An 'SGC-230' autocoupler repair

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At one of our recent radio meetings I was handed an autocoupler and asked if I could have a look at it. The supplied information was that there was 'a relay problem'. It was labelled as a Barrett 511, but on opening it I found it to be an SGC model 230. I know that Codan also badge engineer the SGC-230 as well and call it a Codan 9103, so it was not surprising to find Barrett doing the same.

Photo 1: The 'SGC-230', showing the Barrett label.

The first thing to do was to gather some information about the unit so I downloaded the user manual, refer Reference 1, and also the troubleshooting guide, refer Reference 2, from SGC's website. The user guide does not contain any schematics, so I sent an email to SGC, describing the coupler including the internal panel. I also asked about a replacement for the broken ceramic feedthrough insulator for the antenna connection and what the correct power fuse was since the broken 3AG fuseholder had been 'repaired' by soldering a PCB mounting fuse across it.

A return email included the schematics, details for the fuse and the part number for a replacement insulator. Also mentioned was the fact that the unit was over 10 years old. I removed the broken fuse clips and fuse, replacing them with the correct fuse clips and fuse, which were sourced from Jaycar. Power was applied without anything else connected and I was gratified to see the five volt LED come on and all of the relays operated, with the inductor relays staying operated while the capacitor relays released. This was a good sign as it meant that the microprocessor was probably working.

A new insulator was ordered and while waiting for it to arrive I had another look at the SGC website and found a link to a diagnostic ROM, written by Dave Dunfield, refer Reference 3, for his SGC-230, and which happened to be the same version as the one I was working on. This ROM would allow me to function test it without having to apply RF. I built an RS232 to TTL converter, similar to the one Dave details in his article, which is required so that a computer running a terminal program could communicate with the SGC-230. I also programmed a test EPROM from the image file included with the article.

The new feedthrough insulator arrived and was fitted, so I started testing. The RS232 to TTL converter was connected to the SGC-230 and the SGC EPROM was replaced with the one I had programmed. A PC running Hyperterminal was connected and then the coupler was turned on. The result was a prompt from the test program in the EPROM which confirmed that at least the microprocessor in the SGC-230 was working, so it was onwards with further testing.

Dave's program allows you to operate the relays in any combination and also reports the status of the various detectors in the RF deck. A quick run through all the relays showed that, at the least, they worked so the next step was

Photo 2: The board of the auto tuner, detailing specifications.

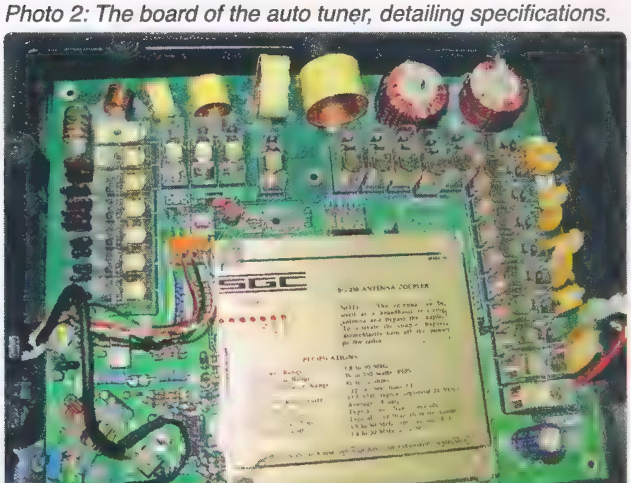


Photo 3: The broken feedthrough insulator.

to test the inductors and capacitors associated with the relays. A look at the schematic for the RF section showed the SGC-230 to be a 'pi' type coupler with capacitors to ground on the RF input and RF output with a number of inductors in series connecting the RF input to the RF output.

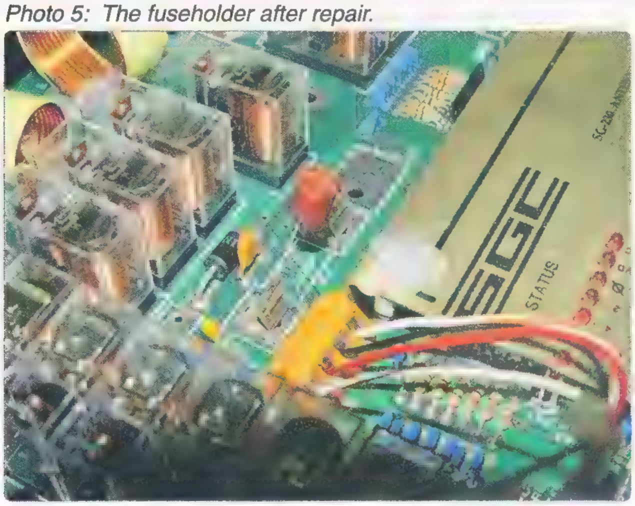
Using Dave's program I made sure that all of the capacitor relays were released, to switch them out of circuit, and all of the inductor relays were operated, to switch them out of circuit. An LC meter was connected to the circuit board at the RF input and then zeroed to compensate for any stray capacitance. The transmitter capacitor relays were operated individually and the measured capacitance was checked against the appropriate capacitance value on the schematic. The same procedure was followed to test the antenna capacitors and all were found to be of the correct value. A point to watch is one side of the LC meter has to be connected to the ground trace on the circuit board, not the RF ground terminal which has two paralleled capacitors isolating it from the circuit board ground; there is also a high value resistor across these capacitors which functions as a static bleed for the antenna connection.

To test the inductors the LC meter was connected from the RF input on the circuit board to the RF output at the ceramic feedthrough, then all of the capacitor relays were released and all of the inductor relays were operated to switch the capacitors and inductors out of circuit. The LC meter was again zeroed to allow for stray inductance and then each inductor relay was released in turn and the measured inductance was checked against the value on the schematic.

Since basic testing of the inductors and capacitors showed them to be OK the next step was to apply RF, using a test load instead of a real antenna. I happened to have a 2.2 Ω 100 watt high power resistor to hand, one of the gold coloured aluminium clad units. A resistor like this is ideal for testing antenna couplers as it presents both a resistance and an inductance, while being able to dissipate a fair amount of power.

Admittedly a 2.2 Ω load is a severe test but HF antennas that are electrically very short, which the SGC-230 is intended to be used with, will present a similar and often worse load. Farnell stock resistors like the one I used, with a 1900 VAC voltage rating, refer Reference 4, which is important as a reactive load can present quite a high voltage as evidenced by the type of antenna connection on the SGC-230.

Photo 5: The fuseholder after repair.



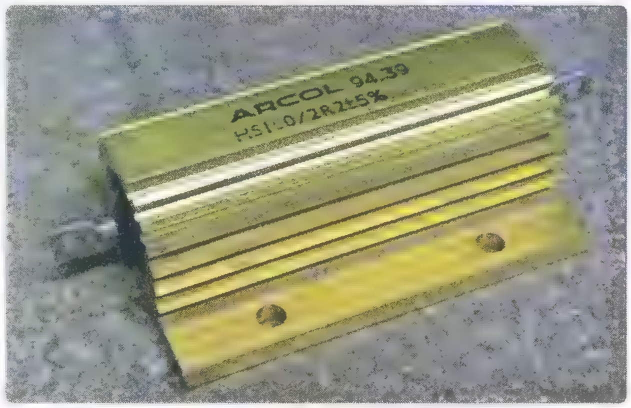


Photo 6: The Arcol 100 watt resistor.

The diagnostic ROM was replaced with the SGC EPROM and the RS232 to TTL converter was disconnected from the board.

I connected the 2.2 Ω resistor between the antenna and RF ground connections and applied about 10 watts of RF but there was no response from the unit apart from the power up action of the relays. Several different frequencies between 80 metres and 10 metres were tried and I saw that the detector LEDS lit up in different combinations at different frequencies, so the various RF detectors were probably OK.

With this in mind I had another look at the schematics supplied by SGC and decided that the frequency counter section that the microprocessor uses to measure the frequency of the applied RF signal was likely to be the culprit given the various detectors seemed to be working and the counter circuit is the only other input to the microprocessor. The counter is made up of a resistive divider and a diode voltage limiter, connected to the RF input, which feeds a 74LS93 divide by 16 counter, followed by a 4020 divide by 32 counter which is connected to the microprocessor.

The resistive divider at the input of the frequency counter section consists of two resistors, both of which tested OK but I found a short to ground at the divider junction. The voltage clamp at the input of the 74LS93 counter consists of a series string of forward biased diodes to ground and one reverse biased diode to clamp any negative signal excursion and it was this diode that was shorted. These diodes are in a 16 pin package, a TND908, which is obsolete so yet another email was sent off to SGC. The response recommended replacing the TND908 with 1N4148 diodes which I did. Another test with RF ended with the same response as before so I removed the RF source and broke out the logic pulser and logic probe. Applying a 100 Hz pulse train from the logic pulser to the input of the 74LS93 and looking at its output with a logic probe showed it was not working, so I replaced it and then retested. Both counters now worked although it took a bit of time to prove this as both dividers cascaded work as a divide by 512 counter and the maximum pulse train frequency from my pulser is 100 Hz; So, for a 100 Hz pulse train on the input the output changes state once every 5.12 seconds.

With the RF and resistor reconnected I tested the unit again and was happy to find it working as I expected it should, so it was time for an on air test. For the on air test I used a 2.75 metre (nine foot) long whip with eight ground radials, each 4.9 metre (16 feet) long. The initial testing went well until I accidentally selected a pre-programmed frequency around 2 MHz. At that point I noticed one of the relays, which turned out to be K12, producing magic smoke. This relay switches an 8 uH inductor in and out of circuit.

A read of the manual (!) confirmed my mistake. At the frequency I had been using the antenna should have been no shorter than seven metres (23 feet - minimum length at 1.8 MHz, not the 2.75 metre length I was using, which would have been OK down to 3.5 MHz. Yet another email to SGC resulted in a replacement relay, and some spares, arriving. With the replacement relay fitted careful testing confirmed the unit was again fully functional, but not foolproof.

References

1. *http://www.sgcworld.com/PubInfoPage.html*
2. *http://www.sgcworld.com/technicalInfoPage.html*
3. *http://www.sgcworld.com/productupdates.html*
4. *http://au.farnell.com/tyco-electronics/hsc1002r2j/resistor-100w-5-2r2/dp/1174284?Ntt=hsc100*