

Radial Leaded Aluminum Electrolytic Capacitors
REF Series



FEATURES

- Super Low Impedance, High ripple current capability
- Endurance: 3000 - 6000 hours at 105°C
- RoHS and Halogen Free Compliance

APPLICATIONS

- Power supplies, general industrial, filtering



LEAD-FREE
LEAD-FREE COMPATIBLE
COMPONENT



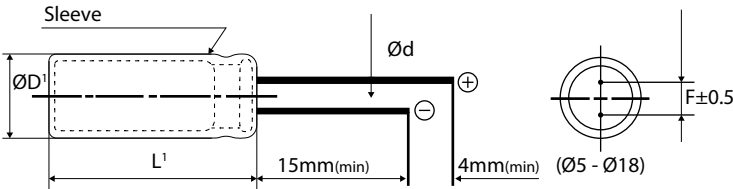
RoHS
COMPLIANT

HOW TO ORDER

Product Type: Radial Aluminum (R)
Series Type: EF
Case Size: 0816
Capacitance Code: 471
Tolerance: M (±20%)
Packaging: K (Ammo Pack)
Rated DC Voltage: 016 (16Vdc)
Special: - (No Code = std)

CASE DIMENSIONS millimeters (inches)

Code	D'±0.50 (0.020)	L'±2.00 (0.079)	d±0.05 (0.002)	F±0.50 (0.020)	Typical Weight (g)	Code	D'±0.50 (0.020)	L'±2.00 (0.079)	d±0.05 (0.002)	F±0.50 (0.020)	Typical Weight (g)
0511	5.00 (0.020)	11.00 (0.433)	0.50 (0.020)	2.00 (0.079)	0.43	1216	12.50 (0.492)	16.00 (0.630)	0.60 (0.024)	5.00 (0.020)	3.11
0512	5.00 (0.020)	12.00 (0.472)	0.50 (0.020)	2.00 (0.079)	1.05	1220	12.50 (0.492)	20.00 (0.787)	0.60 (0.024)	5.00 (0.020)	3.98
0609	6.30 (0.248)	9.00 (0.354)	0.50 (0.020)	2.50 (0.098)	0.54	1225	12.50 (0.492)	25.00 (0.984)	0.60 (0.024)	5.00 (0.020)	5.01
0611	6.30 (0.248)	11.00 (0.433)	0.50 (0.020)	2.50 (0.098)	0.61	1230	12.50 (0.492)	30.00 (1.181)	0.60 (0.024)	5.00 (0.020)	5.95
0612	6.30 (0.248)	12.00 (0.472)	0.50 (0.020)	2.50 (0.098)	0.69	1235	12.50 (0.492)	35.00 (1.378)	0.60 (0.024)	5.00 (0.020)	6.34
0811	8.00 (0.315)	11.00 (0.433)	0.50 (0.020)	3.50 (0.138)	0.95	1320	13.00 (0.512)	20.00 (0.787)	0.60 (0.024)	5.00 (0.020)	3.97
0812	8.00 (0.315)	12.00 (0.472)	0.50 (0.020)	3.50 (0.138)	1.02	1620	16.00 (0.630)	20.00 (0.787)	0.80 (0.315)	7.50 (0.295)	6.85
0816	8.00 (0.315)	16.00 (0.630)	0.50 (0.020)	3.50 (0.138)	1.34	1625	16.00 (0.630)	25.00 (0.984)	0.80 (0.315)	7.50 (0.295)	8.48
0820	8.00 (0.315)	20.00 (0.787)	0.50 (0.020)	3.50 (0.138)	1.72	1640	16.00 (0.630)	40.00 (1.575)	0.80 (0.315)	7.50 (0.295)	13.85
1009	10.00 (0.394)	9.00 (0.354)	0.60(0.024)	5.00 (0.020)	1.32	1820	18.00 (0.709)	20.00 (0.787)	0.80 (0.315)	7.50 (0.295)	9.00
1013	10.00 (0.394)	13.00 (0.512)	0.60(0.024)	5.00 (0.020)	1.65	1825	18.00 (0.709)	25.00 (0.984)	0.80 (0.315)	7.50 (0.295)	9.60
1016	10.00 (0.394)	16.00 (0.630)	0.60(0.024)	5.00 (0.020)	2.18	1830	18.00 (0.709)	30.00 (1.181)	0.80 (0.315)	7.50 (0.295)	12.00
1020	10.00 (0.394)	20.00 (0.787)	0.60(0.024)	5.00 (0.020)	2.58	1835	18.00 (0.709)	35.00 (1.378)	0.80 (0.315)	7.50 (0.295)	12.40
1025	10.00 (0.394)	25.00 (0.984)	0.60(0.024)	5.00 (0.020)	3.11	1840	18.00 (0.709)	40.00 (1.575)	0.80 (0.315)	7.50 (0.295)	16.00



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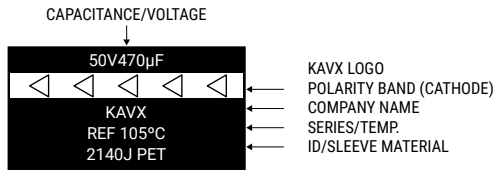


TECHNICAL SPECIFICATIONS

Category Temperature Range:	-40°C to +105°C	
Capacitance Range	At 25°C, 120Hz	6.8μF to 6800μF
Capacitance Tolerance:	At 25°C, 120Hz	±20%
Dissipation Factor (%)	Measurement Frequency: 120Hz at 25°C	Please see the ratings and part number reference table below
Leakage Current:	After 2 minutes at rated working voltage at 25°C*	$I \leq 0.01CV$ or 3μA, whichever is greater

* Note: In the case of an anomalous reading, re-measure the leakage current after following voltage treatment:
Voltage treatment: DC rated voltage to be applied to the capacitors for 120 minutes at 105°C.

MARKING



CAPACITANCE AND RATED VOLTAGE RANGE (FIGURES DENOTES CASE SIZE)

Capacitance		Rated Voltage DC (V _R)									
μF	Code	6.3V	10V	16V	25V	35V	50V	63V	80V	100V	120V
6.8	6R8									0511 0609	
10	100										0612
22	220						0512			0612	0812
27	270									1009	
33	330					0512		0611		1013	0816 1013
47	470				0511			0612		1013	1016
56	560						0612				1016
68	680									1016	1020
82	820							0812 1013			
100	101		0511 0609	0511	0511 0611	0612 0811	0812	0812 1013		1016	1025
120	121						0816	0816			1320
150	151	0511					1013	1013	1016	1020	1225
180	181						0820				
220	221	0611	0611	0611	0611 0812	0812 1009	1013	1016	1020	1320	1230 1620
270	271						1016				
330	331	0611		0812 1009	0816 1013	1016	1016	1020	1020	1225 1620	1825
470	471	0612	0812	0816 1013	0816	1016	1020	1320	1620	1625	
560	561				1016		1220	1320		1825	
680	681		0816 1013	0820 1016	1020	1220	1220	1620	1825	1640 1835	
820	821				1020		1620	1625		1840	
1000	102	0816	0820 1016	1020	1216	1225	1625	1625 1820	1640 1835		
1200	122	0802 1016		1025		1620					
1500	152	1016		1225	1225	1235		1830			
1800	182							1840			
2200	222	1020	1220	1225	1225						
2700	272			1230 1620	1625						
3300	332	1220	1225	1235 1625							
3900	392			1265							
4700	472	1225	1235								
5600	562		1625								
6800	682	1625									

Released ratings

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RATINGS & PART NUMBER REFERENCE

Part No.	Case Size	Capacitance (μF)	Rated Voltage (V)	DF Max. (%)	Impedance Max. at 20°C @100kHz (Ω)	100kHz RMS Current (mA) / 105°C
6.3 Volt						
REF0511151M006*	0511	150	6.3	15	0.290	300
REF0611221M006*	0611	220	6.3	15	0.205	377
REF0611331M006*	0611	330	6.3	15	0.120	455
REF0612471M006*	0612	470	6.3	15	0.100	510
REF0816102M006*	0816	1000	6.3	15	0.052	1000
REF0820122M006*	0820	1200	6.3	15	0.040	1300
REF1016122M006*	1016	1200	6.3	15	0.037	1480
REF1016152M006*	1016	1500	6.3	15	0.037	1480
REF1020222M006*	1020	2200	6.3	15	0.021	2200
REF1220332M006*	1220	3300	6.3	15	0.020	2410
REF1225472M006*	1225	4700	6.3	15	0.015	3340
REF1625682M006B	1625	6800	6.3	15	0.015	3510
10 Volt						
REF0511101M010*	0511	100	10	14	0.290	300
REF0609101M010*	0609	100	10	14	0.290	300
REF0611221M010*	0611	220	10	14	0.120	455
REF0812471M010*	0812	470	10	14	0.071	810
REF0816681M010*	0816	680	10	14	0.055	1046
REF1013681M010*	1013	680	10	14	0.052	1080
REF0820102M010*	0820	1000	10	14	0.040	1300
REF1016102M010*	1016	1000	10	14	0.037	1480
REF1220222M010*	1220	2200	10	14	0.020	2410
REF1225332M010*	1225	3300	10	14	0.020	2820
REF1235472M010B	1235	4700	10	14	0.021	3450
REF1625562M010B	1625	5600	10	14	0.015	3510
16 Volt						
REF0511101M016*	0511	100	16	12	0.210	320
REF0611221M016*	0611	220	16	12	0.084	721
REF0812331M016*	0812	330	16	12	0.071	810
REF1009331M016*	1009	330	16	12	0.092	680
REF0816471M016*	0816	470	16	12	0.055	1045
REF1013471M016*	1013	470	16	12	0.052	1080
REF0820681M016*	0820	680	16	12	0.040	1300
REF1016681M016*	1016	680	16	12	0.040	1480
REF1020102M016*	1020	1000	16	12	0.023	1870
REF1025122M016*	1025	1200	16	12	0.021	2200
REF1220152M016*	1220	1500	16	12	0.029	2410
REF1225222M016*	1225	2200	16	12	0.021	2200
REF1230272M016*	1230	2700	16	12	0.015	3340
REF1620272M016B	1620	2700	16	12	0.017	3190
REF1235332M016B	1235	3300	16	12	0.014	3450
REF1625332M016B	1625	3300	16	12	0.016	3350
REF1625392M016B	1625	3900	16	12	0.015	3510
25 Volt						
REF0511470M025*	0511	47	25	10	0.290	300
REF0511101M025*	0511	100	25	10	0.260	320
REF0611101M025*	0611	100	25	10	0.140	455
REF0611221M025*	0611	220	25	10	0.150	455
REF0812221M025*	0812	220	25	10	0.078	810
REF0816331M025*	0816	330	25	10	0.055	1045
REF1013331M025*	1013	330	25	10	0.052	1080
REF0816471M025*	0816	470	25	10	0.045	1120
REF1016561M025*	1016	560	25	10	0.030	1675
REF1020681M025*	1020	680	25	10	0.036	1870
REF1020821M025*	1020	820	25	10	0.035	1900
REF1216102M025*	1216	1000	25	10	0.028	1920
REF1225152M025*	1225	1500	25	10	0.030	2750
REF1225222M025*	1225	2200	25	10	0.027	2820
REF1625272M025B	1625	2700	25	10	0.015	3510
35 Volt						
REF0512330M035*	0512	33	35	10	0.570	300

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REF0612101M035*	0612	100	35	10	0.450	440
REF0811101M035*	0811	100	35	10	0.200	632
REF0812221M035*	0812	220	35	10	0.100	810
REF1009221M035*	1009	220	35	10	0.120	720
REF1016331M035*	1016	330	35	10	0.037	1480
REF1016471M035*	1016	470	35	10	0.055	1526
REF1220681M035*	1220	680	35	10	0.045	2410
REF1225102M035*	1225	1000	35	10	0.025	2820
REF1620122M035B	1620	1200	35	10	0.017	3190
REF1235152M035B	1235	1500	35	10	0.014	3450
50 Volt						
REF0512220M050*	0512	22	50	8	0.540	288
REF0612560M050*	0612	56	50	8	0.300	435
REF0812101M050*	0812	100	50	8	0.160	774
REF0816121M050*	0816	120	50	8	0.130	1000
REF1013151M050*	1013	150	50	8	0.110	1029
REF0820181M050*	0820	180	50	8	0.085	1240
REF1013221M050*	1013	220	50	8	0.130	1029
REF1016271M050*	1016	270	50	8	0.090	1020
REF1016331M050*	1016	330	50	8	0.045	1150
REF1020471M050*	1020	470	50	8	0.036	1500
REF1220561M050*	1220	560	50	8	0.035	2150
REF1220681M050*	1220	680	50	8	0.040	2100
REF1620821M050B	1620	820	50	8	0.022	2780
REF1625102M050B	1625	1000	50	8	0.025	3060
63 Volt						
REF0611330M063*	0611	33	63	8	1.200	126
REF0612470M063*	0612	47	63	8	0.800	150
REF0812820M063*	0812	82	63	8	0.480	320
REF1013820M063*	1013	82	63	8	0.420	420
REF0812101M063*	0812	100	63	8	0.500	280
REF1013101M063*	1013	100	63	8	0.300	420
REF0816121M063*	0816	120	63	8	0.350	350
REF1013151M063*	1013	150	63	8	0.300	400
REF1016221M063*	1016	220	63	8	0.160	480
REF1020331M063*	1020	330	63	8	0.160	640
REF1320471M063B	1320	470	63	8	0.100	880
REF1320561M063B	1320	560	63	8	0.086	1180
REF1620681M063B	1620	680	63	8	0.085	1250
REF1625821M063B	1625	820	63	8	0.057	1570
REF1625102M063B	1625	1000	63	8	0.045	1800
REF1820102M063B	1820	1000	63	8	0.050	1780
REF1830152M063B	1830	1500	63	8	0.036	2150
REF1840182M063B	1840	1800	63	8	0.032	2280
80 Volt						
REF1016151M080*	1016	150	80	8	0.240	600
REF1020221M080*	1020	220	80	8	0.150	680
REF1220331M080*	1220	330	80	8	0.120	750
REF1620471M080B	1620	470	80	8	0.007	1150
REF1825681M080B	1825	680	80	8	0.036	1750
REF1640102M080B	1640	1000	80	8	0.029	2200
REF1835102M080B	1835	1000	80	8	0.027	2200
100 Volt						
REF05116R8M100*	0511	6.8	100	8	1.400	86
REF06096R8M100*	0609	6.8	100	8	1.800	80
REF0612220M100*	0612	22	100	8	1.000	235
REF1009270M100*	1009	27	100	8	0.470	320
REF1013330M100*	1013	33	100	8	0.450	320
REF1013470M100*	1013	47	100	8	0.320	480
REF1016680M100*	1016	68	100	8	0.220	600
REF1016101M100*	1016	100	100	8	0.200	750
REF1020151M100*	1020	150	100	8	0.170	850
REF1320221M100B	1320	220	100	8	0.150	860
REF1225331M100*	1225	330	100	8	0.100	1000
REF1620331M100B	1620	330	100	8	0.070	1350

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REF1625471M100B	1625	470	100	8	0.045	1640
REF1825561M100B	1825	560	100	8	0.050	1800
REF1640681M100B	1640	680	100	8	0.034	2200
REF1835681M100B	1835	680	100	8	0.034	2200
REF1840821M100B	1840	820	100	8	0.032	2700
120 Volt						
REF0612100M120*	0612	10	120	12	5.500	80
REF0812220M120*	0812	22	120	12	3.500	130
REF0816330M120*	0816	33	120	12	3.000	220
REF1013330M120*	1013	33	120	12	3.000	220
REF1016470M120*	1016	47	120	12	2.500	270
REF1016560M120*	1016	56	120	12	2.200	285
REF1020680M120*	1020	68	120	12	1.800	300
REF1025101M120*	1025	100	120	12	1.500	380
REF1320121M120B	1320	120	120	12	1.300	620
REF1225151M120*	1225	150	120	12	1.000	570
REF1230221M120*	1230	220	120	12	0.800	750
REF1620221M120B	1620	220	120	12	0.600	760
REF1825331M120B	1825	330	120	12	0.420	860

* Used to denote packing type: "K" for Ammo Pack or "B" for Bulk Pack.

DF = When nominal capacitance exceeds 1000μF, add 0.02 to the value above for each 1000μF increase.

All technical data relates to an ambient temperature of +25°C. Capacitance and DF are measured at 120Hz, 0.5RMS with DC bias of 2.2 volts. DCL is measured at rated voltage after 2 minutes

RATED RIPPLE CURRENT MULTIPLIERS (FREQUENCY CORRECTION FACTOR FOR RIPPLE CURRENT)

Cap.(μF) \ Freq.(Hz)	120	1K	10K	100K
C < 220	0.40	0.75	0.90	1.00
220 ≤ C < 680	0.50	0.85	0.94	1.00
680 ≤ C < 2200	0.60	0.87	0.95	1.00
2200 ≤ C < 4700	0.75	0.90	0.95	1.00
C ≥ 4700	0.85	0.95	0.98	1.00

QUALIFICATION TABLE

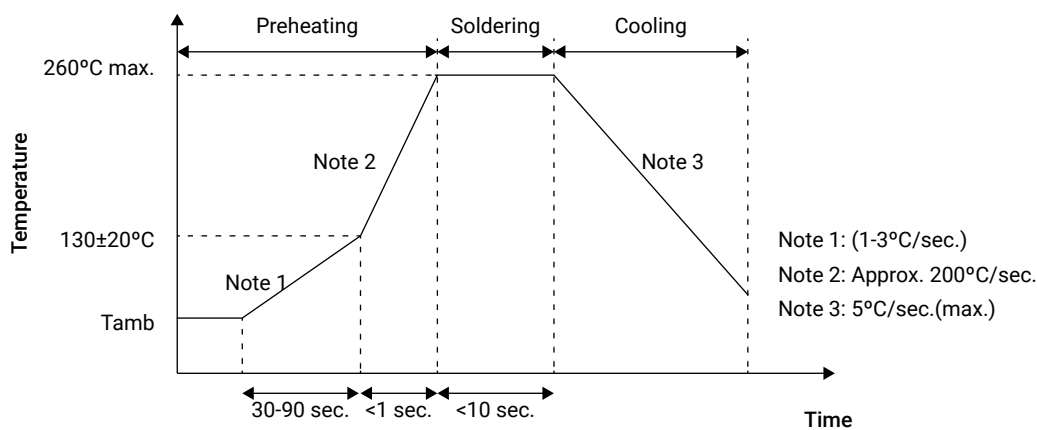
Test	REF Series (Temperature Range -40°C to +105°C)						
	Condition	Characteristics					
Low Temperature Characteristic (Max. Impedance Ratio)	120Hz	Rated Voltage (V)	6.3	10	16	25-100	120
		Z(-25°C) / Z(20°C)	5	4	3	3	3
		Z(-40°C) / Z(20°C)	10	8	5	4	6
Endurance	The following specifications shall be satisfied when the capacitors are restored to 20°C after DC voltage plus rated ripple current is applied for a specified period of time at 105°C.	Visual examination	no visible damage				
		ΔC/C	≤ ±25% of the initial limit				
		DF:	≤ 200% of the initial specified limit				
		DCL:	≤ Initial specified limit				
Load Life	The following specifications shall be satisfied when the capacitors are restored to 20°C after DC voltage plus rated ripple current is applied for a specified period of time at 105°C.	Diameter (mm)	Load life (hours)				
		ØD≤6.3	3000				
		ØD=8	4000				
		ØD=10	5000				
		ØD≥12.5	6000				
Shelf Life	The following specifications shall be satisfied when the capacitors are restored to 20°C after leaving them under no load at 105°C for 1000 hours.	Visual examination	no visible damage				
		ΔC/C	≤ ±25% of the initial limit				
		DF:	≤ 200% of the initial specified limit				
		DCL:	≤ 200% of the initial specified limit				

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SOLDERING

1. When soldering with a soldering iron:
- Soldering conditions (temperature and time) should be within the limits prescribed in the catalogs or the product specifications.
 - If the terminal spacing of a capacitor does not fit the terminal hole spacing of the PC board, reform the terminals in a manner to minimize a mechanical stress into the body of the capacitor.
 - Remove the capacitors from the PC board, after the solder is completely melted, reworking by using a soldering iron minimizes the mechanical stress to the capacitors.
 - Do not touch the capacitor body with the hot tip of the soldering iron.
2. Flow Soldering:
- Do not dip the body of a capacitor into the solder bath, only dip the terminals in. The soldering must be done on the reverse side of PC board.
 - Do not apply flux to any part of capacitors other than their terminals.
 - Make sure the capacitors do not come into contact with any other components while soldering.
 - Soldering conditions (preheat, solder temperature and dipping time) should be within the limits prescribed in the picture below.



STORAGE

- Store with the temperature range between 5 to 35°C (If between 35 to 85°C, it should be less than three months), and the relative humidity of 75% without direct sunshine and store in the package states if possible.
- It is recommended that you open the bag just before use and use up as early as possible.
- Store the capacitors in places free from water, oil or salt water or in condensation status.
- Never store in any area filled with poisonous gases (including hydrogen sulfide, sulfurous acid, nitrous acid, chlorine and ammonia).
- Store the capacitors in places free from ozone, ultraviolet rays or radiation:
(Radial Lead Type)
Before unseal: within 1 year after delivery
After opening: within 1 month

PACKING

Size Code	Bulk Pack					Ammo Pack				
	Bags	Inner Box		Carton		Inner Box		Carton		
		(LxWxH) 290*212*155		(LxWxH) 455*310*350		Quantity	Inner Box Size	Inner Box Quantity	Carton Size	Whole Pieces
		Bags Number	Quantity / pcs	Inner Box Number	Quantity / pcs		(LxWxH)		(LxWxH)	
0511	1000	12	12,000	4	48,000	2000	320x230x50	10	485x345x275	20,000
0512	1000	12	12,000	4	48,000	2000	320x230x50	10	485x345x275	20,000
0609	500	10	5000	4	20,000	2000	340x290x48	10	600x354x265	20,000

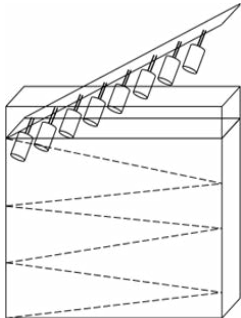
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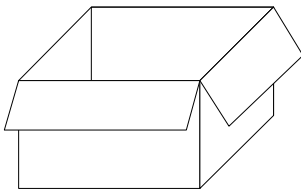


0611	500	10	5000	4	20,000	2000	340x290x48	10	600x354x265	20,000
0612	500	10	5000	4	20,000	2000	340x290x48	10	600x354x265	20,000
0811	500	10	5000	4	20,000	950	320x230x50	6	485x345x275	5700
0812	500	10	5000	4	20,000	950	320x230x50	6	485x345x275	5700
0816	300	10	3000	4	12,000	950	320x230x55	6	485x345x300	5700
0820	300	10	3000	4	12,000	950	320x230x55	6	485x345x300	5700
1009	250	12	3000	4	12,000	600	320x230x50	6	485x345x275	3600
1013	250	10	2500	4	10,000	600	320x230x50	6	485x345x275	3600
1016	250	10	2500	4	10,000	600	320x230x55	6	485x345x300	3600
1020	200	10	2000	4	8000	600	320x230x55	6	485x345x300	3600
1025	150	10	1500	4	6000	600	320x230x68	8	485x345x300	4800
1216	100	14	1400	4	5600	500	330x290x55	5	345x305x315	2500
1220	100	12	1200	4	4800	500	330x290x55	5	345x305x315	2500
1225	100	10	1000	4	4000	500	330x290x55	5	345x305x315	2500
1230	100	10	1000	4	4000	500	330x230x68	4	345x305x315	2000
1235	-	-	440	5	2200	-	-	-	-	-
1320	100	12	1200	4	4800	-	-	-	-	-
1620	-	-	250	5	1250	-	-	-	-	-
1625	-	-	250	5	1250	-	-	-	-	-
1640	-	-	200	5	1000	-	-	-	-	-
1820	-	-	250	5	1250	-	-	-	-	-
1825	-	-	250	5	1250	-	-	-	-	-
1830	-	-	230	5	1150	-	-	-	-	-
1835	-	-	200	5	1000	-	-	-	-	-
1840	-	-	180	5	900	-	-	-	-	-

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