TECHNICAL INFORMATION

INTEGRATED PASSIVE COMPONENTS
WHAT ARE THE REAL BENEFITS?

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Integrated Passive Components - What Are The Real Benefits?

The key pressures being faced by electronic equipment manufacturers in Europe are: cost reduction, downsizing and reduction of component count. Passive components represent a significant challenge, and opportunity for drastic improvement in all three areas. Consider that today's tiny GSM phones contain 250-300 passive components, and the magnitude of both the challenge and the opportunity becomes clear.

Capacitor and Resistor Arrays

AVX, probably the World leader in integrated passive components, offers a number of stages of integration to its customers. The first of these is the capacitor or resistor array. Focusing on capacitor arrays, (resistors follow a similar route), it can be seen from Figure 1a that when compared with 4 x 0603 discrete devices, the 4 element, 0612 array offers a space saving of > 50%. If 0402 discrete capacitors are already being used, a significant space saving may still be achieved by changing to the 0508, 4 element array (Figure 1b). An 0508, 2 element array providing extra flexibility is also available.

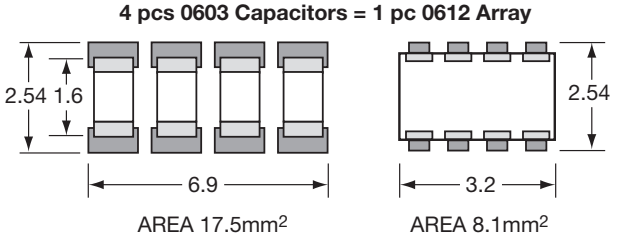


Figure 1a. Space Saving with Arrays - 0612 Size

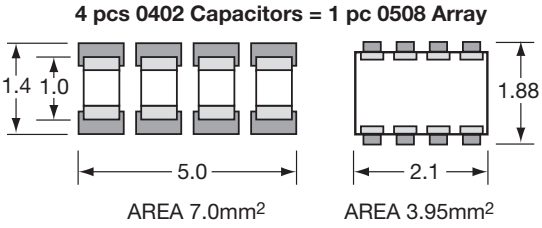


Figure 1b. Space Saving with Arrays - 0508 Size

In terms of cost savings, it is very important that the difference between the price of a component and its cost when placed and soldered onto a PCB is recognized. Because ceramic capacitors are already very low in price, the potential for achieving savings by means of price reduction are extremely limited. However, the conversion cost cc (cc = cost of placement, soldering and inspection) is typically some $0.022, made up of the cost of the pick n' place machine, its downtime, labor and overhead. Therefore, when placing a 4 element array at a cost of $0.022 vs. the $0.088 it would cost to place the 4 discrete capacitors, a saving of some $0.066 is achieved, which is typically more than the price of the 4 separate capacitors! So, logically, even if the customer were to be offered free capacitors by their supplier, these would be too expensive compared to the savings available from changing to arrays.

There is nothing new, in technical terms, for the circuit designer to learn about the characteristics of capacitor arrays: they utilize the Industry standard NP0 (C0G), X7R and Y5V dielectric materials, are available in 10 volt to 100 volt ratings and are offered in capacitance values of 10pF to 1.0µF per element.

|Z| Products

Suppliers of capacitors and resistors are frequently asked by their customers if they can integrate both of these devices into a single chip. With ceramic based C's and R's that has long been feasible but because of the different firing profiles of the resistor inks - typically ruthenium oxide based, and of the palladium silver capacitor electrodes, it has been expensive and cumbersome as it is necessary to first make the capacitor and then, as a separate operation, to construct the resistor on it, re-fire, glaze, test etc.

AVX, working with major materials suppliers has developed the |Z| family of R-C products which completely overcomes the above mentioned incompatibility problem by actually making the capacitor electrodes *out of resistive material* (Figure 2a and 2b).

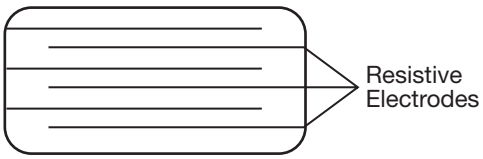


Figure 2a. |Z| Chip Constructions

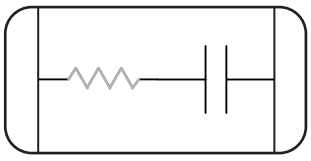


Figure 2b. |Z| Chip Schematic

The basic |Z| chip is a simple series R-C element, available as a single 0603 chip or as a 4 x R-C, 0612 array. Prime applications include line terminators, snubbers, timing circuits etc. It is interesting to note that, when the array is placed, a saving of 7 conversion costs, (i.e. approximately $0.154), is made.

Immediately customers became aware of the possibility of a truly integrated, co-fireable R-C system, they began to ask AVX to supply Low Pass Filters (LPFs), as these are widely used as EMI/RFI suppressors. By adding a very low impedance metallic ground connection, AVX was able to offer such R-C-R, 'T' configuration LPFs; the schematics below illustrate a 'conventional' LPF diagram (Figure 3a) and new style which shows the resistor as being one plate of the capacitor (Figure 3b). It is interesting that, because of the very low parasitic inductance of the integrated |Z| LPF compared to that resulting from constructing the filter from discrete R's and C's, the same capacitance value in the |Z| LPF gives a hugely increased self-resonant frequency. By using the array version of the LPF, a conversion cost saving of approximately 11 x $0.022 = $0.242 is achieved.

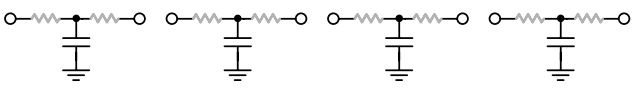


Figure 3a. Low Pass Filter
4 Element Conventional Schematic

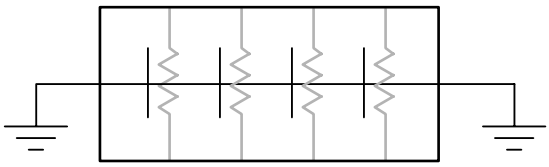


Figure 3b. Low Pass Filter
4 |Z| Element Real Schematic

The |Z| benefits do not stop here however: because of its unique characteristics, it is relatively simple to incorporate multiple values of C's and R's in a single, miniature chip. A good example is a recently developed Rambus clock driver circuit. Figure 4a is a schematic of the required passive devices and Figure 4b is the |Z| solution, housed in a tiny 1206 (3.2 x 1.6mm) chip. AVX also made the chip symmetrical so orientation is not an issue.

Other Integrated Products

Following the tremendous uptake in the electronics industry of capacitor and resistor arrays, and subsequently |Z| products, AVX has also introduced array versions of its TransGuard multilayer varistor transient suppressor, called the MultiGuard, (Figure 5a and 5b), Feedthrough Filter Capacitor arrays, 4 element in an 0612, 10 termination package (Figure 6) and of its unique Dual Resonance Capacitor with SRFs at 900 and 1800MHz (Figure 7).

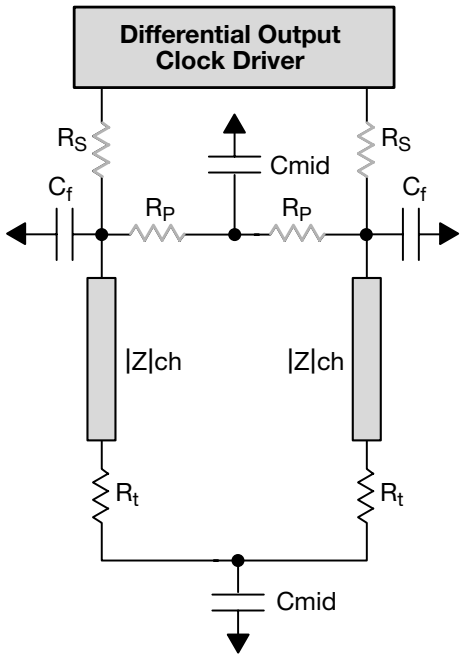
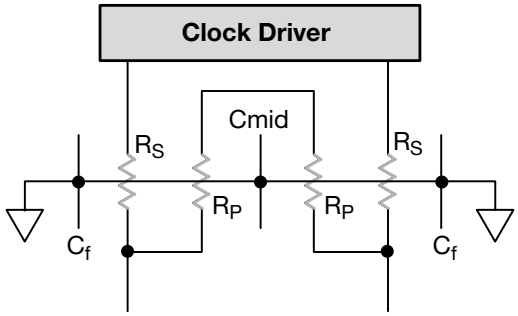


Figure 4a. Rambus Clock Output Driver



R_S = 68Ω ±10% R_P = 39Ω ±10%
C_f = 18pF ±20% Cmid = 100pF ±20%

Figure 4b. |Z| Network for Rambus Clock Circuit

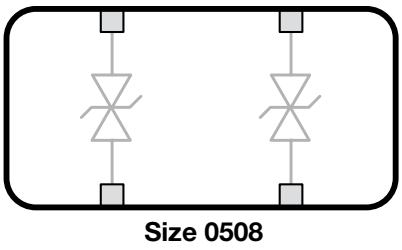


Figure 5a. 2 Element

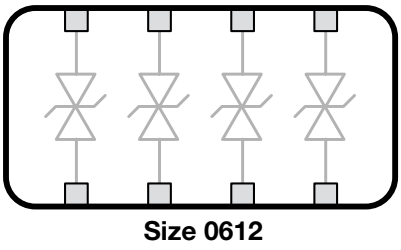


Figure 5b. 4 Element

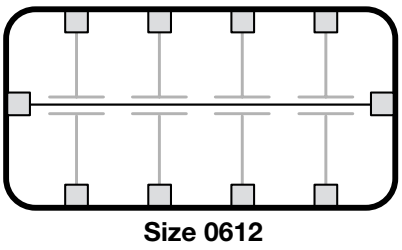


Figure 6. 4 Element Feedthrough Filter Array

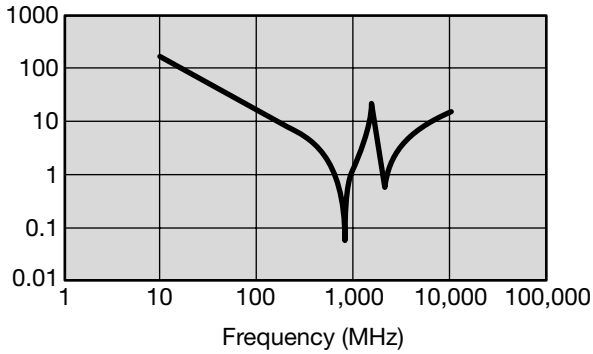


Figure 7. Dual Resonance Capacitors

So, to save cost and space and to reduce component count, simply switch to integrated passive components.

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