UNIVERSAL TRANSCEIVER MODEL 21810
THEORY OF OPERATION

The Universal Transceiver Module is designed to be attached to a Base Station personal computer which is connected in turn to a standard telephone line through a modem Radio frequency data is received from one or many Data Collector Modules which are attached to the batteries of forklifts and lift trucks. Each Data Collector is polled on a periodic basis and the received data is sent to a central collection site via a modem, the Internet and an E-mail process. The transmitter and receiver operate at a frequency of 916.500 mhz.

The Universal Transceiver Module consists of a microprocessor controlled radio frequency transmitter and receiver, an RS232 serial data interface port and a regulated power supply. Power is supplied to the unit through a wire in the serial data cable which attaches to the Base Station PC.

Referring to the schematic, the circuit receives its power from a 5 volt source within the Base Station PC. EMI filters L1,2,3,4,6,8 and 9 are employed on all data and power lines which exit the device and attach to the RS232 data cable. A power supply consisting of voltage regulator IC U2, capacitors C4,C5,C6,C7,resistors R9 and R10 and diode D1 provides regulated 3 volts to the transmitter Ic, receiver IC, and monolithic microwave integrated circuit (MMIC). In certain versions of the circuit, microprocessor U1 can also operate on 3 volts. Its supply voltage is selected with one of two 0 ohm jumpers R7 and R8. Microprocessor U5 is operated at a frequency of 10.00 mhz which is provided by a combination of an internal oscillator circuit and ceramic resonator Y1 . A second crystal/oscillator circuit consisting of Y2, and capacitors C2 and C3 allow the microprocessor to enter a standby mode to reduce power consumption.

The receiver and transmitter portions of the device consist of essentially "cookbook" circuits provided by the IC manufacturer, RF Monolithics. The receiver IC, U4 is an RX2056 amplified sequential hybrid or ASH type receiver. The nature of this type of receiver is that it bit slices the incoming data and thus has no need for such circuit functions as a local oscillator. The receiver essentially has no detectable emissions in the radio frequency range A. detailed data sheet for the receiver is included with this application. In the receive mode of operation, RF transistor Q4 is turned off. RF energy from the external antenna is fed to the device through a short RG174 coax assembly through impedance matching inductor L****. ESD protection is provided by the combination of diode D17 and inductor L11. Diode D17 is selected to provide approximately 3pf of capacitance to resonate with L11. The RF signal is AC coupled to the input of the MMIC (U3) by capacitor C11. The output of the MMIC is also its DC supply line. The RF signal is AC coupled from the output of U6 through capacitor C12 to the input of receiver IC U4. Data output from U4 is fed to the microprocessor through resistor R15. A small capacitor C20 bypassed any residual RF energy to ground.

Baseband level data signals from Receiver IC U7are fed to an automatic gain control circuit consisting of resistors R17,R20,R22, capacitor C21,operational amplifier IC U6,capacitor C22,and resistors R23,R25,R29, and R26. Resistors R31 and R32 form a voltage divider which is connected to the voltage reference output of receiver IC U4.The function of the AGC circuit is to reduce input signal gain in the presence of high signal levels. This is accomplished by comparing the DC level of the baseband voltage output from receiver IC U4 with the reference voltage output.

As the baseband voltage level increases beyond the reference level, the supply voltage to MMIC U3 is reduced through the output and voltage level translation circuit consisting of resistors R24,R27,R28,R30 and transistors Q8 and Q9..

In the transmit mode, the AGC circuit is defeated through the operation of diode D18. A signal from the microprocessor IC U1 is presented to diode D18 serving the twofold purposed of defecting the AGC circuit (by removing power to the MMIC IC U3) and also providing bias to RF transistor Q4 which passes RF energy from the transmitter IC U5 through the connector to the external antenna.

The transmitter IC employed in the device is an RF Monolithics HX2000. A detailed data sheet on the IC is included with this application. . A control signal from the microprocessor drives transistor Q5 through resistor R16. This circuit provides a source of 3 volt power to the receiver. Data to be transmitted is output from the microprocessor to a voltage level translation circuit consisting of resistors R11 and R12, and transistor Q3.. Inductors L12 and L13 serve to prevent stray RF energy from entering other portions of the circuit. Capacitor C17 serves to bypass any residual RF energy present on the 3volt supply pin of transmitter IC U5 to ground.

From a functional standpoint, the device polls Data Collector Modules at predetermined periods of time that may extend from 8 hours to 7 days. It then processes and formats all data received, initiates a call to a local Internet Service Provider through the internal modem, and transmits the data in the form of an E-mail to a central collection site. In a second mode of operation, the Universal Transceiver receives and processes data from Data Collector Modules which periodically attempt to transmit their data even in the absence of a poll. At any time, when a Data Collector Module transmits its data, its internal buffer is cleared and the data collection process begins all over again.

Transmissions are thus infrequent and short. A total of less than 200 bytes of data is transmitted during an interchange between a Data Collector and Universal Transceiver. Data is transmitted at a rate of approximately 12k bits per second . A typical transaction takes approximately 300 milliseconds to complete.

Universal Universal Transceiver Module

A. Universal Transceiver Module

The Universal Transceiver Module shall consist of a power supply circuit, an RF transmitter, a receiver, and an external antenna.. The Universal Transceiver Module shall communicate with the Data Collection module over an RF data link Additionally, the Universal Transceiver Module communicates with a single Base Station (Industrial PC) over an RS232 cable/interface. The Universal Transceiver Module is commanded by the Base Station to poll a specific Data Collection Module. Only a single Universal Transceiver Module may be active at any given time. The Universal Transceiver Module shall be housed in a metal cabinet, shall have provision for an externally mounted antenna and shall be powered from the RS232 port of the Base Station computer.

Transmitter

Carrier Frequency	916.5 MHz
Transmit frequency tolerance	+- 200khz
Harmonics	<-32dbc
Data Rate	<=9600 baud
Power output	-5dbm minimum, +5dbm maximum
Operating Temperature	0° to 50 ° C
Packaging	12"w X 12"h X 6"d unventilated metal cabinet w/latch
Power supply Voltage	5Vdc
Operating current	<20ma
Required transmission range	200' in warehouse environment
Transmission method	Amplitude modulation (on-off keying)
Data format	CMOS 5vdc interface to microprocessor
Power Supply	110Vac input, +5Vdc @500Ma output U.L. listed
Antenna impedance	50 ohm
Antenna connector	Hardwired or optional SMA connector
Antenna	1/4wave or 5/8 wave whip

Receiver

Center Frequency	916.5 MHz
3db bandwidth	+-200Khz
Out of band rejection	>60db @+-30Mhz from center frequency
Dynamic range	-72dbm to –10dbm (not including front end amp)
Total Sensitivity	-95dbm
Emissions	Negligible
Operating voltage	5Vdc
Power consumption	<20ma
Data format	CMOS 5vdc interface to microprocessor
Other Specifications	(see transmitter)

Microprocessor

Crystal Frequency	10Mhz
Clock Frequency	2.5Mhz

FCC CERTIFICATION :

Transmitter subject to operation under CFR47 Part 15.249
Receiver subject to operation under CFR47 Part 15.101(a), and 15.101(b)
Microprocessor section exempt per CFR 47 Part 15.103(b)