



ZeroUI

# #CHARGING

DIO NAZZETTA

## TASKS

- ▶ Study Battery chargers
- ▶ Understand charging
- ▶ Decide
  - ▶ Chemistry of Battery
  - ▶ Voltage
  - ▶ Type of charging
  - ▶ Battery Management IC
  - ▶ Circuit
- ▶ Prototype

zeroUI

## #charging

low sensing

- get IC for charging
- take apart 9v charger
- understand how to read voltage
- 12v power supply (?)
- Li-polymer & Li-ion

## facts

- Single PCB → connection soldered
- Very close to the motor

uniform solution →

| FlyingFingers.co  
MimuGloves.com

Charging step up?

- Possible to charge more than 5V  
from USB electronics

Voltage Plateau:

9V - Plateau  $\approx$  6V / 7V.

Example 7.4V - can it be charged  
with 5V?

3.7V - multiple why.



↳ Materials define the  
voltage

pulling voltage up

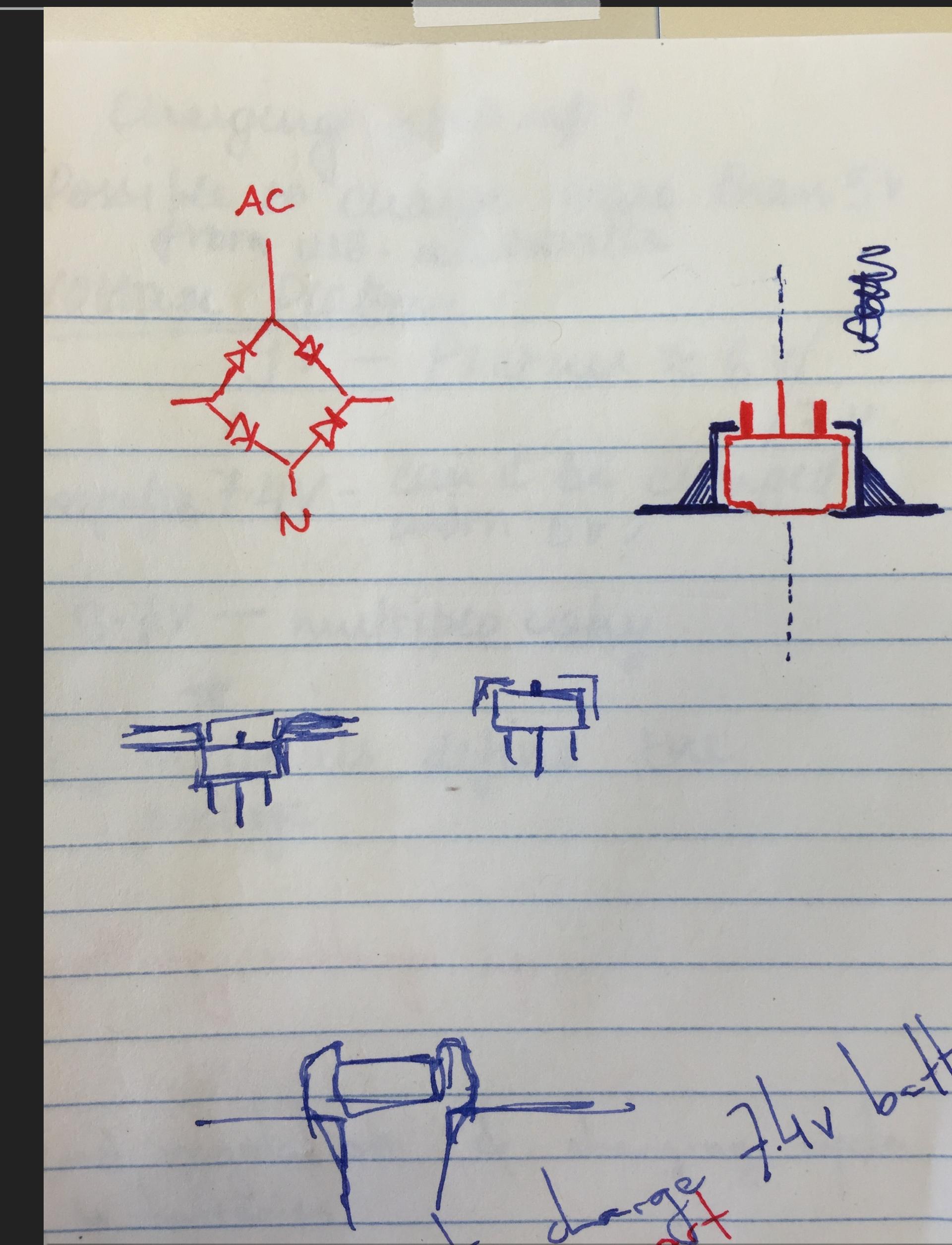
load regulation & charging cycle  
↳ batteries

what's good about each  
connector

- resistance

- Water proof

- cost ~~benefit~~ benefit



# BATTERY CHEMISTRY

ZEROU1 #CHARGING

<u>Li-po</u>	<u>Li-ion</u>
charging current BIC takes care of	careful potential explosion
battery management system	
better capacity (usually)	
can be designed in different shapes	rectangular shapes only
expensive	
no protection needed (current limiting IC)	protection circuit needed
more used in kid. oriented products	
	explosive
less self-aging	

# BATTERY CHEMISTRY

ZEROU1 #CHARGING

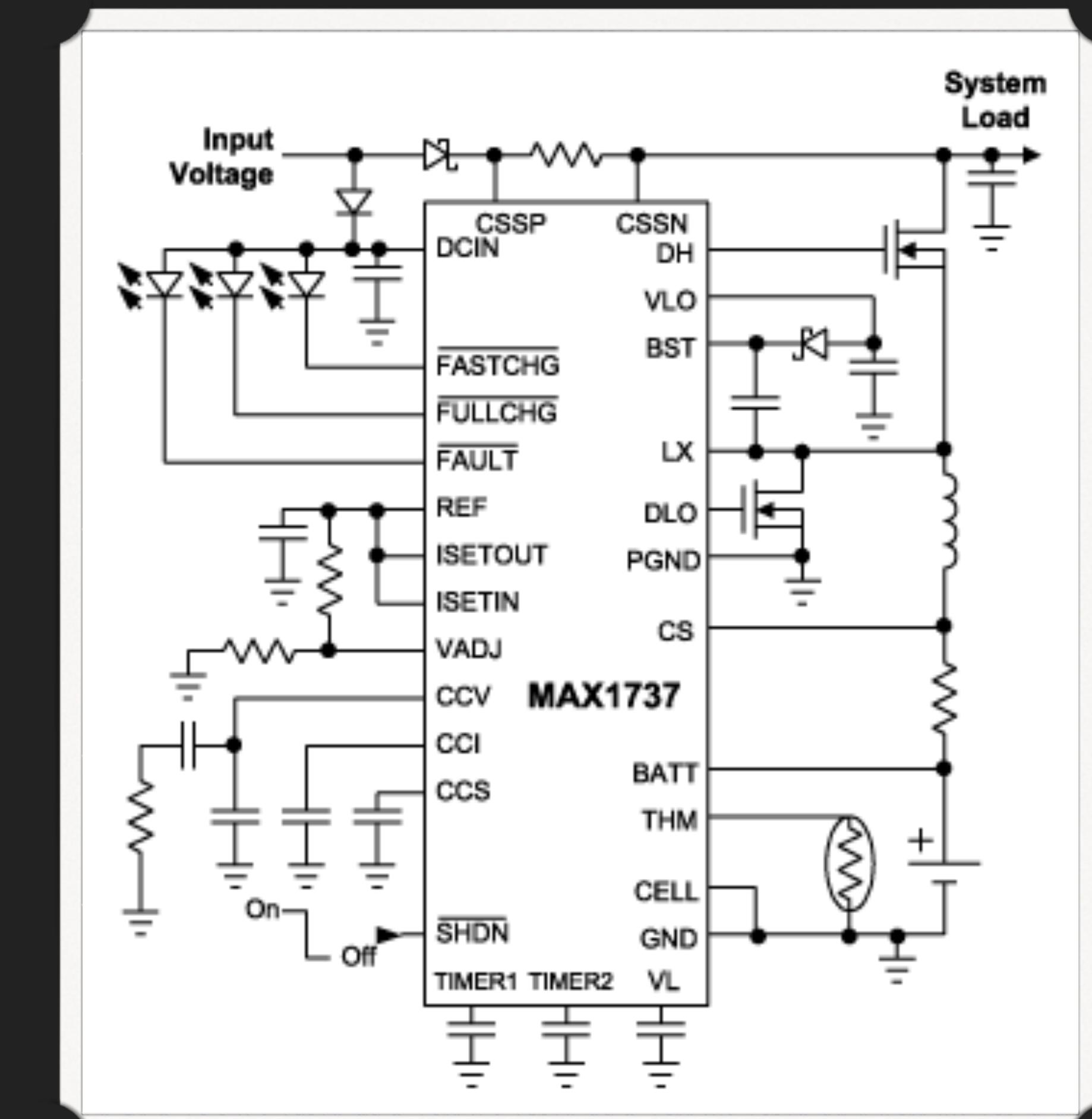
	<b>Li-Po</b>	<b>Li-ion</b>
<b>Chemical Reaction</b>	Varies, depending on electrolyte.	Varies, depending on electrolyte.
<b>Operating Temperature</b>	Improved performance at low and high temperatures.	4° F to 140° F ( -20° C to 60° C)
<b>Recommended for</b>	Cellular telephones, mobile computing devices.	Cellular telephones, mobile computing devices.
<b>Initial Voltage</b>	3.6 & 7.2	3.6 & 7.2
<b>Capacity</b>	Varies depending on the battery; superior to standard lithium-ion.	Varies (generally up to twice the capacity of a Ni-Cd cellular battery)
<b>Discharge Rate</b>	Flat	Flat
<b>Recharge Life</b>	300 – 400 cycles	300 – 400 cycles for 100%
<b>Charging Temperature</b>	32° F to 140° F (0° C to 60° C)	32° F to 140° F (0° C to 60° C)
<b>Storage Life</b>	Loses less than 0.1% per month.	Loses less than 0.1% per month.
<b>Storage Temperature</b>	-4° F to 140° F ( -20° C to 60° C)	-4° F to 140° F ( -20° C to 60° C)
<b>Disposal</b>	Can be recycled by dropping them off at any of our over 7,200 stores nationwide. Should be recycled through your local RadioShack store.	Can be recycled by dropping them off at any of our over 7,200 stores nationwide. Should be recycled through your local RadioShack store.
<b>Other Notes</b>	Typically designed to be recharged in the device rather than in an external charger. Lighter than nickel-based secondary batteries with (Ni-Cd and NiMH). Can be made in a variety of shapes.	Typically designed to be recharged in the device rather than in an external charger. The chemical construction of this battery limits it to a rectangular shape. Lighter than nickel-based secondary batteries with (Ni-Cd and NiMH).

## TYPES OF CHARGING (LITHIUM BATTERIES)

- ▶ Switch-Mode
- ▶ Linear
- ▶ Pulse

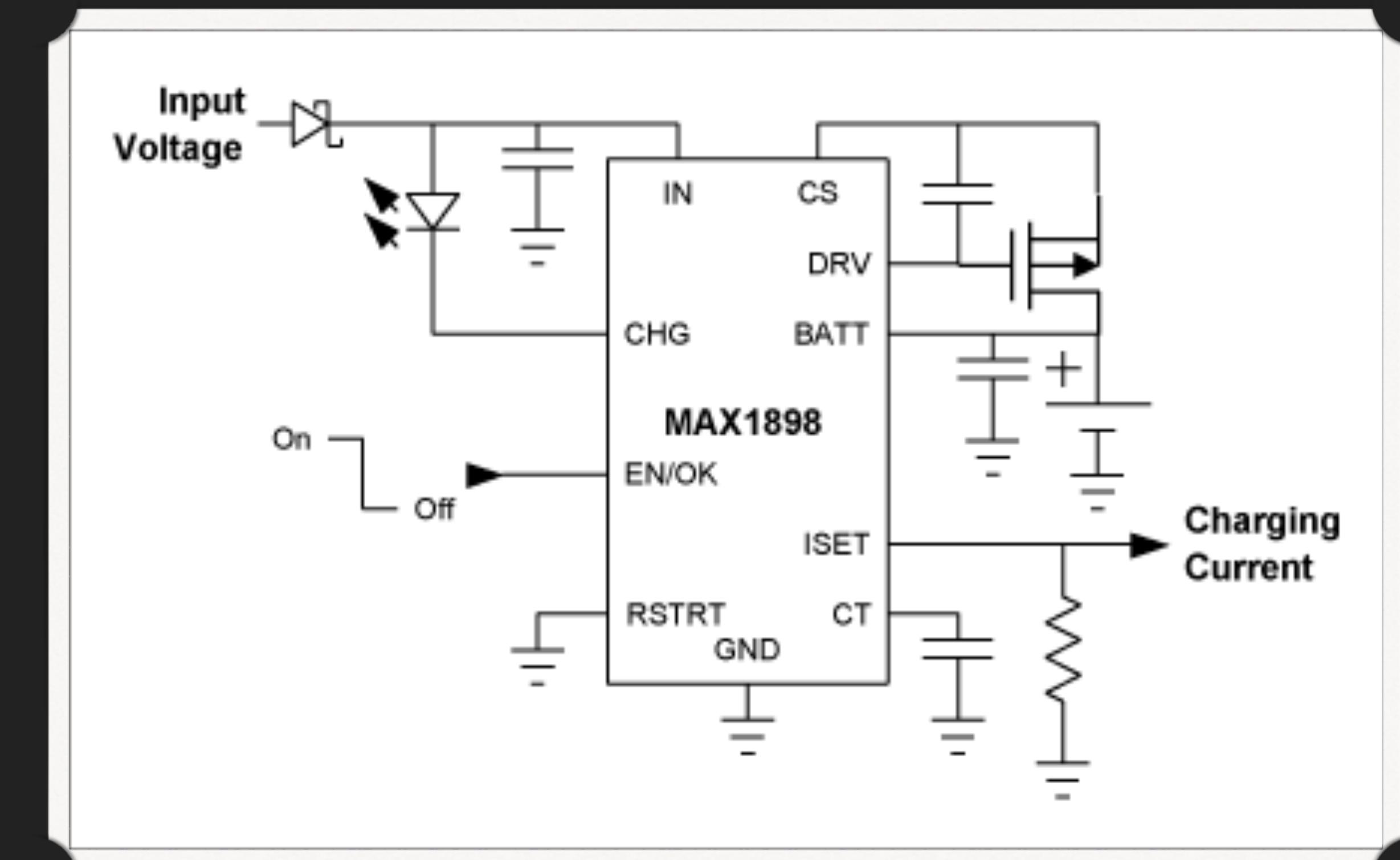
# TYPES OF CHARGING (LITHIUM BATTERIES)

- ▶ Switch-Mode
  - ▶ Low power Dissipation
  - ▶ Scaled
  - ▶ Up to 4A
  - ▶ Complex
  - ▶ Expensive
  - ▶ Noise



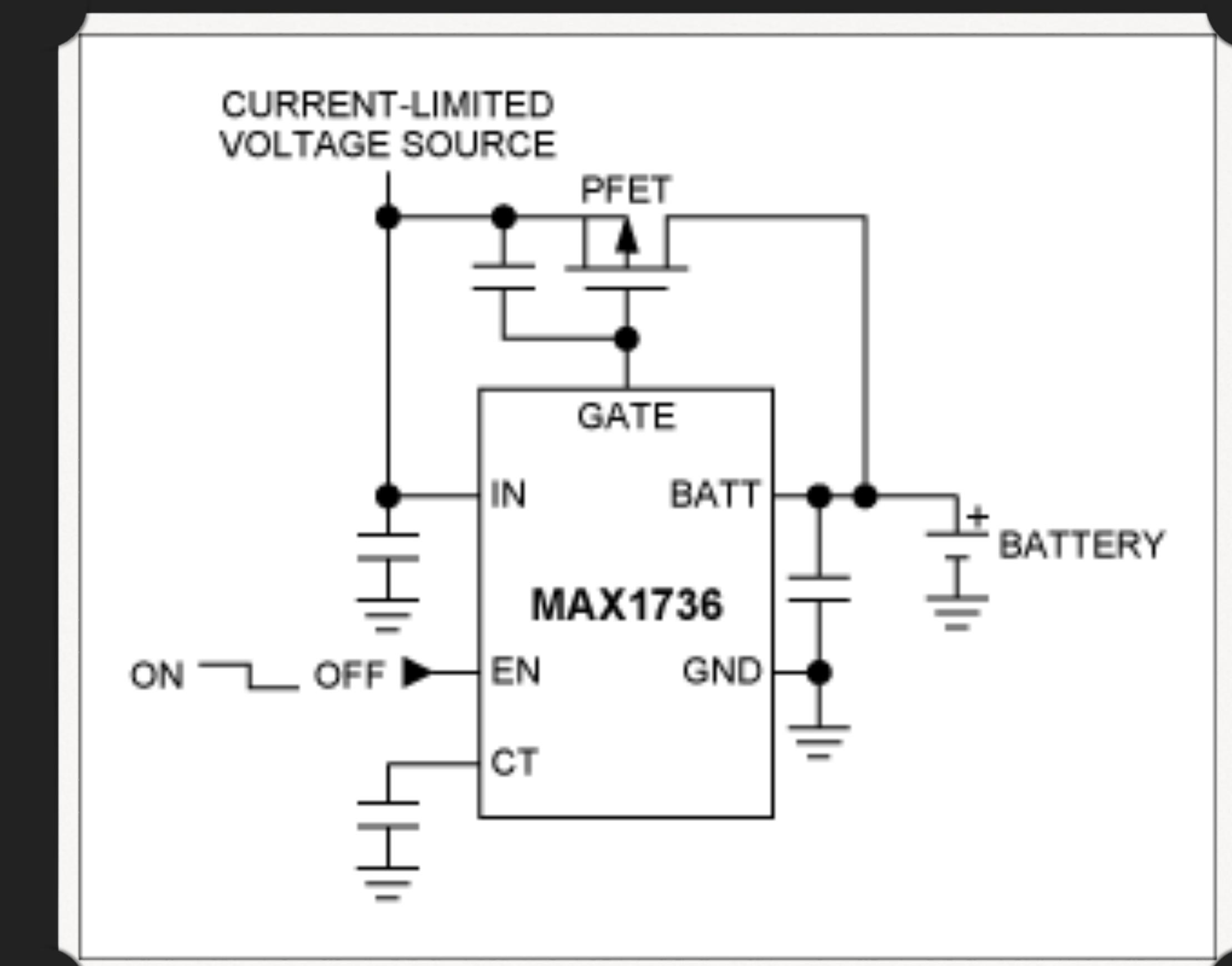
# TYPES OF CHARGING (LITHIUM BATTERIES)

- ▶ Linear
- ▶ Cheap
- ▶ Simple
- ▶ Small
- ▶ High Dissipation



## TYPES OF CHARGING (LITHIUM BATTERIES)

- ▶ Pulse
  - ▶ Low Dissipation
  - ▶ Simple
  - ▶ Limited Current Supply
    - ▶ Very accurate



## Dual-Cell LiPo/Li-ion Power Management IC

Brand	Part #	Output Voltage (V)	Price	Datasheet
<b>MicroChip</b>	MCP73842-8.4	8.4	\$0.94 / 5k	<a href="http://ww1.microchip.com/downloads/en/DeviceDoc/21823D.pdf">http://ww1.microchip.com/downloads/en/DeviceDoc/21823D.pdf</a>
	MCP73862/4	8.4		<a href="http://ww1.microchip.com/downloads/en/DeviceDoc/21893F.pdf">http://ww1.microchip.com/downloads/en/DeviceDoc/21893F.pdf</a>
	MCP73213-A6S/MF	8.4	\$1.28 / 5k	<a href="http://ww1.microchip.com/downloads/en/DeviceDoc/20002190C.pdf">http://ww1.microchip.com/downloads/en/DeviceDoc/20002190C.pdf</a>
<b>Texas Instrument</b>	BQ2057W	8.4	\$0.80 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq2057w.pdf">http://www.ti.com/lit/ds/symlink/bq2057w.pdf</a>
	BQ2057T	8.2	\$0.84 / 1k	<a href="http://www.ti.com/product/BQ2057T">http://www.ti.com/product/BQ2057T</a>
	BQ24004	8.4	\$1.68 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24004.pdf">http://www.ti.com/lit/ds/symlink/bq24004.pdf</a>
	BQ24005	8.4	\$1.68 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24005.pdf">http://www.ti.com/lit/ds/symlink/bq24005.pdf</a>
	BQ24100	8.4	\$2.00 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24100.pdf">http://www.ti.com/lit/ds/symlink/bq24100.pdf</a>
	BQ24103	8.4	\$2.00 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24103.pdf">http://www.ti.com/lit/ds/symlink/bq24103.pdf</a>
	BQ24120	8.4	\$2.00 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24120.pdf">http://www.ti.com/lit/ds/symlink/bq24120.pdf</a>
<b>Maxim</b>	MAX1873	8.4	\$1.98 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX17435	8.4	\$2.41 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX1737	8.4	\$2.86 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX1640	8.4	\$3.05 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX1641	8.4	\$3.05 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX846A	8.4	\$3.25 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>

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	MCP73862/4	8.4		<a href="http://ww1.microchip.com/downloads/en/DeviceDoc/21893F.pdf">http://ww1.microchip.com/downloads/en/DeviceDoc/21893F.pdf</a>
	MCP73213-A6S/MF	8.4	\$1.28 / 5k	<a href="http://ww1.microchip.com/downloads/en/DeviceDoc/20002190C.pdf">http://ww1.microchip.com/downloads/en/DeviceDoc/20002190C.pdf</a>
<b>Texas Instrument</b>	BQ2057W	8.4	\$0.80 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq2057w.pdf">http://www.ti.com/lit/ds/symlink/bq2057w.pdf</a>
	BQ2057T	8.2	\$0.84 / 1k	<a href="http://www.ti.com/product/BQ2057T">http://www.ti.com/product/BQ2057T</a>
	BQ24004	8.4	\$1.68 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24004.pdf">http://www.ti.com/lit/ds/symlink/bq24004.pdf</a>
	BQ24005	8.4	\$1.68 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24005.pdf">http://www.ti.com/lit/ds/symlink/bq24005.pdf</a>
	BQ24100	8.4	\$2.00 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24100.pdf">http://www.ti.com/lit/ds/symlink/bq24100.pdf</a>
	BQ24103	8.4	\$2.00 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24103.pdf">http://www.ti.com/lit/ds/symlink/bq24103.pdf</a>
	BQ24120	8.4	\$2.00 / 1k	<a href="http://www.ti.com/lit/ds/symlink/bq24120.pdf">http://www.ti.com/lit/ds/symlink/bq24120.pdf</a>
<b>Maxim</b>	MAX1873	8.4	\$1.98 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX17435	8.4	\$2.41 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX1737	8.4	\$2.86 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX1640	8.4	\$3.05 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX1641	8.4	\$3.05 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>
	MAX846A	8.4	\$3.25 / 1k	<a href="https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#">https://para.maximintegrated.com/en/results.mvp?fam=batt_chrg&amp;168=Li-Ion%7CLi-Polymer#</a>

# BATTERY MANAGEMENT IC

ZEROU1 #CHARGING

Maxim Integrated Products																		
Product selection table for:		Battery Chargers																
Showing 22 of 73 products		See all Battery Chargers																
NOTE : 3 columns are hidden																		
Part Number	Description	Cell Chemistry	NiMH/ NiCd Cells	Lithium Ion Cells	Protected Vin (max) (V)	Charging Vin (max) (V)	Charger (V)	Charge Rate Set by	Max. Ichg (A)	Max. Ichg (A)	Charge Termination	Charge Regulation	Features	EV Kit	Industry Qualified	Oper. Temp. (°C)	Package/Pin s	Budgetary Price (See Notes)
Current Selections:	= Li-Polymer	-	= 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAX1873	Simple Current-Limited Switch-Mode Li+ Charger Controller	Li-Ion ,Li-Polymer ,NiCd ,NiMH	5,6,7,8,9,10,2,3,4		28	28	8 to 17.6	Resistor	4	4	External Control	Switchmode	Input Current Limit ,Stand Alone	Yes	-	-40 to +85	QSOP/16	\$1.98 @1k
MAX17435	High-Frequency, Low-Cost SMBus Battery Chargers	Li-Ion ,Li-Polymer	-	2,3,4	26	26	4 to 19.2	I2C/SMBus	7	7	External Control ,Max. Voltage	Switchmode	Input Current Limit ,Serial I/F ,Smart Power Selector	Yes	-	-40 to +85	TQFN/24	\$2.41 @1k
MAX1737	Stand-Alone Switch-Mode Lithium-Ion Battery-Charger Controller	Li-Ion ,Li-Polymer	-	1,2,3,4	28	28	4 to 17.6	Resistor	4	4	Timer	Switchmode	Input Current Limit ,Stand Alone ,Thermistor Input ,Timer	Yes	-	-40 to +85	QSOP/28	\$2.86 @1k
MAX1640	Adjustable-Output, Switch-Mode Current Source with Synchronous Rectifier and High-Side Current Sensing	Li-Ion ,Li-Polymer ,NiCd ,NiMH	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	1,2,3,4,5,6	26	26	2 to 24	Resistor	-	-	External Control	Switchmode	-	Yes	-	-40 to +85	QSOP/16	\$3.05 @1k
MAX1641	Adjustable-Output, Switch-Mode Current Source with Synchronous Rectifier and Low-Side Current Sensing	Li-Ion ,Li-Polymer ,NiCd ,NiMH	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	1,2,3,4,5,6	26	26	2 to 24	Resistor	-	-	External Control	Switchmode	-	Yes	-	-40 to +85	QSOP/16	\$3.05 @1k
MAX846A	Cost-Saving, Multichemistry, Battery-Charger System	Li-Ion ,Li-Polymer ,NiCd ,NiMH	1,2,3,4,5,6,7,8,9,10,11	1,2	20	20	18	Resistor	2	2	Current Limit ,Max. Voltage	Linear	Stand Alone	Yes	-	-40 to +85	QSOP/16	\$3.25 @1k
MAX1757	Stand-Alone, Switch-Mode Li+ Battery-Charger with Internal 14V Switch	Li-Ion ,Li-Polymer	-	1,2,3	14	14	4 to 13.2	Resistor	1.5	1.5	Timer	Switchmode	Input Current Limit ,Internal Switch ,Stand Alone ,Thermistor Input ,Timer	Yes	-	-40 to +85	SSOP/28	\$3.26 @1k
MAX1758	Stand-Alone, Switch-Mode Li+ Battery-Charger with Internal 28V Switch	Li-Ion ,Li-Polymer	-	1,2,3,4	28	28	4 to 17.6	Resistor	1.5	1.5	Timer	Switchmode	Input Current Limit ,Internal Switch ,Stand Alone ,Thermistor Input ,Timer	Yes	-	-40 to +85	SSOP/28	\$3.53 @1k
MAX8724	Low-Cost, Improved Accuracy, Multichemistry Battery-Charger	Lead Acid ,Li-Ion ,Li-Polymer ,NiCd ,NiMH ,Universal	2,3,4,5,6,7,8,9,10	2,3,4	28	28	0 to 17.6	Analog Input ,Resistor	5	5	Current Limit ,Max. Voltage	Switchmode	Input Current Limit ,Stand Alone ,Thermistor Input	Yes	-	-40 to +85	TQFN/28	\$3.54 @1k
MAX1908	Low-Cost, Improved Accuracy, Multichemistry Battery-Charger	Lead Acid ,Li-Ion ,Li-Polymer ,NiCd ,NiMH ,Universal	2,3,4,5,6,7,8,9,10	2,3,4	28	28	0 to 17.6	Analog Input ,Resistor	5	5	Current Limit ,Max. Voltage	Switchmode	Input Current Limit ,Stand Alone ,Thermistor Input	Yes	-	-40 to +85	TQFN/28	\$3.54 @1k
MAX745	Switch-Mode, Lithium-Ion Battery Charger	Li-Ion ,Li-Polymer	-	1,2,3,4	24	24	18	Resistor	4	4	Current Limit ,Max. Voltage	Switchmode	Stand Alone ,Thermistor Input	Yes	-	-40 to +85	SSOP/20	\$4.99 @1k
MAX8765	Low-Cost, Improved Accuracy, Multichemistry Battery-Charger	Lead Acid ,Li-Ion ,Li-Polymer ,NiCd ,NiMH ,Universal	2,3,4,5,6,7,8,9,10	2,3,4	28	28	0 to 17.6	Analog Input ,Resistor	5	5	Current Limit ,Max. Voltage	Switchmode	Input Current Limit ,Stand Alone ,Thermistor Input	-	-	-40 to +85	TQFN/28	\$5.68 @1k
MAX17006B	1.2MHz High Performance Charger for 2 or 3 Series Li+ Cells	Li-Ion ,Li-Polymer	-	2,3	26	26	8.4 to 13.2	Analog Input ,Logic Input ,Resistor	5	5	External Control	Switchmode	Input Current Limit ,Smart Power Selector	Yes	-	-40 to +85	TQFN/20	\$5.76 @1k
MAX1772	Low-Cost, Multichemistry Battery-Charger Building Block	Lead Acid ,Li-Ion ,Li-Polymer ,NiCd ,NiMH ,Universal	2,3,4,5,6,7,8,9,10	2,3,4	28	28	0 to 18.2	Analog Input ,Resistor	4	4	External Control	Switchmode	Input Current Limit ,Stand Alone	-	-	-40 to +85	QSOP/28	\$6.22 @1k
MAX1870A	Step-Up / Step-Down Lithium Ion Battery Charger	Li-Ion ,Li-Polymer ,NiCd ,NiMH	6,9,10	2,3,4	28	28	0 to 17.6	Resistor	4	4	External Control	Switchmode	Input Current Limit ,Stand Alone ,Thermistor Input	Yes	-	-40 to +85	TQFN/32	\$6.39 @1k
MAX8731A	SMBus Level 2 Battery Charger with Remote Sense	Li-Ion ,Li-Polymer	-	1,2,3,4	26	26	0 to 19.2	I2C/SMBus	8	8	Current Limit ,Max. Voltage ,Smart Battery Control	Switchmode	Input Current Limit ,Serial I/F	Yes	-	-40 to +85	TQFN/28	\$7.18 @1k
MAX17015B	1.2MHz High Performance Multichemistry Charger	Li-Ion ,Li-Polymer	-	2,3,4,5	26	26	2 to 24	Analog Input ,Logic Input ,Resistor	5	5	External Control	Switchmode	Input Current Limit ,Smart Power Selector	Yes	-	-40 to +85	TQFN/20	\$7.39 @1k
MAX1645B	Smart Chemistry Independent, Battery Charger with Input Current Limiting without INR and VNR Status Bits	Lead Acid ,Li-Ion ,Li-Polymer ,NiCd ,NiMH ,Universal	1,2,3,4,5,6,7,8	2,3,4	28	28	1 to 18.4	I2C/SMBus ,Resistor	3	3	Smart Battery Control	Switchmode	Input Current Limit ,Serial I/F ,Thermistor Input ,Timer	Yes	-	-40 to +85	QSOP/28	-
MAX1647	Chemistry-Independent Battery Charger	Li-Ion ,Li-Polymer ,NiCd ,NiMH ,Universal	1,2,3,4,5,6,7,8	1,2,3,4	28	28	0 to 16.4	I2C/SMBus	4	4	External Control ,Smart Battery Control	Switchmode	Serial I/F ,Thermistor Input	-	-	-40 to +85	SSOP/20	-

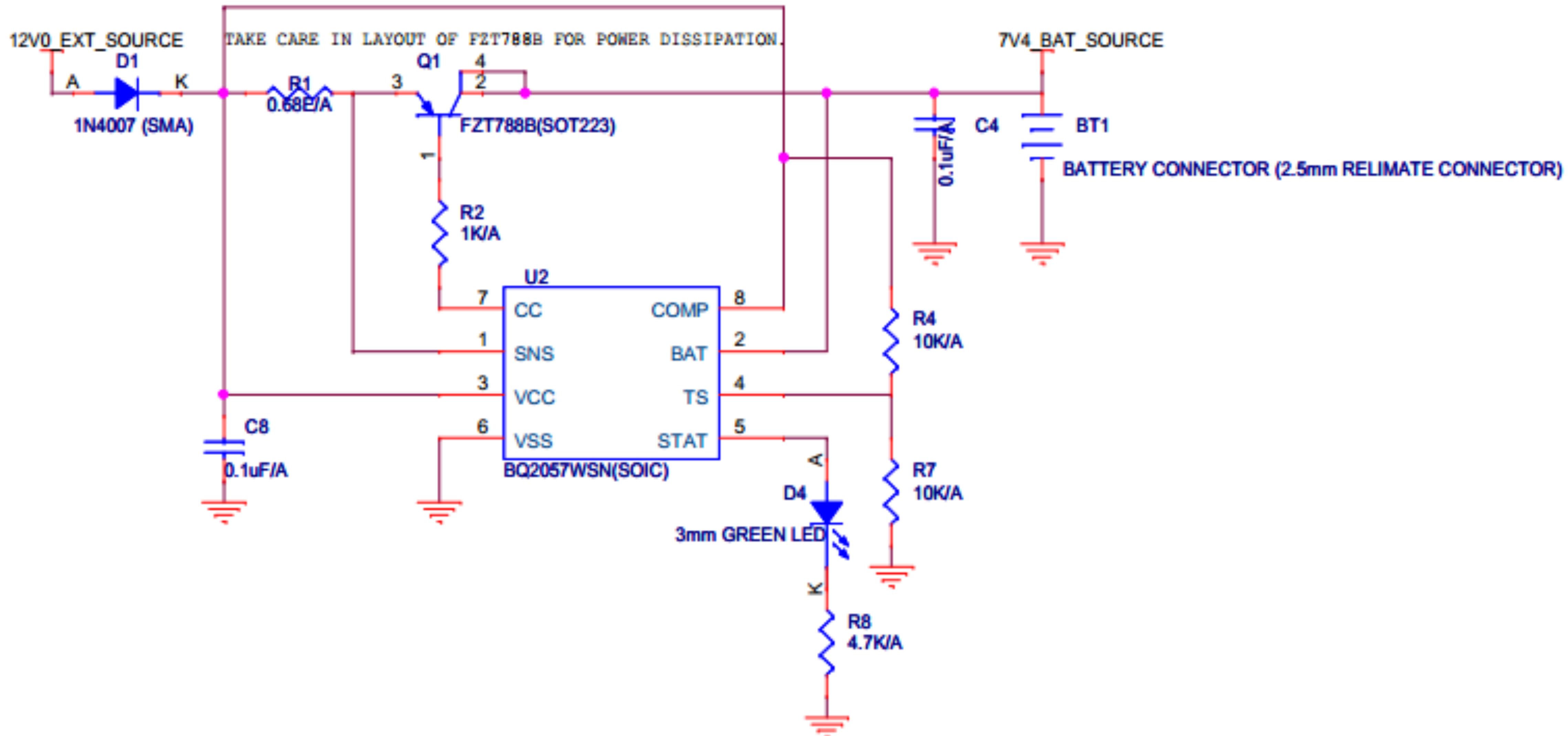
# BATTERY MANAGEMENT IC

ZEROU1 #CHARGING

Part Number	Description	Cell Chemistry	# Series Cells	Battery Charge	Charge Current	Vin (Max) (V)	Charging Contr	Control Interfac	Special Feature	Estimated Pack	Package Group	Approx. Price (US\$)	
BQ24773	1-4S I2C NVDC	Li-Ion/Li-Polymer	2-4 Cells, Singl	Adjustable		4	24	Switching Char	I2C	Power Path	28WQFN: 4 x 4	WQFN	1.50   1ku
BQ24770	1-4S SMBus NV	Li-Ion/Li-Polymer	2-4 Cells, Singl	Adjustable			24	Switching Char	SMBus		28WQFN: 4 x 4	WQFN	1.50   1ku
BQ24780S	1-4 Cell Hybrid	Li-Ion/Li-Polymer	2-4 Cells, Singl	Adjustable		8	30	Switching Char	SMBus		28WQFN: 4 x 4	WQFN	1.50   1ku
BQ40Z60	Complete Multi-	Li-Ion/Li-Polymer	2-4 Cells							Battery Manage	32VQFN: 5 x 5	VQFN	3.01   1ku
BQ24715	2-3 Cell Li+ Battery	SMBus NVD	2-3 Cells	Adjustable			28	Switching Charger			20VQFN: 3.5 x	VQFN	2.25   1ku
BQ24725A	1-4 Cell Li+ Batt	Li-Ion/Li-Polymer	2-4 Cells, Singl	Adjustable		8	24	Switching Char	SMBus	Power Path	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24735	1-4 Cell Li+ Batt	Li-Ion/Li-Polymer	2-4 Cells, Singl	Adjustable			28	Switching Char	SMBus		20VQFN: 3.5 x	VQFN	2.25   1ku
BQ24130	600-kHz Synchr	Li-Ion/Li-Polymer	2-3 Cells, Singl	4.2, 8.4, 12.6		2.5	17	Switching Char	Standalone	Power Path, Sta	20VQFN: 3.5 x	VQFN	1.95   1ku
BQ24707A	1-4 Cell Li+ Batt	Li-Ion/Li-Polymer	2-3 Cells, Singl	Adjustable		10	24	Switching Char	SMBus	Power Path, Sta	20VQFN: 3.5 x	VQFN	2.90   1ku
BQ24171	JEITA Compliant	Li-Ion/Li-Polymer	2-3 Cells, Singl	Adjustable		4	17	Switching Char	Standalone	Power Path, Sta	24VQFN: 3.5 x	VQFN	1.70   1ku
BQ24133	Synchronous S	Li-Ion/Li-Polymer	2-3 Cells, Singl	4.2, 8.4, 12.6		2.5	17	Switching Char	Standalone	Power Path, Sta	24VQFN: 3.5 x	VQFN	1.60   1ku
BQ24170	1.6-MHz Synchr	Li-Ion/Li-Polymer	2-3 Cells, Singl		4.2	4	17	Switching Char	Standalone	Power Path, JEI	24VQFN: 3.5 x	VQFN	1.70   1ku
BQ24618	Stand-Alone US	LiFePO4	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	Standard BAT T	24VQFN: 4 x 4	VQFN	2.75   1ku
UC2909-EP	Enhanced Prod	Lead Acid	2-4 Cells, >4 Ce	Adjustable		2	40	Switching Char	Standalone	Standard BAT T	20SOIC: 7.5 x 1	SOIC	
BQ24707	High-Frequency	Li-Ion/Li-Polymer	2-4 Cells, Singl	Adjustable		8	24	Switching Char	SMBus	Standard BAT T	20VQFN: 3.5 x	VQFN	2.90   1ku
BQ24616	JEITA Compatib	Li-Ion/Li-Polymer	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	JEITA BAT Tem	24VQFN: 4 x 4	VQFN	2.75   1ku
BQ24640	High Efficiency	SuperCap	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	Standard BAT T	16VQFN: 3.5 x	VQFN	2.00   1ku
BQ24620	28V Synchrono	LiFePO4	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	Standard BAT T	16VQFN: 3.5 x	VQFN	2.00   1ku
BQ24600	Standalone Syn	Li-Ion/Li-Polymer	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	Power Path, Sta	16VQFN: 3.5 x	VQFN	2.75   1ku
BQ24617	Stand-Alone Sy	Li-Ion/Li-Polymer	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	Power Path, Sta	24VQFN: 4 x 4	VQFN	2.75   1ku
BQ24630	Stand-Alone Sy	LiFePO4	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	Standard BAT T	24VQFN: 4 x 4	VQFN	2.00   1ku
BQ24610	Stand-Alone Sy	Li-Ion/Li-Polymer	2-4 Cells, >4 Ce	Adjustable		10	28	Switching Char	Standalone	JEITA BAT Tem	24VQFN: 4 x 4	VQFN	2.75   1ku
BQ24765	SMBus Controll	Li-Ion/Li-Polymer	2-4 Cells	Adjustable		10	24	Switching Char	SMBus	Power Path	34VQFN: 7 x 3	VQFN	3.00   1ku
BQ24753A	Host-Controlled	Li-Ion/Li-Polymer	2-4 Cells	Adjustable		10	24	Switching Charger		Power Path, Sta	28VQFN: 5 x 5	VQFN	2.50   1ku
BQ24450	Integrated Char	Lead Acid	2-4 Cells, >4 Ce	Adjustable		10	40	Linear Charger	Standalone	Under Voltage	16SOIC: 7.5 x 1	SOIC	2.75   1ku
BQ24104	Synchronous S	Li-Ion/Li-Polymer	2-3 Cells, Singl		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24745	SMBus-Controll	Li-Ion/Li-Polymer	2-4 Cells	Adjustable		10	24	Switching Charger		Power Path	28VQFN: 5 x 5	VQFN	2.90   1ku
BQ24109	Synchronous S	Li-Ion/Li-Polymer	2-3 Cells, Singl		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24125	Single Chip Swi	Li-Ion/Li-Polymer	2-3 Cells, Singl	Adjustable		4	17	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	3.00   1ku
BQ24103A	Standalone Syn	Li-Ion/Li-Polymer	Single Cell, 2 C		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24113A	Host-Controlled	Li-Ion/Li-Polymer	2-3 Cells, Singl		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24123	Synchronous S	Li-Ion/Li-Polymer	2-3 Cells, Singl		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24120	Synchronous S	Li-Ion/Li-Polymer	Single Cell, 2 C		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ25010	500mA Li-Ion C	Li-Ion/Li-Polymer	2-4 Cells, Singl		4.2	4	24	Switching Char	SMBus	Power Path	20VQFN: 3.5 x	VQFN	1.58   1ku
BQ24105	Standalone Syn	Li-Ion/Li-Polymer	2-3 Cells, Singl	Adjustable		2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	3.00   1ku
BQ24113	Host-controlled	Li-Ion/Li-Polymer	2-3 Cells, Singl		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24103	Standalone Syn	Li-Ion/Li-Polymer	Single Cell, 2 C		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24100	Standalone Syn	Li-Ion/Li-Polymer	Single Cell, 2 C		4.2	2	16	Switching Char	Standalone	Standard BAT T	20VQFN: 3.5 x	VQFN	2.00   1ku
BQ24702	Multi-Chemistry	Li-Ion/Li-Polymer	2-4 Cells	Adjustable		2	28	Switching Char	Standalone	Power Path	24TSSOP: 4.4 x	TSSOP	2.21   1ku
BQ24703	Multi-Chemistry	Li-Ion/Li-Polymer	2-4 Cells	Adjustable		10	24	Switching Charger		Power Path	28VQFN: 5 x 5	TSSOP, VQFN	2.10   1ku
BQ24401	Switch-mode Ni	NiCd, NiMH	2-4 Cells, Singl	Adjustable		2	6	Switching Char	Standalone		8TSSOP: 4.4 x	SOIC, TSSOP	1.55   1ku
BQ24400	Switch-mode Ni	NiCd, NiMH	2-4 Cells, Singl	Adjustable		2	6	Switching Char	Standalone	Standard BAT T	8TSSOP: 4.4 x	SOIC, TSSOP	1.55   1ku
BQ24005	Linear 2-cell Li-I	Li-Ion/Li-Polymer	2 Cells		4.2	1.2	10	Linear Charger	Standalone	Standard BAT T	20HTSSOP: 4.4	HTSSOP	1.68   1ku
BQ24006	Linear 2-cell Li-I	Li-Ion/Li-Polymer	2 Cells		4.2	1.2	10	Linear Charger	Standalone	Standard BAT T	20HTSSOP: 4.4	HTSSOP	2.10   1ku
BQ24004	Linear 2-cell Li-I	Li-Ion/Li-Polymer	2 Cells		4.2	1.2	10	Linear Charger	Standalone	Standard BAT T	20HTSSOP: 4.4	HTSSOP	1.68   1ku
BQ2057W	Low Dropout Li	Li-Ion/Li-Polymer	Single Cell, 2 C		4.2	2	15	Linear Charger	Standalone	Standard BAT T	8TSSOP: 4.4 x	SOIC, TSSOP	0.80   1ku

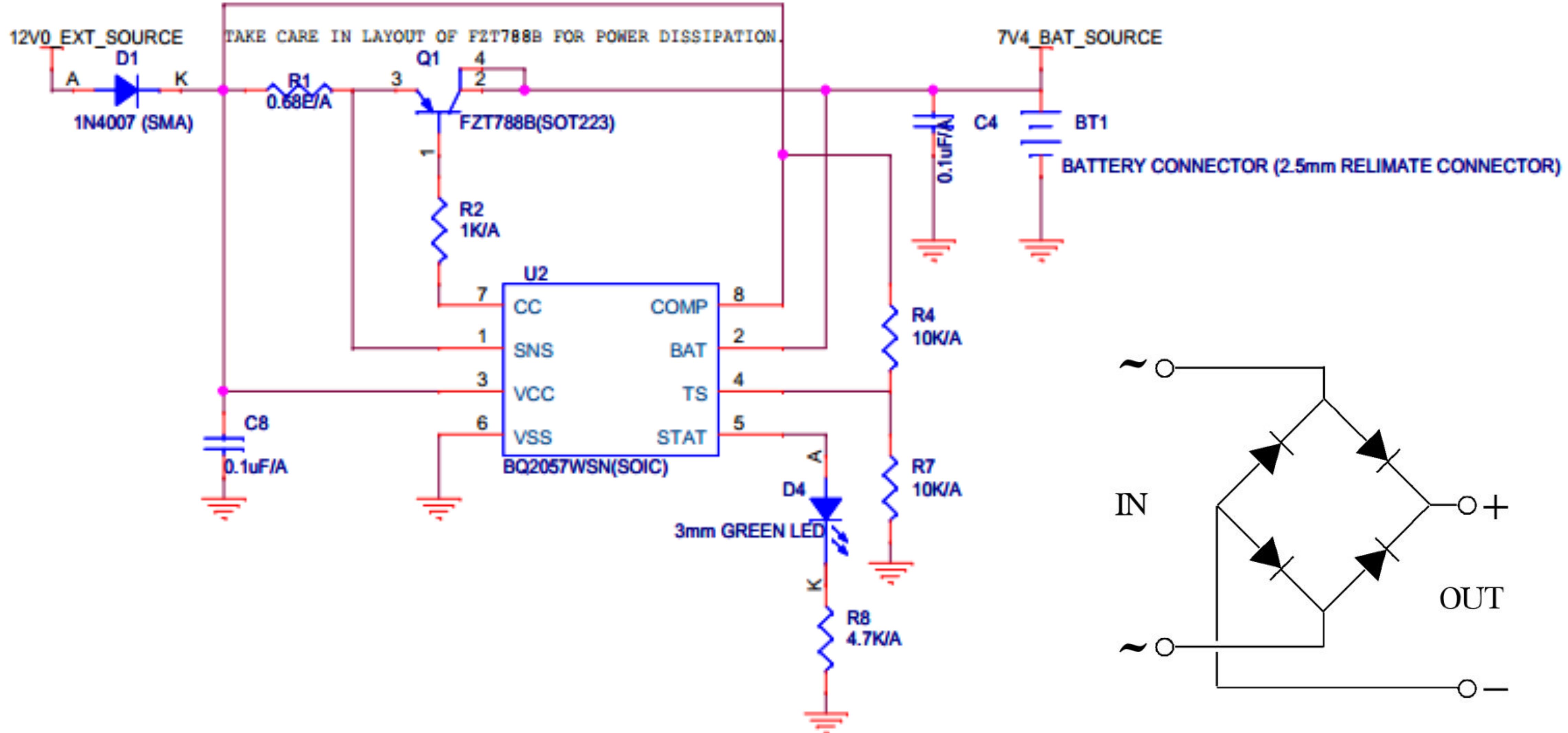
# BATTERY MANAGEMENT IC

# ZEROUTI #CHARGING



# BATTERY MANAGEMENT IC

ZEROU1 #CHARGING



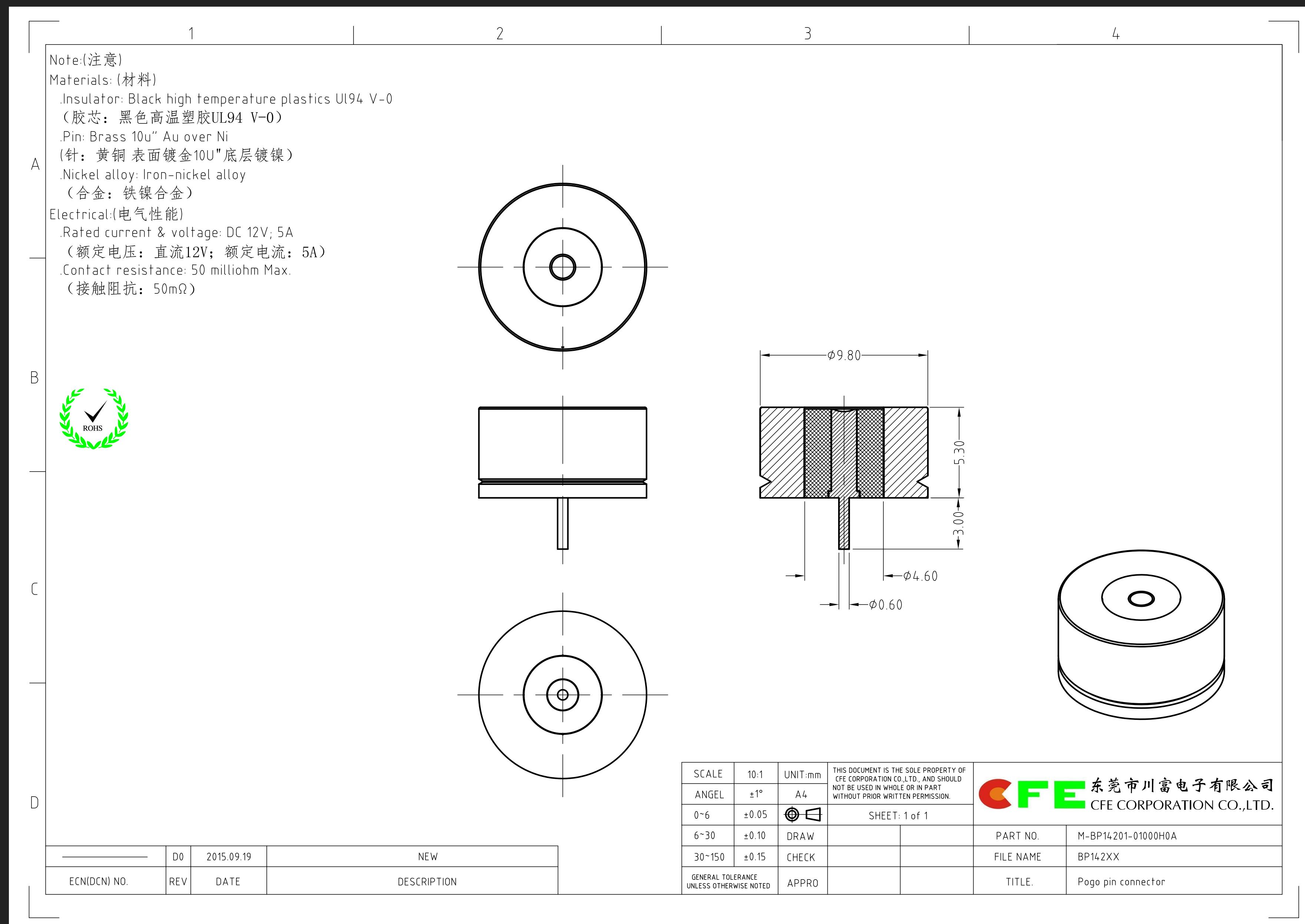
# MAG Connector Q

- Nominal ~~V~~ & current  
~~price~~ (1000 & 5000)  
non-magnetic male (Pogo)
- what dimensions customizable  
↳ can it be ~~smaller~~ (scaled)?
- Who's using  
cable with connector ends

\$1 / set (pair) for 10K order

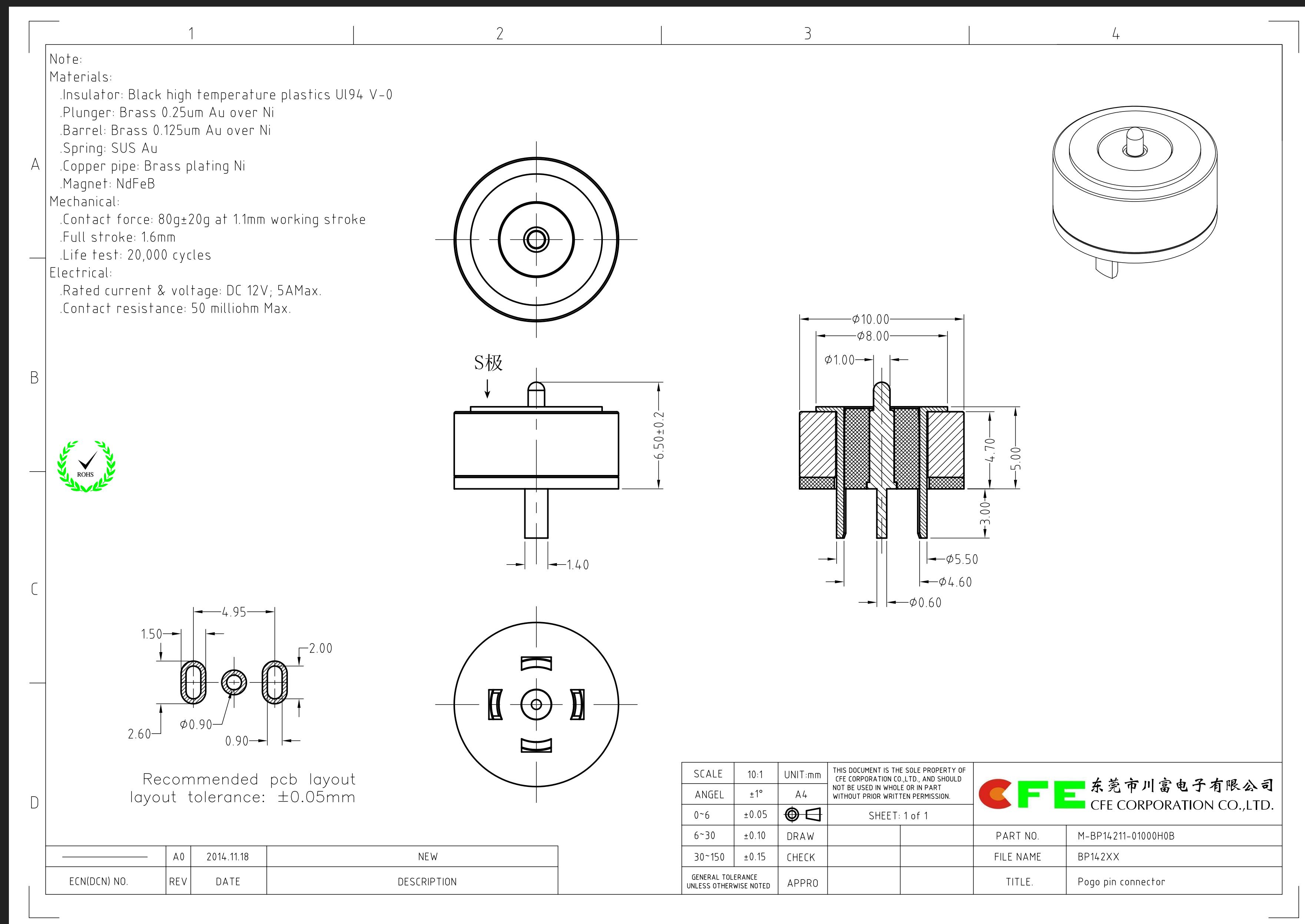
# MAGNETIC CONNECTOR

ZEROU1 #CHARGING



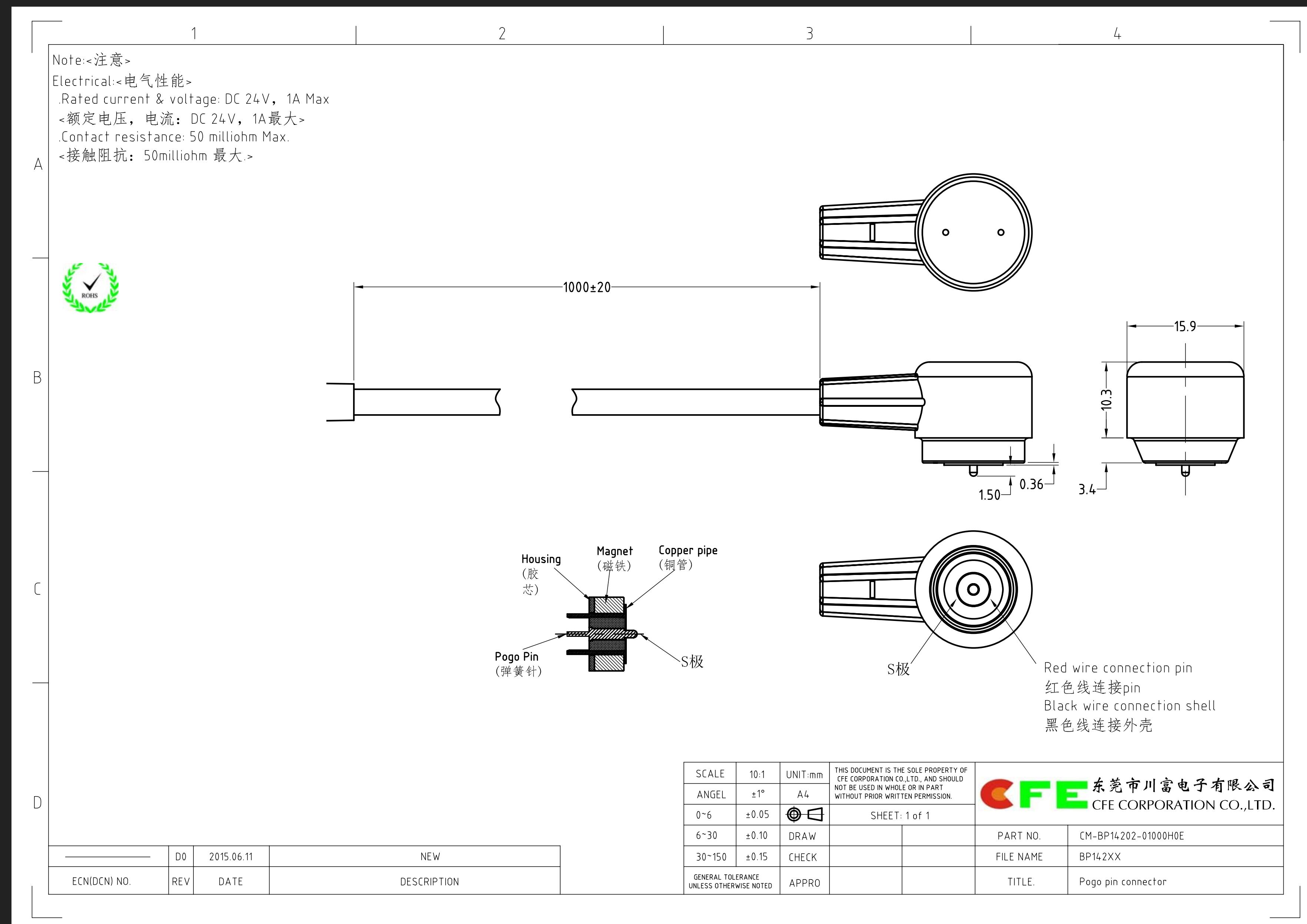
# MAGNETIC CONNECTOR

ZEROUI #CHARGING



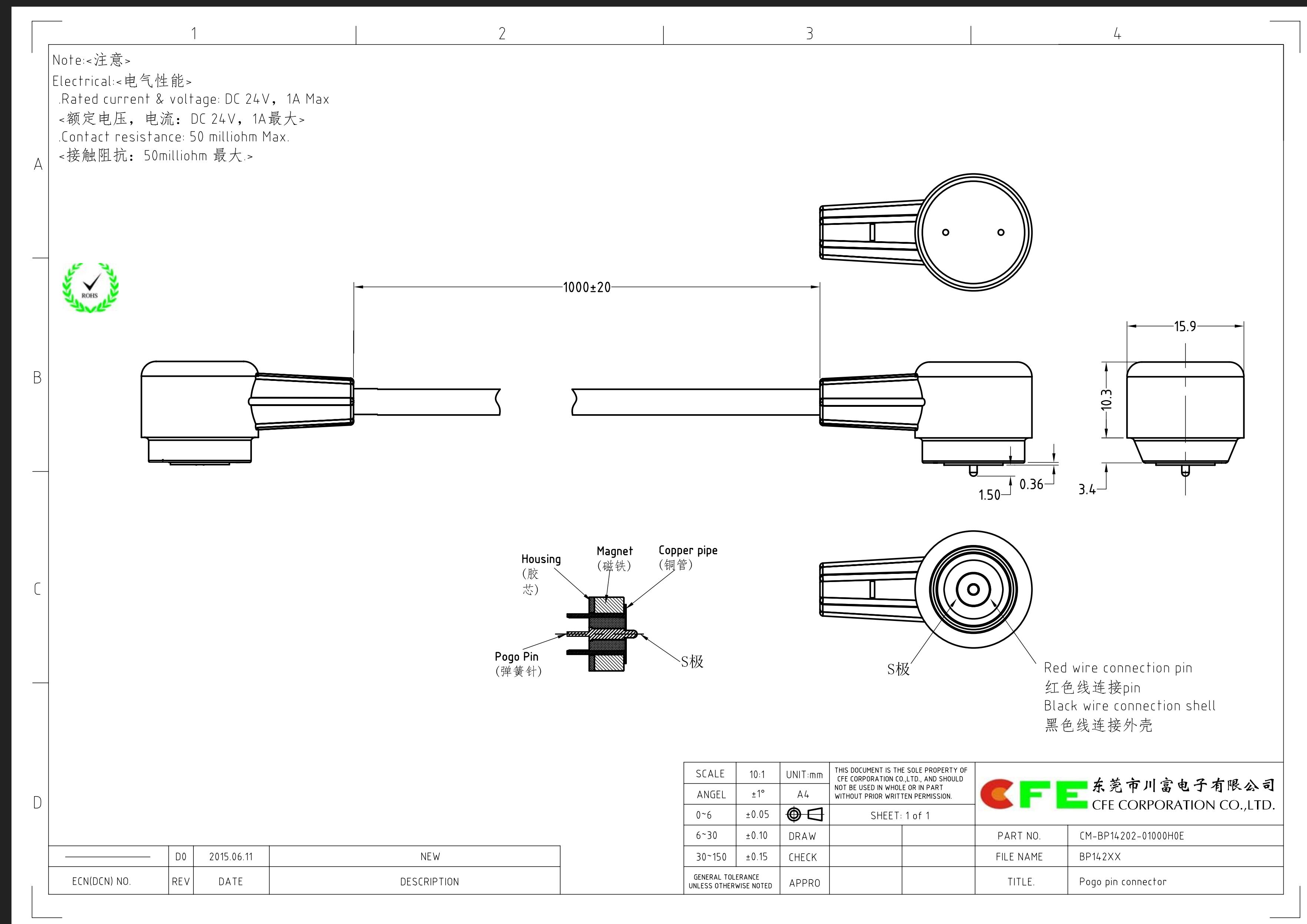
# MAGNETIC CONNECTOR

ZEROUI #CHARGING



# MAGNETIC CONNECTOR

ZEROUI #CHARGING



## MAGNETIC CONNECTORS

- ▶ Customizable
- ▶ No Magnets for Base Station (gravity)
- ▶ Thinner female connector for glove
- ▶ Cable with connector endings (Ziro Accessory)
- ▶ \$1 / set - 10k
- ▶ \$0.85 / set - 50k

# Decisions so far

3/17/16

- magnetic connector
  - good quality
  - reasonable price (\$1 / set)
  - customizable

- battery
  - Lipo 3.7 for glove
  - Lipo 7.4 for module

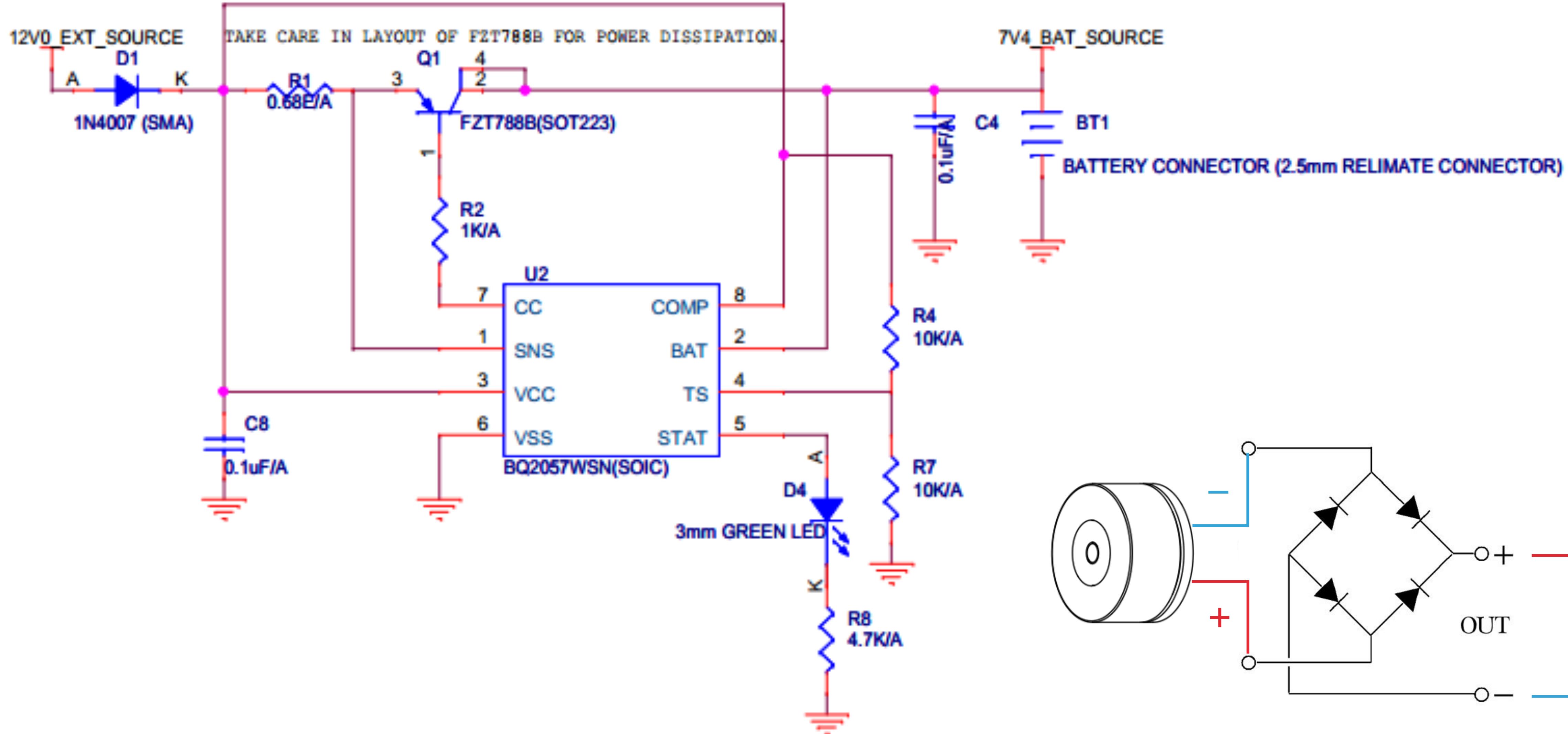
Safety

## TASKS

- ▶ Study Battery chargers ✓
- ▶ Understand charging ✓
- ▶ Decide
  - ▶ Chemistry of Battery ✓
  - ▶ Voltage ✓
  - ▶ Type of charging ✓
  - ▶ Battery Management IC ✓
- ▶ Circuit
- ▶ Prototype

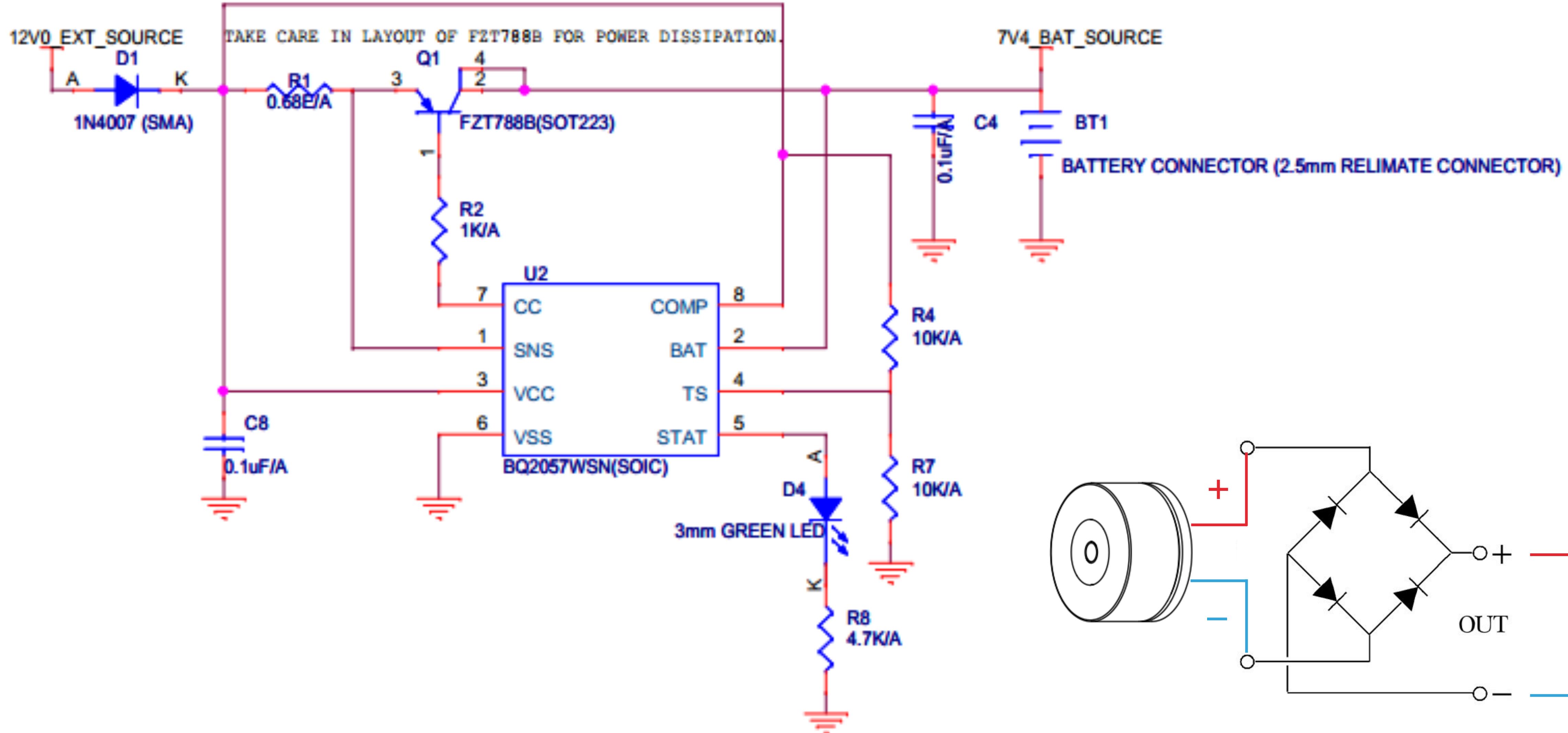
# MODULE CHARGING CIRCUIT

ZEROU1 #CHARGING



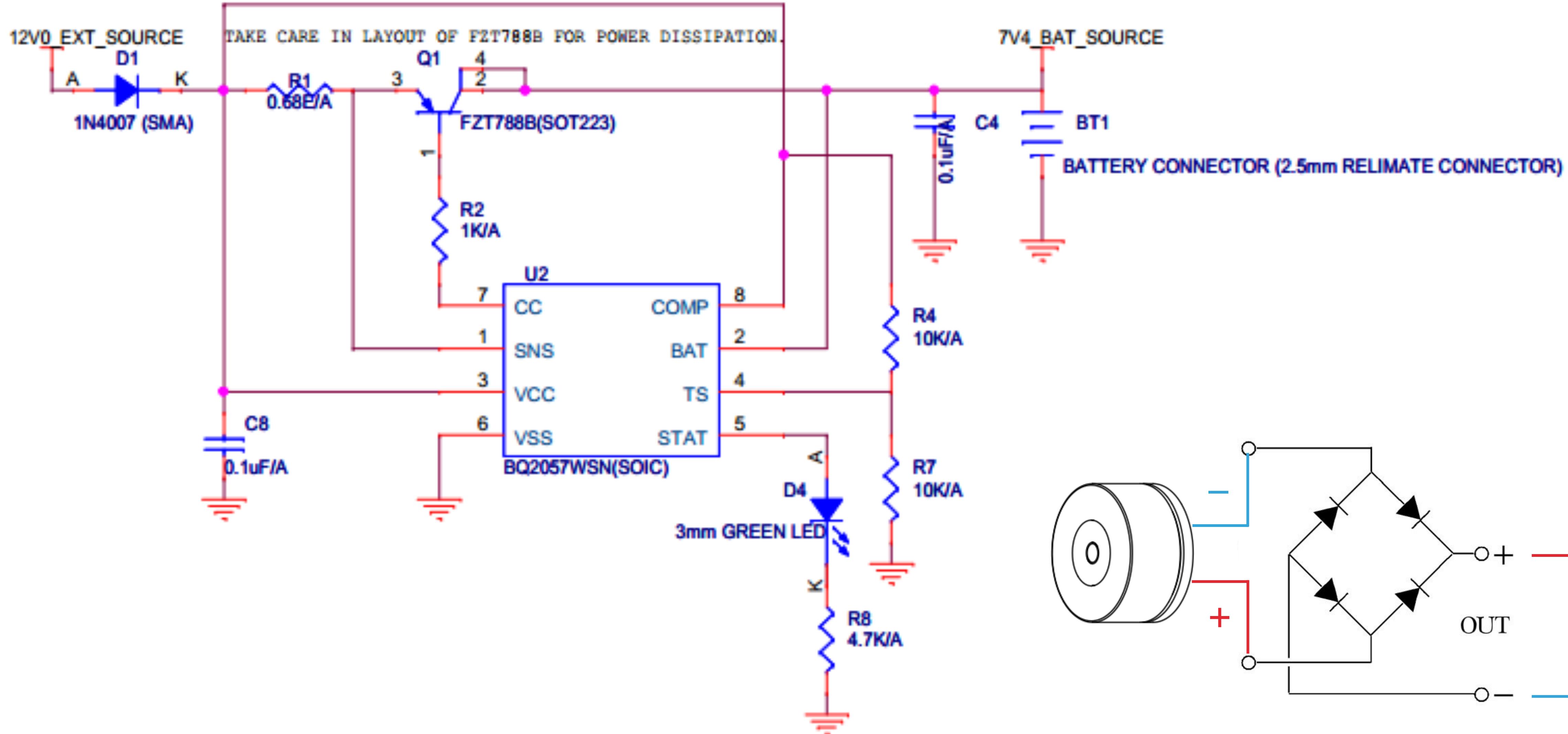
# MODULE CHARGING CIRCUIT

ZEROU1 #CHARGING



# MODULE CHARGING CIRCUIT

ZEROU1 #CHARGING



# COSTS

ZEROUTI #CHARGING

Cost			
Part	Ammount	Price	
Connectors	10k	\$1.00	
Charge Mgmt IC	1k	\$0.80	(up to \$3.00)
Transistors	5k	\$0.30	
Diodes	5k	\$0.05	
LED	5k	\$0.05	
Resistors	5k	< \$0.05	
Capacitors	5k	< \$0.02	
Total		~ \$2.30	up to \$4.50

# SHARING

QR Code

Sharing | creations  
modules | contig  
commonity

Download app  
videos  
**UX**

App could have camera access,  
"QR code" generation  
similar to Snapchat  
share between friends through  
screen or message / facebook

NFL

NBA

## CUSTOMIZATION

Colors - Glove & Modules

- ↳ sewing, leather, fabric, LEDs, wheels
- NFL • football team colors/seats
- University colors
- jackets ?
- charging station
- NFL Bose speakers/headphones
- ↳ Put on Presentation!

Baseball, other sports

