:TEST Engineering Laboratory, Inc
6660-B Dobbin Road • Columbia, MD 21045 • U.S.A.
TEL (410) 290-6652 • FAX (410) 290-6654
http://www.pctestlab.com

CERTIFICATE OF COMPLIANCE

Siemens Transportation Systems
50, rue Barbes
92542 Montrouge Cedex, France
Attention: Mr. Regis Lardennois

Dates of Tests: Sept 25 - Oct 1, 2002
Test Report S/N: 15.220925502.QSC
Test Site: PCTEST Lab, Columbia MD

FCC ID	**QSCWAYSTATION**
APPLICANT	**Siemens Transportation Systems**

FCC Rule Part(s):	**§ 15.247; ANSI C-63.4 (1992)**
Classification:	**Spread Spectrum Transceiver (DSS)**
Max Output Power:	**35.8 dBm EIRP**
Method/System:	**Direct Sequence System (DSS)**
Equipment Type:	**Transportation Control System**
Frequency Range:	**2408 – 2474 MHz**
Model No(s).:	**Wayside Unit**

This equipment 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 in ANSI C-63-4 as modified via email correspondence from the FCC Lab.

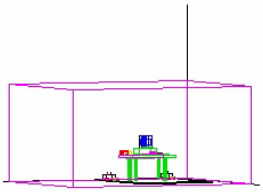
I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking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

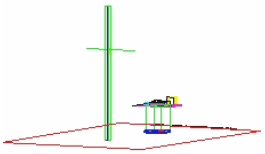
PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.

Randy Ortanez
President

TABLE OF CONTENTS

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.

§2983(a) General Information

Applicant Name:	**Siemens Transportation Systems**
Address:	**50, rue Barbes** **92542 Montrouge Cedex, France**
Attention:	**Mr. Regis Lardennois**

- FCC ID: **QSCWAYSIDE**
- Class: Spread Spectrum Transceiver (DSS)
- Type: Transportation Control System
- Freq. Range: 2408 – 2474 MHz
- Method/System: Direct Sequence System (DSS)
- Model No(s): **Wayside**
- Max. RF Output Power: 35.8 dBm EIRP
- Rule Part(s): § 15.247
- Dates of Tests: Sept 25 - Oct 1, 2002
- Place of Tests: PCTEST Lab, Columbia, MD U.S.A.
- Test Report S/N: 220925502.QSC

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) and FCC Public Notice dated July 12, 1995 entitled "Guidance on Measurement for Direct Sequence Spread Spectrum Systems" were used in the measurement of **Siemens Transportation Control System.**

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.

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).

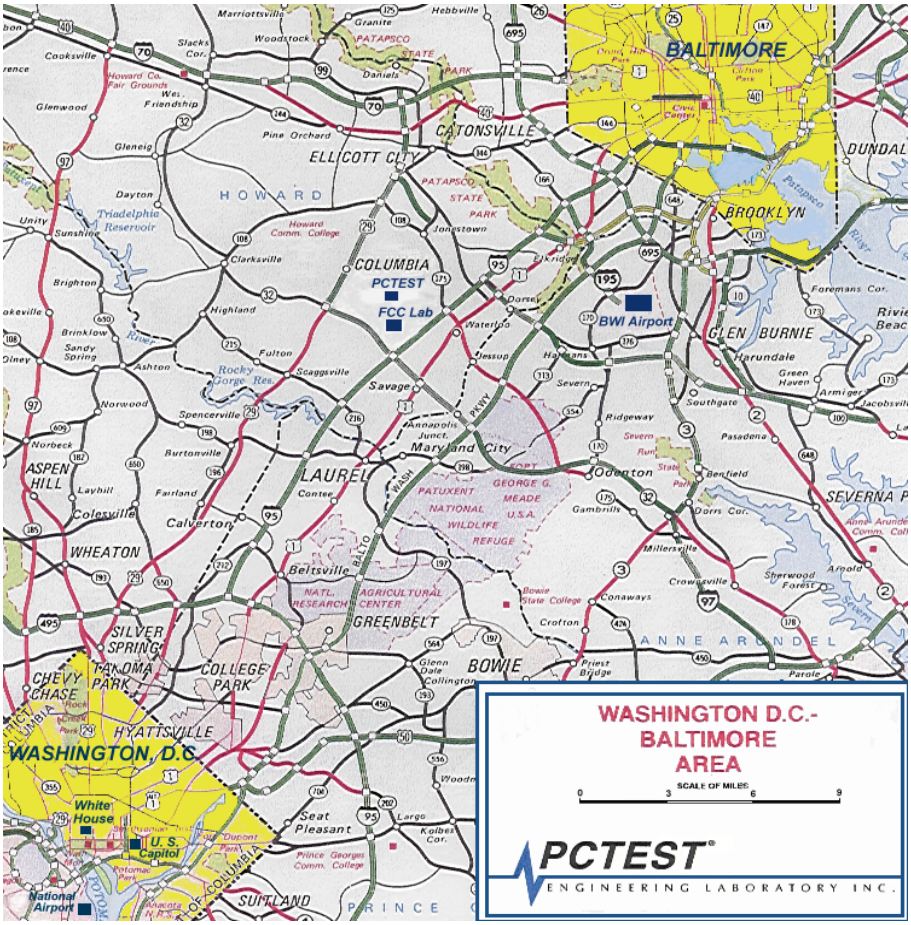


Figure 1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area.

PRODUCT INFORMATION

Equipment Description:

The Equipment under test (EUT) is a Siemens Transportation Control System using spread spectrum direct sequence and time division duplex techniques.

Frequency Range:	2408 – 2474 MHz
Channels:	9
Antenna:	Various, Max Gain is 13.9 dBi Yagi
Spread Spectrum Method:	Direct Sequence (DBPSK modulation)
Max RF Output Power:	35.8 dBm EIRP
Port/Connector(s):	RS232

Description of Tests

Conducted Emissions

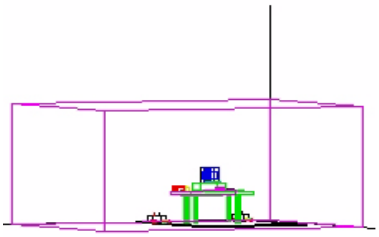


Figure 4. Shielded Enclosure Line-Conducted Test Facility

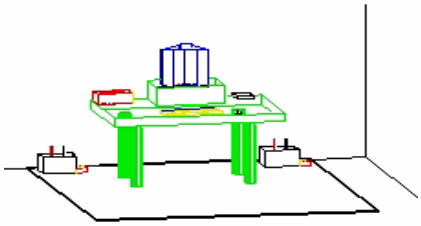


Figure 2. Line Conducted Emission Test Set-Up

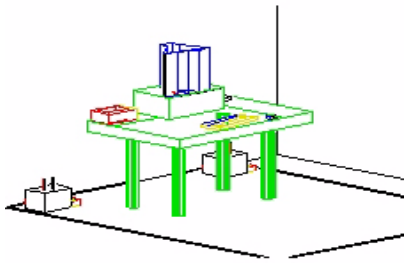


Figure 3. Wooden Table & Bonded LISNs

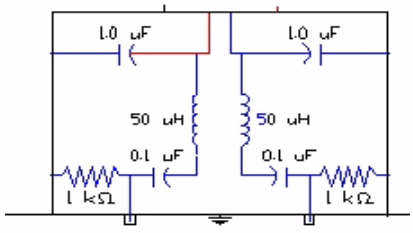


Figure 5. LISN Schematic Diagram

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.

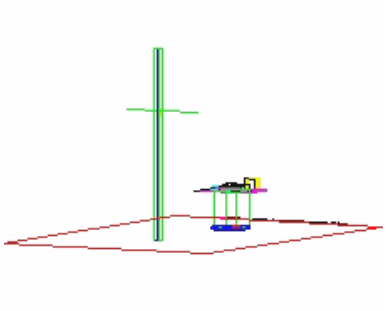


Figure 6. 3-Meter Test Site

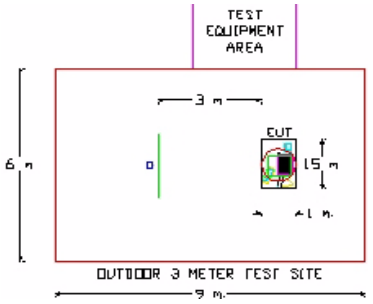


Figure 7. Dimensions of Outdoor Test Site

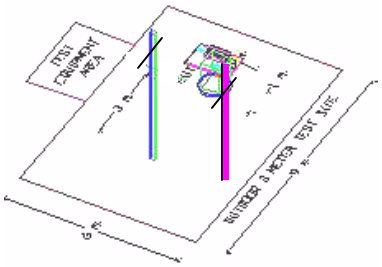


Figure 8. Turntable and mast poles for substituting for EUT

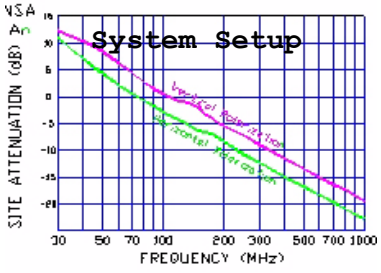


Figure 9. Normalized Site Attenuation Curves (H&V)

Description of Tests (Continued)

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 substitution techniques per FCC email correspondence (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) with the antenna mounted on a mast that simulated actual installation conditions (See photos). 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 or power meter. 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 for reference readings on the EMI meter. Peak power was measured with a power meter.

The EMI measurement system was tuned to the frequencies found during preliminary radiated measurements. The EUT was configured as per the attached configuration drawing(s), and support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency. The EUT, support equipment, and interconnecting cables

were re-arranged and manipulated to maximize each EME emission. The reference reading antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission. Each emission was maximized. Photographs of the worst-case emission can be seen in Appendix C. Each EME reported was calibrated using an HP synthesized signal generator for the frequency of measurement. The Theoretical Normalized Site Attenuation Curves for both horizontal and vertical polarization are shown in Figure 9.

§ 15.205 Restricted Bands

Special attention is made for the EUT's harmonic and spurious radiated emission in the restricted bands of operation. The EUT was tested from 9kHz and up to the tenth harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average measurements was used using RBW 1 MHz – VBW 10Hz and linearly polarized horn antennas. In addition, peak measurements were taken to ensure that the peak levels are not more than 20dB above the average limit. All out of band emissions, other than those created by the spreading sequence, data sequence, and the carrier modulation must not exceed the limits show in Table 1 per 15.209.

Frequency (MHz)	F/S (UV/m)	Meas. Dist. (Meters)
0.009-0.490	2400/F (kHz)	300
0.490-1.705	24000/F (kHz)	30
1.705-30.00	30	30
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3
Above 960	500	3

Table 1. Radiated Emission Limits Per 15.209

Test Equipment

HP 8566B	**Spectrum Analyzer 100Hz-22HGHz**
HP83017A	**Microwave Analyzer 40dB Gain (0.5 – 26.5 GHz)**
HP 3784A	**Digital Transmission Analyzer**
EMCO 3115	**Horn Antenna (1 – 18GHz)**

HP 8495A	20dB Attenuator (DC-40GHz) 0-70dB
HP 8493B	10dB Attenuator
HP	Power Meter
MicroCoax Cables	Low Loss Microwave Cables (1-26.5 GHz)
CDI Dipoles	Dipole Antennas (30 – 1000 MHz)

§ 15.203 Antenna Requirement

An intentional radiator antenna shall be designed to ensure that no antenna other that that furnished by the applicant can be used with the device. The use of a 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 unless the equipment must be professionally installed. This system must be professionally installed by trained individuals. Please see the file attachment "Installation Instructions".

The Siemens Wayside unit complies with the requirement of §15.203.

CONCLUSION

The equipment must be professionally installed. The unit meets the Antenna Requirements of §15.203.

§15.247(a)(2) – Direct Sequence Bandwidth

Res. Bandwidth = 100 kHz (10dB/div)
Vid. BW = 100 kHz
Span = 30 MHz
Ref. Level 23.6 dBm
Sweep 4 ms
(see attached bandwidth plots)

FREQ (MHz)	6dB Bandwidth (MHz)
2408	4.13
2441	4.13
2474	4.13

Table 2. 6dB Bandwidth measurements

Minimum Standard – The transmitter shall have a minimum 6dB bandwidth of 500kHz (0.5 MHz) using a 100 kHz RBW.

REMARKS:

PASS

EMISSIONS MEASUREMENTS

§15.247(b)& (d) Maximum Peak Output Power and Power Spectral Density

Minimum Standard – The maximum peak output power of the transmitter shall not exceed 1 watt equivalent to 36 dBm. There are four possible basic configurations for the wayside transmitters. During testing, the maximum EIRP was obtained for each antenna variation that was applicable to each configuration. In order to show compliance with the peak power output limit, the FCC has directed that power measurement for this application must be measured as EIRP and that the input power to the antenna, measured at the antenna input, must not exceed 1 watt as specified in Section 15.247. Radiated EIRP power and power spectral density measurements were taken at 3 meters using a substitution technique as required by the FCC for EIRP measurements. Conducted measurements were made using a power meter for peak power and a spectrum analyzer for power spectral density measurements. The FCC correspondence requiring the above measurement process has been submitted as an attachment to this application.

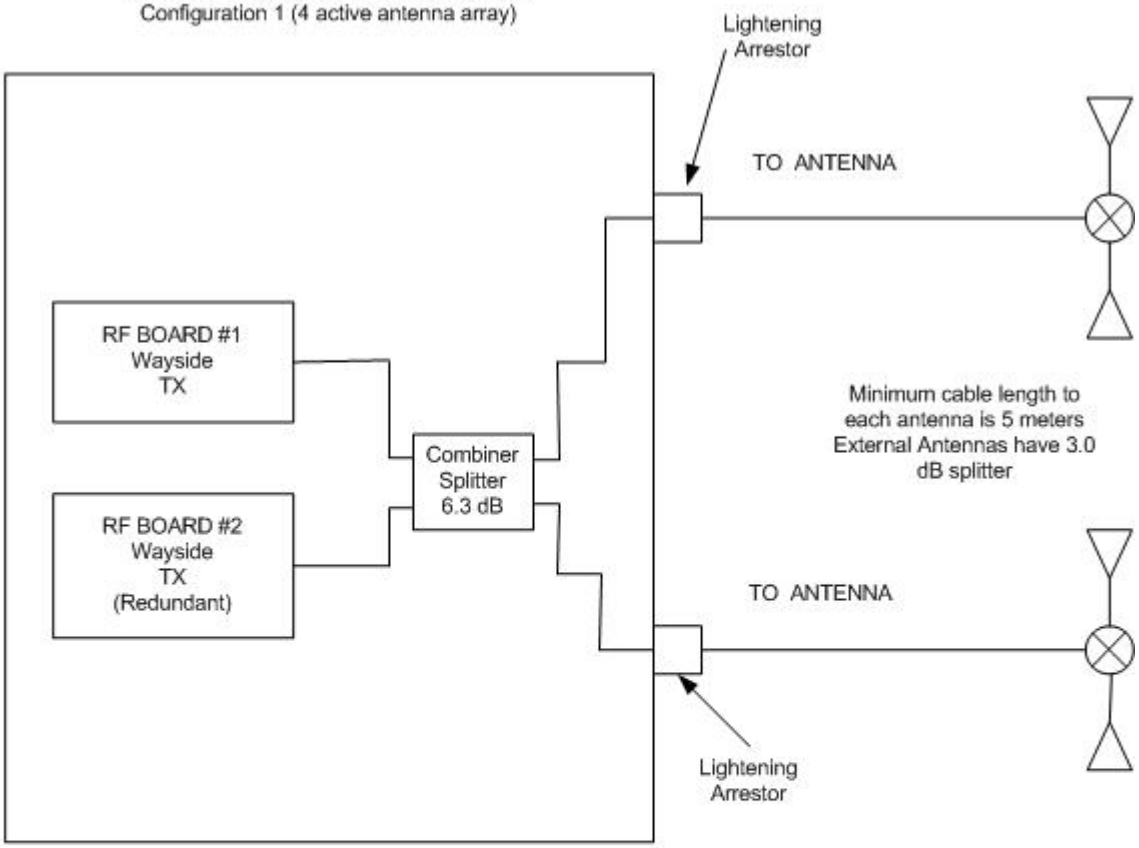
Antennas that can be used for some or all of the wayside configuration follow. The actual antennas used in each configuration are listed according to their gain in the EIRP power table for the configuration tested:

Gain dBi	Type	Manufacturer	Model
13.9	Yagi	Cushcraft	PC2415N
9	Horn	Astron	P-2409
6	Horn	Astron	P-2406
6	Omni	Maxrad	24006

Configuration 1

Following is configuration diagram No.1 for the wayside transmitter. If for any reason one antenna is removed, the unused RF port feeding that antenna will be terminated with a 50 ohm pad. Removal of an antenna will result in slightly lower values of EIRP. This will always be the case due to he maximizing process during testing whereby the antennas were manipulated and oriented, within the constraints of the permitted mounting variations, during testing to produce worst case results. Note that one RF board is a redundant board intended to provide backup service in the event the primary RF board fails.

WAYSIDE TRANSMITTER ENCLOSURE
Configuration 1 (4 active antenna array)



Each configuration 1 transmitter will conform to this specification. Nominal RF output power from each TX board is 27.5 dBm. Only one RF board can be active at one time. The second RF board is redundant and is only used in the event the primary RF output board fails. In this configuration back to back antennas will be mounted on different mast. The nominal loss in the RF combiner/splitter is 6.3 dB, lightening arrestor loss is approximately 0.1 dB and the nominal cable loss is 1.8 dB for a 5 meter length. Internal cables have 0.3 dB loss each for a total of 0.6 dB in each path. All wayside transmitter installations will have a minimum of 5 meters of antenna cable length and most will be longer. Compliance with all power levels is based on input power to the antenna as stipulated in the FCC interpretation letter that is part of this filing. For all antennas configurations, compliance with the EIRP limit is based on measurements made on an open area test site using the substitution technique as requested by the FCC.

Antennas in this configuration may be 13.9 dBi yagi, 9 dBi horn or 6 dBi horn. A few installations will use two 13.9 dBi yagi antenna and two 9 or 6 dBi horn antennas.

There are three variants of the above configuration. The basic configuration is with a 3 meter spacing between parallel back to back antennas mounted on mast approximately 4 meters high. Test for this configuration are presented in Table 3(a). Antennas that can be used in this configuration are listed according to gain with manufacturer and model number referenced in the preceding antenna table. With this configuration, one antenna from each back to back pair can be varied in azimuth angle approximately +/- 45 degrees. This angulation provides the antennas with the ability to "bend" the antenna pattern to maintain communications as the tunnels twist and turn through curves. The maximum possible angle variation was investigated by incrementing the angle in 5 degree steps to obtain maximum EIRP.

Power Measurements 3 meter Parallel

Frequency MHz	Antenna Gain dBi	Number of Antennas	Conducted Power to Antenna dBm	Attenuation Added dB	Power Reduced from nominal y/n	Measured EIRP dBm	System Type	Power Spec Den dBm
2408	13.9	4	15.7	0	n	30.4	Wayside	<1 dBm
2441	13.9	4	15.7	0	n	30.5	Wayside	<1 dBm
2474	13.9	4	15.7	0	n	30.3	Wayside	<1 dBm
2408	9	4	15.7	0	n	25.4	Wayside	<1 dBm
2441	9	4	15.7	0	n	25.5	Wayside	<1 dBm
2474	9	4	15.7	0	n	25.4	Wayside	<1 dBm
2408	6	4	15.7	0	n	22.4	Wayside	<1 dBm
2441	6	4	15.7	0	n	22.5	Wayside	<1 dBm
2474	6	4	15.7	0	n	22.4	Wayside	<1 dBm

Table 3 (a)

The first variant of the above parallel arrangement has the pair of back-to-back antennas mounted 10 meters apart. In this configuration, the antennas are normally mounted such that they are converging at an angle of approximately 15 degrees. In order to permit measurement of this configuration on a 10 meter test site, it was decided to actually aim both pair of antennas directly at the measurement antennas in order to maximize the reference level reading for determining EIRP. With this arrangement, one antenna from each back to back pair can be varied in azimuth angle approximately +/- 45 degrees. Maximum EIRP was obtained by varying the angle in 5 degree steps as above. This angulation provides the antennas with the ability to

"bend" the antenna pattern to maintain communications as the tunnels twist and turn through curves. Data for this variant is presented in Table 3(b).

Output Power Measurements 10 meter Converging

Frequency MHz	Antenna Gain dBi	Number of Antennas	Conducted Power to Antenna dBm	Attenuation Added dB	Power Reduced from nominal y/n	Measured EIRP DBm	System Type	Power Spec Den dBm
2408	13.9	4	15.7	0	n	33.0	Wayside	<1 dBm
2441	13.9	4	15.7	0	n	33.1	Wayside	<1 dBm
2474	13.9	4	15.7	0	n	33.0	Wayside	<1 dBm
2408	9	4	15.7	0	n	28.4	Wayside	<1 dBm
2441	9	4	15.7	0	n	28.5	Wayside	<1 dBm
2474	9	4	15.7	0	n	28.4	Wayside	<1 dBm
2408	6	4	15.7	0	n	25.5	Wayside	<1 dBm
2441	6	4	15.7	0	n	25.6	Wayside	<1 dBm
2474	6	4	15.7	0	n	25.4	Wayside	<1 dBm

Table 3(b)

The second variant of the basic parallel back-to-back configuration has the antenna pair mounted with a separation distance of 1 meter. In this variant the antennas are mounted so that they are slightly diverging, of the order of 10 degrees. With this arrangement, one antenna from each back to back pair can be varied in azimuth angle approximately +/- 45 degrees. In all arrangements, the forward facing antenna pair and the rearward facing antenna pair will maintain the 10 degree divergent pattern. This angulation provides the antennas with the ability to "bend" the antenna pattern to maintain communications as the tunnels twist and turn through curves. Table 3(c) contains the data for this variant. The maximum possible angle variation was investigated in 5 degree increments to obtain maximum EIRP.

Output Power Measurements 1 meter Diverging

Frequency MHz	Antenna Gain dBi	Number of Antennas	Conducted Power to Antenna dBm	Attenuation Added dB	Power Reduced from nominal y/n	Measured EIRP dBm	System Type	Power Spec Den dBm
2408	13.9	4	15.7	0	n	31.4	Wayside	<1 dBm
2441	13.9	4	15.7	0	n	31.6	Wayside	<1 dBm
2474	13.9	4	15.7	0	n	31.3	Wayside	<1 dBm
2408	9	4	15.7	0	n	26.5	Wayside	<1 dBm
2441	9	4	15.7	0	n	26.5	Wayside	<1 dBm
2474	9	4	15.7	0	n	26.4	Wayside	<1 dBm
2408	6	4	15.7	0	n	23.4	Wayside	<1 dBm
2441	6	4	15.7	0	n	23.5	Wayside	<1 dBm
2474	6	4	15.7	0	n	22.3	Wayside	<1 dBm

Table 3(c)

Test site measurement distance in all of the above measurements was 10 meters.

Configuration 2

Following is configuration diagram No.2 for the wayside transmitter. If for any reason one antenna is removed, the unused RF port feeding that antenna will be terminated with a 50 ohm pad. Removal of an antenna will result in slightly lower values of EIRP. This will always be the case due to he maximizing process during testing whereby the antennas were manipulated and oriented, within the constraints of the permitted mounting variations, during testing to produce worst case results. Note that one system is a redundant system intended to provide backup service in the event any component from RF board to antenna of the

system fails. Such an arrangement provides maximum security and safety for special applications in the subway train control system. Again, this configuration generally has a parallel antenna arrangement but may also have the previously defined convergent and divergent configurations.