



### Description

SE1052 is a highly integrated solution for SMPS applications requiring CV (constant voltage) and CC (constant current) modes. It also has built-in LED drivers specifically designed for stand-alone Battery Charging applications. SE1052 integrates three voltage references, three operational amplifiers, and two current sensing circuits together in the same IC. The 1<sup>st</sup> voltage reference, together with one operational amplifier, controls the output voltage. The 2<sup>nd</sup> voltage reference, together with another operational amplifier, senses and limits the amount of the current on the low side, hence the overall current at the output. The 3<sup>rd</sup> voltage reference and operational amplifier senses when the charging current drops to 10% of the programmed value. During charging, SE1052 will turn on Red LED. When the charging is completed, SE1052 will turn on Green LED. The SE1052 is available in SOP8 and DIP8 package.

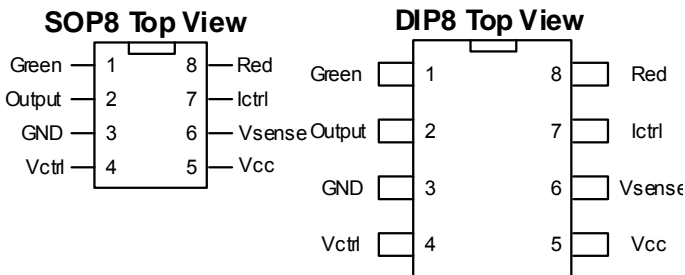
### Features

- Constant Voltage and Constant Current Control
- Low Voltage Operation
- Precision Internal Voltage References
- Low External Component Count
- Current Sink Output Stage
- Easy Compensation
- Low AC Mains Voltage Rejection
- Rugged 1.5KV ESD withstand capability.
- Internal 2 LED drivers
- Available in SOP8 and DIP-8 Package.
- RoHS Compliant and 100% Lead (Pb)-Free

### Application

- Adapters
- Digital Camera Chargers.
- Cellphone Chargers.
- Other Battery Chargers

### Pin Configuration



### Ordering Information

Device	Package	V <sub>OUT</sub>
SE1052	SOP8 and DIP8 (Lead-free)	Fixed output voltages 1.21V

### Pin Description

Name	Pin#	Type	Function
Green	1	Driver	Turning on Green LED when the charging is completed.
V <sub>OUT</sub>	2	Current Sink Output	Output Pin. Sinking Current Only
GND	3	Power Supply	Ground Line. 0V Reference For All Voltages
V <sub>CTRL</sub>	4	Analog Input	Input Pin of the Voltage Control Loop
V <sub>CC</sub>	5	Power Supply	Positive Power Supply Line
V <sub>SENSE</sub>	6	Analog Input	Input Pin of the Current Control Loop
I <sub>CTRL</sub>	7	Analog Input	Input Pin of the Current Control Loop
Red	8	Driver	Turning on Red LED when the charging is in progress.



**Absolute Maximum Rating**

Symbol	Parameter	Maximum	Units
V <sub>CC</sub>	DC Supply Voltage	18	V
V <sub>IN</sub>	Input Supply Voltage	-0.3~ V <sub>CC</sub>	V
θ <sub>JA</sub>	Thermal Resistance Junction to Ambient	250	°C/W
T <sub>J</sub>	Operating Junction Temperature Range	0 to 125	°C
T <sub>STG</sub>	Storage Temperature Range	-40 to 150	°C
T <sub>LEAD</sub>	Lead Temperature (Soldering 10 Sec)	260	°C

**Electrical Characteristic**

V<sub>CC</sub> = 5.0V, T<sub>A</sub> = 25°C, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Total Current Consumption</b>						
I <sub>CC</sub>	Total Supply Current - not taking the output sinking current into account	ISINK=0	0.7	1.2	2.5	mA
<b>Voltage Control Loop</b>						
G <sub>mv</sub>	Transconduction Gain (Vctrl). Sink Current Only <sup>1)</sup>	ISINK=0 to 10mA		2.4		mA/mV
V <sub>REF</sub>	Voltage Control Loop Reference <sup>2)</sup>	ISINK=0	1.198	1.21	1.222	V
LR <sub>v</sub>	Linear Regulation of Voltage Control Loop Reference	V <sub>CC</sub> = 2.5V to 18V		0.6	8	mV
I <sub>IBV</sub>	Input Bias Current (Vctrl)			70		nA
V <sub>OL</sub>	Low Output Voltage at 10mA Sinking Current	Vctrl=V <sub>CC</sub> , Ictrl=Vsense=GND, ISINK=10mA, G and R Pins Open		250	350	mV
I <sub>OS</sub>	Output Short Circuit Current. Output to VCC. Sink Current Only	Vctrl=Vout=V <sub>CC</sub> , Ictrl=Vsense=GND, G and R Pins Open	15	24	35	mA
<b>Current Control loop</b>						
G <sub>mi</sub>	Transconduction Gain (Ictrl). Sink Current Only <sup>3)</sup>	ISINK=0 to 5mA		7.2		mA/mV
V <sub>SENSE</sub>	Current Control Loop Reference <sup>4)</sup>	ISINK=0	192	200	208	mV
LR <sub>i</sub>	Linear Regulation of Current Control Loop Reference	V <sub>CC</sub> =2.5V to 18V		0.8	4	mV
I <sub>IBI</sub>	Current out of pin Ictrl at -200mV			20		uA
V <sub>OL</sub>	Low Output Voltage at 10mA Sinking Current	Vsense=V <sub>CC</sub> , Ictrl=Vctrl=GND, ISINK=10mA, G and R Pins Open		250	350	mV
I <sub>OS</sub>	Output Short Circuit Current. Output to VCC. Sink Current Only	Vsense=Vout=V <sub>CC</sub> , Ictrl=Vctrl=GND, G and R Pins Open	15	24	35	mA



**Electrical Characteristic**

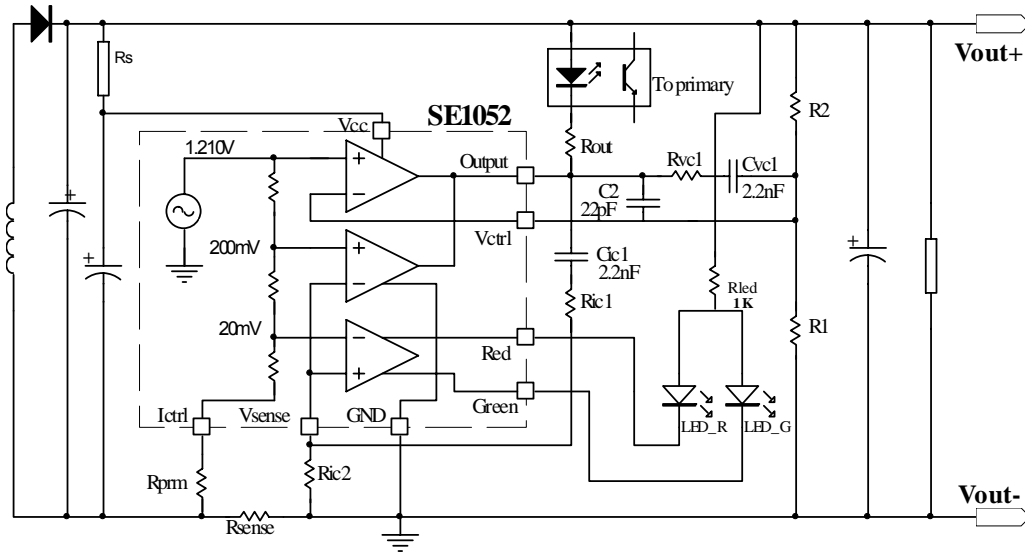
$V_{CC} = 5.0V$ ,  $T_A = 25^{\circ}C$ , unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Current Monitor Loop</b>						
$V_{TH}$	Threshold Voltage of Turning Red Pin from Low to High			20		mV
$H_{ys}$	Hysterisis of the comparator in Current Monitor Loop			14		mV

1. If the voltage on  $V_{CTRL}$  (the negative input of the amplifier) is higher than the positive amplifier input ( $V_{REF}=1.210V$ ), and it is increased by 1mV, the sinking current at the output OUT will be increased by 2.4mA.
2. The internal Voltage Reference is set at 1.210V. The internal Voltage Reference is fixed by bandgap, and trimmed to 1% accuracy at room temperature.
3. When the positive input at  $I_{CTRL}$  is lower than -200mV, and the voltage is decreased by 1mV, the sinking current at the output OUT will be increased by 2.9mA.
4. The internal current sense threshold is set to -200mV. The current control loop precision takes into account the cumulative effects of the internal voltage reference deviation as well as the input offset voltage of the trans-conduction operational amplifier.



### Typical Application



Note 1: 0 ohms of Ric2 is recommended for LED charging indication function.

Note 2: Rprm is used to correctly trigger Green and Red LED's. Rprm=0 is recommended if SE1052 is used to charge one Li-bat cell.  $R_{prm} \leq 1K$  ohms is recommended if SE1052 is used to charge more than one Li-bat cells.



## Application Hints

### Voltage Control

The voltage loop is controlled via a first transconductance operational amplifier, the resistor bridge R1, R2, and the optocoupler which is directly connected to the output.

The relation between the values of R1 and R2 should be chosen as written in Equation 1.

$$R1 = R2 \times V_{ref} / (V_{out} - V_{ref}) \quad Eq1$$

Where  $V_{out}$  is the desired output voltage. To avoid the discharge of the load, the resistor bridge R1, R2 should be highly resistive. For this type of application, a total value of 100K $\Omega$  (or more) would be appropriate for the resistors R1 and R2. As an example, with  $R2 = 100K\Omega$ ,  $V_{out} = 4.10V$ ,  $V_{ref} = 1.210V$ , then  $R1 = 41.9K\Omega$ .

Note that if the low drop diode should be inserted between the load and the voltage regulation resistor bridge to avoid current flowing from the load through the resistor bridge, this drop should be taken into account in the above calculations by replacing  $V_{out}$  by  $(V_{out} + V_{drop})$ .

### Current Control

The current loop is controlled via the second trans-conductance operational amplifier, the sense resistor  $R_{sense}$ , and the optocoupler.

The control equation is:

$$R_{sense} \times I_{-limit} = V_{sense} \quad Eq2$$

$$R_{sense} = V_{sense} / I_{-limit} \quad Eq3$$

where  $I_{-limit}$  is the desired current limit, and  $V_{sense}$  is the threshold voltage for the current control loop.

As an example, with  $I_{-limit} = 1A$ ,  $V_{sense} = -200mV$ , then  $R_{sense} = 200m\Omega$ .

Note that the  $R_{sense}$  resistor should be selected with the consideration of the Maximum Power in full load operations (P-limit).

$$P_{-limit} = V_{sense} \times I_{-limit} \quad Eq4$$

As an example, with  $I_{-limit} = 1A$ , and  $V_{sense} = -200mV$ ,  $P_{-limit} = 200mW$ .

Consequently, for most adapter and battery charger applications, a quarter-watt resistor to make the current sensing function is sufficient.

$V_{sense}$  threshold is achieved internally by a resistor bridge tied to the  $V_{ref}$  voltage reference. Its middle point is tied to the positive input of the current control operational amplifier, and its foot is to be connected to lower potential point of the sense resistor as shown on the following figure. The resistors of this bridge are matched in layout to provide the best precision possible.

The current sinking outputs of the two trans-conductance operational amplifiers are connected together. This makes an ORing function which ensures that whenever the current or the voltage reaches too high values, the optocoupler is activated.

The relation between the controlled current and the controlled output voltage can be described with a square characteristic as shown in the following V/I output-power graph.

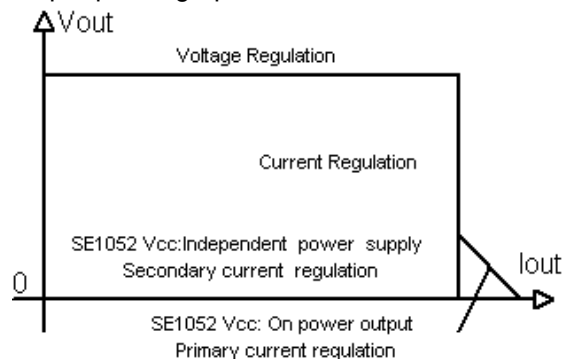


Fig.2 Output voltage versus output current

### Compensation

The voltage-control trans-conductance operational amplifier can be fully compensated. Both of its output and negative input are directly accessible for external compensation components.

An example of a suitable compensation network is shown in Fig.1. It consists of a capacitor  $C_{vc1}=2.2nF$  and a resistor  $R_{cv1}=470K\Omega$  in series, connected in parallel with another capacitor  $C_{vc2}=22pF$ .

The current-control trans-conductance operational amplifier can also be fully compensated. Both of its output and negative input are directly accessible for external compensation components.

An example of a suitable compensation network is shown in Fig.1. It consists of a capacitor  $C_{ic1}=2.2nF$  and a resistor  $R_{ic1}=22K\Omega$  in series.

When the  $V_{cc}$  voltage reaches 12V it could be interesting to limit the current coming through the output in the aim to reduce the dissipation of the device and increase the stability performances of the whole application.

An example of a suitable  $R_{out}$  value could be 330 $\Omega$  in series with the opto-coupler in case  $V_{cc}=12V$ .

### Driving LED

SE1052 provides direct driving pins to Red and Green LED's for charging applications. During charging, SE1052 will turn on Red LED. When the charging is completed, SE1052 will turn on Green LED.



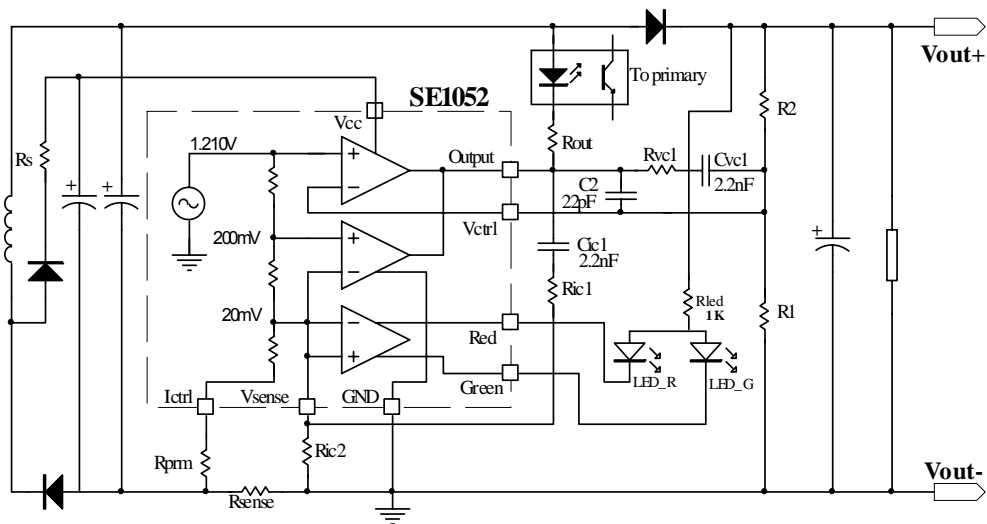
### Start Up and Short Circuit Conditions

Under start-up or short-circuit conditions the SE1052 does not have a high enough supply voltage. This is due to the fact that the chip has its power supply line in common with the power supply line of the charger system. Consequently, the current limitation can only be ensured by the primary PWM module, which should be designed accordingly.

If the primary current limitation is considered not to be precise enough for the application, then a sufficient supply for the SE1052 has to be ensured under any condition. It would then be necessary to add some circuitry to supply the chip with a separate power line. This can be achieved in numerous ways, including an additional winding on the transformer.

The following schematic shows how to realize a low-cost power supply for the SE1052 (with no additional windings).

Please pay attention to the fact that in the particular case presented here, this low-cost power supply can reach voltages as high as twice the voltage of the regulated line. Since the Absolute Maximum Rating of the SE1052 supply voltage is 18V, this low-cost auxiliary power supply can only be used in applications where the regulated line voltage does not exceed 9V.

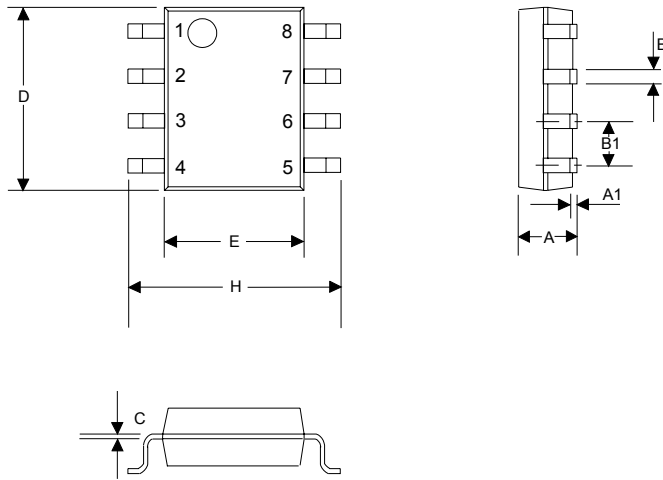


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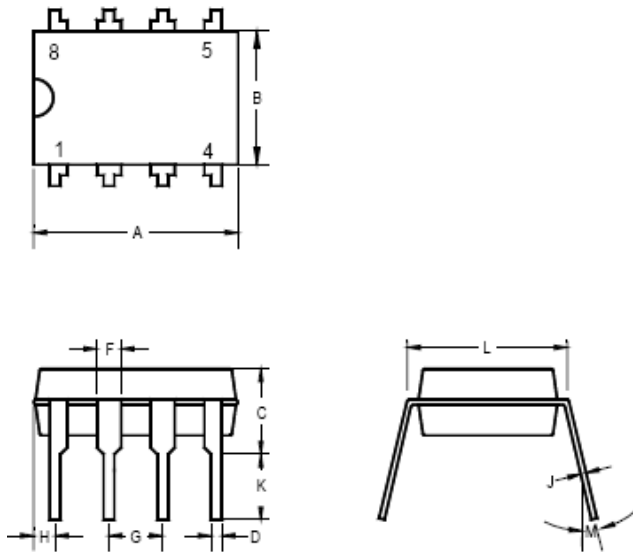


**OUTLINE DRAWING SOP-8**



DIMENSIONS				
DIM <sup>N</sup>	INCHES		MM	
	MIN	MAX	MIN	MAX
A	0.0532	0.0688	1.35	1.75
A1	0.0040	0.0098	0.10	0.25
B	0.0130	0.0200	0.33	0.51
B1	0.050 BSC		1.27 BSC	
C	0.0075	0.0098	0.19	0.25
D	0.1890	0.1968	4.80	5.00
H	0.2284	0.2440	5.80	6.20
E	0.1497	0.1574	3.80	4.00

**OUTLINE DRAWING DIP-8**



	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.355	0.365	0.400	9.02	9.27	10.16
B	0.240	0.250	0.280	6.10	6.35	7.11
C	-	-	0.210	-	-	5.33
D	-	0.018	-	-	0.46	-
F	-	0.060	-	-	1.52	-
G	-	0.100	-	-	2.54	-
H	0.050	-	0.090	1.27	-	2.29
J	0.008	-	0.015	0.20	-	0.38
K	0.115	0.130	0.150	2.92	3.30	3.81
L	0.300 BSC.			7.62 BSC.		
M	-	7°	15°	-	7°	15°



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