BEI SENSORS

Swift comm™

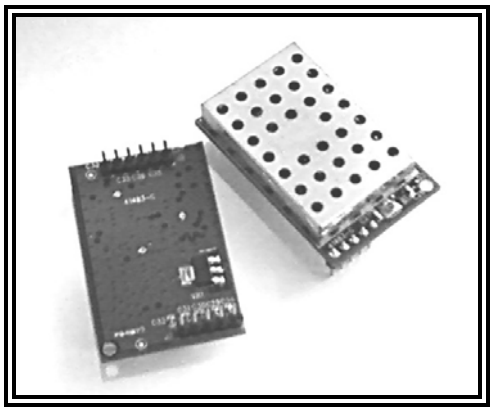
wireless industrial sensor interface

USER MANUAL

September 2011

2.4 GHz Transceiver Module

Part Number 41612



Overview

The Swiftcomm Radio Module is designed for integration into OEM systems operating under FCC part 15.247 regulations for the 2.4 GHz ISM band.

The SwiftComm Radio Module is a 2.4 GHz frequency hopping spread spectrum transceiver. It provides a synchronous TTL level interface for OEM Host communications. Communications include both system and configuration data. The Host supplies system data for transmission to another Host. All frequency hopping, synchronization, and RF system data checking is performed by the transceiver module.

SwiftComm transceivers operate in a Server-Client configuration. One transceiver is configured as a Server and there can be one or many Clients. To establish synchronization between transceivers, the Server emits a beacon. Upon detecting a beacon, a Client transceiver informs its Server of it presents and a RF link is established. SwiftComm transceivers manage all data transmission overhead, including 40 bit encryption and Manchester encoding, assuring secure and reliable data delivery.

The SwiftComm Radio Module features robust Transient Voltage Protection on the antenna port. This allows the SwiftComm radio to operate in outdoor environments subject to lightning strikes. Although not able to withstand a direct lightning strike, the SwiftComm radio will readily survive a near strike.

The OEM is responsible for ensuring the final product meets all FCC and/or appropriate regulatory agency requirements listed herein before selling any product incorporating the SwiftComm Radio Module. Information furnished by BEI Sensors in this specification is believed to be accurate. BEI Sensors makes no warranty, express, statutory, and implied or by description, regarding the information set forth herein. BEI Sensors reserves the right to change specifications at any time and without notice.

Specifications

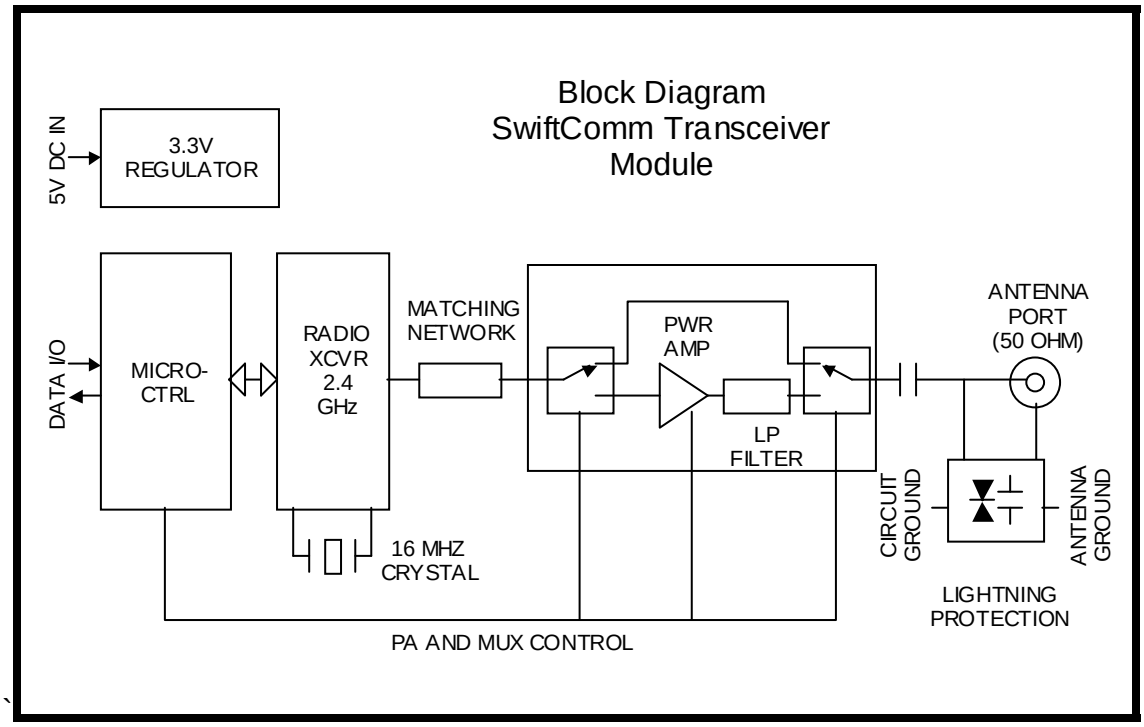
GENERAL	
Interface	11 pin Header
Power Voltage	5V nominal ±2%, ±50mV ripple
Power Consumption (typical)	
Sleep Mode	30 mA
Receive Mode	45 mA
Packet Transmit Mode	85 mA
CW Mode	160 mA

TRANSMITTER / RECEIVER	
RF Power Output	50 mW (17 dBm)
Antenna Impedance	50 ohm
Radio Type	Frequency Hopping Spread Spectrum
Modulation	GFSK
Over Air Packet Data Rate	2 Mbps
Data Encryption	40 bit
Frequency Band	US/Canada: 2.401 – 2.479 GHz
Receiver Sensitivity	-80 dBm typical
Channels	79
Channel Spacing	1.0 MHz
Hopping Sequence	Adaptive, based on interference detected

ENVIRONMENTAL	
Temperature (Operating) Industrial:	-40°C to 85°C
Temperature (Storage)	-50°C to +120°C
Humidity (non-condensing)	10% to 90%

PHYSICAL	
Dimensions	2.85 W 4.46 L 0.77 H (cm)
Weight	10 grams
Antenna Connector	U.FL PCB Jack SMT (Amphenol A-1JA or equivalent)

Block Diagram



I/O Pin Definitions

All signal levels are 0 to 3.3 volts (TTL 5V Tolerant)

Pin Name	Micro-Ctrl Port	Description	Data Direction
J2-1	-	Power Supply Common	-
J2-2	-	Power Supply Input (+5.0 VDC)	-
J2-3	P2.0	Data Packet Ready / C2D Pgm Port	Out
J2-4	RST	Reset / C2CK Pgm Port (10K Pull-up)	not used
J2-5	P0.4	Data Clock	In
J2-6	P0.5	Data Bus Direction	In
J3-1	P1.7	Data Bus Bit 3	In/Out
J3-2	P1.6	Data Bus Bit 2	In/Out
J3-3	P1.5	Data Bus Bit 1	In/Out
J3-4	P1.4	Data Bus Bit 0	In/Out
J3-5	P1.4	Busy / Ready	Out

Command Protocol

Communication with the SwiftComm RF module is via a 4 bit synchronous parallel bus. The Data Bus Direction line selects the data direction, and data is clocked in or out of the module four bits at a time on the falling edge of a pulse on the Data Clock line. The Busy/Ready line indicated whether the module is ready for the next four bits of data to be clocked in or out of the module. Each byte of data is transferred to or from the module upper four bits first, meaning the first read or write is the upper nibble, and the next read or write will be the lower nibble. After each read or write, the Busy/Ready line will toggle low until the module is ready for the next transaction. No action should ever be taken if the Busy/Ready line is low.

I/O:	**Note:**
Data Packet Ready (J2-3)	High = New Packet Ready; Low = No New Packet Ready
Data Clock (J2-5)	Normally high, data clocked on falling edge.
Data Bus Direction (J2-6)	Low = Input Data; High = Output Data;
Data Bus Bits 0 to 3	J3-4 to J3-1
Busy / Ready (J3-5)	Low = Busy; High = Ready

Input Mode (Data Bus Direction = Low):

When in input mode, commands can be sent to the RF module for processing. The command will be processed when the Data Bus Direction line is cycled from low to high. There are currently three supported commands in Input Mode:

1. Null Command: Takes no action.
   Byte 0: 00h

2. Configure Radio: Configures the RF module mode of operation
   Byte 0: 01h
   Byte 1: 00h = Receiver Mode; 01 = Transmitter Mode
   Bytes 2-6: Five byte communication address. Transmitter and receiver address must match to communicate with each other.
   Byte 7: Packet data length. This specifies how many bytes of data the payload will consist of.

3. Send Data Packet: Only supported if configured in Transmitter Mode
   Byte 0: 02h
   Byte 1: Packet Length. This specifies how many bytes are being transmitted.
   Bytes 2-x: Data Payload. The length of this field is specified by the Packet Length above.

Output Mode (Data Bus Direction = High):

When in output mode, data packets can be read from the RF module. The read command is reset when the Data Bus Direction line is cycled from high to low. There is only one supported read function at this time.

1. Read data:
   Byte 0: Status Register.
   - Bit 0: 1 = Link Active; 0 = No Link
   - Bit 1: 1 = Last Packet Unsuccessful; 0 = Last Packet Successful
   - Bit 2: 1 = First packet since link established; 0 = Not first packet
   - Bit 3-7 Reserved

   Byte 1: Reserved
   Bytes 2-x: Data Payload. The length of this field is determined by how many bytes were sent. This field is only valid when the Data Packet Ready line is high.

Regulatory Agency Identification Numbers and Information

United States / FCC	FCC ID: VSR-SWIFTCOMM11
Canadian / IC	IC: 7445A-SWIFTCOMM11

FCC Requirements

The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Swiftcomm IC identifier and FCC notice for this product as well as the FCC Notice statement in a conspicuous location in the user manual.

The user is responsible for all labeling and ensuring the module complies with FCC regulations (see 47CFR2 for exact regulations).

The FCC/IC approval was granted with the module classified as mobile (ie. the antenna is >20 cm from the human body with the exception of hands, wrists, feet, and ankles). The end user needs to ensure that the antenna location complies with this or retest for portable classification (less than 2.5 cm with the same exceptions as mobile) at their own expense.

FCC regulations allow the use of any antenna of the same type and of equal or less gain. However the antenna is still required to have a unique antenna connector such as a reverse-polarity TNC. Following is a list of antennas available through BEI Sensors. Any different antenna type or antenna with gain greater than those listed must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions at user's expense.

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception.

Caution: Any changes or modifications not expressly approved by BEI Sensors could void the FCC compliancy of the SwiftComm module.

FCC Labeling Requirements

A clearly visible label must be installed on the outside of the OEM enclosure specifying the appropriate Swiftcomm FCC identifier for this product as follows:

> CONTAINS TRANSCEIVER WITH FCC ID: VSR-SWIFTCOMM11

The label must also contain the following FCC Notice:

> 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.

FCC Notice

The Following FCC Notice must be included as a caution statement in manuals for OEM products to alert users of RF interference compliance. User manuals shall contain the following or equivalent statements in a conspicuous position:

FCC Notice

This equipment has been tested and found to comply with the limits for a class B digital device pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of the manufacturer could void the user's authority to operate the equipment.

FCC RF Exposure Statement

The Following statement must be included as a caution statement in manuals for OEM products to alert users on FCC RF Exposure compliance. User manuals shall also contain the following or equivalent statements in a conspicuous position:

FCC RF Exposure Statement

To satisfy RF exposure requirements, this device and its antenna must operate with a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Information for Canadian Users (IC NOTICE)

The Original Equipment Manufacturer (OEM) must ensure that Industry Canada labeling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Swiftcomm IC identifier for this product as well as the following Industry Canada Notice statement in a conspicuous location in the user manual.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna having a maximum gain of 5.5 dBi approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that necessary for successful communication**.**

The radio transmitter IC 7445A-SWIFTCOMM11 has been approved by Industry Canada to operate with the antenna and optional coaxial extension cable listed below with a maximum gain of 5.5 dBi. The required antenna impedance is 50 ohms. Antenna types

not included in this list or having a gain greater than 5.5 dBi are strictly prohibited for use with this device.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal de 5.5dBi approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique pour d'autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio (IC 7445A-SWIFTCOMM11) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal de 5.5dBi. L'impédance requise pour chaque type d'antenne est de 50ohms. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage.

Approved Antenna and Optional Coaxial Extension Cable List

This device has been designed to operate with the antenna and optional coaxial extension cable listed below (or equivalent). The antenna has a maximum gain of 5.5 dBi. Antennas not included in this list or having a gain greater than 5.5 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Approved Antenna:

BEI Part # 924-37101
2.4 GHz 5.5 dBi Reverse Polarity-TNC "Rubber Duck" Antenna
Model # HG2405RD-RTP
HyperLink Technologies, Inc. (or equivalent from alternate manufacturer)
1201 Clint Moore Road, Boca Raton FL 33487 USA
Phone: 800-921-2256 Fax: 561-995-2432

Approved Coaxial Extension Cable (0-120 in length) BEI Part # 37109-XXX (XXX = Length in Inches

Pasternack Enterprises, Inc. (or equivalent from alternate manufacturer)
P.O. Box 16759
Irvine, CA 92623
949-261-1920
RP-TNC Male to RP-TNC Female (Bulkhead)
RG-59 U/C Coax 0-120 In Long
With Ground Plane and Mounting Bracket

Sales, Repair and Technical Assistance

BEI Sensors
7230 Hollister Ave.
Goleta CA 93117 USA
800-357-2727 FAX 805-968-3154
WWW.BEIIED.COM

Appendix A. 20 Channel Hop Sequence Explanation

A static table of 256 numbers (called the Randomizer), each between 0 and 19, is hard coded into the microprocessor's program. The sequence of the numbers was randomly generated. These numbers are used to point the channel selection routine to one of the 20 slots in the Active Channel Set.

The Active Channel Set is a dynamic table which contains 20 memory slots. Each slot will contain a channel number (between 2 and 78). When the transmitter and receiver connect with one another, the transmitter selects which channels to fill the Active Channel Set with. When a channel is deemed 'bad' (from too much interference), it is removed from it's slot in the table and replaced with one that has a better history.

Every 600uS, both the transmitter and receiver hop to a new channel for the next communication cycle. The following process selects the channel that they hop to:

1. The next number in the Randomizer is read. When the last number in the randomizer has been used, it starts over at the beginning of the table.
2. The number that is read from the Randomizer (between 0 and 19) selects which slot to read from the Active Channel Set. For instance, if we use the first number in the randomizer table, 11, this would select slot 11.
3. The contents of the selected slot is read, which contains a channel number (between 2 and 78). This is the new channel that both the transmitter and receiver will hop to.

Following is the complete Randomizer Table that shows the random channel sequence.

11,12,3,2,13,1,14,7,11,15,5,0,11,12,10,8,4,7,10,7,5,8,2,11,2,8,7,11,2,14,7,10,8,6,13,11,15,9,8,11
,8,2,11,1,4,13,5,6,13,12,9,14,6,15,7,9,12,14,2,15,7,7,2,0,14,11,4,11,3,10,1,10,14,12,3,14,10,1,15
,8,4,6,10,12,10,7,5,14,14,10,6,1,3,10,12,9,4,15,11,1,7,14,4,0,15,10,5,8,12,8,10,11,2,13,6,13,6,1,
12,8,5,0,5,6,13,8,3,10,7,13,3,0,6,11,12,6,13,2,2,7,11,8,0,11,3,10,9,13,9,3,15,10,5,11,0,8,8,2,4,7,
13,3,10,3,1,5,12,13,11,13,10,7,6,2,12,7,12,10,8,9,10,3,15,13,7,1,1,11,6,3,6,13,11,5,10,11,13,8,1
4,8,13,2,6,2,5,3,5,13,5,10,9,0,0,7,5,14,7,8,2,7,8,10,9,2,6,0,3,7,5,7,2,9,12,7,1,2,2,5,8,8,3,11,6,0,1
2,2,8,2,12,0,11,13,2,4,11

Each of its hopping channels is used equally on average because the Randomizer was pre-calculated to be a statistically random sequence between 0 and 19 distributed on average over 256 cells. Therefore it will provide a pseudo-random sequence of all 20 active channels, each channel averaging use is equal over time. The pattern will repeat every 256 hops (~6 times per second when changing channels every 600 uS).

The associated receiver's ability to shift frequencies in synchronization with the transmitted is assured when the transmitter and receiver connect, they synchronize their Active Channel Set, as well as their index locations within the Randomizer. Each unit then uses an internal clock (600 uS ticks) to determine when the next frequency hop needs to take place. Additionally, the receiver compares its own internal timing to the timing from the transmitter and adjusts accordingly. This was implemented to remove any timing errors induced from slight differences in clock rates between the transmitter and receiver. So each packet that is sent resynchronizes the timing between them.

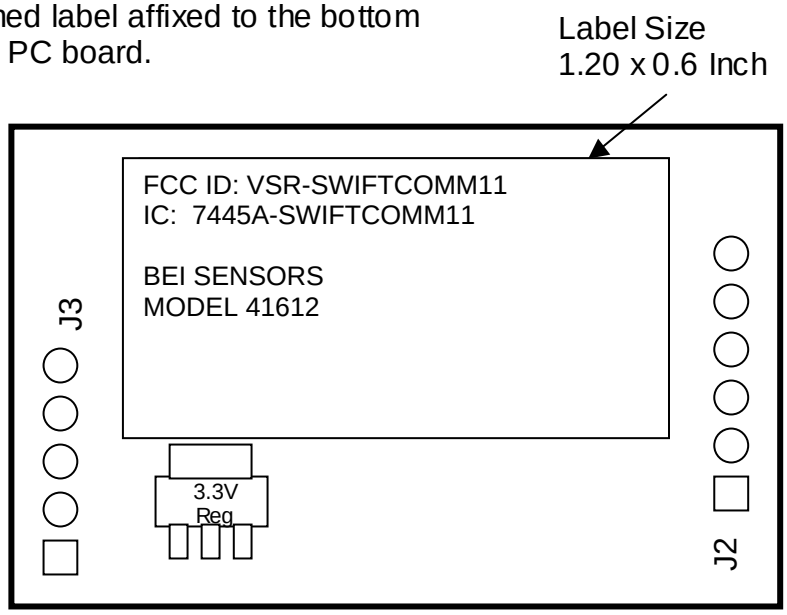
The number of hopping channels used at any given time will be the 20 Active Channel Set. If a particular channel within the set becomes too noisy, it is replaced with a different one, but there are never less (or more) than 20 channels being used at any time.

Appendix B: FCC / IC Label Placement

wireless industrial sensor interface

2.4 GHz Transceiver Module
Part Number 41612

The unit shall have a permanently attached label affixed to the bottom of the PC board.



Bottom View SwiftComm Radio Module

Appendix C: **Modular Approval Checklist:**

MODULAR APPROVAL REQUIREMENTS	YES	NO
(a) The radio elements must have the radio frequency circuitry must be shielded. Physical/discrete and tuning capacitors may be located external to the shield, but must be on the module assembly.	X	
(b) The module shall have buffered modulation/data input(s) (if such inputs are provided) to ensure that the module will comply with the requirements set out in the applicable RSS standard under conditions of excessive data rates or over-modulation.	X	
(c) The module shall have its own power supply regulation on the module. This is to ensure that the module will comply with the requirements set out in the applicable standard regardless of the design of the power supplying circuitry in the host device which houses the module.	X	
(d) The module shall comply with the provisions for external power amplifiers and antennas detailed in this standard. The equipment certification submission shall contain a detailed description of the configuration of all antennas that will be used with the module	X	
(e) The module shall be tested for compliance with the applicable standard in a stand-alone configuration, i.e. the module must not be inside another device during testing.	X	
(f) The module shall comply with the Category I equipment labeling requirements.	X	
(g) The module shall comply with applicable RSS-102 exposure requirements, which are based on the intended use/configurations.	X	
(h) Is the modular device for an Industry Canada licensed exempt service?	X	