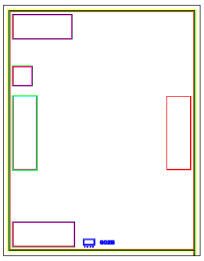
Ultra High Dynamic Range, Shutdown

Monolithic Amplifier Die TSS-23HLN-D+

50Ω 30 MHz to 2 GHz

The Big Deal



- Ultra-High IP3, +42.6 dBm typ.
- Medium power, +28.5 dBm typ.
- Excellent Noise Figure, 1.4 dB typ.
- Shutdown feature
- Operates over wide DC input: +3V to +8V

Product Overview

TSS-23HLN-D+ (RoHS compliant) is an advanced wideband amplifier die with shutdown feature. It is fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the TSS-23HLN-D+ has good input and output return loss over a broad frequency range.

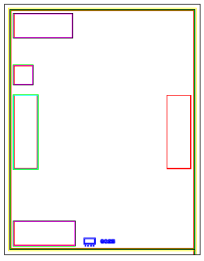
Key Features

Feature	Advantages
Broad Band: 30MHz to 2GHz	Broadband covering primary wireless communications bands: VHF, UHF, Cellular
Extremely High IP3 39.6 dBm typical at 30 MHz 42.6 dBm typical at 1 GHz	The TSS-23HLN-D+ matches industry leading IP3 performance relative to device size and power consumption. The combination of the design and E-PHEMT Structure provides enhanced linearity over a broad frequency range as evidence in the IP3 being approximately 13-15 dB above the P1dB point. This feature makes this amplifier ideal for use in: • Driver amplifiers for complex waveform up converter paths • Drivers in linearized transmit systems • Secondary amplifiers in ultra-High Dynamic range receivers
Shutdown feature	Allow users to turn on and off the amplifier with pulsed signals while keeping the power supply at constant voltage to minimize DC power consumption
Low Noise Figure 1.4 dB at 1GHz	Enables lower system noise figure performance and along with High OIP3 provides high dynamic range
High P1dB, 28.5 dBm at 1 GHz	High P1dB, High OIP3, Low NF results in a very dynamic range preventing amplifier saturation under strong interfering signals.

Ultra High Dynamic Range, Shutdown

Monolithic Amplifier Die

30 MHz to 2 GHz



Product Features

- High IP3, 42.6 dBm typ. at 1 GHz
- Gain, 21.8 dB typ. at 1 GHz
- Low noise figure, 1.4 dB at 1 GHz
- High P1dB 28.5 dBm 1 GHz
- Shutdown feature
- Operates over wide DC input: +3V to 8V

Typical Applications

- Base station infrastructure
- CATV
- Cellular

+RoHS Compliant

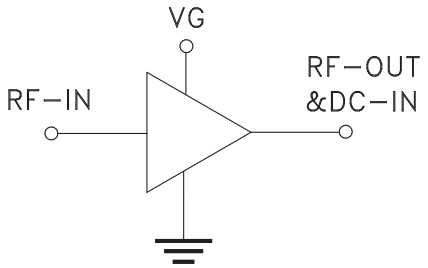
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

General Description

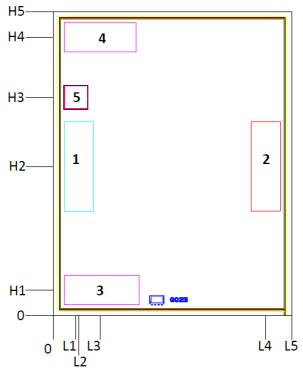
TSS-23HLN-D+ (RoHS compliant) is an advanced wideband amplifier die with shutdown feature. It is fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the TSS-23HLN-D+ has good input and output return loss over a broad frequency range.

Simplified Schematic and Pad description



Pad#	Function
1	RF-IN
2	RF-OUT & DC-IN
5	VG
3,4	Ground

Bonding Pad Position



Dimensions in µm, Typical

L1	L2	L3	L4	L5	H1	H2	H3	H4	H5	Thick-ness	Die Size	Pad Size 1	Pad Size 2	Pad Size 3	Pad Size 4	Pad Size 5
76.0	86.0	160.0	705.0	790.0	86.0	495.0	725.0	925.0	1010.0	100	1010 x 900	101 x 301	98 x 298	251 x 101	241 x 101	81 x 81

Electrical Specifications[1] at 25°C, unless noted

Parameter	Condition(MHz)	Vd = 8V		Vd = 5V		Vd = 3V		Units
		ON State	OFF State	ON State	OFF State	ON State	OFF State	
Frequency Range		30-2000	30-2000	30-2000	30-2000	30-2000	30-2000	MHz
Noise Figure	30	1.4	--	1.2	--	1.1	--	dB
	500	1.4	--	1.2	--	1.2	--	
	1000	1.4	--	1.2	--	1.2	--	
	1500	1.5	--	1.3	--	1.4	--	
	2000	1.6	--	1.4	--	1.5	--	
Gain	30	23.3	-21	23.1	-21	22.4	-21	dB
	500	22.4	-21	22.2	-21	21.4	-21	
	1000	21.8	-23	21.5	-23	20.2	-24	
	1500	21.1	-25	20.7	-26	19.1	-26	
	2000	20.3	-28	19.9	-28	18	-27	
Reversed Isolation	30-2000	27	26	27	26	27	25	dB
Input Return Loss	30	11	12	12	12	12	12	dB
	500	12	12	12	12	11	12	
	1000	10	12	10	12	8	12	
	1500	11	15	10	15	8	15	
	2000	12	20	11	19	8	19	
Output Return Loss	30	15	2	15	2	17	2	dB
	500	14	2	15	2	19	2	
	1000	12	2	16	2	18	2	
	1500	10	2	12	2	11	2	
	2000	8	2	10	2	9	2	
Output Power @1dB compression AMP-ON	30	26.2	--	22.8	--	17.1	--	dBm
	500	27.9	--	23.8	--	18.9	--	
	1000	28.5	--	24.1	--	19	--	
	1500	28.1	--	23.5	--	18.8	--	
	2000	27.7	--	22.8	--	18.1	--	
Ouput IP3 (Pout = 0dBm/Tone)	30	39.6	--	39.8	--	34.1	--	dBm
	500	41.6	--	38	--	33.7	--	
	1000	42.6	--	36.4	--	31.8	--	
	1500	42.6	--	35.5	--	31.1	--	
	2000	41.8	--	34	--	30.3	--	
Device Operating Voltage(VDD)		8	8	5	5	3	3	V
Device Operating Current(ID)		236	8	139	5	74	3	mA
Control Voltage (VG)		0	5	0	5	0	5	V
Device Current Variation vs. Temperature		-225[2]	--	-13[3]	--	27[3]	--	uA/degC
Device Current Variation vs. Voltage		0.0263	--	0.034	--	0.033	--	mA/mV
Thermal Resistance		23.3	--	23.3	--	23.3	--	degC/W

1. Measured on Mini-Circuits Characterization test board. Die is packaged in 3x3 mm, 12-lead MCL package and soldered on TB-TSS-23HLN+. See Characterization Test Circuit (Fig. 1)
2. (Current at 95°C - Current at -45°C)/140
3. (Current at 105°C - Current at -45°C)/150

Absolute Maximum Ratings[4]

Parameter	at 8V	at 3V&5V
Operating Temperature (ground lead)	-40°C to 95°C	-40°C to 105°C
Power Dissipation	3.3W	3.3W
Device Operating Current (ID)	249mA	163mA
Input Power (CW)	+28 dBm (5 minutes max) +15 dBm (continuous) for 0.03-1 GHz +18 dBm (continuous) for 1-2 GHz	+28 dBm (5 minutes max) +10 dBm (continuous) for 0.03-1 GHz +13 dBm (continuous) for 1-2 GHz
DC Voltage on Pad 2	10V	10V
DC Voltage on Pad 5	10V	10V

4. Permanent damage may occur if any of these limits are exceeded.
Electrical maximum ratings are not intended for continuous normal operation.

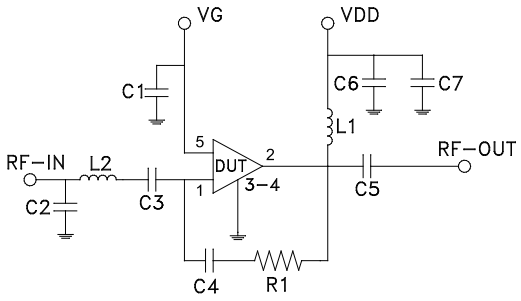
Switching Specifications

Parameter		8V Typ	5V Typ.	3V Typ.	Units
Amplifier ON to Shutdown	OFF TIME (50% Control to 10% RF)	5.3	4.8	6.2	µs
	FALL TIME (90 to 10% RF)	7.3	7.4	3.6	
Amplifier Shutdown to ON	ON TIME (50% Control to 90% RF)	77.7	95.2	144.7	µs
	RISE TIME (10% to 90% RF)	54.2	60.0	200.7	
Control Voltage Leakage		633.3	482.9	311.0	mV

Control Voltage (V_G) Fig. 1

	Min.	Typ.	Max.	Units
Amplifier-ON	—	0	0.7	V
Amplifier-OFF	1.9	5	—	V

Characterization Test Circuit / Recommended Application Circuit

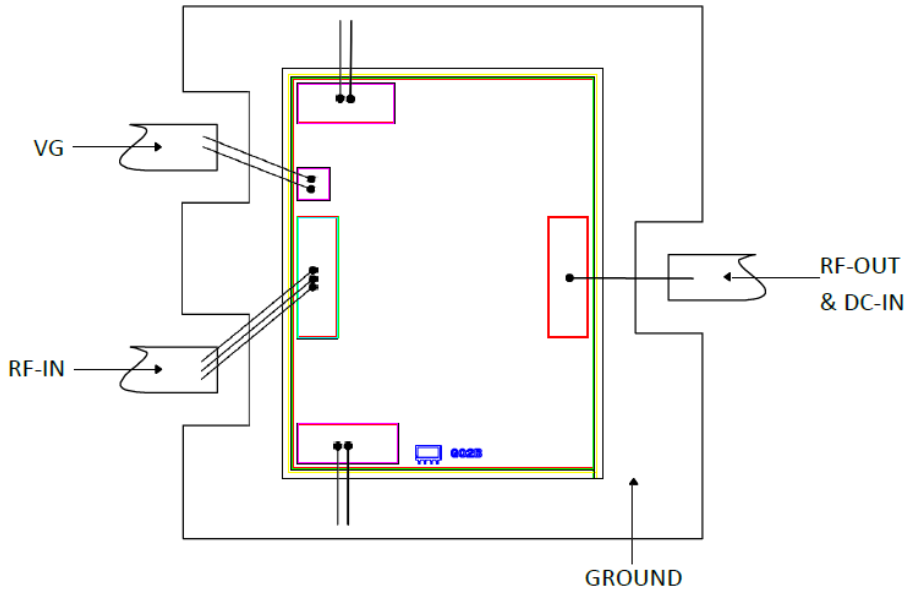


Component	Size	Value	Part Number	Manufacturer
C1	0402	0.1uF	GRM155R71C104KA88D	Murata
C2	0402	1.2pF	GRM1555C1H1R2CA1D	Murata
C3	0402	0.1uF	GRM155R71C104KA88D	Murata
C4	0402	0.1uF	GRM155R71C104KA88D	Murata
C5	0402	1000pF	GRM1555C1H102JA01D	Murata
C6	0402	10000pF	GRM155R71E103KA01D	Murata
C7	0402	0.1uF	GRM155R71C104KA88D	Murata
L1	0805	680nH	0805LS–681XJLB	Coilcraft
L2	0402	1.0nH	0402CS–1N0XJLW	Coilcraft
R1	0402	1.2KOhm	RK73H1ETTP1201F	Koa

Fig 1. Block diagram of Test Circuit used for characterization. (DUT is packaged 3x3mm, 12-lead MCLP package and soldered on Mini-Circuits Characterization test board TB-TSS-23HLN+)
Gain, Return loss, Output power at 1dB compression (P1dB) , output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain and Return Loss: Pin= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, +0dBm/tone at output.
3. Switching Time
   RF Signal: Pin=-25 dBm, f_{RF}=500 MHz.
   V_{DD}=8V,5V or 3V DC, V_G=Pulse signal at 1 KHz with V_{HIGH}=5V, V_{LOW}=0V, 50% duty cycle.

Assembly Diagram



Assembly and Handling Procedure

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC E-PHEMT amplifier dice are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be opened in clean room conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickup tips or sharp antistatic tweezers to deter ESD damage to dice.
3. Die Attach
   The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are DieMat DM6030HK-PT/H579 or Ablestik 84-1LMISR4. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total die periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. It is recommended to use antistatic die pick up tools only.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the dice gold bond pads. Thermosonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1 mil diameter. Bonds must be made from the bond pads on the die to the package or substrate. All bond wires should be kept as short as low as reasonable to minimize performance degradation due to undesirable series inductance.

Additional Detailed Technical Information

additional information is available on our dash board.

Performance Data	Data Table	
	Swept Graphs	
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)	
Case Style	Die	
Die Ordering and packaging information	Quantity, Package	Model No.
	Small, Gel - Pak: 5,10,50,100 KGD*	TSS-23HLN-DG+
	Medium†, Partial wafer: KGD*<1672	TSS-23HLN-DP+
	Large†, Full Wafer	TSS-23HLN-DF+
	†*Available upon request contact sales representative*	
	Refer to AN-60-067	
Environmental Ratings	ENV80	

*Known Good Dice ("KGD") means that the dice in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such dice fall within a predefined range. While DC testing is not definitive, it does help to provide a higher degree of confidence that dice are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

ESD Rating**

Human Body Model (HBM): Class 1A (pass 250V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard 3X3 mm, 12 lead MCLP package.

Additional Notes

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