inpractice

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FLEXIBLE COUPLERS

WHERE CAN I buy insulated flexible couplers for 0.25in shafts - or how can I make one?

AS FAR AS I know, the only manufacturers of 'classic' insulated flexible couplers (**Fig 1**) in recent years was Jackson Bros, which went into receivership in 1998. However, Mainline Electronics bought the company and have now re-started production of most of the product lines. Mainline sell direct from their Leicester headquarters (Tel: 0116 278 0891) and confirm that they have two sizes of flexible couplers in stock for a little over £5 + VAT.

However, you may want to consider some alternatives. One of the most common reasons for using an insulated flexible coupler is for variable capacitors whose shafts are 'floating' above ground potential, as in the popular T-match ATU (*In Practice*, September 1999). In this case you need not only insulation but also low capacitance between the capacitor shaft and the extension shaft through the front panel. The easiest way to achieve this low capacitance is to use an extension shaft made from insulating material, in which case the mechanical coupling itself doesn't need to be insulating. **Fig 2** shows a typical example, using a brass coupling and nylon extension shaft (Maplin RX29G and RX36R). The nylon is a bit springy, so it gives some degree of flexibility if needed. However, it's best to align the extension shaft accurately with a hole in the front panel, and use a bush to give support and a solid 'feel' when you turn it. For a suitable 0.25in bush and nut, simply crunch up an old potentiometer in the vice, to leave exactly what you need - at most, you may need to pass a drill through to remove any internal shoulder. Nylon may be readily available, but it isn't the best RF insulating material and it has a reputation for melting under stress. You can get rod made of better materials such as fibreglass from RS/Electromail (at a price), but generally the best solution is to make life easier for the insulator by moving the coupler back from the metal front panel. This reduces the self-capacitance and, more importantly, it avoids concentrating the electric field in the insulator. By doing this, you can often use almost any material instead of needing to search for something special.

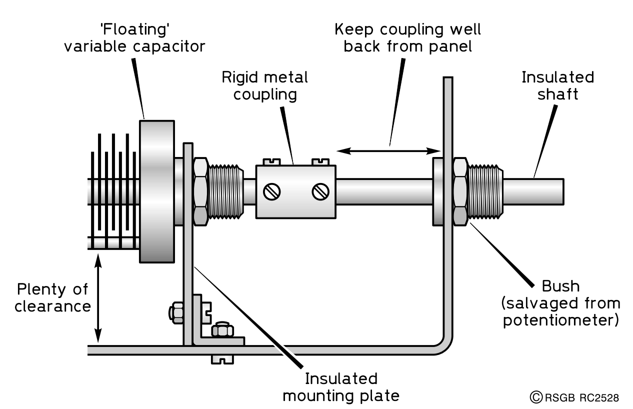

Fig 2: Using a rigid coupler and an insulating shaft for a 'floating' variable capacitor. Keep the metal coupler well back from the panel (shorten the capacitor shaft if necessary).

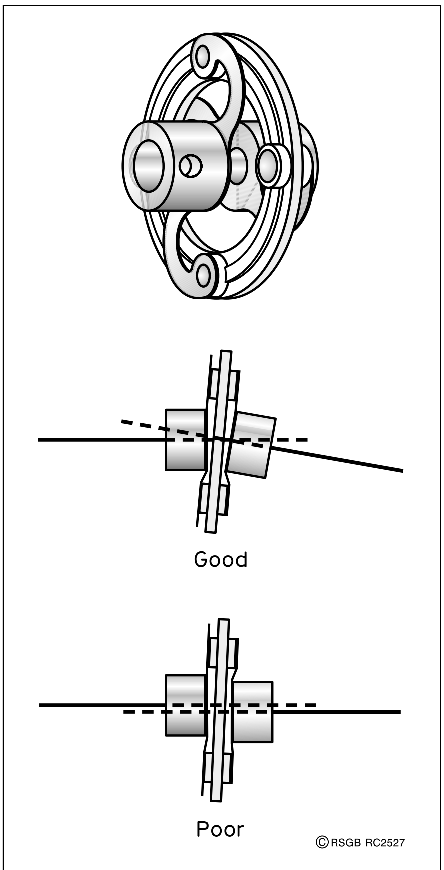

Fig 1: The 'classic' flexible coupler can absorb angular displacement well, but is poor at absorbing sideways displacement.

Turning now to the mechanical aspects, I've already indicated that it's best to avoid the need for flexible couplers in the first place. Also, we often ask these couplers to do impossible things. As shown in Fig 1, flexible couplers are good at absorbing a change in angle between two shafts, but more often we try to make them absorb a sideways misalignment between two parallel shafts - which they really cannot do. For example, the small Jackson Bros coupler (5610, 19mm overall diameter) is capable of absorbing only 0.12mm of sideways displacement, and even the large coupler (4693, 35mm diameter) can only absorb 1mm. It really is far better to take the trouble to remove this displacement, and then use a straight coupler, as in Fig 2.

However, Bill Cole, G0KFW, offers an alternative coupler that is fully flexible and very suitable for low-torque applications such as variable capacitors. "Fit about 30mm of 6mm plastic tubing (as in wine-making kits, lawn mower/motorbike fuel pipe, etc) over the shaft and spindle, leaving a gap appropriate to the voltage (8-10mm) but not far enough to kink the tubing when turned (**Fig 3a**). It's surprising how tightly the tubing grips without any adhesive. This should be flexible enough to accommodate any alignment problems. If the shaft is mounted through the panel using a bush, this gives a nice 'feel' to the operation. I have been using this in my home-made ATU for at least ten years and it has been so

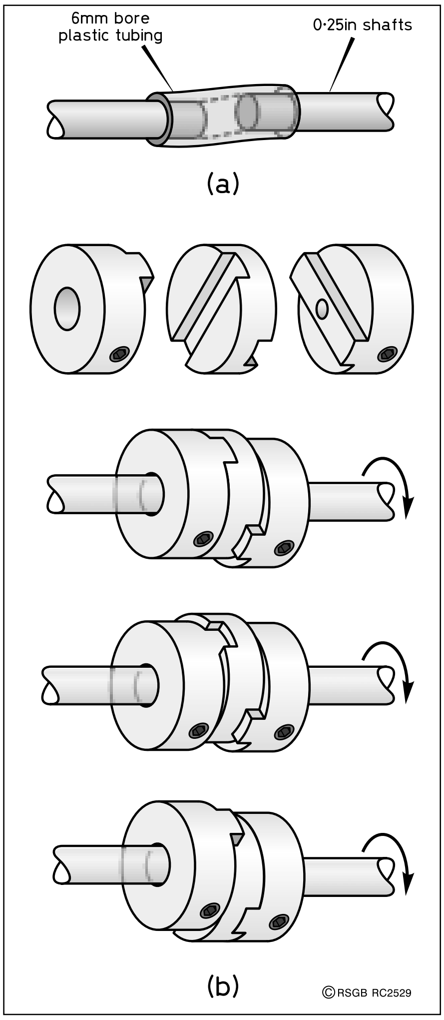

Fig 8: (a) Flexible coupler made from 6mm-bore plastic tubing (G0KFW). (b) 'Oldham'-type coupler can transmit high torque and absorb considerable sideways displacement.

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trouble-free that I'd almost forgotten about it!" This is an excellent low-cost idea, and should meet most low-torque requirements. The only exception would be VFO tuning capacitors, where the shaft rotation must be transmitted very accurately indeed. The Jackson Bros type of coupler (Fig 1) performs very well for this, and also has the advantage of absorbing any small push-pull movements.

For higher-torque applications, such as large switches, you could also consider the 'Oldham' pattern of coupler (**Fig 3b**) which has a sliding intermediate disc that can absorb large amounts of sideways displacement. Although these couplers are not totally backlash-free, they are perfectly adequate for switches. They are obtainable from RS/Electromail, and a 0.25in coupler would require two of 319-483 (£3.01 + VAT each, sold in multiples of 4) and one of 319-499 (£0.468 + VAT each, in multiples of 10). A packaged alternative is the Uni-Lat coupler, a derivative of the Oldham pattern (748-336, £11.80 + VAT). These are not cheap solutions, but for some home-construction applications they might save the day.

S-UNITS

WHAT IS AN S-unit? Is there any standard?

THE ORIGINAL definition of signal strength was in words. The original RST (Readability, Strength, Tone) system of reporting defined nine levels of signal strength, as shown in **Table 1**. Signal strength reports were largely guesswork... and who knows how those nine carefully graduated English descriptions came out in other languages? When S-meters began to appear, they gave a slightly more objective indication based on signal strength alone - but the calibration was still guesswork. In an SSB/CW/AM receiver, the S-meter is connected to the AGC circuit which holds the audio output reasonably constant by controlling the gain of the IF and RF amplifier stages (**Fig 4**). The stronger the signal, the more AGC voltage it generates, and the S-meter indicates this. (In an FM receiver, the S-meter often works on a different principle, but still indicates signal strength.)

S1	Faint signals, barely perceptible
S2	Very weak signals
S3	Weak signals
S4	Fair signals
S5	Fairly good signals
S6	Good signals
S7	Moderately strong signals
S8	Strong signals
S9	Extremely strong signals

Table 1: The original signal strength scale.

There are two big problems with this. One is that AGC is usually not applied on very weak signals, because turning down the IF/RF gain will degrade the signal-to-noise ratio. This can lead to interesting situations where a signal is perfectly copiable in the absence of QRM, but the S-meter hasn't started to move off the stop - it doesn't seem right to give someone a report of 'Readability five, strength zero', does it? Manufacturers usually avoid this problem by being very vague about what happens below S1, rather like your car's speedometer below 10mph. The other problem is what to do with signals that are stronger than S9: what does 'Stronger than extremely strong' mean... if anything?

The interesting property of most S-meters is that they give a fairly linear decibel scale. This is because the AGC-controlled amplifiers have a fairly linear relationship between gain in decibels and the applied AGC voltage that is driving the S-meter. The accuracy of this relationship is by no means guaranteed, because it depends on the design of the controlled amplifiers and the way that AGC is applied, but it does lead to the notion that each S-unit should represent the same number of decibels increase in signal strength. And as we know, after reaching S9 the scale then continues in plain decibels: S9 +10dB, +20dB and so on, up to maybe +60dB. However, decibels are always a *relative* measurement, ie a measurement of power *ratio*, not simply power. This means that the entire S-unit scale also needs to be referenced to some absolute signal level.

So how many decibels *is* an S-unit, after all that? The answer is: it varies! It varies between manufacturers, it almost always varies along the scale of the S-meter, and quite possibly it varies between different examples of the same receiver. There is an IARU standard that each S-unit represents a received signal level change of 6 dB, but a glance at Peter Hart's receiver reviews shows that real-life S-units vary enormously [1]. Typically, the manufacturer aims to get the 20dB step between S9 and S9+20 about right, but below S9 the 'value' of one S-unit gets smaller and smaller, and can be less than 2dB per S-point at the bottom of the range.

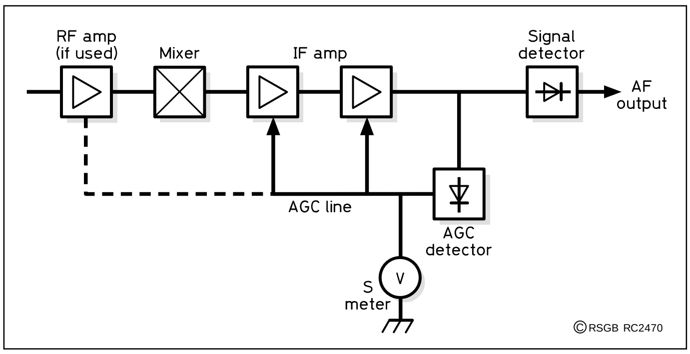

Fig 4: The AGC loop in a receiver keeps strong signals at a constant output level. The S-meter measures signal strength in terms of the AGC control voltage that needs to be applied.

The IARU recommendation is that S-meters should be referenced to S9=50μV for HF receivers and S9=5μV for VHF receivers. The difference reflects the greater sensitivity of VHF receivers, for a 5μV signal is indeed 'extremely strong' at VHF. However, Peter Hart's review measurements once again show that the 'S9' levels of commercial HF receivers can be anywhere from 250μV down to less than 20μV. The other important factor is whether the internal preamp is on or off - if it is on, all signals jump up the S-meter scale. Should you then modify the signal strength report you give to the otherstation? The answer of course is no, because the other person's signal strength cannot rationally depend on which buttons you choose to push at the receiving end.

Why are commercial amateur S-meters so bad? Well, first of all because the IARU has no authority to enforce a standard on manufacturers. But the manufacturers themselves will justly blame the market. It costs money to produce an S-meter with a truly linear decibel scale (although the more 'digital' the receiver becomes, the easier it would be). Also, an S-meter with a genuine 6dB per S-point calibration would seem very sluggish compared with existing meters, promoting the entirely mistaken rumour that the receiver is 'deaf'. Finally, there's the human factor that nobody likes to seem mean about the signal reports they give.

The only logical conclusion is that none of this makes sense! If you look for deep inner truths from your S-meter, it will drive you crazy. In the end, most experienced amateurs almost ignore the S-meter and give subjective reports based on some personal version of Table 1... so much for progress.

REFERENCE

1. Peter Hart routinely measures the signal levels in microvolts required to give S1, S3, S5, S7 and S9, and then S9+20, 40 and 60dB. To calculate the difference in decibels between any two voltages, use the standard formula: dB = 20 $\log_{10}(V_2/V_1)$. Remember that the decibel differences you calculate from Peter's tables will be for steps of *two* S-units. ♦

If you have new questions, or any comments to add to this month's column, I'd be very pleased to hear from you by mail or E-mail. But please remember that I can only answer questions through this column, so they need to be on topics of general interest.