

## Dual Operational Amplifiers and Voltage Reference

### DESCRIPTION

The TS103 is a monolithic IC specifically designed to control the output current and voltage levels of switch mode battery chargers and power supplies. The device contains two operational amplifiers and a precision shunt regulator. OP AMP 1 is designed for voltage control, whose non-inverting input internally connects to the output of the shunt regulator. OP AMP 2 is for current control with both inputs uncommitted. The IC offers the power converter designer a control solution that features increased precision with a corresponding reduction in system complexity and cost.

### FEATURES

- Input Offset Voltage: 0.5mV
- Supply Current: 250µA per OP AMP @ 5V
- Unity Gain Bandwidth: 1MHz
- Output Voltage Swing: 0~(V<sub>CC</sub> - 1.5) V
- Power Supply Voltage: 3~18V
- Fixed Output Voltage Reference: 2.5V±1%
- Sink Current Capability from 0.2~80mA
- Compliant to RoHS Directive 2011/65/EU and in accordance to WEEE 2002/96/EC.
- Halogen-free according to IEC 61249-2-21

### APPLICATION

- Battery chargers
- Switch-Mode Power Supplies
- Linear voltage regulation

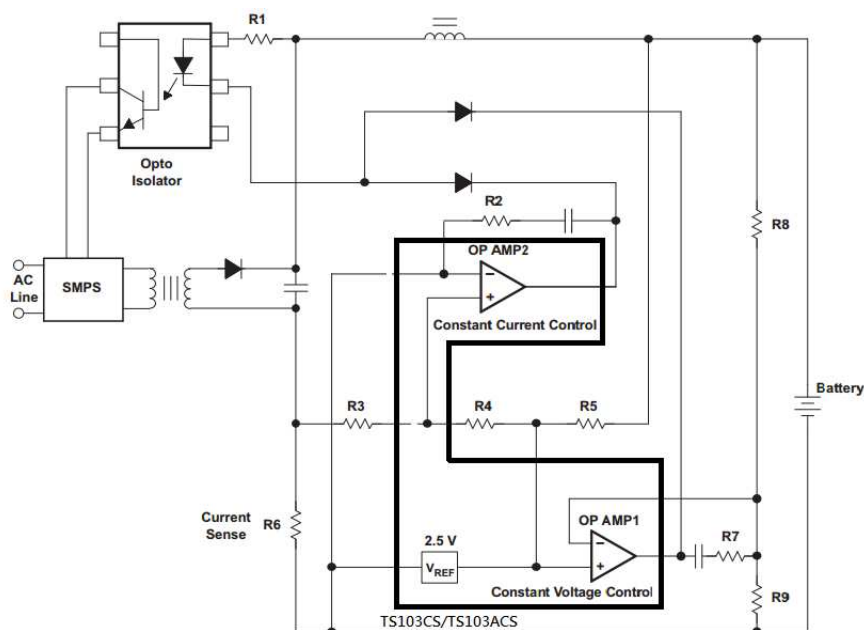


#### Pin Definition:

- |                                  |                    |
|----------------------------------|--------------------|
| 1. Output A                      | 8. V <sub>CC</sub> |
| 2. Input A (-)                   | 7. Output B        |
| 3. Input A (+) / V <sub>KA</sub> | 6. Input B (-)     |
| 4. GND                           | 5. Input B (+)     |

**Note:** MSL 3 (Moisture Sensitivity Level) per J-STD-020

### TYPICAL APPLICATION CIRCUIT



<b>ABSOLUTE MAXIMUM RATINGS</b> (Note 1)			
PARAMETER	SYMBOL	LIMIT	UNIT
Power Supply Voltage ( $V_{CC}$ to GND)	$V_{CC}$	20	V
Op Amp 1 and 2 Input Voltage Range (Pins 2,5,6)	$V_{IN}$	-0.3 to $V_{CC}$ +0.3	V
Op Amp 2 Input Differential Voltage (Pins 5,6)	$V_{ID}$	20	V
Voltage Reference Cathode Current (Pin 3)	$I_K$	100	mA
Power Dissipation	$P_D$	500	mW
Storage Temperature Range	$T_{STG}$	-65 to 150	°C
ESD Protection Voltage (Machine Model)	--	≥200	V

<b>RECOMMENDED OPERATING CONDITIONS</b> (Note 3)			
PARAMETER	SYMBOL	CONDITIONS	UNIT
Supply Voltage	$V_{CC}$	3 ~ 18	V
Operating Ambient Temperature Range	$T_{OPA}$	-40 to +85	°C

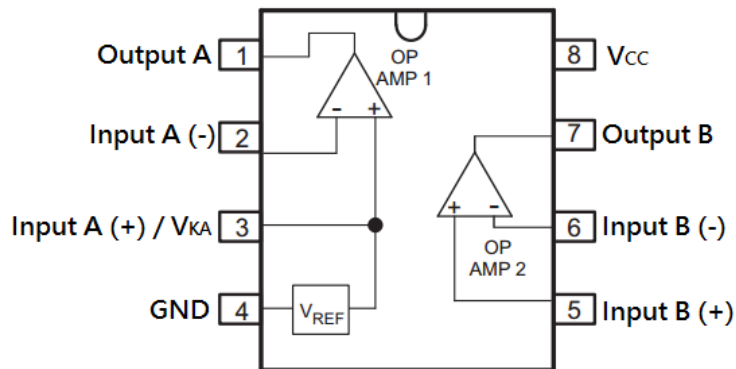
<b>ELECTRICAL SPECIFICATIONS</b> ( $V_{CC} = 18V$ , $T_A = 25^\circ C$ unless otherwise noted)						
PARAMETER	CONDITIONS		MIN	TYP	MAX	UNIT
Total Supply Current, excluding Current in Voltage Reference	$V_{CC} = 5V$ , no load, $-40^\circ C \leq T_A \leq 85^\circ C$		--	0.5	0.8	mA
	$V_{CC} = 18V$ , no load, $-40^\circ C \leq T_A \leq 85^\circ C$		--	0.6	1.2	
<b>Voltage Reference Section</b>						
Reference Voltage	TS103	$I_{KA} = 10mA$	2.475	2.500	2.525	V
		$I_{KA} = 10mA @ -40^\circ C \leq T_A \leq 85^\circ C$	2.45	2.500	2.55	
	TS103A	$I_{KA} = 10mA$	2.490	2.500	2.510	
		$I_{KA} = 10mA @ -40^\circ C \leq T_A \leq 85^\circ C$	2.475	2.500	2.525	
Reference Voltage Deviation Over Full Temperature Range	$I_{KA} = 10mA$ , $T_A = -40$ to $85^\circ C$		--	5	24	mV
Minimum Cathode Current for Regulation			--	0.2	1.0	mA
Dynamic Impedance	$V_{CC} = 1.0$ to $80mA$ , $f < 1kHz$			0.3	0.5	$\Omega$
<b>OP AMP 1 Section</b> ( $V_{CC} = 5V$ , $V_O = 1.4V$ , $T_A = 25^\circ C$ , unless otherwise noted)						
Input Offset Voltage	$T_A = 25^\circ C$ (TS103)		--	0.5	3	mV
	$T_A = 25^\circ C$ (TS103A)		--	0.5	2	
	$T_A = -40$ to $85^\circ C$		--	--	5	
Input Offset Voltage Temperature Drift	$T_A = -40$ to $85^\circ C$		--	7	--	$\mu V/^\circ C$
Input Bias Current (Inverting Input Only)	$T_A = 25^\circ C$		--	20	150	nA
Large Signal Voltage Gain	$V_{CC} = 15V$ , $R_L = 2k\Omega$ , $V_O = 1.4$ to $11.4V$		85	100	--	dB

<b>ELECTRICAL SPECIFICATIONS</b> ( $V_{CC} = 18V, T_A = 25^{\circ}C$ unless otherwise noted)						
PARAMETER	CONDITIONS		MIN	TYP	MAX	UNIT
Power Supply Rejection Ratio	$V_{CC} = 5$ to 18V		70	90	--	dB
Output Current	Source	$V_{CC} = 15V, V_{ID} = 1V, V_O = 2V$	20	40	--	mA
	Sink	$V_{CC} = 15V, V_{ID} = -1V, V_O = 2V$	10	20	--	mA
Output Voltage Swing (High)	$V_{CC} = 18V, R_L = 10k\Omega, V_{ID} = 1V$		16	16.5	--	V
Output Voltage Swing (Low)	$V_{CC} = 18V, R_L = 10k\Omega, V_{ID} = -1V$		--	17	100	mV
Slew Rate	$V_{CC} = 18V, R_L = 2k\Omega, A_V = 1,$ $V_{IN} = 0.5$ to 2V, $C_L = 100pF$		0.2	0.5	--	V/ $\mu$ s
Gain Bandwidth Product	$V_{CC} = 18V, R_L = 2k\Omega, C_L = 100pF$ $V_{IN} = 10mV, f = 100kHz$		0.5	1	--	MHz
<b>OP AMP 2 Section</b> ( $V_{CC} = 5V, V_O = 1.4V, T_A = 25^{\circ}C$ , unless otherwise noted)						
Input Offset Voltage	$T_A = 25^{\circ}C$ (TS103)		--	0.5	3	mV
	$T_A = 25^{\circ}C$ (TS103A)		--	0.5	2	
	$T_A = -40$ to $85^{\circ}C$		--	--	5	
Input Offset Voltage Temperature Drift	$T_A = -40$ to $85^{\circ}C$		--	7	--	$\mu$ V/ $^{\circ}C$
Input Bias Current	$T_A = 25^{\circ}C$		--	20	150	nA
Input Voltage Range	$V_{CC} = 0$ ~18V		0	00	$V_{CC}-1.5$	V
Large Signal Voltage Gain	$V_{CC} = 15V, R_L = 2k\Omega,$ $V_O = 1.4$ to 11.4V		85	100	--	dB
Power Supply Rejection Ratio	$V_{CC} = 5$ to 18V		70	90	--	dB
Output Current	Source	$V_{CC} = 15V, V_{ID} = 1V, V_O = 2V$	20	40	--	mA
	Sink	$V_{CC} = 15V, V_{ID} = -1V, V_O = 2V$	10	20	--	mA
Output Voltage Swing (High)	$V_{CC} = 18V, R_L = 10k\Omega, V_{ID} = 1V$		16	16.5	--	V
Output Voltage Swing (Low)	$V_{CC} = 18V, R_L = 10k\Omega, V_{ID} = -1V$		--	17	100	mV
Slew Rate	$V_{CC} = 18V, R_L = 2k\Omega, A_V = 1,$ $V_{IN} = 0.5$ to 2V, $C_L = 100pF$		0.2	0.5	--	V/ $\mu$ s
Gain Bandwidth Product	$V_{CC} = 18V, R_L = 2k\Omega, C_L = 100pF$ $V_{IN} = 10mV, f = 100kHz$		0.5	1	--	MHz

## ORDERING INFORMATION

PART NO.	PACKAGE	PACKING
TS103CS RLG	SOP-8	2,500pcs / 13"Reel
TS103ACS RLG	SOP-8	2,500pcs / 13"Reel

**BLOCK DIAGRAM**

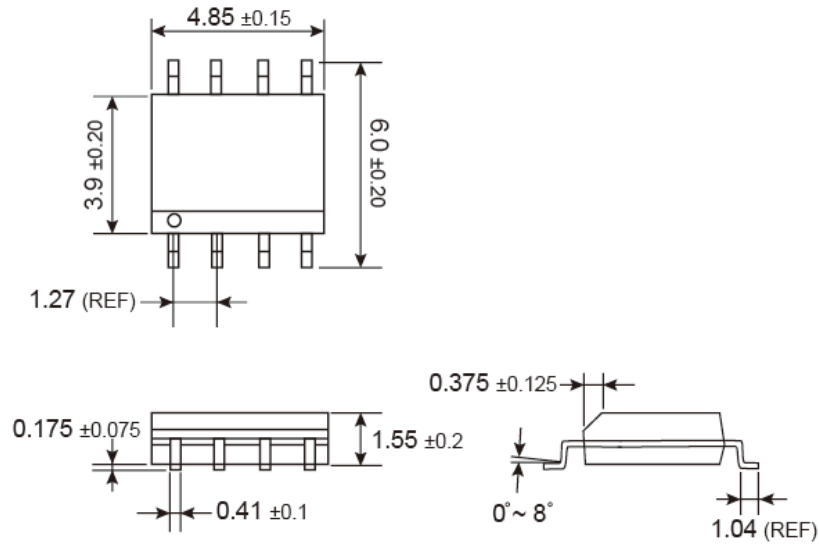


**PIN DESCRIPTION**

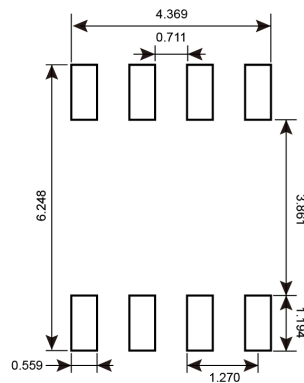
PIN NO.	NAME	FUNCTION
1	Output A	OP AMP 1 output
2	Input A (-)	OP AMP 1 inverting input
3	Input A (+) / $V_{KA}$	OP AMP 1 non-inverting input and shunt reference cathode terminal
4	GND	Negative supply voltage
5	Input B (+)	OP AMP 2 output
6	Input B (-)	OP AMP 2 non-inverting input
7	Output B	OP AMP 2 output
8	$V_{CC}$	Positive supply voltage

**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

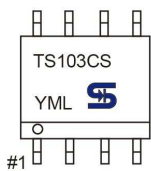
**SOP-8**



**SUGGESTED PAD LAYOUT** (Unit: Millimeters)



**MARKING DIAGRAM**



- Y** = Year Code
- M** = Month Code for Halogen Free Product
  - O** =Jan
  - P** =Feb
  - Q** =Mar
  - R** =Apr
  - S** =May
  - T** =Jun
  - U** =Jul
  - V** =Aug
  - W** =Sep
  - X** =Oct
  - Y** =Nov
  - Z** =Dec
- L** = Lot Code (1~9, A~Z)

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