Sequoia Microelectronics

SQ7103

Dual Operational Amplifier and Voltage Reference

Features

Voltage Reference

- **Fixed output voltage reference +2.5V**
- **Sink current capability : 1mA to 100mA**
- **Typical output impedance : 0.2Ω**
- **±0.4% voltage precision**

Operational Amplifier

- **Low input offset voltage : 0.5mV**
- **Low supply current : 350μA/op-amp (@ V_{CC} = +5V)**
- **Wide bandwidth (unity gain): 0.9MHz**
- **Large output voltage swing : 0V to (V_{CC} – 1.5V)**
- **Input common mode voltage range includes ground**
- **Wide power supply range : 3V to 32V ±1.5V to ±16V**
- **RoHS compliant and Pb free**

Typical Applications

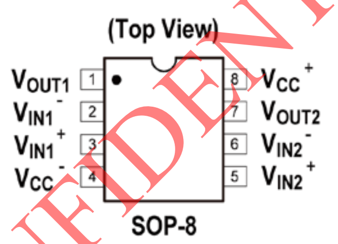
- **Switching mode power supply**
- **Chargers**

Product Description

The SQ7103 is a monolithic IC that includes one independent op-amp and another op-amp for which the non-inverting input is wired to a +2.5V fixed voltage reference. This device offers both space and cost savings in many applications such as power supply management or data acquisition systems.

The SQ7103 is available in a SOP-8 package.

Pin Assignments and Ordering Information



Device	V_{REF} Precision	Packaging	Quantity of Tape & Reel
SQ7103 MST	±0.4%	SOP-8	3000

For pricing, delivery, and ordering information, please contact Sequoia direct at 886-2-8780-8495, or e-mail to sales@sqme.com.tw or visit Sequoia's website at www.sqme.com.tw. Sequoia reserves the right to change the detail specifications as may be required to permit improvements in the design of its products.

Pin Descriptions

Pin No.	Pin Name	Function
1	V_{OUT1}	**Output 1 pin.**
		Output of op-amp 1.
2	V_{IN1}^{-}	**Inverting input 1 pin.**
		Inverting input of op-amp 1.
3	V_{IN1}^{+}	**Non-inverting input 1 pin.**
		Non-inverting input of op-amp 1. Internal +2.5V_{REF} voltage reference.
4	V_{CC}^{-}	**V_{CC}^{-} input pin.**
		In general, this pin as device ground.
5	V_{IN2}^{+}	**Non-inverting input 2 pin.**
		Non-inverting input of op-amp 2.
6	V_{IN2}^{-}	**Inverting input 2 pin.**
		Inverting input of op-amp 2.
7	V_{OUT2}	**Output 2 pin.**
		Output of op-amp 2.
8	V_{CC}^{+}	**V_{CC}^{+} input pin.**
		This pin as system power supply voltage input.

Absolute Maximum Ratings (Note 1)

Symbol	Parametar	Ratings	Unit
V_{CC}	V_{CC}^+ pin supply voltage	-0.5 ~ +36	V
V_{ID}	Differential input voltage	V_{CC} + 0.6	V
V_{IN}	Input voltage	-0.3 ~ +36	V
I_{KA}	Continuous cathode current	-100 ~ +150	mA
	Continuous power dissipation (T_A = +25°C)		
	8 Pin SO (de-rating 6.3mW/°C above +25°C)	0.63	W
T_J	Junction temperature	+150	°C
T_{STG}	Storage temperature range	-65 ~ +150	°C
θ_{JA}	Junction-to-ambient thermal resistance	175	°C/W

Note :

1. Exceeding these ratings could cause damage to the device. All voltages are with respect to V_{CC}^- pin (as ground). Currents are positive into, negative out of the specified terminal.

Recommended Operating Conditions

Symbol	Parametar	Min.	Max.	Unit
V_{CC}	DC supply voltage range	3	32	V
I_{KA}	+2.5V_{REF} cathode current	1	100	mA
T_A	Ambient temperature range (Note 2)	-40	+105	°C

Note :

2. Maximum ambient temperature range is limited by allowable power dissipation.

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition	
Total supply current, excluding current in voltage reference	I_{CC}		0.7	1.2	mA	$V_{CC}=+5V$	No load, T_A at full range
				2.0		$V_{CC}=+30V$	
Voltage Reference							
Reference input voltage	V_{REF}	2.49	2.50	2.51	V	$I_{KA}=10mA$	$T_A=+25°C$
		2.48		2.52			T_A at full range
Reference input voltage deviation over temperature range	ΔV_{REF}		7	30	mV	$V_{KA}=V_{REF}$, $I_{KA}=10mA$, T_A at full range	
Minimum cathode current for regulation	I_{MIN}		0.5	1.0	mA	$V_{KA}=V_{REF}$	
Dynamic impedance (Note 3)	$\|Z_{KA}\|$		0.2	0.5	Ω	$V_{KA}=V_{REF}$, $\Delta I_{KA}=1mA \sim 100mA$, f < 1kHz	
Operational Amplifier 1 (Op-Amp 1 with non-inverting input connected to the internal +2.5V_{REF}) (Over recommended operating conditions unless otherwise specified. $V_{CC}^{+}=5V$, $V_{CC}^{-}=$ground, $T_A=+25°C$)							
Input offset voltage	V_{IO}		0.5	2.0	mV	$V_{ICM}=0V$	$T_A=+25°C$
				3.0			T_A at full range
Input offset voltage drift	DV_{IO}		7		μV/°C		
Input bias current	I_{IB}		20		nA	Negative input	
Large signal voltage gain	A_{VD}		100		V/mV	$V_{CC}=+15V$, $R_L=2kΩ$, $V_{OUT1}=1.4V \sim 11.4V$, T_A at full range	
Supply voltage rejection ratio	SVR	65	100		dB	$V_{ICM}=0V$, $V_{CC}=+5V \sim +30V$	
Output current source	I_{SOURCE}	20	40		mA	$V_{OUT1}=2V$, $V_{CC}=+15V$, $V_{ID}=+1V$	
Short circuit to ground	I_O		40	60	mA	$V_{CC}=+15V$	
Output current sink	I_{SINK}	10	20		mA	$V_{ID}=-1V$, $V_{CC}=+15V$	$V_{OUT1}=2V$
		12	50		μA		$V_{OUT1}=0.2V$
High level output voltage	V_{OH}	26	27		V	$V_{CC}=+30V$, $R_L=2kΩ$	$T_A=+25°C$
		26					T_A at full range
		27	28			$V_{CC}=+30V$, $R_L=10kΩ$	$T_A=+25°C$
		27					T_A at full range
Low level output voltage	V_{OL}		5	20	mV	$R_L=10kΩ$	$T_A=+25°C$
				20			T_A at full range

Note :

3. The dynamic impedance is defined as $|Z_{KA}|=\Delta V_{KA} / \Delta I_{KA}$

Electrical Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition	
Slew rate at unity gain	SR	0.2	0.4		V/μs	$V_{CC}=+15V$, $R_L=2k\Omega$, $C_L=100pF$, unity gain, $V_{IN}=0.5V \sim 2.0V$	
Gain bandwidth product	GBP	0.5	0.9		MHz	$V_{CC}=+30V$, $R_L=2k\Omega$, $C_L=100pF$, $f=100kHz$, $V_{IN}=10mV$	
Total harmonic distortion	THD		0.02		%	$V_{CC}=+30V$, $R_L=2k\Omega$, $C_L=100pF$, $f=1kHz$, $A_V=20dB$, $V_{OUT1}=2\times V_{PP}$	
Operational Amplifier 2 (Independent Op-Amp 2) (Over recommended operating conditions unless otherwise specified. $V_{CC}^{+}=5V$, $V_{CC}^{-}=$ground, $V_{OUT2}=1.4V$, $T_A=+25°C$)							
Input offset voltage	V_{IO}		0.5	2.0	mV	$V_{ICM}=0V$	$T_A=+25°C$
				3.0			T_A at full range
Input offset voltage drift	DV_{IO}		7		μV/°C		
Input offset current	I_{IO}		2	75	nA	$T_A=+25°C$	
				150		T_A at full range	
Input bias current	I_{IB}		20	150	nA	$T_A=+25°C$	
				200		T_A at full range	
Large signal voltage gain	A_{VD}	50	100		V/mV	$V_{CC}=+15V$, $R_L=2k\Omega$, $V_{OUT2}=1.4V \sim 11.4V$	$T_A=+25°C$
		25					T_A at full range
Supply voltage rejection ratio	SVR	65	100		dB	$V_{ICM}=0V$, $V_{CC}=+5V \sim +30V$	
Input common mode voltage range (Note 4)	V_{ICM}	0		V_{CC}-1.5	V	$V_{CC}=+30V$	$T_A=+25°C$
		0		V_{CC} -2			T_A at full range
Common mode rejection ratio	CMRR	70	85		dB	$T_A=+25°C$	
		60				T_A at full range	
Output current source	I_{SOURCE}	20	40		mA	$V_{OUT2}=2V$, $V_{CC}=+15V$, $V_{ID}=+1V$	
Short circuit to ground	I_O		40	60	mA	$V_{CC}=+15V$	
Output current sink	I_{SINK}	10	20		mA	$V_{ID}=-1V$, $V_{CC}=+15V$	$V_{OUT2}=2V$
		12	50		μA		$V_{OUT2}=0.2V$
High level output voltage	V_{OH}	26	27		V	$V_{CC}=+30V$, $R_L=2k\Omega$	$T_A=+25°C$
		26					T_A at full range
		27	28			$V_{CC}=+30V$, $R_L=10k\Omega$	$T_A=+25°C$
		27					T_A at full range

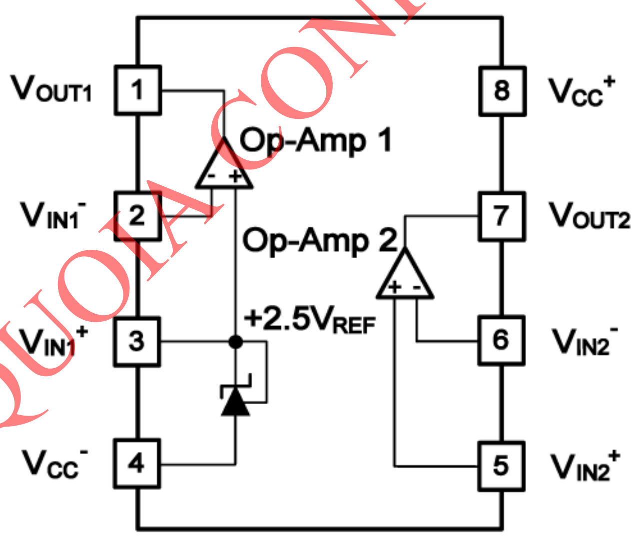
Note :

4. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is (V_{CC}^{+} - 1.5V). Both inputs can go to (V_{CC}^{+} + 0.3V) without damage.

Electrical Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition	
Low level output voltage	V_{OL}		5	20	mV	$R_L = 10k\Omega$	$T_A = +25°C$
				20			T_A at full range
Slew rate at unity gain	SR	0.2	0.4		V/μs	$V_{CC} = +15V$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain, $V_{IN} = 0.5V \sim 2.0V$	
Gain bandwidth product	GBP	0.5	0.9		MHz	$V_{CC} = +30V$, $R_L = 2k\Omega$, $C_L = 100pF$, $f = 100kHz$, $V_{IN} = 10mV$	
Total harmonic distortion	THD		0.02		%	$V_{CC} = +30V$, $R_L = 2k\Omega$, $C_L = 100pF$, $f = 1kHz$, $A_V = 20dB$, $V_{OUT2} = 2 \times V_{PP}$	
Equivalent input noise voltage	e_N		50		$nV/\sqrt{Hz}$	$V_{CC} = +30V$, $R_S = 100\Omega$, $f = 1kHz$	

Functional Block Diagram



Application Information

Introduction

Power supplies and battery chargers require precise control of output voltage and current in order to prevent catastrophic damage to the system connected. Many present day power sources contain a wide assortment of building blocks and glue devices to perform the required sensing for proper regulation. Typical feedback loop circuits may consist of a voltage and current amplifier, summing circuitry and a reference. The SQ7103 contains all of these basic functions in a manner that is easily adaptable to many of the various power source-load configurations.

Operating Description

The SQ7103 is an analog regulation control circuit that is designed to simultaneously close the voltage and current feedback loops in power supply, battery charger and LED lighting applications. This device can control the feedback loop in either constant voltage (CV) or constant current (CC) mode with smooth crossover. A concise description of the integrated circuit blocks is given in below. The functional block diagram of the IC is shown on page 6.

Internal Voltage Reference (+2.5V_{REF})

An internal precision bandgap reference is used to set the +2.5V voltage threshold and current threshold setting. The reference is initially trimmed to a ±0.4% tolerance at $T_A =$ +25°C and is guaranteed to be within ±0.8% over an ambient temperature range of -40°C to +105°C.

Voltage Sensing Operational Amplifier (Op-Amp 1)

The internal Op-Amp 1 is designed to perform the voltage control function. The non-inverting input of the Op-Amp is connected to the precision voltage reference internally. The inverting input of the Op-Amp monitors the voltage information derived from the system output. As the control threshold is internally connected to the voltage reference, the voltage regulation threshold is fixed at +2.5V. For any output voltage from +2.5V up to the maximum limit can be configured with an external resistor divider. The output terminal of Op-Amp 1 (pin 1) provides the error signal for output voltage control. The output pin also provides a means for external compensation.

Independent Operational Amplifier (Op-Amp 2)

The internal Op-Amp 2 is configured as a general purpose Op-Amp with all terminals available for the user. With the low offset voltage provided, 0.5mV, this Op-Amp can be used for current sensing in a constant current regulator.

Example Application

Refer to Figure 1 on page 8; this design is an implementation of constant voltage and constant current for LED lighting application with SQ6562A/SQ7103. The SQ6562A is a transition-mode PFC controller that can be used as a single stage PWM controller in fly-back topology. For detail, please refer the data sheet/application note of the SQ6562A. The SQ7103 has internal voltage reference +2.5V_{REF} and two Op-Amps, with the Op-Amp 1 for constant voltage, and the Op-Amp 2 for constant current control. These D4 and D5 diodes, which independently connects to the output of Op-Amp 1 and Op-Amp 2 as wired OR, are connected to cathode of internal diode of the PC817.

Constant Voltage

The inverting input of the Op-Amp 1, pin 2 is connected from external voltage divider consisting of R13 and R14. Since the non-inverting input of the Op-Amp 1, pin 3, is fixed at +2.5V, pin 2 is also forced to be +2.5V, the voltage at LED+ can be calculated as follows :

$$V_{LED+} = 2.5V \times (1 + \frac{R13}{R14}) + V_{R6} \quad (1)$$

This voltage value might be measured when loading is removed from the system. R8 and C8 together behave as compensation feedback.

Constant Current

Current controller is implemented by the Op-Amp 2. R9 and C9 together behave as compensation feedback. The current sensing resistor, R6, is sitting between the ground and LED-. LED- is fed as inverting input of the Op-Amp 2 to control current.

I_{LED} can be calculated as voltage drop through R6 divided by resistor value as below :

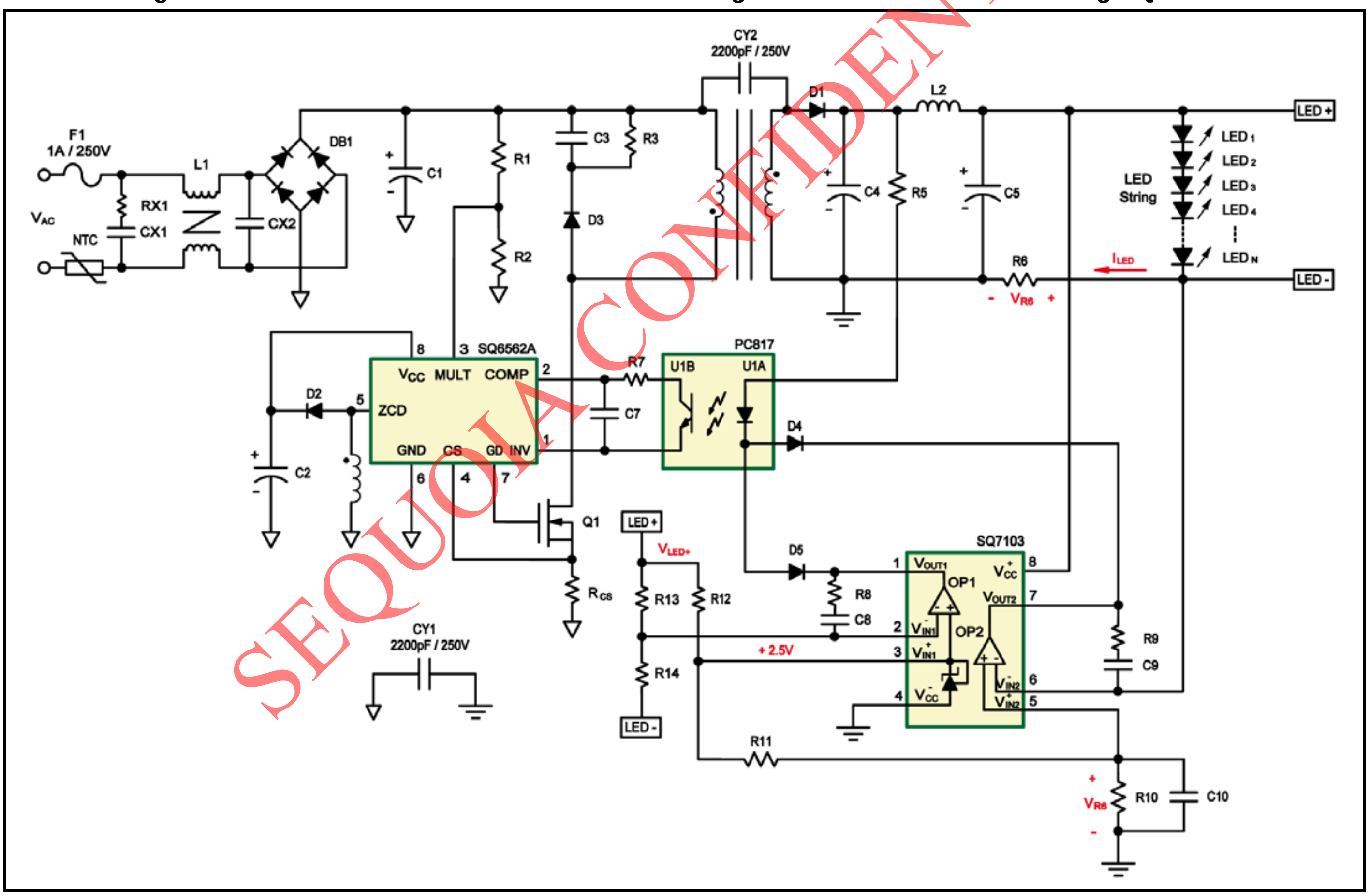
$$I_{LED} = \frac{V_{R6}}{R6} \quad (2)$$

By equating inverting and non-inverting input of Op-Amp 2,

$$V_{R6} = 2.5V \times \frac{R10}{R10 + R11} \quad (3)$$

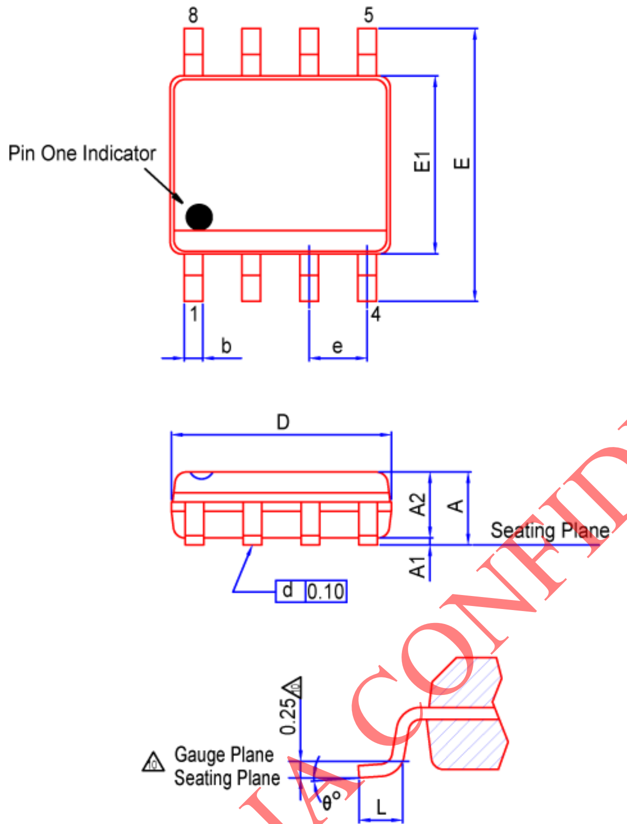
As R10 and R11 are regarded as two variables, R11 has to be decided first, in order to decide R10. R10 and C10 together constitute a low pass RC filter to avoid overshoot return from output voltage.

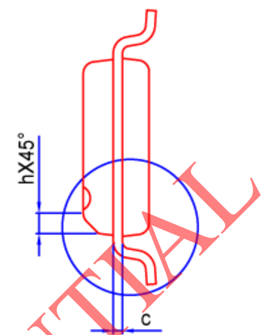
Figure 1. Isolated LED Driver with Constant Voltage and Constant Current Using SQ7103



Package Outline Dimensions

Package Type : SOP-8



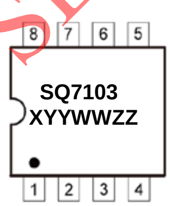


Symbols	Min.	Max.
A	1.35	1.75
A1	0.10	0.25
A2	1.10	1.65
b	0.33	0.51
c	0.19	0.25
D	4.80	5.00
E	5.80	6.20
E1	3.80	4.00
e	1.27 BSC	
L	0.40	1.27
h	0.25	0.50
θ°	0	8

Unit : mm

Marking Information

SOP-8



X = A/T Site, YY = Year, WW = Working Week, ZZ = Device Version

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