MEASUREMENT AND TECHNICAL REPORT ON THE TIRIS Tag-it READER (Commander 320)

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Project 10-1230-005
Report Number RFMA 98/079

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1.0 GENERAL INFORMATION

1.1 Product Description

The reader module (TI PN RI-R00-320A) is a battery or DC power supply operated device designed to use in system RI-R00-0360 with computer interface and batteryless transponders such as inlays RI-I01-0110 (45x45mm) and RI-I02-0110 (45x76mm). This reader module could be integrated into commercial printers and fixed point identification scanners. The transmitter portion of the reader operates at 13.56 MHz and is subject to FCC Part 15, Subpart C, "Intentional Radiator," paragraphs 15.225. Radiated emissions from the intentional radiator portion of the device meet the limits in Section 15.209 of the Rules outside of the 13.56 +/- 0.007 MHz band. The digital electronics portion of the reader is subject to FCC Part 15, Subpart B, "Unintentional Radiator," paragraph 15.109, under the Class A limits. Attachment 1 contains a detailed technical and functional description of the reader and its components.

1.2 Related Grants

No other host equipment was used in the test configuration. However, equipment was communicating to the host (laptop) during test.

1.3 Tested System Details

The reader is mounted into an enclosure such as a thermal transfer barcode printer or fixed-point conveyor identification scanner system. Reader system includes analog RFM, CPU digital module, RS-232 interface board, 50Ω cable, antenna module (matching board and antenna). The reader is attached to an electronics data host such as a computer or printer. These components were assembled as shown on page 1 in Word97 file "a92SwRI.doc".

The reader operates from 12 V_{DC} supplied from either an external battery or power supply. During testing, the reader was powered using an external power supply, Tektronix Model No. PS280, s/n TW51893. The components on the system are listed below in Table 1.1.

TABLE 1.1
RI-R00-0360 READER SYSTEM COMPONENTS

Component Description	Model Number	Revision, Serial Number
Reader Module	RI-R00-320A	Rev. 0, S/N 2
- Analog RFM	- RI-RFM-0320	Rev. 0, S/N 2
- Digital CPU	- RI-CTL-0320-00	Rev. 0, S/N 2
- Firmware	- RI-S00-0320	Rev. 0, S/N 2
RS-232 Interface	RI-R00-232A	Rev. 0, S/N 2
Antenna Module	RI-A00-0315	Rev. 1
- Antenna Matching Network	- RI-A00-M50A	Rev. 1
- 50Ω Cable	- N/A	N/A

The reader antenna measured 7.25" (L) x 3.5" (W).

1.4 Test Methodology

Radiated testing was performed according to the procedures in ANSI C63.4-1992 and the limits prescribed in CFR 47, FCC Parts 15.209 and 15.225. Radiated testing was performed at an antenna to EUT distance of 3 and 30 meters.

1.5 Test Facility

The Open Area Test Site and Conducted Measurement Facility used to collect data are located at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas. Details concerning these test sites are found in the report entitled, "Description of Measurement Facility," dated 28 April 1997, which is on file with the FCC Laboratory Division in Columbia, Maryland. On June 12, 1997, the FCC approved the sites for the purpose of providing test results for submission with equipment authorization applications under the Commission's Equipment Authorization Program.

2.0 PRODUCT LABELING

2.1 FCC ID Label

FCC ID: A92COM320 This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.2 Location of Label on EUT

The label is located on the backside of the reader RI-R00-0320A as shown in photograph on page 5 (Word97 file "a92SwRIpic.doc").

2.3 Label for the Exterior of Devices Incorporating the EUT

The EUT will be incorporated in other devices such as a system housing. The following label is to be supplied with the EUT for placement on the exterior of the device in which the equipment is incorporated as shown in example housing in photograph on page 2 (Word 97 file "a92SwRIpic.doc"):

FCC ID: A92COM320 This equipment contains an intentional radiator approved by the FCC under the FCC ID number shown above. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.4 Supplemental Information to be in the Reader Manual

In addition to reiteration of required information as an intentional radiator, in keeping with sections 15.21 and 15.105 of the FCC rules, the manual supplied with the reader will also include the following admonitions:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NO MODIFICATIONS: Modifications to this device shall not be made without the written consent of Texas Instruments Incorporated. Unauthorized modifications may void the authority granted under Federal Communications Commission Rules permitting the operation of this device.

3.0 SYSTEM TEST CONFIGURATION

3.1 Justification

Radiated tests were performed on the Reader intentional radiator from 13.56 MHz to 1 GHz for the highest fundamental and harmonics. Radiated tests were performed up to 1 GHz for harmonics of the fundamental emission and spurious emissions related to the digital electronics portion of the unit. Both vertical and horizontal polarizations were tested. Radiated signature scans were made at 3 meters in a shielded anechoic chamber.

3.2 EUT Exercise

The reader was powered by 12 V_{DC} and fully operational at power-up. A remotely located laptop computer connected to the reader's RS-232 serial port was capable of turning the transmitter portion of the unit on/off via keyboard command, while the digital electronics portion of the unit remained operational. This capability was used during radiated emissions testing to determine whether an emission was related to the digital portion of the unit or to the reader's transmitter.

3.3 Special Accessories

No ferrites on the cabling or other special accessories were required.

3.4 Equipment Modification

The Reader hardware will be factory configured to +20.78 dBm through resistive potentiometer and then sealed (which has been incorporated in the manufacturing procedure). The antenna was fully tuned (maximum output) for 50Ω impedance at 13.56 MHz. The need for a modification to achieve compliance was determined during equipment testing. A 47 pF capacitor has been added to the digital CPU (TI PN RI-CTL-0320-00) which has been incorporated into the design.

3.5 Configuration of Tested System

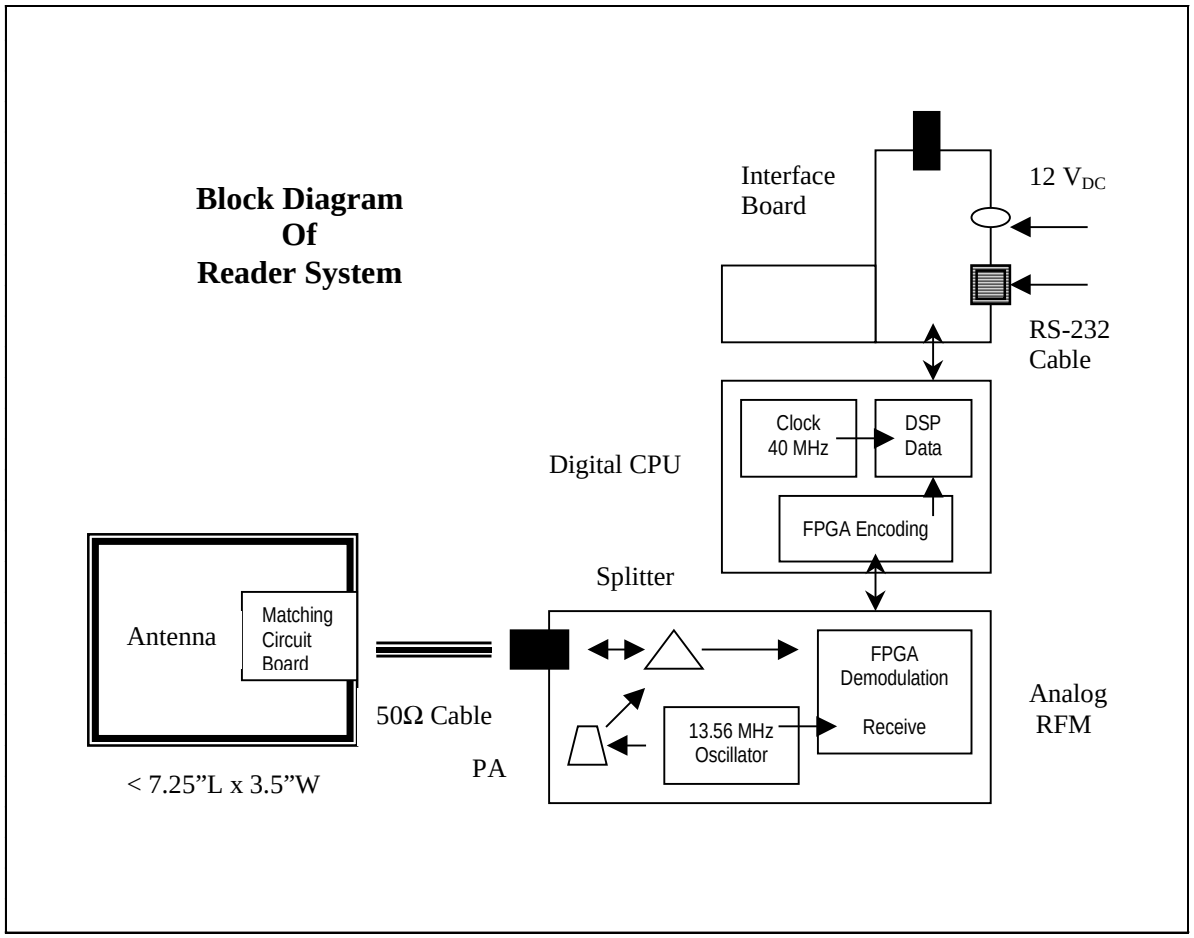
Refer to Section 4.0 for block diagram of tested configuration.

Refer to Appendix C (Word 97 file "a92SwRIpic.doc") for photographs of the EUT test configuration.

3.6 Antenna Connector

This device is intended for incorporation into other devices. It is not a consumer device. It requires installation by a technician or assembly line worker trained in its installation in order to properly install it in other devices such as a printer. The device uses an SMA antenna connector on the RF module board in order to facilitate the placement of the device within other devices so that the cable to the antenna may be more easily routed away from moving parts and hot surfaces. Because this is a device that inherently requires professional installation, it complies with the requirements of Section 15.203 of the Commission's Rules. The written instructions packed with the device will explain the requirement for professional installation.

4.0 BLOCK DIAGRAM OF THE "Tag-it™" SYSTEM



5.0 RADIATED MEASUREMENT PHOTOS

Refer to Appendix C (Word 97 file "a92SwRIpic.doc") for photograph of the OATS setup (page 1).

6.0 RADIATED EMISSION DATA

The data below are the corrected highest level EME measurements taken from the following radiated data sheets. The data sheets include the emission frequencies and the corrected level. An explanation of the field strength calculation is given in paragraph 6.3.

6.1 Radiated Measurement Data

Measurements were made of the fundamental frequency of 13.56 MHz at 30 meters. Additionally, the spectrum was investigated for harmonics and spurious emissions up to 30 MHz at 30 meters. No harmonics or other spurious emissions were detected. The measurement level of the fundamental at the center frequency, as well as the level of the fundamental at the band edges, is shown in Table 6.1.

TABLE 6.1
MEASUREMENTS OF FUNDAMENTAL FREQUENCY

Judgment: EUT Passed by 2.41 dB		
Frequency (MHz)	Corrected Level[1] dB(µV/m)	Limit 30 Meters dB(µV/m)
13.56	52.79	80
13.5485	26.69	29.5
13.5715	27.09	29.5

1 All readings are quasi-peak manual measurements made with a receiver.

The spectrum from 30 MHz to 1 GHz was investigated for spurious emissions. The worst case spurious emissions are given in Table 6.2. Peak signature scans are provided in Appendix A.

TABLE 6.2
MEASUREMENTS OF SPURIOUS EMISSIONS

Judgment EUT passed by 0.6 dB			
Frequency (MHz)	Corrected Level [1] dB (V/m)	Limit dB(V/m)	"dB" Under limit
40.04	38.3	40	1.7
119.98	41.96	43.5	1.54
200[2]	42.9	43.5	0.6

1 All readings are quasi-peak manual measurements made with a receiver.
2 Spurious emissions at 200 MHz were from the Digital CPU component, with some contribution from the host laptop computer. The emission was 0.6 dB under the 15.209 limit with the host laptop computer disconnected. The emission was 0.4 dB over the 15.209 limit with the laptop connected, which is 9.6 dB under the Class A limit for digital devices in 15.109.

Radiated Emissions Test Data

FREQUENCY (MHz)	13.56	13.56	13.5715	13.5485	13.5485	**13.56**	13.5715	27
TRANSDUCER	ALR-25	ALR-25	ALR-25	ALR-25	ALR-25	ALR-25	ALR-25	ALR-25
Antenna to DUT distance (meters)	30	30	30	30	30	30	30	30
Antenna height (meters)	1	1	1	1	1	1	1	1
POLARIZATION to DUT: (‖ = Parallel, ⊥ = Perpendicular)	‖	⊥	⊥	⊥	⊥	⊥	⊥	⊥
SIGNAL DIRECTION	270E	330E	180E	0E	0E	0E	0E	---
RECEIVER ATTENUATION (dB)	0	0	-20	-20	-20	0	-20	-10
METER (dBΦV)	2.8	14.5	8.9	9.8	11.2	**17.3**	11.6	4
TRANSDUCER FACTOR (dB)	34.39	34.39	34.39	34.39	34.39	**34.39**	34.39	26.36
EXTERNAL GAIN/CABLE LOSS (dB)	1.1	1.1	1.1	1.1	1.1	**1.1**	1.1	1.8
CORRECTED LEVEL (dBΦV/m)	38.29[1]	49.99[1]	24.39[1]	25.29[1]	26.69[2]	**52.79[2]**	27.09[2]	22.16[amb]
LIMIT (dBΦV/m)	80	80	29.5	29.5	29.5	80	29.5	29.5

Date: 26 June 1998
Project No.: 10-1230-005
Test Category: FCC Part 15
Time, Temp, & %r.H: 10:14, 80°F, 72%

Detection Method: _X_ CISPR ___ PEAK ___ AVERAGE ___ Other
EUT: TAG-IT
OPR/Asst.: R. McCormick
Approved: _____

Note 1: Power Output at 13.56 MHz adjusted to 18 dBm
Note 2: Power Output at 13.56 MHz adjusted to 20.78 dBm

Radiated Emissions Test Data

FREQUENCY (MHz)	40.04	40.04	50.038	54.21	66.26	119.98	119.98	160.02	160.02
TRANSDUCER	BDA-25	BDA-25	BDA-25	BDA-25	BDA-25	BDA-25	BDA-25	BDA-25	BDA-25
Antenna to DUT distance (meters)	3	3	3	3	3	3	3	3	3
Antenna height (meters)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2
POLARIZATION (V =Vertical H= Horizontal)	V	V	V	V	V	V	V	H	H
SIGNAL DIRECTION	270E	270E	225E	190E	225E	180E	180E	135E	135E
RECEIVER ATTENUATION (dB)	10	—	10	10	0	10	—	40	---
METER (dBΦV)	13.5	22	11.5	12	15.5	17.5	26.2	11.5	49.2
TRANSDUCER FACTOR (dB)	14.1	14.1	9.8	8.3	5.1	11.5	11.5	15.2	15.2
EXTERNAL GAIN/CABLE LOSS (dB)	2.2	2.2	2.5	2.6	3.1	4.3	4.3	-22.8	-22.8
CORRECTED LEVEL (dBΦV/m)	39.8	38.3[1]	33.8	32.9	23.7	43.3	42[1]	43.9	41.6[1]
LIMIT (dBΦV/m)	40	40	40	40	40	43.5	43.5	43.5	43.5

Date: 30 June 1998 Detection Method: _ X_ CISPR ___ PEAK ___ AVERAGE ___ Other
Project No.: 10-1230-005 EUT: TAG-IT
Test Category: FCC Part 15 OPR/Asst.: R. McCormick
Time, Temp, & %r.H.: 09:00, 80°F, 84% Approved: _____

Note 1: Retested with direct injection from Fluke 6060A S/N 3690008
Note 2: PC on, pulse mode, and DC battery; PC contributed to signal level
Note 3: Power Supply, PC off (CW mode)

Radiated Emissions Test Data

FREQUENCY (MHz)	200	200	400.03	480					
TRANSDUCER	T-2	T-2	T-2	T-2					
Antenna to DUT distance (meters)	3	3	3	3					
Antenna height (meters)	1	1.2	2.1	2.1					
POLARIZATION (V= Vertical H= Horizontal)	V	V	H	H					
SIGNAL DIRECTION	90E	90E	90E	270E					
RECEIVER ATTENUATION (dB)	30	30	20	20					
METER (dBΦV)	15	14	17	12					
TRANSDUCER FACTOR (dB)	21.2	21.2	21.9	28.1					
EXTERNAL GAIN/CABLE LOSS (dB)	-22.3	-22.3	-19.2	-18.2					
CORRECTED LEVEL (dBΦV/m)	43.9[2]	42.9[3]	39.7	41.9					
LIMIT (dBΦV/m)	43.5	43.5	46	46					

Date: 30 June 1998
Project No.: 10-1230-005
Test Category: FCC Part 15
Time, Temp, & %r.H: 09:00, 80°F, 84%

Detection Method: _X_ CISPR ___ PEAK ___ AVERAGE ___ Other
EUT: TAG-IT
OPR/Asst.: R. McCormick
Approved: _____

Note 1: Retested with direct injection from Fluke 6060A S/N 3690008
Note 2: PC on, pulse mode, and DC battery; PC contributed to signal level
Note 3: Power Supply, PC off (CW mode)

The frequency tolerance of the Reader System 13.56 MHz fundamental emission was verified to be within the +/-0.01% (+/-1.356 kHz) requirement from Part 15, paragraph 15.225, when exposed to temperature variations of –20 degrees to +50 degrees C. The fundamental emission was monitored on a spectrum analyzer as the Reader System was exposed to +50 degrees C for 10 minutes, and then –20 degrees C for 10 minutes, in accordance with the procedure in ANSI C63.4-1992, paragraph 13.1.6.1. In addition, the 12 Vdc supply voltage was varied from 85% (10.2 Vdc) to 115% (13.8 Vdc) at room temperature in accordance with paragraph 15.225. The frequency of the fundamental emission did not vary more than approximately 60 Hz during the entire procedure.

6.2 Test Instrumentation for Radiated Measurements

Scans were made at an open area test site (OATS) and in an RF semi-anechoic chamber 28' long x 16' wide x 16' high with its interior lined on the ceiling and four walls with pyramidal absorber material up to four feet in length. Measurements were made with a spectrum analyzer and a quasi-peak adapter in the anechoic chamber and with a receiver at the OATS. The list of test instrumentation used to perform the testing is shown in Appendix B.

6.3 Field Strength Calculation

The field strength was calculated by adding the antenna factor and cable factor, and subtracting the amplifier gain (when used) from the measured reading. The basic equation with a sample calculation is provided below:

FS = RA + AF + CF - AG

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation
AG = Amplifier Gain

For example, reducing the 13.56 MHz measurement on the data sheet on page 10 (6^{th} column, bold text) yields:

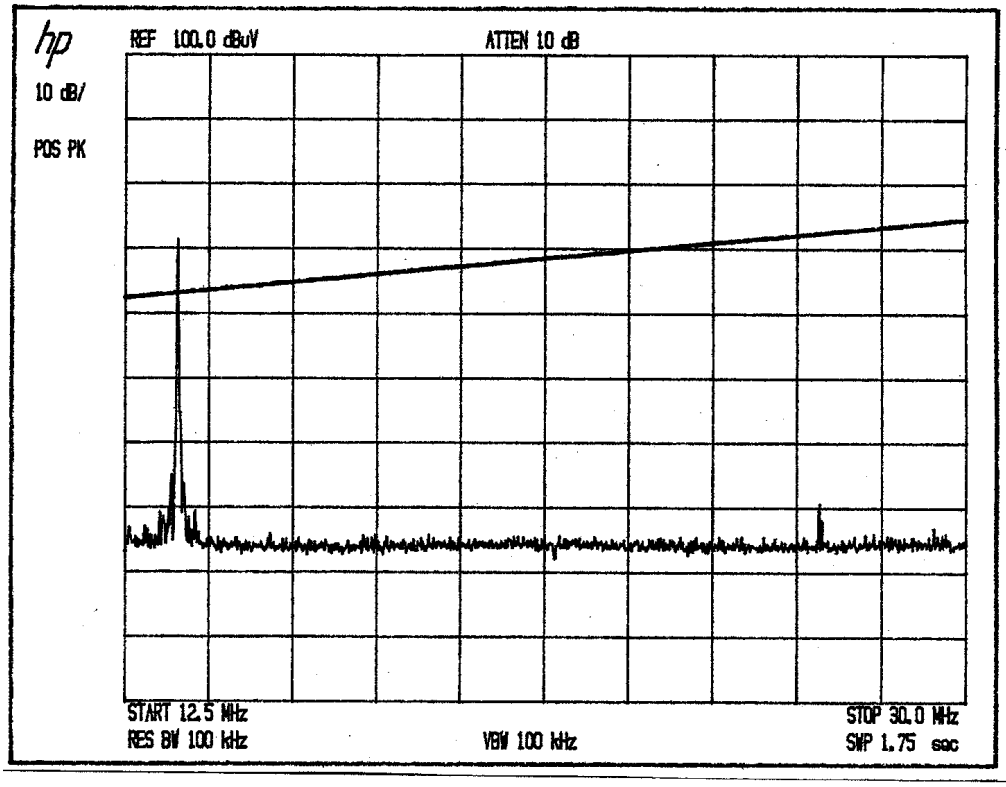
17.3 dB (µV)
34.39 dB (1/m)
1.1 dB (CF/AG FACTOR)
FS = 52.79 dB (µV/m)

To equation convert the dB (µV/m) value to its corresponding level in µV/m is as follows:

Level in µV/m Common Antilogarithm [(52.79 dB µV/m)/20] = 436 µV/m

APPENDIX A

RADIATED SIGNATURE MEASUREMENTS PLOTS



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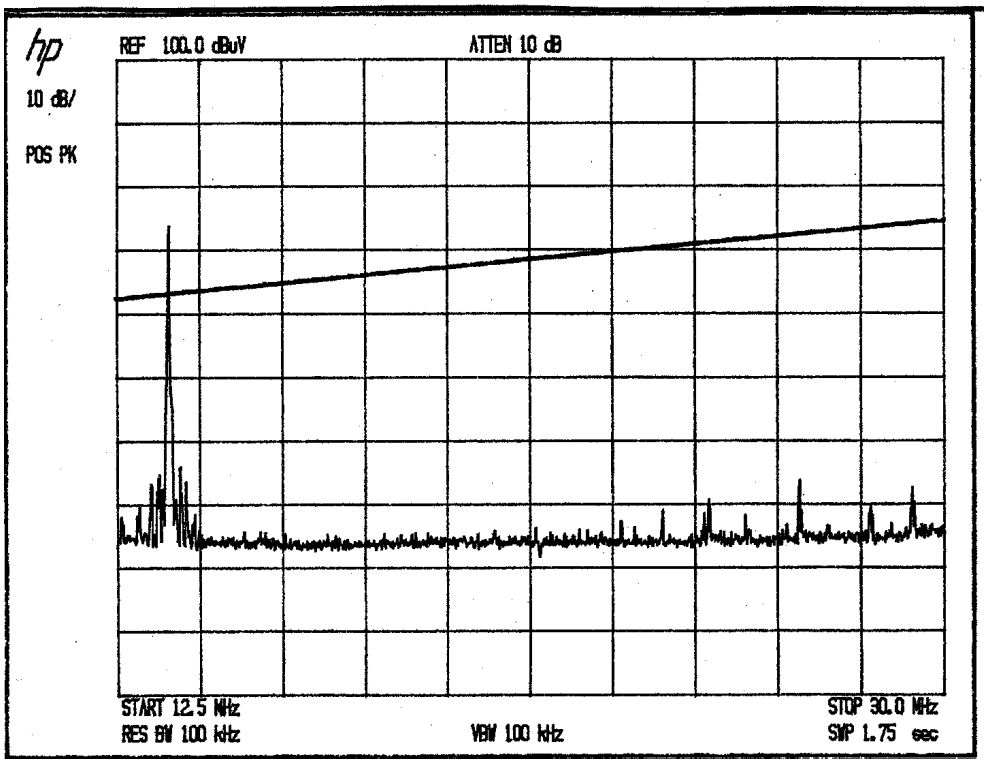
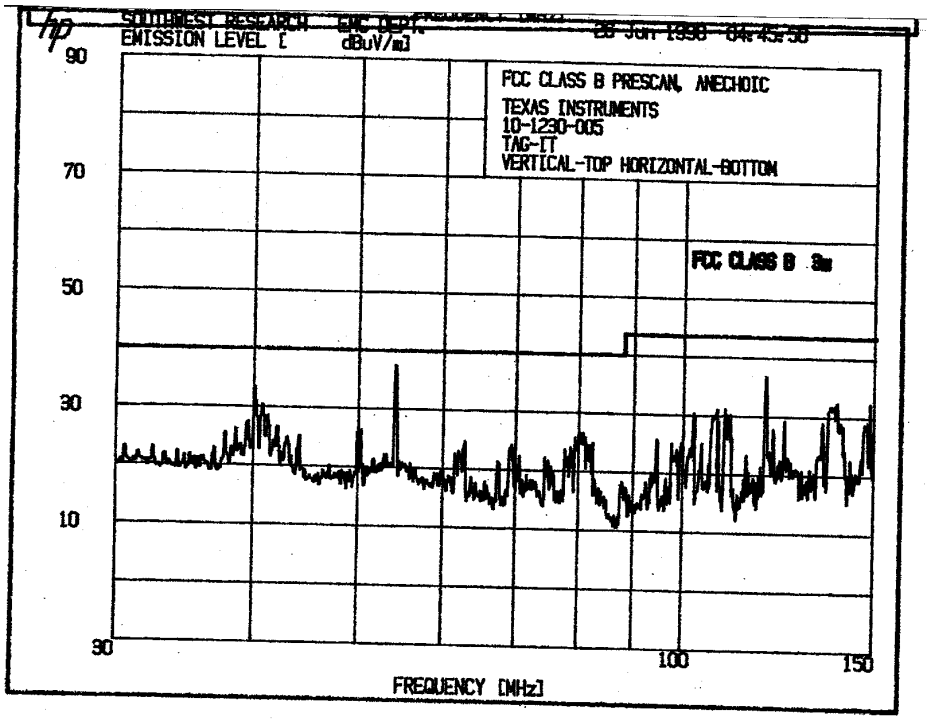


Horizontal Axis



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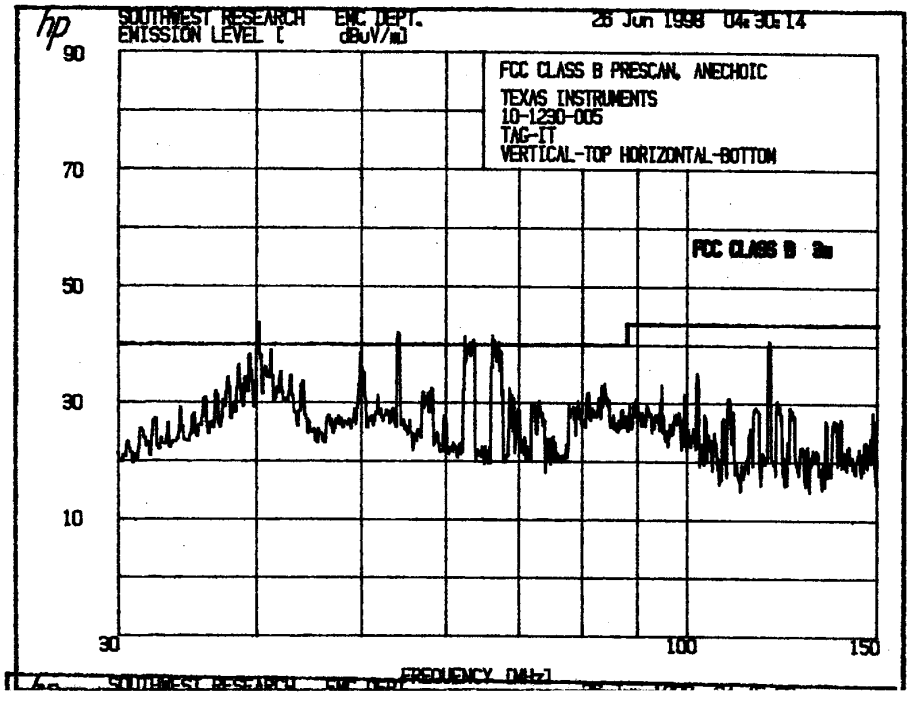

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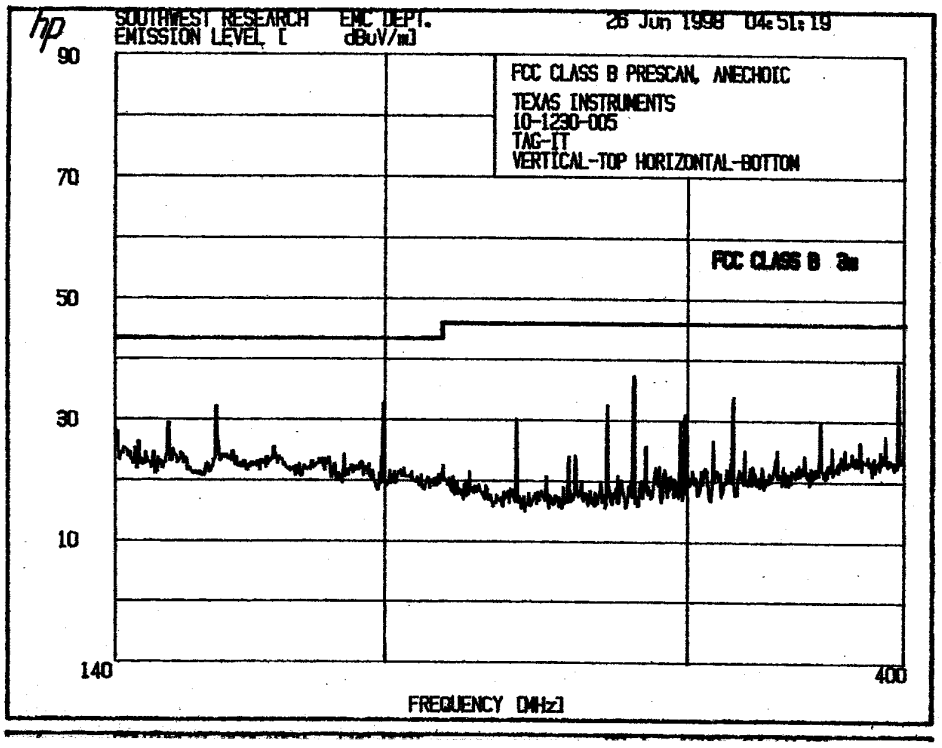

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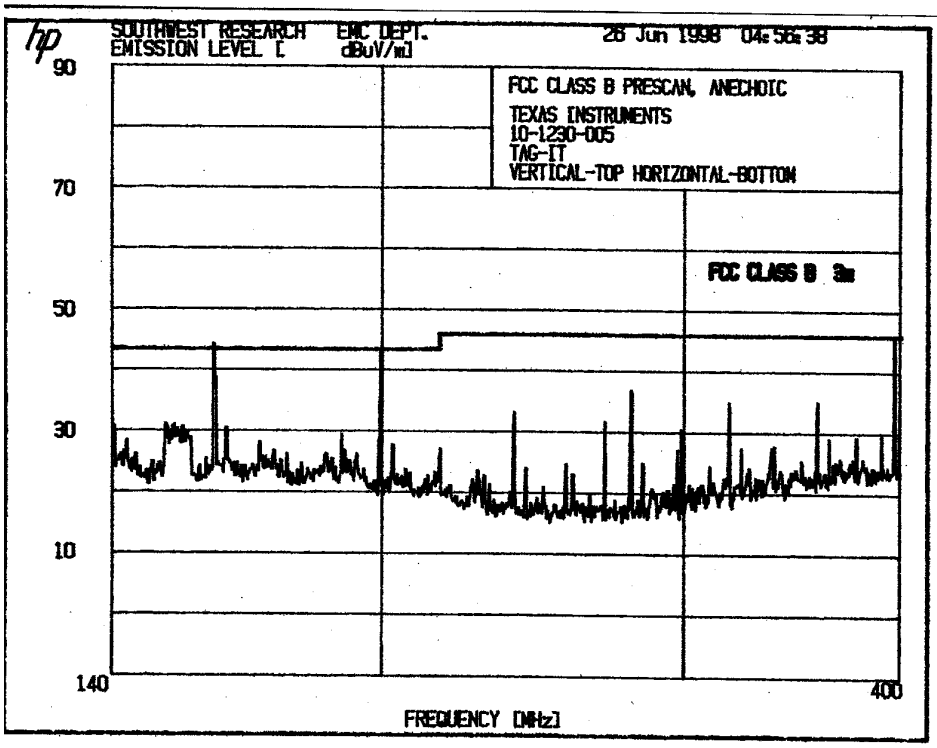

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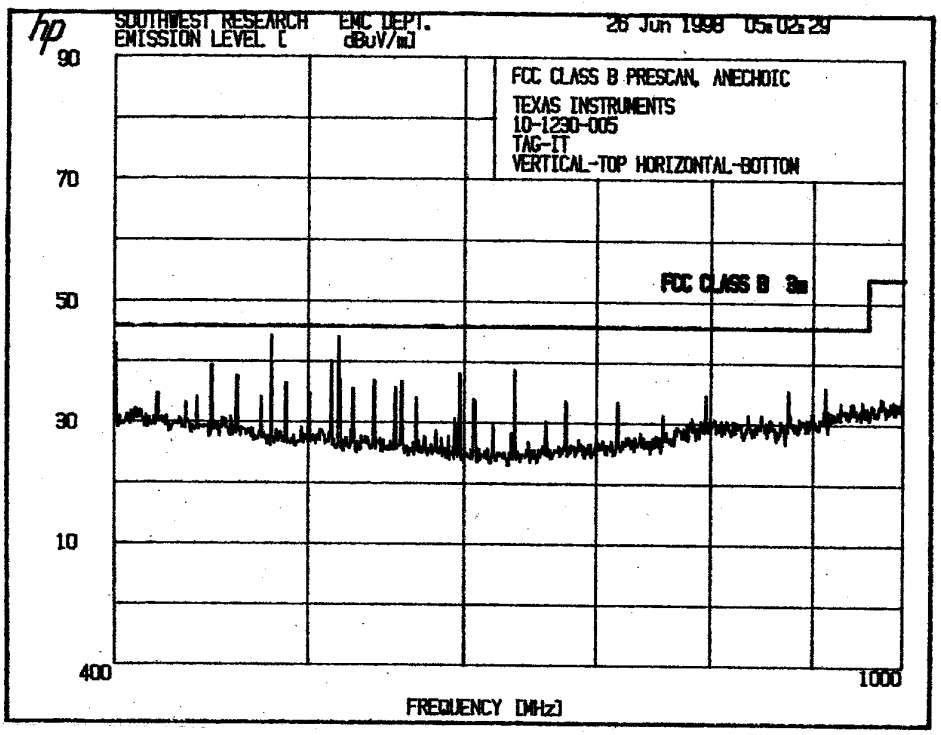
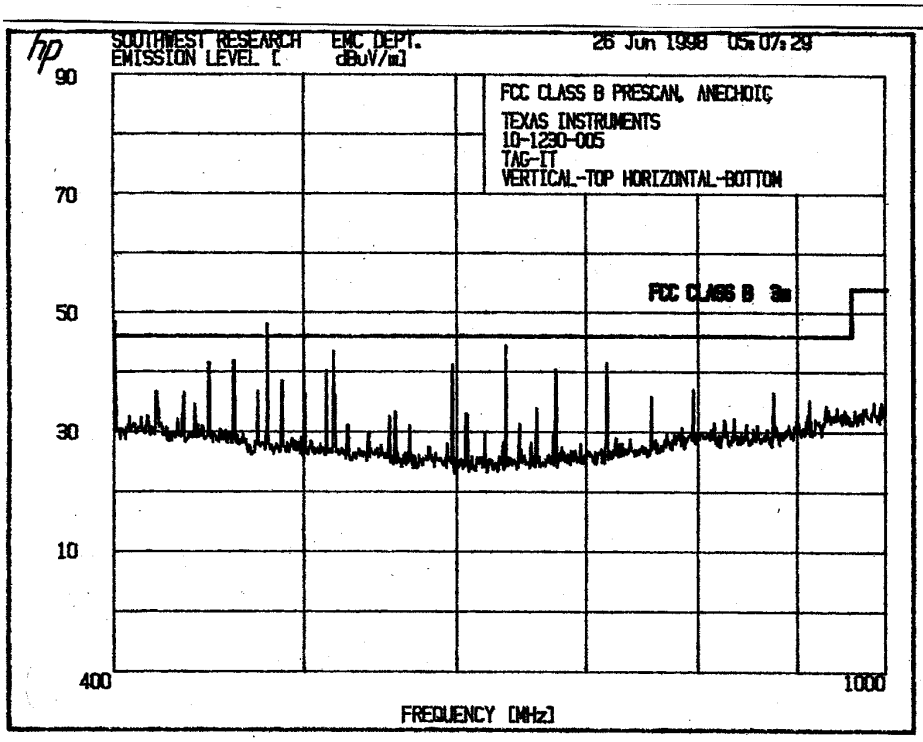


Vertical Axis



Horizontal Axis

APPENDIX B

TEST INSTRUMENTATION

EQUIPMENT USE REPORT

MANUFACTURER	MODEL NO.	DESCRIPTION	SERIAL NO.	CAL DATE
ANECHOIC CHAMBER				
SWRI	UTC 10 221-1	10-1000 MHz 35dB GAIN PR	9112SN15	NCR
HP	9816	CONTROLLER	2320A06479	NCR
EMCO	3121-DB3	ANTENNA, DIPOLE	148	verified
EMCO	3121-DB4	ANTENNA, DIPOLE	1097	verified
EMCO	3121-DB2	ANTENNA, DIPOLE	147	verified
OATS				
POLARAD	ESV	RECEIVER, EMI	872147/53	01NOV98
POLARAD	ESH2	RECEIVER, EMI	879014/018	14NOV98
SWRI	2 MHz-1GHz	OATS PRE-AMP	1	NCR
TEKTRONIX	PS280	POWER SUPPLY	TW51893	NCR
ELECTROMETRICS	BDA25S	ANTENNA, DIPOLE	535	26SEP98
EMPIRE	DM-105-T2	ANTENNA, DIPOLE	L-000176B	26SEP98
EMPIRE	DM-105-T3	ANTENNA, DIPOLE	L-000175	26SEP98
FLUKE	6060A	SIGNAL GENERATOR	3690008	26AUG98
ELECTROMETRICS	ALR-25	LOOP ANTENNA	371	16DEC98
RHODE & SWARTZ	1027.3001.30	TEST RECEIVER, 9 kHz to 2050 MHz	836133/003	24APR99

Appendix C

Photographs of Test Unit

(Word97 file “a92SwRIpic.doc”)

Attachment 1

Description of TIRIS Stationary Unit

System Overview

The Tag-it™ system is comprised of a transponder (or tags), reader(s) and its antenna(s). The reader is controlled by a host system such as a PC, a larger computer, or some other kind of intelligent device (for example a ticket printer).

During a transaction, the transponder (tag) is permanently powered by the signal sent by the reader. This signal also provides the clock frequency to the transponder. It is amplitude modulated to transmit requests from the reader to the transponder (tag). In order to transmit responses to the reader, the transponder (tag) derives the operating energy and the clock from the reader's power signal to generate the sub-carrier frequencies. Modulation depth is 100% and is influenced by the coupling factor between the reader's antenna and the transponder, and thus by the distance between them. The emissions from transponders (tags) was not measurable and well below the regulated limit. The passive tag is not required to be separately certified.

Tag-it Reader (TI PN RI-R00-320A)

A typical reader consists of three electronic boards (interface, digital CPU and analog RFM) and an antenna. The reader can be powered with 12 V_{DC} by either battery or DC source through the interface board. The interface board (TI PN RI-R00-232A) provides on/off switch, power and RS-232 data communication connections. Both interface board and digital CPU have built-in DC filters and voltage regulators. Interface board and digital CPU may not be required if the reader (analog RFM) is integrated into application peripheral such as a thermal demand printer or fixed-point identification system. Typically, the printer would not require the interface board. The data is transmitted through the RS-232 port that is connected to its host (Application Processor) through a serial processor or a Local Area Network (LAN). It sends energy and commands to, and receives signals from the transponder through the antenna.

The basic reader includes a transmitter (with crystal oscillator), receiver and control components. The transmitter operates at a ISM frequency of 13.56 MHz with a defined bandwidth of ±7 kHz. A magnetic field is generated and supplies energy (100% ASK or full duplex) to the batteryless tag and maintains the data communication (FSK modulation) between transponder and reader. The data is transferred from the tag at 26.7 kBaud per second and 37.42 μsec bit length using two fixed side band sub-carrier frequencies of 13.56 MHz ± 423.75 kHz (high) and ± 484.29 kHz (low) through Manchester encoding.

The digital CPU module (TI PN RI-CTL-0320-00) routes communication instruction (serial protocol) set from the computer and processes the tag data through digital signal processor (DSP). CPU module has an on-board 5V DC regulation for its logic circuitry. The analog RFM (transmitter / receiver, TI PN RI-RFM-320) uses down-loadable firmware (TI PN RI-S00-320) to interrogate and respond to the tag through the protocol and energy from the antenna. The firmware can not change any system's output parameters affecting regulated emissions. The antenna module is attached to the reader by 50Ω coaxial cable. The antenna module (TI PN RI-A00-0315) includes a loop wire and matching circuit board (TI PN RI-A00-M50A). The matching circuit board allows 50Ω impedance at 13.56 MHz giving maximum output.

Attachment 1 (continue)

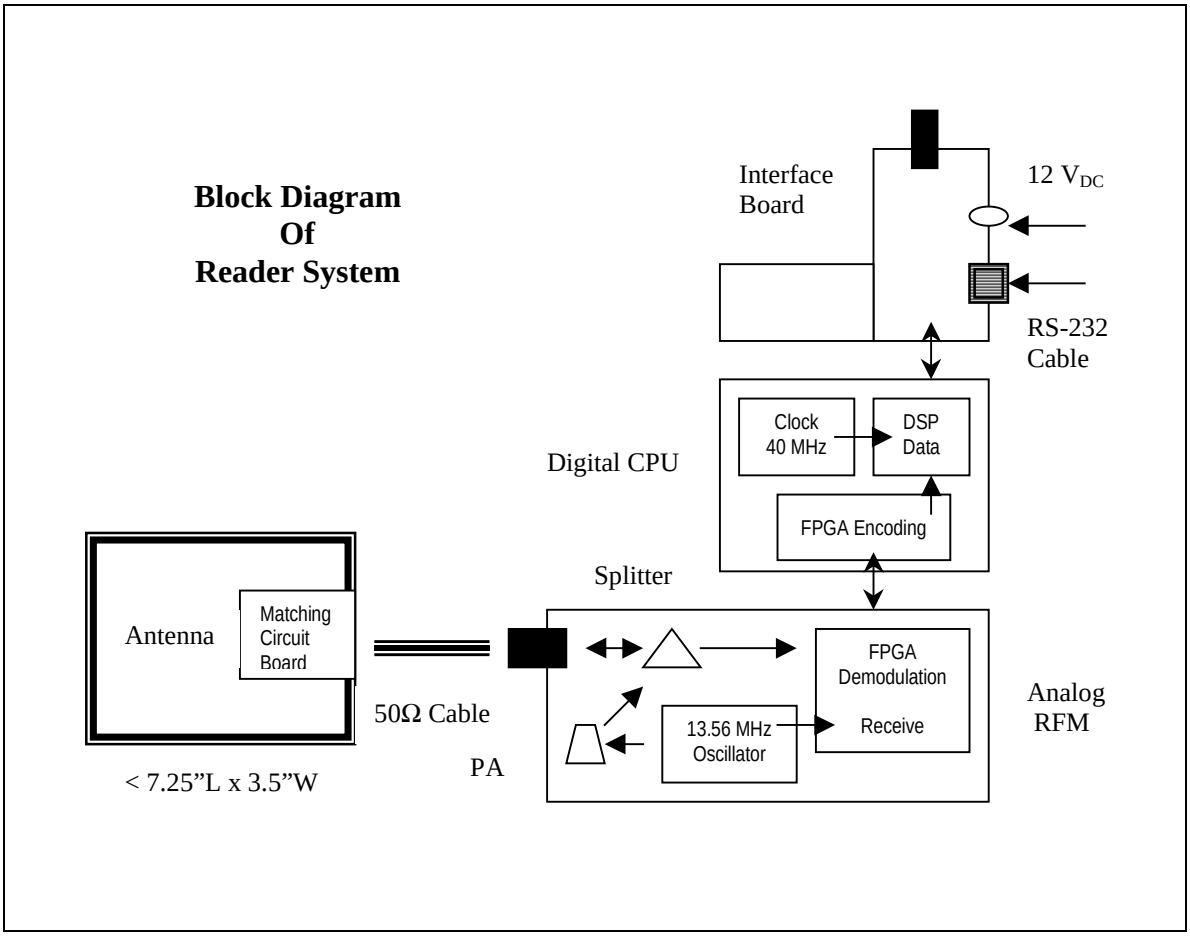


Figure 1: Block Diagram of Reader System

The RF block diagram of the reader is illustrated in Figure 2 in Word97 file "a92rfblock.doc" regarded as FCC Confidential information. The front-end circuitry uses a power-splitter followed by a crystal filter in the receiving path and crystal based sinusoidal wave oscillator. Transmitter generates a RF power output of +20.78 dBm at impedance of 50Ω.

Attachment 1 (continue)

Transponder (Tag)

A Tag-it transponder (tag inlay) comprises a flexible foil antenna, a resonance capacitor and an integrated circuit. The tag inlay can be packaged in different formats such as pressure sensitive labels and plastic cards. The transponder's IC is powered by the electromagnetic field generated by the reader's antenna, this is generally described as a passive transponder.

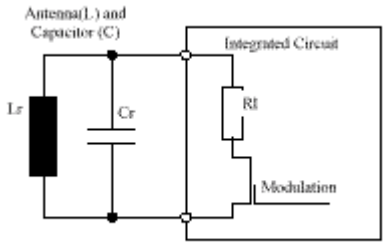


Figure 3: Block Diagram of the Transponder

The IC is flip chip mounted onto the antenna. The electrical parameters of the components: the antenna (including its inductance) and the resonance capacitor; and the layout of the antenna loops all have an effect on the transponder's performance. The L_r/C_r resonance circuit is trimmed to the required target frequency to achieve optimal performance.

The tag uses two sub-carrier AM modulation frequencies for sending its data to the Reader (up-link). The data are encoded in Manchester code by alternating between both sub-carrier frequencies, such generating an FSK modulation scheme. The emissions from transponders (tags) was not measurable and well below the regulated limit. The passive tag is not required to be separately certified.

Attachment 2

Operate to Test

The Tag-it Commander is the reader in the system. It is designed to operate with loop antennas having dimensions of 7.25" (L) x 3.5" (W) or less. Smaller dimension antennas may be employed in order to address applications that have limited space and shorter read range requirements such as the installation of the Tag-it reader in a printer that would also apply the transponder or read a transponder that had been applied to a page or object that was to be presented to the printer to receive an imprint. Such antennas could be fabricated on a printed wiring board assembly rather than being a wire loop enclosed in a plastic case such as shown in page 2 (Word97 file: "a92SwRIpic.doc"). Smaller loop antennas would radiate a lower level RF field than would the antenna shown in this application. In order to accommodate smaller antennas, TI requests that this modular device be authorized with the following condition pertaining to the antenna:

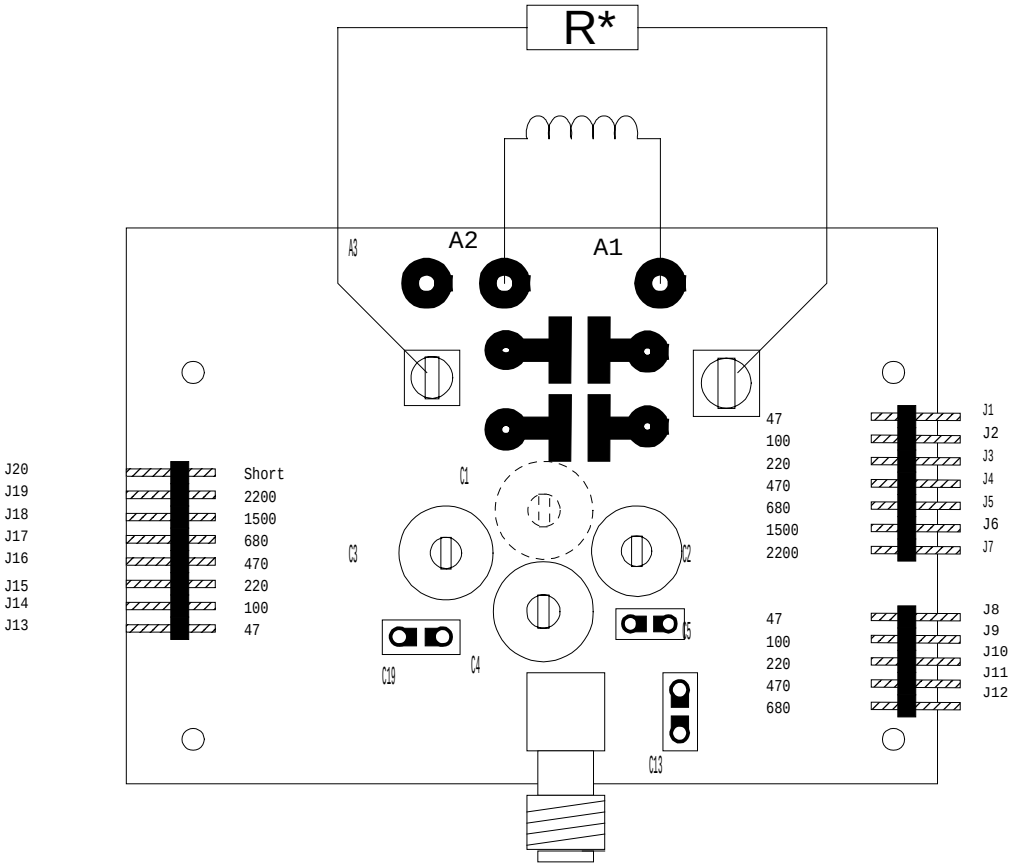
> **This device is approved for use only with a loop antenna having dimensions that do not exceed 7.25" (L) by 3.5" (W). Versions of this device that use larger antennas must be approved as a Class II permissive change, if applicable, or under a new grant of equipment authorization.**

Any antenna connected to this device will need to be matched to the output of the reader. This will require that the Tag-it reader be placed in continuous mode. Note that the adjustments set forth below are not adjustments that are to be made by end users. Instead, they are to be made at the time that any alternative antenna is tested and before the Tag-it reader is incorporated into another device. The following procedure should be used in order to accomplish this adjustment.

Steps:

Note: The following adjustments should be undertaken only by a trained electronics technician.

1. Connect the reader to a 12V /1A DC power source and the RS 232 interface cable to the interface board.
2. Run the Tag-it Navigator demonstration software on the host computer and check connection with command : > Get Commander version <
3. Place transponder (tag) over the antenna
4. Click command >Get Block <, the tag will be recognized with 32 bit default block data column.
5. Click command > Continuous <
6. Click command > Repeat last <, the tag will be continued to be recognized until the tag is removed.
7. Maximum read distance occurs when antenna is fully tuned at 50Ω impedance and 13.56 MHz. The housing that covers the antenna matching network circuit should be removed and the three capacitors located in board's center should then be adjusted individually in sequence until achieving maximum distance when the tag is parallel with the antenna. Jumpers (J1-J20) are preset and should not be moved.



All variable capacitors are 5 - 99 pF

* Value depends on antenna inductance

Adjustable Antenna Matching Network
Component Placement

Attachment 3

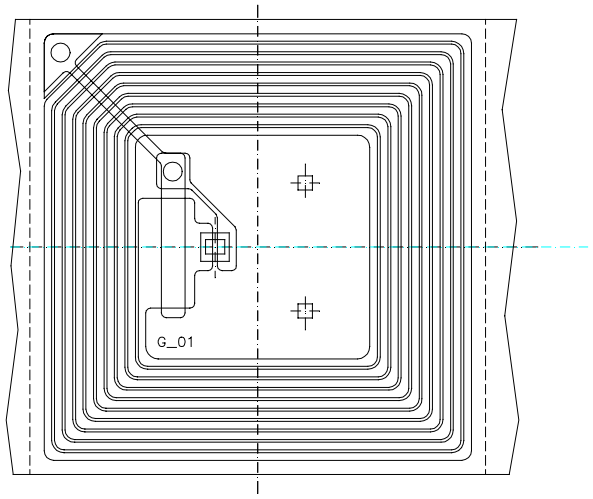
13.56 MHz Tag-it™ Foil Inlay
Coil Size: 45mm x 45mm

Product Description:

The Tag-it™ Foil Inlay represents a new generation of transponders with a working frequency of 13.56 MHz. It is a very thin, batteryless, general purpose read/write transponder on a polymer tape substrate. Data can be stored in a 256bit non-volatile user memory, organized in 8 blocks, which are user programmable in the field. Each block can be locked to protect data against future modification. An important feature is the 'SID' algorithm, which allows to read a multiplicity of transponders within the read range area.

Fig.: Tag-it™ Foil Inlay (on tape)

Top View



Side View

ADVANCE INFORMATION

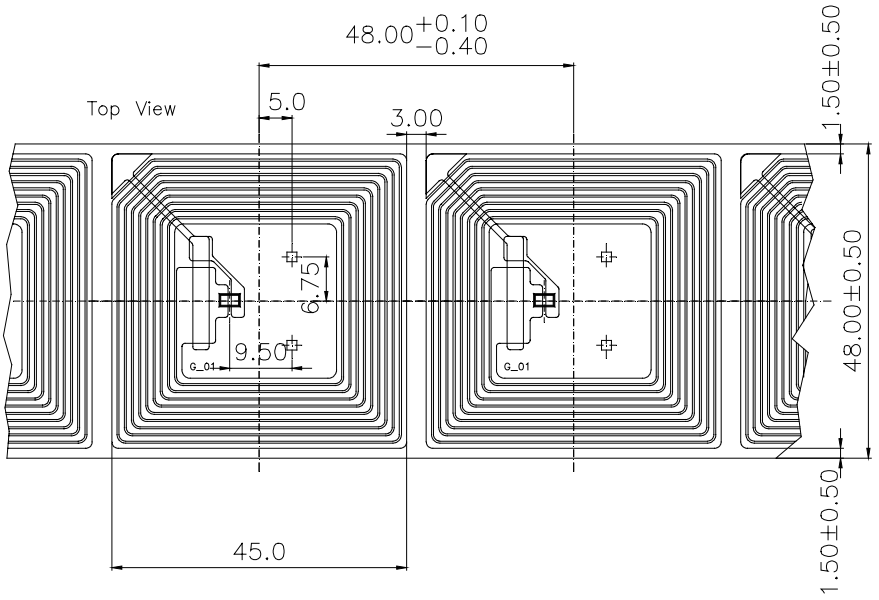
Features:

- 256 Bit user memory size, organized in 8 x 32 bit non-volatile memory
- Field programmable
- Data locking, separately for each 32 bit data block
- Built-in 'SID' (Serial Identification) algorithm, based on 32 bit factory-programmed Address
- 32 bit mask programmed manufacturer, version and function identification
- CRC-CCITT secured data transmission
- Thickness less than 0.38mm
- Delivery as tape material on reel

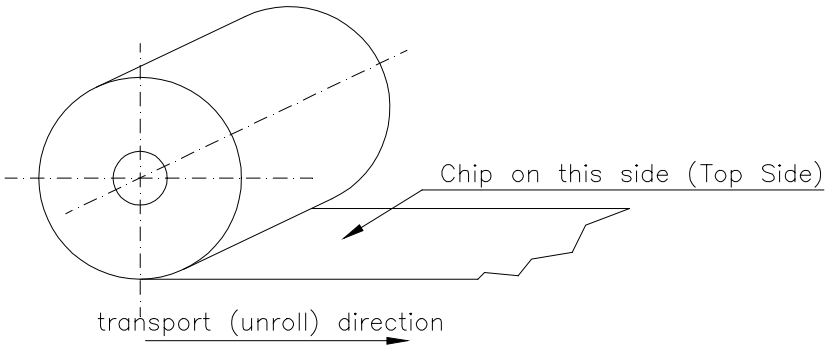
Attachment 3 (continue)

Dimensions:

all Dimensions in [mm]



Orientation on tape:



ADVANCE INFORMATION

Attachment 3 (continue)

Technical Data:

Electrical Data:

Operation Frequency:	13.56 MHz +/- 100ppm
Quality Factor:	typ. 32 at 22°C
Activation Fieldstrength:	Read: typ. 155 dBµV/m Write: typ. 161 dBµV/m
Maximum Operation Fieldstrength:	184 dBµV/m
Transmission Speed:	Uplink: 26.7kBaud Downlink: 9/6.2 kBaud
RX Modulation:	Pulse width coded, AM 100%
TX Frequencies:	Manchester coded, f_C +/- 423.75 kHz f_C +/- 484.29 kHz Low Bit: transition 423.75 kHz to 484.29 kHz High Bit: transition 484.29 kHz to 423.75 kHz

Environmental/Mechanical Data:

Operating Temperatures:	-40°C to + 60°C
Storage Temperatures:	-40°C to + 85°C
Thickness:	Chip- and Through-Contact Position - Max.: 0.375mm All other area - Max.: 0.085mm
Base Material:	Substrate: PET (Polyethylentherephtalat) Conductive Area: Aluminum
Handling: min. Bending Radius:	 Chip to Radius : 30mm Chip away from Radius : 15mm
Delivery:	on Cardboard-Reels, Diameter: 500mm Width : approx. 60mm Inside Width: 50mm ; Hub Diameter: 3 inch approx. 8000 Tag-it™ Foil Inlays per Reel

ADVANCE INFORMATION

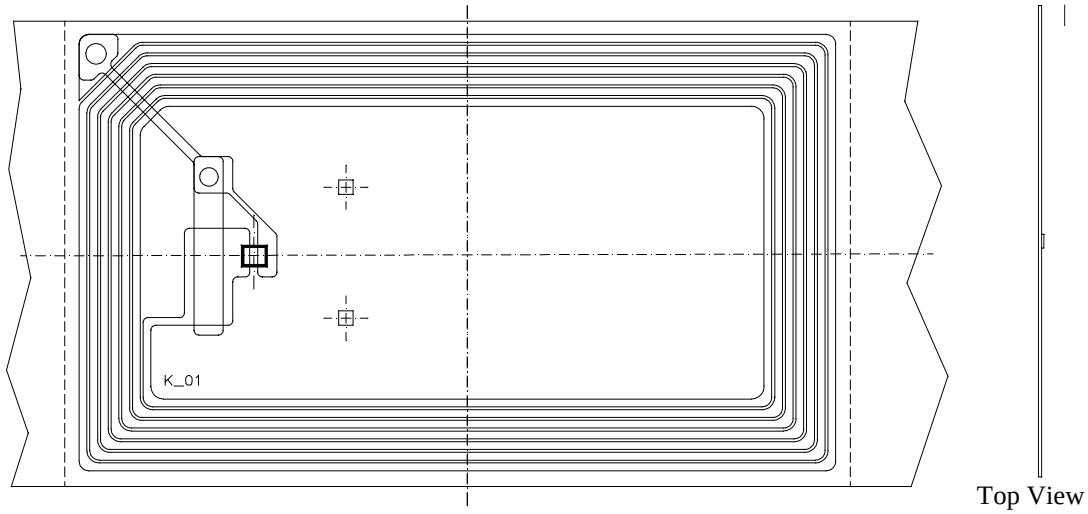
Attachment 3 (continue)

13.56 MHz Tag-it™ Foil Inlay
Coil Size: 45mm x 76mm

Product Description:

The Tag-it™ Foil Inlay represents a new generation of transponders with a working frequency of 13.56 MHz. It is a very thin, batteryless, general purpose read/write transponder on a polymer tape substrate. Data can be stored in a 256bit non-volatile user memory, organized in 8 blocks, which are user programmable in the field. Each block can be locked to protect data against future modification. An important feature is the 'SID' algorithm, which allows to read a multiplicity of transponders within the read range area.

Fig.: Tag-it™ Foil Inlay (on tape)



ADVANCE INFORMATION

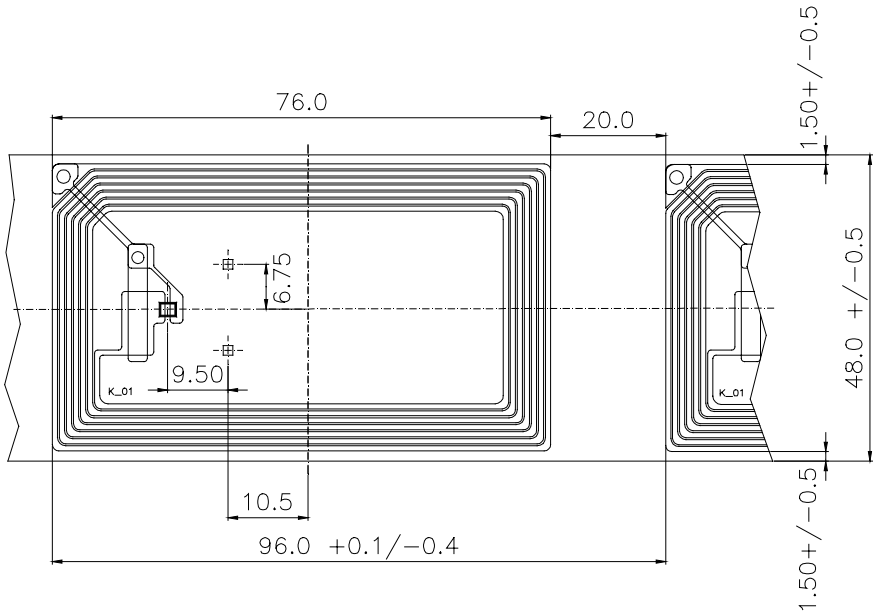
Features:

- 256 Bit user memory size, organized in 8 x 32 bit non-volatile memory
- Field programmable
- Data locking, separately for each 32 bit data block
- Built-in 'SID' (Serial Identification) algorithm, based on 32 bit factory-programmed Address
- 32 bit mask programmed manufacturer, version and function identification
- CRC-CCITT secured data transmission
- Thickness less than 0.38mm
- Delivery as tape material on reel

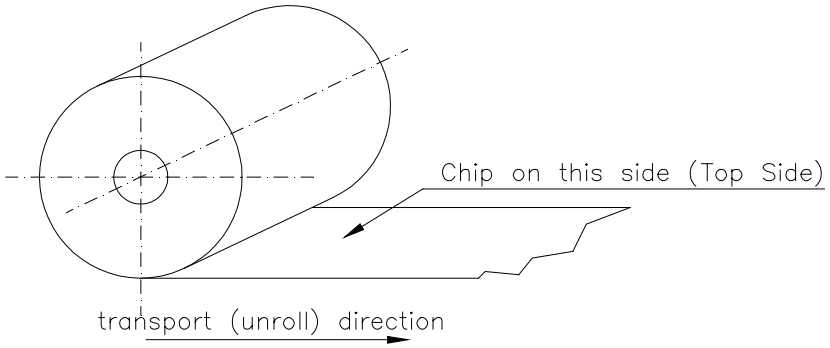
Attachment 3 (continue)

Dimensions:

all Dimensions in [mm]



Orientation on tape:



ADVANCE INFORMATION

Attachment 3 (continue)

Technical Data:

Electrical Data:

Operation Frequency:	13.56 MHz +/- 100ppm
Quality Factor:	typ. 34 at 22°C
Activation Fieldstrength:	Read: typ. 152 dBµV/m Write: typ. 159 dBµV/m
Maximum Operating: Fieldstrength	184 dBµV/m
Transmission Speed:	Uplink: 26.7kBaud Downlink: 9/6.2 kBaud
RX Modulation:	Pulse width coded, AM 100%
TX Frequencies:	Manchester coded, f_C +/- 423.75 kHz f_C +/- 484.29 kHz Low Bit: transition 423.75 kHz to 484.29 kHz High Bit: transition 484.29 kHz to 423.75 kHz

Environmental/Mechanical Data:

Operating Temperatures:	-40°C to + 60°C
Storage Temperatures:	-40°C to + 85°C
Thickness:	Chip- and Through-Contact Position - Max.: 0.375mm All other area - Max.: 0.085mm
Base Material:	Substrate: PET (Polyethylentherephtalat) Conductive Area: Aluminum
Handling: min. Bending Radius:	 Chip to Radius : 30mm Chip away from Radius : 15mm
Delivery:	on Cardboard-Reels, Diameter: 500mm Width : approx. 60mm Inside Width: 50mm ; Hub Diameter: 3 inch approx. 4000 Tag-it™ Foil Inlays per Reel

ADVANCE INFORMATION

Attachment 4

RF Block Diagram of Reader

(Figure 2, Word97 “a92rfblock.doc”, page 1, regarded as FCC Confidentiality)

Attachment 5

Electrical Schematics of Reader's Components

(Postscript files *.psc & *.eps regarded as FCC Confidentiality)

a) Analog RFM (TI PN RI-RFM-0320), Drawing # 00121-A-01 (6 pages), sch_*of6.eps

b) Digital CPU, (TI PN RI-CTL-0320-00), Drawing # 00118-A-01 (5 pages), 118a01p*.psc

c) RS-232 Interface (TI PN RI-R00-232A), Drawing # 00120-A-01 (1 page), 232_12v.psc

d) Antenna Matching Network (TI PN RI-A00-M50A), Drawing # 00119-A-01 (1 page), a92amnsc.doc

Attachment 6

Instruction Manual

Because this device will be incorporated into other devices and will function automatically, there is no separate users manual. However, information required under Part 15 of the Rules will be supplied for insertion into the manuals of devices into which this device is incorporated. The following information will be supplied:

NOTE: This equipment contains a intentional radio frequency radiator approved under the requirements off FCC Rule Part 15. This equipment also contains digital circuitry that has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NO MODIFICATIONS: Modifications to this device shall not be made without the written consent of the party that has been issued the grant of equipment authorization by the Federal Communications Commission for the intentional radiator contained in this device and the party responsible for verifying compliance of this device with the FCC Rules pertaining to emissions from unintentional radiators such as the digital circuitry contained within this device. Unauthorized modifications may void the authority granted under Federal Communications Commission Rules permitting the operation of this device.

Texas Instruments will also prepare a manual that details the handling and installation of this device into other devices. This manual, which will set forth the requirement to incorporate the above language into end user manuals, will be supplied by TI to those companies that purchase the Tag-It™ Commander™ into their products.