FCC ID: MCO1440

Prepared for:

TN TECHNOLOGIES
2555 North IH 35
Round Rock, Texas 78680

By:

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Submitted to:

Federal Communications Commission
Equipment Approval Services
P.O. Box 358315
Pittsburgh, Pennsylvania 15251-3315

February 2000

FCC Application for Certification
of an Intentional Radiator

TN TECHNOLOGIES
1440 Microwave Level Gauge

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Certificate of Compliance

Applicant:	TN Technologies
Applicant's Address:	2555 North IH 35 Round Rock, Texas 78680
Model:	1440 Microwave Level Gauge
Serial Number:	N/A
Project Number:	00391-10
Test Dates:	January 17, 24, 1999

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measurement data and this report. I believe them to be true and accurate. The **TN Technologies Model 1440 Microwave Level Gauge** was tested and found to be in compliance with FCC Part 90 for Intentional Radiators.

Jeffrey A. Lenk,
President

This report has been reviewed and accepted by **TN Technologies**. The undersigned is responsible for ensuring that the **TN Technologies, 1440 Microwave Level Gauge** will continue to comply with the FCC rules.

For TN Technologies

1.0 Equipment Under Test (EUT) Description

The **TN Technologies, 1440 Microwave Level Systems** are CW ranging systems designed to control the level of material surface or material interface for industrial processes. Typical applications include controlling level in hazardous waste handling, pressured chemical processes, and other hostile situations.

An approximately 3 mW signal (input into the antenna) is directed down to the surface of the process material. The return signal is mixed with the transmitter frequency, and the output of the mixer (0 to 9 kHz) represents the phase difference between the transmitted and received signal. The processor uses this phase difference, which is a function of the distance to the process material, to calculate the distance between the distance between the antenna and the process material.

The starting point of the microwave output is set at 9.550 GHz. The frequency of the VCO is stepped by the processor from 9.55 GHz to 10.55 GHz. The microwave circuitry provides a Marker (TTL Pulse), whenever the VCO frequency is harmonically related to the 100 MHz reference frequency. This yields a closed-loop system with 10 Markers being feed back to the processor each time the VCO is stepped from 9.55 GHz to 10.55 GHz. This frequency correction ensures that microwave output will remain in the frequency band from 9.5 GHz to 10.6 GHz.

The **TN Technologies, 1440 Microwave Level Gauge** is intended for operation under the requirements of Part 90 (Subpart I). Specific test requirements include the following:

47 CFR 2.1049	Occupied Bandwidth
47 CFR 90.205	Effective Radiated Power (ERP)
47 CFR 90.210 (c)	Emission Mask, Out of Band Emissions - Radiated
47 CFR 1.1310	Radiofrequency Radiation Exposure Limits
47 CFR 2.1055 (a)	Frequency Stability vs. Temperature
47 CFR 2.1055 (d)	Frequency Stability vs. AC Power

This unit does not re-modulate or re-key the signal.

The system tested consisted of the following:

Manufacturer & Model	Serial #	FCC ID #	Description
TN Technologies	N/A	MCO1440	1440 Microwave Level Gauge

The equipment within this report was tested to verify its compliance with FCC Rule Parts 2, and 90, for Intentional Radiators. A separate verification report pursuant to Part 15, Subpart B has been prepared for the **TN Technologies, 1440 Microwave Level Gauge** as a Digital Device.

2.0 Occupied Bandwidth Measurements

Measurements were made on the **TN Technologies, 1440 Microwave Level Gauge** to determine the occupied bandwidth in accordance with Part 2.1049.

2.1 Test Procedure

All measurements were performed in a controlled laboratory environment. The occupied bandwidth of the **TN Technologies, 1440 Microwave Level Gauge** was measured using a Hewlett Packard HP 8566 Spectrum. Occupied bandwidth was plotted. The occupied bandwidth was measured based on the emission width 26 dB below the peak emission level.

2.2 Test Criteria

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated.

2.3 Test Results

Data for occupied bandwidth testing is located in Appendix A of this report. The widest bandwidth used by the **TN Technologies 1440 Microwave Level Gauge** is 1.004 GHz.

3.0 Effective Radiated Power (ERP) Measurements

Measurements were made on the **TN Technologies, 1440 Microwave Level Gauge** to verify compliance with the maximum effective radiated power (ERP) requirements of §90.205.

ERP measurements were made at the Professional Testing "Open Field" Site, located in Round Rock, Texas, to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

3.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable which allows 360 degree rotation. A measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters.

A Spectrum Analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing. All final measurements were taken using a Quasi-Peak Adapter with a measurement bandwidth of 120 kHz.

3.2 Test Criteria

Section 90.205 lists various levels for the maximum effective radiated power of Part 90 transmitters. Based on this specification, the lowest allowed ERP for the frequency band at 9.5 to 10.6 GHz will be

authorized on a case by case basis. The power output of **TN Technologies 1440 Microwave Level Gauge** is under 1 watts. So 1 watt is the ERP requested by **TN Technologies.** The EUT includes an horn antenna which is permanently attached to the EUT and used for the ERP measurements. This process was also used for the spurious emission measurements. ERP testing was performed by measuring the maximum electric field from the **TN Technologies 1440 Microwave Level Gauge** and translating this level to ERP using the following formula:

$$ERP = \{(E*r)^2\} / (30)$$

Where:

E = Electric Field in v/m

r = distance from the measurement antenna to the EUT in meters

This formula was obtained from the Industry Canada document, 'Guidelines for Measurement of Radio Frequency Fields at Frequencies from 10 kHz to 300 GHz, Document Reference NIR-E, dated January 1994'.

3.3 Test Results

Measurements were performed utilizing a spectrum analyzer IF/video bandwidth of 3 kHz/10 kHz. For final measurements, the frequency span was set for 3 MHz and was centered on the peak of the output signal.

Data for ERP testing is located in Appendix B of this report **TN Technologies 1440 Microwave Level Gauge** met the §90.205 ERP requirements.

4.0 Out of Band Emissions - Radiated

Radiated emissions measurements were made to determine out of band radiated noise produced by the **TN Technologies 1440 Microwave Level Gauge** in accordance with Section 90.210 (c). Evaluation of the spurious emissions for this device was based primarily on Mask C criteria using representative traffic signals.

Radiated emissions measurements were made at the Professional Testing "Open Field" Site 2, located in Marble Falls, Texas, to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

4.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable which allows 360 degree rotation. A measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. The radiated emissions were maximized by cable manipulation, rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters.

The Spectrum Analyzer was used to find the maximums of the radiated emissions during the testing. All final measurements were made using a peak measurement method. The final measurements provided were determined by using the following formula:

Corrected Level = Recorded Level - Pre-Amp Gain + Antenna Factor + Cable Loss

4.2 Test Criteria

In order to evaluate the EUT versus the out of band emission criteria of §90.210, a representative emission mask suitable for this band (Emission mask C) was selected. The requested band for **TN Technologies 1440 Microwave Level Gauge** is from 9.5 GHz to 10.6 GHz. For emissions beyond the requested operation area, the attenuation required by §90.210 does not vary (43 + 10 log(P)) versus emission type. Based on this criteria, transmitter related emissions for the **TN Technologies 1440 Microwave Level Gauge** shall be reduced by the following amount with respect to the level of the fundamental:

Frequency (GHz)	Attenuation versus the fundamental (dB)
9.5 to 10.6	0
below 9.5 or above 10.6	43 + 10 log(P)

The maximum power from the **TN Technologies 1440 Microwave Level Gauge** is 1 watt, which translates the 43 +10 log(P) term to a minimum attenuation of 43 dB.

4.3 Test Results

The **TN Technologies 1440 Microwave Level Gauge** was tested for radiated spurious emissions. The signals were fully modulated for all tests. Radiated emission data sheets are contained in Appendix C of this report. The **TN Technologies 1440 Microwave Level Gauge** met the §90.210(c) radiated emission requirements. Documentation of the immediate area surrounding the intended emission is shown as part of the occupied bandwidth plots.

5.0 Radiofrequency Radiation Exposure Evaluation

An evaluation was performed to provide data regarding the **TN Technologies 1440 Microwave Level Gauge** with respect to the Radiofrequency Radiation Exposure requirements of 47 CFR 1.1310.

5.1 Evaluation Procedure

The primary method of controlling radio frequency radiation exposure from the **TN Technologies 1440 Microwave Level Gauge** will be the responsibility of the installer of the equipment. The device is to be professionally installed by personnel trained and familiar with installation and configuration of wireless systems. The installer is responsible for antenna selection, site selection and final site configuration. Final compliance with Commission RF exposure regulations for this type of site is the responsibility of the installer and is addressed under separate OET documents.

This device is not marketed outside the wireless communications community. In order to install this system properly, the maximum output power versus the frequency range should be reported in the

User's Manual for the device such that this issue can be addressed when the installation site of this device is designed.

5.2 Evaluation Results

The output power level for the **TN Technologies 1440 Microwave Level Gauge** is reported in the User's Manual as being 1.0 watts. In addition, the transmitting frequency for this device is reported as from 9.5 GHz to 10.6 GHz. Based on this information, the **TN Technologies 1440 Microwave Level Gauge** meets the necessary requirements regarding RF exposure.

6.0 Frequency Stability vs. Temperature Test

Measurements were made on the **TN Technologies 1440 Microwave Level Gauge** to verify compliance with the frequency stability requirements of §2.1055(a). Under these specifications, the EUT is tested to verify satisfactory frequency stability versus changes of temperature.

6.1 Test Procedure

The EUT was placed in an environmental test chamber and powered such that the frequency control element received normal voltage and the transmitter provided nominal RF output. The chamber was programmed to cool from room temperature to –30 degrees C and then step in 10-degree increments, each step held for 20 minutes, to 50 degrees C. A HP 8566 Spectrum Analyzer was used to measure the transmitting frequency.

6.2 Test Criteria

Under Section 2.1055(a), the **TN Technologies 1440 Microwave Level Gauge** must operate with frequency between 9.5 GHz to 10.6 GHz band edges with the temperature varied from –30 to 50 degree C.

6.3 Test Results

Data for this test is located in the Appendix D of this report. **TN Technologies 1440 Microwave Level Gauge** meets the frequency stability requirements for frequency stability versus temperature variation based on the criteria listed above.

7.0 Frequency Stability vs. DC Voltage Test

Measurements were made on the **TN Technologies 1440 Microwave Level Gauge** to verify compliance with the frequency stability requirements of §2.1055(d). Under these specifications, the EUT is tested to verify satisfactory frequency stability versus changes of DC Voltage.

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. DC Power to the input terminals was varied from 18VDC to 30VDC. The normal DC mains power for this system is 24 VDC. The center frequency and center frequency power level was recorded at 1 Volt intervals over this range.

7.2 Test Criteria

Under Section 2.1055(a), the **TN Technologies 1440 Microwave Level Gauge** must operate within the frequencies between the 9.5 GHz to 10.6 GHz band edges with the DC voltage varied from 18 to 30 VDC.

7.3 Test Results

Data for this test is located in the Appendix E of this report. **TN Technologies 1440 Microwave Level Gauge** meets the frequency stability requirements for frequency stability versus temperature variation based on the criteria listed above.

8.0 Modifications

No modifications were made on the **TN Technologies 1440 Microwave Level Gauge** during the test.

9.0 List of Test Equipment

A list of the test equipment utilized to perform the conducted and radiated emission measurements is given below. The date of calibration is given for each.

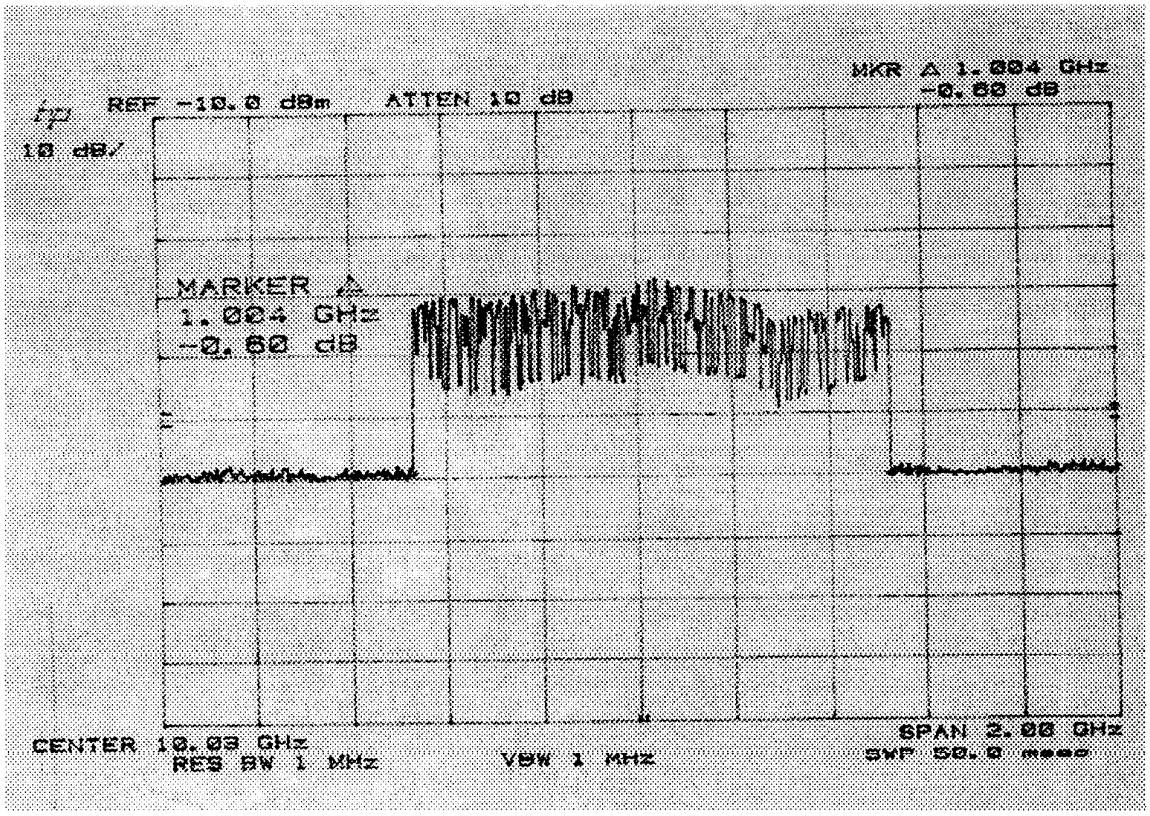
Thermothron SM-32, Temperature Chamber	A/N 0419	Cal Due: Nov 00
EMCO 3115, Double Ridged Horn Antenna	A/N 0267	Cal Due: May 00
L/M 0-1-20N, Preamplifier, 0.01 to 20 GHz	A/N 0238	Cal Due: Jan 01
HP 85650A, Quasi Peak Adapter	A/N 0085	Cal Due: Nov 00
HP 8566B, Spectrum Analyzer, 22 GHz	A/N 0084	Cal Due: Nov 00
Tektronix 492BP, Spectrum Analyzer, 60 GHz	A/N: 1031	Cal Due: Mar 2001
Tektronix WM490U, 40 GHz to 60 GHz mixer	A/N: 1056	Cal Due: Mar 2001
Millitech 5155, 26.5 GHz to 40 GHz mixer	A/N: 1152	Cal Due: Mar 2001
Millitech 26-40, 26.5 GHz to 40 GHz Horn	S/N: 031	Cal Due: Mar 2001
WL Gore 3m SMA to SMA IF Cable	S/N: 250239	Cal Due: Mar 2001
HP 436A Power Meter, 60 GHz	A/N: 1086	Cal Due: May 2000
HP R8486D Power Sensor, 26-40 GHz	A/N: 50013	Cal Due: May 2000
Gigatronix 910-039 Synthesizer, 40 GHz	A/N: 1318	Cal Due: Feb 2001

Appendix A Occupied Bandwidth Test Data

Occupied Bandwidth Data Sheet

TN Technologies
1440 Microwave Level Gauge

SERIAL #: N/A PROJECT #: 00391-10
DATE: January 17, 2000



COMMENT #1: 26 dB Bandwidth = 1.004 GHz

COMMENT #2:

TEST ENGINEER: _____ **APPROVED BY**: _____
Larry Zhou **Jeffrey A. Lenk**

Appendix B Effective Radiated Power Test Data

Effective Radiated Power Data Sheet

TN Technologies
1440 Microwave Level Gauge

SERIAL #: N/A PROJECT #: 00391-10
DATE: January 17, 2000

Antenna Horizontal

Freq. (GHz)	EUT Direction (Deg.)	Antenna Height (Meter)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Level ERP (watts)	Limit (watts)	Margin (watts)
10.05	0.00	1.00	63.40	37.20	5.40	106.00	0.012	1.00	-0.99

Antenna Vertical

Freq. (GHz)	EUT Direction (Deg.)	Antenna Height (Meter)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Level ERP (watts)	Limit (watts)	Margin (watts)
10.05	0.00	1.00	68.50	37.20	5.40	111.10	0.039	1.00	-0.96

TEST ENGINEER _____ **APPROVED BY:** _____
Larry Zhou **Jeffrey A. Lenk**

Appendix C — Out of Band Emissions (Radiated) Test Data

Out of Band Emission - Radiated Data Sheet

TN Technologies
1440 Microwave Level Gauge

SERIAL #: N/A PROJECT #: 00391-10
DATE: January 17, 2000 POLARIZATION: Horizontal

Freq. (GHz)	EUT Direction (Deg)	Recorded Level (dBuV)	Cable Loss (dB)	Antenna Factor (dBuV/m)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
10.050	0.0	64.50	5.4	37.2	107.1	125.3	Ref
9.500	0.0	27.60	5.2	36.5	69.3	82.3	-13.0
10.600	0.0	28.10	5.6	37.2	70.9	82.3	-11.4
20.100	0.0	29.00	43.8	7.4	80.2	82.3	-2.1

COMMENT #1: EUT Height: 1 Meter.

COMMENT #2: All measurements made at 3 meters.

COMMENT #3: Authorized Bandwidth: 1.004 GHz.

TEST ENGINEER: _____ **APPROVED BY:** _____
Larry Zhou **Jeffrey A. Lenk**

Out of Band Emission - Radiated Data Sheet

TN Technologies
1440 Microwave Level Gauge

SERIAL #: N/A
DATE: January 17, 2000
PROJECT #: 00391-10
POLARIZATION: Vertical

Freq. (GHz)	EUT Direction (Deg)	Recorded Level (dBuV)	Cable Loss (dB)	Antenna Factor (dBuV/m)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
10.050	0.0	68.50	5.4	37.2	111.1	125.3	Ref
9.400	0.0	27.90	5.2	36.5	69.6	82.3	-12.7
10.700	0.0	28.20	5.6	37.2	71.0	82.3	-11.3
20.100	0.0	29.20	43.8	7.4	80.4	82.3	-1.9

COMMENT #1: EUT Height: 1 Meter.

COMMENT #2: All measurements made at 3 meters.

COMMENT #3: Authorized Bandwidth: 1.004 GHz.

TEST ENGINEER _____ **APPROVED BY:** _____
Larry Zhou **Jeffrey A. Lenk**

Appendix D

Frequency Stability vs. Temperature Test Data

Frequency Stability vs. Temperature Data Sheet

TN Technologies
1440 Microwave Level Gauge

SERIAL #: N/A PROJECT #: 00391-10
DATE: January 24, 2000

Temperature (C)	Strating Frequency (GHz)	Ending Frequency (GHz)
-30	9.558	10.570
-20	9.560	10.572
-10	9.564	10.570
0	9.552	10.576
10	9.556	10.574
20	9.558	10.576
30	9.560	10.576
40	9.558	10.574
50	9.552	10.572

COMMENT #1: EUT operation frequency stayed between 9.5 GHz to 10.6 GHz, so the EUT met the requirement of frequency stability test.

TEST ENGINEER: Larry Zhou **APPROVED BY**: Jeffrey A. Lenk

Appendix G

Frequency Stability vs. DC Voltage Test Data

Frequency Stability vs. DC Voltage Data Sheet

TN Technologies
1440 Microwave Level Gauge

SERIAL #: N/A PROJECT #: 00391-10
DATE: January 17, 2000

DC Voltage (Volt)	Strating Frequency (GHz)	Ending Frequency (GHz)
18	9.543	10.551
19	9.542	10.550
20	9.543	10.551
21	9.544	10.552
22	9.542	10.550
23	9.542	10.550
24	9.544	10.553
25	9.542	10.550
26	9.543	10.551
27	9.542	10.550
28	9.544	10.552
29	9.543	10.551
30	9.543	10.551

COMMENT #1: EUT operation frequency stayed between 9.5 GHz to 10.6 GHz, so the EUT met the requirement of frequency stability test.

TEST ENGINEER: Larry Zhou **APPROVED BY**: Jeffrey A. Lenk