EMISSIONS TEST REPORT

Report Number: 3098464BOX.001
Project Number: 3098464

Testing performed on the

Model: X200x-x10

To

FCC Part 15, Subpart G

For

Ambient Corporation

Test Performed by:	Test Authorized by:
Intertek – ETL SEMKO	Ambient Corporation
70 Codman Hill Road	79 Chapel Street
Boxborough, MA 01719	Newton, MA 02458

Prepared by: Vathana F. Ven Date: 7/14/06
Vathana F. Ven

Reviewed by: Roland W. Gubisch Date: 7-14-2006
Roland Gubisch

1.0 Job Description

1.1 Client Information

This EUT has been tested at the request of:

Company:	Ambient Corporation 79 Chapel Street Newton, MA 02458
Contact:	Aron Viner
Telephone:	(617) 614-6729
Fax:	(617) 332-7260
Email:	Aron.viner@ambient.corp.com

1.2 Equipment Under Test

Equipment Type:	X2 PLC NODE
Model Number(s):	X200x-x10
Serial number(s):	Prototype
Manufacturer:	Ambient Corporation
EUT receive date:	6/5/06
EUT received condition:	Engineering Prototype
Test start date:	6/5/06
Test end date:	6/29/06

1.3 Test Plan Reference: FCC Part 15, Subpart G

1.4 Test Configuration/Operating Voltage

The equipment under test (EUT) was configured with all 3 ports active and wireless module was installed. The EUT was operated at 115 Vac. Testing followed the procedures specified in Appendix C - Guidelines, FCC 04-245.

Special test conditions:

i) The EUT was tested at three overhead (mounting on the poles) and three underground locations (mounting on the pad transformer) which are~~is~~ typical installations. For the overhead testing locations, the distance between poles was at least 300 meters.

ii) The EUT was tested in the following four configurations and corresponding output power levels:
- On the overhead medium voltage (MV) line with the MV overhead inductive coupler model: 92-000X - 001.
- On the overhead low voltage (LV) line with the LV overhead capacitive coupler model: 62-000X - XXX. The coupling to the LV line was done differentially.
- On the underground MV line with the underground inductive coupler model: C – UGIC -1XX.
- On the underground LV line with the underground inductive coupler model: C – UGIC -1XX.

- The couplers are passive devices and they are part of the system, therefore, separate FCC certification is not required.

iii) The EUT was tested in two test modes. **Test mode 1** was from 2 to 29.99 MHz and **Test mode 2** was from 30-35 MHz, Test mode 1 and Test mode 2 represent the full band of operation.

iv) The output power level settings are corrected to be equal for 10, 20 and 30 MHz bands of operation (see output power plot).

v) During the test, the EUT was operated in head-end (HE) mode which was defined as the worst case scenario (1000 bursts/second, see burst rate plot).

vi) Prior to the field testing, the EUT was pre-scanned in the semi-anechoic chamber to identify the unwanted emissions from 30 MHz to 2 GHz.

vii) All overhead testing was performed at horizontal distance of 10 meters from the poles. Slant distances SL were calculated from the formula:

$$SL = [(\text{line height} - \text{antenna center height})^2 + (\text{horizontal distance})^2]^{1/2}$$

The corresponding distance correction factors CF were calculated according to:

$$CF = 40 \log_{10}(30m/SL) \text{ for frequencies below 30 MHz}$$

$$CF = 20 \log_{10}(10m/SL) \text{ for frequencies at and above 30 MHz}$$

All underground testing was performed at horizontal distance of 3 meters from the transformers due to the low levels of emissions. The overhead measurements were performed at 10 testing points for test mode 1 and 5 testing points for test mode 2. The underground measurements were performed at 16 testing points around the EUT.

All testing were performed with only one coupler connected at any given time.

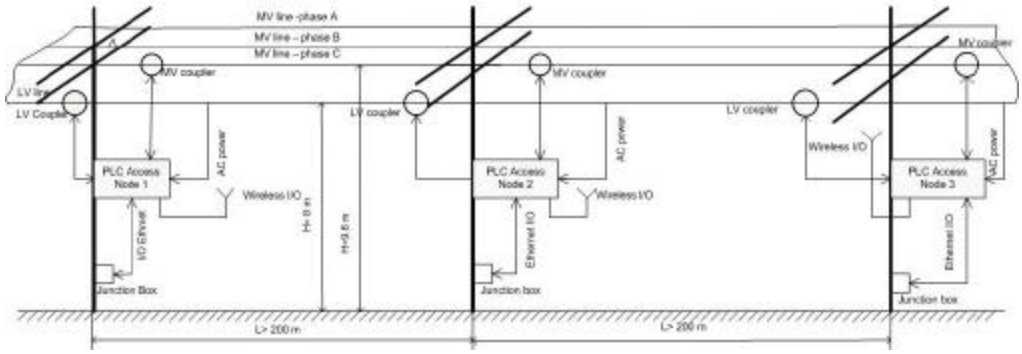
viii) For **Test mode 1**, active loop antenna which was mounted at 1.2 meter above ground on the non-conductive tripod was used to measure the emissions. The emissions were maximized by rotating the antenna 360°.

For **Test mode 2**, the log periodic antenna which was mounted on the mast was used. The emissions were maximized by raising and lowering the antenna from 1 to 4 meters in both polarizations.

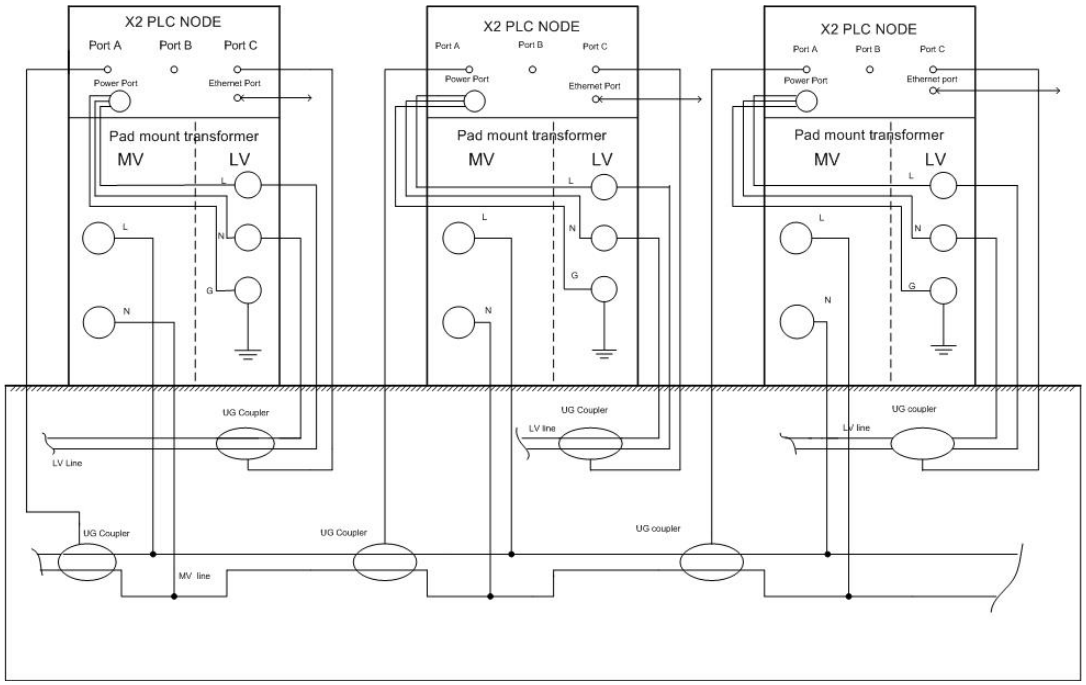
ix) During the radiated emissions scans, a 50 KHz sweep was used.

1.4.1 Block Diagram

Block – diagram 1: for testing X2 PLC NODE on the overhead lines



Block – diagram 2: for testing X2 PLC NODE on the underground lines



1.4.2. Cables:

Cable	Shielding	Connector	Length (m)	Qty.
Coaxial cable	Coax	Metal	>3	3
Power cable	None	Metal	>3	1
Ethernet cable	Foil	Metal	>3	1

1.4.3. Support Equipment:

None.

1.5 Mode(s) of Operation:

The EUT was tested in two test modes. **Test mode 1** was from 2 to 30 MHz and **Test mode 2** was from 30-35 MHz which was the full band of operation. Power setting was defined by appropriated test mode and configuration.

1.5a EUT Cycle Time: Not applicable.

1.6 Floor Standing Equipment: Applicable:____ Not Applicable:_X_

For floor standing equipment, 40cm RFI field uniformity data is located in the chamber equipment folder.

2.0 Test Summary

TEST STANDARD	RESULTS	
Basic Standards from FCC Part 15 Subpart G		
SUB-TEST	**TEST PARAMETER**	**COMMENT**
Emissions	Emissions below specified limits	Pass

Notes:

REVISION SUMMARY – The following changes have been made to this Report:

Date	Project No.	Project Handler	Page(s)	Item	Description of Change

3.0 Sample Calculations

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – AG - DF
Where FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB
DF = Distance factor

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 52.0 dBµV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBµV/m
DF = 14 dB

Level in µV/m = [10(18 dBµV/m)/20] = 7.9 µV/m

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBµV
RF = Reading from receiver in dBµV
LF = LISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBµV to µV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in µV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBµV
$UF = 10^{(48.1\ dB\mu V / 20)}$ = 254 µV/m

3.1 Measurement Uncertainty

The estimation of measurement uncertainty for emissions at a test site (OATS, sheltered site or semi-anechoic chamber) is well-documented in CISPR 16-4-2. Performing *in-situ* testing introduces additional uncertainties relating to characteristics of the site that vary from place to place and may not be stable with time:

— ground reflectivity

— reflections from or absorption by adjacent buildings and foliage

— differing overhead power cable geometries

— field strength roll-off characteristics

— large antenna-to-EUT uncertainty

— absorption and re-radiation of ambient and EUT emissions by long overhead power cables

— ambient emissions including transmitters, HV discharge, industrial noise and auto ignitions

— moisture level, affecting line loss and wooden pole dielectric

— RF resistance variation of ground connection

— changes in primary distribution loads

— capacitor bank switching

— secondary load variations from street lighting and premises.

—

The table below adopts the measuring instrument uncertainties from CISPR 16-4-2 and introduces factors to account for the unique factors introduced by *in-situ* testing. Such factors can only be an estimate.

RF Radiated Emissions *in-situ* Uncertainty Estimate, 10 m distance

Contribution	Probability distribution	9 kHz-30 MHz magnetic loop ± dB	30-100 MHz bilog ± dB
RECEIVER			
amplitude specification (2)	rectangular	1.5	1.5
input mismatch uncertainty (2)	U-shaped	1.0	1.0
SHIELDED CABLES			
cable loss calibration (1)	normal	0.1	0.2
ANTENNA			
antenna factor calibration (2)	rectangular	1.0	1.0
antenna factor frequency interpolation (2)	rectangular	0.3	0.3
mismatch uncertainty (2)	U-shaped	1.0	1.0
measurement distance variation (2)	rectangular	1.0	1.0
SITE			
ground reflectivity variations (3)	normal	1.5	2.0
reflections from structures (3)	normal	2.0	2.0
radiating cable geometry variations (4)	normal	2.0	2.0
field rolloff variations (1)	normal	2.0	1.0
cable absorption and re-radiation (4)	normal	2.0	1.0
measurements near ambient emissions (4)	normal	2.0	2.0
moisture effects (4)	normal	1.0	1.5
RF resistance variations of ground (4)	normal	1.0	1.0
primary load distribution changes (4)	normal	0.5	0.5
secondary load variations (4)	normal	0.5	0.5
Combined standard uncertainty $u_c(y)$	normal	2.94	2.81
Expanded uncertainty U	normal (k = 2)	5.88	5.62

Footnote Basis for estimate

1 Measured
2 Calculated from device calibration or specifications
3 Determined from mathematical modeling
4 Estimated from plausible limits of effect

3.2 Site Description

Test Site(s):

The X2 PLC NODE was tested in *situ* at the following locations:

a) The overhead testing was performed at 120, 178 and 234 Dalmeny Road, Briarcliff Manor, New York.
b) The underground testing was performed at Cedar Creek Lane (Pad 11), Cedar Trail (Pad 8) and Johnston Rd (Pad 1), Charlotte, NC.
c) The pre-scanned was performed in the Semi-anechoic Chambers at Intertek in Boxborough, MA

Test Results: Pass

Test Standard: Basic Standards from **FCC Part 15 Subpart G**

Test: Radiated emissions

Performance Criterion: N/A

Test Environment:

Environmental Conditions During Testing:	Humidity (%):	64	Pressure (hPa):	1003	Ambient (°C):	22
Pretest Verification Performed	Yes		Equipment under Test:		X2003-G10	

Maximum Test Disturbance Parameters: Readings below specified limits.

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	**Equipment Type**	**Make**	**Model No.**	**Serial No.**	**Next Cal. Due**
1	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	12/08/2006
2	ANTENNA	EMCO	3142	9711-1225	05/10/2007
3	CABLE, BNC/BNC	Alpha	RG58B/U	CBL210E	01/03/2007
4	Loop Antenna	EMCO	6502/1	9902-3267	02/20/2007
5	CABLE, BNC/BNC	Alpha	RG58B/U	CBL310E	01/03/2007
6	Loop Antenna	EMCO	6507	1283	01/10/2007
7	ANTENNA	Chase	CBL6112A	2245	05/09/2007
8	Analyzer	Hewlett Packard	HP8593E	3407A01055	04/18/2007
9	Pre-Amplifier	Mini-Circuit	ZKL-2	O011105	10/25/2006
10	Cable	Belden	RG-58	E13	05/12/2007

Software Utilized:

Name	Manufacturer	Version
EXCEL 2000	Microsoft Corporation	9.0.6926 SP-3
EMI BOXBOROUGH	Intertek	2/07/05 Revision

Test Results:

Radiated Emissions: overhead MV line with overhead MV inductive coupler

Company: Ambient Corporation
Model #: X2003-G10
Serial #: Prototype
Engineers: Vathana Ven
Project #: 20295599
Standard: FCC Part 15 Subpart G
Receiver: R&S ESCI (ROS002)
PreAmp: NONE.
Barometer: MAN1
Temp/Humidity/Pressure: 22C/64%/1003 mb
Location: In Field
Date(s): 06/05/06 06/13/06
Limit Distance (m): 30 & 10
Test Distance (m): 10

Antenna & Cables: LF Bands: N, LF, HF, SHF
LF Antenna: LOOP 6502/1 LOOP 6502/1
N Antenna: LOG4 5-10-07 V10.txt LOG4 5-10-07 H10.txt
HF Antenna: NONE. NONE.
SHF Antenna: NONE. NONE.
LF Cable(s): CBL210E 1-03-07.cbl NONE.
N Cable(s): CBL310E 1-03-07.cbl NONE.
HF Cable(s): NONE. NONE.
SHF Cable(s): NONE. NONE.

PreAmp Used? (Y or N): N Voltage/Frequency: 120 Vac/50 Hz Frequency Range: 2 MHz - 30 MHz
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Slant Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
QP	N/A	2.118	23.0	10.8	0.2	0.0	14.5	19.5	30.0	-10.5	9/30 kHz
QP	N/A	12.581	23.0	10.5	0.6	0.0	14.5	19.6	30.0	-10.4	9/30 kHz
QP	N/A	20.549	22.5	10.3	0.8	0.0	14.5	19.1	30.0	-10.9	9/30 kHz
QP	N/A	23.980	24.0	10.3	0.9	0.0	14.5	20.7	30.0	-9.3	9/30 kHz
QP	N/A	26.797	26.0	9.4	0.9	0.0	14.5	21.8	30.0	-8.2	9/30 kHz
QP	H	30.100	15.5	18.1	3.0	0.0	-1.6	38.2	39.1	-0.9	120/300 kHz
QP	H	30.610	12.0	17.8	3.0	0.0	-1.6	34.4	39.1	-4.7	120/300 kHz
QP	H	31.130	13.0	17.5	1.0	0.0	-1.6	33.1	39.1	-6.0	120/300 kHz

Radiated Emissions: overhead LV line with overhead LV capacitive coupler

Company: Ambient Corporation
Model #: X2003-G10
Serial #: Prototype
Engineers: Vathana Ven
Project #: 20295599
Standard: FCC Part 15 Subpart G
Receiver: R&S ESCI (ROS002)
PreAmp: NONE.
Barometer: MAN1
Temp/Humidity/Pressure: 22C/64%/1003 mb
Location: In Field
Date(s): 06/05/06 06/13/06
Limit Distance (m): 30 & 10
Test Distance (m): 10

Antenna & Cables: LF Bands: N, LF, HF, SHF
LF Antenna: LOOP 6502/1 LOOP 6502/1
N Antenna: LOG4 5-10-07 V10.txt LOG4 5-10-07 H10.txt
HF Antenna: NONE. NONE.
SHF Antenna: NONE. NONE.
LF Cable(s): CBL210E 1-03-07.cbl NONE.
N Cable(s): CBL310E 1-03-07.cbl NONE.
HF Cable(s): NONE. NONE.
SHF Cable(s): NONE. NONE.

PreAmp Used? (Y or N): N Voltage/Frequency: 120 Vac/50 Hz Frequency Range: 2 MHz - 30 MHz
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Slant Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
QP	N/A	4.179	25.0	10.8	0.3	0.0	16.2	19.9	30.0	-10.1	9/30 kHz
QP	N/A	18.680	19.0	10.3	0.8	0.0	16.2	13.9	30.0	-16.1	9/30 kHz
QP	N/A	19.139	14.0	10.3	0.8	0.0	16.2	8.9	30.0	-21.1	9/30 kHz
QP	N/A	22.577	13.0	10.3	0.8	0.0	16.2	7.9	30.0	-22.1	9/30 kHz
QP	N/A	23.360	15.0	10.3	0.9	0.0	16.2	10.0	30.0	-20.0	9/30 kHz
QP	N/A	24.296	19.0	10.3	0.9	0.0	16.2	14.0	30.0	-16.0	9/30 kHz

Notes:

Test Results:

Radiated Emissions: underground MV line with underground inductive coupler

Company:	Ambient Corporation			Antenna & Cables:	LF	Bands: N, LF, HF, SHF
Model #:	X2003-G10			LF Antenna:	EMCO 6507	EMCO 6507
Serial #:	Prototype			N Antenna:	Chase 2245	Chase 2245
Engineers:	Chris Capelle	Location:	In Field	HF Antenna:	NONE.	NONE.
Project #:	20295599	Date(s):	06/29/06	SHF Antenna:	NONE.	NONE.
Standard:	FCC Part 15 Subpart G			LF Cable(s):	CBL210E 1-03-07.cbl	NONE.
Receiver:	HP8593E	Limit Distance (m):	30 & 10	N Cable(s):	E13	E13
PreAmp:	ZKL-2 D052005	Test Distance (m):	3	HF Cable(s):	NONE.	NONE.
				SHF Cable(s):	NONE.	NONE.

PreAmp Used? (Y or N): N Voltage/Frequency: 120 Vac/50 Hz Frequency Range: 2 MHz - 2 GHz

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
QP	V	2.005	38.4	16.8	0.1	0.0	40.0	15.4	30.0	-14.6	9/30 kHz
QP	H	29.370	46.6	15.8	0.3	0.0	40.0	22.8	30.0	-7.2	9/30 kHz
QP	V	10.316	39.7	15.9	0.3	0.0	40.0	15.8	30.0	-14.2	9/30 kHz
QP	V	29.688	38.9	15.8	0.3	0.0	40.0	15.0	30.0	-15.0	9/30 kHz
QP	V	31.537	52.5	17.3	0.6	28.1	10.0	32.3	39.1	-7.3	120/300 kHz
QP	V	30.203	52.8	17.3	0.6	28.1	10.0	32.6	39.1	-7.0	120/300 kHz
QP	V	33.090	46.9	16.7	0.6	28.1	10.0	26.1	39.1	-13.5	120/300 kHz
QP	V	31.188	52.4	17.3	0.6	28.1	10.0	32.2	39.1	-7.4	120/300 kHz
QP	V	31.718	56.0	17.3	0.6	28.1	10.0	35.8	39.1	-3.2	120/300 kHz
QP	V	32.537	51.9	16.7	0.6	28.1	10.0	31.1	39.1	-8.5	120/300 kHz
QP	V	33.712	47.3	15.9	0.6	28.1	10.0	25.7	39.1	-13.9	120/300 kHz

Radiated Emissions: underground LV line with underground inductive coupler

Company:	Ambient Corporation			Antenna & Cables:	LF	Bands: N, LF, HF, SHF
Model #:	X2003-G10			LF Antenna:	EMCO 6507	EMCO 6507
Serial #:	Prototype			N Antenna:	Chase 2245	Chase 2245
Engineers:	Chris Capelle	Location:	In Field	HF Antenna:	NONE.	NONE.
Project #:	20295599	Date(s):	06/29/06	SHF Antenna:	NONE.	NONE.
Standard:	FCC Part 15 Subpart G			LF Cable(s):	CBL210E 1-03-07.cbl	NONE.
Receiver:	HP8593E	Limit Distance (m):	30&3	N Cable(s):	E13	E13
PreAmp:	ZKL-2 D052005	Test Distance (m):	3	HF Cable(s):	NONE.	NONE.
				SHF Cable(s):	NONE.	NONE.

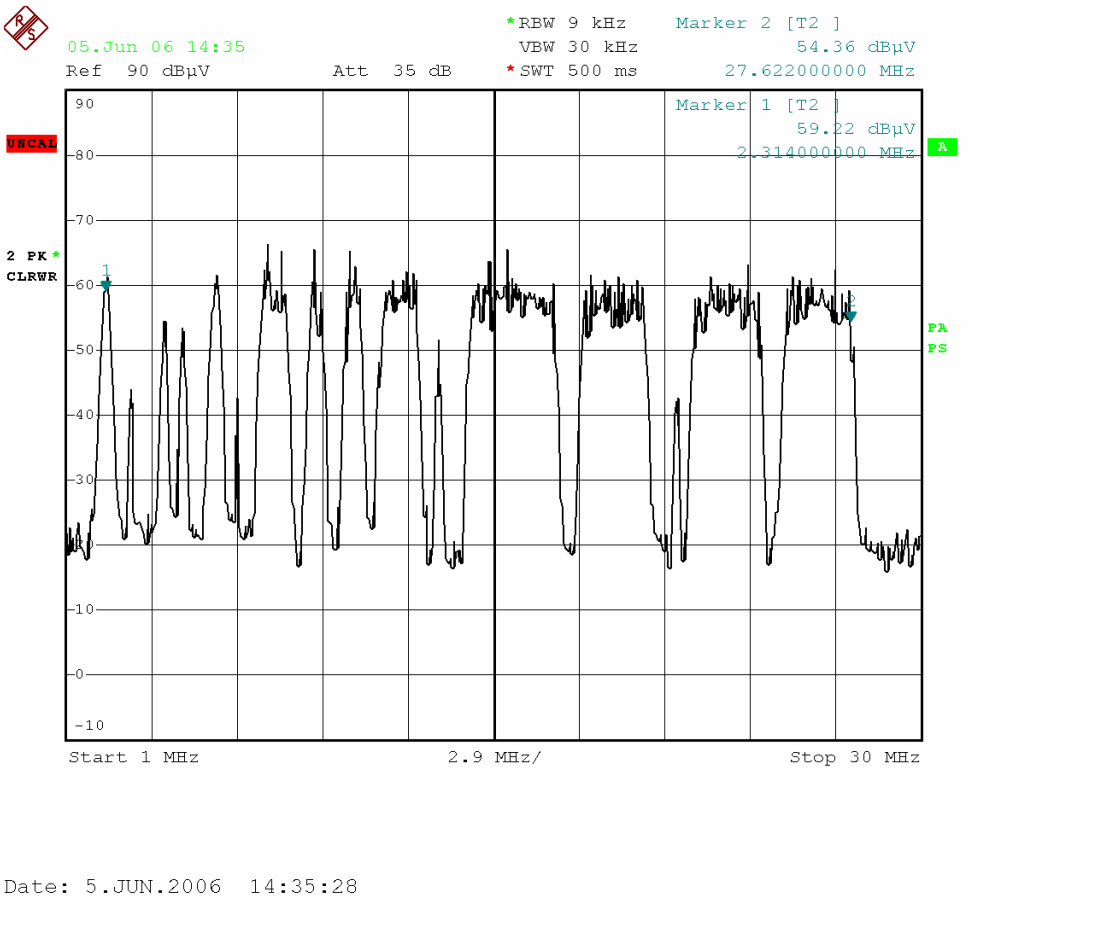
PreAmp Used? (Y or N): N Voltage/Frequency: 120 Vac/50 Hz Frequency Range: 2 MHz - 2 GHz

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
QP	H	2.005	38.4	16.8	0.1	0.0	40.0	15.4	30.0	-14.6	9/30 kHz
QP	V	17.765	39.6	16.2	0.3	0.0	40.0	16.0	30.0	-14.0	9/30 kHz
QP	V	10.316	39.7	15.9	0.3	0.0	40.0	15.8	30.0	-14.2	9/30 kHz
QP	H	29.370	46.6	15.8	0.3	0.0	40.0	22.8	30.0	-7.2	9/30 kHz
QP	V	29.688	38.9	15.8	0.3	0.0	40.0	15.0	30.0	-15.0	120/300 kHz
QP	H	29.690	41.4	15.8	0.3	0.0	40.0	17.5	30.0	-12.5	120/300 kHz
QP	V	31.718	56.0	17.3	0.6	28.1	0.0	45.8	39.1	-13.9	120/300 kHz
QP	V	32.516	37.2	16.7	0.6	28.1	0.0	26.4	39.1	-13.6	120/300 kHz
QP	V	30.191	39.8	17.3	0.6	28.1	0.0	29.6	39.1	-10.4	120/300 kHz

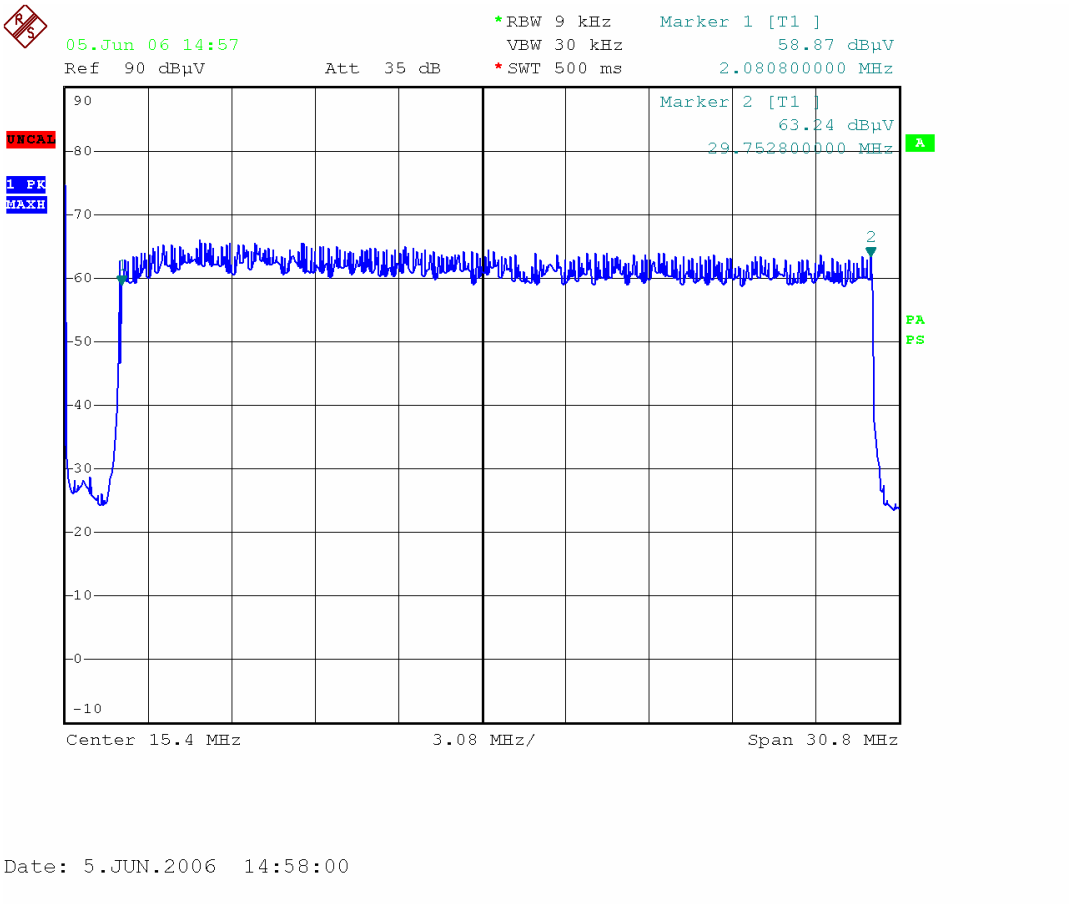
Test Results:

Test mode bandwidth plot for overhead MV and LV lines
Frequency band 2 – 29.99 MHz with "notches" in FCC excluded bands of operation and radio amateurs bands



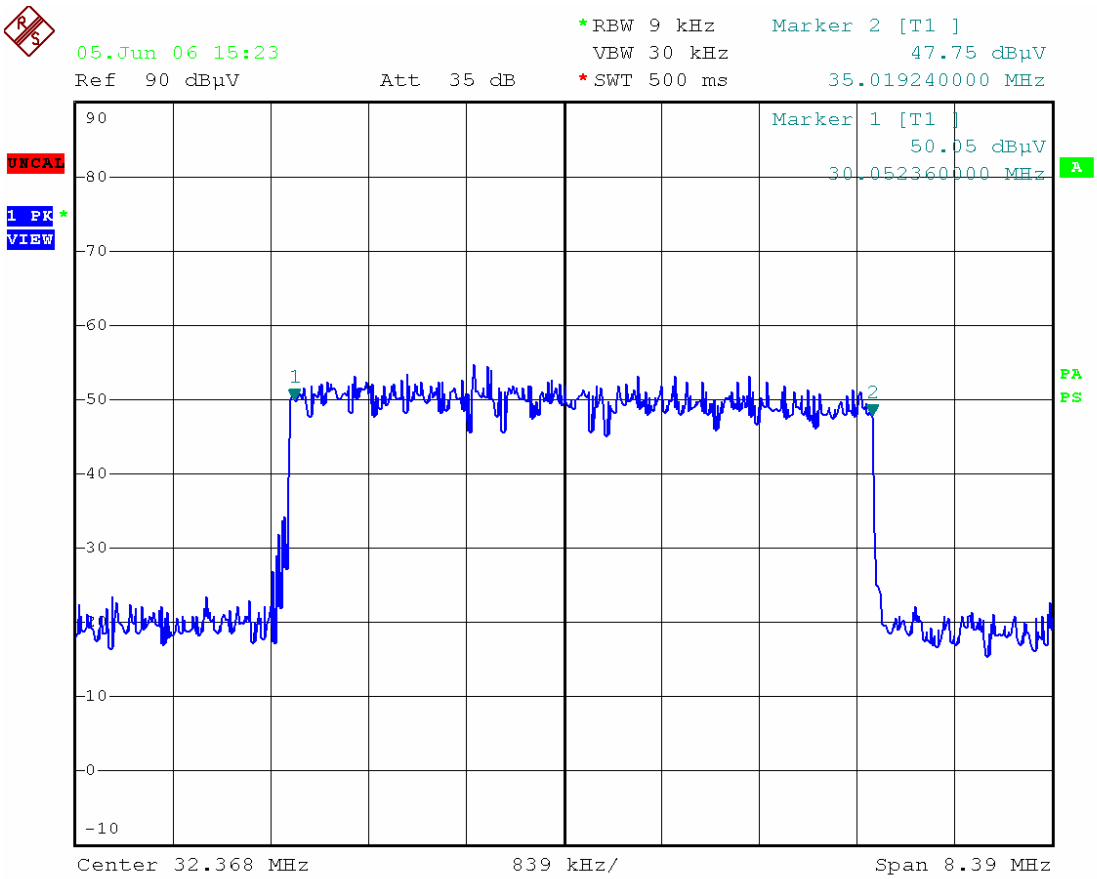
Test Results:

Test mode bandwidth plot for underground MV and LV lines
Frequency band 2 – 29.99 MHz



Test Results:

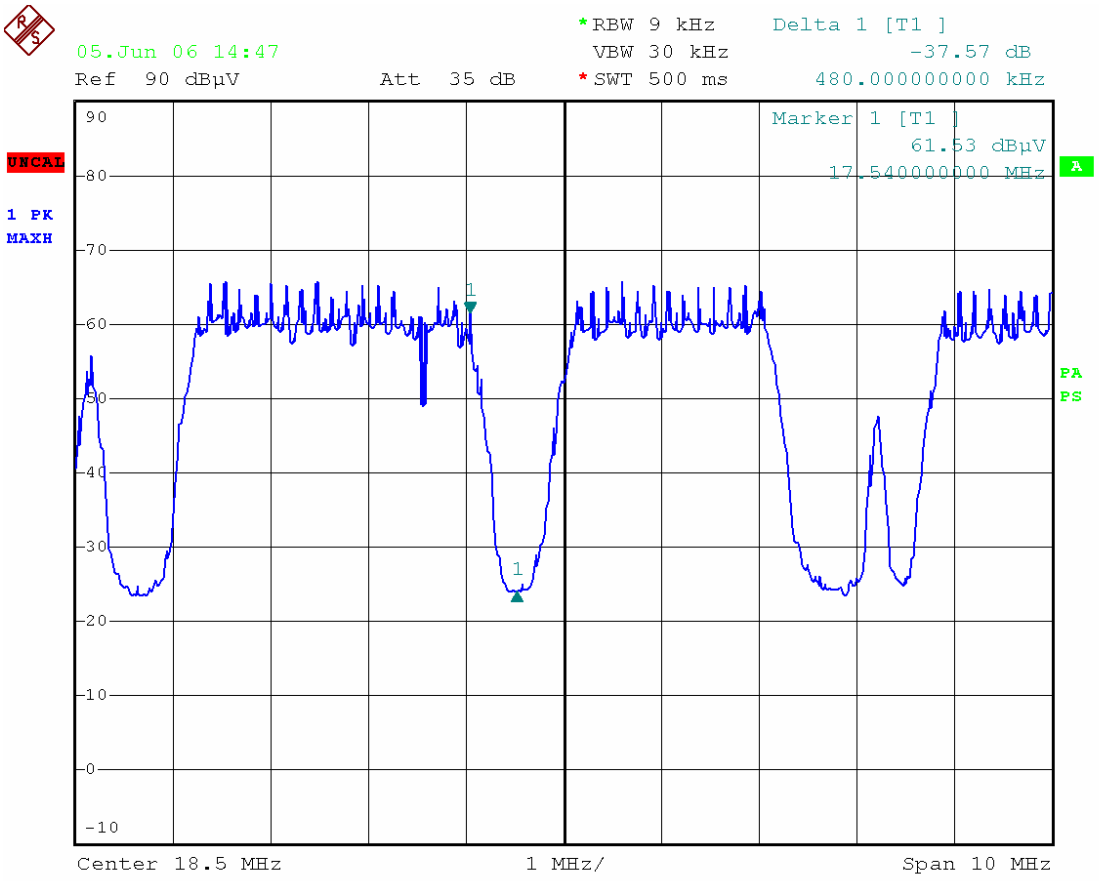
Test mode bandwidth plot for both overhead and underground MV and LV lines
Frequency band 30 - 35 MHz



Date: 5.JUN.2006 15:23:12

Test Results:

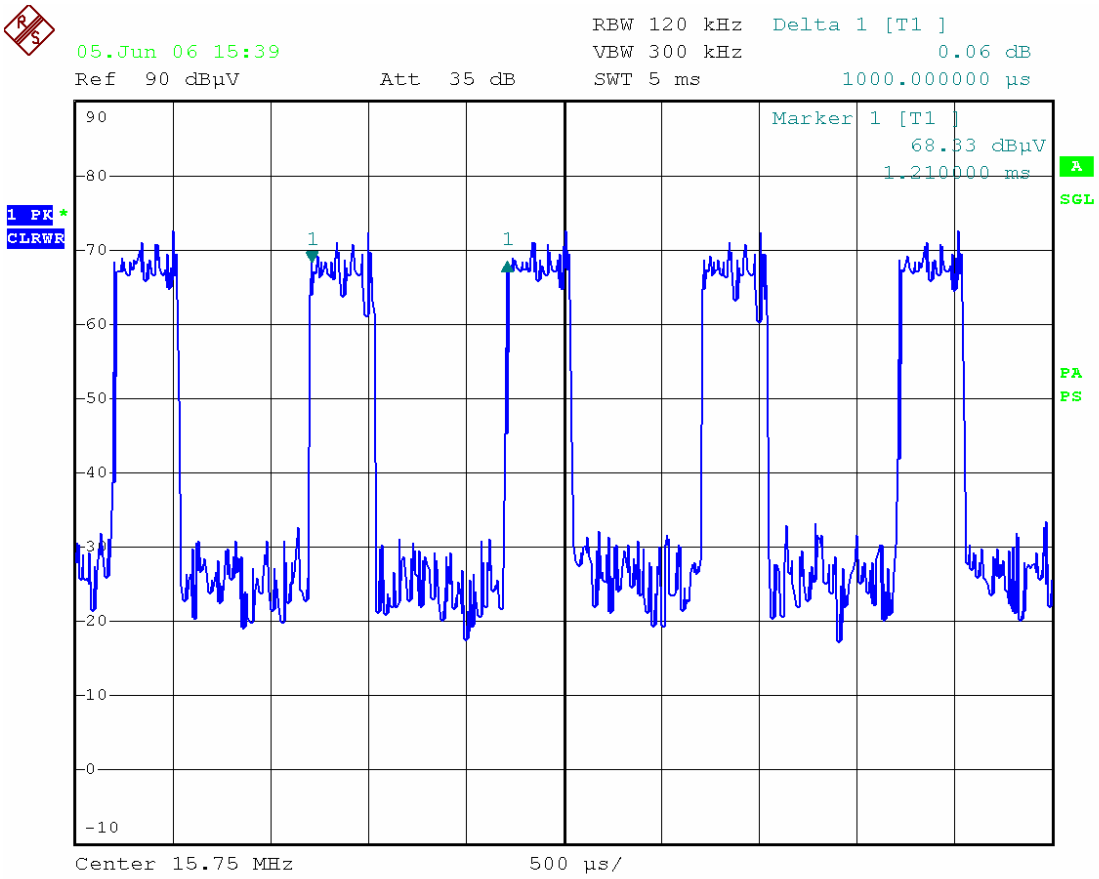
Depth of the notches in the frequency band 2 – 29.99 MHz



Date: 5.JUN.2006 14:47:45

Test Results:

Test mode worst-case burst rate plot



Date: 5.JUN.2006 15:39:20

Test Results:

Output power level for 10, 20 and 30 MHz band of operation (power levels are the same) with "notches" in FCC excluded bands of operation and radio amateurs bands