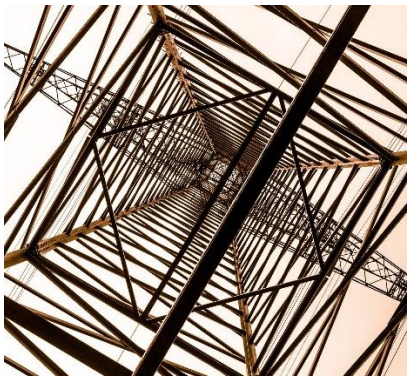
PRODUCT CATALOG 2022

CELLS – MODULES - SYSTEMS

CapTop ITALIA



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CONTENT TABLE

1. Product guide 5

1.1. Product Code Naming System 5

1.2. Products Summary 6

1.2.1. Cells 6

1.2.2. Modules 7

1.2.3. Systems 7

1.3. Terminal Types 7

1.3.1. Products Overview 8

1.4. Environmental friendliness 9

1.5. World-wide distribution networ 9

2. 3.0V Cell series 11

2.1. 3.0V Cell WL Series 13

2.2. Enhanced ESR 3.0V Cell WL Series 14

2.3. 3.0V Cell ST Series 15

2.4. 3.0V Cell SP Series 16

3. Module Series 17

3.1. 18V 500F Series 19

3.2. 54V 165F Series 21

3.3. 72V 125F Series 24

3.4. 96V 93F Series 27

4. System Series 30

4.1. Engine Start Module 30

4.2. 400V Regenerative Power Backup System 35

5. Technical notes 38

5.1. Definition of Supercapacitor . 38

5.2. Classification of Supercapacitor 38

5.3. Calculation formula of Supercapacitor 38

5.4. Working principle of Supercapacitor 40

5.5. Features of Supercapacitor .. 41

5.6. Measuring method of Supercapacitor 42

5.7. Materials of Supercapacitor.. 43

5.8. How Supercapacitor are manufactured 44

5.9. Maintenance 45

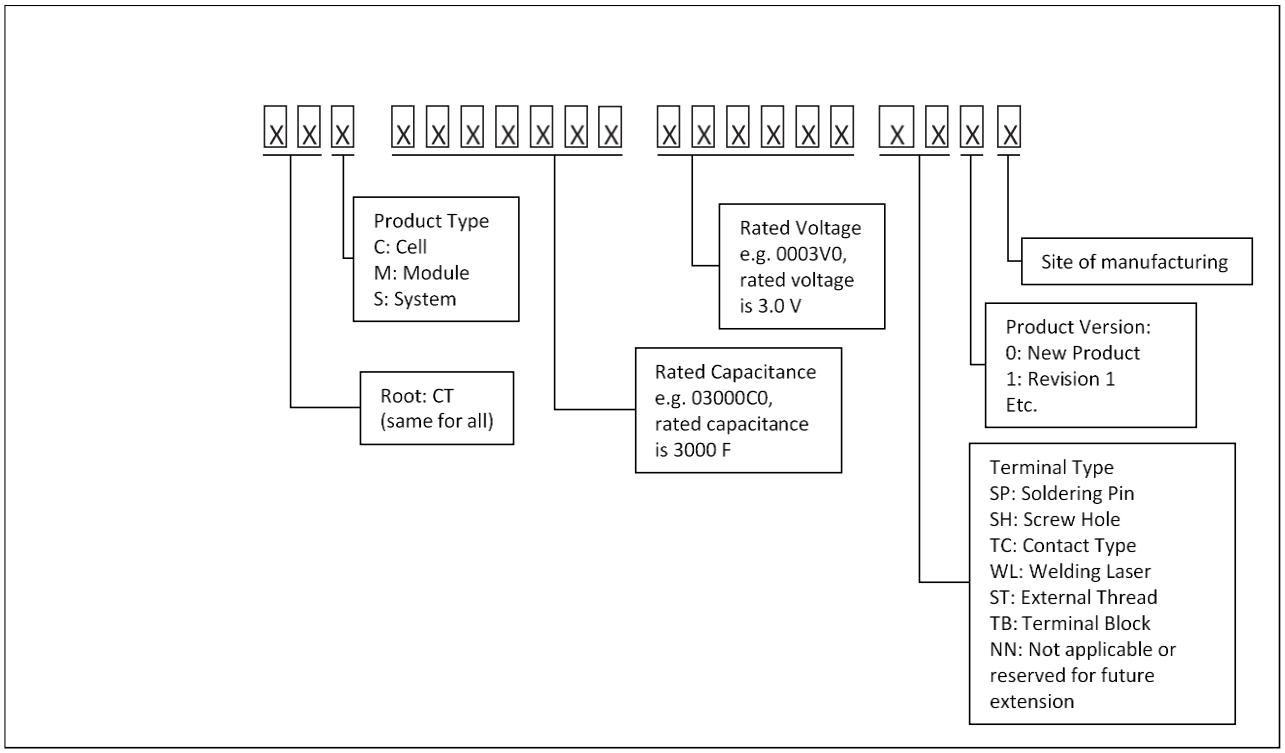
5.10. Disposal 46

Annex 47

1. PRODUCTS GUIDE

1.1. PRODUCT CODE NAMING SYSTEM

CapTop Italia® products are identified by a unique product code. The product code is structured according to the follow naming system:



Examples:

Product Series	Product Code
3.0V Cell WL Series	CTC 03000C0 0003V0 WL00
54V 165F Module Series	CTM 00165C0 0054V0 NN00

1.2. PRODUCTS SUMMARY

1.2.1. CELLS

Product Type	Product Series	Product Code	Page
Cell	3.0V Cell WL Series	CTC 00650C0 0003V0 WL00	13
		CTC 01200C0 0003V0 WL00	13
		CTC 01500C0 0003V0 WL00	13
		CTC 02000C0 0003V0 WL00	13
		CTC 03000C0 0003V0 WL00	13
		CTC 05000C0 0003V0 WL00	13
	Enhanced ESR 3.0V Cell WL Series	CTC 03000C0 0003V0 WL10	14
	3.0V Cell ST Series	CTC 00650C0 0003V0 ST00	15
		CTC 01200C0 0003V0 ST00	15
		CTC 01500C0 0003V0 ST00	15
		CTC 02000C0 0003V0 ST00	15
		CTC 03000C0 0003V0 ST00	15
		CTC 05000C0 0003V0 ST00	15
	3.0V Cell SP Series	CTC 00350C0 0003V0 SP00	16
		CTC 00450C0 0003V0 SP00	
		CTC 00500C0 0003V0 SP00	
		CTC 00600C0 0003V0 SP00	
		CTC 00720C0 0003V0 SP00	
		CTC 00800C0 0003V0 SP00	

1.2.2. MODULES

Product Type	Product Series	Product Code	Page
Module	18V 500F Series	CTM 00500C0 0018V0 NN00	19
	54V 165F Series	CTM 00165C0 0054V0 NN00	21
	72V 125F Series	CTM 00125C0 0072V0 NN00	24
	96V 93F Series	CTM 00093C0 0096V0 NN00	27

1.2.3. SYSTEMS

Product	Product Series	Product Code	Page
System	Engine Start Module	CTM 00300C0 0030V0 TB00	30
	400V Regenerative Power Backup System	CTS 00XXXC0 0400V0 TB00	35

1.3. TERMINAL TYPES

The terminal types of CapTop products are the follows:

Terminal Type	Shortening
Soldering Pin	SP
Screw Hole	SH
Contact Type	TC
Laser Welding	WL
External Thread	ST
Terminal Block	TB
Not applicable or reserved for future extension	NN

1.3.1. PRODUCTS OVERVIEW

Terminal Type		Product Type	Product Series	Product Code	Page
SP	Terminals on same side	Cell	3.0V Cell SP series	CTC 00350C0 0003V0 SP00	16
				CTC 00450C0 0003V0 SP00	
				CTC 00500C0 0003V0 SP00	
				CTC 00600C0 0003V0 SP00	
				CTC 00720C0 0003V0 SP00	
				CTC 00800C0 0003V0 SP00	
SH	Terminals on same side				
TC	Terminals on different side				
WL	Terminals on different side	Cell	3.0V Cell WL series	CTC 00650C0 0003V0 WL00	13
				CTC 01200C0 0003V0 WL00	13
				CTC 01500C0 0003V0 WL00	13
				CTC 02000C0 0003V0 WL00	13
				CTC 03000C0 0003V0 WL00	13
				CTC 05000C0 0003V0 WL00	13
			Enhanced ESR 3.0V Cell WL series	CTC 03000C0 0003V0 WL10	14
ST	Terminals on different side	Cell	3.0V Cell ST Series	CTC 00650C0 0003V0 ST00	15
				CTC 01200C0 0003V0 ST00	15
				CTC 01500C0 0003V0 ST00	15
				CTC 02000C0 0003V0 ST00	15
				CTC 03000C0 0003V0 ST00	15
				CTC 05000C0 0003V0 ST00	15
NN		Module	18V 500F Series	CTM 00500C0 0018V0 NN00	19
			54V 165F Series	CTM 00165C0 0054V0 NN00	21
			72V 125F Series	CTM 00125C0 0072V0 NN00	24
			96V 93F Series	CTM 00093C0 0096V0 NN00	27
TB		System	Engine Start Module	CTS 00300C0 0030V0 TB00	30
			400V Regenerative Power Backup System	CTS 00XXXC0 0400V0 TB00	35

1.4. ENVIRONMENTAL FRIENDLINESS

All CapTop Italia® products are RoHS compliant product.

1.5. WORLD-WIDE DISTRIBUTION NETWORK

Product Type	Product Series	Product Code	Europe
Cell	3.0V Cell WL Series	CTC 00650C0 0003V0 WL00	√
		CTC 01200C0 0003V0 WL00	√
		CTC 01500C0 0003V0 WL00	√
		CTC 02000C0 0003V0 WL00	√
		CTC 03000C0 0003V0 WL00	√
		CTC 05000C0 0003V0 WL00	√
	Enhanced ESR 3.0V Cell WL Series	CTC 03000C0 0003V0 WL10	√
	3.0V Cell ST Series	CTC 00650C0 0003V0 ST00	√
		CTC 01200C0 0003V0 ST00	√
		CTC 01500C0 0003V0 ST00	√
		CTC 02000C0 0003V0 ST00	√
		CTC 03000C0 0003V0 ST00	√
		CTC 05000C0 0003V0 ST00	√
	3.0V Cell SP Series	CTC 00350C0 0003V0 SP00	√
		CTC 00450C0 0003V0 SP00	
		CTC 00500C0 0003V0 SP00	
		CTC 00600C0 0003V0 SP00	
		CTC 00720C0 0003V0 SP00	
		CTC 00800C0 0003V0 SP00	
Module	18V 500F Series	CTM 00500C0 0018V0 NN00	√
	54V 165F Series	CTM 00165C0 0054V0 NN00	√
	72V 125F Series	CTM 00125C0 0072V0 NN00	√
	96V 93F Series	CTM 00093C0 0096V0NN00	√
System	Engine Start Module	CTS 00300C0 0030V0 TB00	√
	400V Regenerative Power Backup	CTS 00XXXC0 0400V0 TB00	√

N.B.

1) **Our product documents are being continually updated. Please be sure to download from our site and check the last version of the documents of your interest before ordering a product.**

2) **Refer to our web site for more information www.captop.it**

2. 3.0V CELL SERIES

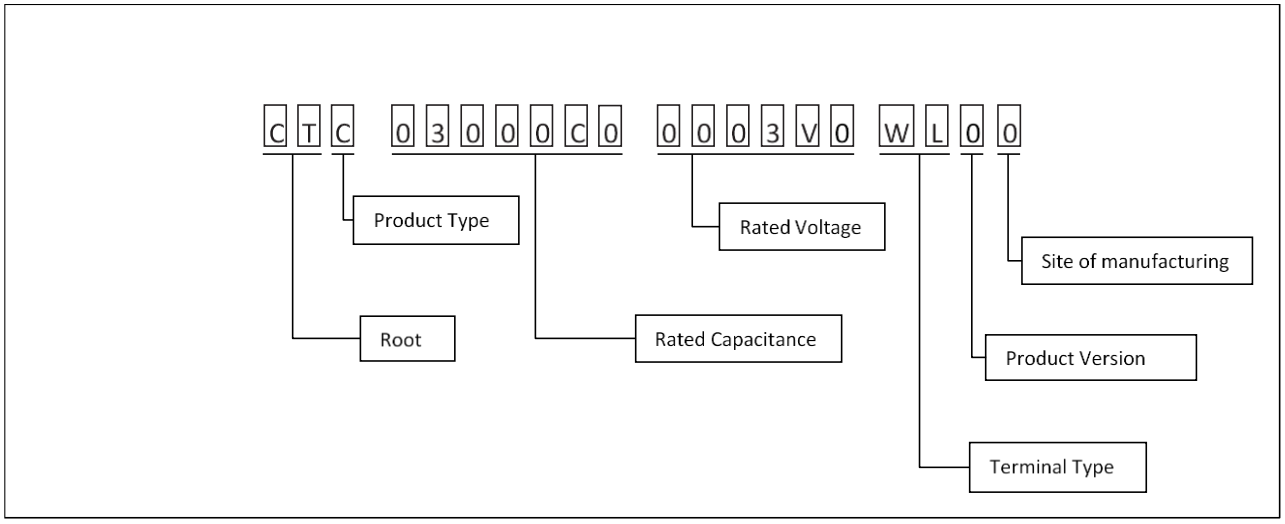
Series introduction

3.0V Cell Series refers to supercap cells, whose rated voltage is 3.0V and capacitance ranges from 350F to 5,000F. According to different terminal designs, three series are available at present and they are 3.0V Cell ST, 3.0V Cell WL and 3.0V Cell SP. Different capacitance, terminal design, and voltage may be obtained upon request.

Moreover, a version of the 3.0V Cell WL Series with enhanced ESR is available, namely Enhanced ESR 3.0V Cell WL Series. The cells of this series are available with a capacitance of **3,000 F**, at present.

Part Number Naming System

Taking 3.0V/3,000F Cell WL Series as an example, coding is as follows:



Construction

Inside structure: wound anode and cathode electrode with separator. Outer structure: aluminium case, insulating sleeve.

The terminals of 3.0V Cell series are laser welding, external thread type and soldering pin. Cells of the same series have same diameter but different height, depending on capacity. In the case of overcharging or abnormality, the explosion-proof valve of the shell will perform depressurization to avoid explosion.

Series	Terminal design
3.0V Cell WL Series	Laser Welding (WL)
Enhanced ESR 3.0V Cell WL Series	Laser Welding (WL)
3.0V Cell ST Series	External Thread (ST)
3.0V Cell SP Series	Soldering Pin (SP)

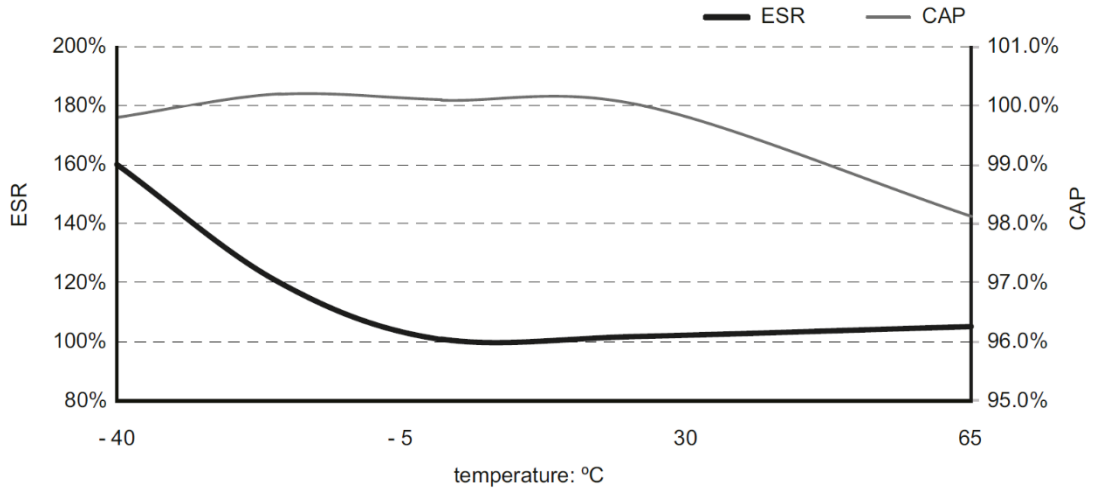
Application

3.0V Cell Series are use in areas like automotive, wind power generation, rail transportation, heavy duty machinery, micro grid, industrial backup power supply, and robot.

Installation

To increase the voltage up to the needed value, 3.0V cells are connected in series; different series may require different connectors. 3.0V Cell ST series can be connected by bolts, the torque should be controlled at 14±2 N·m.

Temperature characteristic curve

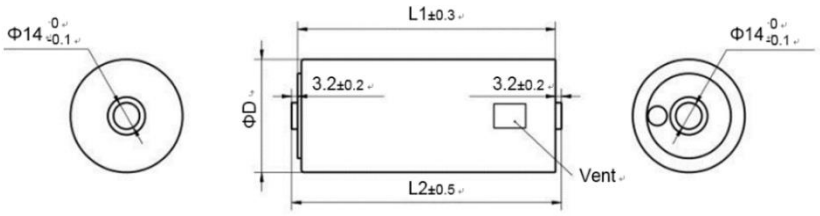


2.1. 3.0V CELL WL SERIES

Product introduction

3.0V Cell WL Series refers to the products whose terminal design is laser welding type (WL). Its rated voltage is 3.0 V and its capacitance ranges from 650F to 5,000F.

Dimension



Cap (F)	L (mm)
650	51. 1
1,200	74.0
1,500	85.0
2,000	102
3,000	138
5,000	203

Specifications	
Items	**Characteristic**
Operating Voltage (DC)	3.0 V
Surge Voltage (DC)	3.15 V
Operating Temperature Range	-40 °C to 65 °C
Capacitance Tolerance	0% a +20% (25 °C)
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of rated value @ 25 °C ESR ≤ 50% of rated value
Life (1,500 hours @65 °C, 3.0V DC)	ΔC ≤ 20% of rated value ESR ≤ 100% of rated value

Standard Products												
CAP (F)	Product Code	ESR (mΩ)		LC (72h @ RT, mA)	Max. Energy Stored (Wh)	Max. Energy Density (Wh/Kg)	Max. Continuous Current (15°/40 °C, A)	Max. Peak Current (A)	Typical Thermal Resistance (°C /W)	Typical Thermal Capacitance, (C_{th}, J/ °C)	Typical Mass (g)
		AC@ 1kHz Max.	DC Max.								
650	CTC 00650C0 0003VO WL00	0.57	0.61	3.5	0.8	4.2	62/101	723	6.3	229	194
1,200	CTC 01200C0 0003VO WL00	0.33	0.44	4.8	1.5	5.7	82/135	1,196	4.9	302	265
1,500	CTC 01500C0 0003VO WL00	0.27	0.36	5.8	1.9	6.1	96/157	1,486	4.5	348	309
2,000	CTC 02000C0 0003VO WL00	0.20	0.27	6.7	2.5	6.8	119/195	1,988	3.9	421	366
3,000	CTC 03000C0 0003VO WL00	0.18	0.22	10.0	3.8	7.6	148/242	2,711	3.1	586	496
5,000	CTC 05000C0 0003VO WL00	0.17	0.21	25.0	6.3	8.6	178/291	3,521	2.2	852	724

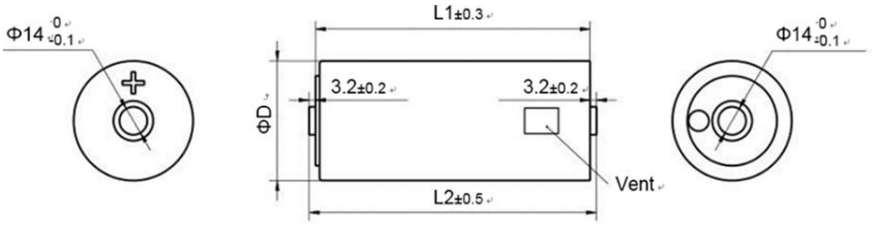
*All values are provisional and may vary.

2.2. ENHANCED ESR 3.0V CELL WL SERIES

Product introduction

Enhanced ESR 3.0V Cell WL Series refers to the products with enhanced ESR and whose terminal design is laser welding type (WL). Its rated voltage is 3.0 V and its capacitance is 3,000 F.

Dimension



Cap (F)	L (mm)
3,000	138

Specifications	
Items	**Characteristic**
Operating Voltage	3.0V DC
Surge Voltage	3.15V DC
Operating Temperature Range	-40°C to 65°C
Capacitance Tolerance	0% to +20% (25°C)
Temperature Performance (-40°C to 65°C)	ΔC ≤ 5% of rated value @ 25°C ΔESR ≤ 50% of rated value @25°C
Life (1,500 hours @65°C, 3.0V DC)	C_{end} ≥ 80% of rated value ESR_{end} ≤ 200% of rated value

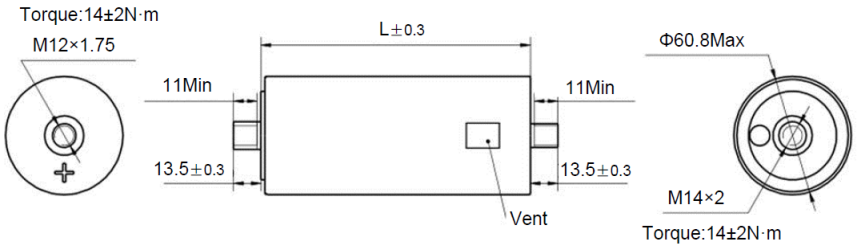
Standard Product												
CAP (F)	Product Code	ESR (mΩ)		LC (mA, RT 72hrs)	Max. Energy Stored (Wh)	Max. Energy Density (Wh/Kg)	Max. Power Density (Kw/Kg)	Max. Continuous Current (15°/40 °C, A)	Max. Peak Current (A)	Typical Thermal Resistance (R th, °C /W)	Typical Thermal Capacitance (C th J/°C)	Typical Mass (g)
		AC@ 1kHz Max.	DC Max.									
3,000	CTC 03000C0 0003VO WL10	0.09	0.11	12	3.75	7.38	39.34	209/342	3,383	3.1	614	508

*All values are provisional and may vary.

2.3. 3.0V CELL ST SERIES

3.0V Cell ST Series refers to the products whose terminal design is external thread type (ST). Its rated voltage is 3.0 V and its capacitance ranges from 650F to 5,000F.

Dimension



Cap (F)	L (mm)
650	51. 1
1,200	74.0
1,500	85.0
2,000	102
3,000	138
5,000	203

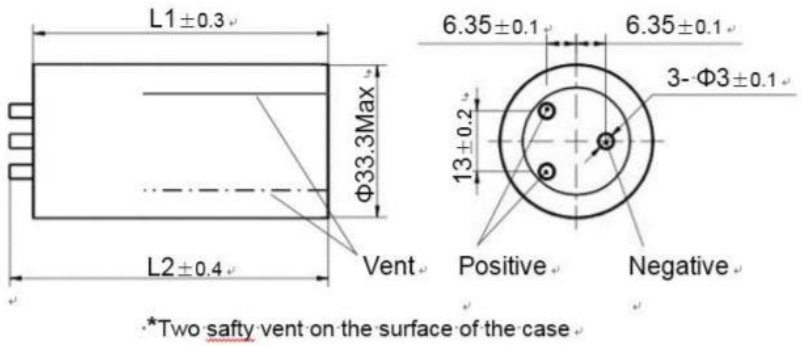
Specifications	
Items	**Characteristic**
Operating Voltage (DC)	3.0 V
Surge Voltage (DC)	3.15 V
Operating Temperature Range	-40 °C to 65 °C
Capacitance Tolerance	0% a +20% (25 °C)
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of rated value @ 25 °C ESR ≤ 50% of rated value
Life (1,500 hours @65 °C, 3.0V DC)	ΔC ≤ 20% of rated value ESR ≤ 100% of rated value

*All values are provisional and may vary.

2.4. 3.0V CELL SP SERIES

3.0V Cell SP Series refers to the products whose terminal design is soldering pin type (ST). Its rated voltage is 3.0 V and its capacitance ranges from 350F to 800F.

Dimension



Cap (F)	L (mm)
350	63.8 L1
	68.7 L2
450	79.8 L1
	84.7 L2
500	79.8 L1
	84.7 L2
600	93.8 L1
	98.7 L2
720	112.8 L1
	118.7 L2
800	112.8 L1
	118.7 L2

Specifications	
Items	**Characteristic**
Operating Voltage (DC)	3.0 V
Surge Voltage (DC)	3.15 V
Operating Temperature Range	-40 °C to 65 °C
Capacitance Tolerance	0% a +20% (25 °C)
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of rated value @ 25 °C ESR ≤ 50% of rated value
Life (1,500 hours @65 °C, 3.0V DC)	ΔC ≤ 20% of rated value ESR ≤ 100% of rated value

Standard Product											
CAP (F)	Product Code	ESR (mΩ)		LC (mA, RT 72hrs)	Max. Energy Stored (Wh)	Max. Energy Density (Wh/Kg)	Max. Continuous Current (15°/40 °C, A)	Max. Peak Current (A)	Typical Thermal Resistance (R th, °C /W)	Typical Thermal Capacitance (C th J/°C)	Typical Mass (g)
		AC@ 1kHz Max.	DC Max.								
350	CTC 00350C0 0003V0 SP00	1.5	2.5	0.5	0.44	6,77	24/39	252	10.1	75	65
450	CTC 00450C0 0003V0 SP00	1.5	2.5	0.9	0.56	7.0	27/43	285	8.4	100	80
500	CTC 00500C0 0003V0 SP00	1.5	2.5	1.0	0.63	7.87	27/43	300	8.4	100	80
600	CTC 00600C0 0003V0 SP00	1.4	2.4	1.2	0.75	7,14	29/47	332	7.4	130	105
720	CTC 00720C0 0003V0 SP00	1.3	1.8	1.4	0.9	8.0	36/59	423	6.3	140	112
800	CTC 00800C0 0003V0 SP00	1.3	1.8	1.5	1.0	8,93	36/59	423	6.3	140	112

*All values are provisional and may vary.

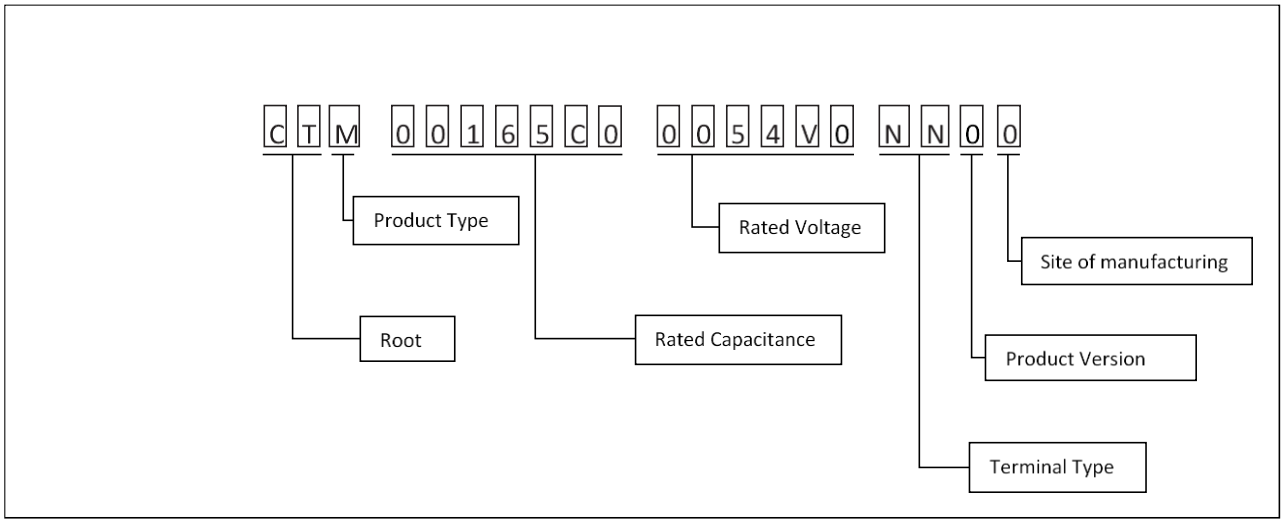
3. MODULE SERIES

Series introduction

CapTop Module Series consists of several 3.0V cells connected in series or parallel. According to different needs of voltage and/or capacitance in each specific application, CapTop Modules can be customized. The most common modules are those at 18V, 54V, 72V, and 96V.

Part Number Naming System

Taking 54V/165F Module Series as an example, coding is as follows:



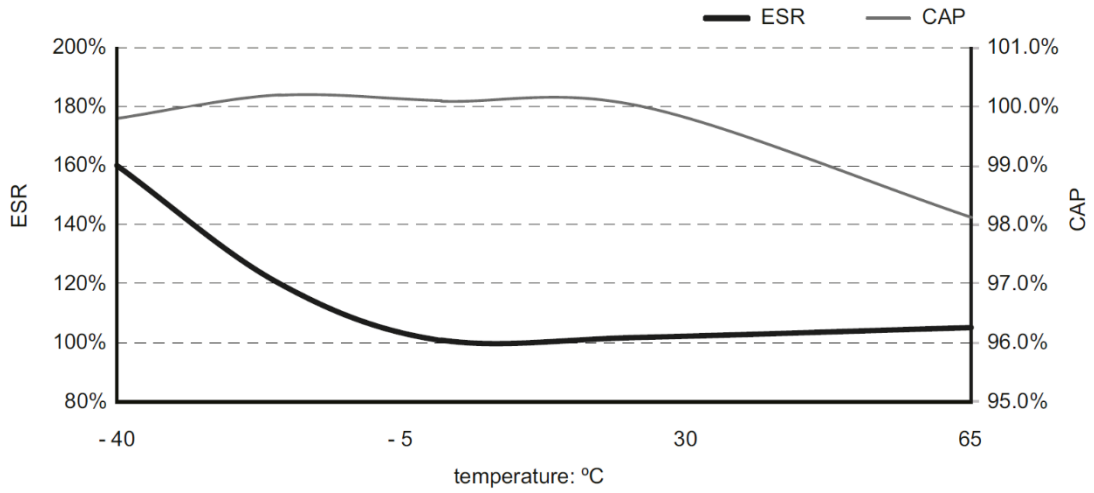
Construction

The terminals of CapTop Module Series are not applicable, or they are reserved for future. The housing is generally an iron or plastic shell with screw hole.

Application

Due to the characteristics of high capacitance and low ESR, CapTop Module Series can be used in sectors like automotive, wind turbine, industrial and micro grid power storage.

Temperature characteristic curve



3.1. 18V 500F MODULE SERIES

Introduction

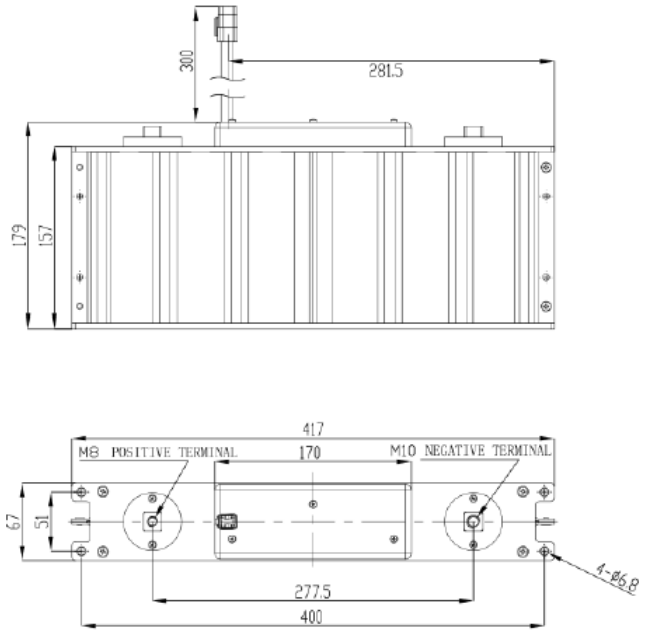
The 18V 500F Module Series is a complete energy storage module consisting of 6 individual supercaps connected in series, of which nominal capacitance is 3,000F.
This module series includes a cell management system equipped with a voltage balance electronic board which can protect each cell from operating in a damaging overvoltage condition. The series module is suitable for applications in different industrial sectors, like automotive, wind turbine, heavy duty machinery and microgrid storage system.

Construction

The module must be fixed through the four holes positioned on the corners with the appropriate screws. The 4P terminal of the cell management system allows the emission of an overvoltage alarm signal and the monitoring of the module inner temperature.

Function

The 18V 500F Module Series has functions, such as overvoltage alarm and temperature monitoring system.



Dimension		
D (Max.)	**L1**	**L2**
417(±1) mm	67(±1) mm	179(±1) mm

Pin definition			
Pin Number	**Wire Color**	**Definition**	**Outputs**
1	Black	GND	/
2	Red	Overvoltage Alarm	High - Inactive
			Low - Active
3	Void	Void	
4	Green	Temperature	

Specifications	
Item	**Characteristics**
Nominal Capacitance	500 F
Capacitance Tolerance	0% / +20%
Rated Voltage - VR	18 V
Surge Voltage	19 V
ESR, DC	1.32 mΩ
Maximum Continuous Current (ΔT=15 °C)	100 A
Maximum Continuous Current (ΔT=40 °C)	160 A
Maximum Peak Current, 1 sec.	2,000 A
Leakage Current (after 72h @ 25 °C)	10 mA
Operating Temperature Range	- 40 °C to +65 °C
Storage Temperature Range	- 40 °C to +70 °C
Environment Humidity	≤ 90% RH
Weight	5.48 kg
Power Terminals	M8/M10
Recommended Torque - Terminal	20/30 Nm
Vibration Specification IEC 255-21-1	IEC 255-21-1
Shock Specification IEC 255-21-2	IEC 255-21-2
Environmental Protection	IP54
Balancing	Equalization Circuit
Cell Voltage Monitoring	Overvoltage Alarm
Temperature Monitoring	NTC Thermistor
Usable Power Density (Pd)	5.379 kW/kg
Impedance Match Power Density (Pmax)	11.21 kW/kg
Gravimetric Energy Density (Emax)	4.1 Wh/kg
Stored Energy	22.5 Wh
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of initial measured value @ 25 °C ESR ≤ 50% of specified value
High Temp. Life (1,500 hours @ 65 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Room Temp. Life (10 years @ 25 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Cycle Life (1,000,000 cycles between VR and 1/2 VR)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Shelf Life (25 °C, uncharged)	4 years
Factory High-Pot Test	DC 2,500 V
Typical Thermal Resistance	0.8 °C/W
Typical Thermal Capacitance	4.400 kJ/ °C

*All values are provisional and may vary.

3.2. 54V 165F MODULE SERIES

Introduction

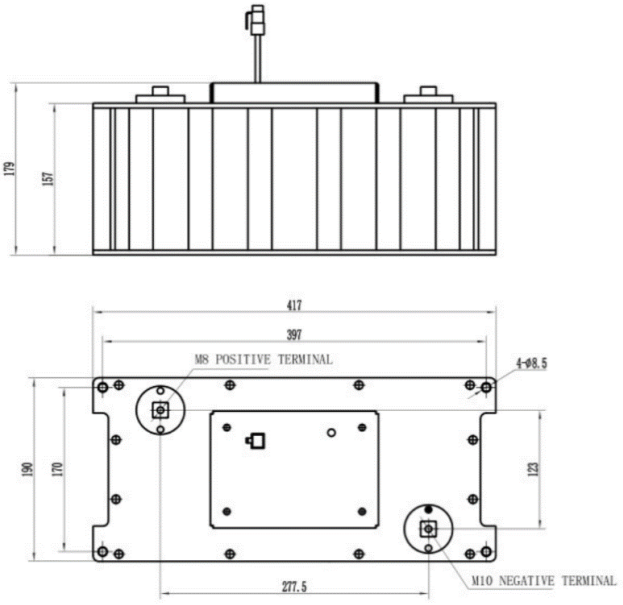
The 54V 165F Module Series is a complete energy storage module consisting of 18 individual supercaps connected in series, of which nominal capacitance is 3,000F.
This module series includes a cell management system equipped with a voltage balance electronic board which can protect each cell from operating in a damaging overvoltage condition. The series module is suitable for applications in different industrial sectors, like automotive, railway transportation, heavy duty machinery and microgrid storage system.

Construction

The module must be fixed through the four holes positioned on the corners with the appropriate screws. The 4P terminal of the cell management system allows the emission of an overvoltage alarm signal and the monitoring of the module inner temperature.

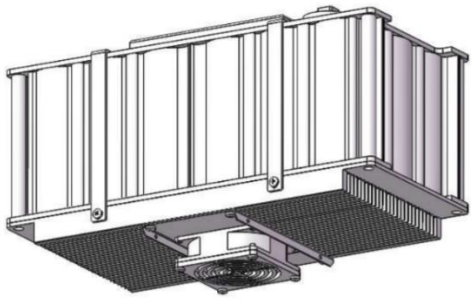
Function

The 54V 165F module series has functions, such as overvoltage alarm, temperature monitoring system and polling function (each cell voltage output).



Dimension		
D (Max.)	**L1**	**L2**
417 mm	190 mm	179 mm

Pin definition			
Pin Number	**Wire Color**	**Definition**	**Outputs**
1	Black	GND	/
2	Red	Overvoltage Alarm	High - Inactive
			Low - Active
3	Void	Void	
4	Green	Temperature	



Optional Accessories
Fan and heat sink can be installed on the module, which can increase module cooling capacity. The fan needs external 24V power supply and must be installed under the module with the sink.

Specifications	
Item	**Characteristics**
Nominal Capacitance	165 F
Capacitance Tolerance	0% / +20%
Rated Voltage - VR	54 V
Surge Voltage	57 V
ESR, DC	3.96 mΩ
Maximum Continuous Current (ΔT=15 °C)	90 A
Maximum Continuous Current (ΔT=40 °C)	150 A
Maximum Peak Current, 1 sec.	2000 A
Leakage Current (25 °C, after 72h)	10 mA
Operating Temperature Range	- 40 °C to +65 °C
Storage Temperature Range	- 40 °C to +70 °C
Power Terminals	M8/M10
Recommended Torque - Terminal	20/30 Nm
Vibration Specification IEC 255-21-1	IEC 255-21-1
Shock Specification IEC 255-21-2	IEC 255-21-2
Cell Voltage Monitoring	Overvoltage Alarm
Temperature Monitoring	NTC Thermistor
Stored Energy	66.8 Wh
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of initial measured value ESR ≤ 50% of specified value
High Temp. Life (1,500 hours @ 65 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Room Temp. Life (10 years @ 25 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Cycle Life (1,000,000 cycles between VR and 1/2 VR)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Shelf Life (25 °C, uncharged)	4 years
Factory High-Pot Test	DC 2,500 V
Typical Thermal Resistance	0.3 °C/W
Typical Thermal Capacitance	14.000 kJ/°C

Difference parameter list	
Environmental Protection	IP54
Weight	13.63 kg
Usable Power Density (Pd)	6.484 kW/kg
Impedance Match Power Density (Pmax)	13.51 kW/kg
Gravimetric Energy Density (Emax)	4.9 Wh/kg
Environment Humidity	≤90% RH
Installation	M8 short screw

*All values are provisional and may vary.

3.3. 72V 125F MODULE SERIES

Introduction

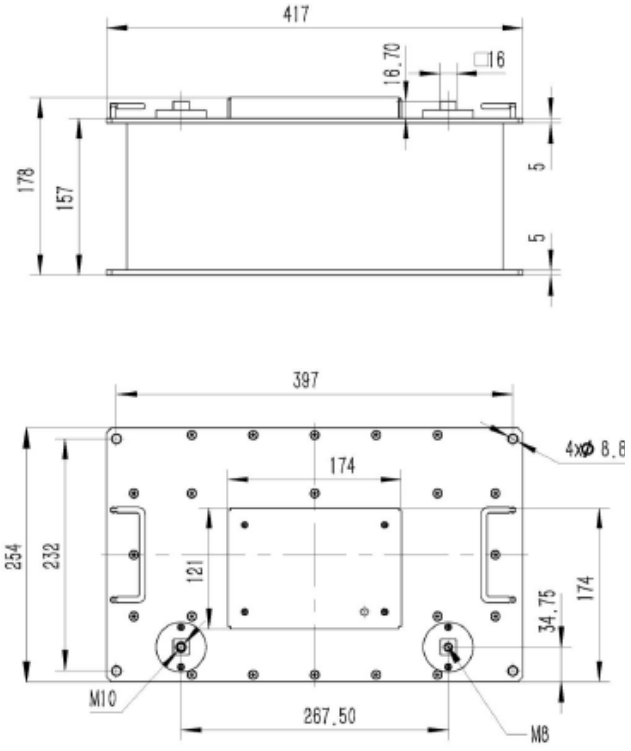
The 72V 125F Module Series is a complete energy storage module consisting of 18 individual supercaps connected in series, of which nominal capacitance is 3,000F.
This module series includes a cell management system equipped with a voltage balance electronic board which can protect each cell from operating in a damaging overvoltage condition. This module with aluminium housing is suitable for applications like automotive, railway transportation, heavy duty machinery and energy storage system.

Construction

The module must be fixed through the four holes positioned on the corners with the appropriate screws. The 4P terminal of the cell management system allows the emission of an overvoltage alarm signal and the monitoring of the module inner temperature.

Function

The 72V 125F Module Series has functions, such as over-voltage alarm, temperature monitor.



Dimension		
D (Max.)	L1	L2
417 mm	274 mm	179 mm

Pin definition			
Pin Number	Wire Color	Definition	Outputs
1	Black	GND	/
2	Red	Overvoltage Alarm	High - Inactive
			Low - Active
3	Void	Void	
4	Green	Temperature	

Optional Accessories
Suitable fan and heat sink available upon request. Please contact us for more information.

Specifications	
Item	**Characteristics**
Nominal capacitance	125 F
Capacitance tolerance	0% / +20%
Rated voltage - VR	72 V
Surge voltage	75 V
ESR, DC	5.28 mΩ
Maximum continuous current (ΔT=15 °C)	100 A
Maximum continuous current (ΔT=40 °C)	160 A
Maximum peak current, 1 sec.	2000 A
Leakage current (25 °C, after 72h)	10 mA
Operating temperature range	-40 °C to +65 °C
Storage temperature range	-40 °C to +70 °C
Power Terminals	M8/M10
Recommended Torque - Terminal	20/30 Nm
Vibration Specification	IEC 255-21-1
Shock Specification	IEC 255-21-2
Cell Voltage Monitoring	Overvoltage Alarm
Temperature Monitoring	NTC Thermistor
Stored Energy	90 Wh
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of initial measured value @ 25 °C ESR ≤ 50% of specified value
High Temp. Life (1,500 hours @ 65 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Room Temp. Life (10 years @ 25 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Cycle Life (1,000,000 cycles between VR and 1/2 VR)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Shelf Life (25 °C, uncharged)	4 years
Factory High-Pot Test	DC 2,500 V
Typical Thermal Resistance	0.2 °C/W
Typical Thermal Capacitance	16.500 kJ/°C

*All values are provisional and may vary.

Difference parameter list	
Environmental Protection	IP54
Weight	18.9 kg
Usable Power Density (Pd)	6.232 kW/kg
Impedance Match Power Density (Pmax)	12.98 kW/kg
Gravimetric Energy Density (Emax)	4.8 Wh/kg
Environment Humidity	≤90% RH
Installation	M8 short screw

*All values are provisional and may vary.

3.4. 96V 93F MODULE SERIES

Introduction

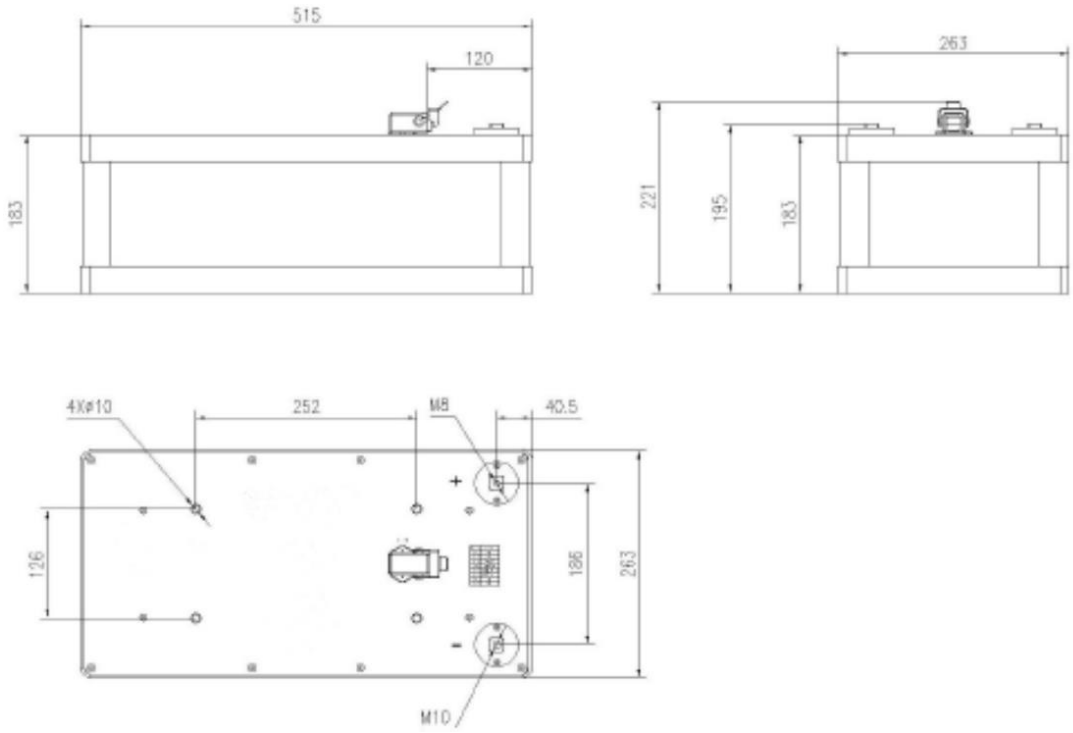
The 96V 93F Module Series is a complete energy storage module consisting of 32 individual supercaps connected in series, of which nominal capacitance is 3,000F.
This module series includes a cell management system equipped with a voltage balance electronic board, which can protect each cell from operating in a damaging overvoltage condition. This module series is suitable for applications in different industrial sectors, like pitch control system (wind turbines), railway transportation, heavy duty machinery and microgrid storage system.

Construction

The module must be fixed through the four holes positioned on the corners with the appropriate screws. The 4P terminal of the cell management system allows the emission of an overvoltage alarm signal and the monitoring of the module inner temperature.

Function

The 96V 93F Module Series has functions, such as high-temperature alarm and mid-point voltage measurement.



Pin definition		
Pin Number	**Definition**	**Remark**
1	NC	
2	NC	
3	Temperature signal	Pt100
4	Temperature signal	
5	Midpoint voltage (+)	
6	Negative voltage (-)	
7	NC	
8	NC	

Dimension		
D (Max.)	**L1**	**L2**
515 mm	263 mm	221 mm

Optional Accessories
Suitable fan and heat sink available upon request. Please contact us for more information.

Specifications	
Item	**Characteristics**
Nominal capacitance	93 F
Capacitance tolerance	0% / +20%
Rated voltage - VR	96 V
Surge voltage	100 V
ESR, DC	7.04 mΩ
Maximum continuous current (ΔT=15 °C)	100 A
Maximum continuous current (ΔT=40 °C)	160 A
Maximum peak current, 1 sec.	2000 A
Leakage current (25 °C, after 72h)	10 mA
Operating temperature range	-40 °C to +65 °C
Storage temperature range	-40 °C to +70 °C
Power Terminals	M8/M10
Recommended Torque - Terminal	20/30 Nm
Vibration Specification	IEC 255-21-1
Shock Specification	IEC 255-21-2
Cell Voltage Monitoring	Midpoint Voltage
Temperature Monitoring	Pt100
Stored Energy	119 Wh
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of initial measured value @ 25 °C ESR ≤ 50% of specified value
High Temp. Life (1,500 hours @ 65 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Room Temp. Life (10 years @ 25 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Cycle Life (1,000,000 cycles between VR and 1/2 VR)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Shelf Life (25 °C, uncharged)	4 years
Factory High-Pot Test	DC 2,500 V
Typical Thermal Resistance	0.12 °C/W
Typical Thermal Capacitance	21.000 kJ/°C

Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of initial measured value@ 25 °C ESR ≤ 50% of specified value
High Temp. Life (1,500 hours @ 65 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Room Temp. Life (10 years @ 25 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Cycle Life (1,000,000 cycles between VR and 1/2 VR)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Shelf Life (25 °C, uncharged)	4 years
Factory High-Pot Test	DC 2,500 V
Typical Thermal Resistance	0.12 °C/W
Typical Thermal Capacitance	21.000 kJ/ °C

Difference parameter list	
Environmental Protection	IP54
Weight	23.47 kg
Usable Power Density (Pd)	6.693 kW/kg
Impedance Match Power Density (Pmax)	13.94 kW/kg
Gravimetric Energy Density (Emax)	5.1 Wh/kg
Environment Humidity	≤90% RH
Installation	M8 short screw

*All values are provisional and may vary.

4. SYSTEM SERIES

4.1. ENGINE START MODULE

Introduction

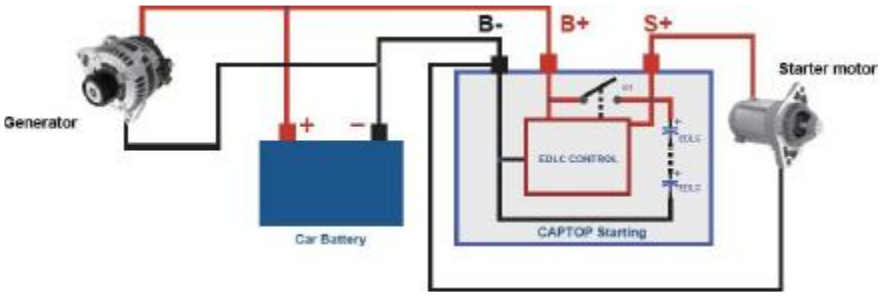
CapTop Engine Start Module is a small-size, easy installation and maintenance free auxiliary system
for improving start-up performance of heavy vehicles. It extends battery life reducing replacing costs
and has a long service life itself (8-10 yrs). The engine starter has extended operation temperature,
low stand by consumption and four operation modes: Starting Enhanced, On-line, Normal and
Emergency. Switching between modes is automatic, depending on the status of the batteries. Suitable
for heavy duty vehicles engine start.

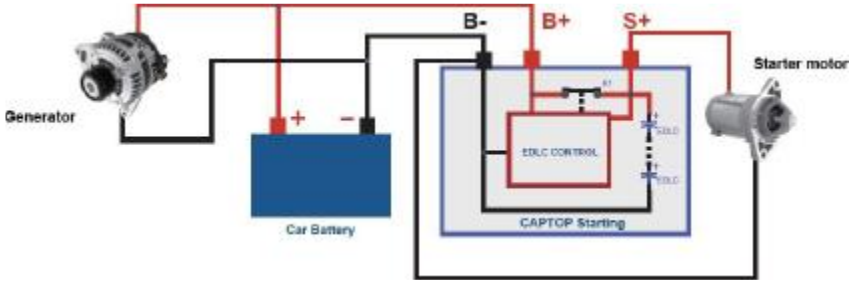
FEATURES AND BENEFITS
Operating temperature -40C° - +65C°
Improving the start-up performance of heavy-duty vehicles in ultra-low temperature
Effective reducing the engine start failures
Automatic switching betweenâ€œAuxiliary Startâ€andâ€œJump startâ€depending on battery power status
Emergency starting function enables vehicles to start up in case of battery deep discharge and damage
Prolonging battery life and reducing the costs of battery replacement
Unique on-line mode improving vehicle driving performance and reducing fuel consumption
Low standby power consumption
Small size and weight enable easy assembling
Up to 8-10 years of service life
Maintenance-Free

Specifications	
Electrical	
Nominal Capacitance	300 F
Capacitance Tolerance	0% / +20%
Cold Cranking Amps	1100 CCA
Peak Power	50.7 kW
Input voltage (B+ terminal)	10 ~ 30 VDC
Output voltage	15V or 30.0 V
Current draw (on batteries)	30 A max. (from battery when charging) Current draw (on batteries) ＜10 mA
Charging time (min)	5 min max. (Initial installation)

Environmental	
Operating Temperature Range	Designed for heavy duty environments -40 °C to +65 °C
Environment Humidity	0% ~ 90%
Storage Temperature Range	-20 °C ~ 60 °C
Physical	
Size	BCI Group 31 13" L x 6 13/16" W x 9 7/16" H (330 mm L x 173 mm W x 240 mm H)
Weight	13.0 kg
Environmental Protection	IP65

*All values are provisional and may vary.

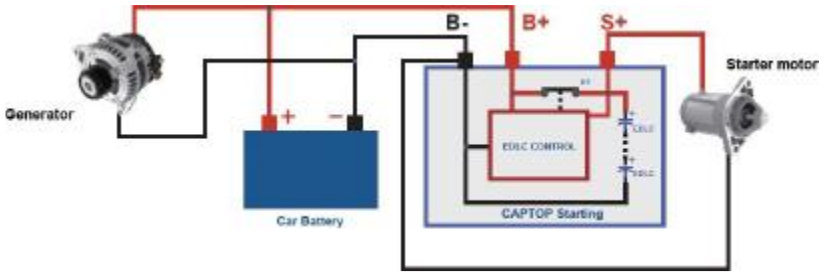
UNIQUE FEATURES
Starting Enhanced Mode
CapTop Engine Start Module has a monitoring function of temperature and battery status , can switch automatically to starting enhanced mode. **Under this mode, the module can provide a larger starting current to compensate the adverse effects to engine caused by external ambient temperature and battery status.**
On-line Operating Mode
During driving, CapTop Engine Start Module parallel with the battery can enhance the stability of the power system, improve the driving performance and reduce the fuel consumption.
Normal Operating Mode
CapTop Engine Start Module monitors the operating environment temperature and the battery status, in case of "normal" the module can automatically switch to normal operation mode, the car can start repeatedly without waiting, and the starting energy comes from the battery and starting module, whereat the module takes 70% of the starting energy and reduces the battery start load.
Emergency Start Mode
CapTop Engine Start Module also has emergency starting function. When the battery is deep discharged and cannot offer the minimum energy to the module, the starting module can be recharged by an external power supply (10-30V). After charging the emergency start mode take effect manually by press the button on module to start the car.
Operating Mode 1 (Starting Enhanced Mode):
The vehicle is out of operation, the battery voltage is below 24V or the ambient temperature is less than 0C°    **The internal K1 disconnected, the control system starts boosting to increase the car battery voltage to 28.2-30V, the energy stored in EDLC can provide the energy needed to start the car.**
Operating Mode 2 (On-line Operating Mode):
Driving condition:



During driving K1 is closed, the module in parallel with the battery stabilizes system voltage to make the whole power supply system more stable and can reduce fuel consumption.

Operating Mode 3 (Normal Operating Mode):

The vehicle is out of operation, the battery voltage is above 24V and the ambient temperature is higher than 0C°

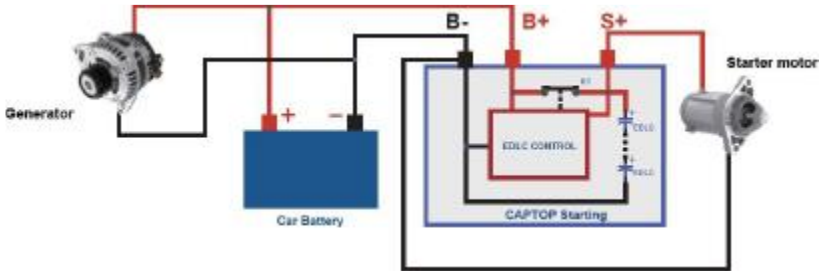


The internal K1 of the starting module is closed, the energy needed to start up is mainly supplied by the module, and the car battery acts as an auxiliar y power. This mode can reduce the interval time of frequent startup and directly operate the next start process without waiting, while a competitor's module requires a 5-15-minute charging process for each start-stop.

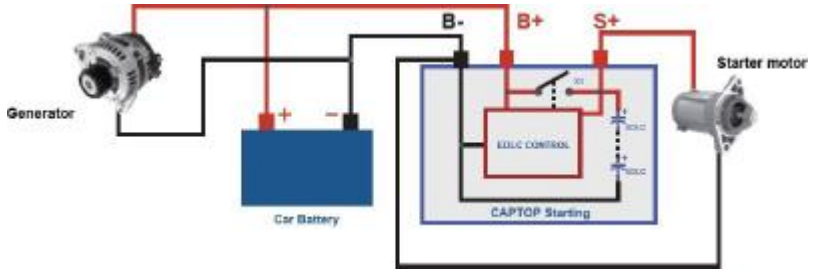
This application is suitable for waiting before the traffic lights and the engine start- stop.

Operating Mode 4 (Emergency Starting Mode):

The voltage of vehicle battery is 0, the module starts the emergency start mode:



The car battery has been damaged or deeply discharged (can't provide the minimum energy to start the module), SPS starting module can be recharged with an external power supply (10-30V). After charging, start manually the emergency mode by press the button on module to start the car.



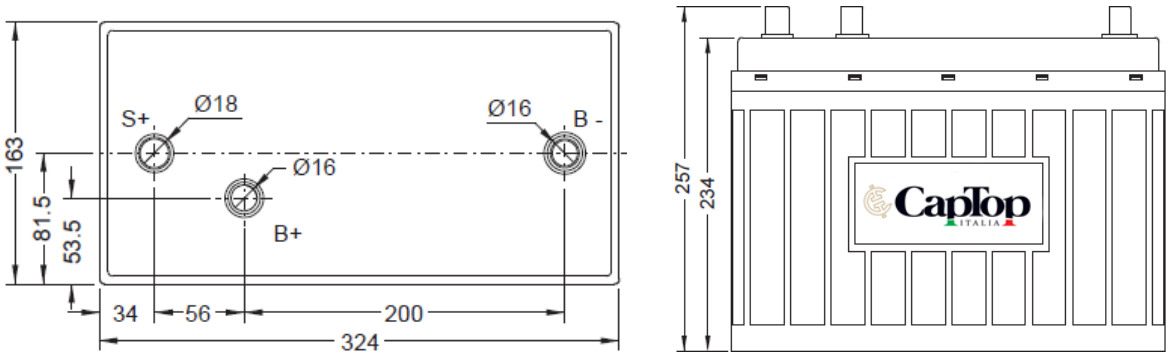
In emergency starting mode, K1 will be closed aft er 15 seconds, SPS starting module will supply autonomously power to the car for starting, and switches automatically to operating mode 2 afterwards.

INSTALLATION
a. The module should be charged to 28V before connecting to the battery.
b. The B+ terminal should be connected with the positive terminal of the battery, the B- terminal should be connected with the negative terminal of the battery.
c. The S+ terminal should be connected with the positive terminal of the motor, the B- terminal should be connected with the negative terminal of the motor.

WARNINGS
a. The S+ and B- terminal should not be connected.
b. Do not connect the terminals to battery by reversed polarity.
c. The connection between the module and the cable is firm.

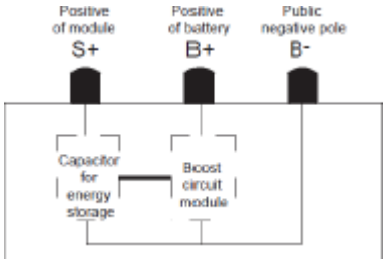
Dimensions

The module is outputted by the battery pole on the upper surface.



Dimension		
D (Max.)	L1	L2
324 mm	163 mm	257 mm

PRODUCT SKETCH DIAGRAM



Product dimensions are for reference only unless otherwise identified. Product dimensions and specifications may change without notice.

4.2. 400V Regenerative Power Backup System

Introduction

CapTop 400V Regenerative Power Backup System has high Power Density, over 1,000,000 duty cycles, low maintenance needs and compact design.
The system comprises a super-capacitive 54V storage based on CTM00165C00054V0NN00 power module and a DC/DC converter that provides bidirectional energy transfer from/to the 400V DC bus and the storage, that can range from 165F to 1650F.
CapTop 400V Regenerative Power Backup System is suitable for applications like elevators and cranes, heavy duty machinery and Energy storage system. Provides additional power when the load goes up, recovers energy when the load goes down and acts as emergency backup if the grid is off.

Construction

The system is fixed by 4 positioning holes in the middle, and output by screw holes on surface.

Dimension		
D (Max.)	L1	L2
1000-2000 mm	600- 1200 mm	400 mm

Pin definition			
Pin Number	Wire Color	Definition	Outputs
1	Black	GND	
2	Red	CAN H	
3	Orange	CAN L	
4	Void		

Optional Accessories
TBD

Specifications	
Item	**Characteristics**
Nominal Capacitance	From 165 F to 1650 F
Capacitance Tolerance	0% / +20%
Rated Voltage - VR (low voltage side)	54 V
Surge Voltage (low voltage side)	57 V
Rated Voltage - VR (high voltage side)	375 V - 415 V
Maximum Continuous Current (ΔT=15 °C)	60 A
Maximum Continuous Current (ΔT=40 °C)	68 A
Maximum Peak Current, 1 sec.	85 A
Maximum power	3 kW
Operating Temperature Range	- 40 °C to +65 °C
Storage Temperature Range	- 40 °C to +70 °C
Power Terminals	TBD / custom
Recommended Torque - Terminal	TBD
Vibration Specification IEC 255-21-1	TBD
Shock Specification IEC 255-21-2	TBD
Remote Control, Diagnostic and Monitoring	via Can Open connector
Temperature Monitoring	NTC Thermistor
Stored Energy	from 67.5 Wh to 675 Wh
Temperature Performance (-40 °C to 65 °C)	ΔC ≤ 5% of initial measured value ESR ≤ 50% of specified value
High Temp. Life (1,500 hours @ 65 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Room Temp. Life (10 years @ 25 °C, Rated Voltage)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Cycle Life (1,000,000 cycles between VR and 1/2 VR)	ΔC ≤ 20% of initial measured value ESR ≤ 200% of specified value
Shelf Life (25 °C, uncharged)	4 years
Factory High-Pot Test	TBD
Typical Thermal Resistance	TBD
Typical Thermal Capacitance	TBD

*All values are provisional and may vary.

Difference parameter list	
Environmental Protection	IP54 (TBD)
Weight	From 25 kg to 350 kg
Usable Power Density (Pd)	TBD
Impedance Match Power Density (Pmax)	TBD
Gravimetric Energy Density (Emax)	TBD
Environment Humidity	≤90% RH
Installation	Only by qualified personnel

*All values are provisional and may vary.

5. TECHNICAL NOTES

5.1. DEFINITION OF SUPERCAPACITOR

A supercapacitor (SC or ultracapacitor) is a high-capacity capacitor with very high capacity compared to normal capacitor. Typical capacity for SC is between 1 F and 5,000 F, even over 10,000 F, while normal capacitors has a capacitance of pF (10^{-12} F) or µF (10^{-6} F) magnitude*.
This type of energy storage device was developed in the US in the 1960s to 1970s by General Electric (GE) and Standard Oil of Ohio (SOHIO) as new-type of energy storage devices, then was commercialized for the first time as "Supercapacitor" in the 1980s by Japanese company NEC.
Thanks to its properties and working principle, SC combines the features of the normal capacitor in fast charging/discharging ability and the energy storage ability of battery, so it fills the gap between electrolytic capacitors and rechargeable batteries.

$1\ \mathrm{F}=10^3\ \mathrm{mF}$ $1\ \mathrm{mF}=10^3\mu\mathrm{F}$

$1\mu\mathrm{F}=10^3\ \mathrm{nF}$ $1\ \mathrm{nF}=10^3\ \mathrm{pF}$

*Capacitance units and magnitude

Comparison between ultracapacitor with other types of power supply in features						
Type of Power	Battery				Capacitor	
	Lead-acid	Nickel-cadmium	NI-MH (nickel-metal hydride)	Lithium-ion battery	Traditional capacitor	Ultracapacitor
Specific Power (W/kg)	40	300	60~70	100~120	104~106	2,000~20,000
Specific Energy (Wh/kg)	28~36	20~40	45~70	130	0.01~0.05	5~15
Working Temperature (°C)	-10~40	-40~50	-20~40	-20~60	-20~100	-40~65
Cycle Life (Number of cycles)	<500	500~1,000	1,000~3,000	1,000~2,000	100,000	10,00,000
Charging Time (min)	600~1,200	90~360	90~240	90~240	10^{-3}~10^{-6}	0.5~15.0

5.2. CLASSIFICATION OF SUPERCAPACITOR

According to different energy storage mechanism, SC can be divided into electric double-layer capacitors (EDLC - based on pure electrostatic mechanism) and pseudocapacitors (based electrostatic and electrochemical faradic redox reaction mechanisms).
According to different electrode active material, electrochemical capacitors could also be divided into metal oxides SC and polymer SC.

5.3. CALCULATION FORMULA OF SUPERCAPACITOR

Capacitance (C, expressed in Farad, F), can be defined as the aptitude of a conducting object to accumulate electric charge (q, expressed in Coulomb, C) when it is subject to an electric potential difference (ΔV, expressed in Volt, V) respect to another conducting object.

$$C = \frac{q}{\Delta V} \qquad C = \frac{1C}{1} = 1F$$

If one capacitor stores a charge of 1 C and the applied voltage is 1V between two electrodes, the capacitance would be 1F.
However, for a plane-parallel capacitor, the capacitance is usually calculated with the following equation:

$$C_i = \varepsilon \frac{A}{d} \qquad C_{sp} = \frac{C_i}{w_{em}} \qquad \varepsilon = \varepsilon_0 \varepsilon_r$$

Where:

- C_i, is capacitance
- ε, is the permittivity and is defined as product between vacuum (ε_0) and relative permittivities (ε_r);
- *A*, is the area of plate capacitor;
- *d*, is the distance between the two parallel plates;
- C_{sp}, is specific capacitance;
- *w, weight*.

Specific Energy (E_{sp}) and Power (P_{sp}) can be calculated with the following equation:

$$E_{sp} = \frac{1}{2} C_{sp} V^2 \qquad P_{sp} = \frac{V^2}{4 R_{cell} w}$$

Where:

- R_{cell}, is the Equivalent Series Resistance (ESR).

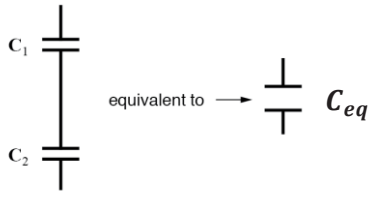
Multiple capacitor cab be connected in series or in parallel. For these types of layout is possible to define an equivalent capacitance (C_{eq}) with the following equation:

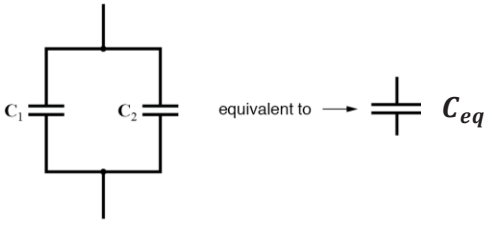
Series connections

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_n} = \sum_{i=1}^{n} \frac{1}{C_i}$$

Parallel connections

$$C_{eq} = C_1 + C_2 + \ldots + C_n = \sum_{i=1}^{n} C_i$$





Series connections of *n* capacitor with equal capacitance:

$$C_{eq} = \frac{C}{n}$$

Parallel connections of *n* capacitor with equal capacitance:

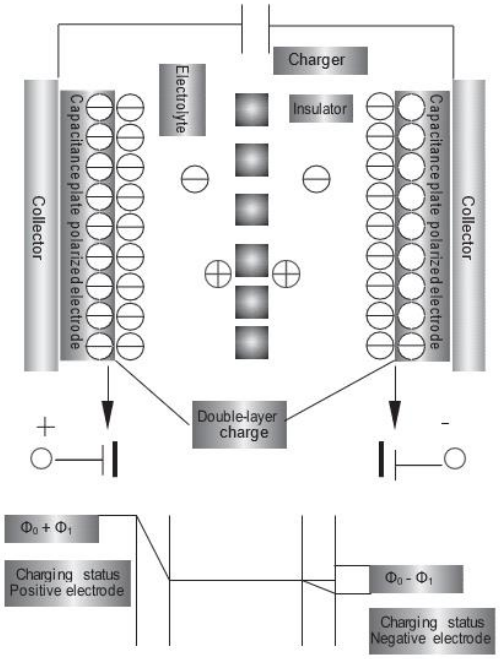
$$C_{eq} = nC$$

5.4. WORKING PRINCIPLE OF SUPERCAPACITOR (FIGURE 1)

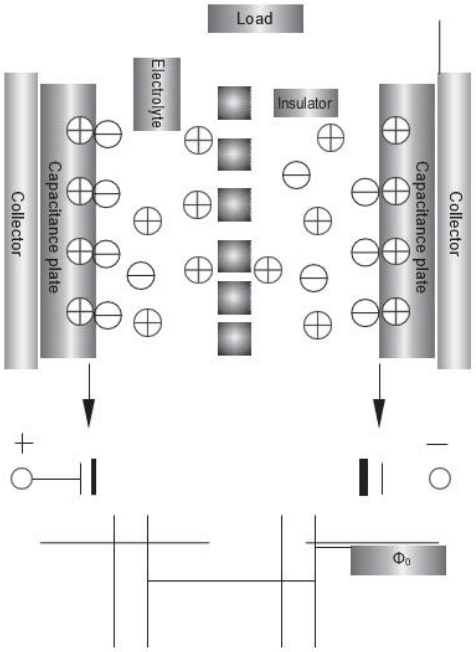
SC components are:

- Two electrodes, composed by current collector (usually aluminium), an active material (usually porous carbon) and an organic binder;
- Dielectric separator, to avoid short-circuit between the two electrodes (usually thin paper foil)
- Electrolytic solution, composed by a solvent (usually non-aqueous) and a salt (usually organic).

SC have a high capacitance thanks to its porous carbon electrode materials with high specific surface area (≈ 2,000 m^2g). Moreover, the distance between charges is determined by the size of the ion in the electrolyte, which is less than one nanometer (10^{-9}m). As a result, the SC with large surface area ($C \propto A$) and a very small distance ($C \propto d^{-1}$) between charges, has far more capacitance than any conventional high-capacitance component of the same volume.
SC using high surface area activated carbon is based on the electrostatic mechanism of separating the charges on the surface of carbon electrode/electrolyte to generate electric double layer capacitance (EDLC). SC using metal oxide or conductive polymers generate capacitance when the ions adsorb on the electrode and redox reaction takes place on the surface of oxide electrode, so it is called *quasi-Faraday capacitance*.



Potential with outside the power supply, charging mode



Potential without outside power supply, discharge mode

Figure 1 | Working Principle of supercapacitor

5.5. FEATURES OF SUPERCAPACITOR

SC is a kind of energy storage device, whose electrochemical storage process is pure electrostatic, without the need of redox reaction as in electrochemical battery. Therefore, the SC can tolerate repeated charge/discharge cycles for hundreds of thousands of times without any deterioration, far more than that of the battery.
In addition, SC has excellent power density, so it is suitable for high power output in a short period of time. With fast charging speed and simple pattern, it can bear high charging current and complete the charging process in few seconds or few minutes.
The electrochemical storage process incurred during the charging/discharging steps is highly reversible even at low temperature. Most charge transfer process takes place on the electrode surface, so the decrease of capacitance attenuation with temperature is very small.
The features of SC are summarized below:

- **High power density**.
  SC has very low internal resistance, and it could achieve both fast charge storage and release. The power density output of an SC is 10 times higher than normal batteries.
- **Long service life in terms of charging and discharging cycles.**
  The charging and discharging process of SC does not involve electrochemical reaction, therefore its cycle life can reach more than tens of thousands of cycles.
- **Charging time is short.**
  Thanks to the electrostatic charging process, SC can reach more than 95% of its nominal capacity after charging for 10 s ~ 10 min, much faster than the battery.
- **Settle the contradiction between the high ratio power and high ratio energy output.**
  SC can provide a high ratio power of 1 to 5 kw/kg and at the same time, reach a high ratio energy output 5-20 Wh/kg. When combines with a battery system, it can form an energy storage system with both high ratio power and high ratio energy output.
- **Long storage time.**
  After charging, although there is a bit leakage current (which occurs due to the influence of electric field to the ions) without any redox reaction, therefore no new material is produced. Therefore, the storage time for SC can almost be unlimited.
- **Large current in discharge.**
  Little power loss during the discharge process, large current which is dozens of times than that of the battery.
- **Excellent performance under low temperature.**
  Working temperature ranges from -40 °C ~ +70 °C; while the working temperature for normal battery is -20 °C ~ +60 °C.
- **No pollution, safe and reliable.**
  SC is a green energy resource, with no pollution to the environment.
- **Maintenance-free during the whole service life.**
  SC adopts a fully sealed structure, with no vitalization of water or other liquid, so it is maintenance-free during the whole service life.

5.6. MEASURING METHOD OF SUPERCAPACITOR

1.Charge and Discharge procedure (Figure 2):

- Charge the capacitor using constant current I to rated voltage V0;
- Keep rated voltage for 5 min;
- Discharge the capacitor using constant current I to half rated voltage, record discharge time T1 during voltage change from V1 to V2;
- Rest 2-5s, record voltage change ΔV;
- Discharge it to a very low voltage around 0.01 V;
- V1=85% V0 V2=50% V0.

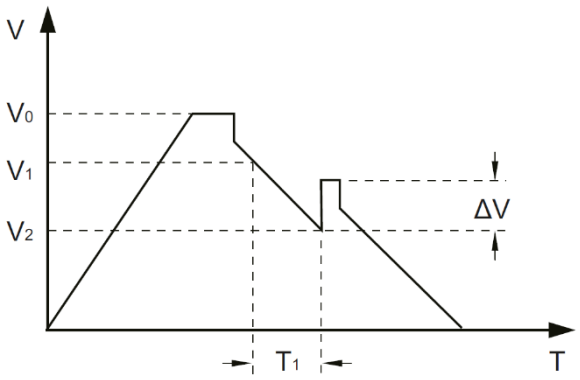


Figure 2 | Charge and Discharge procedure

2.Capacitance

$$C = \frac{I \cdot T_1}{V_1 - V_2}$$

Where:
C: Capacitance (F);
I: Constant Discharge Current (A);
T_1: Discharge Time (s);
V_1-V_2 : Voltage Change (V).

2. ESR, DC

$$ESR_{DC} = \frac{\Delta V}{I}$$

Where:
ESR_{DC}: DC Equivalent Series Resistance (Ω);
I: Constant Discharge Current (A);
ΔV : Voltage Change (V).

2. ESR, AC

Measure ESR_{AC} using LCR meter.

Frequency: 1KHz
Voltage: fully discharge

REMARK: CAPTOP CAPACITORS SHOULD BE DISCHARGED WITH RESISTOR FOR 12 HOURS OR MORE BEFORE EACH TIME MEASUREMENT OF CAPACITANCE OR ESR

5.7. MATERIAL OF SUPERCAPACITOR (FIGURE 3 AND 4)

SC is mainly composed of four parts, such as current collector, electrode, electrolyte and the dielectric separator. Among them, electrode material is the core influence factor of the SC performances.
In double layer electric capacitor, electrode materials include carbon black, activated carbon fiber, activated carbon powder, carbon aerogel, carbon microsphere, carbon nanotube (CNT), vitreous carbon, etc.
The precursors include hydrocarbon, polymer materials, renewable fuel, coal, oil, etc.

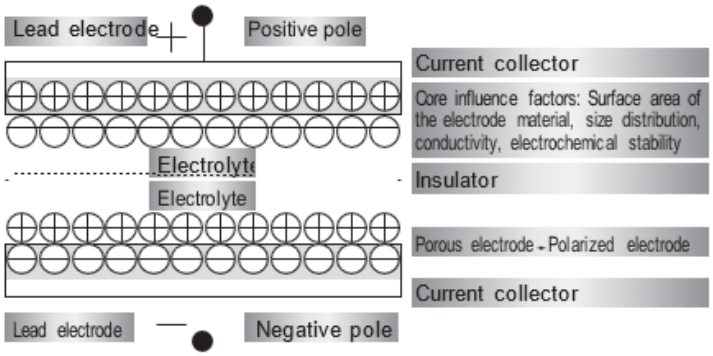


Figure 3 | *The basic structure of the supercapacitor*

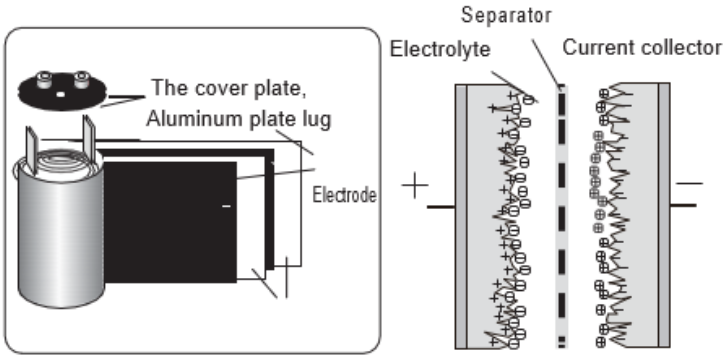


Figure 4 | The structure of the supercapacitor

5.8. HOW SUPERCAPACITOR ARE MANIFACTURED

1.Manufacture of Coating

A slurry of the coating material is made by mixing activated carbon, solvents, and other materials.

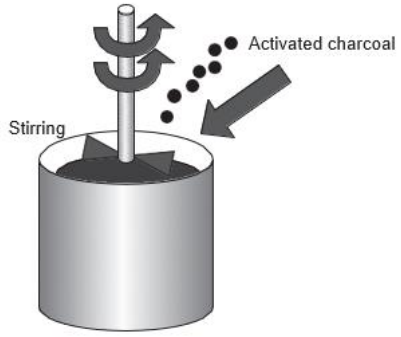


Figure 5

2.Coating

Aluminium foil is coated with the activated carbon material to make activated carbon electrodes.

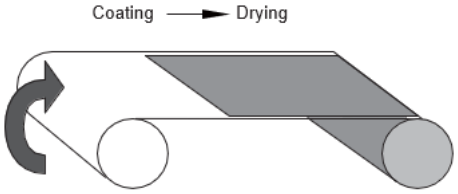


Figure 6

3.Slit

The large source roll is slit into right size in length-ways according to requirement.

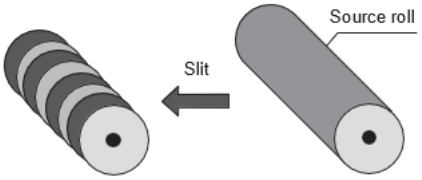


Figure 7

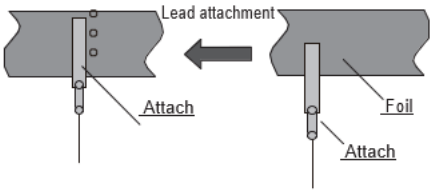


Figure 8

4.Coiling and Fastening tape

Coiling: use professional coiling equipment to do this job, applicable to small capacitance products (such as SCV). Fastening tape: Electrolytic paper layers are coiled between the cathode and anode foil layers, separating the conductive layers, during coiling to form the "element", applicable to large capacitance products.

5.Wetting /Assembly

Wetting: drive electrolyte into the element by vacuuming and pressing, then heat the material to 85 degree to turn the liquid into solid, which is applicable to small capacitance products. Assembly: Assembly the parts according to technological requirement, applicable to large capacitance products.

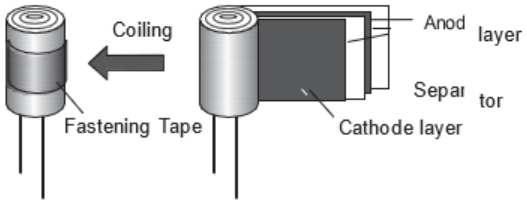


Figure 9

6.Assembly/Injection

Assembly: Assembly all the parts into one case, applicable for small capacitance products.
Injection: The element is wetted with an electrolyte using, for example, a lower pressure to drive the fluid into the element, applicable to large capacitance products.

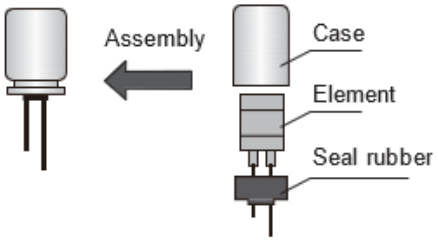


Figure 10

7. Final Test

100% of the products are subjected to electrical testing and visual inspection, to remove the infant mortality failures.

5.9. MAINTENANCE

1. Using

Prior to removal from the system, cable removal, or any other handling ensure that the energy storage module is completely discharged in a safe manner. The stored energy and the voltage levels may be lethal if mishandling occurs. Maintenance should only be conducted by trained personnel on discharged modules.

2. Routine maintenance

Clean exterior surface of dirt/grime: use a cleaning cloth dampened with a water/soap solution. Do not use high-pressure sprays or immersion sprays. Keep excess amounts of water away from the Cell Management System cover and power terminals. Frequency: 6 months for outside use, 12 months for inside use (or as needed).

Checklist:

- Check mounting fasteners for proper torque: avoid mechanical damage. Frequency: 6 months for high vibration environments, 12 months for low vibration environments.
- Inspect housing for signs of damage: potential internal damage to be identified. Frequency: 6 months for outside use, 12 months for inside use (or as needed).
- Check signal/ground connections: avoid false signals or shock hazards. Frequency: 6 months for high vibration environments, 12 months for low vibration environment.

3. Storage

The discharged module can be stored in the original package in a dry place. Discharge a used module prior to stock or shipment. A shorting resistor across the terminals is strongly recommended to maintain a short circuit after having discharged the module.

In long term storage, please store CapTop product in following condition.

- Temperature: 15 °C ~ 35 °C
- Humidity: 40% RH ~ 75% RH
- No-dust, non-acidic and/or non-alkaline atmosphere Avoid direct sun light.

4. Others

Ambient temperature greatly affects the lifetime of the capacitor, by reducing the temperature by 10 °C, lifetime can be approximately doubled;
Do not disassemble CapTop products: they contain electrolyte;
Avoid serious mechanical impacts onto capacitor, such as force or twist capacitor. Please contact us for the following cases:

- If you want to subject CapTop products to severe vibrating conditions exceeding rated specification;
- If you want to connect a certain number of single capacitors to make a module;
- Series connection: Over-rated voltage may be applied to a single CapTop product in series connection due to the deviation of capacitance and ESR of each CapTop product.

Please inform us if you are using CapTop product in series connection and please design so as not to apply over-rated voltage to each capacitor, and use CapTop product from same date code/lot.

5.10. Disposal

Do not dispose of module in trash. Dispose of according to local regulations.

ANNEX

International Standard		
1	IEC 60721-3-3	Classification of environmental conditions-Part 3-3: Classification of groups of environmental parameters and their severities; Stationary use at weather protected locations.
2	IEC62391-1-2006	Fixed electric double-layer capacitors for use in electronic equipment-Part 1: Generic specification.
3	IEC62391-2-2006	Fixed electric double-layer capacitors for use in electronic equipment-Part 2: Sectional specification-Electric double-layer capacitors for power application.
4	IEC-62576-2009	Electric double-layer capacitors for use in hybrid electric vehicles - Test methods for electrical characteristics.
5	ISO 7637-2-2011	Road vehicles - Electrical disturbances from conduction and coupling- Part 2: Electrical transient conduction along supply lines only.
6	SAE J2380-2009	Vibration Testing of Electric Vehicle Batteries.
7	SAE_J2464-2009	Electric and Hybrid Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing.
8	IPC-A-610D	Acceptability of Electronic Assemblies.

Version	Date	Revision History
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