ALTERNATIVE SOLUTIONS

Using Panasonic Capacitor Technology to Replace Tantalums

MLCC For Small Capacitance Values
SMT Aluminum Electrolytic For Large Capacitance Values
SP-Cap For Low ESR Values

SP-Cap	SMT Aluminum Electrolytic	MLCC

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Breaking Away From The Tantalum Trap

In today's market there is an increasing need for stable voltage in countless applications but especially for the computers and digital equipment that use powerful microprocessors, such as CPU, ASIC and LSI. These processors deal with massive volumes of data and require large scale integration and faster clock speeds which call for more load current and in turn, lower operating voltages. Additionally, the market is seeing current ramp at the start of LSI operations (di/dt) becoming faster and faster.

The components industry is under pressure to provide solutions that manage the risk of unstable power. Various capacitor technologies are employed in voltage regulators such as tantalum capacitors, aluminum capacitors, and for low ESR (equivalent series resistance), polymer capacitors and multi-layer ceramic capacitors (MLCC).

SP-Cap, MLCC, & SMT Aluminum Electrolytic Capacitors as capacitive alternatives to Tantalum.

The Unstable Supply of Rare Tantalum Ore

The first technology mentioned, Tantalum capacitors, uses a semi-rare metal (tantalum) as its primary material and because of its scarcity it suffers from cyclical shortages. Our industry saw one such shortage in the year 2000. **To solve this cyclical shortage of material other types of capacitors found their way into applications which typically used Tantalums, for instance, MLCCs replaced the smaller capacitance tantalums, larger capacitance tantalums were replaced by aluminum capacitors, and in the low ESR arena polymer aluminum capacitors found themselves as an excellent substitute.** Looking ahead it appears that another shortage is coming due to the instable supply of tantalum ore, according to industry sources. This will inevitably lead to a shortage in supply and an increase in the cost of tantalum capacitors.

Breaking Away from Tantalum Capacitors

Unfortunately, Tantalum capacitors have a strong foothold in the North American market, especially when compared to their use throughout the rest of the world. In the past, tantalums were chosen because there was a lack of other options available and the industry's willingness to work around its notable weakness of mandatory voltage derating (in order to prevent failures).

With the pending shortage and inevitable price increase; now is the perfect time to contemplate how to break away from the tantalum trap. With an abundant supply of material, Aluminum capacitors are one viable option; with products that include aluminum polymer capacitors and surface mount aluminum capacitors.

Three Options From Panasonic To Help You Avoid The Tantalum Trap

1. Use the cross references supplied in this brochure to choose a tantalum alternative solution.
   - MLCC's
   - SMT Aluminum Electrolytics
   - SP-Caps
2. A local Panasonic Sales Representative is available to work with you on Tantalum alternative designs. Call 1-800-344-2112 for assistance.
3. Visit www.panasonic.com/TantalumOptions for access to complete tantalum alternative product design information

BREAK AWAY TODAY!

Polymer aluminum capacitors use polymer as a solid electrolyte. They boast ESR values as low as 4.5mohm (@100KHz). This is because polymer offers 10,000 times more conductivity than the electrolyte found in wet aluminum technology, and 1,000 times more than tantalum technology. Polymer Aluminum Capacitors have available capacitance ranges from a few microfarads to 560uF. Layered aluminum foil construction realizes significantly lower ESL (equivalent series inductance) when compared with wound-type aluminum capacitors. In addition, they also offer stable capacitance against frequency and temperature changes.

Surface Mount Aluminum Capacitors cover an extensive CV range from 6.3V to 450V / 0.1uF to 6800uF, and are available for general purpose to low impedance. State-of-the-art SMT aluminum capacitors use high-conductivity electrolyte, achieving 60mohm (100KHz) ESR which surpasses regular tantalums.

If we can rethink the entrenched use of tantalum capacitors and view capacitor selection from a new perspective, we will be able to achieve better designs and reduce costs at the same time.

Tantalum-to-SP-CAP Cross Reference

Tantalum Capacitors							Panasonic SP-Cap Recommended Replacements							
Rated voltage (V)	Cap (μF)	Size code / ESR(Ω)					(1/2 capacitance of Ta)				(Same capacitance of Ta)			
		B	C	V	D	E								
		3528-21	6032-28	7343-20	7343-31	7343-43	P/N	R.V. (V)	Cap. (μF)	ESR (Ω)	P/N	R.V. (V)	Cap. (μF)	ESR (Ω)
4 (Circuit voltage 2.0V max.)	100	0.65	0.20	-	0.20	-	EEFCD0D101ER	2	100	0.018	-	-	-	-
	150	1.00	0.30	0.20	0.15	-	EEFCD0D101ER	2	100	0.018	EEFCD0D151ER	2	150	0.018
	220	0.40	-	0.30	-	-	EEFCD0D101ER	2	100	0.018	EEFCD0D221ER	2	220	0.018
	330	-	0.09	0.30	0.15	-	EEFCD0D151ER	2	150	0.018	EEFCX0D331R	2	330	0.015
	470	-	-	-	0.15	0.15	EEFCD0D221ER	2	220	0.018	EEFCX0D471R	2	470	0.015
	680	-	-	-	0.15	0.10	EEFCX0D331R	2	330	0.015	-	-	-	-
	1000	-	-	-	-	0.10	EEFCX0D471R	2	470	0.015	-	-	-	-
6.3 (Circuit voltage 2.5V~3.3V)	47	0.50	0.25	-	0.22	-	EEFCD0J220ER	6.3	22	0.040	EEFCD0J470ER	6.3	47	0.018
	68	0.65	0.20	-	0.20	-	EEFCD0J330ER	6.3	33	0.028	EEFCD0G680ER	4	68	0.018
	100	1.50	0.30	0.20	0.15	-	EEFCD0J470ER	6.3	47	0.018	EEFCD0G101ER	4	100	0.018
	150	-	0.30	0.30	0.15	-	EEFCD0G820ER	4	82	0.018	EEFCX0G151R	4	150	0.015
	220	-	0.30	0.30	0.15	0.15	EEFCD0G101ER	4	100	0.018	EEFCX0G221R	4	220	0.015
	330	-	-	-	0.15	0.15	EEFCX0G151R	4	150	0.015	-	-	-	-
	470	-	-	-	0.15	0.10	EEFCX0G221R	4	220	0.015	-	-	-	-
10 (Circuit voltage 3.3V~5V)	22	0.70	0.40	-	-	-	EEFCD0J100ER	6.3	10	0.055	EEFCD0J220ER	6.3	22	0.040
	47	0.65	0.30	0.30	0.22	-	EEFCD0J220ER	6.3	22	0.040	EEFCD0J470ER	6.3	47	0.018
	68	1.50	0.30	0.30	0.20	-	EEFCD0J330ER	6.3	33	0.028	EEFCD0J680ER	6.3	68	0.018
	100	-	0.20	0.40	0.15	-	EEFCD0J470ER	6.3	47	0.018	EEFCX0J101R	6.3	100	0.015
	150	-	0.70	0.30	0.15	0.15	EEFCD0J680ER	6.3	68	0.018	EEFCX0J151R	6.3	150	0.015
	220	-	-	0.50	0.15	0.15	EEFCX0J101R	6.3	100	0.015	-	-	-	-
	330	-	-	-	0.15	0.10	EEFCX0J151R	6.3	150	0.015	-	-	-	-
	470	-	-	-	0.10	0.10	EEFCX0G221R	4	220	0.015	-	-	-	-
16 (Circuit voltage 5V~8V)	10	0.80	0.60	-	-	-	EEFCD1A220ER	10	22	0.025	EEFCD0J100ER	6.3	10	0.055
	22	1.00	0.35	-	0.25	-	EEFCD1A220ER	10	22	0.025	EEFCD0J220ER	6.3	22	0.040
	33	-	0.30	-	0.25	-	EEFCD1A220ER	10	22	0.025	EEFCD0J330ER	6.3	33	0.028
	47	-	0.50	0.30	0.20	-	EEFCD1A220ER	10	22	0.025	EEFCD0J470ER	6.3	47	0.018
	68	-	1.00	0.50	0.15	-	EEFCD1A330ER	10	33	0.025	EEFCD0J680ER	6.3	68	0.018
	100	-	-	0.50	0.15	-	EEFCD0J470ER	6.3	47	0.018	EEFCX0J101R	6.3	100	0.015
	150	-	-	-	0.40	0.15	EEFCD0J680ER	6.3	68	0.018	EEFCX0J151R	6.3	150	0.015
	220	-	-	-	-	0.40	EEFCX0J101R	6.3	100	0.015	-	-	-	-

Tantalum-to-SMT Aluminum Electrolytic Capacitor Cross Reference

Tantalum Capacitors							Panasonic Aluminum Electrolytic Capacitors (SMD, LOW ESR)									
Rated Voltage	Cap (μF)	Size code / ESR(Ω)					V-FK series					V-FP series				
		B 3528-21	C 6032-28	V 7343-20	D 7343-31	E 7343-43	P/N	Size	R.V. V	Cap. μF	ESR Ω	P/N	Size	R.V. V	Cap. μF	ESR Ω
4 Circuit voltage 2.0V max.	100	0.65	0.20	-	0.20	-	EEEFKJ101UAR	C (5x5.8)	6.3	100	0.70	EEEFP0J101AP	D (6.3x5.8)	6.3	100	0.26
	150	1.00	0.30	0.20	0.15	-	EEEFK1A151AP	D (6.3x5.8)	10	150	0.36	EEEFP0J221AP	D (6.3x5.8)	6.3	220	0.26
	220	0.40	-	0.30	-	-	EEEFK0J221AP	D (6.3x5.8)	6.3	220	0.36	EEEFP0J221AP	D (6.3x5.8)	6.3	220	0.26
	330	-	0.09	0.30	0.15	-	EEEFKJ331XAP	D8 (6.3x7.7)	6.3	330	0.34	EEEFPJ331XAP	D8 (6.3x7.7)	6.3	330	0.16
	470	-	-	-	0.15	0.15	EEEFK0J471AP	F (8x10)	6.3	470	0.16	EEEFP0J471AP	F (8x10)	6.3	470	0.08
	680	-	-	-	0.15	0.10	EEEFK1A681AP	F (8x10)	10	680	0.16	EEEFP1A681AP	F (8x10)	10.0	680	0.08
	1000	-	-	-	-	0.10	EEEFK0J102AP	G (10x10)	6.3	1000	0.08	EEEFP0J102AP	G (10x10)	6.3	1000	0.06
6.3 Circuit voltage 2.5V~3.3V	47	0.50	0.25	-	0.22	-	EEEFK1C470AP	D (6.3x5.8)	16	47	0.36	EEEFP0J470AR	C (5x5.8)	6.3	47	0.36
	68	0.65	0.20	-	0.20	-	EEEFKJ101UAR	C (5x5.8)	6.3	100	0.70	EEEFP0J101AP	D (6.3x5.8)	6.3	100	0.26
	100	1.50	0.30	0.20	0.15	-	EEEFKJ101UAR	C (5x5.8)	6.3	100	0.70	EEEFP0J101AP	D (6.3x5.8)	6.3	100	0.26
	150	-	0.30	0.30	0.15	-	EEEFK1A151AP	D (6.3x5.8)	10	150	0.36	EEEFP0J221AP	D (6.3x5.8)	6.3	220	0.26
	220	-	0.30	0.30	0.15	0.15	EEEFK0J221AP	D (6.3x5.8)	6.3	220	0.36	EEEFP0J221AP	D (6.3x5.8)	6.3	220	0.26
	330	-	-	-	0.15	0.15	EEEFKJ331XAP	D8 (6.3x7.7)	6.3	330	0.34	EEEFPJ331XAP	D8 (6.3x7.7)	6.3	330	0.16
	470	-	-	-	0.15	0.10	EEEFK0J471AP	F (8x10)	6.3	470	0.16	EEEFP0J471AP	F (8x10)	6.3	470	0.08
10 Circuit voltage 3.3V~5V	22	0.70	0.40	-	-	-	EEEFK1C220AR	C (5x5.8)	16	22	0.70	EEEFP1C220AR	C (4x5.8)	16	22	0.36
	47	0.65	0.30	0.30	0.22	-	EEEFKC470UAR	C (5x5.8)	16	47	0.70	EEEFP1C470AP	D (6.3x5.8)	16	47	0.26
	68	1.50	0.30	0.30	0.20	-	EEEFK1C680AP	D (6.3x5.8)	16	68	0.36	EEEFP1C680AP	D (6.3x5.8)	16	68	0.26
	100	-	0.20	0.40	0.15	-	EEEFK1C101AP	D (6.3x5.8)	16	100	0.36	EEEFP1C101AP	D (6.3x5.8)	16	100	0.26
	150	-	0.70	0.30	0.15	0.15	EEEFK1A151AP	D (6.3x5.8)	10	150	0.36	EEEFPC151XAP	D8 (6.3x7.7)	16	150	0.16
	220	-	-	0.50	0.15	0.15	EEEFKA221XAP	D8 (6.3x7.7)	10	220	0.34	EEEFPA221XAP	D8 (6.3x7.7)	10	220	0.16
	330	-	-	-	0.15	0.10	EEEFK1A331AP	F (8x10)	10	330	0.16	EEEFP1A331AP	F (8x10)	10	330	0.08
	470	-	-	-	0.10	0.10	EEEFK1A471AP	F (8x10)	10	470	0.16	EEEFP1A471AP	F (8x10)	10	470	0.08
16 Circuit voltage 5V~8V	10	0.80	0.60	-	-	-	EEEFK1V100AR	C (5x5.8)	35	10	0.70	EEEFP1C220AR	C (4x5.8)	16	10	0.36
	22	1.00	0.35	-	0.25	-	EEEFK1C220AR	C (5x5.8)	16	22	0.70	EEEFP1E330AP	D (6.3x5.8)	25	33	0.26
	33	-	0.30	-	0.25	-	EEEFK1V330AP	D (6.3x5.8)	35	33	0.36	EEEFP1E330AP	D (6.3x5.8)	25	33	0.26
	47	-	0.50	0.30	0.20	-	EEEFK1C470AP	D (6.3x5.8)	16	47	0.36	EEEFP1C470AP	D (6.3x5.8)	16	47	0.26
	68	-	1.00	0.50	0.15	-	EEEFK1C680AP	D (6.3x5.8)	16	68	0.36	EEEFPC101XAP	D8 (6.3x7.7)	16	100	0.16
	100	-	-	0.50	0.15	-	EEEFK1C101AP	D (6.3x5.8)	16	100	0.36	EEEFPC101XAP	D8 (6.3x7.7)	16	100	0.16
	150	-	-	-	0.40	0.15	EEEFKC151XAP	D8 (6.3x7.7)	16	150	0.34	EEEFPC151XAP	D8 (6.3x7.7)	16	150	0.16
	220	-	-	-	-	0.40	EEEFKC221XAP	D8 (6.3x7.7)	16	220	0.34	EEEFPC221XAP	D8 (6.3x7.7)	16	220	0.16
25	10	3.00	0.60	-	0.40	-	EEEFK1E100AR	B (4x5.8)	25	10	.1.35	EEEFP1E100AR	B (4x5.8)	25	10	0.85
	22	-	1.00	0.50	0.30	-	EEEFK1E220AR	C (5x5.8)	25	22	0.70	EEEFP1E220AR	C (5x5.8)	25	22	0.36
	33	-	1.00	-	0.40	0.30	EEEFKE330UAR	C (5x5.8)	25	33	0.70	EEEFPE330UAR	C (5x5.8)	25	33	0.36
	47	-	-	-	0.20	0.30	EEEFK1E470AP	D (6.3x5.8)	25	47	0.36	EEEFP1E470AP	D (6.3x5.8)	25	47	0.26
	68	-	-	-	0.50	0.30	EEEFK1E680AP	D (6.3x5.8)	25	68	0.36	EEEFP1E680AP	D (6.3x5.8)	25	68	0.26
	100	-	-	-	-	0.25	EEEFKE101XAP	D8 (6.3x7.7)	25	100	0.34	EEEFPE101XAP	D8 (6.3x7.7)	25	100	0.18
35	10	-	1.20	0.80	0.40	-	EEEFKV100UAR	B (4x5.8)	35	10	.1.35	EEEFPV100UAR	B (4x5.8)	35	10	0.85
	22	-	-	-	0.40	0.30	EEEFK1V220AR	C (5x5.8)	35	22	0.70	EEEFP1V220AR	C (5x5.8)	35	22	0.36
	33	-	-	-	0.60	0.60	EEEFK1V330AP	D (6.3x5.8)	35	33	0.36	EEEFP1V330AP	D (6.3x5.8)	35	33	0.26
	47	-	-	-	-	0.50	EEEFK1V470AP	D (6.3x5.8)	35	47	0.36	EEEFP1V470AP	D (6.3x5.8)	35	47	0.26
50	10	-	-	-	0.70	0.40	EEEFK1H100P	D (6.3x5.8)	50	10	0.88	-	-	-	-	-
	22	-	-	-	-	0.50	EEEFK1H220XP	D8 (6.3x7.7)	50	22	0.68	-	-	-	-	-

Tantalum-to-MLCC Cross Reference

Tantalum Capacitor Values					Panasonic MLCC (Multi-Layer Ceramic Chip) Capacitor Recommended Replacements							
Rated Voltage V	Cap µF	Size Codes P 2012-12	A 3216-18	B 3528-21	P/N	Size	R.V. (V)	Cap. (µF)	P/N	Size	R.V. (V)	Cap. (µF)
4/6.3	0.47	-	-	-	ECJ0EB0J474K	0402	6.3	0.47	ECJ1VB0J474K	0603	6.3	0.47
	1	-	-	-	ECJ0EB0J105K	0402	6.3	1	ECJ1VB0J105K	0603	6.3	1
	2.2	-	-	-	ECJ0EB0J225M	0402	6.3	2.2	ECJ1VB0J225K	0603	6.3	2.2
	4.7	-	-	-	ECJ0EB0J475M	0402	6.3	4.7	ECJ1VB0J475K	0603	6.3	4.7
	10	-	-	-	ECJ1VB0J106M	0603	6.3	10	ECJ2FB0J106K	0805	6.3	10
	22	-	-	-	ECJ2FB0J226M	0805	6.3	22	ECJDV50J226M	1206	6.3	22
10	0.47	-	-	-	ECJ0EB1A474K	0402	10	0.47	ECJ1VB1A474K	0603	10	0.47
	1	-	-	-	ECJ0EB1A105K	0402	10	1	ECJ1VB1A105K	0603	10	1
	2.2	-	-	-	ECJ1VB1A225K	0603	10	2.2	ECJ2FB1A225K	0805	10	2.2
	4.7	-	-	-	ECJ1VB1A475K	0603	10	4.7	ECJ2FB1A475K	0805	10	4.7
	10	-	-	-	ECJ1VB1A106M	0603	10	10	ECJ2FB1A106M	0805	10	10
	22	-	-	-	ECJ2FB1A226M	0805	10	22	ECJ3YB1A226M	1206	10	22
16	0.47	-	-	-	ECJ0EB1C474K *	0402	16	0.47	ECJ1VB1C474K	0603	16	0.47
	1	-	-	-	ECJ0EB1C105M	0402	16	1	ECJ1VB1C105K	0603	16	1
	2.2	-	-	-	ECJ1VB1C225K *	0603	16	2.2	ECJ2FB1C225K	0805	16	2.2
	4.7	-	-	-	ECJ1VB1C475K *	0603	16	4.7	ECJ2FB1C475K	0805	16	4.7
	10	-	-	-	ECJ2FB1C106K *	0805	16	10	ECJ3YB1C106K	1206	16	10
	22	-	-	-	ECJ3YB1C226M	1206	16	22	-	-	-	-
25	0.47	-	-	-	ECJ1VB1E474K	0603	25	0.47	ECJ2FB1E474K	0805	25	0.47
	1	-	-	-	ECJ1VB1E105K	0603	25	1	ECJ2FB1E105K	0805	25	1
	2.2	-	-	-	ECJ2FB1E225K	0805	25	2.2	ECJ3YB1E225K	1206	25	2.2
	4.7	-	-	-	ECJ2FB1E475K	0805	25	4.7	ECJ3YB1E475K	1206	25	4.7
	10	-	-	-	ECJ3YB1E106K	1206	25	10	-	-	-	-
	22	-	-	-	-	-	-	-	-	-	-	-

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* ECJ0EB1C474K available 02/09
ECJ1VB1C225K available 01/09
ECJ1VB1C475K available 12/09
ECJ2FB1C106K available 02/09

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Panasonic Industrial Company's Electronic Components Division is one of the industry's largest suppliers of standard and custom electronic components. Our wide product offering, coupled with our global manufacturing and sales capabilities, as well as our commitment to customer service make us a preferred vendor to the world's most famous original equipment manufacturers of high-tech electronic products.

Panasonic SP-Cap is a SMT aluminum electrolytic capacitor that uses a conductive polymer as the electrolyte material. SP-Caps are primarily used as input and output capacitors for DC to DC converters due to the excellent ultra low ESR values. The SP-Cap line up offers excellent price/performance for moderate to high CV (Capacitance x Voltage) values, very low ESR/impedance, high ripple current and high frequency performance.
http://www.panasonic.com/industrial/components/capcitive/cap_spcap.htm

Panasonic's surface mount type Aluminum Electrolytic capacitors are available in a broad range of voltage ratings and capacitance values. With features like low ESR, high ripple current, long service life, and operating temperatures up to 125°C, they can be used in various types of applications including audio/visual equipment, telecommunications, automotive and industrial controllers among others.
http://www.panasonic.com/industrial/components/capacitive/cap_smtelec.htm

Panasonic manufactures a wide variety of Multi-Layer Ceramic Chip Capacitors with a variety of different features and specifications which include small sizes, large capacitance values, low ESR/ESL, high frequency characteristics, low self inductance and excellent solderability.
http://www.panasonic.com/industrial/components/capacitive/cap_mlcc.htm

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