THE ELECTROMAGNETIC EMISSIONS ACCORDING TO

FCC PART 90, 1998
AND
FCC PART 15, SUBPART B, CLASS B, 1997

OF THE

BURGHARDT INC.
BU-1000 DATA TRANSCEIVER DATA TRANSCEIVER BOARD

PREPARED FOR

BURGHARDT INC.
710 10th STREET SW
P.O. BOX 73
WATERTOWN, SD 57201-0073

PREPARED BY

GLOBAL CERTIFICATION LABORATORIES, LTD.
4 MATTHEWS DRIVE
EAST HADDAM CT 06423

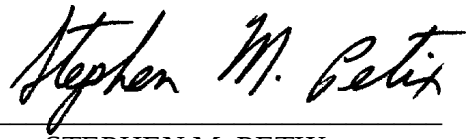
DATE RELEASED

2/14/00

FILE REF: BUR0001

SIGNATURE PAGE

THIS REPORT WAS PREPARED BY:



STEPHEN M. PETIX

TESTING WAS PERFORMED BY:

STEPHEN M. PETIX

THIS REPORT WAS REVIEWED BY:

JAMES COSTELLO

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INTRODUCTION

This report describes the results of electromagnetic emissions testing on the

BURGHARDT INC.
BU-1000 DATA TRANSCEIVER,

The Equipment Under Test. The EUT was subjected to the following tests:

FCC PART 90, using emission mask "C" and
FCC PART 15, SUBPART B, CLASS B.

The tests and measurements included in the standards above are:

TERMINAL DISTURBANCE VOLTAGES
(CONDUCTED EMISSIONS) ANALYSIS

RADIATED ELECTRIC FIELD EMISSIONS ANALYSIS
(EFFECTIVE RADIATED POWER &
ABSOLUTE FIELD STRENGTH MEASUREMENTS)

OCCUPIED BANDWIDTH

FREUENCY STABILITY DUE TO TEMPERATURE & POWER
VOLTAGE VARIATIONS

SPURIOUS EMISSIONS (MEASURED AS FIELD STRENGTHS AND
RELATIVE LEVELS AT ANTENNA TERMINALS)

TRANSIENT FREQUENCY RESPONSE

The FCC ID Code number of the BU-1000 DATA TRANSCEIVER is: OV2BU-1000
The results reported in this document relate only to the unit(s) tested.
All testing was performed at the facilities of

Global Certification Laboratories, Ltd.
East Haddam CT.

All test equipment calibration is N.I.S.T. traceable. This report contains detailed descriptions of the test procedures, test data and a written summary of the results. The report may not be reproduced, except in its entirety, without the permission of Global Certification Laboratories. This report contains 37 numbered pages, plus Title, Signature and Table of Contents Pages.

PRODUCT IDENTIFICATION

EQUIPMENT UNDER TEST (EUT): BURGHARDT INC.

MODEL:
BU-1000 DATA TRANSCEIVER
Three transceiver boards at the following frequencies were examined:
1) 173.203 MHz
2) 173.3125 MHz
3) 173.39625 MHz

SERIAL: NONE

DEVIATIONS FROM SPECIFICATIONS: NONE

EUT SUPPORT EQUIPMENT:

ENCLOSURE:
Consisting of a GENERAL ELECTRIC "Rr13%" power meter with a Meter Reading Unit (MRU) and pulse initiator included inside the meter housing.

DIPOLE ANTENNA:
½ wave resonant at 173 MHz.

OMNI-PRO SOFTWARE (Madison SD)
This software is used to control the MRU. This software defines the test modulation. The test modulation is representative of an actual condition with the exception that it is on continuously.

TECHNICAL DESCRIPTION
BURGHARDT INC.
BU-1000 DATA TRANSCEIVER

The BU-1000 DATA TRANSCEIVER is a low-power data transceiver board. It is used to communicate the electrical power consumption of a home or other facility to the local power company via a radio link. It uses the F2D emission type.

The BU-1000 is connected with two cables to a Meter Reading Unit or "MRU" board. One cable supplies +12 VDC power, while the second cable carries interface signals between the BU-1000 and MRU boards. The MRU is located in the power meter housing. An encoder that reads the rotation of the power meter dial is used to encode the meter movement to the MRU. The OMNI-PRO nonvolatile PROM code controls the MRU.

The BU-1000 is normally in a passive, receive mode. It is continually powered by the building mains power. When the local Power Company requires a meter reading, it transmits a wakeup signal to all BU-1000's in a 2 kilometer radius.

When a BU-1000 receives this signal with its integral ½ wave dipole, the MRU board encodes the meter reading with the pulse initiator/encoder and passes this information to the BU-1000. The BU-1000 then transmits the meter reading to the power company via the dipole antenna. If a customer is further than 2 kilometers from the company, repeater stations are used to relay the signal.

***

David Smith of BURGHARDT has supplied the following theory of operation:

RECEIVER SECTION

The receiver is a double conversion superhetrodyne design. When in receive mode, the signal is allowed to pass to Q1 RF AMP where it is amplified and sent to U1 for the first mix. X2 is a 3rd overtone crystal which is tripled by Q2 to produce the first mix frequency. The first mixer is located in U1 and produces a 10.7MHZ first IF. X1 produces the 2nd mix frequency of 10.245MHZ. It is mixed in U1 to produce a 455KHZ 2nd IF frequency. Receiver audio is then detected in U1 to produce RXA out.

TRANSMIT SECTION

Modulation is applied to D3 varactor and is used to shift the frequency of X201 to produce FM modulation. X201 is a 3rd overtone crystal. Its' frequency is tripled by Q241 to give the appropriate output frequency. It is then amplified by the Q242 pre-driver and Q243 final stages. It is passed through D440/441 switching when in the transmit mode and from there applied to the antenna.

TECHNICAL DESCRIPTION
BURGHARDT INC.
BU-1000 DATA TRANSCEIVER

BU-1000 SPECIFICATIONS:
GENERAL
FREQUENCY COVERAGE: 1 CHANNEL
(173.20375/173.21/173.2375/173.2625/173.2875/173.3125/173.3375/173.3625/
173.39/ OR 173.39625 MHz)
TX CURRENT DRAW: 250MA
RX CURRENT DRAW: 120MA
RECEIVER
SENSITIVITY: 10DB SINAD AT .8UV
AUDIO OUTPUT LEVEL: 2VPP AT 3KHZ DEVIATION
1ST IF FREQUENCY: 10.7 MHz
2ND IF FREQUENCY: 455 kHz
TRANSMITTER
POWER: 250MW

***

A single BU-1000 can only be configured for a single frequency. For this application, Testing was performed on the lowest, middle and highest frequencies of the entire frequency band. The performance of the BU-1000 at the following test frequencies is representative of what to expect over the entire frequency coverage range:
1: 173.20300 MHz
2: 173.31250 MHz
3: 173.39625 MHz

BU-1000 INSTALLATION
The BU-1000 has a 5 pin connector for hookup to the MRU(meter reading unit) modem and a BNC connector for connection to a half wave dipole. The pinout of the 5 pin connector is as follows.
1) PTT (push to talk)
2) 12V (regulated 12 volt input)
3) Mod in (modulation input)
4) RXA (receiver audio output)
5) GND (ground)

TECHNICAL DESCRIPTION
BURGHARDT INC.
BU-1000 DATA TRANSCEIVER

The BU-1000 has a two-pin connector to receive the +/-12 VDC power signal from the MRU. For all tests and measurements in this report, the ½ wave dipole and a short length of coax were soldered across the antenna terminals. The coax was used to directly measure the antenna signal with a spectrum analyzer. The impedance looking into the antenna port was 50 ohms. Therefore, no impedance matching network was needed for measurements directly connected to 50 ohm instrumentation.

The 173.2030, 173.3125 and 173.39625 MHz boards all underwent the same tests and measurements. The measurements included effective radiated power of the carrier, absolute field strength of spurious and unintentional emissions, occupied bandwidth and frequency stability under temperature & voltage variations and transient frequency response.

The EUT is used in the Private Land and Mobile Service bands specified by FCC Part 90. The authorized bandwidth of the BU-1000 DATA TRANSCEIVER is 20kHz.

All spurious and intentional radiated emissions are to meet emission mask "C" limits of FCC Part 90. All unintentional radiated emissions produced during the receive state are to meet FCC Part 15, Class B.

The EUT has a removable, external antenna. A BNC connector is used to connect the antenna to the BU-1000 transmitter. Only the dipole antenna design used for testing is acceptable for use with the BU-1000. The BU-1000 is to be installed and maintained by authorized personnel only.

This report will show that the EUT meets the Part 90 radiated power requirements, has a frequency stability of 5 ppm under temperature and power variations, has an acceptable transient frequency response and has an occupied bandwidth of 20 kHz, when transmitting.

The EUT is powered by 12 VDC from the MRU. The entire test vehicle is powered by 120 VAC at 60 Hz.

COMPLIANCE STATEMENT
BURGHARDT INC.
BU-1000 DATA TRANSCEIVER

The BU-1000 DATA TRANSCEIVER complies with the requirements of FCC PART 90, Subpart I, using Emission Mask "C," and FCC PART 15 Subpart B, CLASS B for conducted and radiated emissions, when configured with the following modifications:

1. Chip inductors L294 and L300 are changed to 1 uH and variable inductors L295 and L298 re-aligned.

2. A 173 MHz self-resonant dipole is used for sending and receiving messages instead of the original internal loop antenna.

3. The BU-1000 transmitter board is installed inside an enclosure made of ABS plastic, with its interior coated with a copper/nickel conductive coating. The MRU may be in this enclosure, or it may be in the meter enclosure, as was the case with the testing described in this report. The MRU made no significant addition to emissions.

The measurements in this report represent the maximum levels of emissions from the BU-1000 DATA TRANSCEIVER. The measurements and limits are discussed later in the report. Calibration of all instrumentation used in this test program is N.I.S.T. traceable.

The results reported in this document relate only to the unit(s) tested.

ANSI C63.4 and FCC Parts 2, 90 and 15 of the Code of Federal Regulations, Title 47 were consulted to insure the measurements are accurate and the test site correctly configured.

EMISSIONS TEST INSTRUMENTATION

The following instrumentation is used in emissions measurements. All test equipment calibration is N.I.S.T. traceable.

	Model	Serial	Last Cal.	Cal. Due
ADVANTEST Spectrum Analyzer	R3361A	91730394	3/14/99	3/14/00
ADVANTEST Preamplifier	R14601	93120019	1/20/00	1/20/01
ADVANTEST Preselector	R3551	92970013	N/A	N/A
AILTECH Log Periodic Antenna	90005/3146	1095	11/11/98	1/30/00
ELECTROMETRICS Horn Antenna	RGA-60	6139	N/A	N/A
EMCO Reference Dipole	3120 B-2	0043	N/A	N/A
EMCO Horn Antenna	3115	2498	N/A	N/A
FLUKE Digital Multimeter	76	6540398	4/11/99	4/11/00
GLOBAL Laboratories 3, 10 & 30 meter O.A.T.S.	N/A	N/A	11/6/99	1/30/00
HEWLETT PACKARD Spectrum Analyzer	8569B	2607A03112	8/25/99	8/25/00
KROHN-HITE 1kHz Oscillator	4300a	3357	2/5/98	2/5/01
MARCONI Signal Generator	2022C	52022-930X	4/26/99	4/26/00
RAYPROOF Shielded Room		4536	N/A	N/A
SCHWARZBECK 50 Ω Artificial Mains Network	NNLK 8121	8121245	1/4/00	1/04/01
SCHWARZBECK Biconical Antenna	VHA-9103	"A"	11/11/98	1/30/00
SCHWARZBECK RF Receiver 9KH to 30 MHz.	VUME 1518	1518167	2/11/99	2/11/00
SCHWARZBECK RF Receiver 30 to 1000 MHz	VUME 1520	1520427	2/11/99	2/11/00
STACO ENERGY PRODUCTS Variable Autotransformer	None	H-214	N/A	N/A

FCC PART 15, SUBPART B
TERMINAL DISTURBANCE VOLTAGES (CONDUCTED EMISSIONS)

FCC PART 15 Terminal Disturbance Voltage Tests are normally performed in an 8'x10'x15' shielded enclosure with filtered power supply lines. The EUT is configured per FCC Part 15, Subpart B to maximize emissions. A Radio Frequency test receiver, in accordance with CISPR 16 is used to measure disturbance voltages. An Artificial Mains Network (AMN), also in accordance with CISPR 16, is used to isolate the EUT from any interference on the power lines and to maintain a constant 50Ω/50μH impedance across the test bandwidth. Specific devices are noted on data pages.

The EUT is placed on a wooden table 0.8m high, located >0.4m from any wall of the shielded room and at least 0.8m from the AMN. Floor-standing EUTs are placed on a horizontal ground plane, which is not in contact with the reference ground. The EUT is connected to the AMN, which is supplied with the rated power of the EUT. If the EUT supply cord is >1m in length, it is shortened by bundling in a coil no longer than 0.4m. Ground wires are connected. Equipment with multiple power cords are connected per CISPR 16 or tested separately.

The frequency spectrum for the test is from 0.45MHz to 30.00MHz. The neutral and all phase lines are separately scanned for disturbance voltages.

The test spectrum is slowly scanned with the receiver in Quasi-Peak mode. When a disturbance signal is detected, it is observed for a minimum of 5 seconds. Frequency and amplitude are entered into an Excel spreadsheet, where the measurement is compared to limits.

Limits for Terminal Disturbance Voltages are:

	Freq. (MHz)	dB (μV) Quasi-Peak
CLASS A	0.45-1.705	60
	1.705-30.0	69.5
CLASS B	0.45-30.0	48

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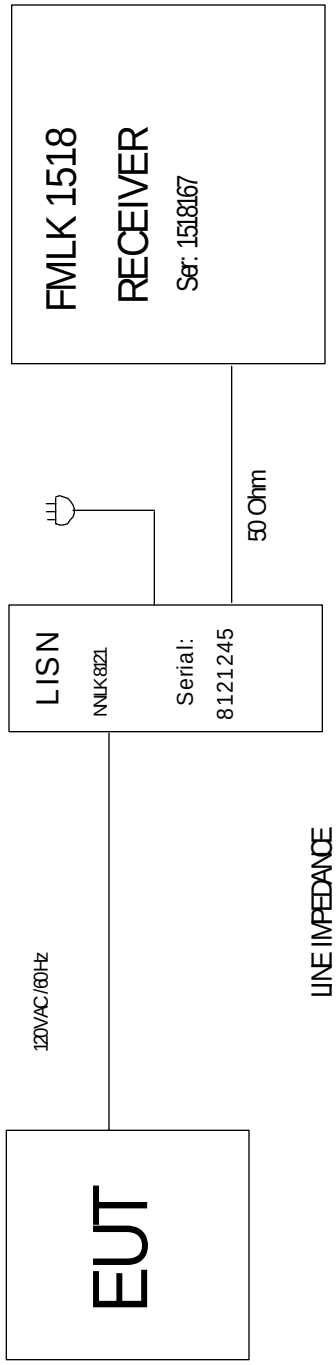
TERMINAL DISTURBANCE VOLTAGE TEST SET-UP



(EXCEPT WHERE EUT SIZE PROHIBITS, TESTING IS DONE IN A SHIELDED ROOM)

DATA TABLE EXPLANATION
TERMINAL DISTURBANCE VOLTAGE TEST

The DATA TABLE PAGES contain the following information:

TITLE: indicating the test performed
EUT
PERSON WHO PERFORMED THE TEST
TEST STANDARD(S)
DATE OF TEST
TEST SITE
TEST INSTRUMENTATION
NOTES
THE LINE UNDER TEST

The DATA TABLE headings are as follows:

FREQ. MHz	the FREQUENCY, in megahertz, at which a signal is detected.
QUASI-P dB(µV)	The QUASI-PEAK AMPLITUDE, in decibels per microvolt, of the signal.
LIMIT QUASI-P dB(µV)	The LIMIT, in decibels per microvolt, or picowatt, for the above signal.
PASS?	Is the signal acceptable under the standards? ("YES" or "NO")
MARGIN dB	The MARGIN, in decibels per microvolt, by which the EUT passes or fails.
AMPL AVER dB(µV)	The AVERAGE AMPLITUDE, in decibels per microvolt, of the signal.
LIMIT AVER dB(µV)	The LIMIT, in decibels per microvolt, for the above signal.
PASS?	Is the signal acceptable under the standards? ("YES" or "NO")
MARGIN dB	The MARGIN, in decibels, by which the EUT passes or fails.

TERMINAL DISTURBANCE VOLTAGE DATA

TERMINAL DISTURBANCE VOLTAGES DETECTED FROM 0.45MHz - 30MHz
FOR FCC PART 15, SUBPART B, CLASS B.

FILE: BUR9901
EUT NAME: BU-1000 DATA TRANSCEIVER

THE EUT IS A 173 MHz TRANSCEIVER TO BE MOUNTED ON ELECTRIC POWER METERS. THE BU-1000 WILL REPORT THE ELECTRICAL USAGE TO THE LOCAL ELECTRIC POWER COMPANY VIA A 173 MHz RF LINK WHEN QUERIED.

THE EUT IS POWERED BY 120 VAC, 60 Hz.
THE EUT IS NOT SERIALIZED.
CUSTOMER REPRESENTATIVE: DAVE J. SMITH (not present)

MEASURED BY JACK ROGERS ON 12/08/99 & 2/5/00 TO FCC PART 15, SUBPART B, CLASS B IN AN 8'x10'x15' SHIELDED ROOM UTILIZING A SCHWARZBECK ARTIFICIAL MAINS NETWORK MODEL NNLK8121 AND A SCHWARZBECK INTERFERENCE RECEIVER MODEL FMLK 1518.

In all the measurements below, the EUT is transmitting a modulated test signal programmed in the MRU. Trial measurements showed that this represents the highest conducted emissions available from the EUT.

Three BU-1000 boards have been made, they are each operating at one of the three frequencies.

Continued on next page.

TERMINAL DISTURBANCE VOLTAGE DATA

The 173.2030 MHz BU-1000 board is measured first.

TESTING NEUTRAL LINE :

FREQ. (MHz)	AMPL QUASI-P dB(µV)	AMPL + LISN LOSSES dB(µV)	LIMIT QUASI-P dB(µV)	PASS?	MARGIN dB
0.45	32.0	32.11	48	YES	15.9
7.30	14.0	14.06	48	YES	33.9
14.30	18.0	18.61	48	YES	29.4
24.00	18.0	20.30	48	YES	27.7
30.00	5.0	8.05	48	YES	40.0
ALL OTHER FREQUENCIES BELOW LIMITS					

TESTING LINE1:

FREQ. (MHz)	AMPL QUASI-P dB(µV)	AMPL + LISN LOSSES dB(µV)	LIMIT QUASI-P dB(µV)	PASS?	MARGIN dB
0.45	36.0	36.11	48	YES	11.9
0.20	35.0	35.11	48	YES	12.9
18.60	13.0	14.48	48	YES	33.5
ALL SIGNALS ARE BELOW 10 dBuV.					
30.00	0.0	3.05	48	YES	45.0
ALL OTHER FREQUENCIES BELOW LIMITS					

Continued on next page.

TERMINAL DISTURBANCE VOLTAGE DATA

The 173.3125 MHz BU-1000 board is measured.

TESTING NEUTRAL LINE :

FREQ. (MHz)	AMPL QUASI-P dB(µV)	AMPL + LISN LOSSES dB(µV)	LIMIT QUASI-P dB(µV)	PASS?	MARGIN dB
0.45	34.0	34.11	48	YES	13.9
7.00	12.0	12.06	48	YES	35.9
7.30	32.0	32.06	48	YES	15.9
12.25	25.0	25.61	48	YES	22.4
14.31	33.0	33.61	48	YES	14.4
20.00	39.0	40.67	48	YES	7.3
28.00	32.0	33.40	48	YES	14.6
28.80	32.0	33.40	48	YES	14.6
29.90	13.0	15.40	48	YES	32.6
ALL OTHER FREQUENCIES BELOW LIMITS					

TESTING LINE1:

FREQ. (MHz)	AMPL QUASI-P dB(µV)	AMPL + LISN LOSSES dB(µV)	LIMIT QUASI-P dB(µV)	PASS?	MARGIN dB
0.45	32.0	32.11	48	YES	15.9
8.00	30.0	30.06	48	YES	17.9
12.00	27.0	27.61	48	YES	20.4
12.29	23.0	23.61	48	YES	24.4
14.32	34.0	34.61	48	YES	13.4
16.00	28.0	29.16	48	YES	18.8
19.00	30.0	31.67	48	YES	16.3
20.00	38.0	39.67	48	YES	8.3
30.00	12.0	15.05	48	YES	33.0
ALL OTHER FREQUENCIES BELOW LIMITS					

Continued on next page.

TERMINAL DISTURBANCE VOLTAGE DATA

The 173.39625 MHz BU-1000 board is measured.

TESTING NEUTRAL LINE :

FREQ. (MHz)	AMPL QUASI-P dB(µV)	AMPL + LISN LOSSES dB(µV)	LIMIT QUASI-P dB(µV)	PASS?	MARGIN dB
0.45	27.0	27.11	48	YES	20.9
7.00	10.0	10.06	48	YES	37.9
7.30	0.0	0.06	48	YES	47.9
12.25	30.0	30.61	48	YES	17.4
14.31	35.0	35.61	48	YES	12.4
20.00	38.0	39.67	48	YES	8.3
28.00	32.0	33.40	48	YES	14.6
28.80	12.0	13.40	48	YES	34.6
29.90	12.0	14.40	48	YES	33.6
ALL OTHER FREQUENCIES BELOW LIMITS					

TESTING LINE1:

FREQ. (MHz)	AMPL QUASI-P dB(µV)	AMPL + LISN LOSSES dB(µV)	LIMIT QUASI-P dB(µV)	PASS?	MARGIN dB
0.45	23.0	23.11	48	YES	24.9
7.37	33.0	33.06	48	YES	14.9
12.00	26.0	26.61	48	YES	21.4
12.29	24.0	24.61	48	YES	23.4
14.32	34.0	34.61	48	YES	13.4
16.00	25.0	26.16	48	YES	21.8
19.00	28.0	29.67	48	YES	18.3
20.00	37.0	38.67	48	YES	9.3
30.00	11.0	14.05	48	YES	34.0
ALL OTHER FREQUENCIES BELOW LIMITS					

THE BURGHARDT BU-1000 MEETS THE CONDUCTED EMISSION REQUIREMENT OF FCC PART 15 FOR CLASS B WITHOUT MODIFICATIONS.

IT ACHIEVES THIS WHILE IT IS IN THE TRANSMITTING OR RECEIVING MODES.

EMI TEST PROCEDURES
FCC PART 15, SUBPART B
UNINTENTIONAL RADIATED E-FIELD EMISSIONS

Unintentional emissions may be produced whenever the EUT is in the receive state. FCC Part 15 is used to evaluate them. Part 15 radiated measurements are performed on an open field test site with a metal ground plane, which conforms to specifications in CISPR 16. At Global Laboratories, our 3 & 10m test site is sheltered with a pegged post-and-beam wooden building. The EUT is positioned on a remotely controlled turntable to permit emission measurements from all sides of the EUT. The EUT is configured per FCC Part 15 to maximize emissions.

A Radio Frequency test receiver, in accordance with CISPR 16 is used to measure radiated emissions. Antenna height is variable between 1 and 4 meters for maximum signal reception. An antenna-to-EUT separation of 3 (Class B), or 10 (Class A) meters is established. Broadband antennas are used in both horizontal and vertical attitudes for maximum signal reception.

Emissions are first examined with a spectrum analyzer in Peak mode to isolate EUT-generated signals from the ambient. Signals are then measured with a Quasi-Peak receiver conforming to CISPR 16 and compared to limits. Antenna factors and cable loss are calculated in a computer spreadsheet.

Limits for radiated emissions are:

	Freq. (MHz)	dB(μV/m) Quasi-Peak
Class A	30-88	39
(@ 10m)	88-216	43.5
	216-960	46.4
	960-1000	49.5
Class B	30-88	40
(@3m)	88-216	43.5
	216-960	46
	960-1000	54

EMI TEST PROCEDURES
FCC PART 90
EFFECTIVE RADIATED POWER &
INTENTIONAL/SPURIOUS RADIATED EMISSION MEASUREMENTS

The effective radiated power (ERP) emission measurements use a substitution method. The ERP measurements are used to determine the radiated power of the fundamental carrier as well as the limit of any spurious emissions produced by the EUT whenever it is transmitting. Spurious emissions are those emissions, other than the carrier, that appear when the transmitter is operating.

Measurements are performed in the open area test site (OATS) normally used to measure unintentional emission. The OATS uses a metal ground plane that conforms to specifications in CISPR 16 and ANS C63. In most projects, the 1 and 3 meter test sites are used. A frequency range of 9 kHz to the 10^{th} harmonic of the fundamental carrier frequency is evaluated.

The EUT is positioned with the radiating element oriented normally and 1.5 meters above a metal ground plane. The radiating element can be an integral or external antenna, used to project the transmission signal. The test antenna is oriented to receive the maximum level of the fundamental carrier signal. Horizontal and vertical antenna polarities are used. The maximum carrier signal level is stored in a spectrum analyzer channel.

After this is done, the EUT is removed from the measurement site and replaced with a reference dipole antenna. The reference antenna element lengths are adjusted for ½ wave resonance at the carrier frequency. Then it is located in the former EUT position.

A signal generator and amplifier/preamplifier (if necessary) are used to inject a signal into the dipole. Using the second channel of the spectrum analyzer, the signal generator output is adjusted until the same emission level is produced from the dipole as what was produced from the EUT.

The effective radiated power (ERP) produced by the EUT is calculated from the power generated by the signal generator/amplifier/pre-amplifier and factoring in the cable losses and antenna gain factors.

EMI TEST PROCEDURES
FCC PART 90
EFFECTIVE RADIATED POWER EMISSION & INTENTIONAL/SPURIOUS RADIATED EMISSION MEASUREMENTS

The limits all spurious emissions must meet are calculated from formulas stated in the standard. The formulas depend on the type of emission (i.e. F3E), the carrier frequency and the authorized bandwidth for the carrier. The limits are in terms of decibels below the ERP of the carrier frequency. The limit formulae are called "emission masks."

For example, emission mask "C" of Part 90 uses a limit formula of 43 + 10 log P, where P is the effective radiated power of the EUT in watts. Any frequency more than 250% removed from the authorized bandwidth is to be reduced in dB calculated with this formula.

For convenience, the maximum allowable level of the spurious emissions calculated by the emission mask formula is replicated with the same signal source/reference dipole antenna combination that was used to measure the ERP.

The receiver reading obtained is converted to an absolute field strength value as in conventional EMC measurements.

All spurious emissions measurements are performed with the carrier signal modulated. The modulation is representative of actual EUT operation unless specifically defined in the standard. The ERP calculation is based on measurements performed with an unmodulated carrier signal.

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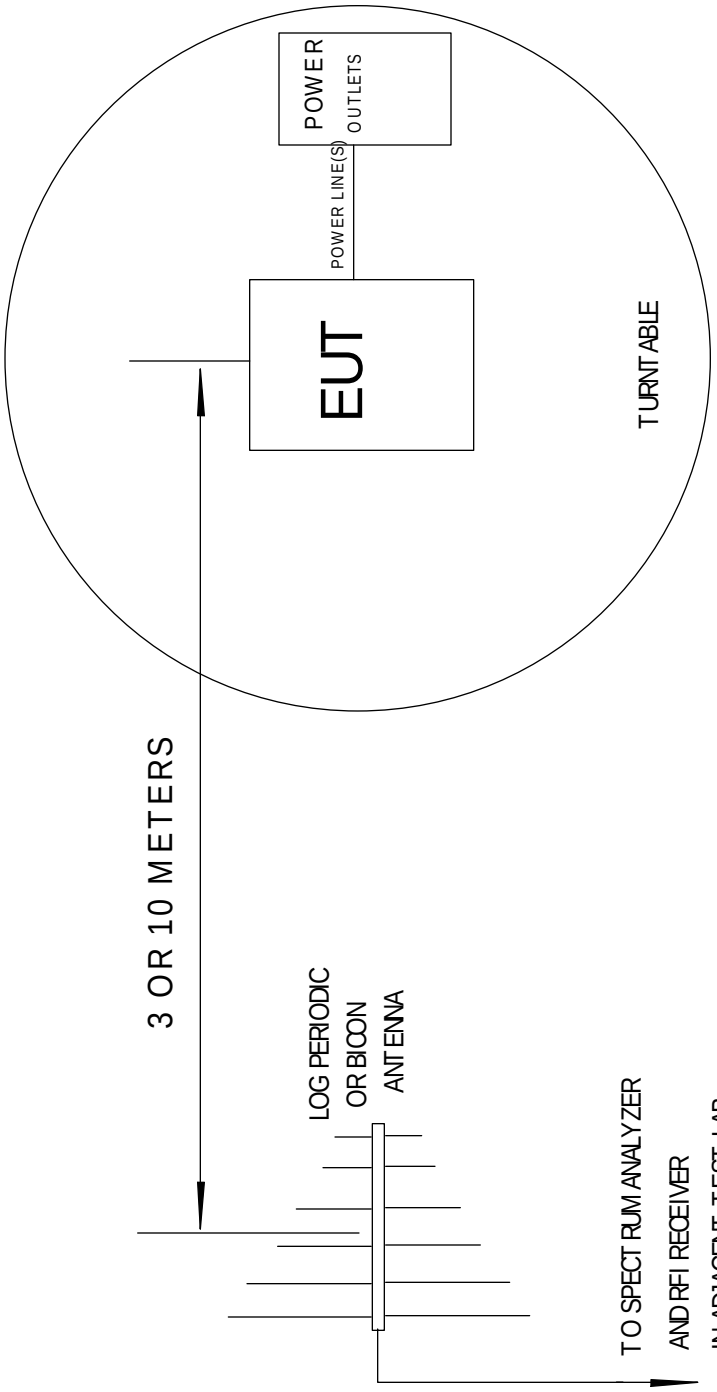
RADIATED EMISSIONS TEST SET-UP

TURNTABLE AND ANTENNA ARE LOCATED
IN A POST-AND-BEAM WOODEN "BARN"



DATA TABLE EXPLANATION
RADIATED ELECTRIC EMISSIONS TESTS

The DATA TABLE PAGES contain the following information:

TITLE: indicating the test performed
EUT
PERSON WHO PERFORMED THE TEST
TEST STANDARD(S)
DATE OF TEST
TEST SITE
TEST INSTRUMENTATION
NOTES

The DATA TABLE headings are as follows:

FREQ. MHz	The FREQUENCY, in megahertz, at which a signal is detected.
AMPL QUASI-P dB(µV)	The QUASI-PEAK AMPLITUDE, in decibels microvolt, of the signal.
AMPL PEAK dBm	The PEAK AMPLITUDE, in decibels milliwatt, of the signal.
AZIMUTH DEGREES	Approximate turntable position with respect to the antenna (mostly for diagnostics).
CABLE LOSS	Insertion loss due to the transmission line between the antenna and the measuring set. Measured in dB.
ANTENNA FACTORS dB /m	Convert measured antenna voltage to units of field strength, also account for antenna's loss receiving the radiated signal.
TOTAL FIELD dB(µV/m)	the sum of the received signal at the measuring set, plus cable and antenna losses.
EFFECTIVE RADIATED POWER	the power supplied to an antenna multiplied by the gain of the antenna in linear units. The gain is added if dB units are used. The units may be in dBm or mW.
LIMIT QUASI-P dB(µV/m)	the LIMIT, in decibel microvolt per meter, for the above signal
PASS?	Is the signal acceptable under the standards? ("YES" or "NO")
MARGIN	the MARGIN, in decibels, by which the EUT passes or fails.

RADIATED EMISSIONS TEST DATA

RADIATED EMISSIONS DATA USING FCC PARTS 90 & 15 LIMITS FOR CLASS B EQUIPMENT AT A 3 METER EUT TO ANTENNA DISTANCE.

FILE: BUR9901
BU-1000: BU-1000 DATA TRANSCEIVER

THE EUT IS A 173 MHz TRANSCEIVER TO BE MOUNTED ON ELECTRIC POWER METERS. THE BU-1000 WILL REPORT THE ELECTRICAL USAGE TO THE LOCAL ELECTRIC POWER COMPANY VIA A 173 MHz RF LINK WHEN QUERIED.

THE EUT IS POWERED BY 120 VAC, 60 Hz.
THE EUT IS NOT SERIALIZED.
CUSTOMER REPRESENTATIVE: DAVE J. SMITH (not present)

MEASURED BY STEVE PETIX IN JANUARY 2000 TO FCC PARTS 90 & 15 FOR CLASS B EQUIPMENT USING THE 3 AND 1 METER OPEN AREA TEST SITES, (OATS).

THE EUT MEASURING ANTENNAS ARE:
A SCHWARZBECK MODEL VHA9103 BICONICAL ANTENNA, (s/n: A) IS USED FOR 30 TO 300 MHz.
AN AILTECH MODEL 96005, (s/n 1095), LOG PERIODIC ANTENNA IS USED FOR 300 TO 1000 MHz.
AN EMCO MODEL 3115 s/n 2498 GUIDED RIDGE HORN ANTENNA IS USED FOR 1 TO 18 GHz.

THE SUBSTITUTION ANTENNAS ARE:
EMCO DIPOLE "B" FOR 40 TO 400 MHz.

THE ANTENNAS ARE FACING THE METER FACE IN ORDER TO OBTAIN FREQUENCIES OF INTEREST. ONCE FOUND, THEY WILL BE MAXIMIZED BY ANTENNA HEIGHT SCANS.

A QUASI-PEAK RFI RECEIVER IS USED FOR MEASUREMENTS BELOW 1000 MHz.
A MICROWAVE SPECTRUM ANALYZER IN PEAK MODE IS USED FOR MEASUREMENTS ABOVE 1000 MHz.

The BU-1000 is in a constant transmission mode for the Part 90 measurements.
The signal is unmodulated when the effective radiated power of the carrier frequency is measured.
The transmitter carrier is modulated by a representative modulating signal installed by the manufacturer when the spurious emissions are measured.
The EUT is designed to use a 20 kHz channel bandwidth.

The EUT transmitter effective radiated power is measured with the 173.203 MHz board using a substitution method. This calculation will be the basis for the radiated limits used for the spurious emissions.

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RADIATED EMISSIONS TEST DATA

The green jumper wire is removed so the BU-1000 is no longer transmitting. This is the normal state, where it is always powered and waiting for an RF activation signal. The BU-1000 dipole is oriented vertically and two meters off the ground plane. In practice, the antenna will be 2 meters above the Earth and vertical. FCC Class B limits are used because of the domestic environment the EUT will likely be used in.

THE 30 TO 300 MHz ANTENNA IS VERTICAL AND AT 3 METERS.

FREQ. (MHz)	AMPL QUASI-P dB(μV)	AZIMUTH DEGREES	CABLE LOSS dB(μV)	ANTENNA FACTORS dB	TOTAL FIELD dB(μV/m)	LIMIT QUASI-P dB(μV)	PASS?	MARGIN dB
54.21	23	180	1.08	9.95	34.03	40	YES	5.97
108.44	25	180	2.02	11.03	38.05	43.5	YES	5.45
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

THE 30 TO 300 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.

FREQ. (MHz)	AMPL QUASI-P dB(μV)	AZIMUTH DEGREES	CABLE LOSS dB(μV)	ANTENNA FACTORS dB	TOTAL FIELD dB(μV/m)	LIMIT QUASI-P dB(μV)	PASS?	MARGIN dB
54.21	11	180	1.08	9.95	22.03	40	YES	17.97
108.44	18	135	2.02	11.03	31.05	43.5	YES	12.45
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

THE 300 TO 1000 MHz ANTENNA IS VERTICAL AND AT 3 METERS.

FREQ. (MHz)	AMPL QUASI-P dB(μV)	AZIMUTH DEGREES	CABLE LOSS dB(μV)	ANTENNA FACTORS dB	TOTAL FIELD dB(μV/m)	LIMIT QUASI-P dB(μV)	PASS?	MARGIN dB
NO SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

THE 300 TO 1000 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.

FREQ. (MHz)	AMPL QUASI-P dB(μV)	AZIMUTH DEGREES	CABLE LOSS dB(μV)	ANTENNA FACTORS dB	TOTAL FIELD dB(μV/m)	LIMIT QUASI-P dB(μV)	PASS?	MARGIN dB
NO SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

THE 1 to 18 GHz ANTENNA IS VERTICAL AND AT 3 METERS.

FREQ. (MHz)	AMPL QUASI-P dB(μV)	AZIMUTH DEGREES	CABLE LOSS dB	ANTENNA FACTORS dB	TOTAL FIELD dB(μV/m)	LIMIT QUASI-P dB(μV/m)	PASS?	MARGIN dB
NO SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

THE 1 to 18 GHz ANTENNA IS HORIZONTAL AND AT 3 METERS.

FREQ. (MHz)	AMPL QUASI-P dB(μV)	AZIMUTH DEGREES	CABLE LOSS dB	ANTENNA FACTORS dB	TOTAL FIELD dB(μV/m)	LIMIT QUASI-P dB(μV/m)	PASS?	MARGIN dB
NO SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

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RADIATED EMISSIONS TEST DATA

Prior work showed that the following modification were needed when the BU-1000 is transmitting. The modifications are needed to keep fundamental and spurious emissions under the Part 90 limits defined by emission mask "C".

1) Chip inductors L294 and L300 have been changed to 1 uH and the variable inductors L295 and L298 were re-aligned.

2) The loop antenna that was originally incorporated onto the BU-1000 circuit board has been found to resonate at 692 MHz rather than the intended 173 MHz carrier. To correct this, the circuit trace that made up the 1/4 wave loop antenna was cut at the first solder pad. The shorting link was also removed. After this was done, a 173 MHz self-resonant dipole with 2 meters of coax cable was soldered to the BU-1000 transmitter board, The dipole was mounted vertically two meters above the OATS ground-plane using a non-conductive tower. The coaxial antenna cable exits the enclosure by way of the mounting barrel. The BU-1000 and its enclosure are normally mounted on the power meter housing.

3) The BU-1000 transmitter board is installed inside an enclosure made of ABS plastic that has been sprayed with a copper/nickel conductive coating on the inner surfaces. The enclosure has an elastomer gasket between the cover and circuit board.

The fundamental frequency of the first board studied is 173.203 MHz. Later measurements will use the 173.3125 MHz and 173.39625 MHz circuit boards.

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RADIATED EMISSIONS TEST DATA

The substitution method is used to calculate the limit for signals that are removed from the fundamental by 250% of the authorized bandwidth.

For this work, the substitution dipole antenna was oriented vertically with each aerial element 407mm long (1/2 wave resonant at 173 MHz). A 10 meter RG-214 cable connected the signal generator to the substitution dipole. An amplifier was needed to boost the signal from the signal generator. The amplifier had a gain of 37dB. The "Matching Signal Generator Output" column accounts for the amplifier gain in dB.

As seen in the first line of the table below, a 131dBuV matching signal generator output (which includes the 37 dB amplifier gain) was needed for the reference antenna signal to match the EUT signal. The first line of the table translates this power level into the EUT effective radiated power.

FREQ. (MHz)	TOTAL AERIAL LENGTH (mm)	MATCH SIG GEN OUTPUT (dBuV)	MATCH SIG GEN OUTPUT (dBm)	LAB to OATS REF ANT CABLE LOSS (dBm)	DIPOLE ANTENNA. GAIN (dBi)	EFFECTIVE RADIATED POWER (dBm)	EFFECTIVE RADIATED POWER (mw)
173.203	407.00	131	24	3.5	2.00	22.50	177.83
173.203	407.00	95	-12	3.5	2.00	-13.50	0.04

Spurious emissions need to have a radiated power 35.5 dB lower than the fundamental's radiated power, or -13 dBm. The 35.5 dB requirement comes from the 43 + 10 X log P limit formula of emission mask "C". From the table above, P = 0.17783 watts.

When the matching signal generator output was set at 95 dBuV, an effective radiated power of -13.5 dBm results, as seen in the second line of the table. This is the maximum radiated power spurious emissions may produce and it is below the fundamental by 35.5 dB.

The Quasi-Peak receiver is used to measure the field produced by the 95 dBuV signal sent to the reference dipole. The table below converts this into a field strength, after the addition of the receive antenna factors, & cable losses.

THE 30 TO 300 MHz ANTENNA IS VERT. & @ 3m.					
FREQ. (MHz)	AMPL QUASI-P dB(µV)	AZIMUTH DEGREES	CABLE LOSS dB(µV)	ANTENNA FACTORS dB	TOTAL FIELD dB(µV/m)
173.203	60	180	3.44	16.93	80.37

The Emission Mask "C" limit in terms of a field strength is 80.37 dB(uV/m) for frequencies greater than +/-100 kHz removed from the center frequency.

Because of the predictable field distribution around a dipole, no turntable rotations are needed. Antenna height scans are used to obtain the maximum signal strength for all field strength measurements that follow. The modulating signal supplied by the manufacturer is operational.

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RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.203 MHz)								
THE 30 TO 300 MHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV)**	**PASS?**	**MARGIN dB**
54.22	19	180	1.08	9.95	30.03	80.37	YES	50.34
57.74	36	180	1.69	9.31	47.00	80.37	YES	33.37
115.47	50	180	2.50	11.41	63.91	80.37	YES	16.46
173.203	93	180	3.44	16.93	113.37	N/A	N/A	N/A
162.55	35	180	2.98	16.72	54.70	80.37	YES	25.67
180.41	31	180	3.44	17.54	51.98	80.37	YES	28.39
183.92	34	180	3.44	17.86	55.30	80.37	YES	25.07
231.01	51	180	3.92	18.60	73.52	80.37	YES	6.85
288.69	35	180	4.83	19.76	59.59	80.37	YES	20.78
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND THIS RANGE								

(Fundamental Carrier = 173.203 MHz)								
THE 30 TO 300 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV)**	**PASS?**	**MARGIN dB**
57.74	28	180	1.69	9.31	39.00	80.37	YES	41.37
115.47	35	180	2.50	11.41	48.91	80.37	YES	31.46
173.203	80	180	3.44	16.93	100.37	N/A	N/A	N/A
176.86	23	180	3.44	17.08	43.51	80.37	YES	36.85
231.01	32	180	3.92	18.60	54.52	80.37	YES	25.85
288.69	26	180	4.83	19.76	50.59	80.37	YES	29.78
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND THIS RANGE								

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RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.203 MHz)								
THE 300 TO 1000 MHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
335.76	22	180	5.14	17.36	44.50	86.37	YES	41.9
346.41	43	180	5.14	16.88	65.02	86.37	YES	21.3
404.17	29	180	5.31	14.78	49.09	86.37	YES	37.3
461.92	42	180	6.19	16.74	64.93	86.37	YES	21.4
519.63	39	180	7.31	18.26	64.57	86.37	YES	21.8
577.36	39	180	7.31	18.92	65.23	86.37	YES	21.1
635.10	44	180	7.78	19.60	71.38	86.37	YES	15.0
692.87	35	180	8.17	20.35	63.53	86.37	YES	22.8
750.56	34	180	9.03	20.36	63.39	86.37	YES	23.0
808.30	31	180	9.84	20.48	61.33	86.37	YES	25.0
866.06	32	180	11.31	22.72	66.03	86.37	YES	20.3
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

(Fundamental Carrier = 173.203 MHz)								
THE 300 TO 1000 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
346.41	47	180	5.14	16.88	69.02	86.37	YES	17.3
404.17	24	180	5.31	14.78	44.09	86.37	YES	42.3
519.63	39	180	7.31	18.26	64.57	86.37	YES	21.8
577.36	31	180	7.31	18.92	57.23	86.37	YES	29.1
635.10	40	180	7.78	19.60	67.38	86.37	YES	19.0
692.87	38	180	8.17	20.35	66.53	86.37	YES	19.8
750.56	28	180	9.03	20.36	57.39	86.37	YES	29.0
808.30	27	180	9.84	20.48	57.33	86.37	YES	29.0
866.06	31	180	11.31	22.72	65.03	86.37	YES	21.3
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

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RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.203 MHz)								
THE 1 to 18 GHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL PEAK dBm**	**AMPL PEAK dB(µV)**	**CABLE LOSS dB**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
1040	-80	27	10.85	24.80	62.65	80.37	YES	17.72
1098	-82	25	10.85	24.80	60.65	80.37	YES	19.72
1155	-80	27	10.85	25.04	62.89	80.37	YES	17.48
1214	-84	23	13.39	25.28	61.67	80.37	YES	18.70
1329	-83	24	13.39	25.52	62.91	80.37	YES	17.46
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND UP TO 2.6 GHz.								

(Fundamental Carrier = 173.203 MHz)								
THE 1 to 18 GHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL PEAK dBm**	**AMPL PEAK dB(µV)**	**CABLE LOSS dB**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
1040	-83	24	10.85	24.80	59.65	80.37	YES	20.72
1214	-84	23	13.39	25.28	61.67	80.37	YES	18.70
1329	-82	25	13.39	25.52	63.91	80.37	YES	16.46
1386	-83	24	16.60	25.52	66.12	80.37	YES	14.25
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND UP TO 2.6 GHz.								

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RADIATED EMISSIONS TEST DATA

The transmitter board a.k.a. BU-1000 is changed to one that uses a specified fundamental carrier frequency of 173.3125 MHz. The antenna measurements at 3 meters are repeated.

(Fundamental Carrier = 173.3125 MHz)								
THE 30 TO 300 MHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV)**	**PASS?**	**MARGIN dB**
54.24	32.5	180	1.08	9.95	43.53	80.37	YES	36.84
57.77	40	180	1.69	9.31	51.00	80.37	YES	29.37
86.66	41	180	2.02	7.70	50.72	80.37	YES	29.65
108.43	27	180	2.02	11.03	40.05	80.37	YES	40.32
115.57	49	180	2.50	11.41	62.91	80.37	YES	17.46
144.44	44	180	2.98	13.10	60.09	80.37	YES	20.28
173.203	91	180	3.44	16.93	111.37	N/A	N/A	N/A
202.24	42	180	3.60	18.62	64.22	80.37	YES	16.15
231.16	47	180	3.92	18.60	69.52	80.37	YES	10.85
288.86	35	180	4.83	19.76	59.59	80.37	YES	20.78
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND THIS RANGE								

(Fundamental Carrier = 173.3125 MHz)								
THE 30 TO 300 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV)**	**PASS?**	**MARGIN dB**
54.24	27	180	1.08	9.95	38.03	80.37	YES	42.34
57.77	31	180	1.69	9.31	42.00	80.37	YES	38.37
86.66	40	180	2.02	7.70	49.72	80.37	YES	30.65
115.57	40	180	2.50	11.41	53.91	80.37	YES	26.46
144.44	36	180	2.98	13.10	52.09	80.37	YES	28.28
173.203	81	180	3.44	16.93	101.37	N/A	N/A	N/A
202.24	41	180	3.60	18.62	63.22	80.37	YES	17.15
231.16	40	180	3.92	18.60	62.52	80.37	YES	17.85
288.86	26	180	4.83	19.76	50.59	80.37	YES	29.78
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND THIS RANGE								

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RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.3125 MHz)								
THE 300 TO 1000 MHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(μV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(μV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(μV/m)**	**LIMIT QUASI-P dB(μV/m)**	**PASS?**	**MARGIN dB**
346.67	60	180	5.14	16.88	82.02	86.37	YES	4.3
375.56	40	180	5.31	15.76	61.08	86.37	YES	25.3
404.44	33	180	5.31	14.78	53.09	86.37	YES	33.3
433.30	34	180	5.31	15.76	55.07	86.37	YES	31.3
462.18	39	180	6.19	16.74	61.93	86.37	YES	24.4
520.00	47	180	7.31	18.30	72.61	86.37	YES	13.8
548.87	43	180	7.31	18.61	68.92	86.37	YES	17.4
577.77	45	180	7.31	18.92	71.23	86.37	YES	15.1
606.64	43	180	7.78	19.22	70.00	86.37	YES	16.4
635.51	45	180	7.78	19.60	72.38	86.37	YES	14.0
664.44	35	180	8.17	19.98	63.15	86.37	YES	23.2
693.00	45	180	8.17	20.35	73.53	86.37	YES	12.8
751.00	32	180	9.03	20.36	61.39	86.37	YES	25.0
779.94	30	180	9.03	20.27	59.30	86.37	YES	27.1
808.83	30	180	9.84	20.48	60.33	86.37	YES	26.0
866.63	32	180	11.31	22.72	66.03	86.37	YES	20.3
924.35	21	180	11.31	23.44	55.75	86.37	YES	30.6
982.10	29	180	10.77	21.70	61.47	86.37	YES	24.9
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

(Fundamental Carrier = 173.3125 MHz)								
THE 300 TO 1000 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(μV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(μV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(μV/m)**	**LIMIT QUASI-P dB(μV/m)**	**PASS?**	**MARGIN dB**
346.67	48	180	5.14	16.88	70.02	86.37	YES	16.3
375.56	36	180	5.31	15.76	57.08	86.37	YES	29.3
404.44	28	180	5.31	14.78	48.09	86.37	YES	38.3
520.00	42	180	7.31	18.30	67.61	86.37	YES	18.8
548.87	35	180	7.31	18.61	60.92	86.37	YES	25.4
577.77	38	180	7.31	18.92	64.23	86.37	YES	22.1
606.64	38	180	7.78	19.22	65.00	86.37	YES	21.4
635.51	32	180	7.78	19.60	59.38	86.37	YES	27.0
664.44	35	180	8.17	19.98	63.15	86.37	YES	23.2
693.00	46	180	8.17	20.35	74.53	86.37	YES	11.8
751.00	30	180	9.03	20.36	59.39	86.37	YES	27.0
779.94	28	180	9.03	20.27	57.30	86.37	YES	29.1
866.63	33	180	11.31	22.72	67.03	86.37	YES	19.3
982.10	30	180	10.77	21.70	62.47	86.37	YES	23.9
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

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RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.3125 MHz)								
THE 1 to 18 GHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL PEAK dBm**	**AMPL PEAK dB(μV)**	**CABLE LOSS dB**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(μV/m)**	**LIMIT QUASI-P dB(μV/m)**	**PASS?**	**MARGIN dB**
1041	-79	28	10.85	24.80	63.65	80.37	YES	16.72
1127	-83	24	10.85	25.04	59.89	80.37	YES	20.48
1272	-79	28	13.39	25.28	66.67	80.37	YES	13.70
1388	-82	25	16.60	25.52	67.12	80.37	YES	13.25
1446	-80	27	16.60	25.76	69.36	80.37	YES	11.01
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND UP TO 2.6 GHz.								

(Fundamental Carrier = 173.3125 MHz)								
THE 1 to 18 GHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL PEAK dBm**	**AMPL PEAK dB(μV)**	**CABLE LOSS dB**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(μV/m)**	**LIMIT QUASI-P dB(μV/m)**	**PASS?**	**MARGIN dB**
1041	-78	29	10.85	24.80	64.65	80.37	YES	15.72
1127	-86	21	10.85	25.04	56.89	80.37	YES	23.48
1156	-85	22	10.85	25.04	57.89	80.37	YES	22.48
1185	-83	24	13.39	25.04	62.43	80.37	YES	17.94
1214	-79	28	13.39	25.28	66.67	80.37	YES	13.70
1272	-77	30	13.39	25.28	68.67	80.37	YES	11.70
1301	-81	26	13.39	25.52	64.91	80.37	YES	15.46
1388	-82	25	16.60	25.52	67.12	80.37	YES	13.25
1446	-83	24	16.60	25.76	66.36	80.37	YES	14.01
1504	-84	23	16.60	26.00	65.60	80.37	YES	14.77
1620	-87	20	15.08	26.50	61.58	80.37	YES	18.79
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND UP TO 2.6 GHz.								

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RADIATED EMISSIONS TEST DATA

The transmitter board a.k.a. BU-1000 is changed to one that uses a specified fundamental carrier frequency of 173.39625 MHz. The antenna measurements at 3 meters are repeated.

(Fundamental Carrier = 173.39625 MHz)								
THE 30 TO 300 MHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV)**	**PASS?**	**MARGIN dB**
57.8	40	180	1.69	9.31	51.00	80.37	YES	29.37
108.43	21	180	2.02	11.03	34.05	80.37	YES	46.32
115.57	51	180	2.50	11.41	64.91	80.37	YES	15.46
168.04	36	180	3.44	16.83	56.27	80.37	YES	24.10
173.203	93	180	3.44	16.93	113.37	N/A	N/A	N/A
231.26	55	180	3.92	18.60	77.52	80.37	YES	2.85
288.86	38	180	4.83	19.76	62.59	80.37	YES	17.78
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND THIS RANGE								

(Fundamental Carrier = 173.39625 MHz)								
THE 30 TO 300 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV)**	**PASS?**	**MARGIN dB**
57.8	34	180	1.69	9.31	45.00	80.37	YES	35.37
115.57	40	180	2.50	11.41	53.91	80.37	YES	26.46
173.203	85	180	3.44	16.93	105.37	N/A	N/A	N/A
231.26	40	180	3.92	18.60	62.52	80.37	YES	17.85
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND THIS RANGE								

continued on next page

RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.39625 MHz)								
THE 300 TO 1000 MHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
346.67	44	180	5.14	16.88	66.02	86.37	YES	20.3
404.61	34	180	5.31	14.78	54.09	86.37	YES	32.3
462.18	40	180	6.19	16.74	62.93	86.37	YES	23.4
520.19	48	180	7.31	18.30	73.61	86.37	YES	12.8
578.00	41	180	7.31	18.92	67.23	86.37	YES	19.1
635.80	43	180	7.78	19.60	70.38	86.37	YES	16.0
693.61	40	180	8.17	20.35	68.53	86.37	YES	17.8
751.42	35	180	9.03	20.36	64.39	86.37	YES	22.0
808.83	39	180	9.84	20.48	69.33	86.37	YES	17.0
982.60	20	180	10.77	21.70	52.47	86.37	YES	33.9
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

(Fundamental Carrier = 173.39625 MHz)								
THE 300 TO 1000 MHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL QUASI-P dB(µV)**	**AZIMUTH DEGREES**	**CABLE LOSS dB(µV)**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
346.67	59	180	5.14	16.88	81.02	86.37	YES	5.3
357.56	37	180	5.14	16.40	58.54	86.37	YES	27.8
404.61	38	180	5.31	14.78	58.09	86.37	YES	28.3
462.43	36	180	6.19	16.74	58.93	86.37	YES	27.4
520.19	47	180	7.31	18.30	72.61	86.37	YES	13.8
578.00	33	180	7.31	18.92	59.23	86.37	YES	27.1
635.80	46	180	7.78	19.60	73.38	86.37	YES	13.0
693.61	31	180	8.17	20.35	59.53	86.37	YES	26.8
751.42	27	180	9.03	20.36	56.39	86.37	YES	30.0
808.83	29	180	9.84	20.48	59.33	86.37	YES	27.0
982.60	16	180	10.77	21.70	48.47	86.37	YES	37.9
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND FOR THIS RANGE.								

continued on next page

RADIATED EMISSIONS TEST DATA

(Fundamental Carrier = 173.39625 MHz)								
THE 1 to 18 GHz ANTENNA IS VERTICAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL PEAK dBm**	**AMPL PEAK dB(µV)**	**CABLE LOSS dB**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
1215	-82	25	13.39	25.28	63.67	80.37	YES	16.70
1389	-89	18	16.60	25.52	60.12	80.37	YES	20.25
1505	-88	19	16.60	26.00	61.60	80.37	YES	18.77
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND UP TO 2.6 GHz.								

(Fundamental Carrier = 173.39625 MHz)								
THE 1 to 18 GHz ANTENNA IS HORIZONTAL AND AT 3 METERS.								
FREQ. (MHz)	**AMPL PEAK dBm**	**AMPL PEAK dB(µV)**	**CABLE LOSS dB**	**ANTENNA FACTORS dB**	**TOTAL FIELD dB(µV/m)**	**LIMIT QUASI-P dB(µV/m)**	**PASS?**	**MARGIN dB**
1041.3	-82	25	10.85	24.80	60.65	80.37	YES	19.72
1099	-93	14	10.85	24.80	49.65	80.37	YES	30.72
1215	-82	25	13.39	25.28	63.67	80.37	YES	16.70
1389	-91	16	16.60	25.52	58.12	80.37	YES	22.25
NO OTHER SIGNIFICANT EUT GENERATED SIGNALS FOUND UP TO 2.6 GHz.								

THE BURGHARDT MODEL BU-1000 DATA TRANSCEIVER BOARD MEETS THE RADIATED EMISSIONS REQUIREMENTS OF FCC PART 90 AND PART 15 FOR CLASS B WITH THE MODIFICATIONS MENTIONED ON THE THIRD PAGE OF THIS SPREADSHEET.

EMI TEST PROCEDURES
FCC PART 90
OCCUPIED BANDWIDTH MEASUREMENTS,

It is necessary to measure and submit the occupied bandwidth of the fundamental or carrier transmitter signals according to Part 2, section 2.1049 and Part 90, section 90.209 of title 47 of the FCC rules. The occupied bandwidth is the frequency span, centered on the fundamental frequency, where 99% of the radiated power exists. The FCC specifies the occupied bandwidth i.e. "authorized bandwidth" for all relevant product families.

The occupied bandwidth measurements were obtained at the EUT antenna terminals. A 50 ohm impedance match was achieved by simply connecting a 50 ohm coax to the antenna output of the BU-1000 transmitter board.

The spectrum analyzer's "Max Hold" and marker features were used to determine the frequency bandwidth occupied by the transmitter signal. The occupied bandwidth measurements were made with the carrier modulated by the modulation signal supplied by Burghardt.

The modulated carrier bandwidth of all three test frequencies was within the 20 kHz limit authorized in Part 90, section 90.209. The spectrum analyzer plots included in separate plot and photo section document the occupied bandwidth for all three transmitter frequencies used by this EUT.

EMI TEST PROCEDURES
FCC PART 90
SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS

Part 2; section 2.1051 of the FCC title 47 rules requires a relative measurement of spurious emissions at the antenna terminals of the EUT.

This measurement was performed using the same connection to the EUT as used in the occupied bandwidth measurements. The spectrum analyzer was connected the EUT board with a coaxial cable soldered to the antenna outputs.

The spectrum analyzer reference level was adjusted so the peak of the fundamental is at the reference level. The spectrum is plotted up to the tenth harmonic of the fundamental carrier frequency.

All spurious emissions are at least 20 dB below the carrier power level when measured this way. Spectrum analyzer plots of the relative level of spurious emissions for all three test boards are included in the plot and photo section of this report.

EMI TEST PROCEDURES
FCC PART 90
FREQUENCY STABILITY MEASUREMENTS

Part 2; section 2.1055 of the FCC title 47 rules requires a measurement of the carrier frequency stability under temperature and power voltage variations. The same methods of interfacing the EUT to the spectrum analyzer that were used for the occupied bandwidth measurements are used for the frequency stability measurements.

The EUT is first cooled to the lowest temperature of this test while powered. The EUT is allowed a stabilization period in order for the temperature compensating circuits to work. After this period and while the EUT is still at the low temperature, the spectrum analyze "max hold" feature is used to record the carrier signal.

A plot is taken in this way every 10° C as the EUT is warmed to 50°C . All plots are superimposed over the proceeding one. The total frequency drift must be within the tolerance specified for frequency stability.

A refrigerator is used to produce the cold temperature, while a portable heater or test chamber oven is used to generate the high temperatures of this test. A thermocouple is used to observe the temperatures of the EUT during all phases of the test.

Frequency stability was also measured while the power input was varied from 85% to 115% of the nominal power voltage. An AC power source or autotransformer is used to produce varying AC power voltage. A DC power supply is used to produce varying DC power voltage for battery or DC powered equipment.

The BU-1000 DATA TRANSCEIVER frequency stability due to a -10°C to 50°C temperature variation is within the +/-5.0 ppm requirement. The +/-5.0 ppm equates to approximately +/-1 kHz on either side of the modulated 173 MHz carrier.

The BU-1000 DATA TRANSCEIVER frequency stability due to the 85% to 115% power voltage variation is also +/- 1kHz, which is within the +/-5.0 ppm requirement.

Spectrum analyzer plots of frequency stability under temperature and power voltage variations for all three test frequencies are included in the plot and photo section of this report.

EMI TEST PROCEDURES
FCC PART 90
TRANSIENT FREQUENCY BEHAVIOUR

Section 90.214 requires transmitters designed to operate in the 150-174 MHz and 421-512 MHz bands to control transient frequency effects within defined time intervals and frequency differences. Section 90.214 recommends a 1 kHz test signal is used.

For this project, the modulation signal supplied by Burghardt was removed and replaced with a 1 kHz test signal that was injected into pin three of the five-pin connector on the BU-1000 board. The 1 kHz signal used a coaxial cable between the board and the signal generator. A0.1ufd capacitor was used between the coax center conductor and pin 3. The outer conductor was connected to the circuit ground plane.

With this arrangement, the 1 kHz test signal would modulate the BU-1000 carrier signal. The test signal generator produced a one-volt signal level, square waveform (to better approximate a digital transmission. A plot is included that shows the 173 MHz carrier with and without the 1kHz, one volt, square wave modulation.

The transient frequency measurement was performed by first operating the EUT until thermal stabilization was achieved with the 1 kHz test signal modulation applied. After a warm-up period of approximately 1minute, a spectrum analyzer trace of the resulting antenna voltage was stored in one spectrum analyzer channel. Upon connecting the "key" signal cable to its post on the MRU board, another spectrum analyzer trace was made and stored on the second channel while using the "Max Hold" function.

The resulting trace was plotted and is displayed in the photo and plot section of this report. When the "key" wire is connected to its post on the MRU board, the carrier frequency with modulation appears displaced from where it had been centered in the first spectrum analyzer channel. Because power was never removed from the BU-1000, the frequency displacement is due to the capture of the 1 kHz modulating test signal by the BU-1000. The 173.2030 MHz BU-1000 board was used. The performance of boards that use different carrier frequencies will be identical because the compensation circuits of all BU-1000 boards are identical regardless of the carrier frequency.

According to the data collected, there never was > 0.5 kHz frequency shift in the modulated carrier upon application of the 1 kHz test signal. The plot labeled "Max freq. shift after key of 1 kHz" demonstrates this. Section 90.214 allows for a +/-12.5 kHz frequency difference.

SUMMARY
BURGHARDT INC.
BU-1000 DATA TRANSCEIVER

The BU-1000 DATA TRANSCEIVER, the EUT, was tested for RF emissions in accordance with the applicable agency rules and guidelines.

The EUT was subjected to a TERMINAL DISTURBANCE VOLTAGE (CONDUCTED) EMISSIONS ANALYSIS.
The frequencies closest to the applicable limits are:
0.45 MHz, with an 11.9 dB margin on the LINE conductor for 173.2030 MHz.
20 MHz, with a 7.3 dB margin on the NEUTRAL conductor for 173.3125 MHz.
20 MHz, with an 8.3 dB margin on the NEUTRAL conductor for 173.39625 MHz.

The EUT was subjected to Part 15 RADIATED ELECTRIC FIELD ANALYSIS.
The frequency closest to the limits was 108.44 MHz, with a 5.45 dB margin.

The EUT was subjected to PART 90 RADIATED ELECTRIC FIELD ANALYSIS, using emission Mask "C". The frequencies closest to the limits and the margins are:
For the 173.203 MHz carrier; 231 MHz, with a 6.85 dB margin
For the 173.3125 MHz carrier; 346.67 MHz, with a 4.3 dB margin
For the 173.39625 MHz carrier; 231 MHz, with a 2.85 dB margin

The EUT occupied bandwidth was measured and found to be +/-12 kHz when it was modulated by the supplied test signal. The EUT has adequate frequency stability during temperature and power voltage variations.

The EUT transient frequency response is within 0.5 kHz of nominal upon detecting a 1 kHz test signal modulation.

The BURGHARDT INC. BU-1000 DATA TRANSCEIVER complies with the requirements of Part 90 with the following modifications:

1. Chip inductors L294 and L300 are changed to 1 uH and variable inductors L295 and L298 re-aligned.

2. A 173 MHz self-resonant dipole is used for sending and receiving messages instead of the original internal loop antenna.

3. The BU-1000 transmitter board is installed inside an enclosure made of ABS plastic, with its interior coated with a copper/nickel conductive coating. The MRU may be in this enclosure, or it may be in the meter enclosure, as was the case with the testing described in this report. The MRU made no significant addition to emissions.