

Extended Lifetime Aluminum Electrolytic Capacitors

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- ▶ NIC Global Technical Support Contacts



Any questions on the following material, please contact:
Jim Wright, NIC Components Corp.
jwright@niccomp.com 631-396-7500 x213
Or - NIC Technical support @ TPMG@niccomp.com

Longer Life End Products & Applications

In designing a product, the engineer must assure that the shortest-lived component lasts long enough to provide a useful service life for the equipment

LED, Florescent & Induction Lighting
+60,000 Hrs Lifetime
About 10 years burning on 6000hrs /year (~70% of time)

Indeed on a 12-hour switching cycle, lamps are shown to achieve a massive **80,000 hours** life when operated on electronic ballasts.

Power management for redundant systems
Fault-tolerant critical power supplies



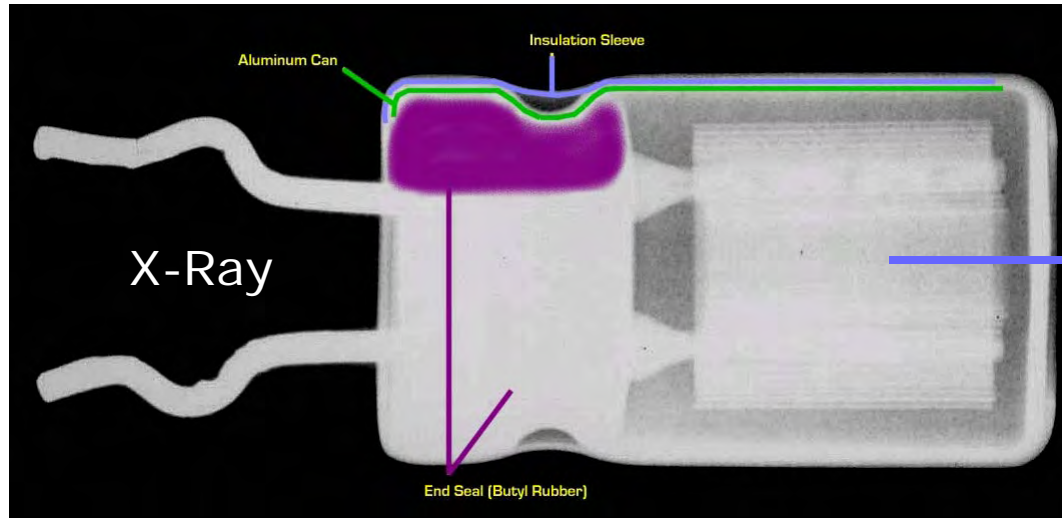
Digital Home Appliances
>10 Year Life Span



80,000-hour ratings for servers, power supplies and medical applications



Electrolytic Capacitor - Life Time Behavior



Wound Capacitor Element
Saturated with Liquid Electrolyte

Liquid Electrolyte Construction Aluminum Electrolytic Capacitors

Most common & highest volume construction used globally
(~100 Billion Units / Year)



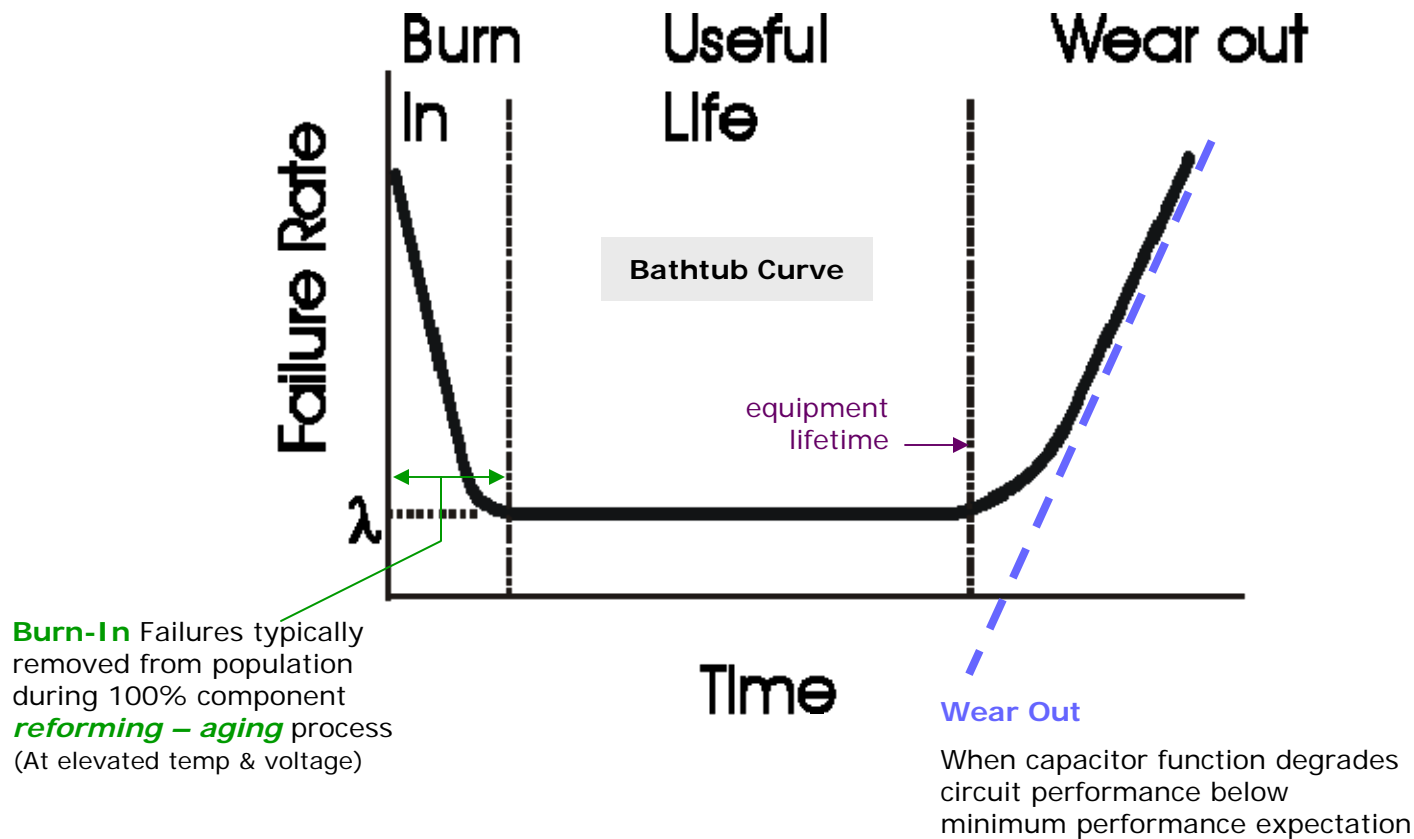
Liquid electrolyte construction has advantages and disadvantages

Advantages (pros):	Disadvantages (cons):
<ul style="list-style-type: none"> ✓ Low Cost ✓ Surge Resistant ✓ Self Healing ✓ High Capacitance ✓ High Voltage 	<ul style="list-style-type: none"> ✗ Limited Lifetime ✗ Wear out ✗ Typically larger size than Tantalum & MLCC

Electrolytic Capacitor - Life Time Behavior

Component Lifetime Estimates are based upon circuit behaviour expectation

- Component **wear-out** is point when capacitor function degrades circuit performance below minimum performance expectation
- Goal is to select component to meet the end use equipment lifetime requirement, prior to capacitor wear out

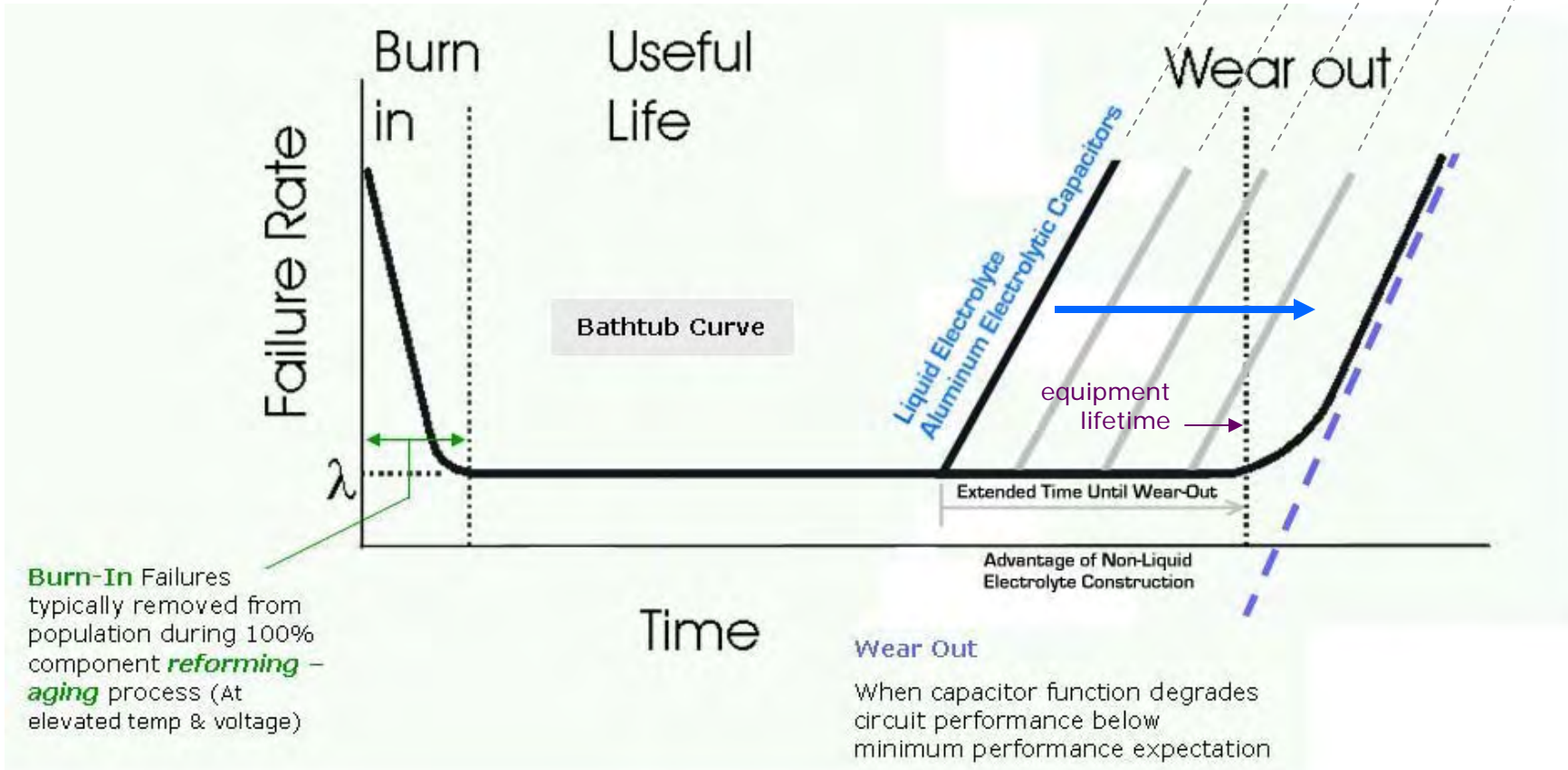


Electrolytic Capacitor - Life Time Behavior

Capacitor Lifetime Performance Comparison

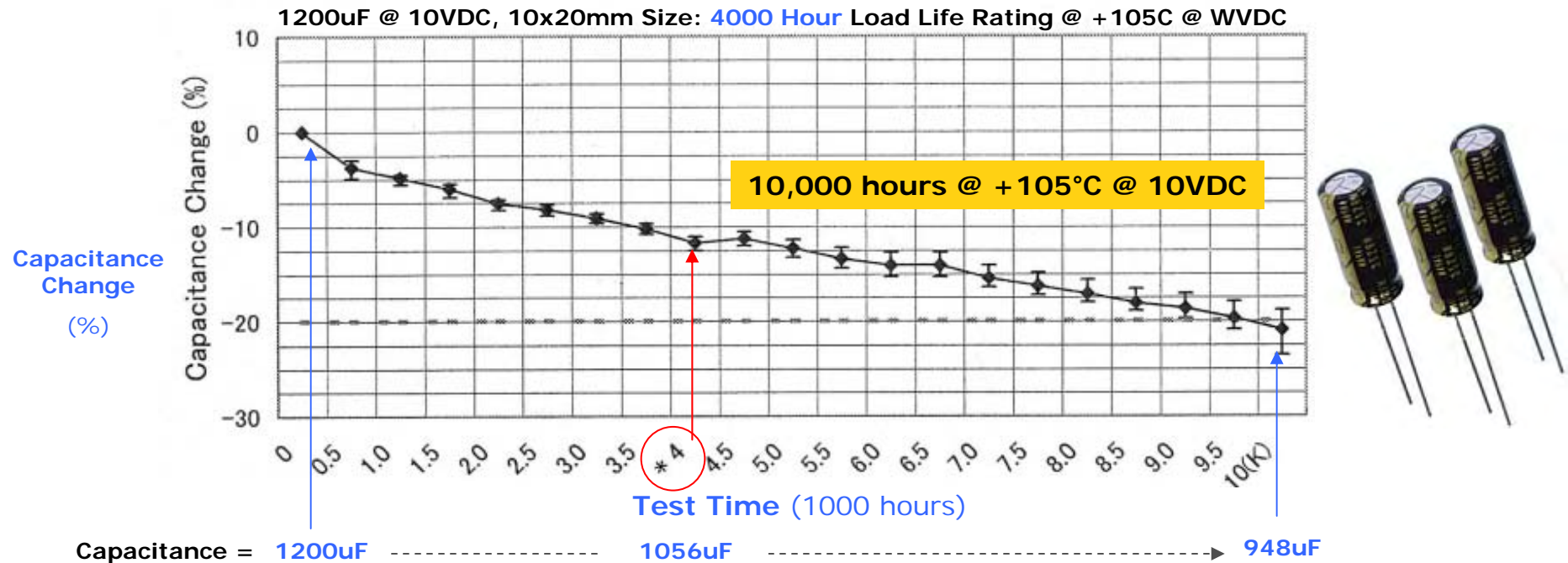
COMPARISON EXAMPLE

- 10,000 hrs @ +105°C
- 8000 hrs @ +105°C
- 4000 hrs @ +105°C
- 2000 hrs @ +105°C
- 1000 hrs @ +105°C



Electrolytic Capacitor - Life Time Behavior

Performance Characteristic Change over Time @ Rated Temperature



- Dissipation of the liquid electrolyte from the capacitor reduces the cathode connection, resulting in capacitance decrease & DF (ESR) increase

- The rate of dissipation follows the Arrhenius equation for chemical reactions

- ✓ Temperature affects how quickly a reaction occurs

- ✓ Reaction rate will double for each 10°C increase in temperature (rule of thumb)

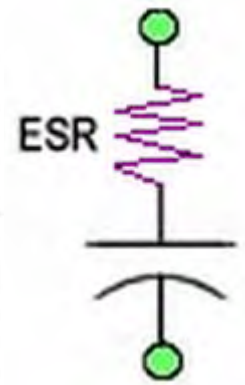
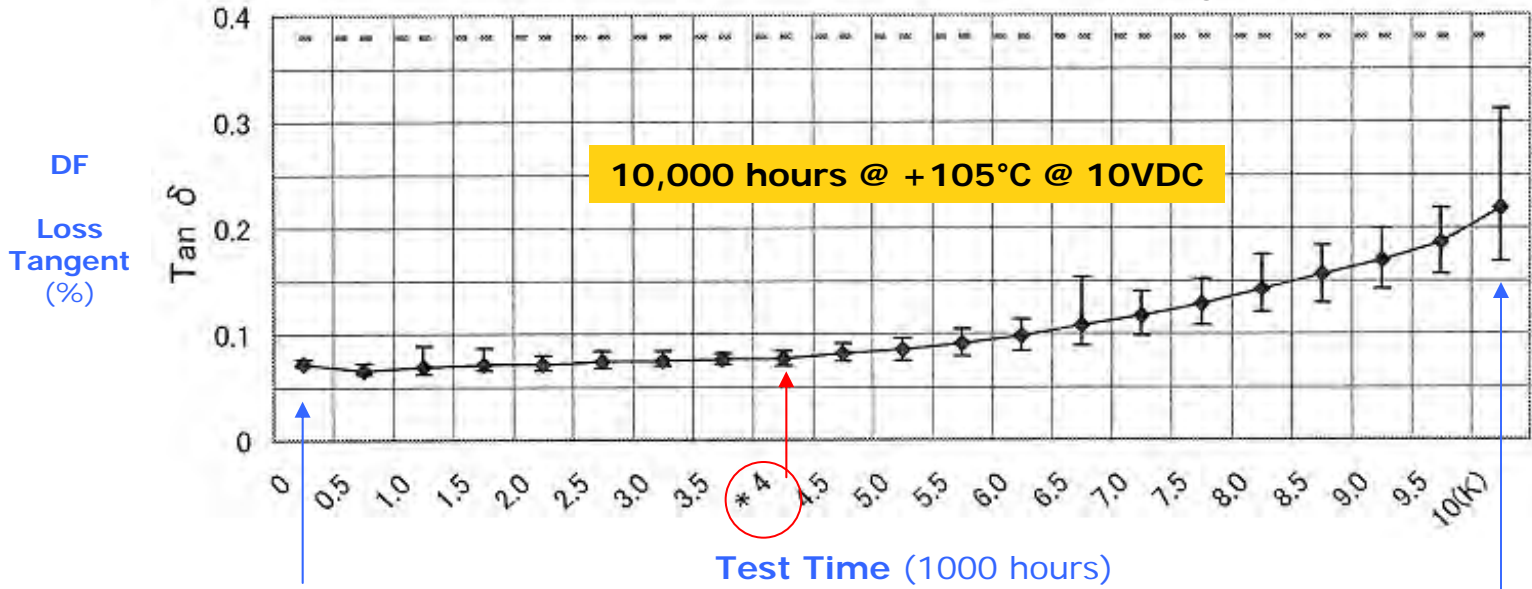
How much does temperature affect reaction rate within liquid electrolyte aluminum electrolytic capacitors?

→ Capacitor life time expectation doubles for 10°C decrease in operating temperature

Electrolytic Capacitor - Life Time Behavior

Performance Characteristic Change over Time @ Rated Temperature

1200uF @ 10VDC, 10x20mm Size: 4000 Hour Load Life Rating @ +105C @ WVDC



Tan δ = 0.19 0.38
 120Hz ESR (Max) = 0.26 ohm 0.66 ohm

- Increasing resistive losses over time
- Capacitor becomes less efficient over time of operation
- ESR (Equivalent Series Resistance) increases over time

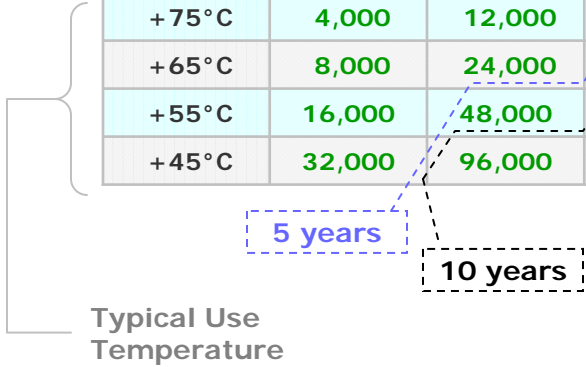
Life Estimate – Operating Temperature



Estimated Life (Hours) Operation

Ratings (Hours) @ Rated VDC / Estimated Life (Hours) @ Rated VDC

	General Purpose	High Reflow Rated	Low ESR High Reflow Rated	Low ESR 6.3~100VDC	Low ESR +125°C 6.3~100VDC	Long Life 6.3~50VDC
Temp	NACE	NAWE	NAZU	NAZT	NATT	NAZV
+125°C	-	-	-	-	2,000	-
+105°C	-	1,000	3,000	5,000	8,000	10,000
+95°C	-	2,000	6,000	10,000	16,000	20,000
+85°C	2,000	6,000	12,000	20,000	32,000	40,000
+75°C	4,000	12,000	24,000	40,000	64,000	80,000
+65°C	8,000	24,000	48,000	80,000	128,000	>15 years
+55°C	16,000	48,000	96,000	>15 years	>15 years	>15 years
+45°C	32,000	96,000	>15 years	>15 years	>15 years	>15 years

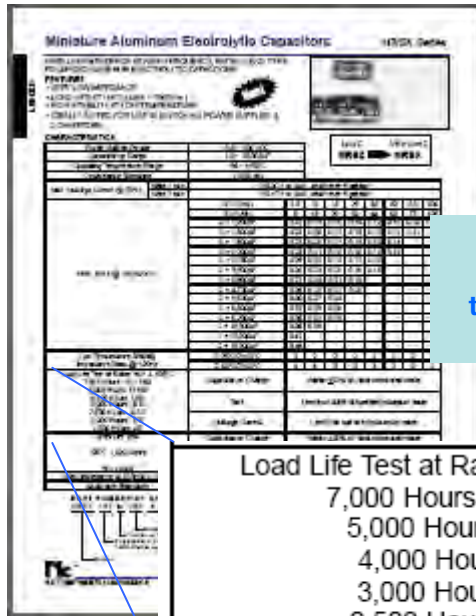


Convert Hours to Years (24/7)

Hours	Years	Hours	Years
1,000	0.1	24,000	2.7
2,000	0.2	32,000	3.7
3,000	0.3	40,000	4.6
4,000	0.5	43,800	5.0
5,000	0.6	48,000	5.5
6,000	0.7	64,000	7.3
8,000	0.9	80,000	9.1
10,000	1.1	87,600	10.0
12,000	1.4	96,000	11.0
16,000	1.8	128,000	14.6
20,000	2.3	160,000	>15

Capacitor Specification Review

Specification Sheet



Load Life Rated at maximum rated temperature (i.e. +105°C) and WVDC

Load Life Test Limits

Load Life Test at Rated W.V. & 105°C 7,000 Hours: 16 ~ 18Ø 5,000 Hours: 12.5Ø 4,000 Hours: 10Ø 3,000 Hours: 8 Ø 2,500 Hours: 6.3Ø 2,000 Hours: 5 Ø 1,000 Hours: 4Ø	Capacitance Change	Within ±20% of initial measured value
	Tan δ	Less than 200% of specified maximum value
	Leakage Current	Less than specified maximum value

Load Life Rating by Component Diameter (Ø mm)
Based upon endurance test results performed by component manufacturer

NOTE: Possible variation in test limits between component manufacturers
Example: ±30% instead of ±20% limit for Δ Capacitance

+105°C

Extended Lifetime Rated Components



12,000 hours
10,000 hours
8,000 hours
7,000 hours
5,000 hours



NRBX 160V - 450VDC Lighting Radial Ledged (LDD)

NSPE-H SMT V-Chip Low ESR Hybrid

NAZV SMT V-Chip 8 & 10mm

NRGB Low Voltage Lighting Radial Ledged (LDD)

NRSH Low ESR & High RCR to 100VDC Radial Ledged (LDD)







NRE-HL Low Z - ESR & High RCR Radial Ledged (LDD)

NRE-FL Low Z - ESR Radial Ledged (LDD)

NRB-XS High Voltage Lighting Radial Ledged (LDD)

Extended Lifetime Rated Products

+150°C & +125°C







Maximum Temperature Rating	Load Life Rating	NIC Series	Type		Temp. Range	Type / Voltage Ratings
+150°C	1000 Hrs	NRE-WX		LDD	-40 ~ +150°C	Special Temp / 10 - 63VDC
+125°C	3000 Hrs 1500 Hrs	NSPE-T		SMT	-55 ~ +125°C	Hybrid Low ESR / Special Temp 25 - 63VDC
+125°C	2000 Hrs	NSPE-U		SMT	-55 ~ +125°C	Hybrid Low ESR / Special Temp 6.3 - 16VDC
+125°C	2000 Hrs 1500 Hrs 1000 Hrs	NATT		SMT	-40 ~ +125°C	Special Temp / 6.3 - 100VDC
+125°C	2000 Hrs	NATK		SMT	-40 ~ +125°C	Special Temp / 16 - 35VDC
+125°C	2000 Hrs 1000 Hrs	NRWX		LDD	-55 ~ +125°C	Special Temp / 10 - 50VDC

Temp.	Load Life Estimation (Hours)
+150°C	1000 hrs
+140°C	2000 hrs
+130°C	4000 hrs
+120°C	8000 hrs
+110°C	16,000 hrs
+105°C	22,627 hrs
+95°C	45,250 hrs
+85°C	90,500 hrs
+75°C	> 15 years

Hours	Years
8,000	0.9
16,000	1.8
43,800	5
87,600	10
131,400	15

Extended Lifetime Rated Products

+150°C & +125°C

Maximum Temperature Rating	Load Life Rating	NIC Series	Type		Temp. Range	Type / Voltage Ratings
+150°C	1000 Hrs	NRE-WX		LDD	-40 ~ +150°C	Special Temp / 10 - 63VDC
+125°C	3000 Hrs 1500 Hrs	NSPE-T		SMT	-55 ~ +125°C	Hybrid Low ESR / Special Temp 25 - 63VDC
+125°C	2000 Hrs	NSPE-U		SMT	-55 ~ +125°C	Hybrid Low ESR / Special Temp 6.3 - 16VDC
+125°C	2000 Hrs 1500 Hrs 1000 Hrs	NATT		SMT	-40 ~ +125°C	Special Temp / 6.3 - 100VDC
+125°C	2000 Hrs	NATK		SMT	-40 ~ +125°C	Special Temp / 16 - 35VDC
+125°C	2000 Hrs 1000 Hrs	NRWX		LDD	-55 ~ +125°C	Special Temp / 10 - 50VDC

Temp.	Load Life Estimation (Hours)
+125°C	2000 hrs
+115°C	4000 hrs
+105°C	8000 hrs
+95°C	16,000 hrs
+85°C	32,000 hrs
+75°C	64,000 hrs
+65°C	128,000 hrs

Hours	Years
8,000	0.9
16,000	1.8
32,000	3.7
64,000	7.3
128,000	14.6

Extended Lifetime Rated Products

+105°C

Maximum Temperature Rating	Load Life Rating	NIC Series (PDF)	Type		Temp. Range	Type / Voltage Ratings
+105°C	12,000 Hrs 10,000 Hrs	NRBX		LDD	-25 ~ +105°C	Long Life / 160 - 450VDC
+105°C	10,000 Hrs 7000 Hrs 5000 Hrs	NSPE-H		SMT	-55 ~ +105°C	Hybrid Low ESR / 10Khrs SMT 25 - 100VDC
+105°C	10,000 Hrs 7000 Hrs	NAZV		SMT	-25 ~ +105°C	10Khrs SMT 6.3 - 50VDC
+105°C	10,000 Hrs	NRGB		LDD	-25 ~ +105°C	10Khrs All Sizes / 10 - 100VDC
+105°C	10,000 Hrs 8000 Hrs 6000 Hrs	NRSH		LDD	-40 ~ +105°C	Low ESR / 6.3 - 50VDC
+105°C	10,000 Hrs 8000 Hrs 7000 Hrs 6000 Hrs 5000 Hrs 4000 Hrs	NRE-HL		LDD	-40 ~ +105°C	Low ESR / 6.3 - 100VDC
+105°C	10,000 Hrs 8000 Hrs 7000 Hrs 5000 Hrs 4000 Hrs 2000 Hrs	NRE-FL		LDD	-40 ~ +105°C	Low ESR / 6.3 - 250VDC
+105°C	10,000 Hrs 8000 Hrs 5000 Hrs	NRB-XS		LDD	-25 ~ +105°C	High RC Rated / 160 - 450VDC

Temp.	Load Life Estimation (Hours)
+105°C	10,000 hrs
+95°C	20,000 hrs
+85°C	40,000 hrs
+75°C	80,000 hrs
+65°C	> 15 years

Hours	Years
10,000	1.1
20,000	2.3
40,000	4.6
80,000	9.1



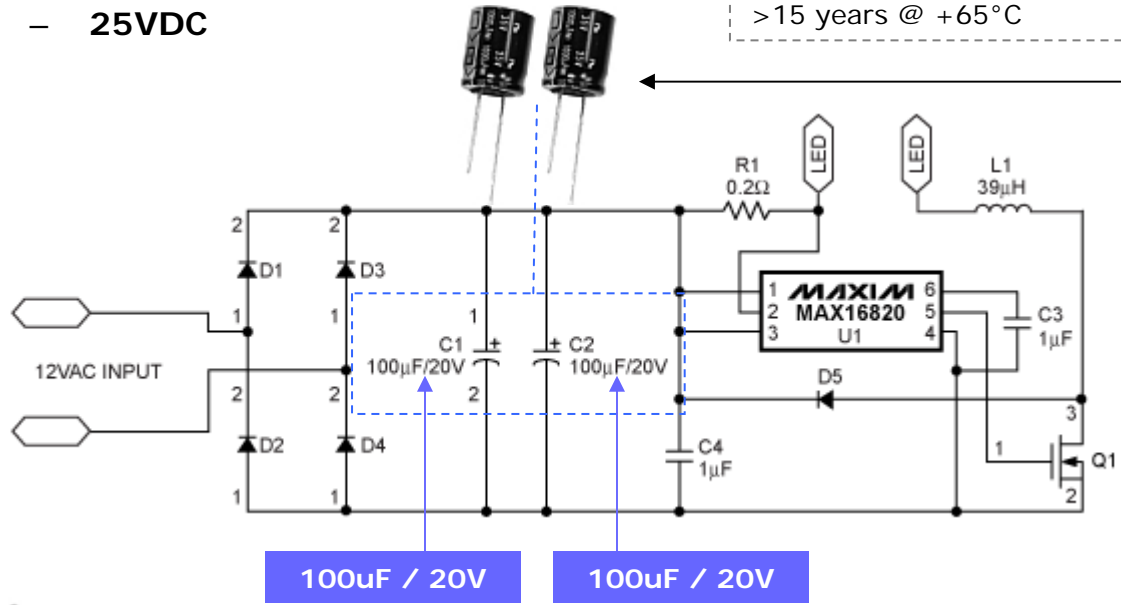
GOAL:
9+ Years Operation
80,000 Hrs @ +75°C = 10,000 Hrs @ +105°C
200uF @ ≥20VDC

www.niccomp.com/catalog/NRGB.pdf

Available Today

- Radial Leaded
- 10,000 hours @ +105°C
 - 2 X 100uF
 - 25VDC

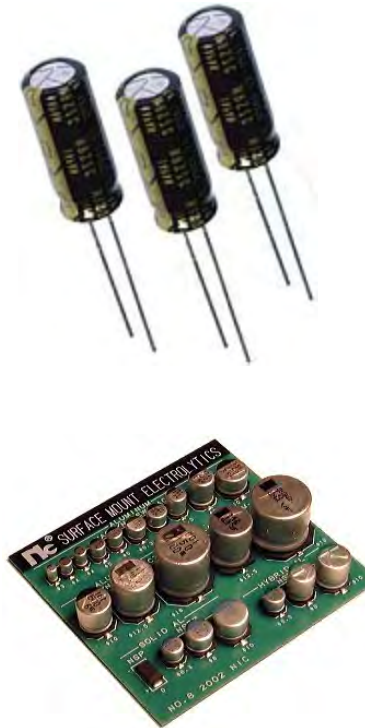
PN: **NRGB101M25V6.3X11F**
 100 μF, 25VDC, 6.3x11mm 2.5mm LS
 -40C ~ +105C
 10,000 hrs @ +105°C
 40,000 hrs @ +85°C
80,000 hrs @ +75°C
 >15 years @ +65°C



Low Cost & Smallest Size Solution

For higher voltage requirements (>16VDC) look to **aluminium electrolytic capacitors**

- **Lower cost solution**
 - Aluminium E-cap :
 - 100uF @ 25VDC \approx \$0.11 each
 - 220uF @ 25VDC \approx \$0.18 each
 - Tantalum E-cap:
 - 100uF @ 25VDC = >\$0.75 each
- Wide range of offerings CVs – sizes: SMT & LDD
- Voltages to 450VDC
- Transient resistant:
 - EOS resistant (Surge rating
 - Reverse bias tolerant
- Stable characteristic under voltage bias
 - Superior to high cap ceramic MLCCs





Cross Reference – Extended Lifetime Aluminium Electrolytic Capacitors

NIC Series	Type	Load Life Rating	Category Temp	ELNA	EPCOS	NICHICON	PANASONIC	RUBYCON	UCC
NRE-WX	LDD	1000 hrs	150°C	• • •	• • •	UBX	• • •	RX50	• • •
NATT	SMT	2,000 hrs	125°C	• • •	B41161 ¹	UCJ	EEVTG	• • •	• • •
NRWX	LDD	2,000 hrs	125°C	• • •	• • •	• • •	• • •	• • •	• • •
NRBX	LDD	12,000 hrs	105°C	RJ4	B43858	UCA	EEUED	BXA	KXG, KXJ
NSPE-H	SMT	10,000 hrs	105°C	• • •	• • •	PCF ³	• • •	• • •	PXH ²
NAZV	SMT	10,000 hrs	105°C	• • •	• • •	UCW	• • •	• • •	MZE
NRGB	LDD	10,000 hrs	105°C	• • •	• • •	• • •	• • •	YXM	• • •
NRSH	LDD	10,000 hrs	105°C	RJF	• • •	UHV	• • •	ZLH	KZH
NRE-HL	LDD	10,000 hrs	105°C	RJL	B41888	• • •	• • •	ZL	EKY
NRE-FL	LDD	10,000 hrs	105°C	• • •	B41888	• • •	• • •	YXF	KMF, KMY
NRB-XS	LDD	10,000 hrs	105°C	• • •	• • •	UCA	EEUEE	BXC	KXG
NRSZC	LDD	7,000 hrs	105°C	• • •	B41863	UPW	EEUFC	• • •	• • •
NRSX	LDD	7,000 hrs	105°C	RJ3, RJH	• • •	UPF, UPL	EEAFC	• • •	LXZ, KMF

Notes:

¹ EPCOS **B41161** series is +125°C, load life is 1000 hours; ~4000 hours @ +105°C

² UCC **PXH** is solid polymer, but only rated 1000 hours & 20VDC Max

³ NICHICON **PCF** is solid polymer, but only rated 2000 hours & 25VDC Max

NIC Technical Support



→ NIC Corporate

NIC Components Corp.

70 Maxess Road, Melville, NY USA 11747
TEL: 1-631-396-7500

Covering North America

- ▶ Jim Wright (VP - Technology) jwright@niccomp.com x 213
- ▶ Paul Harris (Technical Manager) pharris@niccomp.com x 205
- ▶ Matt Ciesinski (Product Engineer & Product Compliance Manager) mciesinski@niccomp.com x 265
- ▶ Mike Mack (Associate Engineer) mmack@niccomp.com NIC Lab x 331

→ NIC Singapore

NIC Components Asia Pte Ltd

701 Sims Drive, #07-01 LHK Building, Singapore 387383
TEL: 65-68441575

Covering SE Asia

- ▶ Ng Chin Khoon "CK" (QA Manager - SE Asia) ckng@niccomp.com.sg

→ NIC Europe

NIC Components Europe Ltd

14 Top Angel Buckingham Industrial Park
Buckingham MK18 1TH United Kingdom
TEL: +44 (1280) 813 737

Covering Europe

- ▶ Tony Titre (Technical Sales Engineer - NIC Europe) tony.titre@niccomp.com



www.NICcomp.com

