PCTEST Engineering Laboratory, Inc.
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CERTIFICATE OF COMPLIANCE

WINKLER INDUSTRIAL CO., LTD.
30/F, Amiata Industrial Building
58-64 Lei Muk Road
Kwai Chung, Hong Kong
Attention: W.K. Leung, Marketing Executive

Dates of Tests: April 24-25, 2002
Test Report S/N: TX.220206200.PVA
Test Site: PCTEST Lab, MD U.S.A.

FCC ID	**PVART-01**
APPLICANT	**WINKLER INDUSTRIAL CO., LTD.**

FCC Rule Part(s):	**§ 15.231 Subpart C – Intentional Radiator**
Classification:	**Remote Control Transmitter (DSC)**
EUT Type:	**Wireless Indoor/Outdoor Thermometer**
Tx Freq. Range:	**434MHz ~ 434MHz**
Trade Name:	**WINKLER**
Model(s):	***RT-01, WT-5***

This device has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified is ANSI C63.4-1992. There were no deviations to the standard.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.

Alfred Cirwithian
Vice President Engineering

Lab Code 100431-0

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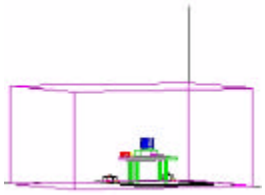
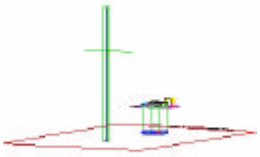
MEASUREMENT REPORT





Scope - Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission.

Company Name:	**WINKLER INDUSTRIAL CO., LTD.**
Address:	**30/F, Amiata Industrial Building**
	58-64 Lei Muk Road
	Kwai Chung, Hong Kong
Attention:	**W.K. Leung, Marketing Executive**

- FCC ID: **PVART-01**
- Model: ***RT-01, WT-5***
- Trade Name: ***WINKLER***
- EUT Type: Wireless Indoor/Outdoor Thermometer
- Application Type: Transmitter Certification
- Freq. Range: 434MHz ~ 434MHz
- FCC Rule Part(s): § 15.231 Subpart C – Intentional Radiator
- Dates of Tests: April 24-25, 2002
- Place of Tests: PCTEST Lab, Columbia, MD U.S.A.
- Test Report S/N: TX. 220206200.PVA

NVLAP Lab Code 100431-0

1.1 INTRODUCTION

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz (ANSI C63.4-1992) was used in determining radiated and conducted emissions emanating from **Winkler (Model(s): RT-01, WT-5) Wireless Indoor/Outdoor Thermometer FCC ID: PVART-01.**

These measurement tests were conducted at ***PCTEST Engineering Laboratory, Inc.*** facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49'38" W longitude. The facility is 1.5 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4 on October 19, 1992.

1.2 PCTEST Location

The map at right shows the location of the PCTEST Lab, its proximity to the FCC Lab, the Columbia vicinity area, the Baltimore-Washington International (BWI) airport, and the city of Baltimore, and the Washington, D.C. area. (see Figure1).

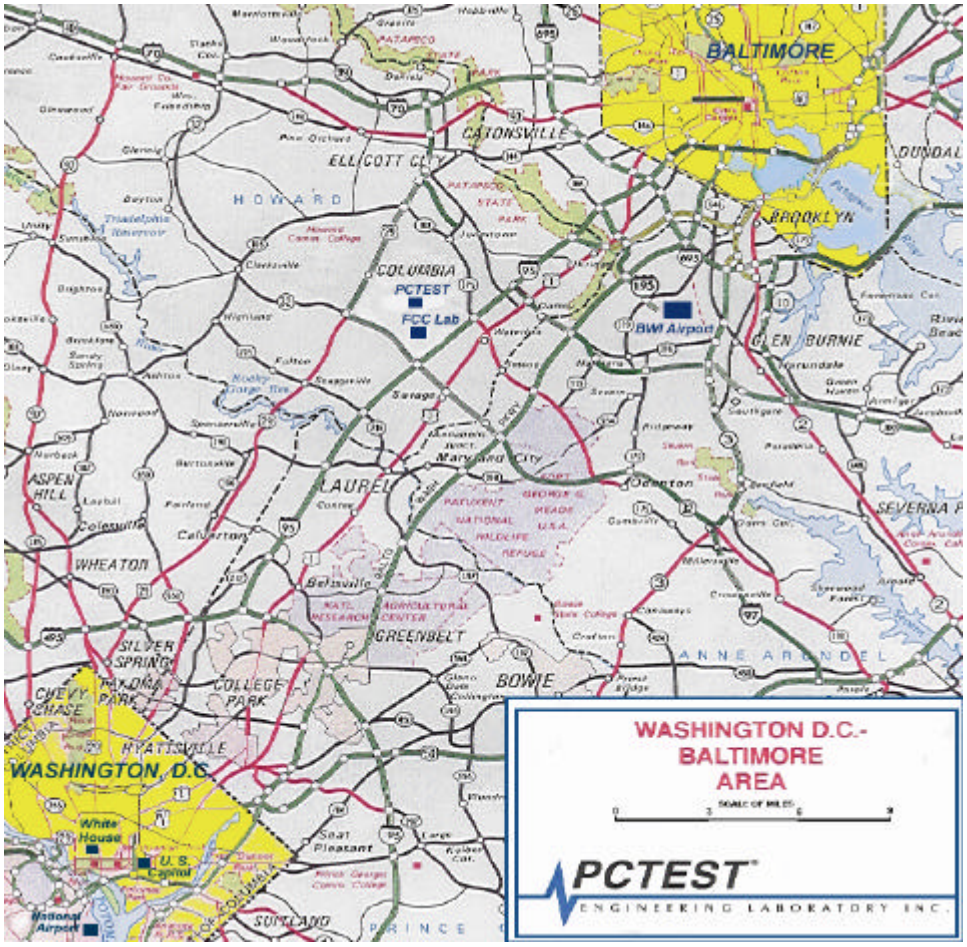


Figure 1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area.

2.1 Product Information

2.2 Equipment Description

The Equipment Under Test (EUT) is the **WINKLER (Model(s): *RT-01, WT-5*) Wireless Indoor/Outdoor Thermometer FCC ID: PVART-01.**

* **Tx Freq. Range:**	**434MHz ~ 434MHz**
* **Antenna:**	**Built-in internal looped antenna on-board**
* **Power Supply:**	**Main Unit: (2) AA Batteries** **Remote Unit: (2) AA Batteries**
* **Dimensions (WxHxD):**	**Main Unit: 100 x 140 x 30 mm** **Remote Unit: 65 x 80 x 35 mm**

EMI Suppression Devices

No modifications were made to the device.

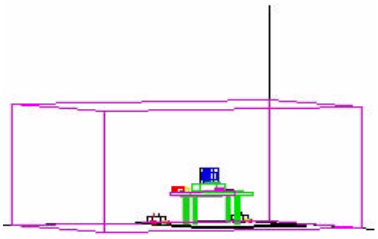


Figure 2. Shielded Enclosure Line-Conducted Test Facility

3.1 Description of Tests

3.2 Conducted Emissions (n/a - powered by Four AA batteries)

The line-conducted facility is located inside a 16'x20'x10' shielded enclosure. It is manufactured by Ray Proof Series 81 (see Figure 2). The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1m. x 1.5m. wooden table 80cm. high is placed 40cm. away from the vertical wall and 1.5m away from the side wall of the shielded room (see Figure 3). Solar Electronics and EMCO Model 3725/2 (10kHz-30MHz) 50Ω/50µH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room (see Figure 4). The EUT is powered from the Solar LISN and the support equipment is powered from the EMCO LISN. Power to the LISNs are filtered by a high-current high-insertion loss Ray Proof power line filters (100dB 14kHz-10GHz). The purpose of the filter is to attenuate ambient signal interference and this filter is also bonded to the shielded enclosure. All electrical cables are shielded by braided tinned copper zipper tubing with inner diameter of 1/2". If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply lines will be connected to the Solar LISN. LISN schematic diagram is shown in Figure 5. All interconnecting cables more than 1 meter were shortened by non-inductive bundling (serpentine fashion) to a 1-meter length. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer to determine the frequency producing the maximum EME from the EUT. The spectrum was scanned from 450kHz to 30MHz with 20 msec. sweep time. The frequency producing the maximum level was reexamined using EMI/ Field Intensity Meter and Quasi-Peak adapter. The detector function was set to CISPR quasi-peak mode. The bandwidth of the receiver was set to 10 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission. Each emission was maximized by: switching power lines; varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/or support equipment, and powering the monitor from the floor mounted outlet box and the computer aux AC outlet, if applicable; whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in Appendix C. Each EME reported was calibrated using the HP8640B signal generator.

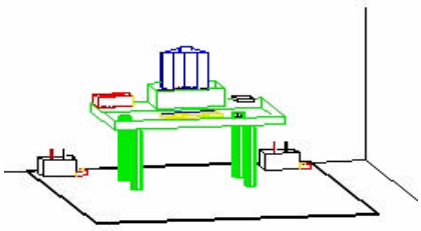


Figure 3. Line Conducted Emission Test Set-Up

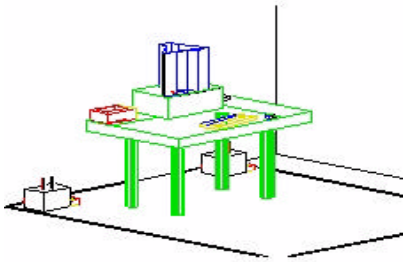


Figure 4. Wooden Table & Bonded LISNs

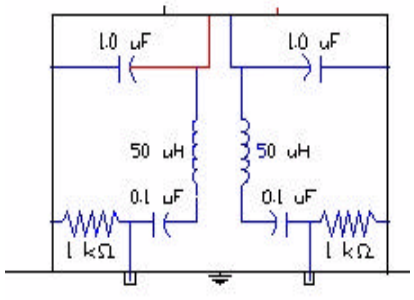


Figure 5. LISN Schematic Diagram

3.1 Description of Tests (continued)

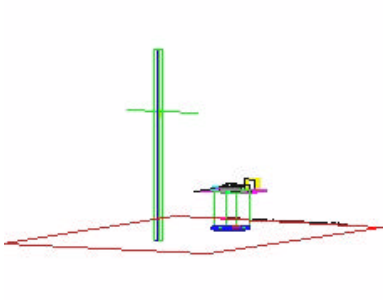


Figure 6. 3-Meter Test Site

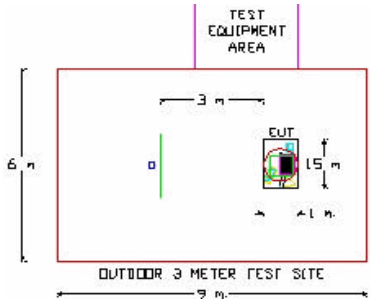


Figure 7. Dimensions of Outdoor Test Site

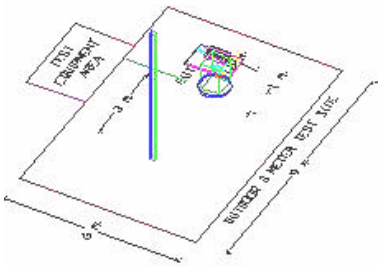


Figure 8. Turntable and System Setup

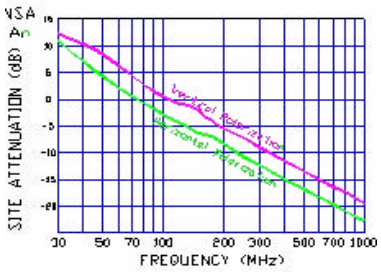


Figure 9. Normalized Site Attenuation Curves (H&V)

3.3 Radiated Emissions

Preliminary measurements were made indoors at 1 meter using broadband antennas, broadband amplifier, and spectrum analyzer to determine the frequency producing the maximum EME. Appropriate precaution was taken to ensure that all EME from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, turntable azimuth with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 to 200 MHz using biconical antenna and from 200 to 1000 MHz using log-spiral antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used.

Final measurements were made outdoors at 3-meter test range using Roberts™ Dipole antennas or horn antenna (see Figure 6). The test equipment was placed on a wooden and plastic bench situated on a 1.5 x 2 meter area adjacent to the measurement area (see Figure 7). Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined and investigated using EMI/Field Intensity Meter and Quasi-Peak Adapter. The detector function was set to CISPR quasi-peak mode and the bandwidth of the receiver was set to 100kHz or 1 MHz depending on the frequency or type of signal.

The half-wave dipole antenna was tuned to the frequency found during preliminary radiated measurements. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8-meter high non-metallic 1 x 1.5 meter table (see Figure 8). The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each EME emission. The turntable containing the system was rotated; the antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission. Each emission was maximized by: varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/or support equipment; powering the monitor from the floor mounted outlet box and the computer aux AC outlet if applicable, and changing the polarity of the antenna; whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in Attachment H. Each EME reported was calibrated using the HP8640B signal generator. The Theoretical Normalized Site Attenuation Curves for both horizontal and vertical polarization are shown in Figure 9 according to ANSI C63.4.

4.1 §15.203 Antenna Requirement

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the applicant can be used with the device. The use of permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with this requirement.

CONCLUSION

The WINKLER Wireless Indoor/Outdoor Thermometer complies with the requirement of §15.203 with a built-in looped antenna permanently attached to the transmitter.

5.1 Occupied Bandwidth Measurement

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70MHz and below 900MHz. The bandwidth is determined at the points 20 dB down from the modulated carrier.

@ 434 MHz	
434 MHz x 0.0025	= 1.085 MHz
0.7875 MHz / 2	= +/- 393.75 kHz

A sample transmitter output was fed into the R&S Spectrum Analyzer and was plotted.

Span:	2 MHz
Vertical Scale:	5 dB/div
Center Frequency:	434 MHz

The bandwidth at 20 dB is **200 kHz**, which is within the allowable limit of **400kHz** at 434 MHz.

6.1 Frequency Measurements (Spurious)

Operating Frequencies: 434 MHz
Distance of Measurements: 3 meters

FREQ. (MHz)	Level* (dBm)	AFCL (dB)	POL (H/V)	(dBmV/m) (PEAK)	FS (PEAK)	F/S (AVG)	(dBmV/m) (AVG)	MARGIN (dB)
434.0	- 55.0	24.1	V	76.1	6382.635	3127.491	69.90	2.96
868.0	- 84.0	31.8	V	54.8	549.541	269.275	48.60	4.26
1302.0	- 86.2	31.2	V	52.0	398.107	195.0725	45.80	7.06
1736.0	- 86.0	34.5	V	55.5	595.662	291.8745	49.30	3.56
2170.0	- 88.4	36.7	V	55.3	582.103	285.2306	49.10	3.76

Table 1. Radiated Measurements at 3-meters.

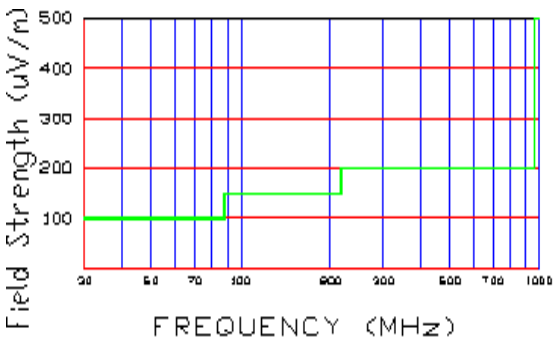


Figure 10. Spurious Radiated Limits at 3 meters

NOTES:

1. All channels were investigated and the worst-case is reported.
2. The EUT was tested with a new battery.
3. Radiated Limits per §15.231:

Fund. Freq. (MHz)	F/S (mV/m)	F/S Spurious (mV/m)
40.66 ~ 40.70	1000	100
70 ~ 130	500	50
130 ~ 174	500 ~ 1500	50 ~ 150
174 ~ 260	1500	150
260 ~ 470	1500 ~ 5000	150 ~ 500
470 & above	5000	500

4. Limit = 602.55 mV/m
5. * Note: These frequencies fall under restricted bands according to §15.205. The field strength of emissions at these frequencies does not exceed the limits specified in §15.205.

ERP Measurements by Substitution Method:

The EUT was placed on a wooden turntable 3-meters away from the receive antenna. The receive antenna height and turntable rotation was adjusted for the highest reading on the receive spectrum analyzer. A half-wave dipole was substituted in place of the EUT. This dipole antenna was driven by signal generator and the level of the signal generator was adjusted to obtain the same receive spectrum analyzer reading that was measured with the EUT. This ERP level is recorded. Above 1 GHz, horn antenna is used and the difference between the gains of the horn and dipole antenna are taken into consideration to determine EIRP.

7.1 SUPPORT EQUIPMENT USED

1. WINKLER Wireless Indoor/Outdoor Thermometer FCC ID: PVART-01 (EUT)

(Please see "Attachment H - Test Setup Photographs" for actual system test setup.)

8.1 Plot(s) of Emissions

See Attachment D

9.1 Sample Calculations

$$dB\mu V = 20 \log_{10} (\mu V/m)$$
$$dB\mu V = dBm + 107$$

9.2 Example 1:

Calculation of Limit @ 434MHz per Section 15.231

260 MHz Limit = 1500µV/m @ 3m

470 MHz Limit = 5000µV/m @ 3m

$\frac{5000-1500}{470-260} = \frac{3500}{210}$

$\frac{(434-260)(3500)}{(210)} =$ 2900µV/m

2900+1500 = 4400µV/m (72.86dBµV/m) @ 3m

9.3 Example 2:

Calculation of Duty Cycle per Section 15.35(c)

During a 100ms Period there were 3 wide Pulses @ 3.8ms each and 20 Narrow Pulses @ 1.9ms each.

The total time is (20)(1.9ms) + (3)(3.8ms) = 49.4ms.

The Duty Cycle is 49.4%.

# of Ultra Wide Pulse = 1 Ultra Wide = 10ms

# of Code Groups per 100ms = 1 Wide Pulses = 0.9ms

# of Wide Pulses = 19 Narrow Pulses = 0.45ms

# of Narrow Pulses = 21

0.9ms x 19 = 17.1ms
0.45ms x 21 = 9.45ms
10.0ms x 1 = 10ms
17.1ms + 9.45ms + 10.0ms = 36.55ms/100 x 100% = 36.55% Duty Cycle

10.1 Accuracy of Measurement

10.2 Measurement Uncertainty Calculations:

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994).

Contribution (Line Conducted)	Probability Distribution	Uncertainty (± dB)	
		9kHz-150MHz	150-30MHz
Receiver specification	Rectangular	1.5	1.5
LISN coupling specification	Rectangular	1.5	1.5
Cable and input attenuator calibration	Normal (k=2)	0.3	0.5
Mismatch: Receiver VRC Γ_1 = 0.03 LISN VRC Γ_R = 0.8 (9kHz) 0.2 (30MHz) Uncertainty limits 20Log(1 ± Γ_1 Γ_R)	U-Shaped	0.2	0.35
System repeatability	Std. deviation	0.2	0.05
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	1.26	1.30
Expanded uncertainty	Normal (k=2)	2.5	2.6

Calculations for 150kHz to 30MHz:

$$u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)} = \pm\sqrt{\frac{1.5^2 + 1.5^2}{3} + (\frac{0.5}{2})^2 + 0.35} = \pm 1.298\text{dB}$$

$U = 2U_c(y) = \pm 2.6\text{dB}$

Contribution (Radiated Emissions)	Probability Distribution	Uncertainties (± dB)	
		3 m	10 m
Ambient Signals		-	-
Antenna factor calibration	Normal (k=2)	± 1.0	± 1.0
Cable loss calibration	Normal (k=2)	± 0.5	± 0.5
Receiver specification	Rectangular	± 1.5	±1.5
Antenna directivity	Rectangular	+ 0.5 / - 0	+ 0.5
Antenna factor variation with height	Rectangular	± 2.0	± 0.5
Antenna phase centre variation	Rectangular	0.0	± 0.2
Antenna factor frequency interpolation	Rectangular	±. 0.25	± 0.25
Measurement distance variation	Rectangular	± 0.6	± 0.4
Site imperfections	Rectangular	± 2.0	± 2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67 (Bi) 0.3 (Lp) Uncertainty limits 20Log(1 ± Γ_1 Γ_R)	U-Shaped	+ 1.1 - 1.25	± 0.5
System repeatability	Std. Deviation	± 0.5	± 0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+ 2.19 / - 2.21	+ 1.74 / - 1.72
Expanded uncertainty U	Normal (k=2)	+ 4.38 / - 4.42	+ 3.48 / - 3.44

Calculations for 3m biconical antenna. Coverage factor of k=2 will ensure that the level of confidence will be approximately 95%, therefore:

$U = 2u_c(y) = 2 \times \pm 2.19 = \pm 4.38\text{dB}$

11.1 Test Equipment

Type	Model	Cal. Due Date	S/N
Microwave Spectrum Analyzer	HP 8566B (100Hz-22GHz)	12/05/02	3638A08713
Microwave Spectrum Analyzer	HP 8566B (100Hz-22GHz)	04/17/03	2542A11898
Spectrum Analyzer/Tracking Gen.	HP 8591A (9kHz-1.8GHz)	06/02/02	3144A02458
Spectrum Analyzer	HP 8591A (9kHz-1.8GHz)	10/15/02	3108A02053
Spectrum Analyzer	HP 8594A (9kHz-2.9GHz)	11/02/02	3051A00187
Signal Generator*	HP 8640B (500Hz-1GHz)	06/02/02	2232A19558
Signal Generator*	HP 8640B (500Hz-1GHz)	06/02/02	1851A09816
Signal Generator*	Rohde & Schwarz (0.1-1000MHz)	09/11/02	894215/012
Ailtech/Eaton Receiver	NM 37/57A-SL (30-1000MHz)	04/12/03	0792-03271
Ailtech/Eaton Receiver	NM 37/57A (30-1000MHz)	03/11/03	0805-03334
Ailtech/Eaton Receiver	NM 17/27A (0.1-32MHz)	09/17/02	0608-03241
Quasi-Peak Adapter	HP 85650A	08/09/02	2043A00301
Ailtech/Eaton Adapter	CCA-7 CISPR/ANSI QP Adapter	03/11/03	0194-04082
RG58 Coax Test Cable	No. 167		n/a
Harmonic/Flicker Test System	HP 6841A (IEC 555-2/3)		3531A00115
Broadband Amplifier (2)	HP 8447D		1145A00470, 1937A03348
Broadband Amplifier	HP 8447F		2443A03784
Transient Limiter	HP 11947A (9kHz-200MHz)		2820A00300
Horn Antenna	EMCO Model 3115 (1-18GHz)		9704-5182
Horn Antenna	EMCO Model 3115 (1-18GHz)		9205-3874
Horn Antenna	EMCO Model 3116 (18-40GHz)		9203-2178
Biconical Antenna (4)	Eaton 94455/Eaton 94455-1/Singer 94455-1/Compliance Design 1295, 1332, 0355		
Log-Spiral Antenna (3)	Ailtech/Eaton 93490-1		0608, 1103, 1104
Roberts Dipoles	Compliance Design (1 set) A100		5118
Ailtech Dipoles	DM-105A (1 set)		33448-111
EMCO LISN (2)	3816/2		1077, 1079
EMCO LISN	3725/2		2009
Microwave Preamplifier 40dB Gain	HP 83017A (0.5-26.5GHz)		3123A00181
Microwave Cables	MicroCoax (1.0-26.5GHz)		
Ailtech/Eaton Receiver	NM37/57A-SL		0792-03271
Spectrum Analyzer	HP 8591A		3034A01395
Modulation Analyzer	HP 8901A		2432A03467
NTSC Pattern Generator	Leader 408		0377433
Noise Figure Meter	HP 8970B		3106A02189
Noise Figure Meter	Ailtech 7510		TE31700
Noise Generator	Ailtech 7010		1473
Microwave Survey Meter	Holaday Model 1501 (2.450GHz)		80931
Digital Thermometer	Extech Instruments 421305		426966
Attenuator	HP 8495A (0-70dB) DC-4GHz		
Bi-Directional Coax Coupler	Narda 3020A (50-1000MHz)		
Shielded Screen Room	RF Lindgren Model 26-2/2-0		6710 (PCT270)
Shielded Semi-Anechoic Chamber	Ray Proof Model S81		R2437 (PCT278)
Environmental Chamber	Associated Systems Model 1025 (Temperature/Humidity)		PCT285

* Calibration traceable to the National Institute of Standards and Technology (NIST).

12.1 Conclusion

The data collected shows that the **Winkler (Model(s): RT-01, WT-5)** ***Wireless Indoor/Outdoor Thermometer*** **FCC ID: PVART-01** complies with §15.231 Subpart C of the FCC Rules.

No modifications were made to the device.