

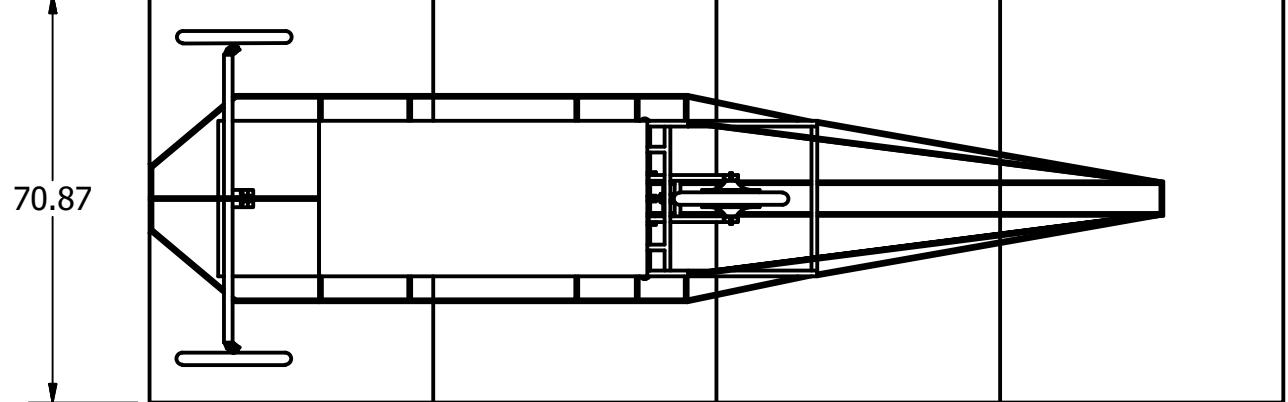
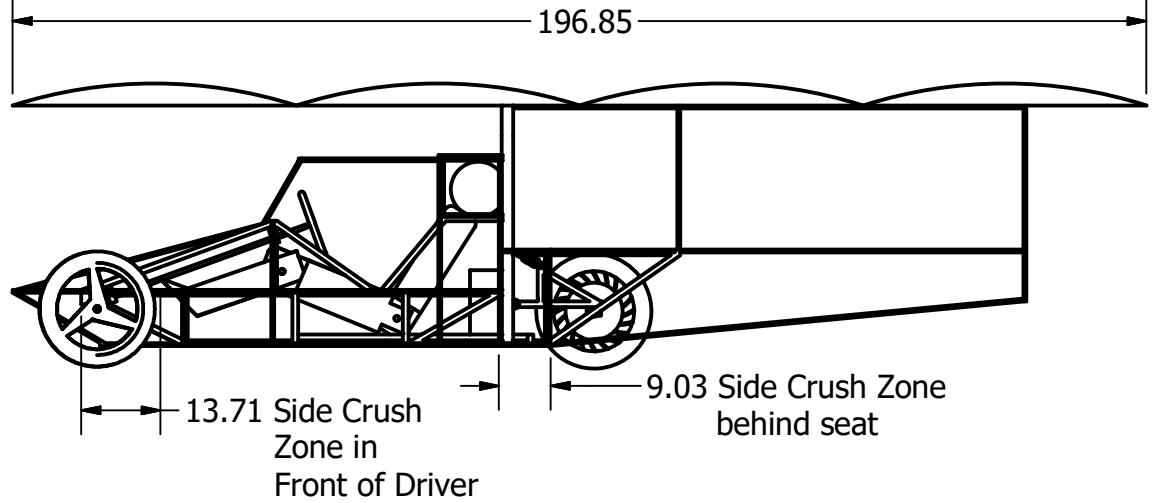
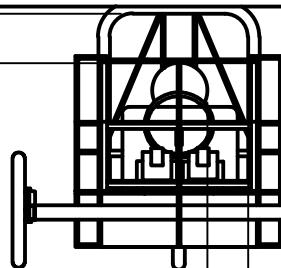
8.58

Top of Head  
to Roll Bar

2

1

49.16

7.08 Side of Head  
to Roll Bar

Note: All dimensions are in inches

DRAWN  
Dak Cheung Cheng 2/19/2020

CHECKED

QA

MFG

APPROVED

BT Solar Knights

TITLE

Chassis

SIZE

A

DWG NO

2 of 2

REV

SCALE

0.03 : 1

SHEET 1 OF 1

2

1

4

A

A

B

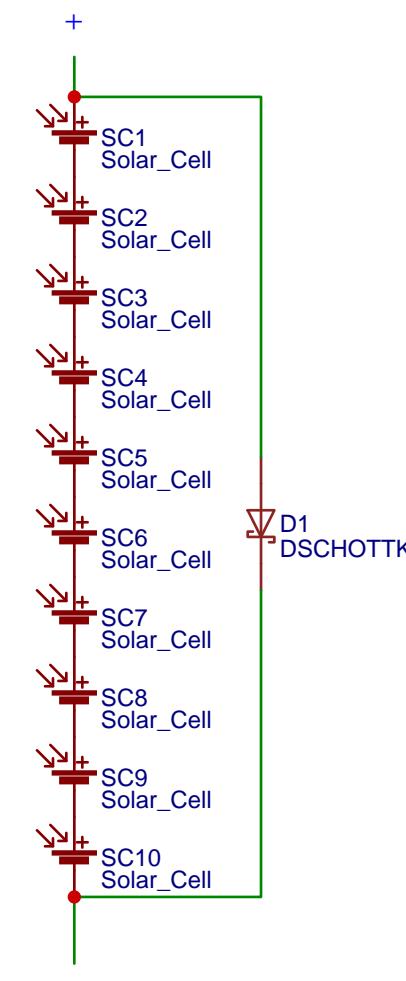
B

C

C

D

D



TITLE:

Solar Sub-Panel

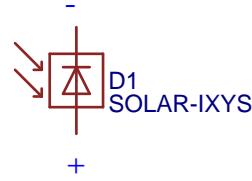
REV: 1.0



Company: BT Solar Knights

Sheet: 1/1

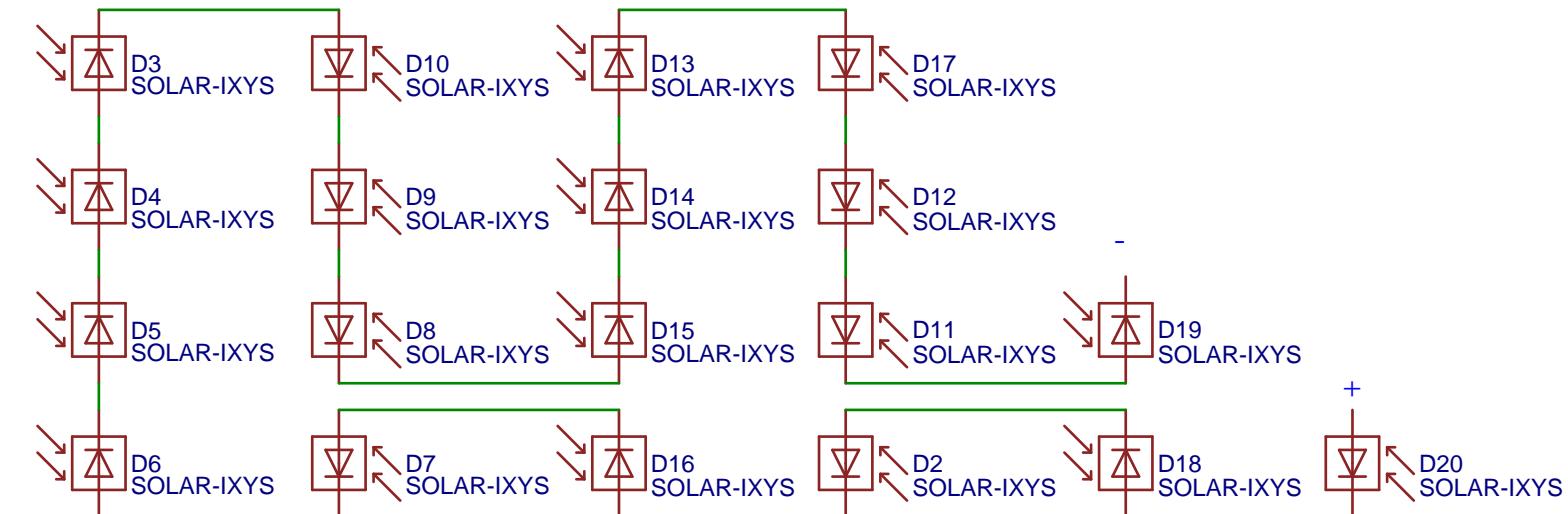
Date: 2020-01-08 Drawn By: Dak Cheung Cheng



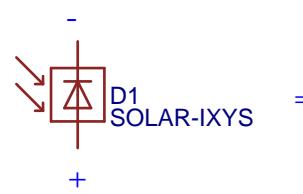
= one 10-cell solar sub-panel (found in other schematic)

Note: The solar panel is an odd shape because we need exactly 190 cells in one panel and we want to minimize the amount of connector wire running from the solar panel to the MPPT.

The final panel is shaped in a rectangle 5 m long by 1.8 m wide

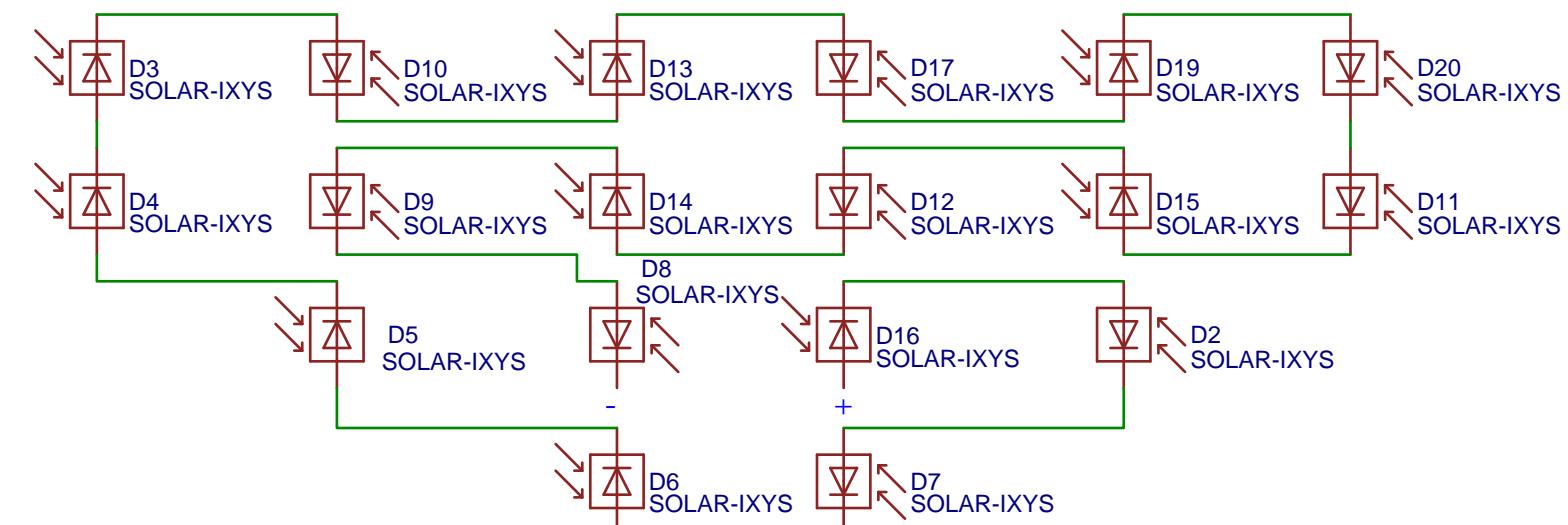


TITLE:		Left Side 190-cell Solar Panel	REV: 1.0
	Company:	BT Solar Knights	Sheet: 1/1
	Date:	2020-01-08	Drawn By: Dak Cheung Cheng

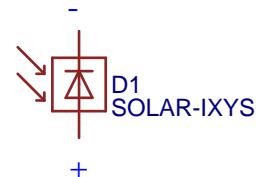


= one 10-cell solar sub-panel (found in other schematic)

Note: The solar panel is an odd shape because we need exactly 180 cells in one panel and we want to minimize the amount of connector wire running from the solar panel to the MPPT.  
The final panel is shaped in a rectangle 5 m long by 1.8 m wide



TITLE:		REV: 1.0
Center 180-cell Solar Panel		
Company:	BT Solar Knights	Sheet: 1/1
Date:	2020-01-08	Drawn By: Dak Cheung Cheng

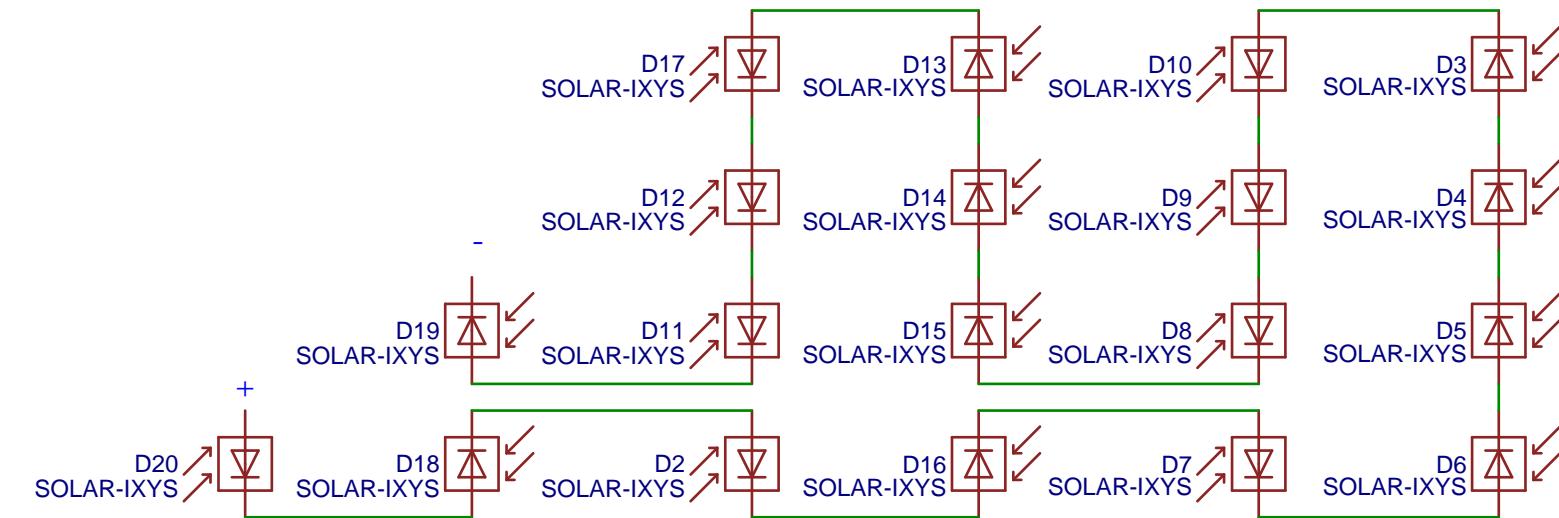


= one 10-cell solar sub-panel (found in other schematic)

A

A

Note: The solar panel is an odd shape because we need exactly 190 cells in one panel and we want to minimize the amount of connector wire running from the solar panel to the MPPT.  
The final panel is shaped in a rectangle 5 m long by 1.8 m wide



B

B

C

C

D

D

TITLE:		Right Side 190-cell Solar Panel	REV: 1.0
	Company:	BT Solar Knights	Sheet: 1/1
Date:	2020-01-08	Drawn By:	Dak Cheung Cheng

A

A

B

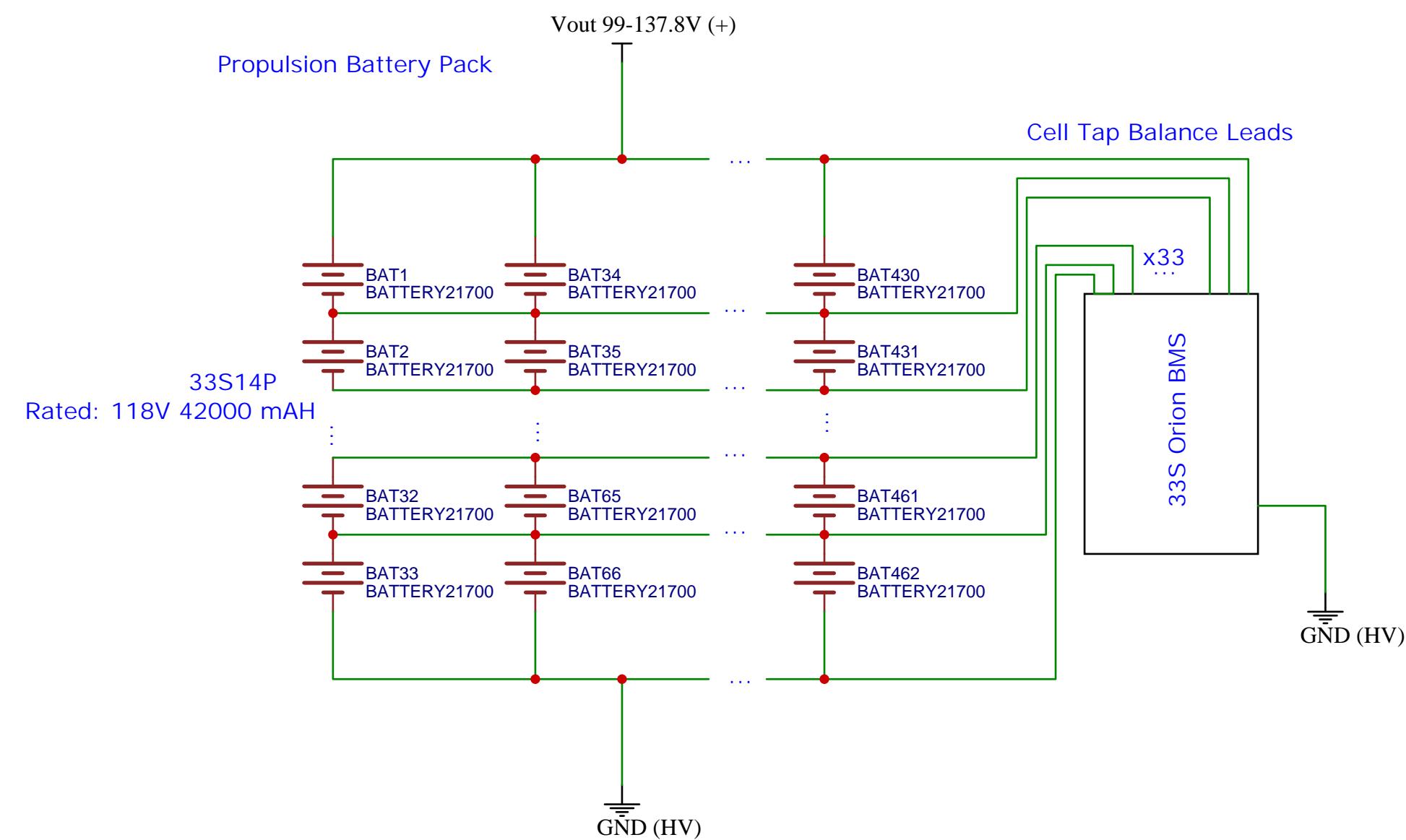
B

C

C

D

D



TITLE:

Propulsion Battery Pack

REV: 1.0



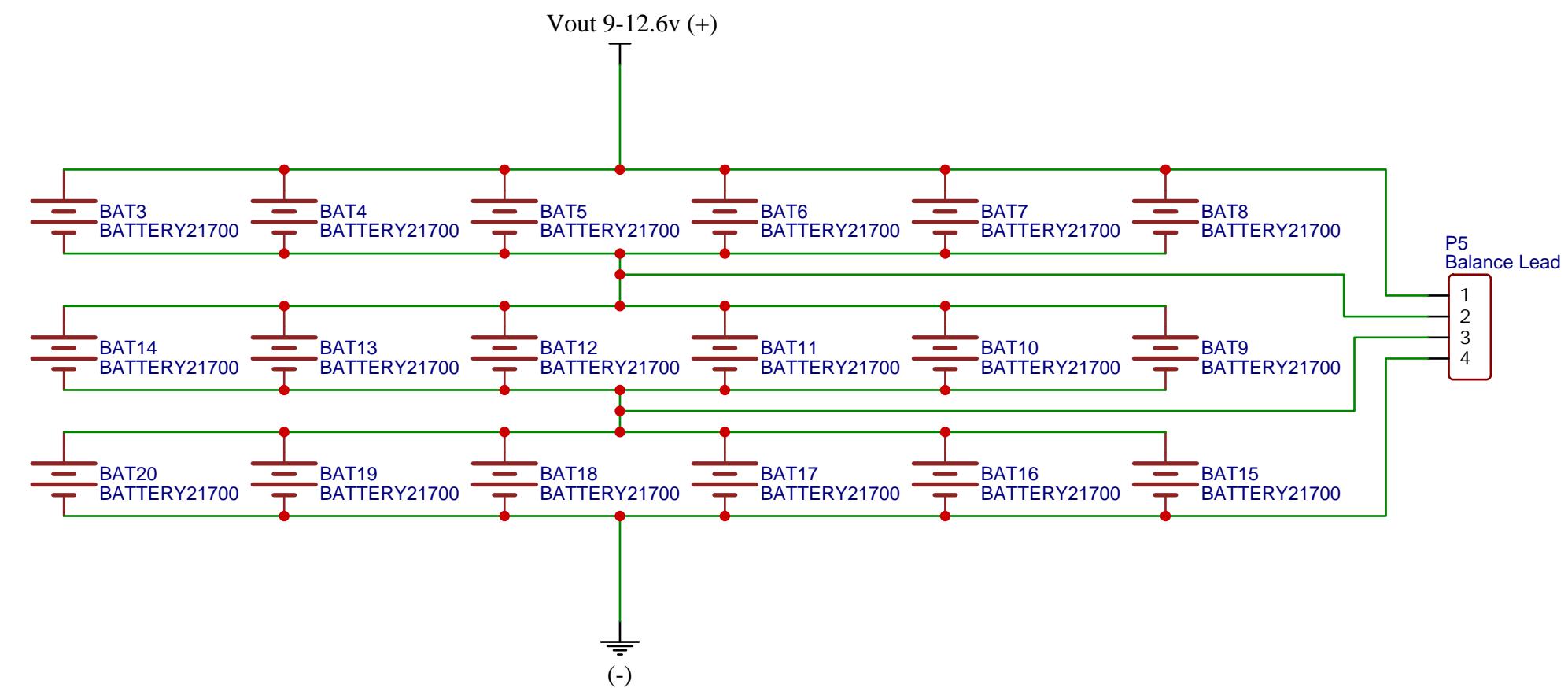
Company: BT Solar Knights

Sheet: 1/1

Date: 2019-11-03 Drawn By: Dak Cheung Cheng

A

A



B

B

C

C

D

D

TITLE:

Auxiliary Battery Pack

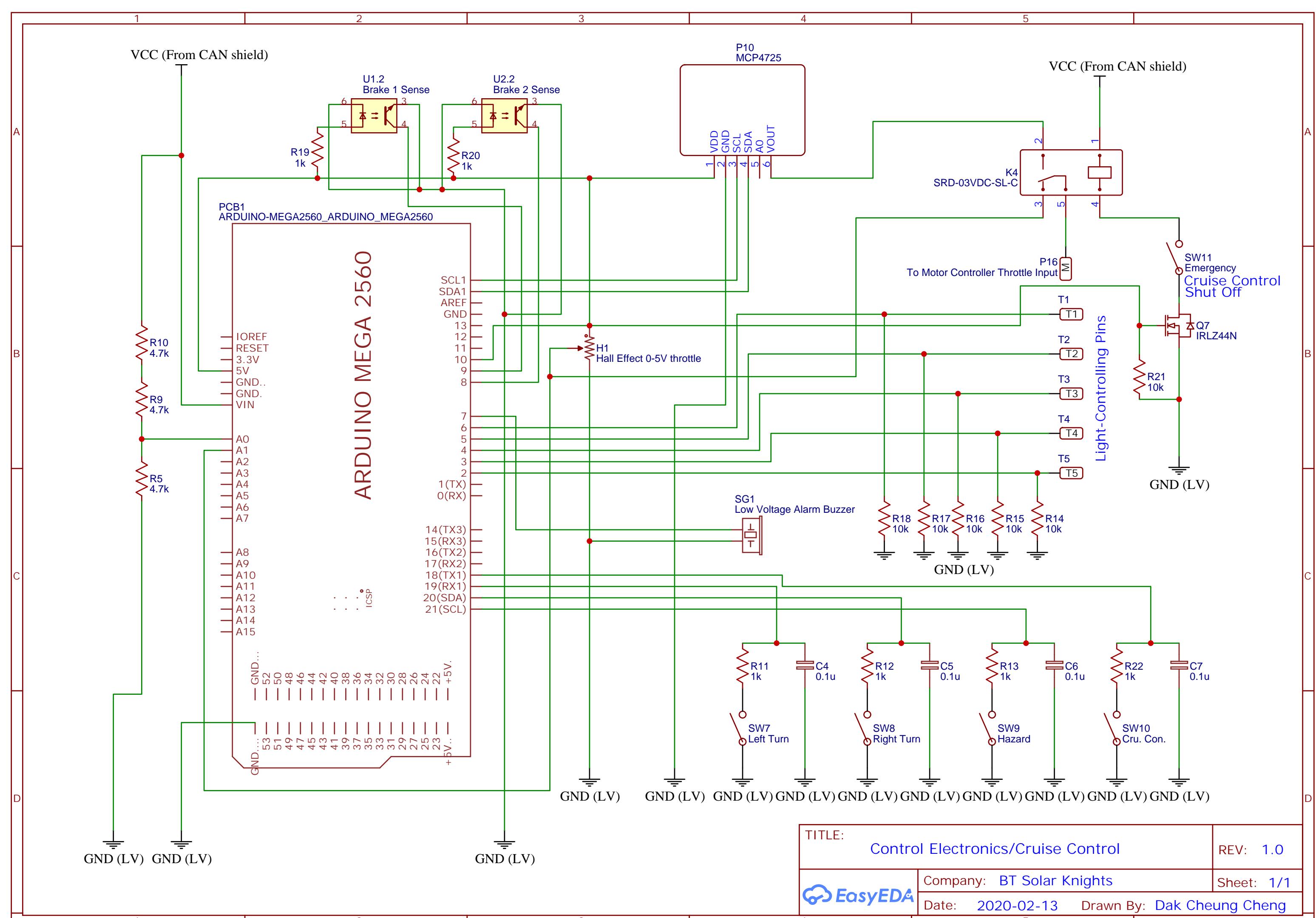
REV: 1.0

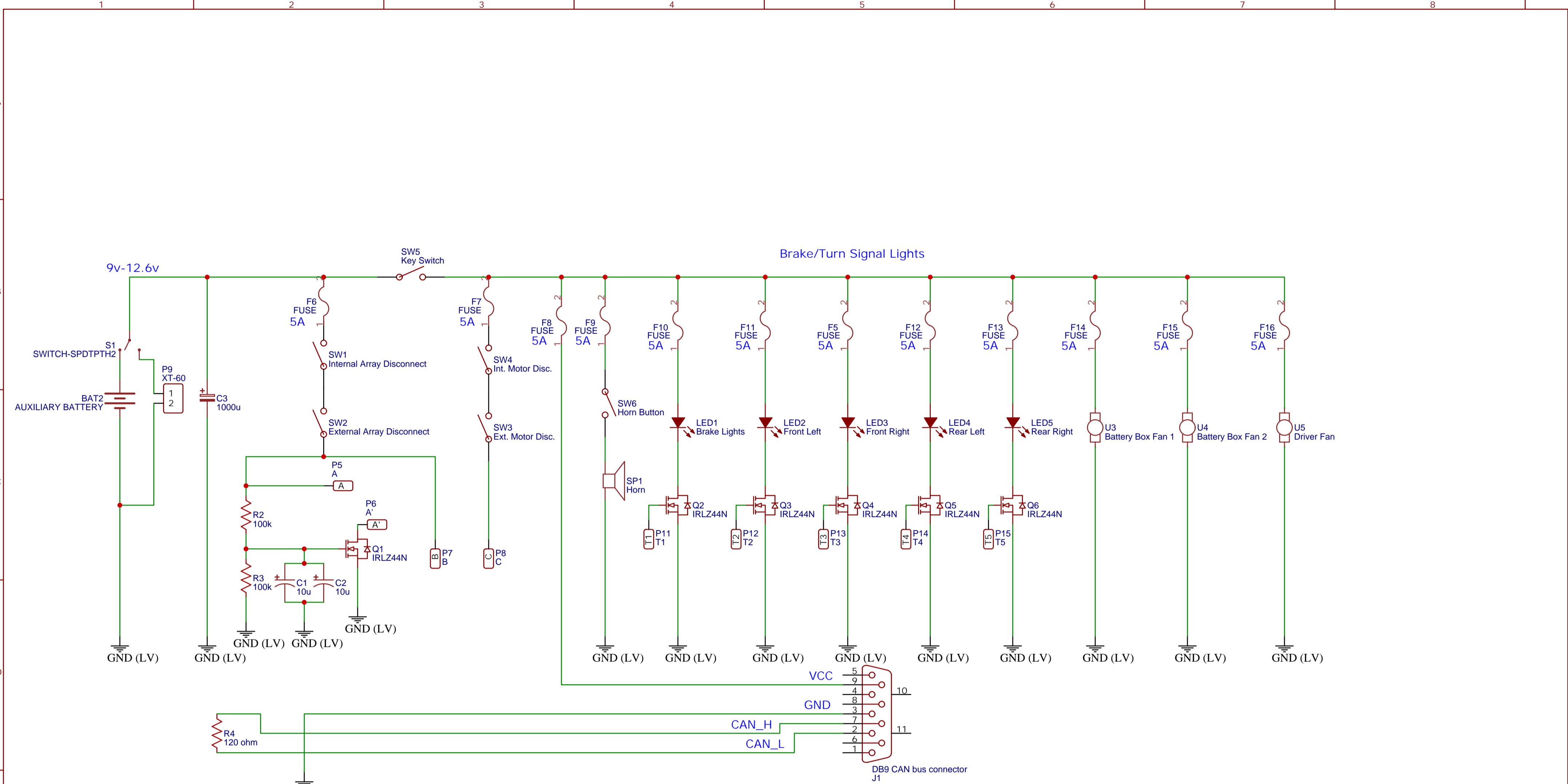


Company: BT Solar Knights

Sheet: 1/1

Date: 2020-02-01 Drawn By: Dak Cheung Cheng



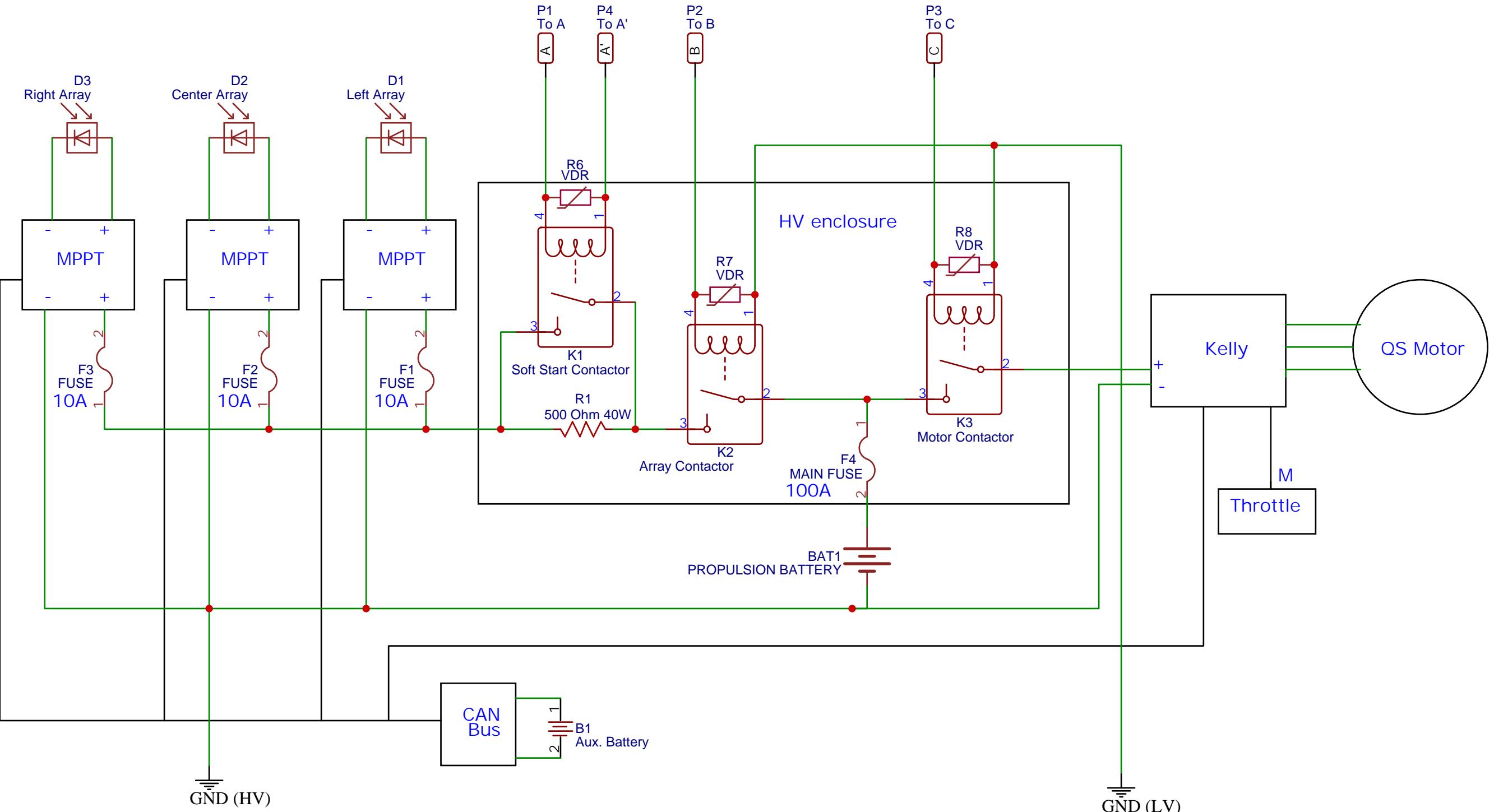


Notes: GND (LV) is completely electrically isolated from GND (HV)

The XT60 connector parallel to the battery and the SPDT switch allows for no power interruption during battery swaps

Arduino power is supplied through CAN bus

TITLE: Low Voltage/Data Lines		REV: 1.0
	Company: BT Solar Knights	Sheet: 1/1
	Date: 2020-02-12	Drawn By: Dak Cheung Cheng



Notes:

Drivers A, B, and C are found in the Low Voltage System Schematics

Dark Lines are simplified connections that will be elaborated in other schematics

Dark Lines are simplified connections that will be elaborated in other schematics

GND (HV) and GND (LV) are completely electrically isolated from each other

TITLE: High Voltage System		REV: 1.0
	Company: BT Solar Knights	Sheet: 1/1
	Date: 2020-02-10	Drawn By: Dak Cheung Cheng

Spec. No.	INR21700-30T	Version No.	Tentative
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# SPECIFICATION OF PRODUCT

**for Lithium-ion rechargeable cell**

**Model name : INR21700-30T**

**(Tentative)**

**Sep 13, 2017**

**Samsung SDI Co., Ltd.  
Cell Business Division**

Spec. No.	INR21700-30T	Version No.	Tentative
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## **Revision history**

Revision No.	Date('yr-m-d)	Page	Item	Description	Changes / Author
V0.0	'15-12-29			Initial Version	Sang-Hun Jeong

Spec. No.	INR21700-30T	Version No.	Tentative
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## 1.0. Scope

This product specification has been prepared to specify the rechargeable lithium-ion cell ('cell') to be supplied to the customer by Samsung SDI Co., Ltd.

## 2.0. Description and model name

- 2.1 Description                    lithium-ion rechargeable cell  
2.2 Model name                  INR21700-30T

## 3.0. Nominal specifications

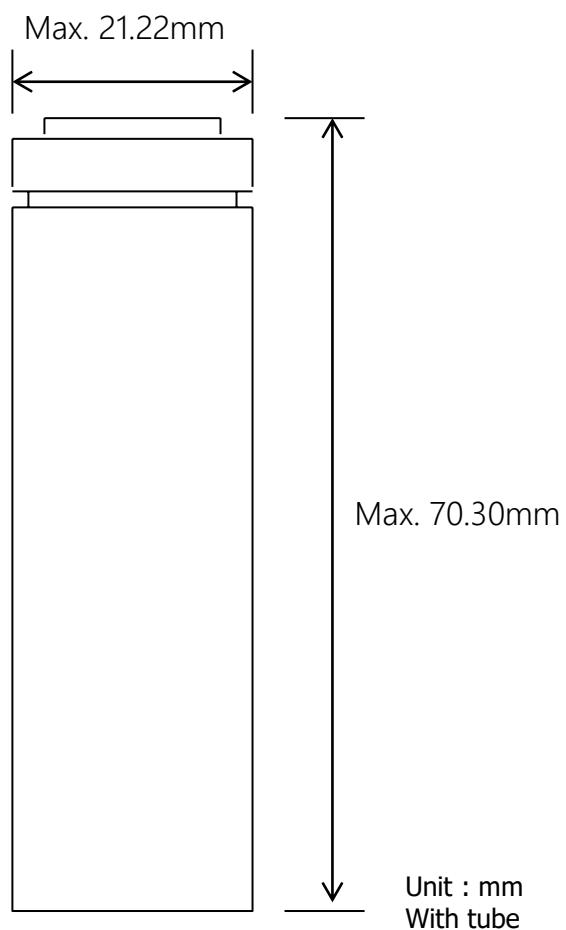
Item	Specification
3.1 Standard discharge capacity	Typical : 3,000mAh (Min. 2,900mAh) - Charge: 0.5C (1.5A), 4.20V, 0.05C(150mA) cut-off - Discharge: 0.2C (600mA), 2.5V cut-off * 1C = 3,000mA
3.2 Rated discharge capacity	Min. 2,900mAh - Charge: 4A, 4.20V, CCCV 100mA cut-off - Discharge: 10A , 2.5V cut-off
3.2 Nominal voltage	3.6V
3.3 Standard charge	CCCV, 1.5A, 4.2V, 150mA cut-off
3.4 Rated charge	CCCV, 4A, 4.2V, 100mA cut-off
3.5 Charging time	Standard charge : 130min / 150mA cut-off Rapid charge: 60min (at 25°C) / 100mA cut-off
3.6 Max. continuous discharge (Continuous)	35A(at 25°C), 60% at 250 cycle
3.7 Discharge cut-off voltage End of discharge	2.5V
3.8 Cell weight	70.0g max
3.9 Cell dimension	Height : Max. 70.30 mm Diameter : Max. 21.22 mm
3.10 Operating temperature (surface temperature)	Charge : 0 to 50°C (recommended recharge release < 45°C) Discharge: -20 to 80°C (recommended re-discharge release < 60°C)
3.11 Storage temperature (Recovery 90% after storage)	1.5 year      -30~25°C(1*) 3 months      -30~45°C(1*) 1 month       -30~60°C(1*)

Note (1): If the cell is kept as ex-factory status,  
the capacity recovery rate is more than 90% of 10A discharge capacity  
100% is 2,900mAh at 25°C with SOC 100% after formation.

Spec. No.	INR21700-30T	Version No.	Tentative
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#### 4.0 Outline dimensions

See the attachment (Fig. 1)



**Fig.1. Outline dimensions of INR21700-30T**

Spec. No.	INR21700-30T	Version No.	Tentative
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## 5.0. Appearance

There shall be no such defects as scratch, rust, discoloration, leakage which may adversely affect commercial value of the cell.

## 6.0. Standard test conditions

### 6.1 Environmental conditions

Unless otherwise specified, all tests stated in this specification are conducted at temperature  $25 \pm 5^\circ\text{C}$  and humidity  $65 \pm 20\%$ .

### 6.2 Measuring equipments

#### (1) Amp-meter and volt-meter

The amp-meter and volt-meter should have an accuracy of the grade 0.5mA and mV or higher.

#### (2) Slide caliper

The slide caliper should have 0.01 mm scale.

#### (3) Impedance meter

The impedance meter with AC 1 kHz should be used.

## 7.0. Characteristics

### 7.1 Standard charge

This "Standard charge" means charging the cell CCCV with charge current 0.5CmA (1,500mA), constant voltage 4.2V and 150mA cut-off in CV mode at  $25^\circ\text{C}$  for capacity.

### 7.2 Rated charge

Rated charge means charging the cell CCCV with charge current 4A and 100mA cut-off at  $25^\circ\text{C}$

### 7.3 Standard discharge capacity

The standard discharge capacity is the initial discharge capacity of the cell, which is measured with discharge current of 600mA(0.2C) with 2.5V cut-off at  $25^\circ\text{C}$  within 1hour after the standard charge.

Standard discharge capacity  $\geq 2,900\text{mAh}$

### 7.4 Rated discharge capacity

The rated discharge is the discharge capacity of the cell, which is measured with discharge current of 10A with 2.5V cut-off at  $25^\circ\text{C}$  within 1hour after the rated charge.

Standard rated discharge capacity  $\geq 2,900\text{mAh}$

Spec. No.	INR21700-30T	Version No.	Tentative
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#### 7.5 Initial internal impedance

Initial internal impedance measured at AC 1kHz after standard charge

Initial internal impedance  $\leq 15\text{m}\Omega$

#### 7.6 Temperature dependence of discharge capacity

Capacity comparison at each temperature, measured with discharge constant current 10A and 2.5V cut-off after the standard charge is as follows.

Temperature	Discharge temperature				
	-20°C	-10°C	0°C	25°C	60°C
Relative capacity	60%	75%	80%	100%	100%

Note: If charge temperature and discharge temperature is not the same,  
the interval for temperature change is 3 hours.

Percentage index of the discharge at 25°C at 10A (=2,900mAh) is 100%.

#### 7.7 Temperature dependence of charge capacity

Capacity comparison at each temperature, measured with discharge constant current 10A and 2.5V cut-off after the standard charge is as follows.

	Charge temperature				Discharge temperature 25°C
	0°C	5°C	25°C	50°C	
Relative capacity	80%	90%	100%	95%	

Note: If charge temperature and discharge temperature is not the same,  
the interval for temperature change is 3 hours.

Percentage index of the discharge at 25°C at 10A (=2,900mAh) is 100%.

#### 7.8 Discharge rate capabilities

Discharge capacity is measured with the various currents in under table and 2.5V cut-off after the standard charge.

Current	Discharge condition				
	0.4A	5A	10A	15A	20A
Relative Capacity	100%	97%	100%	97%	95%

Note: Percentage index of the discharge at 25°C at 10A (=2,900mAh) is 100%.

Spec. No.	INR21700-30T	Version No.	Tentative
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#### 7.9 Cycle life

With rated charge and maximum continuous discharge.

Capacity after 250cycles,

Capacity  $\geq$  1,740mAh (60% of the standard capacity at 25°C)

#### 7.10 Storage characteristics

Rated discharge capacity after storage for 1 month at 60°C from the standard charged state is  $\geq$  90% of the rated discharge capacity (=2,900mAh) at 25°C

#### 7.11 Status of the cell as of ex-factory

The cell should be shipped in 3.60V ~ 3.80V Charging voltage range.

### 8.0. Mechanical Characteristics

#### 8.1 Drop test

Test method: Fully rated charged Cells drop onto the concrete floor from 1.0m height at a random direction 3 times. The cells or batteries are dropped so as to obtain impacts in random orientations. After the test, the sample shall be put on rest for a minimum of one hour and then a visual inspection shall be performed.

Criteria: No fire, no explosion.

Drop test shall be performed with the IEC62133 standard

#### 8.2 Vibration test

Test method: As to the UN transportation regulation (UN38.3), for each axis (X and Y axis with cylindrical cells) 7Hz→200Hz→7Hz for 15min, repetition 12 times totally 3hours, the acceleration 1g during 7 to 18Hz and 8g (amplitude 1.6mm) up to 200Hz.

Criteria: No leakage, with less than 10mV of OCV drop

Vibration test shall be performed with the UN38.3 standard

### 9.0. Safety

#### 9.1 Overcharge test

Test method: Cell is to be discharged at a constant current of 0.6A to 2.5V. The cell is then to be charged with a 20V and 18A. Charging duration is to be 7h.

Criteria: No fire, and no explosion.

Overcharge test shall be performed with the UL1642 standard

Spec. No.	INR21700-30T	Version No.	Tentative
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### 9.2 External short-circuit test

Test method: Fully rated charged cell is to be short-circuited by connecting the positive and negative terminals of the battery with a circuit load having a resistance load of  $80 \pm 20$  mW. The battery is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state of less than 0.2 V and the battery case temperature has returned to  $\pm 10^\circ\text{C}$  of ambient temperature. The return to near ambient of the battery (cell) casing in an indication of ultimate results.

Criteria: No fire, and no explosion

External short-circuit test shall be performed with the UL1642 standard

### 9.3 Forced discharge test

Test method: A discharged cell is subjected to a reverse charge at 1.0C (3.0A) for 90 min.

Criteria: No fire, and no explosion.

Forced discharge test shall be performed with the IEC62133 standard

### 9.4 Heating test

Test method: To heat up the standard charged cell at heating rate  $5^\circ\text{C}$  per minute up to  $130^\circ\text{C}$  and keep the cell in oven for 1 hour.

Criteria: No fire, and no explosion.

## 10.0. Warranty

Samsung SDI will be responsible for replacing the cell against defects or poor workmanship for 15months from the date of shipping. Any other problem caused by malfunction of the equipment or mix-use of the cell is not under this warranty.

The warranty set forth in proper using and handling conditions described above and excludes in the case of a defect which is not related to manufacturing of the cell.

## 11.0. Others

### 11.1 Storage for a long time

If the cell is kept for a long time (3 months or more), It is strongly recommended that the cell is preserved at dry and low-temperature.

### 11.2 Others

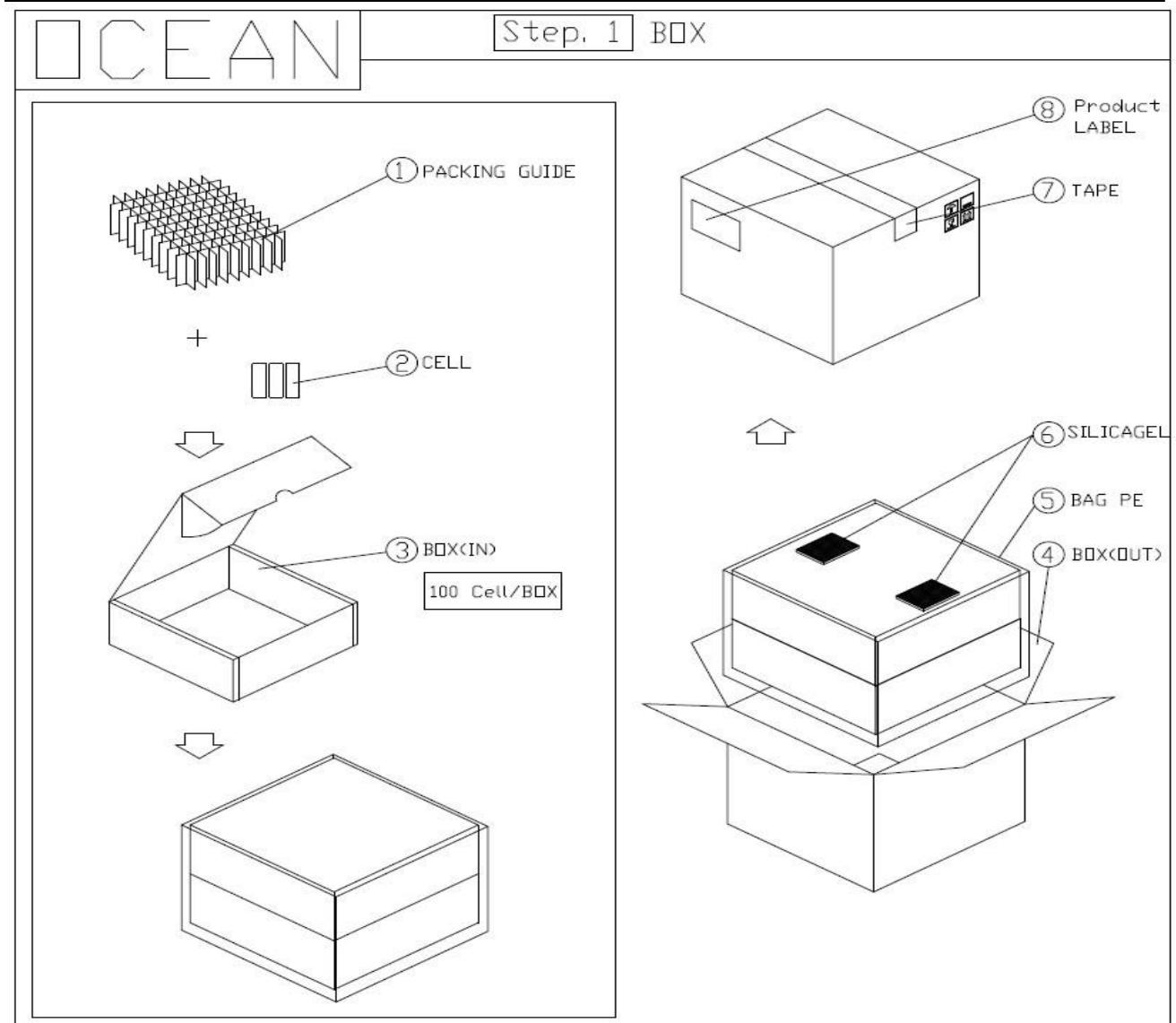
Any matters that specifications do not have, should be conferred with between the both parties.

Spec. No.	INR21700-30T	Version No.	Tentative
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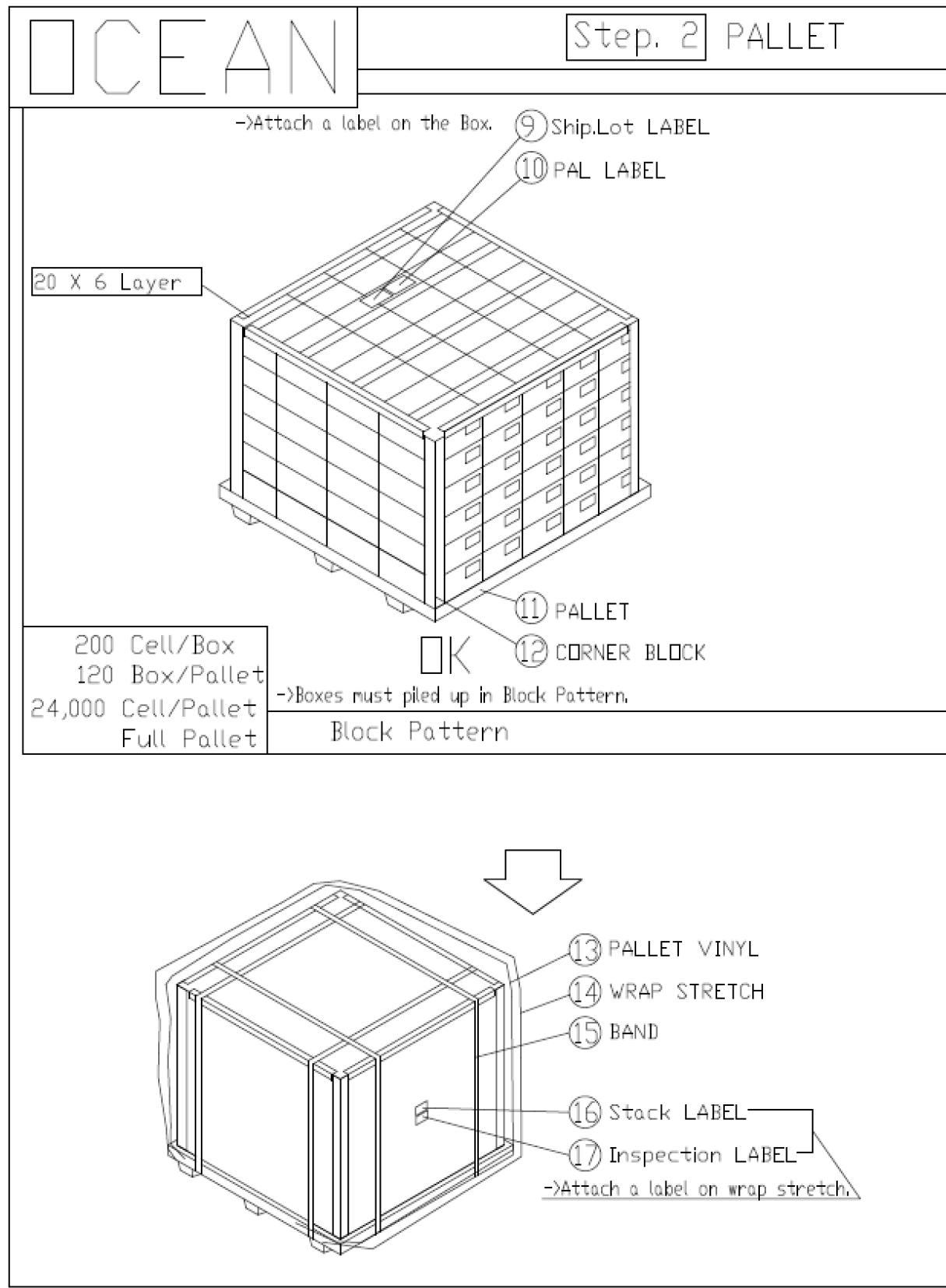
## 12. Packaging

### 12.1 Ocean

NO	PART NAME	MATERIAL	Q'ty	NO	PART NAME	MATERIAL	Q'ty
1	PACKING GUIDE	MANILA 300g	2 pcs /BOX	9	Ship.Lot LABEL	ART PAPER	1 pcs /PALLET
2	CELL	CILINDERICAL	200 pcs /BOX	10	PAL LABEL	ART PAPER	1 pcs /PALLET
3	BOX(PACKING CASE IN)	SW1-E	2 pcs /BOX	11	PALLET	PLASTIC	1 pcs /PALLET
4	BOX(PACKING CASE OUT)	DW1-BA	1 pcs /BOX	12	CORNER BLOCK	C.F.B	8 pcs /PALLET
5	BAG PE	LD-PE	1 pcs /BOX	13	PALLET VINYL	LD-PE	1 pcs /PALLET
6	SILICAGEL	SI	2 pcs /BOX	14	WRAP STRETCH	LD-PE	0.044 ROL/PALLET
7	TAPE	OPP	0.02ROL/BOX	15	BAND (BAND PP)	PP	0.016 ROL/PALLET
8	Product LABEL	ART PAPER	1 pcs /BOX	16	Stack LABEL	ART PAPER	1 pcs /PALLET
				17	Inspection LABEL	ART PAPER	1 pcs /PALLET



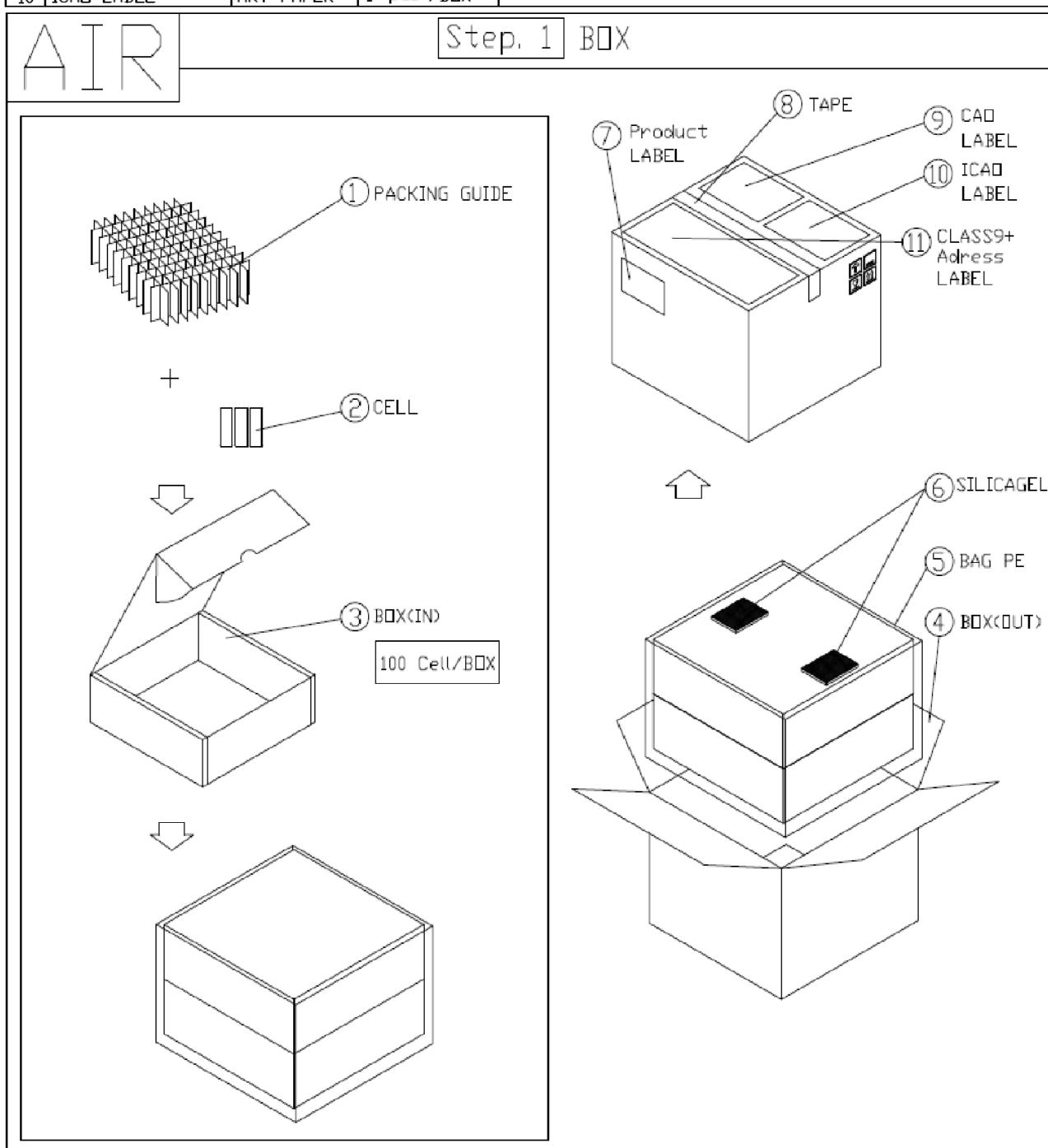
Spec. No.	INR21700-30T	Version No.	Tentative
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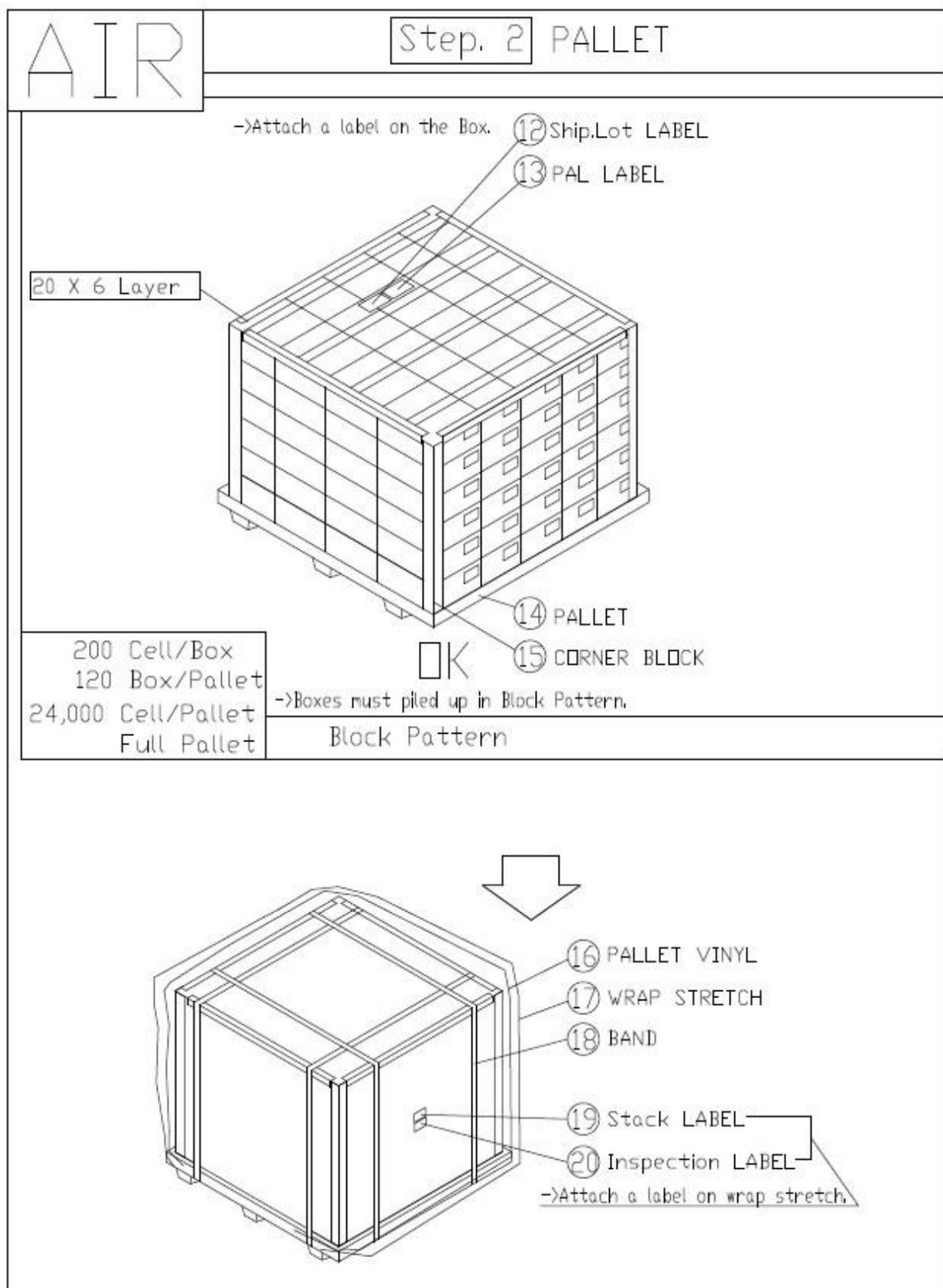
Spec. No.	INR21700-30T	Version No.	Tentative
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## 12.2 Air

NO	PART NAME	MATERIAL	Q'ty	NO	PART NAME	MATERIAL	Q'ty
1	PACKING GUIDE	MANILA 300g	2 pcs /BOX	11	CLASS9+Address LABEL	ART PAPER	1 pcs /BOX
2	CELL	CILINDERICAL	200 pcs /BOX	12	Ship.Lot LABEL	ART PAPER	1 pcs /PALLET
3	BOX(PACKING CASE IN)	SW1-E	2 pcs /BOX	13	PAL LABEL	ART PAPER	1 pcs /PALLET
4	BOX(PACKING CASE OUT)	DW1-BA	1 pcs /BOX	14	PALLET	PLASTIC	1 pcs/PALLET
5	BAG PE	LD-PE	1 pcs /BOX	15	CORNER BLOCK	C.F.B	8 pcs/PALLET
6	SILICAGEL	SI	2 pcs /BOX	16	PALLET VINYL	LD-PE	1 pcs /PALLET
7	Product LABEL	OPP	0.02RDL/BOX	17	WRAP STRETCH	LD-PE	0.044 RDL/PALLET
8	TAPE	ART PAPER	1 pcs /BOX	19	Stack LABEL	ART PAPER	1 pcs /PALLET
9	CAO LABEL	ART PAPER	1 pcs /BOX	20	Inspection LABEL	ART PAPER	1 pcs /PALLET
10	ICAO LABEL	ART PAPER	1 pcs /BOX				



Spec. No.	INR21700-30T	Version No.	Tentative
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Spec. No.	INR21700-30T	Version No.	Tentative
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## Proper Use and Handling of Lithium Ion Cells

See before using lithium-ion cell

This document has been prepared to describe the appropriate cautions and prohibitions, which the customer should take or employ when the customer uses and handles the lithium ion cell to be manufactured and supplied by Samsung SDI Co., Ltd., in order to obtain optimum performance and safety.

### 1. Charging

#### 1.1 Charging current

Charging current should be less than maximum charge current specified in the product specification.

#### 1.2 Charging voltage

Charging should be done by voltage less than that specified in the product specification.

#### 1.3 Charging time

Continuous charging under specified voltage does not cause any loss of performance characteristics. However, the charge timer is recommended to be installed from a safety consideration, which shuts off further charging at time specified in the product specification.

#### 1.4 Charging temperature

The cell should be charged within a range of specified temperatures in the specification.

#### 1.5 Reverse charging

The cell should be connected, confirming that its poles are correctly aligned.

Inverse charging should be strictly prohibited. If the cell is connected improperly, it may be damaged.

### 2. Discharging

#### 2.1 Discharging

The cell shall be discharged continuously at less than maximum discharge current specified in the product specification. In case of the higher discharge current should be set, it shall be discussed together with SDI.

#### 2.2 Discharging temperature

2.2.1 The cell should be discharged within a range of temperatures specified in the product specification.

2.2.2 Otherwise, it may cause loss of characteristics.

Spec. No.	INR21700-30T	Version No.	Tentative
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### 2.3 Over-discharging

- 2.3.1 The system should be equipped with a device to prevent further discharging exceeding discharging cut-off voltage specified in the product specification.
- 2.3.2 Over-discharging may cause loss of performance, characteristics of battery function.
- 2.3.3 Over-discharging may occur by self-discharge if the battery is left for a very long time without any use.
- 2.3.4 The charger should be equipped with a device to detect cell voltage and to determine recharging procedures.

## 3. Storage

### 3.1 Storage conditions

- 3.1.1 The cell should be stored within a range of temperatures specified in the product specification.
- 3.1.2 Otherwise, it may cause loss of performance characteristics, leakage and/or rust.

### 3.2 Long-term storage

- 3.2.1 The cell should be used within a short period after charging because long-term storage may cause loss of capacity by self-discharging.
- 3.2.2 If long-term storage is necessary, the cell should be stored at lower voltage within a range specified in the product specification, because storage with higher voltage may cause more loss of performance characteristics.
- 3.2.3 Store the battery at 0 ~ 23°C, low humidity (below 65%), no dust and no corrosive gas atmosphere.

## 4. Cycle life

### 4.1 Cycle life performance

- 4.1.1 The cell can be charged/discharged repeatedly up to times specified in the produce specification with a certain level of capacity also specified in the product specification.
- 4.1.2 Cycle life may be determined by conditions of charging, discharging, operating temperature and/or storage.

## 5. Battery Pack Assembly

### 5.1 Prohibition of usage of damaged cell

- 5.1.1 The cell should be inspected visually before battery assembly.
- 5.1.2 The cell should not be used if sleeve-damage, can-distortion and/or electrolyte-smell is detected.

Spec. No.	INR21700-30T	Version No.	Tentative
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## 5.2 Terminals handling

5.2.1 Excessive force on the negative terminal should be avoided when external strip terminal is welded.

## 5.3 Transportation

5.3.1 If the cell is necessary to be transported to such as the battery manufacturer, careful precautions should be taken to avoid damage of cell.

# 6. Others

## 6.1 Disassembly

6.1.1 The cell should not be dismantled from the battery pack.

6.1.2 Internal short-circuit caused by disassembly may lead to heat generation and/or venting.

6.1.3 When the electrolyte is coming in contact with the skin or eyes, wash immediately with fresh water and seek medical advice.

## 6.2 Short-circuiting

6.2.1 Short-circuit results in very high current which leads to heat generation.

6.2.2 An appropriate circuitry should be employed to protect accidental short-circuiting.

## 6.3 Incineration

6.3.1 Incinerating and disposing of the cell in fire are strictly prohibited, because it may cause rupture and explosion.

## 6.4 Immersion

6.4.1 Soaking the cell in water is strictly prohibited, because it may cause corrosion and leakage of components to be damaged to functions.

## 6.5 Mixing use

6.5.1 Different types of cell, or same types but different cell manufacturer's shall not be used, which may lead to cell imbalance, cell rupture or damage to system due to the different characteristics of cell.

6.5.2 Do not mix use the cells from different batches/ranks even they are the same cell types from the same manufacturer.

## 6.6 Battery disposal

6.6.1 Although the cell contains no environmentally hazardous component, such as lead or cadmium. the battery should be disposed according to the local regulations when it is disposed.

6.6.2 The cell should be disposed with a discharged state to avoid heat generation by an inadvertent short-circuit.

Spec. No.	INR21700-30T	Version No.	Tentative
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## 6.7 Caution

- 6.7.1 The Battery used in this device may present a risk of fire or chemical burn if mistreated.
- 6.7.2 Do not disassemble, expose to heat above 100°C or incinerate it.
- 6.7.3 Replace battery with Samsung SDI battery only.
- 6.7.4 Use of another battery may present a risk of fire or explosion.
- 6.7.5 Dispose of used battery promptly.
- 6.7.6 Keep away from children.
- 6.7.7 Do not disassemble and do not dispose in fire.

Spec. No.	INR21700-30T	Version No.	Tentative
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## Pack Design Guideline for Lithium Ion Cells

**If a customer's battery pack cannot meet Pack Design Guideline, SDI cannot take responsibility for a quality issue about a battery cell.**

### 1. Electrical design

#### 1.1 Charge

1.1.1 Stop charging the battery if charging isn't completed within the specified time.

1.1.2 The battery can be used within the following temperature ranges.

Don't exceed these ranges.

**Charge temperature ranges (Cell Surface) : 0°C ~ 50°C**

1.1.3 Charge current must be controlled by specified value in Cell specification.

1.1.4 **Cut-off Voltage of charging must be under 4.2V.**

1.1.5 Charger must stop charging battery by detecting either charging time or current specified in Cell's specification.

1.1.6 Recharge Voltage must be at least 0.1V lower than Max charging Voltage.

1.1.7 Do not charge the battery under 1.0V voltage.

1.1.8 Voltage range of the battery for pre-charge mode is 1.0 ~ 3.0V with a charging current of 0.1 ~ 0.5C

#### 1.2 Discharge

1.2.1 Discharge current must be controlled by specified value in Cell's specification.

1.2.2 Cut-off Voltage of discharging for BBU Application must be over 2.5V.

1.2.3 The battery can be used within the following temperature ranges.

Don't exceed these ranges.

**Discharge temperature ranges (Cell Surface) : -20°C ~ 80°C**

#### 1.3 Storage

Store the battery at low temperature (below 60°C, 20°C is recommended), low humidity(below 65%), no dust and no corrosive gas atmosphere.

#### 1.4 Design of positioning the battery pack in application and charger

To prevent the deterioration of the battery performance caused by heat, battery shall be positioned away from the area where heat is generated in the application and the charger.

#### 1.5 Safety Device

Be sure adopting proper safe device such as PTC specified type or model in Cell Specification. If you intend to adopt different safety device which is not specified in Cell Specification, please contact Samsung SDI to investigate any potential safety problem.

Be sure designing 2nd protective devices such as PTC & PCM at the same time to protect Cell just in case one protective device is fault.

Spec. No.	INR21700-30T	Version No.	Tentative
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## 2. Design of System

### 2.1 Connection between the cell and the battery

- 2.1.1 The cell should not be soldered directly with other cells. Namely, the cell should be welded with leads on its terminal and then be soldered with wire or leads to solder.
- 2.1.2 Otherwise, it may cause damage of component, such as separator and insulator, by heat generation.

### 2.2 Positioning the battery in the System

- 2.2.1 The battery should be positioned as possible as far from heat sources and high temperature components.
- 2.2.2 Otherwise, it may cause loss of characteristics.
- 2.2.3 The recommended spacing between the cells is more than 1mm.

### 2.3 Mechanical shock protection of the battery

- 2.3.1 The battery should be equipped with appropriate shock absorbers in the pack in order to minimize shock, which can damage the cells. .
- 2.3.2 Otherwise, it may cause shape distortion, leakage, heat generation and/or rupture and/or open circuit.
- 2.3.3 Ultrasonic should not be used when manufacturing battery packs as it can damage the connection between component parts.

### 2.4 Short-circuit protection of the cell

- 2.4.1 The cell is equipped with an insulating sleeve to protect short-circuit which may occur during transportation, battery assembly and /or system operation.
- 2.4.2 If the cell sleeve is damaged by some causes such as outside impact, it may cause short-circuit with some wiring inside the battery.

### 2.5 Connection between the battery and charger/system

- 2.5.1 The battery should be designed to be connected only to the specified charger and system.
- 2.5.2 A reverse connection of the battery, even in the specified system, should be avoided by employing special battery design such as a special terminals.

Spec. No.	INR21700-30T	Version No.	Tentative
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## 2.6 Pack design

2.6.1 The current consumption of the battery pack should be under 10uA after shut down.

2.6.2 Cell voltage monitoring system.

The system (charger or pack) should be equipped with a device to monitor each voltage of cell block to avoid cell imbalance which can cause damage to the cells.

2.6.3 The battery pack or system should have warning system such as over temperature, over voltage, over current, and so on.

2.6.4 Mechanical design

Item	Portable IT	Power-Tool	Medical	E-Bike	E-Scooter	EV/LEV	ESS/UPS
<input type="checkbox"/> Need partitions(separator) between BMS and a Cell	◎	◎	◎	◎	◎	◎	◎
<input type="checkbox"/> Need to check if the pack is designed to be able to avoid thermal runaway (1KWh ↑ )					◎	◎	◎
<input type="checkbox"/> Need to analyze the battery pack's thermal distribution and its effect on the pack's life cycle					◎	◎	◎
<input type="checkbox"/> Need to use a non-flammable (VO level) case	◎	◎	◎	◎	◎	◎	◎
<input type="checkbox"/> Need to apply improved material (Steel) to the case						◎	◎
<input type="checkbox"/> Need to analyze the battery pack's structure, system, installation status and use environment						◎	◎

Spec. No.	INR21700-30T	Version No.	Tentative
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## **Handling precaution and prohibitions of lithium rechargeable cells and batteries**

Inaccurate handling of lithium ion and lithium ion batteries rechargeable battery may cause leakage, heat, smoke, an explosion, or fire.

This could cause deterioration of performance or failure. Please be sure to follow instructions carefully.

### **1. Safety precaution and prohibitions**

To assure product safety, describe the following precautions in the instruction manual of the application.

### **2. Danger**

#### **2.1 Electrical misusage**

- 2.1.1 Use dedicated charger.
- 2.1.2 Use or charge the battery only in the dedicated application.
- 2.1.3 Don't charge the battery by an electric outlet directly or a cigarette lighter charger.
- 2.1.4 Don't charge the battery reversely.

#### **2.2 Environmental misusage**

- 2.2.1 Don't leave the battery near the fire or a heated source.
- 2.2.2 Don't throw the battery into the fire.
- 2.2.3 Don't leave, charge or use the battery in a car or similar place where inside of temperature may be over 60°C.
- 2.2.4 Don't immerse, throw, wet the battery in water / seawater.

#### **2.3 Others**

- 2.3.1 Don't fold the battery cased with laminated film such as pouch and Polymer.
- 2.3.2 Don't store the battery in a pocket or a bag together with metallic objects such as keys, necklaces, hairpins, coins, or screws.
- 2.3.3 Don't short circuit (+) and (-) terminals with metallic object intentionally.
- 2.3.4 Don't pierce the battery with a sharp object such as a needle, screw drivers.
- 2.3.5 Don't heat partial area of the battery with heated objects such as soldering iron.
- 2.3.6 Don't hit with heavy objects such as a hammer, weight.
- 2.3.7 Don't step on the battery and throw or drop the battery on the hard floor to avoid mechanical hock.
- 2.3.8 Don't disassemble the battery or modify the battery design including electric circuit.
- 2.3.9 Don't solder on the battery directly.
- 2.3.10 Don't use seriously scared or deformed battery.
- 2.3.11 Don't put the battery into a microwave oven, dryer ,or high-pressure container.
- 2.3.12 Don't use or assemble the battery with other makers' batteries, different types and/or models of batteries such as dry batteries, nickel-metal hydride batteries, or nickel-cadmium batteries.
- 2.3.13 Don't use or assemble old and new batteries together.

Spec. No.	INR21700-30T	Version No.	Tentative
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### **3. Warning**

- 3.1** Stop using the battery if the battery becomes abnormally hot, order, discoloration, deformation, or abnormal conditions is detected during use, charge, or storage.
- 3.2** Keep away from fire immediately when leakage or foul odors are detected. If liquid leaks onto your skin or cloths, wash well with fresh water immediately.
- 3.3** If liquid leaking from the battery gets into your eyes, don't rub your eyes and wash them with clean water and go to see a doctor immediately.
- 3.4** If the terminals of the battery become dirty, wipe with a dry cloth before using the battery.
- 3.5** Cover terminals with proper insulating tape before disposal.

### **4. Caution**

#### **4.1 Electrical misusage**

Battery must be charge with constant current-constant voltage (CC/CV).

#### **4.2 Others**

- 4.2.1 Keep the battery away from babies and children to avoid any accidents such as swallow.
- 4.2.2 If younger children use the battery, their guardians should explain the proper handling method and precaution before using.
- 4.2.3 Before using the battery, be sure to read the user's manual and precaution of its handling.
- 4.2.4 Before using charger, be sure to read the user's manual of the charger.
- 4.2.5 Before installing and removing the battery from application, be sure to read user's manual of the application.
- 4.2.6 Replace the battery when using time of battery becomes much shorter than usual.
- 4.2.7 Cover terminals with insulating tape before proper disposal.
- 4.2.8 If the battery is needed to be stored for an long period, battery should be removed from the application and stored in a place where humidity and temperature are low.
- 4.2.9 While the battery is charged, used and stored, keep it away from object materials with static electric chargers.

### **5. Safety Handling Procedure for the Transporter**

#### **5.1 Quarantine**

Packages that are crushed, punctured or torn open to reveal contents should not be transported. Such packages should be isolated until the shipper has been consulted, provided instructions and, if appropriate, arranged to have the product inspected and repacked.

#### **5.2 Spilled Product**

In the event that damage to packaging results in the release of cells or batteries, the spilled products should be promptly collected and segregated and the shipper should be contacted for instructions.

Spec. No.	INR21700-30T	Version No.	Tentative
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## Samsung SDI emergency contact information

- **Samsung SDI Co., Ltd (Headquarter)**  
150-20, Gongse-ro, Giheung-gu, Yongin-si, Gyeonggi-do, Korea  
Tel: +82-31-8006-3100, Fax : +82-31-210-7887
- **Samsung SDI Co., Ltd (Cheonan Factory, Production)**  
467, Beonyeong-ro, Seobuk-gu, Cheonan-si, Chungcheongnam-Do, Korea  
Tel: +82-41-560-3114, Fax : +82-41-550-3399
- **Samsung SDI China Co., Ltd (Tianjin Factory, Production)**  
301726, China Tianjin Developing Zone OF Yi-Xian Park, Wuqing Country, TianJin, China  
Tel: +86-22-8212-9971(5300),
- **Samsung SDI Energy Malaysia SDN. Bhd. (Malaysia Factory, Production)**  
Lot 635 & 660, Kawasan Perindustrian, Tuanku Jaafar, 71450 Sungai Gadut, Negeri Sembilan Darul Khusus, Malaysia  
Tel: (+60)6-677-6160, 6153, Fax: (+60)6-677-6164
- **Samsung SDI America, Inc (San Jose, Sales)**  
3655 North First St. San Jose CA 95134  
Tel: +1-408-544-4541, Fax: +1-949-260-2221
- **Samsung SDI Europe GmbH (Munich, Sales)**  
85737, Oskar-Messter-Strasse 29 Ismaning, Germany  
Tel: +49-89-9292-7799(20), Fax: +49-89-9292-7799(99)
- **Samsung SDI Japan Co., Ltd (Tokyo, Sales)**  
108-0075, Shinagawa Grand Central Tower 9F, 2-16-4, Konan, Minato-ku, Tokyo, Japan  
Tel. +81-3-6369-6401, +81-3-6369-6404 Fax. +81-3-6369-6388
- **Samsung SDI Taiwan Branch (Taipei, Sales)**  
7F-1, No.399, Ruiguang Rd., Neihu Dist., Taipei Taiwan (ROC)  
Tel +886-2-8178-5900, Fax +886-2-8751-3131
- **Samsung SDI India Branch (New Delhi, Sales)**  
1st Fl.M-6 Uppal's Plaza, Jasola District Centre, New Delhi 110025, INDIA  
Tel. +91-11-4316-1224, +91-11-4316-1221 Fax. +91-11-4316-1200



## Lithium Ion Battery Management System

### Main Features

- Monitors every cell voltage in series
- Field programmable and upgradeable
- Intelligent cell balancing (efficient passive balancing)
- Enforces min. and max. cell voltages
- Enforces maximum current limits
- Enforces temperature limits
- Professional and robust design
- Monitors state-of-charge
- Retains lifetime data about battery history
- Integration with 3rd party smartphone apps (Torque, EngineLink) and external displays

### Battery Compatibility

- Compatible with almost all lithium-ion cells
- One-click setup for common battery types
- Supports 4-180 cells in series per BMS unit (2x additional remote units can be used in series)

### Battery Calculations

- State of Charge (SOC) & Pack Health
- Open-Circuit (sitting) cell voltages
- Charge & Discharge current limits
- Internal resistance (for all cells and total pack)

### Centralized Design

- No cell tap boards or external circuitry
- Fast cell voltage polling (every 25 mS typical)
- High immunity to EMI and other noise
- High accuracy cell voltage measurement

### 2x Programmable CANBUS Interfaces

- CAN2.0B (11-bit and 29-bit IDs supported)
- Independently operate at different baud rates
- Fully customizable message formatting
- Field upgradable firmware and settings using either CAN interface
- One-click setup for many common chargers and inverters
- ISO-15765 OBD2 protocol compatible
- Compatible with CAN-Open and J1939

### Charger Support

- Integrated support for J1772 charging stations
- Works with J1772 proximity & pilot signals
- Supports CHAdeMO DC fast charging protocol

### Input / Output

- Easy interfacing with chargers and loads
- On/off outputs for controlling charge and discharge sources
- 0 – 5V analog outputs for gradual current reduction (improves usable range of battery)
- Thermal management controls for battery cooling / heating

### Diagnostic Features

- Diagnostic trouble codes quickly identify and diagnose battery problems
- Freeze frame data records exact conditions and battery data when a fault occurred
- Supports OBD2 automotive protocol for storing diagnostic trouble codes and polling live data

### Data Logging

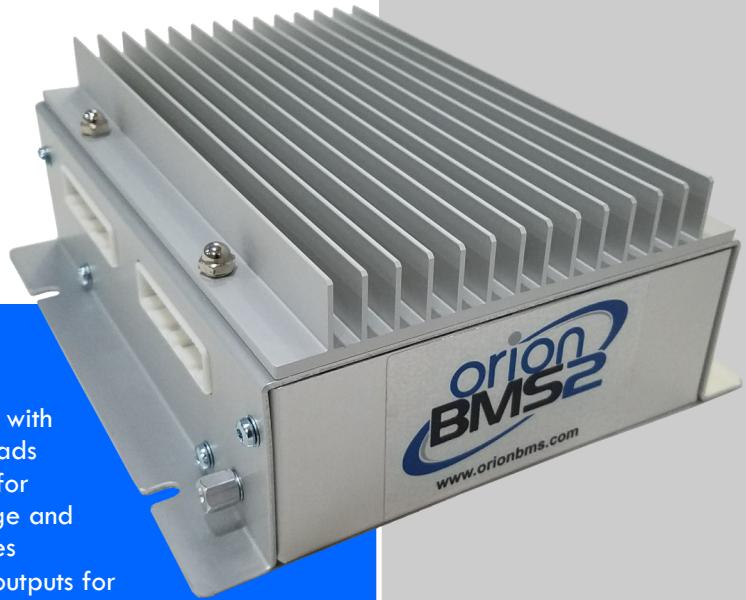
- Unit tracks total number of battery cycles
- Records detailed lifetime battery usage and environment conditions internally.
- All BMS parameters can be logged using PC utility software
- Optional WiFi Connect module can record any parameters to a memory card or Internet
- Internal event logging for easy troubleshooting

### Other Features

- Integrated isolation fault detection circuit
- Multiple remote modules may be used in series
- Automotive grade locking connectors
- Temperature compensation for improved monitoring in different temperatures
- Integrated status LED for indicating faults

### Common Applications

- Electric Vehicles (cars, trucks, busses, boats, heavy equipment, racing, etc)
- Hybrid & Plug-In Hybrid Vehicles
- Solar and wind energy storage
- UPS and peak shaving applications
- Research & Laboratory Testing



The Orion BMS is a product of Ewert Energy Systems, Inc.

Ewert Energy Systems is a research and development company focused on developing solutions for plug-in hybrid and electric vehicles and other energy storage applications.



## Cell Voltage Monitoring Specs

- Cell voltage measurement resolution of 0.1mV.
- Maximum individual cell voltage rating: 0.5v to 5v per cell tap.
- Cell voltage measurement total error <0.25% across full product temperature range.
- Total pack voltages from 12vDC up to 800vDC (maximum).
- Supports from 4 to 340 cells per battery pack (requires remote modules for more than 180 cells, 800vDC maximum).

## Reliability & EMI Immunity

- Operates through the highest class passenger vehicle load dump ISO 7637 Class IV (178V, 400mS, 0.5 ohm source.)
- Operates through ISO 7637 "cold crank" brownouts down to 5v on input supply rail and can operate > 100mS with no power (with initial voltage of at least 12v)
- Meets EN 50498: 2010 EMC Aftermarket Vehicle Directive
- Meets European UNECE Reg 10.05 (Replaced Road Vehicle Directive)

## Product Dimensions & Weight (Typical, With Heatsink)

- 24-72 Cells: 7.15" (W) x 6.72" (L) x 2.37" (H) — 2.50 lbs
- 84-108 Cells: 9.50" (W) x 6.72" (L) x 2.37" (H) — 3.25 lbs
- 120-180 Cells: 15.52" (W) x 6.72" (L) x 2.37" (H) — 4.80 lbs

Specification Item	Min	Typ	Max	Units
Input Supply Voltage	8		30	Vdc
Supply Current—Active (at 25 degrees Celsius)		< 2		Watts
Supply Current—Sleep (at 25 degrees Celsius, 12vDC)		450		µA
Operating Temperature	-40		80	C
Sampling Rate for Current Sensor		8		mS
Sampling Rate for Cell Voltages		25	40	mS
Isolation Between Cell Tap #1 and Chassis / Input Supply	1.5			kVrms
Isolation Between Cell Taps #2+ and Chassis / Input Supply	2.5			kVrms
Isolation Between Cell Tap Connectors	2.5			kVrms
Digital Output Switching Voltage (Open Drain)			30	V
Digital Output Sink Continuous Current (Some outputs can pulse up to 4A for contactors—see wiring manual for details)			175	mA
Cell Voltage Measurement Range	0.5		5	V
Cell Voltage Measurement Error (over 1-5v range)			0.25	%
Cell Balancing Current			200	mA
Cell Current (Operating)		0.5		mA
Cell Current (Low Power Sleep)		50		µA
Thermistor Accuracy		1		C
Cell Voltage Reporting Resolution		0.1		mV

## Optional Specifications

CAN bus speed	125, 250, 500, or 1000 Kbps
Current Sensor Values	+/- 200A, 500A, 800A, 1000A Available

## Isolation

- Cell taps isolated from input power supply, chassis and I/O
- 2.5kV isolation between each connector of cell taps
- Isolation allows for use of in-pack safety disconnects and fuses
- High voltage isolation fault detection circuit to monitor the breakdown of wire insulation

## I/O Interfaces

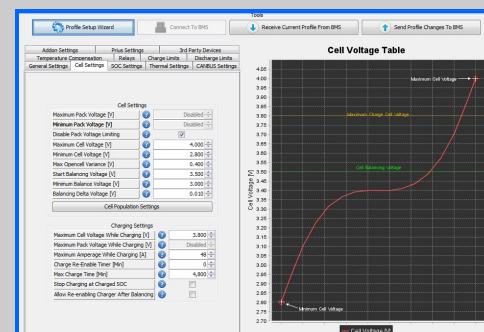
- 2 Digital signal outputs for enabling charge and discharge.
- 1 Digital signal output to control a battery charger
- 5 Digital programmable multi-purpose outputs
- 2 Digital programmable CANBUS (CAN2.0B) interfaces.
- 3 Analog 0-5v outputs that represent the following signals: Charge / Discharge Current Limits and State of Charge (SOC)
- 1 PWM fan output and fan speed feedback monitor (external switch and relay required, uses MPO4)
- 8 Thermistor inputs (Can support up to 800 thermistors through external thermistor expansion modules (sold separately)
- 1 Dual range current sensor input (measures pack current)

## Power Supply

- 3 redundant 12V—24V DC power supplies for reliability
- BMS retains data and settings without power
- Low power sleep mode



Screenshot of Torque smartphone display



Screenshot of BMS utility

## MG Solar MPPT – version: WSC

The MG Solar MPPT is a high efficient charge controller with Maximum Power Point Tracking (MPPT) function. The converter is based on a boost topology.



### Advantages of the MG Solar MPPT

- Ultra-fast MPPT algorithm that anticipates on fast changes in light intensity;
- High converter and tracking efficiency;
- MCU power supplied by the battery;
- Low quiescent current when in shutdown;
- Suitable to charge Lithium-Ion batteries;
- On/Off control by switching the CAN-Bus supply voltage;
- CAN-Bus interface;
- Power level control for adjusting charge power if the battery is fully charged;
- Low weight;

### Technical specifications

Technical specifications		WSC-Si
Input voltage range <sup>*1</sup>	$U_{IN}$	22 – 120 V
Output voltage range <sup>*1</sup>	$U_{OUT}$	25 – 180 V
Output voltage limit	$U_{OUT\_LIM}$	Configurable <sup>*3</sup>
Input power range <sup>*2</sup>	$P_{IN}$	5 – 700 W
Input current range	$I_{IN\_MAX}$	0.5 - 7 A
Input current limit	$I_{IN\_LIM}$	Configurable <sup>*3</sup>
Output to input ratio range <sup>*1</sup>	$U_{OUT}/U_{IN}$	1.0 – 3.5
Max. input forward current ( $V_{IN} > V_{OUT}$ )	$I_{FW\_MAX}$	6 A
Peak efficiency <sup>*4</sup>	$\eta_e$	> 99%
CAN bus isolation voltage	$U_{ISO}$	500 V
Isolated CAN transceiver supply voltage	$U_{CAN}$	10 – 58 V
Isolated CAN transceiver current draw <sup>*5</sup>	$I_{CAN}$	6 mA at 12 V <sub>CAN</sub> 3.5 mA at 30 V <sub>CAN</sub>
Off state current draw	$I_{OUT\_OFF}$	20 µA at 30 V <sub>OUT</sub> 50 µA at 60 V <sub>OUT</sub>
Weight		
Weight (approx.)		540 g
Environmental		
Operating temperature		-20°C to +55°C
Relative humidity		Max. 95% (non-condensing)

<sup>\*1</sup> The input voltage must be less than the output voltage for the converter to track the maximum power point.

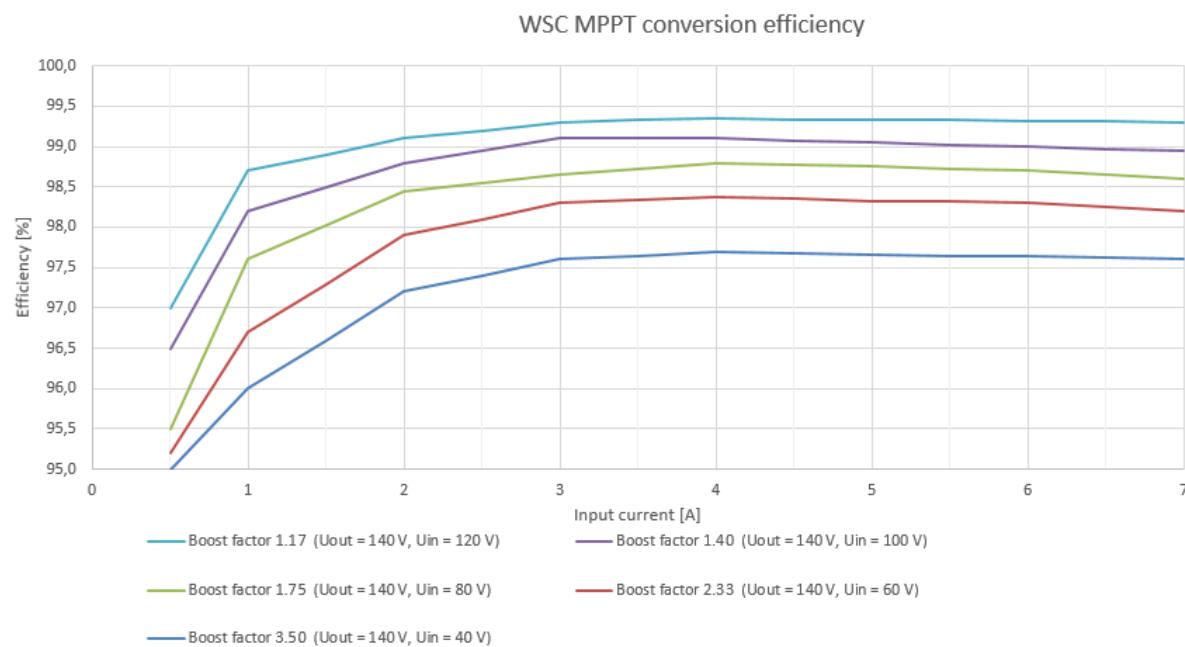
<sup>\*2</sup> Maximum under NTP conditions with natural convection.

<sup>\*3</sup> The input current and output voltage will be limited to a value specified by the customer.

<sup>\*4</sup> Depending on application, peak efficiency is reached with a low boost factor. Higher boost factors will decrease efficiency. Efficiency rating and graphs include the power loss of the electronics (microprocessor etc.) required to operate the MPPT.

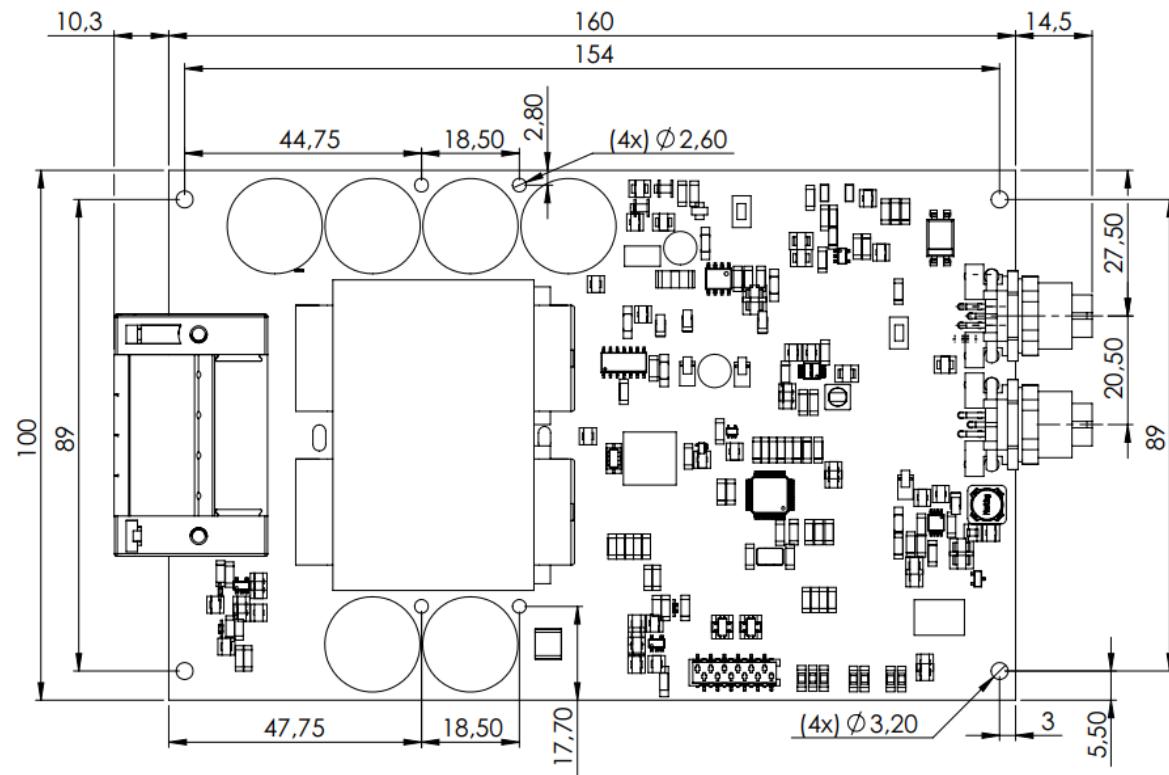
<sup>\*5</sup> Typical supply current when operational and communicating at 250k. CAN supply voltage does not need to be present for the MG MPPT to operate. ATTENTION: Like other MPPT manufacturers the CAN supply power is not included in the efficiency rating and graphs.

## Efficiency



## Dimensions

Dimensions in mm.



# SunPower Cell Pricing

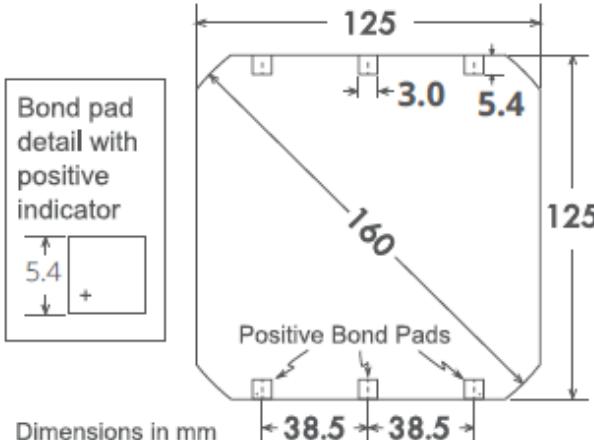
Specifically for small orders

June.2019

SUNNIVA TECH

# SunPower Gen 1 Cell – 160 mm

Cell Physical Characteristics	
Wafer:	Monocrystalline silicon
Design:	All back contact
Front:	Uniform, black antireflection coating
Back:	Tin-coated, copper metal grid
Cell Area:	Approximately 153cm <sup>2</sup>
Cell Weight:	Approximately 6.5 grams
Cell Thickness:	150µm +/- 30µm

The diagram illustrates the physical dimensions of the SunPower Gen 1 Cell. It shows a square cell with a total width and height of 125 mm. The central finger pitch is 3.0 mm, and the side finger pitch is 5.4 mm. The positive bond pads are located at the top and bottom edges, with a dimension of 150 mm indicated. The negative bond pads are located on the left and right edges. A detailed inset shows a single bond pad with a width of 5.4 mm and a length of 3.0 mm, with a '+' sign indicating the positive side.

Bond pad area dimensions are 5.4mm x 3.0mm

Metal finger pitch between positive and negative fingers is 599um.

Positive/Negative pole bond pad sides have "+/-" indicators on leftmost and rightmost bond pads

Electrical Characteristics of a typical Maxeon Gen II Cell							
At Standard Test Conditions (STC)							
STC: 1000W/m <sup>2</sup> , AM 1.5G and cell temp 25°C							
	Cell Bin	Pmpp (Wp)	Eff. (%)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)
Premium Performance	Jp1	3.44	22.4	0.575	5.98	0.677	6.33

Electrical parameters are nominal values.

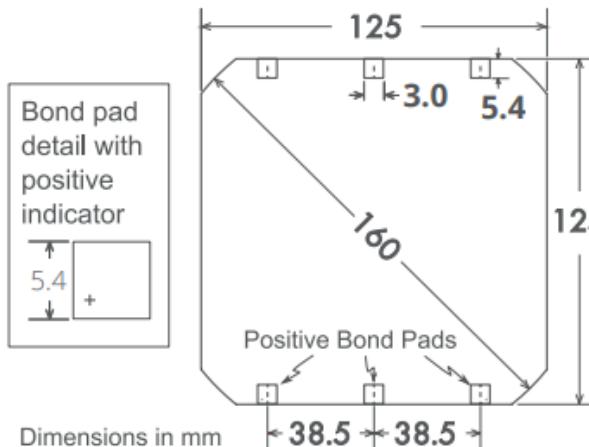
Temp.Coefficients in SunPower Panels: Voltage: -1.74mV/°C, Current: 2.9mA/°C,  
Power: -0.29%/°C

Cell Bin	Cosmetic Quality	Unit Price
Jp1	Highest	\$2.9

## Note:

- Pricing is not including tax and shipping
- The minimum packaging is 150 PCS, order quantity should be multiple of 150
- Cells have limited availability
- Spec sheets are available at SunPower website: <https://us.sunpower.com/buy-solar-cells/>

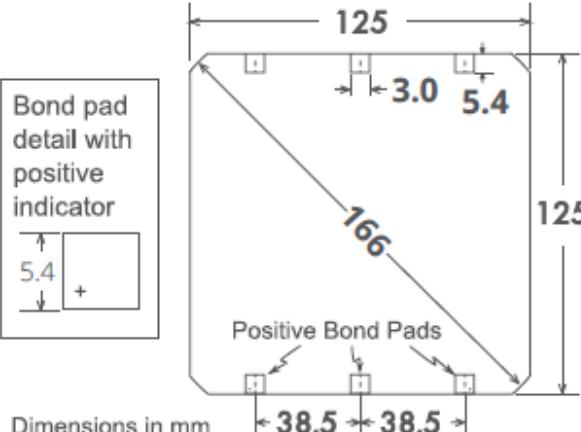
# SunPower Gen 1 Cell – 160 mm

Cell Physical Characteristics	
Wafer:	Monocrystalline silicon
Design:	All back contact
Front:	Uniform, black antireflection coating
Back:	Tin-coated, copper metal grid
Cell Area:	Approximately 153cm <sup>2</sup>
Cell Weight:	Approximately 6.5grams
Cell Thickness:	150µm +/- 30µm
 <p>The diagram illustrates the physical dimensions of the cell. It shows a trapezoidal shape with a total width of 160 mm. The top horizontal dimension is 125 mm, and the bottom horizontal dimension is 38.5 mm. The vertical height is also 125 mm. A callout box provides a detailed view of a bond pad area, which is 5.4 mm wide and 3.0 mm high, with a '+' sign indicating the positive side.</p>	
<p>Bond pad area dimensions are 5.4mm x 3.0mm Metal finger pitch between positive and negative fingers is 471um. Positive/Negative pole bond pad sides have "+/-" indicators on leftmost and rightmost bond pads</p>	

Electrical Characteristics of a typical Maxeon Gen III Cell At Standard Test Conditions (STC) STC: 1000W/m <sup>2</sup> , AM 1.5G and cell temp 25°C							
	Cell Bin	Pmpp (Wp)	Eff. (%)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)
Ultra Peak Performance	Me1	3.72	24.3	0.632	5.89	0.730	6.18
Ultra Premium Performance	Le1	3.62	23.7	0.621	5.84	0.721	6.15

Cell Bin	Eff %	Unit Price
Me1	24.3	\$7.6/cell
Le1	23.7	\$5.5/cell

# SunPower Gen 3 Cell – 166 mm

Cell Physical Characteristics	
Wafer:	Monocrystalline silicon
Design:	All back contact
Front:	Uniform, black antireflection coating
Back:	Tin-coated, copper metal grid
Cell Area:	Approximately 155cm <sup>2</sup>
Cell Weight:	Approximately 6.6 grams
Cell Thickness:	150µm +/- 30µm
 <p>Dimensions in mm</p> <p>Bond pad area dimensions are 5.4mm x 3.0mm Metal finger pitch between positive and negative fingers is 471µm. Positive/Negative pole bond pad sides have "+/-" indicators on leftmost and rightmost bond pads</p>	

Electrical Characteristics of a typical Maxeon Gen III Cell At Standard Test Conditions (STC)							
	Cell Bin	Pmpp (Wp)	Eff. (%)	Vmpp (V)	Impp (A)	Voc (V)	Isc (A)
Max Peak Performance	Me3	3.89	25.1	0.640	6.08	0.727	6.45
Max Premium Performance	Le3	3.84	24.8	0.634	6.06	0.724	6.43

Electrical parameters are nominal values.

Temp.Coefficients in SunPower Panels: Voltage: -1.74mV/°C, Current: 2.9mA/°C,  
Power: -0.29%/°C

Cell Bin	Cosmetic Quality	Unit Price
Me3	Highest	\$19.9/cell
Le3	Highest	\$9.8/cell

## Note:

- Pricing is not including tax and shipping
- The minimum packaging is 150 pcs, order quantity should be multiple of 150
- Cells have limited availability
- Spec sheets are available at SunPower website: <https://us.sunpower.com/buy-solar-cells/>

# SunPower Interconnect Tab

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## Interconnect Tab and Process Recommendations



SunPower recommends customers use SunPower's patented tin-plated copper strain-relieved interconnect tabs, which can be purchased from SunPower. These interconnects are easily solderable and compatible with lead free processing. Tabs weigh approximately 0.3 grams.

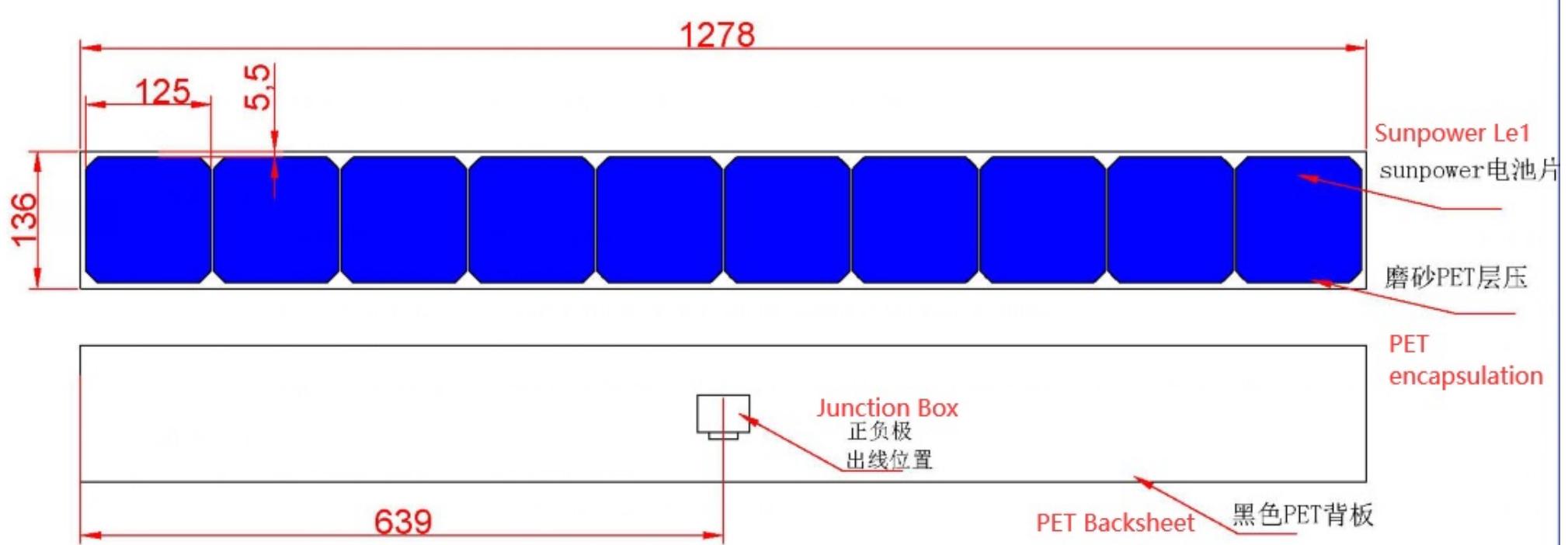
Our patented interconnect tabs are packaged in boxes of 3600 or 36,000 each.

<http://us.sunpower.com/about/sunpower-technology/patents/>

Interconnect Tab	150 pcs Unit Price
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### Note:

- Pricing is not including tax and shipping
- Order 1200/ one box , or 600/ half box
- Tabs have limited availability





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Below is the specification for the motor:

For Motor

Item: QSMOTOR 20X2.125inch **1500W** 205 V3 Electric Bike Cast Wheel SPEC

- Motor Type: BLDC Permanent Magnet Outer Rotor In-Wheel Hub Motor
- Brand: QS Motor,QSMOTOR
- Motor Design: double axle with rim
- Matched Tire: 20X2.125inch
- Stator: Steel Core
- Rated Voltage: 48V-144V
- Speed: 850RPM @ 96V
- Max Torque: approx 130N.m
- Max Efficiency: approx 84%
- Continuous Battery Current: 61A (96V)
- Suggest Peak Phase Current: 146A
- Thermic Probe: KTY83/122 (as default, optional)
- Working Temperature: 70-110°C , peak 120 °C
- Brake type: Disc brake, PCD6\*44mm-M5
- Drop-outs: 155mm
- Single Hall Set with waterproof connectors
- 4mm<sup>2</sup> Cross Section of Phase Wire (not include insulation layer)
- Hall Sensor Phasing angle: 120 degree
- Waterproof Grade: IP54
- Color: Black

Best regards.

**Judy** -Powered by SIA

*No QS Motor, No Super EVs!*



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# **Kelly KHB High Power Brushless Motor Controller User' s Manual**

## **Devices Supported:**

<b>KHB72601</b>	<b>KHB12101</b>
<b>KHB72701</b>	<b>KHB14201</b>
<b>KHB72101</b>	<b>KHB14301</b>
<b>KHB12151</b>	<b>KHB14401</b>
<b>KHB12201</b>	<b>KHB14601</b>
<b>KHB12251</b>	
<b>KHB12301</b>	
<b>KHB12401</b>	
<b>KHB12601</b>	
<b>KHB12801</b>	

Rev.4.5  
Dec. 2016

# Contents

<b>Chapter1</b>	Introduction.....	2
1.1	Overview.....	2
<b>Chapter 2</b>	Features and Specifications.....	3
2.1	General functions.....	3
2.2	Features.....	4
2.3	Specifications.....	5
2.4	Naming Regulations.....	5
<b>Chapter 3</b>	Wiring and Installation.....	6
3.1	Mounting the Controller.....	6
3.2	Connections.....	8
3.2.1	Front Panel and back panel of KHB Motor Controller:.....	8
3.2.2	Wiring of KHB Motor Controller.....	12
3.3	Communication Port.....	13
3.4	Installation Check List.....	13
<b>Chapter 4</b>	Maintenance.....	14
4.1	Cleaning.....	14
4.2	Configuration.....	14
<b>Table 1:</b>	LED CODES.....	15
Contact Us:	.....	17

# Chapter 1 Introduction

## 1.1 Overview

This manual introduces the Kelly high power BLDC motor controllers' features, their installation and their maintenance. Read the manual carefully and thoroughly before using the controller. If you have any questions, please contact the support center of Kelly Controls.

Kelly's programmable motor controllers provide high efficient, smooth and quiet controls for electric motorcycles, forklifts, hybrid vehicles, electric vehicles and electric boats, as well as industrial motor speed or torque control. It uses high power MOSFET's and, PWM to achieve efficiencies of up to 99% in most cases. A powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to adjust parameters, conduct tests, and obtain diagnostic information quickly and easily.

# Chapter 2 Features and Specifications

## 2.1 General functions

- (1) Extended fault detection and protection. The LED flashing pattern indicates the fault sources. Green LED indicates normal operation. Controller will shut down in some fault conditions.
- (2) Monitoring battery voltage. It will stop driving if the battery voltage is too high and it will progressively cut back motor drive power as battery voltage drops until it cuts out altogether at the preset "Low Battery Voltage" setting.
- (3) Built-in current loop and over current protection.
- (4) Configurable motor temperature protection range.
- (5) Current cutback at low temperature and high temperature to protect battery and controller.  
The current begins to ramp down at 90°C case temperature, shutting down at 100°C.
- (6) Enhanced regen brake function. A novel ABS technique provides powerful and smooth regen.
- (7) The controller keeps monitoring battery recharging voltage during regenerative braking, progressively cutting back current as battery voltage rises then cutting off regen altogether when voltage goes too high.
- (8) Pulsed reverse alarm output.
- (9) 3 switch inputs which are activated by connection to Ground. Default to throttle switch, brake switch and reversing switch.
- (10) 3 analog 0-5V inputs that default to throttle input, brake input and motor temperature input.
- (11) Provision of a +5 volt output to supply various kinds of sensors, including Hall effect type.
- (12) Main contactor driver. Cutting off the power if any fault is detected.
- (13) Current meter to display both drive and regen current. Save shunt.
- (14) 3 hall position sensor inputs. Open collector, pull up provided.
- (15) Maximum reverse speed is configurable to half of max forward speed.
- (16) Configurable and programmable with a host computer through RS232 or USB. Provide free GUI which can run on Windows XP/2000, Windows 7 and Vista(recommend using Kelly Standard USB To RS232 Converter).
- (17) Configurable boost switch. Enables the maximum output power achievable if the switch is turned on.
- (18) Configurable economy switch. Limits the maximum current to half if the switch is turned on.
- (19) Maximum reverse power is configurable to half power.
- (20) Configurable 12V brake signal input, in lieu of motor temperature sensor.
- (21) Optional joystick throttle. A bi-symmetrical 0-5V signal for both forwarding and reversing
- (22) Configurable motor over-temperature detection and protection with the recommended thermistor KTY84-130.
- (23)Optional CAN bus.
- (24)Supply voltage 8V-30V

**Caution!** *Regeneration has braking effect but does not replace the function of a mechanical brake. A mechanical brake is required to stop your vehicle. Regen IS NOT a safety feature! Controller may stop regen, without warning, to protect itself or the battery(it won't protect you!).*

## 2.2 Features

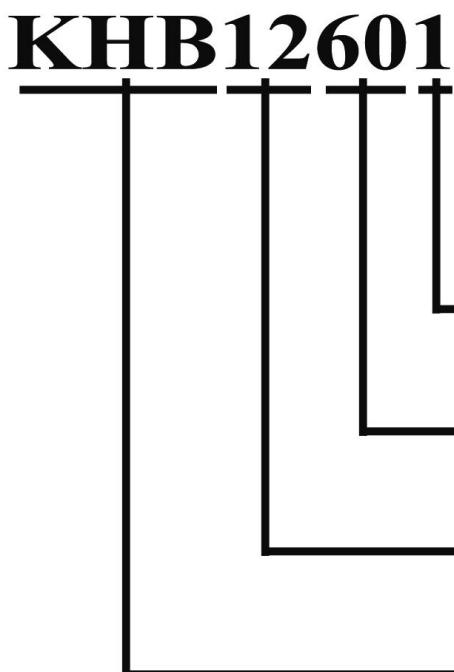
- 1) Opto-isolated technology achieve stability.
- 2) Intelligence with powerful microprocessor.
- 3) Synchronous rectification, ultra low drop and fast PWM to achieve very high efficiency.
- 4) Electronic reversing.
- 5) Voltage monitoring on 3 motor phases, bus, and power supply.
- 6) Voltage monitoring on voltage source 12V and 5V.
- 7) Current sense on all 3 motor phases.
- 8) Current control loop.
- 9) Hardware over current protection.
- 10) Hardware over voltage protection.
- 11) Support torque mode, speed mode, and balanced mode operation.
- 12) Configurable limit for motor current and battery current.
- 13) Low EMC.
- 14) LED fault code.
- 15) Battery protection: current cutback, warning and shutdown at configurable high and low battery voltage.
- 16) Rugged aluminum housing for maximum heat dissipation and harsh environment. Support fan or water cooling.
- 17) Rugged high current terminals, and rugged aviation connectors for small signal.
- 18) Thermal protection: current cut back, warning and shutdown at high temperature.
- 19) Configurable 60 degree or 120 degree hall position sensors.
- 20) Support motors with any number of poles. Up to 40,000 electric RPM standard. Optional high speed 70,000 ERPM, and ultra high speed 100,000 ERPM.  
(Electric RPM = mechanical RPM \* motor pole pairs).
- 21) Support three modes of regenerative braking: brake switch regen, release throttle regen, 0-5K or 0-5V analog signal variable regen for KHB and HP controllers.
- 22) Configurable high pedal protection: the controller will not work if high throttle is detected at power on.
- 23) Current multiplication: Take less current from battery, output more current to motor.
- 24) Easy installation: 2 or 3-wire pot, or hall sensor throttle can work with KHB and HIP controllers.
- 25) Remote fault code LED driver.
- 26) Current meter output.
- 27) Standard PC/Laptop computer is used to do programming. No special tools needed.
- 28) User program provided. Easy to use. No cost to customers.

## 2.3 Specifications

- (1) Frequency of Operation: 16.6kHz.
- (2) Standby Battery Current depending on the model: usually less than 2mA.
- (3) 5V Sensor Supply Current: 40mA.
- (4) Controller supply voltage range, PWR, 8 to 30V (24V preferred)
- (5) Controller input power, PWR: less than 10W.
- (6) Configurable battery voltage range, B+. Max operating range: 18V to 136V for controller rated equal 120V. 18V to 180V for controller rated equal 144V.
- (7) Standard Throttle Input: 0-5 Volts(3-wire resistive pot), 1-4 Volts(hall active throttle).
- (8) Analog Brake and Throttle Input: 0-5 Volts. Producing 0-5V signal with 3-wire pot.
- (9) Reverse Alarm, Main Contactor Coil Driver, Meter.
- (10) Full Power Operating Temperature Range: 0°C to 50°C (controller case temperature).
- (11) Operating Temperature Range:-30 °C to 90 °C ,100 °C shutdown(controller case temperature).
- (12) Motor Current Limit, 1 minute: 150A - 1000A, depending on the model.
- (13) Motor Current Limit, continuous: 75A - 500A, depending on the model.
- (14) Max Battery Current : Configurable..

## 2.4 Naming Regulations

The naming regulations of Kelly KHB BLDC motor controllers:



The eighth letter represents regeneration  
(0:non-regeneration, 1:with-regeneration).

The sixth and seventh letters = the max current/10

The fourth and fifth letters = nominal voltage/10

The first three letters represent Kelly's high power brushless motor controller.

# Chapter 3 Wiring and Installation

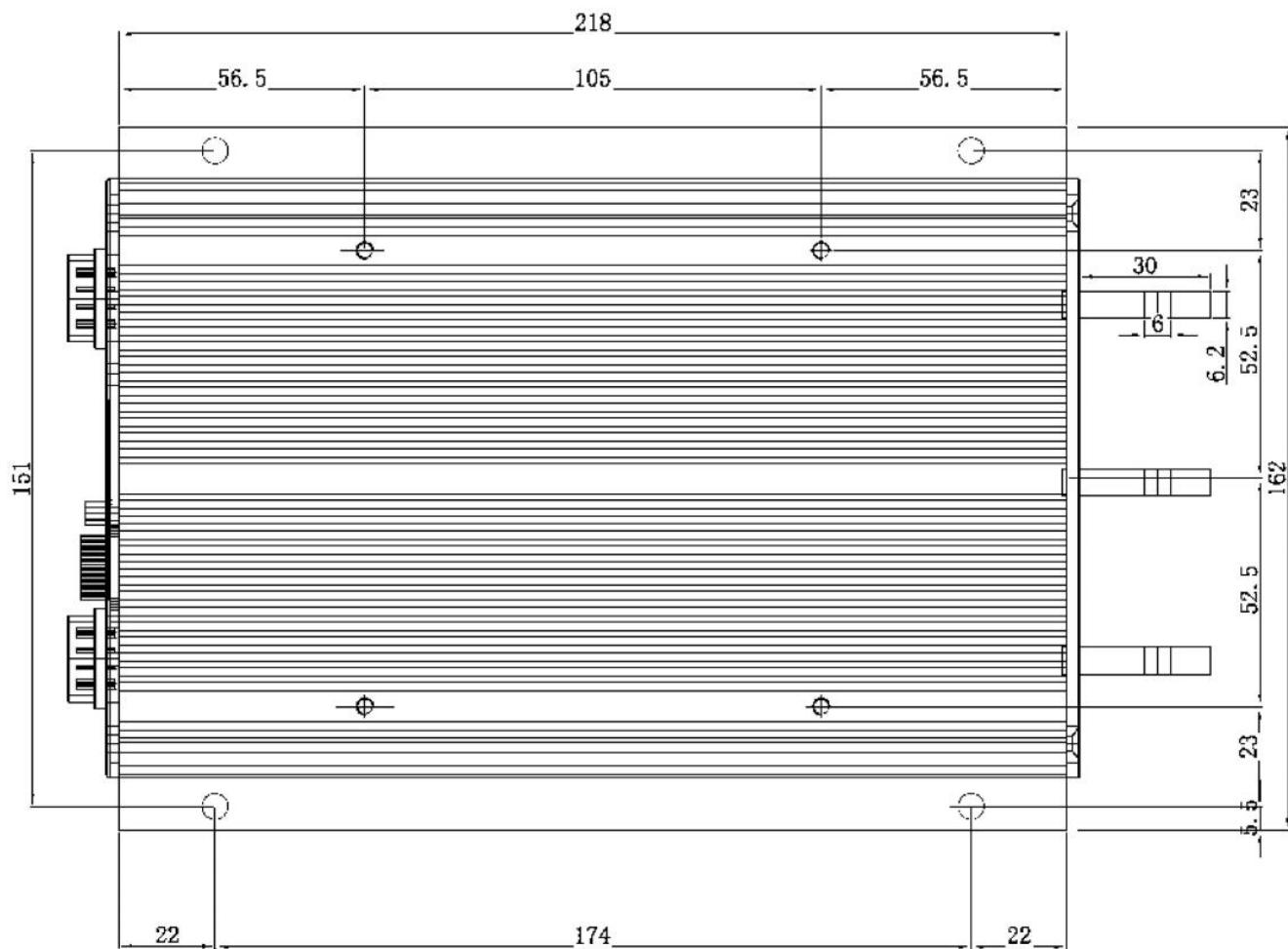
## 3.1 Mounting the Controller

The controller can be oriented in any position which should be as clean and dry as possible, and if necessary, shielded with a cover to protect it from water and contaminants.

To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with six screws. Applying silicon grease or some other thermal conductive material to contact surface will enhance thermal performance.

Proper heat sinking and airflow are vital to achieve the full power capability of the controller.

### The case outline and mounting holes' dimensions of KHB Controllers:



Height: 84 millimeters

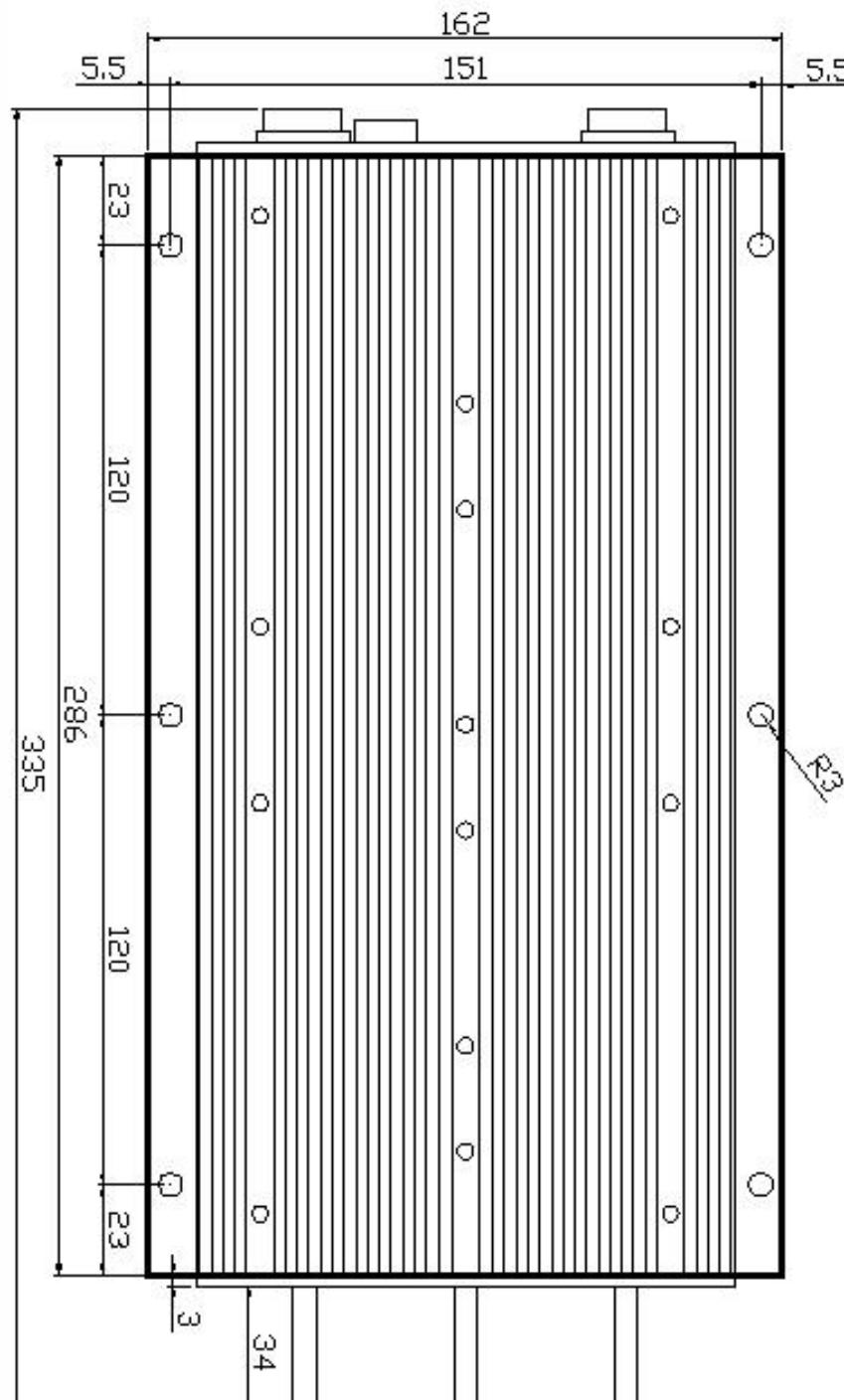
Length: 218 millimeters

**Figure 1:** KHB mounting holes' dimensions (dimensions in millimeters)

Controller models with above dimension: KHB12151, KHB12201, KHB12251

KHB12301, KHB12401

KHB14201, KHB72601

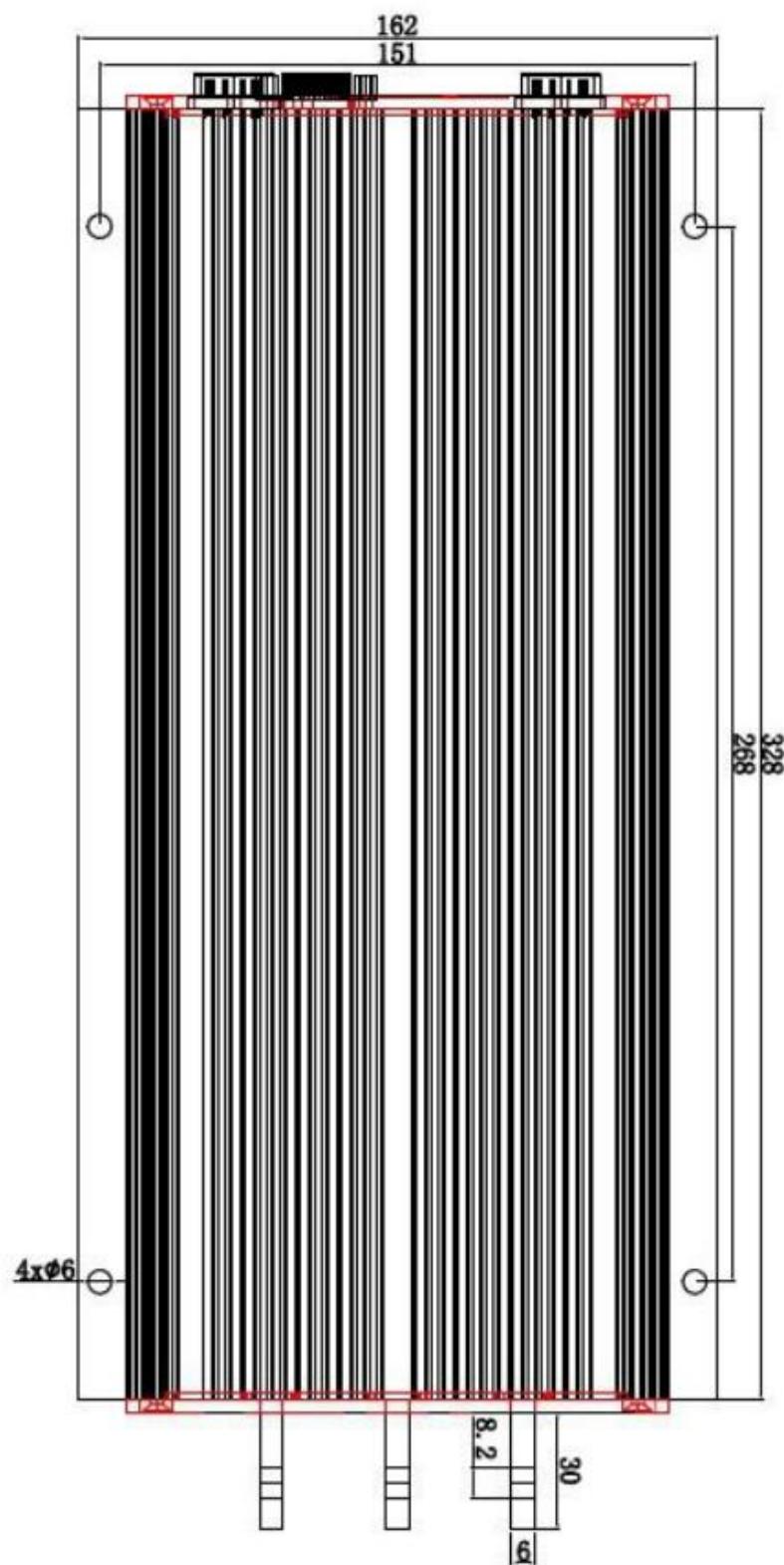


**Figure 2:** KHB mounting holes' dimensions (dimensions in millimeters)

Controller models with above dimension: KHB72701, KHB72101

KHB12601, KHB12801

KHB14301, KHB14401



Height: 84 millimeters

Length: 328 millimeters

**Figure 3:** KHB mounting holes' dimensions (dimensions in millimeters)  
Controller models with above dimension: KHB14601, KHB12101

## 3.2 Connections

### 3.2.1 Front Panel and back panel of KHB Motor Controller:

Five metal bars in front panel and two plugs (J1, J2) in back panel are provided for connecting to the battery, motor and control signals shown as Figure 4,6 and 8.

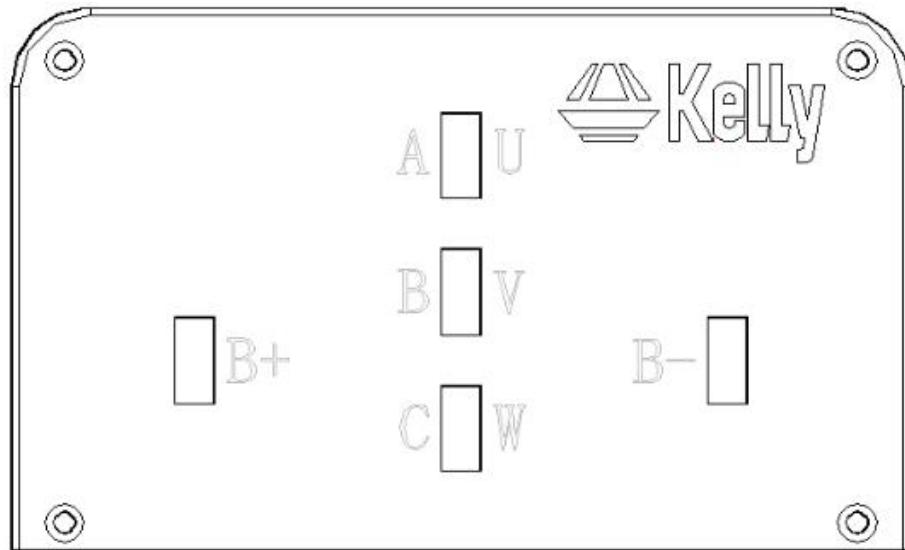


Figure 4: Front panel of KHB motor controller

B+: battery positive

B-: battery negative

A/U: Output A/U phase

B/V: Output B/V phase

C/W: Output C/W phase



Figure 5: Front panel of KHB14601, KHB12101 motor controller

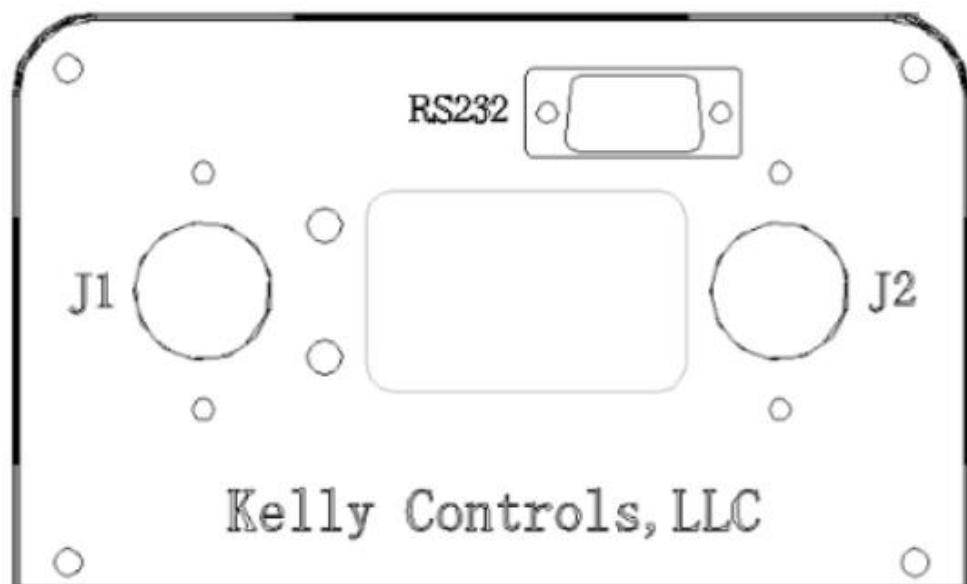


Figure 6: Back panel of KHB motor controller

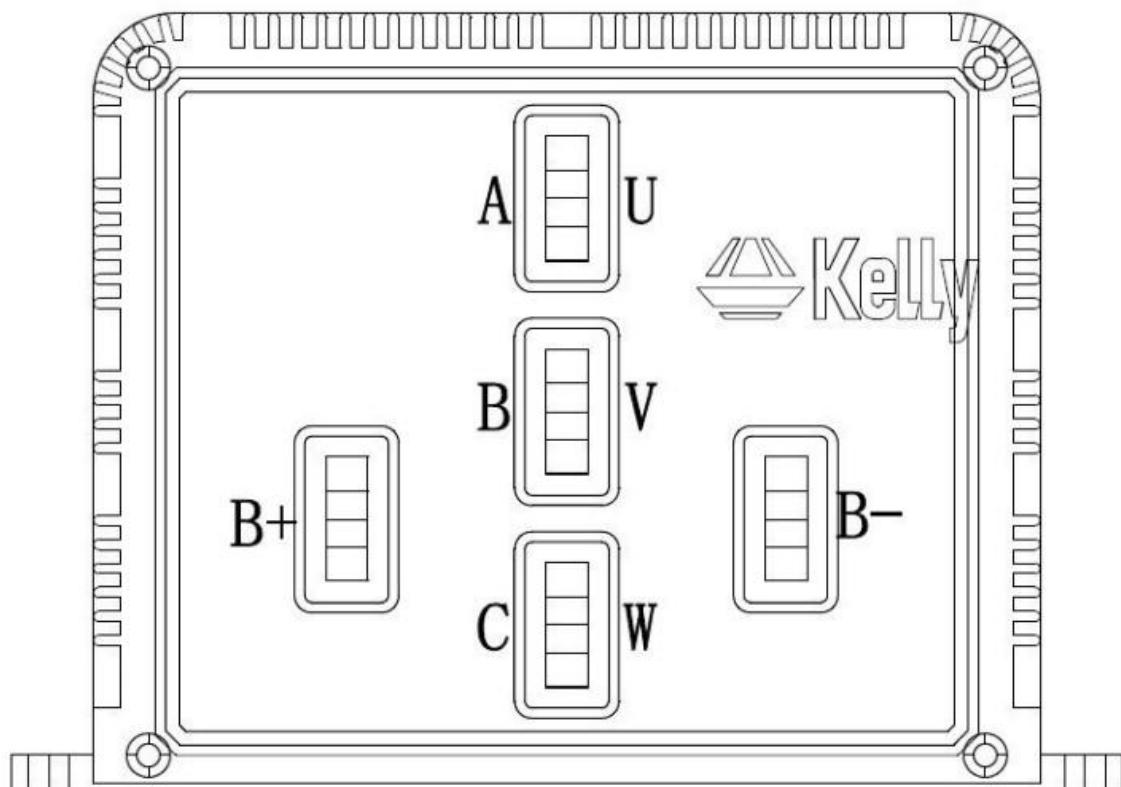
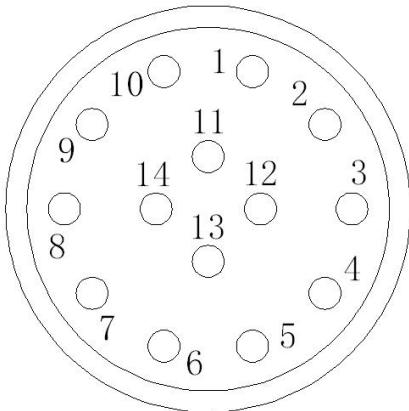


Figure 7: Back panel of KHB14601, KHB12101 motor controller



**Figure 8:** The connecting diagram of J1 and J2

### J1 Pin Definition

- 1- PWR: Controller power supply (output).
- 2- Current meter. <200mA
- 3- Main contactor driver. <2A
- 4- Alarm: To drive reverse beeper. <200mA
- 5- RTN: Signal return
- 6- Green LED: Running indication
  
- 7- RTN: Signal return
- 8- Reserved
- 9- Boost Switch (only available on the controller with 32-bit micro)
- 10- CAN bus high
- 11- CAN bus low
- 12- 12V brake
- 13- RTN: Signal return, or power supply return
- 14- Red LED: Fault code.

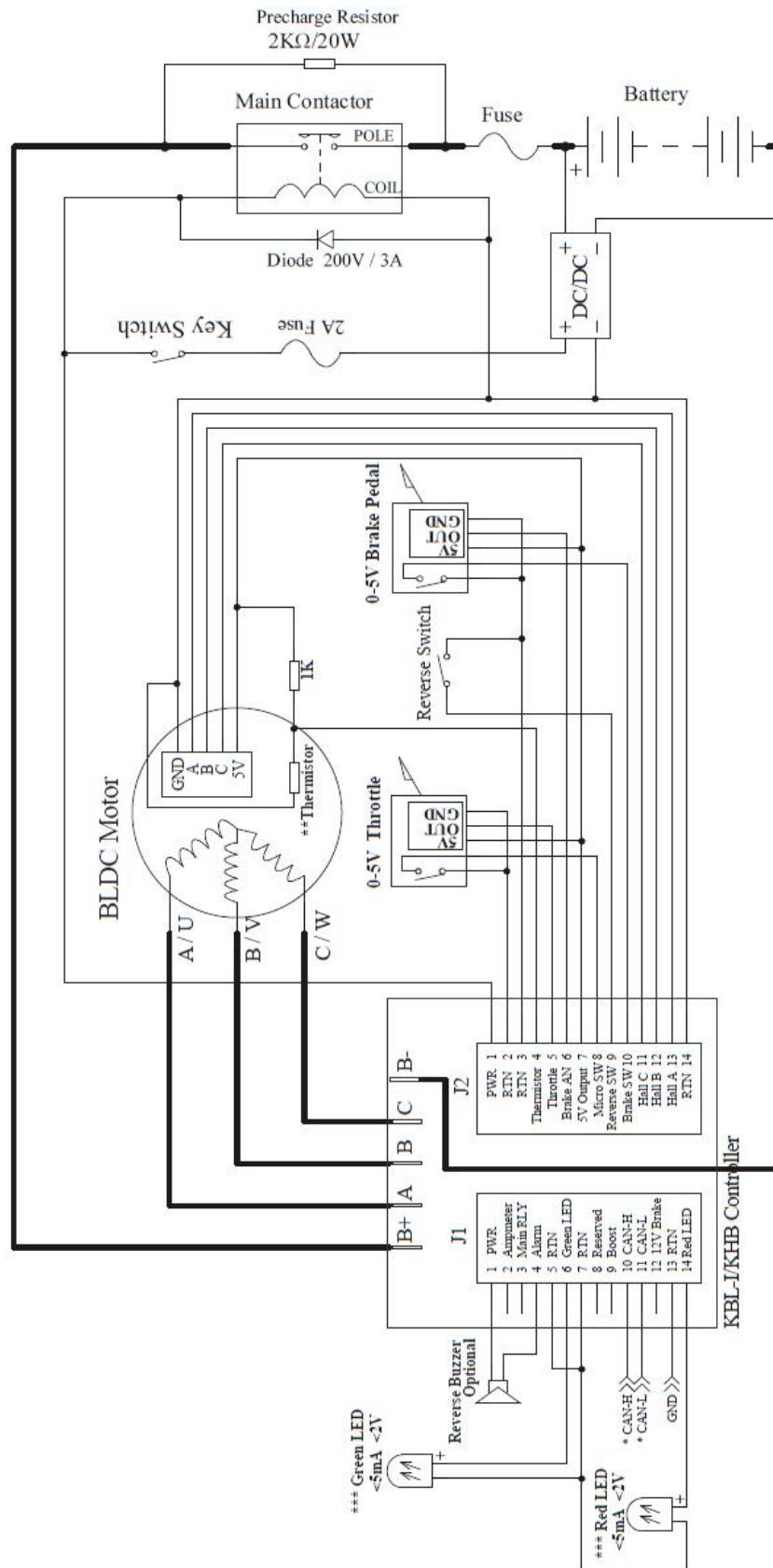
### J2 Pin Definition

- 1- PWR: Controller power supply (input)
- 2- RTN: Signal return, or power supply return
- 3- RTN: Signal return
- 4- Motor temperature input.
- 5- Throttle analog input, 0-5V
- 6- Brake analog input, 0-5V
- 7- 5V: 5V supply output. <40mA
- 8- Micro\_SW: Throttle switch input
- 9- Reversing switch input
- 10- Brake switch input
- 11- Hall phase C
- 12- Hall phase B
- 13- Hall phase A
- 14- RTN: Signal return

#### Notes:

1. All RTN and GND pins are internally connected, but isolated from B-.
2. Two PWR pins, J1-1 and J2-1, are internally connected. It's recommended to use J1-1 to supply peripherals like alarm and contactor. Twist peripheral wires with PWR is the preferred for EMC.
3. Kelly Ammeter positive connect to 5V power supply of controller, negative to J1-2.
4. Switch to ground is active. Open switch is inactive.

### 3.2.2 Wiring of KHB Motor Controller



NOTE: 0-5K potentiometer can be used as throttle signal. Wire 5V and RTN to two end terminals, and wiper will output 0-5V signal.

Please securely wire B- before any other wiring. Never put contactor or break on B-.

\* CAN bus is depolarized by default.

\*\* Thermistor is optional item, default to KTY84-130.

\*\*\* When you connect an external LED, the LED front panel brightness will be reduced.

**Figure 9:** Standard Wiring for KHB Controllers  
(12V or 24V battery supply is required)

### 3.3 Communication Port

A RS232 port is provided to communicate with host computer for calibration and configuration.

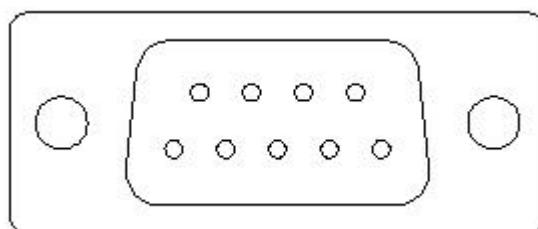


Figure 10: standard RS232 Interface

### 3.4 Installation Check List

Before operating the vehicle, complete the following checkout procedures. Use LED code as a reference as listed in Table 1.

**Caution:**

- Put the vehicle up on blocks to get the drive wheels off the ground before beginning these tests.
- Do not allow anyone to stand directly in front of or behind the vehicle during the checkout.
- Make sure the PWR switch and the brake is off
- Use well-insulated tools.

- Make sure the wire is connected correctly
- Turn on the PWR switch, the Red flashes once and the Green is off. After the start-up delay, normally the Red will stay off and the Green will turn on. If there is error, the Red LED will flashes for fault codes.  
**If the S/N less: 11xxxxxx:** Turn on the PWR switch, the Red flashes once and the Green is on. Normally, the Red will stay off. If there is error, the Red LED will flashes for fault codes.
- The fault code will be detected automatically at restart.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. Verify wiring or voltage and the fuse if it does not. The motor should run faster with increasing throttle. If not, refer to the Table 1 LED code, and correct the fault as determined by the fault code.
- Take the vehicle off the blocks and drive it in a clear area. It should have smooth acceleration and good power.

# Chapter 4 Maintenance

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller as this will void your warranty. However, periodic, exterior cleaning of the controller should be carried out.

The controller is a high powered device. When working with any battery powered vehicle, proper safety precautions should be taken that include, but are not limited to, proper training, wearing eye protection, avoidance of loose clothing, hair and jewelry. Always use insulated tools.

## 4.1 Cleaning

Although the controller requires virtually no maintenance after properly installation, the following minor maintenance is recommended in certain applications.

- Remove power by disconnecting the battery, starting with battery positive.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil, resistor or a horn) across the controller's B+ and B- terminals.
- Remove any dirt or corrosion from the bus bar area. The controller should be wiped down with a moist rag. Make sure that the controller is dry before reconnecting the battery.
- Make sure the connections to the bus bars, if fitted, are tight. To avoid physically stressing the bus bars use two, well-insulated wrenches.

## 4.2 Configuration

You can configure the controller with a host computer through either an RS232 or USB port.

- Disconnect motor wiring from controller.
- Do not connect B+, throttle and so on. The controller may display fault code in some conditions, but it doesn't affect programming or configuration.
- Use a straight through RS232 cable or Kelly USB To RS232 Converter to connect to a host computer. Provide 10V-30V (either J2 pin1 or J1 pin1) to PWR. Wire power supply return to any RTN pin, isolated from B-.

Download the free configuration software from:

<http://www.kellycontroller.com/support.php>

**Caution:**

- Make certain that the motor is disconnected before trying to run the Configuration Software!
- Configuration software will be regularly updated and published on the website. Please Update your Configuration Software regularly. You must uninstall the older version before updating.
- When setting "Hall Sensor Type" in GUI, do not use "Auto-Check". This has been deleted from the newer configuration software versions.

## Table 1: LED CODES

### Green LED Codes

LED Code	Explanation	Solution
Green Off	No power or switched off	1. Check if all wires are correct. 2. Check fuse and power supply.
Green On	Normal operation	That's great! You got solution!
Green & Red are both On		1. Software still upgrading. 2. Supply voltage too low or battery too high 3. The controller is damaged. Contact Kelly about a warranty repair.

### Red LED Codes

LED Code	Explanation	Solution
1,2      ☒    ☒☒	Over voltage error	1. Battery voltage is too high for the controller. Check battery volts and configuration. 2. Regeneration over-voltage. Controller will have cut back or stopped regen. 3. This only accurate to $\pm$ 2% upon Overvoltage setting.
1,3      ☒    ☒☒☒	Low voltage error	1. The controller will clear after 5 seconds if battery volts returns to normal. 2. Check battery volts & recharge if required.
1,4      ☒    ☒☒☒☒	Over temperature warning	1. Controller case temperature is above 90°C. Current will be limited. Reduce controller loading or switch Off until controller cools down. 2. Clean or improve heatsink or fan.
2,1      ☒☒    ☒	Motor did not start	Motor did not reach 25 electrical RPM within 2 seconds of start-up. Hall sensor or phase wiring problem.
2,2      ☒☒    ☒☒	Internal voltage fault	1. Measure that B+ & PWR are correct when measured to B- or RTN. 2. There may be excessive load on the +5V supply caused by too low a value of Regen or throttle potentiometers or incorrect wiring. 3. Controller is damaged. Contact Kelly about a warranty repair.
2,3      ☒☒    ☒☒☒	Over temperature	The controller temperature has exceeded 100°C. The controller will be stopped but will restart when temperature falls below 80°C.
2,4      ☒☒    ☒☒☒☒	Throttle error at power-up	1. Throttle signal is higher than the preset 'dead zone' at Power On. Fault clears when throttle is

			released. 2. Set throttle model as "Hall Active" throttle in GUI if you use that throttle model.
3,1	xxx ☒	Frequent reset	May be caused by over-voltage, bad motor intermittent earthing problem, bad wiring, etc.
3,2	xxx ☒	Internal reset	May be caused by some transient fault condition like a temporary over-current, momentarily high or low battery voltage. This can happen during normal operation.
3,3	xxx ☓	Hall throttle is open or short-circuit	When the throttle is repaired, a restart will clear the fault.
3,4	xxx ☓	Non-zero throttle on direction change	Controller won't allow a direction change unless the throttle or speed is at zero. Fault clears when throttle is released.
4,1	xxxx ☒	Regen or Start-up over-voltage	Motor drive is disabled if an over-voltage is detected at start-up or during regen. The voltage threshold detection level is set during configuration.
4,2	xxxx ☒	Hall sensor error	1. Incorrect or loose wiring or a damaged hall sensor. 2. Also be caused by incorrect hall angle configuration (60 degree or 120 degree).
4,3	xxxx ☓	Motor over-temperature	Motor temperature has exceeded the configured maximum. The controller will shut down until the motor temperature cools down.
The Red LED flashes once at power on as a confidence check and then normally stays Off. "1, 2" means the Red flashes once and after a second pause, flashes twice. The pause time between multiple flash code groups is two seconds.			

## **Contact Us:**

**Kelly Controls**

**Home Page:**

<http://www.KellyController.com>

**E-mail:**

[Support@KellyController.com](mailto:Support@KellyController.com)

**Phone:**

(01) 224 637 5092

Model	Peak Current 1 Minute	Continuous Current	Voltage
KHB72601	600A	300A	24V-72V
KHB72701	700A	350A	24V-72V
KHB72101	1000A	500A	24V-72V
KHB12151	150A	75A	24V-120V
KHB12201	200A	100A	24V-120V
KHB12251	250A	125A	24V-120V
KHB12301	300A	150A	24V-120V
KHB12401	400A	200A	24V-120V
KHB12601	600A	300A	24V-120V
KHB12801	800A	400A	24V-120V
KHB12101	1000A	500A	24V-120V
KHB14201	200A	100A	24V-144V
KHB14301	300A	150A	24V-144V
KHB14401	400A	200A	24V-144V



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**Photo**



**Description**

**New arrive electric bicycle forged aluminum hydraulic disc brake system assembly**

**Product Description**

Electric bicycle hydraulic disc brake system



**Specification:**

1. Model: 152PYD+BS152
2. Including 2pcs 203mm plate, PCD6\*44mm, 2mm thickness
3. The length of oil of both front and rear can be customized according to your e-bike(900mm for front, 1600mm for rear as default)
4. Callipers: double-piston 2\*21mm
5. Installing Distance of front tire: 74mm(as default) or 51mm
6. Installing distance of rear tire: 51mm
7. Wiring: two core wiring

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- This item:** 2PCS 22mm NC Red Mushroom Emergency Stop Push Button Switch 600V 10A ZB2-BE102C \$9.89
- Nxtop Momentary On Off Reset Push Button Switch 1 NO N/O Green Mark Instant Button Switch, 600V, 10... \$9.69
- uxcell a12082000ux0371 1 NC N/C Red Sign Momentary Push Button Switch, 600V, 10 Amp, ZB2-EA42, 5 x... \$7.99

## Inspired by your recent shopping trends

Page 1 of 13



8 Gauge 8 AWG 15 Feet  
Black + 15 Feet Red  
Welding Battery Pure  
Copper Flexible Cable...

322

\$29.29



Hilitchi 100Pcs 12-10AWG  
Insulated Terminals Ring  
Electrical Wire Crimp  
Connectors (Yellow...)

47

\$7.86



Hilitchi 100Pcs 12-10AWG  
Insulated Terminals Ring  
Electrical Wire Crimp  
Connectors (Yellow...)

26

\$7.85



E-VOLT 80 PC Yellow Heat  
Shrink Ring Crimp  
Connectors: Sizes: #10,  
1/4", 5/16", 3/8". Gauge...

55

\$19.99



Hilitchi 100Pcs 16-14AWG  
Insulated Terminals Ring  
Electrical Wire Crimp  
Connectors (Blue, M5)

6

\$6.99



Hil  
Ins  
Ele  
Co

\$7

## Have a question?

Find answers in product info, Q&As, reviews

Type your question or keyword

## Product description

Features: push to stop and lock, twist to reset, 2 screw terminals, 1 NC contact type, mushroom emergency stop push button switch. The switches are structured compactly and operated quickly and gently. Can be widely used to control the electromagnetic starter, contactor, relay and other automatic control electric circuits.

## Product information

### Technical Details

Item Weight	8 ounces
Package Dimensions	4 x 2.9 x 2.8 inches
Material	Plastic, Metal
Measurement System	Imperial, Metric
Switch Style	Push Button Switch
Batteries Included?	No
Batteries Required?	No

### Additional Information

ASIN	B07FJPNKGP
Customer Reviews	<a href="#">2 ratings</a> 4.0 out of 5 stars
Best Sellers Rank	#77,288 in Tools & Home Improvement ( <a href="#">See Top 100 in Tools &amp; Home Improvement</a> ) #74 in <a href="#">Pushbutton Switches</a>
Shipping Weight	8 ounces ( <a href="#">View shipping rates and policies</a> )
Date First Available	July 9, 2018

### Feedback

**FWP 700V 5-1200A**

Electrical Characteristics				Ordering Information			Dimensions	Curves	
Type	Rated Current RMS-Amps	I <sup>2</sup> t (A <sup>2</sup> Sec)		Watts Loss	Part Number	Carton Qty.	Carton Weight (lbs)	Figure Number	BIF #
		Pre-arc	Clearing at 700V						
FWP 700V	5	1.6	10	1.5	FWP-5B	10	2.25	Fig. 1	35785316
	10	3.6	20	4	FWP-10B				
	15	10	75	5.5	FWP-15B				
	20	26	180	6	FWP-20B				
	25	44	340	7	FWP-25B				
	30	58	450	9	FWP-30B				
	35	34	160	12	FWP-35B	5	1.21	Fig. 1	35785308
	40	76	320	12	FWP-40B				
	50	135	600	12	FWP-50B				
	60	210	950	15.5	FWP-60B				
	70	305	2000	18	FWP-70B				
	80	360	2400	21	FWP-80B	1	0.24	Fig. 1	361
	90	415	2700	25	FWP-90B				
	100	540	3500	27	FWP-100B				
	125	1800	7300	28	FWP-125A				
	150	2900	11700	32	FWP-150A	6.60	0.65	Fig. 2	35785308
	175	4200	16700	35	FWP-175A				
	200	5500	22000	43	FWP-200A				
	225	7700	31300	45	FWP-225A				
	250	10500	42500	48	FWP-250A	1.17	2.39	Fig. 3	361
	300	17600	71200	58	FWP-300A				
	350	23700	95600	65	FWP-350A				
	400	31000	125000	78	FWP-400A				
	450	36400	137000	94	FWP-450A	1.21	6.60	Fig. 2	35785308
	500	45200	170000	107	FWP-500A				
	600	66700	250000	122	FWP-600A				
	700	54000	300000	125	FWP-700A				
	800	78000	450000	140	FWP-800A	Fig. 3	6.60	Fig. 3	361
	900	91500	530000	150	FWP-900A				
	1000	120000	600000	170	FWP-1000A				
	1200	195000	1100000	190	FWP-1200A				

■ Interrupting rating 200kA RMS Symmetrical.

■ Watts loss provided at rated current.

■ (700 Vdc/Interrupting rating 50kA) U.L. Recognition &amp; CSA Component Acceptance on 5 through 100 &amp; 700 through 800 amperes.

■ (700 Vdc/Interrupting rating 10kA) U.L. Recognition &amp; CSA Component Acceptance on 125 through 600 amperes.

1 kg = 2.2 lbs 1 lb = 0.45 kg

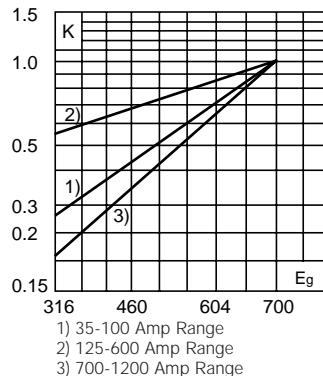
# FWP 700V 5-1200A



## Electrical Characteristics

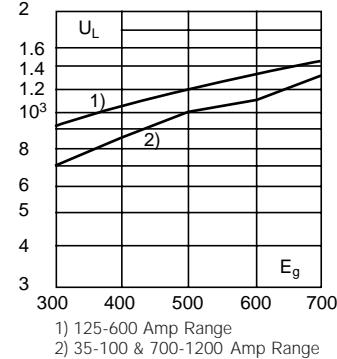
### Total Clearing I<sup>2</sup>t

The total clearing I<sup>2</sup>t at rated voltage and at power factor of 15% are given in the electrical characteristics. For other voltages, the clearing I<sup>2</sup>t is found by multiplying by correction factor, K, given as a function of applied working voltage, E<sub>g</sub>, (RMS).



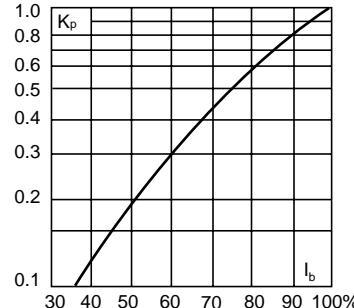
### Arc Voltage

This curve gives the peak arc voltage, U<sub>L</sub>, which may appear across the fuse during its operation as a function of the applied working voltage, E<sub>g</sub>, (RMS) at a power factor of 15%.



### Power Losses

Watts loss at rated current is given in the electrical characteristics. The curve allows the calculation of the power losses at load currents lower than the rated current. The correction factor, K<sub>p</sub>, is given as a function of the RMS load current, I<sub>b</sub>, in % of the rated current.



## Dimensions

Fig. 1: 5-800 Amp Range

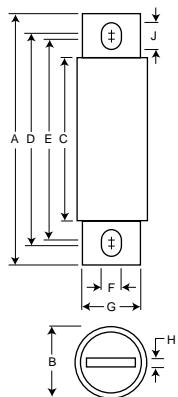


Fig. 2: 900-1000 Amp Range

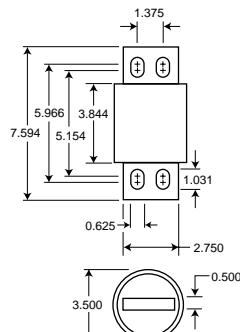
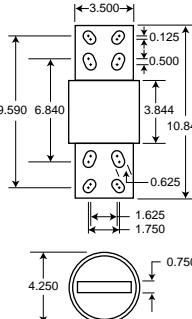


Fig. 3: 1200 Amp Range



Order #	Fig.	A	B	C	D	E	F	G	H	J
FWP-5B-30B	1	2.870	0.563	1.855	2.477	2.477	0.250	0.405	0.063	0.250
FWP-35B-60B	1	4.375	0.813	2.750	3.708	3.312	0.344	0.725	0.125	0.542
FWP-70B-100B	1	4.406	0.947	2.594	3.625	3.563	0.344	0.750	0.125	0.375
FWP-125A-200A	1	5.090	1.500	2.840	4.190	3.500	0.410	1.000	0.250	0.750
FWP-225A-400A	1	5.090	2.000	2.840	4.280	3.530	0.410	1.500	0.250	0.780
FWP-450A-600A	1	7.090	2.500	2.840	5.720	4.190	0.530	2.000	0.380	1.300
FWP-700A-800A	1	6.630	2.000	2.844	5.562	5.062	0.625	1.500	0.250	0.875
FWP-900A-1000A	2					See Drawing				
FWP-1200A	3					See Drawing				

Dimension in inches.

1mm = 0.0394" 1" = 25.4mm

The only controlled copy of this BIF document is the electronic read-only version located on the Bussmann Network Drive. All other copies of this document are by definition uncontrolled. This bulletin is intended to clearly present comprehensive product data and provide technical information that will help the end user with design applications. Bussmann reserves the right, without notice, to change design or construction of any products and to discontinue or limit distribution of any products. Bussmann also reserves the right to change or update, without notice, any technical information contained in this bulletin. Once a product has been selected, it should be tested by the user in all possible applications.

# GIGAVAC®

200+ Amp  
100-800 Vdc Contactor  
**GV220**  
**Series**



## FEATURES

- PCB mountable option allows lowest cost OEM solution by eliminating need for cables, wires and connector.
- Hermetically Sealed – Designed to meet: UL1604 for Class I & II, Div 2 and Class III for use in hazardous locations, IP67 for temporary water immersion for 30 min, SAE J1171 - external ignition protection, and ISO8846 for protection against ignition around flammable gasses.
- Meets CE Conformance standards.
- Built-in coil suppression for all DC coils – Saves you engineering time and parts cost to add external coil suppression.
- Stainless steel hardware and brass mounting inserts, for years of corrosion free service.
- Not position sensitive – can be mounted in any position for ease of installation.

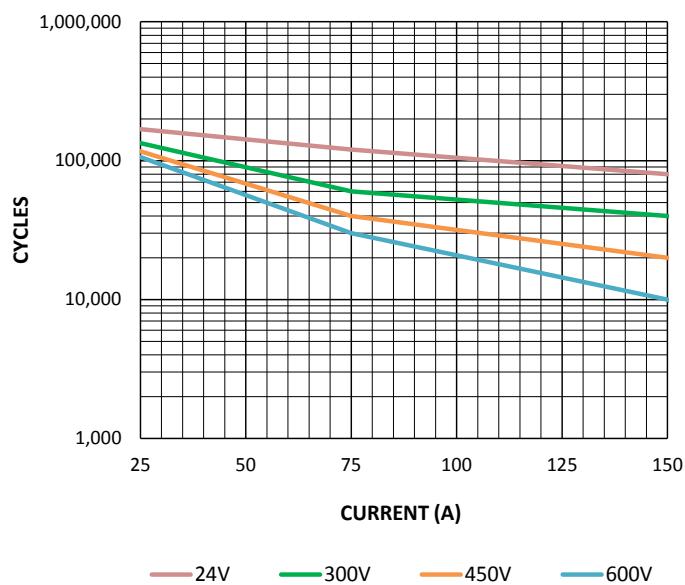
**ADVANCED SWITCHING SOLUTIONS**

## PRODUCT SPECIFICATIONS

Specifications	Units	Data
<b>Rated Voltage<sup>8</sup></b>	V	800
<b>Contact Arrangement</b>		
Main	Form X	SPST-NO
Auxiliary <sup>1</sup>	Form A or B	SPST-NO or SPST-NC
<b>Mechanical Life</b>	Cycles	1,000,000
<b>Contact Resistance<sup>2</sup></b>		
Max	mohms	0.4
Typical	mohms	0.3
<b>Insulation Resistance<sup>4</sup></b>	Mohms	100
<b>Dielectric At Sea Level (Leakage &lt; 1mA)</b>	VRMS	2,500
<b>Shock, 1/2 Sine, 11ms</b>		
Actuated (closed)	G	35
Non Actuated (open)	G	25
<b>Vibration, Sinusoidal (10-2000 Hz Peak)</b>	G	25
<b>Environmental Seal</b>	Exceeds IP67 & IP69K	
<b>Salt Fog</b>	MIL-STD-810	

## POWER SWITCHING

### DC POWER SWITCHING CYCLES<sup>7</sup>



## COIL RATINGS at 25°C

Coil P/N Designation	B	C	F
<b>Coil Voltage, Nominal (VDC)</b>	12	24	48
<b>Coil Voltage, Max (V)</b>	16	32	64
<b>Pick-Up Voltage, Max (V)<sup>6</sup></b>	8	16	28
<b>Drop-Out Voltage, Max (V)<sup>6</sup></b>	3	7	10
<b>Drop-Out Voltage, Min (V)<sup>6</sup></b>	0.5	0.5	1.8
<b>Coil Current (A)<sup>6</sup></b>	0.68	0.28	0.16
<b>Coil Power (W)<sup>6</sup></b>	8	6.8	7.6
<b>Operate Time, Max (ms)<sup>3</sup></b>	20	20	30
<b>Release Time, Max (ms)</b>	12	12	12
<b>Internal Coil Suppression</b>	TVS		
<b>Coil Back EMF (V)</b>	55	55	80

Consult GIGAVAC for additional coil options



## UPRIGHT MOUNT DIMENSIONS

### Auxiliary Leads

B=SPST-NO

Blue Lead = T1

White Lead = T2

C=SPST-NC

Orange Lead = T1

White Lead = T2

(Refer to Part Number System on page 7)

### Coil Leads

Red Lead = X1(+)

Black Lead = X2(-)

(Refer to Part Number System on page 7)

### Upright Mounting

M5 or No. 10 Screws

Torque 1.7-4 Nm [15-35 in-lb]

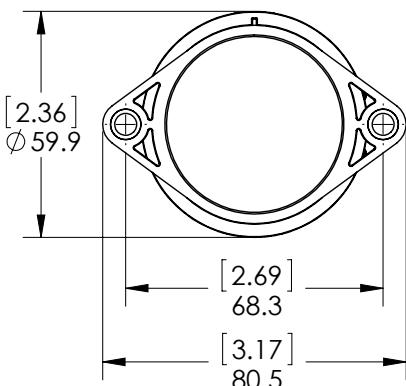
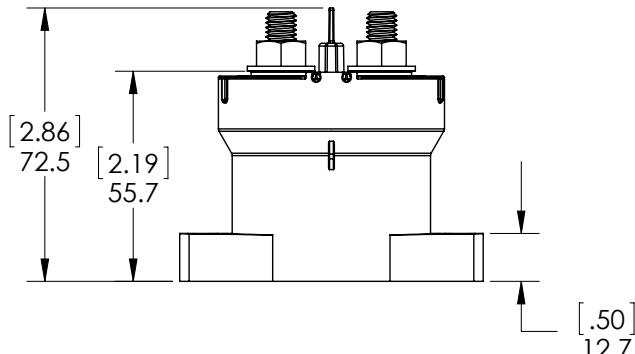
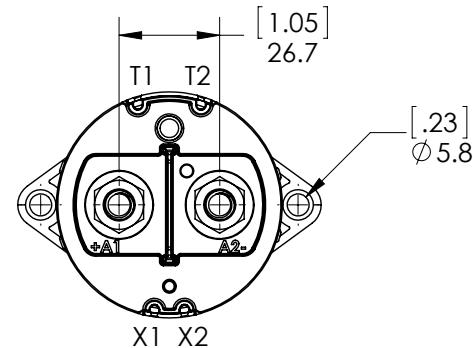
### Upright Mount Power Connection

Silver Plated Copper M8x1.25 stud

Stainless M8x1.25 flanged nut

Torque 10 Nm [90 in-lb] max

### Upright Mount



## SIDE MOUNT DIMENSIONS



### Auxiliary Leads

B=SPST-NO  
Blue Lead = T1  
White Lead = T2

C=SPST-NC  
Orange Lead = T1  
White Lead = T2

(Refer to Part Number System on page 7)

### Coil Leads

Red Lead = X1(+)

Black Lead = X2(-)

(Refer to Part Number System on page 7)

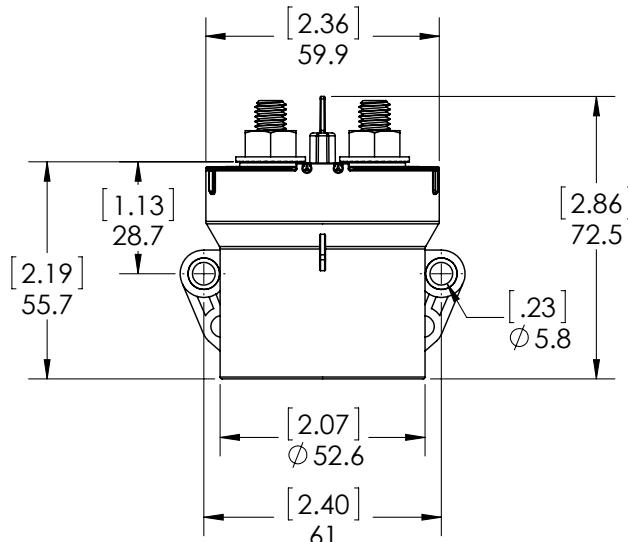
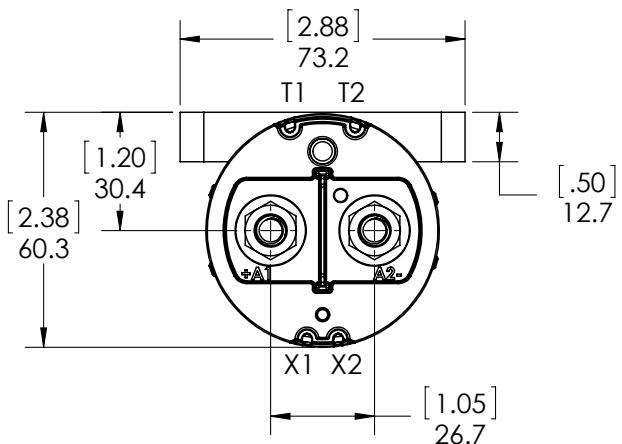
### Side Mounting

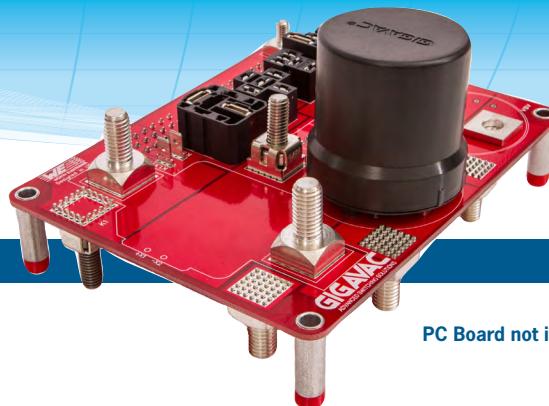
M5 or No. 10 Screws  
Torque 1.7-4 Nm [15-35 in-lb]

### Side Mount Power Connection

Silver Plated Copper M8x1.25 stud  
Stainless M8x1.25 flanged nut  
Torque 10 Nm [90 in-lb] max

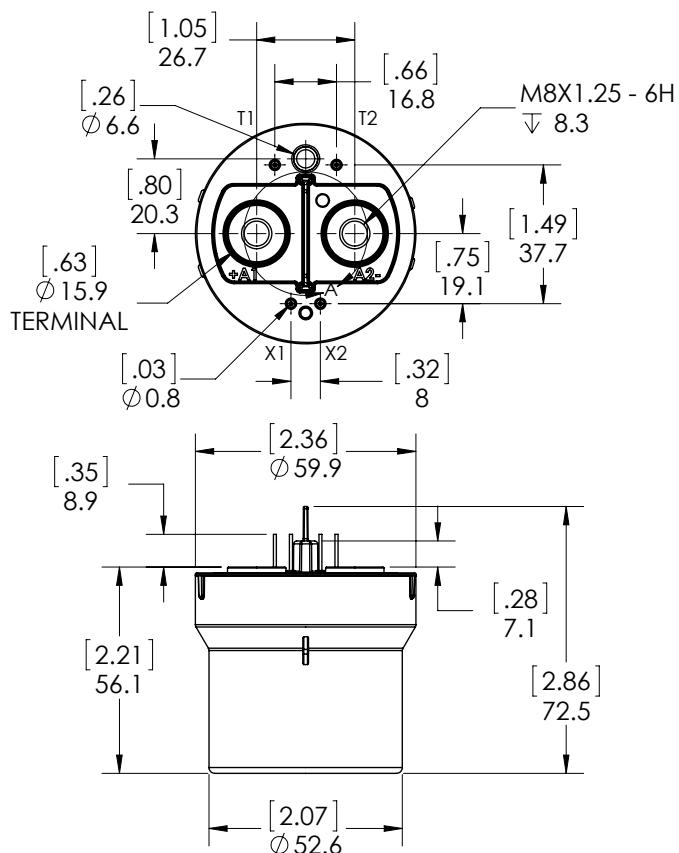
### Side Mount



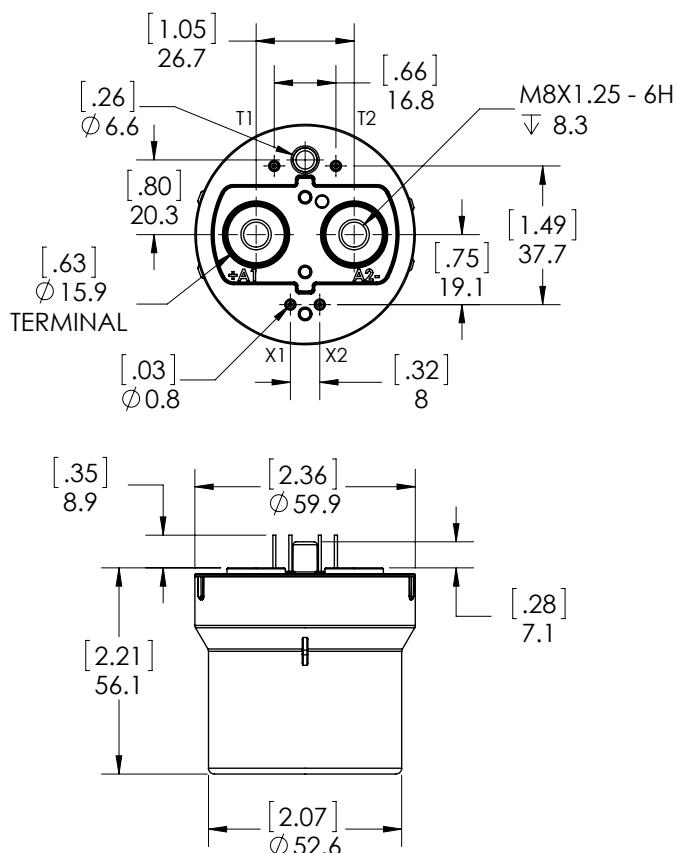


## PCB MOUNT DIMENSIONS

PCB Mount with Barrier



PCB Mount

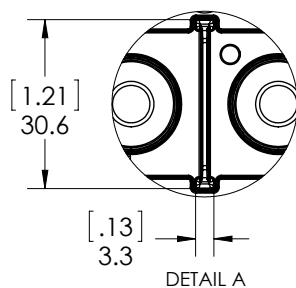


PCB Mounting / Power Connection

M8x1.25 bolt  
Torque 10 Nm [90 in-lb] max

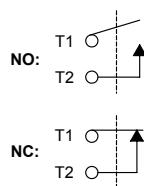
PCB Coil and Auxiliary Pin Material

510 Phosphor Bronze, Tin Plated

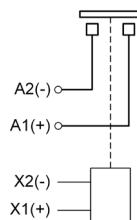


## SPECIFICATIONS AND CURRENT CARRY RATINGS

### Auxiliary contacts (optional)



### Power Contacts



### Temperature and Weight

Operating ambient Temp Range = -55 to +85°C<sup>5</sup>

Storage ambient Temp Range = -70 to +150°C

Weight, typical:

Upright Mount = 0.44 kg (0.97 lb)

Side Mount = 0.45 kg (0.99 lb)

PCB Mount = 0.38 kg (0.84 lb)

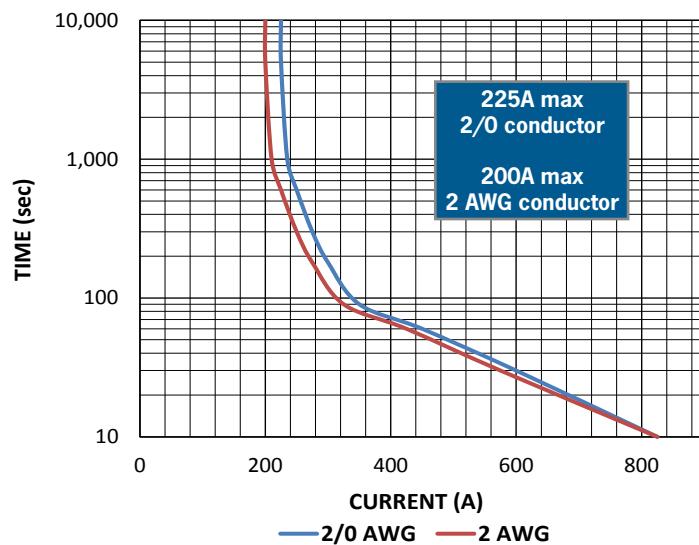
### Packaging

24 units per shipping box

21 in x 18 in x 4 in shipping box

### CURRENT CARRY vs TIME

with 85°C terminal temperature rise



**PART NUMBER SYSTEM**

GV22	1	B	A	B
<b>Mounting</b>	<b>1</b> = Upright			
	<b>2</b> = Side			
	<b>4</b> = PCB, M8			
	<b>5</b> = PCB, M8, with barrier			
<b>Coil Voltage</b>		<b>B</b> = 12 Vdc, Internal Coil Suppression		
		<b>C</b> = 24 Vdc, Internal Coil Suppression		
		<b>F</b> = 48 Vdc, Internal Coil Suppression		
<b>Coil Termination</b>		<b>A</b> = Flying leads 38 cm (15 in)		
		<b>P</b> = Pins (PCB)		
<b>Auxiliary Contacts</b>			<b>X</b> = None	
			<b>B</b> = SPST-NO Normally Open	
			<b>C</b> = SPST-NC Normally Closed	

**Notes & Definitions:**

- 1** Auxiliary contact rating is 2A, 24Vdc Resistive load, 100,000 cycles. Minimum current is 0.1mA, 5V. The auxiliary contact is mechanically linked to the main power contacts.
- 2** Contact resistance measured at currents higher than 100A.
- 3** Operation time is measured at 25°C and includes maximum 7ms bounce.
- 4** Insulation resistance is 50 Mohms after life.
- 5** Contactor can operate up to 125°C in special cases - contact GIGAVAC for details.
- 6** Contactor is operated by a coil that changes resistance with temperature. Since Pick-up Current, Coil Current and Coil Power are specified at Nominal Voltage, they will be lower than indicated at temperatures above 25°C and higher than indicated at temperatures below 25°C. Similarly, Pick-up and Drop-out Voltages will be higher than indicated at temperatures above 25°C and lower than indicated at temperatures below 25°C.
- 7** Limit make current to 500A to avoid contact welding. For AC power switching cycles, contact factory.
- 8** Rated voltage refers to max voltage for which make/break load cycles are provided. Contactor can be used in higher voltage systems. Contact GIGAVAC for more info.

**APPLICATION NOTES**

- Contactors feature internal transient voltage suppressor for coil suppression. No external diodes should be added across the coil.
- Power switching lifecycles are based on current flow from A1(+) to A2(-). For best breaking performance, the contactor should be installed so that current flows from A1(+) to A2(-). There are cases where the contactor will interrupt power in the opposite direction but please contact GIGAVAC to confirm suitability. Direction of current flow is not relevant during make or when flowing on closed contacts. For bi-directional contactors, please contact GIGAVAC.
- Applications with capacitors will require a pre-charge circuit.
- Electrical life rating is based on resistive load with 27µH maximum inductance in circuit. Because your application may be different, we suggest you test the contactor in your circuit to verify life is as required.
- End of life is defined as when the dielectric, insulation resistance or contact resistance exceeds the specifications listed.

# LSCR SERIES HIGH-SPEED FUSE BLOCKS

700 V/1000 V



## Description

Littelfuse LSCR Series is a comprehensive line of modular fuse blocks, designed to accommodate a wide range of High-Speed and UL Power Fuses. These LSCR Series blocks have modular stud type design that enables easy mounting in panel boards.

LSCR Series blocks are CE Certified and RoHS Compliant.

## Features/Benefits

- Modular design reduces inventory requirements
- Sold in pairs for convenience
- Supplied with nut and belleville washer
- 200kA Short-circuit withstand rating
- Constructed of molded phenolic (with plated steel studs) provide greater heat dissipation

## Electrical & Mechanical Specifications

CATALOG/ ORDERING NUMBER	AMPERE RATING	VOLTAGE RATING	TERMINAL (STUD) MATERIAL	INSULATOR		TERMINAL (STUD) SIZE	STUD TORQUE		MOUNTING FASTNER SIZE	FASTENER TORQUE		AGENCY APPROVALS		
				MATERIAL	MAX. BASE TEMPERATURE		(in.lbs)	(N-m)		(in.lbs)	(N-m)	UR	CURUS	CSA
LSCR001	400A	700Vac/dc	Plated Steel	Molded Phenolic	150°C (302°F)	1/4-20 UNC	61	6.9	#10	20-25	2.3-2.8	•		•
LSCR002	800A	700Vac/dc	Plated Steel	Molded Phenolic	150°C (302°F)	3/8-16 UNC	192	21.7	#10	20-25	2.3-2.8	•		•
LSCR101	400A	1000Vac/dc	Steel, Zinc Plated	Thermoplastic	125°C (257°F)	1/4-20 UNC	75	8.5	#10	25-30	2.8-3.4	•		
LSCR102	800A	1000Vac/dc	Steel, Zinc Plated	Thermoplastic	125°C (257°F)	3/8-16 UNC	230	26	#10	25-30	2.8-3.4		•	
LSCR103	1200A	1000Vac/dc	Steel, Zinc Plated	Thermoplastic	125°C (257°F)	1/2-13 UNC	300	34	1/4"	25-30	2.8-3.4		•	

## Specifications

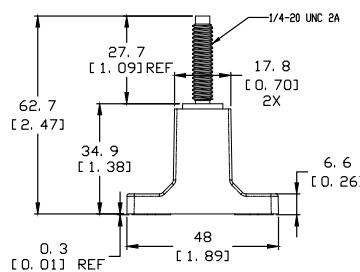
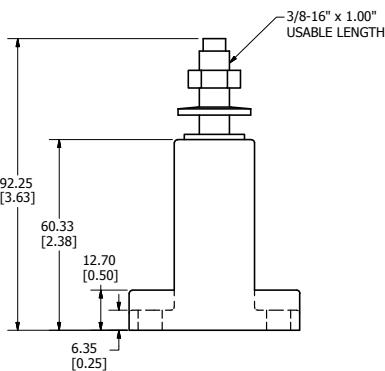
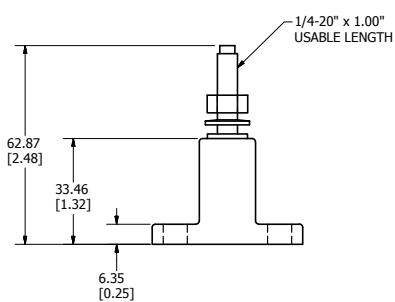
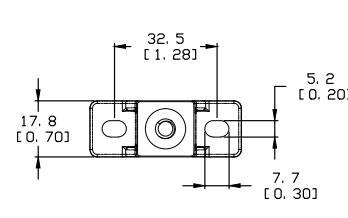
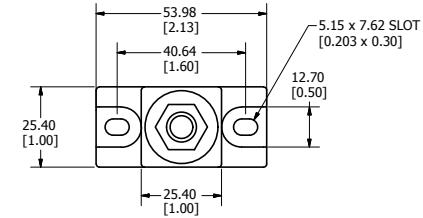
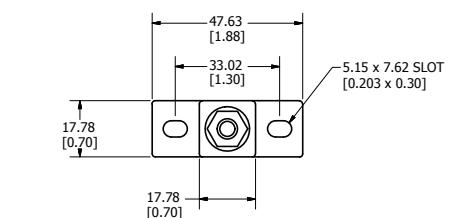
Voltage Rating	700 V / 1000 V
Ampere Ratings	400A, 800A and 1200A
Withstand Rating	200kA
Approvals	UL Recognized (File: E14721) cURus Recognized (E14721) CSA Certified (File: 73160)
Material	<b>Base:</b> Molded Phenolic or Thermoplastic <b>Terminal Construction:</b> Plated steel.
Flammability Rating	UL94 V-0
Environmental	RoHS Compliant
Country of Origin	LSCR0xx - China LSCR1xx - USA

## Web Resources

For more information, visit: [littelfuse.com/lscr](http://littelfuse.com/lscr)

# LSCR SERIES HIGH-SPEED FUSE BLOCKS

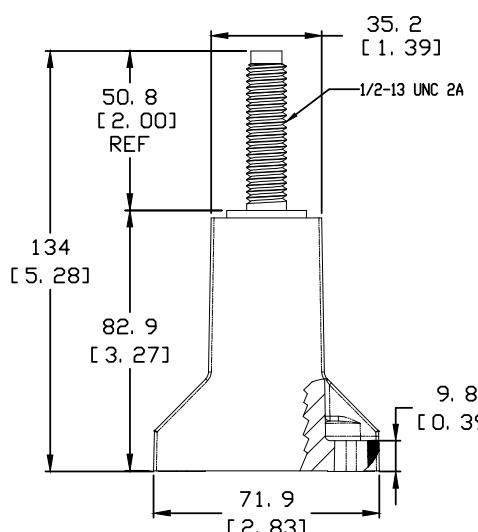
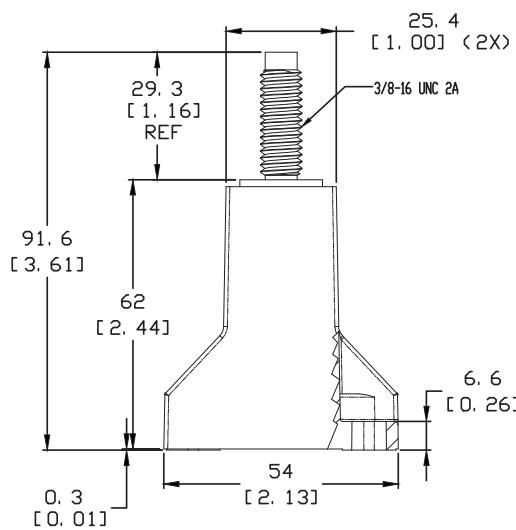
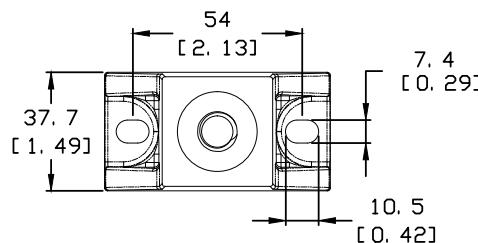
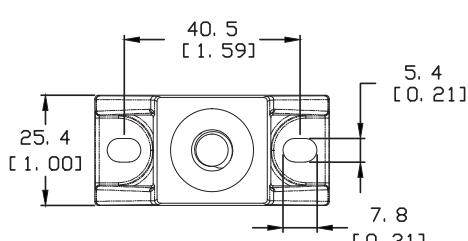
## Dimensions mm (inches)



LSCR001

LSCR002

LSCR101



LSCR102

LSCR103

# LSCR SERIES HIGH-SPEED FUSE BLOCKS

## High-Speed Fuse Block Selection Guide

FUSE SERIES	CATALOG NUMBER	LSCR001	LSCR002	LSCR101	LSCR102	LSCR103
	TERMINAL SIZE	1/4 - 20 UNC	3/8 - 16 UNC	1/4 - 20 UNC	3/8 - 16 UNC	1/2 - 13 UNC
	VOLTAGE RATING	700Vac/dc	700Vac/dc	1000Vac/dc	1000Vac/dc	1000Vac/dc
AMPERE RATING		400A	800A	400A	800A	1200A
L15S	70-400	X		X		
	500-800		X		X	
L17T	70-250	X		X		
	300-800		X		X	
L25S	35-200	X		X		
	225-800		X		X	
L50S	35-200	X		X		
	225-800		X		X	
	700-800					X
L50QS	35-200	X		X		
	225-800		X		X	
	700-800					X
L60S	35-200	X		X		
	225-800		X		X	
	700-800					X
KLC	35-60	X		X		
	70-800		X		X	
	225-800					X
L70S	35-100	X		X		
	125-800		X		X	
	450-800					X
L70QS	35-100	X		X		
	125-800		X		X	
	450-800					X
JLLN	70-200	X		X		
	225-800		X		X	
	700-1200					X
JLLS	70-200	X		X		
	225-800		X		X	
	700-1200					X
JLS	70-100	X		X		
	110-200	X		X		
	225-400		X		X	
	450-600		X		X	
SPFJ	70-100			X		
	125-200			X		
	250-400				X	
	450					X
L75QS	35-100			X		
	125-800				X	
	450-800					X

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## SPYRE

Dual piston actuated mechanical disc brake for road and CX.



**PRODUCT NAME** SPYRE

**MOUNTING TYPE** FLAT

**LIST PRICE** \$64.99  
**IN STOCK**

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## INFORMATION

### PRODUCT DESCRIPTION

The Spyre, a mechanical disc brake that offers superior performance with incredibly easy setup. This is a dual piston actuated mechanical disc brake caliper which provides precise clamping force. This translates into even pad and rotor wear because the rotor does not need to flex to one side during

braking. We added a simple cable barrel adjuster to make fine tuning

easy. All of this in an incredibly thin 40mm, 146g package, that works with any drop bar levers on the market. Rotors and adapters are sold separately.

For tandem bikes, we recommend the Spyre caliper paired with our 2.3 mm thick rotors. This will give optimum stopping performance for you and your partner.

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## SPECIFICATIONS

### SPYRE

- Weight: 154g per caliper
- Dual sided actuation
- Works with ALL cable actuated road levers. Compressionless (linear strand) housing is highly recommended
- Comes with TRP ultra-grippy semi-metallic pads
- Calipers are compatible with Shimano M525/M515 pads
- 160mm rotors recommended on front wheel
- Rotors, adapters, and flat mount mounting bolts sold separately
- All flat mount calipers being mounted to the fork require the FF-5 Front Flat Mount 140/160mm adapter
- For help identifying mounting type see our guide [here](#). (<https://trpcycling.com/wp-content/uploads/2017/10/PM-vs-FM-FR.jpg>)

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**REAR FLAT MOUNT BOLT LENGTH  
GUIDE**  
**(HTTPS://TRPCYCLING.COM/WP-  
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◀ WHEEL 20/16 - OUT OF STOCK

Brake Plate Assembly - fits sprocket hubs ▶

## BRAKE PLATE ASSEMBLY - FITS SMOOTH HUBS

[Back to: Wheels, Brakes, Tires](#)

**PART# 1591**

Fits our SPROCKET mount hub (not the smooth hub) alloy wheels.



\$66.48

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Add to Cart

### Description

One brake plate assembly, shoes included. Powder coated, cable-ready mechanical drum brake assembly.

Two are pictured to show both sides of the unit.

Weight = 1.3 lbs



#### Related Products

[Brake Plate Assembly, fits sprocket hubs](#)      [WHEEL 20/16](#)

[Brake Plate Assembly, fits smooth hubs](#)      [Brake Plate Assembly - fits sprocket hubs](#)

[Brake Shoes, replacement](#)

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