TRIMMER CAPACITORS STILL MAKE SENSE

Many designers consider trimmer capacitors to be mundane, archaic and certainly well understood. But even so, the volume of inquires received at Voltronics. Increases year after year concerning fundamental characteristics of trimmer capacitors. So it's certainly helpful to review their basic properties, especially with the appearance of new trimmer applications in the latest wireless personal-communications devices.

The trimmer capacitor is one of those components that every designer would rather do without. In an ideal world, the exact values of each component would be known and perfectly matched to the requirements of the circuit, Trimmers would therefore quickly become extinct.

That day, however, has not come, and isn't likely to any time soon, because there is always some variability among components that must be compensated for. Trimmer capacitors are still the best way to achieve optimum circuit performance at the least overall cost. For instance, after burn-in and temperature cycling, crystals can drift but can be brought back to the exact frequency with trimmer capacitors.

Trimmers have taken their share of knocks over the years on several counts. First, because the traditional trimmer is not a sealed device, dirt and other contaminants can enter it, causing degradation of performance and possible failure. In addition, because the trimmer is a mechanical device, it seems out of place in today's ubiquitous silicon, surface-mount environment.

While there is some justification for those complaints, the fact is that today's best trimmers are every bit as reliable as their semi conductor counterparts on the circuit board. They'll deliver repeatable performance for the life of the host product and are in fact available in surface-mount configuration.

In short, while no designer desires adjustment in order to meet customer specifications, they almost always require some "tweaking." The bright side is that trimmers provide a way to make this a simple, accurate, and ultimately, less expensive task.

There are a variety of trimmer types available. What's important is choosing the right one for each application. Each of these trimmer types has its positive and negative aspects, and some are better suited to particular circuits than others.

Trimmer types include:
Half turn:
- Ceramic through-hole and chip SMT
- Film, mica, paper

Multi-turn:
- Glass or quartz tubular
- Sapphire-dielectric tubular
- Air-dielectric tubular
- Teflon-dielectric tubular

Ceramic half-turn trimmers are the most common types, and millions have been placed in service. Their advantages are that they are small, inexpensive, and available on tape and reel. They also provide a significant amount of capacitance (up to 40pF). These characteristics have assured them a place in the electronics world, regardless of their shortcomings.

These shortcomings include mediocre temperature stability, which worsens as capacitance increases. Finally, they cannot be turned with a great degree of precision. Taken together, these characteristics make ceramic trimmers unsuitable for applications in which precision is of paramount concern.

However, they are well suited to applications in which low cost and small size are the overriding concerns. The Q of these devices is about 1500 at 1 MHz, normal temperature coefficient is ranges from 0 to -750 ppm/°C, and capacitance drift ranges from ± 1% to ±5%. Maximum withstanding voltage is generally around than 220 V dc.

When higher levels of performance are required, mult-turn tubular trimmers are the better choice. These devices use glass, quartz, sapphire, air, or Teflon as the dielectric. They can be made to provide extremely linear tuning with no reversals in the tuning range, and have high Q, low RF loss, low series inductance, and self-resonant frequencies (SRF's) as high as 10 GHz.

Mult-turn glass, quartz and sapphire trimmers change capacitance by moving a piston inside a dielectric tube, which is metalized on the outside. As the piston overlaps with more of the stator plates, the capacitance increases. The dielectric tubes have inner diameters precise to ±0.0002 in. with matching pistons. They are available in numerous capacitance ranges, depending on the dielectric, with maximum values of 16pF for quartz, 250 pF for glass, 8 pF for sapphire and 55 pF for PTFE piston.

There are two types of tuning mechanisms used: rotating and non-rotating. In the rotating style, the piston is permanently attached to the adjustment screw. As the screw-piston assembly is turned into a threaded bushing, the piston is engaged into the metalized part of the dielectric tube. One problem with this design is that when the piston rotates the air gap between the piston circumference and the glass can change due to inherent eccectricities in the mating parts, thus resulting in tuning reversals. The advantage of this design is ease of assembly and economy of machining that translates into lower costs.

In the non-rotating style, the piston is placed on bushing rails and is driven by a screw that's captured in the bushing and does not move axially. As the screw is turned, the piston slides along the rails and moves into the metalized area of the dielectric tube. Because the piston does not rotate, the air gap stays constant and tuning is linear within ±1% versus ±10% on the rotating version. It also assures better stability under shock and vibration. Because the screw slot remains fixed in the axial plane, it provides easier tuning access for the user. And because the current runs along the bushing rails rather than along the screw, the non-rotating styles have lower inductance and higher self-resonant frequencies.

At higher frequencies, the multi-turn trimmer with air, Teflon or sapphire dielectrics provides the best solution. In the air trimmer, capacitance is created by a movable set of concentric metal rings fitted into a fixed set of parallel rings (see figure). As the rings mesh, capacitance increases. A fine-thread screw provides many turns of resolution for setting to the exact desired value.