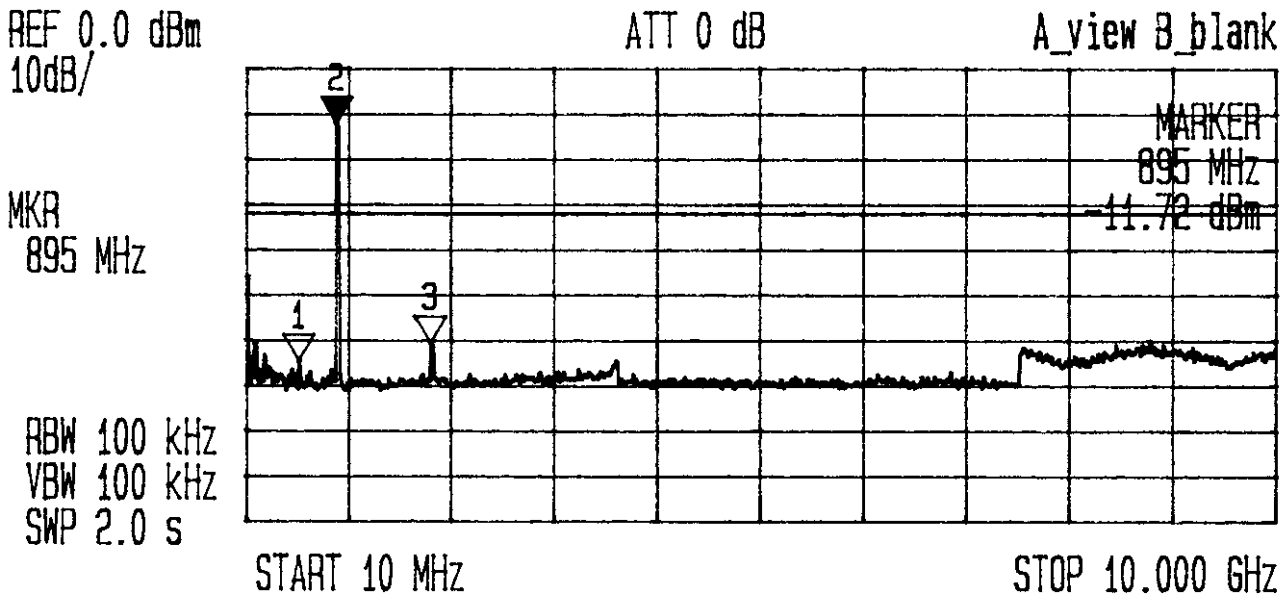
Date: April 20 **,1999**
Tested by: Hung Trinh



UltraTech
Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [✓] Base Transmitter
Channel #: 10 (MIDDLE). **Tx Frequency:** 914.40MHz

Date: April 20 1999
Tested by: Hung Trinh



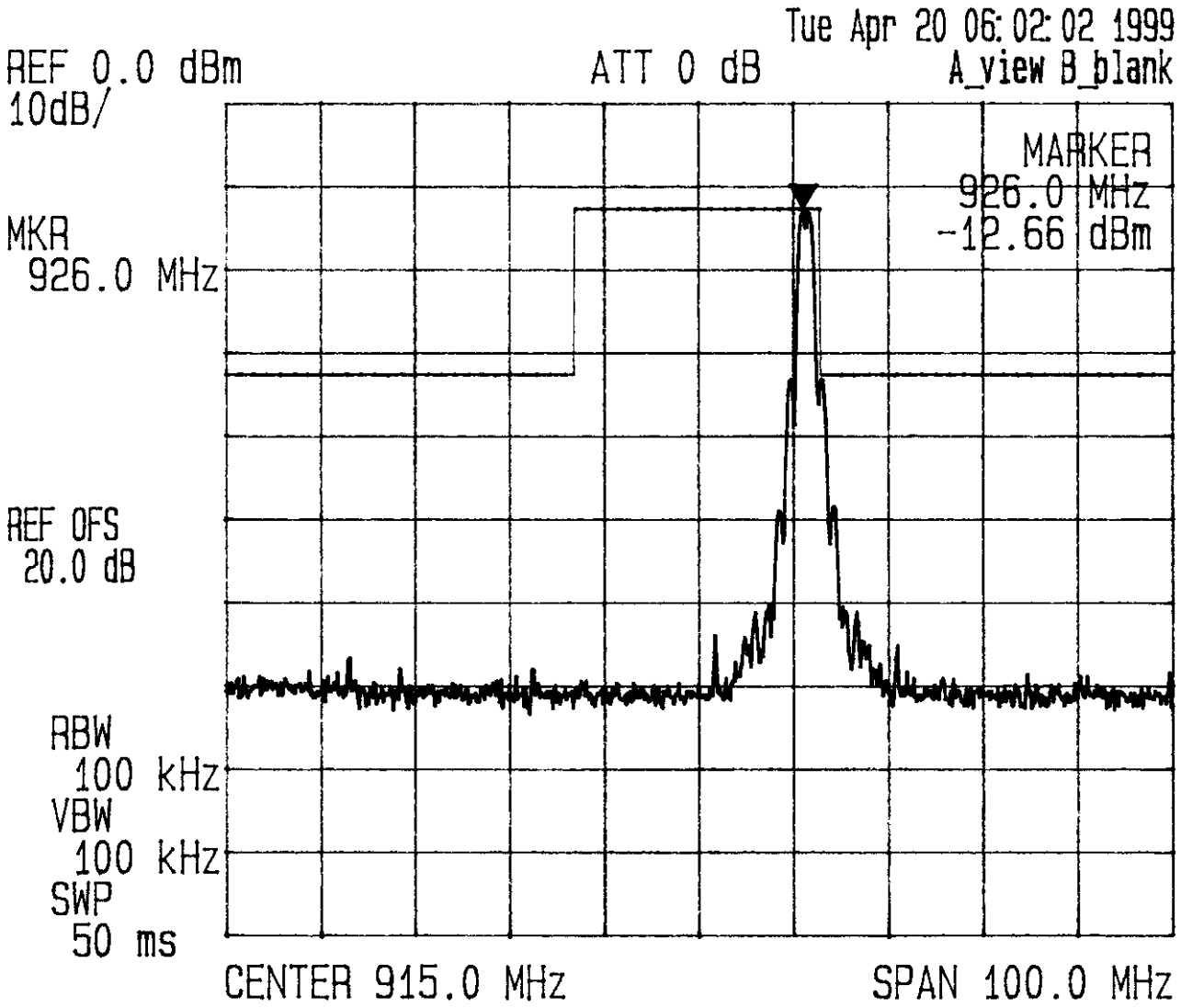
*** Multi Marker List ***

No.1:	524 MHz	-64.19 dBm	A
No.2:	895 MHz	-11.72 dBm	A
No.3:	1.808 GHz	-60.41 dBm	A
No.4:			
No.5:			
No.6:			
No.7:			
No.8:			
Δ:			

UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 20 (HIGHEST) **Tx Frequency:** 925.80 MHz

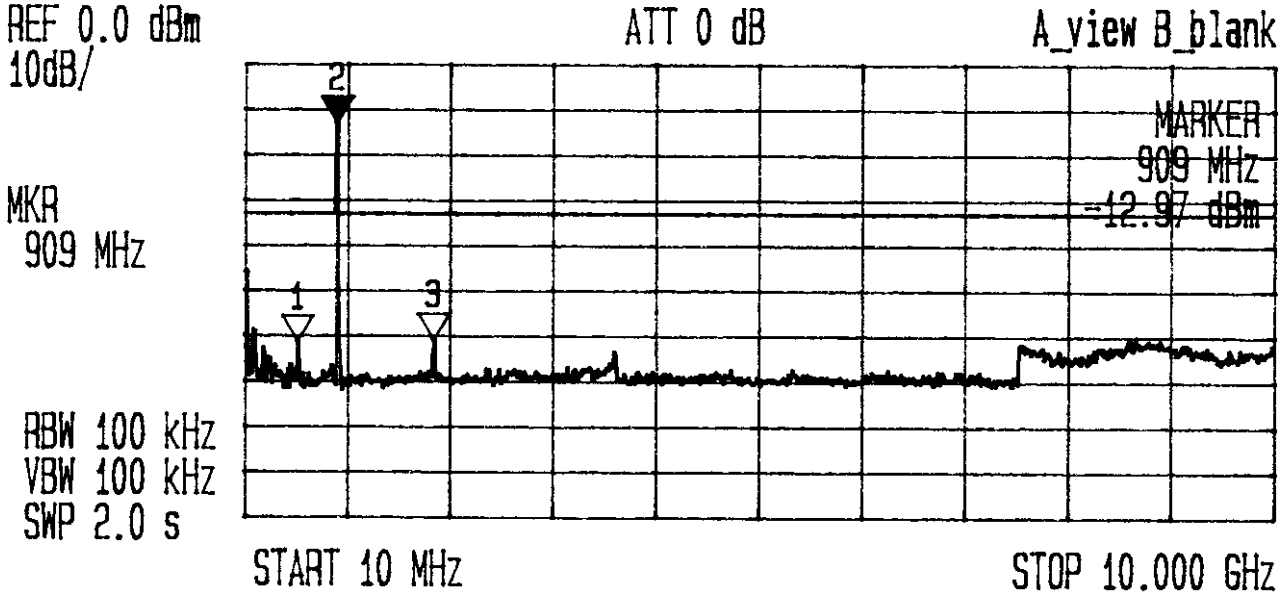
Date: April 20**,1999**
Tested by: Hung Trinh



UltraTech Engineering Labs Inc.

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 20 (HIGHEST) **Tx Frequency:** 925.80 MHz

Date: April 20 1999
Tested by: Hung Trinh



*** Multi Marker List ***

No.1:	524 MHz	-61.41 dBm	A
No.2:	909 MHz	-12.97 dBm	A
No.3:	1.851 GHz	-60.63 dBm	A
No.4:			
No.5:			
No.6:			
No.7:			
No.8:			
Δ:			

4.4. TRANSMITTER RADIATED EMISSIONS @ 3 METERS, FCC CFR 47, PARA. 15.247(C), 15.209 & 15.205

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

FCC REQUIREMENTS:

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in @ 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 15.209(a)

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- **@ FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in **@15.35** for limiting peak emissions apply.

FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 - 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 - 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 - 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 - 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 - 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 - 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 - 156.9	2200 - 2300	9000 - 9200	

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	DISTANCE (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

3.6V DC 550mA (Handset), 9V DC 300mA (Base)

TEST EQUIPMENT:

- **Spectrum Analyzer**, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- **Microwave Amplifier**, HP, Model 83017A, Frequency Range 1 to 26.5 GHz, 34-38 dBdB gain nominal.
- **Active Loop Antenna**, Emco, Model 6507, SN 8906-1167, Frequency Range 1 KHz - 30 MHz, @ 50 Ohms
- **Log Periodic/Bow-Tie Antenna**, Emco, Model 3143, SN 1029, 20 - 1000 MHz, @ 50 ohms.
- **Horn Antenna**, Emco, Model 3115, SN 9701-5061, Frequency Range: 1 - 18 GHz, @ 50 Ohms.
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-10, 26.5-40GHz
- **Mixer**, Tektronix, P/N 118-0098-00, 18-26.5GHz
- **Mixer**, Tektronix, P/N 119-0098-00, 26.5-40GHz

METHOD OF MEASUREMENTS:

Refer to **ANSI 63.4-1992, Para. 8** for detailed radiated emissions measurement procedures.

Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.

For measurement below 1 GHz, set RBW = 100 KHz, VBW $\geq$ 100 KHz, SWEEP=AUTO.

For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.

If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated

The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.993 - Field Strength Spurious Emissions

(a) Measurements was made to detect spurious emissions radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data were supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph 2.989(c) as appropriate. For equipment operating on frequencies below 1 GHz, an Open Field Test is normally required, with the measuring instrument antenna located in the far field at all test frequencies. In event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurement will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with the reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

(b) Measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emission are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hung Trinh, EMI/RFI Technician

DATE: April 18, 1999

MEASUREMENT DATA

RADIATED EMISSIONS MEASUREMENTS @ 3 METERS

TEST CONFIGURATION

- *This lowest, middle and highest channels were established at its full rated output power. The emissions were investigated from the lowest frequency generated by the transmitter up to the 10th harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Parts 15.247(c) or 15.209(a) whichever was applicable.*
- *For measuring radiated emissions at frequencies below 1 GHz, the Spectrum Analyzer was set as 100 KHz RBW, VBW ≥ RBW, SWEEP TIME: AUTO, PEAK DETECTOR.*
- *For measuring radiated emissions at frequencies above 1 GHz, the Spectrum Analyzer was set as 1 MHz RBW, 1 MHz VBW, SWEEP TIME: AUTO for PEAK measurements and 1 MHz RBW, 10 Hz VBW, SWEEP TIME: AUTO for AVERAGE measurements.*
- *The following measurements were the worst cases when the radiating antenna was placed in both horizontal and vertical polarization.*
- *The following **AVERAGE** rf levels were obtained from either Peak or Average readings added by the duty cycle correction factor. **DUTY CYCLE FACTOR = Continuous***

HANDSET

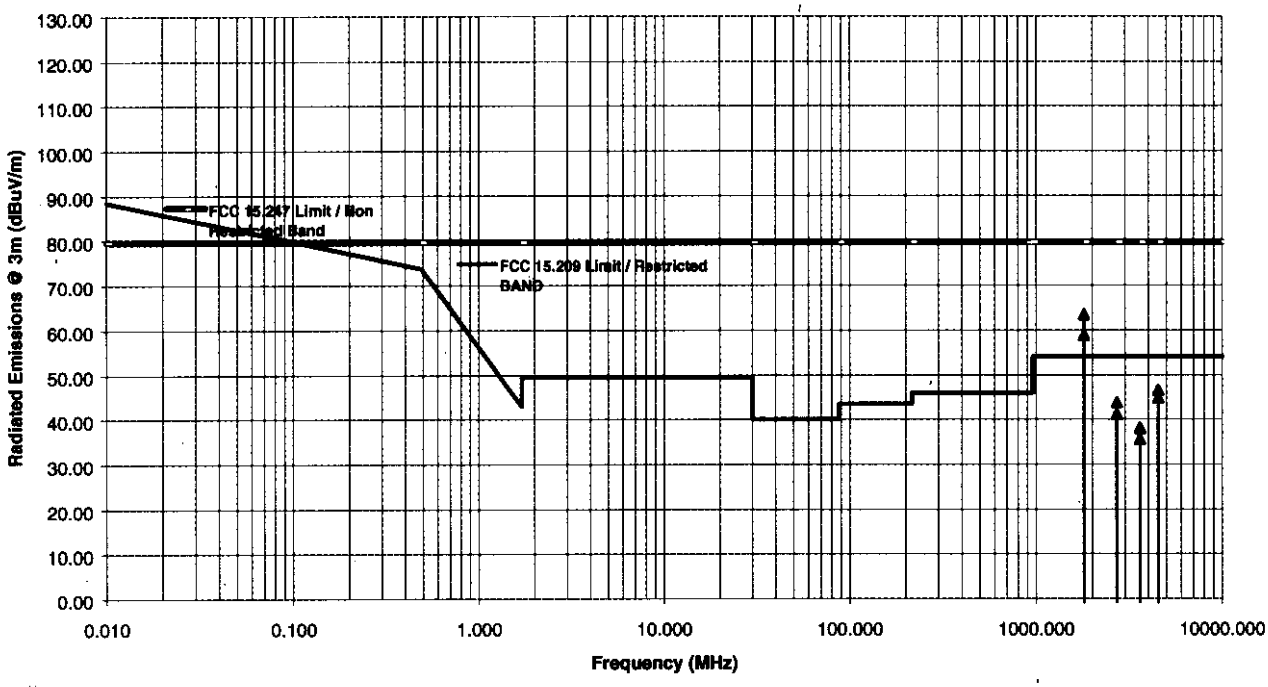
CHANNEL FREQUENCY TESTED: 904.2MHz
FULL RATED POWER: 0.0023Watt

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
904.20	99.16	--	V	--	--	--	--
904.20	99.59	--	H	--	--	--	--
1808.40	68.66	58.86	V	54.0	79.6	-20.7	PASS
1808.40	72.03	63.47	H	54.0	79.6	-16.1	PASS
2712.60	51.25	43.78	V	54.0	79.6	-10.2	PASS**
2712.60	49.50	41.19	H	54.0	79.6	-12.8	PASS**
3616.80	49.16	38.09	V	54.0	79.6	-15.9	PASS**
3616.80	47.25	35.75	H	54.0	79.6	-18.3	PASS**
4521.00	55.75	46.63	V	54.0	79.6	-7.4	PASS**
4521.00	55.31	44.84	H	54.0	79.6	-9.2	PASS**

No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details

*** Emission within the restricted band specified in @ 15.205(a)***

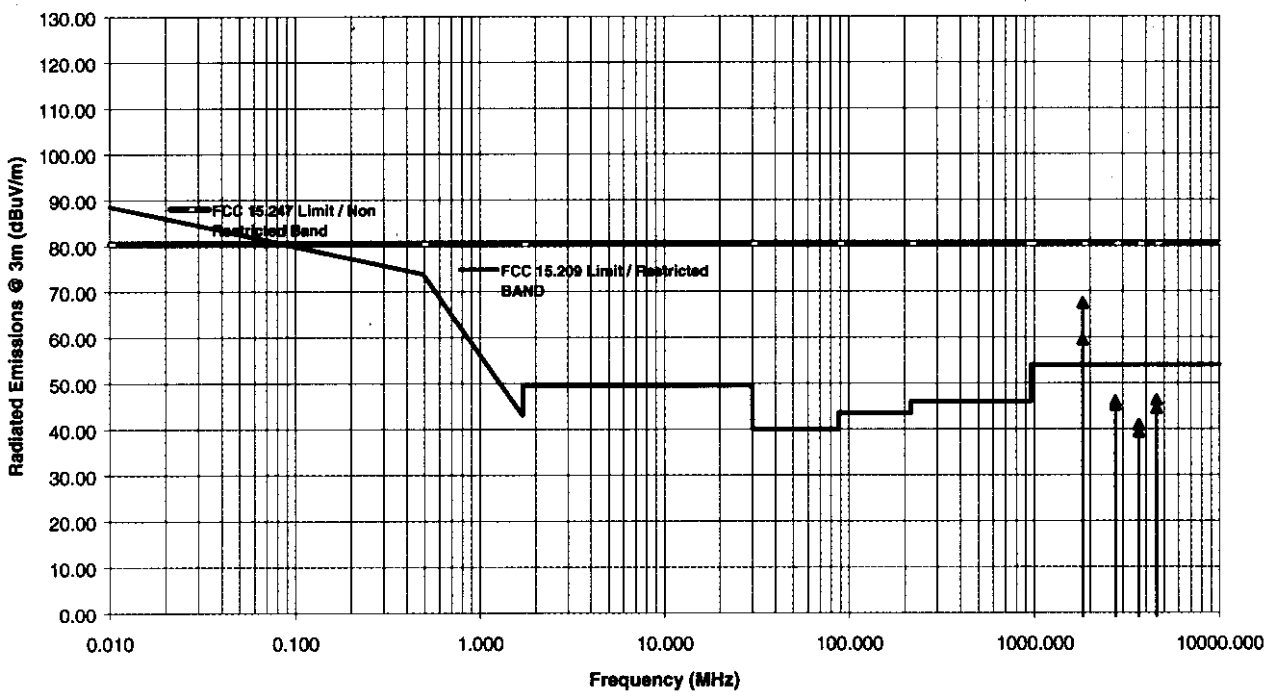
Transmitter Radiated Emissions Measurements at 3 Meter OFTS
Daewoo Telecom Ltd. Digital Cordless Telephone
TRANSMIT Freq.: 904.2MHz



HANDSET							
CHANNEL FREQUENCY TESTED: 914.4MHz FULL RATED POWER: 0.0025 Watt							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
914.40	99.03	--	V	--	--	--	--
914.40	100.38	--	H	--	--	--	--
1828.80	68.31	59.44	V	54.0	80.4	-21.0	PASS
1828.80	73.72	67.44	H	54.0	80.4	-13.0	PASS
2743.20	54.91	46.06	V	54.0	80.4	-7.9	PASS**
2743.20	53.78	45.22	H	54.0	80.4	-8.8	PASS**
3657.60	50.13	40.94	V	54.0	80.4	-13.1	PASS**
3657.60	49.78	39.38	H	54.0	80.4	-14.6	PASS**
4572.00	55.44	46.31	V	54.0	80.4	-7.7	PASS**
4572.00	54.28	44.50	H	54.0	80.4	-9.5	PASS**
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details							

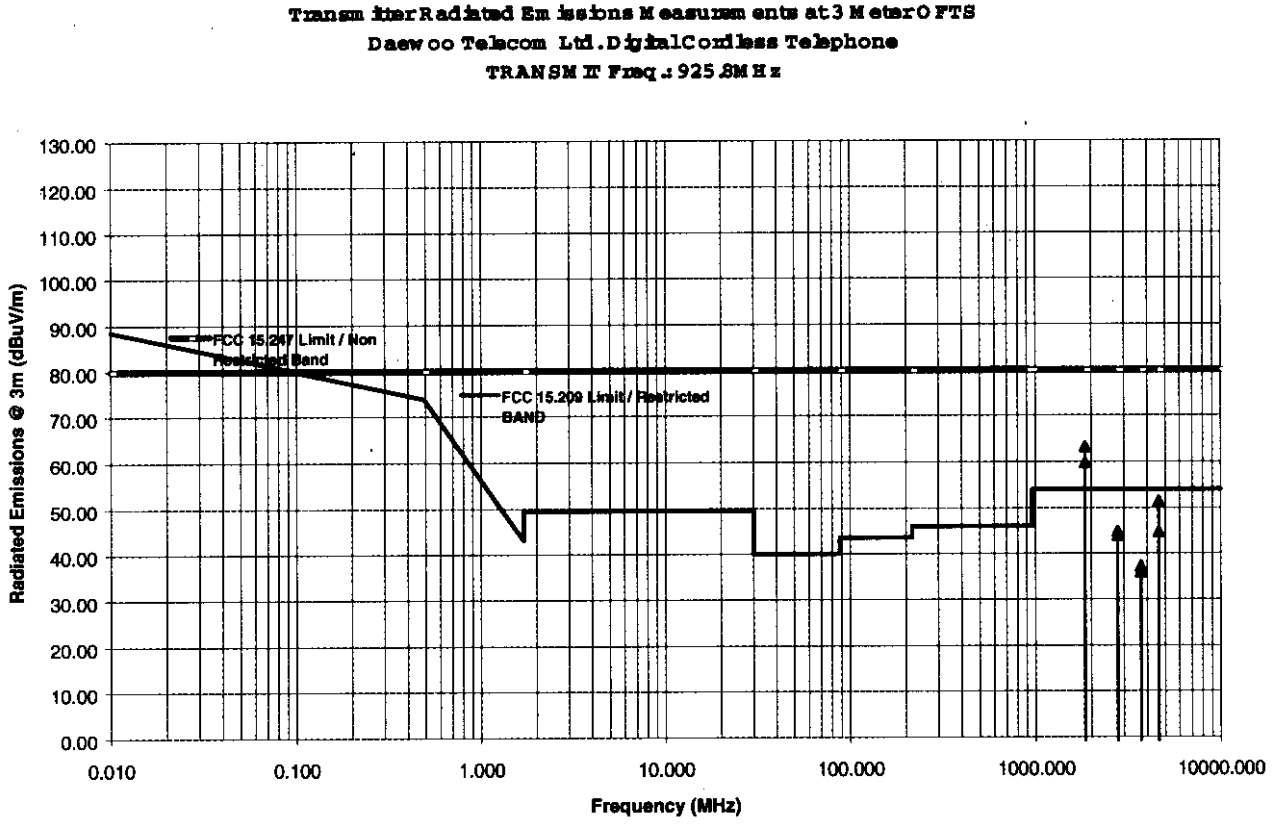
** ***Emission within the restricted band specified in @ 15.205(a)***

Transmitter Radiated Emissions Measurements at 3 Meter OFTS
Daewoo Telecom Ltd. Digital Cordless Telephone
TRANSMIT Freq.: 914.4MHz



HANDSET							
CHANNEL FREQUENCY TESTED: 925.8 MHz FULL RATED POWER: 0.0027 Watt							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
925.80	98.19	--	V	--	--	--	--
925.80	99.94	--	H	--	--	--	--
1851.60	66.50	59.78	V	54.0	79.9	-20.1	PASS
1851.60	71.06	63.28	H	54.0	79.9	-16.6	PASS
2777.40	52.53	43.88	V	54.0	79.9	-10.1	PASS**
2777.40	53.31	44.78	H	54.0	79.9	-9.2	PASS**
3703.20	48.09	36.00	V	54.0	79.9	-18.0	PASS**
3703.20	48.78	37.25	H	54.0	79.9	-16.8	PASS**
4629.00	59.69	51.44	V	54.0	79.9	-2.6	PASS**
4629.00	55.38	44.72	H	54.0	79.9	-9.3	PASS**
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details							

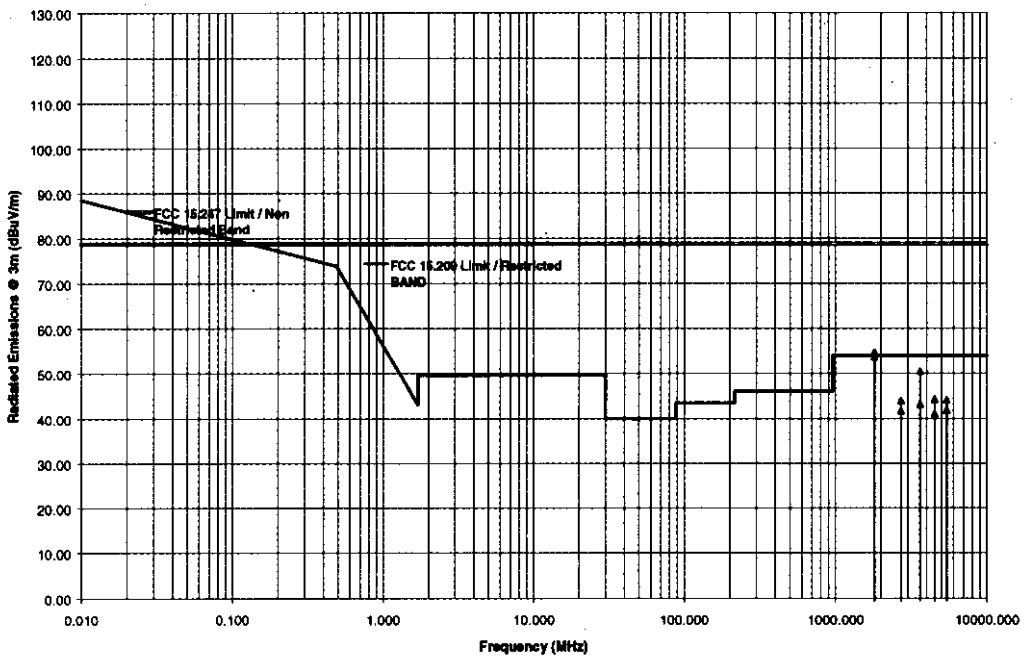
** ***Emission within the restricted band specified in @ 15.205(a)***



BASE							
CHANNEL FREQUENCY TESTED: 904.2 MHz **FULL RATED POWER: 0.0011 Watt**							
FREQUENCY (MHz)	**RF PEAK LEVEL (dBuV/m)**	**RF AVG LEVEL (dBuV/m)**	**ANTENNA PLANE (H/V)**	**LIMIT 15.209 (dBuV/m)**	**LIMIT 15.247 (dBuV/m)**	**MARGIN (dB)**	**PASS/ FAIL**
904.20	98.75	--	V	--	--	--	--
904.20	97.68	--	H	--	--	--	--
1808.40	63.66	54.69	V	54.0	78.8	-24.1	PASS
1808.40	64.25	53.66	H	54.0	78.8	-25.1	PASS
2712.60	52.78	41.72	V	54.0	78.8	-12.3	PASS**
2712.60	53.19	43.94	H	54.0	78.8	-10.1	PASS**
3616.80	59.81	50.38	V	54.0	78.8	-3.6	PASS**
3616.80	55.06	43.13	H	54.0	78.8	-10.9	PASS**
4521.00	58.94	44.28	V	54.0	78.8	-9.7	PASS**
4521.00	55.63	41.00	H	54.0	78.8	-13.0	PASS**
5425.20	57.47	44.09	V	54.0	78.8	-9.9	PASS**
5425.20	55.19	41.87	H	54.0	78.8	-12.1	PASS**
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details							

***** Emission within the restricted band specified in @ 15.205(a)***

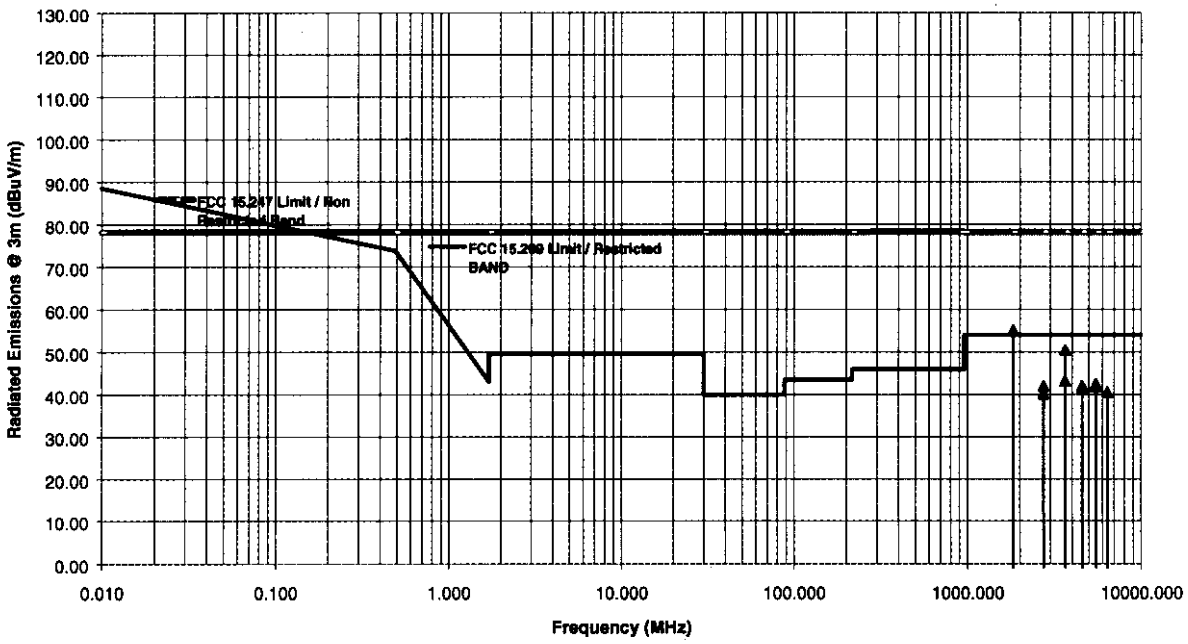
Transmitter Radiated Emissions Measurements at 3 Meter OFTS
Daewoo Telecom Ltd. Digital Cordless Telephone (Base)
TRANSMIT Freq.: 904.2MHz



BASE							
CHANNEL FREQUENCY TESTED: 914.4MHz FULL RATED POWER: 0.0012 Watt							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
914.40	98.31	--	V	--	--	--	--
914.40	96.63	--	H	--	--	--	--
1828.80	64.41	54.97	V	54.0	78.3	-23.3	PASS
1828.80	64.78	55.03	H	54.0	78.3	-23.3	PASS
2743.20	51.91	41.91	V	54.0	78.3	-12.1	PASS**
2743.20	50.47	40.13	H	54.0	78.3	-13.9	PASS**
3657.60	59.34	50.38	V	54.0	78.3	-3.6	PASS**
3657.60	54.31	43.09	H	54.0	78.3	-10.9	PASS**
4572.00	53.88	41.38	V	54.0	78.3	-12.6	PASS**
4572.00	52.44	42.01	H	54.0	78.3	-12.0	PASS**
5486.40	54.50	42.41	V	54.0	78.3	-35.9	PASS
5486.40	55.03	41.78	H	54.0	78.3	-36.5	PASS
6400.80	53.34	40.50	V	54.0	78.3	-37.8	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details							

** *Emission within the restricted band specified in @ 15.205(a)*

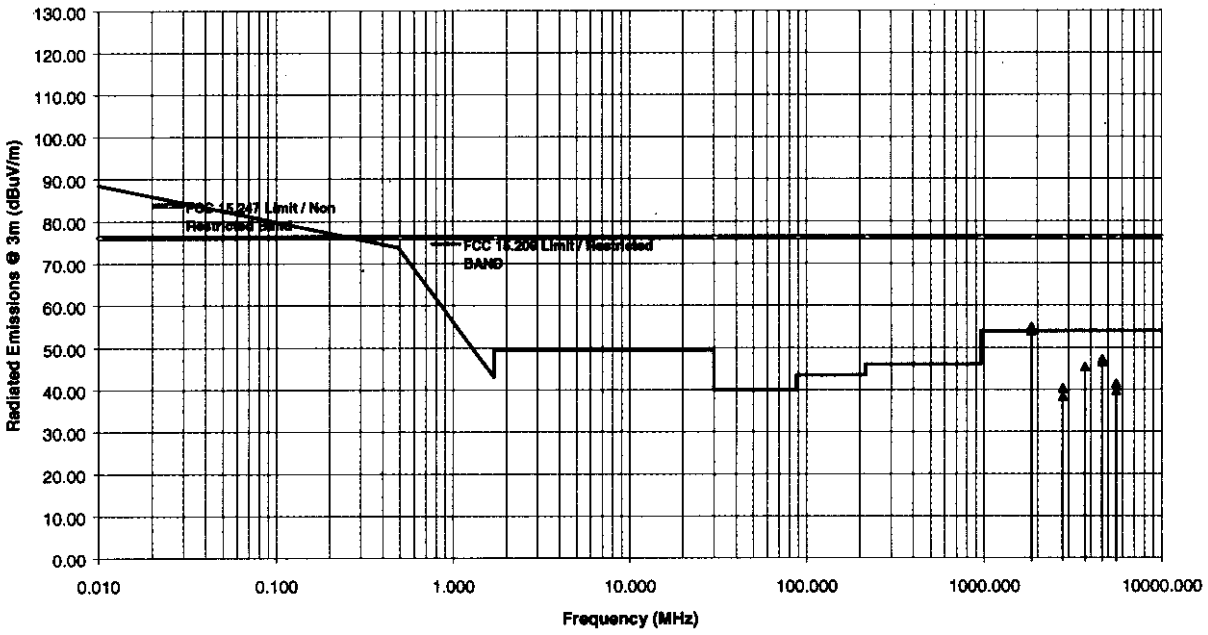
Transmitter Radiated Emissions Measurements at 3 Meter OFTS
Daewoo Telecom Ltd. Digital Cordless Telephone (Base)
TRANSMIT Freq.: 914.4MHz



BASE							
CHANNEL FREQUENCY TESTED: 925.8 MHz FULL RATED POWER: 0.0013 Watt							
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
925.80	95.91	--	V	--	--	--	--
925.80	96.19	--	H	--	--	--	--
1851.60	63.88	53.91	V	54.0	76.2	-22.3	PASS
1851.60	64.06	54.91	H	54.0	76.2	-21.3	PASS
2777.40	51.03	40.31	V	54.0	76.2	-13.7	PASS**
2777.40	48.34	38.38	H	54.0	76.2	-15.6	PASS**
3703.20	56.09	45.41	V	54.0	76.2	-8.6	PASS**
3703.20	56.16	45.41	H	54.0	76.2	-8.6	PASS**
4629.00	56.31	46.47	V	54.0	76.2	-7.5	PASS**
4629.00	57.06	47.31	H	54.0	76.2	-6.7	PASS**
5554.80	54.88	41.41	V	54.0	76.2	-34.8	PASS
5554.80	52.84	39.72	H	54.0	76.2	-36.5	PASS
No other significant emissions were found in the frequency range from 10 MHz to 10 GHz. Refer to attached plots for details							

*** Emission within the restricted band specified in @ 15.205(a)***

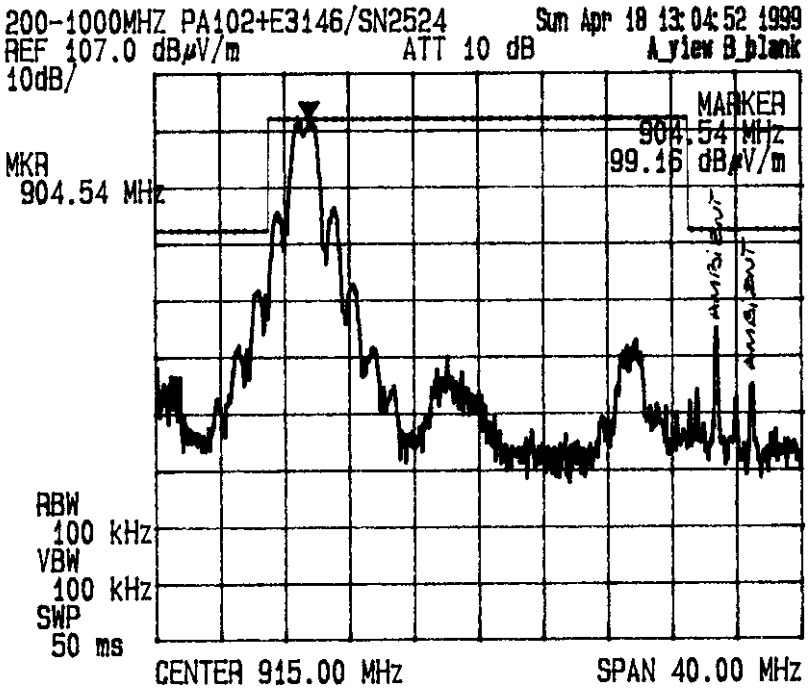
Transmitter Radiated Emissions Measurements at 3 Meter OFTS
Daewoo Telecom Ltd. Digital Cordless Telephone (Base)
TRANSMIT Freq.: 925.8MHz



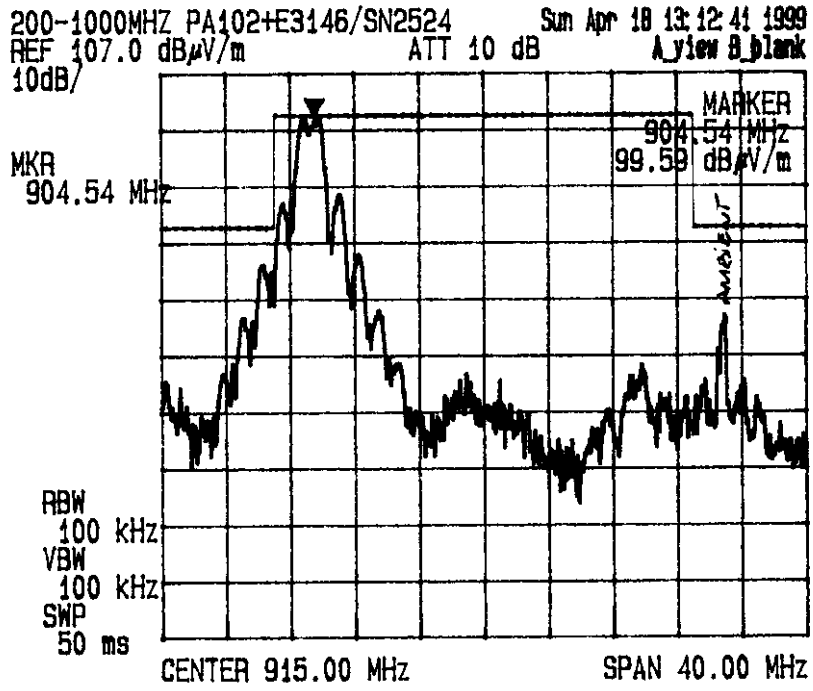
Date: April 18,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [V] Handset Transmitter, [ ] Base Transmitter
Channel #: 1 (Lowest) Tx Frequency: 904.2 MHz

Radiated Emissions Measurements @ 3 Meters



VERTICAL



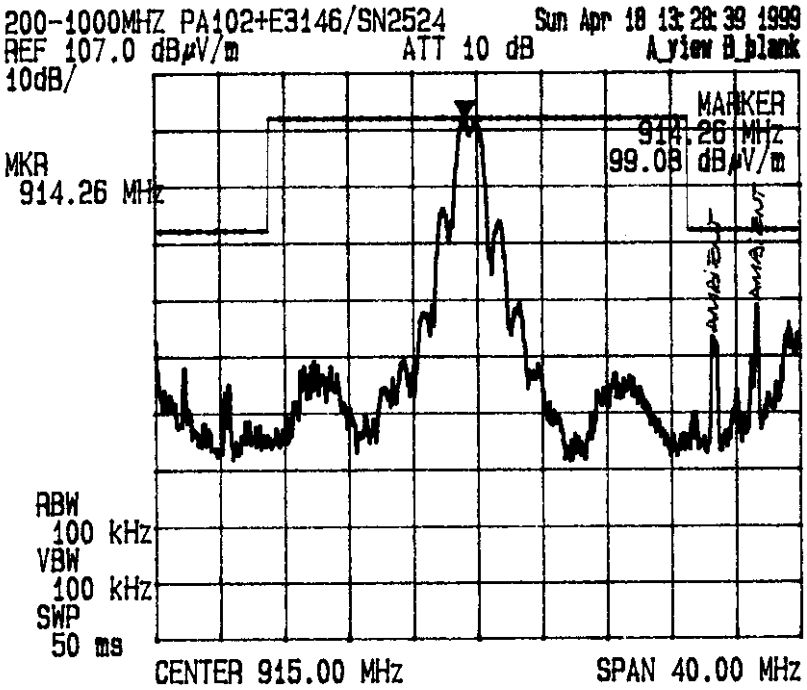
HORIZONTAL

UltraTech
Engineering Labs Inc.

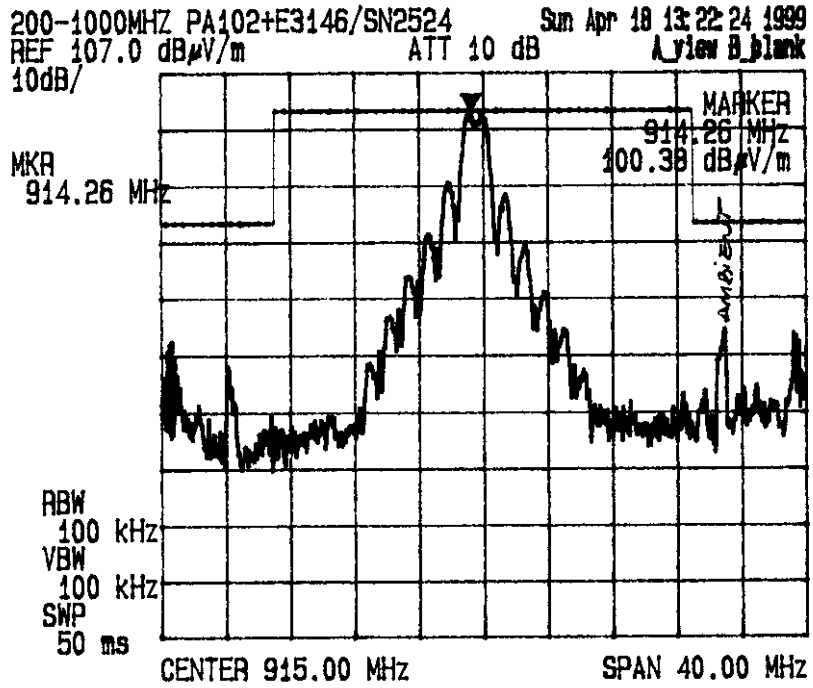
Date: April 28 ,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [X] Handset Transmitter, [ ] Base Transmitter
Channel #: 10 (middle), Tx Frequency: 914.26 MHz

Radiated Emissions Measurements @ 3 Meters



VERTICAL



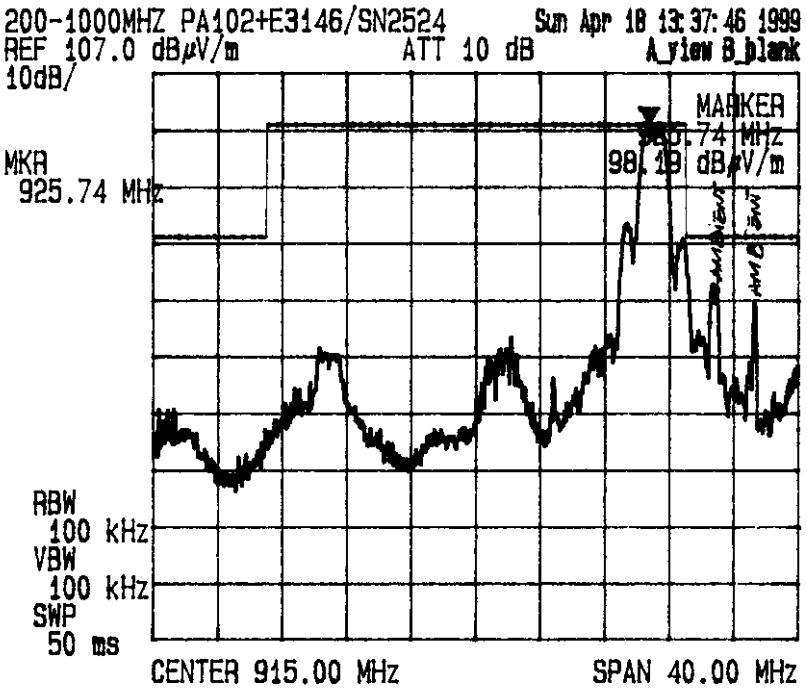
HORIZONTAL

UltraTech
Engineering Labs Inc.

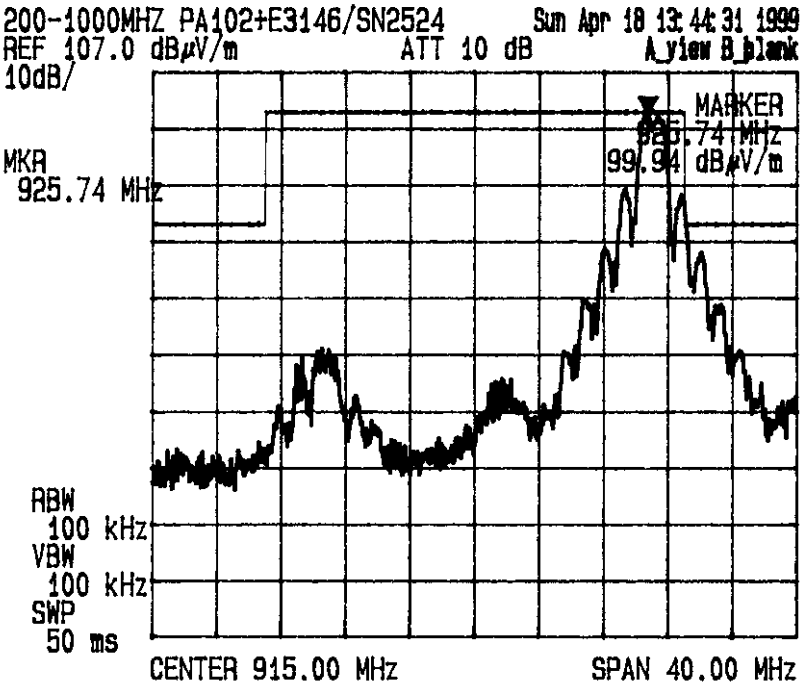
Date: April 18, 1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [X] Handset Transmitter, [ ] Base Transmitter
Channel #: 60 (HIGHEST) Tx Frequency: 925.8 MHz

Radiated Emissions Measurements @ 3 Meters



VERTICAL



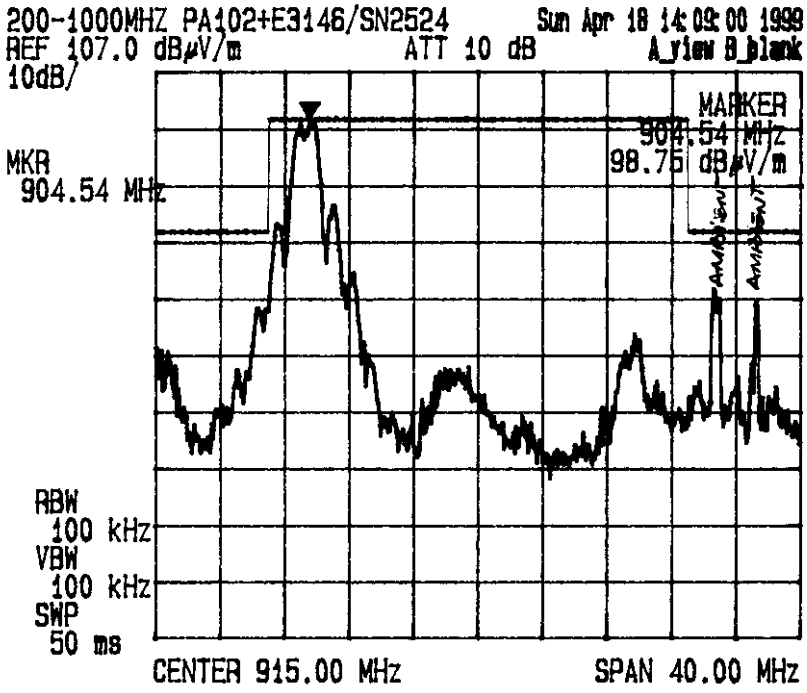
HORIZONTAL

UltraTech
Engineering Labs Inc.

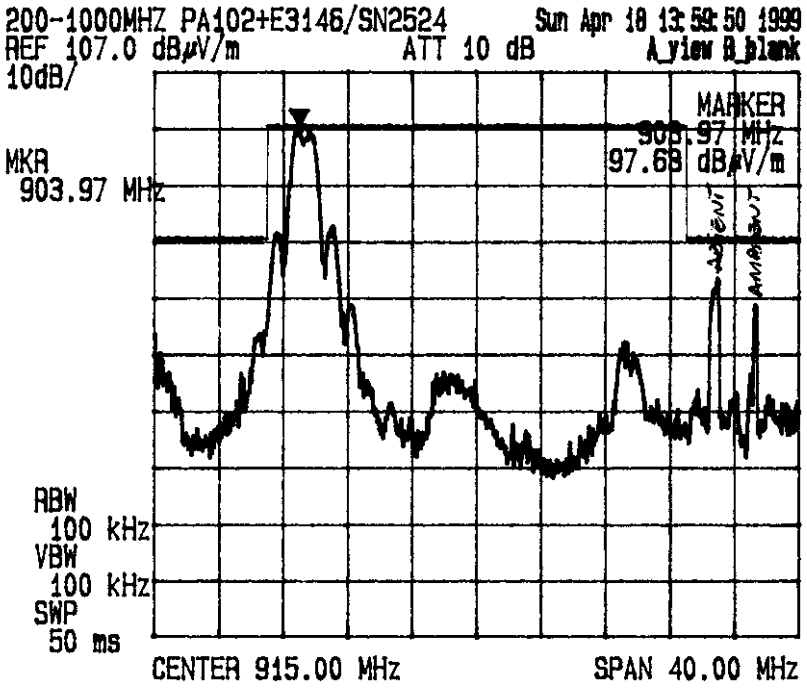
Date: April 18 ,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 1 (Lowest) Tx Frequency: 904.20MHz

Radiated Emissions Measurements @ 3 Meters



VERTICAL



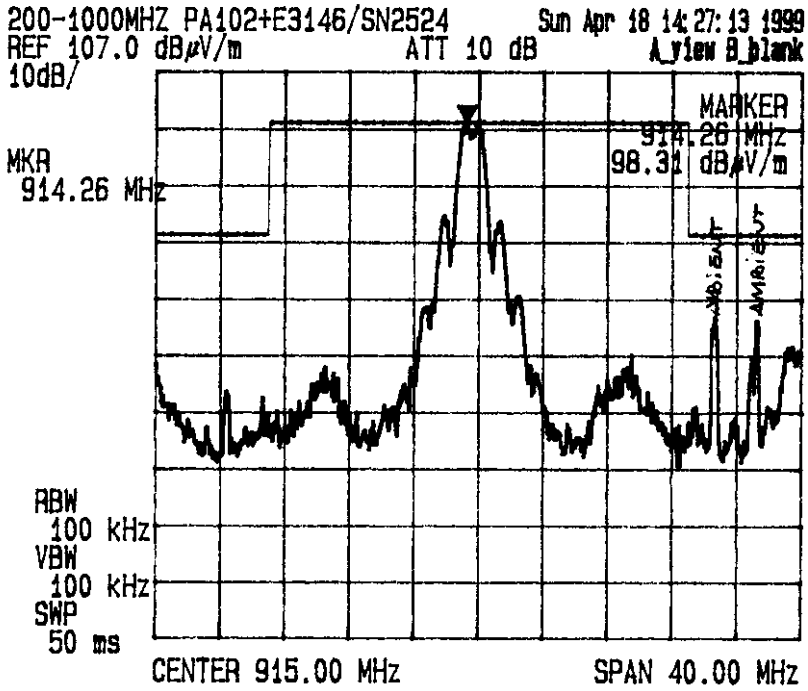
HORIZONTAL

UltraTech
Engineering Labs Inc.

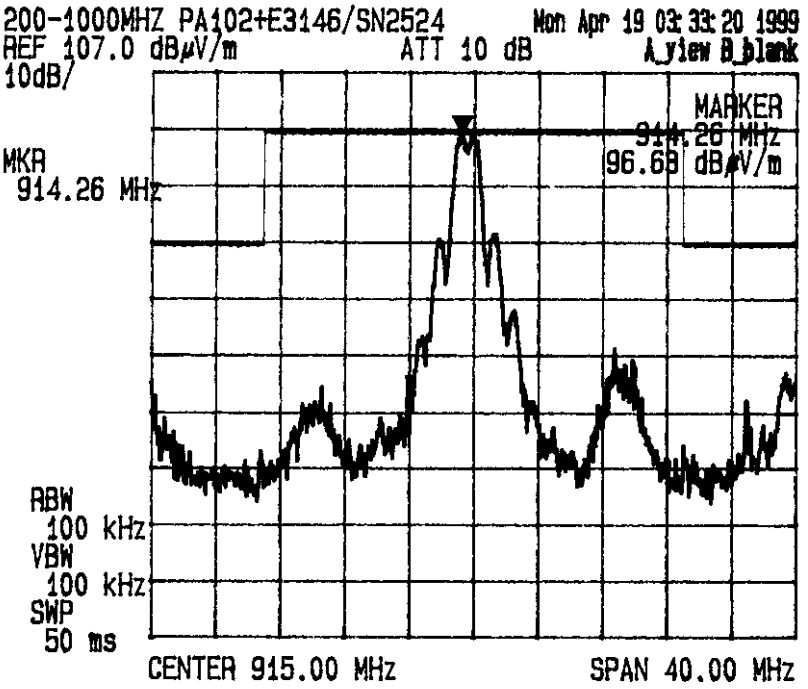
Date: April 19 ,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 10 (mid) Tx Frequency: 914.40 MHz

Radiated Emissions Measurements @ 3 Meters



VERTICAL



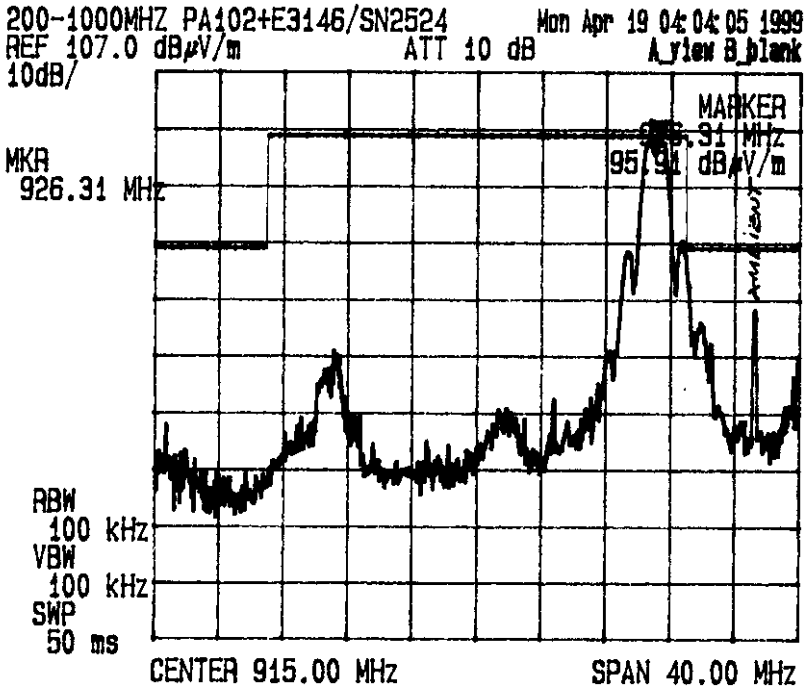
HORIZONTAL

UltraTech
Engineering Labs Inc.

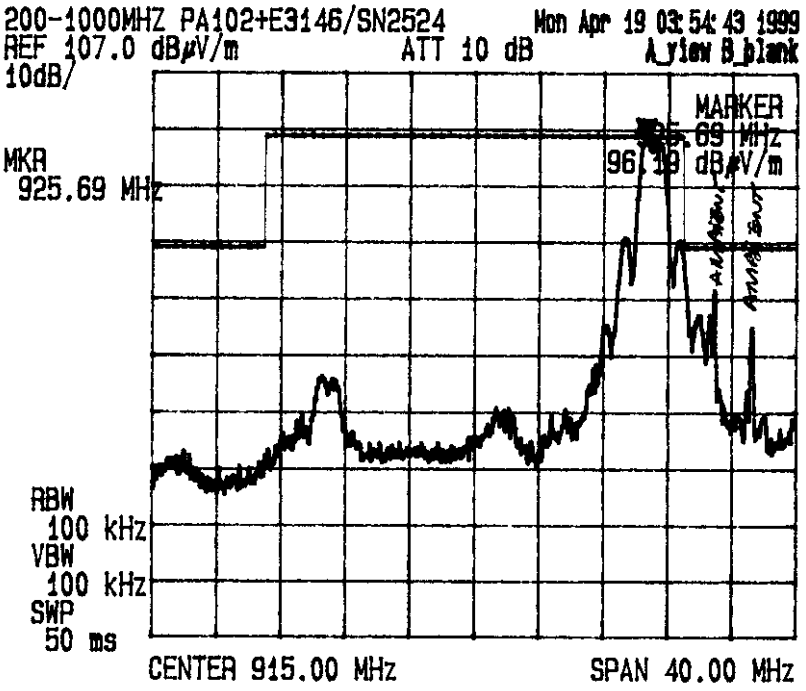
Date: April 19, 1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [X] Base Transmitter
Channel #: 20 (HIGHEST) Tx Frequency: 925.8

Radiated Emissions Measurements @ 3 Meters



VERTICAL



HORIZONTAL

UltraTech
Engineering Labs Inc.

4.5. TRANSMITTED POWER DENSITY OF A DIRECT SEQUENCE SPREAD SPECTRUM SYSTEM, FCC CFR 47, PARA. 15.247(D)

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

FCC REQUIREMENTS:

For a direct sequence system, the transmitted power density average over any 1second interval shall not be greater than 8 dBm in any 3 KHz bandwidth within this band.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

3.6V DC 550mA (Handset), 9V DC 300mA (Base)

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT

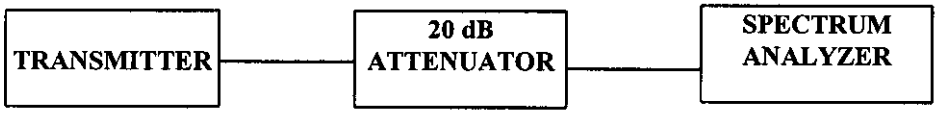
METHOD OF MEASUREMENT:

A scan was made by using a spectrum analyzer with the detector function set to NORMAL mode.

Locate and zoom in on emission peak(s) within the passband. Set RBW = 3 KHz, VBW $\geq$ RBW, Sweep = SPAN/3 KHz. For example, a span of 1.5 MHz, the sweep should be $1.6x10^6/3.0x10^3$= 500 seconds. The measured peak level must be no greater than +8 dBm.

- For devices with spectrum line spacing greater than 3 KHz no change is required.
- For devices with spectrum line spacing equal to or less than 3 KHz, the resolution bandwidth must be reduced below 3 KHz until the individual lines in the spectrum are resolved. The measurement data must then be normalized to 3 KHz by summing the power of all the individual spectral lines within 3 KHz band (in linear power units) to determine compliance.
- If the spectrum line spacing cannot be resolved on the available spectrum analyzer, the noise density function on most modern conventional spectrum analyzer will directly measure the noise power density normalized to 1 Hz noise power bandwidth. Add 30 dB for correction to 3 KHz.
- Should all the above fail or any controversy develop regarding accuracy of measurement, the Laboratory will use HP 89440A Vector Signal Analyzer for final measurement unless a clear showing can be made for a further alternate.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hung Trinh, EMI/RFI Technician

DATE: April 22. 1999

MEASUREMENT DATA:

TEST CONFIGURATION

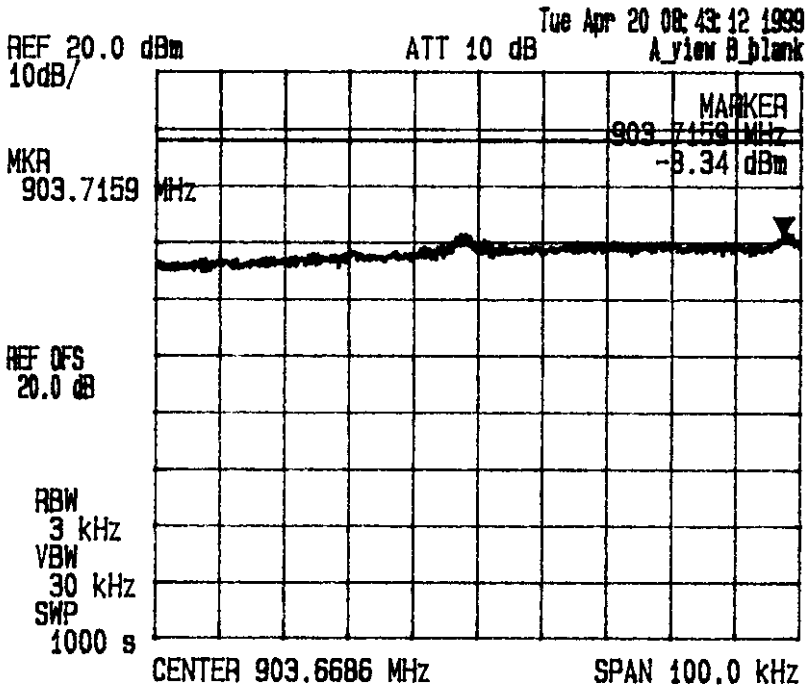
- *The transmitter was coupled to the Spectrum Analyzer through a 20 dB attenuator.*
- *The insertion loss between the transmitter output terminal and the spectrum analyzer was measured to be 20 dB*
- *The channel frequencies were established on the extreme edges (both upper and lower) and middle of the 904.2 - 925.8 MHz band at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Part 15.247(d)*

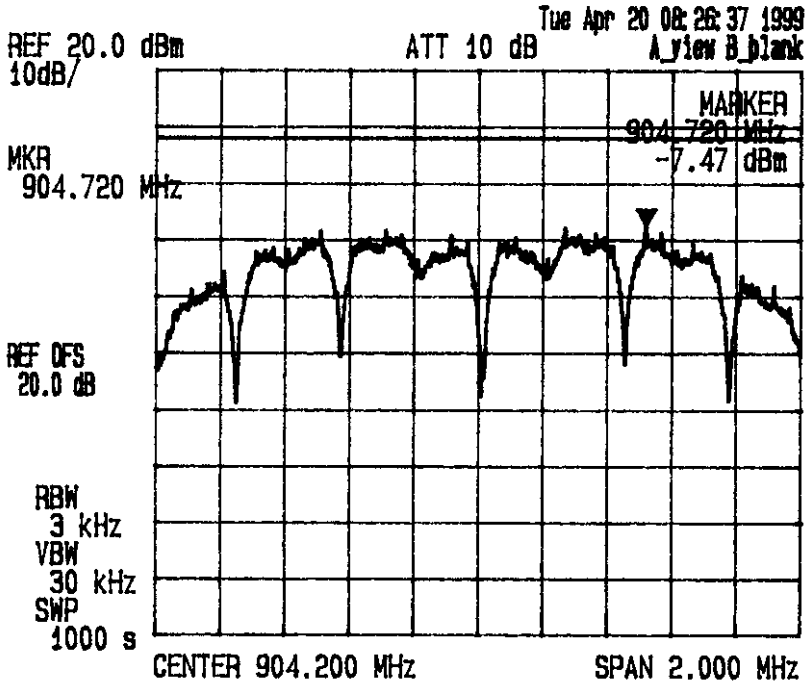
HANDSET					
CHANNEL NUMBER	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN 3 KHz BW (dBm)	LIMIT (dBm)	MARGIN (dB)	COMMENTS (PASS/FAIL)
1	904.2	-7.47	8.0	-15.5	PASS
10	914.4	-7.31	8.0	-15.3	PASS
20	925.8	-7.41	8.0	-15.4	PASS

BASE					
CHANNEL NUMBER	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN 3 KHz BW (dBm)	LIMIT (dBm)	MARGIN (dB)	COMMENTS (PASS/FAIL)
1	904.2	-16.59	8.0	-24.6	PASS
10	914.4	-17.81	8.0	-25.8	PASS
20	925.8	-18.34	8.0	-26.3	PASS

Date: April 20,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 1 (Lowest), Tx Frequency: 903.20 MHz





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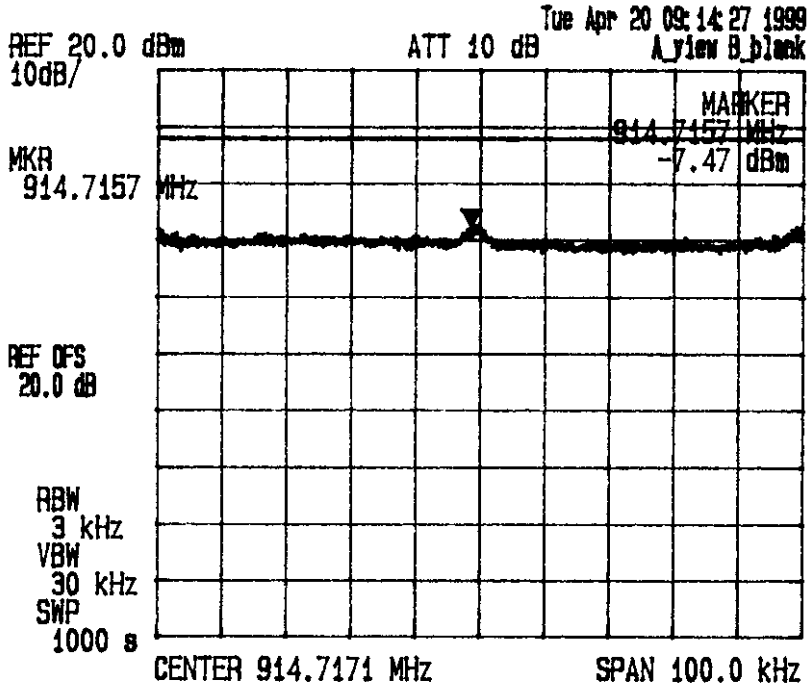
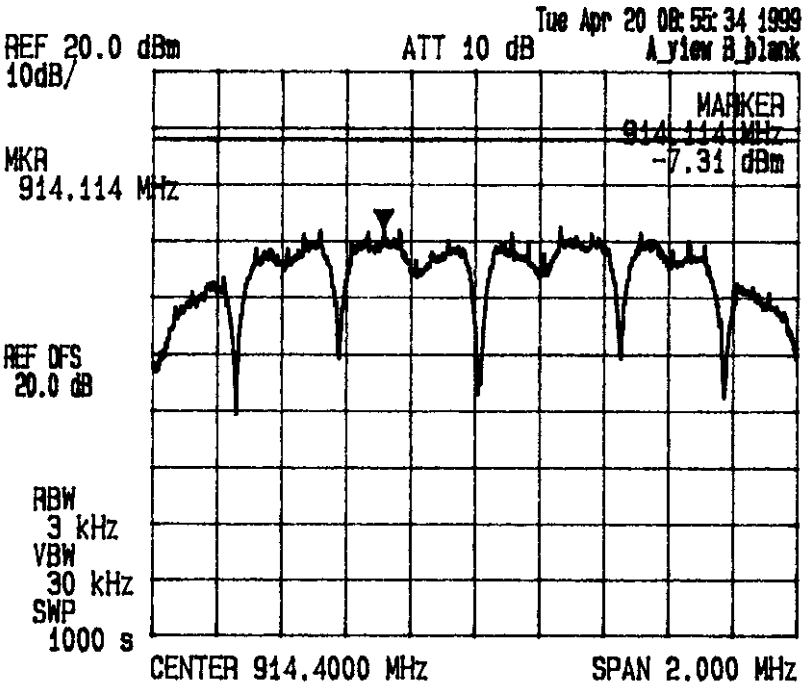
Engineering Labs Inc.

Date: April 20 ,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 10 (MIDDLE), Tx Frequency: 914.400MHz





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Engineering Labs Inc.

Date: April 20,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [M] Handset Transmitter, [ ] Base Transmitter
Channel #: 20 (Highest) Tx Frequency: 925.80MHz

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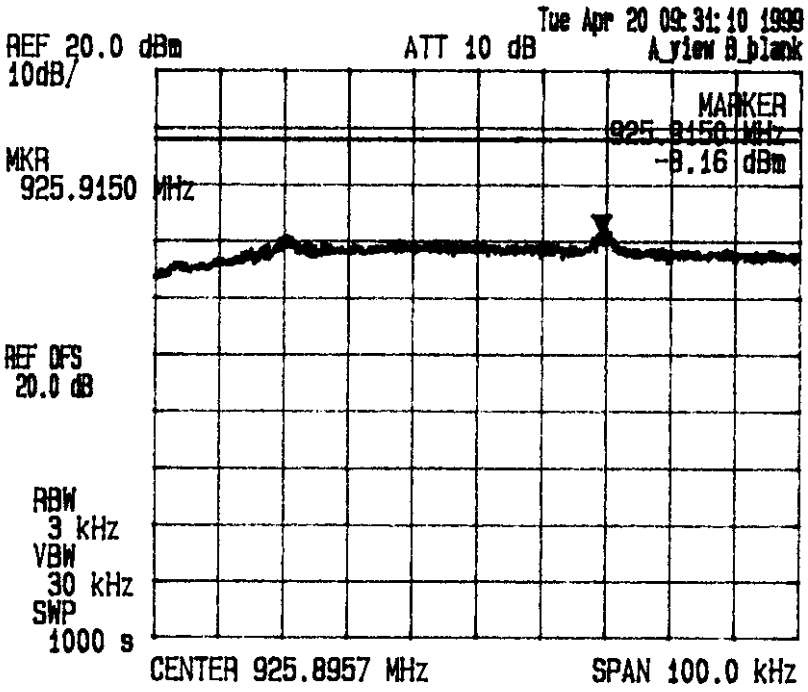
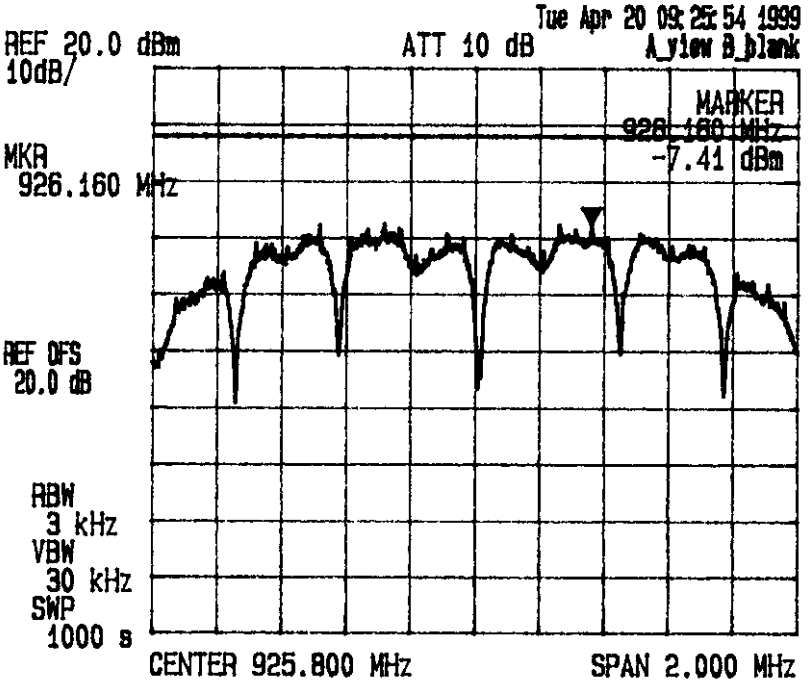
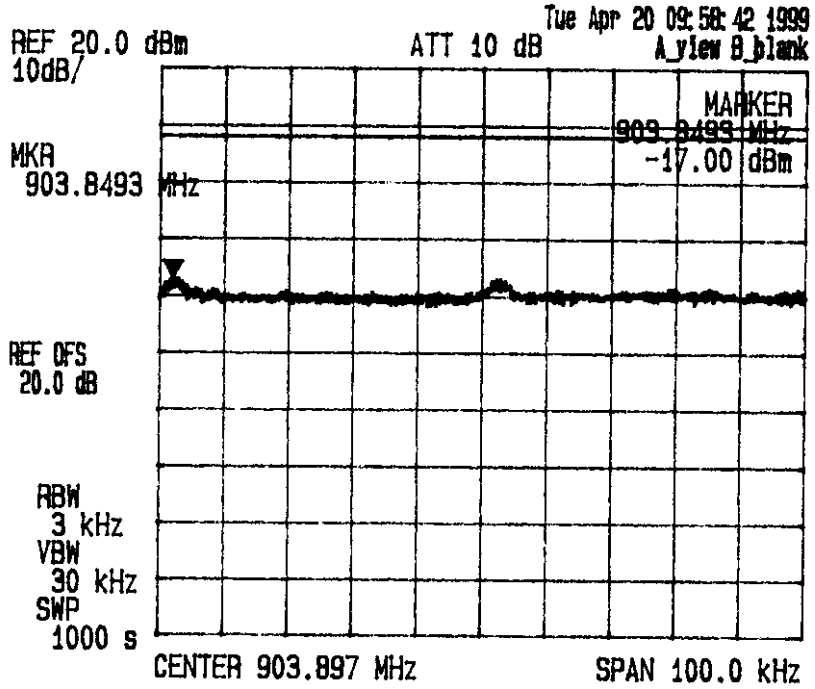
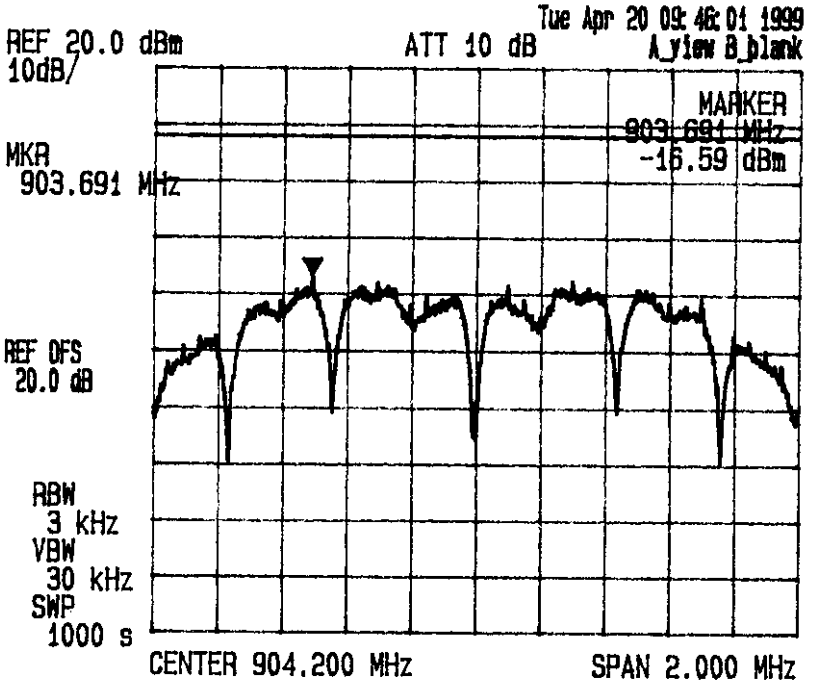




Date: April 20,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: L (LOWEST), Tx Frequency: 903.69 MHz

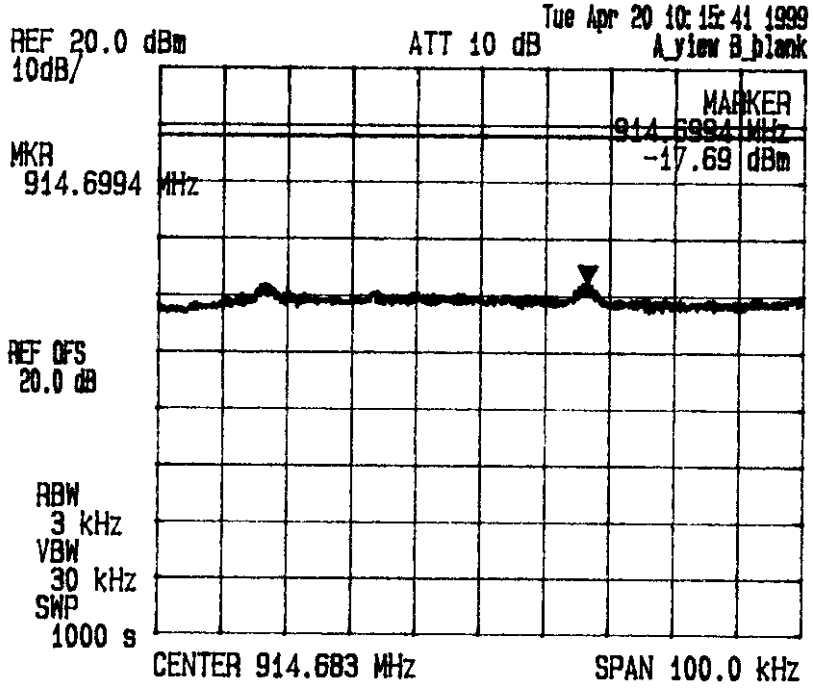


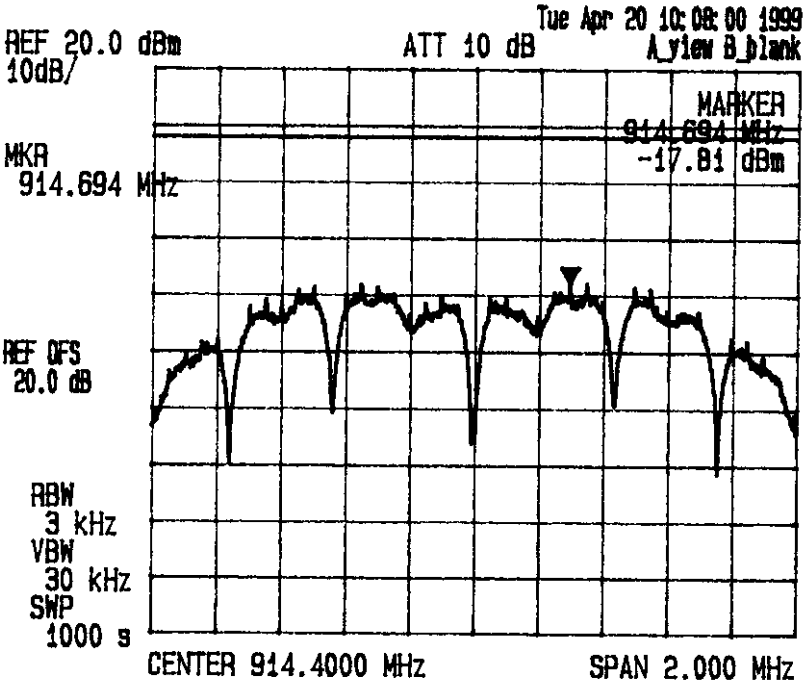


UltraTech Engineering Labs Inc.

Date: April 20,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [M] Base Transmitter
Channel #: 10 (mid) Tx Frequency: 914.400MHz



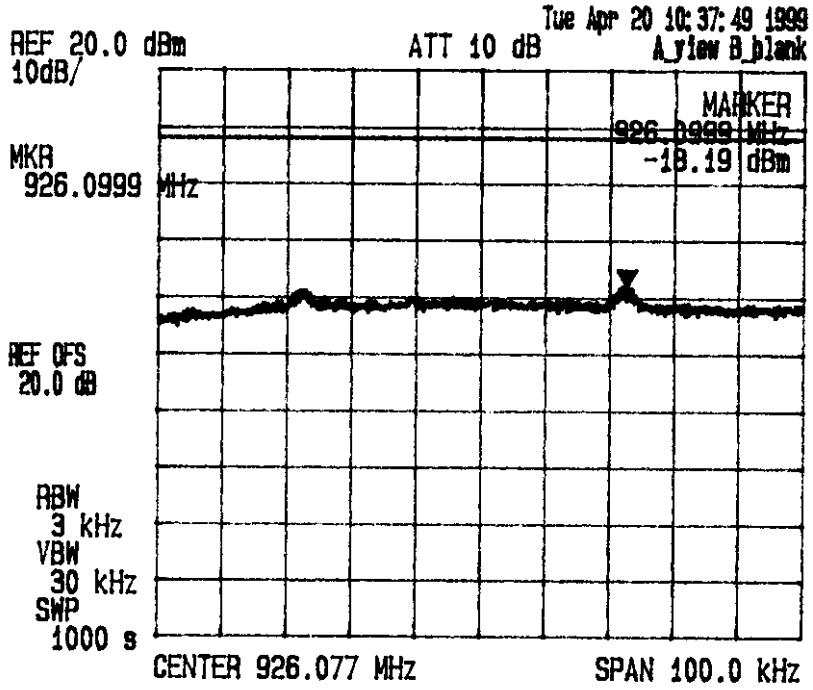


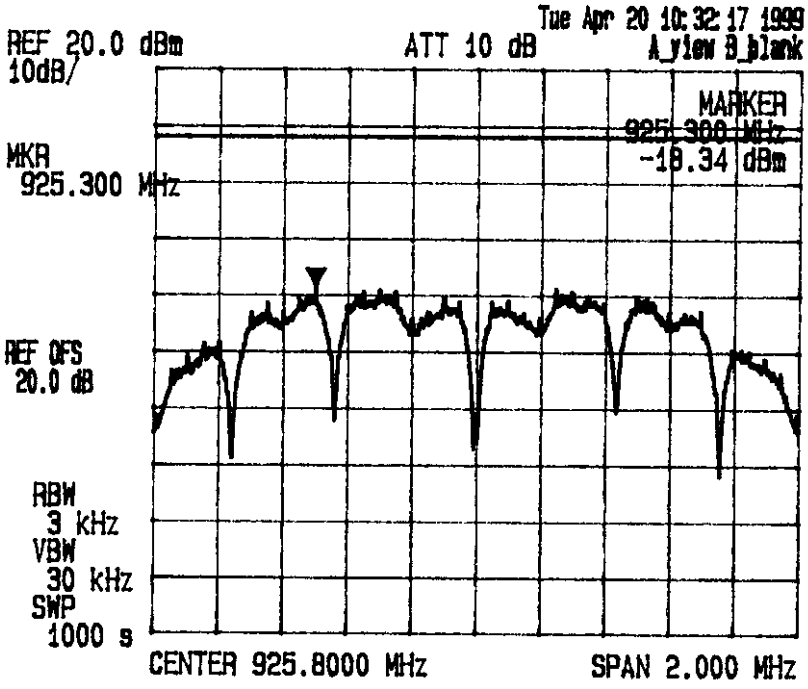
UltraTech
Engineering Labs Inc.

Date: April 20,1999
Tested by: Hung Trinh

DAEWOO TELECOM LTD.
TS-101 CORDLESS TELEPHONE
Tested Component: [ ] Handset Transmitter, [X] Base Transmitter
Channel #: 20 (Highest) Tx Frequency: 925.800MHz

UltraTech
Engineering Labs Inc.





4.6. PROCESSING GAIN OF A DIRECT SEQUENCE SPREAD SPECTRUM, FCC CFR 47, PARA. 15.247(E)

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

FCC REQUIREMENTS:

The processing gain of a direct sequence system shall be at least 10 dB. The processing gain shall be determined from the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on, as measured at the demodulated output of the receiver.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

3.6V DC 550mA (Handset), 9V DC 300mA (Base)

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- 3dB & 40 dB Attenuators, 50 Ohm IN/OUT
- Fluke RF Signal Generator, Model 6061A, Freq. Range: 10 KHz - 1050 MHz.
- HP Synthesized Sweeper, Model HP83752B, S/N: 3610A00457, Freq. Range: 10 kHz – 20 GHz.
- HP 8900 RF Peak Power Meter, Measuring Frequency Range: 100 MHz - 18 GHz.
- Bert Fireberd 4000 Communication Analyzer

METHOD OF MEASUREMENT:- Jamming Margin Method

The processing gain may be measured using the CW jamming margin method. Figure 1 shows the test configuration. The test consists of stepping a signal generator in 50 KHZ increments across the passband of the system. At each point, the generator level required to produce the recommended Bit Error Rate (BER) is recorded. This level is jammer level. The output power of the transmitting unit is measured at the same point. The Jammer to Signal (J/S) ratio is then calculated. Discard the worst 20% of the J/S data points. The lowest remaining J/S ratio is used when calculating the Process Gain.

The signal to noise ratio for an ideal differentially coherent detetion of a differentially encoded BPSK receiver can be derived from the Bit Error Probability (Pb) versus Signal-to-Noise ratio. See attached plot for detailed information.

For measurement of the $(S/N)_o$ we use the Pb of $1.0x10^{-5}$ minimum.

Ref.: Viterbi, A.J. Principles of Coherent Communications (New York: McGraw-HILL 1966), Pg. 207

Using equation (1) shown above, calculate the signal to noise ratio required for your chosen BER. This value and the measured J/S ratio are used in the following equation to calculate the Process Gain (Gp) of the system.

$$Gp = (S/N)o+Mj+Lsys$$

Where:

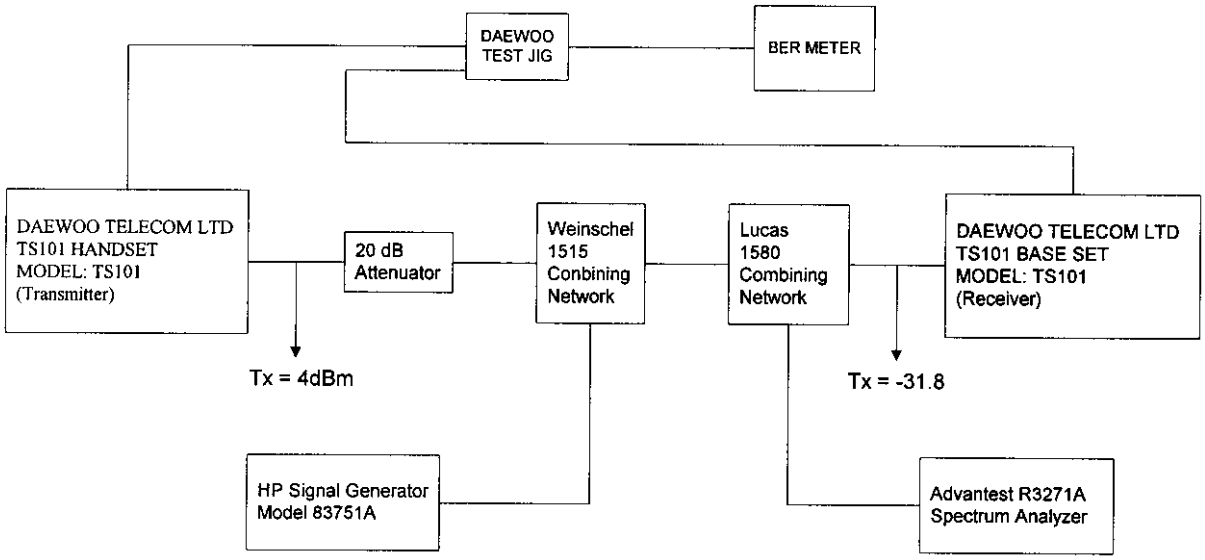
(S/N)o: Theoretical signal to noise ratio required to maintain the normal operation just before the BER appears. In real measurements the maximum error of 0.001 is allowed in an ideal system using their modulation scheme with all codes turned off (i.e. no spreading or processing gain).

Mj: Maximum jammer to Signal Ratio that recorded at the detected BER.

Lsys: System losses such as non-ideal synchronization, tracking circuitry, non-optimal baseband receiver filtering and etc... These losses can be in excess of 3 dB for each transmitter and receiver pair. For the purpose of this processing gain calculation we assume a Lsys at its minimum value of 2 dB.

Ref.: Dixon, R, Spread Spectrum Systems. (New York: Wiley, 1984), Chapter 1.

- (S/N)o: Refer to attached curcves, BER versus (S/N)o for Differiential Coherent Detection of Differientially Encoded BPSK
- Processing gain Gp = (S/N)o + Lsys + Mj = (S/N)o + 2 + Mj



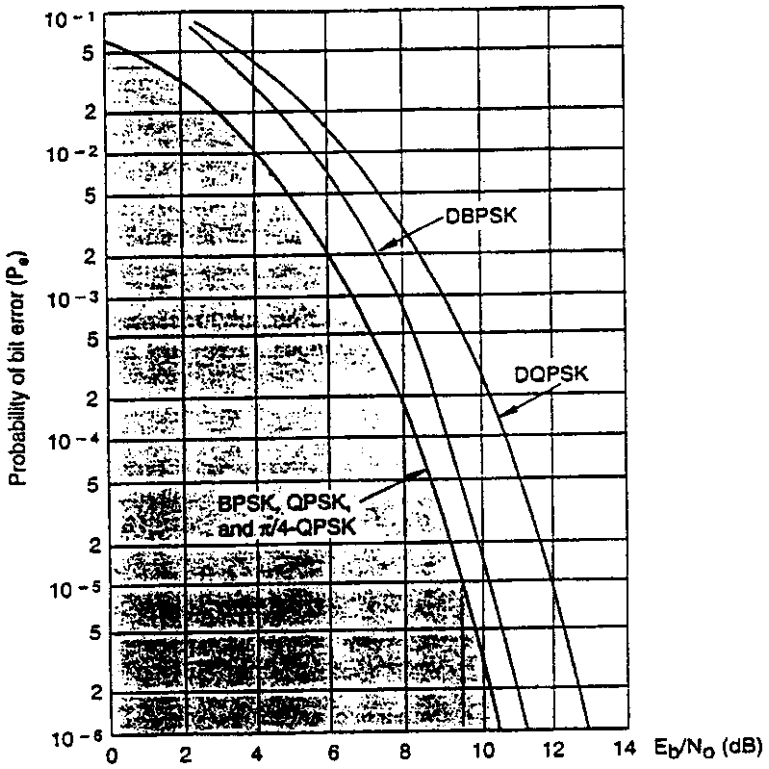


Figure 4.5.1 Theoretical $P_e = f(E_b/N_0)$ performance in a stationary additive white Gaussian noise (AWGN) environment. Ideal, linearly amplified coherent BPSK, QPSK, and differentially demodulated DBPSK systems are illustrated. The performance of non-linearly amplified FQPSK and GMSK is compared to ideal linearly amplified QPSK in Figures 4.3.33 and 4.3.34. (From Proakis, 1989.) See Appendix A.3.

tically equivalent term bit-error rate (BER) is used in applied references and specifications.

Power efficiency of modulated systems is defined as being inversely proportional to the

$$\text{BER} = f(C/N)$$

and/or

$$\text{BER} = f(E_b/N_o)$$

equations and performance curves, where E_b is the average energy of a modulated bit and N_o is the noise power spectral density (the noise power in a normalized 1-Hz bandwidth) at the demodulator input. The higher the probability of error, the lower the power efficiency, since transmitted power is "wasted" on more bad data.

Processing Gain Measurements for Conexant's DCT

1. Scope

This document details the results of measurement of the processing gain of a DCT FFF phone with reference to the Code of Federal Regulations, Title 47, Chapter 1, Part 15 Radio Frequency Devices (FCC).

FCC	Federal Communications Commission
SNR	Signal to Noise Ratio
JSR	Jammer to Signal Ratio
CW	Continuous wave (jammer)
HS	Handset
BS	Basestation
DBPSK	Differential Binary Phase Shift Keying

Table 1: Abbreviations

2. An Overview of the Processing Gain

Processing Gain Calculation

Theoretical processing gain limit for the 12bit Spreading BPSK system is 10.8dB.

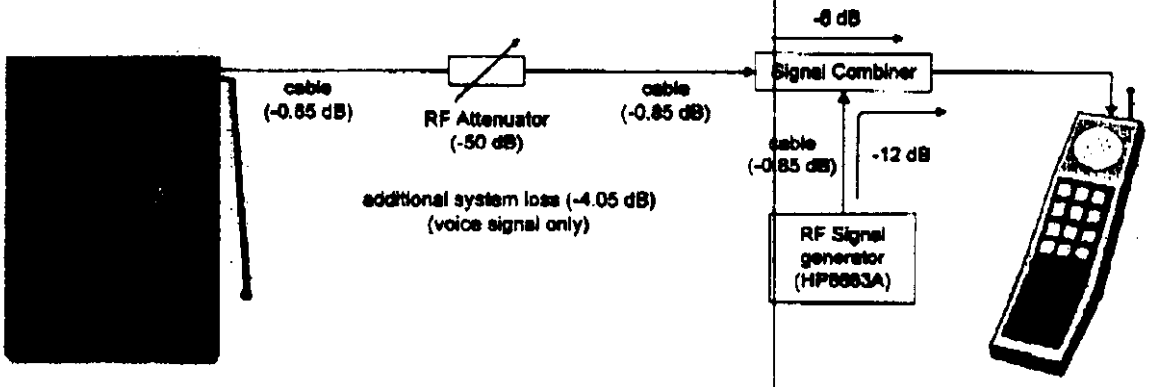
Processing Gain Measurement Method

Following method is specified by the FCC to measure processing gain. The detailed are in FCC documents 15.247 (e)(1). This involves transmitting a CW jammer in the RF passband of the system and measuring the jammer to signal ratio (JSR) required to achieve a certain bit error rate. The choice of the actual value of the bit error rate is left up to the tester. The jammer is stepped in 50 kHz increments across the entire passband and in each case the JSR to achieve the desired bit error rate is measured. The JSR is measured at the RF input to the system under test. The lowest 20% of the JSR data (in dB) are discarded. The processing gain can then be calculated as follows: -

$$G_p = \left(\frac{S}{N}\right)_{theory} + \left(\frac{J}{S}\right)_{measured} + L_{system}$$

where G_p is the processing gain, the SNR is that theoretically predicted for the system under the test to achieve the desired bit error rate, the JSR is the lowest value (in dB) in the remaining data set and L_{sys} adjusts for non-ideal system losses. L_{sys} can not be greater than 2 dB.

3. Processing Gain Measurement Test Setup



The following parameters were used in the test setup.

HS Tx power (dBm)	-1.9	
BS LNA gain (dB)	0	
Channel attenuation (dB)	-50	
Test system losses (signal) (dB)	-11.75	-4.05 dB (system), -6 dB (signal combiner), -1.7 dB (2 cables)
Test system losses (jammer) (dB)	-12.85	-12 dB (signal combiner), -0.85 dB (cable)

Table 2: Test Setup Parameters

4. Results & Calculation

The following measurement results were taken at the basestation. The desired bit error rate was set at 10^{-3}.

Jammer Frequency (MHz)	BER (BS)	Received jammer power (dBm)	Received signal power (dBm)	Jammer/Signal ratio (dB)
913.80	9.4×10^{-4}	-59.55	-63.65	4.1
913.85	9.6×10^{-4}	-57.95	-63.65	5.7
913.90	9.6×10^{-4}	-60.15	-63.65	3.5
913.95	9.6×10^{-4}	-64.25	-63.65	-0.6
914.00	1.1×10^{-3}	-61.55	-63.65	2.1
914.05	9.8×10^{-4}	-61.55	-63.65	2.1
914.10	1.1×10^{-3}	-61.95	-63.65	1.7
914.15	9.2×10^{-4}	-62.85	-63.65	0.8
914.20	1.0×10^{-3}	-59.85	-63.65	3.8
914.25	1.0×10^{-3}	-61.15	-63.65	2.5
914.30	1.1×10^{-3}	-62.05	-63.65	1.6
914.35	1.0×10^{-3}	-57.65	-63.65	6.0
914.40	1.1×10^{-3}	-55.65	-63.65	8.0
914.45	1.0×10^{-3}	-49.35	-63.65	14.3
914.50	1.1×10^{-3}	-59.25	-63.65	4.4
914.55	1.0×10^{-3}	-62.35	-63.65	1.3
914.60	9.7×10^{-4}	-59.05	-63.65	4.6
914.65	1.0×10^{-3}	-61.05	-63.65	2.6
914.70	1.1×10^{-3}	-62.35	-63.65	1.1
914.75	9.0×10^{-4}	-61.95	-63.65	1.7
914.80	1.0×10^{-3}	-61.05	-63.65	2.6
914.85	9.9×10^{-4}	-62.35	-63.65	1.3
914.90	1.1×10^{-3}	-64.05	-63.65	-0.4
914.95	9.2×10^{-4}	-56.25	-63.65	7.4
915.00	1.0×10^{-3}	-59.85	-63.65	3.8
915.05	1.1×10^{-3}	-57.25	-63.65	6.4
915.10	9.9×10^{-4}	-58.15	-63.65	5.5

Table 3: Test Results

For DBPSK at 10^{-3} bit error rate the required SNR is 8.0 dB. Using the results above and the data in the table below the processing gain is calculated to be 11.3 dB.

required SNR (dB)	8.0
system losses (dB)	2.0
J/S ratio at 50% point (dB)	1.30
FCC Processing gain (dB)	11.3

Table 4: Processing Gain Calculation data

Conclusions

The result measured for processing gain of 11.3 dB is close to the actual processing gain due to a 12 chip spreading code of $10 \times \log_{10}(12) = 10.8$ dB

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hung Trinh, RFI/EMI Technician

DATE: April 21, 1999

MEASUREMENT DATA:

Test Method Employed: Jamming Margin

Test Configuration #: DBPSK MODULATION, 85.3 Kbps Data Rate

Remarks: Since the base and handset radio transmitter and receiver were identical, test for base receiver was conducted and would also represent the handset.

Measured The Transmitter's Peak RF Power @ Receiver Input Terminal: -31.8 dBm

MIN. MEASURED PROCESSING GAIN: 11.5 dB

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) x10-5	DBPSK Approx. (S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
1	-1.00	1.5	10.1	2.0	8.90	21.0
2	-0.95	2.5	10.0	2.0	7.60	19.6
3	-0.90	1.3	10.2	2.0	7.30	19.5
4	-0.85	1.0	10.2	2.0	7.30	19.5
5	-0.80	1.3	10.2	2.0	4.90	17.1
6	-0.75	2.5	10.0	2.0	10.10	22.1
7	-0.70	1.0	10.2	2.0	2.80	15.0
8	-0.65	2.0	10.1	2.0	0.80	12.9
9	-0.60	2.0	10.1	2.0	1.70	13.8
10	-0.55	1.5	10.1	2.0	3.10	15.2
11	-0.50	1.8	10.1	2.0	1.60	13.7
12	-0.45	2.0	10.1	2.0	2.30	14.4
13	-0.40	2.0	10.1	2.0	3.10	15.2
14	-0.35	1.5	10.1	2.0	0.80	12.9
15	-0.30	1.0	10.2	2.0	1.20	13.4
16	-0.25	2.3	10.0	2.0	1.30	13.3
17	**-0.20**	**2.5**	**10.0**	**2.0**	**-0.50**	**11.5**
18	-0.15	5.0	9.5	2.0	0.40	11.9
19	-0.10	1.5	10.1	2.0	-0.20	11.9
20	-0.05	1.3	10.2	2.0	0.30	12.5
21	0.00	1.8	10.1	2.0	8.10	20.2

Continued..

Test Point	Jammer Signal Freq. + /- Fc (MHz)	(BER) x10-5	DBPSK Approx. (S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
22	0.05	2.0	10.1	2.0	3.90	16.0
23	0.10	1.3	10.2	2.0	-0.30	11.9
24	0.15	1.0	10.2	2.0	1.30	13.5
25	0.20	1.3	10.2	2.0	2.40	14.6
26	0.25	2.0	10.1	2.0	1.90	14.0
27	0.30	1.0	10.2	2.0	1.80	14.0
28	0.35	1.0	10.2	2.0	2.40	14.6
29	0.40	1.8	10.1	2.0	-0.45	11.6
30	0.45	1.3	10.2	2.0	8.39	20.6
31	0.50	1.0	10.2	2.0	2.52	14.7
32	0.55	1.2	10.2	2.0	1.33	13.5
33	0.60	1.8	10.1	2.0	1.96	14.1
34	0.65	1.0	10.2	2.0	1.64	13.9
35	0.70	1.3	10.2	2.0	2.27	14.5
36	0.75	1.5	10.1	2.0	1.40	13.5
37	0.80	1.3	10.2	2.0	7.49	19.7
38	0.85	1.5	10.1	2.0	4.49	16.6
39	0.90	1.5	10.1	2.0	4.30	16.4
40	0.95	1.3	10.2	2.0	4.20	16.4
41	1.00	1.3	10.2	2.0	8.50	20.7
Minimum Processing Gain = 11.5dB						

4.7. AC POWERLINE CONDUCTED EMISSIONS, FCC CFR 47, PARA. 15.107(A)

PRODUCT NAME: **Digital Cordless Telephone, Model No.: TS101**

NAME OF TEST: **AC Powerline Conducted Emissions.**

FCC LIMIT:

The RF voltage conducted back onto the public utility lines shall not exceed 250 μV or 48.0 dBμV measured from 450 KHz to 30 MHz.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

3.6V DC 550mA (Handset), 9V DC 300mA (Base)

TEST EQUIPMENT:

- Advantest R3271 Spectrum Analyzer, Frequency Range: 100Hz-26.5GHz, with built-in Peak, Quasi-Peak and Average Detectors.
- HP 11947A Transient Limiter, HP, Model 11947A, Frequency Range: 9KHz-200MHz, Attenuation: 10dB HP.
- HP 7475 Plotter
- EMCO 3825/2 LISN, Frequency Range: 9KHz-200MHz
- RF Shielded Enclosure (12x16x12 feet)

METHOD OF MEASUREMENTS:

Refer to ANSI C63.4-1992.

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Hien Luu, RFI/EMI Technician

DATE: April 1, 1999

MEASUREMENT DATA

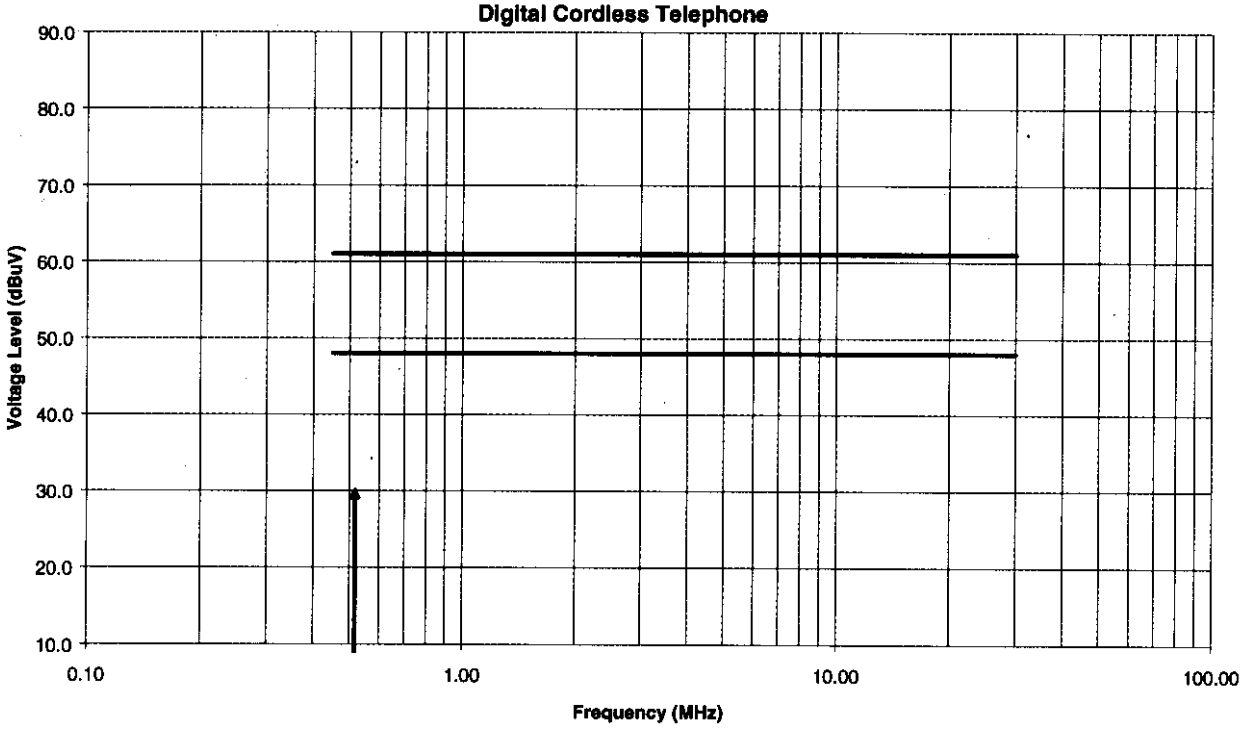
AC POWER-LINE CONDUCTED EMISSIONS

REMARKS

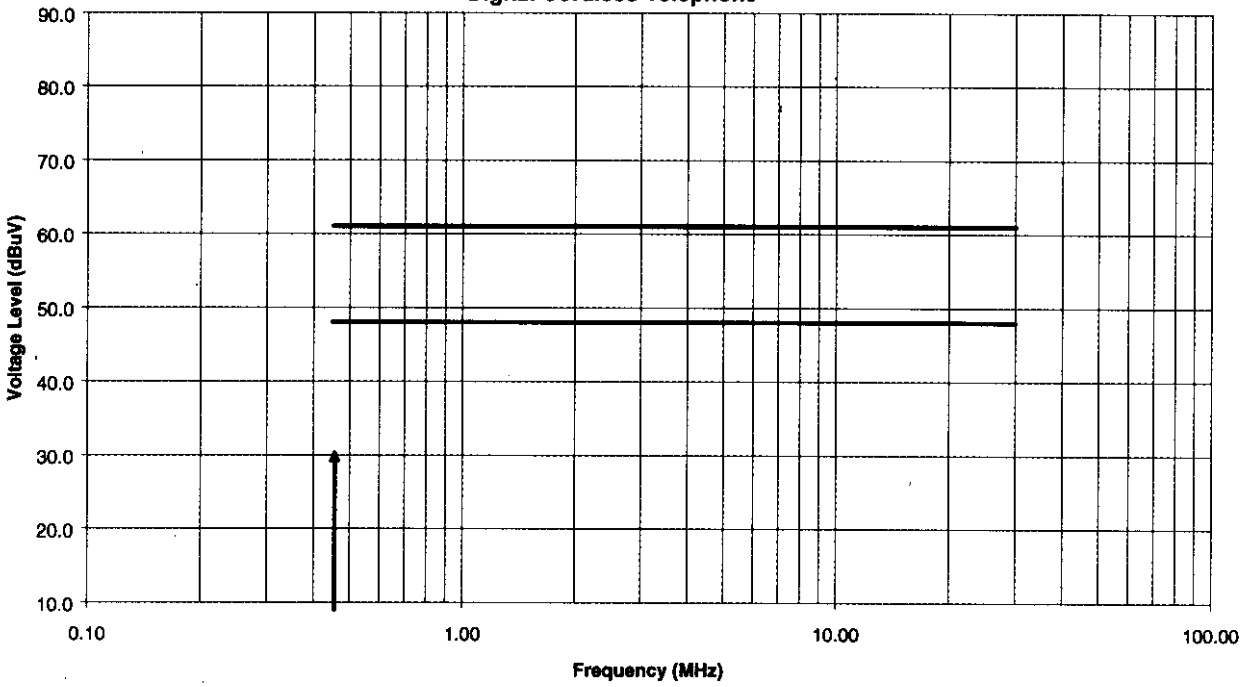
- *All rf emissions from 450 KHz to 30 MHz were scanned, and eight highest emission levels were recorded. See attached plots.*
- *P: Peak Detector, 10 KHz RBW, VBW ≥ RBW*
- *Q: CISPR QUASI-PEAK, 9 KHz RBW, VBW ≥ RBW*
- *QP/BB: for broadband emission (QP level - AVG level > 6 dB); the recorded level was QP level less 13 dB.*

FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP/NB LIMIT (dBuV)	QP/BB LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.52	29.6	QP	48.0	61.0	-31.4	PASS	L1
0.46	29.8	QP	48.0	61.0	-31.2	PASS	L2

AC Conducted Emissions - Line #1 (Hot)
Ultratech Engineering Labs Inc.
Daewoo Telecom Ltd.
Digital Cordless Telephone



AC Conducted Emissions - Line #2 (Neutral)
Ultratech Engineering Labs Inc.
Daewoo Telecom Ltd.
Digital Cordless Telephone



UltraTech
Engineering Labs Inc.

POWER-LINE CONDUCTED EMISSIONS MEASUREMENTS

APPLICANT: DAEWOO
PRODUCT: CORDLESS PHONE
MODEL: TS-101

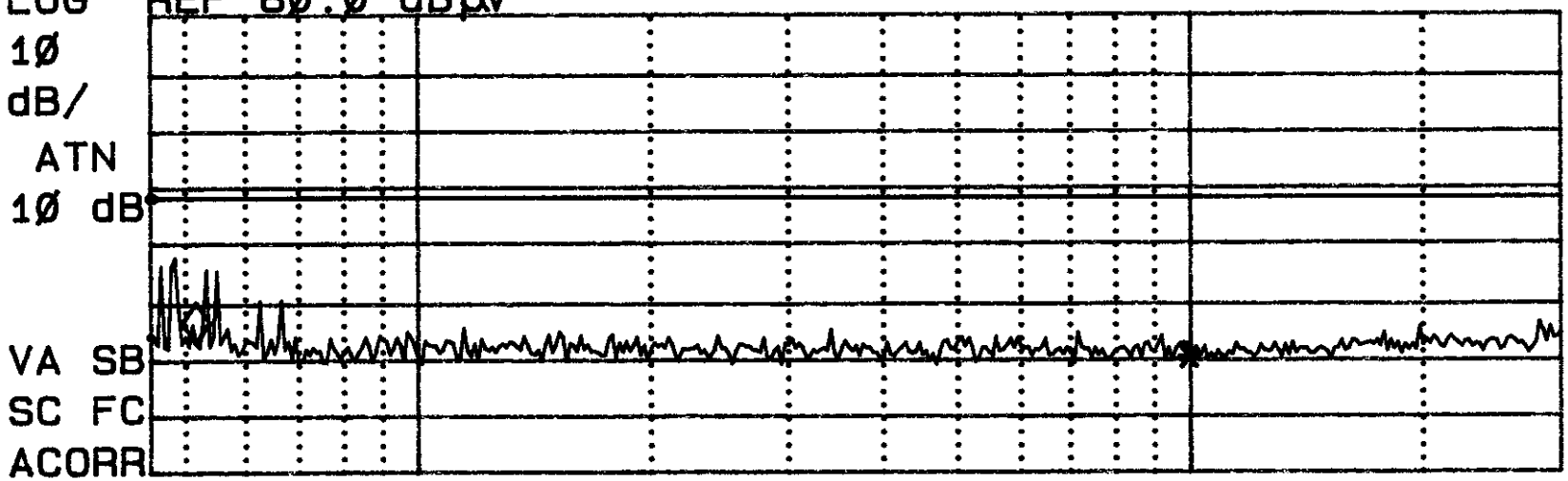
EMI Detector: [ ] Peak [✓] Quasi Peak [ ] Average Temp.: 20 °C, Humidity: 22 %
Line Tested: L, Input Voltage: 120V, Tested by: HIEN Test Date: APR 1/97
Comments:

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP∆L1
1	Ø.51755Ø	38.3	29.6	14.1	-18.4

No user Menu

STOP
3Ø.ØØ MHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 52Ø kHz
22.63 dBµV



UltraTech
Engineering Labs Inc.

POWER-LINE CONDUCTED EMISSIONS MEASUREMENTS

APPLICANT: DAEWOO
PRODUCT: CORDLESS PHONE
MODEL: FS-101

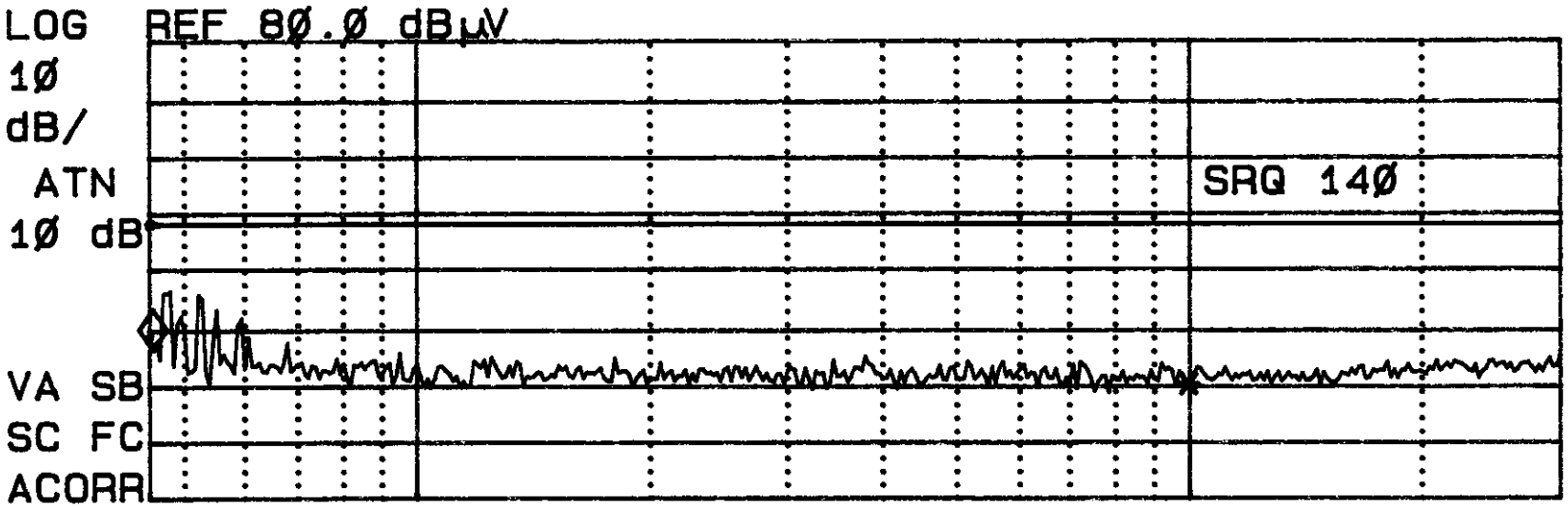
EMI Detector: [ ] Peak [✓] Quasi Peak [ ] Average Temp.: 20 °C, Humidity: 22 %
Line Tested: II, Input Voltage: 120V, Tested by: HIEN Test Date: APR 1/99
Comments:

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	QP Δ L1
1	Ø.456575	38.2	29.8	14.1	-18.2

No user Menu

START
45Ø kHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 46Ø kHz
26.Ø8 dBµV



START 45Ø kHz
IF BW 9.Ø kHz
AVG BW 3Ø kHz
STOP 3Ø.ØØ MHz
SWP 1.33 sec

5. EXHIBIT 5 - GENERAL TEST PROCEDURES

5.1. AC POWERLINE CONDUCTED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- AC Powerline Conducted Emissions were performed in the shielded room, 16'(L) by 12'(W) by 12'(H).
- Conducted power-line measurements were made over the frequency range from 450 KHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT was operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, ac power-line conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlets. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (10 KHz RBW, VBW $\geq$ RBW), frequency span 450KHz-30MHz.
- The maximum conducted emission for a given mode of operation was found by using the following step-by-step procedure:

  Step1. Monitor the frequency range of interest at a fixed EUT azimuth.

  Step2. Manipulate the system cables and peripheral devices to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.

Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.

- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and VBW ≥ RBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and the final highest RF signal level and frequency was record.

- ***Broad-band ac Powerline conducted emissions***:- If the EUT exhibits ac Powerline conducted emissions that exceed the limit with the instrument set to the quasi-peak mode, then measurements should be made in the average mode. If the amplitude measured in the quasi-peak mode is at least 6 dB higher than the amplitude measured in the average mode, the level measured in quasi peak mode may be reduced by 13 dB before comparing it to the limit.

5.2. ELECTRICAL FIELD RADIATED EMISSIONS MEASUREMENTS - GENERAL TEST METHOD

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC.

- Radiated emissions measurements were made using the following test instruments:

  1) Calibrated EMCO active loop antenna in the frequency range from 10 KHz to 1 MHz
  2) Calibrated EMCO biconilog antenna in the frequency range from 30 MHz to 2000 MHz.
  3) Horn Antennas:
     a) Horn Antenna, Emco, Model 3115, 1 – 18 GHz
     b) Horn Antenna, Emco, Model 3160-09, 18-26.5GHz
     c) Horn Antenna, Emco, Model 3160-10, 26.5-40GHz
     d) Mixer, Tektronix, P/N 118-0098-00, 18-26.5GHz
     e) Mixer, Tektronix, P/N 119-0098-00, 26.5-40GHz
  4) Calibrated Advantest spectrum analyzer and pre-selector/pre-amplifier. In general, the spectrum analyzer would be used as follows:

     – The rf electric field levels were measured with the spectrum analyzer set to PEAK detector (1 KHz RBW and 1 KHz VBW for frequency below 30 MHz, 100 KHz RBW and VBW ≥ RBW for Frequency below 1 GHz and 1 MHz RBW and 1 MHz VBW for frequency greater than 1 GHz).

     – If any rf emission was observed to be a broadband noise, the spectrum analyzer's CISPR QUASI-PEAK detector (120 KHz RBW and 1MHz VBW) was then set to measure the signal level.

     – If the signal being measured was narrowband and the ambient field was broadband, the bandwidth of the spectrum analyzer was reduced.

- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.

- During this process, cables and peripheral devices were manipulated within the range of likely configuration.

- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement (each variable within bounds specified elsewhere) were explored to produce the highest amplitude signal relative to the limit.

The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.

Step4: Move the antenna over its full allowed range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.

Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.

Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

Step7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$\mathbf{FS = RA + AF + CF - AG}$$

Where	FS	=	Field Strength
	RA	=	Receiver/Analyzer Reading
	AF	=	Antenna Factor
	CF	=	Cable Attenuation Factor
	AG	=	Amplifier Gain

Example: If a receiver reading of 60.0 dBμV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:.

Field Level in dBμV/m = 60 + 7.0 + 1.0 - 30 = 38.0 dBμV/m.

Field Level in μV/m = $10^{(38/20)}$ = 79.43 μV/m.

Notes: The frequency and amplitude of at least six highest conducted emissions relative to the limit are recorded unless such emissions are more than 20 dB below the limit. If less than six emissions are within 20dB of the limit, the background or receiver noise level shall be reported at representative frequencies.