

TECHNICAL INFORMATION

TIGHT TOLERANCE KAVX ACCU-P® RF CAPACITORS IMPROVE ANTENNA EFFICIENCY

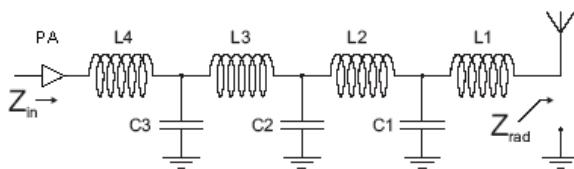
By Leonid Talalaevsky and Avital Yaish
KAVX Isreal Ltd
P.O.B 45008, Jerusalem 9145001, Isreal

Abstract:

KAVX Accu-P® capacitors are the ideal component for improving antenna efficiency due to the repeatability of their RF performance and the availability of non-standard values and ultra-tight tolerances.

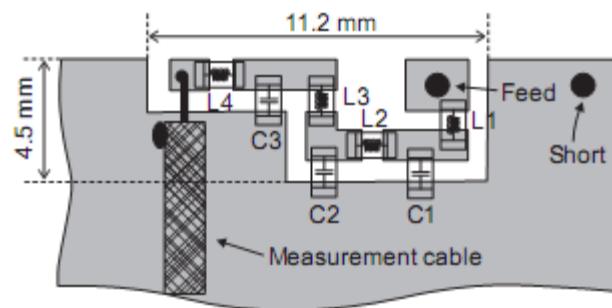
Tight Tolerance KAVX Accu-P® RF Capacitors Improve Cellular F-Antenna Efficiency

In order to increase the antenna efficiency it is necessary to match the antenna to the source resistance. See below a typical matching scheme.



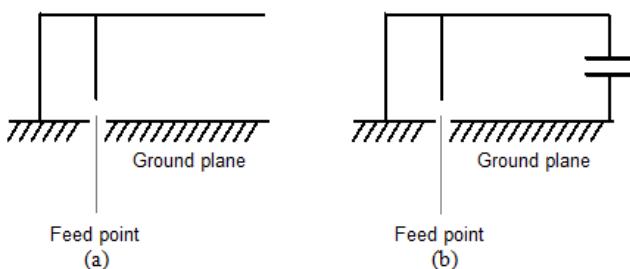
Standard antenna matching scheme

Antenna matching circuits are synthesized using different CAD tools, often resulting in non-standard values of capacitors and inductors.



Example of matching network layout

Inverted-F antennas are widely used in cell phones A hardware and other small wireless devices. The performance is similar to a quarter-wave ground plane.



Inverted F-antenna (a) with capacitive load (b)

It is found that a capacitive load decreases the resonance length from $\lambda/4$ to less than $\lambda/4$ i.e. it greatly reduces the size of the antenna. Capacitive load can be applied to different antenna types. For standard PFA approximately $0.1 - 0.2$ pF of loading capacitance is required. The tuning sensitivity to that capacitance is $0.1 - 0.2$ Hz shift per 0.1 pF change. It is therefore of utmost importance for the capacitor used to be both accurate and repeatable. Accu-P® capacitors are the ideal choice.

Using the closest standard parts instead of the non-standard values will significantly change the matching quality.

KAVX provides tight tolerance capacitors with any requested non-standard value for precisely implementing the matching circuit.

Their main features are:

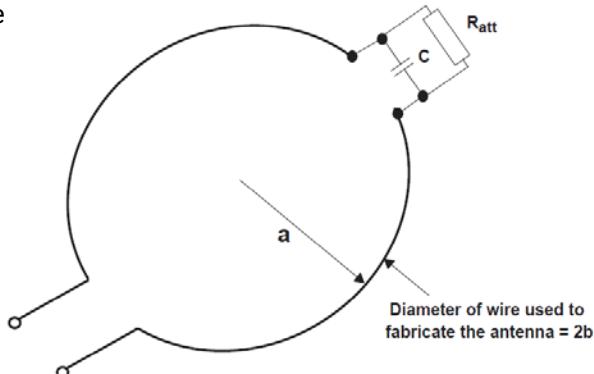
- Tight capacitance tolerances as low as ± 0.1 pF.
- Low ESR and high Q.
- High R.
- High SRF uniformity.
- Repeatable CEFF ESR and Q vs. Frequency.
- Intermediate non-standard values readily available.
- Engineering data and S-Parameters are available.

They are ideal for use in modules and mobile phone antenna matching circuits

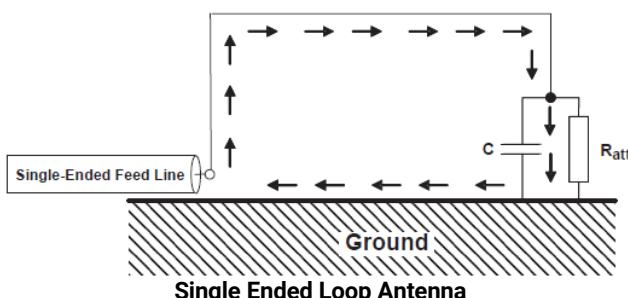
Tight Tolerance KAVX Accu-P® RF Capacitors Improve Cellular Loop Antenna Efficiency

Loop Antennas

Loop antennas are often used for body-worn or hand-held equipment such as mobile phones. Since they are magnetic antennas they are not detuned by the dielectric constant of the material in their reactive



Loop Antenna with Differential Feed



Single Ended Loop Antenna

Together with the capacitor C the inductance of the wire or PC trace builds a resonant circuit. Often a resistor R_{att} is added to reduce the quality factor of the antenna to make it less sensitive to capacitor tolerances. Of course this resistor dissipates energy and reduces the antenna's efficiency. By using tight capacitance tolerances R_{att} may be reduced or eliminated thus increasing the antenna efficiency.

The maximum usable quality factor is a function of the cap

$$\sqrt{\frac{C}{C - \frac{1}{Q_{max}}}}$$

$$n = \frac{Q}{\pi} \frac{R}{f} \frac{1}{L} \quad R_r \text{ radiation resistance}$$



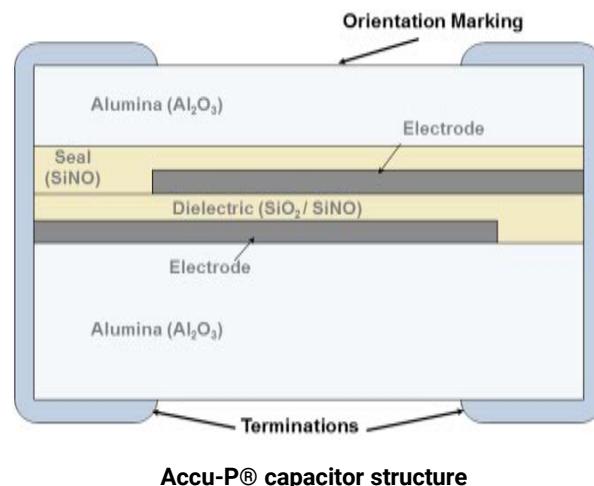
In order to increase the antenna efficiency it is therefore essential to maximize C. This is achieved by using tight capacitance tolerances which results in a low $\frac{\Delta C}{C}$.

An accurate and repeatable capacitor is critical. KAVX Accu-P® capacitors are the ideal component for this application due to the repeatability of their RF performance and the availability of tight tolerances.

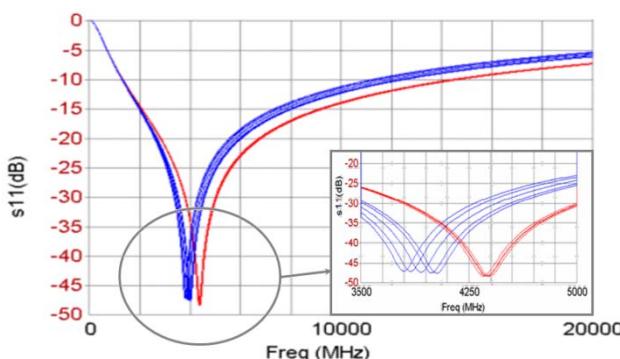
AVX Accu-P® RF Capacitors

AVX Accu-P® RF Capacitors are made by Thin-Film Technology and exhibit nearly ideal characteristics. Their main features are:

- High purity electrodes for very low and repeatable ESR>
- Highly pure low- dielectric for high breakdown voltage high insulation resistance and low losses at frequencies up to 100 GHz .
- Very tight dimensional control for uniform and stable frequency characteristics unit to unit batch to batch year after year.
- Tight capacitance tolerances . . pF
- Easy availability of non-standard values.



Accu-P® capacitor structure



Typical SRF distribution for **Thin Film** vs. **ceramic MLCC**

Accu-P® Tight Tolerance Engineering Kits

Accu-P® 01005
Designer Kit Type 3100LF
Order Number: Accu-P® C005KITL1

Volts	Capacitors Value pF	Tolerance
16	0.05	P
	0.1	P
	0.2	P
	0.3	P
	0.4	P
	0.5	P
	0.6	P
	0.7	P
	0.8	P
	0.9	P
	1.0	Q
	1.2	Q
	1.5	Q
	1.8	Q
	2.2	Q

7500 Capacitors, 500 each of 15 values

Tolerance P = $\pm 0.02\text{pF}$

Q = $\pm 0.03\text{pF}$

Accu-P® 01005 Engineering Kit

Accu-P®
Designer Kit Type 2800LF
Order Number: Accu-P® 0201KITL5

Volts	Capacitors Value pF	Tolerance
100	0.05	Z
	0.10	Z
	0.15	Z
	0.20	Z
	0.25	Z
	0.30	Z
	0.35	Z
	0.40	Z
	0.45	Z
	0.50	Z
50	0.55	P
	0.60	P
	0.65	P
	0.70	P
	0.75	P
	0.80	P
	0.85	P
	0.90	P
	0.95	P
	1.0	P
	1.1	P
	1.2	P
	1.3	P
	1.4	P
	1.5	P
25	1.6	P
	1.7	P
	1.8	P
1.9	1.9	P
	2.0	P

600 Capacitors, 20 each of 30 values

Tolerance Z = $\pm 0.01\text{pF}$

P = $\pm 0.02\text{pF}$

Accu-P® 0201 Engineering Kit

Accu-P®
Designer Kit Type 2700LF
Order Number: Accu-P® 0402KITL4

Volts	Capacitors Value pF	Tolerance
100	0.05	Z
	0.10	Z
	0.15	Z
	0.20	Z
	0.25	Z
	0.30	Z
	0.35	Z
	0.40	Z
	0.45	Z
	0.50	Z
	0.55	P
	0.60	P
	0.65	P
	0.70	P
	0.75	P
50	0.80	P
	0.85	P
	0.90	P
	0.95	P
	1.0	P
	1.1	P
	1.2	P
	1.3	P
	1.4	P
	1.5	P
25	1.6	P
	1.7	P
	1.8	P

600 Capacitors, 20 each of 30 values

Tolerance Z = $\pm 0.01\text{pF}$

P = $\pm 0.02\text{pF}$

Accu-P® 0402 Engineering Kit

References

- ISM-Band and Short Range Device Antennas. Texas Instruments Application Report SWRA046A (2005) Matthew Loy / Iboun Sylla (Editors)

TECHNICAL NOTE

DATE: 30/07/2023
FROM: Amir Kopelman –Technical Services Manager
RE: Accu-P® 3 digit Capacitance Ordering Codes

The following 3 digit capacitance ordering codes should be used for ordering **Intermediate (non standard)** values Accu-P® capacitors:

Capacitance Range	Ordering Code	Example	
		Capacitance	Ordering P/N
0.00 to 0.99pF	Rxx	0.15pF	04023JR15ABSTR
1.00 to 1.99pF	Axx	1.55pF	04023JA55PBSTR
2.00 to 2.99pF	Bxx	2.85pF	04023JB85PBSTR
3.00 to 3.99pF	Cxx	3.85pF	02013JC85ABSTR
4.00 to 4.99pF	Dxx	4.85pF	06033JD85BBSTR
5.00 to 5.99pF	Exx	5.85pF	04023JE85ABSTR
6.00 to 6.99pF	Fxx	6.85pF	06035JF85BBSTR
7.00 to 7.99pF	Gxx	7.85pF	04023JG85BBSTR
8.00 to 8.99pF	Hxx	8.85pF	08055JH85BBTTR
9.00 to 9.99pF	Jxx	9.85pF	04023JJ85BBSTR
10.0 to 19.9pF	Kxx	13.8pF	04023KK38FBSTR
20.0 to 29.9pF	Lxx	22.5pF	06033JL25GBSTR
30.0 to 39.9pF	Mxx	33.8pF	0402ZKM38FBSTR
40.0 to 49.9pF	Nxx	43.5pF	08053KN35FBTTR

Regards,



FOLLOW US:

VISIT US AT WWW.KYOCERA-AVX.COM

North America
Tel: +1 864-967-2150

Europe
Tel: +44 1276-697000

Asia
Tel: +65 6286-7555

Central America
Tel: +55 11-46881960

Japan
Tel: +81 740-321250