

USER MANUAL

PBLH-54R0/166SDHV

TYPE 54V Rack Mounted Module

166F | 54 VDC | ULTRACAPACITOR

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1. OVERVIEW:

The PBLH-54R0/166SDHV Ultracapacitor Module is comprised of 18 series-connected 3V, 3000F ultracapacitor cells. Power terminals are located at the same end of the module to enable convenient series and parallel module-to-module connections.

The module is built into a sealed aluminum housing rated to IP65 against dust and water ingress, and qualified to IEC 61373 for shock and vibration, making it well suited to demanding transportation and industrial environments. A protective-earth (PE) ground tap and metal-lined mounting features are provided for secure, safe installation.

The module features dedicated active cell balancing circuitry with over-voltage alarm and temperature monitoring.

Key electrical, thermal, and mechanical specifications are summarized in **Table 1** below for easy reference. For latest specifications, see Tecate Group website for full datasheet specifications.

Table 1. Key Specifications – PBLH-54R0/166SDHV

PERFORMANCE	
Rated Voltage (Nominal)	54.0 V
Surge Voltage	57.6 V
Max. Series Voltage	1500 V
Capacitance	166 F
Capacitance Tolerance	-0% / +20%
Typical ESR DC	3.5 mΩ
Total Energy	67.4 Wh
Max. Current	2,500 A
Leakage Current	5 mA
THERMAL	
Max. Continuous Current ($\Delta T = 15\text{ }^{\circ}\text{C}$)	130 A
Max. Continuous Current ($\Delta T = 40\text{ }^{\circ}\text{C}$)	200 A
Thermal Resistance	0.2 $^{\circ}\text{C}/\text{W}$
SAFETY	
Short Circuit Current (calculated)	12,200 A
Isolation Voltage (DC, Terminal – Case, 60 s)	4.3 kV

MONITORING	
Temperature Sensor	PT100
Communication Interface	Analog
Output Connector	5-pin circular Phoenix Contact Part Number: 1551888
Cell Voltage Monitoring	Over-Voltage Alarm
Cell Balancing	Active Balancing
MECHANICAL & PHYSICAL	
Length	487.2 ± 2.0 mm
Width	418.0 ± 1.0 mm
Height	71.0 ± 1.0 mm
Weight	Max. 18 kg
Power Terminals	M8 (+) / M10 (-)
Recommended Torque	20 N·m (M8) / 30 N·m (M10)
Vibration & Shock Protection	IEC 61373
Environmental Protection	IP65

2. UNPACKING:

Prior to unpacking the module, inspect the shipping carton for signs of damage. Damage to the shipping carton or module should be reported immediately to the carrier.

Remove the module from the shipping carton and retain the shipping materials until the unit has been inspected and is determined to be operational.

If a shorting strap is fitted across the positive and negative power terminals for transport safety, leave it in place until the module is ready to be connected to a system.

NOTE: The original shipping materials are approved for both air and ground shipment. The module should be removed from the shipping carton by lifting the body of the module.

3. SAFETY:



- Do not operate above specified voltage.
- Do not operate above specified temperature rating.
- Do not touch terminals with conductors while energized. Serious burns, shock, or material fusing may occur.
- Protect surrounding electrical components from incidental contact.
- Provide sufficient electrical isolation when working above rated voltage.
- Prior to installation in or removal from equipment, fully discharge the module.
- Do not attempt to open the module housing.

4. INSTALLATION

4.1 Mechanical Installation

4.1.1 Mounting

Ensure the module is mounted in a location protected from external conditions. Refer to **Figure 1** for mounting positions and overall dimensions.

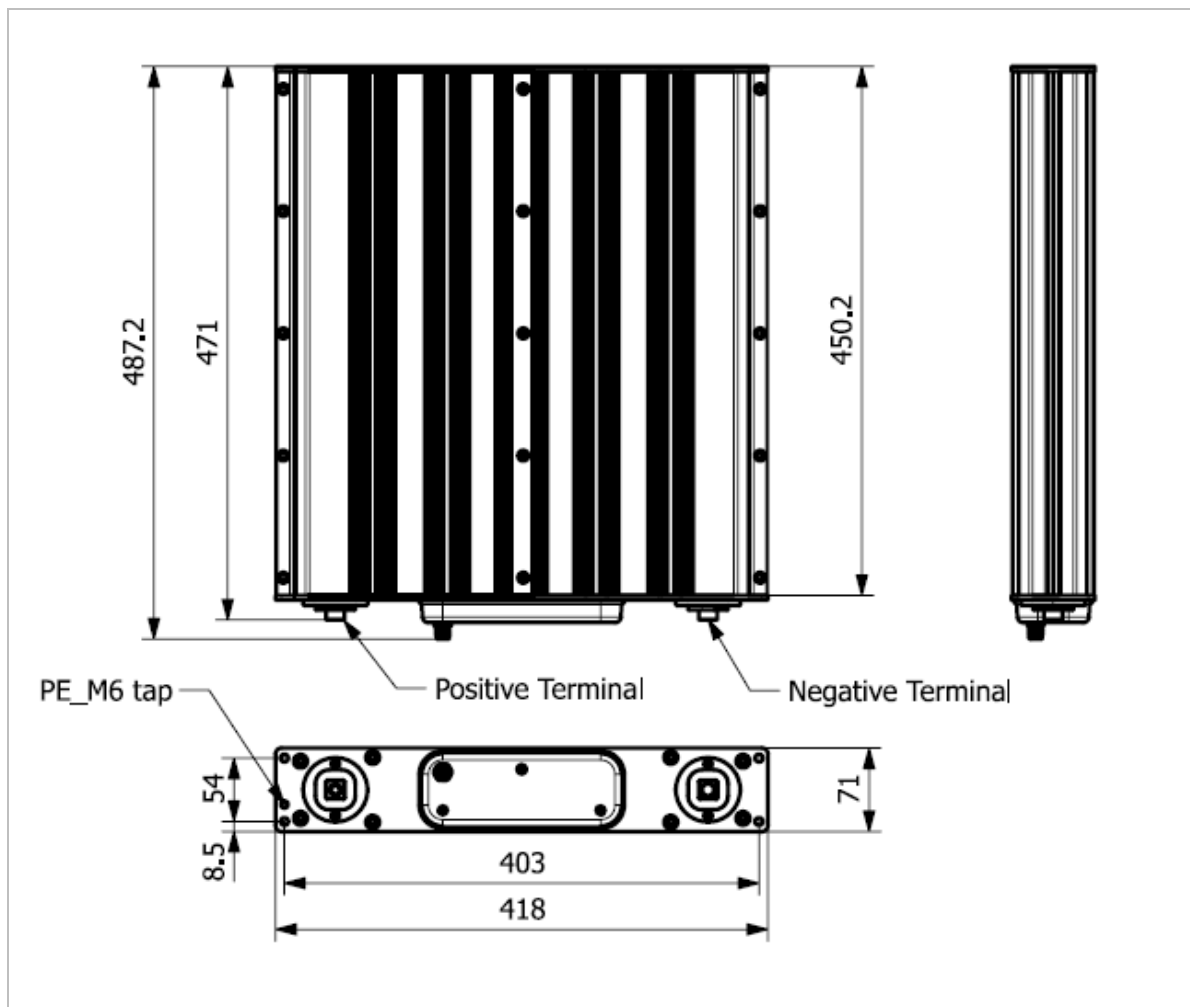


Figure 1. Mounting positions and dimensions (mm).

4.1.2 MODULE CHASSIS GROUND

The module chassis should be properly grounded to the system chassis through the module mounting bolt pass-through hole. See **Figure 2** for earth bolt location. See **Figure 3** for a recommended hardware stack-up for proper connection.

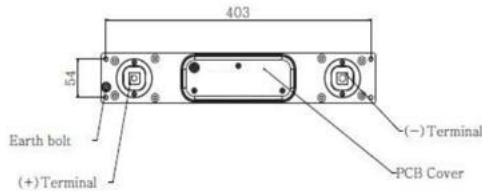


Figure 2. Earth/Ground location

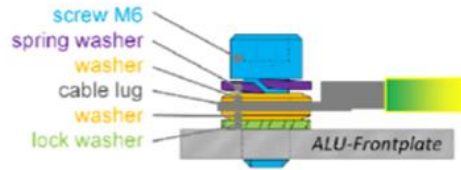


Figure 3. Chassis ground connection

4.1.2 MODULE TO MODULE CONNECTIONS:

Ensure the modules are discharged to 0V before attempting connections. Ultracapacitor modules can be connected in series and/or parallel to achieve higher operating voltages and applications with high power demands.

4.1 Series Connection:



Figure 4: Series connection of PBLH-54R0/166SDHV modules

4.2 Parallel Connection:



Figure 5: Parallel connection of PBLH-54R0/166SDHV modules

5. TERMINAL CONNECTIONS:

The PBLH-54R0/166SDHV Ultracapacitor modules are designed to connect directly to an electrical cable ring connector or a bus bar option. **Connection hardware is not included.** The positive and negative terminals both have a threaded hole for bolt connection. Terminal thread sizes are different: the positive terminal is M8 and the negative terminal is M10. Wave washers are required to ensure long-term, reliable connections. Ultracapacitor modules have very low ESR which may be adversely impacted by poor mechanical connections to the cable ring connector or bus bar. A separate M6 protective-earth (PE) tap is provided for chassis grounding. It is recommended that all module terminal connections be adequately protected to avoid shock hazards and corrosion.

5.1 TIGHTENING INSTRUCTIONS:

TORQUE SPECIFICATIONS are NOT the same for the positive and negative terminals and should be applied according to specification below.

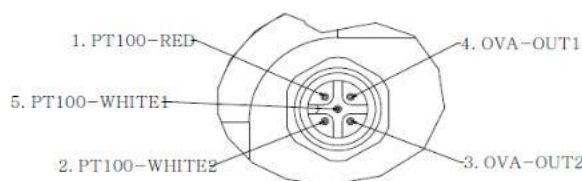
- 5.1.1 Positive Terminal M8 bolt – Torque of 20 N·m.
- 5.1.2 Negative Terminal M10 bolt – Torque of 30 N·m.

6. MONITORING OUTPUT CONNECTOR & DIAGRAMS:

Each module is equipped with a 5-pin circular output connector located between the positive and negative terminals. This enables monitoring of the PT100 thermistor and over-voltage monitoring signals to the user system. **See Section 6.5 for system mating connector information.**

6.1 Module Connector Pinout:

The output signals are isolated from the capacitor voltage and from chassis ground. Recommended signal level is 5 VDC. Connector diagram:



Pin #	Signal	Notes
1	PT100 – Red	
2	PT100 – White	
3	OVA OUT2	Over-Voltage Alarm Output State: ACTIVE HIGH = No Alarm LOW = Alarm Event
4	OVA OUT1	Over-Voltage Alarm Output State: ACTIVE HIGH = No Alarm LOW = Alarm Event
5	PT100 - White	

6.2 Over-Voltage Alarm:

- 6.2.1 Each cell voltage of the module is monitored and actively balanced. If any single cell of the module exceeds ~2.8V threshold, the balancing circuit is activated to discharge the cell.
- 6.2.2 If a cell voltage continues to rise, the Over-Voltage Alarm event triggers at 3.1V. The output of Pin 3 and 4 short circuit and the alarm output switches LOW signaling the user to stop charging.
- 6.2.2 When the cell voltage decreases below the cell's 3V threshold voltage threshold, Over-Voltage Alarm is automatically released to an ACTIVE HIGH status.
- 6.2.3 Recommend a pull-up resistor (typically 1 kΩ) between the alarm pin and a 5V supply.

6.3 Temperature Sensor:

A PT100 platinum RTD is integrated in the middle of the module for temperature monitoring. PT100 resistance increases with temperature following the standard IEC 60751 curve, reading 100 Ω at 0 °C and approximately 109.7 Ω at 25 °C. Please refer to **Section 9 Appendix I** for the resistance values across the operating temperature range.

6.4 System Mating Connector Info:

Module Connector	Mating Plug	Description
Phoenix Contact 1551888	See latest manufacturer for recommended mating plug part number	5-pin circular connector

7. MAINTENANCE:

7.1 Power Rating: If the applied voltage exceeds the rated voltage, charging should be stopped immediately. **Discharging the module to 0V has no negative consequences.**

7.2 Temperature: The module's optimal operating temperature range is –40 °C to +65 °C. If the temperature exceeds 70 °C to preserve module performance and life cycle.

7.3 Do not expose to direct sunlight: Ensure the module is not exposed to direct sunlight, which will cause the temperature to rise inside the module.

7.4 Projected Life: The module has a projected life of over 10 years at rated voltage and +25 °C, and a projected cycle life of 1,000,000 cycles. Actual life may be decreased under high-temperature conditions or over-voltage charging.

7.5 Detection of Abnormal Conditions: If abnormal conditions are detected, the system should be shut down to enable a safe evaluation of electrical and mechanical connections. Abnormal conditions to watch for:

1. High temperature exceeding normal operating conditions.
2. Increase in the internal resistance or initial voltage drop.
3. Deformation of the module case.

9. APPENDIX I

Reference values to EN 60 751 (ITS 90) in Ohm for Pt100 temperature sensors in 1°C steps

°C	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9
-200	18.520	-	-	-	-	-	-	-	-	-
-190	22.825	22.397	21.967	21.538	21.108	20.677	20.247	19.815	19.384	18.952
-180	27.096	26.671	26.245	25.819	25.392	24.965	24.538	24.110	23.682	23.254
-170	31.335	30.913	30.490	30.067	29.643	29.220	28.796	28.371	27.947	27.522
-160	35.543	35.124	34.704	34.284	33.864	33.443	33.022	32.601	32.179	31.757
-150	39.723	39.305	38.889	38.472	38.055	37.637	37.219	36.800	36.382	35.963
-140	43.876	43.462	43.048	42.633	42.218	41.803	41.388	40.972	40.556	40.140
-130	48.005	47.593	47.181	46.769	46.356	45.944	45.531	45.117	44.704	44.290
-120	52.110	51.700	51.291	50.881	50.470	50.060	49.649	49.239	48.828	48.416
-110	56.193	55.786	55.378	54.970	54.562	54.154	53.746	53.337	52.928	52.519
-100	60.256	59.850	59.445	59.039	58.633	58.227	57.821	57.414	57.007	56.600
-90	64.300	63.896	63.492	63.088	62.684	62.280	61.876	61.471	61.066	60.661
-80	68.325	67.924	67.522	67.120	66.717	66.315	65.912	65.509	65.106	64.703
-70	72.335	71.934	71.534	71.134	70.733	70.332	69.931	69.530	69.129	68.727
-60	76.328	75.929	75.530	75.131	74.732	74.333	73.934	73.534	73.134	72.735
-50	80.306	79.909	79.512	79.114	78.717	78.319	77.921	77.523	77.125	76.726
-40	84.271	83.875	83.479	83.083	82.687	82.290	81.894	81.497	81.100	80.703
-30	88.222	87.827	87.432	87.038	86.643	86.248	85.853	85.457	85.062	84.666
-20	92.160	91.767	91.373	90.980	90.586	90.192	89.796	89.404	89.010	88.616
-10	96.086	95.694	95.302	94.909	94.517	94.124	93.732	93.339	92.946	92.553
0	100.000	99.609	99.218	98.827	98.436	98.044	97.653	97.261	96.870	96.478

°C	0	1	2	3	4	5	6	7	8	9
0	100.000	100.391	100.781	101.172	101.562	101.953	102.343	102.733	103.123	103.513
10	103.903	104.292	104.682	105.071	105.460	105.849	106.238	106.627	107.016	107.405
20	107.794	108.182	108.570	108.959	109.347	109.735	110.123	110.510	110.898	111.286
30	111.673	112.060	112.447	112.835	113.221	113.608	113.995	114.382	114.768	115.155
40	115.541	115.927	116.313	116.699	117.085	117.470	117.856	118.241	118.627	119.012
50	119.397	119.782	120.167	120.552	120.936	121.321	121.705	122.090	122.474	122.858
60	123.242	123.626	124.009	124.393	124.777	125.160	125.543	125.926	126.309	126.692
70	127.075	127.458	127.840	128.223	128.605	128.987	129.370	129.752	130.133	130.515
80	130.897	131.278	131.660	132.041	132.422	132.803	133.184	133.565	133.946	134.326
90	134.707	135.087	135.468	135.848	136.228	136.608	136.987	137.367	137.747	138.126
100	138.506	138.885	139.264	139.643	140.022	140.400	140.779	141.158	141.536	141.914
110	142.293	142.671	143.049	143.426	143.804	144.182	144.559	144.937	145.314	145.691
120	146.068	146.445	146.822	147.199	147.575	147.951	148.328	148.704	149.080	149.456
130	149.832	150.208	150.583	150.959	151.334	151.710	152.085	152.460	152.835	153.210
140	153.584	153.959	154.333	154.708	155.082	155.456	155.830	156.204	156.578	156.952
150	157.325	157.699	158.072	158.445	158.818	159.191	159.564	159.937	160.309	160.682
160	161.054	161.427	161.799	162.171	162.543	162.915	163.286	163.658	164.030	164.401
170	164.772	165.143	165.514	165.885	166.256	166.627	166.997	167.368	167.738	168.108
180	168.478	168.848	169.218	169.588	169.958	170.327	170.696	171.066	171.435	171.804
190	172.173	172.542	172.910	173.279	173.648	174.016	174.384	174.752	175.120	175.488
200	175.856	176.224	176.591	176.959	177.326	177.693	178.060	178.427	178.794	179.161
210	179.528	179.894	180.260	180.627	180.993	181.359	181.725	182.091	182.456	182.822
220	183.188	183.553	183.918	184.283	184.648	185.013	185.378	185.743	186.107	186.472
230	186.836	187.200	187.564	187.928	188.292	188.656	189.019	189.383	189.746	190.110
240	190.473	190.836	191.199	191.562	191.924	192.287	192.649	193.012	193.374	193.736
250	194.096	194.460	194.822	195.183	195.545	195.906	196.268	196.629	196.990	197.351
260	197.712	198.073	198.433	198.794	199.154	199.514	199.875	200.235	200.595	200.954
270	201.314	201.674	202.033	202.393	202.752	203.111	203.470	203.829	204.188	204.546
280	204.905	205.263	205.622	205.980	206.338	206.696	207.054	207.411	207.769	208.127
290	208.484	208.841	209.198	209.555	209.912	210.269	210.626	210.982	211.339	211.695
300	212.052	212.406	212.764	213.120	213.475	213.831	214.187	214.542	214.897	215.252

The reference values have been calculated according to the International Temperature Scale ITS 90.
(For Pt500 or Pt1000 temperature sensors, the reference values have to be multiplied by 5 or 10 respectively).

Reference values to EN 60 751 (ITS 90)
in Ohm for Pt100 temperature sensors in 1°C steps

°C	0	1	2	3	4	5	6	7	8	9
310	216.608	216.962	216.317	216.672	217.027	217.381	217.736	218.090	218.444	218.798
320	219.152	219.506	219.860	220.213	220.567	220.920	221.273	221.626	221.979	222.332
330	222.685	223.038	223.390	223.743	224.095	224.447	224.799	225.151	225.503	225.855
340	226.206	226.558	226.909	227.260	227.612	227.963	228.314	228.664	229.015	229.366
350	229.716	230.066	230.417	230.767	231.117	231.467	231.816	232.166	232.516	232.865
360	233.214	233.564	233.913	234.262	234.610	234.959	235.308	235.656	236.005	236.353
370	236.701	237.049	237.397	237.745	238.093	238.440	238.788	239.135	239.482	239.829
380	240.176	240.523	240.870	241.217	241.563	241.910	242.256	242.602	242.948	243.294
390	243.640	243.986	244.331	244.677	245.022	245.367	245.713	246.058	246.403	246.747
400	247.092	247.437	247.781	248.125	248.470	248.814	249.158	249.502	249.845	250.189
410	250.533	250.876	251.219	251.562	251.906	252.248	252.591	252.934	253.277	253.619
420	253.962	254.304	254.646	254.988	255.330	255.672	256.013	256.355	256.696	257.038
430	257.379	257.720	258.061	258.402	258.743	259.083	259.424	259.764	260.105	260.445
440	260.785	261.125	261.465	261.804	262.144	262.483	262.823	263.162	263.501	263.840
450	264.179	264.518	264.857	265.195	265.534	265.872	266.210	266.548	266.886	267.224
460	267.562	267.900	268.237	268.574	268.912	269.249	269.586	269.923	270.260	270.597
470	270.933	271.270	271.606	271.942	272.278	272.614	272.950	273.286	273.622	273.957
480	274.293	274.628	274.963	275.298	275.633	275.968	276.303	276.638	276.972	277.307
490	277.641	277.975	278.309	278.643	278.977	279.311	279.644	279.978	280.311	280.644
500	280.978	281.311	281.643	281.976	282.309	282.641	282.974	283.306	283.638	283.971
510	284.303	284.634	284.966	285.298	285.629	285.961	286.292	286.623	286.954	287.285
520	287.616	287.947	288.277	288.608	288.938	289.268	289.599	289.929	290.258	290.588
530	290.918	291.247	291.577	291.906	292.235	292.565	292.894	293.222	293.551	293.880
540	294.208	294.537	294.865	295.193	295.521	295.849	296.177	296.505	296.832	297.160
550	297.487	297.814	298.142	298.469	298.795	299.122	299.449	299.775	300.102	300.428
560	300.754	301.080	301.406	301.732	302.058	302.384	302.709	303.035	303.360	303.685
570	304.010	304.335	304.660	304.985	305.309	305.634	305.958	306.282	306.606	306.930
580	307.254	307.578	307.902	308.225	308.549	308.872	309.195	309.518	309.841	310.164
590	310.487	310.810	311.132	311.454	311.777	312.099	312.421	312.743	313.065	313.386
600	313.708	314.029	314.351	314.672	314.993	315.314	315.635	315.956	316.277	316.597
610	316.918	317.238	317.558	317.878	318.198	318.518	318.838	319.157	319.477	319.796
620	320.116	320.435	320.754	321.073	321.391	321.710	322.029	322.347	322.666	322.984
630	323.302	323.620	323.938	324.256	324.573	324.891	325.208	325.526	325.843	326.160
640	326.477	326.794	327.110	327.427	327.744	328.060	328.376	328.692	329.008	329.324
650	329.640	329.956	330.271	330.587	330.902	331.217	331.533	331.848	332.162	332.477
660	332.792	333.106	333.421	333.735	334.049	334.363	334.677	334.991	335.305	335.619
670	335.932	336.246	336.559	336.872	337.185	337.498	337.811	338.123	338.436	338.748
680	339.061	339.373	339.685	339.997	340.309	340.621	340.932	341.244	341.555	341.867
690	342.178	342.489	342.800	343.111	343.422	343.732	344.043	344.353	344.663	344.973
700	345.284	345.593	345.903	346.213	346.522	346.832	347.141	347.451	347.760	348.069
710	348.378	348.686	348.995	349.303	349.612	349.920	350.228	350.536	350.844	351.152
720	351.460	351.768	352.075	352.382	352.690	352.997	353.304	353.611	353.918	354.224
730	354.531	354.837	355.144	355.450	355.756	356.062	356.368	356.674	356.979	357.285
740	357.590	357.896	358.201	358.506	358.811	359.116	359.420	359.725	360.029	360.334
750	360.638	360.942	361.246	361.550	361.854	362.158	362.461	362.765	363.068	363.371
760	363.674	363.977	364.280	364.583	364.886	365.188	365.491	365.793	366.095	366.397
770	366.699	367.001	367.303	367.604	367.906	368.207	368.508	368.810	369.111	369.412
780	369.712	370.013	370.314	370.614	370.914	371.215	371.515	371.815	372.115	372.414
790	372.714	373.013	373.313	373.612	373.911	374.210	374.509	374.808	375.107	375.406
800	375.704	376.002	376.301	376.599	376.897	377.195	377.493	377.790	378.088	378.385
810	378.683	378.980	379.277	379.574	379.871	380.167	380.464	380.761	381.057	381.353
820	381.650	381.946	382.242	382.537	382.833	383.129	383.424	383.720	384.015	384.310
830	384.605	384.900	385.195	385.489	385.784	386.078	386.373	386.667	386.961	387.255
840	387.549	387.843	388.136	388.430	388.723	389.016	389.310	389.603	389.896	390.188
850	390.481	-	-	-	-	-	-	-	-	-

The reference values have been calculated according to the International Temperature Scale ITS 90.
 (For Pt500 or Pt1000 temperature sensors, the reference values have to be multiplied by 5 or 10 respectively).