Exhibit F: Technical Report

FCC ID: CW21668-2-1W

FCC Part 90 Subpart I

Report of Measurements

January 17, 2002

Device: Remote Firing Device (Remote)

Model: 1668-2-1W

Manufacturer: Rothenbuhler Engineering

Address: PO Box 708
2191 Rhodes Road
Sedro Woolley, Wa 98284

The data in this report was collected on
3/1/01,3/21/01,3/26/01,12/13/01,12/14/01, 1/08/02 and compiled by

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Herb Hainey, PE

General Information

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Test Locations
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Fax: 360 595-2722
E-mail: acmetest@acmetesting.com

Test Personnel: Daniel B. Staton, Senior EMC Technician

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Summary of Test Results
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FCC ID CW21668-2-1W

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Description of Device

Device:	Remote Firing Device (Remote)
Model Number:	1668-2
Serial Number:	145
Address:	52278
Frequency:	161.000 Mhz
Firmware:	Ver 1.4
Radio Module:	25900032
Power:	Internal 7.5 Volt Battery
Peripherals:	None
Cables:	None

Related Submittals/Grants

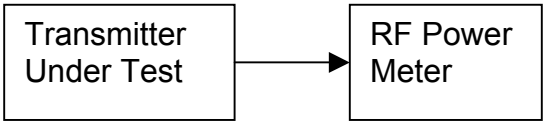
CW21649
CW21662-1
CW21662-2
CW21668-1
CW21668-2

RF Power Output

Test Requirement
Sec. 2.1046 RF Power Output

Test Technical Standard
Sec. 90.205

Test Procedure



Test Results
Manufacturer's Nominal RF output power rating = 1.0 Watts (30.0 dbm)

Measured RF output power = 30.59 dBm (1.15 Watts) at 151.000 Mhz
28.83 dBm (760 mW) at 170.000 Mhz

The 1668-2 uses a monopole whip antenna with a measured gain of 0.88 = -0.55db relative to an isotropic source. Therefor the Effective Radiated Power is:

Frequency (MHz)	Transmitter Output (W)	Effective Radiated Power (W) With 0.88 gain antenna
151	1.15	1.01
170	0.76	0.67
Nominal	1.00	0.88

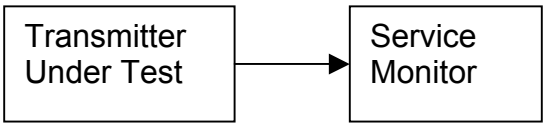
See file Output Power.pdf

Modulation Characteristics

Test Requirement
Sec. 2.1047(d) Modulation Characteristics

The emission designator “F2D” was selected based upon guidelines in CFR 47 sec. 2.201. The modulating signal is generated by a MAX604 modem chip. The audio tones used are 1300 Hz and 2100 Hz sine waves. These tones modulate the transmitter at a 1200 baud rate.

Test Procedure
Measure Peak Deviation on Service Monitor



Test Results

Modulation Characteristics

Modulation Tone	Deviation
1300 Hz	1.96 Khz
2100 Hz	1.96 Khz
1200 Baud Data (using 1300Hz/2100 Hz tones)	2.18 Khz

Note: Since the transmitter uses modem generated tones of 1300 Hz and 2100 Hz only (and will never use anything else), with levels set at the factory for 2 KHz nominal deviation, no frequency versus modulation curves have been generated.

Necessary Bandwidth

The required bandwidth for 1200 baud data using 1300 Hz/2100 Hz @2Khz Deviation is **9.56 Khz.** The emission designator would be **9K56F2D**

Paragraph 2.202 does not list F2D modulation. A calculation is provided to justify the 9.56 Khz necessary bandwidth

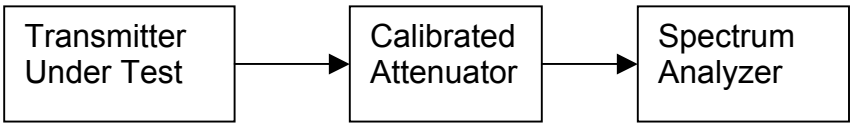
See file: Necessary Bandwidth.pdf for complete formula and calculation.

Occupied Bandwidth

Test Requirement
Sec. 2.1049 Occupied Bandwidth

Test Technical Standard
Sec. 90.210 Emission Masks – Emission mask “D”

Test Procedure
TIA/EIA-603:1993 Section 2.2.11
1300Hz/2100Hz/Random 1200 Baud Data were checked against emission mask “D”.



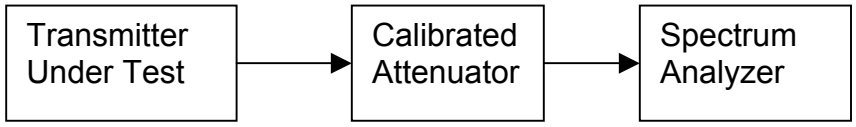
Test Results
See file: AcmeData.pdf

Spurious Emissions at Antenna Terminals

Test Requirement
Sec. 2.1051 Spurious Emissions at Antenna Terminals

Test Technical Standard
Sec. 90.210 (d),(m) for 12.5 Khz Channel

Test Procedure
TIA/EIA-603:1993 Section 2.2.13



Test Results
See “Antenna Conducted Spurious Emissions: 30Mhz – 2Ghz” in AcmeData.pdf

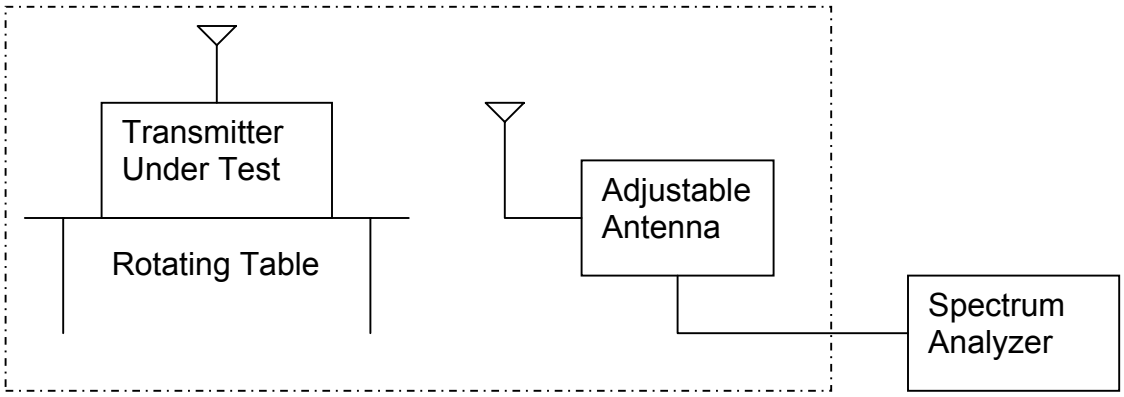
Field Strength of Spurious Radiation

Test Requirement
Sec. 2.1053 Field Strength of Spurious Radiation

Test Technical Standard
Sec. 90.210 (d.3)

Test Procedure
TIA/EIA-603:1993 Section 2.2.12

Calibrated 3 Meter Test Site



Test Results

No	Emission Frequency Mhz	Measurement dBuV/m	Power Into Ideal Dipole (dbm)	Limit (dbm)	Margin (db)
1	117.846	58.8	-38.6	-20	18.6
2	144.016	62.1	-35.3	-20	15.3
3	322.037	66.2	-31.2	-20	11.2
4	483.036	65.9	-31.5	-20	11.5
5	644.021	54.8	-42.6	-20	22.6
6	805.033	64.6	-32.8	-20	12.8
7	966.023	77.3	-20.1	-20	0.1
8	1127.11	61.5	-33.7	-20	13.7
9	1288.01	57.8	-37.4	-20	17.4
10	1449.1	52.3	-42.9	-20	22.9
11	1610.05	55.5	-39.7	-20	19.7

See file: AcmeData.pdf section “PRODUCT EMISSIONS”

Calculation of Radiated Power Limit

All emissions below 1000 MHz are expressed in terms of the equivalent power that would have to be fed into a dipole antenna in order to produce the same electric field strenght. All emissions above 1000 Mhz are expressed in terms of equivalent isotropic power. The equivalent power was determined by using the following formula: $P_t=E^2R^2/30\ G$

Where

Pt is power in watts
E is electric field strength in V/m
R is distance from transmitter in m
G is antenna gain factor relative to an isotropic radiator

Example: If the output power of the transmitter is **1.5 watts** (1.76dbW)

The minimum attenuation (90.210.d.3) is 50+10log(1.5) = 51.76 Therefore the maximum power of any spurious emission must not exceed
1.76dbW – 51.76db = -50dbW = **-20dbm** = 0.01 mW

Using the above power formula simplified for E we have $E=SQRT(30*G*P_t)/R$

For R=3m, $G_{dipole}=1.64$, $P_t=0.01W$

$E = SQRT(30*1.64*0.01x10^{-3})/3$

$= 7.39x10^{-3}$ V/m = 73.9 mV/m = **77.4 dbuV/m** At 3 meters

Example Calculation of Equivalent Power into Ideal Dipole

$P_t=E^2R^2/30\ G$

E = **58.8 dBuV/m** = 871uV/m = 8.71E-4 V/m
R = 3 m
G = 1.64 (dipole <1GHz), 1.0 (horn > 1GHz)
Emission Frequency = 117.846 MHz

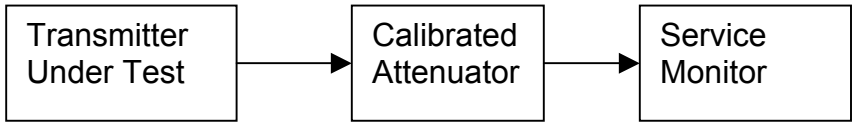
P = (8.71E-4)^2 * 3^2 / 30 / 1.64 = 1.388E-7 Watts = -68.6 dbW = -38.6 dbm

Frequency Stability

Test Requirement
Sec. 2.1055 Frequency stability

Test Technical Standard
Sec. 90.213 12.5 kHz Channels

Test Procedure
TIA/EIA-603:1993 Section 2.2.2



Test Results

See file: TemperatureTest.pdf and BatteryTest.pdf

Included for additional reference is the Frequency Stability data for the previously certified FCC ID: CW21668-1 that also uses the SONIK 5A204B radio module. The radio module including all frequency determining components are identical to those used in the CW21668-2-1W. In the –2-1W version the power output of the radio is reduced from 5.0 watts to 1.0 watts

Test run at norminal battery voltage of 12.0Vdc on 152.87 MHz.

Temp (deg C)	-30	-20	-10	0	10	20	30	40	50	60
Error (ppm)	-2.9	0.6	3.7	4.8	4.9	2.9	0.9	-0.8	-1.9	-2.1

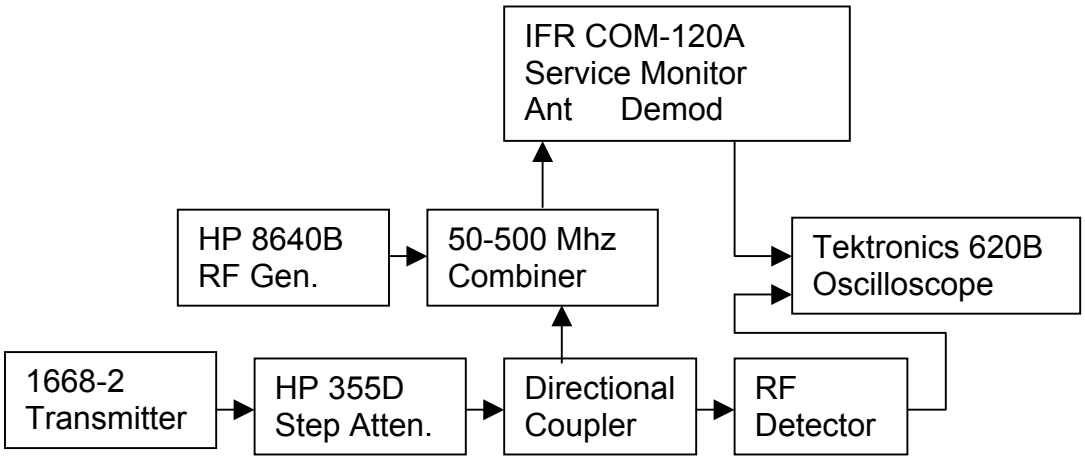
Test run at LOW battery voltage of 11.0 Vdc on 152.87 Mhz

Temp (deg C)	-30	-20	-10	0	10	20	30	40	50	60
Error (ppm)	-4.0	0.8	3.6	4.7	4.8	2.7	0.8	-1.0	-2.0	-2.3

Transient Frequency Behavior

Test Technical Standard
Sec. 90.214

Test Procedure
TIA/EIA-603:1993 Section 2.2.19



Test Results

See file:TransientTest.pdf

RF Exposure Compliance Requirements

The EUT meets the requirement that it be operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines (ref. 47 CFR 1.1307, 1.1310, 2.1091, and 2.1093).

As a remote blasting device, the 1668-2-1W will not be operated closer than 20cm from a person's head or body and can therefore be considered a modile transmitter per 47 CFR 2.1091. The 1668-2-1W has only one antenna configuration. The antenna factor for the antenna has been determined by actual measurement.

Table 1 in 47 CFR 1.1310 defines the maximum permissible exposure level for Occupational/Controlled Exposure to 1.0 mW/cm^2. The General Population/Uncontrolled Exposure level is 0.2 mW/cm^2.

Section 47 CFR 2.1091(c) indicates that part 90 devices are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if they operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more. The 1668-2-1W has an antenna factor of 0.88 and a maximum requested nominal output of 1.0 watt. The effective radiated power is given by the formula $P_{erff} = P_t * G_{ant.}$ = 1.0 * 0.88 = **0.88 watts(ERP)** which is below the limit of 1.5 watts(ERP).

Antenna Gain Calculations 1668-2-1W
Measurements recorded 3/1/01 at Acme Testing, Acme WA

Max Received Voltage	108.0 dbuV
Cable Loss	1.6 db
Antenna Factor of receive antenna	15.5 db
Field Strength(FS)	125.1 dbuV/M
Conducted Power(P)	1.1 Watts
Distance(r)	3 Meters

Field Strength in Volts/Meter: 125.1 dbuV/M = $(10^{\wedge(125.1/20)})/1E6$ = 1.8V/M
Field Strength (FS) is given by the relationship (FS) = $((30*P*G)^{\wedge 0.5})/r$
Solving for Antenna Gain (G), G = $(FS^{\wedge 2} * r^{\wedge 2})/(30*P)$, $(1.8^{\wedge 2} * 3^{\wedge 2})/(30*1.1)$ = .884
$Gain_{(Numeric)}$= .884
Gain $db_{isotropic}$ = 10Log(.884) = -.54$db_{isotropic}$
Gain relative to a dipole antenna with a 2.15 db gain, (-.54 – 2.15) = -2.69 db_{dipole}

Test Equipment

Rothenbuhler Engineering

IFR	Communications Monitor	COM-120A	485002436
HP	Signal Generator	8640B	1741A07326
HP	VHF Attenuator	355D	1204A24115
Tektronix	Digital Oscilloscope	TDS620B	B030182
Instek	Laboratory DC Supply	PS-3030	9669588
JFW	Directional Coupler	50C-007-10	207963
JFW	RF Detector	50D-003	N/A
RE	Combiner	50-500 Mhz	N/A

A list of Acme Equipment is included in AcmeData.pdf

The power meter used to measure the conducted power output at NWEMC's Sultan test facility is listed in file Output Power.pdf