20-V/300-mA Wide-Input High-PSRR Ultra-Low Noise LDO Regulator

Features

- Input Voltage Range: 2.5 V to 20 V
- Output Voltage Range:
  - Adjustable: 1.22 V to 18 V
  - Fixed: 1.5 V to 5 V
- ±2% Output Accuracy over Line Regulation, Load Regulation, and Operating Temperature Range
- 300-mA Maximum Output Current
- Low Dropout Voltage: 550 mV Maximum at 300 mA
- High PSRR:
  - 79 dB at 1 kHz
  - 56 dB at 100 kHz
- 5.68-μV_{RMS} Output Voltage Noise
- Excellent Transient Response
- Stable with a 2.2-µF to 100-µF Ceramic Output Capacitor
- Integrated Protection:
  - Over-Current Protection
  - Output Short-Circuit Protection
  - Over-Temperature Protection
- Junction Temperature Range: −40°C to +125°C
- Package Options:
  - SOT23-5

Description

The LT1964ES5 series of products are 300-mA high PSRR, ultra-low noise, and low-dropout linear regulators with a 20-V wide input voltage range. The LT1964ES5 series of products support both adjustable output voltage ranging from 1.22 V to 18 V with an external resistor divider and fixed output voltage ranging from 1.5 V to 5 V. The LT1964ES5 series of products are stable with a 2.2-µF to 100-µF ceramic output capacitor.

The LT1964ES5 series of products have high PSRR with 79 dB at 1 kHz and 5.68 μV_{RMS} ultra-low noise. These features make the LT1964ES5 series suitable for noise-sensitive applications, such as high-performance analog devices or high-definition imaging equipment, to suppress the large ripple and noise generated from the previous stage power supply. Besides, output short-circuit protection and thermal protection features improve the system reliability under multiple operating conditions.

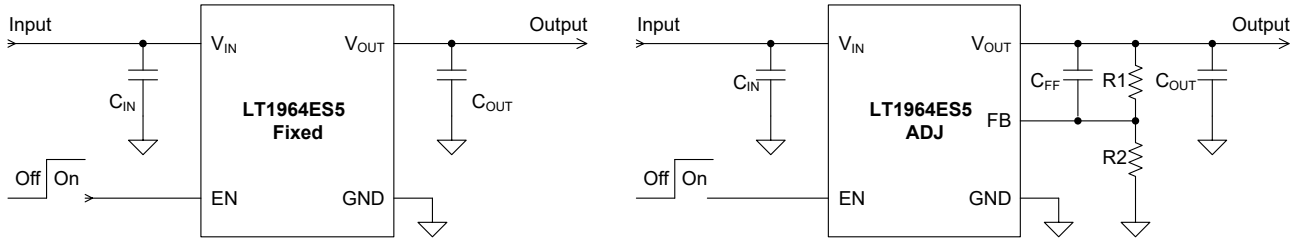
The LT1964ES5 series provides the SOT23-5 package with a guaranteed junction temperature range from –40° C to+125°C.

Part Number	Output Voltage	Package
LT1964ES5-BYP	Adjustable	SOT23-5
LT1964ES533	Fixed 3.3 V	SOT23-5
LT1964ES550	Fixed 5.0 V	SOT23-5

Applications

- Low-Noise Power Supply
- High-Definition Imaging System
- Infrared Image Equipment
- Medical Equipment

Typical Application Circuit



Pin Configuration and Functions

LT1964ES5
SOT23-5 Package
Top View

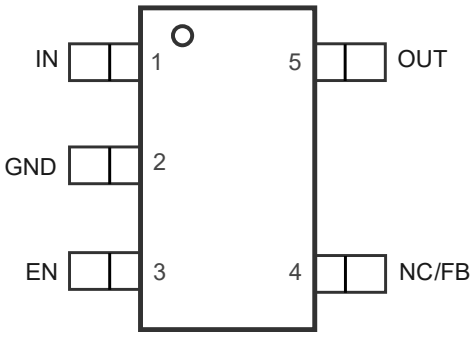


Table 1. Pin Functions: LT1964ES5

Pin No.	Pin Name	I/O	Description
3	EN	I	Regulator enable pin. Drive EN high to turn on the regulator; and drive EN low to turn off the regulator.
4	FB	I	Output voltage feedback pin (adjustable output only). Connect to a resistor divider to adjust the output voltage.
2	GND	–	Ground reference pin. Connect the GND pin to the PCB ground plane directly.
1	IN	I	Input voltage pin. Bypass IN to GND with a 10-μF or greater capacitor.
4	NC	–	No connection (fixed output only).
5	OUT	O	Regulated output voltage pin.

Specifications

Absolute Maximum Ratings

Parameter		Min	Max	Unit
V_{IN}, V_{EN}		−0.3	24	V
V_{OUT} (fixed output only)		−0.3	6	V
V_{OUT} (adjustable output only)		−0.3	24	V
V_{FB} (adjustable output only)		−0.3	6	V
T_J	Maximum Junction Temperature	−40	150	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_L	Lead Temperature (Soldering 10 sec)		260	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.
(2) All voltage values are with respect to GND.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	±2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	±1.5	kV

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Parameter		Min	Max	Unit
V_{IN}		2.5	20	V
V_{EN}		0	V_N	V
C_{OUT}		2.2	100	µF
T_J	Junction Temperature Range	−40	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JB}	$\theta_{JC,TOP}$	Unit
SOT23-5	162.4	79	62.33	°C/W

Electrical Characteristics

All test conditions: −40°C ≤ T_J ≤ 125°C, V_N = $V_{OUT(NOM)}$ + 1 V or 2.5 V, whichever is greater; typically, T_J = 25°C, V_{OUT} = 3.3 V, C_N = C_{OUT} = 4.7 µF, and C_{FF} = 100 nF for adjustable output, unless otherwise noted.

Parameter		Conditions	Min	Typ	Max	Unit
Supply Input Voltage and Current						
V_{IN}	Input Supply Voltage Range (1)		$V_{IN(MIN)}$		20	V
UVLO	Input Supply Voltage Rising			2.25	2.4	V
	Hysteresis			200		mV
I_Q	Quiescent Current	I_{OUT} = 0 mA		98	160	µA
		I_{OUT} = 1 mA		127		µA
I_{SD}	Shutdown Current	EN = GND, V_{IN} = $V_{N(MN)}$ to 20 V		0.6	5	µA
Enable Input Voltage and Current						
$V_{IH(EN)}$	EN Input High Level (enable)		1.6		V_N	V
$V_{IL(EN)}$	EN Input Low Level (disable)		0		0.5	V
I_{EN}	EN Pin Leakage Current	V_{EN} = 0 V to 20 V		0.5	1	µA
Regulated Output Voltage and Current						
V_{OUT}	Output Voltage Accuracy (2)		−2%		2%	
V_{FB}	Feedback Pin Voltage (2)	Adjustable output only		1.22		V
I_{FB}	Feedback Pin Leakage Current (2)	V_{FB} = 1.5 V	−100		100	nA
ΔV_{OUT}	Line Regulation	V_N = $V_{OUT(NOM)}$ + 1 V to 20 V, I_{OUT} = 1 mA		0.007		%/V
	Load Regulation	I_{OUT} = 1 mA to 300 mA		0.01		%/mA
V_{DO}	Dropout Voltage (3) of Fixed Output Option	I_{OUT} = 100 mA, V_{OUT} = 5 V		210	250	mV
		I_{OUT} = 300 mA, V_{OUT} = 5 V		350	550	mV
		I_{OUT} = 100 mA, V_{OUT} = 3.3 V		210	250	mV
		I_{OUT} = 300 mA, V_{OUT} = 3.3 V		350	550	mV
	Dropout Voltage (3) of Adjutable Output Option	I_{OUT} = 100 mA, V_{OUT} = 18 V		125	200	mV
		I_{OUT} = 300 mA, V_{OUT} = 18 V		375	600	mV
		I_{OUT} = 100 mA, V_{OUT} = 10 V		125	200	mV
		I_{OUT} = 300 mA, V_{OUT} = 10 V		375	600	mV
I_{LIM}	Output Current Limit	V_{OUT} = 0.9 × $V_{OUT(NOM)}$	310	450		mA
I_{SC}	Short-Circuit Current Limit	V_{OUT} is forced to ≤ 20 mV		180		mA
PSRR	Power Supply Rejection Ratio (4)	I_{OUT} = 100 mA, f = 120 Hz		79		dB
		I_{OUT} = 100 mA, f = 1 kHz		79		dB
		I_{OUT} = 100 mA, f = 100 kHz		56		dB
		I_{OUT} = 100 mA, f = 1 MHz		41		dB
V_N	Output Noise Voltage (4)	I_{OUT} = 100 mA, BW = 10 Hz to 100 kHz		5.68		μV_{RMS}

Parameter		Conditions	Min	Typ	Max	Unit
t_{STR}	Start-up Time (4)	From EN ≥ $V_{H(EN)}$ to OUT ≥ 95% of $V_{OUT(NOM)}$		600		μs
Operating Temperature Range						
T_{SD}	Thermal Shutdown Temperature			165		ºC
	Hysteresis			25		ºC

(1) $V_{IN(MIN)}$ = $V_{OUT(NOM)}$ + 1 V or 2.5 V, whichever is greater.
(2) FB pin is available for adjustable output only. Tolerance of external resistors is not included.
(3) Dropout voltage is the minimum input to output voltage differential needed to maintain regulation at a specified output current and measure for $V_{OUT(NOM)}$ ≥ 2.5V. In the dropout mode, the output voltage will be equal to V_{IN} − V_{DO}.
(4) Not test during production. Measured with C_{OUT} = 2.2 μF.

Typical Performance Characteristics

All test conditions: −40°C ≤ T_J ≤ 125°C, V_N = $V_{OUT(NOM)}$ + 1 V or 2.5 V, whichever is greater; typically, T_J = 25°C, V_{OUT} = 3.3 V, C_N = 4.7 µF, C_{OUT} = 2.2 µF, and C_{FF} = 100 nF for adjustable output, unless otherwise noted.

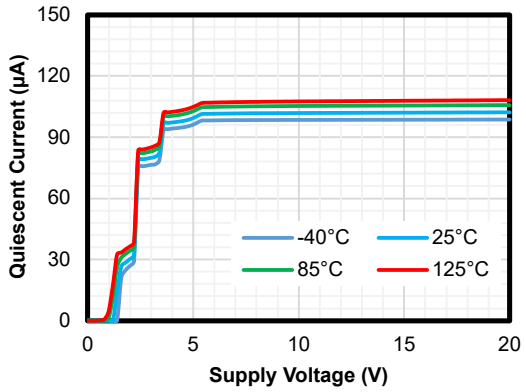


Figure 1. Quiescent Current vs Supply Voltage

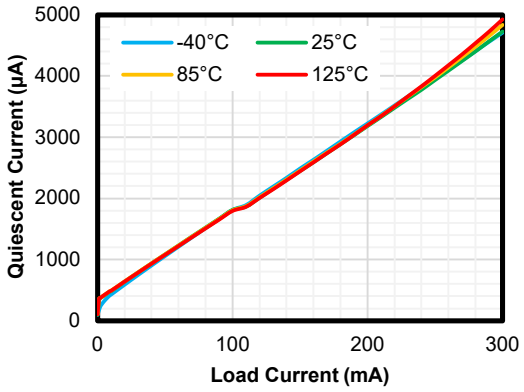


Figure 2. Quiescent Current vs Load Current

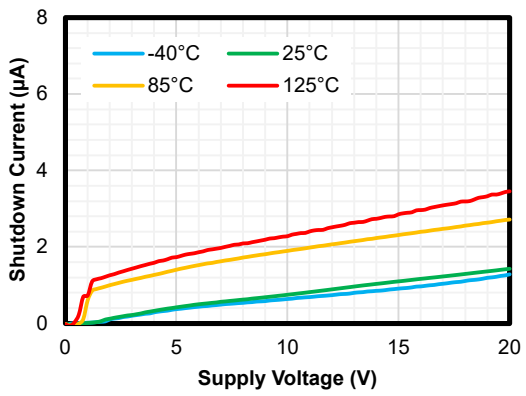


Figure 3. Shutdown Current vs Supply Voltage

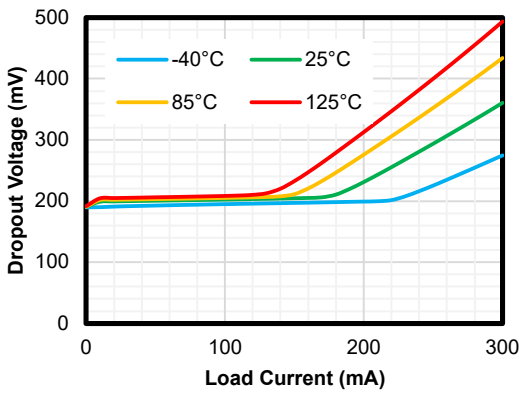


Figure 4. Dropout Voltage vs Load Current

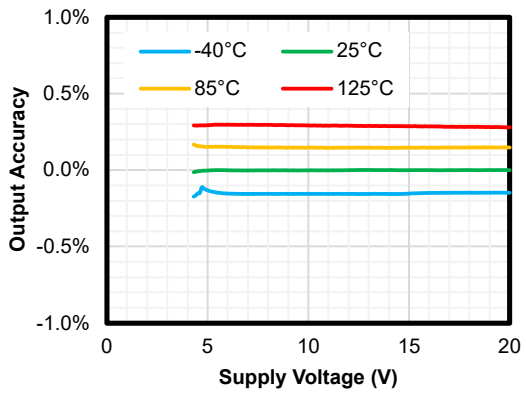


Figure 5. Line Regulation

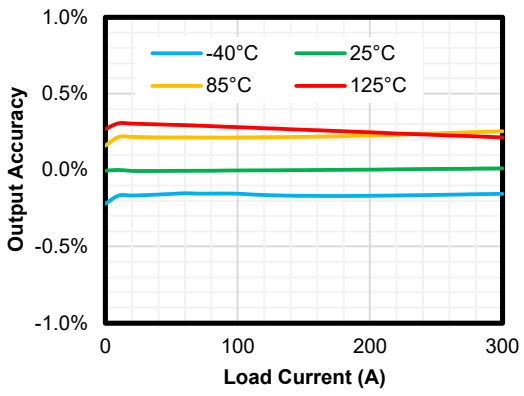


Figure 6. Load Regulation

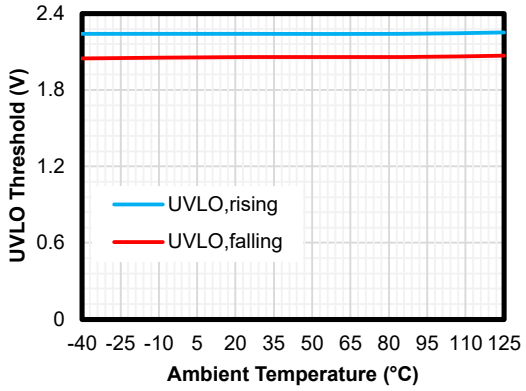


Figure 7. UVLO vs Temperature

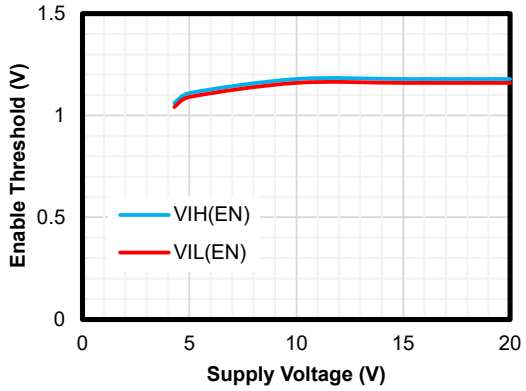


Figure 8. EN threshold vs Supply Voltage

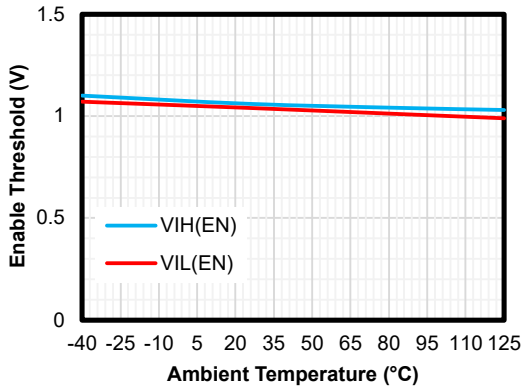


Figure 9. EN Threshold vs Temperature

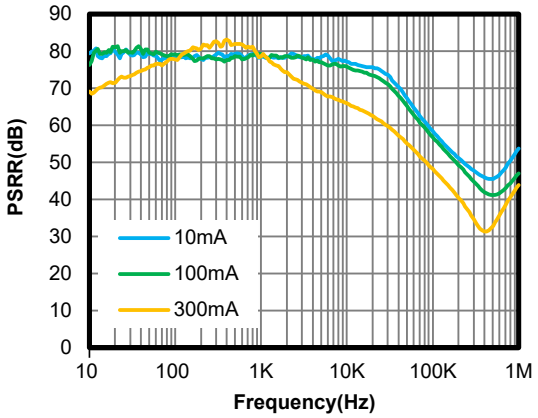


Figure 10. PSRR

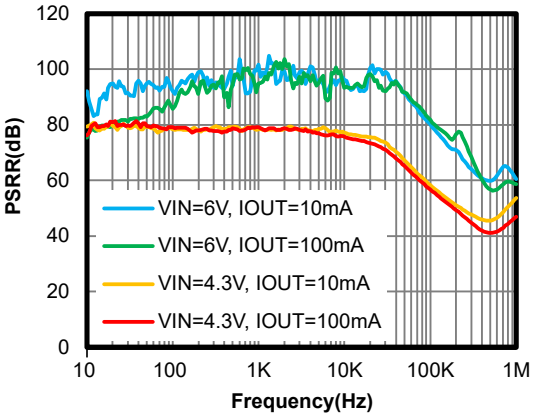


Figure 11. PSRR

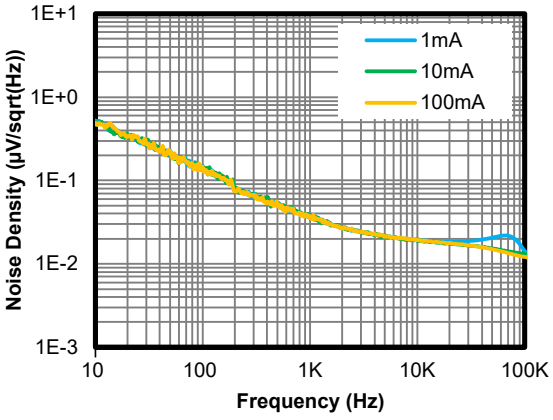


Figure 12. Noise

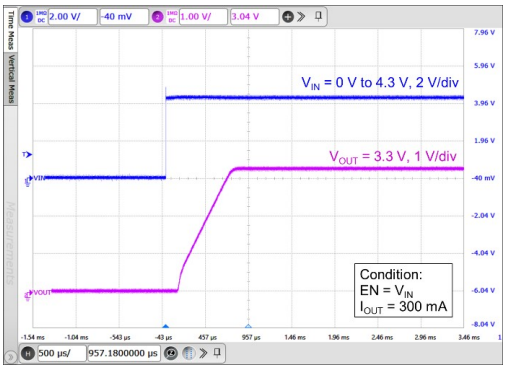


Figure 13. Startup with VIN

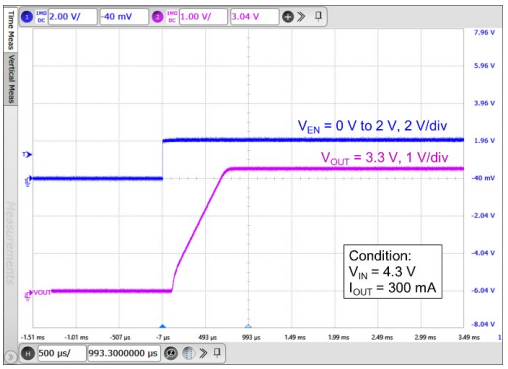


Figure 14. Startup with EN

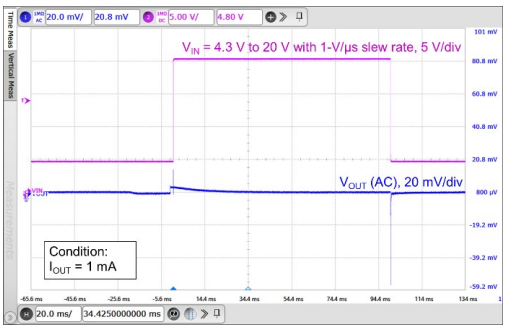


Figure 15. Line Transient

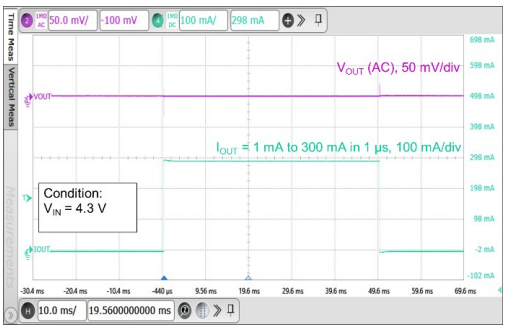


Figure 16. Load Transient

Detailed Description

Overview

The LT1964ES5 series of products are 300-mA high PSRR, ultra-low noise, and low-dropout linear regulators with a 20-V wide input voltage range. The LT1964ES5 series of products support both adjustable output voltage ranging from 1.22 V to 18 V with an external resistor divider and fixed output voltage ranging from 1.5 V to 5 V. The LT1964ES5 series of products are stable with a 2.2-µF to 100-µF ceramic output capacitor.

The LT1964ES5 series of products have high PSRR with 79 dB at 1 kHz and 5.68 μV_{RMS} ultra-low noise. These features make the LT1964ES5 series suitable for noise-sensitive applications, such as high-performance analog devices or high-definition imaging equipment, to suppress the large ripple and noise generated from the previous stage power supply. Besides, output short-circuit protection and thermal protection features improve system reliability under multiple operating conditions.

Functional Block Diagram

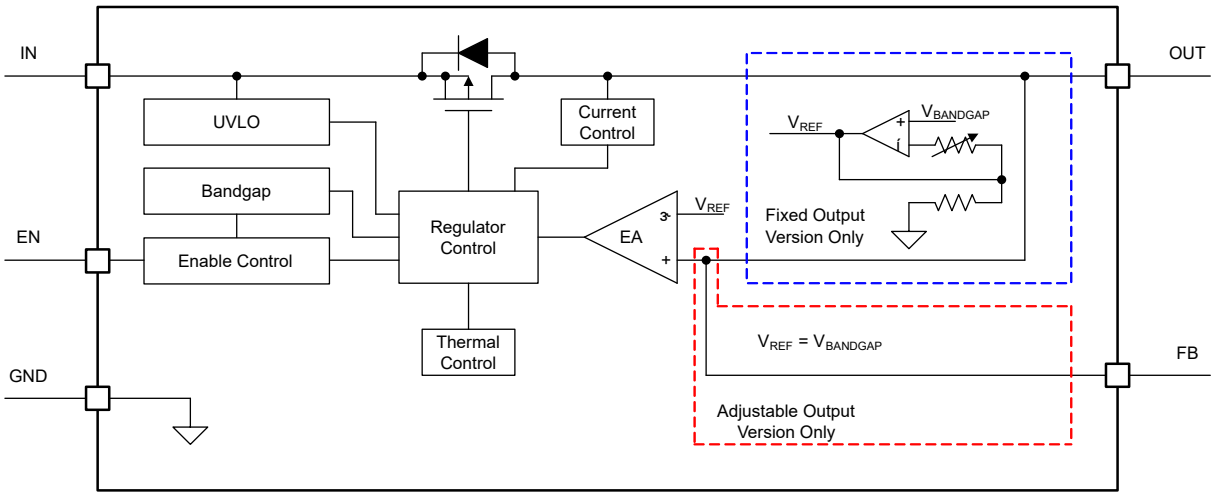


Figure 17. Functional Block Diagram

Feature Description

Enable (EN)

The enable pin (EN) is active high. Connect this pin to the GPIO of an external processor or digital logic control circuit to enable and disable the device. Or connect this pin to the IN pin for self-bias applications.

Under-Voltage Lockout (UVLO)

The LT1964ES5 series uses an under-voltage lockout circuit to keep the output shut off until the internal circuitry operates properly. Refer to the Electrical Characteristics table for the UVLO threshold and hysteresis.

Fixed Output Voltage

The LT1964ES5 series is available in fixed voltage versions of 1.5 V to 5 V. When the input voltage is higher than $V_{OUT(NOM)}$ + 1 V, the output voltage is well regulated according to the selected voltage option. When the input voltage falls below $V_{OUT(NOM)}$ + 1V, the output voltage tracks the input voltage minus the dropout voltage according to the load current. When the input voltage falls below UVLO, the output turns off.

Adjustable Output Voltage (FB and OUT)

The output voltage of the LT1964ES5 series with the FB pin can be set from 1.22 V to 18 V by selecting different external resistors. Use Equation 1 to calculate the output voltage.

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R1}{R2}\right) \quad (1)$$

Where the feedback voltage VFB is 1.22 V.

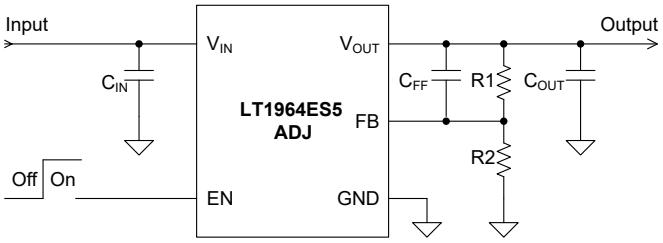


Figure 18. Adjustable Output

Over-Current Protection and Short-to-Ground Protection

The LT1964ES5 series integrates an internal current limit that helps to protect the regulator during fault conditions.

- When the output voltage is pulled down below the regulated voltage, over-current protection starts to work and limits the output current to I_{LIM}.
- When the output voltage is pulled down below 20 mV, or shorted to the ground directly, short-to-ground protection starts to work and limits the output current to I_{SC}.
- During startup, the output current is limited to I_{SC} before the output voltage ramps higher than the short-to-ground threshold.

Under the over-current conditions, the internal junction temperature ramps up quickly. When the junction temperature is high enough, it will cause over-temperature protection.

Over-Temperature Protection

The over-temperature protection starts to work when the junction temperature exceeds the thermal shutdown threshold, which turns off the regulator immediately. Until when the device cools down and the junction temperature falls below the thermal shutdown threshold minus thermal shutdown hysteresis, the regulator turns on again.

The junction temperature range should be limited according to the Recommended Operating Conditions table, continuously operating above the junction temperature range will reduce the device lifetime.

Application and Implementation

> Note
>
> Information in the following application sections is not part of the TOKMAS's component specification and TOKMAS does not warrant its accuracy or completeness. Customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

The LT1964ES5 devices are a series of 20-V, 300-mA high PSRR, ultra-low noise, low-dropout linear regulators. The following application schematics show the typical usage of the LT1964ES5 series.

Typical Application

Figure 19 and Figure 20 show the typical application schematics of the LT1964ES5 series.

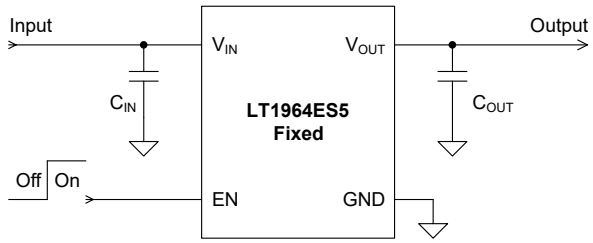


Figure 19. Typical Application Schematic of Fixed Output

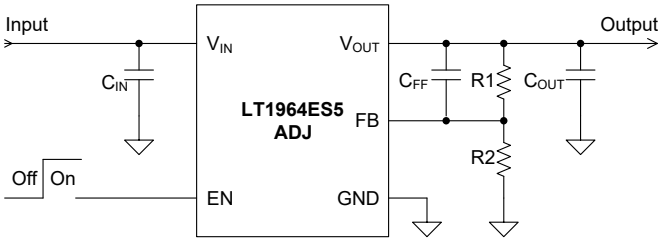


Figure 20. Typical Application Schematic of Adjustable Output

Input Capacitor and Output Capacitor

TOKMAS recommends adding a 4.7-µF or greater capacitor with a 0.1-µF bypass capacitor in parallel at the IN pin to keep the input voltage stable. The voltage rating of the capacitors must be greater than the maximum input voltage.

To ensure loop stability, the LT1964ES5 series requires an output capacitor of 2.2 µF to 100 µF. TOKMAS recommends selecting an X7R type 4.7-µF ceramic capacitor with the low ESR over temperature.

Both input capacitors and output capacitors must be placed as close to the device pins as possible.

Power Dissipation

During normal operation, LDO junction temperature should meet the requirement in the Recommended Operating Conditions table. Using the below equations to calculate the power dissipation and estimate the junction temperature.

The power dissipation can be calculated using Equation 2.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND} \quad (2)$$

The junction temperature can be estimated using Equation 3 . θ_{JA} is the junction-to-ambient thermal resistance.

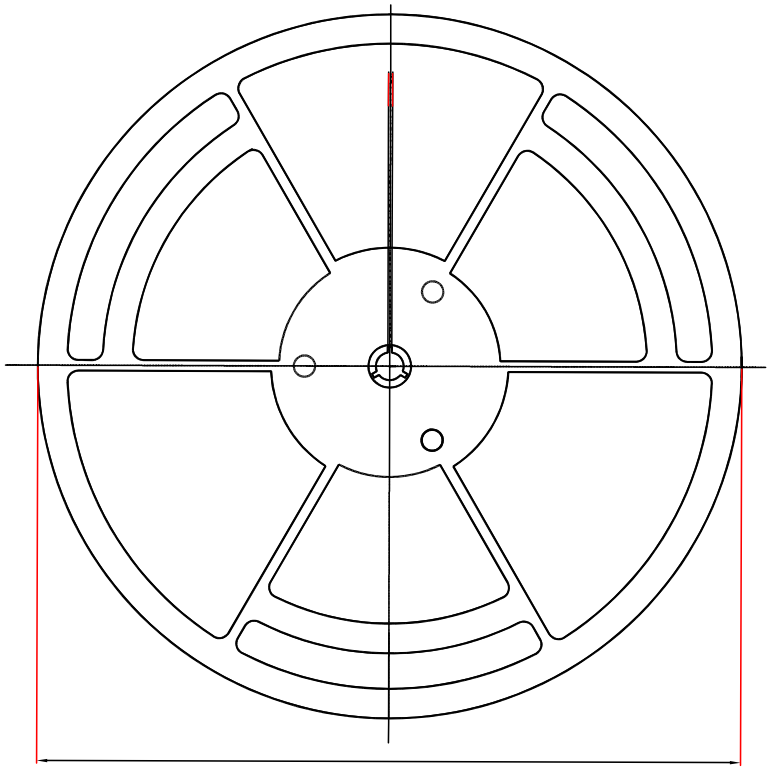
$$T_J = T_A + P_D \times \theta_{JA} \quad (3)$$

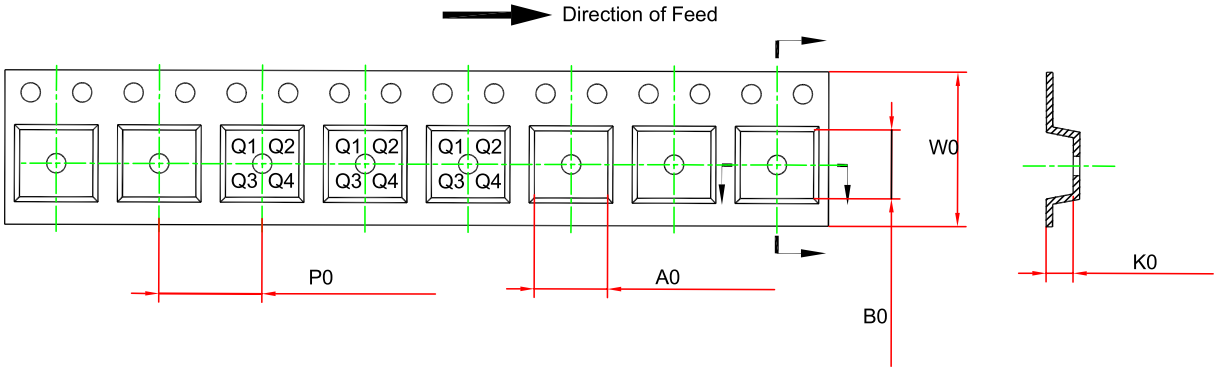
Layout

Layout Guideline

- Both input capacitors and output capacitors must be placed to the device pins as close as possible, and the vias between capacitors and device power pins must be avoided.
- It is recommended to bypass the input pin to ground with a 0.1-µF bypass capacitor. The loop area formed by the bypass capacitor connection, the IN pin and the GND pin of the system must be as small as possible.
- It is recommended to use wide and thick copper to minimize I×R drop and heat dissipation.

Tape and Reel Information



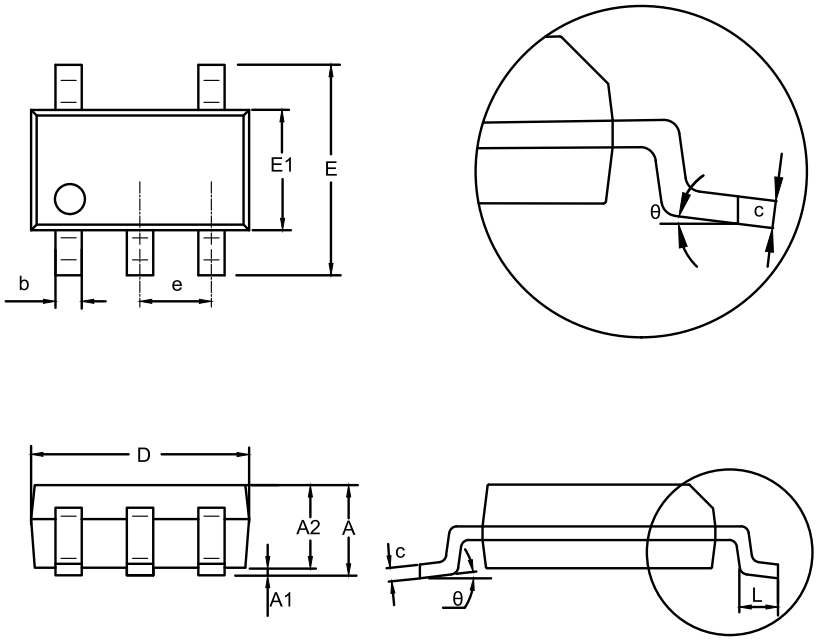


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
LT1964ES5-xxx	SOT23-5	180	12	3.3	3.25	1.4	4	8	Q3

Package Outline Dimensions

SOT23-5

Package Outline Dimensions S5T(SOT23-5-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.