



**Screwdriver Antenna Memory**

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## **User s Guide**

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Version 2.4 (SAM-G)

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### **Important**

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Prior to opening the sealed SAM control unit, read the [Sensor and Wiring Installation Guide](#). Once the SAM unit is opened, you will not be able to return it for refund. We understand that there may be cases where you may be unable to install the sensor assembly into your antenna thus making the SAM unusable. For this reason, we packaged the sensor assembly separately so you can install it and verify it's operation prior to opening the SAM control unit.

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### Warranty

1. KO6YD Designs warrants to the original owner of this product that this product to be free from defects in material and workmanship for a period of 90 days from the date of purchase. If the unit fails within the warranty period, KO6YD Designs will repair or replace (at KO6YD Designs' option) a malfunctioning unit.
2. If purchased from an authorized dealer, warranty claims should first be reported to that same dealer. KO6YD Designs will work with the dealer to repair or replace (at KO6YD Designs' option) a malfunctioning unit.
3. KO6YD Designs assumes no responsibility for damage caused by the improper installation or operation of the SAM unit.
4. Installation and use of the Screwdriver Antenna Memory is at the user's own risk.
5. Under no circumstances is KO6YD Designs liable for consequential damages to person or property by the use of any KO6YD Designs products.
6. This warrant is given in lieu of any other warranty expressed or implied.
7. Opening the sealed SAM unit indicates your acceptance of this warranty.
8. Any modifications will void warranty.

If you do not agree to these terms, you can return the unopened SAM unit for a refund less shipping.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### Introduction

Thank you for your purchase of the Screwdriver Antenna Memory or SAM. The SAM adds a tuning preset feature to many models of mobile antennas more commonly known as a "screwdriver".

If you currently own an antenna, you may have marked various locations on the antenna to indicate the approximate coil location for each band. With the SAM, you will no longer need these markings since the SAM is replacing them with an electronic version. Your current "Up/Down" toggle switch is replaced by the SAM control unit which contains a 2 digit LED display, a mode button and a VFO style tuning knob with integrated push button.

The SAM uses a VFO style tuning knob to manually adjust the antenna coil position. You may then save up to 16 different positions into memory for later recall. Once recalled, you still have the ability to manually fine tune the antenna once you reach a memorized position. This is useful for lower frequencies where the antenna can have a narrow bandwidth. In this case the SAM is used to get you "close" to the frequency.

It's important to remember that the SAM only tracks the position based on the rotation of the screw shaft and not the physical position of the coil. Many factors can affect the antenna tuning so that when the SAM returns the antenna coil back to a preset position, it may not indicate the same SWR. Environmental factors such as condensation on the coil, nearby obstructions, etc. may affect the fine tuning of the antenna assembly. However, the SAM will get you very close. At higher frequencies where the antenna typically has a wider bandwidth, fine tuning may not be required. Other mechanical factors such as backlash on the motor / screw shaft assembly and road vibration can affect the precision of the SAM.

Backlash inaccuracies are caused by your antenna when there is a one or two turn "dead zone" when changing directions. That is, if the antenna is being driven up then stops, it may take a turn or two of the screw shaft in the other direction before the coil starts moving down. This varies between antenna models.

The SAM works by counting turns, but that is only when the SAM is controlling the motor. Road vibration that causes the coil to move may cause the SAM to become "out of sync" with the antenna. Because of this, you may want to check the calibration of the SAM and antenna on a regular basis. The SAM has a special "calibrate mode" that will help you re-calibrate the SAM and the antenna without losing your memory locations.

### Circuit Description

The heart of the SAM system unit is a small microprocessor which controls the position of the antenna by counting the turns of the central screw shaft. Since the processor controls the up and down movement of the antenna at all times, it will always track the location of antenna coil. This position can be saved into a non-volatile memory for later recall. Also, the current position of the antenna is maintained in non-volatile memory so the SAM remembers the last position of the antenna coil when powered off.

The sensing operation at the antenna is done by attaching a small magnet on the internal turning shaft. The sensor is a small sealed reed switch that is attached to the outer tube of the antenna or inside if space permits. Inside the antenna there is a magnet that is attached to the screw shaft. The sensor must be attached in such a way that when the antenna motor is turning, this sensor is "pulsed" once per turn. This sensor is connected to the main processor via an opto-isolator.

The antenna motor receives power from one of two relays inside the SAM. Each relay controls a single direction by selectively switching 12V to one of the antenna motor leads. The normal closed state of each relay is connected to ground so when one relay is active, the other completes the circuit through the motor to ground. The SAM micro processor will selectively activate one of the relays to control the motor.

## SAM Installation

### Sensor Installation and Wiring

The sensor installation is covered in the [Sensor and Wiring Installation Guide](#). Before you continue, you should verify the proper installation of the sensor and wiring.

### Location of SAM Control Box

The SAM was designed for mobile operation however the heat of direct sunlight can cause damage or erratic operation. The unit should be mounted out of direct sunlight. If dash mounting is desired, you should provide some sort of method to shield it from direct sunlight.

### Connecting the SAM

On the back of the unit, you will find a 6 pin MOLEX connector (Figure 1). You also received a matching connector with “pigtail” wires attached. The connector on the pigtail assembly plugs into the rear of the SAM control unit as indicated in Figure 1. Notice that when looking at the rear of the SAM, the RED wire should connect to the left most pin on the rear panel connector.

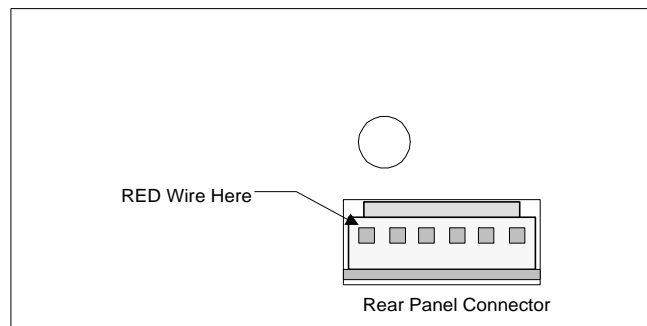


Figure 1  
SAM Rear Connection Diagram

**Although the SAM has internal fuse protection, the user should provide external fuse protection for the system.**

The SAM contains a 5A rated fuse since the traces on the SAM PCB are rated about 5A. All the antennas we have seen have been well under 5A continuous current. The startup surge could be higher but it's the sustained current that needs to be under 5A. The fuse in the SAM is a fast acting type. It was chosen to provide the best protection. If you find that your antenna assembly is blowing the fuse on a regular basis, you can try and replace the “fast acting” fuse in the SAM with a standard AGC (3AG) (Littlefuse 311 series) 5A. These are the common 5A fuses you get at the auto parts store. If you continue to blow fuses, you may need to add a “dropping resistor” to lower the current. A 1.5 to 2.5 ohm at 25W (The Big square ceramic ones) are a good choice.

### External Dropping Resistor

Many screwdriver antennas use a power screwdriver as the motor. (Hence the name [screwdriver](#) antenna). These are typically a 3-4 volt motor. If you connect this directly to 12V they would not last very long and the current draw would be very large. To solve this, the manufacture uses some form of dropping resistor to limit the current to the motor. The typical values are in the 2 to 4 ohm range but they must be high wattage types. In many models this is installed inside the antenna. Some however have chosen to mount the dropping resistor externally. The SAM has provided support for mounting an external resistor. Inside the SAM there is a jumper labeled J5. This has a connector with a small loop of 18Ga wire. This jumper is directly inline with the power to the motor only (Not the electronics). If you wish, the external dropping resistor can be placed inline with this jumper by removing the small loop of 18ga and install two 18ga leads to an external resistor. This resistor should not be mounted within the case of the SAM since they tend to get quite hot. The leads can be routed out a pair of holes drilled on the back. If you do this, install grommets on the holes and after drilling, be sure to clean out any metal filings in the case that could short out the SAM.

**Note that the SAM Warranty does not cover problems resulting from this, or any, modification.**

## Operation Overview

The system has three operating modes. The following is an overview of the various modes. More detail will be covered in a later section. The operating modes of the SAM are changed by pressing the “MODE” push button. The display will change to indicate the current operating mode.

### Memory Mode

The memory mode, is indicated by a number from 1 to 16 on the display. In this mode, the user turns the tuning dial to the desired memory location as indicated on the display then briefly presses the tune knob to “activate” the preset. At this time, the antenna will begin moving up or down as required until it reaches the memorized preset location. While the antenna is moving in this mode, the selected memory number will flash. The display will stop flashing once the antenna has reached it’s position.

The memory mode is also used to store antenna positions for later recall using the above procedure.

### Jog Mode

The jog mode is used to tune the antenna prior to memorizing an antenna position. It is also used to fine tune the antenna after using a memory preset. To fine tune the antenna, the user would turn the tune knob on the SAM. Each encoder “click” will raise or lower the antenna in very small increments. There is also a “Fast Jog” mode which helps to move the coil in larger steps.

### Program Mode

The program mode is used to program the initial settings into the SAM unit as well as change user defined operating parameters. The setup mode allows setting of the following items.

Parameter	Symbol	Remarks
Antenna Lower Limit	P0	Used to set the low limit of antenna travel. (Resets High limit)
Antenna High Limit	P1	Used to set the high limit of antenna travel
Calibrate Mode	P2	Puts unit into calibrate mode
Set Startup Mode	P3	a. Display Version of SAM Chip (Press Tune Knob Once) 24 = Version 2.4 b. Sets the startup mode for the SAM (Press and <u>HOLD</u> Tune) 0=Normal 1=Night / Auto-dim feature F=Reset

To enter Program mode: Press and hold the MODE button until P2 is displayed. Parameter settings are selected by using the TUNE knob.

To exit Program mode: Press the MODE button.

## Initial Setup and Calibration

This section will cover the operation of the SAM unit. When you power up your SAM for the first time, you will notice the display will indicate P0. This indicates that the SAM has automatically started up into the PROGRAM mode number 0 and needs to be calibrated before you begin any operations. This is a reminder that you need to program the “lower limit” (Zero Point) of the antenna.

### Important

Prior to connecting the SAM unit, move the antenna to it’s lowest limit as the first thing you will need to do is calibrate the SAM by setting the lower antenna limit.

### Calibration

Calibration of the SAM involves setting the lower and upper limits of the antenna travel. Once these limits are set, the SAM will not allow you to move the antenna below the lower limit or above the upper limit. You must first define the lower limit of the antenna travel which defines the zero or origin for memory and other operations. If you have powered up the SAM with the  $\text{P0}$  display AND your antenna is at its physical lower limit, set this position as the lower limit by pressing AND HOLDING the Tune knob. The display will change to 3 lines to indicate the lower (zero) limit has been set. From this point on, the SAM will not allow you to move the antenna below this limit.

Once the lower limit is set, you can now set the antenna's upper limit. Although this is optional it provides a method to keep you from accidentally moving the coil past its physical upper limit which may cause damage. To set the upper limit, use the MODE button to get into JOG mode. For details of the Jog mode you can review the next section. Using the tune knob, "Jog" the antenna to its upper limit of operation. One option is to select the "Fast" Jog by pressing the tune knob while in Jog mode. An F- will appear on the display. The Fast Jog will not make the antenna move faster but will cause the antenna to move farther on each encoder click. When you approach the upper physical limit, you should re-select the normal Jog mode by again pressing the tune knob. It is recommended that you not hit the physical upper limit but define this close to the antenna physical limit of travel. The best is to adjust the coil until you know it's extended a little more than your lowest operating frequency. If you wish to set the upper limit to the physical antenna limit, as you get close to the upper limit, click the Tune knob a single step at a time. If you allow the antenna to hit the upper limit, the SAM may continue to count the turns but the physical antenna will not extend any further. You will lose the calibration of the lower limit and need to repeat the calibration procedure.

Once you have the antenna at its upper limit, press and HOLD the Mode button until the  $\text{P2}$  is displayed. Select the  $\text{P1}$  setting with the Tune knob and press and HOLD the Tune knob until 3 lines appear. This will program the current antenna position as the upper limit of travel. Once set, the SAM will not move the antenna above this point.

Now that the SAM and antenna are calibrated, you may begin normal operation and setting memories.

From this point, when you power up the SAM, it will enter the memory mode indicated by a number from 1 to 16 on the display. You may switch between the Memory and Jog modes by pressing the MODE button.

## SAM Operation Details

### Jog Mode

In Jog mode, the tuning knob is used to raise and lower the antenna coil in small amounts. This mode is selected by pressing the Mode button until the Jog mode is indicated by the  $\text{J-}$  on the display. In jog mode, as you turn the Tune knob, the antenna coil motor will be given a "kick" depending on the direction you are turning. As you turn the knob CW, the antenna coil will be extended. And as you turn the knob CCW, the coil will be retracted. Each click of the Tune knob will result in a single turn in the antenna screw shaft. While using the Jog mode, remember to click the knob slowly since the antenna will not react as fast as you turn so click it one or two times a second to give the antenna time to move. When "jogging" the antenna, the movement is indicated on the display by the horizontal line on the right moving up or down. When the line is in the center ( $\text{J-}$ ), the antenna has stopped moving. While fine tuning the antenna if you find you have "over shot" and need to tune the other direction, stop turning the knob and let the antenna stop (Display =  $\text{J-}$ ) before turning in the other direction. If you turn the Jog back and forth too quickly, you can lose calibration of the antenna position.

The jog mode can also be set to "Fast" mode. This is selected by briefly pressing the TUNE knob once while in Jog mode. The display will then indicate  $\text{-}$ . This will not make the antenna coil move faster, however, each click of the tuning knob will cause the antenna to advance the motor more turns per tuning knob click. The default is 5 turns per click and can be changed by the user. Remember, each click will add 5

more steps in the direction of you are turning. That is, if you turn the knob 5 “clicks”, the antenna will move 25 (assuming 5 turns per step) turns. So, it is more important not to “get ahead” of the antenna too far. One feature of the SAM is that whenever the antenna is in motion, you can stop it by pressing the Tune knob. This way, if you have turned the knob and while the antenna is moving you notice your dip in SWR, you can quickly press the Tune knob to stop the antenna motion.

You may change the FAST jog step size by pressing and HOLDING the Tune knob while in the Fast mode. The display will change to (#=Current Value). To change, just turn the TUNE knob from 0 to F (16) and press the TUNE knob to save. I recommend you keep the number “around” 5. Once you have memories programmed, you may find you don’t use this feature very often.

### **Memory Mode**

The memory mode is indicated by a number from 1 to 16 on the display. The Memory mode is selected by pressing the Mode button until you see a memory number. Once you have antenna positions programmed into memory, having the SAM return the antenna to a saved position is as simple as turning the Tune knob to the desired memory number and briefly press the Tune knob. The antenna will begin to move up or down as needed to return to the prior saved position. While the antenna is in motion, the display will flash the selected memory number. Once the antenna has stopped moving, the display will stop flashing and remain on the selected number. While the antenna is moving to it’s new location you may stop the antenna at anytime by pressing the Tune or Mode button. This will only stop the antenna and not alter the selected memory location.

To set a new memory, tune the antenna using the Jog mode (or selecting a known memory then use jog to fine tune it.) Once the antenna is tuned to the desired frequency, use the Mode button to select the Memory mode. The SAM will display a memory selection, turn the tuning knob until the desired storage memory number is displayed. Then press and HOLD the tuning knob for 2 seconds. The display change to -- which indicates that the current antenna position has been saved into the indicated memory location. When you release the knob it will again display the saved memory location number.

### Program Mode

You should not need to access this under normal operation but if for some reason you need to re-calibrate the antenna or reset the SAM, it can be done from this mode. The most common reason for using this mode would be to re-calibrate the antenna. Factors such as road vibration can cause the coil to move a turn or two. The Program mode is selected by pressing and holding the MODE button. The default setting will be P2 which is the re-calibration mode. You may select the various P mode options with the Tune knob. The P0 setting is used to set the bottom limit (or the zero point) of the antenna. This is the origin from which all memory positions are referenced. When you press and hold the knob in the P0 mode, the current antenna position will now become the zero (or bottom) point. The SAM will not move the antenna below this position. When setting P0, the P1 (high limit) will also be reset. For this reason, the upper limit will need to be reset using P1. After setting the lower limit with P0, you should enter the Jog mode and run the antenna to the upper limit. Re-enter the Program mode and select P1. Press and hold the Tune knob until three lines appear which indicates the limit has been stored. The P3 is used to set the SAM startup profile. One thing you can do from P3 is reset the lower and upper limits. You can reset the SAM from P3 by briefly pressing the tuning knob to display an 0. Then, turn the knob to select . Then, press the Tune knob. Then, when you power on the SAM, you will again receive the P0 to indicate the SAM wants you to define the lower antenna limit.

### Auto Dim (Night Mode)

The Auto Dim feature of the SAM, when enabled, will automatically blank the LED display. Whenever any operation is performed, the display will be lit. After there has been no user input on the SAM for a brief amount of time, the LED display will be turned off with the exception of a single decimal point in the lower right. This will indicate that the SAM is still powered up. The primary benefit of this is reducing the display intensity for night driving. To enable this, select the program mode P3 (SAM Startup Profile) as described in the previous chapter.

### Re-calibration

On some antennas, road vibration or other physical factors may cause the antenna to become out of calibration. The calibrate mode allows you to move the physical antenna coil position yet the SAM's internal position value will remain unchanged. That is, the SAM will think the antenna is still at the location it was at prior to selecting the calibrate mode.

You can access the calibration function from the Program (P2) mode which is selected by pressing and holding the MODE button. Then select P2 with the Tune knob and press the Tune knob. When in calibrate mode, a - will be in the display. This operates just like the Jog mode with one exception. As in normal Jog mode the antenna will move one turn per "click". However, once the antenna stops, the SAM's internal position value will be unchanged. For example, if the antenna position before calibration was at turn 100 and you clicked the Tune knob to move the antenna down 2 turns, internal position would remain at 100 yet the physical position of the coil has moved down two "clicks".

The calibrate mode is useful to adjust the position of the antenna if it should ever get off by a turn or two without having to perform a full calibration and memory re-program.

Should you need to re-calibrate the SAM, just select and move to a known memory location (frequency). Then, select the calibrate mode P2 and fine tune the antenna as you would in the Jog mode to get it back into resonance. Another option is to physically mark a known memory location position on your antenna (like the tape / band marking). Then, select and move to the known memory. Then, with the calibrate mode, move the antenna until it is back on your marked position. To exit the calibrate mode just press the MODE button.

## Error Indications

There are a few errors that can appear on the SAM unit. Any errors are shown as a flashing **0** on the display.

1 - This indicates that you attempted to select and move to a memory location that has yet to be programmed. This will display when you press the Tune knob to move the antenna.

- When the SAM is powered up, it will check the status of the index / sensor. In order for the SAM to work properly, the magnet must be off the sensor at power up. If at power up the SAM sees the index sensor active, it will turn on the motor until the index sensor no longer is active (i.e., near the magnet). If after a few seconds the SAM never sees the index sensor shut off, it will stop and display **0**. This would indicate that the index sensor wires may be shorted or the magnet may be too close to the sensor and is activating the sensor at all times when spinning.

2 through 9 are not used at this time.

## Full System Reset

To reset the system you can press and hold the Mode button as you turn on the Power. This will cause a system reset and display P0 which will indicate you will have to re-set the antenna zero location. However, you will not lose any memory locations. So, once you reset the antenna zero position, all prior memory positions should be operational.

**ICOM 706 Auto Tune Control.**

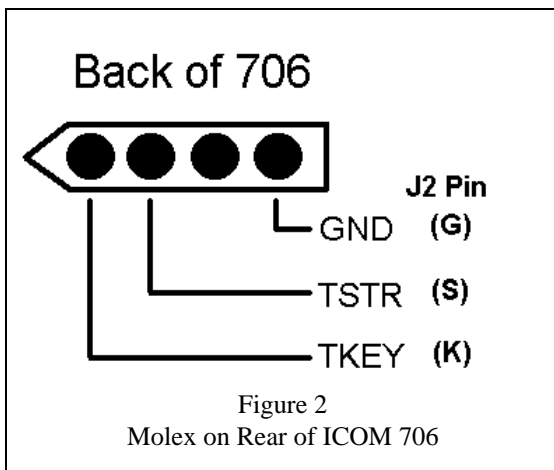
The Screwdriver Antenna Memory (SAM) has an additional option. This option is the Auto Tune Option that will help automate the fine tuning of the antenna system.

This option is primarily designed for connection to an ICOM 706. However, the TKEY output line is a signal that is pulled to ground through a 4.7K resistor. In theory, this can be used to key another model of radio via the CW key or PTT signals.

**Connection**

On the back of the SAM there is a small hole that has been capped just above the main connector. This can be removed and replaced with a grommet available from any auto parts store. To install this option, disconnect the SAM and remove the cover. Inside you will find a connector labeled “TUNE” located near the main rear connector. The pins of the connector are labeled S, G and K and has a small plug attached. This plug is a “punch down” type of connector and is designed for 24 AWG wires.. You can use a small screwdriver blade to punch the wires down while holding the connector in a pliers or vice. The following table and diagram show how to route the wires from this connector to your ICOM 706.

Label	Signal	Function
S	TSTR	<u>Tune Start signal.</u> This is an input to the SAM which is not used at this time. However, it is needed since it is used to enable the tuner option on the ICOM 706.
G	GND	<u>Ground Signal.</u> This is a common signal ground between the SAM unit and the ICOM 706.
K	TKEY	<u>Key signal.</u> When active, this line is pulled to ground via a 4.7K 1/4W resistor. This is done ONLY when enabled in the SAM and only in JOG mode. This signal along with the ground can be used to key a radio other than the ICOM 706 with appropriate circuitry.



The connection to the ICOM 706 is done to the TUNER jack which is the 4 pin Molex connector on the rear of the radio. This connector is keyed with a square end and a pointed end. Connect the wires from the SAM unit to the back of the ICOM 706 Tuner jack as shown in Figure 1.

The Molex connector needed is a 4 pin .093” Connector.

### Auto Tune Operation

To enable the Auto Tune Option on the SAM, you need to put the unit into JOG (J-) mode. From here, just press and hold the Tune knob until you see an  $\uparrow$ . The  $\uparrow$  Indicates the “Auto” Tune is enabled. If you press and hold the TUNE knob again, you will see the  $\square$  which indicates the “Auto” Tune has been disabled.

#### IMPORTANT

You MUST have the SAM unit turned on BEFORE you power up your ICOM 706. If not, the ICOM 706 will not enable the Tuner logic inside the radio. You do not however need to enable the Auto Tune (above) prior to turning on the radio, just having the SAM turned on is enough.

Once you have enabled the Auto Tune (A1), any operation in the Jog (or Fast Jog) mode will cause the SAM to automatically switch the ICOM 706 to 10 Watts and transmit. The ICOM 706 will also emit a sidetone to indicate the operation is being performed. This will continue as long as the antenna is in motion and for about 1/2 second afterward. You can toggle the Auto Tune option on and off by pressing and holding the Tune knob while in the JOG mode.

If you should power off the SAM and leave the radio on, the ICOM 706 may disable the tuner processing and you will have to power the radio off then power on the SAM then the radio again. Also, the SAM will always power up with the Auto Tune option disabled ( $\square$ ).

### SAM PCB Layout reference

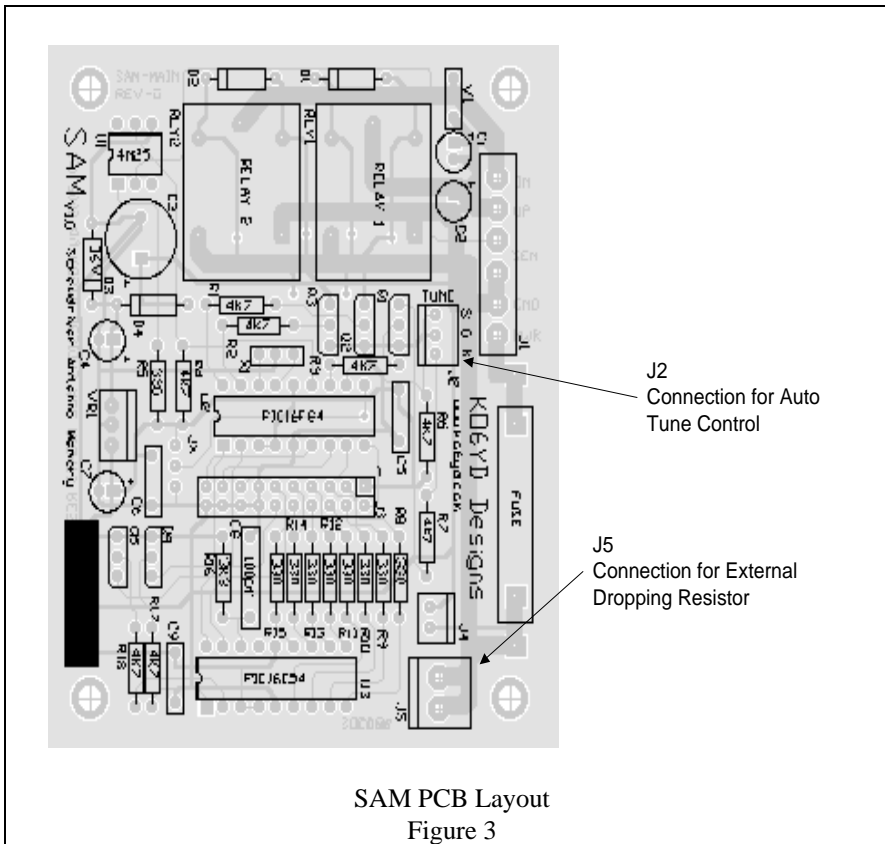


Figure 3 shows the layout of the SAM Circuit Board. Note the location of jumpers J2 (Auto tune connection) and J5 (External Dropping Resistor Connection)