FCC ID: MCO1440-15

TN Technologies'
Model 1440
Microwave Level Gauge

Electromagnetic Emissions
Measurement Report

Prepared for:

TN TECHNOLOGIES
255 North IH35
Round Rock, Texas 78680

By:

TN TECHNOLOGIES
255 North IH35
Round Rock, Texas 78680

Prepared by: Michael H. Fesler, Design Engineer
Signature:_____
Date: March 10, 2000

Applicable Notes

1. The associated digital and analog circuitry, which is located on the same PCB as the microwave circuitry, was tested by Professional Testing to following standards:
   a. Verified to Part 15 of Title 47.
   b. Certification to EN55011 Group 1, Class A, ITE (CE Mark requirement)
2. The Part 15 Certification will be limited to sealed metal tanks.
3. Reference 15.203- The antenna is permanently attached at the factory (TN).
4. Reference 15.205- The fundamental frequency remains within a 9.52GHz to 10.58GHz frequency band with the circuit tolerances and temperature variation included.
5. Reference 15.207- The Model 1440 is dc-powered equipment, which is never directly connected to the public utility (AC) power line.
6. A test plan was submitted to the FCC on 2-14-2000. A copy of the test plan and the FCC reply is included in Appendix A. The FCC required that the scanned frequency band be increased to the 5th Harmonic, and NOT only to 22 GHz, as TN purposed. TN increased the scanned frequency band as requested (to 53GHz). NOTE: Our competitor, Saab, was only required to make measurements in the 8-12 GHz frequency band. A copy of their waiver is included in Appendix A.
7. With the equipment installed in a typical worst-case, TN performed the scans of the fundamental, and 2nd Harmonic (out to 22GHz).
8. Professional Testing performed the scans of the 3rd, 4th, and 5th Harmonic (out to 60GHz). The test report from Professional Testing was scanned into TN's test report. The actual PDF file from professional testing is attached:
   filename: 00446-10(s).PDF (secure .PDF file authorized 10 March, 2000)

TN Technologies'

Model 1440
Level Gauge

Electromagnetic Emissions
Measurement Procedure and Data
{Frequency Scan to 22GHz}

This portion of the testing was performed by:

TN TECHNOLOGIES
2555 NORTH IH35
Round Rock, Texas 78680
Phone: (512) 388-9100

Test configurations

Device configurations tested:

Rod antenna – 1 foot rod
Horn antenna – 2 inch horn
Horn antenna – 8 inch horn

Each device configuration was mounted into the tank via a mounting flange and paper gasket. The mounting flange will be typical for the device configuration being tested.

Measurement Procedure

Measurements were made with a spectrum analyzer using a 1 MHz BW, and a preamp was used to improve signal level. All possible RF leakage areas (mounting flanges, gaskets, etc.) of the tank were surveyed at very close (near contact) range to identify any areas of detectable emissions up through 22GHz. Initially the scans were done with the Model 1440 in the normal sweeping mode so that the frequencies of maximum emissions can be identified.

The measurement antenna was set up at 0.5 meters from each point of significant emissions. The emissions at 0.5 meters was reported through 22GHz first with the Model 1440 in the sweeping mode and then with the sweep stopped at each frequency which has been identified as generating an emissions maximum.

Test Equipment:

Narda Model 640 Standard Gain Horn (for fundamental frequency- 9.5GHz to 10.6GHz)
Narda Model 638 Standard Gain Horn (for the harmonic- 19.0GHz to 21.2GHz)
HP 8563E Spectrum Analyzer (Calibrated on 2-3-2000 Calibration due: 2-3-2001)
HP 8449A Preamplifier (Calibrated on 1-3-2000 Calibration due: 1-3-2001)

Test Results:

For all three antenna configurations, the worst-case radiated emissions were from the gasket used to mount the EUT to the tank. A separate data sheet is provided for each of the antenna configurations.

Antenna Configuration of EUT: 8” Horn Antenna

Freq. (GHz)	Recorded Level @ 0.5meter (dBµV)	Pre-amp Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit @0.5 meter (dBµV)	Margin (dB)	Comments
10.013	**55.70**	**31.22**	**34.23**	**6.82**	**65.53**	**69.5**	**3.97**	**Maximum Horizontal Measurement**
10.269	**50.67**	**31.28**	**34.45**	**7.21**	**61.05**	**69.5**	**8.45**	**Maximum Vertical Measurement**

Notes:

1. Corrected Level = Recorded Level – Pre-Amp Gain + Antenna Factor + Cable Loss
2. In Section 15.209, the limit above 960MHz is 53.9 dB(µV/m) at 3 meters, and was extrapolated to 0.5 meters using 20 dB/decade factor.
3. Noise Floor with EUT off: 45 to 46 dBµV
4. The radiated emissions from the harmonic (19.0 GHz to 21.2 GHz) were below the noise floor at a measurement distance of 0.25 meter.

Test by Michael H. Fesler, Design Engineer
Signature:_____
Date: February 7, 2000

Antenna Configuration of EUT: 2” Horn Antenna

Freq. (GHz)	Recorded Level @ 0.5meter (dBµV)	Pre-amp Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit @0.5 meter (dBµV)	Margin (dB)	Comments
10.069	**54.50**	**31.34**	**34.28**	**7.02**	**64.46**	**69.5**	**5.04**	**Maximum Horizontal Measurement**
10.069	**50.50**	**31.34**	**34.28**	**7.02**	**60.46**	**69.5**	**9.04**	**Maximum Vertical Measurement**

Notes:

1. Corrected Level = Recorded Level – Pre-Amp Gain + Antenna Factor + Cable Loss
2. In Section 15.209, the limit above 960MHz is 53.9 dB(µV/m) at 3 meters, and was extrapolated to 0.5 meters using 20 dB/decade factor.
3. Noise Floor with EUT off: 45 to 46 dBµV
4. The radiated emissions from the harmonic (19.0 GHz to 21.2 GHz) were below the noise floor at a measurement distance of 0.25 meter.

Test by Michael H. Fesler, Design Engineer
Signature:_____
Date: February 7, 2000

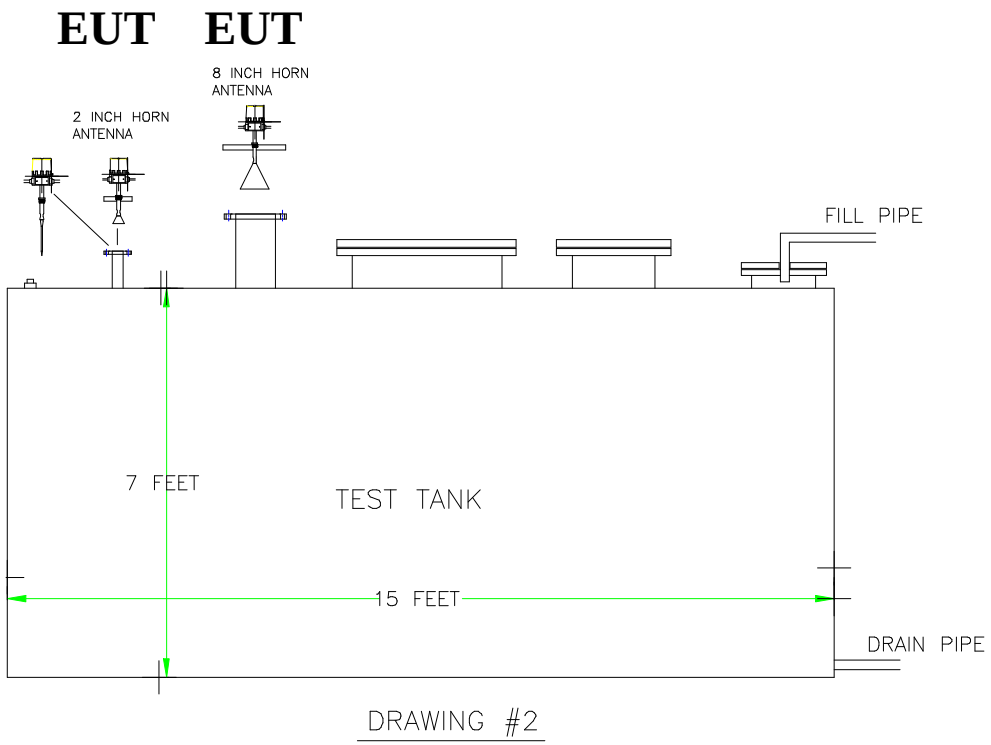
Antenna Configuration of EUT: Dielectric Rod Antenna

Freq. (GHz)	Recorded Level @ 0.5meter (dBµV)	Pre-amp Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit @0.5 meter (dBµV)	Margin (dB)	Comments
9.717	**55.17**	**31.25**	**33.97**	**6.28**	**64.17**	**69.5**	**5.33**	**Maximum Horizontal Measurement**
9.863	**50.17**	**31.25**	**34.10**	**6.68**	**59.70**	**69.5**	**9.8**	**Maximum Vertical Measurement**

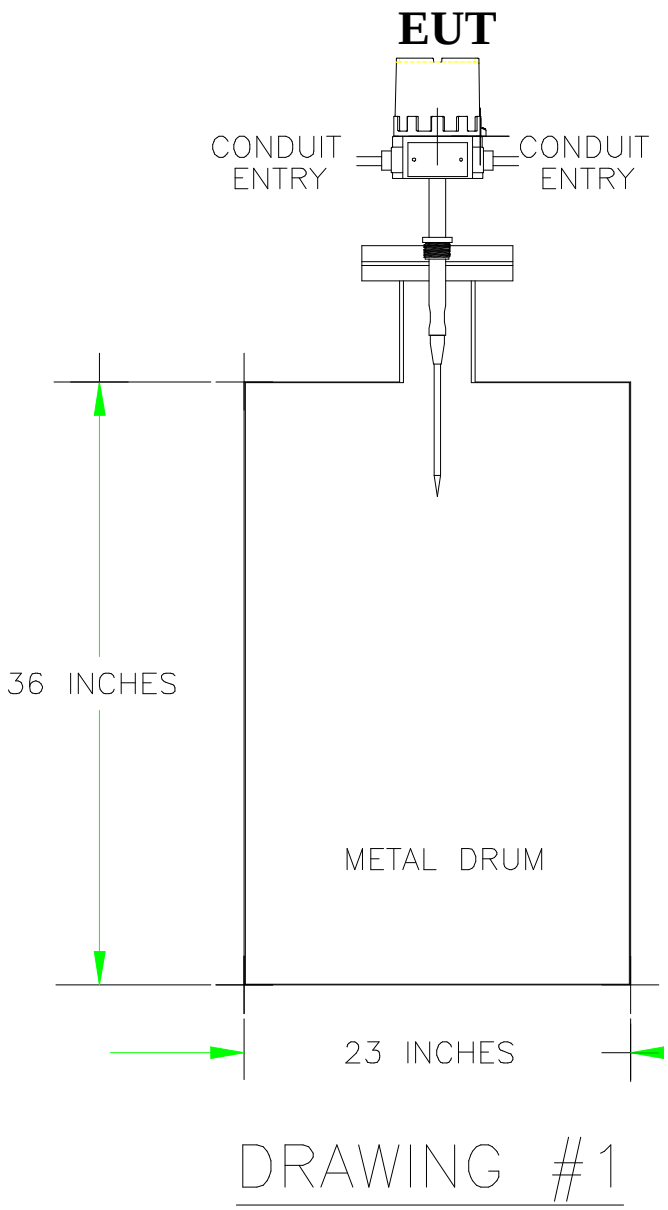
Notes:

1. Corrected Level = Recorded Level – Pre-Amp Gain + Antenna Factor + Cable Loss
2. In Section 15.209, the limit above 960MHz is 53.9 dB(µV/m) at 3 meters, and was extrapolated to 0.5 meters using 20 dB/decade factor.
3. Noise Floor with EUT off: 45 to 46 dBµV
4. The radiated emissions from the harmonic (19.0 GHz to 21.2 GHz) were below the noise floor at a measurement distance of 0.25 meter.

Test by Michael H. Fesler, Design Engineer
Signature:_____
Date: February 7, 2000



Sketch of test tank



Sketch of Test Fixture

Figure 1
TN Technologies Horizontal Test Tank

TN Technologies'

Model 1440
Level Gauge

Electromagnetic Emissions
Measurement Procedure and Data
{Frequency Scan from 22GHz to 53GHz}

This portion of the testing was performed by:

Professional Testing (EMI), Inc.
1601 FM 1460, Suite B
Round Rock, Texas 78664
Phone: (512) 244-3371

Test configurations

Device configurations tested:

Rod antenna – 1 foot rod
Horn antenna – 2 inch horn
Horn antenna – 8 inch horn

Testing performed on March 4, 2000 by Professional Testing @ TN Technologies:

Each device configuration was mounted into the tank via a mounting flange and paper gasket. The mounting flange will be typical for the device configuration being tested. The Rod antenna was also tested on a test fixture (55 Gallon metal drum). All of the measurements were below the noise floor of the test equipment.

Testing performed on March 8, 2000 by Professional Testing @ Professional Testing:

Since all of the reading were below the noise level of the equipment, Professional Testing wanted to conduct a post test verification of test equipment. Additional testing was performed with the shield cover was removed from the EUT. NOTE: Even with the shield cover removed the from EUT, the harmonics were within the Part 15 specifications with a 6.6dB margin.

TN Technologies'

Model 1440
Level Gauge

Electromagnetic Emissions
Measurement Report

Appendix A

Test Plan submitted to the FCC on 2-14-2000
+ FCC Reply

Cover Sheet

The attached document is the proposed test plan for TN Technologies Model 1440 microwave level gauge. It is essentially the same as has been done by other manufactures except that the proposed test tank provides a more rigorous emissions test.

From:

Tom Erb
TN Technologies
2555 North Hiway 35
Round Rock, Tx 78664
512 388 9212
FAX 512 388 9248
Email terb@TN-Technologies.com

Main company phone 512 388 9100
Main company FAX 512 388 9200

FCC Part 15 Test Plan for TN-Technologies Model 1440 Level Gauge

General

The Model 1440 Level Gauge is a swept frequency ranging system used to continuously measure the level of materials in tanks in an industrial setting. Typical users include the chemical industry, waste disposal operations, petrochemical plants and other hostile installations. In operation the model 1440 is permanently installed on a tank with the signal launched into the tank by threading it into a pipe fitting or bolting it in via a pipe flange. In all cases, the primary beam (main lobe) of the antenna is directed vertically downward into the tank.

The model 1440 uses a swept frequency signal (FMCW) over a nominal range of 9.55GHz to 10.55GHz at about 0 dbm feed into the antenna. Signal launch configurations include:

Dielectric Rod Antenna (lengths typically range from under a foot to two feet)
Horn Antennas ranging in size from 2 inches to 8 inches
Wetted waveguide configurations using metal and dielectric waveguides

In all cases, the antenna or waveguide is an integral part of the gauge. The signal is coupled directly from the transceiver module into the end of the antenna feed waveguide without any cable or connectors.

An FCC approved laboratory will do all of the required testing except for the “as installed” (on a tank) testing. To insure compliance with 15.209, testing of the tank-installed configuration will be performed by TN Technologies at the TN tank test site. The test installations will be on a horizontal tank (see figure 1) that is 15 feet long by 7 feet in diameter. This tank includes several gasketed entry flanges that are used for mounting test units as well as other access. In order to provide a worst-case condition for emissions testing, the tank will be partially filled with water.

Background

Other microwave level gauge manufacturers have used 30 to 60 foot tall tanks for Part 15 emissions testing. As a result of the much shorter range, TN’s proposed test tank will have reflected signals on the order of 20db to 30db stronger than those used by other manufacturers. We know from our applications experience with similar devices that this type of tank (horizontal cylinder) generates considerable ringing throughout the tank. Thus, this tank is most likely to reveal any excessive emissions in the device mounting area or at any other gasketed (i.e., not RF sealed) access ports on the tank.

Tank emission test plan:

Test configurations

Device configurations tested will include:

Rod antenna – 1 foot rod
Horn antenna – 2 inch horn
Horn antenna – 8 inch horn

Note: the wetted waveguide configurations will not be tested since emissions from a captured wave configuration will be considerably less than any antenna launch configuration.

Each device configuration will be mounted into the tank via a mounting flange and paper gasket. The mounting flange will be typical for the device configuration being tested.

> Note: These devices are also offered in pipe thread mount instead of flange mount. The threaded configurations will not be tested since the threaded mount offers no gasket gap of possible leakage. Any emissions from non-mounting ports would be the same as for the flange mounted configurations.

Measurement Procedure

All possible RF leakage areas (mounting flanges, gaskets, etc.) of the tank will be surveyed at very close (near contact) range to identify any areas of detectable emissions up through 22GHz. This survey will be done with the Model 1440 in the normal sweeping mode so that the frequencies of maximum emissions can be identified.

The measurement antenna will be set up at 0.5 meters from each point of significant emissions. The emissions at 0.5 meters will be documented through 22GHz first with the Model 1440 in the sweeping mode and then with the sweep stopped at each frequency which has been identified as generating an emissions maximum.

The emissions data will be adjusted by 15.56db to normalize it to 3 meters.

Test equipment

Narda Model 640 Standard Gain Horn
Narda Model 638 Standard Gain Horn
HP 8563E Spectrum Analyzer (Calibration date: 2-3-2000)
HP 8449A Preamplifier (Calibration date: 1-3-2000)

Figure 1
TN Technologies Horizontal Test Tank

-----Original Message-----

From: **Joe Dichoso [mailto:JDICHOSO@fcc.gov]**
Sent: Friday, February 18, 2000 8:02 AM
To: TERB@tn-technologies.com
Cc: GCZUMAK@fcc.gov; RFABINA@fcc.gov
Subject: proposed test plan

The test procedure appears to be acceptable, EXCEPT that 15.33(a)(2) requires that the scanned frequency range be up to the 5th harmonic, and NOT only up to 22 GHz, as you propose. You will have to use external mixers, which are not listed on their equipment list.
The grant condition will limit the operation of the EUT to installations in metal tanks, as only a metal tank is being tested.

COMMITECH GROUP **Saab Marine Electronics**

TELEFAX MESSAGE

To : FCC Equipment Authorization Division, Application Processing Branch
Attn : Gregory M Czumak
CC : Hans Östergren, Svenska EMS Lab AB
Fax no : 0091-3013442050 **Date : 6 Jul 95 - 20.14**
Ref. no: GR-FAX-95.139 **Pages : 1** (incl. this one)

Sender : Olle Edvardsson, Saab Tank Control (a division of Saab Marine Electronics AB)
TEL. DIRECT: +46 13 162571 FAX: +46 13 161033

Ref . Certification of K8CTH2000

FCC ID : K8CTH2000

Dear mr Czumak!

Thank you for your statement on the above mentioned project dated june 28 1995. We are planning for precessing your demands but I would appreciate very much a few advice on practical details.

A. Due to practical details we intend to place the DUT on its wooden support (with weels to turn it) directly on the metallic floor at the test facility at Svenska EMC Lab AB but maintaining the same geometry versus the floor as used earlier. Then the measuring setup will be more similar to the new measurement procedure which has not been implemented at Svenska EMC Lab AB yet concerning the turntable. Measurements will be done above the DUT as earlier and 3 m beside it so that the full range 0-90° at 3m distance will be covered. Identically the same measurement equipment will be used as the measurement earlier this year you have a report on.

B. Due to the results from the earlier measurements we intend to measure around the fundamental only at this time (ie 8-12 GHz). That is we'd like to exclude both lower frequencies (1-8 GHz measured last time and <1 GHz measured earlier) and higher ones (12-40 GHz) also measured and reported earlier. All emission at such frequencies were found to be much lower than the fundamental but still having the same limit level so a rather small change in the measurement setup should not critical I guess.

This is acceptable.

GMC

If this is OK please send a fax to the number given above. I will be in the office next week but generally many offices are running at half speed now due to hollidays.

Saab Marine Electronics AB Olle Edvardsson

Postal address	Telephone	Cables	Telex	Telefax
Saab Marine Electronics AB	Nat. 013-16 25 70	saab goteborg	21352 saabms s	Nat. 013-16 10 33

TN Technologies'

Model 1440
Level Gauge

Electromagnetic Emissions
End of Measurement Report