Report of Measurements
for
Medical Telemetry System, Model 340
Manufactured by
GE Marquette Medical Systems
61 Barnes Park Road, North
Wallingford, CT 06492
By
TÜV Rheinland of North America, Inc.
Newtown, CT 06470

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1. General

1.1 Equipment Tested

Medical Telemetry System, Model 340

1.2 Manufacturer

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1.3 Description of Device Tested

The MODEL 340 Medical Telemetry System is a separate transmitter and receiver combination that provides a wireless link of medical sensors (such as ECG, UA, and Ultrasound) to a monitoring station. The receiver used with this system is subject to the FCC Declaration of Conformity procedure. The transmitter is in a metal enclosure that measures 19cm X 13.5cm x 4.4cm and weighs 0.7kg with batteries installed. The front of the transmitter has the DC power switch, inputs for headphones, a “Remote Event Mark” switch, and a BNC antenna connector. The back of the transmitter has inputs for ECG, UA, and Ultrasound medical sensors. The bottom of the transmitter has the battery compartment. The Model 340 is intended for operation in the 450 - 470 MHz range, in accordance with the provisions of FCC paragraphs §90.217 and §90.238(e). Certification is being sought in accordance with paragraphs §2.1031 through §2.1057.

2. Test Summary and Purpose

2.1 Test summary

Paragraph	Test Name	Result
§2.1046(a)	RF Power Output	Complies
§2.1047	Modulation Characteristics	Complies
§2.1049	Occupied Bandwidth	Complies
§2.1051	Spurious Emissions at Antenna Terminals	Complies
§2.1053	Field Strength of Spurious Emissions	Complies
§2.1055	Frequency Stability	Complies
§2.1057	Frequency to be Investigated	Performed
§90.217(b)	Exemption from Technical Standards	Complies

2.2 Purpose

The purpose of this report is to present test results for a FCC Grant of Approval under Section §90.217. Although §90.217 exempts the device from the other technical requirements of part 90, a certification filing is required to contain the measured results from sections §2.1046 to §2.057 above. Although these measurements are presented for this sections, no criteria is applied to them

3. Measurement Equipment Used

The measuring equipment used for measurements is shown in the following tables.

The equipment shown in the following table is located at TÜV Rheinland of North America, Inc., Newtown CT. The equipment was used for all measurements.

Equipment	Frequency Range of Measurements Performed	Manufacturer and Model	Calibration Last/Next
EMI Receiver	450 - 4500 MHz	HP85462A[1]	Nov 99/Nov 00
RF Filter/pre-amp	450 - 4500 MHz	HP85460A[1]	Nov 99/Nov 00
Spectrum Analyzer	450 - 4500 MHz	HP8593E	Aug 00/Aug 01
Pre-Amp	1 – 25 GHz	HP8449A	Aug 00/Aug 01
Bi-Conical Antenna	30 – 300 MHz	EMCO 3109	Jan 00/Jan 01
Log-Periodic Antenna	300 – 1000 GHz	EMCO 3146	Jan 00/Jan 01
Bi-Log Antenna	30 – 2000 MHz	Schaffner CBL6112B	Sep 00/Sep 01
Ridged Horn Antenna	2000 - 4500 MHz	EMCO 3115	Aug 00/Aug 01
LISN	450 kHz to 30 MHz	Schwarzbeck NSLK 8126A	Jul 00/Jul 01
700MHz Hi-Pass Filter	500-5000	Microlab	Sep 00/Sep 01
Attenuator, 10 dB	10 dB	Microlab	Jul 00/Jul 01
Attenuator, 30 dB	30 dB	Pasternack	Jul 00/Jul 01

[1]Note: The HP85462A Receiver and the HP85469A Filter/pre-amp is also known collectively as the **HP8546A**.

4. REPORT OF MEASUREMENTS

4.1 RF Power Output (§2.1046(a))

DATE:	12 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1046(a)
TEST NAME:	RF Power Output
TEMPERATURE:	22°C
HUMIDITY:	45% RH

MODE OF OPERATION:

The transmitter was unmodulated and operated from internal battery power.

PROCEDURE:

The output power was measured at each frequency of operation. The transmitter output was connected directly to the 50Ω input of the HP8593E spectrum analyzer through external 50Ω attenuators and coaxial cable using type N Male to SMA Female adapters. External attenuation consisted of a10dB and a 30 dB attenuator. The coax cable loss was 5.0 dB. A total attenuation of 45.0 dB was entered as a factor in the spectrum analyzer. The measured results reported by the analyzer include are corrected for the external attenuation.

Detector:	Atten:	RBW:	VBW:	Span:
Peak	10 dB	1 kHz	1 kHz	100 kHz

CRITERIA: Power shall not exceed 120 mW (20.8 dBm) per 90.217(b)

MEASUREMENT DATA:
Refer to file Appendix E 2.1046(a) RF Power Output Data.pdf
Output Power = 117.9 dBµV (12.3 mW)

RESULT: Complies.

4.2 Modulation Characteristics (§2.1047)

DATE:	12 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1047
TEST NAME:	Modulation Characteristics

MEASUREMENT DATA:
See file Appendix F 2.1047 Modulation Characteristics.doc

4.3 Occupied Bandwidth (§2.1049)

DATE:	11 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1049
TEST NAME:	Occupied Bandwidth
TEMPERATURE:	22°C
HUMIDITY:	40% RH

MODE OF OPERATION:

The Transmitter unit was operated from internal battery power. Maximum modulation was applied to all three inputs using the provided transducer simulator.

PROCEDURE:

The occupied bandwidth was measured using the OBW function of the HP 8593E spectrum analyzer. The transmitter output was connected to the 50Ω input of the HP8593E spectrum analyzer through external 50Ω attenuators and coaxial cable using type N Female to BNC Male adapters. External attenuation consisted of external 10dB and a 30 dB attenuators, and the coax cable loss of 5.0 dB. A total attenuation (of 45.0 dB) was entered as a factor in the spectrum analyzer. Analyzer settings were as follow. The measured results reported by the analyzer include are corrected for the external attenuation.

Detector:	Atten:	RBW:	VBW:	Span:
Peak	10 dB	100 Hz	1 kHz	37.5 kHz

CRITERIA: The transmitter is exempt from the technical requirement set out in Subpart I of PART 90. However, the equipment shall demonstrate that any emission appearing on a frequency 25 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier, per §90.217(b).

MEASUREMENT DATA: Occupied Bandwidth = 0.94 kHz.
See file Appendix G 2.1045 Occupied Bandwidth.pdf

RESULT: Complies.

4.4 Spurious Emissions at Antenna Terminals (§2.1051)

DATE:	12 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1051
TEST NAME:	Spurious emissions at antenna terminals
TEMPERATURE:	22°C
HUMIDITY:	45% RH

MODE OF OPERATION:

The transmitter was operated from internal battery power. No modulation was applied.

PROCEDURE:

The transmitter output was connected to the 50Ω input of the HP8546A EMI Receiver through external 50Ω attenuators and coaxial cable using type N Male to SMA Female adapters. External attenuation consisted of an external 10dB attenuator, and the coax cable loss of 1.5 dB. The total attenuation (of 11.5 dB) was entered as a factor in the spectrum analyzer. Receiver settings were as follow.

Spectrum Analyzer Settings	From 150 kHz to 30 MHz	From 30 MHz to 1Ghz	Fundimental Frequency	From 1 GHz to 5 GHz
Detector:	Peak	Peak	Peak	Peak
AVG BW:	30 kHz	300 kHz	1 kHz	300 kHz
IF BW:	9 kHz	120 kHz	1 kHz	120 kHz
Internal Attenuation:	20 dB	30 dB	50 dB	20 dB

The spectrum from 450 to 5000 MHz was scanned. Spectrum analyzer plots are in file Appendix H 2.1051 Spurious Emissions at Antenna.pdf.

CRITERIA:

Power of spurious emissions shall be attenuated below the unmodulated carrier power (P) as follows:

Under §90.217(b), the Model 340 qualifies for exemption from technical standards for equipment designed to operate with a 12.5 kHz channel bandwidth. Any emission appearing on a frequency 25 kHz or more removed from the assigned frequency shall be attenuated at least 30 dB below the unmodulated carrier.

MEASUREMENT DATA:

See file Appendix H 2.1051 Spurious Emissions at antenna.pdf

The amplitude of spurious emissions were attenuated more than 20 dB below the value stated above, therefore data measurements need not be reported, per §2.1057(c). However, the maximum emission observed was –50.31 dBm at 13.7 MHz.

RESULT: Complies.

4.5 Field Strength of Spurious Emissions (§2.1053)

DATE:	25 Nov 94
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1053, §90.217(b)
TEST NAME:	Field Strength of Spurious Emissions
TEMPERATURE:	22°C
HUMIDITY:	45% RH

MODE OF OPERATION:

The Transmitter unit was unmodulated and operated from internal battery power.

PROCEDURE:

The EUT was positioned on the surface of a .6m (w) x 1m (d) x .8m (h) plastic table, which was placed on the surface of a turntable. Preliminary measurements were first performed in a semi-anechoic chamber for the purpose of identifying the frequency and approximate strength of any spurious emissions in an ambient free environment. Measurements were made with both vertical and horizontal polarization of the antennas from 30 MHz to 5000 MHz. Any emissions noted were then verified individually on the Open Area Test Site (OATS). All measurements were performed with a 3-meter separation between the EUT and measurement antenna.

The settings for the Receiver were as follows:

Detector:	Atten:	RBW:	VBW:	Freq. Range:
Peak	10 dB	120 kHz	300 kHz	30 - 5000 MHz

CRITERIA: Transmitter is less than 120 milliwatts, therefore any emissions appearing on a frequency 25 kHz or more removed from the assigned frequency must be at least 30 dB below the unmodulated carrier, per §90.217(b).

MEASUREMENT DATA: See file Appendix I 2.1053 Spurious Emissions Radiated.pdf
Curves showing the characteristics shall be supplied.

Distance from Antenna to EUT: 3m
Reference level at Fundamental
Frequency of 460.6625 MHz: Vertical: 95.7 dBµV/m
Horizontal: 96.8 dBµV/m

30 – 5000 MHz FINAL Measured Levels				**Criteria (30 dB below Fundamental peak** (dBµV/m) **per §90.217(b))**	**Quasi-Peak Δ**	**Antenna + Cable Factors** (included in measured levels)	**Result**	**Polarization**
Frequency (MHz)	**Peak** dBµV/m	**Quasi-Peak** dBµV/m	**Average** dBµV/m					
225.597	54.5	53.9	53.3	65.7	-11.8	14.0	Complied	Vertical
225.597	43.2	42.3	41.5	66.8	-24.5	14.0	Complied	Horizontal
239.409	48.6	47.7	46.9	66.8	-19.1	15.2	Complied	Horizontal
239.414	43.5	42.2	41.2	65.7	-23.5	15.2	Complied	Vertical
307.063	27.5	25.2	23.6	65.7	-40.5	17.7	Complied	Vertical
479.379	31.4	28.0	25.4	65.7	-37.7	23.4	Complied	Vertical
921.311	40.4	37.8	36.4	65.7	-27.9	29.8	Complied	Vertical
921.327	49.3	48.3	48.1	66.8	-18.5	29.8	Complied	Horizontal
1381.983	54.6	53.8	53.6	65.7	-11.9	35.6	Complied	Vertical
1381.986	49.6	48.4	48.0	66.8	-18.4	35.6	Complied	Horizontal
2302.960	49.0	46.9	46.3	65.7	-18.8	29.5	Complied	Vertical
2303.300	50.8	50.2	50.0	66.8	-16.6	29.5	Complied	Horizontal
2763.970	60.1	59.6	58.9	65.7	-6.1	31.2	Complied	Vertical
2764.000	56.9	56.6	56.1	66.8	-10.2	31.2	Complied	Horizontal
3224.600	55.7	55.1	54.3	65.7	-10.7	31.7	Complied	Vertical
3224.600	54.7	54.3	54.0	66.8	-12.5	31.7	Complied	Horizontal
3684.990	66.1	65.7	65.9	65.7	0.0	33.1	Complied	Vertical
3685.300	56.9	56.7	56.5	66.8	-10.2	33.1	Complied	Horizontal
4145.970	54.9	54.4	53.6	65.7	-11.4	34.0	Complied	Vertical
4606.650	54.9	54.2	53.5	65.7	-11.5	34.0	Complied	Vertical
4606.670	48.9	48.6	48.4	66.8	-18.2	34.0	Complied	Horizontal

RESULT: Complies.
Refer to OATS Plot in file Appendix J 2.1055 Frequency Stability.pdf

4.6 Frequency Stability (§2.1055)

4.6.1 Frequency Stability - Temperature (§2.1055(a)(1))

DATE:	20 Sep 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1055(a)(1), §90.213(a)
TEST NAME:	Frequency Stability
TEMPERATURE:	28°C
HUMIDITY:	55% RH

MODE OF OPERATION:

The transmitter was operated from internal battery power. No modulation was applied to the transmitter for this test.

PROCEDURE:

The EUT has an internal sensor that shuts turns off the transmitter power when the temperature reaches approximately 10°C. Therefore, the test requirement for the temperature range from -30°C to +50°C could not be conducted below 0°C. A thermocouple was placed on the transmitter module inside the EUT for internal temperature measurements. The EUT was placed inside a Tenney Model: T14 temperature chamber. The temperature was reduced gradually to 0°C. The transmitter turned off when the temperature reached 9°C. The temperature was allowed to stabilize at 0°C. The temperature was then increased to 10°C and the transmitter turned on at 10°C. At 10°C and each 10-degree step thereafter, up to 50°C, the temperature was allowed at least 45 minutes to stabilize and the temperature and frequency data was recorded.

CRITERIA: Exempt from criteria of §90.213 per §90.217, however, a frequency tolerance of ± 2.5ppm from assigned frequency was maintained.

Reference Frequency: 460.6625 MHz
Upper limit (+2.5 ppm above reference frequency): 460.663652 MHz
Lower limit (-2.5 ppm below reference frequency): 460.661348 MHz
Maximum Frequency Δ from Reference Frequency: ±1.151656 kHz

MEASUREMENT DATA: See files Appendix J 2.1055 Frequency Stability.pdf

The maximum frequency deviation was 0.523 kHz or 1.114 ppm at 10°C

#	Temp. in °C	Measured Frequency (MHz)	Δ Freq. From Ref. In (kHz)	Δ Freq. From Ref. In ppm ±2.5ppm Max	Result	Comments
1	28	460.662478	-0.022	-0.048	Complied	Room Temp.
2	2	N/A	N/A	N/A	N/A	XMTR auto shut-off at 9°C
3	10	460.663013	0.523	1.114	Complied	At auto power up at 10°C
4	10	460.662721	0.221	0.480	Complied	Stabilized at 10°C
5	20	460.662618	0.118	0.256	Complied	Stabilized at 20°C
6	30	460.662457	-0.043	-0.093	Complied	Stabilized at 30°C
7	40	460.662208	-0.292	-0.634	Complied	Stabilized at 40°C
8	50	460.662038	-0.462	-1.003	Complied	Stabilized at 50°C

RESULT: Complies

4.6.2 Frequency Stability - Battery End Point (§2.1057(d)(2))

DATE:	20 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1055(d)(2)
TEST NAME:	Frequency Stability
TEMPERATURE:	23°C
HUMIDITY:	45% RH

MODE OF OPERATION: The transmitter was operated from a HP6299A adjustable regulated power supply.

PROCEDURE: The primary supply voltage was reduced to the battery operating end-point, specified by the manufacturer. The transmitter continued to operate normally.

CRITERIA: The manufacturer's specified battery end-point is: 4.08V

MEASUREMENT DATA: See files Appendix J 2.1055 Frequency Stability.pdf
Plots showing the characteristics shall be supplied.

The power supply was connected to the battery terminals of the transmitter. A reference plot was made of the transmitter with the power supply adjusted to normal operating voltage (6.0VDC). The power supply was then adjusted to the manufacturer's specified battery end-point voltage (4.08V). In both cases, the voltage of the power supply was monitored with a calibrated digital voltmeter. The Transmitter output was monitored with the HP8546A EMI Receiver. A "Battery End-point" plot was then made of the transmitter.

RESULT: Complies

4.7 Frequency spectrum to be investigated (§2.1057(a)(1))

DATE:	20 Sep 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§2.1057(a)(1)
TEST NAME:	Frequency spectrum to be investigated
TEMPERATURE:	22°C
HUMIDITY:	45% RH

CRITERIA: The frequencies shall be investigated from the lowest radio frequency (450kHz), to the 10^{th} harmonic of the highest fundamental frequency (4.7Ghz)

Result: The lowest frequency generated in the transmitter is 40MHz. The transmitter frequency of operation is 460.6625 MHz. Therefore, the required frequencies to be investigated are from 40MHz to 4.67 GHz. The investigation range for this report was from 30MHz to 5 GHz.

4.8 Conducted Emissions (§15.107)

DATE:	12 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§15.107
TEST NAME:	Conducted Emissions
TEMPERATURE:	NA
HUMIDITY:	NA

Conducted emissions measurements were not performed as the transmitter is powered by a replaceable battery and has no provision for connection to the mains or for recharging of the battery.

4.9 Exemption from Technical Requirements (§90.217)

DATE:	23 Oct 2000
EQUIPMENT TESTED:	Model 340 Medical Telemetry System
MANUFACTURER:	GE Marquette Medical Systems
PARAGRAPH:	§90.217
TEST NAME:	Exemption from Technical Standards

CRITERIA: The sum of the bandwidth occupied by the emitted signal plus the bandwidth required for the frequency stability shall be adjusted so that any emission appearing on a frequency 25 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

DATA:

A. Occupied Bandwidth from section 4.3 above	0.94 kHz
B. Maximum Frequency Stability Deviation from section 4.6 (Temperature variation plus Battery End-Point variation)	0.518 kHz
A. + B. (above)	1.52 kHz

RESULT: Complies