



# SG-230 Smartuner<sup>®</sup>

Microprocessor Controlled Automatic Antenna Coupler

**OPERATION/MAINTENANCE MANUAL**

# POWER TOOLS

Getting the most from every watt of HF-SSB Power



# **SG-230 ANTENNA COUPLER**

**Installation and Operations Manual**

**Revised: March 1995**

**Caution:** Carefully read the "Quick Start" on the following page and all pertinent sections of this manual prior to operating your Smartuner for the first time. This unit will provide outstanding service if you follow the detailed recommendations within this manual.

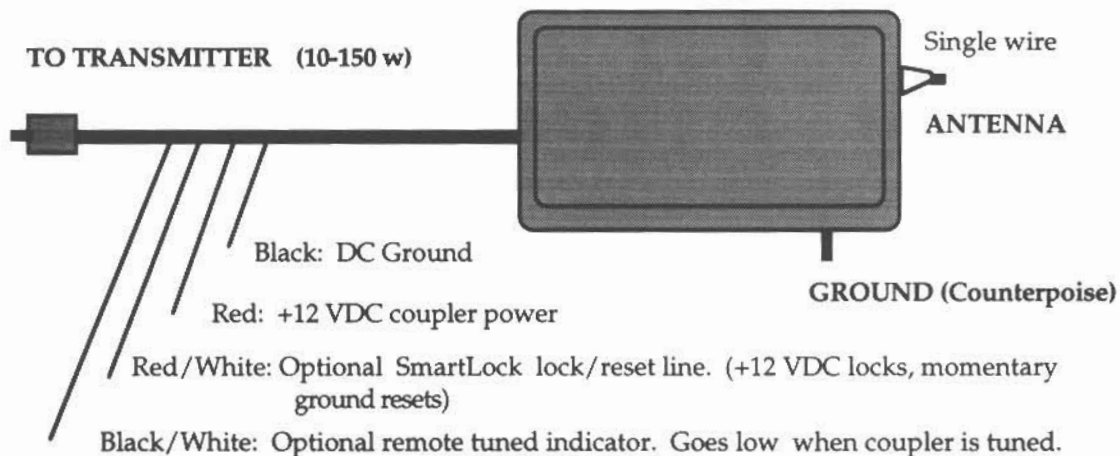
# Quick Start Guide

To quickly install your antenna coupler you will need the following:

1. An HF radio with 10 to 150 watts output.
2. An HF antenna with a single wire feed (not coax fed).  
Minimum length of 8 feet (to 3.5 MHz) or 23 feet (1.8 MHz).
3. A good ground (counterpoise) for the antenna and coupler
4. +12 VDC and ground for the coupler.
5. An LED or other indicating device. (Optional)

## CONNECTIONS:

Connect the Smarttuner as shown in the following diagram:



## OPERATION:

1. Turn on Radio. Apply 12 VDC power to the coupler.
2. As power is applied, coupler should make one "click" sound.
3. Coupler should come up in the bypass (untuned) state.
4. To tune, speak normally, whistle or use CW.
5. Tuning should be done at full power. Clicking is heard.
6. When tuned, clicking stops and Black/White wire goes low.

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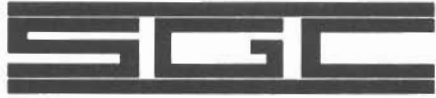


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## 1.0 GENERAL INFORMATION

The SG-230 is believed to be the most widely used antenna coupler in the world. The Smartuner™ reputation has grown to legend status because it is a very simple to use and highly reliable piece of electronic equipment. A Smartuner will provide maximum transfer of radio energy from any HF transmitter to any end fed HF antenna within the frequency and power limits of its specifications.

This document is designed to guide the SG-230 Smartuner user through installation and operation of the unit. This document will also recommend various steps which may be undertaken in the field to provide correct operation of the SG-230 should difficulty be encountered. Smartuners are extraordinarily reliable. But you should be aware that there are scores of fine points to any HF installation which are easily overlooked and may cause difficulty. Our goal in this manual is to help you quickly obtain the best possible performance from your HF radio installation. By reading this manual carefully, you can avoid most of the pitfalls which can degrade the performance of your HF system.

## 1.1 EXPERIENCE LEVELS OF USERS

The Smartuner may be installed successfully by anyone willing to review this manual. However, if you are inexperienced in HF radio installation and operation, do not be shy about seeking advice from people with more experience than your own. This will help you achieve good results quickly and with a minimum of frustration. Even the most experienced professional HF users will occasionally run into difficulty.

Regardless of the level of your experience, SGC stands ready to offer you installation suggestions and help you resolve any aspect of Smartuner operation which is not entirely satisfactory. If you have a specific question, please send us a fax at our Bellevue, Washington (USA) headquarters. The number is (206) 746-6384. If you require telephone assistance, please call us at (206) 746-6310 during business hours, 8:00 Am to 5:00 PM Pacific Time.

## 1.2 WHAT IS AN ANTENNA COUPLER?

Antenna "couplers" are placed at the antenna and match conditions of the antenna to the feed line in a very precise manner. Antenna "tuners", on the other hand, are generally located at the transmitter output at the radio end of the coaxial feed line. Do not be confused by the term "coupler" or "tuner". Tuners placed *at the transmitter* allow substantial losses in feedlines to be corrected in order to fool a transmitter into working correctly. The losses are dissipated through heat or to ground. A coupler *installed at the antenna* eliminates these losses by providing a proper match of the antenna to the feed line. The Smartuner is a true antenna coupler.



There are several key points which we will emphasize throughout this manual which will result in the best possible operation of your Smartuner. These include:

- The coupler must be located *at the antenna*.
- No coax may be connected to the coupler output.
- Make sure the coupler has clean 12 VDC power supplied to it.
- The ground system must always be *larger* than the antenna.
- The antenna wire should be of the largest gauge practical.
- Capacitance at the coupler output must be minimal.
- Insure the antenna is of sufficient length for your lowest operating frequency.

Strictly observing these basic rules will insure good operations under the widest range of conditions.

This manual should be thoroughly studied if you plan to have the best possible signal and most reliable operation of your HF system.

**PLEASE MAKE NOTE OF THE FOLLOWING INFORMATION FOR YOUR RECORDS:**

Date unit was Purchased:

Dealer from whom purchased:

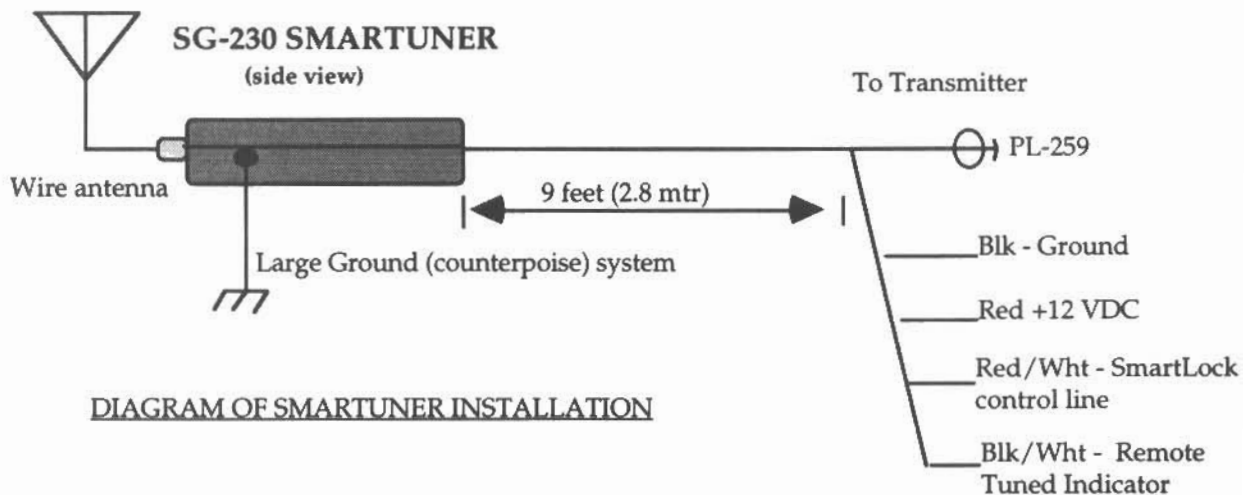
Date installed:

Type of antenna used:



## 1.3 OVERALL DESCRIPTION

The SG-230 is a general purpose coupler which can be operated with any type of radio and almost any type of antenna configuration. The coupler network configuration is of an  $\pi$  or L type; it automatically selects appropriate algorithms that have been set from the internal coupler measurement, and reads and feeds this information back to the microprocessor. The initial (first time) tuning may take several milliseconds to a few seconds depending on the complexity of the tuning process for a special antenna configuration. After tuning the first time for a specific frequency and antenna, this information is entered in the non-volatile computer memory which will store up to 500 tuning solutions. When the same conditions are encountered again, re-tuning is accomplished within 10 milliseconds by first recalling the information from the memory. Special software has been designed by SGC to allow accurate and fine tuning of the coupler. For software description, refer to the MicroTune™ section of the manual.



If antenna conditions or transmitter conditions have changed since the information was stored into memory, new information is calculated and a new tuning solution derived. This new information is stored to memory for future reference. An important concept to grasp is that the Smartuner will always look for the *best possible tuning solution* and will improve existing tuning solutions whenever possible.

The SG-230 may be bypassed and your antenna used as a broadband receiving antenna. To do this, turn off the power to the coupler for 2 seconds and then turn it back on. In this situation, the coupler is reset to stand-by waiting for the first RF power to be transmitted before providing a tuning solution. In the stand-by mode, the antenna bypasses tuning elements and connects the antenna directly to the

receiver with no tuning elements engaged. This allows for receiving signals throughout the HF range.

The coupler will re-tune or hunt if the input to the coupler drops below 10.5 VDC. This situation may occur if a marginal battery is used or if you are transmitting at high power with an inadequate power supply or battery. Batteries must be fully charged for proper operation and large gauge wiring to the transmitter and coupler must be used to avoid retuning.

If broadband operation is required during scanning operations, jumper J-2 on the printed circuit board inside the coupler may be set to the "YES" mode. This will bypass tuning elements on receive. Jumper J-2 is located near IC-7 on the printed circuit board.

In some cases, it may be desirable to re-tune the coupler and bypass the memory information. The coupler will store 500 tuning solutions in non-volatile memory. However, if you wish to bypass the recalled tuning solutions, place jumper J-3, also located near IC-7 on the printed circuit board, to the "NO" position.

Many people wonder what happens when 500 tuning solutions are used. You don't need to worry about this condition as the Smartuner will over-write previous tuning solutions as new information is calculated. The Smartuner constantly "learns" changing antenna and radio conditions and constantly updates its memory without the operator having to do anything. That's what we mean when we say the Smartuner is *smart*.

#### **1.4 COUPLER NETWORK CONFIGURATION**

The coupler network configuration is designed with 64 different input capacitor values, 32 output capacitor values and 256 inductor values, thus providing about a half million different  $\pi$  or L configurations. The coupler requires an input of 5 to 150 watts to operate. The unit operates on 12 volts and can be optionally supplied to operate at 24 VDC. The 24 VDC option may be installed in the field. Please contact your dealer or SGC and order Part Number 54-52.

### 1.5 OPERATION INDICATORS

If desired, a remote tuned indicator LED may be connected between the +12 VDC power source and the remote tuned indicator line (Black/white wire). The remote tuned indicator wire goes low (I.E. becomes grounded) when the coupler is tuned.

Remember when you are hooking up the remote tuned indicator line that it goes to ground *when the coupler is tuned*. In other words, the LED goes between the black/white wire and the +12 VDC supply.

This coupler tuned indicator is also built into the SmartLock™ antenna coupler control unit along with other indicators. This device will be discussed later in this manual.

Operational status of the coupler and the onboard computer's tuning decisions is displayed by 7 LED's, which are located on the control computer cover on the main printed circuit board (PCB). These indicators are only visible when the cover of the coupler is removed. The function that each LED indicates is described in Section 7 of this manual. These 7 LED's are not designed to be interpreted by other than factory and trained service personnel.

**CAUTION:** Dangerous voltages exist inside the Smartuner when it is operated with an HF transmitter. High RF voltages in excess of 10 kV may be expected in normal operation of this unit. In addition to shock hazard, these RF voltages may produce burns which are very painful if you come in contact with exposed components. Therefore, DO NOT operate without the cover secured in place unless you are a well experienced radio technician or engineer.

As a matter of good installation and engineering practice, exposed metal antenna elements should be located in such a manner as to prevent accidental contact with people (especially young children), pets and small animals.

### 1.6 MECHANICAL DESIGN

The SG-230 is supplied in a weather proof case with two mounting brackets. RF and DC power are supplied to the unit through the same cable. This special cable consists of a 50 ohm coaxial cable and four conductors. The four conductor wires

are for the ground, the positive power lead, the optional SmartLock control and optional LED indicator.

The SG-230 antenna coupler's weatherproof case is designed to withstand the environmental conditions encountered aboard ship when mounted on the weatherdecks. The internal construction is designed to withstand the shock and vibration of marine service. Corrosion-resistant hardware and passive alloys are employed throughout. We do not recommend opening the Smarttuner case unless it is necessary. For 99% of installations, the factory settings for jumpers will be correct. Should you have occasion to open the case, use care to insure the gasket which seals the unit is placed properly to maintain watertight integrity of the unit.

Although the Smarttuner is built very solidly, it is good installation practice to provide additional protection from the elements. SGC makes the following recommendations:

### **1.7 MARINE MOUNTING**

The Smarttuner should be located inside the house or under the aft lazarette on a sailboat. On power boats, the coupler may be mounted outside, but an addition protective housing is recommended. The preferred installation if vertical is with the standoff insulator pointing upward.

A stuffing gland for the RF and DC cables is provided on the lower edge of the weather housing, along with a 1/4-20 stainless steel ground stud. The antenna connects to the ceramic insulator on the top of the weather housing.

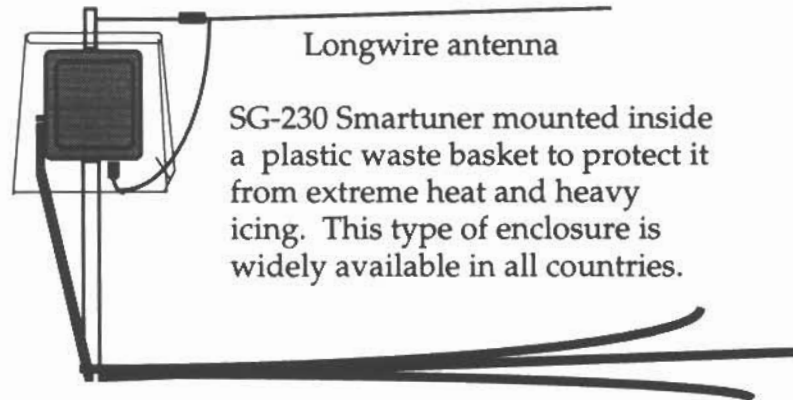
The SG-230 may be mounted in any position including inverted without any degradation of performance. If the coupler is to be exposed to long periods of high vibration, such as aboard helicopters or tug boats, installation of the optional shock mounting is recommended.

### **1.8 DESERT AND HIGH TEMPERATURE INSTALLATIONS**

The Smarttuner may be used in very hot climates on a continuous basis if some additional protection from direct sunlight is provided. The best protection for a mobile installation is provided by the QMS (Quick Mounting System) which keeps the antenna coupler outside of a vehicle. Temperatures inside a vehicle may exceed 212 degrees F (100 C). If a QMS is not used, it is very desirable to keep the coupler in the shade if possible. Please refer to the diagram in the following section.

### **1.9 EXTREMELY COLD TEMPERATURE INSTALLATIONS**

Your Smartuner will operate down to specified temperatures. We recommend placing the Smartuner under some kind of housing other than the case to prevent heavy build up of ice. If you are mounting on a tower in a hot or cold climate, placing a plastic wastebasket (such as those made by Rubbermaid™) are excellent weather covers and cost only a few dollars.



### **1.10 REMOTE INSTALLATIONS**

The SG-230 is supplied with 9 feet of cable standard. SGC has two standard lengths of antenna extension cable available in the event you need to mount the cable farther than 9 feet from the transmitter. A 25 foot extension cable is available (SGC Part Number 54-61) as is a 50 foot cable (SGC Part Number 54-62).

If you need to install the antenna coupler more than 50 feet from the transmitter site, up to 2 extension cables may be used for a total of 75 or 100 feet. However, SGC does not recommend installing the Smartuner more than 100 feet from the transmitter because two losses must be considered.

The first loss in long distance installations is normal attenuation of the radio signal coming from the antenna to the radio via the coax. As you may be aware, the longer the coaxial cable run, the higher the loss will be. The amount of loss is dependent on frequency. At 2 MHz, the loss is approximately .5 dB, while at 30 MHz the loss in 100 feet of coaxial cable is over 2 dB. This means that a 100 watt transmitter would actually deliver about 70 watts to the antenna after running through 100 feet of coax at 30 MHz.

If you are seeking the utmost performance at 30 MHz and you can not avoid a run of 100 feet, or longer, we recommend using a larger low loss type of coax such as RG-8 (foam dielectric) or Belden type 9943 coax. Both of these will reduce attenuation to under 1 dB per hundred feet. You should be aware that this heavier cable is less easy to work and may be quite expensive.



The second loss which must be considered is the losses in the DC power, lock/reset and indicator control lines. At any distance other than the 9 foot cable which is supplied by SGC, we recommend that the DC voltage at the antenna coupler be measured. This is because if the coupler voltage drops below 10 volts, the coupler will go into a retuning sequence.

For this reason, SGC recommends that if distances are great, the input DC voltage at the transmitter site be adjusted to provide for 12 to 14 volts at the coupler site.

We do specifically advise against use of a different power supply than is used to power the radio because of the danger of creating ground loops which may cause oscillation of the final amplifiers or other undesired side effects. If you decide to use a separate power supply mounted at the antenna coupler location, please be advised that SGC does not provide technical support in this area.

### **1.11 UPGRADE SEQUENCE**

The current version of the SG-230 coupler will have a revision number located on the printed circuit board. The first Smartuners were early in the alphabet. More recent version of the coupler are in the "T" range and beyond.

The Smartuner is one of the most finely tuned products on the market. Each revision of the coupler includes the newest circuit designs in order to continue moving the state of the art forward in coupler design.

The original Smartuners with Revision numbers prior to "R" were usually three wire sets plus coax. In other words, the coupler control line was not available.

With the advent of Revision R, the reset line was added to allow the operator to force the unit into the bypass mode on receive (useful for broadband scanning) and to find the lowest possible SWR under a given set of conditions on a single particular frequency.

Revision T of the coupler was the next major move forward with the addition of the locking function to keep the coupler from retuning.

SGC will continue making incremental improvements in the Smartuner product. When you buy your product today and a new feature is added, you can always upgrade for modest fees to the latest version of the unit. The versions change are infrequent now, however, because the unit is so highly refined and meets precisely the needs of the HF professional.

However, if you ever hear a long time Smartuner user saying they would like to upgrade to the latest version of the unit, have them contact SGC because special discounts are always provided to our customers.

**2.0 SPECIFICATIONS - SG-230**

<b>HF Frequency Range:</b>	1.8 to 30.0 MHz
	<b>Note:</b> The SG-230 may be operated as low as 1.6 MHz and is commonly used as an antenna matching unit for differential GPS transmitter site antennas. However, when operated under these conditions, a longer antenna is recommended, such as a 60 foot tower section for operation in the 1700-1710 KHz band and an appropriately larger counterpoise. In addition, inductor heating may become pronounced at high power levels in the SG-230's torroid inductors which are commonly used at these frequencies. For this reason, we recommend 70 watts at 1700 KHz and 50 watts at 1600 KHz on a continuous basis.
<b>Power Input Range:</b>	3 to 150 watts (PEP)
<b>Input Impedance Range:</b>	45 to 55 ohms
<b>VSWR: (Typical)</b>	Typically less than 2:1
<b>DC Input Requirement:</b>	13.8 VDC
<b>DC Operating Range</b>	10.5 to 15 VDC
<b>Input Current: Average:</b>	.9 amps
<b>Random set time:</b>	Typical: less than 2 seconds
<b>Recurrent set time:</b>	Typical: less than 10 milliseconds
<b>Antenna Length:</b>	8 to 80 ft., 3.5-30 MHz 23 to 80 ft., 1.8-30 MHz
<b>Installation:</b>	Any position
<b>Operating Temperature:</b>	-35° to +70°C
<b>Size:</b>	16 x 12 x 3 inches
<b>Weight:</b>	8 pounds (3.5 kilos)
<b>Case Construction:</b>	Plastic ABS weatherproof case
<b>Control Cable:</b>	SGC special cable, 9 feet coaxial and two power input wires (replaceable by any standard cable plus remote tune LED wire)

**2.1 ACCESSORIES**

Shock Mounting Tray. SGC Part Number 54-50  
24 VDC Power option. SGC Part Number 54-52  
25 foot extension cable. SGC Part Number 54-61  
50 foot extension cable. SGC Part number 54-62  
SmartLock control box. SGC Part Number 54-63





## 2.2 RECOMMENDED ANTENNAS

**SG-105** Marine and Base station antenna. This is a 60 foot end fed long wire type antenna. SGC Part Number 55-10.

**SG-107** Delta Loop Antenna. This is a delta loop 11 meters high by 11 meters wide at the base. SGC Part Number 55-12.

**SG-203** Marine 28 foot whip antenna. This antenna is used for most power boat installations. SGC Part Number 55-24.

**SG-303** High performance 9 foot whip antenna. This dual element antenna is designed for severe marine and land mobile service. SGC Part Number 55-27.

**QMS** - Quick Mounting System which houses SG-230 Smartuner and also provides a sturdy mounting platform for the SG-303 antenna system. Designed for fly away installations requiring no holes installation of high performance HF antenna system. SGC Part Number 55-45.

## 3.0 PARTS FURNISHED

1. Antenna Coupler
2. 9 foot special cable (RG-58 plus 4 conductors in a single jacket.)
3. Instruction Manual

## 3.1 USER SUPPLIED ITEMS

The user of the SG-230 will need to supply a suitable HF radio antenna. Such an antenna may be as simple as an 8 foot long piece of wire and several ground/counterpoise radials of 8 feet or longer. The longer the antenna, up to about 80 feet, the better all around performance will be. Longer antennas may be used, but please refer to the sections on antennas for discussion of limitations.

The user will also have to supply a good counterpoise. Such a counterpoise is a large metal surface (much larger electrically than the antenna). Generally, the bigger the counterpoise, the better your signal will be.

## 3.2 TECHNICAL SUPPORT

Before contacting SGC for technical support, please take a few minutes to think through your installation and ask if there is anything obvious which you have overlooked in the installation. Check to make sure your ground system is both adequate and tight and that proper voltage is supplied to the coupler.



In the event you experience difficulty with your SG-230 antenna coupler, you should contact SGC for technical advise. Before calling, we ask you to have the following information ready so that we may readily assist you.

1. **Coupler Information.** Please have the serial number of your coupler, the name of the dealer from whom the unit was purchased and the approximate date of purchase.
2. **Antenna Information.** Please be ready to describe your antenna installation. You will need to advise us whether the antenna is a wire type, a dipole, vee, vertical, long wire or whip antenna.
3. **Ground System.** You should be ready to describe your ground system in detail. If you are dealing with a marine installation, you should have a description of the vessel's bonding system. If you are using the coupler in a mobile setting, you should be able to describe bonding of the hood, trunk and other vehicle parts which may have been done. In an aircraft, you should be able to describe the location of the coupler and the type of ground connection used.
4. **Power supply voltage.** One of the common mistakes made when installing couplers is to assume that a connection is good when it hasn't been measured. If you experience any type of erratic or intermittent operation, please measure the power supply voltage *inside the coupler*.
5. **Describe Coupler behavior.** If you are having a problem, determine if it is happening all the time or only part of the time. Does the problem occur only on certain frequencies? Does the problem only happen in certain modes? This type of information is extremely useful in quickly isolating your problem.
6. **Be patient.** Finding the reason for less than ideal system operation may take one telephone call or it may take several calls. Regardless of how complex the problem is, your SGC representative will be able to walk you through the process of solving your problem in a logical step-by-step manner. *There is nothing magic about HF.* Although it may seem so at times, the rules of physics don't change. The Smartuner and accessories will always give top performance when carefully installed.

#### **4.0 ANTENNA TYPES**

The automatic antenna coupler is designed for use with end-fed unbalanced antennas such as whips and long wires. The radiating portion of the antenna is connected directly to the coupler through a high voltage insulator. It is extremely important that the antenna type, site location and grounding technique be correctly chosen so that the system will radiate effectively.

Broadband resonant antennas (e.g. log periodic) that cover the full range of the system may be used with the coupler if desired. Narrow band resonant antennas, such as dipoles, vee's and inverted vee's may only be used if the antenna VSWR (including coaxial feeder) is less than, or equal to 3:1 at the operating frequency.

Note that if a dipole or Vee type antenna is used, the antenna may be operated at any frequency within the range of the coupler if each side of the vee or dipole is 23 feet or longer. In addition, the SG-230 is just as happy feeding a conventional Vee antenna as an inverted Vee. The coupler is very flexible in this regard.

#### **4.1 ANTENNA SELECTION**

The automatic antenna coupler will operate into almost any end fed antenna with a length of 2.5 meters or more, provided an effective ground is used. The antenna efficiency will be proportional to length and in most applications will be maximum at a length of 1/4 wavelength. This means that the longest possible antenna should be selected for each installation. Very short antennas are only recommended when there is no other alternative such as in a vehicular mobile installation. The performance of short whip antennas is usually very poor, particularly at the lower frequencies, and radiation efficiency will be only a few percent of a full sized antenna. However, a special electrically long antenna such as the SG-303 9 ft. mobile antenna overcomes much of the radiation problem.

#### **4.2 WHIP ANTENNA - 2.5-3.0 METERS (8-9 FT)**

This antenna is recommended only for vehicular mobile installations. The short length will result in poorer performance when compared with the longer antennas. A special high performance 9 foot antenna, the SG-303, is manufactured by SGC specifically for this problem. The SG-303 is SGC Part Number 55-27.

#### **4.3 WHIP ANTENNA - 7.0 TO 8.5 METER (28 FT)**

This antenna is recommended for marine installation on smaller vessels. It may also be used in base stations if there is no way of using a longer antenna. The SG-203 is this type of antenna. Order SGC Part Number 55-23.

#### **4.4 WHIP ANTENNA - 10.7 METER (35 FT)**

This is the preferred antenna for marine installation when there is no room for a longwire antenna. It will also provide reasonable efficiency for base station use and is the shortest recommended base antenna. Order SGC Part Number 55-24 for the SG-204 35 foot whip antenna.

#### **4.5 LONGWIRE ANTENNA - 23 METER (75 FT) AND 46 METER (150 FT)**

For most applications the longwire antenna will give the best results and is recommended when practical. The diagrams at the end of this section show some recommended methods of installation. These are only a few of the many possible methods of installation and frequently a different configuration will be the best at a particular site. SGC's long wire antenna, 60 feet in length, provides efficient operation on low frequencies and high frequencies alike. Order SGC Part Number 55-10.

#### **4.6 BACKSTAY ANTENNAS - 8 METERS (28 FT) AND LONGER**

Although we would love to sell everyone a high performance marine whip antenna, the backstay of a sailboat is almost impossible to improve upon in most installations.

#### **5.0 TYPICAL INSTALLATIONS**

Figures 5.01 through 5.10 show some typical installations for the automatic antenna coupler.

**Figure 5.01 Jeep Installation**

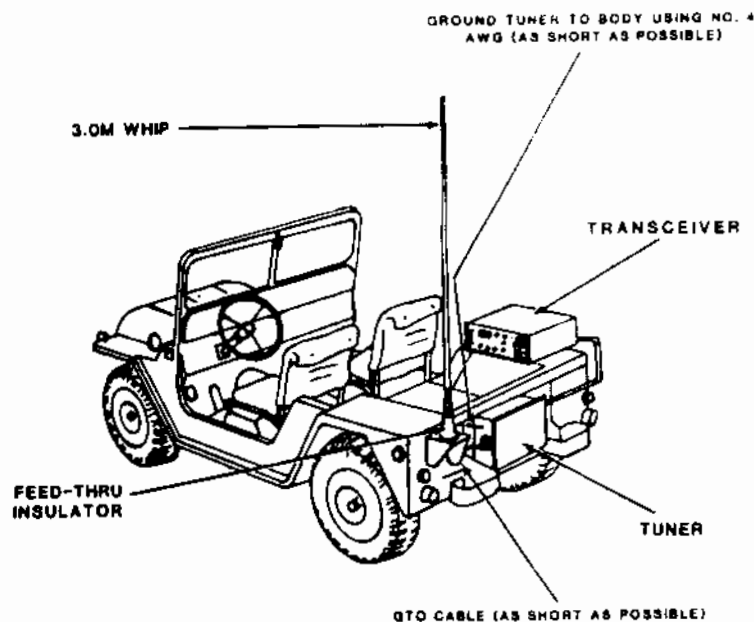


Figure 5.02 Vehicle installation

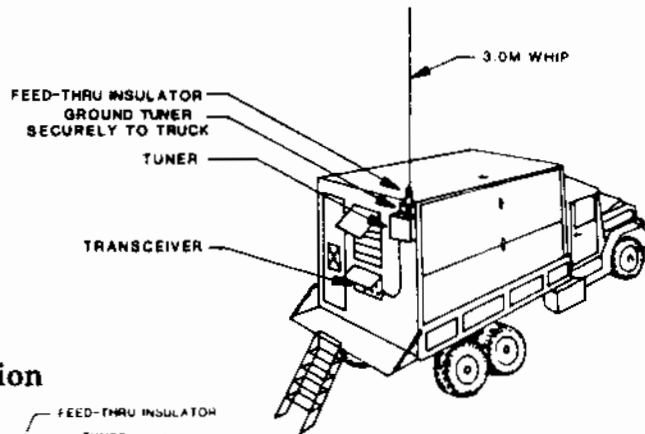


Figure 5.03 Motor Vessel installation

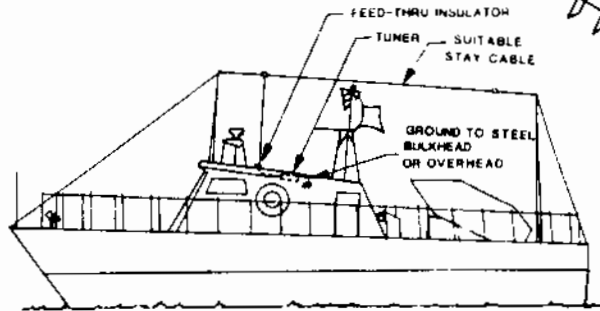


Figure 5.04 Base installation

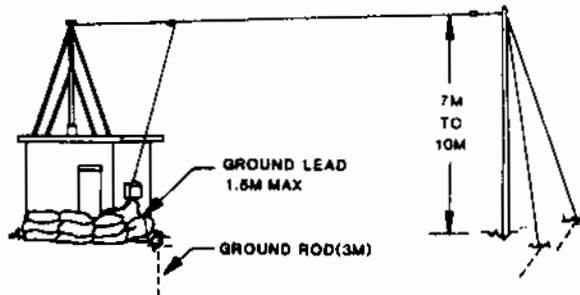
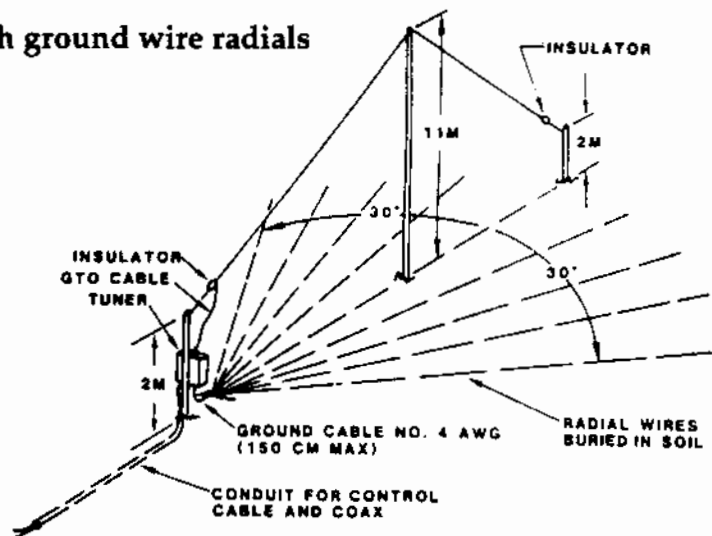
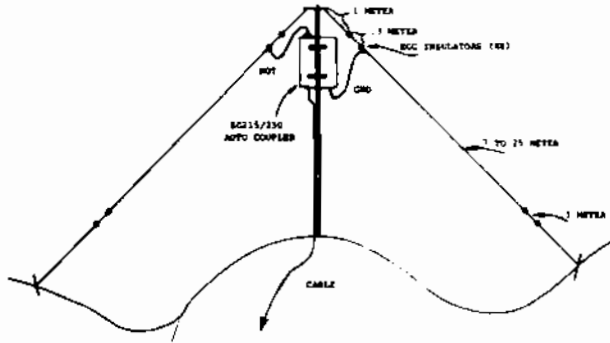


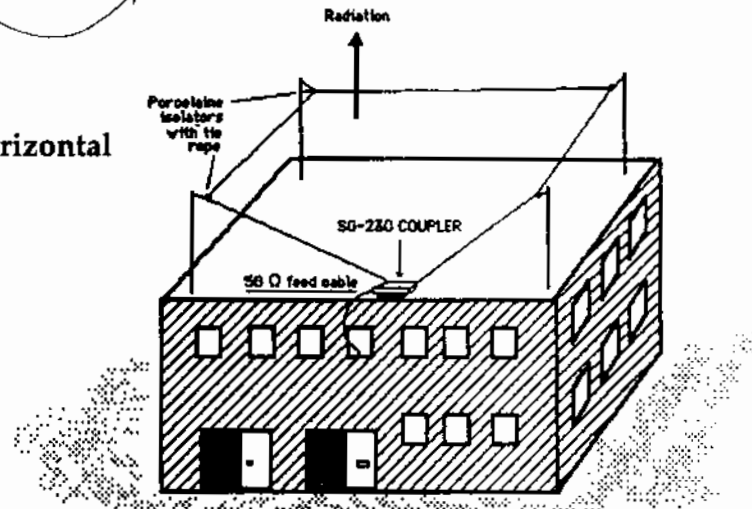
Figure 5.05 Base installation with ground wire radials



**Figure 5.06 Base dipole installation**



**Figure 5.07 Base Quadra Loop Horizontal**



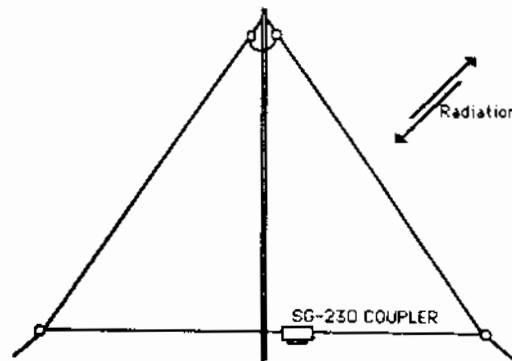
The horizontal quad loop is a groundless antenna for high angle radiation and is ideal for HF communications from zero to 500 miles in the frequency range of 2 to 10 MHz. This configuration provides optimum near-right angle reflection to the ionosphere for short range communications.

The horizontal quad loop is a groundless antenna for high angle radiation and is ideal for HF communications from zero to 500 miles in the frequency range of 2 to 10 MHz. This configuration provides optimum near-right angle reflection to the ionosphere for short range communications.

A square base can be from 8 to 15 meters long and can be configured to the shape of the structure as necessary, to provide the best arrangement. The height of the supporting poles should be 20 to 40 feet. Supporting poles should be as tall as possible to provide the antenna with the greatest isolation from industrial noise generated by the building, such as fluorescent lights and electrical motors. Loop antennas are also less susceptible to industrial RF noise generated by the building, because they are isolated from the ground system of the building.

Loop wires are attached at one end on the high voltage active side of the coupler and on the other end at the ground side of the coupler.

**Figure 5.08 Base Delta Loop**



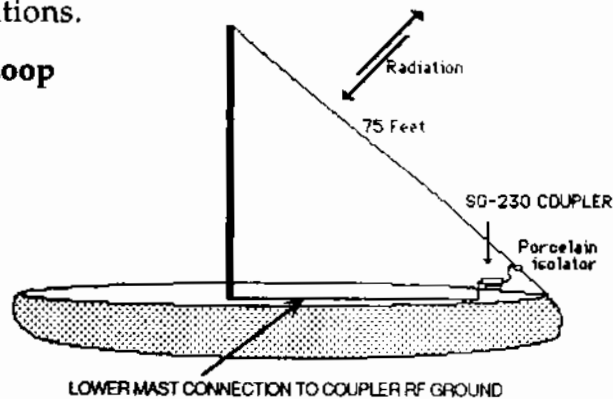
The delta loop antennas are ideally suited to long range communications due to their low angle. This configuration is best for communications ranging from 500 to 5000 miles in the HF frequency range of 4 to 22 MHz. Noise rejection is excellent, as stated for the quad loop antenna. Because the antenna system is not connected to a ground, noise rejection is enhanced. If mounted on the roof-top of the building, it is further isolated from the building which generates RF noise.

The supporting mast should be 8 to 14 meters tall to provide good overall HF performance.

Note that with this type of antenna, the coupler may be mounted in the middle of the horizontal portion of the loop or it may be mounted at the corner. If mounted at the corner and the lead from the coupler attached to the vertical leg, the polarization of the loop tends to be vertical and is slightly better for low angle long distance communications.

Loops in the horizontal plane may also be used. This type of antenna provides exceptionally good performance on the low frequency bands for short to intermediate range communications.

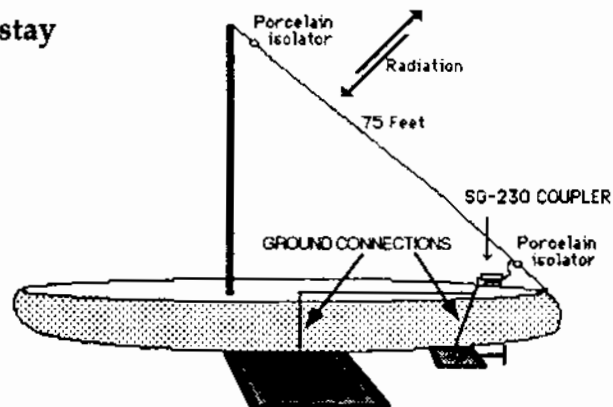
**Figure 5.09 Vessel Groundless Loop**



The triangular loop antenna for sailboats is designed to operate in a groundless environment and still provide high performance. This type of installation will require only one insulator point on the bottom backstay and an electrical connection on top of the mast and the stay. The grounded side of the coupler should be connected to the bottom of the mast. Although not our best recommendation, this antenna will provide a workable solution in some installations.



Figure 5.10 Vessel insulated backstay



The insulated backstay antenna requires two porcelain isolators. The coupler must be placed as close as possible to the base of the backstay antenna. Proper grounding of the coupler is very important. Connect the RF ground terminal of the coupler to all of the metal parts or structures of the boat (keel, engine etc.).

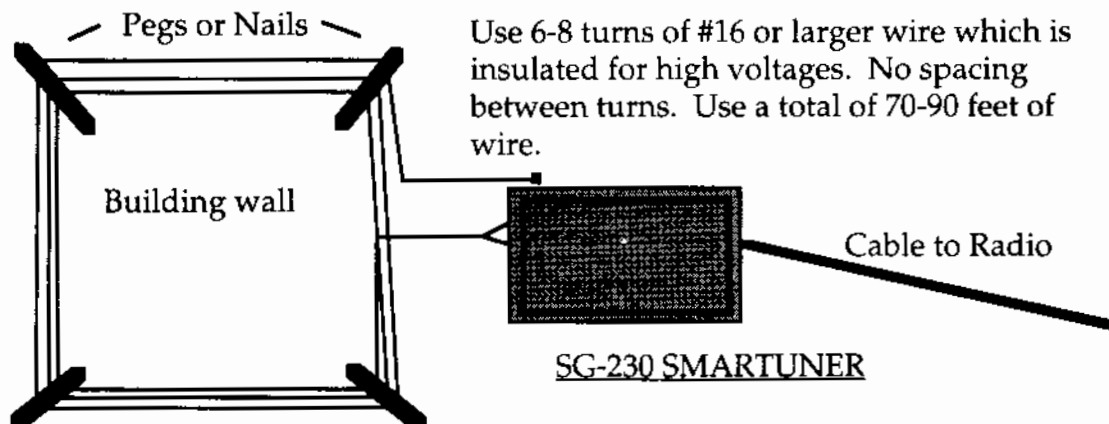
### 5.1 APARTMENT LOOP ANTENNA

Loop antennas can be used very effectively in small apartments, offices and holding rooms. Radiation for a loop antenna is always efficient but highly directive. Therefore, the orientation of the loop is very important. Generally, the vertical loop antenna with horizontal radiation is much preferred for a general application throughout the 1.8 to 30 MHz band. However, loop antennas can be very effective when mounted horizontally to the ground to radiate vertically and provide efficient short range communications on higher frequencies. Generally HF connections are difficult to establish in the distance range of 50 to 250 miles. In a large room (such as 20 x 30), we would recommend the installation of a single wire loop antenna mounted on the ceiling with the coupler against the wall directly below the antenna. The wire gauge should not be less than 16 AWG with insulation.

When operation is for a small room, it is recommended that a small multiple wire loop (6 loops) on a rectangular configuration 3 by 4 feet be installed (as illustrated in the figure below).

This configuration allows operation from 1.8 to 30 MHz and the SG-230 will tune and load all frequencies well below a ratio of 1:15 VSWR. Directivity will be high from 3 to 12 dB depending upon the frequency. If this is a problem, two loops at 90 degrees can be installed to communicate at 90 degrees off direction of the first loop antenna. Loop antennas are low noise antennas. However, because they are used in apartments and crowded urban cities, high industrial noise can be expected. Avoid using neon or fluorescent lights within 50 feet of the loop antenna, as they may completely jam one or several frequency bands.

**Figure 5.11 Small loop antenna (3 x 4 feet)**



Loop antennas of much larger sizes can be used, however, please remember that while the low frequency operation of such antennas may be quite good, the larger antennas may not work well at very high frequencies when located in a plane parallel to the earth. This is because large loop antennas generally radiate their maximum lobe (field strength) at right angles to their plane.

This means that a large loop, say 60 feet on a side, mounted 20 feet above the ground would radiate much of its energy upward. While during the day this would work well for close in communications, longer distances would be achieved with the loop mounted vertically. The vertical loop antenna of one quarter wavelength is the basis of the "quad" type directional antenna.

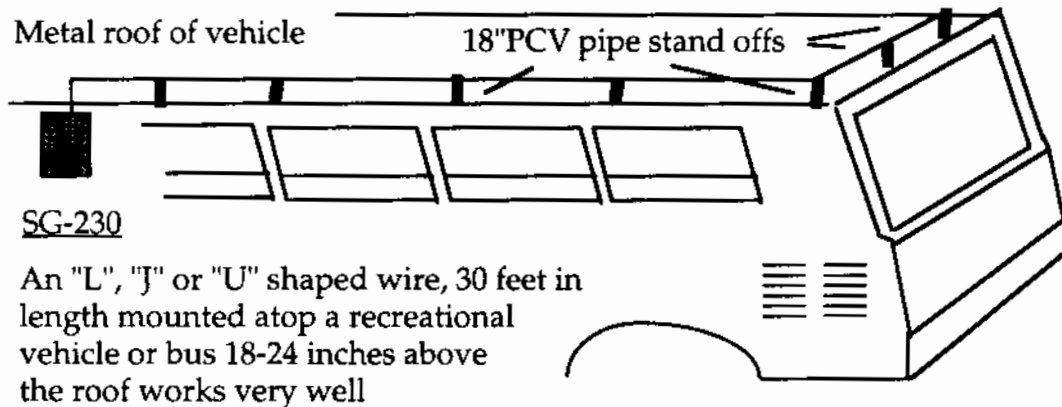
Loop antennas represent a DC short circuit and for this reason are much less susceptible to noise than are other kinds of antennas. In certain residential and industrial areas where high noise levels occur, the loop antenna may provide a substantial improvement in both receiving and transmitting performance at very little cost.

## **5.2 RECREATIONAL VEHICLE (RV) ANTENNAS**

RV or trailers provide an excellent base to install effective low cost antennas, and both configurations, end fed or loop antennas can be used.

An End fed antenna could be very effectively used if a metal cabin structure is available. Loop antennas have the advantage of not requiring a ground system, but are highly directive. Mounting the antenna is relatively simple and can be mounted on short (18 inches 1/2 inch diameter) plastic plumbing pipes. In the end fed antenna, it is recommended that the antenna be as long as possible in an "L" shape configuration, as illustrated in the diagram on the following page.

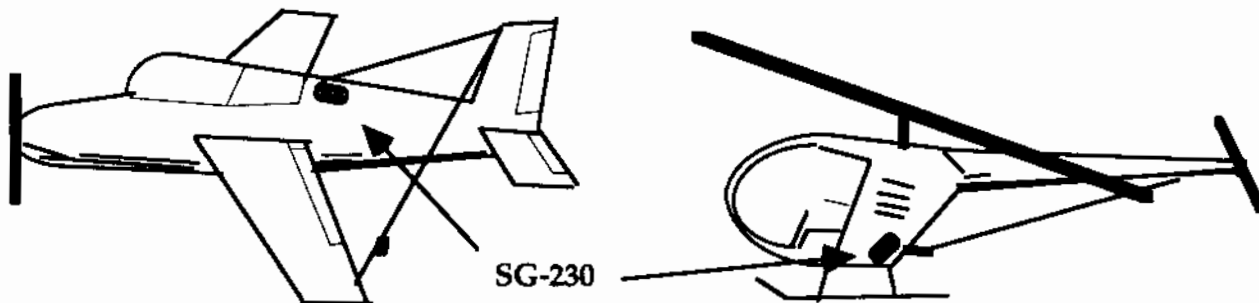
**Figure 5.12 Recreational vehicle, bus or truck detail:**



**SG-230**

An "L", "J" or "U" shaped wire, 30 feet in length mounted atop a recreational vehicle or bus 18-24 inches above the roof works very well

**Figure 5.13 Aircraft Installation Detail:**



**SG-230**

On fixed wing aircraft, coupler mounts on ceiling and antenna runs from there to vertical stabilizer and then to wing tip.

On rotary craft, a long wire antenna of 15 to 20 feet under the tail rotor boom works quite well on all frequencies.

When installed in high performance turboprop or jet aircraft, the Smartuner will operate well with a shunt fed antenna. This is generally a 13 foot piece of metal which mounts on the fuselage of the aircraft and is grounded to the aircraft at one end. The device looks something like a towel bar on the underside of the aircraft. The Smartuner will also match well the more common wire antenna from fuselage to vertical stabilizer (and continuing to a wingtip if desired) and a long wire antenna under the tail rotor of helicopters. This long wire approach has proven very effective on Bell JetRangers and LongRangers in particular.

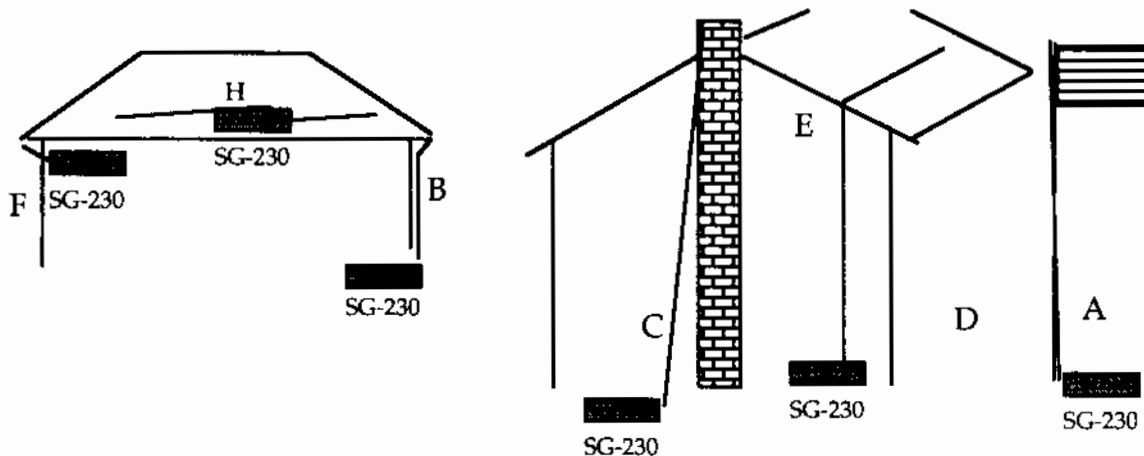
### **5.3 LOW PROFILE, HIDDEN AND COVERT ANTENNAS**

There are two general types of low profile, hidden and covert antennas. The first group is the paramilitary user who will wish to operate from a residence or

commercial building without drawing attention to the fact that long range HF communication is in process. The second class of covert antenna user (and a larger group) is the amateur radio community which finds itself more restricted almost daily by covenants, building codes and tenant requirements.

We will consider a typical residential home and point out covert antennas which have been used very successfully for intercontinental communications.

As you review the diagram on the following page, remember that the antennas used include both groundless loop type antennas and those which require a counterpoise (ground).



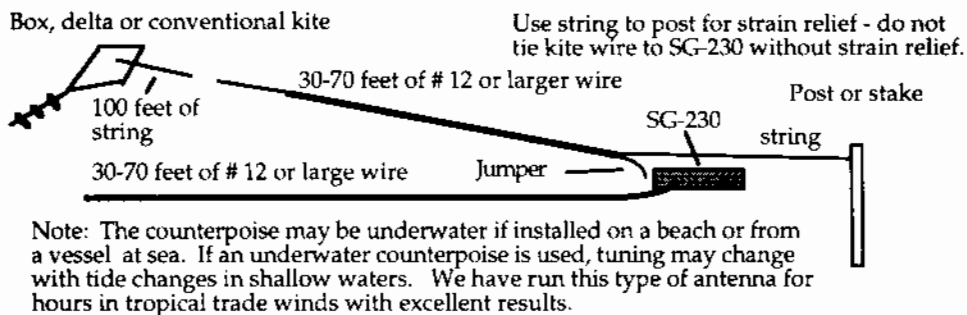
- A. If a flag pole is made of PVC pipe, it is easy to tape a large gauge wire to the inside of the pipe and use a good counterpoise. Typical flag poles are 25 to 35 feet in height and offer excellent performance on all bands.
- B. The down spout, rain gutter antenna works well if the piping and gutter are aluminum. You may wish to secure the joints with hose clamps or plumbers tape to assure low resistance connections.
- C. Masonry chimneys are visually "busy". You can run a #10 copper wire parallel to the chimney with little risk of detection. Some short stand offs and you have a support for a vertical dipole type antenna.
- D. The Inverted "L" antenna may work slightly better if it is installed clear of a building, but for covert operations, this type of installation is a favorite. Especially if the feedpoint is at ground level adjacent to an iron or copper water line entering the house which will provide an excellent counterpoise.
- E. Along the edge of the roof, held off by some inexpensive TV twinlead standoffs, you can hide 25 to 40 feet of antenna on virtually any house.
- F. Under the roof overhang, all kinds of wire antennas may be installed.

- G. Loop antennas installed on the inside or outside wall work well at higher frequencies and provide some directional characteristics. These antennas are also less prone to man made noise.
- H. All types of antennas may be hidden inside the roof of a building which uses non-metallic roofing materials.

#### **5.4 EMERGENCY ANTENNAS**

There are a couple of antennas which don't fit into any category in particular, but which should be mentioned because when used with a Smartuner, they will deliver spectacular results.

#### **5.5 KITE ANTENNA:**



This is our recommended antenna to be carried aboard all types of vessels. This is because when a wind strong enough to damage a boat occurs, it is easy to fly a kite and this may lift fifty to one hundred feet of antenna wire. For good emergency communications, you will only need 30-70 feet of antenna and a strongly built (Mylar or nylon) kite.

Remember that when a mast comes down, you have easy access to the high voltage feedline which may be secured to a kite antenna. Offshore power boats can use this antenna as well, since 10-20 knot winds are almost always available when underway at sea.

#### **5.6 TACTICAL INSTALLATIONS**

Over the course of nearly 25 years of HF, SGC equipment has been used everywhere from camelback in the desert to Antarctic expeditions. Along the way we have collected a number of tips to get maximum system performance from your radio system when you are operating in a tactical or disaster situation. These tips, by the way, also apply when you go camping or are involved in amateur radio Field Day activities:

### **5.7 TACTICAL ANTENNA SUPPORTS**

Except for a barren desert, just about all landscapes have structures (natural and man made) which can be used for antenna supports. All it usually takes is several hundred feet of rope and some creativity. Here are some examples to consider. If you wonder which structure would work best remember the one with the greatest height and greatest distance from grounded metal will generally give the best performance.

1. Natural rock formations such as cliffs and bluffs.
2. Tall trees.
3. Water towers.
4. Church spires and minarets of mosques.
5. Strung between rooftops of buildings.
6. Sign posts such as for banks and gasoline stations.
7. Telephone (*not power*) poles. There's no power line noise on telephone poles.
8. Railroad trestles
9. Highway structures - signs, overpasses and bridges.
10. Flag poles at public buildings, schools and hospitals.

### **5.8 TACTICAL GROUNDS AND COUNTERPOISES**

Just as antenna opportunities abound, so do ground and counterpoise opportunities to the professional eye. Some of our favorite examples which correspond to the antennas above include:

1. Cross country water and petroleum transmission pipes. (As it passes under a bluff?)
2. Long steel cables along a mountain highway. (With nearby trees?)
3. Chain link fencing. (Around the water tower?)
4. Metal lawn sprinkler piping. (In the church yard?)
5. Fire department stand pipes. ( Required in most big city building codes!)
6. Underground metal petroleum storage tanks. (At the gasoline station?)
7. Metal fencing of any type. (A barbed wire fence along a pasture under telephone pole?)

8. 100 feet of wire thrown in a river or sea. (Under a trestle?)
9. Metal drain culverts. (Along a highway?)
10. 4-5 cars parked with their metal bumpers touching or a sheet metal roof. (Hospital or public building.)

As you can see from this list, there are an almost limitless number of options available for the trained professional to install a high performance antenna system with only a small amount of wire and an SG-230 Smartuner.

## **6.0 GENERAL NOTES ON ANTENNAS AND COUPLERS**

1. The longer the antenna, the better the antenna performance. By doubling the length of the antenna, an improvement of 3 - 6 dB can be expected in your radiation or receiving characteristics. This is the equivalent of transmitting with 400 watts, when in actuality you are using only 100 watts.
2. A ground for "end fed" antennas can be very effectively created by running radial wires from the coupler point and laying them onto the ground. It is recommended that for a good ground, 12 radials should be used and they be about 1/3 longer than the antenna length. The number of radials can be reduced; however, you need at least one. Efficiency pattern and radiation will decrease in proportion.
3. Antennas will always perform better if the wire is of a large gauge. Never use anything less than gauge 16. If gauge 6 is used, an improvement of 6 dB can be expected over the 16 gauge. The radial ground wire should be at least the same size as of the antenna wire.
4. The SG-230 coupler can handle antennas beyond the specified minimum range of 8 to 80 feet and should be extended as much as possible. In some cases, the antenna can be 300 feet or longer. In this situation, you may find some tuning holes that are of no importance to the present application. However, if this is not the case, the antenna can be made a little shorter or longer to overcome the tuning hole on the frequency band you may have wanted to use.
5. Always install the antenna system as far away as possible from any electrical or industrial noise source. Electrical appliance, electric motor or fluorescent lighting noise may cover up weak or even very strong signals.
6. The SG-230 is a remarkable antenna coupler that will tune practically any antenna-good or bad. Keep in mind that it is not the coupler that will radiate the RF energy, it is the antenna. Therefore, use only good size wire and long antennas.



7. Never use a feed line or coaxial cable at the output of the antenna coupler. The function of the coupler is to couple the radio to the antenna and not to use it as a mid point connector. The antenna system starts at the output of the coupler. Therefore, the lead end from the coupler to the hypothetical antenna is part of the antenna system. Avoid having the lead end wire touch any other metal structure, as it will capacitively short your antenna to ground.
8. The backstay of your mast is the *only* viable antenna on a sailboat. The SG-230 coupler is specifically designed to be used for such applications.
9. For vehicular installation, do not use any inexpensive CB antennas and/or mounts. These antennas will not perform well between 1.8 to 10 MHz even though the coupler will load and tune the antenna whip. A very high voltage of 15 to 30,000 volts RF will be applied to the antenna depending on the RF power level and frequency. The inexpensive ball mounts for CB antennas are not designed for this stringent a purpose. The use of an antenna system, such as the SG-303, is highly recommended as it was specifically designed for such extreme applications.

## **6.1 STEPS TO ANTENNA INSTALLATION**

System installation is a three part process covering the following steps:

- a) Selection and installation of the antenna
- b) Mounting the antenna coupler
- c) Connecting the appropriate interface cables between the coupler and the transceiver

This manual section will discuss the three steps mentioned above in detail and will provide sufficient information to enable the user to confidently install a complete system properly.

The antenna system is a key part of the communication system and for satisfactory operation the system must be carefully selected, then installed correctly. The unbalanced antennas used with the automatic antenna coupler use the ground (counterpoise) as half of the antenna system. The ground forms an "image" antenna and is a critical part of the system. It is essential to consider both the ground and the antenna when designing the system installation.

**6.2 ANTENNA LOCATION**

The figures in Section 4 illustrate several different antenna installations. The following points should be carefully considered when designing the antenna system.

- a) The antenna should be located in a position free of obstructions, particularly in the desired direction of communication.
- b) The antenna should be kept as far away as possible from buildings, trees and vegetation. If metallic masts or supports are used, arrange the insulators so that the antenna is spaced at least 2 meters from the mast.
- c) Remember that the radiating part of the antenna starts at the coupler. The location of the bottom portion of the antenna is very important.
- d) Vertical antennas have an omni-directional radiation pattern and will provide equal performance in all directions.
- e) Horizontal wire antennas have maximum radiation broadside to the antenna when the frequency is less than  $1/4$  wavelength. As the frequency increases beyond  $1/4$  wavelength, lobes will appear in the radiation pattern with the principal lobes becoming closer to the plane of the antenna as the length increases. At all times, radiation will be minimal at the end of the antenna and it should be located so that the ends point in directions where communications are not required.
- f) The "V" construction minimizes the directivity of the horizontal antenna and is recommended for all around coverage. In addition, the "V" antenna is a compromise between vertical and horizontal polarization and will give good results for communications with land or marine mobiles using vertical whip antennas.
- g) High voltages (sometimes exceeding 30,000V RF) are present on the antenna. All parts of the antenna and coupler must be located or protected so that there is no possibility of accidental contact.
- h) Do not locate the antenna close to other antenna systems.
- i) Make sure that the antenna is rigidly supported. The antenna will de-tune if it sags or sways.
- j) The connection from the coupler to the ground must be a small percentage of the total length of the antenna. Do not let the length of the ground strap exceed 1 meter. Use heavy gauge wire or strap for ground connection.
- k) Whip antennas should be connected with the minimum length of wire. (Do not exceed 0.6 meters).

- 1) Do not locate the coupler farther from the transceiver than necessary. If the distance exceeds 10 meters (30 ft) , it is recommended that low loss coaxial cable, such as RG-8 or RG-213 be used.

### **6.3 GROUND SYSTEMS - GENERAL**

The ground system (also called a counterpoise) is a key part of the overall antenna system and is the primary cause of poor performance and the difficulty of adjusting the coupler. A good ground is essential.

#### **6.3.1 VEHICLE GROUNDS**

Connect the coupler directly to the frame of the vehicle. Ensure that a heavy strap is used from the coupler ground lug and that the connections are cleared of all paint and dirt so that the shiny metal is exposed. SGC always recommends that two grounding bolts with star washers be used to insure no ground resistance is encountered. Make sure that the grounding point is not insulated from other parts of the vehicle by non-metallic couplings, bushings, fiberglass panels, etc. Modern vehicle assembly techniques which use spot welding may not always adequately connect various body parts. Use an ohm meter and insure your vehicle is electrically bonded.

Another area to watch is trunk lids and hoods. Because many body parts are dip painted, they may float above the RF ground when assembled. Use of short heavy braid to insure all doors and hatches are grounded is good installation practice. Although this is tedious work, the benefit is that once completed you will have a much superior radiated signal and lower noise floor on receive.

#### **6.3.2 MARINE GROUNDS**

A metal hulled vessel in salt water provides an almost ideal ground. The coupler should be connected directly to the hull using the shortest possible ground strap or 2 to 3 inch wide 2 mil copper foil. Make sure that the contact point is free from paint and dirt. Ensure a good contact area for minimum resistance.

Wooden and fiberglass hulled vessels present more of a grounding problem. It is normally necessary to bond all large metallic parts such as the stove, fuel tanks, engine, propeller shaft, etc., and sometimes an external grounding plate should be connected to the hull. The bonding and grounding plate should take into consideration the problems of electrolysis. Severe damage may result if dissimilar metals are connected together.

Our experience is that sacrificial zincs, which double as radio grounds, may help, but are not by themselves a complete solution. If you use one (or more) of these devices, remember to provide for a large physical counterpoise in addition.

In a sailboat installation, we generally place the Smartuner in the aft lazarette and then run at least three runs of foil forward. One runs up the port chine, just below the waterline, another up the starboard chine below the waterline and the third up the center of the vessel.

The center foil is generally connected to the rudder post, transmission, engine and keel bolts. The chine foils are attached to through hulls, the stove, tankage and so forth. The idea is to get as much metal inside the vessel connected as possible. Metal toe rails and life lines work well as do keel coolers on motorized craft.

Gordon West, WB6NOA, whose Radio School has taught thousands of mariners how to get their ham radio license, has a neat trick for attaching foil to keel bolts. When a large keel bolt is exposed, he simply drills into the keel bolt and taps the hole for a suitable stainless steel machine screw. This is then attached with suitable copper washers and a very solid electrical connection is made.

Although it is not mandatory that ground foil be glued into place, we consider it a good idea to keep the space below decks neat and orderly under all conditions.

If you are using a backstay antenna, try to visualize your ground as you look down from the top of the mast. Ask yourself if you see 100 square feet of metal below you. The closer to this figure you can get, the better your radiated signal will be. What you are trying to do is make a large capacitor to the sea water. Consider the salt water of the sea to be one plate of a capacitor, the ground system the other and the hull to be the dielectric.

On marine installations, you should also be very aware of potential noise sources which may need to be bypassed to ground. We have encountered just about every source of noise imaginable in vessel installations. When you are laying in a ground system is the best time to track down annoying noise sources. Not only will you get much better voice communications, but Weatherfax, Navtex and Loran reception will improve as well if they are also tied into the ground system.

Particular attention should be paid to any device which uses an electric motor. This means to turn on the water pressure pump, bilge pump, hot water forced air heater fans, refrigeration and autopilot motors. A few small capacitors to ground (.01 microfarads at 100 VDC) can resolve many issues. Bypassing of the vessel's alternator is also a good idea.

### **6.3.3 BASE STATION GROUNDS**

In areas of high ground conductivity, an effective ground can be made through a grounding rod. The rod should be approximately 3 meters in length and should be installed as close as possible to the coupler. It may be necessary to use several ground rods bonded together to improve the ground contact. Water pipes are sometimes recommended as grounds and may be used provided plastic pipe is not buried as part of the system and the following conditions are met:

- a) The water pipe is close to the coupler.
- b) The water pipe enters the ground very close to the coupler bonding point.
- c) There are no joints or couplings in the pipe that will increase the resistance path to ground.
- d) The water pipe enters soil with good conductivity.
- e) A low resistance contact is made to the water pipe.

Frequently the ground conductivity will not be sufficient to provide satisfactory operation of the coupler. This is almost certainly the case with well drained sandy, rocky or loamy soils and a counterpoise (artificial ground) must be used as the ground system. This is also very important in a rooftop installation where there is no existing ground plane. The ideal ground would be a conducting surface extending several wavelengths in all directions around the antenna. On a rooftop, this situation may be approximated by placing a screen of chicken mesh, copper hardware cloth or similar material over the roof of the building. More frequently, a counterpoise system of radial wires must be used. SGC recommends the use of at least 8-12 radials bonded together in the center. If the antenna is at ground level, the radials should be buried a few inches below the surface.

### **6.4 CORROSION**

The ground connections are subject to corrosion and oxidation. All joints must be clean and the hardware adequately tightened. Joints should be well soldered wherever possible. The joints may be protected by an application of silicon grease, and under severe conditions, covered with electrical tape and waterproof varnish or a durable brand of silicon caulking.

If you are mounting your Smartuner on a vessel where a lot of salt spray is encountered, it is a good idea to put the wire connections which are exposed to weather on your 6-month periodic maintenance plan. Then, every six months, you will be reminded to undo each of the connections, clean, retighten and reseal.

Use jumpers around metal backstay triangles on split backstay antennas. Corrosion may cause up to several hundred ohms of resistance to occur even though you may think that a metal-to-metal connection would be a good one.

### 6.5 ANTENNA COUPLER MOUNTING

The coupler is mounted using the proper mounting ears on the case. Choose a location immediately adjacent to the antenna feed point. In trunk mounted mobile installations, it is very important that the coupler is located so that the antenna insulator is within a few centimeters of the antenna exit hole. Note also that the antenna lead must pass through an insulated bushing. High voltage connecting cable must be used. (RG-8U cable with solid insulation may be used if the outer shielding is removed). A protective housing is highly recommended when the coupler is installed on the outside, or on the deck.

### 6.6 ANTENNA CONNECTION

The antenna lead is connected to the high voltage insulator. During operation, use two wrenches when tightening the nut to prevent the stud rotating. A potential of several thousand volts may be present at the antenna terminal and adequate protection must be made against accidental contact. It is also necessary that the antenna is spaced at least 3 centimeters from the conducting surface. Sharp points in the lead-in wire should be avoided to prevent corona discharges.

### 7.0 INSTALLATION PROCEDURES

The following diagrams will assist you with installing the Smartuner with SGC equipment.

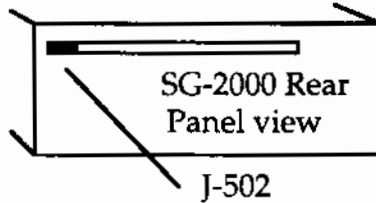
#### 7.1 INSTALLATION WITH SG-2000

The SG-2000 is shipped with all necessary connectors for installation of a Smartuner™ and for installation of peripherals via the audio input/output jack on the rear panel. You will see the connectors when you remove the Philips head screws which hold the protective sheet metal cover over the rear panel connectors.

From left to right, these jacks provide the following:

- J-502**      SG-230 Smartuner™ connections
- J-301**      Aux. Audio input/output and PTT line
- J-503**      Remote control head or multiple head junction box
- J-504**      Remote control head or multiple head junction box (Head mounted on radio is normally connected here.)
- Ext. SPK**      External Speaker
- Oven**      Turns oven On-Off (Shipped with oven ON as default)

## SG-2000 TO SG-230 COUPLER CONNECTIONS



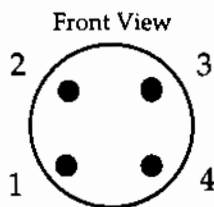
### SG-2000

J-502-1  
J-502-2  
J-502-3

### SG-230 Smartuner Wire

Black wire of coupler cable ( Ground)  
Red wire of coupler cable ( +12 VDC)  
Black-white wire of coupler cable (TND)  
Red-white wire (To optional SmartLock)

## 7.2 SG-1700 TO SG-230 COUPLER CONNECTIONS



### SG-1700

Pin 1  
Pin 2  
Pin 3  
Pin 4

### SG-230 Coupler

Not used.  
Black/white (TND)  
Red ( +12 VDC)  
Black (Ground)

The SG-1700 coupler connector is located on rear panel of the radio.

### On All Radios:

The SG-230 requires only a source of 13.6 VDC (Optional: 24 VDC), an RF transmission line (RG-58/U up to 30 ft., RG-8 OR RG-213/U if over 30 ft.) plus suitable ground and antenna systems. No band switch information, low power tuning or handshake is required, since the coupler tunes on RF voice or carrier. Power consumption is normally less than 1 amp, allowing for use of small gauge wire. The PCB is fully protected against power reversal. The output for a remote mounted tune indicator, if desired is strictly optional.

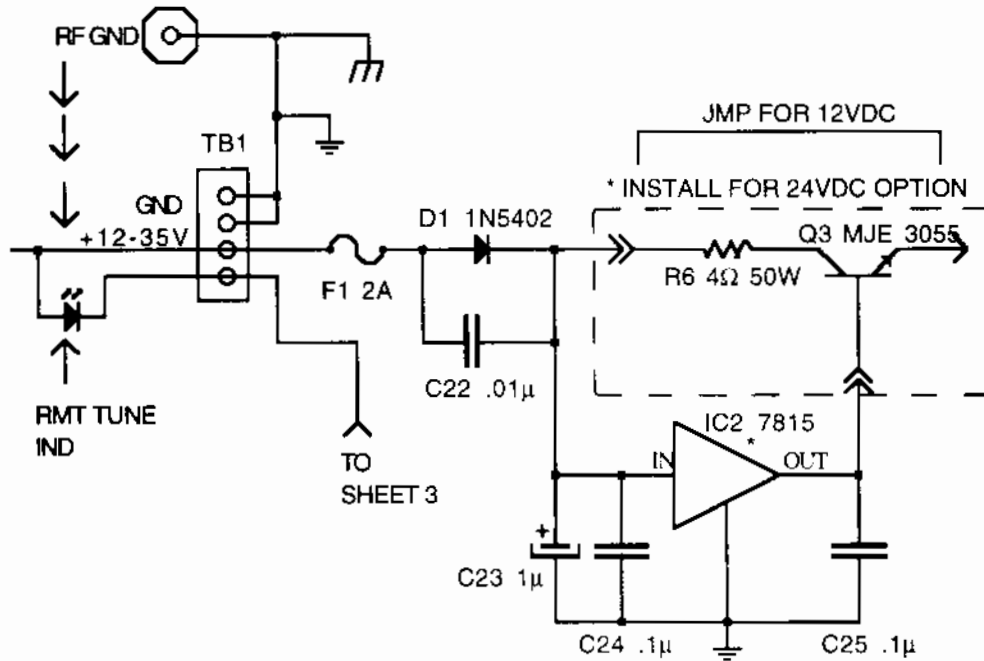
When installing your SG-230 remember to allow for the power to be disconnected from the battery during periods when equipment is not being used. This will prevent draining the battery unnecessarily.

## 7.3 REMOTE TUNE INDICATOR LED FOR EXTERNAL USE

The only necessary connections to the SG-230 Antenna Coupler are 12 VDC power supply (Optional: 24 VDC) and RF coaxial cables. In addition, a tuned LED indicator may be connected externally to the "RMT TND" line for visual "Coupler Tuned" recognition. LED must be connected in series with 4.7K $\Omega$  1 Watt resistor if the input power source is 24 VDC, as indicated in the illustration below:



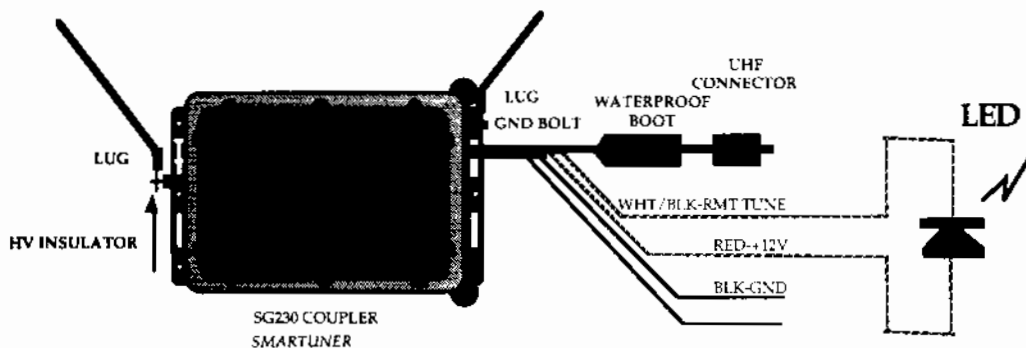
**Figure 7.3.0 Remote Tuned Indicator Circuitry**



NOTE: The remote tuned indicator line goes low (to ground) when the SG-230 is tuned.

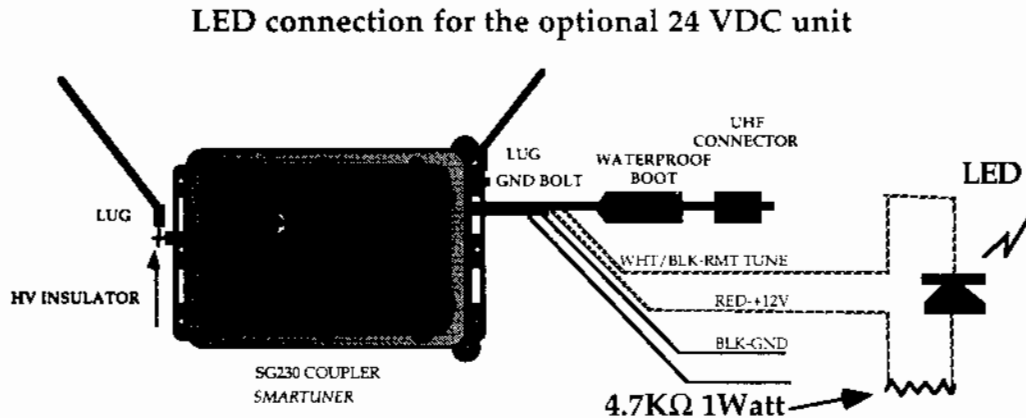
**Figure 7.3.1 LED Indicator installation 12 VDC**

LED connection for the standard 12 VDC unit



Note that the tuned indicator LED is connected between the +12 VDC supply and the black-white wire. If you connect the black-white wire to an LED and then ground one side of the LED, you will get no tuning indication.

**Figure 7.3.2. LED Indicator installation 24 VDC**



A remote LED indicator in the above schematic represents a simplified configuration. It does not take into account the normal cable hook-up between the internal connector of the coupler TB1 and the optional external four pin connector shown in above figure 6.1. A series resistor is not required with the LED when the coupler is operated on 12 VDC, providing LED is rated at 25 milli-amp minimum.

If you are planning to use the SG-230 with another manufacturer's equipment and you are not clear on the function of the Remote Tuned Indicator line, think of it this way: The remote tuned line goes to ground when the SG-230 is tuned. If you provide this information to the manufacturer of the radio equipment, they should be able to instruct you on how to connect the remote tuned line to achieve a front panel display. (Naturally, SGC would like you to use our SG-2000 series radio!)

## 7.4 WEATHERDECK MOUNTING

Weatherdeck mounting can be used. Years of experience have shown that inside mounting or even splash-proof mounting is preferred, particularly in cold, damp environments. In tropical use, shielding from direct sunlight is desirable.

The base of the antenna should be connected to the high voltage feed-through insulator on the housing. Note that this insulator is not designed to support heavy mechanical loads. If such loading is encountered, the use of a strain insulator is desirable.

The ground system should be connected to the 1/4 inch stainless steel stud protruding from the bottom of the housing. Connection to the ground system is of extreme importance for a successful installation. Ground runs of over a few inches should be made from 4 inch wide copper strap or larger. The actual ground system should be as good as possible, as the ground is an integral part of the antenna system. See section 5.2.2 on grounding. However, couplers in general require the antenna parameters to be within the range of the tuning parameters or the coupler

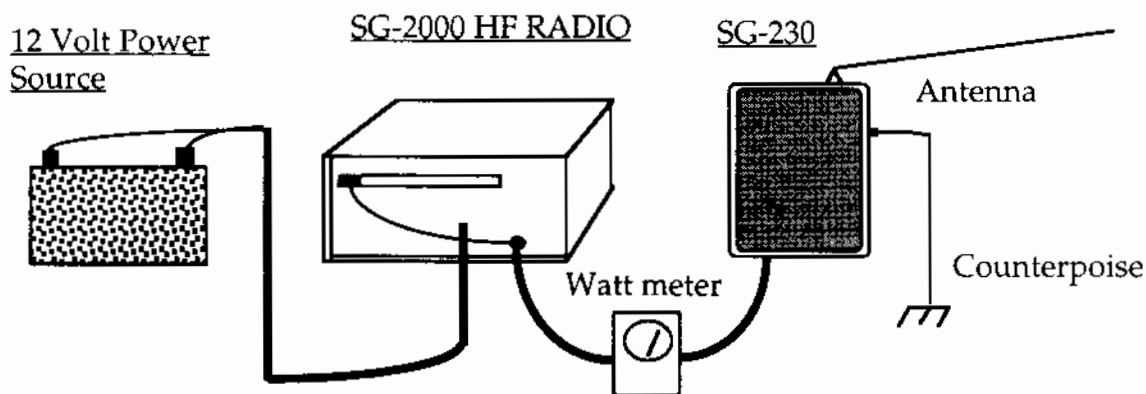
SGC Inc. SGC Building, 13737 S.E. 26th St. Bellevue, WA. 98005 USA

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will not find a satisfactory match. It should always be remembered that the computer in the SG-230 is unable to second-guess the installer.

**A PROPER ANTENNA/GROUND INSTALLATION IS OF GREAT IMPORTANCE. REGARDLESS OF WHETHER YOUR STATION IS A BASE STATION, MARINE, OR LAND MOBILE.**

### SETUP FOR ELECTRICAL CHECK OUT:



### 8.0 ELECTRICAL CHECKOUT

After the SG-230 antenna coupler has been installed, the SSB transmitter should be adjusted to the *highest* frequency desired, and a directional watt meter (i.e. Bird Model 43) should be inserted into the transmission line. The transmitter should then be powered. The SG-230 will begin to tune when RF power is applied, and you will hear a "clattering" of PC mounted relays. If the antenna length and ground parameters are within range, the relay noises will stop when just a few words are spoken, and the reflected power on the watt meter would indicate a value of better than 2:1 VSWR. The "TUNED" LED, which is mounted on the PC board will light, and if there is a remote "TUNED" indicator, it will also light.

Next the SSB transmitter should be adjusted to the *lowest* desired frequency, and the test as outlined above should be repeated. The SG-230 should immediately sense the mismatch, and switch to the tune mode to retune the antenna system. Since the algorithm must search through more possible values of L and C to find an appropriate combination at the lower frequencies, the tune cycle may take longer. A few spoken words should achieve an "all tuned" indication. The SG-230 installation and tune-up is considered complete if the above tests have been successfully performed.

The SG-230 will probably not be supplied from SGC with memory data appropriate to your installation, and the memory feature may not seem impressive at first. Allow the SG-230 to "learn" your antenna's requirements by proceeding from frequency to frequency and allowing the normal tune-up to occur. As the SG-230 computer memorizes more and more frequencies, you should then be able to return to a previously tuned frequency and find that the coupler immediately responds 'ALL TUNED', even before the first word is completed. The memory system is capable of storing hundreds of individual frequency/relay combinations, mostly in the lower operating frequencies. This provides better memory resolution at the lower frequencies where antenna systems are inherently narrow band. Usually, only one or two memory positions are needed to provide satisfactory coverage at higher frequency bands.

### **8.1 COUPLER CONFIGURATION**

Schematic Q30101200, page 1 is the schematic diagram of the two basic coupler networks. Note that the "L" network as viewed from the generator, may be configured as either "C in" or "C out", whichever is required by the load. In either case, the end of the network containing the shunt C element will be the HIGHER impedance end of the network.

### **8.2 SCHEMATIC DIAGRAMS**

Schematic Q30101200, pages 1,2 ,3 and 4 are the schematic diagrams of the antenna coupler. RF input is applied to UHF fitting J1, 13.6 VDC is connected to the terminals marked - and + on TB1, and an appropriate antenna and ground system are connected to feed through insulator and stainless steel stud respectively. The "ALL TUNED" flag line on TB1 is connected to the remote indicator device if used.

### **8.3 TUNING PROCESS**

There is an array of detector devices in the SG-230 which monitor the antenna system impedance, reactance signal and the VSWR load when RF power is applied to the unit. The coupler also monitors forward power, since the control computer requires an indication of both forward and reflected power in order to allow tuning to proceed. The computer uses the forward power detector as a check to ensure that the measurements made are applied RF and are not spurious levels from the data conversion system. The SG-230 will proceed to tune *only* when enough forward power is present to confirm this check. After RF is applied to the coupler array, it then passes through the detector system. The detector system consists of 6 capacitors in shunt on the input arm of the network, arranged in binary increments, 8 inductors in the series arm, arranged in binary increments, and 5 more capacitors in

shunt on the output arm, also arranged in binary increments. Relays are provided in conjunction with each lumped constant and allow removal or entry as desired. A network having 64 values on input shunt C, 32 values of output shunt C and up to 256 values of series L is possible with the manipulation of these 26 relays.

#### **8.4 IMPEDANCE DETECTOR**

RF transformers T1 and T2 drive the impedance bridge which is balanced at 50 ohms. T1 samples the line current and thus D8 outputs a negative DC level proportional to line current. A tertiary winding on transformer T2 provides a line voltage sample to D10 which provides a positive voltage proportional to line voltage. R44 and R46 act as a summing network for the current and voltage signals, with ratios chosen such, that at 50 ohms, the summed signals result in a balanced or zero voltage condition. If the line impedance goes to HIGH, the signal from the *voltage* sensor will be relatively higher than the *current* sensor, which will result in a net POSITIVE output voltage from the summing network. Similarly, a LOW line impedance will result in more output from the *current* sensor, resulting in a net NEGATIVE output voltage from the summing network. The summing network output is applied to IC-15A which operates as a ground referenced comparator. Low impedance is indicated by DS2.

#### **8.5 VSWR DETECTOR**

A directional coupler is made up of a current transformer T3 and a voltage transformer T2, in conjunction with termination resistors R58 and R63. The coupler is inserted in the 50 ohm transmission line between the input connector, J1, and the tuning network. The FORWARD power is measured across termination R63 and REFLECTED power is measured across termination R58. Diode D11 generates a positive DC voltage proportional to FORWARD power and D12 generates a positive DC voltage proportional to REFLECTED power. The FORWARD DC output is fed to a voltage divider consisting of R52, R54 and R62. These voltages are input to the FORWARD detector and the inverting input of the 4:1 and 2:1 VSWR comparators, IC-15B and IC-15C, respectively. The REFLECTED DC output is input to the non-inverting input of both the 4:1 and 2:1 VSWR comparators. With the VSWR less than 2:1, both comparator outputs will be low. If the voltage at the non-inverting input is higher than the voltage set by the voltage divider, the comparator output will go high, indicating a VSWR higher than 4:1 or 2:1, and will light display indicators, DS3 and DS4. Note that the full output from the FORWARD power detector is connected through transistor inverter Q4 to IC-3C, a CMOS gate connected as an inverter. It is permissible to eliminate a comparator on the FORWARD sensor line since this signal is typically much larger in

amplitude than the output signals from the summing network. Forward power is indicated by DS6.

### **8.6 PHASE DETECTOR**

A phase detector is formed by T1, A1 and their associated components. This detector indicates the state of any reactance associated with the antenna coupler as noted from the generator. A line current sample is compared in phase with a voltage sample in a double balanced mixer. Output polarity is positive for a net capacitive reactance. The output of the phase detector A1, is connected to comparator IC-15B, which goes high when the line reactance is inductive and is indicated by DS5.

### **8.7 THE CONTROL DEVICE (CPU -CENTRAL PROCESSING UNIT)**

A tune-up algorithm, which is contained in the memory of the computer system, actually implements the antenna matching. The computer is designed around the CMOS MC146805E2 CPU which features a versatile instruction set and on-chip timer and RAM. The antenna coupler relays are controlled through 1C9, a MM5480 decoder/driver. The MM5480 is used as a serial to parallel interface port, and the clock and data inputs of the MM5480 are driven from CPU ports PA1 and PA0, respectively. During operation, data is transferred into the CPU under program control from the array of sensor/comparators. Basically, the program monitors the status of the input sensors and starting from a preset condition baseline, manipulates the RF elements through its control algorithm which results in a correctly tuned condition. When the tuning algorithm is complete, the computer creates a table in non-volatile memory which correlates the status of the various network relays with the applied RF frequency. This table is stored in EPROM 1C8 and is the basis of the exclusive *learning* feature of the SG-230. After it has stored and latched the network status, the CPU returns to the "STOP" mode and waits for another "TUNE REQUEST" condition. When a "TUNE REQUEST" is received, the first step in the control algorithm is to measure the frequency of the signal which has generated the request. From the frequency data, the computer then searches the table stored in 1C8 for any frequency/network status which may be stored. If data is found, it is tested for validity, and the required "end of tune" conditions will be sensed by the RF sensors. Then the data will be latched in place, and the CPU will again return to the "STOP" mode. This process takes about 20 milliseconds, which is the same length of time that is required to close the network relays.

### **8.8 INITIALIZATION**

The microcomputer is usually in the STOP mode and requires an interrupt signal (IRQ) to start program implementation. The IRQ is obtained from the RF sensor



network as follows: The positive output from the FORWARD power detector is buffered through Q4 and IC-3C and applied as a positive logic "1" to NAND gate IC-4C. The resultant output to NAND gate IC-4C is logic "0". This output, which is directly connected to the IRQ request input of the CPU, will activate the computer and after the initialization process, begins to implement the control algorithm tuning.

## 8.9 INFORMATION READ

The data sensors are interfaced with the CPU through input ports PA3 through PA7. After an IRQ, the tune algorithm program can access any desired variable by simply searching for the desired input port (lacking any applicable pre-stored data). Since the comparators effectively preprocess the desired data, to read any specific variable, the CPU need only look at the required port for the desired variable.

## 8.10 STORING MEMORY

When it is necessary for the associated RF tuner parameter to be changed, it writes the desired data into the series to parallel buffer, 1C9. This is done by out-putting the desired status of the network relays in a serial data stream from PA0 on the CPU. Clocking is derived from PA1. If, for example, it is desired at some time in the tune-up sequence to *increase* the inductance by one binary increment, the CPU examines the binary number representing the status of the L control relays, decrements that number by one and clocks that number, one bit at a time into the register in 1C9. In order to *increase* the inductance, it is necessary to *decrease* the binary number in the CPU register. A data 1 equals a CLOSED relay which in turn, equals a shorted conductor. Similarly, the CPU is able to manage the bits which control the input and output C banks.

## 8.11 OPTIONAL SMARTLOCK

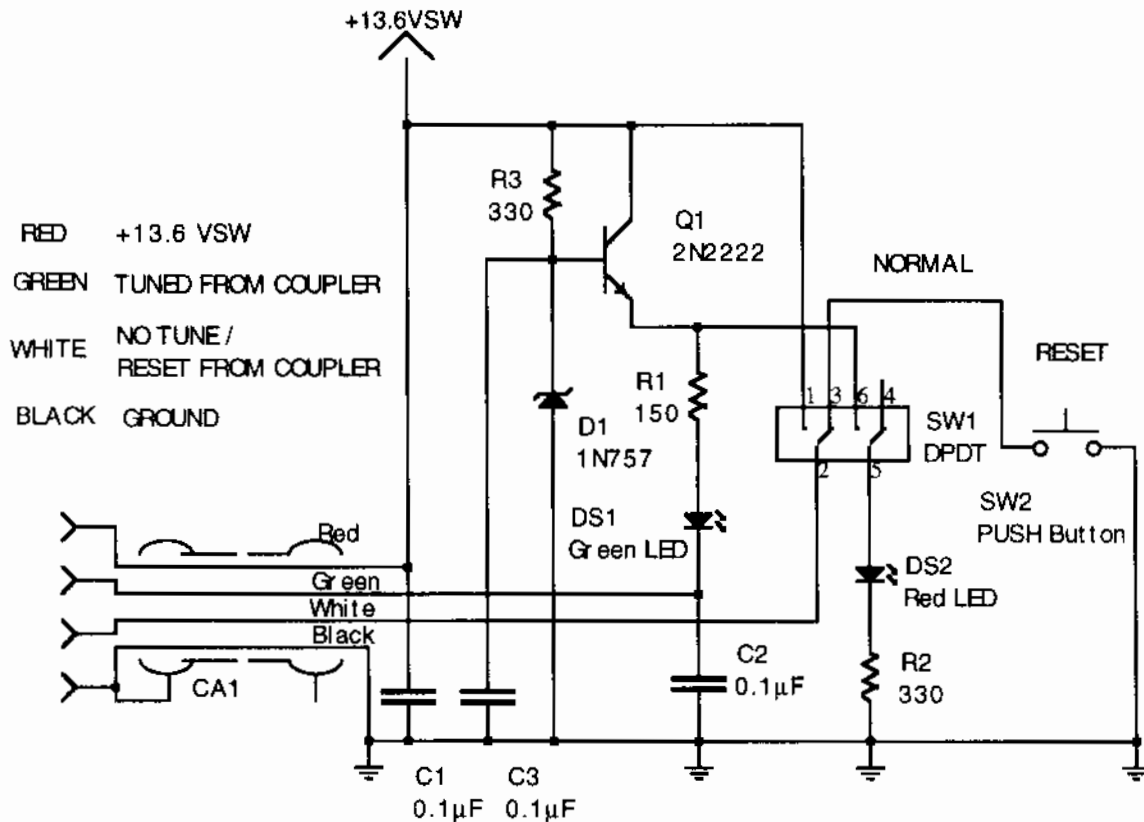
Beginning with Revision T of the SG-230 product, an additional control line, Red with White trace, was added. This wire normally floats - in other words, it is not connected to anything. When this wire is connected to a ground momentarily, the coupler is caused to reset and go through its tuning sequence again. When this wire is connected to + 12 VDC, the coupler is locked, preventing operation with any other tuning solution until the +12 VDC is removed from this wire.

SmartLock - SG-230 Smarttuner connections:

Red	-	Red wire (+12 VDC)
Green	-	Black/White wire
		<b>Remote tuned indicator line</b>
White	-	Red/White wire
		<b>Tuner lock/reset line</b>
Black	-	Black (Ground)



## OPTIONAL SMARTLOCK SCHEMATIC DIAGRAM



### 8.12 BYPASS OPERATION, JUMPERS

The SG-230 may be bypassed for broadband (untuned antenna) scanning listening. All you need to do is remove power from the Smartuner for 2 seconds and reapply power. When the coupler comes back on, the tuning elements remain out of the circuit until the Smartuner is activated by a *transmitted* signal.

If broadband operation is required during receive for scan operation, jumper J-2 may be set to the "YES" position. This will drop the tuning elements out of the circuit on receive only. Jumper J-2 is located adjacent to IC-7 on the printed circuit board. If you open your Smartuner to access this jumper, please use caution to insure that the waterproof seal is carefully placed prior to refitting the coupler cover.

Setting J-2 to the "YES" position is recommended if you are using a radio for split band communications, scanning selective calling protocols or for ALE (Automatic Link Establishment). The default is: TUNING ELEMENTS OUT ON RCV: [no].

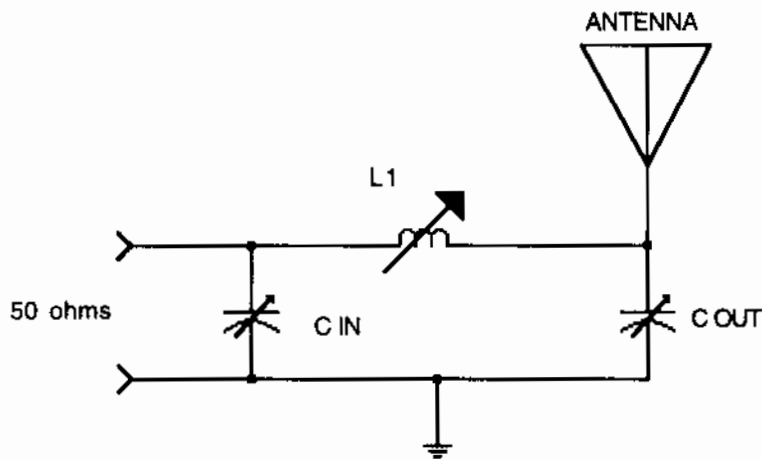
Jumper J-3 bypasses the coupler's memories. This means that each time the coupler is used on a substantially different frequency, it will retune rather than use previously stored information. The default is TUNE FROM MEMORY: [yes]

# SG-230 MicroTune™ Software

Copyright November-1991

## 9.0 GENERAL DESCRIPTION

The SG-230 MicroTune™ Software is unique software which allows fine and precise tuning of the digitally controlled  $\pi$  & L network antenna coupler configurations.



The versatile MicroTune™ software offers its' user these very special functions:

1. The coupler is activated whenever forward power is present.
2. In addition to sampling VSWR to determine if the coupler should re-tune, frequency comparison is employed. This causes the coupler to tune whenever the transmit frequency changes independent of the VSWR reading.
3. Extensive tuning algorithms are used to test and verify different antenna situations. Initially, the first tuning cycle will require several hundred milliseconds. Any further tuning is accomplished in a matter of milliseconds when recalled from memory.
4. Facilities and algorithms are used, which enable accurate tuning at the low end of the frequency band, and the use of even shorter antennas than previously possible.
5. The BITE (Built-In-Test-Equipment) Indicator Tune LED includes a safety feature which alerts the operator to a mismatched condition, via blinking indicators, when proper tuning conditions have not been met. In this situation, the software will "time out" within 20 seconds unless a new



frequency is sensed, which will cause an immediate time out, and the coupler will attempt to match the new frequency.

The sophisticated MicroTune™ software of the SG-230 enables precise tuning of the coupler components and tuning of a wide variety of antennas.

The microprocessor of the coupler is turned on every time that the coupler has forward power. However, re-tuning takes place only if the VSWR is greater than 2:1, or if the frequency has changed. Upon initiation of the tuning, one of the five tuning paths is selected for the initial tuning, depending on the condition of the tuning indicators.

## 9.1 PROGRAM DESCRIPTION

When DC power is applied, the computer initializes the processor registers in accordance with the hardware. All tuning elements are then removed and the 'tune' indicators are turned off. At this time the computer reverts to a "sleep" mode awaiting RF power.

When RF power is verified, the computer will perform a test to verify forward power is present. If no forward power is detected, the computer will revert back to the "sleep" mode.

Once forward power is detected, the current transmit tuning element data is sent to the relays and the VSWR is checked. If the VSWR is greater than 2:1, the program branches to the 're-tune' selection. If the VSWR is less than 2:1, the current frequency is compared to the most recent frequency employed. If a difference in frequency is detected, the program again branches to the re-tune program. If it is determined that the VSWR is less than 2:1 and the frequency has not changed, the computer returns to the "sleep" mode.

Once it is determined that re-tuning is necessary, a test is made to see if 'J3' is set to tune from memory. If the result is re-tuning from memory, the frequency is measured and tuning data is recalled from the memory based on the frequency measured.

The recalled data is then tested for validity. If the data proves invalid, it is bypassed and re-tuning is performed. If the data recalled proves valid, the data is sent to the relays and the VSWR is checked. If the VSWR is less than 2:1, the program branches to the "OK Tuned" section of the program. If the VSWR is found to be greater than 2:1, the program branches to the "re-tune" program.

Several tests are made to determine which tuning algorithm or path should be used to tune the coupler. These tests are based on frequency, antenna input impedance, antenna phase, and VSWR. Numerous sub-routines are executed repeatedly,

depending on the status of the criteria mentioned above, in order to achieve proper tuning.

Should the initial primary tuning sequence prove unsuccessful, secondary algorithms are attempted until all possible routines have been exhausted. If, at this point, an acceptable VSWR has not been achieved, the coupler status acquisition time is increased, and the tuning process is repeated.

If, after the second attempt, the coupler still cannot achieve a proper VSWR, the program branches to a "no-tune" program. Here, the tune indicators will blink on and off, all tuning elements will be removed, and the coupler will go into a 20 second time delay. During this time delay, the transmit frequency is monitored. Should a change in frequency occur, the coupler will revert to the beginning of the interrupt segment of the program and attempt to tune the new frequency.

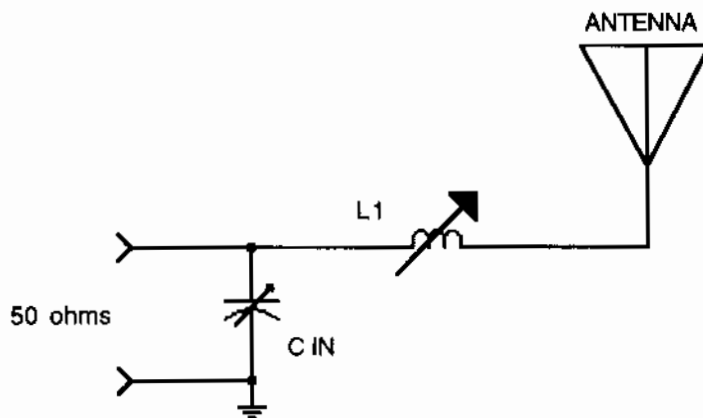
If the coupler achieves a good VSWR during the tuning sequence, the program branches to the "OK Tune" section of the code. Here, the tune indicators are engaged. A test is then made to check if 'J3' is set to tune from memory. If so, the frequency is measured and the tuning elements used are saved in memory coupled with a verification code.

Once saved, a test is made on 'J2' to check if the duplex mode has been selected. If so, the transmit tuning elements remain in circuit until the receive mode is verified. At this time all tuning elements are removed.

The current frequency is then saved for future comparison and the computer reverts back to the "sleep" mode.

## **9.2 TUNING ALGORITHMS OR PATHS**

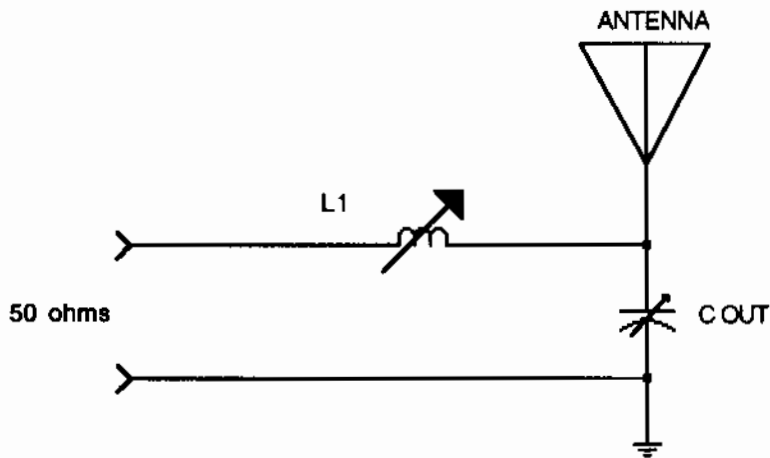
As mentioned previously, various tests are executed to determine the most logical tuning sequence to be performed. Dependent on the test results, additional tests and appropriate sub-routines are executed throughout the tuning process. Following are examples of the activity that occurs when the coupler must be matched to a frequency that requires a slightly longer or shorter antenna:

**9.3 ANTENNA TOO SHORT**

Once the coupler has verified RF power, the tuning sequence proceeds as follows:

1. Series inductance is added until the phase is deemed as being inductive. At this point it is normal for the input impedance to be low.
2. Input capacitance is added until the antenna is no longer inductive.
3. Tests are conducted continuously on the VSWR phase and input impedance. As long as the VSWR is greater than 4:1, the program will continue to increment the series inductance in .25  $\mu$ h steps - each time normalizing the input impedance with input capacitance.
4. When the VSWR goes below 4:1, the computer will retain the data it determines is less than 2:1 until input impedance is no longer low or VSWR climbs higher than 2:1. The previous data is then tested once again to verify validity.
5. At this point the tune indicators are engaged. The current relay data is saved if 'J-3' is set to tune from memory, and if 'J-2' is set to the tuning elements out during receive position, the program waits until forward power is no longer present, then removes all tuning elements. The current frequency is saved for future frequency comparison, and the computer reverts back to the "sleep" mode.

## 9.4 ANTENNA TOO LONG



Once the coupler has verified RF power, the tuning sequence proceeds as follows:

1. Output capacitance is added until the input impedance test results are low.
2. At this point, the antenna will be capacitive. Therefore, series inductance is added until the antenna is no longer capacitive.
3. Fine tuning is performed by trying a small amount of input capacitance (this may or may not be required).
4. At this point, the program executes the "OK Tuned" sequence, reacting to 'J-3', 'J-2', etc., eventually reverting to the "sleep" mode.

The preceding gives a simplified overall program flow on only two possible antenna conditions. Much more complex tuning is normally the case. Further detailed description, however, is beyond the scope of this publication.

The actual program is copyrighted and is not available.

## 9.5 J-2 - TUNING ELEMENTS OUT DURING RECEIVE

(FACTORY DEFAULT SETTING: NO)

- YES** In this position the software will retain data required in transmit to match the coupler while removing all tuning elements when no forward power is detected.
- NO** In this position the coupler will retain the required tuning data and will not change anything whether in receive or transmit.

If typical operation is out of band duplex, "YES" would be most likely to give better performance. If in band operation is typical and duplex or simplex is the predominant mode of operation, then 'NO' is usually the better choice.

### **9.6 J-3 - TUNE FROM MEMORY**

(FACTORY DEFAULT SETTING: YES)

**YES** In this position the coupler will recall data previously saved and try this data before attempting to re-tune. If the data is valid and the VSWR is less than 2:1 the tune is done. In this position the coupler will save any new data in its' memory for any frequency. A new frequency must first be learned, while in this mode, before it can be recalled.

**NO** In this position, the coupler will not use previously saved tuning data. Each time a different frequency is selected the coupler will proceed through a complete tuning sequence.

Clearly, the advantage of "YES" is speed. The coupler will seem to be matched instantly when in this position, if the frequency being used has previously been memorized in this mode. Obvious disadvantages include a difference in frequency too small for the computer to detect. This would result in recall of valid data that may not necessarily present the best match.

It is suggested to start with 'J-3' in the "YES" position. If operation is as expected, don't change it.

- Note: You cannot re-tune any information from the memory if the memory has not been previously loaded. The memory can be loaded only in the 'YES' function.





## 10.0 TROUBLESHOOTING THE SG-230 - GENERAL

There are only a small number of installation mistakes which can be made. These will fall into one of several categories: Ground fault, cable fault and antenna fault. There is also a slight chance of an electrical fault in the coupler, but the odds of this happening to your coupler are many times smaller!

### 10.1 THREE SOURCES OF TROUBLE

When you are troubleshooting the SG-230 and you understand that there are three variables, you should change each variable, in sequence to determine where the problem lies. If you change the ground, antenna or supply voltage, you are bound to change the performance of the coupler.

### 10.2 GROUND FAULTS

The key problem encountered here is when an installation has been made without a proper counterpoise. If the counterpoise is electrically smaller than the antenna, the system may load "upside down" - where the antenna acts as the counterpoise and the counterpoise radiates. When this condition occurs, the operator may encounter "RF Bites" from touching metal objects connected to the counterpoise.

A second kind of ground fault occurs when the decision whether the ground or the antenna should radiate is very difficult. When this condition is encountered (usually at a frequency where the counterpoise is near resonance) the coupler may cycle repeatedly. This condition may be addressed as follows:

1. You may give short bursts of CW and when the coupler stops in a tuned condition, as indicated by the remote LED, you may invoke the SmartLock control line (applying +12 VDC to the Red/White wire) thus forcing the coupler to retain correct settings.
2. You may simply change the ground system so that it becomes larger than the antenna at the problem frequency.

The third kind of ground fault which we encounter is when a ground system and an antenna have very different electrical resistance. This happens when you install a very conductive copper antenna wire in an aircraft. When the fuselage is used as a counterpoise, the aluminum must be *much bigger* than would a copper ground because the internal resistance of aluminum is significantly higher than copper.

By the way, this is why we don't like to use aluminum ground wires as radials. Remember that when aluminum is used in house wiring, several gauges larger are needed to carry the same amount of current. The same applies here.

The fourth kind of ground fault you may encounter is where the ground is not properly bonded to the coupler. We go to considerable effort to make sure the stainless steel ground stud is well connected to the coupler. In fact, we go so far as to use large braid on the inside of the coupler.

Particularly in automobiles and aircraft, a single ground connection will not do. It is mandatory that at least two ground bolt connections are used.

The fifth situation to check for is what we call "*dangerous assumptions*" about the ground system. One example is when water pipes are used. When you bond from the antenna coupler to copper or iron water pipes, you might make an assumption that the water pipes are a good ground. But in many installations, copper pipes are used in the building but a plastic main connects to the municipal system just outside the service entrance. So much for a good ground!

### **10.3 ANTENNA FAULTS**

The key to getting the most out of your Smartuner is to realize the antenna begins right at the ceramic feed through insulator on the SG-230 case. In other words, this is the feed point of your antenna system. Failing to install your coupler accordingly will result in unsatisfactory operation. With this concept in mind, let's review some of the common troubles which you can easily avoid with a properly planned installation.

1. Coax on the output is probably the single most commonly asked question about the coupler and is the most misunderstood. Let us reiterate: The Smartuner was not designed to feed a piece of coax. What is coax? Well, to some installers it is an easy way to get RF signals from one place to another. But from the Smartuner's view, it is a high capacitance shunt to ground! Every foot of coax represents 29 pico Farads of capacitance. 29 pico Farads to ground may not sound like much, but when you are dealing with RF, a small capacitance can represent a large loss.

2. Stray ground capacitance is the next largest cause of malfunctioning installations. If you have a long lead wire from the coupler to a feed through (on a wall or bulkhead), you significantly increase your chance of problems. Wire running parallel a grounded surface may represent a significant capacitance to ground and, just like with coax, this will cause problems.

To give you an idea how these two points can cause problems let us relate an incident which happened in late 1992. We had a Smartuner user who had a coupler installed in a mobile ham radio installation. The customer's coupler could not find

a lock on several bands. After going through his installation carefully, he called SGC for technical support. This user was nearing wits end.

What we discovered, in working through this logical troubleshooting process with him, was that he had used coaxial feed line from the insulator on the coupler to the antenna feed point. Because he had read about the dangers of capacitance to ground in an earlier edition of this manual, he did not have the coax shield grounded. We had him remove the ungrounded braid and the installation began to work just great!

It is experiences like this which have taught us time and time again to be fanatical about using the shortest possible wire and no coax on the output of the coupler.

Another key lesson here is that even if you have a low capacitance lead, a high capacitance antenna will not work well. If you have a whip type antenna, mounted on the back of a van, you will have a large portion of the antenna running right next to grounded sheet metal. This causes a very high loss to ground. This is one reason why we do not recommend CB type whip antennas. The other reason is the base insulation in ball mounts is inadequate for everything but extremely low power.

3. Long lead lines are the next problem. If you have a Smartuner feeding a 9 foot antenna with a one foot feed line located inside a hull or inside a vehicle, you have 10% of the antenna where it will do you no good. If you have more than 5% of the antenna inside a grounded cabin, you will begin to lose performance.

A good rule of thumb is that under one foot of feed line is a good installation, one to two feet aren't very good installations and over two feet, you are asking for trouble.

4. The next category of antenna fault is what we call the "odd reactance" problem. Although the Smartuner is an exceptionally well designed product, you may from time to time find an antenna length which just won't work quite right. Generally this occurs when the Smartuner is having a tough time making up its mind about which of two tuning solutions is best. If it is a very close call, you can have an antenna which causes cycling and just won't stay locked.

The solution in these kinds of cases is to add or subtract a couple of feet of wire from the antenna. This generally cures the problem.

As part of your check out of an HF system, you should operate on all channels and frequencies which you plan to use on a regular basis to insure the coupler and antenna which you have provided work well.

5. Sporadic operation may be caused by poor antenna insulators. We have seen, on sailboats for example, people trying to save money by expecting the fiberglass hull to act as an insulator and not use a lower insulator. The hull is not a good insulator and a thin layer of wet salt water will degrade a ground. Another example

is where mobile HF users rely on a poor quality ball type mount. These are especially prone to arc over inside the ball mount where it is difficult to detect.

The point we are making here is simply this: You should have a leakage path of 2 inches at all points on your antenna and especially in the area of the feed point. This is because 10,000 to 30,000 volts of RF energy will not be adequately confined by inexpensive insulators.

#### **10.4 TRANSMITTER FAULTS**

There are some problems which are quite vexing and which don't relate directly to the antenna or the ground system, but which may cause a problem. Let's discuss two of the most common types:

1. The transmitter may have a tendency to oscillate. The general symptom is that the coupler will work well with another radio but will not tune correctly when the desired radio is in place. The coupler finds a tuning solution, as indicated by the remote tune indicator going on, but then resumes hunting. In a majority of cases this will be caused by an overly sensitive transmitter final amplifier section or by inadequate shielding around the amplifier. We know of several radios, which oscillate relatively easier than most radios, which are built using a plastic case. Plastic cases are not an adequate shield for serious RF components! In some of these cases, putting grounded foil around the radio, or changing the radio location and orientation has changed the symptoms. But the bottom line in this kind of situation, is simply this: If you want real good performance, select a real solid radio such as the SG-2000.

2. Power supplies have been known to cause problems for HF users because they change voltage when the load on them changes. The point here is that if the transmitter is drawing heavy current, as transmitters do when they are running at peak input power, the voltage to the antenna coupler may change enough to cause the coupler to either drop into a reset mode (under 11 VDC being present) or, the transmitter final amplifier impedance may change greatly, thus changing the tuning solution.

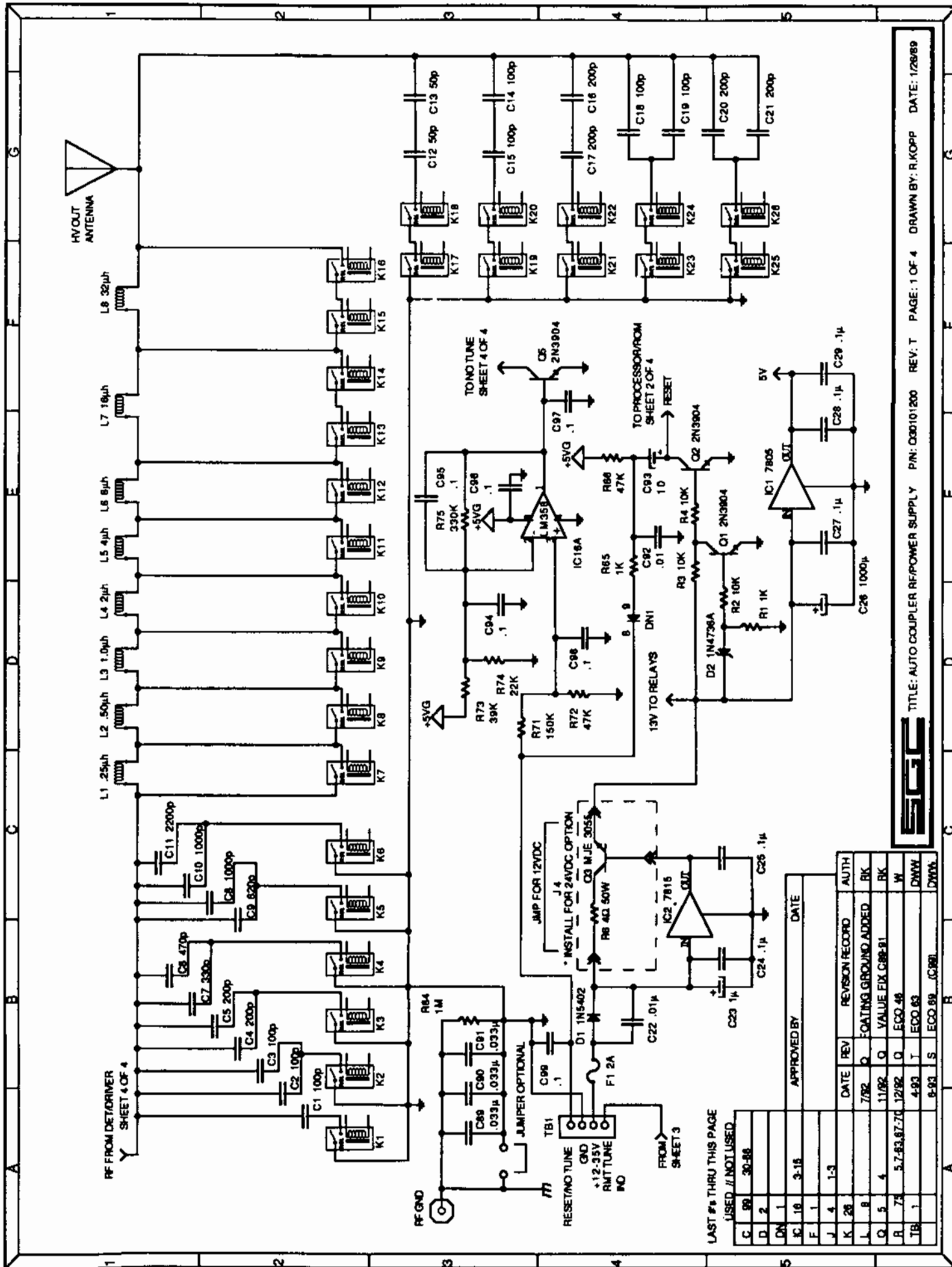
To alleviate this condition, remember to use a power supply which has both adequate current handling capacity and also good dynamic regulation. Better yet, use a regulated power supply of an adequate rating.

#### **10.5 A FINAL POINTER ON TROUBLESHOOTING**

Remember that the SG-230 is an excellent piece of equipment which will give outstanding performance. If you have a problem with the coupler finding a tuning solution, you should *change one variable at a time*.

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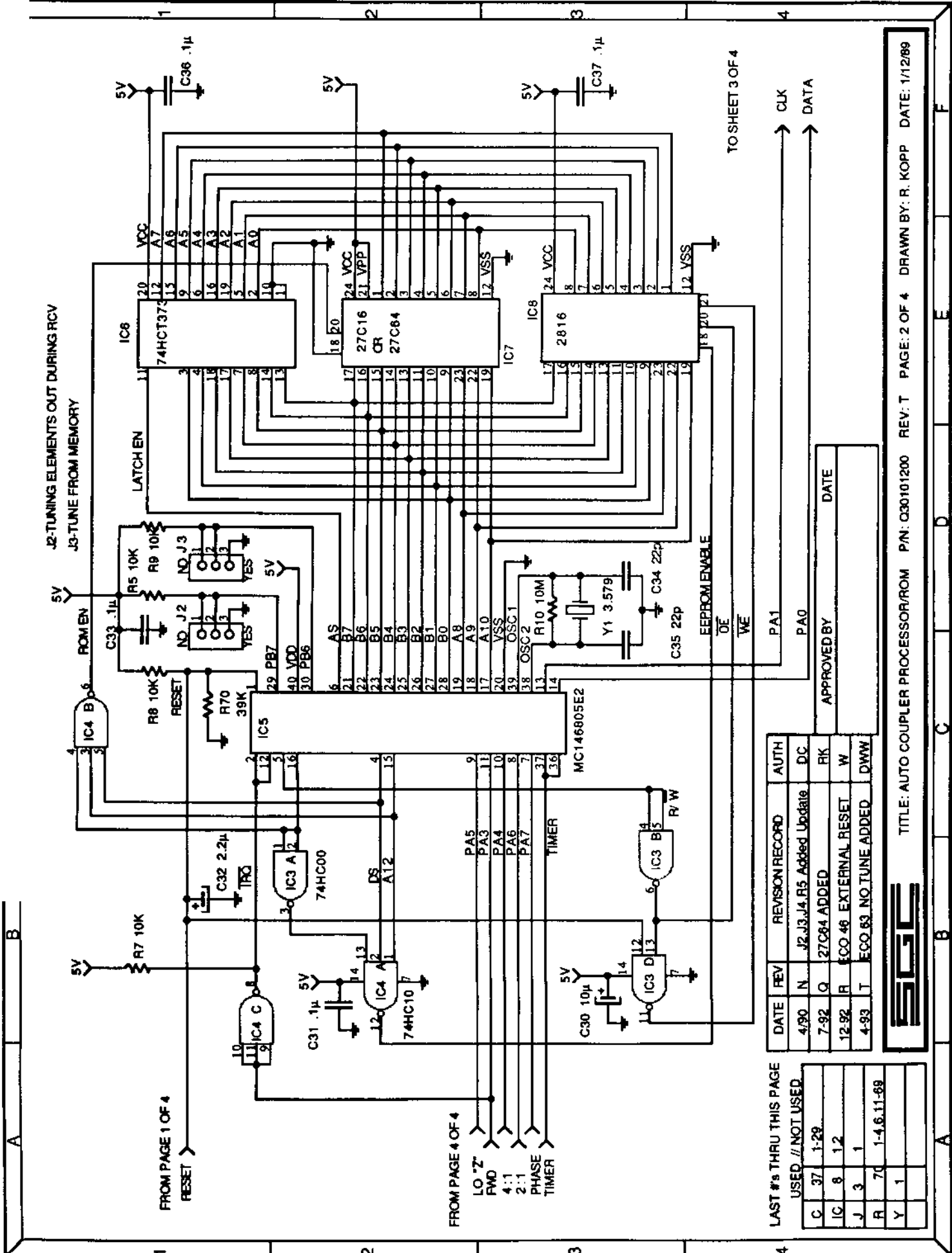
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IC	16	3-15
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R	75	5-7-83, 87-70, 12/92
TB	1	4-93 T, ECO 83, 8-93 S, ECO 99, (C98)

APPROVED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

DATE	REV	REVISION RECORD	AUTH
7/82	Q	COATING GROUND ADDED	BK
11/92	Q	VALUE FIX C88-81	BK
5-7-83, 87-70, 12/92	Q	ECO 46	W
4-93 T, ECO 83, 8-93 S, ECO 99, (C98)	T	ECO 83	DWW
	S	ECO 99, (C98)	DWW



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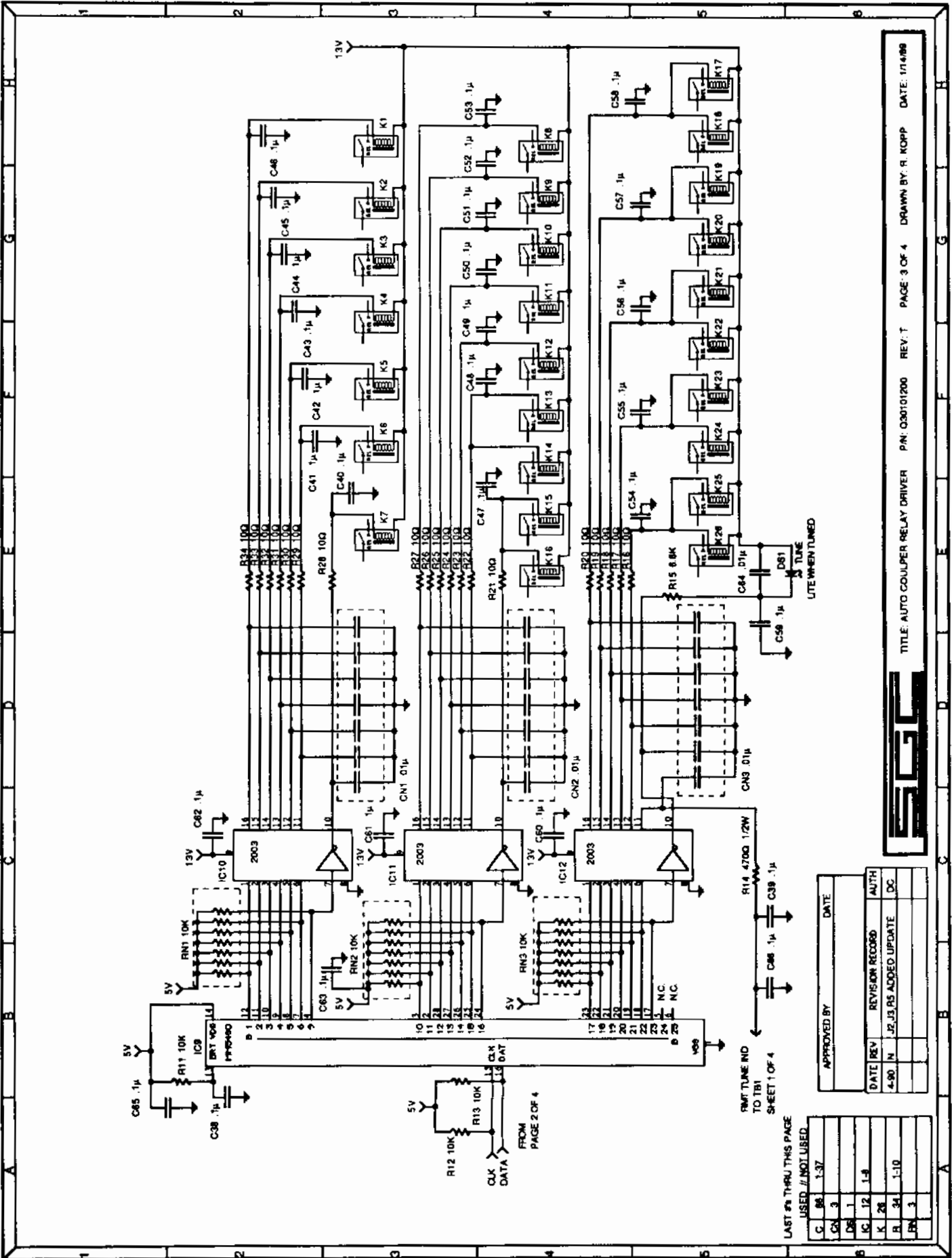
DATE	REV	REVISION RECORD	AUTH
4-90	N	J2, J3, J4, R5 Added Update	DC
7-92	Q	27C84 ADDED	RK
12-92	R	ECO 46 EXTERNAL RESET	W
4-93	T	ECO 63 NO TUNE ADDED	DWW

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C 37 1-29		
IC 8 1-2		
J 3 1		
R 70 1-4.6.11-89		
Y 1		



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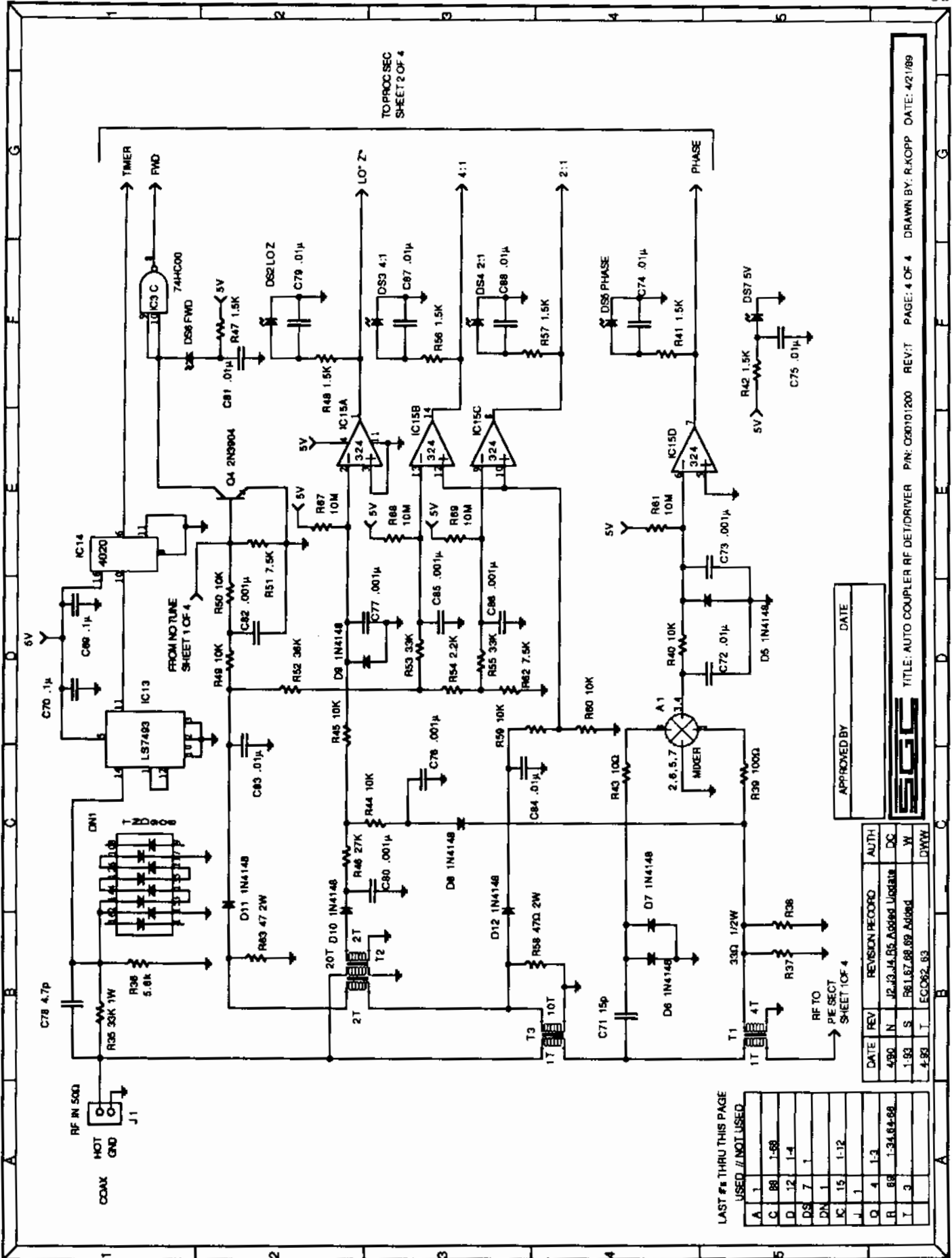


DATE	REV	REVISION RECORD	AUTH
4-90	N	J2, J3, R5 ADDED, UPDATE	DC

APPROVED BY	DATE

TITLE: AUTO COUPLER RELAY DRIVER P/N: Q30701200 REV: T PAGE 3 OF 4 DRAWN BY: R. KOPP DATE: 1/16/89





TO PROC SEC SHEET 2 OF 4

FROM NOTUNE SHEET 1 OF 4

APPROVED BY \_\_\_\_\_ DATE \_\_\_\_\_

DATE	REV	REVISION RECORD	AUTH
4/90	N	J2,J3,J4,R5 Added Update	DC
1/93	S	R6,R7,R8,R9 Added	W
4/93	T	EC062, 83	DJWW

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D	12	1-4
DS	7	1
DN	1	
IC	15	1-12
J	1	
D	4	1-3
R	88	1-34, 64-88
T	3	

TITLE: AUTO COUPLER RF DET/DRIVER PIN: 060101200 REV: T PAGE: 4 OF 4 DRAWN BY: R.KOPP DATE: 4/2/89

9 FT. HIGH PERFORMANCE HF SSB ANTENNA FOR MARINE AND MOBILE USE

# MODEL SG-303

(SGC Part Number 55-27)

## DESCRIPTION

The SG-303 is designed for high radiating performance and operates in the HF SSB range of 2-30 MHz. The SG-303 provides reliable long range communications and its' short length permits communication while the vehicle is in motion (60 MPH, 100 KPH speed maximum). The antenna must be used with an antenna coupler (SG-230 or any coupler with similar specifications).

## SPECIFICATIONS

1	Maximum input power:	150 watts PEP or CW
2	Operating range:	2-30 MHz
3	Primary loading resonance:	11 MHz
4	Secondary loading resonance:	22.0 MHz
5	Mounting:	High voltage, 4-way ratchet
6	Ratchet mount material:	Stainless steel
7	Maximum vehicle or boat speed:	60 MPH/100 KPH when antenna is erected
8	Radiation:	Omnidirectional
9	Total maximum weight:	6 pounds
10	Maximum total height:	9 feet
11	Maximum shipping length:	4.5 feet

## ITEMS SUPPLIED:

- 1 Loaded 8 ft. whip antenna (in two sections of 4 ft)
- 2 High voltage insulated 4-way ratchet mount
- 3 Special SGC heavy duty base spring
- 4 3 ft. high voltage wire, one end terminated by a round lug
- 5 High voltage wall feed-through bushing (hole  $\varnothing = .890$  inch)
- 6 3 ft. 3/4 inch wide ground strap for coupler grounding
- 7 Antenna tip hook
- 8 Lug to connect high voltage wire to coupler
- 9 Manual

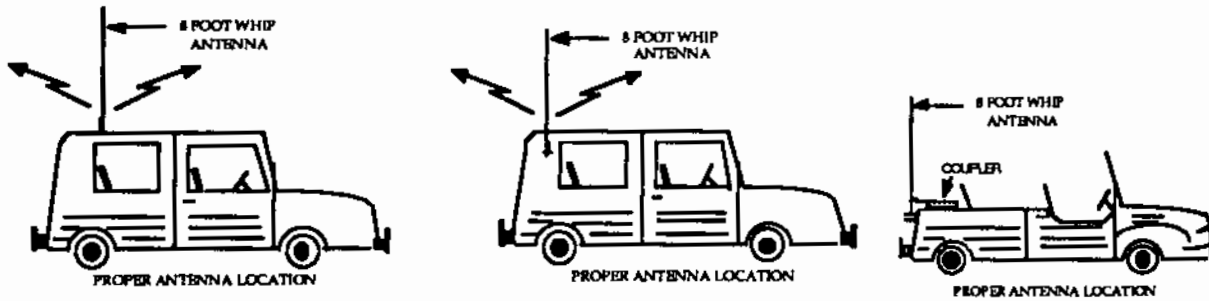
## NOT SUPPLIED AND MAY BE REQUIRED FOR INSTALLATION:

Three braided 3/4 inch wide ground straps, or 3 inch wide copper foil (3 mil thickness) 20 ft. long to connect to coupler ground for fiberglass or non metallic boats or 3 sets of electrical stranded wire, gauge 12, or larger, connected together for each 20 foot ground strap leg.

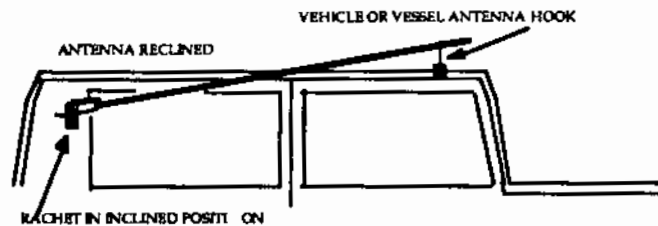
## INSTALLATION - VEHICULAR

Select a protected area in the vehicle or boat to allow proper mechanical installation of the coupler. The coupler must be within 2 feet of the base of the antenna. The SG-303 must be mounted outside on an unobstructed area and at the highest point of the vehicle.

## PROPER VEHICULAR INSTALLATIONS

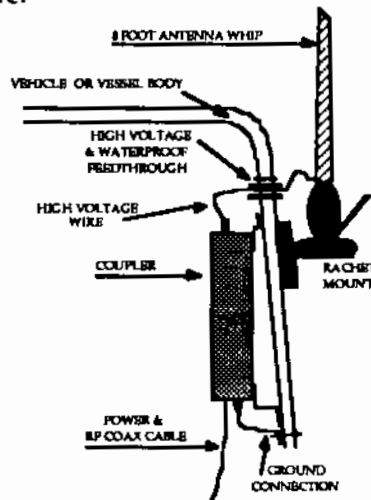


The ratchet mount and antenna tip hook can be used to fold the antenna down when it is not in use (as shown below).



## COUPLER AND ANTENNA INSTALLATION

The high voltage wire which connects the coupler to the antenna base must be at least 2 inches away from any metal structure. Never tie wrap this wire to other wires or to a metal holder. If the high voltage wire is not at least 2 inches away from any metal structure or wires, high voltage arcing may occur, which will damage the coupler and subsequently the transmitter. Mechanically the coupler can be installed in any position. **NOTE:** Any excess high voltage wire between the antenna and coupler must be cut off before attaching the wire to the coupler. The same applies to the ground wire.

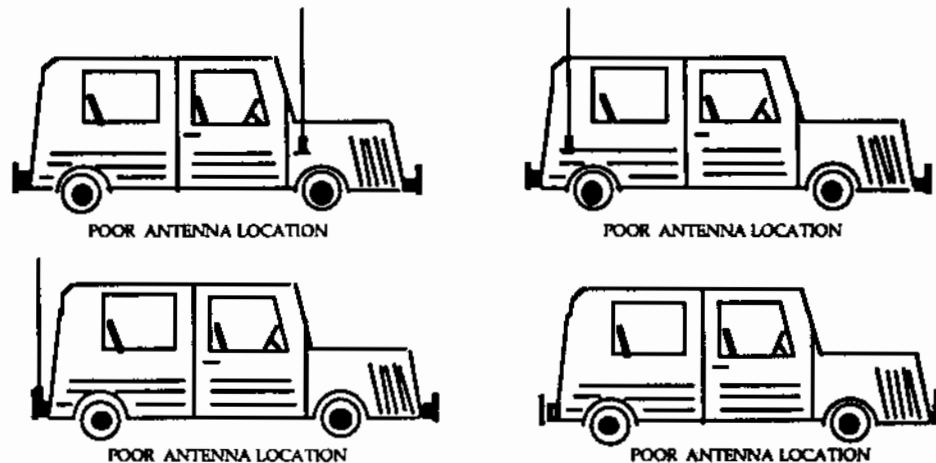


**IMPORTANT:** The high voltage antenna wire must always be at least 2 inches away from any metal structure.

The antenna must be unobstructed. Do not mount the antenna next to the metal body of the vehicle, as shown below. This will severely limit the radiation and the range of communication, and may cause the antenna to arc and damage the coupler and transmitter.

The hole diameter for the high voltage and waterproof feed-through bushing is .890 inches. Install bushing in a location which allows the antenna to be reclined. Routing of RF coaxial cable and the two wires for the 12 volt supply to the coupler is not critical. If necessary, the coupler can be installed as much as 100 ft. away from the radio. These wires can be tie wrapped to any metallic or non-metallic point of the body structure.

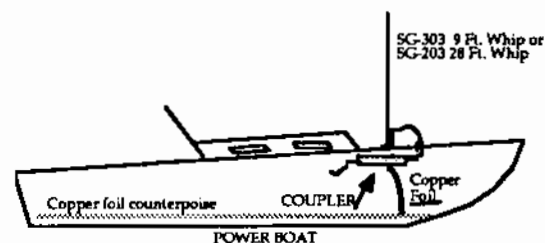
### WRONG VEHICULAR INSTALLATION



The antenna locations in the four illustrations above will provide poor radiation and are not recommended.

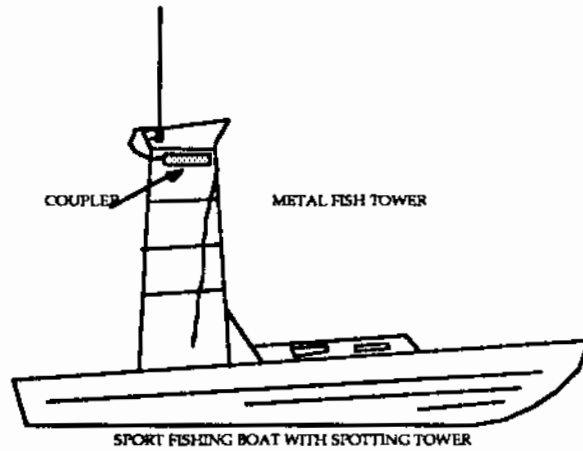
### INSTALLATION - VESSEL MOUNTING

In many cases, when the vessel is limited by space, a short and efficient antenna such as the SG-303 is the best solution for good HF SSB performance. Choose an unobstructed section of the boat to mount the antenna, as shown below.



### SMALL BOAT WITH FISHING TOWER

The 9 ft SG-303 whip can be mounted on top of the fishing tower. If this location is used, then the coupler must also be mounted on top of the tower, preferably in a protected area.



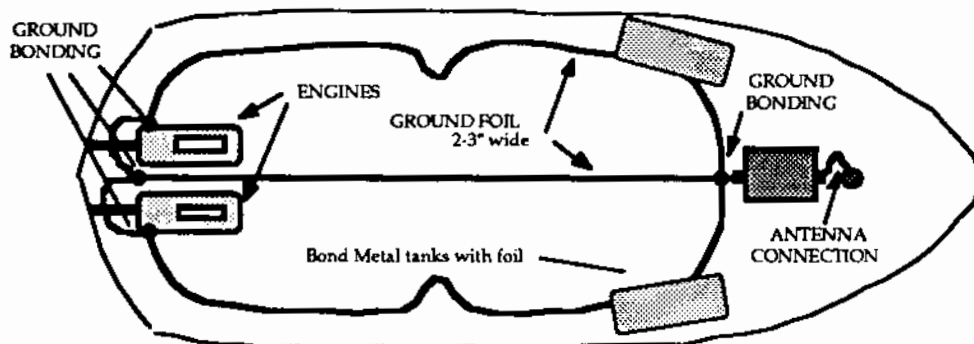
The metal structure of the tower can be used as the ground for the coupler. Make sure that the tower is grounded to the rest of the metal structures of the boat, such as the engine, railing, water tanks, etc. If this is not possible, use three 20 ft. ground straps to tie all the metal structures together (recommended ground straps of 20 ft. each not supplied).

### **SMALL METAL-HULL SPEED BOAT**

Use the metal structure of the boat for ground purposes. Follow the installation instructions of the coupler and the SG-303 antenna as described for the vehicular installation.

### **SMALL FIBERGLASS-HULL SPEED BOAT**

Mount the antenna on the bow. Use 3 ground straps laid in the bottom of the boat with the ends tied on the engine ground to create a proper RF ground on your boat.



All other metal structures in the vessel, such as the engine, railing, stove, metal fuel and water tanks, etc. must be tied and bonded with the ground strap grounding system. In all cases never install the antenna next to a metal structure; it must be at least 2 feet away. Always mount the antenna above any metal structure to provide best radiation and proper operation.

### **FINAL IMPORTANT NOTE**

The SG-303 must be at least 4 feet away from any VHF, CB, GPS, Loran or other antenna system already existing on the boat or vehicle. Also clear rigging by 4 feet.

## INTRODUCTION

SGC's QMS (Quick Mount System) is the newest addition to the many outstanding products manufactured by SGC, Inc. that incorporate the latest technological developments in both design and craftsmanship. Featuring state of the art technology in microprocessor based communication equipment, the QMS represents high reliability backed by over 20 years of communications experience!

NOTE: SGC, Inc. retains the right to change, modify, delete and add to the QMS series at any time without notice)

## QMS (Quick Mount System)

\*We recommend upon removal of the QMS antenna system from it's packaging, that a thorough review and accounting be done of the items. This is necessary to insure that no damage has occurred due to shipping and that all items are accounted for as verified from the packing list as follows:

- One QMS Manual
- One Warranty Card
- One QMS Black Anodized Assembly complete with four straps (each two feet in length)

Note:When the QMS is purchased in a package configuration (ie, QMS-1 or QMS-2), please refer to the SG-230 and SG-303 manuals for their respective packing lists of the items supplied.

## QMS INSTALLATION INSTRUCTIONS

The QMS (Quick Mount System) antenna and coupler system can be mounted in virtually any location convenient to the user. Some consideration may be given, however, to the items listed below:

1. Locate the QMS system as far from the engine as possible. This should reduce interference generated by the engine, spark plug noise, etc. from getting into the antenna system.



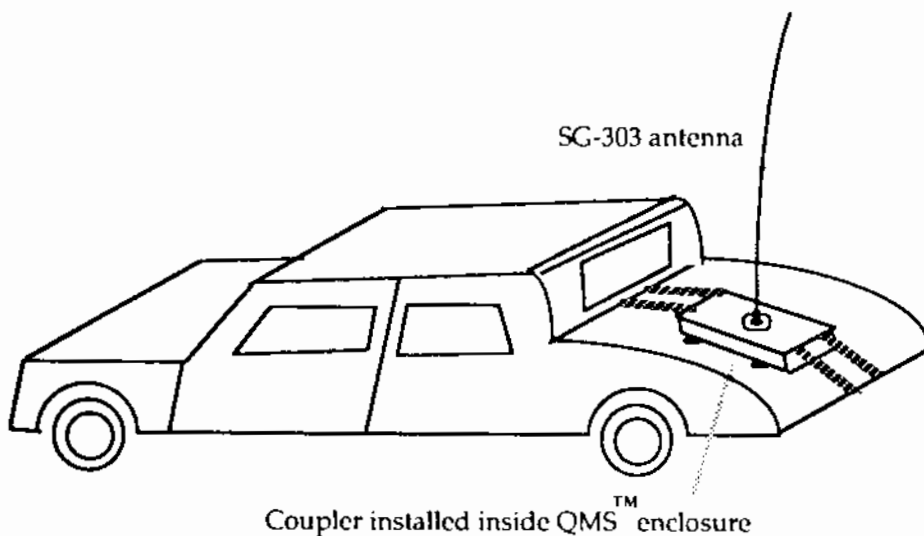
2. If possible, mounting of your QMS in an area clear of objects will reduce the QMS from being damaged. For instance, if driving in rough terrain, the QMS is likely to be hit by trees, stumps, rocks, etc. If the unit were mounted on the back of the vehicle, damage would be less likely to occur than if a side mount was used.

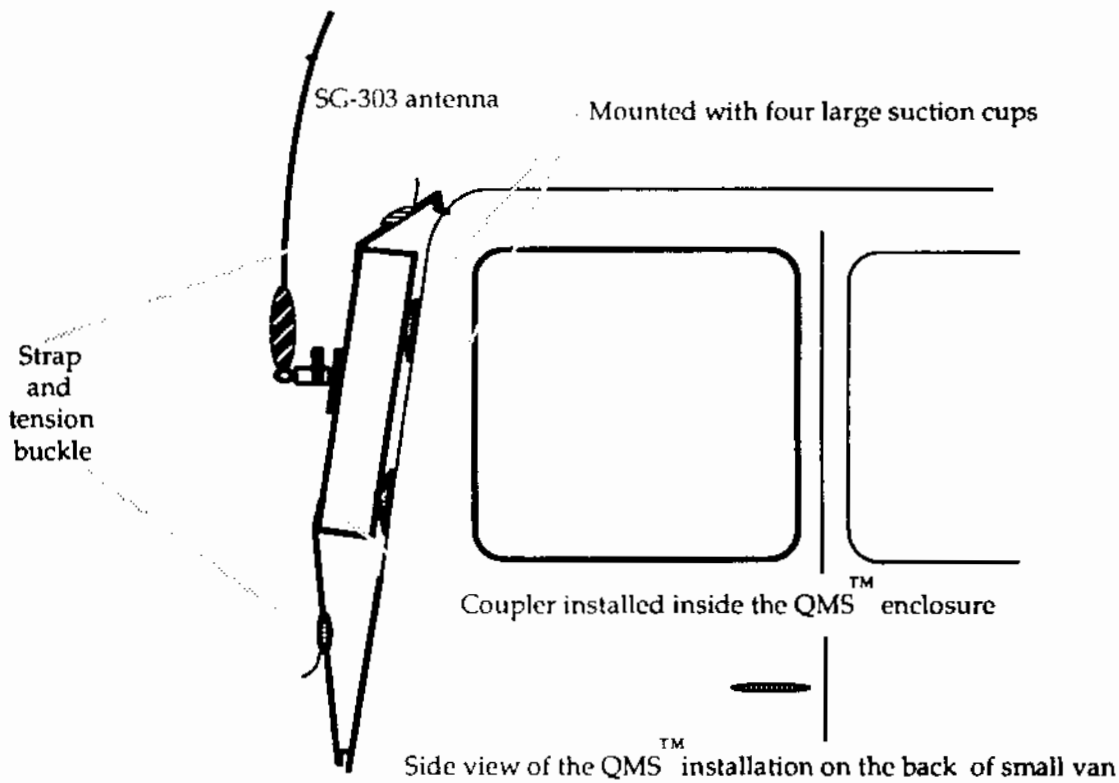
3. If you will be traveling in an area where use of your SG-303 antenna is not feasible, the antenna should be folded down and secured to prevent damage from brush, trees or low structures, etc..

4. Also to be considered is the interconnection to the radio/transceiver. A passage way for a small control cable consisting of an RG-58 coax cable, control wire, power and ground, plus the optional tuned indicator wire will need to be routed to the transceiver.

Note: By removing the four screws for the ratchet mount base of the SG-303 antenna, the mount can be installed or reinstalled to provide the user with the set-up most suitable for his application. Insure the screws are tightly secured if the remounting procedure is followed.

Once a location of the QMS has been selected, mounting becomes a very simple task. The QMS enclosure can be mounted in virtually any altitude and the straps can be moved to either side of the enclosure to accommodate the vehicle (see attached drawings for typical installation).





To insure safe operation of your QMS system, the following installation, mechanical and electrical precautions should always be taken:

1. Insure that all four straps are pulled down tightly and the suction cup feet have been securely compressed.
2. Insure that the high voltage wire protruding from your antenna system is not routed near any metallic objects such as your vehicles frame, metal posts, etc.. This wire is part of the flexible insulator of your QMS system.
3. Insure that the ground braid is attached to a good vehicle ground system. Do not run ground currents through any hinges. Be sure to make the ground braid as short as possible, removing all paint and rust from your grounding area. Remember, your ground system is one half of your antenna system.
4. The control wire to the QMS, from the transceiver/radio, must be located away from any other wiring inside your vehicle. This control wire contains a high power RF coax cable which can radiate into other wires (such as your head to transceiver control cables) causing feedback in your transceiver.
5. The webbing, buckles and hooks have a rating of 1,000 pounds. Insure that the hooks are attached to a suitable structure, such as a trunk lid, or something that will not concave when the straps are pulled tightly to secure the unit.

SGC Inc. SGC Building, 13737 S.E. 26th St. Bellevue, WA. 98005 USA  
 P.O. Box 3526, 98009. Telex: 328834. Fax: (206) 746-6384 Tel: (206) 746-6310

\*In no case should the operator use less than the four straps provided to secure the unit. The suction cups alone will not provide sufficient mounting for the QMS.

6. When locating the gutter clip (which secures your SG-303 antenna when not in use), mount the unit in a location where the tip of the SG-303 antenna is easily accessible for threading through the "O" ring. Failure to thread the SG-303 antenna will result in possible damage to both the antenna and your vehicle.

7. When the QMS system is securely fastened to your vehicle, route the control cable to your transceiver. Any 150 watt PEP, 50  $\Omega$  transceiver may be used. The control cable consists of four wires; one RG-58 coax cable and three small wires (for connections, refer to the SG-230 manual).

8. Refer to the QMS system illustration for dimensions and mounting details.

When you are confident that all items 1 through 8 have been thoroughly checked, you are ready to install the tip of the SG-303 antenna. Be sure to secure all items with the appropriate tool and to read all product manuals prior to installation or operation.

**WARNING: If you do not properly and securely attach this unit to the vehicle and it comes loose, the speed of the vehicle may cause the unit to injure others.**

## GENERAL INSTALLATION INFORMATION

The mobile communication tips found below are applicable to any mobile installation and are not limited to the QMS or any other SGC product.

1. For the best performance and radiation, always mount your antenna system on the highest part of the vehicle. Approximately 3 to 15 db in radiation performance may be gained in simply re-positioning your antenna system from a low to a high point.

2. Never use your antenna system while the antenna is reclined against the body or the roof of the vehicle. In this situation, you may find your antenna system performance varies from 6 to 15db making it very difficult or impossible for your coupler to find a proper tuning position.

3. The noise generated in your vehicle can, in some cases, totally obliterate your receiving signal. A noise blanker cannot eliminate the noise, it can only help reduce the consequences associated with the noise generated and may give you a clearer signal in some cases.

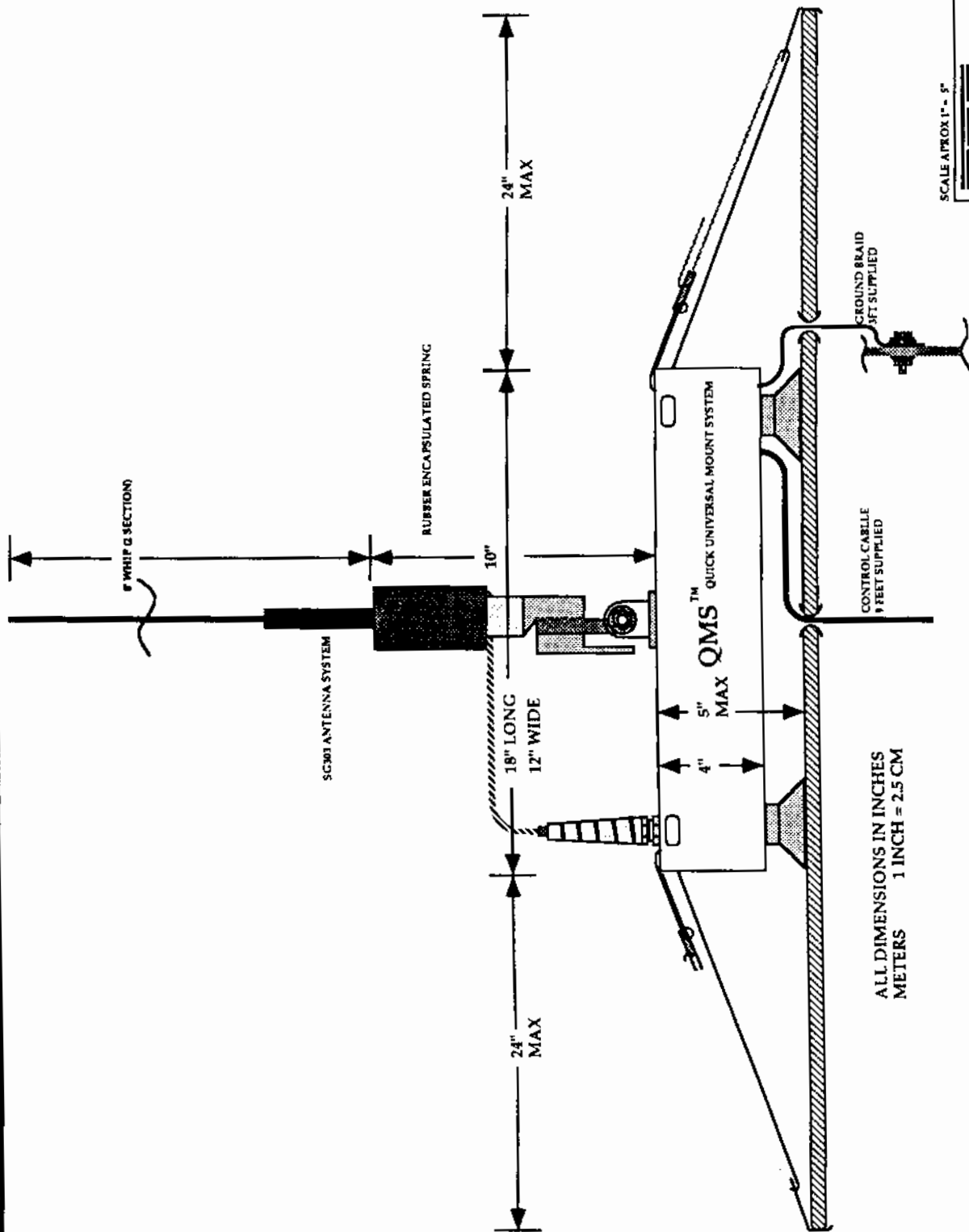
The most efficient way to approach a vehicular noise problem, is to eliminate the noise at it's source. Upon finding the source, use the appropriate technique to eliminate the noise, replacing the defective item if need be. Only use the appropriate filter component to filter out any noise (before it radiates to your antenna).

4. For the connection to your battery system of the radio, use a heavy gauge wire (not less than six gauge). Never use your chassis ground return for your negative line connection. Doing so will cause you to loose too much in line voltage and pick up unnecessary electrical vehicle noise. Always make a direct connection from the radio to the battery, and remember, you need as much input power as possible to generate the most output power possible.

5. If you use your radio system very often, you may consider the use of a small sealed 40 AH gel cell battery which requires no service, mounted directly next to your radio. This will provide you the best overall performance and eliminate a great deal of electrical noise found in your line.

Use of the gel cell battery may require a lesser gauge wire to recharge, in comparison to the large wire required to connect the radio directly to the main battery.

6. In the charging line of this auxiliary battery, you may want a diode of 100 A capacity to allow the battery to be charged, and not discharge in the rest of the electrical system. If you wish, you may use this auxiliary battery, in an emergency situation, to jump the main battery. To do this, however, you must provide a local or remote switch to allow the battery to operate the electrical system of the vehicle (temporarily) to start the engine.



ALL DIMENSIONS IN INCHES  
METERS 1 INCH = 2.5 CM

SCALE APPROX 1" = 5"

	SG 303 / SG230
QMS™ SYSTEM, DIMENSIONS	
Q40101216-A	
DOC 10-1-91	

DATE	REV	REVISION	AUTH

## ADDITIONAL INSTALLATION SUGGESTIONS

### SUCTION CUPS

#### 1. PAINTED SURFACE PRECAUTIONS

When applying the high suction devices incorporated into the QMS, it is important to observe two important rules:

- Surfaces must be cleaned prior to installation to prevent scratching.
- Surfaces must be protected during removal to prevent marring.

Following the steps below will eliminate risk of damage to painted surfaces.

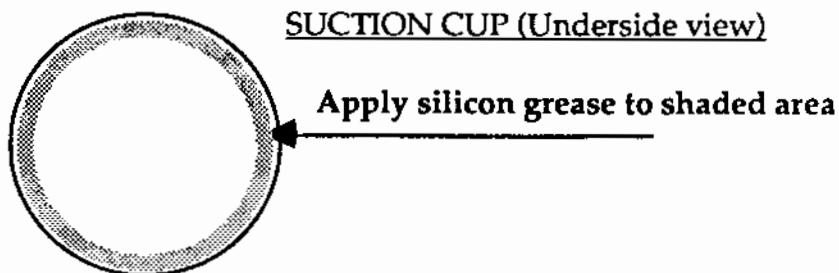
#### 2. APPLICATION

The suction cups on your QMS are of extremely high quality. They will provide excellent service for many years provided you follow certain basic cautions when using them:

A. When you are applying the suction cups, prepare the surface by cleaning with mild detergent and rinsing thoroughly. The clean surface, free of scratches, will provide superior holding power.

If the QMS being applied has been previously used, the suction cups should be cleaned with mild detergent and water then rinsed thoroughly.

B. Spread a thin layer of silicon grease, or pharmaceutical grade lubricant such as "Vaseline", around the edge of the suction cup where it comes in contact with the surface of the vehicle. Refer to the following drawing:



This will prevent slow leakage of air which will reduce the holding power of the suction cups over time and also protect the painted surface.

If the surface of the vehicle is very rough the installation procedure remains the same and the suction cup will have to be pressed against the vehicle surface the same way as before; however, more lubricant may be necessary.

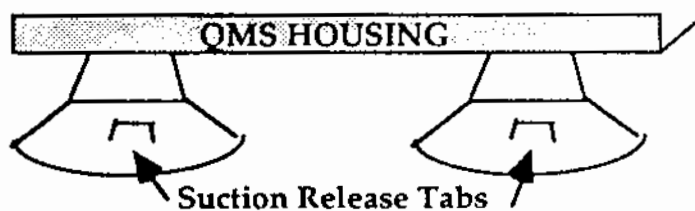
#### 4. **TIGHTENING**

The QMS enclosure must be very tightly strapped to the vehicle. To insure it is properly strapped, grab the base of the antenna mounted on the QMS and push firmly up and down. The vehicle should move up and down but the QMS should not. If the QMS moves and the vehicle does not, increase the tension on the QMS straps.

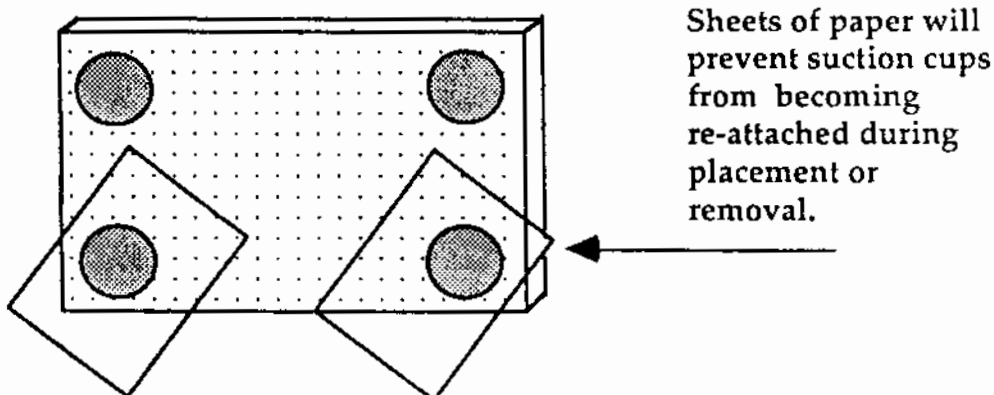
#### 3. **REMOVAL**

A. It is suggested that the vehicle be washed in the area of the suction cups before removal. This will reduce any chance of surface marring.

B. Release suction by applying a rolling sideways motion to the tabs on the suction cups as shown in the following drawing:



C. To make removal of the unit easier, you may slide a piece of paper between the suction cup and the vehicle surface. In this way, each of the suction cup tabs may be loosened sequentially as shown:



#### 4. **STORAGE**

In the event that your QMS unit is being stored for long periods of time, it is a good idea to apply a thin coating of talcum powder to the suction cups. This increases the life span of rubber products.

## LIMITED WARRANTY

### 3 YEARS

This SGC Radiotelephone is warranted to be free from defects in workmanship and material for a period of three (3) years from the date of purchase. A warranty Registration Card is furnished with each SGC radio. This card must be completed and returned to SGC by the purchaser to validate this warranty.

In no event will SGC be liable for any incidental or consequential damages for failure or defect in the radiotelephone. SGC disclaims such liability to the full extent permitted by law; but some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

The warranty is extended by SGC to the original purchaser only. In the event of a defect, malfunction or failure during the three (3) year period, SGC, at its option, will either refund the purchase price, repair or replace the radiotelephone. The radiotelephone must be delivered to the nearest SGC authorized service station to obtain such remedies. Parts will be replaced free for the full warranty period. Labor involved in repairing the radiotelephone or replacing parts will be provided free of charge for ninety (90) days from the date of purchase; purchaser shall pay for all labor after ninety (90) days. Any transportation, removal or reinstallation charges will be paid by the purchaser whenever incurred in connection with this warranty.

This warranty is void if:

- (a) The radiotelephone has not been registered with SGC (please use the card supplied).
- (b) The radiotelephone has not been operated in accordance with the procedures described in the operating instructions.
- (c) The radiotelephone has been serviced, adapted or modified by other than service stations approved by SGC,
- (d) The radiotelephone is improperly installed, operated, misused, abused, damaged or the subject of accident, negligence or damaged in repair or alteration.

There is no warranty coverage for the following:

- (a) The range or geographical coverage that the radiotelephone will give;
- (b) The distance over which usable radio signals will be transmitted or received, or be free from interruption in operation;
- (c) The non-performance of the radiotelephone caused by inadequate or improperly tuned antenna and grounding systems with the radio;
- (d) The routine maintenance, periodic adjustment and performance test of the radiotelephone, or of system changes involving the radio.,

This warranty gives you specific legal rights. Before considering any legal action we hope you will communicate directly with SGC; we will make every effort to see that you are satisfied with your purchase.

This is the complete and only warranty for your radiotelephone. SGC assumes no obligation or liability for additions or modifications to the above warranty unless made in writing and signed by an authorized officer of SGC.





# SGC's 20 dB Advantage with **QMS<sup>TM</sup>**

SGC engineers have discovered that the QMS-II antenna system, comprised of an SG-230 Smartuner<sup>TM</sup> mounted in a QMS and driving the SG-303 high performance whip antenna will typically yield 20 dB of gain over a conventional 1.8 to 30 MHz HF mobile antenna installation. When you start making claims of 20 dB, a lot of people (maybe even you) will be skeptical. So let us show you how you can get more than 20 dB of gain by simply using a QMS compared with any other 1.8 to 30 MHz system:

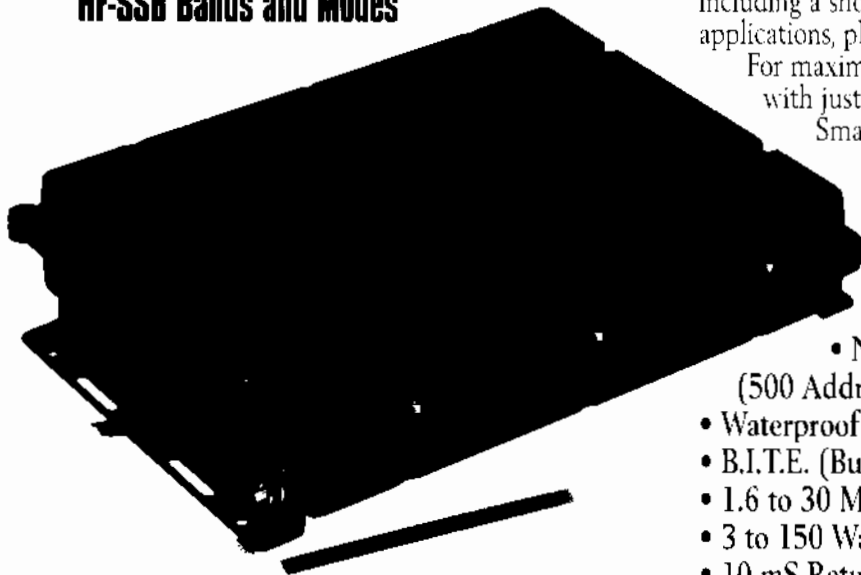
1. Most antennas are so heavy that they are mounted on the bumper of a vehicle. Because of this location, about a *third of the antenna is less than a foot from the grounded body sheet metal*. This is equivalent to a capacitor of 25 to 100 pico Farads shorting your antenna. **QMS gains 3 to 6 dB.**
2. Body sheet metal prevents the antenna from radiating evenly. It shields your signal in certain directions and causes *distorted radiation lobes*. **QMS gains another 3 to 6 dB.**
3. If your antenna coupler is mounted in the trunk of a vehicle, you will have 1 to 2 feet of HV cable going to the antenna on the outside. With as short as a 1 foot lead wire, and using a 9 foot antenna, this means that fully *10% of the antenna system is inside the vehicle* where it won't transmit or receive. It also creates another 10 to 100 pico Farads of capacitance which results in more losses! **With QMS, you'll pick up 3-6 dB.**
4. Wire size of the antenna counts. Almost all of the resonant type mobile antennas are wound with number 22 wire. The SG-303, the antenna used with the QMS, is wound with 3 millimeter wide tape wire strap - equivalent to AWG # 4 wire. With a 100 watt class transceiver, you'll develop 3 to 7 amps (or more) of RF on the antenna. *7 amps through #22 wire represents major losses*. **The QMS with the SG-303 antenna scores another 3-6 dB advantage.**
5. The SG-303 is actually *two antennas in a single casing*. There is a single rod equivalent to the conventional stainless steel whip element, which is resonant at about 22 MHz, plus there is a helically wound element which is resonant at about 10 MHz. This means that on lower frequencies, those under 20 MHz or so, the SG-303 will vastly outperform a conventional 9 foot whip. **Chalk up another 3 to 6 dB for QMS.**
6. Some hams use the so-called "antenna tuner" built into some radios and feed their antennas directly with coax. The problem is that with a non-resonant antenna, a very high SWR exists on the feedline between the radio and antenna even if you get a low SWR reading with a built in tuner. *Built in tuners are nothing more than trimmers*. The QMS system puts a true coupler right at the antenna. When your feedline SWR is above 4-1 you have effectively put 29 pico Farads per foot capacitance to ground! **That's at least 3 to 6 dB more for QMS!**

**Add it up: 20 dB GAIN USING QMS!**

# SG 230

## SMARTUNER<sup>®</sup>

Automatic Antenna Coupler for all  
HF-SSB Bands and Modes



**G**IVES ALMOST ANY HF-SSB A  
MAJOR BOOST IN RANGE AND CLARITY.

*Ideally, your HF-SSB radio would always be perfectly tuned to your antenna - for maximum range and clarity. It's a goal that's been easy to wish for, but not so easy to achieve. Until SGC developed the intelligent, micro-processor-controlled, SG-230 Smartuner<sup>®</sup>.*

The SG-230 Smartuner<sup>®</sup> - 'intelligently' - tunes any length antenna from 8-80 ft! No preliminary tuning or adjustment is required, and the Smartuner<sup>®</sup> will operate with any HF transceiver in the 1.6-30 MHz range and output power from 3 to 150 watts.

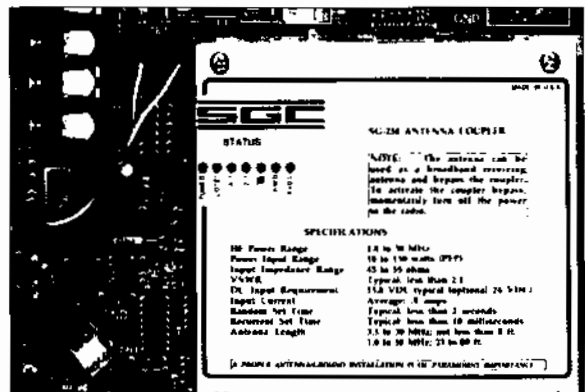
Smartuner<sup>®</sup> automatically evaluates and switches 64 input and 32 output capacitance combinations, plus 256 inductance combinations in a "pi" network—over a half-million precision matches. Smartuner<sup>®</sup> then remembers the chosen frequency and tuning values and automatically reselects those

values - in less than 10 ms, each time you select that frequency.

Flexibility is a key Smartuner<sup>®</sup> feature. It is available with a number of attractive options, including a shock mount for military and extreme applications, plus a 24 VDC option.

For maximum range, clarity and flexibility, with just about any HF-SSB, the SG-230 Smartuner<sup>®</sup> is your smartest choice.  
Cat. # 54-12

- Microprocessor Controlled, Precision, Automatic Antenna Tuning
- Non-Volatile Memory (500 Addresses)
- Waterproof for All Weather
- B.I.T.E. (Built In Test Equipment) Indicator
- 1.6 to 30 MHz Range
- 3 to 150 Watts Input Power
- 10 mS Retuning Time
- Tunes from 8 to 80 ft. Antennas
- For Marine, Aviation, Ham and Para-Military Applications



A seven LED B.I.T.E. (Built In Test Equipment) status display indicates DC power, forward power, phase, two VSWR levels, low impedance and tuned conditions.

**SGC**

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