OMNEX
CONTROL SYSTEMS INC

Model DEX-900
Spread Spectrum Data Transceiver

Specifications
Technical Description
Circuit Diagrams

Contents

1.0 Introduction

The DEX-900 is a frequency hopped spread spectrum transceiver designed to be compatible with US (FCC Part 15.247) and Canadian (RSS-210) regulations for license free use in the 902-928 MHz band.

The transceiver will typically be used for the remote control and monitoring of industrial equipment such as cranes, concrete pumps, loaders, etc.. Operating primarily as a receiver, the DEX-900 receives control commands from an OMNEX model TPCB-1847 transceiver and occasionally sends back a short packet of data to the control transceiver. Transmitted data usually includes such information as engine rpm, temperature, etc., which is displayed on an LCD viewed by the operator. The DEX-900 is embedded as part of a complete OMNEX control system package and is not sold separately as a stand-alone device.

2.0 Specifications

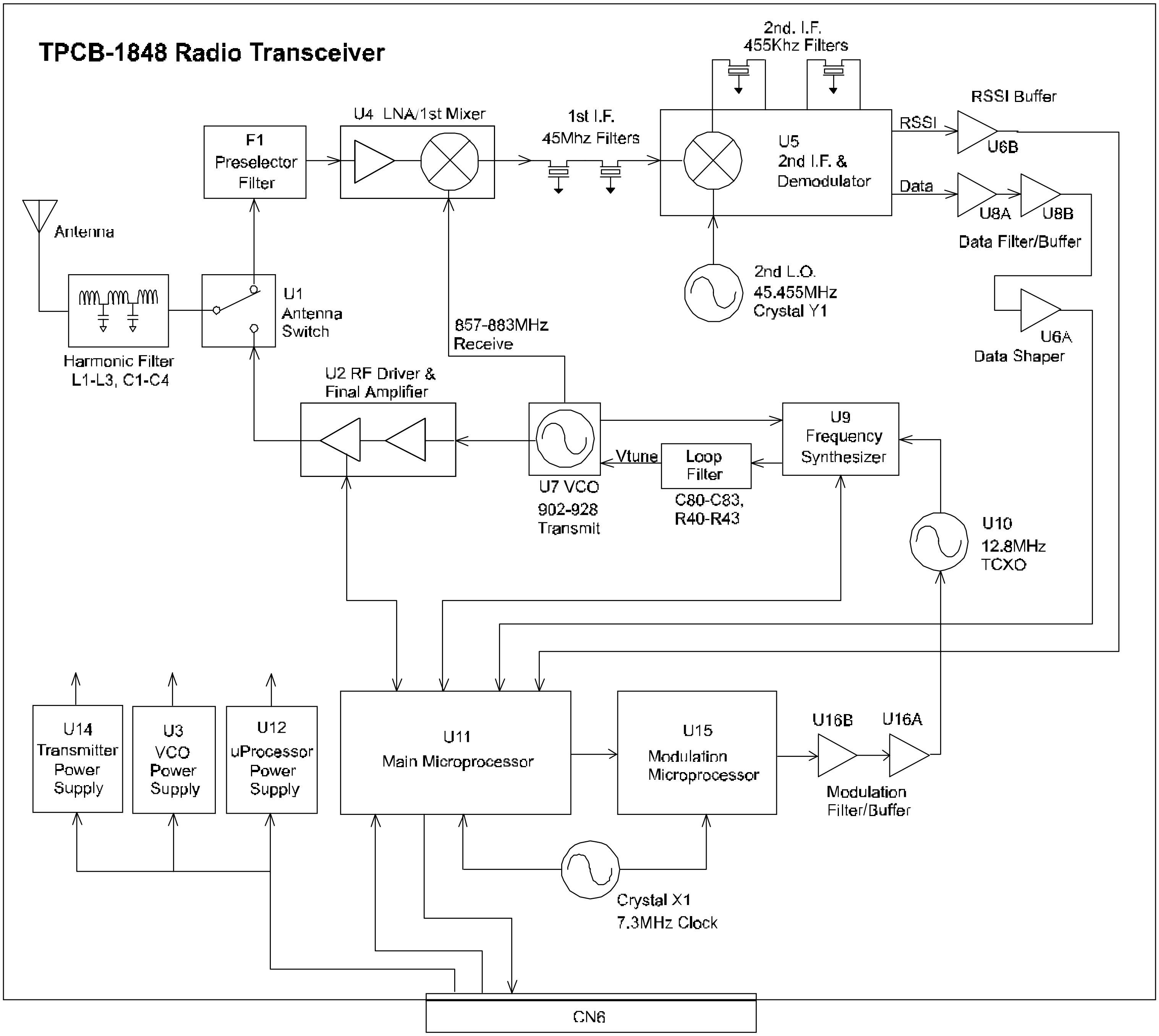
Parameter	MIN	TYP	MAX	UNITS
Frequency Range	902		928	MHz
DC Supply Voltage	9.6	12	24	VDC
Frequency Stability (synthesized with TCXO reference)		+/- 2.5		PPM
Operating Temperature	-30		+70	°C
Transmitter R.F. Power Output		.085	0.100	Watts
Receiver Sensitivity (12db Sinad)	0.5	0.45	0.4	uV

Type of Emission: Frequency Hopping Spread Spectrum
Number of Radio Channels: 256

3.0 Technical Description

3.1 System Block Diagram:

System Block Diagram



3.2 System General Description:

The DEX-900 is a frequency hopping spread spectrum (FHSS) transceiver designed to be compatible with FCC Part 15.247 (US) and RSS-210 (Canada) regulations for license free operation in the 902-928 MHz frequency band. The major elements include a frequency agile, narrow band R.F. transmitter and receiver, and an embedded microprocessor for frequency hopping sequence generation and modulation. Packets of telemetry and control data are transmitted to, and received from, a compatible Omnex model TPCB-1847 transceiver.

One packet is sent on each frequency in the hop sequence. A data packet consists of six bytes. This includes radio ID, data, and a CRC-16 word. The embedded microprocessor generates a digitally filtered bit stream that is sent into the transmit VCO. The microprocessor also generates a Reed-Solomon pseudo random frequency hop sequence of length 64 based on a pre-programmed seed. The full 902 to 928 MHz band is utilized in equally spaced 100 kHz channels. The DEX-900 functions primarily as a receiver, switching to transmit mode only occasionally to send a short packet of data to another compatible OMNEX transceiver.

3.3 Power Supply:

Refer schematic diagram DSCH-1848-01 sheets 2 & 3.

The transceiver is typically powered by a 12VDC vehicle battery. Separate linear voltage regulators are provided for the microprocessor (U12), the VCO (U3) and the R.F. power amplifier (U14). All regulators provide a 5 volt DC output.

3.4 Main Microprocessor:

Refer to schematic diagram DSCH-1848-01 sheet 3, and DSCH-1850 sheet 1.

A Motorola 68HC11 microprocessor, U11, is employed to handle frequency synthesis control, frequency hopping, data packet formatting. Crystal X1 provides the 7.3 MHz clock. The microprocessor also provides outputs that will control the driver circuits ultimately connected to some kind of machine. Programming options, including setting an ID code, are made possible through the use of DIP switches accessible to the operator. The programming switches SW1-SW-4, along with multiplexers U1-U4 are contained on a separate plug-in circuit bard, TPCB-1850. The switch board also contains LED status indicators, D1-D3 and a test point, P1, to monitor received signal strength.

3.5 Transmitter Modulator / Filter:

Refer to schematic diagram DSCH-1848-01sheets 2 and 3.

The transmitter employs a filtered FSK modulation scheme. Data from the main microprocessor ,U11, is converted to a digitally encoded analog signal by a secondary microprocessor, U15, and resistor ladder consisting of R92-R96 and op amp U16:B. The analog data is further shaped by a low pass filter consisting of R99 and C122. The modulation level (deviation) is preset to +/- 4KHz by potentiometer R100, and is not user accessible. FM modulation is achieved by applying the filtered data signal to a voltage controlled tuning pin on the synthesizer TCXO reference oscillator, U10.

3.6 VCO and Synthesizer:

Refer to schematic diagram DSCH-1848-01 sheet 2.

The frequency synthesizer is the heart of the transceiver hardware. The RF oscillator is provided by a Maxim 2620 VCO, U7. The resonant tank circuit is comprised of L16, C55 and varactor diode D1. D1 provides the necessary frequency pulling capability. U7 contains separate output buffers for the R.F. and synthesizer drive. The frequency synthesizer is a Philips SA7025, U9, which is programmed by the microprocessor with the frequency hopping sequence. The synthesizer loop filter consists of R40-R43 and C80-C83. A 12.8MHz TCXO, U10, provides a stable reference oscillator as well a method of modulating the transmitter by means of a voltage controlled tuning pin.

3.7 R.F. Final Amplifier & Harmonic Filter:

See schematic diagram DSCH-1848-01 sheet 2.

The output of the VCO is applied to R.F amplifier , U2. The final amplifier stage is enabled the microprocessor. The R.F. output is routed through a solid state switch, U1, followed by a 7-pole harmonic filter consisting of inductors L1-L3 and C1-C4, before being applied to an SMB antenna connector J1. Maximum R.F. output is 0.1 watt into 50 ohms.

3.8 Receiver Preselector, LNA & 1st Mixer:

See schematic diagram DSCH-1848-01 sheet 2.

The received signal is routed through antenna switch, U1, to dielectric filter, F1, before being applied to the LNA and first mixer, both of which are contained in IC U4. The output from the VCO, U7, is also applied to the mixer resulting in a first I.F. output frequency of 45MHz.

3.9 Receiver I.F. & Demodulator

The 45MHz 1st I.F. is passed through crystal filters F4 and F5 before being applied to 2nd I.F. and demodulator, U5. The 2nd mixer/L.O., I.F. amplifiers and quadrature detector are all contained within U5. The 2nd local oscillator is stabilized by crystal Y1 at 45.455MHz, and results in a 2nd mixer output of 455KHz which passes through ceramic filters F2 and F3. U5 also provides an RSSI output which is buffered by op amp U6:B. The demodulated baseband output is filtered and shaped by op amp U8, then followed by U6:A which serves as a data shaper providing a square wave digital output which is applied to the main microprocessor.

3.10 Emission Types

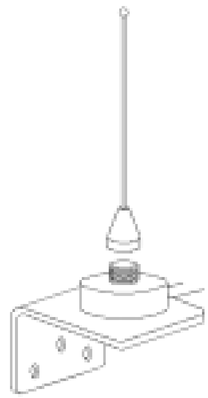
The transceiver contains the following "fixed" frequency sources:

X1 - 7.3MHz main Microprocessor clock crystal.
Y1 - 45.455MHz **r**eceiver 2nd L.O. crystal.
U10 - 12.8MHz crystal controlled TCXO synthesizer reference oscillator.

The transceiver contains the following "variable" frequency source:

U7- 902-928 MHz (transmit) 857-883 MHz (receive) Voltage controlled oscillator. Phase locked to reference TCXO.

3.11 Antenna



The antenna consists of a 1/4 wave stainless steel whip, and a mobile type angled mounting bracket. The SMB connector (J1) on the DEX-900 transceiver is terminated to a BNC bulkhead connector which is mounted on system control box in which the DEX-900 is embedded. The coaxial cable from the antenna is attached to the BNC connector.

4.0 Spread Spectrum Operation

The transceiver system consists of two transceivers - the 'remote' transceiver and the 'local' transceiver. The remote transceiver (this is the operator control box) is the 'master', which controls the transmit/receive sequence. The remote transceiver can be configured with a variable transmit/receive hop ratio. The remote transmits for the selected number of hops, then switches to the receive mode for one hop. The frequency for this hop is the next frequency in the hop sequence. In the data packet transmitted in the hop immediately prior to the receive hop, the remote sets a bit (the 'Tx' bit) which indicates to the local transceiver that the remote transceiver will be in the receive mode during the next hop. This indicates to the local transceiver that it can switch to the transmit mode for that hop.
The 'local' transceiver (mounted on the machine to be controlled) initially puts itself into an 'acquire' mode, during which it tests the RSSI of the first six channels of it's frequency hop sequence. It then monitors the frequency with the lowest RSSI for valid data packets from the remote transceiver. When it detects a valid data packet it begins frequency hopping in the receive mode. It must be configured with the same frequency group, hop sequence, and ID as the remote transceiver. When the local transceiver receives a valid data packet with the 'Tx' bit set, it switches to the transmit mode for the next hop. After the transmit hop, it switches back to the receive mode. If the local transceiver does not receive a valid data packet during a hop, it still changes to the next frequency after the hop time. After a number of hops during which it receives no valid data packets, it puts itself back into the 'acquire' mode

4.1 Frequency Plan

The transceiver can be set to operate on any one of 256 frequency channels in the 902-928MHz band. The frequencies are divided into four groups of 64 frequencies; each group using every fourth available frequency. 63 out of 64 frequencies in a group are then used equally in a pseudo random sequence. 63 different sequences are available for use in each frequency group. Each channel is 30KHz wide.

FREQUENCY PLAN

HOP FREQ. NUMBER	GROUP #1 (MHz)	GROUP #2 (MHz)	GROUP #3 (MHz)	GROUP #4 (MHz)
0	902.3	902.4	902.5	902.6
1	902.7	902.8	902.9	903.0
2	903.1	903.2	903.3	903.4
3	903.5	903.6	903.7	903.8
4	903.9	904.0	904.1	904.2
5	904.3	904.4	904.5	904.6
6	904.7	904.8	904.9	905.0
7	905.1	905.2	905.3	905.4
8	905.5	905.6	905.7	905.8
9	905.9	906.0	906.1	906.2
XX	**Add 400 KHz per Frequency Hop Number**			
54	923.8	923.9	924.0	924.1
55	924.2	924.3	924.4	924.5
56	924.6	924.7	924.8	924.9
57	925.0	925.1	925.2	925.3
58	925.4	925.5	925.6	925.7
59	925.8	925.9	926.0	926.1
60	926.2	926.3	926.4	926.5
61	926.6	927.7	926.8	926.9
62	927.0	927.1	927.2	927.3

63	927.4	927.5	927.6	927.7

4.2 Per Hop Activities

The transceiver operates on a different frequency every 20 ms. A full hop cycle takes 1.26 sec. The transmitter ON time is approximately 19 ms per frequency, and the remaining time is used to switch frequency and to key the transmit power amplifier on and off.

A data packet is constructed by a number of ASCII bytes assembled by the 68HX11E9 processor as follows:

IDLE (1 BYTE)	16 BIT ADDRESS (SW1 & 2)	CONFIG. (1 BYTE)	11 USER DATA BYTES (MAX)	2 BYTE CRC-16 CHECK SUM

The data waveform is then encoded in the PIC processor to band limit the modulation. Four output bits from the PIC are used to form a simple D/A converter. Data is sent at a rate of 9600 bits per second.

5.0 FCC / ISC Identification Labeling

5.1 FCC and ISC Identification Label

A single label will be used for both FCC and ISC (Industry Canada) identification numbers. The label is shown below in actual size.

Material: Metal Foil

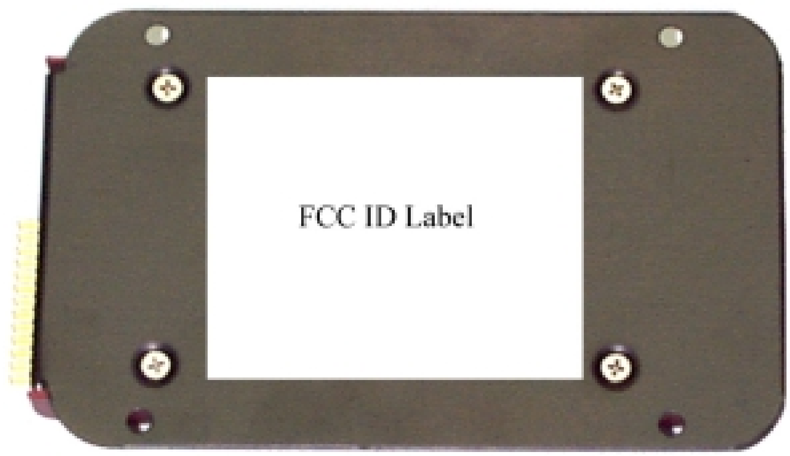
Adhesive: SCOTCH - 3M 486MP High Performance Adhesive.

Color: The actual label will be white lettering on a black background. The diagram below shows the label in "negative" form.

HOPLink Spread Spectrum Receiver	
FCC ID:	**IA9FH1848D**
ISC ID:	**XXXXXXXXX**
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 interference received, including interference that may cause undesired operation. **MADE IN CANADA**	
OMNEX Control Systems Inc.	

5.3 FCC and ISC Identification Label Placement

The identification label will be placed on the bottom of the transceiver as indicated below.



6.0 Schematic Diagrams and Component Layouts

6.1 DSCH-1847-01 Transceiver Schematic Diagram - Sheet 2

6.2 DSCH-1847-01 Transceiver Schematic Diagram - Sheet 3

6.3 TPCB-1847-01 Transceiver Component Layout - Top Side

6.4 TPCB-1847-01 Transceiver Component Layout - Bottom Side

6.5 DSCH-1850-01 Switch Board Schematic Diagram

6.6 TPCB-1850-01 Switch Board Component Layout