Spectrum Wireless

2010ET

10 Mbps Spread Spectrum
Wireless Transceiver

User Manual

Notices:

The information in this document is preliminary. The manufacturer assumes no responsibility for any errors that may appear in this document.

Ethernet and Ethernet II are trademarks of XEROX.

LANalyzer is a registered trademark of Novell, Inc.

The manufacturer assumes no responsibility for damage caused by interference due to this equipment.

Regulatory Notices:

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.

Pursuant to Part 15.21 of the FCC Rules, any changes or modifications to this equipment not expressly approved by Spectrum Wireless may cause harmful interference and void the FCC authorization to operate this equipment.

The revision of this document is 1.2.

Table of Contents

1. Introduction

1.1 WELCOME

The 2010ET is a wireless transceiver providing 10 Mbps burst data rate to support wireless connections for IEEE 802.3 and Ethernet II (TCP/IP) LANs. The 2010ET functions as an Ethernet MAU[1]; the MAC[2] frame from a standard AUI[3] port is encapsulated to form an RF MAC frame. It uses state-of-the-art spread spectrum technology to implement robust 10 Mbps burst transmissions. It also actualizes efficient utilization of frame buffers and coordination of RF and wired interface traffic to maintain high throughput. In addition, the 2010ET offers true “Plug and Play” - no additional driver software is required for operation. The 2010ET can be connected not only to a computer but also to a hub or to a router. Accordingly, you can create various kinds of innovative LANs combining existing wired devices and 2010ETs, while still protecting your investment in existing network equipment.

[1] **Medium Attachment Unit**

[2] **Medium Access Control**

[3] **Attachment Unit Interface**

1.2 FEATURES OF THE 2010ET

The 2010ET has the following features;

- Full wireless Ethernet 10 Mbps data rate.
- State-of-the-art spread spectrum technology provides reliable, secure, long range, radio link operation.
- True “Plug and Play” installation for compatibility with all 802.3 and Ethernet II LAN devices, all operating systems and all protocol stacks.
- Configurable parameters for modifying link behavior.

2. Structure

2.1 BLOCK DIAGRAM

Figure 2-1 shows a block diagram of the 2010ET.

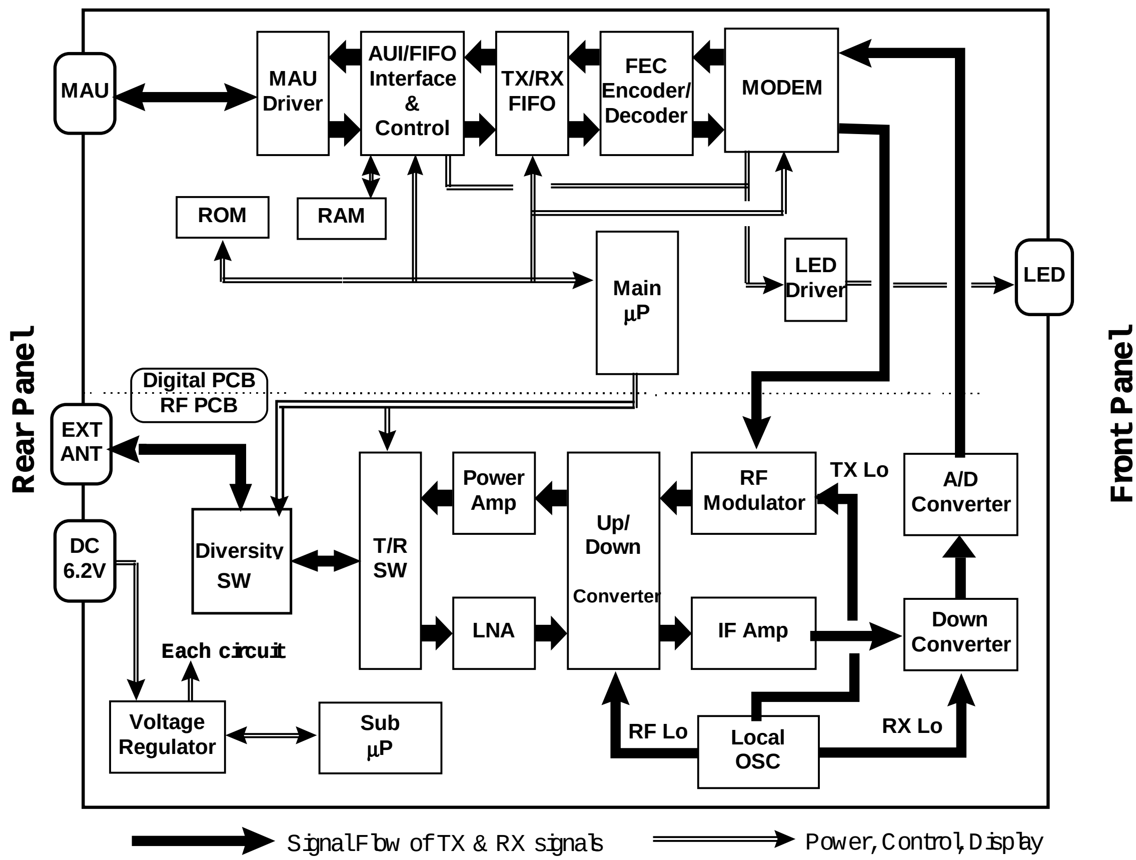


Figure 2-1

2.2 DESCRIPTION OF BLOCK

MAU port: The AUI port of an Ethernet device connects to the MAU port of the 2010ET through a transceiver cable (AUI cable). The connector type is physically the same as for a standard MAU.

MAU Driver: Bi-directional driver to the MAU port.

AUI/FIFO Interface & Control: provides fast-in-fast-out buffer management using *TX/RX FIFO* to minimize the degradation of the throughput.

TX/RX FIFO: FIFO RAM managed by *AUI/FIFO Interface & Control*.

FEC Encoder/Decoder: Encoder and decoder for efficient forward error correction.

MODEM: generates baseband transmission signals corresponding to the uploaded data stream or control data generated by the *Main μP*. It also regenerates the received data bit stream corresponding to the output of the *A/D Converter*.

RF Modulator: modulates the IF carrier by the output of the *MODEM*.

Up/Down Converter: up-converts the modulated RF signal of the *RF Modulator* to radio transmission signals in the 2.4 GHz band. It also down-converts incoming RF signals of the 2.4 GHz band to IF signals.

Power Amp: amplifies the 2.4 GHz band signals up to transmit power .

RF SW: switches the signal flow from an antenna to a receiver or from the *Power Amp* to the antenna.

Diversity SW: switches the antenna to use the internal antenna or the external antenna, controlled by the *Main μP* to improve reception.

Ext. Ant. port: The external antenna connects to this port. RF signals at 2436 MHz are transmitted or received. The connector type is SMA female.

LNA (Low Noise Amplifier): reduces the noise figure of the receiver to obtain sufficient sensitivity.

Local OSC: provides local signals fed to the *Up/Down Converter* , to the *RF Modulator* and to the *Down Converter*.

IF Amp: amplifies the IF signal of 487 MHz enough to be handled by the *A/D Converter*.

Down Converter: regenerates baseband signals from IF signals fed to the *A/D Converter*.

A/D Converter: converts analog baseband signals to digital signal stream for the *MODEM*.

Main μP (Micro Processor): controls the signal flow, hardware functions, and the protocol.

DC 6.2V port: The output of the AC adapter connects to this port. This voltage is tightly specified. Please contact Spectrum if you need to use alternate power sources.

LED: indicates operating situations of the 2010ET. Please refer to the specifications for detail.

Sub μP : controls power fed to each circuit of the 2010ET.

2.3 PRINCIPLE OF OPERATION

2.3.1 UPLOAD PROCESS

The ***Upload*** is defined as data flow from an Ethernet device to the 2010ET. On the ***Upload***, it provides the following;

- detection of preamble of the Ethernet frame followed by the frame sync pattern;
- suppression of the Ethernet preamble and frame sync[4] for RF transmission;
- generation of a ***Collision*** signal if an ***Upload*** commences while the AUI interface is busy; generation of the busy ***Collision*** is selected through configuration setup; This enables the 2010ET to force the Ethernet card into its exponential back-off algorithm for flow control; If generation of the ***Collision*** is not selected, then no ***Collision*** is generated but ***Upload***s are ignored.
- generation, when enabled through the configuration setup, of the ***SQE*** (Signal Quality Error) test signal toward the MAU port;
- FEC-encoding, when FEC is enabled through configuration setup;
- generation of header information (RF MAC and RF physical layer);
- spread-spectrum carrier sense[5] before transmission, with preference given to reception;
- data and spread-spectrum modulation onto a carrier of 2.4 GHz and RF transmission.
- Figure 2-2 shows a encapsulation process described above.

---

[4] These portions of the frame are meaningless for wireless transmission.

[5] 2010ET Senses signals after correlation. It means that interference, such as microwave ovens and different kinds of wireless LAN systems, cannot be sensed.

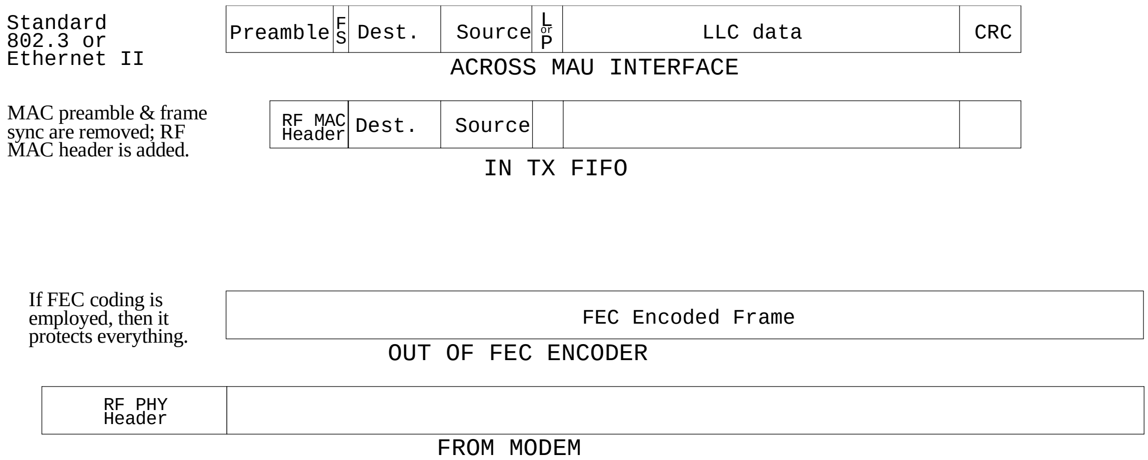

Standard 802.3 or Ethernet II
Preamble
F S
Dest.
Source
L or P
LLC data
CRC
ACROSS MAU INTERFACE
MAC preamble & frame sync are removed; RF MAC header is added.
RF MAC Header
Dest.
Source
IN TX FIFO
If FEC coding is employed, then it protects everything.
FEC Encoded Frame
OUT OF FEC ENCODER
RF PHY Header
FROM MODEM

Figure 2-2

2.3.2 DOWNLOAD PROCESS

The ***Download*** is defined as data flow from the 2010ET to an Ethernet device. On the ***Download***, it provides the following;

- detection of and time alignment to received radio signal;
- demodulation of PHY header and MAC frame;
- FEC decoding when the 2010ET recognizes that the received frame is FEC encoded by reading the PHY header;
- checking of 32-bit CRC (generated by an Ethernet card which ***Upload***ed the frame);
- conversion of serial stream to bytes for storing in FIFO;
- regeneration of the Ethernet preamble and frame sync;
- detection of collision conditions for avoiding collisions when ***Downloading*** or ***Uploading*** and signaling of such a condition to the AUI interface and to the CPU.

2.3.3 BUFFER MEMORY

A data transfer is called an ***Upload*** when the Ethernet device conveys a frame to the buffer memory, and a ***Download*** when a frame is conveyed from the buffer memory to the Ethernet device. The buffer memory is organized as 16 2-Kbytes FIFOs; each FIFO being independently employed and capable of storing a maximum-length Ethernet frame of 1518-bytes.

When all buffers are consumed, a ***Collision*** signal is generated to force the Ethernet card into its exponential back-off algorithm for flow control. If generation of the ***Collision*** is not selected, then no ***Collision*** is generated but ***Upload***(s) are ignored.

2.3.4 FORWARD ERROR CORRECTION (FEC)

The nominal transmission mode (uncoded mode) employs modulation without FEC. The enhanced-robustness mode (coded mode) employs FEC to overcome errors due to multipath propagation conditions. The coded mode and/or selection of a diversity antenna can be selected by the RF-MAC-level re-transmission protocol.

2.3.5 RE-TRANSMISSION

A re-transmission protocol at the RF MAC layer provides enhanced reliability. The 32-bit CRC, checked by the 802.3 MAC layer to provide ultimate data reliability, is also used to support the re-transmission protocol.

Figure 2-3 shows the conceptual signal flow diagram of the re-transmission.

The use of the MAC-level re-transmission protocol, recommended by 802.11 draft standard, is important for high throughput. Re-transmission via the level-four transport protocol must be avoided because of the long time-out typically employed.

Prior to the re-transmission, the 2010ET recognizes and memorizes the source MAC address of an Ethernet device connected to the 2010ET through the MAU port. The ***Download*** occurs only when the 2010ET recognizes the memorized source MAC address and destination MAC address written in a received radio frame. Once the 2010ET memorizes the source MAC address, no update of the source MAC address is performed in the 2010ET unless the power turns off.

Please Note: The re-transmission function is not suitable for implementation when multiple MAC addresses are reported on the MAU port, such as when the unit is connected to a hub. In this case, we recommend that the 2010ET be configured with re-transmission disabled.

The re-transmission protocol is based on the recognition of acknowledgment generated by a 2010ET that received a radio data frame from another. A radio frame that carries the acknowledgment is called an ***Ack***-frame and affects only the RF MAC level protocol. Contents of the ***Ack***-frame never appear at the MAU port. The ***Ack***-frame is transmitted immediately after reception is completed.

The re-transmission is not available for Broadcast-frames because no Ack-frame can be transmitted for Broadcast-frames[6].

Figure 2-3 shows two different causes of re-transmission. One is missing an ***Ack***-frame (Ack #2) and another is missing a data-frame (Data #3). In each case, the 2010ET #1 receives no return of the ***Ack***-frame from the 2010ET #2. The 2010ET #1 then initiates the re-transmission. The 2010ET #1 also recognizes that a duplicate frame has been received which it then filters out (i.e. download does not occur). This function is called ***Duplicate filter***.

The duplicate filter is functional only when a single Ethernet device is connected to the 2010ET. The function will be updated in the future to make it available for multiple Ethernet devices.

Duplicate frames the 2010ET has not filtered out will be removed by a function of ***NOS*** (Network Operating System). The number of re-transmissions is limited to seven (i.e. eight transmission totally).

Accordingly, if no transmissions succeeded after seven re-transmissions, then the re-transmission will depend on the re-transmission function provided by the ***NOS*** protocol.

The value of the time-out is currently fixed at 300 μsec. It will be updated to be user-definable through configuration setup in the future to support various ranges of wireless links.

---

[6] **Contains a destination address of all 1 bits.**

indicates missing radio frame.
Note: No duplicate frame is downloaded when a single ethernet device is connected to the unit.

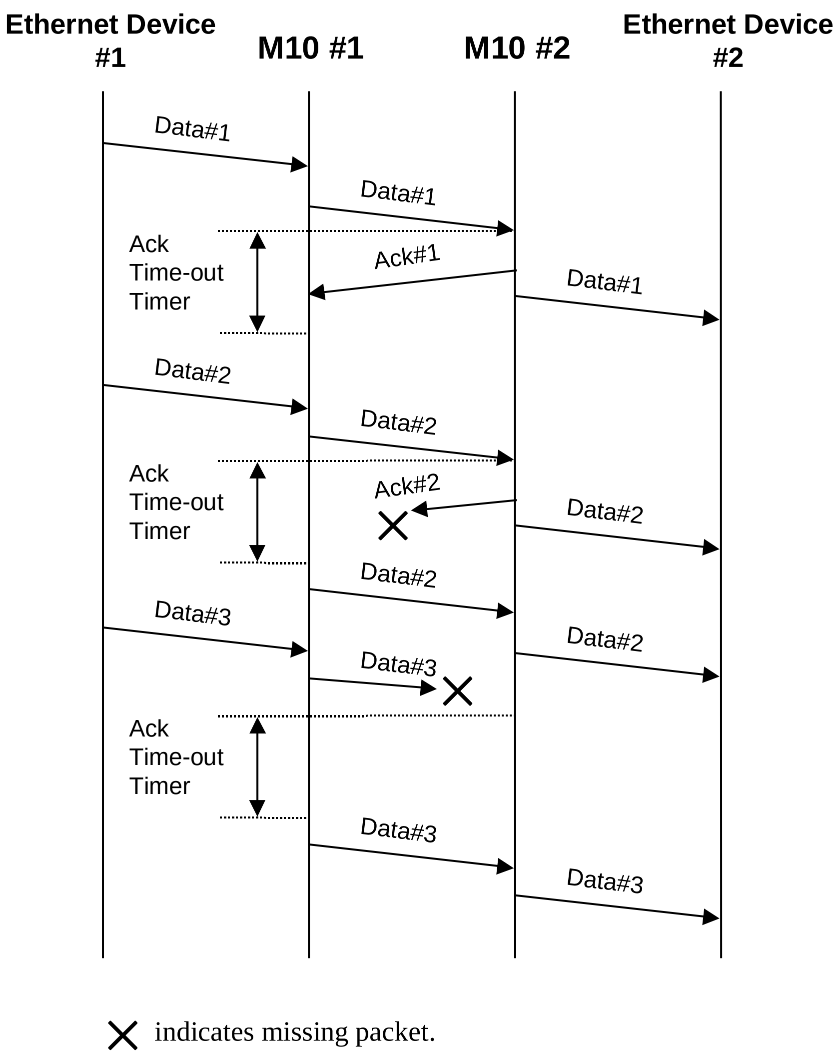


Figure 2-3

2.3.6 SECURITY

Security is of great concern with any wireless transmission system because it is more susceptible to eavesdropping than wired transmission systems. The 2010ET offers excellent security not using conventional cryptography.

Security is achieved by continuously changing and pseudorandomly selecting spreading codes. A user may select from 2^{16} (64k) different sequences to determine the order in which the spreading codes are used; this provides excellent security against eavesdropping by unintended parties.

The sequences can be selected through the configuration options provided by the 2010ET.

2.3.7 ANTENNA DIVERSITY

The 2010ET also offers additional robustness via an ***Antenna-selection diversity*** function.

The 2010ET can use two antennae, the Internal antenna and the External antenna[7]. If a user enables the diversity function through the configuration setup, the 2010ET selects the antenna for each re-transmission.

The antenna by which the last transmission has succeeded is memorized and used for the next transmission of a new uploaded frame.

Please note: This function is only applicable to internal Wireless LAN deployments.

[7] **If the 2010ET is used without the external antenna, this diversity function cannot be available.**

2.3.8 ANTENNA RECOGNITION

The FCC prohibits standard types of antenna connectors used for systems such as the 2010ET. However, the 2010ET uses a ***standard SMA female connector*** for the ***External antenna port.*** Compliance is achieved by using a special ***Antenna recognition*** function. This is done electrically, not by mechanical means. Accordingly, no antenna or antenna systems other than those provided by Spectrum are available. If such antennae or antenna systems are connected to the 2010ET, the 2010ET will not transmit.

The external antenna port outputs low dc voltage up to +5 V for recognition. The 2010ET is unconditionally safe against any types of passive loads connected to the ***External antenna port.***

Warning ***If you connect the*** *External antenna port* ***to any measuring equipment, please check the dc voltage restrictions for the input ports of your equipment.***

Note ***You cannot observe transmit signals by connecting the*** *External antenna port* ***to any measuring equipment because of the antenna recognition function described above. Please use a measuring antenna on your equipment and a standard Spectrum-supplied antenna on the 2010ET if you need to take measurements.***

2.3.9 CHANNEL ACCESS PROTOCOL

The 2010ET provides for adaptive P-CSMA[8] by using a sequence of P values. These are loosely tied to the transmission attempts in that the P values in the sequence corresponding to the attempt number, but any successful receive resets to P_{zero} for the next attempt. If that attempt fails, the sequence of P values is resumed according to which attempt is in progress. (P is a power of two, up to 256.)

[8] **On Ethernet both carrier sensing and collision detection are simple processes. For any radio channel the ability to detect collisions is lost; in addition, for a spread-spectrum system with changing codes (for security) the ability to perform carrier sensing is limited to the acquisition of the preamble portion of a transmission. The channel-access protocol (CAP) employed in the 2010ET is called P-persistent CSMA.**

When a 2010ET has scheduled a transmission, the start time of that transmission is selected randomly from a grid of P possible start times, these being separated by the slot time. The slot time is somewhat larger than the one-way propagation time; this ensures that if only one transmission is started at a slot boundary, then all other 2010ETs can detect that transmission and cancel any other pending transmissions. Of course, there remains the probability 1/P that any two radios might select the same slot boundary on which to transmit, in which case the two transmissions will collide. In dense radio environments, selecting a large value for P keeps the network from collapsing, while in less-dense environments a small P gives higher throughput. With P as a configurable parameter (in fact, dynamically configurable) the 2010ET suports a variety of user-controlled CAP strategies.

3. Appearance

3.1 DIMENSIONS

148mm(W) × 210mm(D) × 75mm(H), excluding projections.

3.2 FRONT AND REAR PANEL

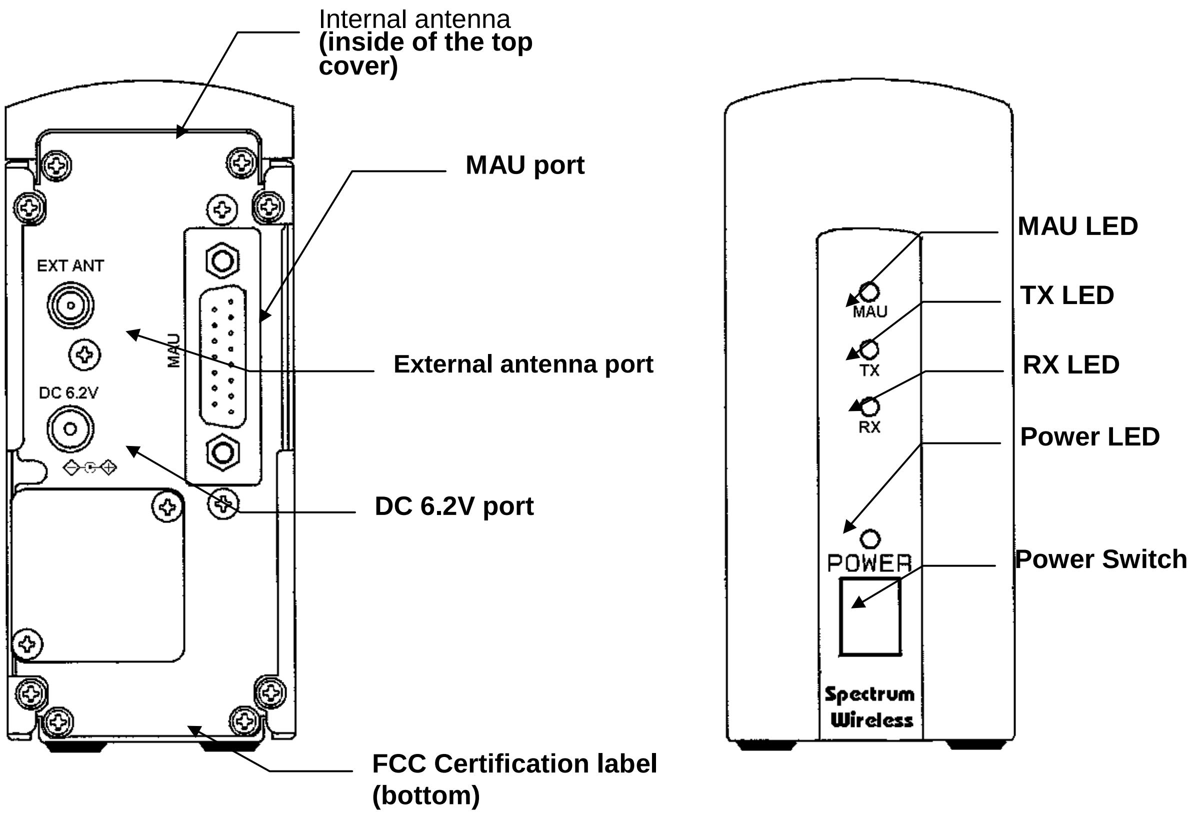


Figure 3-1

4. Specifications

4.1 GENERAL

Frequency Range	: 2,400-2,483.5 MHz ISM band
Carrier Frequency	: 2,436.07 MHz
Type of Emission	: Direct Sequence Spread Spectrum
Chip Modulation	: BPSK, 32 Mcps
Processing Gain	: 12dB (Nominal)
Communication Method	: Half Duplex
Channel Access Method	: SS-P-CSMA[9]
Type of Interface	: MAU (driven by AUI)
Datalink Interface	: IEEE802.3 or Ethernet II MAC
Network Addressing	: derived from attached NIC *(Note-1)*
RF MAC Protocol	: Radio encapsulation of IEEE802.3 or Ethernet II MAC frame.
Network Topology	: Peer to peer

Note 1 The 2010ET has its own MAC address for the configuration of operating parameters. The 2010ET also memorizes a single MAC address of the attached Network Interface Card(s) for the re-transmission protocol.

[9] **Spread Spectrum p-persistent CSMA**

4.2 RADIO

Table 4-1

Parameter	Min.	Typ.	Max.	Unit	Note
Carrier Frequency Stability	-10		+10	PPM	
Peak Power Density	-6	-2		dBm/ MHz	1
Data Rate		10		Mbps	
Sensitivity		-85	-81	dBm	2

1 Measured by spectrum analyzer with RBW=1MHz, VBW=10Hz. Total transmit power can be calculated by adding 16.0±0.6 dB to the Peak Power Density. Accordingly, typical total transmit power is 14 dBm.

2 Input power at which the throughput without re-transmission degrades to 75% of typical value (see Table 4-2). See Figure 4-1.

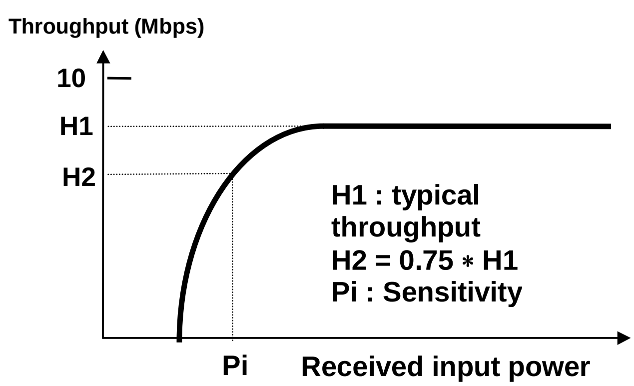


Figure 4-1

4.3 NETWORK

Table 4-2

Parameter	Min.	Typ.	Max.	Unit	Note
Throughput without Re-transmission	7.9	8.8		Mbps	1
Throughput with Re-transmission	6.8	7.6		Mbps	1
Boot up Time			5.5	sec	2

1 10 (Mbps) × Measured Average Utilization(%) under the condition of two units connected by cable through 60 dB attenuator and uni-directional data flow.

2 Time for self checking and stabilization of radio operating point. If AC power is switched, additional time must be considered because of its time constant.

4.4 PORT

4.4.1 MAU PORT

4.4.1.1 Pin assignment

Table 4-3

DTE (AUI)		2010ET (MAU)
PIN	Data Flow	PIN
3 Data out+ 10 Data out-	→ 2	3 Data in+ 10 Data in-
11 Shield	1	11 Shield
5 Data in+ 12 Data in-	← 2	5 Data out+ 12 Data out-
4 Shield	1	4 Shield
7 Control out+ 15 Control out-	NC	7 Control in+ 15 Control in-
8 Shield	1	8 Shield
2 Control in+ 9 Control in-	← 2	2 Control out+ 9 Control out-
1 Shield	1	1 Shield
6 Voltage common 13 Voltage+	NC	6 Voltage common 13 Voltage+
14 Shield	1	14 Shield
Schell Protective Ground		Schell Protective Ground

1000pF

2010ET
Chassis Ground

4.4.1.2 Absolute maximum ratings of the driver (Am7992B)

Table 4-4

Parameter	Min.	Typ.	Max.	Unit	Note
DC Voltage Applied to Outputs	- 0.5		+ 5.0	V	
DC Voltage Applied to Inputs	- 6.0		+ 12.0	V	
DC Logic Input Voltage			+ 5.5	V	
DC Output Current, into Outputs			100	mA	
DC Input Current (Logic)			± 30	mA	

4.4.1.3 Transformer (ST7032)

Table 4-5

Parameter	Min.	Typ.	Max.	Unit	Note
Common Mode Standoff			2000	Vrms	
Rise Time			3.0	ns	

4.4.2 DC 6.2V PORT

4.4.2.1 Power requirement

Table 4-1

Parameter	Min.	Typ.	Max.	Unit	Note
Supplied DC Voltage	6.00	6.20	6.85	Vdc	1
Ripple and Spurious		30	100	mVp-p	1
Current Consumption (TX)		1.6	2.0	A	
Current Consumption (RX)		1.1			

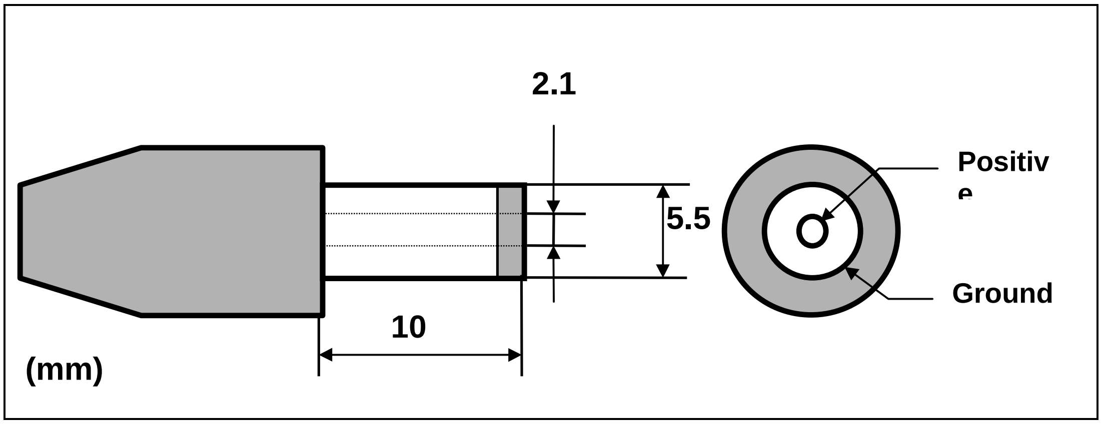
1. Measured at current draw of 1.8 A.

4.4.2.2 Power jack requirement

Ground : 5.5 mm outer diameter

Positive pin : 2.1 mm inner diameter

Pin length : 10 mm



Note Ground is connected to a chassis of the 2010ET.

Figure 4-2

4.5 LED DISPLAY

Label	Color	Description
MAU	Green	Indicates MAU signal (upload or download) is active.
TX	Red	1. During the power-up cycle, it blinks on and off slowly five times in approximately one second to indicate that the firmware has passed its integrity; or, it flashes on and off very rapidly for four or five seconds to indicate that the firmware has been damaged. No indication described above is available in some case of hardware failure. 2. After normal power-up cycle, it Indicates radio transmission. 3. During the firmware-uploaded cycle ; refer to the description accompanying the new firmware.
RX	Green	1. Indicates radio signal detection. 2. Sometimes flashes even if no true signal is received because of the optimized false alarm rate.
Power	Red	1. It turns on at approximately 1/4 second after applying the power to indicate activation of the unit. 2. If the hardware check sequence fails, it turns off automatically approximately 5 seconds after power on.

4.6 EMISSIONS

Non-intentional	:	**FCC part 15** (Radio Frequency Devices)
		Subpart B (Unintentional Radiator)
		Class A digital devices & peripherals
Intentional	:	**FCC part 15** (Radio Frequency Devices)
		Subpart C (Intentional Radiator)

4.7 ENVIRONMENTAL

Operating Temperature Range	:	0 ~ +40
Storage Temperature Range	:	-20 ~ +60
Humidity	:	0% ~ 90%

4.8 CONFIGURABLE PARAMETERS

Table 4-2

Parameters	Configurable Value/State		Default	Remarks
AUI Busy Collision	On			Assertion of CO (Control Out) if frame offered when all buffers full.
	Off			
SQE Test	On			Brief assertion of CO after frame
	Off			
Download	Normal			If "Download all frames" is selected, 2010ET downloads all frames regardless of CRC check.
	Download all frames			
FEC Sequence	Try #	Available configuration		The FEC is selected depending on number of trial of re-transmission.
	1	FEC on or off for each trial	Off	
	2		On	
	3		On	
	4		On	
	5		On	
	6		On	
	7		On	
	8		On	
P-CSMA slots	Try #	Available configuration		Wait-time before each Transmission is individually defined as $20\mu s * 2^P$. Larger numbers are required when many units are simultaneously operated for less collisions.
	1	P-CSMA slot-number P of 1 to 8 for each trial.	2	
	2		3	
	3		4	
	4		5	
	5		6	
	6		7	
	7		8	
	8		8	
Number of re-transmissions	0 - 7		7	"0" means no re-transmission
Address Checking	On			Acknowledgments are sent for received frames with matched destination address only when this is On, and unconditionally sent when this is Off.
	Off			
Security Code Channel	0000h ~ FFFFh		2D1Bh	Spreading code changes pseudo randomly by a sequence defined by this code channel.
Duplicate Filter	On			If this switch turns on, received duplicate frames are discarded.
	Off			

<table>
<tr><td>Search Code</td><td colspan="3">44BCh, 41B9h, 3D22h, 9D82h, 2E21h, 8474h, 848Bh, D121h</td><td>44BCh</td><td>Search Code is a PN code used for initial acquisition. Different codes set on multiple systems in the same area can lead to an increase in aggregate throughput.</td></tr>
<tr><td rowspan="10">Antenna Selection</td><td rowspan="2">Diversity off</td><td colspan="2">Always External</td><td></td><td rowspan="10">‘Same’ keeps the same antenna as previous transmission. ‘Toggle’ alternates antenna.</td></tr>
<tr><td colspan="2">Always Internal</td><td></td></tr>
<tr><td rowspan="8">Diversity on</td><td>Re-TX #</td><td>Selection</td><td>-</td></tr>
<tr><td>1</td><td rowspan="7">‘Same’ or ‘Toggle’ for each re-TX</td><td>-</td></tr>
<tr><td>2</td><td>-</td></tr>
<tr><td>3</td><td>-</td></tr>
<tr><td>4</td><td>-</td></tr>
<tr><td>5</td><td>-</td></tr>
<tr><td>6</td><td>-</td></tr>
<tr><td>7</td><td>-</td></tr>
<tr><td rowspan="2">RF Address</td><td colspan="3">Derived from attached NIC</td><td></td><td rowspan="2">RF address is used on RF reception by the 2010ET to determine whether to send an ACK, and at the transmitter to recognize its ACK. It is not used if ‘Address Checking’ is set to OFF.</td></tr>
<tr><td colspan="3">12-hex-digit (configurable)</td><td></td></tr>
<tr><td rowspan="2">Set Upload Address</td><td colspan="3">MAC Address (00606FXXXXXX)</td><td></td><td rowspan="2">Upload address is used for configuration and firmware upgrades only. Each 2010ET has its own unique 12-hex-digit MAC Address which is used as a default upload address. However, one can select the Null Address ‘00606F000000’ as the Upload Address for convenience.</td></tr>
<tr><td colspan="3">Spectrum Null Address (00606F000000)</td><td></td></tr>
</table>

Configuration software for Microsoft Windows is available.

5. Compliance with standards

5.1 MAU

While the 2010ET has been designed to appear electrically as a standard MAU, it executes a medium-access protocol appropriate for the wireless medium. As a result, certain of its behaviors are not reflected in a wired-medium MAU, and the transparency to the wired-medium MAC in the attached computer or bridging device cannot be absolute. MAUs for wired networks have no internal storage; they operate with negligible delay relative to the signals at the AUI/MAU interface.

Because the MAC software in the attached computer is executing a protocol appropriate for the wired medium and the 2010ET must employ a protocol appropriate for the wireless medium, the 2010ET stores frames in buffers in order to isolate the wired and wireless media.

This results in important differences from conventional 802.3 MAUs; these include buffer delay as well as the need for RF re-transmissions and for flow control.

5.1.1 BUFFER DELAY

The protocol operating over a 2010ET link must anticipate a delay of two frames in each direction. When a frame is offered from the AUI port, it first is saved in a buffer. Subsequently, the frame is transferred over the RF channel to a receive buffer in the destination 2010ET. Only then is the frame downloaded to the destination AUI port.

This need not limit the throughput if the transport protocol properly anticipates the delay. If the protocol waits for each frame to be acknowledged, then the throughput achieved will be very low due to the excess delay. However, if burst mode is used, then the effect of the delay can be made negligible. This effect can be readily demonstrated using, for example, Perform 3.

5.1.2 FLOW CONTROL

When no buffers are available for ***UPLOAD*** of AUI frames to the 2010ET, some action is required. The 2010ET may:

1) Invoke flow control (default for the 2010ET connected to an AUI port), by using the ***COLLISION*** signal to force the Ethernet card into its exponential back-off algorithm. Because there are eight ***UPLOAD*** buffers, this flow control can always maximize RF throughput even though the attached device may delay re-offering frames.

2) Ignore ***UPLOAD*** frames when no ***UPLOAD*** buffer is available. This may be required when the 2010ET is connected to multiple computers (e.g., via a hub) which might be disrupted by excessive collision indications. However, ignored frames will incur a large delay for retransmission by the level-4 transport protocol (TCP,IPX), or may not be re-offered at all for datagrams (UDP,SPX). Although using the ***COLLISION*** signal for flow control is the default, the user must make an informed selection between these two possibilities based on network topology, acceptable link behavior and the requirements of the application software.

6. Recommended Test Procedure

6.1 THROUGHPUT

While the 2010ET offers true 10 Mbps RF transmission, the real measure of network performance is average throughput. This requires not only high-data-rate modem transmissions, but also efficient utilization of frame buffers and coordination of RF and wired-interface traffic. The 2010ET's throughput is greater than or equal to 6.8 Mbps with re-transmission and 7.9 Mbps without re-transmission under the definition and specified measurement described below.

6.1.1 DEFINITION OF THE THROUGHPUT

The throughput of the 2010ET is defined as average transmitted bits per second from one 2010ET to another, as described in the following test procedure.

6.1.2 SETUP FOR MEASURING THE THROUGHPUT

Figure 6-1 shows the recommended setup for measuring throughput.

We recommend the following specifications for the test equipment:

- **LAN analyzer-1**: HP's J2S22B or equivalent.
- **LAN analyzer-2**: HP's J2S22B or equivalent or a PC with an installed NIC and Novell's "LANalyzer".
- **Hub**: HP's J2610A or equivalent. The function of this hub is to simply convert the AUI port from the 2010ET to a 10BaseT port for the LAN analyzer. If the LAN analyzer has an AUI port, then this hub is not required.
- **Attenuator** : HP's 8494A (0 - 11dB; 1dB step) and 8496A (0 - 110dB; 10dB step) or equivalent. Two attenuators are connected to provide wide variable range and precise adjustment.

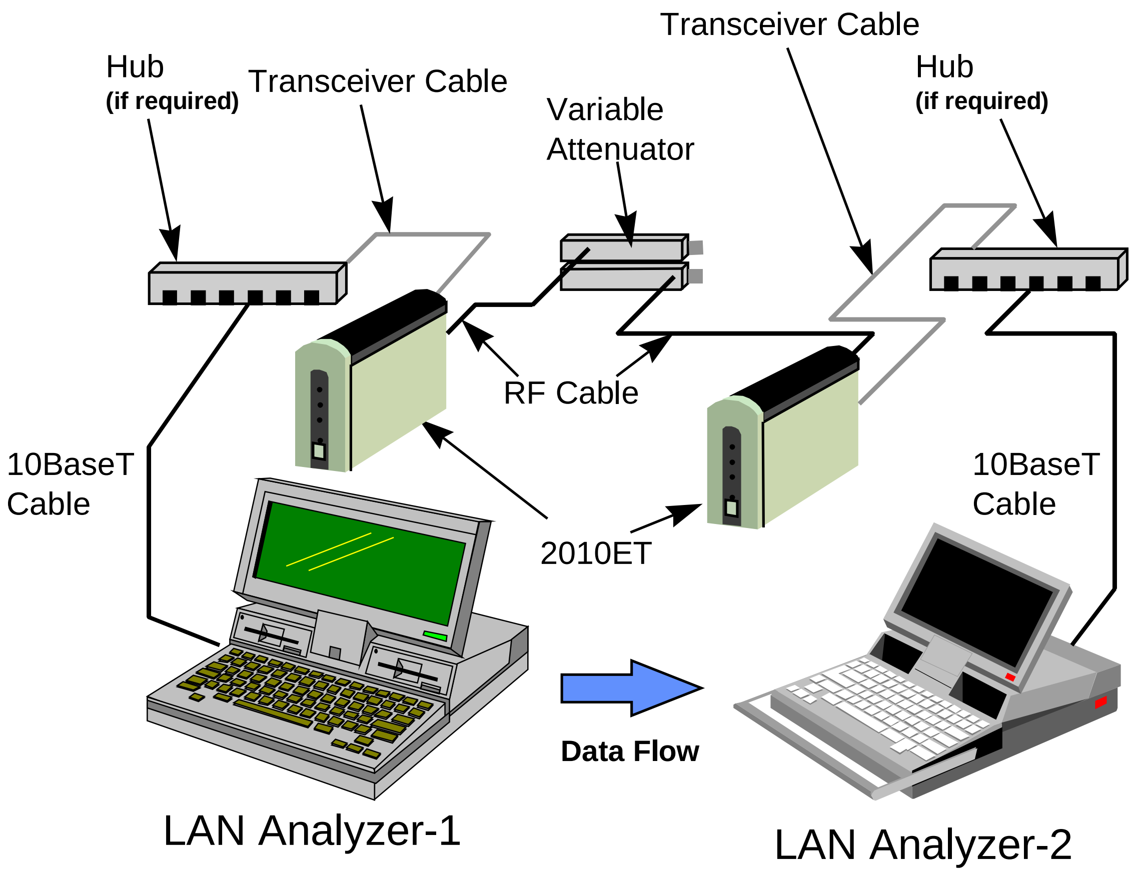

Transceiver Cable
Hub
(if required)
Transceiver Cable
Variable
Attenuator
Hub
(if required)
RF Cable
10BaseT
Cable
10BaseT
Cable
2010ET
Data Flow
LAN Analyzer-1
LAN Analyzer-2

Figure 6-1

6.1.3 THROUGHPUT MEASURING PROCEDURE

1. Setup shown as Figure 6-1. Power sources of the 2010ETs must be connected also (not shown in the figure).
2. Power on 2010ETs.
3. Initiate hubs and LAN analyzers.
4. Transmit frames from LAN analyzer-1 using parameters in Table 6-1.

Table 6-1

Average Utilization (%)	98
Average Frame Rate (fr/sec)	Note-1
Inter-frame spacing (ms)	Note-1
Times to send	Continuous
Activate message	√
Message #	1
Message Type	802.3 Fox Message
Frame length (bytes)	1500
Source address	Note-2
Destination address	Note-3
FCS type	Good

Note-1: This value is determined indirectly.

Note-2: Source address varies depend on the products. If the MSB is set to 1, then the re-transmission is suspended.

Note-3: Destination address does nothing with this measurement.

5. Observe average utilization by LAN analyzer-2.
6. The average throughput can be calculated as (average utilization observed by LAN analyzer-2) * 10 Mbps.

7. Customer Service

For sales and technical support, please contact Spectrum Wireless.

Spectrum Wireless, Inc.
2600 Denali St. Suite 420
Anchorage AK 99503
Phone: (907) 272-1066
Fax: (907) 272-1075

E-mail: info@spectrumwireless.net

WWW: www.spectrumwireless.net