

TEST REPORT #170702

STANDARD: FCC PART 15

SUBPART C--INTENTIONAL RADIATORS

**SECTION 15.249 OPERATION WITHIN THE BANDS 902-928 MHZ,
2400-2483.5 MHZ, 5725-5875 MHZ, AND 24.0-24.25 GHZ.**

EQUIPMENT TESTED:

GRACO INC. & SUBSIDIARIES

**MODEL: MATRIX TANK LEVEL MONITOR
P/N: 117267**

TEST DATE: 17 JULY 2002

1100 Falcon Avenue
Glencoe, MN 55336



Tele: 320-864-4444
Fax: 320-864-6611

Prepared for:

Graco Inc. & Subsidiaries
PO Box 1441
Minneapolis, MN 55440-1441

Test agent:

International Certification Services, Inc.
1100 Falcon Avenue
Glencoe, MN 55336
Tele: 320-864-4444
Fax: 320-864-6611

Test location:

International Certification Services, Inc.
1100 Falcon Avenue
Glencoe, MN 55336
Tele: 320-864-4444
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Prepared by:

International Certification Services, Inc.
1100 Falcon Avenue
Glencoe, MN 55336

International Certification Services represents to the client that testing is done in accordance with standard procedures applicable and that reported test results are accurate within generally accepted commercial ranges of accuracy.

This report only applies to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. International Certification Services shall have no liability for any deductions, inferences or generalizations drawn by the client or others from this report.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval.

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1.0 TEST SUMMARY

TEST REPORT: #170702	
COMPANY:	Graco Inc. & Subsidiaries
AGENT:	International Certification Services, Inc.
PHONE:	320-864-4444
TEST DATE:	17 July, 2002
EQUIPMENT UNDER TEST:	Matrix Tank Level Monitor P/N: 117267
GENERAL TEST SUMMARY: The testing was performed at International Certification Services, Inc. at 1100 Falcon Ave, Glencoe, MN 55336	
VERIFICATION / CERTIFICATION STATUS:	The Matrix Tank Level Monitor P/N: 117267 was found to be in compliance with the FCC Part 15 Subpart C, Section 15.249 requirements.
MODIFICATIONS NECESSARY:	None

TESTED BY

Duane R. Bagdons

WRITTEN BY

Duane R. Bagdons

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Applicable Standards

47 CFR Ch.1 (10-1-98 Edition)

FCC Part 15

Radio Frequency Devices

Subpart C

Intentional Radiators

Section 15.249 Operation within the Bands 902-928 Mhz, 2400-2483.5 Mhz, 5725-5875 Mhz, and 24.0-24.25 Ghz

2.1 Referenced Standards

ANSI C63.4-1992 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 Ghz.

2.2 Equipment Units Tested

The equipment tested was a wireless transceiver Tank Level Monitor. It mounts on a tank of solution and after it is programmed it will respond to a signal from a control unit to transmit the level of solution in the tank. The Tank Level Monitor transmits to the controller and on to the computer to record the level of solution in the tank at any time. The Receiver portion of the circuit is an integrated chip (Melixis TH71112 (868-915 Mhz FSK/FMIASK Receiver) which is preceded by a SAW filter. The Transmitter portion of the circuit is also a Melixis chip Type (TH71081 868-915 ASK Transmitter / LO Source). The Tank Level Monitor product consists of two PC boards 1) Control and RF board, and 2) Ultrasonics board. The Receiver, Transmitter and Micro Processor controller are contained on the Control and RF board and the Ultrasonics sensor electronics are on the Ultrasonics board. The Tank Level Monitor product senses the level in the tank with the Ultrasonic sensor and converts this information via the Controller Microprocessor to a serial digital data train. This information is then used to key the transmitter output circuit in a pulse modulated fashion. The maximum transmitted burst is 83 ms worst case limited by the internal data buffer in the circuit. Each cell time is 832 uS long and the worst case duty cycle is 50%. The minimum spacing between the data bursts is 1.5 seconds.

2.3 Equipment and Cable Configuration

See photos of the EUT PC board and schematic and test configuration setup in Attachment A

2.4 List of Test Equipment

<u>Test Equipment</u>	<u>Model</u>	<u>S/N</u>	<u>Last Calibration Date</u>
Spectrum Analyzer	Hewlett-Packard 8566B	2421A00458	08/27/01
Preamp	MiniCircuits ZKL-2R7	N/A	11/21/01
Log Periodic Antenna (200-1000 MHz)	EMCO 3146	9101-2991	12/17/01
Horn Antenna (1-18 Ghz)	EMCO 3115	5697	12/17/01

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Measurement cable losses, and antenna correction factors are included in the Corrected Data column of the data sheet. Quasi Peak Detection was used for measuring the Fundamental frequency signal and Average detection method was used to measure the Harmonics since they were all above 1000 Mhz. The Resolution BW was set at 1 Mhz and the Video BW was set at 1 Hz with a Span of 0 Hz to perform the correct average detected measurements.

2.5 Units of Measurement.

All measurements were taken in dBuV/m with the antenna located at 3 meters distance from the EUT. Frequency measurements are recorded in Mhz. Input power to the intentional radiator was not recorded---only the radiated emissions with the internal transmitting antenna were recorded.

2.6 Location of Test Site

The open area test site (OATS) and conducted measurement facility used to collect the data was International Certification Services, Inc. at 1100 Falcon Ave. in Glencoe, MN 55336. This site has been certified to be in compliance with the normalized site attenuation section of CISPR 16-1. (See FCC Registration number: 91103 and Industry Canada File number: IC 3701.)

2.7 Measurement Procedures

The antenna was placed at a distance of 3 meters from the EUT. The EUT was set on an insulating table in the OATS site and rotated through 360 degrees to determine the worst case EUT orientation. The antenna was then positioned vertical and horizontal to determine which antenna polarity orientation was worst case. Then certification data was recorded at all the transmitter frequencies from the fundamental to the 10th harmonic at an antenna height variation of from 1-4 meters.

Since the transmitter is pulse modulated and the data burst is less than 100 mS, statement in 15.35 (c) applies.

“When the radiated emissions limits are expressed in terms of the average value of the emission, and pulsed operation is employed , the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds....”

Using this statement, the harmonics (which are measured with the Average Detector) were converted to Linear levels and since the maximum duty cycle was 50%, the measured voltage was reduced by 50%, reconverted to dBuV/m and compared to the Average Limit of 53.979 dBuV/m. The Fundamental frequency reading (measured in Quasi Peak) was kept as original and compared against the standard of 93.979 dBuV/m.

2.8 Reporting Measurement Data

See data sheets and plots in Attachment B for the Transmitter section and in Attachment C for the Receiver section of the product.

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2.9 Radiated Emissions Data

The frequency and amplitude of the tuned frequency of the EUT along with the frequencies and amplitudes of the harmonics up to the 2nd harmonic are reported in the data sheets in Attachment B. Signal frequencies above 2745.505001Mhz were below the noise floor of the measurement system. This information is plotted against the limit of section 15.249 of FCC Part 15 subpart C. Both Horizontal and Vertical antenna polarities as well as antenna heights of 1 to 4 meters were observed but all maximum signal strengths occurred in the Horizontal antenna polarity and at 1 meter antenna height.

The Final Level, expressed in dBuV/m, is arrived at by taking the reading from the spectrum analyzer (Level dBuV) and adding the antenna correction factor and cable loss factor (Factor dB) and subtracting the preamp gain. This result then has the FCC limit subtracted from it to provide the margin which gives the tabular data as shown in the data sheets in Attachment B.

Example:

<u>Frequency</u> <u>(MHz)</u>	<u>Level</u> <u>(dBuV)</u>	+	<u>Factor</u> <u>(dB)</u>	=	<u>Corr Data</u> <u>(dBuV/m)</u>	-	<u>FCC Limit</u> <u>(dBuV/m)</u>	=	<u>Margin</u> <u>(dB)</u>
100.0	20.6	+	11.0	=	31.6	-	43.5	=	-11.9

2.10 Operating Frequency Data for Intentional Radiators

All operating frequencies and harmonic frequencies and ambient temperature at which all data was taken at is recorded in the data sheets in Attachment B.

2.11 Occupied Bandwidth Data for Intentional Radiators

The occupied BW data for the EUT is listed in the data sheets in Attachment B.

2.12 Summary of Results

The EUT passed the requirements of FCC Part 15 Subpart C, Section 15.249 with a minimum passing margin of -3.669 dB (Average Detected signal) at the Harmonic frequency of 1830.33 Mhz. No modifications were necessary to accomplish this compliance.

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ATTACHMENT A

RADIATED MEASUREMENT SCHEMATIC AND PHOTOS

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**Model: Matrix Tank Level Monitor
Transmitter Radiated Emissions
Test Configuration**



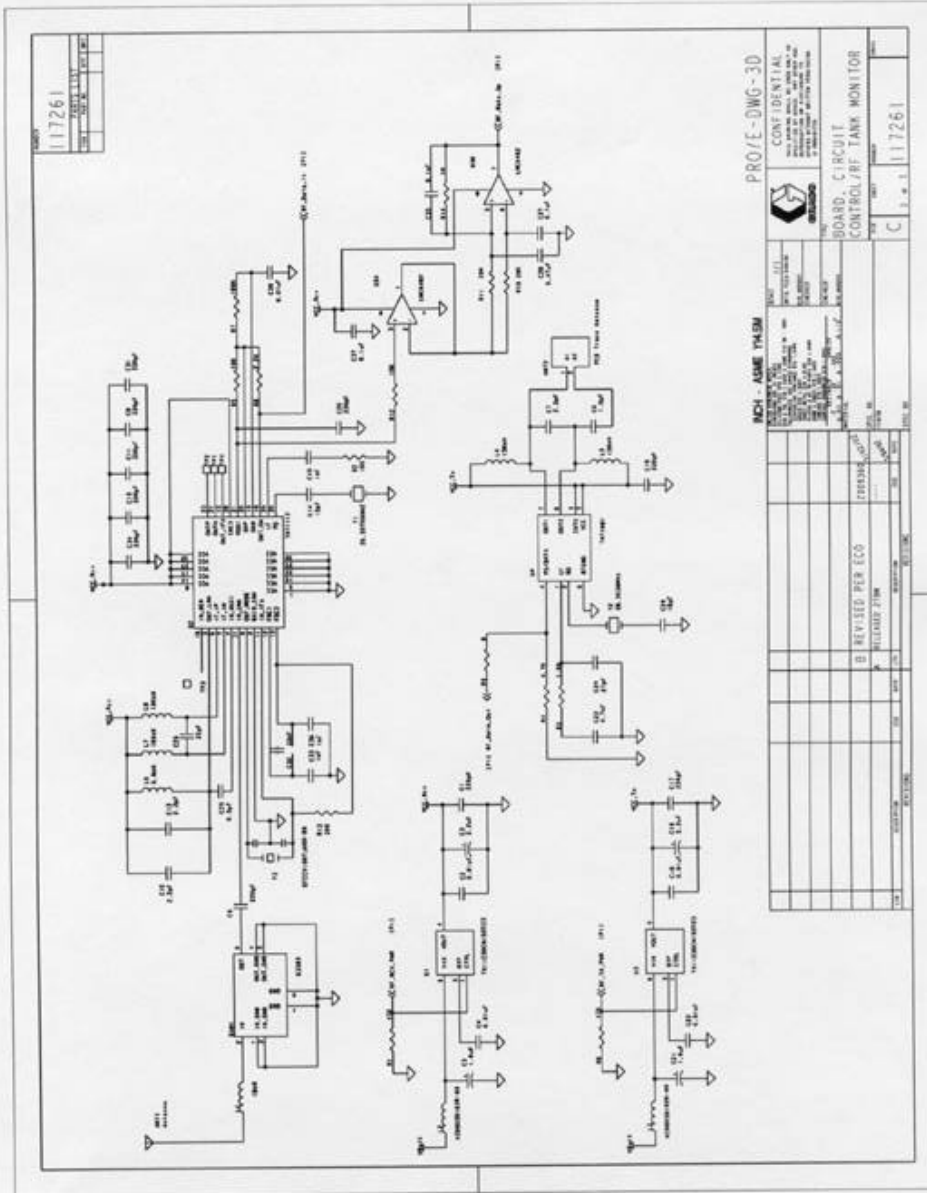
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[illegible]

Model: Matrix Tank Level Monitor
Control and RF Schematic Page 2 of 2
Electrical Schematic



PRO/E-DWG-3D

CONFIDENTIAL

BOARD, CIRCUIT

CONTROL / RF TANK MONITOR

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117261

117261

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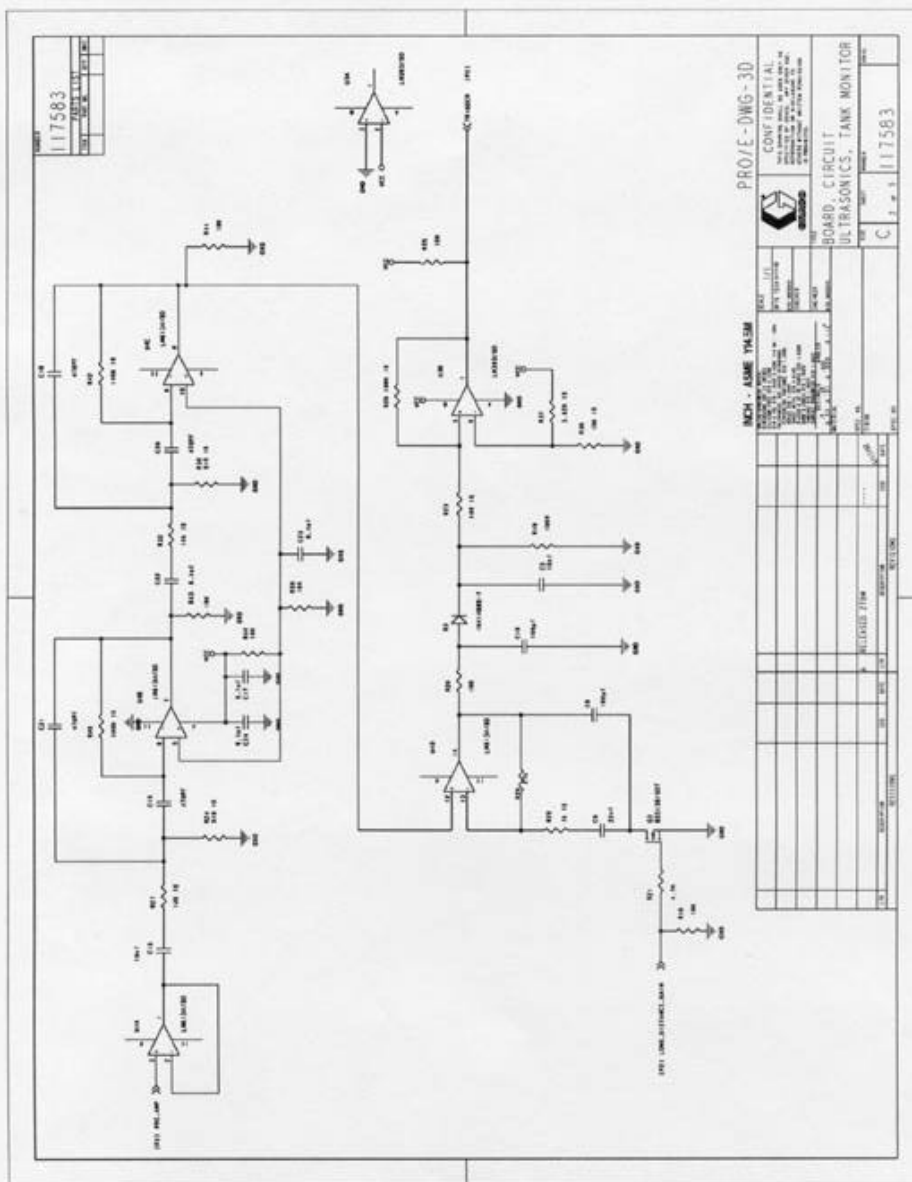
117261

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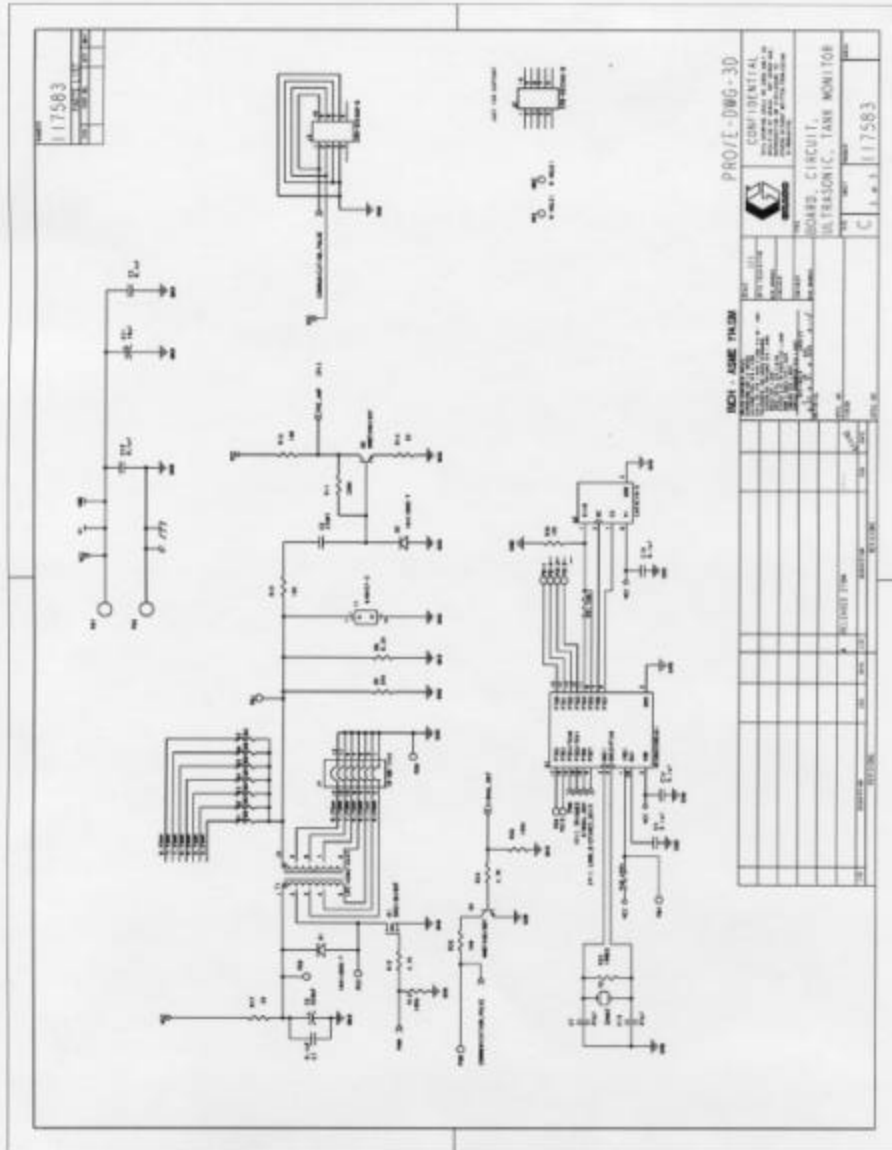


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Model: Matrix Tank Level Monitor
UltraSonicS Schematic Page 1 of 2
Electrical Schematic



Model: Matrix Tank Level Monitor
UltraSonics Schematic Page 2 of 2
Electrical Schematic



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**ATTACHMENT B
TRANSMITTER SECTION
DETAILED TEST DATA SHEETS**

Each radiated emissions plot indicates the receiving antenna measurement distance in meters and the emission amplitudes with respect to their applicable limits. The associated tabulation for each radiated plot lists the emission frequency, the final emission level, and the margin from the limit.

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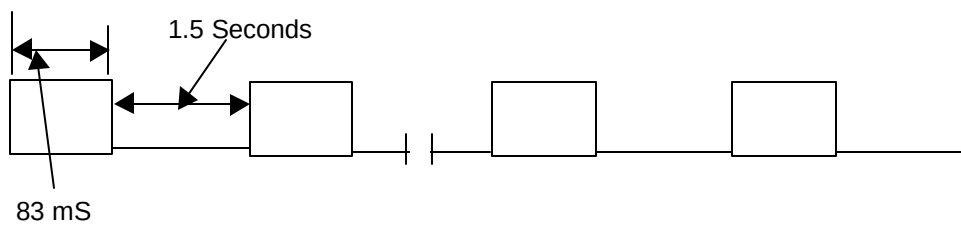


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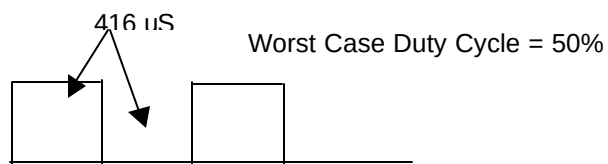
Graco Inc. & Subsidiaries
Model: Matrix Tank Level Monitor P/N: 117267
Temperature: 95 Deg F.
Humidity: 45 % R.H.

Test Technician: Duane R. Bagdons

Center Frequency: 915.199 Mhz



Transmit Burst Sequence Timing



Transmitted Cell Definition

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Preliminary testing was done to determine what antenna polarity and antenna height generated the highest signal levels. Tests were performed at this test configuration and then each frequency was maximized to 0-360 degrees orientation and antenna height of 1-4 meters.

Transmit signal total BW (See plot)

Certification testing was performed at the OATS site with an antenna distance of 3 meters and the EUT at 90 Degrees to the antenna.

The limit for section 15.249 is 50 mV/m with a Quasi Peak Detector for the fundamental signal and 500 uV/m with an Average Detector for the Harmonics. This converted to dBuV is 93.979 dBuV/m for the Fundamental signal and 53.979 dBuV for the Harmonics which is the limit shown in the next table. Also, as explained in section 2.7 only 50% of the measured Harmonic signal was recorded. The 50% was taken of the Linear measured data and then converted back to dBuV/m for the table below.

Freq (Mhz)	Corr Data (dBuV)	Corr Data (uV)	50% Corr Data (uV)	50% Corr Data (dBuV)	Limit	Margin
915.199	87.057	22534.61	11267.3038	81.036	93.979	-12.942
1830.33	56.330923	655.4599	327.729967	50.31	53.979	-3.669
2745.505	54.691936	542.7462	271.373105	48.67134	53.979	-5.307664
3660.79	14.989735	5.616771	2.80838571	8.969	53.979	-45.01
4575.913	19.000212	8.912727	4.45636346	12.9796	53.979	-40.9994
5491.117	20.408266	10.48126	5.24062766	14.38767	53.979	-39.59133
6406.321	25.335066	1.266753	0.63337665	-3.966759	53.979	-57.94576
7321.525	27.926886	1.396344	0.69817215	-3.12075	53.979	-57.09975
8236.729	33.521338	1.676067	0.83803345	-1.534773	53.979	-55.51377
9151.933	35.276776	1.763839	0.8819194	-1.091422	53.979	-55.07042

Worst
Case
Margin

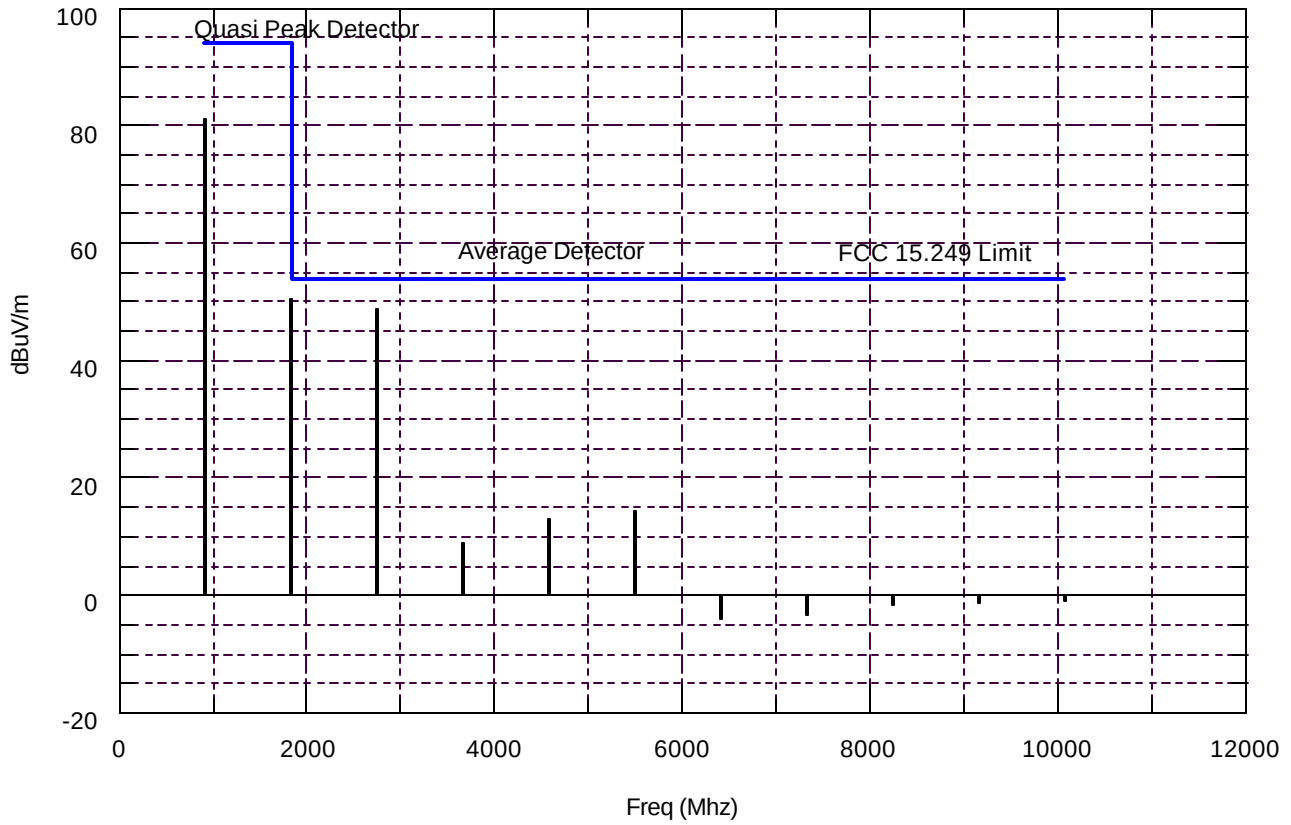
Signal frequencies above 2745.505 Mhz were below the ground floor noise hence only the ground floor was recorded.

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Model: Matrix Tank Level Monitor P/N: 117267
Transmitted Signal Harmonics



International Certification Services, Inc.

July 17, 2002

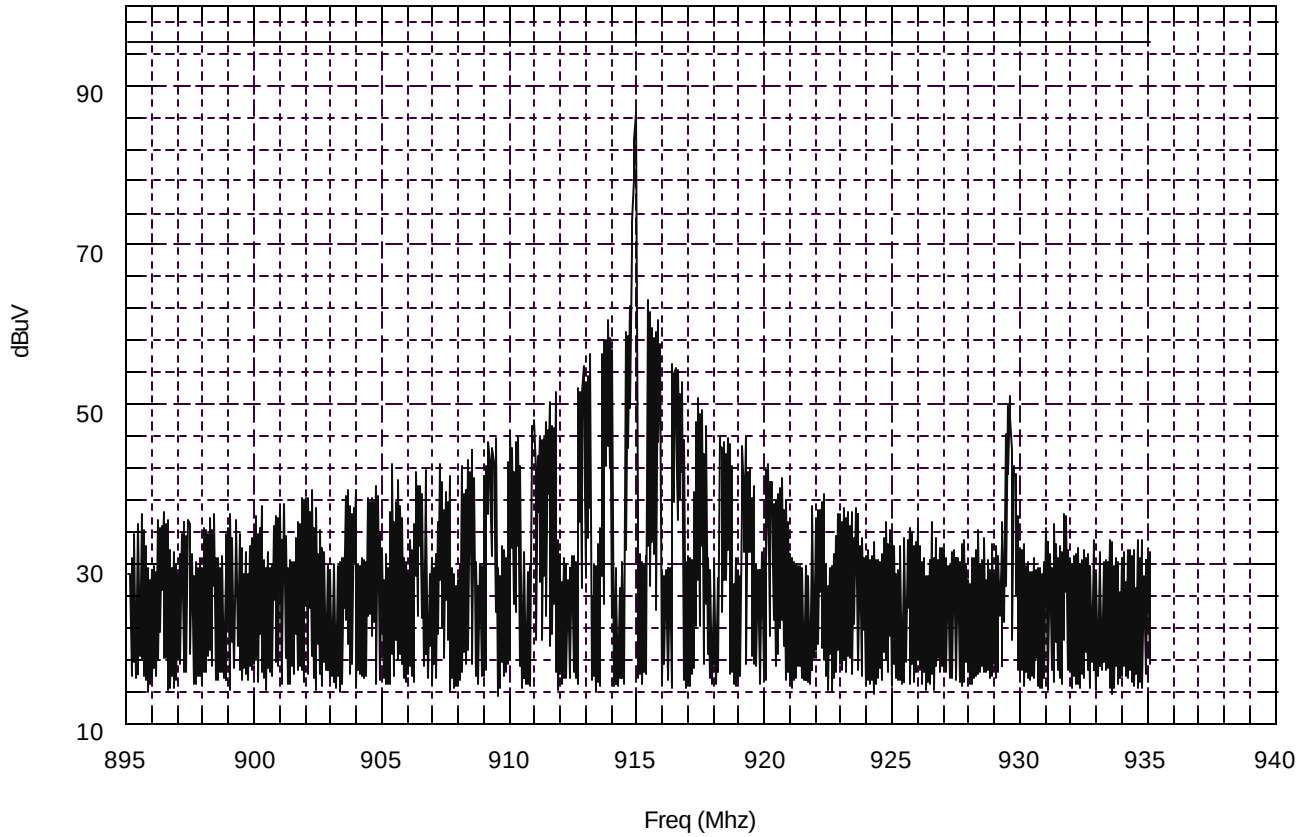


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Graco Inc & Subsidiaries

Model: Matrix Tank Level Monitor P/N: 117267

FCC 15.249 Intentional Radiator Radiated Emissions



International Certification Services, Inc.

July 17, 2002

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**ATTACHMENT C
RECEIVER SECTION
DETAILED TEST DATA SHEETS**

Graco Inc. & Subsidiaries

Model: Matrix Tank Level Monitor P/N: 117267

Temperature: 95 Deg F.

Humidity: 45 % R.H.

Test Technician: Duane R. Bagdons

Center Frequency: 915.199 Mhz

Since this product is a Transceiver, the receiver section must be observed per the ANSI C63-4 requirement. An external signal was induced to the receiver from a signal generator by wrapping a wire around the antenna to inductively couple this signal into the receiver. The signal generator was set to 915.199 Mhz. The Signal Generator was unmodulated and set to an output level of -50 dBm to excite the receiver local oscillator. No emitted signals were observed on the OATS site so the EUT was taken into the shield room and observed with an antenna at 3 meters distance. Still no signals were observed so a near field probe was taped directly to the top of the receiver chip and then we were able to detect the signals. Attached is a photo of the test set up just described as well as plots from 30-1000 Mhz and from 30-140 Mhz were the only signal activity was noted. A data table is also attached to record the only signals that were detected. These signals were detected with the Peak Detector on the Spectrum Analyzer.

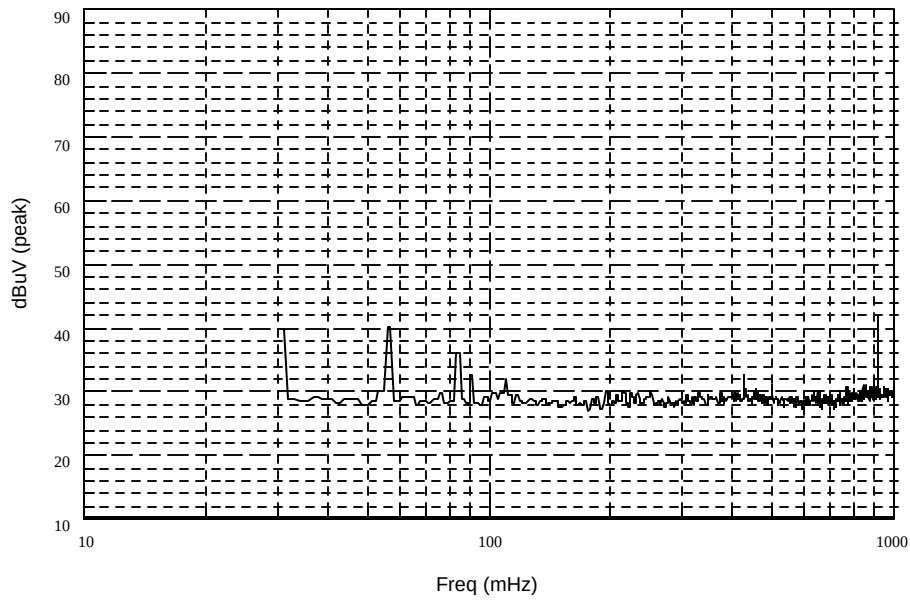
Freq (mHz)	dBuV (peak)
53.215	40.68
79.815	36.96
88.72	34.31
106.435	33.73
425.714	33.48
851.375	31.85
915.199	42.57

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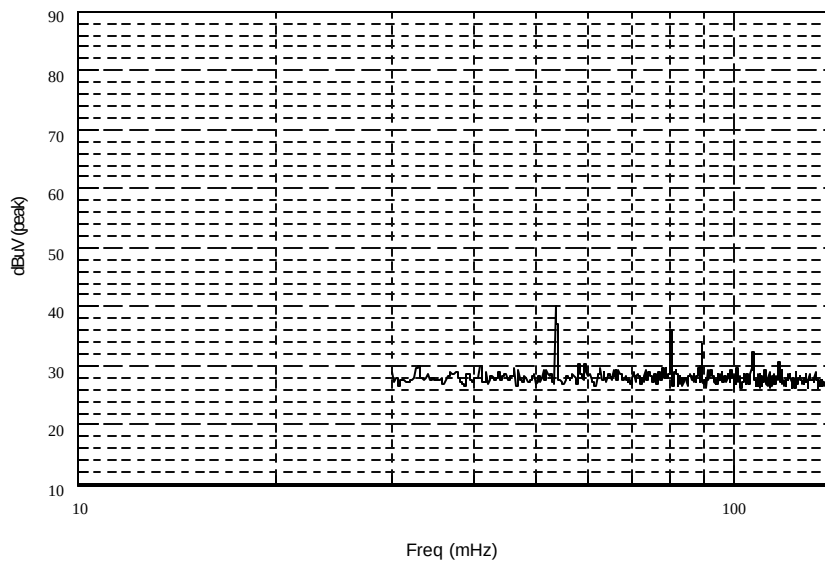
Graco Inc & Subsidiaries
Model: Matrix Tank Level Monitor P/N 117267
Emissions from 30 mHz to 1 GHz
Receiver Emissions (Near Field)



International Certification Services, Inc.

07-19-02

Graco Inc & Subsidiaries
Model: Matrix Tank Level Monitor P/N 117267
Emissions from 30 mHz to 140 mHz
Receiver Emissions (Near Field)



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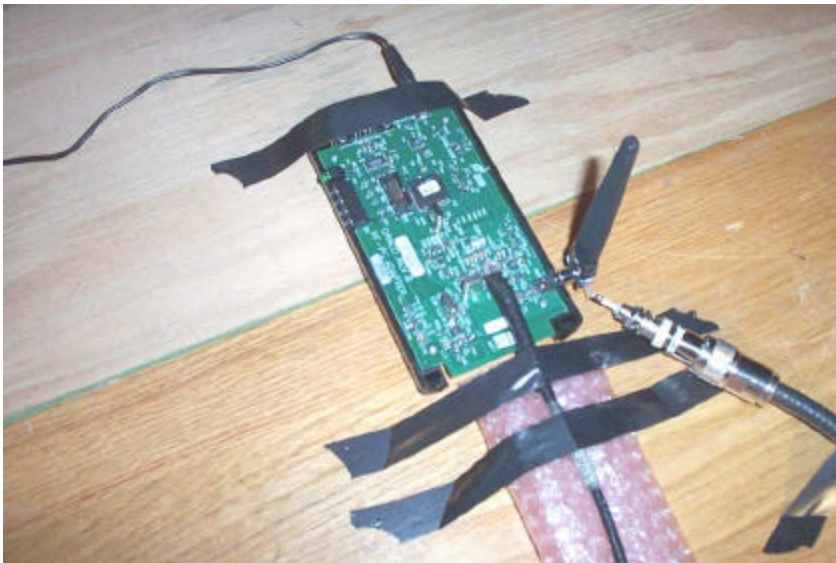
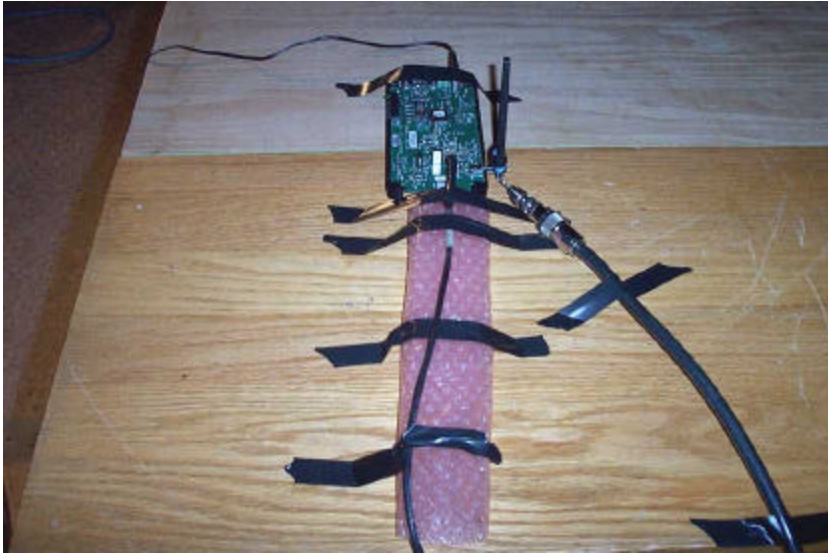
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**Model: Matrix Tank Level Monitor
Receiver Radiated Emissions
Test Configuration**



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ATTACHMENT D

**PRODUCT DATA SHEET OR PRODUCT INFORMATION FORM AS
SUPPLIED BY THE CUSTOMER**

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COMPANY NAME: Graco Inc. & Subsidiaries

CUSTOMER REPRESENTATIVE: International Certification Services, Inc.

EQUIPMENT DESCRIPTION: Matrix Tank Level Monitor P/N: 117267

MODEL NUMBER: 117267

SERIAL NUMBER: Engineering Unit

TYPE OF TEST: ☐ Development
☐ Initial Design Verification
☐ Design Change (Please describe exact changes below)
☒ Production Sample (Audit Test)

Changes made: NONE

OSCILLATOR FREQUENCIES:

32.768 kHz, 3.6864 Mhz, 28.5938 Mhz, 26.59706 Mhz, 32 Mhz

PRODUCT SHIELDING PROVISION:

Plastic enclosure

SOFTWARE AND / OR OPERATING MODES:

The unit tested was set up to constantly transmit a burst of pulses so the signal could be observed and recorded..

I/O CABLES: NONE

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