ANALOG DEVICES

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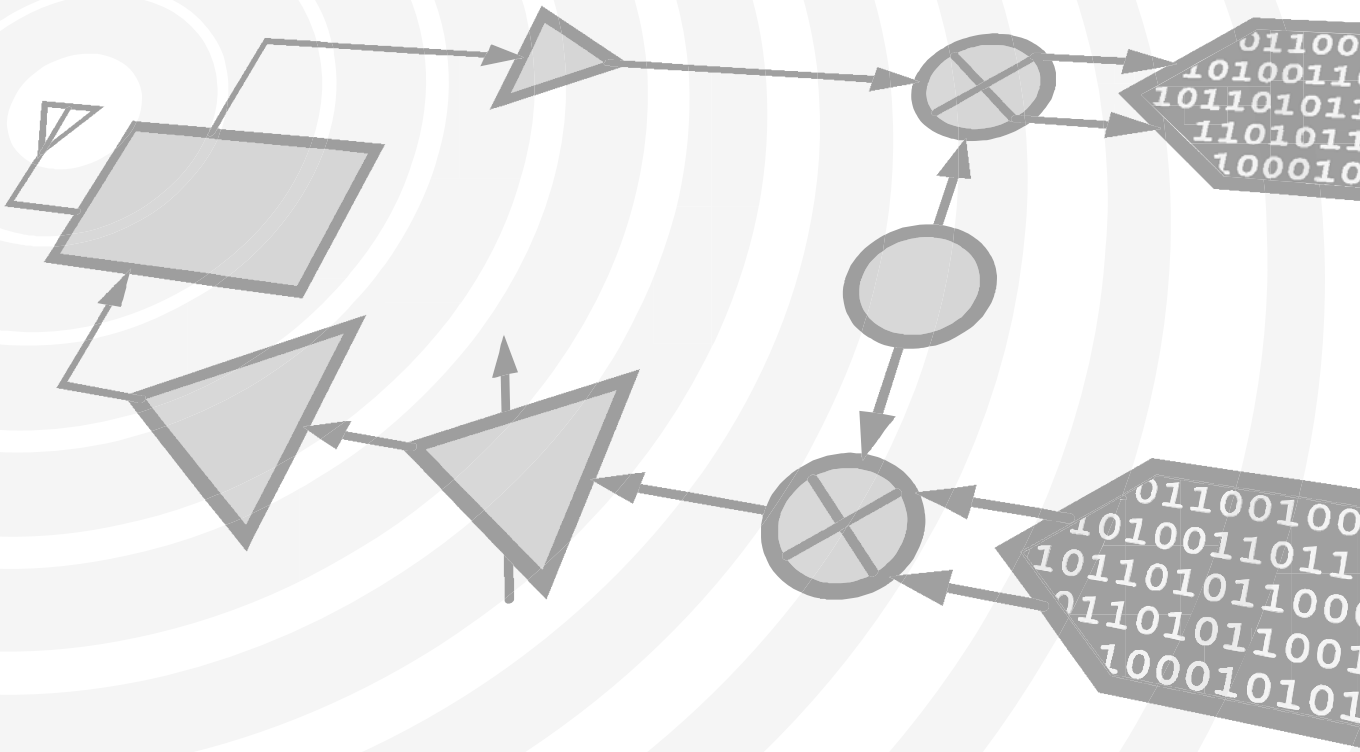

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HMC7144LC4

28Gbps EML DRIVER w/ Peak-Detector

Typical Applications

The HMC7144LC4 is ideal for:

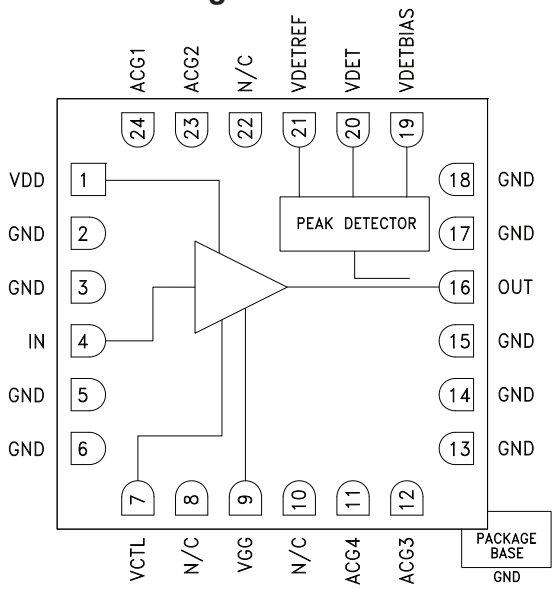
- 100Gb Ethernet ER4/ LR4 systems
- CFP/CFP2 or similar form factor modules
- Optical transceivers and pluggable modules
- Broadband gain stages and pre-amplifiers
- Broadband Test & Measurement Equipment

Features

- Operation up to 28.3 Gbps
- Low DC Power Dissipation,

  0.12W for 1.5Vpp swing @ 3.5V supply
  0.50W for 2.3Vpp swing @ 6V supply
- Adjustable Output Amplitude from 1.2Vpp to 2.3Vpp
- Integrated Peak Detector
- 24 Lead Ceramic 4x4mm SMT Package: 16 mm^2

Functional Diagram



General Description

The HMC7144LC4 is a broadband driver amplifier for electro-absorption modulated lasers (EML) and supports data-rates up to 28.3Gbps to meet the 100Gb Ethernet system requirements. The part provides the module designers scalable power dissipation for varying drive voltage characteristics of different modulators and the power consumption of the module can be set as low as 0.12W to 0.5W at 1.5Vpp and 2.2Vpp outputs amplitudes, respectively. The HMC7144LC4 supports wide range of supply voltages from 3.5V to 6V and delivering excellent time domain performance. The driver incorporates the unique feature, peak-detector with reference, which enables the continuous output amplitude monitoring without the need for an external high-frequency circuitry. The output amplitude and cross-point can be adjusted via control pins. The input and output are 50 Ohms matched and used AC coupled. The HMC7144LC4 is in robust leadless 4x4mm ceramic surface mountable package.

Electrical Specifications, T_A = +25°C

Parameter	Conditions	Vdd = 3.5V			Vdd = 5.0V			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Maximum Data Rate			28.3	32		28.3	32	Gbps
Gain	DC - 10 GHz 10 GHz - 20 GHz 20 GHz - 30 GHz	10 11.8 5.8	13 12.8 8.8	13.8 13.5 13	11 10 7	15 14 12	16 15 13	dB
Input Return Loss	DC - 10 GHz 10 GHz - 20 GHz 20 GHz - 30 GHz		-13 -16 -18	-10 -9 -4		-13 -14 -16	-10 -10 -7	dB
Output Return Loss	DC - 10 GHz 10 GHz - 20 GHz 20 GHz - 30 GHz		-23 -21 -18	-15 -13 -11		-23 -21 -15	-10 -10 -7	dB
Group Delay Variation	DC - 10 GHz 10 GHz - 20 GHz 20 GHz - 30 GHz		±5 ±10 ±22			±6 ±10 ±20		ps

Electrical Specifications (Continued)

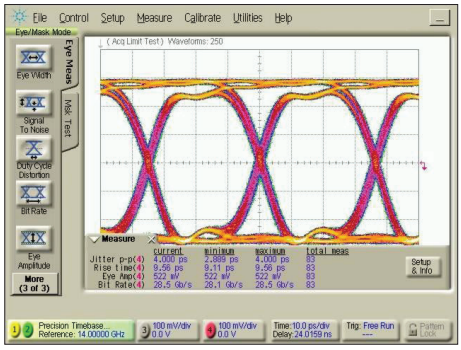
Parameter	Conditions	Vdd = 3.5V			Vdd = 5.0V			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Adjustable Output Swing Range [1]		0.9		1.5	1.2		2.2	Vpp
Rise Time [1]	20% - 80%		14.5			15		ps
Fall Time [1]	20% - 80%		16.2			16		ps
Additive RMS Jitter [2]		240	270	320	240	250	310	fs
Deterministic Jitter				2			2	ps
Signal-to-Noise Ratio (SNR) [1]			23			22		dB
Supply Current (Idd)	Idd	40	45	55	50	70	80	mA
Bias Current Adjust / Cross-Point Adjust (Vgg)	Vgg	-1	-0.9	-0.5	-1	-0.85	-0.5	V
Output Amplitude Adjust (Vctl)	Vctl	-1	-0.2	0.2	-1	0	0.2	V
Cross-Point Range		45	50	55	45	50	55	%
Peak Detect Sensitivity		40	50	60	40	50	60	mV/V

[1] Data input = 28 Gbps NRZ PRBS 2^{31}-1 pattern, 0.5Vpp.

[2] Additive RMS jitter is calculated by $J_{RMS,DUT} = \sqrt{[\ (Jtested)^2 - (Jsource)^2\ ]}$ with 28 Gbps 10101... pattern, 0.5Vpp.

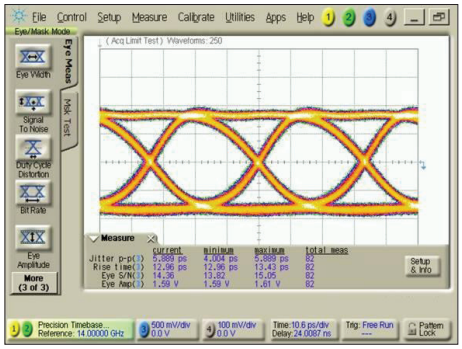
* Adjust Vgg between -1V to 0V to achieve desired cross-point percentage.

28 Gbps NRZ Input Eye Diagram



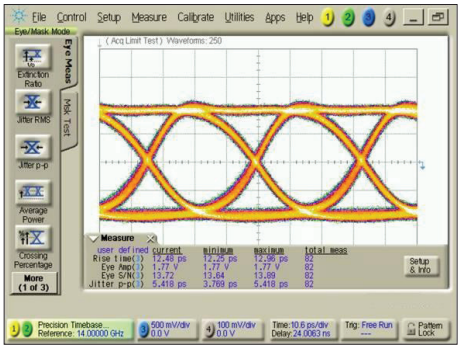
Vin=510mVpp, 28Gbps PRBS 2^{31}-1 input data

28 Gbps Output Eye Diagram @ Vdd=3.5V



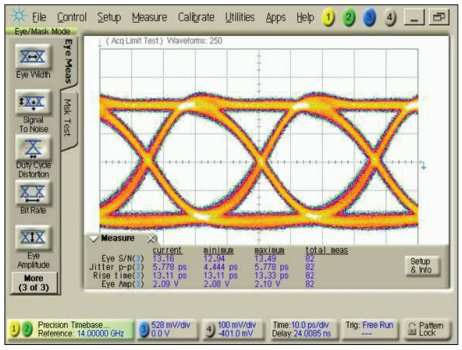
VCTL= -0.3V, VGG=-0.9V, Idd=44mA,
Vout=1.59Vpp, Pdiss=0.15W

28 Gbps Output Eye Diagram @ Vdd=4.0V



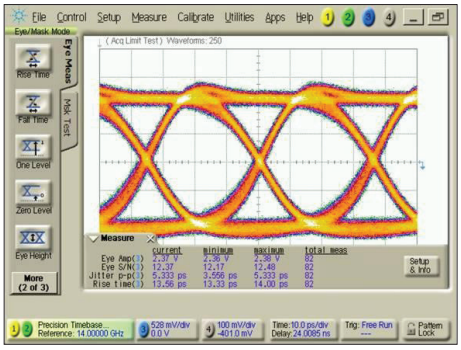
VCTL=-0.2V, VGG=-0.89V, Idd=50mA,
Vout=1.77Vpp, Pdiss=0.20W

28 Gbps Output Eye Diagram @ Vdd=5.0V



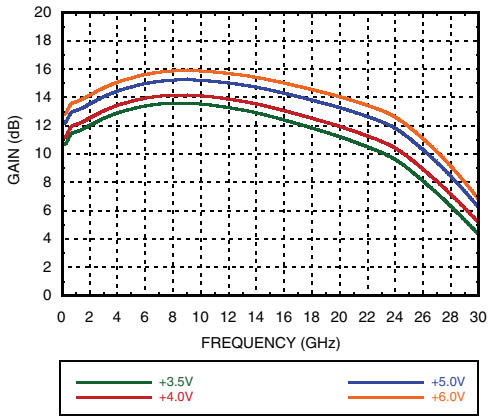
VCTL=-0.05, VGG=-0.85V, Idd=64mA,
Vout=2.09 Vpp, Pdiss=0.32W

28 Gbps Output Eye Diagram @ Vdd=6.0V

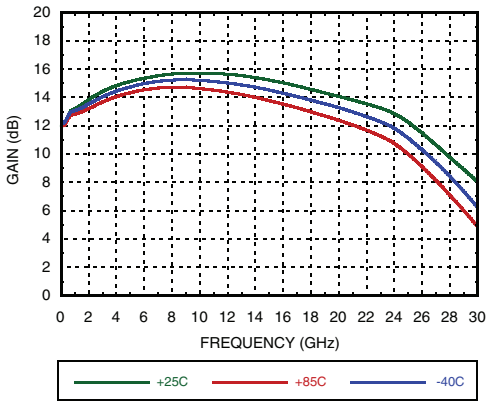


VCTL=-0.03V, VGG=-0.81V, Idd=79mA,
Vout=2.37Vpp, Pdiss=0.47W

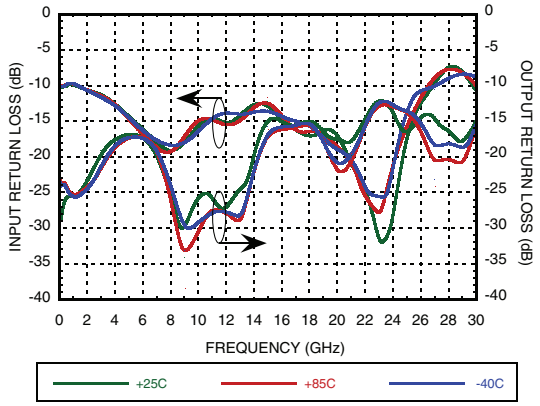
Gain over Supply [1]



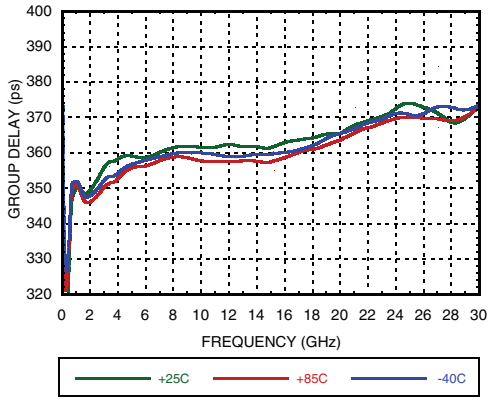
Gain over Temperature [2]



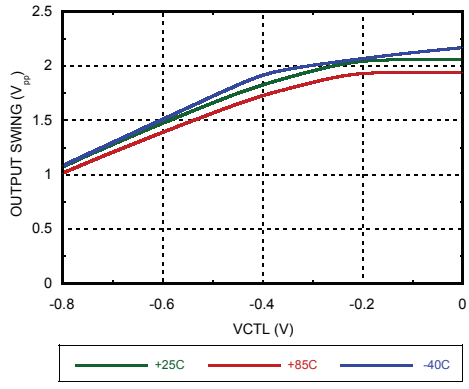
Input/Output Return Loss over Temperature [2]



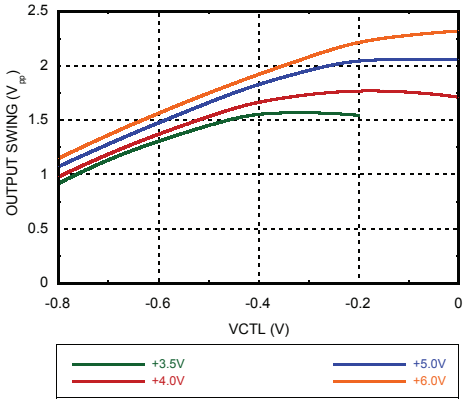
Group Delay vs. Frequency over Temperature [1][2]



Output Swing vs. VCTL over Temperature [1][2][3]

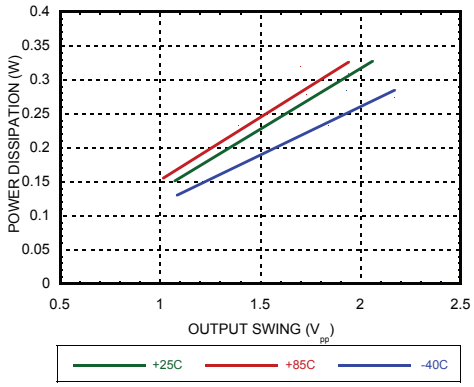


Output Swing vs. VCTL over Supply [1][3]

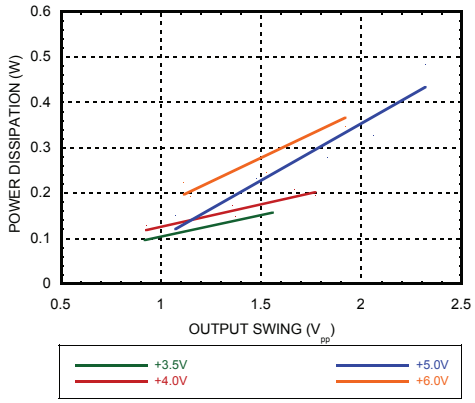


[1] Vgg=-0.90V
[2] Vdd=5V. Refer to Table -1 for typical bias voltages.
[3] Data input = 28 Gbps NRZ PRBS 2^{31}-1 pattern, 0.5Vpp

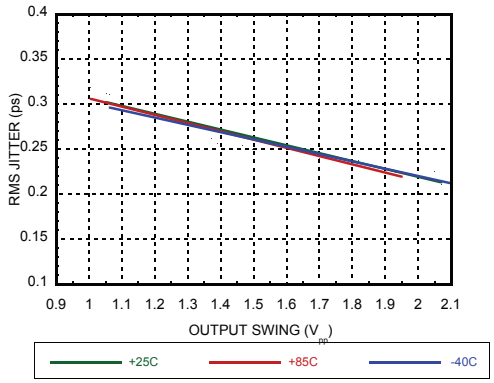
Power Dissipation vs. Output Swing over Temperature [1][3]



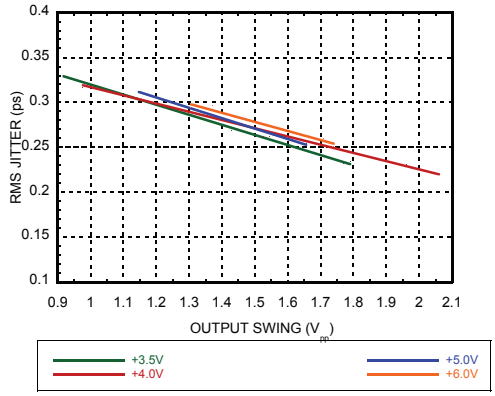
Power Dissipation vs. Output Swing over Supply [2][3]



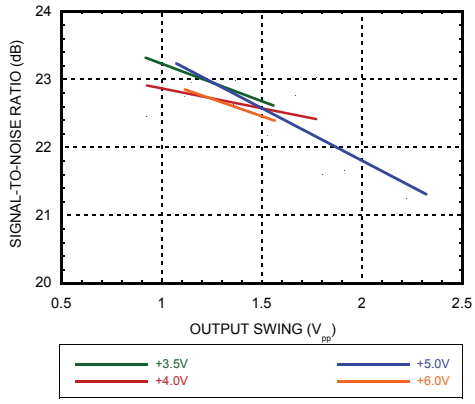
RMS Jitter vs. Output Swing over Temperature [1][4][5]



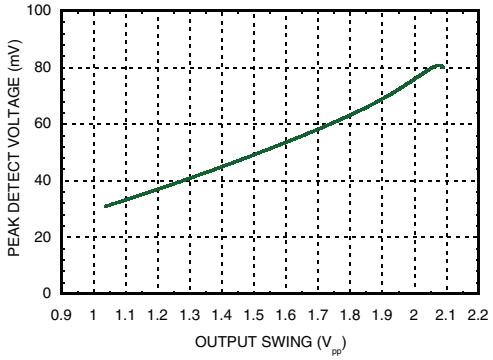
RMS Jitter vs. Output Swing over Supply [2][4][5]



Signal-to-Noise Ratio vs. Output Swing over Supply [2][3]



Peak-Detect Voltage vs. Output Swing [1][6]



[1] Vdd=5V. Refer to Table -1 for typical bias voltages [2] Vgg=-0.90V
[3] Data input = 28 Gbps NRZ PRBS 2^{31}-1 pattern, 0.5Vpp [4] The total peak-to-peak jitter of the source is $J_{pp(source)}$ = 5 ps
[5] Data input = 0.5Vpp, 28 Gbps 1010... pattern for RMS jitter, data input = 0.5Vpp, 28 Gbps NRZ PRBS 2^{31}-1 pattern for peak-to-peak jitter, additive RMS jitter is calculated with the formula $J_{RMS}=\sqrt{[(Jtested)^2-(Jsource)^2]}$ [6] VDETBIAS=1.5V, Peak-Detect Voltage=VDET-VDETREF

Absolute Maximum Ratings

Drain Bias Voltages (Vdd)	+12 V
Minimum Gate Bias Voltage (Vgg)	-1.5 V
Maximum Gate Bias Voltage (Vgg)	0 V
Minimum Control Bias Voltage (Vctl)	-1.5 V
Maximum Control Bias Voltage (Vctl)	2.0 V
Maximum Detector Bias Voltage (Vdetbias)	2.5 V
Input Voltage Swing (Vin)	2 Vpp
Channel Temperature	175 °C
Continuous Pdiss (T = 85 °C) (derate 43.8 mW/°C above 85 °C)	2.84 W
Thermal Resistance (channel to ground paddle)	23 °C/W
Storage Temperature	-65 to +150 °C
Operating Temperature	-40 to +85 °C
ESD Sensitivity (HBM)	Class 1A

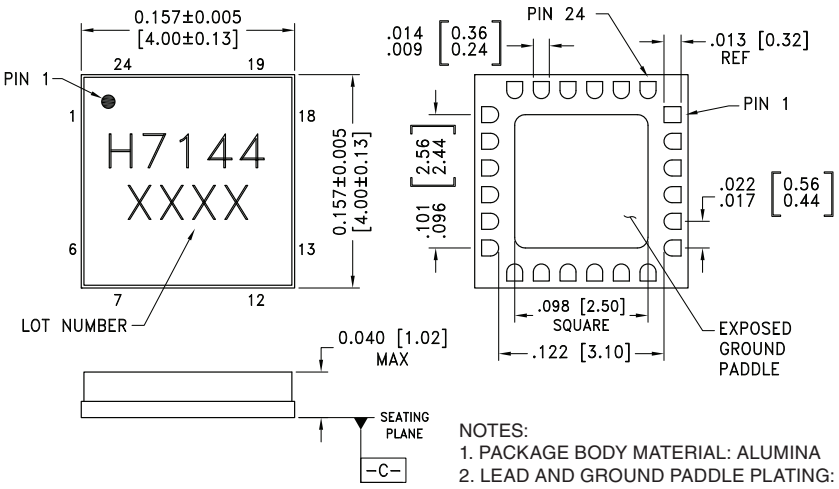
Table -1. Typical Bias Voltages*

Vdd (V)	Vctl (V)	Vgg (V)	Idd (mA)
3.5V	-0.4V	-0.9V	45
4.0V	-0.4V	-0.85V	53
5.0V	0V	-0.85V	70
6.0V	-0.2V	-0.8V	76

* When input data amplitude is 500mVpp

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Outline Drawing



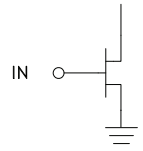
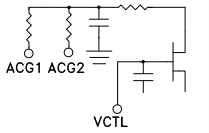
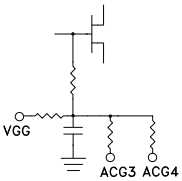
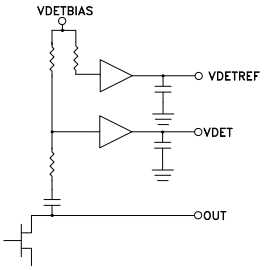
NOTES:
1. PACKAGE BODY MATERIAL: ALUMINA
2. LEAD AND GROUND PADDLE PLATING: 30-80 MICROINCHES GOLD OVER 50 MICROINCHES MINIMUM NICKEL.
3. DIMENSIONS ARE IN INCHES [MILLIMETERS].
4. LEAD SPACING TOLERANCE IS NON-CUMULATIVE.
5. CHARACTERS TO BE BLACK INK MARKED WITH .018"MIN to .030"MAX HEIGHT REQUIREMENTS. UTILIZE MAXIMUM CHARACTER HEIGHT BASED ON LID DIMENSIONS AND BEST FIT. LOCATE APPROX. AS SHOWN.
6. PACKAGE WARP SHALL NOT EXCEED 0.05mm DATUM -C-
7. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.

Package Information

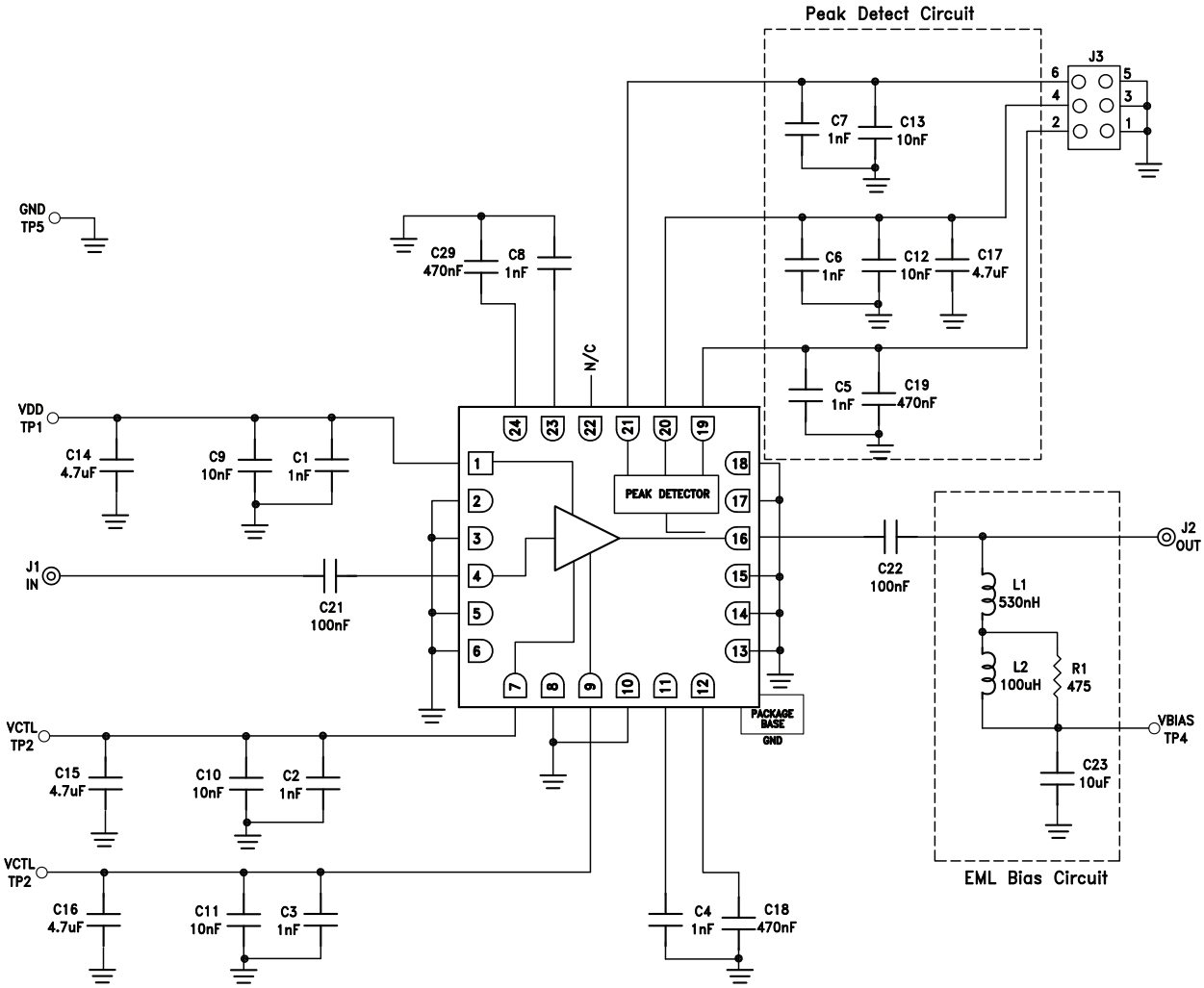
Part Number	Package Body Material	Lead Finish	MSL Rating	Package Marking [2]
HMC7144LC4	Alumina, White	Gold over Nickel	MSL1 [1]	H7144 XXXX

[1] Max peak reflow temperature of 260 °C
[2] 4-Digit lot number XXXX

Pin Descriptions

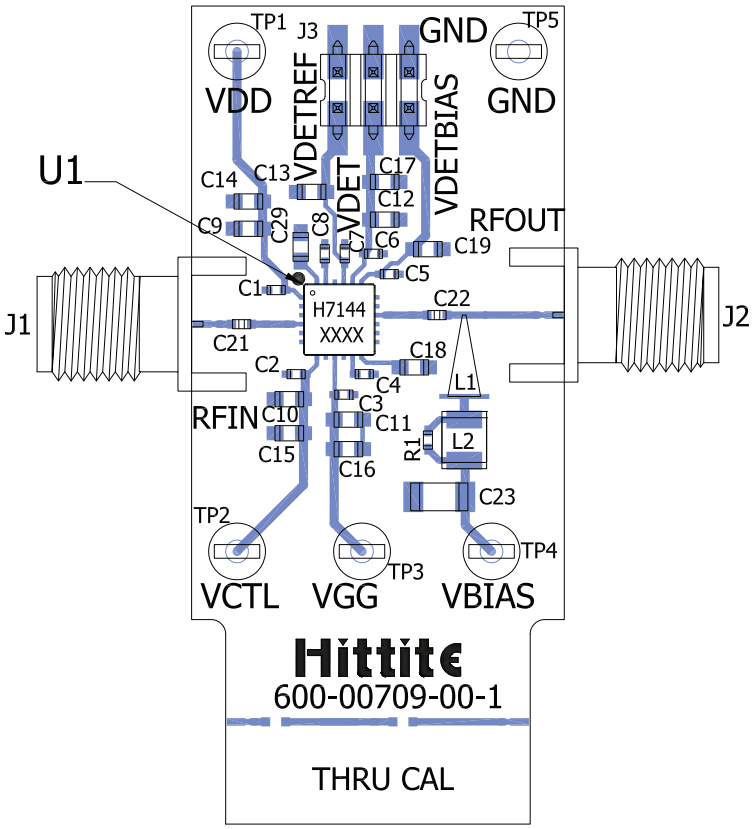
Pin Number	Function	Description	Interface Schematic
1	VDD	Supply voltage	
2, 3, 5, 6, 13, 14, 15, 17, 18	GND	These pins and die bottom must be connected to RF/ DC ground.	
4	IN	This pin is DC coupled and matched to 50 Ohms.	
7	VCTL	Gate control voltage used to control the output voltage swing of the amplifier. Typical value is -0.2V.	
23	ACG2	Low frequency termination. Attach bypass capacitors per application circuit herein.	
24	ACG1		
8, 10, 22	N/C	No connection required.	
9	VGG	The gate control voltage used to change the current of the amplifier and for cross-point adjustment of eye-diagram. Typical value is -0.85V	
11	ACG4	Low frequency termination. Attach bypass capacitors per application circuit herein.	
12	ACG3		
16	OUT	This pin is DC coupled and matched to 50 Ohms.	
19	VDETBIAS	The bias voltage for detector. Set to +1.5V.	
20	VDET	Detector output voltage.	
21	VDETREF	Detector reference voltage.	

Application Circuit



- Evaluation board schematic

Evaluation PCB



List of Materials for Evaluation PCB EVAL01-HMC7144LC4[1]

Item	Description
J1 - J2	K Connector
J3	2mm 6 Pins SMT Header
TP1-TP5	DC Test Point
C1-C3	1000 pF Capacitor, 0402 Pkg.
C9-C13	10 nF Capacitor, 0603 Pkg.
C14-C17	4.7 µF Capacitor, 0603 Pkg.
C18-C19, C29	0.47 µF Capacitor, 0603 Pkg.
C21-C22	100 nF Capacitor, Casel Pkg.
C23	10 µF Capacitor, 1206 Pkg.
L1	0.53 µH Inductor, Conical Pkg.
L2	100 µH Inductor, 1210 Pkg.
R1	475 Ohms Resistor, 0402 Pkg.
U1	HMC7144LC4 28Gbps EML Driver w/Peak-Detector
PCB [2]	600-00709-00 Evaluation Board

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350 or Arlon 25 FR

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Hittite upon request.

Device Operation

These devices are susceptible to damage from Electrostatic Discharge. Proper precautions should be observed during handling, assembly and test.

Device Power Up Instructions

1. Ground the device
2. Set Vgg to -1V to ensure the device is turned-off when supply is applied in step-4. (no drain current)
3. Set Vctl to its typical value given in Table -1 (no drain current)
4. Set Vdd to its typical value given in Table -1 (no drain current)
5. Increase Vgg till the supply current Idd reach to its desired value

• Vgg may be adjusted to get the desired eye crossing point percentage

• Vctl may be adjusted to set the the desired output voltage swing.

• Vdd may be further adjusted to optimize the power consumption and the output voltage swing.

Device Power Down Instructions

1. Reverse the sequence identified above in steps 1 through 4.

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Наши контакты:

Телефон: +7 812 627 14 35

Электронная почта: sales@st-electron.ru

Адрес: 198099, Санкт-Петербург, Промышленная ул, дом № 19, литера Н, помещение 100-Н Офис 331