DS-UAA3201

UAA3201 Development System User’s Guide

Covers the follow parts:

UAA3201

Radios, Inc.

UAA3201 Development System User’s Guide

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UAA3201 Development System Limitations

The UAA3201 Development System (“DS-UAA3201 ”) is intended for use by engineers for the purpose of evaluating the feasibility of implementing the DS-UAA3201 in various wireless applications. The user’s environment must be limited to use of the development system within an environment which provides for adequate isolation of RF emissions which might be caused by operation of the DS-UAA3201. In field testing, the device must not be operated in a residential area or any area where radio devices might be subject to harmful electrical interference. The development system has not been certified for use by the FCC in accord with Part 15, ETSI I-ETS 300 220 or I-ETS 300 220-1 regulations, or other known standards of operation governing radio emissions. Distribution and sale of the DS-UAA3201 is intended solely for use in future development of devices which may be subject to FCC regulation, or other authorities governing radio emission. DS-UAA3201 may not be resold by users for any purpose. Accordingly, operation of the DS-UAA3201 in the development of future devices is deemed within the discretion of the user and the user shall have all responsibility for any compliance with any FCC regulation or other authority governing radio emissions of such development or use, including without limitation reducing electrical interference to legally acceptable levels. All products developed by user must be approved by the FCC or other authority governing radio emission prior to marketing or sale of such products and user bears all responsibility for obtaining the FCC’s prior approval, or approval as needed from any other authority governing radio emissions.

DS-UAA3201 is an experimental device, and Radios, Inc. makes no representation with respect to the adequacy of the DS-UAA3201 in developing low-power wireless data communications applications or systems, nor for the adequacy of such design or result. Radios, Inc. does not and cannot warrant that the functioning of the DS-UAA3201 will be uninterrupted or error-free.

The DS-UAA3201 and products based on the technology in the DS-UAA3201 operate on shared radio channels. Radio interference can occur in any place at any time, and thus the communications link may not be absolutely reliable. Products using the DS-UAA3201 technology must be designed so that a loss of communications due to radio interference or otherwise will not endanger either people or property and will not cause the loss of valuable data. Radios, Inc. assumes no liability for the performance of products which are designed or created using the DS-UAA3201. Radios, Inc.’s products are not suitable for use in life-support applications, biological hazard applications, nuclear control applications, or radioactive areas.

UAA3201 Development System Warranty

Radios, Inc. warrants solely to the purchaser that the hardware components of the UAA3201 Development System (DS-UAA3201) will be free from defects in materials and workmanship under normal use for a period of 90 days from the date of shipment by Radios, Inc. This limited warranty does not extend to any components or circuits which have been subjected to modification, misuse, neglect, accident, or improper installation or application. Radios, Inc.'s entire liability and the purchaser's sole and exclusive remedy for the breach of this Limited Hardware Warranty shall be, at Radios, Inc.'s option, when accompanied by a valid receipt, either (i) repair or replacement of the defective components or (ii) upon return of the defective DS-UAA3201, refund of the purchase price paid for the DS-UAA3201. EXCEPT FOR THE LIMITED HARDWARE WARRANTY SET FORTH ABOVE, RADIOS, INC. AND ITS LICENSORS PROVIDE THE HARDWARE ON AN "AS IS" BASIS, AND WITHOUT WARRANTY OF ANY KIND EITHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF NONINFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

Limitation of liability. IN NO EVENT SHALL RADIOS, INC. OR ITS SUPPLIERS BE LIABLE FOR ANY DAMAGES (WHETHER SPECIAL, INCIDENTAL, CONSEQUENTIAL OR OTHERWISE) IN EXCESS OF THE PRICE ACTUALLY PAID BY YOU TO RADIOS, INC. FOR THE DS-UAA3201, REGARDLESS OF UNDER WHAT LEGAL THEORY, TORT, OR CONTRACT SUCH DAMAGES MAY BE ALLEGED (INCLUDING, WITHOUT LIMITATION, ANY CLAIMS, DAMAGES, OR LIABILITIES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF BUSINESS INFORMATION, OR FOR INJURY TO PERSON OR PROPERTY) ARISING OUT OF THE USE OR INABILITY TO USE THE DS-UAA3201, EVEN IF RADIOS, INC. HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. BECAUSE SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

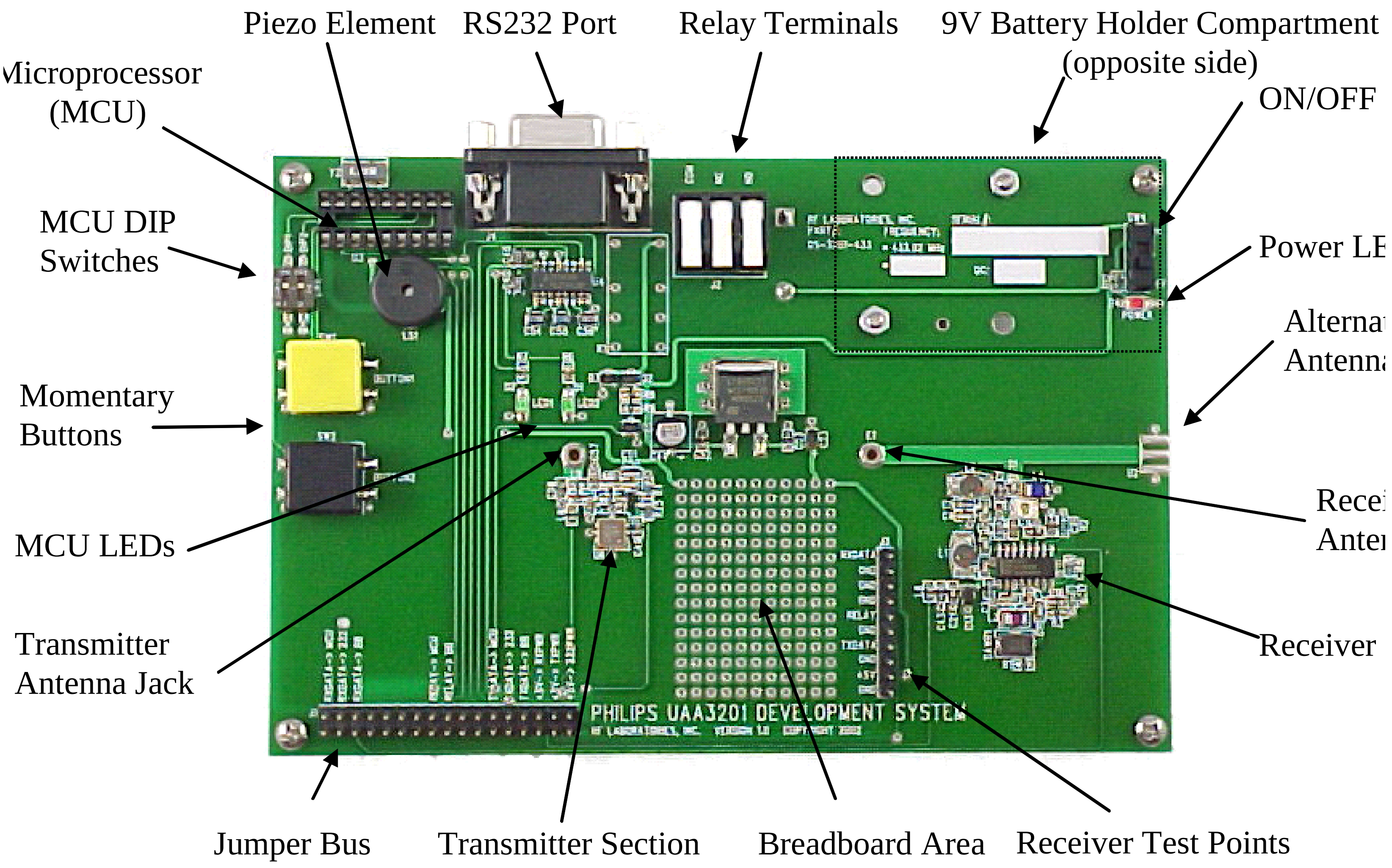
1. UAA3201 Development System Introduction

1.1 General Description

The UAA3201 Development System comprises the hardware, firmware and software resources commonly used by wireless designers in the design and development of wireless applications. The UAA3201 Development System (DS-UAA3201) offers a comprehensive test suite that allows the developer/designer to vary a number of electrical firmware, software and antenna parameters to facilitate the optimal architecture and topology for the given application being developed.

1.2 Intended User

The UAA3201 Development System ("DS-UAA3201 ") is intended for use solely by engineers for the purpose of evaluating the feasibility of implementing the DS-UAA3201 in various wireless applications. The user's evaluation must be limited to use of the development system within a environment which provides for adequate isolation of RF emissions which might be caused by operation of the DS-UAA3201. In field testing, the device must not be operated in a residential area or any area where radio devices might be subject to harmful electrical interference. This Kit has not been certified for use by the FCC in accord with Part 15 ETSI I-ETS 300 220 or I-ETS 300 220-1 regulations or other known standards of operation governing radio emissions.



Piezo Element
RS232 Port
Relay Terminals
9V Battery Holder Compartment (opposite side)
Microprocessor (MCU)
ON/OFF
MCU DIP Switches
Power LE
Alterna Antenn
Momentary Buttons
Recei Anter
MCU LEDs
Transmitter Antenna Jack
Receiver
PHILIPS UAA3201 DEVELOPMENT SYSTEM
Jumper Bus
Transmitter Section
Breadboard Area
Receiver Test Points

FIGURE 1

2.2 Getting Started

Required Equipment:

DS-UAA3201 (UAA3201 Development System)

- Two DS-UAA3201 development boards (Figure 1)
- Two antennas
- Two 9 volt batteries
- DS-UAA3201 user's manual

* DS-UAA3201 Windows software

* Two computers each with one available 9 pin, serial communication port and Windows 98 or later installed.

* Two serial cables - male to female, DB9

Note 1: For RS-232 Windows-based Software Testing Only

Setup:

1. Select a location that lends itself to wireless testing, i.e., line-of-sight with as few metal objects and RF pathway obstructions as practical.

2. Ensure that jumper and dipswitch settings match that required for desired test. Units are shipped with the radios interfaced to microcontroller.

3. Install 9 volt battery in holder underneath each development board.

4. Install two monopole antennas per unit into PCB mounted jacks indicated by "Receiver Antenna Jack" and "Transmitter Antenna Jack" in Figure 1.

5. Turn power switch to the "ON" position, and you are ready to test.

3 Assembly and DS-UAA3201 Overview

3.1 Assembly of Development System

The UAA3201 Development System comes assembled in a default configuration for immediate evaluation except for battery and antenna installations.

3.2 Jumpers and DIP Settings

The DS-UAA3201 units are shipped with the following default jumper settings:

(“ON” MEANS THAT JUMPER IS INSERTED, “OFF” MEANS THAT IT IS NOT)

JUMPER BUS:

RXDATA -> MCU (ON)
RXDATA -> 232 (OFF)
RXDATA -> BB (OFF)
RELAY -> MCU (ON)
RELAY -> MCU (OFF)
TXDATA ->MCU (ON)
TXDATA ->232 (OFF)
TXDATA ->BB (OFF)
+5V -> RXPWR (ON)
+5V -> TXPWR (ON)
+5V -> 232PWR (OFF)

*** The settings may be modified after the demands of the respective application.**

3.3 Power Supply and Regulation

The DS-UAA3201 units are power by a 9 volt alkaline cell and regulated with a industry standard 7805 voltage regulator. The board’s VCC/VDD is therefore 5 volts.

3.4 Microcontroller (MCU) Section

All DS-UAA3201's are supplied with an on-board, 4 MHz, flash-based, microcontroller (MCU). It can be reprogrammed up to 10,000 times with an inexpensive programmer. The MCU comes pre-programmed with sample code which allows the user to transmit and receive simple asyncronous protocol with its corresponding DS-UAA3201 unit. The sample code can be modified in an ASCII editor and reprogrammed according to the requirements of the user's application. The MCU is connected to the receiver's data output, wake-up and power down features, as well as, the transmitter's data input, two LEDs, a piezo element and one relay.

The MCU comes pre-programmed with embedded firmware and software which supports simple, asyncronous communication between both DS-UAA3201 development boards. The sample code includes a basic method for preemption detection, LED and relay activation as well as a warbling beep routine to drive the on-board piezo element.

3.5 Antenna Options and Interfaces

The DS-UAA3201's antenna input can be matched to a number of external antennas by using the "L" inductor network provided on the development unit.

The DS-UAA3201 allows for two antenna polarizations and several different antenna types such as monopole whip, helical, helically loaded whips and others. There are two antenna feed ports: horizontal SMA and direct PCB mount via the on-board jack. The units a shipped with two monopole whip antennas which are inserted directly into the transmit and receive antenna ports (Figure 1)

3.6 RS-232 Interface

The Windows-based software supplied with the DS-UAA3201T package permits the users to communicate PC to PC where both DS-UAA3201 units are connected via their RS232 port and the associated jumpers are appropriately placed.

3.7 Breadboard Area

The development board offers a prototype area with several 0.100" spaced vias. There are also VCC and GND rails provided at the top and bottom of this section.

3.8 Receiver Section

The receiver section is the core of the development system and the primary purpose for its use. The receiver area includes one DS-UAA3201 which comes with a factory preset frequency.

3.9 Transmitter Section

The development system board includes a transmitter which can be used to test the receiver portion of the system if other external transmitters or signal generators are not available. The on-board transmitter’s frequency, modulation and baud rate are all set to match the default configuration of the receiver as shipped from the factory.

4 Operation Instructions and Guidelines

4.1 Theory of Operation

The DS-UAA3201 employs one receiver and one transmitter per unit. Transmission and reception of wireless data is controlled in one of three ways: by microprocessor, RS232 (PC) or external hardware mounted in the prototyping area.

The development boards ship with microprocessor control as their default setting. After applying power, the asyncronous preemption can the initiated by the depression of SW2 (the yellow momentary button). The data packet is a simple three byte word preceded by a two byte preamble to place the comparator threshold of the DS-UAA3201 in at optimal bias for reception of the first byte of data.

As the DS-UAA3201 demodulates the received data from the transmitter, the IC's data output is sent to either the MCU, RS232 or breadboard for processing. If the MCU is interfaced to the RFIC, the sample firmware will acknowledge a valid data packet by responding with a beep, blink an LED once and finally toggle the on-board relay between states. If both DS-UAA3201 boards are jumpered to the RS232 interface and connected to a PC with the DS-UAA3201 development software via a serial cable, the RFIC's data output will be shown in the software "received data" display screen.

The units come with two monopole antennas which employ the ground plane of the DS-UAA3201 board itself as a reference. The socket the antennas use will also accept other antennas with diameters between 0.048"-0.064". Located on the edge of the receiver side of the units (Figure 1, "Receiver Antenna Jack") is an SMA edge connector footprint intended for future installation of an SMA connector in the event the user desires to supply a signal to the DS-UAA3201 receiver from another signal source.

4.2 I/O Interface

The DS-UAA3201 boards are provided with one RS232 port, one relay output and one SMA edge connector footprint.

4.3 LED, Piezo and Button Functions

The development system is shipped with the microprocessor jumpered such that a depression the yellow button on the left side of the DS-UAA3201 will prompt the transmission of one data packet. The LED will light also to indicate that a transmission did indeed occur. The piezo element in turn is prompted to warble as an indication of a valid reception of one data packet.

4.4 Microcontroller Protocol

The microcontroller is preprogrammed with a simple asynchronous protocol intended to serve as a starting point for those unfamiliar with wireless data transmission. It consists of a three-byte word preceded by a two-byte preamble to place the comparator threshold of the DS-UAA3201 in an optimal bias for reception of the first byte of data. The protocol in hexadecimal is as follows: FF, 00, F5, AA,AA.

4.5 RS232 Interface and Windows Software

Installation:

Insert DS-UAA3201 CD into PC and navigate to “DS-UAA3201 Windows Software (Installation Files)\setup.exe”. Follow all prompts, and repeat process for other PC to be used in test.

The RS232 port is located to the rear of the both units (Figure 1, “RS232 Port”). After installing the DS-UAA3201 development software and determining which serial communication port is free for use, connect a nine-pin serial cable between the DS-UAA3201 RS232 port and the PC’s serial communication port.

To open the DS-UAA3201T software, go to the Windows *start menu*, and after going into *programs,* scroll down to *UAA3201 Development System.* Before starting your testing, it is necessary to designate a communications port from the scroll-down menu labelled “Comm Port” to the right of the “File” menu. Next a baud rate must be assigned in the next menu tab to the right. The baud rates for both sides of the DS-UAA3201 system must match each other in order for the units to communicate. The last menu bar is to execute a clear screen function which clears the receive data screen of all of its contents.

The preamble section in the lower left hand corner of the DS-UAA3201 software window contains two user-definable bytes that can be modified to experiment with comparator bias levels which are necessary to optimize for best reception of the first data byte of the transmitted data packet.

The three header bytes can be used for redundancy or as address bytes. They will, along with the preamble bytes, be transmitted with every packet. It is necessary that the header bytes match each other in both DS-UAA3201 software windows.

The software also facilitates a checksum feature which is activated by selection of the “Checksum” radial box. The final feature of the program is an auto-transmit switch which causes the last entered data packet to be re-transmitted continuously.

After all of the above settings have been determined, set and are matching in both DS-UAA3201 software windows, testing may begin by simply typing any text into the lower window label “Transmit Data.” Thereafter, each depression of the “Send” button will cause the current data in the “Transmit Data” window to be transmitted once.

If user desired to experiment with different baud rates, care must be taken that the DS-UAA3201 receiver IC bandwidth settings match the data rates used in the DS-UAA3201 software.

5 Developing Applications with the DS-UAA3201

5.1 A DS-UAA3201 Overview

The UAA3201 is a fully integrated single chip receiver, primarily intended for use in VHF and UHF systems employing direct AM Return-to-Zero (RZ) Amplitude Shift Keying (ASK) modulation.

The RF signal is fed directly into the mixer stage where it is mixed down to nominal 500 kHz IF by the integrated SAWR controlled oscillator. The IF signal is then passed to the IF amplifier which increases the level. A 5th order elliptic low-pass filter acts as the main IF filtering. The output voltage of that filter is demodulated by a limiting amplifier that rectifies the incoming IF. The demodulated signal passes two RC filter stages and is then limited by a data comparator which makes it available at the data output pin.

5.2 Mixer

The mixer is a single balanced emitter coupled pair with internally set bias current. The optimum impedance is 320 ohms at 430 MHz. A capacitor is used to transform a 50 ohms generator impedance to the optimum value.

5.3 Oscillator

The oscillator consists of a transistor in common base configuration and a tank circuit including the SAWR. A resistor is used to control the bias current through the transistor. Another resistor is required to reduce unwanted responses of the tank circuit.

5.4 IF Amplifier

The IF amplifier is a differential input, single-ended output emitter coupled pair. It is used to decouple the first and the second IF filter and to provide some additional gain in order to reduce the influence of the noise of the limiter on the total noise figure.

5.5 IF Filters

The first IF filter is an RC filter formed by internal resistors and an external capacitor. The second IF filter is an external elliptic filter. The source impedance is 1.4 k ohms and the load is high-impedance. The bandwidth of the IF filter in the application and test circuit is 800 kHz due to the centre frequency spread of the SAWR. It may be reduced when SAWRs with less tolerances are used or temperature range requirements are lower. A smaller bandwidth of the filter will yield a higher sensitivity of the receiver. As the RF signal is mixed down to a low IF signal there is no image rejection possible.

5.6 Limiter

The limiting amplifier consists of three DC coupled amplifier stages with a total gain of 60 dB. A Received Signal Strength Indicator (RSSI) signal is generated by rectifying the IF signal. The limiter has a lower frequency limit of 100 kHz which can be controlled by capacitors. The upper frequency limit is 3 MHz.

5.7 Comparator

The 2 x IF component in the RSSI signal is removed by the first order low-pass capacitor. After passing a buffer stage the signal is split into two paths, leading via RC filters to the inputs of a voltage comparator. The time constant of one path is compared to the bit duration. Consequently the potential at the negative comparator input represents the average magnitude of the RSSI signal. The second path with a short time constant allows the signal at the positive comparator input to follow the RSSI signal instantaneously. This results in a variable comparator threshold, depending on the strength of the incoming signal. Hence the comparator output is switched on, when the RSSI signal exceeds its average value, i.e. when an ASK 'on' signal is received. The low-pass filter capacitor rejects the unwanted 2 x IF component and reduces the noise bandwidth of the data filter. A resistor is used to set the current of an internal source. This current is drawn from the positive comparator input, thereby applying an offset and driving the output into the 'off' state during the absence of an input signal. This offset can be increased by lowering the value of the resistor yielding a higher noise immunity at the expense of reduced sensitivity.

5.8 Band Gap Reference

The band gap reference controls the biasing of the whole circuit. In this block currents are generated that are constant over the temperature range and currents that are proportional to the absolute temperature. The current consumption of the receiver rises with increasing temperature, because the blocks with the highest current consumption are biased by currents that are proportional to the absolute temperature.

5.9 Antenna Design Considerations

Three types of antennas are normally associated with DS-UAA3201 applications, (1) quarter-wave monopole, (2) helical (coil), and (3) pcb loop. Of these antenna types, the quarter-wave monopole is preferred, giving the best range performance. Typical SR and SH receivers employing quarter-wave monopole antennas generally provide about 100 meters open field range. The DS-UAA3201 is designed to be connected to a quarter-wave monopole antenna at its input ANT pin, with no further coupling network, and provide this similar range. Of course, the monopole can be a free-standing "wire," or a metal trace built directly into the pcb. The antenna need not be a quarter-wavelength long, but shorter lengths will reduce range. Although the other two antenna types, helical and pcb loop, are less efficient antennas than the monopole, they provide cost and/or ergonomic advantages. The pcb loop antenna is a very inexpensive structure to produce, being built into the pcb. The only requirement is that there be enough "room " on the pcb to build a sufficiently effective antenna. This antenna has the further advantage that it can be hidden from the end- user. The primary disadvantage is that this is usually the least efficient of the three antenna types being discussed, with a typical range of 30 meters. Loop antennas are more commonly found in transmitters than receivers. Where the antenna must be hidden, but still be rather efficient, a good choice is the helical antenna. The structure is simply a "coil " of wire, inexpensive, and easy to fabricate. Typical range for this type of antenna is 60 meters. (Both helical and pcb loop antennas are commonly found in transmitter designs, which usually requires a small unit with the antenna hidden from the user.) Another aspect of antenna selection, aside from its effectiveness at "picking-up " signal from the "ether," is its directionality. Every type of antenna has its own signature of energy distribution in the 3-dimensional space that surrounds it. This signature is generally composed of "peaks" and "nulls"; if the transmit antenna "peak" is pointed at the receiving antenna's "peak," then range is maximized. However, optimizing this for a particular application or installation is generally not practical. All one can do in these cases is choose the antenna that meets the other constraints, like cost and form-factor, then test to determine if the system provides adequate range in all the required directions and orientations. Unfortunately, much of this work is empirical.

Antenna types are described above without any special coupling circuits required. However, Philips does recommend some sort of DC path be provided from the ANT pin to VSSRF. This could be provided by an LC filter attached from the ANT pin to VSSRF, or simply a resistor. The ANT input is internally AC-coupled, so no external biasing is required. The input circuit impedance is very high (i.e. a FET gate), shunted by approximately 2pF of parasitic capacitance, giving an input AC-impedance of about 200 Ω at 400MHz. Specialized 50 Ω antennas may also be connected directly to the MICRF001. The antenna should be connected as closely as possible to the IC pin, minimizing parasitic inductance between the antenna pad and the pin. (Use a >25mil trace,<200mil long, if possible). The antenna can be located away from the pin of the device, but this requires using a transmission line from the antenna to the IC input pin and an impedance matching coupling circuit. Philips does not recommend such an approach for users who lack the necessary RF expertise and test equipment to design transmission line matching networks.

Suitable antennas are crucial to the success the application. Here are several key points to consider in designing antennas for your application:

Where possible, the antenna should be placed on the outside of the product. Also, try to place the antenna on the top of the product. If the product is “body worn”, try to get the antenna away for the body as far as practical.

Regulatory agencies prefer antennas that are permanently fixed to the product. Antennas can be supplied with a cable, provided a non-standard connector is used to discourage antenna substitution (these connectors are often referred to as “Part 15” connectors).

An antenna cannot be placed inside a metal case, as the case will shield it. Also, some plastics (and coatings) significantly attenuate RF signals and these materials should not be used for product cases, if the antenna is going to be inside the case. The antenna designs used in the kit are included in the Drawings section of the manual. Many other antenna designs are possible, but efficient antenna development requires access to antenna test equipment such as a vector network analyzer, calibrated test antenna, antenna range, etc. Unless you have access to this type of equipment, the use of an antenna consultant is recommended. A patch or slot antenna can be used in some applications where an external antenna would be subject to damage. These types of antennas usually have to be designed on a case-by-case basis.

5.10 Noise Management

Noise sources are found in all places and at all times. So the real question regarding noise generation and management is not IF but: how much, what frequency and at what amplitude. Radios which operate under FCC “Part 15” guidelines are subject to noise like any other receiver. Some noise sources commonly encountered by wireless developers are microprocessors, motors or fans, high frequency logic circuits among others. When there exist sufficient speed regarding the rise time and fall time of microprocessor clocks, harmonics can be found around critical frequencies of the receiver. If the option exists, the designer should choose a microprocessor that has the slowest rise and fall time possible for the given application to avoid problematic harmonics relative to the receiver. Swithing power supplies, brush-type motors and other radio unfriendly devices should be avoided around the receive circuitry. Adequate bypass capacitors, chokes, series resistors and shielding can be helpful in managing such problems.

6 Low-power Radios and Regulatory Compliance

6.1 Electromagnetic Compliance

All low-power radio utilizing a frequency 9 Khz or about is subject to electromagnetic compliance and conformance. Often these devices use less than 1 mW or 0 dBm of power, operate shorter distances (1 to 1000 feet) and are simple in design.These devices are unlicensed meaning that they may be used without the end user having to apply for any other type of FCC authorization. In that the frequencies these devices use are shared by millions, one has to take occupied bandwidth inference into account when determining if the desired application is suitable for this regulatory area.

Normally part 15 or low-power radios are used for short-range low-cost applications where human life or safety are not considerations. Among some of these are remote controls for automotive and home alarms, garage door openers and simple contact closers amoung others. Data and telemetry is also another area where Part 15 devices are employed. DS-UAA3201 is intended to support the design of these types of low-power wireless applications. Most low-power wireless systems operate with few interference problems. However, these systems operate on shared radio channels, so interference can occur at any place and at any time.

6.2 A Regulatory Overview for The United States

Although the DS-UAA3201 normally does not exceed the FCC regulations for unintentional radiation, the wireless developer should be aware of the requirements for the transmitter being used.

Non-licensed transmitters operate on a variety of frequencies. They must share these frequencies with licensed transmitters and are prohibited from causing interference to licensed transmitters.
The Federal Communications Commission (FCC) has rules to limit the potential for harmful interference to licensed transmitters by low-power, non-licensed transmitters. In its regulations, the FCC takes into account that different types of products that incorporate low-power transmitters have different potentials for causing harmful interference. As a result, the FCC's regulations are most restrictive on products that are most likely to cause harmful interference, and less restrictive on those that are least likely to cause interference.

This overview is intended to provide a general understanding of the FCC's regulations and policies applying to products using low-power transmitters. It reflects the current text and interpretations of the FCC's regulations. More detailed information is contained in the regulations themselves, which can be found in Part 15 of Title 47 of the Code of Federal Regulations.

Manufacturers and parties selling low-power, non-licensed transmitters, or products containing low-power, non-licensed transmitters, are strongly encouraged to review the FCC's regulations closely. Recognizing that new uses of low-power transmitters often generate questions that are not directly addressed in the regulations, we welcome inquiries or requests for specific interpretations. Occasionally, the FCC proposes changes to its regulations, generally to address industry concerns and/or as new uses of low-power transmission equipment appear.

The terms “low-power transmitter,” “low-power, non-licensed transmitter,” and “Part 15 transmitter” all refer to the same thing: a low-power, non-licensed transmitter that complies with the regulations in Part 15 of the FCC rules. Part 15 transmitters use very little power, most of them less than a milliwatt. They are “non-licensed” because their operators are not required to obtain a license from the FCC to use them.

Although an operator does not have to obtain a license to use a Part 15 transmitter, the transmitter itself is required to have an FCC authorization before it can be legally marketed in the United States. This authorization requirement helps ensure that Part 15 transmitters comply with the Commission’s technical standards and, thus, are capable of being operated with little potential for causing interference to authorized radio communications.

If a Part 15 transmitter does cause interference to authorized radio communications, even if the transmitter complies with all of the technical standards and equipment authorization requirements in the FCC rules, then its operator will be required to cease operation, at least until the interference problem is corrected.

Part 15 transmitters receive no regulatory protection from interference.

Changing the antenna on a transmitter can significantly increase, or decrease, the strength of the signal that is ultimately transmitted. Except for cable locating equipment, the standards in Part 15 are not based solely on output power but also take into account the antenna characteristics. Thus, a low power transmitter that complies with the technical standards in Part 15 with a particular antenna attached can exceed the Part 15 standards if a different antenna is attached. Should this happen it could pose a serious interference problem to authorized radio communications such as emergency, broadcast and air-traffic control communications.

In order to prevent such interference problems, each Part 15 transmitter must be designed to ensure that no type of antenna can be used with it other than the one used to demonstrate compliance with the technical standards. This means that Part 15 transmitters must have permanently attached antennas, or detachable antennas with unique connectors. A “unique connector” is one that is not of a standard type found in electronic supply stores.

It is recognized that suppliers of Part 15 transmitters often want their customers to be able to replace an antenna if it should break. With this in mind, Part 15 allows transmitters to be designed so that the user can replace a broken antenna. When this is done, the replacement antenna must be electrically identical to the antenna that was used to obtain FCC authorization for the transmitter. The replacement antenna also must include the unique connector described above to ensure it is used with the proper transmitter.

Hobbyists, inventors and other parties that design and build Part 15 transmitters with no intention of ever marketing them may construct and operate up to five such transmitters for their own personal use without having to obtain FCC equipment authorization. If possible, these transmitters should be tested for compliance with the Commission’s rules. If such testing is not practicable, their designers and builders are required to employ good engineering practices in order to ensure compliance with the Part 15 standards.

Home-built transmitters, like all Part 15 transmitters, are not allowed to cause interference to licensed radio communications and must accept any interference that they receive. If a home-built Part 15 transmitter does cause interference to licensed radio communications, the Commission will require its operator to cease operation until the interference problem is corrected. Furthermore, if the Commission determines that the operator of such a transmitter has not attempted to ensure compliance with the Part 15 technical standards by employing good engineering practices then that operator may be fined up to $10,000 for each violation and $75,000 for a repeat or continuing violation.

Operating a prototype of a product that is ultimately intended for market is not considered “personal use.” Thus, a party that designs and builds a transmitter with plans to mass produce and market a future version of it must obtain an experimental license from the FCC in order to operate the transmitter for any purpose other than testing for compliance with the Part 15 technical standards.

A Part 15 transmitter must be tested and authorized before it may be marketed. There are two ways to obtain authorization: certification and verification.

The ***certification*** procedure requires that tests be performed to measure the levels of radio frequency energy that are radiated by the device into the open air or conducted by the device onto the power lines. A description of the measurement facilities of the laboratory where these tests are performed must be on file with the Commission’s laboratory or must accompany the certification application. After these tests have been performed, a report must be produced showing the test procedure, the test results, and some additional information about the device including design drawings. Certified transmitters also are required to have two labels attached: an FCC ID label and a compliance label. The FCC ID label identifies the FCC equipment authorization file that is associated with the transmitter, and serves as an indication to consumers that the transmitter has been authorized by the FCC. The compliance label indicates to consumers that the transmitter was authorized under Part 15 of the FCC rules and that it may not cause, nor is it protected from, harmful interference. The FCC ID. The FCC ID must be permanently marked (etched, engraved, indelibly printed, etc.) either directly on the transmitter, or on a tag that is permanently affixed (riveted, welded, glued, etc.) to it. The FCC ID label must be readily visible to the purchaser at the time of purchase.

The FCC ID is a string of 4 to 17 characters. It may contain any combination of capital letters, numbers, or the dash/hyphen character. Characters 4 through 17 may be designated, as desired, by the applicant. The first three characters, however, are the “grantee code,” a code assigned by the FCC to each particular applicant (grantee). Any application filed with the FCC must have an FCC ID that begins with an assigned grantee code.

The Grantee Code. To obtain a code, new applicants must send in a letter stating the applicant’s name and address and requesting a grantee code. This letter must be accompanied by a completed “Fee Advice Form” (FCC Form 159), and a $45 processing fee.

The Compliance Label. The applicant for a grant of certification is responsible for having the compliance label produced and for having it affixed to each device that is marketed or imported. The wording for the compliance label is in Part 15, and may be included on the same label as the FCC ID, if desired. The compliance label and FCC ID label may not be attached to any devices until a grant of certification has been obtained for the devices.

Once the report demonstrating compliance with the technical standards has been completed, and the compliance label and FCC ID label have been designed, the party wishing to get the transmitter certified (it can be anyone) must file a copy of the report, an “Application for Equipment Authorization” (FCC Form 731) and an $845 application fee, with the FCC.

After the application is submitted, the FCC’s lab will review the report and may or may not request a sample of the transmitter to test. If the application is complete and accurate, and any tests performed by the FCC’s lab confirm that the transmitter is compliant, the FCC will then issue a grant of certification for the transmitter. Marketing of the transmitter may begin after the applicant has received a copy of this grant.

Typically, 90% of the applications for certification that the FCC receives are processed within 30 calendar days. This time frame may increase due to incomplete applications and pre-grant sampling, if determined to be necessary.

The ***verification*** procedure requires that tests be performed on the transmitter to be authorized using a laboratory that has calibrated its test site or, if the transmitter is incapable of being tested at a laboratory, at the installation site. These tests measure the levels of radio frequency energy that are radiated by the transmitter into the open air or conducted by the transmitter onto the power lines. After these tests are performed, a report must be produced showing the test procedure, the test results, and some additional information about the transmitter including design drawings.

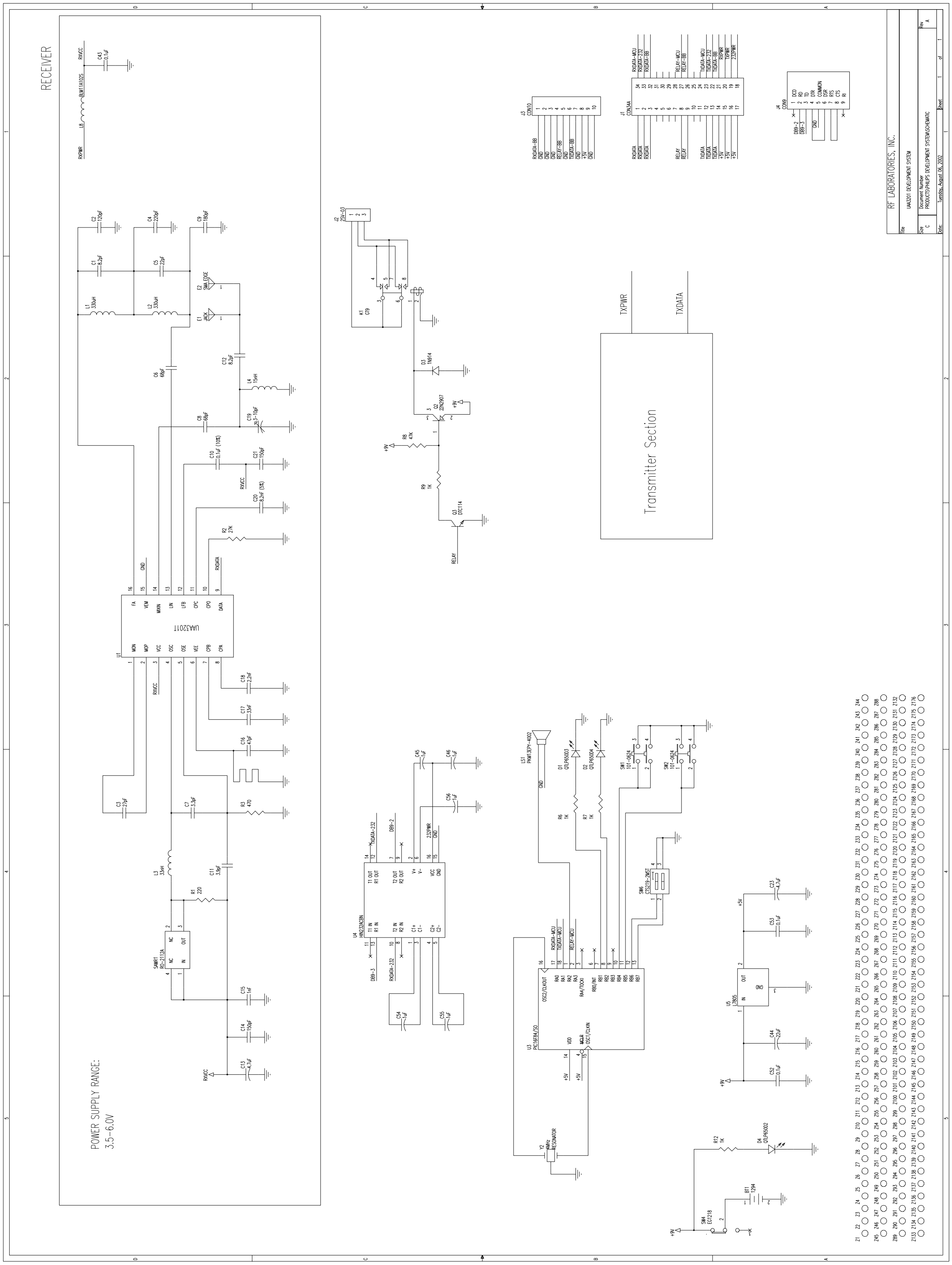
Once the report is completed, the manufacturer (or importer for an imported device) is required to keep a copy of it on file as evidence that the transmitter meets the technical standards in Part 15. The manufacturer (importer) must be able to produce this report on short notice should the FCC ever request it.

The manufacturer (or importer) is responsible for having the compliance label produced, and for having it affixed to each transmitter that is marketed or imported. Verified transmitters must be uniquely identified with a brand name and/or model number that cannot be confused with other, electrically different transmitters on themarket. However, they may not be labelled with an FCC ID or in a manner that could be confused with an FCC ID.

Once the report showing compliance is in the manufacturer’s (or importer’s) files and the compliance label has been attached to the transmitter, marketing of the transmitter may begin. ***There is no filing with the FCC required for verified equipment.***

Any equipment that connects to the public switched telephone network, such as a cordless telephone, is also subject to regulations in Part 68 of the FCC Rules and must be registered by the FCC prior to marketing. The rules in Part 68 are designed to protect against harm to the telephone network

7. Schematic


RECEIVER
POWER SUPPLY RANGE:
3.5~6.0V
UAA3201T
Transmitter Section
TXPWR
TXDATA
RXDATA
RELAY
PIC16F84/SO
HIN232ACBN
RF LABORATORIES, INC.
Title
UAA3201 DEVELOPMENT SYSTEM
Size
C
Document Number
PRODUCTS\PHILIPS DEVELOPMENT SYSTEM\SCHEMATIC
Rev
A
Date:
Tuesday, August 06, 2002
Sheet
1
of
1

8. Sample Firmware

```
;**********************************************************************
;                                                                     *
;    Filename:      DS-UAA3201.asm                                    *
;    Date:          11/28/01                                          *
;    File Version:  A                                                 *
;                                                                     *
;    Author:        Engineering                                       *
;    Company:       RF Laboratories                                   *
;                                                                     *
;                                                                     *
;**********************************************************************
;                                                                     *
;    Files required:                                                  *
;                                                                     *
;                   p16F84A.inc                                       *
;                                                                     *
;**********************************************************************
;                                                                     *
;    Notes:                                                           *
;             Sample asyncronous communication code                   *
;             for Philips Development System                          *
;                                                                     *
;                                                                     *
;**********************************************************************

      list      p=16F84A            ;List directive to define processor
      #include <p16F84A.inc>        ;Processor specific variable definitions

      __CONFIG   _CP_OFF & _WDT_OFF & _PWRTE_ON & _XT_OSC   ;Configuration directive

; ‘__CONFIG’ directive is used to embed configuration data within .asm file.
; The lables following the directive are located in the respective .inc file.
; See respective data sheet for additional information on configuration word.


;—— Define Ports ——————————————————————————
#Define relay           porta, 0    ;Relay controller pin (output)
#Define txdata          porta, 1    ;Output pin for transmitting data (output)
#Define piezo           porta, 2    ;Piezo pin for controlling beeper (output)
#Define led2            porta, 3    ;Led2 power pin (output)
#Define led1            porta, 4    ;Led1 power pin (output)

#Define rxdata          portb, 0    ;Data input pin for recieving data (input)
#Define fetsw           portb, 1    ;Control pin for switching MOSFET in receiver
                                     section
#Define rxsdn           portb, 2    ;Shut down control pin for QwikRadio™ receiver
                                     (output)
#Define rxwup           portb, 3    ;Wake-up input pin from receiver (input)
#Define button1         portb, 4    ;Input from button one (depressed = low)
#Define button2         portb, 5    ;Input from button two (depressed = low)
#Define dip1            portb, 6    ;Input from DIP one (On = low)
#Define dip2            portb, 7    ;Input from DIP two (On = low)
```

```
;—— variables ————————————————————————————-

temp                equ   0x0C        ;Temporary storage of W
tempstatus          equ   0x0D        ;Temporary storage of status reg
temp1               equ   0x0E        ;Delay constant value for beep subroutine
temp2               equ   0x0F        ;Delay constant value for beep subroutine
beepctr             equ   0x10        ;Counter for length of each tone for multitonal
                                       beep subroutine
bitCntr             equ   0x11        ;Counter for tracking how many bits have been
                                       sent or received
TXByte              equ   0x12        ;Contains byte to transmit upon entry into
                                       SendByte routine
RXByte              equ   0x13        ;Contains received byte from Receiver
TempData            equ   0x14        ;Temporary storage of data to transmit
repeat              equ   0x15        ;Counter for number of times to repeat beep
                                       subroutine
count1              equ   0x16        ;Counter for misc. delay routines
count2              equ   0x17        ;Counter for misc. delay routines
count3              equ   0x18        ;Counter for misc. delay routines
MS_Tim              equ   0x19        ;Counter for Dly1 and Dly2 routines

;**********************************************************************
            ORG     0x000             ;Processor reset vector
            goto    Init              ;Go to beginning of program


;<———————————————— Check button depression ————————————————>
checkbutton btfsc button2             ;Test button2, skip next line if depressed
            return                    ;Return from subroutine
            call  SendBurst           ;Send data burst
            return                    ;Return from subroutine

;<———————————————— GetByte Receive Routine ————————————————>
;Received byte is in RXByte on exit

GetByte     movlw 0x08
            movwf BitCntr             ;Load bit counter for 8 data bits

TestInput   btfss   rxdata            ;Look for start bit (high), skip if true
            goto  TestInput           ;loop if no data detected

InputHigh   call    WaitHalfBit       ;Wait one half of one bit length
            btfss rxdata              ;Check start bit again
            goto  TestInput           ;Loop if no data detected

GetBits     call    Wait1Bit          ;Wait one bit length
            btfss rxdata              ;Test bit condition
            bcf   status,c            ;Set carry if incoming bit is low (zero)
            btfsc rxdata              ;Test bit
            bsf   status,c            ;Clear carry if incoming bit is high (one)
            rrf     RxByte,1          ;Rotate carry into RxByte
            decfsz  BitCntr,1         ;Decrease counter, skip if all 8 bits have been
                                       received
            goto    GetBits           ;Get more bits
            call  Wait1Bit            ;Shift to stop bit (low) before looking for next
                                       start bit
            return                    ;Return with received byte in RxByte
```

```
;<—————————————————— Serial Data TX Routine ——————————————————>
;Enter routine with byte to transmit in txbyte

SendByte    movlw 0x08
            movwf BitCntr           ;Load bit counter for 8 data bits

            bsf   txdata            ;Begin start bit (High)

            call  Wait1Bit          ;Wait one bit length

NextBit     rrf   txbyte,1          ;Rotate TxByte out to carry
            btfss status, C         ;Test carry, skip if set
            bcf   txdata            ;Clear output pin for logical low (zero)
            btfsc Status, c         ;Test carry, skip if set
            bsf   txdata            ;Set output pin for logical high (one)

Continue    call  Wait1Bit          ;Wait one bit length

           decfsz BitCntr,1         ;Decrease bit counter & skip if zero. Result —>
                                     register
            goto  NextBit           ;no more bits so jump and do stop bits
            bcf   txdata            ;Begin stop bit

            call  Wait1Bit          ;Wait 1 stop bit
            call  Wait1Bit          ;Wait 1 stop bit (total 2 stop bits)

            return
;<—————————————————— Warble Beep Routine ——————————————————>

Beep        movlw 0x05              ;Repeat Warble x times
            movwf repeat            ;Move constant to repeat register
Tone1                               ;Generate 5.1KHz Tone
            movlw 153               ;Load working value for number of times to beep
            movwf beepctr           ;Move working value into beepctr register

bp1         bsf   piezo             ;Start high period of beep signal
            call  delay1            ;Wait 98uS
            bcf   piezo             ;Start low period of beep signal
            call  delay1            ;Wait 98uS
           decfsz beepctr,1         ;One period is complete, skip next line if
                                     beepctr is depleted
            goto  bp1               ;Repeat 5.1KHz beep routine

            movlw 7                 ;Load value for a wait period between high and
                                     low frequency beeps
            call  dly2              ;Call delay routine
Tone2                               ;Generate 4KHz Tone
            movlw 122               ;Load working value for number of times to beep
            movwf beepctr           ;Move working value into beepctr register
bp2         bsf   piezo             ;Start high period of beep signal
            call  delay2            ;Wait 124uS
            bcf   piezo             ;Start low period of beep signal
            call  delay2            ;Wait 124uS
           decfsz beepctr,1         ;One period is complete, skip next line of
                                     beepctr is depleted
            goto  bp2               ;Repeat 4KHz beep routine
           decfsz repeat,f          ;Decrease repeat register and skip if zero
            goto  Tone1             ;Repeat beep signal
            return                  ;Return from beep routine

;<——————— Delay routine for waiting one bit period (833uS @ 1200 baud) ————————>

Wait1Bit    movlw d’255'            ;Load constant into working for count1
            movwf count1            ;Load working into count1 register
repeat1    decfsz count1,f          ;Decrease count1 and skip when counter equals
                                     zero
            goto  repeat1           ;Repeat until counter equals zero
            movlw d’22'             ;Load constant into working for count2
            movwf count2            ;Load working into count2 register
repeat2    decfsz count2,f          ;Decrease count2 and skip when counter equals
                                     zero
            goto  repeat2           ;Repeat until counter equals zero
            return                  ;Return from delay routine

;<——————————————— Pre/interbyte delay of 2.0 mS ——————————>

ByteDelay
            movlw d’255'            ;Load constant into working for count1
            movwf count1            ;Load working into count1 register
repeat3    decfsz count1,f          ;Decrease count1 and skip when counter equals
                                     zero
            goto  repeat3           ;Repeat until counter equals zero
            movlw d’255'            ;Load constant into working for count2
            movwf count2            ;Load working into count2 register
repeat4    decfsz count2,f          ;Decrease count1 and skip when counter equals
                                     zero
            goto  repeat4           ;Repeat until counter equals zero
            movlw d’155'            ;Load constant into working for count3
            movwf count3            ;Load working into count3 register
repeat5    decfsz count3,f          ;Decrease count3 and skip when counter equals
                                     zero
            goto  repeat5           ;Repeat until counter equals zero
            return                  ;Return from delay routine

;<——— Delay routine for waiting one half a bit period (416uS @ 1200 baud) ———>

WaitHalfBit movlw d’138'            ;Load constant into working for count3
            movwf count3            ;Load working into count3 register
repeat6    decfsz count3,f          ;Decrease count3 and skip when counter equals
                                     zero
            goto  repeat6           ;Repeat until counter equals zero
            return                  ;Return from delay routine

;<———————————————98uS delay—————————————————>

delay1      clrf  temp1             ;Clear temp1 register
            movlw 32                ;Load constant into working for temp1
            movwf temp1             ;Load working into temp1 register
dl1        decfsz temp1,1           ;Decrease temp1 and skip when counter equals
                                     zero
            goto  dl1               ;Repeat until counter equals zero
            return                  ;Return from delay routine
```

```
;<————————————————124uS delay—————————————————>

delay2
            clrf  temp1             ;Clear temp1 register
            movlw 41                ;Load constant into working for temp1
            movwf temp1             ;Load working into temp1 register
dl2        decfsz temp1,1           ;Decrease temp1 and skip when counter equals
                                     zero
            goto  dl2               ;Repeat until counter equals zero
            return                  ;Return from delay routine



;<———————      Delay Routine (approx. 1/2 sec.)———————>

Dly1        clrf    Count1          ;Clear counter for this routine, other counters
                                     are being loaded
            movlw 100               ;Load MS_Tim register with constant for 1/2 sec
            movwf MS_Tim            ;Load working into MS_Tim register
tt1loop     movlw   6               ;Load constant into working for Count2
            movwf   Count2          ;Load working into Count2 register
ttloop      decfsz  Count1,f        ;Count1 becomes 0xFF on first decrement
            goto    ttloop          ;Repeat until Count1 equals zero
            decfsz  Count2,f        ;Decrease secondary counter
            goto    ttloop          ;Repeat until Count2 equals zero
            decfsz  MS_Tim,f        ;Decrease MS_Tim counter and skip when counter
                                     equals zero
            goto    tt1loop         ;Repeat until MS_Tim equals zero
            return                  ;Return from delay routine

;<———————      Delay Routine ———————>

;Dly enters with a number in MS_Timer and delays in increments of this number
;times 6FFH to give delays in increments of 5 milliseconds.
;set at approx. 5 Msec delay
;Uses Count1,Count2,MS_Timer

Dly2        clrf  Count1            ;Clear counter for this routine, other counter
                                     being loaded
            movwf MS_Tim            ;Load working into MS_Tim for any desired
                                     time period
ttloop3     movlw   d’6'            ;Load constant into working for Count2
            movwf   Count2          ;Load working into Count2 register
ttloop2     decfsz  Count1,f        ;Count1 becomes 0xFF on first decrement
            goto    ttloop2         ;Repeat until Count1 equals zero
            decfsz  Count2,f        ;Decrease secondary counter
            goto    ttloop2         ;Repeat until Count2 equals zero
            decfsz  MS_Tim,f        ;Decrease MS_Tim counter and skip when counter
                                     equals zero
            goto    ttloop3         ;Repeat until MS_Tim equals zero
            return                  ;Return from delay routine
```

```
;<——————————————— Send Entire Data Burst Routine ——————————————>

SendBurst   movlw b’11111111’       ;Load first preamble byte into working
            movwf TxByte            ;Load working into TXByte register
            call  Sendbyte          ;Send first preamble byte

            movlw b’00000000’       ;Load second preamble byte into working
            movwf TxByte            ;Load working into TxByte register
            call  Sendbyte          ;Send second preamble byte

            movlw 0xF5              ;Load first header byte into working
            movwf TxByte            ;Load working into TxByte register
            call  SendByte          ;Send first header byte

            movlw 0xAA              ;Load address byte 0 into working
            movwf TxByte            ;Load working into TxByte register
            call  SendByte          ;Send address byte 0

            movlw 0xAA              ;Load address byte 1 into working
            movwf TxByte            ;Load working into TxByte register
            call  SendByte          ;Send address byte 1

            return                  ;Done with SendBurst, return to Start

;<——————————————— Main Loop ————————————————>

Start       call  GetByte           ;Call data receive routine

CheckPreamble
            movlw 0xF5              ;Load constant into working for RxByte
            subwf RxByte,0          ;Subtract working from RxByte
            btfss status,z          ;Skip if subtraction set zero flag high
            goto  Chkbut            ;Check button 2 status for depression

CheckAdr0   call  GetByte           ;Call data receive routine for next byte

            movlw 0xAA              ;Load first address byte into working
            subwf RxByte,0          ;Subtract working from RxByte
            btfss status,z          ;Skip if subtraction set zero flag high
            goto  Chkbut            ;Check button 2 status for depression

CheckAdr1   call  GetByte           ;Call data receive routine for next byte

            movlw 0xAA              ;Load second address byte into working
            subwf RxByte,w          ;Subtract working for RxByte
            btfss status,z          ;Skip if subtraction set zero flag high
            goto  Chkbut            ;Check button 2 status for depression

            call  beep              ;Beep once when good data is received

Chkbut      call  checkbutton       ;Check button 2 for depression
            goto  Start             ;Go back to start and do it all over again
```

```
;<———————————————— Init Ins & Outs ———————————————————>

Init         bsf   status, rp0       ;Select bank #1
             movlw B’11110000'       ;Initialize port “a” (0=output 1=input)
             movwf TRISA             ;Load working value into tris register
             movlw B’11111001'       ;Initialize port “b” (0=output 1=input)
             movwf TRISB             ;Load working value into tris register
             movlw B’10001000'       ;Prescale assigned to WDT = 1:1
             movwf option_reg        ;TMR0 on internal instruction cycle, DISABLE
                                      pull-ups

             bcf   status, rp0       ;Switch back to bank 0
             movlw B’00000000'       ;DISABLE ALL INTERRUPTS
;            movlw B’10001000'       ;Enable global interrupts, enable rb4-rb7 pin
                                      change
             movwf intcon            ;Load working value into interrupt register

             bcf   relay             ;Turn OFF relay
             bcf   led1              ;Turn OFF led1
             bcf   led2              ;Turn OFF led2
             bcf   piezo             ;Turn OFF piezo
             bcf   txdata            ;Set Data low (normal state)

             clrf  Count1            ;Initialization of delay counter by clearing
             clrf  Count2            ;Initialization of delay counter by clearing
             clrf  Count3            ;Initialization of delay counter by clearing
             clrf  MS_Tim            ;Initialization of delay counter by clearing

             goto  Start             ;Go to main program

      END
```

9. FAQ's

10. Support

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