

GXF Series

- Downsizing and high-ripple current version of GXE series
- For automobile modules and networking equipment and other high temperature applications
- Endurance with ripple current : 3,000 hours at 125°C
- Solvent resistant type except 160 to 400V_{dc}
- RoHS2 Compliant
- AEC-Q200 compliant : Please contact Chemi-Con for more details, test data, information.



SPECIFICATIONS

Items	Characteristics									
Category	-40 to +125°C									
Temperature Range										
Rated Voltage Range	25 to 400V _{dc}									
Capacitance Tolerance	±20%(M) (20°C, 120Hz)									
Leakage Current	25 to 100V _{dc}				160 to 400V _{dc}					
	I=0.03CV or 4µA, whichever is greater.				CV≤1,000		I=0.1CV+40			
					CV>1,000		I=0.04CV+100			
Where, I : Max. leakage current (µA), C : Nominal capacitance (µF), V : Rated voltage (V) (at 20°C after 1 minute)										
Dissipation Factor (tan δ)	Rated voltage (V _{dc})	25V	35V	50V	63V	80V	100V	160 to 250V	350 to 400V	
	tan δ (Max.)	0.14	0.12	0.10	0.10	0.08	0.08	0.15	0.20	
	When nominal capacitance exceeds 1,000µF, add 0.02 to the value above for each 1,000µF increase. (at 20°C, 120Hz)									
Low Temperature Characteristics (Max. Impedance Ratio)	Rated voltage (V _{dc})	25V	35V	50V	63V	80V	100V	160 to 250V	350 to 400V	
	Z(-25°C)/Z(+20°C)	2	2	2	2	2	2	3	6	
	Z(-40°C)/Z(+20°C)	4	4	4	4	4	4	6	12	
(at 120Hz)										
Endurance	The following specifications shall be satisfied when the capacitors are restored to 20°C after subjected to DC voltage with the rated ripple current is applied (the peak voltage shall not exceed the rated voltage) for the 3,000 hours at 125°C.									
	Rated Voltage	25 to 100V _{dc}					160 to 400V _{dc}			
	Capacitance change	≤±30% of the initial value					≤±20% of the initial value			
	D.F. (tan δ)	≤300% of the initial specified value					≤200% of the initial specified value			
	Leakage current	≤The initial specified value					≤The initial specified value			
Shelf Life	The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them for 1,000 hours (500hours for 160 to 400V _{dc}) at 125°C without voltage applied. Before the measurement, the capacitor shall be preconditioned by applying voltage according to Item 4.1 of JIS C 5101-4.									
	Rated Voltage	25 to 100V _{dc}					160 to 400V _{dc}			
	Capacitance change	≤±30% of the initial value					≤±20% of the initial value			
	D.F. (tan δ)	≤300% of the initial specified value					≤200% of the initial specified value			
	Leakage current	≤The initial specified value					≤500% of the initial specified value			

DIMENSIONS [mm]

- Terminal Code : E



ΦD	10	12.5	14.5	16	18
Φd	0.6	0.6	0.8	0.8	0.8
F	5.0	5.0	7.5	7.5	7.5
ΦD'	ΦD+0.5max.				
L'	L+1.5max.				

PART NUMBERING SYSTEM



Please refer to "Product code guide (radial lead type)"

◆STANDARD RATINGS

VV (V _{dc})	Cap (μF)	Case size φDxL (mm)	ESR (Ωmax./100kHz)		Rated ripple current (mA _{rms} /125°C, 100kHz)	Part No.	VV (V _{dc})	Cap (μF)	Case size φDxL (mm)	ESR (Ωmax./100kHz)		Rated ripple current (mA _{rms} /125°C, 100kHz)	Part No.
			20°C	-40°C						20°C	-40°C		
25	510	10 × 12.5	0.14	2.1	900	EGXF250E□□511MJC5S	50	680	14.5 × 20	0.038	0.22	1,610	EGXF500E□□681MU20S
	750	10 × 16	0.094	1.5	1,300	EGXF250E□□751MJ16S		750	12.5 × 25	0.038	0.18	2,030	EGXF500E□□751MK25S
	910	12.5 × 15	0.082	1.1	1,220	EGXF250E□□911MK15S		750	18 × 15	0.085	0.87	1,370	EGXF500E□□751MM15S
	1,200	10 × 20	0.073	1.1	1,540	EGXF250E□□122MJ20S		910	16 × 20	0.037	0.17	1,740	EGXF500E□□911ML20S
	1,200	14.5 × 15	0.067	0.80	1,320	EGXF250E□□122MU15S		1,000	12.5 × 30	0.031	0.14	2,510	EGXF500E□□102MK30S
	1,500	10 × 25	0.042	0.24	1,880	EGXF250E□□152MJ25S		1,000	14.5 × 25	0.031	0.14	2,480	EGXF500E□□102MU25S
	1,600	16 × 15	0.063	0.76	1,430	EGXF250E□□162ML15S		1,200	12.5 × 35	0.027	0.11	2,900	EGXF500E□□122MK35S
	1,800	12.5 × 20	0.038	0.19	1,590	EGXF250E□□182MK20S		1,200	18 × 20	0.036	0.14	1,830	EGXF500E□□122MM20S
	2,000	10 × 30	0.033	0.19	2,150	EGXF250E□□202MJ30S		1,300	14.5 × 30	0.026	0.11	2,870	EGXF500E□□132MU30S
	2,200	14.5 × 20	0.030	0.17	1,780	EGXF250E□□222MU20S		1,300	16 × 25	0.027	0.13	2,690	EGXF500E□□132ML25S
	2,400	18 × 15	0.053	0.51	1,630	EGXF250E□□242MM15S		1,500	12.5 × 40	0.023	0.090	3,260	EGXF500E□□152MK40S
	2,700	12.5 × 25	0.030	0.14	2,280	EGXF250E□□272MK25S		1,500	14.5 × 35	0.023	0.085	3,160	EGXF500E□□152MM35S
	3,000	16 × 20	0.029	0.13	1,890	EGXF250E□□302ML20S		1,600	16 × 30	0.023	0.094	3,150	EGXF500E□□162ML30S
	3,300	12.5 × 30	0.025	0.10	2,760	EGXF250E□□332MK30S		1,800	18 × 25	0.025	0.11	2,900	EGXF500E□□182MM25S
	3,600	14.5 × 25	0.025	0.11	2,760	EGXF250E□□362MU25S		2,000	14.5 × 40	0.020	0.072	3,560	EGXF500E□□202MU40S
	4,300	12.5 × 35	0.022	0.080	3,120	EGXF250E□□432MK35S		2,000	16 × 35	0.020	0.074	3,470	EGXF500E□□202ML35S
	4,300	16 × 25	0.022	0.092	3,030	EGXF250E□□432ML25S		2,200	18 × 30	0.021	0.079	3,330	EGXF500E□□222MM30S
	4,300	18 × 20	0.028	0.10	1,930	EGXF250E□□432MM20S		2,400	16 × 40	0.018	0.063	3,800	EGXF500E□□242ML40S
	4,700	14.5 × 30	0.020	0.081	3,090	EGXF250E□□472MU30S		2,700	18 × 35	0.019	0.065	3,590	EGXF500E□□272MM35S
	5,100	12.5 × 40	0.019	0.068	3,610	EGXF250E□□512MK40S		3,300	18 × 40	0.017	0.058	3,850	EGXF500E□□332MM40S
	5,100	14.5 × 35	0.018	0.065	3,430	EGXF250E□□512MU35S		390	12.5 × 20	0.097	0.75	1,310	EGXF630E□□391MK20S
	5,100	16 × 30	0.018	0.071	3,330	EGXF250E□□512ML30S		510	12.5 × 25	0.072	0.55	1,880	EGXF630E□□511MK25S
5,600	18 × 25	0.020	0.078	3,200	EGXF250E□□562MM25S	510	14.5 × 20	0.072	0.59	1,510	EGXF630E□□511MU20S		
6,800	14.5 × 40	0.016	0.054	3,820	EGXF250E□□682MU40S	620	16 × 20	0.062	0.39	1,630	EGXF630E□□621ML20S		
6,800	16 × 35	0.016	0.056	3,630	EGXF250E□□682ML35S	680	12.5 × 30	0.052	0.37	2,410	EGXF630E□□681MK30S		
7,500	18 × 30	0.016	0.060	3,480	EGXF250E□□752MM30S	680	14.5 × 25	0.054	0.40	2,130	EGXF630E□□681MU25S		
8,200	16 × 40	0.015	0.048	3,930	EGXF250E□□822ML40S	820	12.5 × 35	0.044	0.29	2,760	EGXF630E□□821MK35S		
9,100	18 × 35	0.015	0.049	3,750	EGXF250E□□912MM35S	820	18 × 20	0.055	0.29	1,750	EGXF630E□□821MM20S		
11,000	18 × 40	0.014	0.043	4,040	EGXF250E□□113MM40S	910	14.5 × 30	0.042	0.30	2,700	EGXF630E□□911MU30S		
35	300	10 × 12.5	0.14	2.1	900	EGXF350E□□301MJC5S	63	910	16 × 25	0.047	0.27	2,300	EGXF630E□□911ML25S
	510	10 × 16	0.094	1.5	1,300	EGXF350E□□511MJ16S		1,000	12.5 × 40	0.038	0.26	3,080	EGXF630E□□102MK40S
	560	12.5 × 15	0.082	1.1	1,220	EGXF350E□□561MK15S		1,100	14.5 × 35	0.037	0.24	2,940	EGXF630E□□112MU35S
	680	10 × 20	0.073	1.1	1,540	EGXF350E□□681MJ20S		1,100	16 × 30	0.037	0.23	2,940	EGXF630E□□112ML30S
	750	14.5 × 15	0.067	0.80	1,320	EGXF350E□□751MU15S		1,200	18 × 25	0.044	0.22	2,440	EGXF630E□□122MM25S
	820	10 × 25	0.042	0.24	1,880	EGXF350E□□821MJ25S		1,300	14.5 × 40	0.032	0.20	3,350	EGXF630E□□132MU40S
	1,100	12.5 × 20	0.038	0.19	1,590	EGXF350E□□112MK20S		1,300	16 × 35	0.031	0.17	3,220	EGXF630E□□132ML35S
	1,100	16 × 15	0.063	0.76	1,430	EGXF350E□□112ML15S		1,500	18 × 30	0.037	0.18	3,100	EGXF630E□□152MM30S
	1,200	10 × 30	0.033	0.19	2,150	EGXF350E□□122MJ30S		1,800	16 × 40	0.028	0.15	3,590	EGXF630E□□182ML40S
	1,500	12.5 × 25	0.030	0.14	2,280	EGXF350E□□152MK25S		2,000	18 × 35	0.028	0.13	3,450	EGXF630E□□202MM35S
	1,500	14.5 × 20	0.030	0.17	1,780	EGXF350E□□152MU20S		2,400	18 × 40	0.023	0.10	3,690	EGXF630E□□242MM40S
	1,500	18 × 15	0.053	0.51	1,630	EGXF350E□□152MM15S		240	12.5 × 20	0.097	0.75	1,310	EGXF800E□□241MK20S
	2,000	12.5 × 30	0.025	0.10	2,760	EGXF350E□□202MK30S		330	12.5 × 25	0.072	0.55	1,880	EGXF800E□□331MK25S
	2,000	16 × 20	0.029	0.13	1,890	EGXF350E□□202ML20S		330	14.5 × 20	0.072	0.59	1,510	EGXF800E□□331MU20S
	2,200	14.5 × 25	0.025	0.11	2,760	EGXF350E□□222MU25S		390	16 × 20	0.062	0.39	1,630	EGXF800E□□391ML20S
	2,400	12.5 × 35	0.022	0.080	3,120	EGXF350E□□242MK35S		430	12.5 × 30	0.052	0.37	2,410	EGXF800E□□431MK30S
	2,400	16 × 25	0.022	0.092	3,030	EGXF350E□□242ML25S		470	14.5 × 25	0.054	0.40	2,130	EGXF800E□□471MU25S
	2,400	18 × 20	0.028	0.10	1,930	EGXF350E□□242MM20S		560	12.5 × 35	0.044	0.29	2,760	EGXF800E□□561MK35S
	2,700	12.5 × 40	0.019	0.068	3,610	EGXF350E□□272MK40S		560	16 × 25	0.047	0.27	2,300	EGXF800E□□561ML25S
	2,700	14.5 × 30	0.020	0.081	3,090	EGXF350E□□272MJ30S		560	18 × 20	0.055	0.29	1,750	EGXF800E□□561MM20S
	3,000	14.5 × 35	0.018	0.065	3,430	EGXF350E□□302MU35S		620	12.5 × 40	0.038	0.26	3,080	EGXF800E□□621MK40S
	3,300	16 × 30	0.018	0.071	3,330	EGXF350E□□332ML30S		620	14.5 × 30	0.042	0.30	2,700	EGXF800E□□621MU30S
3,300	18 × 25	0.020	0.078	3,200	EGXF350E□□332MM25S	680	14.5 × 35	0.037	0.24	2,940	EGXF800E□□681MK35S		
3,900	14.5 × 40	0.016	0.054	3,820	EGXF350E□□392MU40S	680	16 × 30	0.037	0.23	2,940	EGXF800E□□681ML30S		
4,300	16 × 35	0.016	0.056	3,630	EGXF350E□□432ML35S	750	18 × 25	0.044	0.22	2,440	EGXF800E□□751MM25S		
4,300	18 × 30	0.016	0.060	3,480	EGXF350E□□432MM30S	820	14.5 × 40	0.032	0.20	3,350	EGXF800E□□821MU40S		
4,700	16 × 40	0.015	0.048	3,930	EGXF350E□□472ML40S	910	16 × 35	0.031	0.17	3,220	EGXF800E□□911ML35S		
5,100	18 × 35	0.015	0.049	3,750	EGXF350E□□512MM35S	910	18 × 30	0.037	0.18	3,100	EGXF800E□□911MM30S		
6,200	18 × 40	0.014	0.043	4,040	EGXF350E□□622MM40S	1,100	16 × 40	0.028	0.15	3,590	EGXF800E□□112ML40S		
50	160	10 × 12.5	0.24	3.6	730	EGXF500E□□161MJC5S	100	1,300	18 × 35	0.028	0.13	3,450	EGXF800E□□132MM35S
	240	10 × 16	0.16	2.5	1,080	EGXF500E□□241MJ16S		1,500	18 × 40	0.023	0.10	3,690	EGXF800E□□152MM40S
	270	12.5 × 15	0.14	1.8	1,020	EGXF500E□□271MK15S		130	12.5 × 20	0.12	0.94	1,210	EGXF101E□□131MK20S
	330	10 × 20	0.12	1.8	1,290	EGXF500E□□331MJ20S		180	14.5 × 20	0.082	0.69	1,450	EGXF101E□□181MU20S
	390	14.5 × 15	0.12	1.4	1,090	EGXF500E□□391MU15S		200	12.5 × 25	0.082	0.70	1,800	EGXF101E□□201MK25S
	430	10 × 25	0.055	0.31	1,740	EGXF500E□□431MJ25S		240	12.5 × 30	0.062	0.52	2,290	EGXF101E□□241MK30S
	510	12.5 × 20	0.049	0.24	1,410	EGXF500E□□511MK20S		240	16 × 20	0.071	0.53	1,580	EGXF101E□□241ML20S
	560	10 × 30	0.041	0.25	2,020	EGXF500E□□561MJ30S		270	14.5 × 25	0.064	0.52	2,050	EGXF101E□□271MU25S
560	16 × 15	0.11	1.3	1,190	EGXF500E□□561ML15S	330	12.5 × 35	0.051	0.38	2,680	EGXF101E□□331MK35S		

◆STANDARD RATINGS

□□ is not solvent resistant.

VV (V _{dc})	Cap (μF)	Case size φDxL(mm)	ESR (Ωmax./100kHz)		Rated ripple current (mA _{rms} /125°C, 100kHz)	Part No.	VV (V _{dc})	Cap (μF)	Case size φDxL(mm)	ESR (Ωmax./100kHz)		Rated ripple current (mA _{rms} /125°C, 100kHz)	Part No.
			20°C	-40°C						20°C	-40°C		
100	330	16×25	0.057	0.39	2,190	EGXF101E□□331ML25S	250	39	10×30	—	—	1,410	EGXF251E□□390MJ30S
	330	18×20	0.069	0.39	1,690	EGXF101E□□331MM20S		47	10×35	—	—	1,600	EGXF251E□□470MJ35S
	360	14.5×30	0.050	0.40	2,620	EGXF101E□□361MU30S		51	12.5×25	—	—	1,510	EGXF251E□□510MK25S
	390	12.5×40	0.044	0.33	2,970	EGXF101E□□391MK40S		51	14.5×20	—	—	1,340	EGXF251E□□510MU20S
	390	14.5×35	0.044	0.33	2,850	EGXF101E□□391MU35S		56	10×40	—	—	1,790	EGXF251E□□560MJ40S
	390	16×30	0.044	0.33	2,770	EGXF101E□□391ML30S		62	16×20	—	—	1,500	EGXF251E□□620ML20S
	430	18×25	0.054	0.32	2,310	EGXF101E□□431MM25S		68	12.5×30	—	—	1,770	EGXF251E□□680MK30S
	510	14.5×40	0.038	0.26	3,230	EGXF101E□□511MU40S		68	14.5×25	—	—	1,610	EGXF251E□□680MU25S
	510	16×35	0.037	0.26	3,010	EGXF101E□□511ML35S		82	12.5×35	—	—	1,970	EGXF251E□□820MK35S
	560	18×30	0.043	0.26	2,830	EGXF101E□□561MM30S		82	18×20	—	—	1,730	EGXF251E□□820MM20S
	620	16×40	0.032	0.21	3,320	EGXF101E□□621ML40S		91	14.5×30	—	—	1,880	EGXF251E□□910MU30S
	680	18×35	0.034	0.19	3,210	EGXF101E□□681MM35S		91	16×25	—	—	1,850	EGXF251E□□910ML25S
820	18×40	0.029	0.16	3,410	EGXF101E□□821MM40S	100	12.5×40	—	—	2,150	EGXF251E□□101MK40S		
160	51	10×20	—	—	900	EGXF161E□□510MJ20S	100	14.5×35	—	—	2,030	EGXF251E□□101MU35S	
	62	10×25	—	—	1,200	EGXF161E□□620MJ25S	120	18×25	—	—	2,050	EGXF251E□□121MM25S	
	75	12.5×20	—	—	1,220	EGXF161E□□750MK20S	130	14.5×40	—	—	2,250	EGXF251E□□131MU40S	
	82	10×30	—	—	1,410	EGXF161E□□820MJ30S	16	10×20	—	—	460	EGXF351E□□160MJ20S	
	100	10×35	—	—	1,600	EGXF161E□□101MJ35S	20	10×25	—	—	610	EGXF351E□□200MJ25S	
	100	14.5×20	—	—	1,340	EGXF161E□□101MU20S	24	12.5×20	—	—	680	EGXF351E□□240MK20S	
	110	12.5×25	—	—	1,510	EGXF161E□□111MK25S	27	10×30	—	—	720	EGXF351E□□270MJ30S	
	120	10×40	—	—	1,790	EGXF161E□□121MJ40S	33	10×35	—	—	820	EGXF351E□□330MJ35S	
	130	16×20	—	—	1,500	EGXF161E□□131ML20S	33	14.5×20	—	—	870	EGXF351E□□330MU20S	
	150	12.5×30	—	—	1,770	EGXF161E□□151MK30S	36	10×40	—	—	940	EGXF351E□□360MJ40S	
	150	14.5×25	—	—	1,610	EGXF161E□□151MU25S	36	12.5×25	—	—	980	EGXF351E□□360MK25S	
	180	12.5×35	—	—	1,970	EGXF161E□□181MK35S	43	16×20	—	—	970	EGXF351E□□430ML20S	
	180	14.5×30	—	—	1,880	EGXF161E□□181MU30S	47	12.5×30	—	—	1,210	EGXF351E□□470MK30S	
	180	18×20	—	—	1,730	EGXF161E□□181MM20S	47	14.5×25	—	—	1,210	EGXF351E□□470MU25S	
	200	12.5×40	—	—	2,150	EGXF161E□□201MK40S	56	12.5×35	—	—	1,330	EGXF351E□□560MK35S	
200	16×25	—	—	1,850	EGXF161E□□201ML25S	56	16×25	—	—	1,130	EGXF351E□□560ML25S		
220	14.5×35	—	—	2,030	EGXF161E□□221MU35S	56	18×20	—	—	1,060	EGXF351E□□560MM20S		
240	18×25	—	—	2,050	EGXF161E□□241MM25S	62	14.5×30	—	—	1,410	EGXF351E□□620MU30S		
270	14.5×40	—	—	2,250	EGXF161E□□271MU40S	68	12.5×40	—	—	1,450	EGXF351E□□680MK40S		
200	36	10×20	—	—	900	EGXF201E□□360MJ20S	68	14.5×35	—	—	1,590	EGXF351E□□680MU35S	
	43	10×25	—	—	1,200	EGXF201E□□430MJ25S	75	18×25	—	—	1,200	EGXF351E□□750MM25S	
	56	12.5×20	—	—	1,220	EGXF201E□□560MK20S	91	14.5×40	—	—	1,820	EGXF351E□□910MU40S	
	62	10×30	—	—	1,410	EGXF201E□□620MJ30S	12	10×20	—	—	460	EGXF401E□□120MJ20S	
	75	10×35	—	—	1,600	EGXF201E□□750MJ35S	16	10×25	—	—	610	EGXF401E□□160MJ25S	
	75	14.5×20	—	—	1,340	EGXF201E□□750MU20S	20	10×30	—	—	720	EGXF401E□□200MJ30S	
	82	10×40	—	—	1,790	EGXF201E□□820MJ40S	20	12.5×20	—	—	680	EGXF401E□□200MK20S	
	82	12.5×25	—	—	1,510	EGXF201E□□820MK25S	24	10×35	—	—	820	EGXF401E□□240MJ35S	
	100	12.5×30	—	—	1,770	EGXF201E□□101MK30S	24	14.5×20	—	—	870	EGXF401E□□240MU20S	
	100	16×20	—	—	1,500	EGXF201E□□101ML20S	27	12.5×25	—	—	980	EGXF401E□□270MK25S	
	110	14.5×25	—	—	1,610	EGXF201E□□111MU25S	30	10×40	—	—	940	EGXF401E□□300MJ40S	
	130	12.5×35	—	—	1,970	EGXF201E□□131MK35S	33	16×20	—	—	970	EGXF401E□□330ML20S	
	130	14.5×30	—	—	1,880	EGXF201E□□131MU30S	36	12.5×30	—	—	1,210	EGXF401E□□360MK30S	
	130	18×20	—	—	1,730	EGXF201E□□131MM20S	36	14.5×25	—	—	1,210	EGXF401E□□360MU25S	
	150	12.5×40	—	—	2,150	EGXF201E□□151MK40S	43	12.5×35	—	—	1,330	EGXF401E□□430MK35S	
150	16×25	—	—	1,850	EGXF201E□□151ML25S	43	18×20	—	—	1,060	EGXF401E□□430MM20S		
160	14.5×35	—	—	2,030	EGXF201E□□161MU35S	47	14.5×30	—	—	1,410	EGXF401E□□470MU30S		
180	18×25	—	—	2,050	EGXF201E□□181MM25S	47	16×25	—	—	1,130	EGXF401E□□470ML25S		
200	14.5×40	—	—	2,250	EGXF201E□□201MU40S	51	12.5×40	—	—	1,450	EGXF401E□□510MK40S		
250	24	10×20	—	—	900	EGXF251E□□240MJ20S	56	14.5×35	—	—	1,590	EGXF401E□□560MU35S	
	30	10×25	—	—	1,200	EGXF251E□□300MJ25S	62	18×25	—	—	1,200	EGXF401E□□620MM25S	
	36	12.5×20	—	—	1,220	EGXF251E□□360MK20S	68	14.5×40	—	—	1,820	EGXF401E□□680MU40S	

□□ : Enter the appropriate lead forming or taping code.

◆RATED RIPPLE CURRENT MULTIPLIERS

● Frequency Multipliers

(25 to 100V_{dc})

Capacitance(μF)	Frequency(Hz)	120	1k	10k	100k
130 to 240		0.40	0.82	0.93	1.00
270 to 560		0.50	0.85	0.94	1.00
620 to 2,000		0.60	0.87	0.95	1.00
2,200 to 4,300		0.75	0.90	0.95	1.00
4,700 to 11,000		0.85	0.95	0.98	1.00

(160 to 400V_{dc})

Capacitance(μF)	Frequency(Hz)	50	120	300	1k	10k	100k
12 to 33		0.15	0.30	0.45	0.65	0.95	1.00
36 to 270		0.25	0.35	0.50	0.70	0.96	1.00

Please contact us for lifetime estimation.