



# SM204 Fox Hunt Transmitter Manual

## Release 1, March 2012

The SM204 is a low power transmitter/receiver combination suitable for generating a 2 milliwatt modulated carrier burst on the 433MHz band for the purposes of Direction Finding competition work. This manual is divided into three chapters:

- Construction
- Operation
- Circuit Description

The SM204 Transmitter is the compliment to the SM205 Receiver, which is used for tracking and locating a concealed SM204 unit. The SM204 transmits a unique 2-tone burst at frequent intervals that sounds quite different to other transmission sources, making it easy to discern when operating in the field.

If both the SM204 and SM205 kits have been purchased together, then it is recommended to construct the SM204 unit first as it is the easier of the two projects to build and the experience will prepare the builder for the construction of the SM205 receiver unit

The microprocessor provided has been pre-programmed and should work as soon as power is applied to the completed unit. A programming header has been added to the pcb in the event that additional software features are to be added in the future. Re-programming would require an Atmel serial programmer (AVRISPMkII), a copy of AVR Studio 4 or higher and a knowledge of Assembly Language Programming for the AVR devices. (these programming items are not included with this kit)

## CHAPTER 1 – CONSTRUCTION

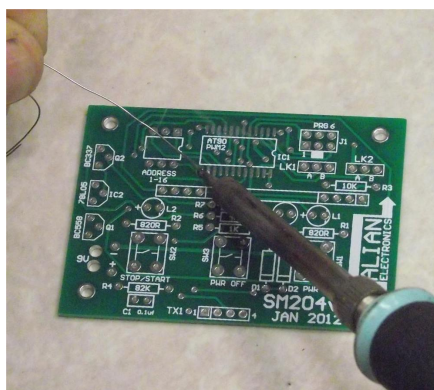
Most people capable of a careful, systematic approach to kit building will be capable of constructing this project. It does contain one surface-mount IC to install, but with basic magnifying glass, a fine-tipped soldering iron and the section of very fine 'cotton' solder provided with the kit, assembly should not be an obstacle. **Note that a complete parts list for this kit is contained on the last page of this manual.**

### MOUNTING THE SURFACE-MOUNT IC's

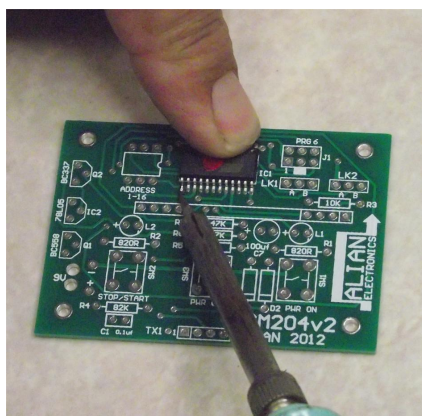
For the sake of stability and ease of access, the surface mount chip should be the first part to go onto the board. Orientation of the chip is important. The round dot on the top left-hand corner of the chip represents Pin1. This should be oriented to the corner of the chip outline with a white square printed on the corner.

First place a small blob of solder on a corner pad. Then Sweat the IC to the pad as centrally as possible. Then solder the diagonal corner before soldering the remainder of the pins.

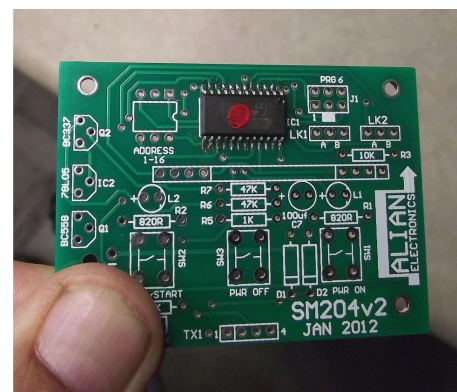
These images show the chip-soldering process in three steps:



Board preparation



Sweat the I.C. to the pcb.



The chips soldered in place.

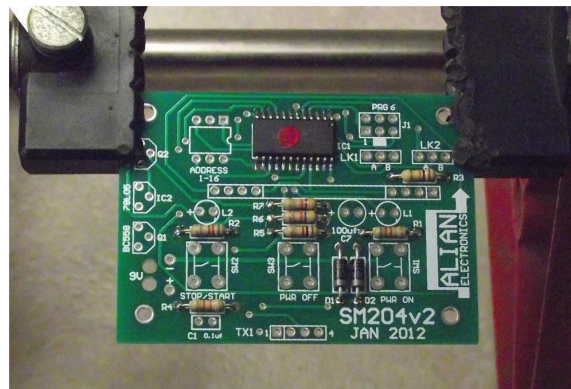
A section of very 0.35mm fine (cotton-like) solder has been provided for this IC mounting work. All remaining soldering may be carried out with the larger 0.71mm solder also provided with the kit.

## PLACING THE REMAINING COMPONENTS

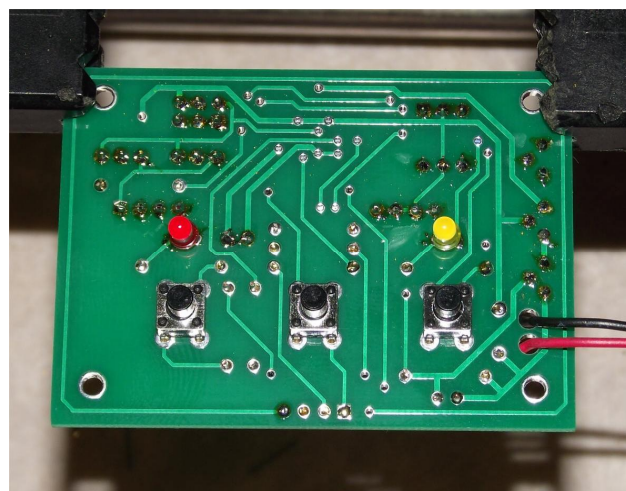
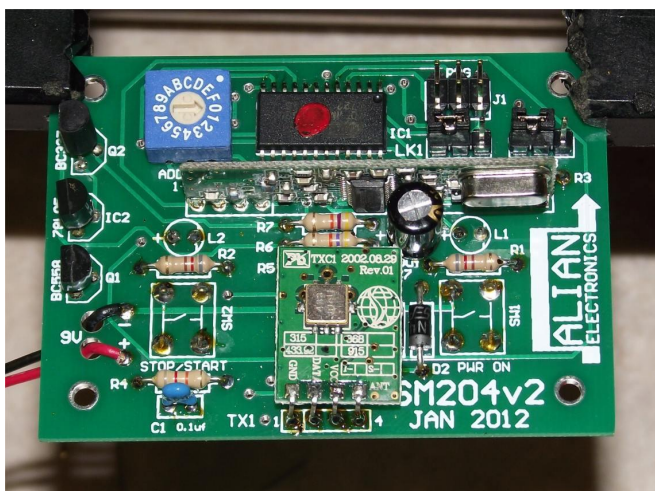
After the IC has been placed, the next step is to mount the resistors and diodes. As these parts have been pre-cut & bent, they are ready to drop straight into the board.

The pcb is Double-sided, which means that the inside of each hole is also lined with copper and it is ok to solder the resistors in place from the top of the board.

All resistors are standard ¼ watt, 5% using the common 3-band resistor colour code. If unfamiliar with this code, you may need to consult a reference book or internet web site for a description of how the code system works.



The red & yellow LEDs must be raised to approximately the same height as the push-button switches. The transmitter module legs are not cut, they are folded to 90° and soldered flush with the board.



## PREPARING THE ENCLOSURE LABEL

Before the board is fitted to the enclosure, the label should be attached to the front. The label is a self-adhesive polyester film. It needs to be trimmed with scissors before attempting to attach it to the enclosure.

The best way to attach these labels is to pull back a corner and cut off a small triangle of backing paper.

Place the label within the rebate on the front of the enclosure with the exposed corner going down last. Then the remainder of the backing may be removed and the label smoothed down.

Use a sharp knife to remove the label material around the LED holes.



The assembled module can now be fitted to the rear of the enclosure faceplate. Four chrome-plated screws have been provided for this purpose. The two LEDs and three push-button switches should come up to label height so that a positive 'click' can be felt when a button is pressed.

## ATTACHING THE ANTENNA WIRE AND BATTERY CLIP

When the SM204 pcb is complete, pass the red and black wires of the battery clip through the battery compartment, through the two strain-relief holes in the pcb, and then solder the wires onto the board. The grey figure-8 antenna wire (formed from two thin ribbon cable sections) must pass through the hole in the centre-top of the enclosure, then split and solder to two locations on the pcb. One strand is the transmit antenna and the other is the receive antenna.

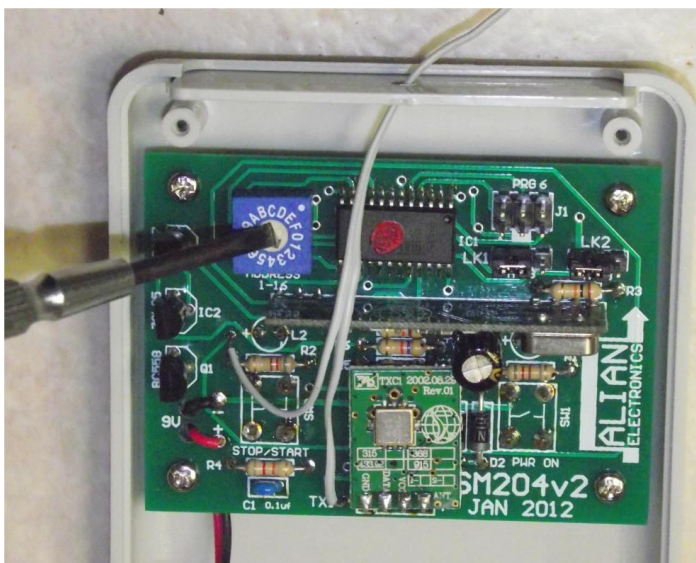
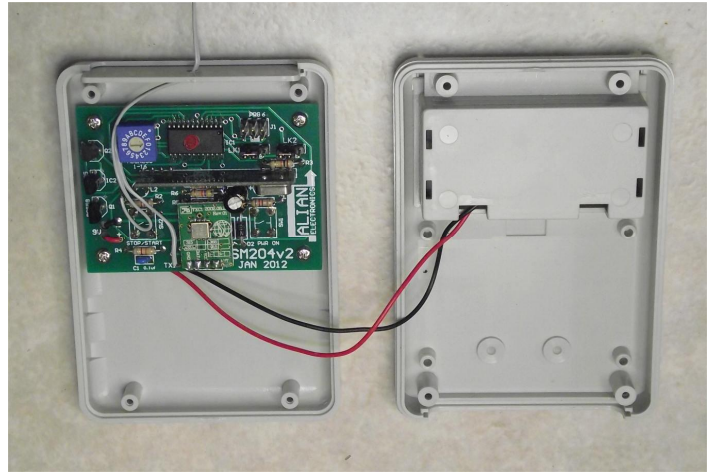


At this point it is ok to perform a brief test of the unit. Attach the battery then press the ON button. The red LED should glow. Then press the TX button and the Yellow LED should glow.

If a scanning receiver is not available, it should be possible to hear if it is transmitting by placing it very close to an FM radio and tune around the band. There should be enough signal-overload for the unique 2-tone squawk to be heard breaking through in several spots.

### SETTING THE ADDRESS CODE

Each SM204 unit may be associated with one of 16 Address Codes. This will be the code that it will respond to and begin transmitting when issued by an SM205 Receiver unit set to the same code.



Place a small flat-blade screwdriver into the blue rotary switch and choose a code by pointing the arrow to a number/letter.

Where multiple SM204 units are to be used at a DF event, it is appropriate for all of them to be set to different codes. Placing a sticky-label on the back of the unit with the address code chosen from: 0123456789ABCDEF written on in pen is useful when identifying each unit in the field

The two halves of the enclosure may now be screwed together using the four small black self-tapper screws provided.

This completes the electronic assembly phase of the project.

## CHAPTER 2 – OPERATION

The **SM204** unit has both a receiver and transmitter module inside that operates on the 70cm LIPD frequency of **433.920 MHz**. Even though the transmissions appear to be continuous, there is a gap where the unit switches back to receive where it will listen for remote STOP/START commands being sent from an SM205 unit.

### TIME OUT TIMER

The SM104 has an option link inside designated **LK1** which may be placed in the **A** or **B** position. When in the **A** position (default) a **30 minute** time out timer is active for the transmitter so that 30 minutes after the transmitter is manually or remotely activated, it will revert back to the receive standby state. If the link is placed in position **B**, then this timer is inhibited and the unit will remain in a transmit state for the life of the battery.

### THE POWER ON/OFF BUTTONS

The unit is turned **ON** by briefly pressing the **ON** button. The unit is turned **OFF** by pressing and holding the **OFF** button for **1 full second** (to prevent accidental shutdowns).



## THE TRANSMITTER

The transmitter may be engaged by pressing the TX button, or remotely activated by receiving the appropriate control command over 433 MHz. The transmitter is active when the yellow led indicator is on. Pressing the TX button a second time will turn the transmitter OFF

The 2mw transmitter should be audible from 100 to 150 metres away from a sniffer receiver. This range may be significantly diminished if the transmitter is placed on or behind metal objects. If the transmitter is simply placed on the ground, this may reduce the transmit range to around 50-70 metres.

If the SM204 is in a standby state where its power is turned on, but it is not transmitting, its receiver module is still active. If it hears a transmission from an SM205 with an address code that matches the unit, it will engage the TX mode as though the TX button had been manually pressed.

## UNIVERSAL SHUTDOWN

While listening between the gaps of its transmission, if it hears the Universal Stop Code being generated by an SM205 within its range, it will stop transmitting and return to its standby state. The range of effectiveness of the shutdown code may vary between some modules as there are variations in the response time of automatic gain control in some receivers.

During a competition event, where several hidden units may be on standby or transmitting, the Universal Shutdown Code is useful to restore all units back to the standby state.

## CONCEALING THE TRANSMITTER

This is a bit of an art and the operator can show some imagination in doing this. Remember that if the antenna wire is laying on the ground or covered over, that its transmit radius will be greatly diminished.

Placing the unit in the crotch of a tree at head height is often a good location, particularly if the unit and its wire may be concealed by bark & leaves.

Another option is a hollowed out cola can, with the antenna wire carefully threaded up a protruding plastic drinking straw. It may then look like discarded litter.

It can be used to challenge the mettle of the hunter. Once this unit was placed under a dead bird in a mulch heap. Another time it was clamped to the underside of a wheelbarrow. It has even been hidden in the back-pack of a hunter, so it kept moving around as the hunt progressed.

With an organised hunt, a coordinator would carefully note concealment locations and store multiple units, all in the standby state, in different places around a parkland well before the event begins. They may then be activated one-at-a-time using the remote activation codes. This way there is less chance of the process of concealment being observed by contestants.

Normally a hunt is at an end when a contestant has located the transmitter, picked it up and pressed the TX button to halt the session.

## WHY SHORT-RANGE UHF WAS SELECTED FOR THIS PROJECT

There are several reasons why this system uses UHF. It operates on 433.920 MHz, which is inside the Amateur 70cm band, but it is also on the LIPD (Low interference potential device) frequency which permits low power operation without any licensing requirements by the operators. This means it is quite legal for kids and non-radio amateurs to use.

The 2 milliwatt transmission is not a great output, but this is quite enough to be a challenge in a public park, a section of bushland, or even a large back yard. This means that there tends to be a large number of short-range events for many people to enjoy, rather than fewer long-range hunts that requires more specialised equipment and perhaps motor vehicles. This system does become a great stepping stone to hone skills for those who may wish to move-on to bigger events and other radio bands.

Being UHF, the antennas are small and very directional, making it easy to hold and work with at close quarters. Many kids and even Scout & Guide groups have had a lot of fun with this equipment.

Lastly, price is an important consideration for these kits. On this UHF frequency we use low-cost Transmit and Receive RF modules that are pre-built, tuned and ready to use.

## CHAPTER 3 – HOW IT WORKS

Much of the intelligence for this system is contained within the software. Ports on the microprocessor can enable or disable the receiver and transmitter module so that both are never active at the same time.

Other ports read the push-button switches, debounce them, then perform the allotted task. The receiver module within the SM204 decodes AM transmissions and has both an Analog and Digital output. The Digital output is coupled to the microprocessor serial input port, so that it may respond to remote commands.

### POWER ACTIVATION CIRCUIT

It was important that when this unit was off, it was *really* off, with no residual current drain. The 9V battery is switched to the regulator via a PNP transistor (Q1). Pushing the ON button provides a turn-on signal to earth via D2. This provides enough momentary power to wake up the micro. The first thing that it does is to send port PD0 High in order to turn on Q2 and keep the power rail going when the ON button is released. Pressing OFF for one second simply removes the drive from the base of Q2 and the power rail will shut off totally.

### THE CONTROL CODE DATA FORMAT

The control characters used are pre-set by the 16 position rotary encoder switch inside both the **SM205** sniffer and the **SM204** transmitter units. This allows the transmitter to individually activate up to sixteen different **SM204** transmitter units scattered around a wide area. There is also a universal **OFF** control character (ASCII '48') that when sent, will shut down all **SM204** transmitters within reception range.

These are the control characters sent by each of the sixteen encoder positions:

Encoder position	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
ASCII code sent	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
Text equivalent	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O

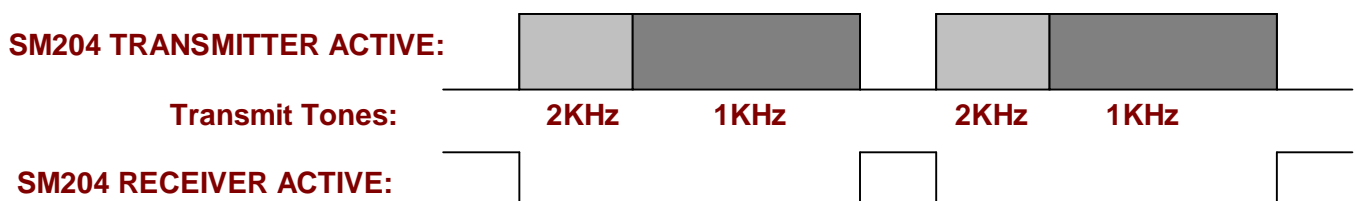
The format of the data transmission is **12 bytes** of data in short bursts at a 1200 baud data speed. The first ten bytes sent are all the same character as set by the above encoder position chart (or special character **48**). The last two characters sent are always Ascii characters 13 and 10, which are standard Carriage return and Line Feed characters.

(This means that it is possible to monitor and view transmitted data with a simple PC terminal program such as 'Telix' where a receiver has been hooked up to an RS232 port.)

### THE TRANSMITTER FORMAT

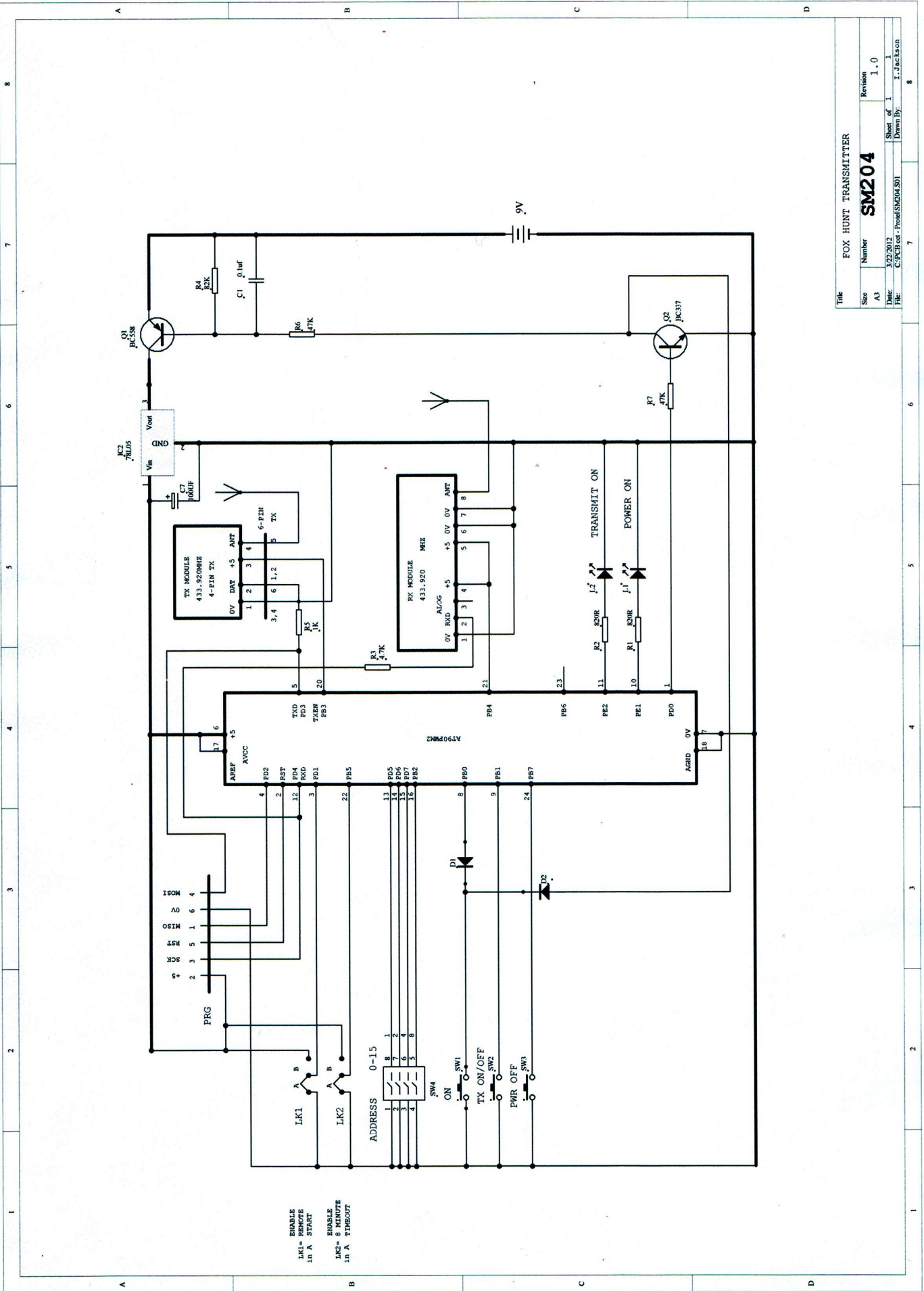
This is the distinctive 2-tone burst signal that may be readily heard by the hunters. The transmission format is a 100ms burst of 2KHz tone, immediately followed by 300ms of 1 KHz tone. There is a 100ms gap where the receiver stage is briefly activated, then the cycle repeats. During the receive interval, the SM104 will respond to a shut down control code (ASCII 48) if one is generated by an SM205 receive unit.

This simple timing diagram demonstrates this sequence:



The 2mw transmitter should be audible up to 150 metres away from a sniffer receiver. This range may be significantly diminished if the transmitter is placed on or behind metal objects. If the transmitter is simply placed on the ground, this may reduce the transmit range to around 50-70 metres.





Title FOX HUNT TRANSMITTER			
Size	Number	Revision	
A3		1.0	
Date	3/22/2012	Sheet of	1
File	C:\Kibicee - Project\SM204.SMT	Drawn By	I. Jackson

## SM204 KIT PARTS LIST

PCB	SM204v2 DF Hunt Transmitter board
R1	820 ohms
R2	820 ohms
R3	10K
R4	82K
R5	1K
R6	47K
R7	47K
C1	0.1uf mono
C7	100uf 25V electro RB
SW1	PB switch 3.5 mm high
SW2	PB switch 3.5 mm high
SW3	PB switch 3.5 mm high
SW5	16 position address encoder
IC1	AT90PWM2 micro
IC2	LM78L05 +5V regulator
Q1	BC558 PNP transistor
Q2	BC337 NPN transistor
D1	1N4007 diode
D2	1N4007 diode
L1	Yellow 3mm LED
L2	Red 3mm LED
RX	Receiver Module
TX	Transmitter module
LK1	3-pin header
LK1 Shunt	Shorting link for LK1 Header
LK2	3-pin header
LK2 Shunt	Shorting link for LK2 Header
PRG	6 pin programming header
ENCL	Plastic enclosure
CLIP	9V battery clip
LABEL	Enclosure label for SM204
Solder #1	A section of very fine 0.3mm solder for the IC's
Solder #2	A section of medium 0.71mm solder for general work