

TL103Wx 内部基準電圧付き、デュアル・オペアンプ

1 特長

- TL103W および TL103WA のピン互換アップグレード製品である新しい **TL103WB**
- B バージョンの仕様を以下のように改善:
 - 電源電圧範囲: 3V~36V
 - 低い最大入力オフセット電圧: $\pm 2\text{mV}$ (25°C) および $\pm 2.5\text{mV}$ (全温度範囲)
 - ゲイン帯域幅: 1.2MHz
 - 合計消費電流: 550 μA
 - EMI 除去: RF および EMI フィルタを内蔵
 - 温度範囲: -40°C~125°C
- B バージョンの基準電圧の仕様を改善:
 - 2.5V の固定基準電圧
 - 厳しいトレランス: 最大 0.44% (25°C) および 1.04% (全温度範囲)
 - 広いシンク電流範囲: 100mA で 0.2mA (代表値)

2 アプリケーション

- バッテリー充電器
- スイッチモード電源
- リニア電圧レギュレーション
- データ収集システム
- 高精度定電流シンク

3 概要

TL103Wx デバイスは、デュアル オペアンプと固定基準電圧の構築ブロックを組み合わせたものです。どちらも、スイッチモード電源とリニア電源の制御回路によく使用されます。オペアンプ 1 は非反転入力に 2.5V の固定基準電圧に内部で接続されているのに対し、オペアンプ 2 は独立しており、両方の入力は不確定です。

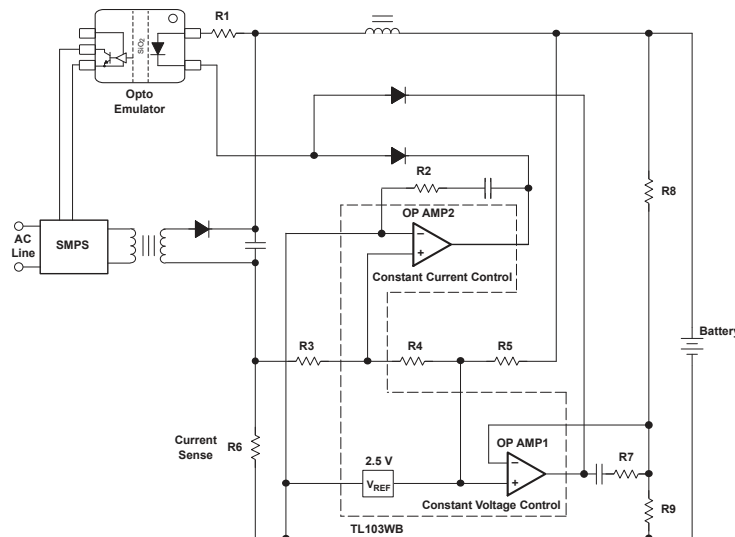
アップグレードされた TL103WB は、より広い電源電圧範囲 (最大 36V)、より小さい消費電流 (275 μA /アンプ)、より厳しい電圧レギュレーションなどの点で改良されています。このレギュレーションは、両オペアンプ向けの低いオフセット電圧 (代表値 0.3mV) と、基準電圧の厳しいトレランス (25°C で 0.44%、動作温度範囲全体にわたって 1.04%) により達成されます。

TL103WB は、-40°C~125°C の広い温度範囲に対応しています。

パッケージ情報

部品番号	チャンネル数	パッケージ (1)	パッケージ サイズ (2)
TL103W TL103WA	デュアル + 基準電圧	D (SOIC, 8)	4.9mm × 6mm
TL103WB		DDF (SOT-23, 8)	2.9mm × 2.8mm

- 詳細については、[セクション 10](#) を参照してください。
- パッケージ サイズ (長さ × 幅) は公称値であり、該当する場合はピンも含まれます。



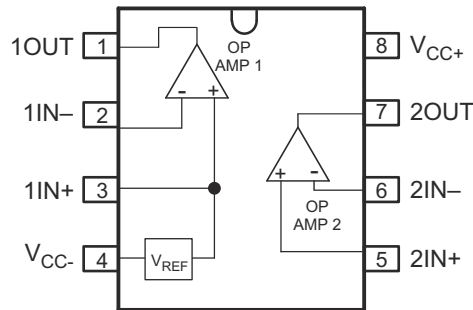
代表的なアプリケーション回路



Table of Contents

1 特長	1	6.3 Feature Description.....	12
2 アプリケーション	1	6.4 Device Functional Modes.....	13
3 概要	1	7 Application and Implementation	14
4 Pin Configuration and Functions	3	7.1 Application Information.....	14
5 Specifications	4	7.2 Typical Applications.....	14
5.1 Absolute Maximum Ratings.....	4	7.3 Power Supply Recommendations.....	17
5.2 ESD Ratings.....	4	7.4 Layout.....	17
5.3 Recommended Operating Conditions.....	4	8 Device and Documentation Support	19
5.4 Thermal Information.....	5	8.1 Documentation Support.....	19
5.5 Electrical Characteristics: OP AMP1 (V_{REF} at Noninverting input).....	5	8.2 ドキュメントの更新通知を受け取る方法.....	19
5.6 Electrical Characteristics: OP AMP2 (Independent Amplifier).....	6	8.3 サポート・リソース.....	19
5.7 Typical Characteristics: TL103WB.....	8	8.4 Trademarks.....	19
6 Detailed Description	12	8.5 静電気放電に関する注意事項.....	19
6.1 Overview.....	12	8.6 用語集.....	19
6.2 Functional Block Diagram.....	12	9 Revision History	19
		10 Mechanical, Packaging, and Orderable Information	21

4 Pin Configuration and Functions



**図 4-1. D and DDF Packages,
8-Pin SOIC and SOT-23-THN
(Top View)**

表 4-1. Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
1OUT	1	O	Opamp 1 output
1IN-	2	I	Opamp 1 inverting input
1IN+	3	I	Opamp 1 non-inverting input and Shunt reference cathode terminal
V _{CC-}	4	I	Negative Supply Voltage
2IN+	5	I	Opamp 2 non-inverting input
2IN-	6	I	Opamp 2 inverting input
2OUT	7	O	Opamp 2 output
V _{CC+}	8	I	Positive Supply Voltage

(1) I = input, O = output

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

			MIN	MAX	UNIT
V _{CC±}	Supply voltage	TL103W/TL103WA	0	36	V
		TL103WB	0	40	
V _{ID}	Operational amplifier input differential voltage			36	V
V _I	Operational amplifier input voltage range ⁽²⁾		(V _{CC-}) - 0.3	V _{CC+}	V
I _{KA}	Voltage reference cathode current			100	mA
T _J	Maximum junction temperature			150	°C
T _{stg}	Storage temperature range		-65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Rating* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) Not applicable to pin 4 (1IN+)

5.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2500	V
		Charged device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V _{CC±}	Supply voltage	TL103W/TL103WA	3	32	V
		TL103WB	3	36	
V _{ICR}	Input common-mode voltage range		V _{CC-}	(V _{CC+}) - 2	V
I _K	Cathode current	TL103W/TL103WA	0.5	100	mA
		TL103WB	0.2	100	
T _A	Operating free-air temperature	TL103W/TL103WA	-40	105	°C
		TL103WB	-40	125	

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TL103Wx		UNIT
		SOIC (D)	SOT-23 (DDF)	
		8 PINS	8 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	135.4	170.1	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	77.3	89.7	°C/W
R _{θJB}	Junction-to-board thermal resistance	78.9	87.5	°C/W
Ψ _{JT}	Junction-to-top characterization parameter	27.4	7.5	°C/W
Ψ _{JB}	Junction-to-board characterization parameter	78.1	87.3	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	–	–	°C/W

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

5.5 Electrical Characteristics: OP AMP1 (V_{REF} at Noninverting input)

V_{CC+} = 5V, V_{CC-} = GND, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT									
AMPLIFIER																	
V _{IO}	Input offset voltage	V _{ICM} = 0V	TL103W			±1	±4	mV									
				Full range			±5										
			TL103WA			±0.5	±3.0										
				Full range			±5										
TL103WB			±0.3	±2													
	Full range			±2.5													
αV _{IO}	Input offset-voltage drift		TL103W/TL103WA	Full range		±7		μV/°C									
			TL103WB	Full range		±2											
I _B	Input bias current (negative input)		TL103W/TL103WA			-20		nA									
			TL103WB			-15											
A _{VD}	Large-signal voltage gain	V _{CC+} = 15V, R _L = 2kΩ, V _{ICM} = 0V	TL103W/TL103WA			100		V/mV									
			TL103WB			210											
PSRR	Supply-voltage rejection ratio	V _{CC+} = 5V to 30V, V _{ICM} = 0V	TL103W/TL103WA		65	100		dB									
			TL103WB		99	114											
I _O	Output current	V _{CC+} = 15V, V _O = 2V, V _{ID} = 1V	Source		20	40		mA									
			Sink	TL103W/TL103WA		10	12										
		V _{CC+} = 15V, V _O = 0.2V, V _{ID} = -1V	Sink	TL103W/TL103WA		12	50		μA								
			TL103WB		60	100											
I _{sc}	Short-circuit to GND	V _{CC+} = 15V				±40	±68	mA									
									V _O	Voltage output swing from rail	V _{CC+} = 30V, R _L = 2kΩ	Positive Rail (V _{CC+})	TL103W/TL103WA		26	27	V
													Full range		26		
											TL103WB			27.4	28.3		
												Full range		27.4			
									V _{CC+} = 30V, R _L = 10kΩ	Positive Rail (V _{CC+})	TL103W/TL103WA		27	28			
Full range		27															
TL103WB			27.6	28.6													
	Full range		27.6														
R _L = 10kΩ	Negative Rail (V _{CC-})			5	20												
		Full range			20												
SR	Slew rate at unity gain	V _{CC+} = 15V, C _L = 100pF, R _L = 2kΩ, V _I = 0.5V to 2V, unity gain	TL103W/TL103WA		0.2	0.4		V/μs									
			TL103WB		0.2	0.5											
GBW	Gain bandwidth product	V _{CC+} = 30V, V _I = 10mV, C _L = 100pF, R _L = 2kΩ, f = 100kHz	TL103W/TL103WA		0.5 ⁽¹⁾	0.9		MHz									
		V _{CC+} = 36V, V _I = 10mV, C _L = 100pF, R _L = 2kΩ, f = 100kHz	TL103WB		0.7 ⁽¹⁾	1.2											

5.5 Electrical Characteristics: OP AMP1 (V_{REF} at Noninverting input) (続き)

V_{CC+} = 5V, V_{CC-} = GND, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT
THD	Total harmonic distortion	V _{CC+} = 30V, V _O = 2V _{pp} , C _L = 100pF, R _L = 2kΩ, f = 1kHz, A _V = 20dB	TL103W/TL103WA			0.02		%
		V _{CC+} = 36V, V _O = 2V _{pp} , C _L = 100pF, R _L = 2kΩ, f = 1kHz, A _V = 20dB	TL103WB			0.005		
I _{CC}	Total supply current, excluding cathode-current reference (both amplifiers)	V _{CC+} = 5V, no load	TL103W/TL103WA	Full range		0.7	1.2	mA
		V _{CC+} = 30V, no load					2	
		V _{CC+} = 5V, no load	TL103WB	Full range		0.55	0.77	
		V _{CC+} = 36V, no load					1.35	
VOLTAGE REFERENCE								
V _{ref}	Reference Voltage	I _K = 10mA	TL103W		2.482	2.5	2.518	V
				Full Range	2.465		2.535	V
			TL103WA/TL103WB		2.489	2.5	2.511	V
				Full Range	2.474		2.526	V
ΔV _{ref}	Reference input voltage deviation over temperature range	I _K = 10mA	TL103W	Full Range		7	35 ⁽¹⁾	mV
			TL103WA/TL103WB	Full Range		7	26 ⁽¹⁾	mV
I _{min}	Minimum cathode current for regulation		TL103W/TL103Wx			0.5	1	mA
			TL103WB			0.2	1	
Z _K	Dynamic impedance	I _K = 1mA to 100mA, f < 1kHz				0.45	0.8	Ω

(1) Not tested in production, limits set by characterization and simulation.

5.6 Electrical Characteristics: OP AMP2 (Independent Amplifier)

V_{CC+} = 5V, V_{CC-} = GND, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A	MIN	TYP	MAX	UNIT
V _{IO}	Input offset voltage	V _{ICM} = 0V	TL103W			±1	±4	mV
				Full range			±5	
			TL103WA			±0.5	±3.0	
				Full range			±5	
TL103WB			±0.3	±2				
	Full range			±2.5				
αV _{IO}	Input offset-voltage drift		TL103W/TL103WA	Full range		±7		μV/°C
			TL103WB	Full range		±2		
I _{IO}	Input offset current		TL103W/TL103WA			±2	±75	nA
				Full range			±150	
			TL103WB			±0.5	±4	
				Full range			±5	
I _{IB}	Input bias current		TL103W/TL103WA			-20	-150	nA
				Full range			-200	
			TL103WB			-15	-35	
				Full range			-50	
A _{VD}	Large-signal voltage gain	V _{CC+} = 15V, R _L = 2kΩ, V _O = 1.4V to 11.4V	TL103W/TL103WA		50	100		V/mV
				Full range	25	100		
			TL103WB		77	210		
				Full range	45	210		
PSRR	Supply-voltage rejection ratio	V _{CC+} = 5V to 30V	TL103W/TL103WA		65	100		dB
			TL103WB		99	114		
V _{ICR}	Input common-mode voltage range	V _{CC+} = 30V			V _{CC-}	(V _{CC+}) - 1.5		V
				Full range	V _{CC-}	(V _{CC+}) - 2		

5.6 Electrical Characteristics: OP AMP2 (Independent Amplifier) (続き)

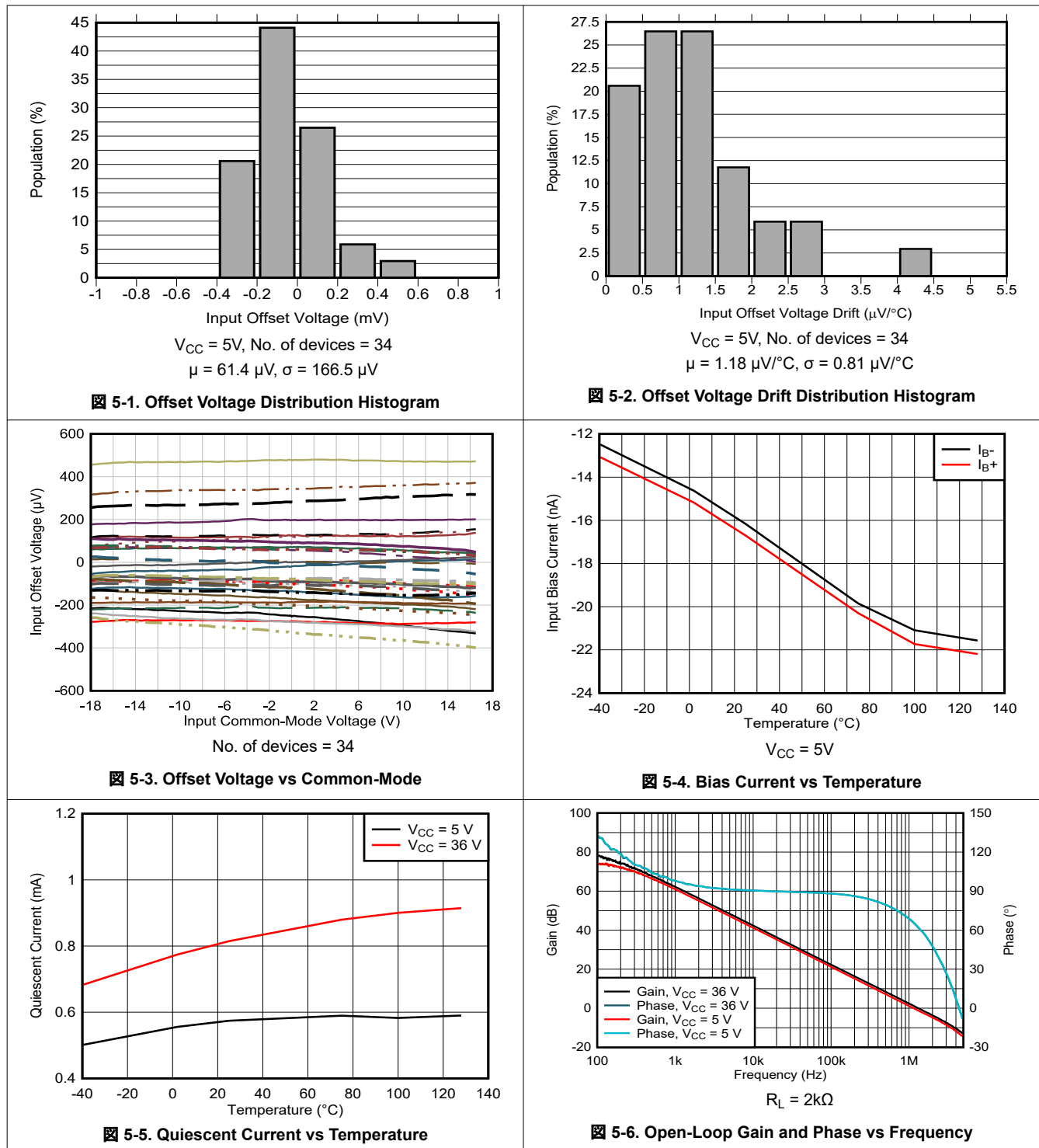
$V_{CC+} = 5V$, $V_{CC-} = GND$, $T_A = 25^\circ C$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
CMRR	Common-mode rejection ratio	$V_{CC+} = 30V$		TL103W/TL103WA		70	95	dB
					Full range	60		
				TL103WB		93	104	
					Full range	70		
I_O	Output current	$V_{CC+} = 15V$, $V_O = 2V$, $V_{ID} = 1V$	Source	TL103W/TL103WA		20	40	mA
			Sink			10	12	
				TL103WB		10	24	
		$V_{CC+} = 15V$, $V_O = 0.2V$, $V_{ID} = -1V$	Sink	TL103W/TL103WA		12	50	μA
				TL103WB		60	100	
I_{SC}	Short-circuit to GND	$V_{CC+} = 15V$			± 40	± 68	mA	
V_O	Voltage output swing from rail	$V_{CC+} = 30V$, $R_L = 2k\Omega$	Positive Rail (V_{CC+})	TL103W/TL103WA		26	27	V
				Full range	26			
			TL103WB		27.4	28.3		
				Full range	27.4			
		$V_{CC+} = 30V$, $R_L = 10k\Omega$	Positive Rail (V_{CC+})	TL103W/TL103WA		27	28	V
				Full range	27			
			TL103WB		27.6	28.6		
				Full range	27.6			
		$R_L = 10k\Omega$	Negative Rail (V_{CC-})			5	20	mV
				Full range			20	
SR	Slew rate at unity gain	$V_{CC+} = 15V$, $C_L = 100pF$, $R_L = 2k\Omega$, $V_I = 0.5V$ to $2V$, unity gain		TL103W/TL103WA		0.2	0.4	V/ μs
				TL103WB		0.2	0.5	
GBW	Gain bandwidth product	$V_{CC+} = 30V$, $V_I = 10mV$, $C_L = 100pF$, $R_L = 2k\Omega$, $f = 100kHz$		TL103W/TL103WA		0.5 ⁽¹⁾	0.9	MHz
		$V_{CC+} = 36V$, $V_I = 10mV$, $C_L = 100pF$, $R_L = 2k\Omega$, $f = 100kHz$		TL103WB		0.7 ⁽¹⁾	1.2	
THD	Total harmonic distortion	$V_{CC+} = 30V$, $V_O = 2V_{PP}$, $C_L = 100pF$, $R_L = 2k\Omega$, $f = 1kHz$, $A_V = 20dB$		TL103W/TL103WA		0.02		%
		$V_{CC+} = 36V$, $V_O = 2V_{PP}$, $C_L = 100pF$, $R_L = 2k\Omega$, $f = 1kHz$, $A_V = 20dB$		TL103WB		0.005		
V_n	Equivalent input noise voltage	$V_{CC+} = 30V$, $R_S = 100\Omega$, $f = 1kHz$		TL103W/TL103WA		50		nV/ \sqrt{Hz}
		$V_{CC+} = 36V$, $R_S = 100\Omega$, $f = 1kHz$		TL103WB		38		
I_{CC}	Total supply current, excluding cathode-current reference (both amplifiers)	$V_{CC+} = 5V$, no load		TL103W/TL103WA		0.7	1.2	mA
		$V_{CC+} = 30V$, no load			Full range		2	
		$V_{CC+} = 5V$, no load	TL103WB		0.55	0.77		
		$V_{CC+} = 36V$, no load		Full range		1.35		

(1) Not tested in production, limits set by characterization and simulation.

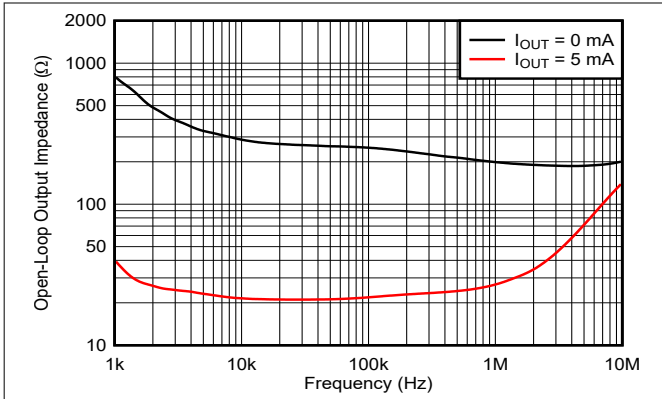
5.7 Typical Characteristics: TL103WB

at $T_A \cong 25^\circ\text{C}$, $V_{CC} = 36\text{V} (\pm 18\text{V})$, $V_{CM} = V_{CC} / 2$, $R_L = 10\text{k}\Omega$ connected to $V_{CC} / 2$ (unless otherwise noted)

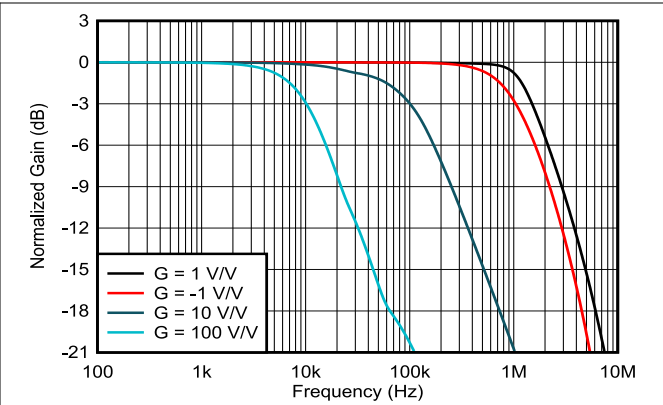


5.7 Typical Characteristics: TL103WB (continued)

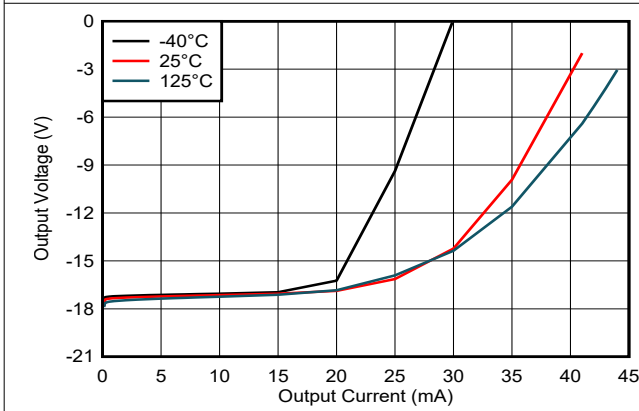
at $T_A \cong 25^\circ\text{C}$, $V_{CC} = 36\text{V} (\pm 18\text{V})$, $V_{CM} = V_{CC} / 2$, $R_L = 10\text{k}\Omega$ connected to $V_{CC} / 2$ (unless otherwise noted)



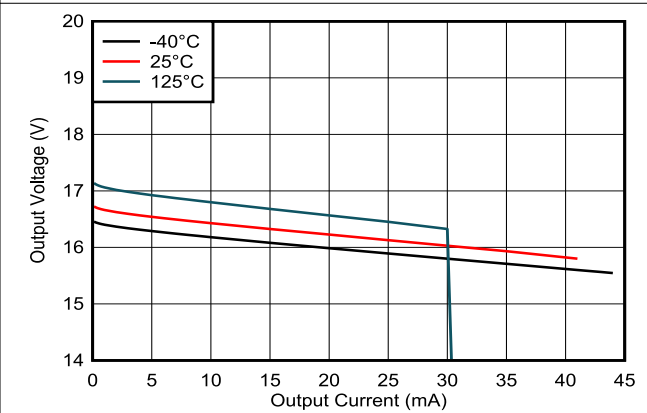
5-7. Open-Loop Output Impedance vs Frequency



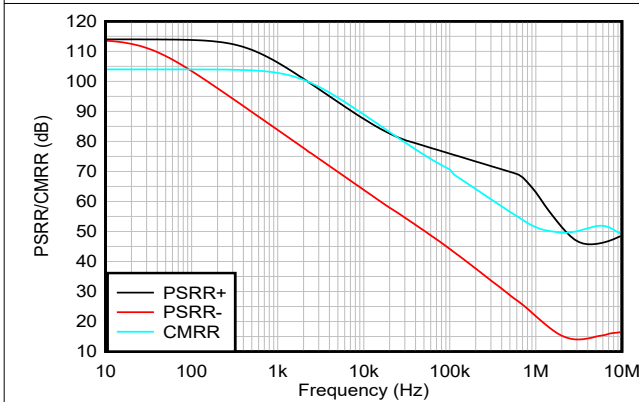
5-8. Closed-Loop Gain vs Frequency



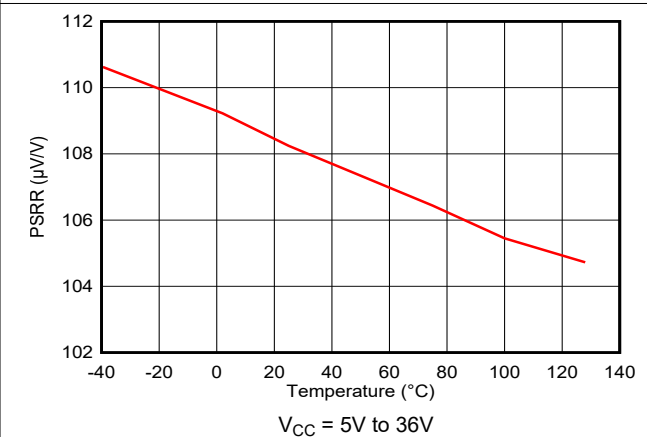
5-9. Output Voltage vs Output Current (Sinking)



5-10. Output Voltage vs Output Current (Sourcing)



5-11. PSRR and CMRR vs Frequency



5-12. Supply-Voltage Rejection Ratio vs Temperature

5.7 Typical Characteristics: TL103WB (continued)

at $T_A \cong 25^\circ\text{C}$, $V_{CC} = 36\text{V} (\pm 18\text{V})$, $V_{CM} = V_{CC} / 2$, $R_L = 10\text{k}\Omega$ connected to $V_{CC} / 2$ (unless otherwise noted)

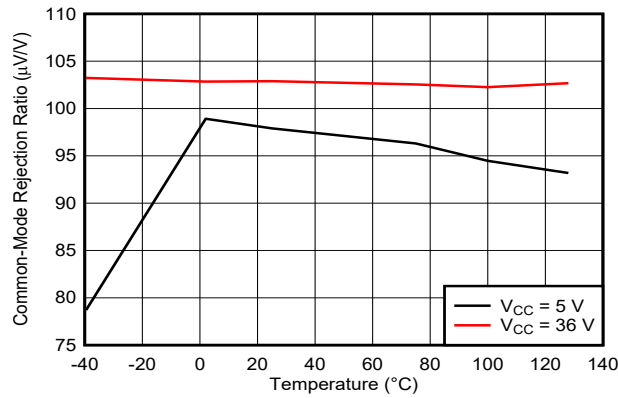


Figure 5-13. CMRR vs Temperature

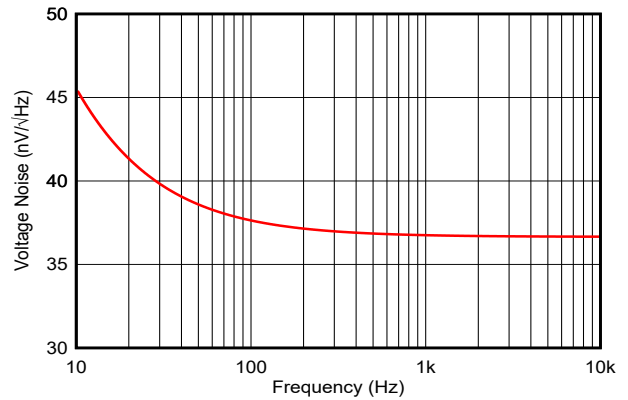
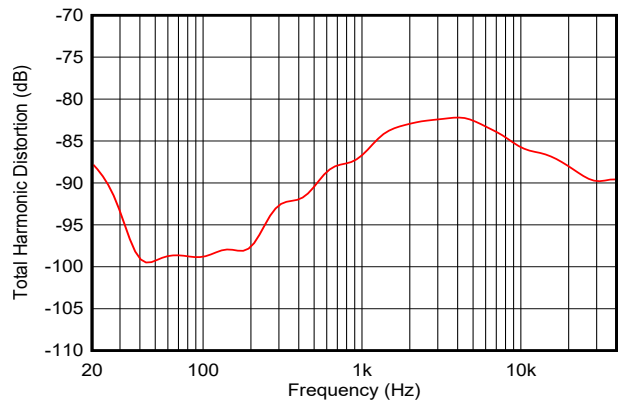
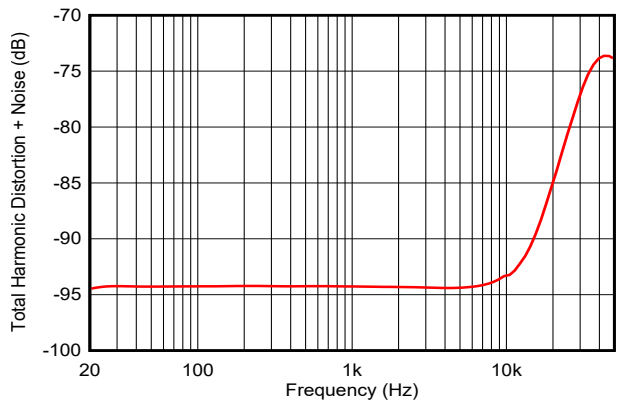


Figure 5-14. Input Voltage Noise Spectral Density vs Frequency



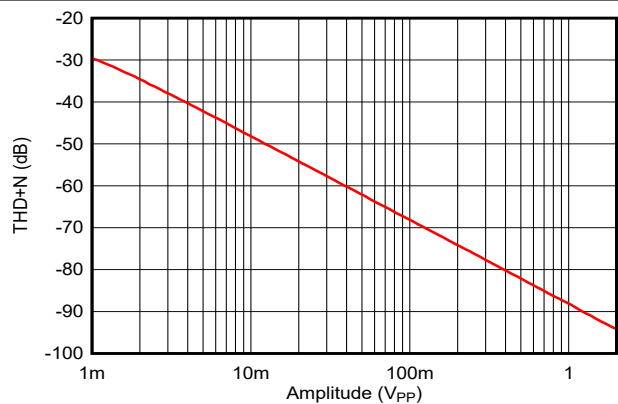
$V_{CC} = 30\text{V}$, $V_{OUT} = 2V_{PP}$, $R_L = 2\text{k}\Omega$, $C_L = 100\text{pF}$, $A_V = 20\text{dB}$

Figure 5-15. Total Harmonic Distortion vs Frequency



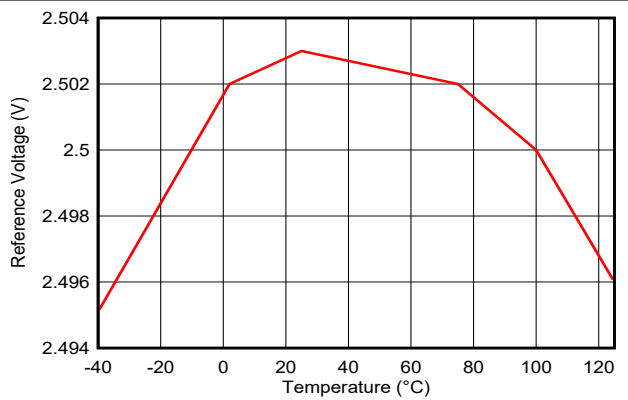
$V_{OUT} = 2V_{PP}$, $R_L = 2\text{k}\Omega$, $BW = 80\text{kHz}$, $A_V = 0\text{dB}$

Figure 5-16. Total Harmonic Distortion + Noise vs Frequency



$f = 1\text{kHz}$, $R_L = 2\text{k}\Omega$, $BW = 80\text{kHz}$, $A_V = 0\text{dB}$

Figure 5-17. Total Harmonic Distortion + Noise vs Amplitude

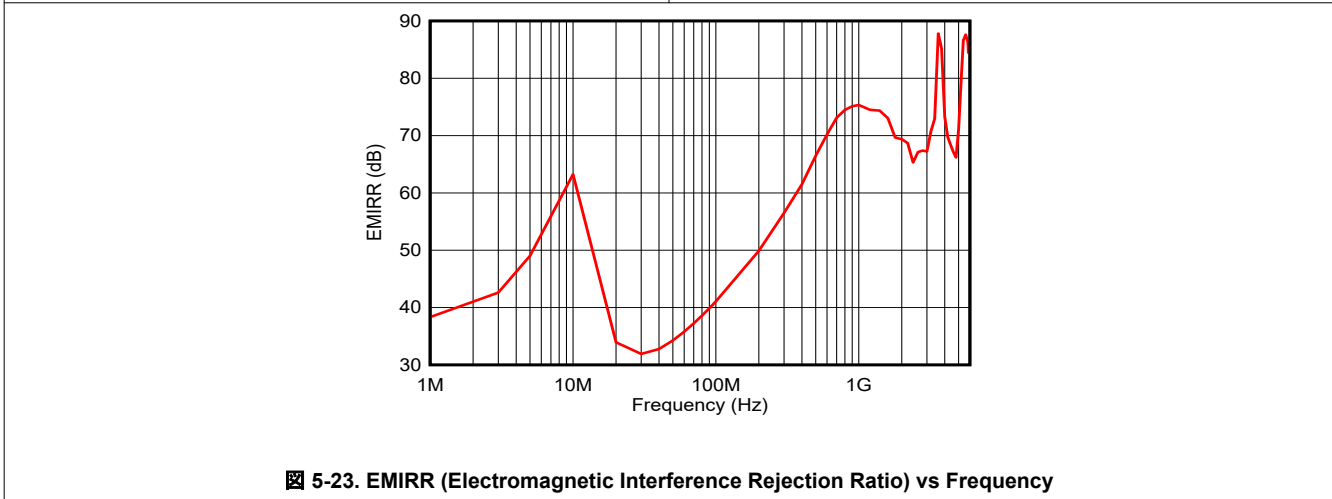
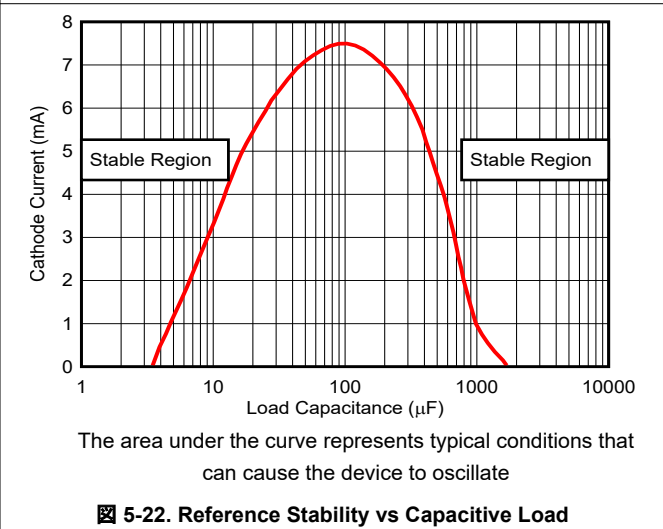
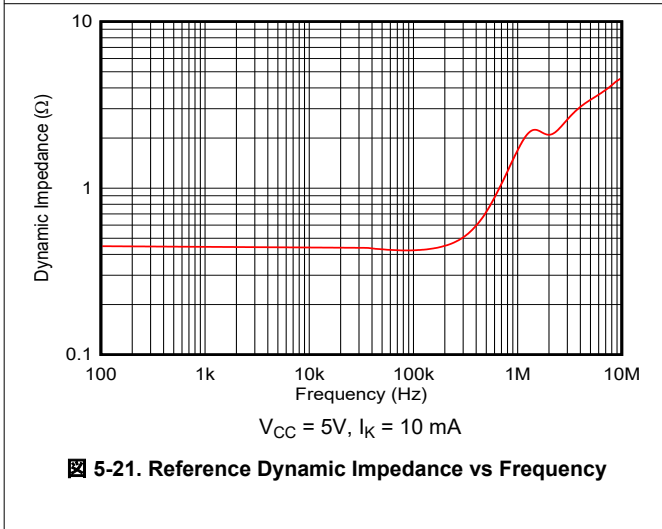
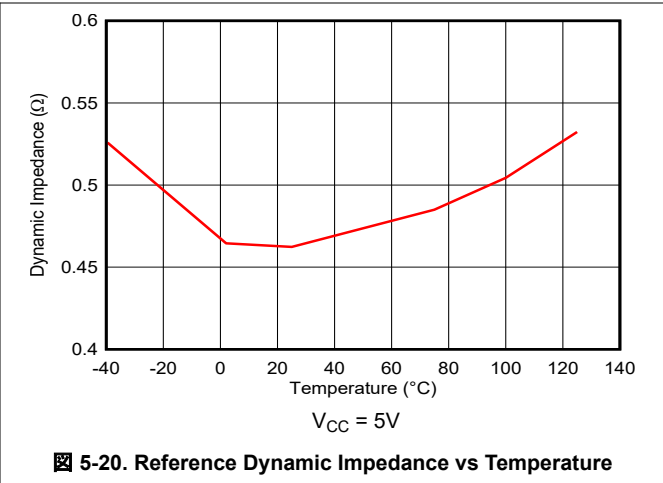
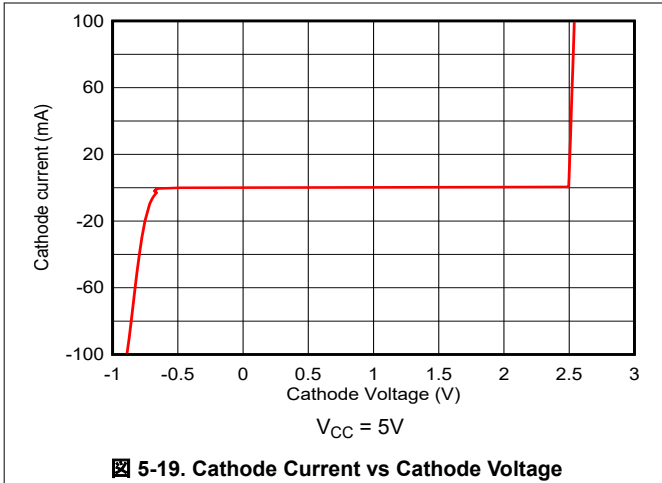


$V_{CC} = 5\text{V}$, $I_K = 10\text{mA}$

Figure 5-18. Reference Voltage vs Temperature

5.7 Typical Characteristics: TL103WB (continued)

at $T_A \cong 25^\circ\text{C}$, $V_{CC} = 36\text{V} (\pm 18\text{V})$, $V_{CM} = V_{CC} / 2$, $R_L = 10\text{k}\Omega$ connected to $V_{CC} / 2$ (unless otherwise noted)



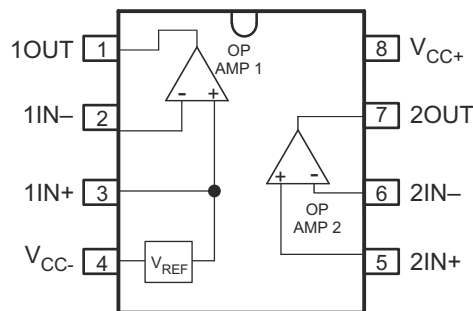
6 Detailed Description

6.1 Overview

The TL103Wx features two high-voltage amplifiers and a shunt voltage reference to allow for cost-sensitive and compact battery charger CC/CV feedback circuits. The upgraded TL103WB features is designed to provide a wide supply range (up to 36V), low offset voltage ($\pm 0.3\text{mV}$ typical) and a 1.2MHz bandwidth. The integrated voltage reference is tied to the non-inverting pin of one of OP AMP 1 and provides a fixed 2.5V referenced to the negative supply of the device. The shunt reference of the TL103WA/TL103WB features a tight tolerance of 0.44% at 25°C.

When a single supply voltage of 5V is used (or $\pm 2.5\text{V}$ split supply), the TL103Wx internal reference allows for a more accurate and power-efficient mid-supply signal to be used throughout your circuit. The TL103W/TL103WA devices are characterized for operation from -40°C to 85°C , the TL103WB devices are characterized for operation from -40°C to 125°C .

6.2 Functional Block Diagram



6.3 Feature Description

6.3.1 Internal Reference

The TL103Wx family features an internal shunt reference, tied to the non-inverting pin of one of the devices amplifiers. When supplied with enough voltage headroom ($\geq 2.5\text{V}$) and cathode current (0.5mA typical), the reference of the TL103Wx is forced to a fixed 2.5V. To not exceed the maximum cathode current, be sure that the reference input is current limited. Unlike many linear regulators, the reference of the TL103W is internally compensated to be stable without an output capacitor between the cathode and anode. If the reference is used to supply a load, stability criteria shown in [Figure 5-22](#) needs to be met.

Reference voltage tolerance varies based off the device grade chosen. At 25°C the TL103W features a reference tolerance of 0.72%, while the TL103WA/TL103WB both feature reference tolerances of 0.44%.

6.3.2 Input Common Mode Range

The valid common mode range is from device ground to $V_{CC+} - 1.5\text{V}$ ($V_{CC+} - 2\text{V}$ across temperature). Inputs may exceed V_{CC+} up to the absolute maximum voltage without device damage. At least one input must be in the valid input common-mode range for the output to be the correct phase. If both inputs exceed the valid range, then the output phase is undefined. If either input is more than 0.3V below V_{CC-} , then input current should be limited to 1mA and the output phase is undefined.

6.3.3 EMI Rejection

The TL103WB uses integrated electromagnetic interference (EMI) filtering to reduce the effects of EMI from sources such as wireless communications (radio frequency interference - RFI) and densely-populated boards with a mix of analog signal chain and digital components. EMI immunity can be improved with circuit design techniques; the TL103WB benefits from these design improvements. Texas Instruments has developed the ability to accurately measure and quantify the immunity of an operational amplifier over a broad frequency spectrum extending from 10MHz to 6GHz. 図 6-1 shows the results of this testing on the TL103WB. 表 6-1 shows the EMIRR IN+ values for the TL103WB at particular frequencies commonly encountered in real-world applications. The [EMI Rejection Ratio of Operational Amplifiers application report](#) contains detailed information on the topic of EMIRR performance relating to op amps and is available for download from www.ti.com.

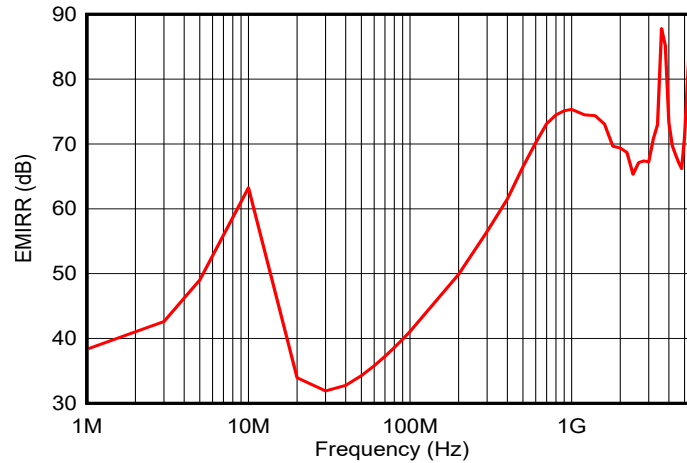


図 6-1. EMIRR Testing

表 6-1. TL103WB EMIRR IN+ for Frequencies of Interest

FREQUENCY	APPLICATION OR ALLOCATION	EMIRR IN+
400MHz	Mobile radio, mobile satellite, space operation, weather, radar, ultra-high frequency (UHF) applications	62dB
900MHz	Global system for mobile communications (GSM) applications, radio communication, navigation, GPS (to 1.6GHz), GSM, aeronautical mobile, UHF applications	75dB
1.8GHz	GSM applications, mobile personal communications, broadband, satellite, L-band (1 GHz to 2GHz)	70dB
2.4GHz	802.11b, 802.11g, 802.11n, Bluetooth®, mobile personal communications, industrial, scientific and medical (ISM) radio band, amateur radio and satellite, S-band (2GHz to 4GHz)	65dB
3.6GHz	Radiolocation, aero communication and navigation, satellite, mobile, S-band	88dB
5GHz	802.11a, 802.11n, aero communication and navigation, mobile communication, space and satellite operation, C-band (4GHz to 8GHz)	71dB

6.4 Device Functional Modes

This device has one mode of operation that applies when operated within the recommended operating conditions.

7 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

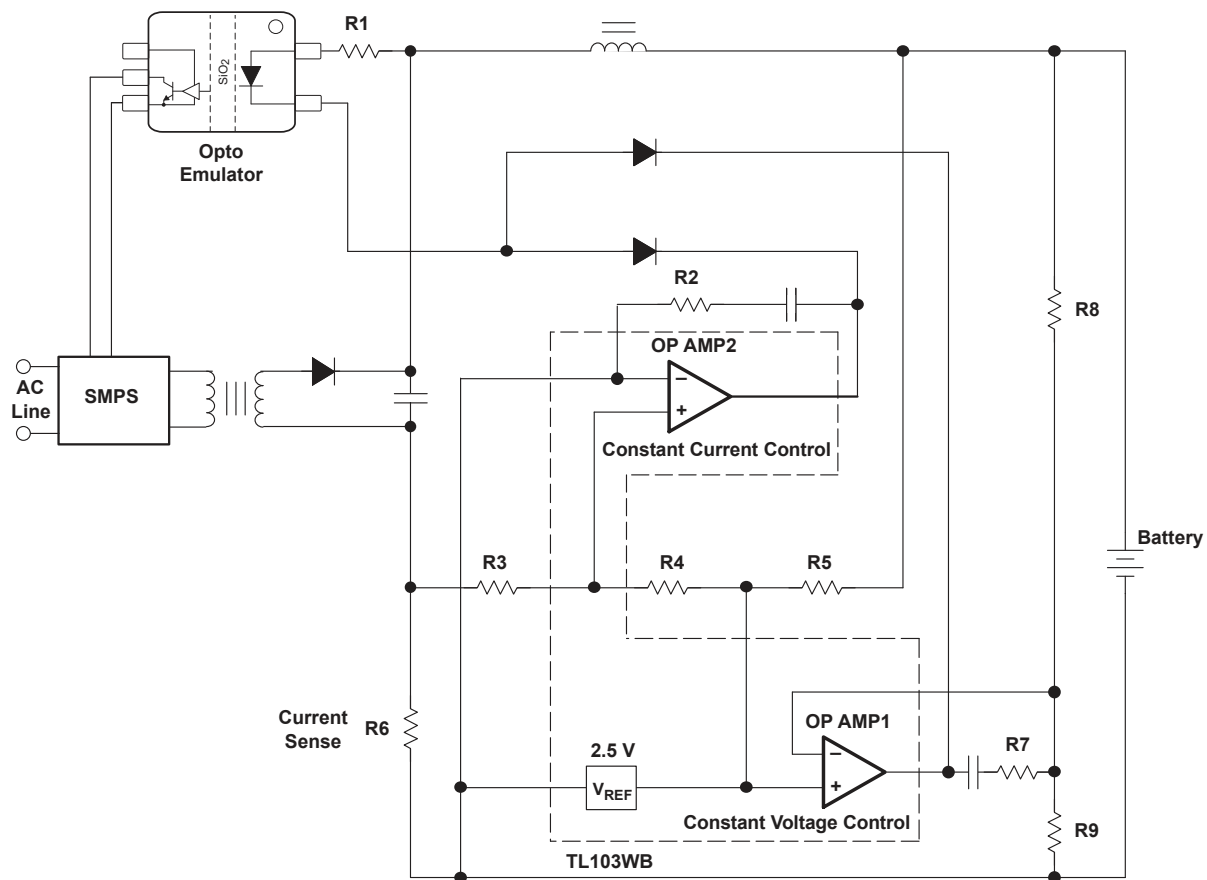
7.1 Application Information

The TL103Wx family offers a cost-effective and compact device for applications requiring both an accurate DC signal and signal conditioning. These devices offer a fixed 2.5V reference, wide bandwidth (1 to 1.2 MHz) and a low total supply current (0.55 to 0.7mA).

7.2 Typical Applications

7.2.1 Isolated Flyback CC/CV Feedback

As shown in [Figure 7-1](#), the TL103Wx is often used alongside an opto-coupler/opto-emulator to provide feedback to an isolated flyback. Utilizing the TL103Wx in this way allows for both an accurate and cost-optimized battery charger design that can achieve a stable CC/CV (Constant Current/Constant Voltage) charging profile. In this example, a simplified design procedure will be discussed. Additional details can be found in [Designing CC-CV Feedback Circuits With the TL103WB](#).



Typical Application Circuit

7.2.1.1 Design Requirements

The objective is to design an accurate CC-CV feedback circuit with the requirements provided in [表 7-1](#).

表 7-1. Design Parameters

PARAMETER	VALUE
Maximum Charge Current	6A
Battery Voltage Range	6V to 20V

7.2.1.2 Detailed Design Procedure

To switch between CV control and CC control, diodes are utilized to achieve an OR logic function as shown in [図 7-1](#). Designing the circuit in this way allows one of the amplifiers (configured in either CC or CV mode) to dominate the feedback in the design. In this design, *GND* refers to the negative node at the secondary side of the switch-mode power supply.

The fixed 2.5V of the TL103Wx reference provides a stable DC voltage that is used to specify the CC current and CV voltage. One of the requirements of achieving this fixed value, however, is that the cathode of the reference must be supplied with a voltage of 2.5V or above.

7.2.1.2.1 Constant Current Circuit

For the constant current feedback circuit, the amplifier is configured in a low-side current sense configuration. Resistor R6 is used as the current sensing resistor to sense the current flowing between the battery and flyback converter. This is shown in [式 1](#), where I_{BAT} is the output current delivered to the battery. The voltage at the non-inverting input of the amplifier specifies the maximum current (or constant current) that is delivered to the battery.

$$V_{BAT-} = I_{BAT} \times R6 \quad (1)$$

The reference of the TL103Wx is powered by the battery voltage. To be able to achieve a constant current, this reference needs to be provided with 2.5V or greater to provide a fixed 2.5V. The first step in designing a constant current circuit is to specify that 2.5V can be achieved at the battery's minimum voltage. The value of R5 must also be designed so that a sink-current between 0.5mA to 100 mA (for TL103W or TL103WA) is achieved across the specified range of the battery voltage. These two steps are shown below.

$$V_{BAT(min)} \times \frac{R4 + R3}{R4 + R3 + R5 + R6} \geq 2.5 \text{ V} \quad (2)$$

$$0.5 \text{ mA} \leq \frac{V_{BAT} - V_{REF}}{R5} \leq 100 \text{ mA} \quad (3)$$

For this design R5 is chosen to be 2kΩ. Knowing this and the specified battery range of 6V to 20V, we can calculate that the reference sinks anywhere from 1.75mA to 10mA using [式 2](#).

Once a fixed 2.5V reference is achieved, we can use this accurate DC voltage to specify a constant current target on the non-inverting input of the amplifier. This can be done by calculating the voltage at the amplifier's inverting input when a constant current target is achieved. Specifying R6 to be 10mΩ along with a constant current design target of 6A, we find that this voltage to be 60 mV using [式 1](#). The voltage at the non-inverting pin of the amplifier is specified by [式 4](#).

$$V_{IN+} = 2.5 \text{ V} \times \frac{R3}{R4 + R3} \quad (4)$$

Using the component values and design targets calculated so far, [式 2](#) and [式 4](#) can be updated to:

$$6 \text{ V} \times \frac{R4 + R3}{R4 + R3 + 2 \text{ k}\Omega + 10 \text{ m}\Omega} \geq 2.5 \text{ V} \quad (5)$$

$$60\text{ mV} = 2.5\text{ V} \times \frac{R3}{R4 + R3} \tag{6}$$

Using both 式 5 and 式 6, we calculate that R3 needs to be greater than around 34.28Ω. Adding additional headroom to this, we can calculate R3 = 36Ω and R4 = 1464Ω.

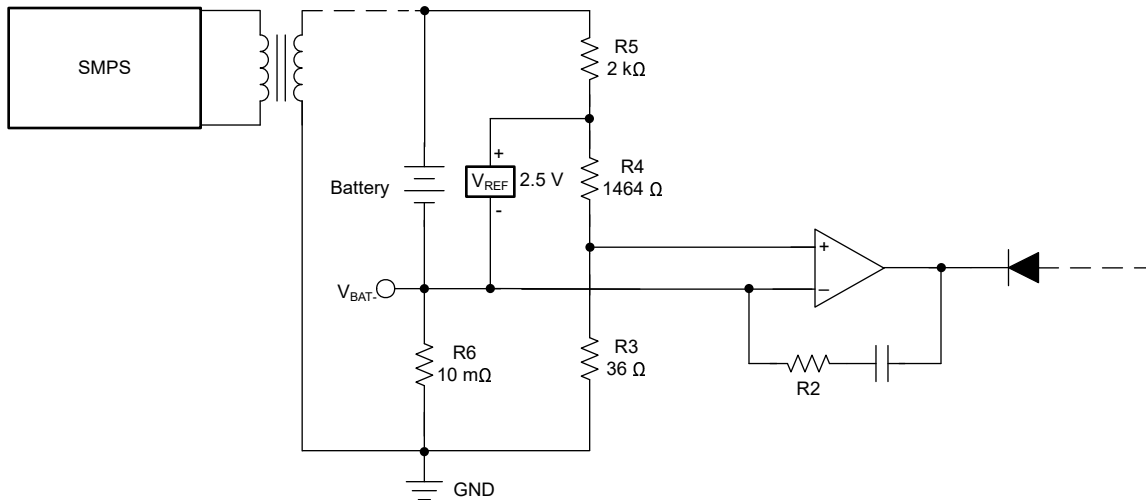


図 7-1. Constant Current Feedback Circuit

7.2.1.2.2 Constant Voltage Circuit

For the constant voltage feedback circuit, resistors R8 and R9 divide down the battery voltage to compare against the TL103Wx's reference. This is shown in 図 7-2. The voltage at the inverting input of the amplifier is designed to equal 2.5V when the battery reaches its maximum specified voltage (or desired constant voltage value). This is shown in for a maximum voltage of 20V provided in 表 7-1.

$$V_{BAT} \times \frac{R9}{R8 + R9} = 2.5\text{ V} \tag{7}$$

$$20\text{ V} \times \frac{R9}{R8 + R9} = 2.5\text{ V} \tag{8}$$

To mimic the constant current circuit and achieve a total impedance and 2kΩ across the battery, R8 is set to 1.96kΩ and R9 to 280Ω.

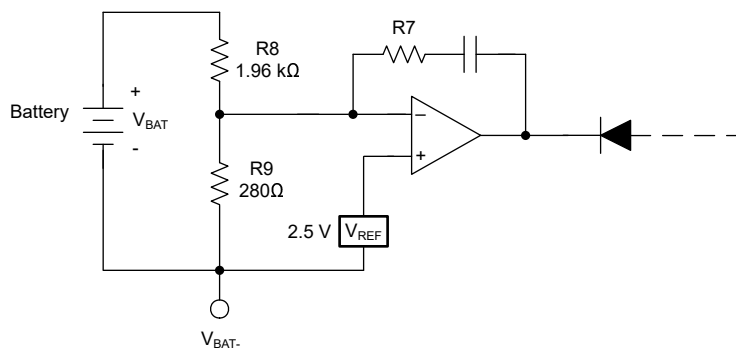


図 7-2. Constant Voltage Circuit

7.2.2 Constant Current Sink

Figure 7-3 shows the use of the TL103Wx along with a transistor to provide a constant current sink source. This type of circuit is common in LED drivers and can provide accurate performance and high bandwidth with minimal external components. Accuracy of this circuit is dominated by the reference voltage tolerance, amplifier offset voltage, and resistor tolerance. R_{LIM} is placed to limit the shunt current of the circuit's reference to a maximum of 100mA.

$$I_{SINK} = \left(V_{REF} \times \frac{R_2}{R_1 + R_2} \right) \times R_S \quad (9)$$

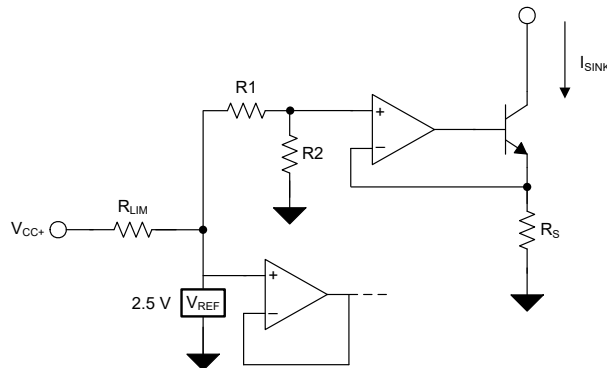


Figure 7-3. TL103Wx as Constant Current Sink

7.3 Power Supply Recommendations

Place 0.1µF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high-impedance power supplies. For more detailed information on bypass capacitor placement, see [セクション 7.4](#)

7.4 Layout

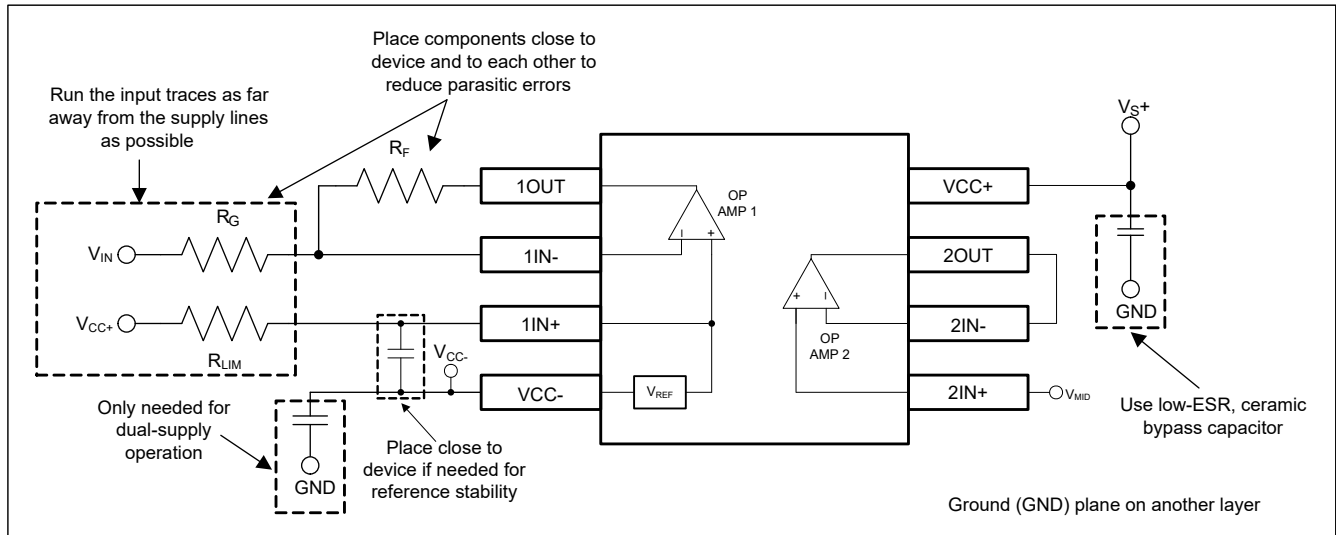
7.4.1 Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

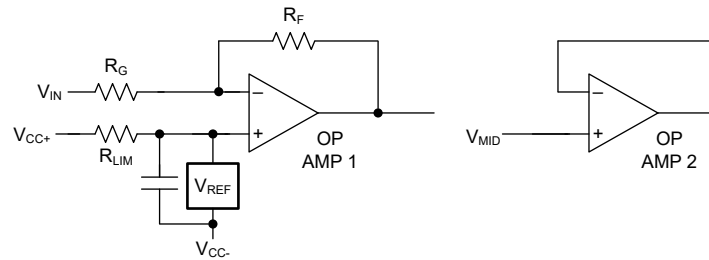
- Noise can propagate into analog circuitry through the power pins of the circuit as a whole, as well as the operational amplifier. Bypass capacitors are used to reduce the coupled noise by providing low-impedance power sources local to the analog circuitry.
 - Connect low-ESR, 0.1µF ceramic bypass capacitors between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable for single-supply applications.
 - If a bypass capacitor is needed to help stabilize the reference, place this capacitor as close to the reference pin as possible.
- Separate grounding for analog and digital portions of circuitry is one of the simplest and most-effective methods of noise suppression. One or more layers on multilayer PCBs are usually devoted to ground planes. A ground plane helps distribute heat and reduces EMI noise pickup. Make sure to physically separate digital and analog grounds, paying attention to the flow of the ground current.
- To reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If not possible to keep them separate, cross the sensitive trace perpendicular as opposed to in parallel with the noisy trace.
- Place the external components as close to the device as possible. Keeping R_F and R_G close to the inverting input minimizes parasitic capacitance, as shown in [セクション 7.4.2](#).
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

- For applications shunting high currents through the reference, pay attention to the cathode and anode traces. Ensure the width of these traces are designed with proper current density.

7.4.2 Layout Example



7-4. Operational Amplifier Board Layout for Inverting Configuration



7-5. Operational Amplifier Schematic for Inverting Configuration

8 Device and Documentation Support

8.1 Documentation Support

8.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [EMI Rejection Ratio of Operational Amplifiers application report](#)
- Texas Instruments, [Designing CC-CV Feedback Circuits With the TL103WB](#)

8.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

8.3 サポート・リソース

テキサス・インスツルメンツ E2E™ サポート・フォーラムは、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計に必要な支援を迅速に得ることができます。

リンクされているコンテンツは、各寄稿者により「現状のまま」提供されるものです。これらはテキサス・インスツルメンツの仕様を構成するものではなく、必ずしもテキサス・インスツルメンツの見解を反映したものではありません。テキサス・インスツルメンツの[使用条件](#)を参照してください。

8.4 Trademarks

テキサス・インスツルメンツ E2E™ is a trademark of Texas Instruments.

Bluetooth® is a registered trademark of Bluetooth SIG, Inc.

すべての商標は、それぞれの所有者に帰属します。

8.5 静電気放電に関する注意事項



この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わない場合、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

8.6 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

9 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision Q (December 2023) to Revision R (April 2024) Page

- TL103WB の DDF (SOT-23, 8) パッケージを事前情報 (プレビュー) から量産データ (アクティブ) に変更..... 1

Changes from Revision P (November 2023) to Revision Q (December 2023) Page

- Updated maximum dynamic impedance from 0.5 Ω to 0.8 Ω in *Electrical Characteristics* table..... 5
- Updated EMIRR IN+ values in *EMIRR IN+ for Frequencies of Interest* table 13

Changes from Revision O (October 2023) to Revision P (November 2023)	Page
• Updated typical large-signal voltage gain of TL103WB from 140V/mV to 210 V/mV.....	5
• Updated minimum limit of supply-voltage rejection ratio of TL103WB from 80 dB to 99dB.....	5
• Added footnote in Electrical Characteristics tables to specify specifications which have limits set by characterization.....	5
• Updated minimum limit of gain bandwidth product for TL103WB from 0.5MHz to 0.7MHz.....	5
• Updated maximum limit of total supply current for TL103WB at 25°C from 0.92 mA to 0.77mA.....	5
• Updated maximum limit of total supply current for TL103WB at full temperature range from 1.6mA to 1.35mA.....	5
• Updated minimum limit of large-signal voltage gain for TL103WB at 25°C from 70V/mV to 77V/mV.....	6
• Updated minimum limit of large-signal voltage gain for TL103WB at full temperature range from 35V/mV to 45V/mV.....	6
• Added new CMRR specifications for TL103WB.....	6

Changes from Revision N (August 2023) to Revision O (October 2023)	Page
• 「特長」セクションの最大入力オフセット電圧、基準電圧のトレランス、合計消費電流、シンク電流範囲を変更	1
• TL103WB とフォトカプラ エミュレータを含めるよう「代表的なアプリケーション回路」図を変更	1
• TL103WB D (SOIC, 8) のステータスを事前情報 (プレビュー) から量産データ (アクティブ) に変更.....	1
• Changed <i>Thermal Information</i> table to include latest thermal metrics	5
• Added DDF information to <i>Thermal Information</i> table.....	5
• Updated k_{SVR} term to PSRR.....	5
• Changed maximum short circuit current from $\pm 60\text{mA}$ to $\pm 68\text{ mA}$	5
• Maximum reference input voltage deviation over temperature range for TL103W was changed from 30mV to 35mV.....	5
• Maximum reference input voltage deviation over temperature range for TL103WA was changed from 30mV to 26mV.....	5
• Added figures to the <i>Typical Characteristics</i> section to highlight the TL103WB device.....	8
• Added the <i>Detailed Description</i> and <i>Application and Implementation</i> sections.....	12
• Added the <i>Application and Implementation</i> sections.....	14

Changes from Revision M (October 2016) to Revision N (August 2023)	Page
• 「特長」セクションを更新し、TL103WB を強調	1
• ドキュメント全体にわたって表、図、相互参照の採番方法を更新.....	1
• ドキュメント全体を通して TL103WB の製品情報を追加	1
• 「概要」セクションを更新	1
• チャンネル数を含めるよう「製品情報」表を更新	1
• Removed DRJ package details and added DDF package for preview.....	3
• Updated formatting for <i>Electrical Characteristics</i> tables.....	5
• Updated typical dynamic impedance from 0.2 Ω to 0.45 Ω in <i>Electrical Characteristics</i> tables	5

Changes from Revision L (February 2016) to Revision M (October 2016)	Page
• Changed positive and negative terminals OP AMP 2 in the D Package image of <i>Pin Configuration and Functions</i>	3

Changes from Revision K (October 2010) to Revision L (February 2016)	Page
<ul style="list-style-type: none"> • 「製品情報」表、「ピン構成および機能」、「ESD 定格」、「熱に関する情報」、「デバイスおよびドキュメントのサポート」、「メカニカル、パッケージ、および注文情報」セクションを追加 • 「特長」を「2kV の ESD 保護 (HBM)」から「2.5kV の ESD 保護 (HBM)」に変更..... • 「代表的なアプリケーション回路」のツェナー ダイオード部品を V_{REF} に変更 • Changed the Zener diode component to V_{REF} in the D Package of <i>Pin Configuration and Functions</i> 	1 1 1 3

10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

重要なお知らせと免責事項

テキサス・インスツルメンツは、技術データと信頼性データ(データシートを含みます)、設計リソース(リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、テキサス・インスツルメンツ製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適したテキサス・インスツルメンツ製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとします。

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されているテキサス・インスツルメンツ製品を使用するアプリケーションの開発の目的でのみ、テキサス・インスツルメンツはその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。テキサス・インスツルメンツや第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、テキサス・インスツルメンツおよびその代理人を完全に補償するものとし、テキサス・インスツルメンツは一切の責任を拒否します。

テキサス・インスツルメンツの製品は、[テキサス・インスツルメンツの販売条件](#)、または [ti.com](https://www.ti.com) やかかるテキサス・インスツルメンツ製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。テキサス・インスツルメンツがこれらのリソースを提供することは、適用されるテキサス・インスツルメンツの保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、テキサス・インスツルメンツはそれらに異議を唱え、拒否します。

郵送先住所: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024, Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TL103WAID	Obsolete	Production	SOIC (D) 8	-	-	Call TI	Call TI	-40 to 105	Z103WA
TL103WAIDR	Active	Production	SOIC (D) 8	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	Z103WA
TL103WAIDR.A	Active	Production	SOIC (D) 8	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	Z103WA
TL103WBIDDFR	Active	Production	SOT-23-THIN (DDF) 8	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T13DF
TL103WBIDDFR.A	Active	Production	SOT-23-THIN (DDF) 8	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T13DF
TL103WBIDR	Active	Production	SOIC (D) 8	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TL103D
TL103WBIDR.A	Active	Production	SOIC (D) 8	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TL103D
TL103WID	Obsolete	Production	SOIC (D) 8	-	-	Call TI	Call TI	-40 to 105	Z103W
TL103WIDR	Active	Production	SOIC (D) 8	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	Z103W
TL103WIDR.A	Active	Production	SOIC (D) 8	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	Z103W

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative

and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL103WAIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL103WBIDFR	SOT-23-THIN	DDF	8	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TL103WBIDR	SOIC	D	8	3000	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL103WIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

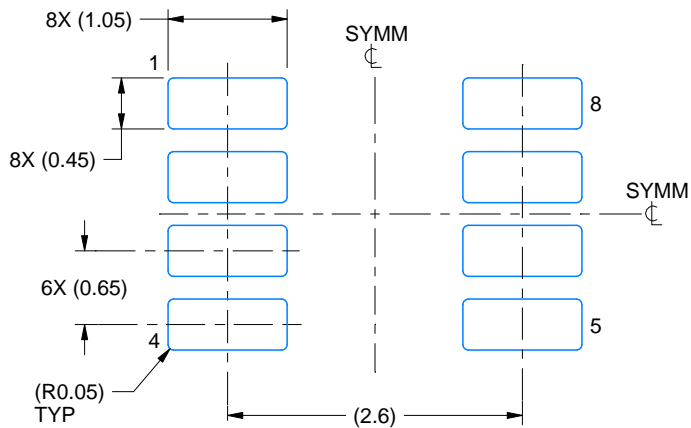
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL103WAIDR	SOIC	D	8	2500	353.0	353.0	32.0
TL103WBIDFR	SOT-23-THIN	DDF	8	3000	210.0	185.0	35.0
TL103WBIDR	SOIC	D	8	3000	353.0	353.0	32.0
TL103WIDR	SOIC	D	8	2500	353.0	353.0	32.0

EXAMPLE BOARD LAYOUT

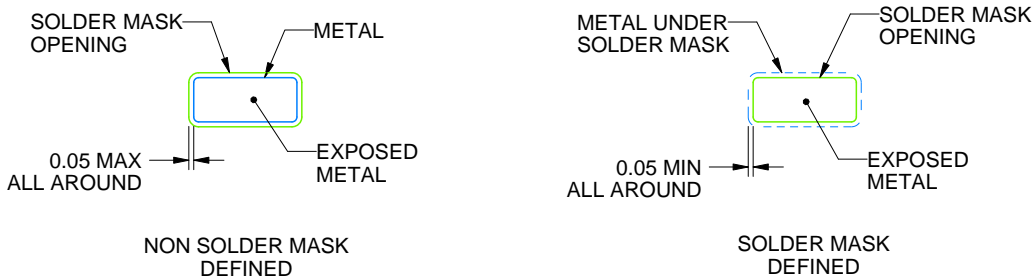
DDF0008A

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4222047/E 07/2024

NOTES: (continued)

- 4. Publication IPC-7351 may have alternate designs.
- 5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DDF0008A

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4222047/E 07/2024

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.



D0008A

PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

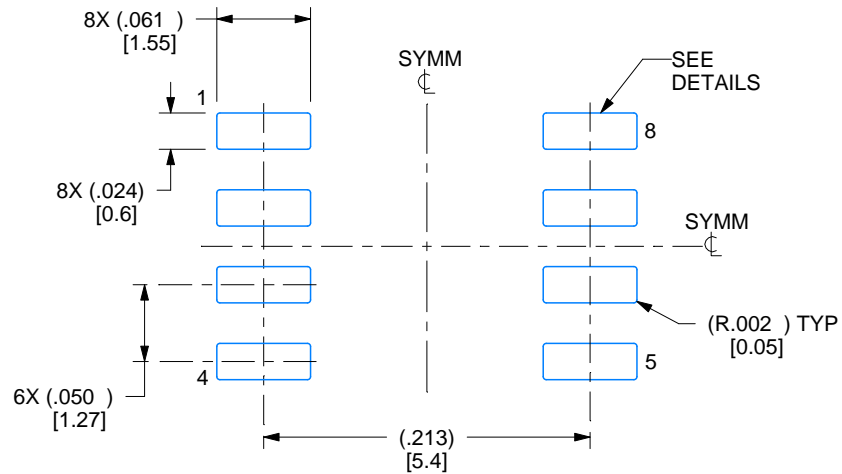
- Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed $.006$ [0.15] per side.
- This dimension does not include interlead flash.
- Reference JEDEC registration MS-012, variation AA.

EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

重要なお知らせと免責事項

TI は、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、[TI の総合的な品質ガイドライン](#)、[ti.com](#) または TI 製品などに関連して提供される他の適用条件に従い提供されます。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。TI がカスタム、またはカスタマー仕様として明示的に指定していない限り、TI の製品は標準的なカタログに掲載される汎用機器です。

お客様がいかなる追加条項または代替条項を提案する場合も、TI はそれらに異議を唱え、拒否します。

Copyright © 2026, Texas Instruments Incorporated

最終更新日 : 2025 年 10 月