LS ULTRACAPACITOR MODULE
User Manual

Part No. : LSU M 050R4P 0166F EA
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LS Ultracapacitor Module

User Manual

CONTENT

Overview

The LS 50.4V/167F Ultracapacitor Modules have high energy and low ESR to meet energy storage and power delivery requirements.

The cells used in the modules have 2.8 V maximum voltage rating and are connected in series to get higher operating voltage of modules. To meet the long cycle life requirements, the cells operate under 2.8V. In addition, all the cells are balanced by balancing circuit connected parallel to each cell.

If any cell in the module has gone into an over voltage condition, an alarm signal will indicate. The signal is available for monitoring the abnormal cell voltage (2.8V nominal with 2.75V~2.85V range due to tolerances)

Item		Value	Comments
Rated Capacitance	F	166	3000F unit 18 series
Max. Voltage	V	50.4	2.8V/cell
ESR(DC)	mΩ	6.5 (Max.)	
Rated Current	A	150	RMS
Ambient Temp.	℃	-40 ~ 65	Storage @ -40 ~ 70
Ambient Humidity	%	0 ~ 95	Storage @ 0 ~ 100
Weight	kg	17.2	
Dimension-W	mm	190	
Dimension-D	mm	416	
Dimension-H	mm	184	

Description

Identification of features

- Product Image

<Fig. 1> Product Image

Part Description

- Output terminal

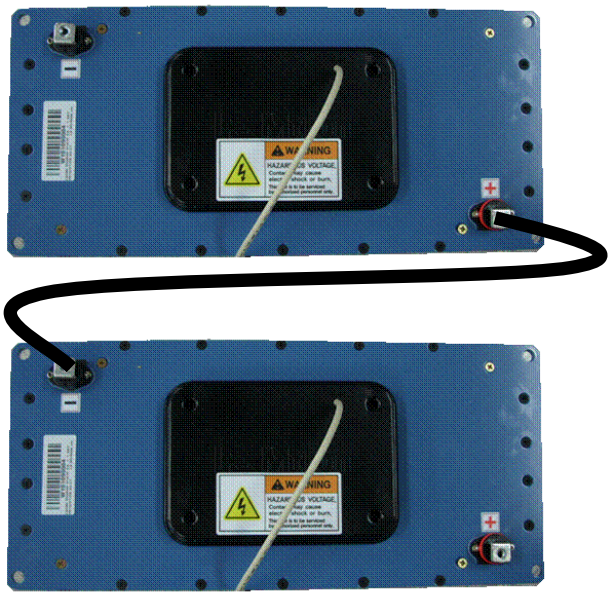
  - They are designed to connect directly to a ring or a bus bar. The positive and negative terminals have each hole for the screw. The threaded size is M6. Wave washers are required to ensure long term, reliable connections. When implementing torque to the terminals, it is suggested to apply the maximum torque for the M6 bolt and screw hole. Because the modules have a very low ESR, total ESR will be affected by a ring lug, bus bar or torque. Therefore, it needs more attention to assemble the modules.

- Thermistor

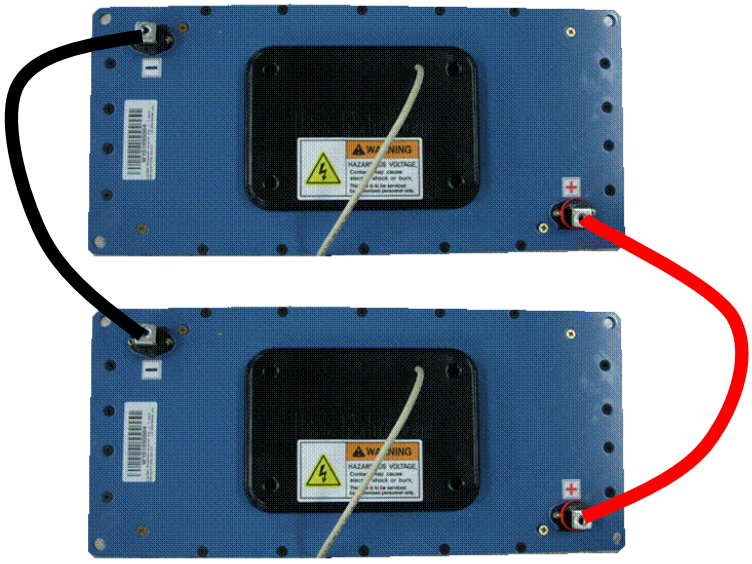
  - The NTC thermistor is used for module temperature monitoring. The temperature output is also available via the connector supplied with the module. The resistance measured through the thermistor relates to temperature according to the DK Sensor 10K@ 25℃ resistance to temperature chart for the appendix I.

System Design

- Module to module connections



<Fig. 2> Series Connection of Modules



<Fig. 3> Parallel Connection of Modules

- Monitoring connector

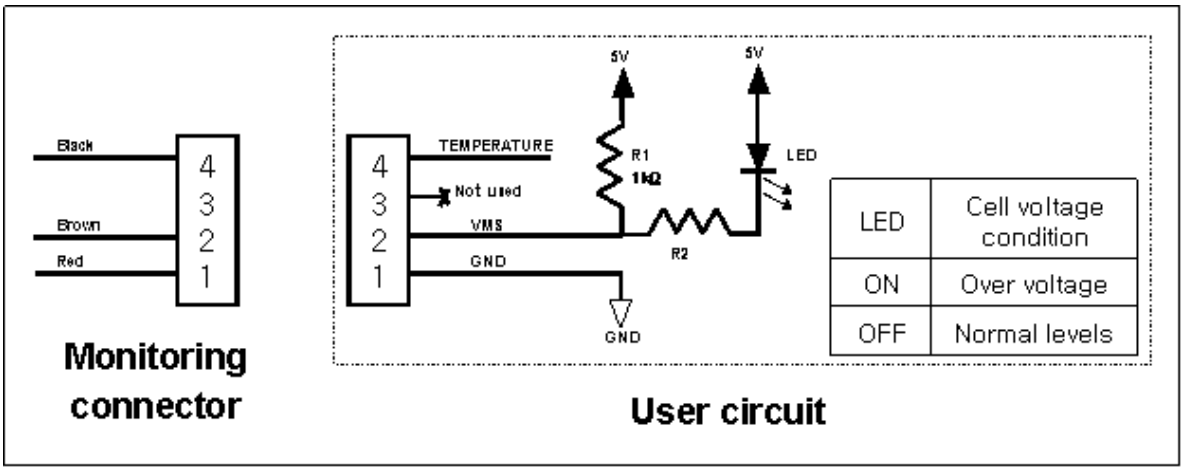
  - The output of connector is tabulated below.

Pin #	Wire color	Pin out	Signal	Max. current
1	Red	GND		
2	Brown	Voltage monitoring signal	HIGH - inactive LOW - active	5mA
3		Not used		
4	Black	TEMP		

- Pin 1 is connected with monitoring connector output signals receiver circuit's ground. The output signals are isolated from the capacitor voltage and from chassis ground. The recommended voltage is 5V DC.

- When a cell in the module goes into over voltage condition, pin 2 has alarm signal. When every cell voltage is not over voltage state, the output of Pin 2 is high. If any cell in the module is exceeding normal voltage, the voltage balancing circuit becomes active and starts to discharge the cell to become normal voltage range. Then the output of Pin 2 goes low. At this time, user should stop charging. However, in order to use the signal, the user needs to attach a pull-up resistor(typically 1kΩ) to pin 2 and a 5V supply.

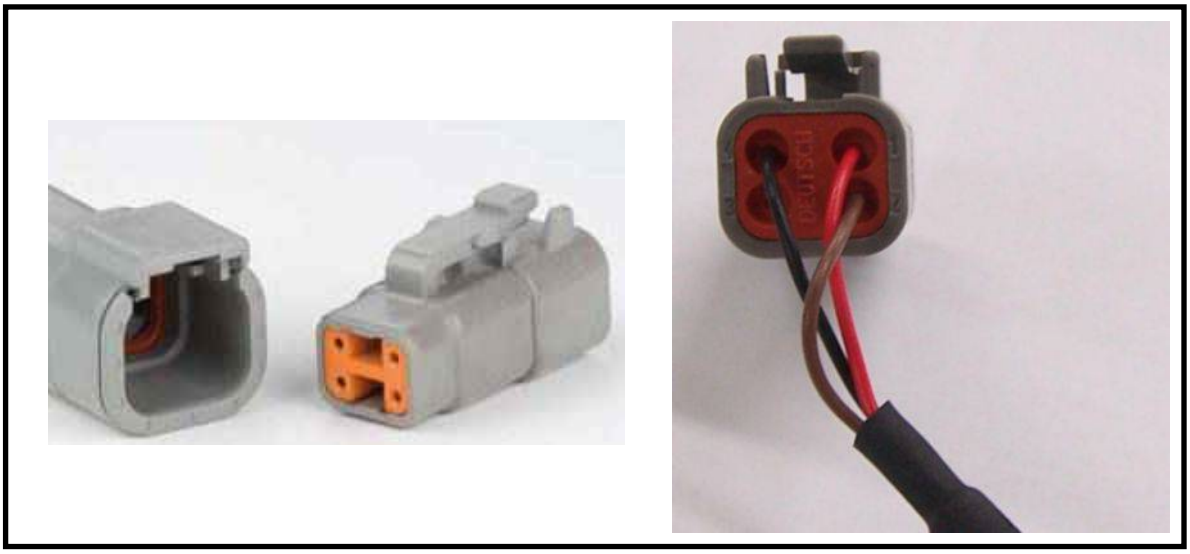
- When the cell voltage is below the threshold, the voltage balancing circuit becomes inactive and the cell stop discharging. At the same time, the output of Pin 2 goes high. Pin 2 output is indicated by LED. The output signal receiver circuit is as following.



<Fig. 4> Typical output signal receiver circuit to the monitoring connector

- Pin 3 is not used.

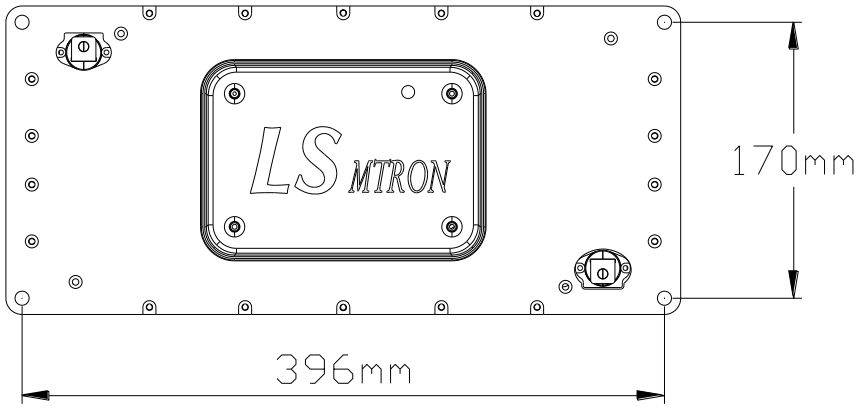
- Pin 4 is connected with a NTC thermistor for temperature monitoring. According to temperature variation in the module, the resistance of the thermistor is determined. The resistance is 10KΩ with one-percent error, when the internal temperature in the module is 25 ℃.



<Fig. 5> Monitoring connector

Mounting

Fig. 6 shows the mounting positions of the module.



<Fig. 6 Mounting Positions>

Maintenance

Power Rating

The rated voltage and current of the module max 50.4V and 150A. If the applied voltage is over 50.4V, charging the module should be stopped. And the allowable low voltage level of the module depends on the user's requirements, but full discharging to 0V does not affect the module performance.

Temperature

The module has its optimal operating temperature range of -40 to 65. Over 70℃, charging and discharging should be stopped to expect its performance and life cycle.

Maintenance

The module has its expected life cycle over 10years at normal conditions. However the life cycle of the module may be decreased in high temperature condition or over voltage charging.

If following abnormal module performances are detected, operation should be stopped and checking the electrical & mechanical connections is recommended.

- Monitoring high temperature in normal operating conditions

- Internal resistance increase or initial voltage drop increase

- Deformation of the module case

Contact Information

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Appendix I

T(℃)	Rmin(kΩ)	Rcent(kΩ)	Rmax(kΩ)	DR(%)	DT(℃)
−40	332.8	348.4	364.6	4.65%	0.67
−39	311.2	325.5	340.4	4.58%	0.66
−38	291.2	304.3	318.0	4.51%	0.66
−37	272.5	284.7	297.3	4.44%	0.65
−36	255.2	266.4	278.0	4.37%	0.65
−35	239.1	249.4	260.2	4.30%	0.64
−34	224.2	233.7	243.6	4.23%	0.64
−33	210.2	219.0	228.1	4.17%	0.63
−32	197.3	205.4	213.8	4.10%	0.63
−31	185.2	192.7	200.4	4.03%	0.62
−30	173.9	180.8	188.0	3.97%	0.61
−29	163.4	169.8	176.4	3.90%	0.61
−28	153.6	159.5	165.6	3.84%	0.60
−27	144.5	149.9	155.6	3.77%	0.60
−26	135.9	141.0	146.2	3.71%	0.59
−25	127.9	132.6	137.5	3.64%	0.59
−24	120.5	124.8	129.3	3.58%	0.58
−23	113.5	117.5	121.6	3.52%	0.58
−22	107.0	110.7	114.5	3.46%	0.57
−21	100.9	104.3	107.8	3.40%	0.56
−20	95.15	98.33	101.6	3.34%	0.56
−19	89.79	92.74	95.77	3.27%	0.55
−18	84.76	87.50	90.31	3.21%	0.55
−17	80.05	82.59	85.19	3.16%	0.54
−16	75.63	77.98	80.40	3.10%	0.53
−15	71.49	73.66	75.90	3.04%	0.53
−14	67.59	69.61	71.69	2.98%	0.52
−13	63.94	65.81	67.73	2.92%	0.51
−12	60.50	62.24	64.02	2.86%	0.51
−11	57.27	58.88	60.53	2.81%	0.50
−10	54.23	55.73	57.26	2.75%	0.49
−9	51.37	52.76	54.18	2.69%	0.49
−8	48.68	49.97	51.29	2.64%	0.48
−7	46.15	47.35	48.57	2.58%	0.47
−6	43.77	44.88	46.01	2.53%	0.47
−5	41.52	42.55	43.60	2.47%	0.46
−4	39.40	40.36	41.34	2.42%	0.45
−3	37.41	38.29	39.20	2.37%	0.45
−2	35.52	36.35	37.19	2.31%	0.44

T(℃)	Rmin(kΩ)	Rcent(kΩ)	Rmax(kΩ)	DR(%)	DT(℃)
-1	33.74	34.51	35.29	2.26%	0.43
0	32.07	32.78	33.50	2.21%	0.43
1	30.48	31.14	31.81	2.15%	0.42
2	28.99	29.60	30.22	2.10%	0.41
3	27.57	28.14	28.72	2.05%	0.40
4	26.24	26.76	27.30	2.00%	0.40
5	24.97	25.46	25.96	1.95%	0.39
6	23.78	24.23	24.69	1.90%	0.38
7	22.64	23.07	23.49	1.85%	0.37
8	21.57	21.96	22.36	1.80%	0.37
9	20.56	20.92	21.29	1.75%	0.36
10	19.60	19.94	20.27	1.70%	0.35
11	18.69	19.00	19.31	1.65%	0.34
12	17.83	18.12	18.41	1.60%	0.34
13	17.01	17.28	17.54	1.55%	0.33
14	16.24	16.48	16.73	1.51%	0.32
15	15.50	15.73	15.96	1.46%	0.31
16	14.80	15.01	15.22	1.41%	0.30
17	14.14	14.33	14.53	1.36%	0.30
18	13.51	13.69	13.87	1.32%	0.29
19	12.91	13.08	13.24	1.27%	0.28
20	12.35	12.50	12.65	1.23%	0.27
21	11.81	11.95	12.09	1.18%	0.26
22	11.29	11.42	11.55	1.13%	0.25
23	10.81	10.92	11.04	1.09%	0.24
24	10.34	10.45	10.56	1.04%	0.24
25	9.900	10.00	10.10	1.00%	0.23
26	9.472	9.572	9.671	1.04%	0.24
27	9.064	9.164	9.264	1.09%	0.25
28	8.677	8.776	8.875	1.13%	0.26
29	8.308	8.406	8.505	1.18%	0.27
30	7.957	8.054	8.153	1.22%	0.29
31	7.622	7.719	7.817	1.26%	0.30
32	7.304	7.400	7.496	1.30%	0.31
33	7.000	7.095	7.191	1.35%	0.32
34	6.711	6.805	6.900	1.39%	0.33
35	6.436	6.528	6.622	1.43%	0.35
36	6.173	6.265	6.357	1.47%	0.36
37	5.922	6.013	6.104	1.52%	0.37
38	5.683	5.772	5.862	1.56%	0.38
39	5.455	5.543	5.631	1.60%	0.40
40	5.237	5.324	5.411	1.64%	0.41
41	5.030	5.114	5.200	1.68%	0.42
42	4.831	4.915	4.999	1.72%	0.44
43	4.641	4.724	4.807	1.76%	0.45
44	4.460	4.541	4.623	1.80%	0.46

T(℃)	Rmin(kΩ)	Rcent(kΩ)	Rmax(kΩ)	DR(%)	DT(℃)
45	4.287	4.367	4.447	1.84%	0.47
46	4.122	4.200	4.279	1.88%	0.49
47	3.964	4.040	4.118	1.92%	0.50
48	3.812	3.887	3.964	1.96%	0.51
49	3.668	3.741	3.816	2.00%	0.53
50	3.529	3.601	3.675	2.04%	0.54
51	3.397	3.468	3.540	2.08%	0.55
52	3.270	3.339	3.410	2.11%	0.57
53	3.149	3.217	3.286	2.15%	0.58
54	3.032	3.099	3.167	2.19%	0.59
55	2.921	2.986	3.053	2.23%	0.61
56	2.814	2.878	2.944	2.27%	0.62
57	2.712	2.775	2.839	2.30%	0.64
58	2.614	2.675	2.738	2.34%	0.65
59	2.520	2.580	2.642	2.38%	0.66
60	2.430	2.489	2.549	2.41%	0.68
61	2.344	2.401	2.460	2.45%	0.69
62	2.261	2.317	2.375	2.49%	0.71
63	2.181	2.237	2.293	2.52%	0.72
64	2.105	2.159	2.214	2.56%	0.74
65	2.032	2.085	2.139	2.60%	0.75
66	1.962	2.013	2.066	2.63%	0.77
67	1.894	1.945	1.997	2.67%	0.78
68	1.829	1.879	1.930	2.70%	0.80
69	1.767	1.815	1.865	2.74%	0.81
70	1.707	1.755	1.803	2.77%	0.83
71	1.650	1.696	1.744	2.81%	0.84
72	1.594	1.640	1.686	2.84%	0.86
73	1.541	1.586	1.631	2.88%	0.87
74	1.490	1.534	1.578	2.91%	0.89
75	1.441	1.483	1.527	2.95%	0.90
76	1.394	1.435	1.478	2.98%	0.92
77	1.348	1.389	1.431	3.01%	0.93
78	1.304	1.344	1.385	3.05%	0.95
79	1.262	1.301	1.341	3.08%	0.96
80	1.222	1.260	1.299	3.11%	0.98
81	1.183	1.220	1.258	3.15%	1.00
82	1.145	1.181	1.219	3.18%	1.01
83	1.109	1.144	1.181	3.21%	1.03
84	1.074	1.109	1.145	3.25%	1.04
85	1.040	1.074	1.110	3.28%	1.06
86	1.008	1.041	1.076	3.31%	1.08
87	0.9765	1.009	1.043	3.34%	1.09
88	0.9464	0.9785	1.011	3.38%	1.11
89	0.9174	0.9488	0.9811	3.41%	1.12
90	0.8894	0.9201	0.9517	3.44%	1.14

Appendix Ⅱ