LMK1D120x 低付加ジッタ LVDS バッファ

1 特長

- 2 入力、4 出力 (2:4) または 8 出力 (2:8) の高性能 LVDS クロック・バッファ・ファミリ
- 変調周波数 (最大 2GHz)
- 電源電圧:1.71V～3.465V
- 小さい付加ジッタ:156.25MHz 時、12kHz～20MHz の範囲で最大 60fs RMS
  - 非常に小さい位相ノイズフロア:-164dBc/Hz (標準値)
- 非常に小さい伝搬遅延:575ps (最大値)
- 出力スキュー:20ps (最大値)
- ユニバーサル入力は LVDS、LVPECL、LVCMOS、HCSL、CML の信号レベルを受け入れ可能
- LVDS リファレンス電圧 V_{AC_REF} は、容量性結合入力に使用可能
- 産業用温度範囲:-40℃～105℃
- パッケージ:
  - LMK1D1204:3mm × 3mm 16 ピン VQFN (RGT)
  - LMK1D1208:5mm × 5mm 28 ピン VQFN (RHD)

2 アプリケーション

- テレコミュニケーションおよびネットワーク機器
- 医療用画像処理
- 試験 / 測定機器
- ワイヤレス・インフラ
- 業務用オーディオ、ビデオ、サイネージ

3 概要

LMK1D120x クロック・バッファは、2 つのクロック入力 (IN0 および IN1) のいずれか 1 つを 4 ペアまたは 8 ペアの差動 LVDS クロック出力 (OUT0～OUT7) に分配します。このとき、クロック分配のスキューを最小限に抑えます。LMK1D12x ファミリは、入力マルチプレクサに 2 つのクロック源を接続できます。入力は LVDS、LVPECL、HCSL、CML、LVCMOS のいずれかに対応可能です。

LMK1D12x は、50Ω の伝送経路を駆動するように特化して設計されています。シングルエンド・モードで入力を駆動する場合には、図 9-6 に示す適切なバイアス電圧を未使用の負入力ピンに印加する必要があります。

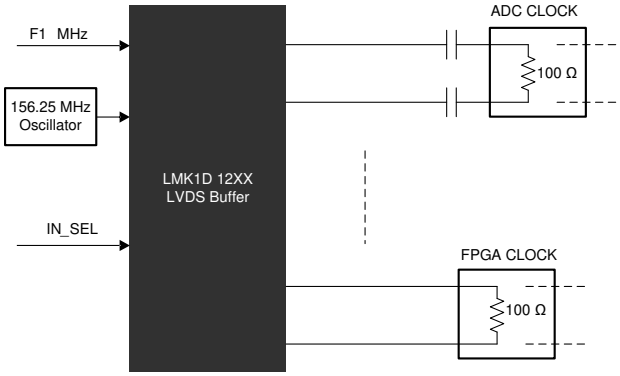
IN_SEL ピンは、どの入力を出力に転送するかを選択します。このピンがオープンのままの場合、出力はディセーブルになります (ロジック LOW)。このデバイスは、フェイルセーフ機能をサポートしています。さらに、このデバイスは入力ヒステリシスを備えており、入力信号が存在しないときに出力がランダムに発振することを防止します。

このデバイスは、1.8V、2.5V、または 3.3V 電源で動作し、-40℃～105℃ (周囲温度) で動作が規定されています。LMK1D12x のパッケージ・バリアントを以下の表に示します。

パッケージ情報

部品番号	パッケージ(1)	パッケージ・サイズ (公称) (2)
LMK1D1204	VQFN (16)	3.00mm × 3.00mm
LMK1D1208	VQFN (28)	5.00mm × 5.00mm

(1) 利用可能なすべてのパッケージについては、データシートの末尾にある注文情報を参照してください。
(2) 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。



アプリケーションの例

英語版の TI 製品についての情報を翻訳したこの資料は、製品の概要を確認する目的で便宜的に提供しているものです。該当する正式な英語版の最新情報は、www.ti.com で閲覧でき、その内容が常に優先されます。TI では翻訳の正確性および妥当性につきましては一切保証いたしません。実際の設計などの前には、必ず最新版の英語版をご参照くださいますようお願いいたします。

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4 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 A (August 2021) to Revision B (June 2023) **Page**

- 表のタイトルを「製品情報」から「パッケージ情報」に変更。 ... 1
- Added the *Device Comparison* table for LMK1Dxxxx buffer family of devices ... 3
- Moved the *Power Supply Recommendations* and *Layout* sections to the *Application and Implementation* section ... 18

Changes from Revision * (December 2020) to Revision A (August 2021) **Page**

- 最初の公開リリース ... 1

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5 Device Comparison

表 5-1. Device Comparison

DEVICE	DEVICE TYPE	FEATURES	OUTPUT SWING	PACKAGE	BODY SIZE
LMK1D2108	Dual 1:8	Global output enable and swing control through pin control	350 mV 500 mV	VQFN (48)	7.00 mm × 7.00 mm
LMK1D2106	Dual 1:6	Global output enable and swing control through pin control	350 mV 500 mV	VQFN (40)	6.00 mm x 6.00 mm
LMK1D2104	Dual 1:4	Global output enable and swing control through pin control	350 mV 500 mV	VQFN (28)	5.00 mm × 5.00 mm
LMK1D2102	Dual 1:2	Global output enable and swing control through pin control	350 mV 500 mV	VQFN (16)	3.00 mm × 3.00 mm
LMK1D1216	2:16	Global output enable control through pin control	350 mV 500 mV	VQFN (48)	7.00 mm × 7.00 mm
LMK1D1212	2:12	Global output enable control through pin control	350 mV 500 mV	VQFN (40)	6.00 mm × 6.00 mm
LMK1D1208P	2:8	Individual output enable control through pin control	350 mV 500 mV	VQGN (40)	6.00 mm × 6.00 mm
LMK1D1208I	2:8	Individual output enable control through I^2C	350 mV 500 mV	VQFN (40)	6.00 mm × 6.00 mm
LMK1D1208	2:8	Global output enable control through pin control	350 mV	VQFN (28)	5.00 mm × 5.00 mm
LMK1D1204P	2:4	Individual output enable control through pin control	350 mV	VQGN (28)	5.00 mm × 5.00 mm
LMK1D1204	2:4	Global output enable control through pin control	350 mV	VQFN (16)	3.00 mm × 3.00 mm

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6 Pin Configuration and Functions

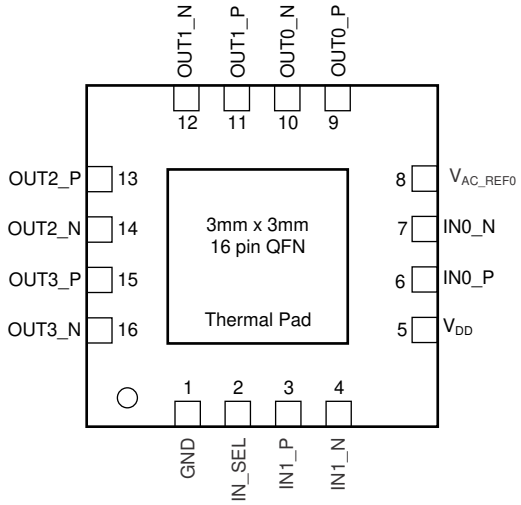

図 6-1. LMK1D1204: RGT Package 16-Pin VQFN Top View

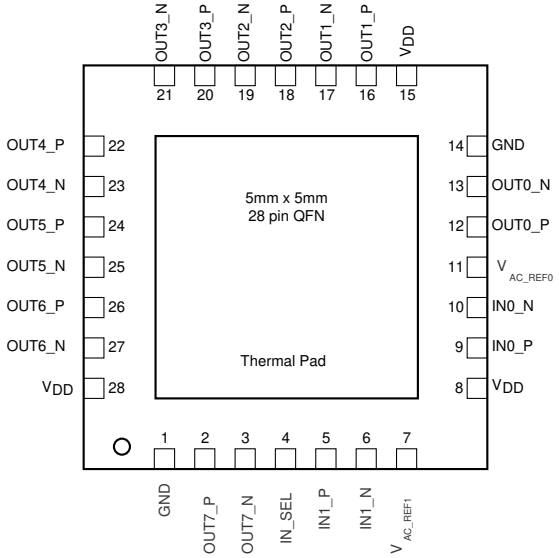

図 6-2. LMK1D1208: RHD Package 28-Pin VQFN Top View

表 6-1. Pin Functions

PIN			TYPE(1)	DESCRIPTION
NAME	LMK1D1204	LMK1D1208		
DIFFERENTIAL/SINGLE-ENDED CLOCK INPUT				
IN0_P	6	9	I	Primary: Differential input pair or single-ended input
IN0_N	7	10		
IN1_P	3	5	I	Secondary: Differential input pair or single-ended input.
IN1_N	4	6		Note that INP0, INN0 are used indistinguishably with IN0_P, IN0_N.
INPUT SELECT				
IN_SEL	2	4	I	Input Selection with an internal 500-kΩ pullup and 320-kΩ pulldown resistor, selects input port; (See 表 9-1)

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表 6-1. Pin Functions (continued)

PIN			TYPE[1]	DESCRIPTION
NAME	LMK1D1204	LMK1D1208		
BIAS VOLTAGE OUTPUT				
V_{AC_REF0}	8	11	O	Bias voltage output for capacitive coupled inputs. If used, TI recommends using a 0.1-µF capacitor to GND on this pin.
V_{AC_REF1}	—	7		
DIFFERENTIAL CLOCK OUTPUT				
OUT0_P	9	12	O	Differential LVDS output pair number 0
OUT0_N	10	13		
OUT1_P	11	16	O	Differential LVDS output pair number 1
OUT1_N	12	17		
OUT2_P	13	18	O	Differential LVDS output pair number 2
OUT2_N	14	19		
OUT3_P	15	20	O	Differential LVDS output pair number 3
OUT3_N	16	21		
OUT4_P	—	22	O	Differential LVDS output pair number 4
OUT4_N		23		
OUT5_P	—	24	O	Differential LVDS output pair number 5
OUT5_N		25		
OUT6_P	—	26	O	Differential LVDS output pair number 6
OUT6_N		27		
OUT7_P	—	2	O	Differential LVDS output pair number 7
OUT7_N		3		
SUPPLY VOLTAGE				
V_{DD}	5	8	P	Device Power Supply (1.8V or 2.5V or 3.3V)
		15		
		28		
GROUND				
GND	1	1	G	Ground
	—	14		
MISC				
DAP	DAP	DAP	GND	Die Attach Pad. Connect to the PCB ground plane for heat dissipation.
NC	—	—	NC	No Connection

(1) G = Ground, I = Input, O = Output, P = Power

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7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V_{DD}	Supply voltage	–0.3	3.6	V
V_{IN}	Input voltage	–0.3	3.6	V
V_O	Output voltage	–0.3	V_{DD} + 0.3	V
I_{IN}	Input current	–20	20	mA
I_O	Continuous output current	–50	50	mA
T_J	Junction temperature		135	°C
T_{stg}	Storage temperature (2)	–65	150	°C

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) Device unpowered

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±3000	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002, all pins(2)	±1000	

(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.

7.3 Recommended Operating Conditions

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

			MIN	NOM	MAX	UNIT
V_{DD}	Core supply voltage	3.3-V supply	3.135	3.3	3.465	V
		2.5-V supply	2.375	2.5	2.625	
		1.8-V supply	1.71	1.8	1.89	
Supply Ramp	Supply voltage ramp	Requires monotonic ramp (10-90% of V_{DD})	0.1		20	ms
T_A	Operating free-air temperature		–40		105	°C
T_J	Operating junction temperature		–40		135	°C

7.4 Electrical Characteristics

V_{DD} = 1.8 V ± 5 %, –40°C ≤ T_A ≤ 105°C. Typical values are at V_{DD} = 1.8 V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY CHARACTERISTICS						
SINGLE-ENDED LVCMOS/LVTTL CLOCK INPUT (Applies to V_{DD} = 1.8 V ± 5%, 2.5 V ± 5% and 3.3 V ± 5%)						
f_{IN}	Input frequency	Clock input	DC		250	MHz
$V_{IN_S\text{-}E}$	Single-ended Input Voltage Swing	Assumes a square wave input with two levels	0.4		3.465	V
dVIN/dt	Input Slew Rate (20% to 80% of the amplitude)		0.05			V/ns
I_{IH}	Input high current	V_{DD} = 3.465 V, V_{IH} = 3.465 V			50	µA
I_{IL}	Input low current	V_{DD} = 3.465 V, V_{IL} = 0 V	–30			µA

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V_{DD} = 1.8 V ± 5 %, –40°C ≤ T_A ≤ 105°C. Typical values are at V_{DD} = 1.8 V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
C_{IN_SE}	Input capacitance	at 25°C		3.5		pF
DIFFERENTIAL CLOCK INPUT (Applies to V_{DD} = 1.8 V ± 5%, 2.5 V ± 5% and 3.3 V ± 5%)						
f_{IN}	Input frequency	Clock input			2	GHz
$V_{IN,DIFF(p-p)}$	Differential input voltage peak-to-peak {2*(V_{INP}-V_{INN})}	V_{ICM} = 1 V (V_{DD} = 1.8 V)	0.3		2.4	V_{PP}
		V_{ICM} = 1.25 V (V_{DD} = 2.5 V/3.3 V)	0.3		2.4	
V_{ICM}	Input common mode voltage	$V_{IN,DIFF(P-P)}$ > 0.4 V (V_{DD} = 1.8 V/2.5/3.3 V)	0.25		2.3	V
I_{IH}	Input high current	V_{DD} = 3.465 V, V_{INP} = 2.4 V, V_{INN} = 1.2 V			30	µA
I_{IL}	Input low current	V_{DD} = 3.465 V, V_{INP} = 0 V, V_{INN} = 1.2 V	–30			µA
C_{IN_S-E}	Input capacitance (Single-ended)	at 25°C		3.5		pF
LVDS DC OUTPUT CHARACTERISTICS						
$V_{OC(SS)}$	Steady-state common mode output voltage	$V_{IN,DIFF(P-P)}$ = 0.3 V, R_{LOAD} = 100 Ω (V_{DD} = 1.8 V)	1		1.2	V
		$V_{IN,DIFF(P-P)}$ = 0.3 V, R_{LOAD} = 100 Ω (V_{DD} = 2.5 V/3.3 V)	1.1		1.375	
LVDS AC OUTPUT CHARACTERISTICS						
V_{ring}	Output overshoot and undershoot	$V_{IN,DIFF(P-P)}$ = 0.3 V, R_{LOAD} = 100 Ω, f_{OUT} = 491.52 MHz	–0.1		0.1	V_{OD}
I_{OS}	Short-circuit output current (differential)	V_{OUTP} = V_{OUTN}	–12		12	mA
$I_{OS(cm)}$	Short-circuit output current (common-mode)	V_{OUTP} = V_{OUTN} = 0	–24		24	mA
t_{PD}	Propagation delay	$V_{IN,DIFF(P-P)}$ = 0.3 V, R_{LOAD} = 100 Ω (2)	0.3		0.575	ns
$t_{SK,\ PP}$	Part-to-part skew	Skew between outputs on different parts subjected to the same operating conditions with the same input and output loading.			250	ps
$t_{SK,\ P}$	Pulse skew	50% duty cycle input, crossing point-to-crossing-point distortion (4)	–20		20	ps
$t_{RJIT(ADD)}$	Random additive Jitter (rms)	f_{IN} = 156.25 MHz with 50% duty-cycle, Input slew rate = 1.5V/ns, Integration range = 12 kHz – 20 MHz, with output load R_{LOAD} = 100 Ω		50	60	fs, RMS
Phase noise	Phase Noise for a carrier frequency of 156.25 MHz with 50% duty-cycle, Input slew rate = 1.5V/ns with output load R_{LOAD} = 100 Ω	PN_{1kHz}		–143		dBc/Hz
		PN_{10kHz}		–152		
		PN_{100kHz}		–157		
		PN_{1MHz}		–160		
		PN_{floor}		–164		
MUX_{ISO}	Mux Isolation	f_{IN} = 156.25 MHz. The difference in power level at f_{IN} when the selected clock is active and the unselected clock is static versus when the selected clock is inactive and the unselected clock is active.		80		dB
ODC	Output duty cycle	With 50% duty cycle input	45		55	%
t_R/t_F	Output rise and fall time	20% to 80% with R_{LOAD} = 100 Ω			300	ps
V_{AC_REF}	Reference output voltage	VDD = 2.5 V, I_{LOAD} = 100 µA	0.9	1.25	1.375	V

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V_{DD} = 1.8 V ± 5 %, –40°C ≤ T_A ≤ 105°C. Typical values are at V_{DD} = 1.8 V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY NOISE REJECTION (PSNR) V_{DD} = 2.5 V/ 3.3 V						
PSNR	Power Supply Noise Rejection ($f_{carrier}$ = 156.25 MHz)	10 kHz, 100 mVpp ripple injected on V_{DD}		–70		dBc
		1 MHz, 100 mVpp ripple injected on V_{DD}		–50		

(1) Measured between single-ended/differential input crossing point to the differential output crossing point.
(2) Defined as the magnitude of the time difference between the high-to-low and low-to-high propagation delay times at an output.

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7.5 Typical Characteristics

The 図 7-1 captures the variation of the LMK1D1208 current consumption with input frequency and supply voltage. The LMK1D1204 follows a similar trend. 図 7-2 shows the variation of the differential output voltage (VOD) swept across frequency. This result is applicable to LMK1D1204 as well.

It is important to note that 図 7-1 and 図 7-2 serve as a guidance to the users on what to expect for the range of operating frequency supported by LMK1D120x. It is crucial to note that these graphs were plotted for a limited number of frequencies and load conditions which may not represent the customer system.

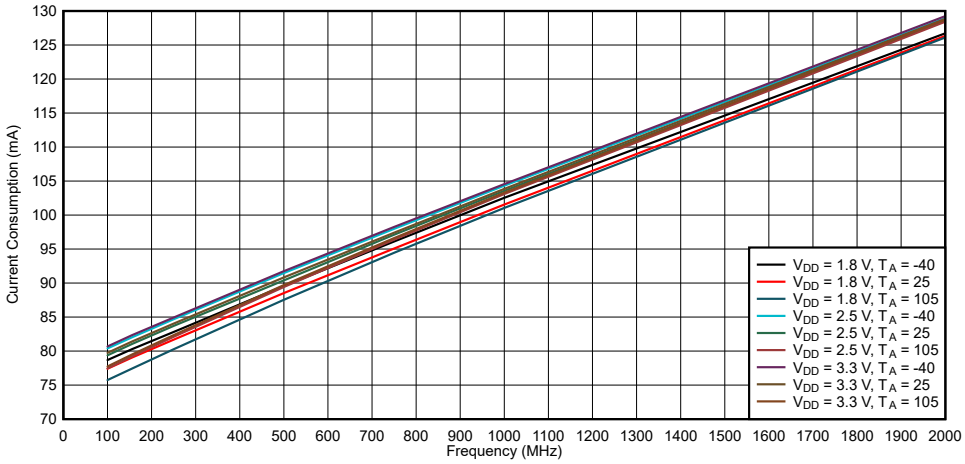

図 7-1. LMK1D1208 Current Consumption vs. Frequency

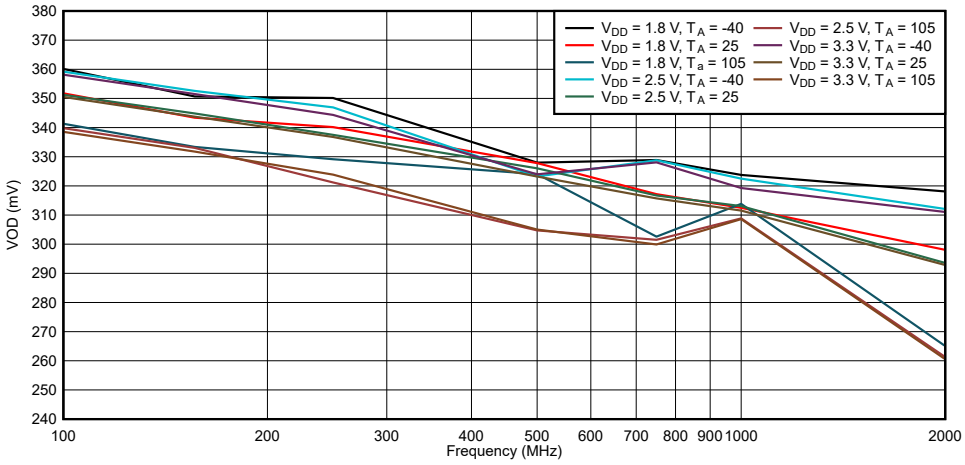

図 7-2. LMK1D1208 VOD vs. Frequency

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8 Parameter Measurement Information

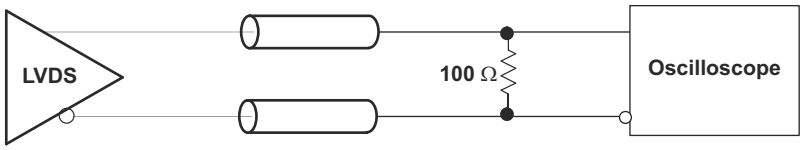

図 8-1. LVDS Output DC Configuration During Device Test

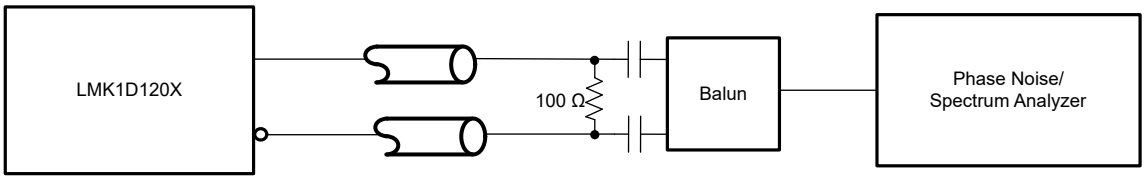

図 8-2. LVDS Output AC Configuration During Device Test

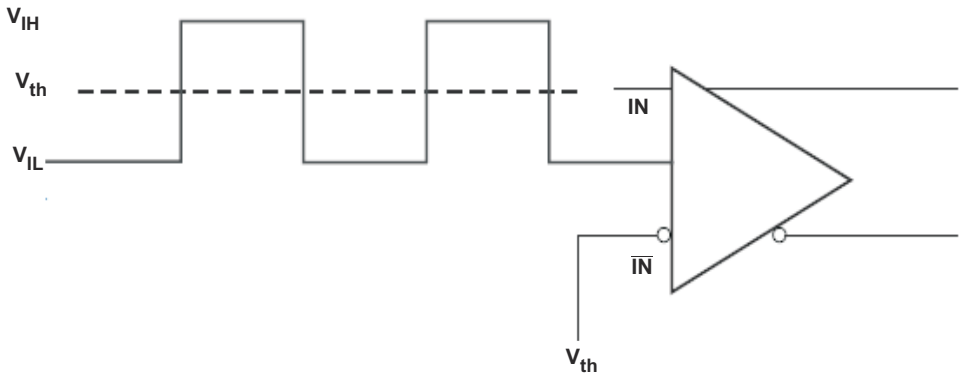

図 8-3. DC-Coupled LVCMOS Input During Device Test

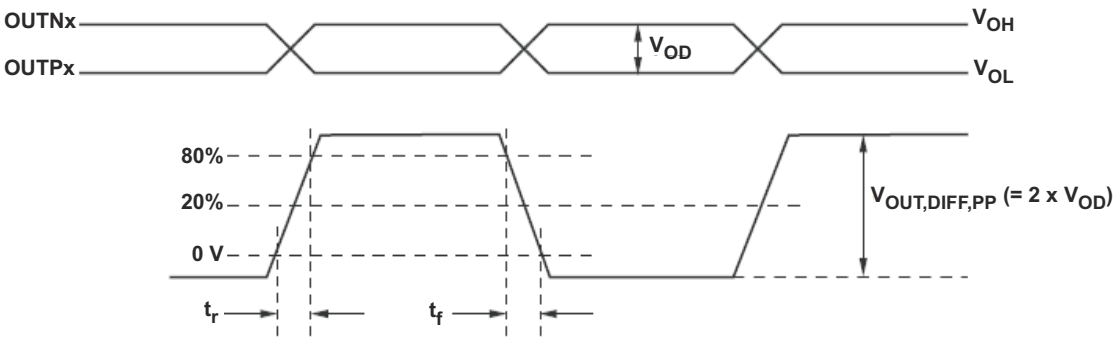

図 8-4. Output Voltage and Rise/Fall Time

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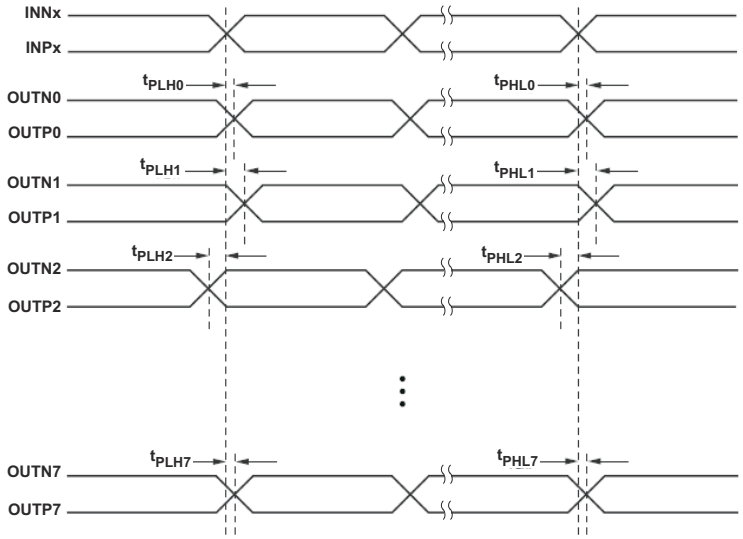


A. Output skew is calculated as the greater of the following: the difference between the fastest and the slowest t_{PLHn} or the difference between the fastest and the slowest t_{PHLn} (n = 0, 1, 2, ..7)

B. Part to part skew is calculated as the greater of the following: the difference between the fastest and the slowest t_{PLHn} or the difference between the fastest and the slowest t_{PHLn} across multiple devices (n = 0, 1, 2, ..7)

図 8-5. Output Skew and Part-to-Part Skew

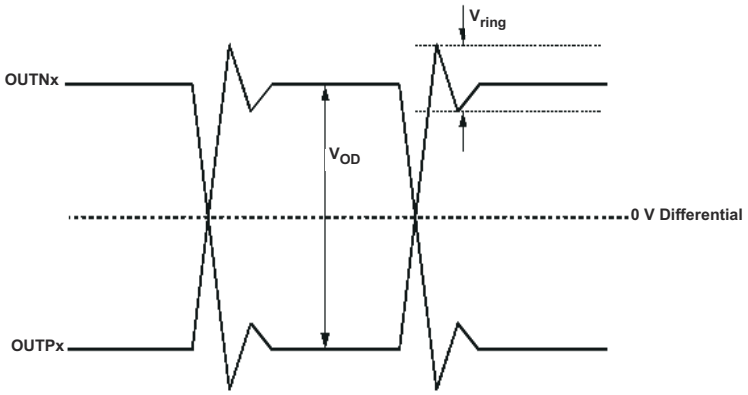


図 8-6. Output Overshoot and Undershoot

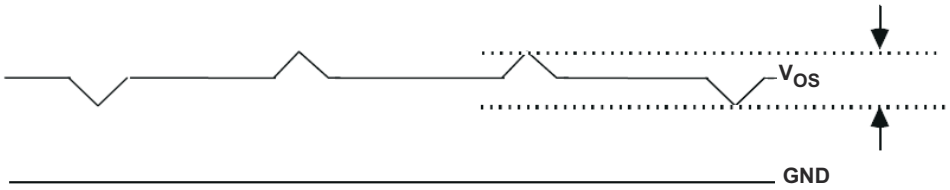


図 8-7. Output AC Common Mode

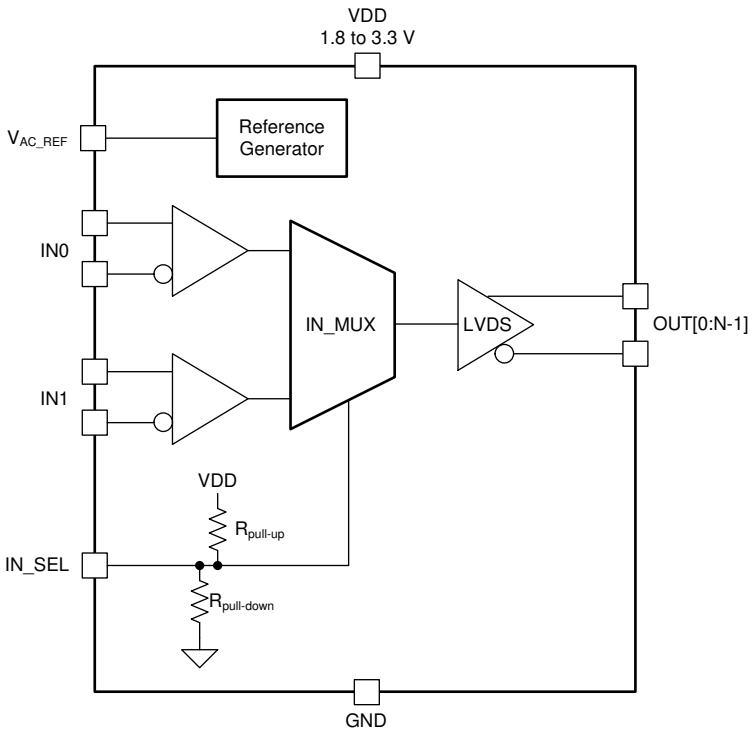
9 Detailed Description

9.1 Overview

The LMK1D120x LVDS drivers use CMOS transistors to control the output current. Therefore, proper biasing and termination are required to ensure correct operation of the device and to maximize signal integrity.

The proper LVDS termination for signal integrity over two 50-Ω lines is 100 Ω between the outputs on the receiver end. Either DC-coupled termination or AC-coupled termination can be used for LVDS outputs. TI recommends placing a termination resistor close to the receiver. If the receiver is internally biased to a voltage different than the output common-mode voltage of the LMK1D12XX, AC-coupling must be used. If the LVDS receiver has internal 100-Ω termination, external termination must be omitted.

9.2 Functional Block Diagram



9.3 Feature Description

The LMK1D120x is a low additive jitter LVDS fan-out buffer that can generate up to eight copies of two selectable LVPECL, LVDS, LP-HCSL, HCSL or LVCMOS inputs. The LMK1D120x can accept reference clock frequencies up to 2 GHz while providing low output skew.

9.3.1 Fail-Safe Input and Hysteresis

The LMK1D120x family of devices is designed to support fail-safe input operation feature. This feature allows the user to drive the device inputs before V_{DD} is applied without damaging the device. Refer to *Specifications* for more information on the maximum input supported by the device. User should note that incorporating the fail-safe inputs also results in a slight increase in clock input pin capacitance.

The device also incorporates an input hysteresis which prevents random oscillation in absence of an input signal. Furthermore, this feature allows the input pins to be left open.

9.3.2 Input Mux

The LMK1D120x family of devices has a 2:1 input mux. This feature allows the user to select between the two clock inputs (using the IN_SEL pin) to the device and fan it out to the outputs. More information on the input selection is provided in the next section.

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9.4 Device Functional Modes

The two inputs of the LMK1D120x are internally muxed together and can be selected through the control pin (see 表 9-1). Unused input can be left floating thus reducing the need for additional components. Both AC- and DC-coupling schemes can be used with the LMK1D120x to provide greater system flexibility.

表 9-1. Input Selection Table

IN_SEL	ACTIVE CLOCK INPUT
0	IN0_P, IN0_N
1	IN1_P, IN1_N
Open	None (1)

(1) The input buffers are disabled and the outputs are static logic low.

9.4.1 LVDS Output Termination

TI recommends unused outputs to be terminated differentially with a 100-Ω resistor for optimum performance, although unterminated outputs are also okay but will result in slight degradation in performance (Output AC common-mode V_{OS}) in the outputs being used.

The LMK1D120x can be connected to LVDS receiver inputs with DC- and AC-coupling as shown in 図 9-1 and 図 9-2 (respectively).

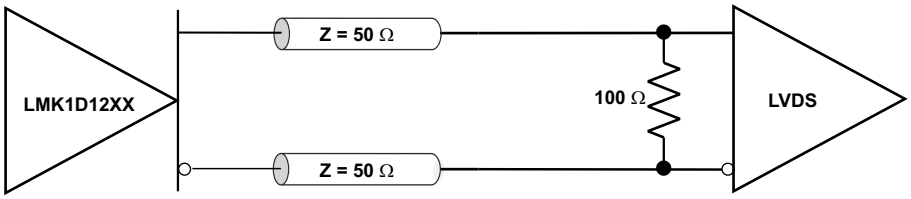

図 9-1. Output DC Termination

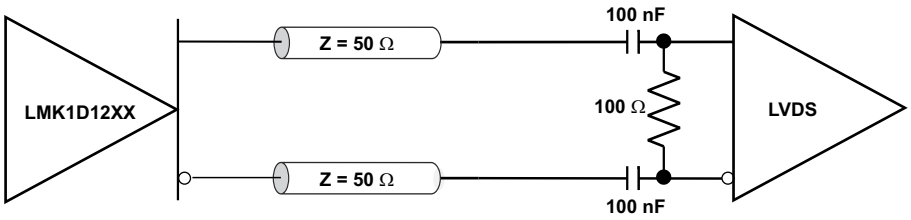

図 9-2. Output AC Termination (With the Receiver Internally Biased)

9.4.2 Input Termination

The LMK1D120x input stage is designed with flexibility in mind to allow the user to drive the device with a wide variety of signal types. This device can be interfaced with LVDS, LVPECL, LP-HCSL, HCSL, CML or LVCMOS drivers. Please refer to *Electrical Characteristics* for more details.

LVDS drivers can be connected to LMK1D120x inputs with DC- and AC-coupling as shown 図 9-3 and 図 9-4 (respectively).

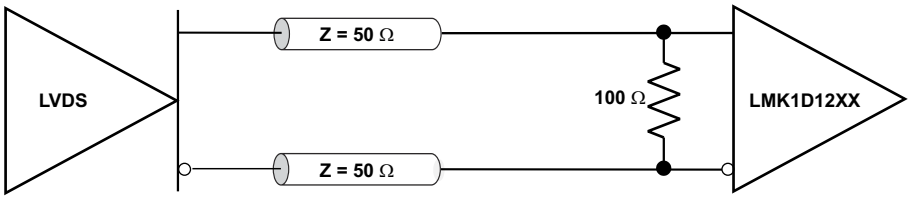

図 9-3. LVDS Clock Driver Connected to LMK1D120x Input (DC-Coupled)

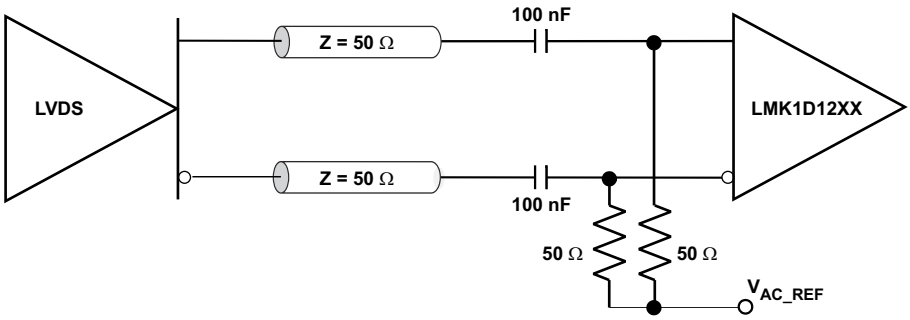

図 9-4. LVDS Clock Driver Connected to LMK1D120x Input (AC-Coupled)

図 9-5 shows how to connect LVPECL inputs to the LMK1D120x. The series resistors are required to reduce the LVPECL signal swing if the signal swing is >1.6 V_{PP}.

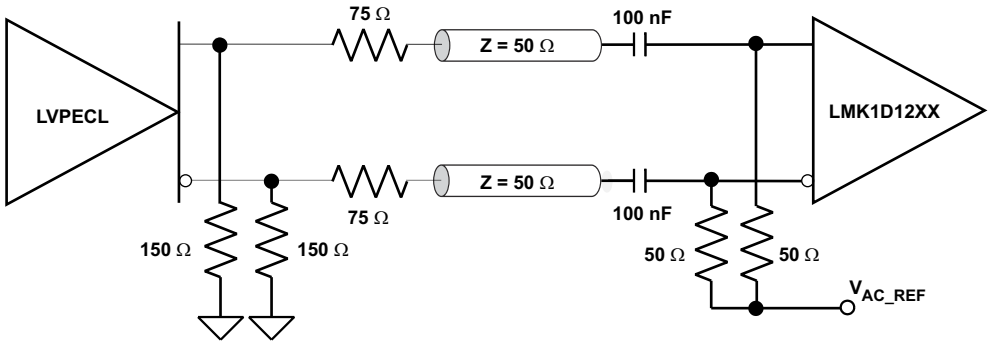

図 9-5. LVPECL Clock Driver Connected to LMK1D120x Input

図 9-6 illustrates how to couple a LVCMOS clock input to the LMK1D120x directly.

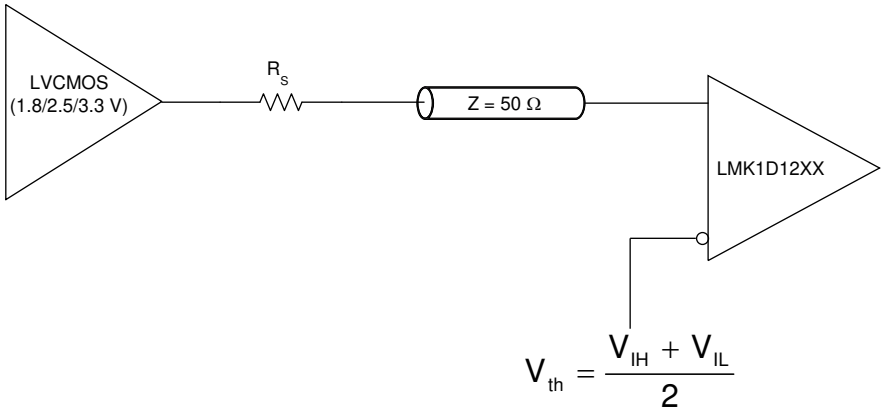

図 9-6. 1.8-V/2.5-V/3.3-V LVCMOS Clock Driver Connected to LMK1D120x Input

For unused input, TI recommends grounding both input pins (INP, INN) using 1-kΩ resistors.

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10 Application and Implementation

注

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10.1 Application Information

The LMK1D120x is a low additive jitter universal to LVDS fan-out buffer with 2 selectable inputs. The small package, low output skew, and low additive jitter make for a flexible device in demanding applications.

10.2 Typical Application

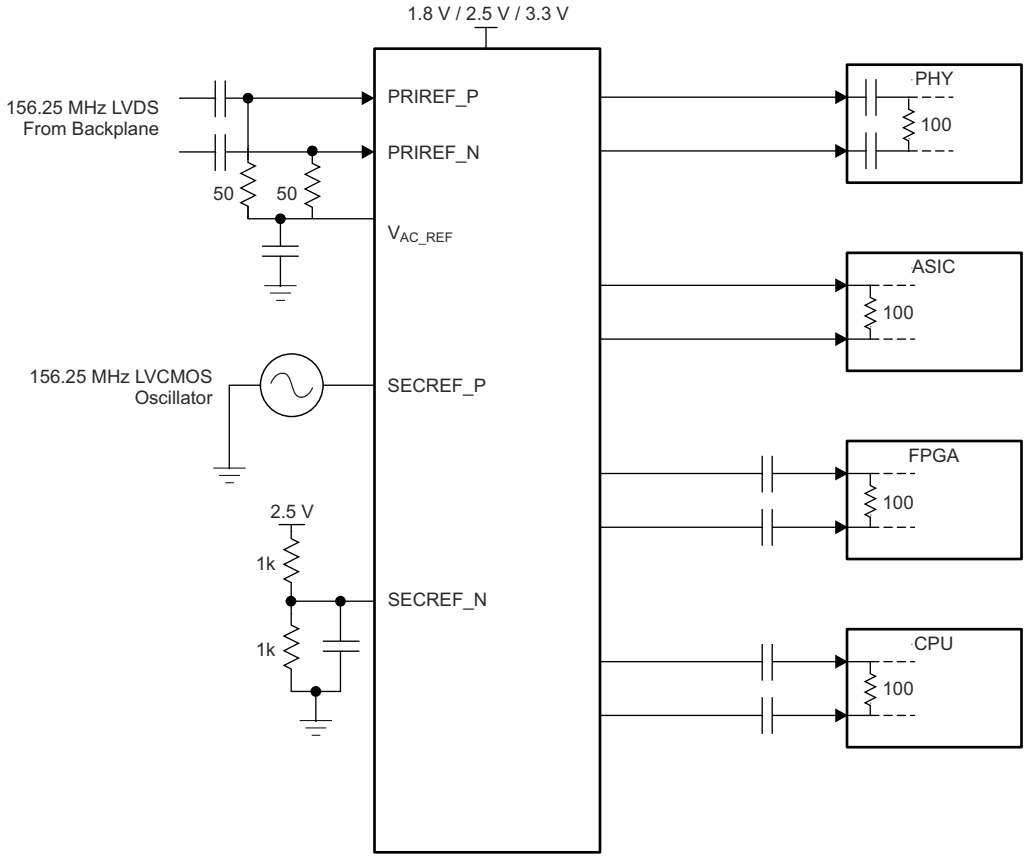

図 10-1. Fan-Out Buffer for Line Card Application

10.2.1 Design Requirements

The LMK1D120x shown in 図 10-1 is configured to select two inputs: a 156.25-MHz LVDS clock from the backplane, or a secondary 156.25-MHz LVCMOS 2.5-V oscillator. The LVDS clock is AC-coupled and biased using the integrated reference voltage generator. A resistor divider is used to set the threshold voltage correctly for the LVCMOS clock. 0.1-µF capacitors are used to reduce noise on both V_{AC_REF} and SECREF_N. Either input signal can be then fanned out to desired devices, as shown. The configuration example is driving 4 LVDS receivers in a line card application with the following properties:

- The PHY device is capable of DC-coupling with an LVDS driver such as the LMK1D120x. This PHY device features internal termination so no additional components are required for proper operation.
- The ASIC LVDS receiver features internal termination and operates at the same common-mode voltage as the LMK1D120x. Again, no additional components are required.
- The FPGA requires external AC-coupling, but has internal termination. 0.1-µF capacitors are placed to provide AC-coupling. Similarly, the CPU is internally terminated, and requires only external AC-coupling capacitors.
- Unused outputs of the LMK1D device are terminated differentially with a 100-Ω resistor for optimum performance.

10.2.2 Detailed Design Procedure

See *Input Termination* for proper input terminations, dependent on single-ended or differential inputs.

See *LVDS Output Termination* for output termination schemes depending on the receiver application.

TI recommends unused outputs to be terminated differentially with a 100-Ω resistor for optimum performance, although unterminated outputs are also okay but will result in slight degradation in performance (Output AC common-mode V_{OS}) in the outputs being used.

In this example, the PHY, ASIC, and FPGA or CPU require different schemes. Power-supply filtering and bypassing is critical for low-noise applications.

See *Power Supply Recommendations* for recommended filtering techniques. A reference layout is provided in *Low-Additive Jitter, Four LVDS Outputs Clock Buffer Evaluation Board* (SCAU043).

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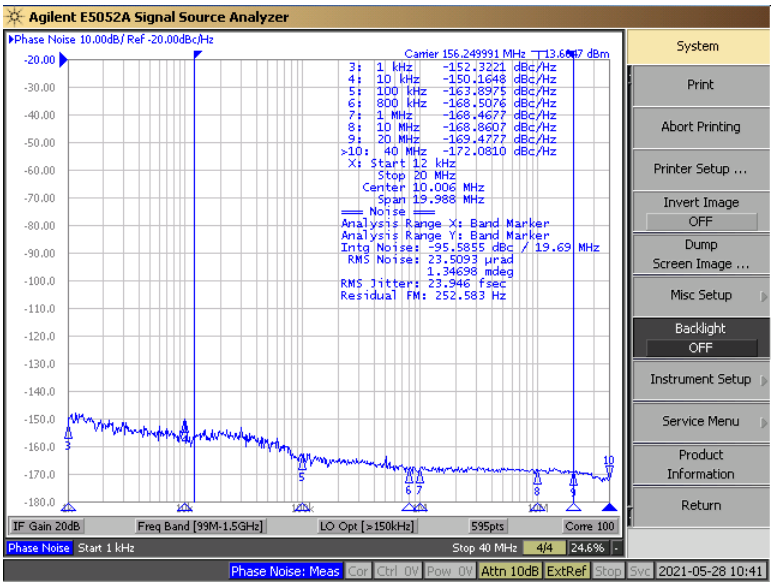
10.2.3 Application Curves

The LMK1D1208's low additive noise is shown below. The low noise 156.25-MHz source with 24-fs RMS jitter shown in 図 10-2 drives the LMK1D1208, resulting in 46.4-fs RMS when integrated from 12 kHz to 20 MHz (図 10-3). The resultant additive jitter is a low 39.7-fs RMS for this configuration. Note that this result applies to the LMK1D1204 device as well.



A. Reference signal is low-noise Rohde and Schwarz SMA100B

図 10-2. LMK1D208 Reference Phase Noise, 156.25 MHz, 24-fs RMS (12 kHz to 20 MHz)

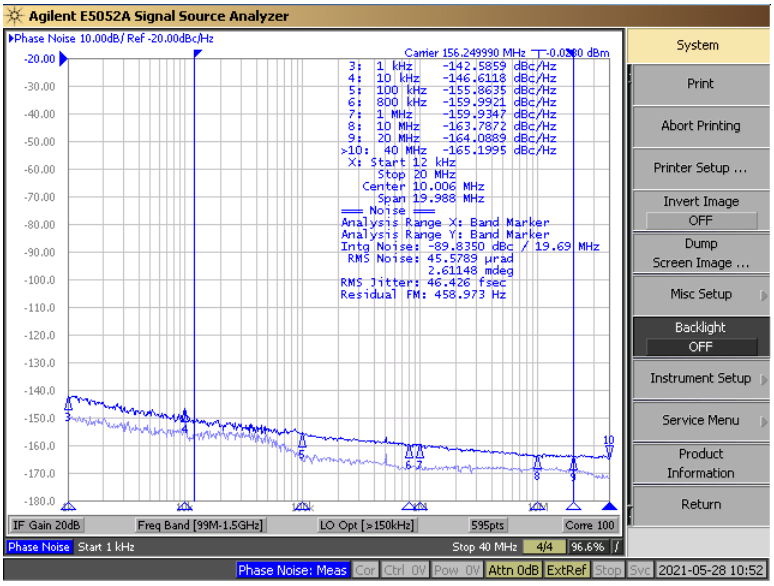


図 10-3. LMK1D1208 Output Phase Noise, 156.25 MHz, 46.4-fs RMS (12 kHz to 20 MHz)

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The 図 10-4 captures the low close-in phase noise of the LMK1D1208 device. The LMK1D1204 and LMK1D1208 have excellent flicker noise as a result of superior process technology and design. This enables their use for clock distribution in radar systems, medical imaging systems etc which require ultra-low close-in phase noise clocks.

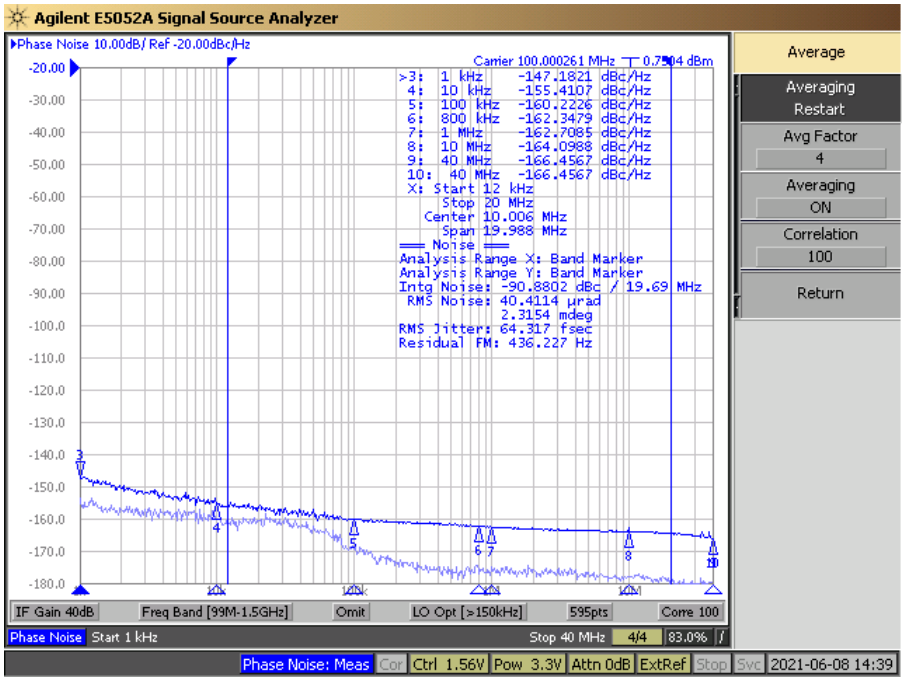

図 10-4. LMK1D1208 Output Phase Noise, 100 MHz, 1 kHz offset: -147 dBc/Hz

10.3 Power Supply Recommendations

High-performance clock buffers are sensitive to noise on the power supply, which can dramatically increase the additive jitter of the buffer. Thus, it is essential to reduce noise from the system power supply, especially when jitter or phase noise is critical to applications.

Filter capacitors are used to eliminate the low-frequency noise from the power supply, where the bypass capacitors provide the low impedance path for high-frequency noise and guard the power-supply system against the induced fluctuations. These bypass capacitors also provide instantaneous current surges as required by the device and must have low equivalent series resistance (ESR). To properly use the bypass capacitors, they must be placed close to the power-supply pins and laid out with short loops to minimize inductance. TI recommends adding as many high-frequency (for example, 0.1-µF) bypass capacitors as there are supply pins in the package. TI recommends, but does not require, inserting a ferrite bead between the board power supply and the chip power supply that isolates the high-frequency switching noises generated by the clock driver; these beads prevent the switching noise from leaking into the board supply. Choose an appropriate ferrite bead with low DC-resistance because it is imperative to provide adequate isolation between the board supply and the chip supply, as well as to maintain a voltage at the supply pins that is greater than the minimum voltage required for proper operation.

図 10-5 shows this recommended power-supply decoupling method.

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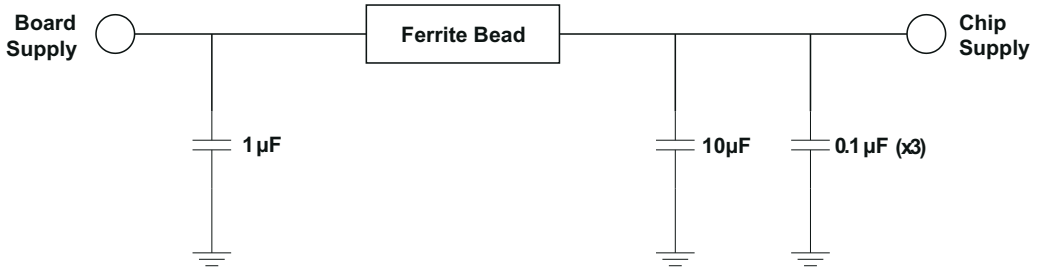

図 10-5. Power Supply Decoupling

10.4 Layout

10.4.1 Layout Guidelines

For reliability and performance reasons, the die temperature must be limited to a maximum of 135°C.

The device package has an exposed pad that provides the primary heat removal path to the printed circuit board (PCB). To maximize the heat dissipation from the package, a thermal landing pattern including multiple vias to a ground plane must be incorporated into the PCB within the footprint of the package. The thermal pad must be soldered down to ensure adequate heat conduction to of the package. 図 10-6 shows a recommended land and via pattern for LMK1D1208.

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10.4.2 Layout Example

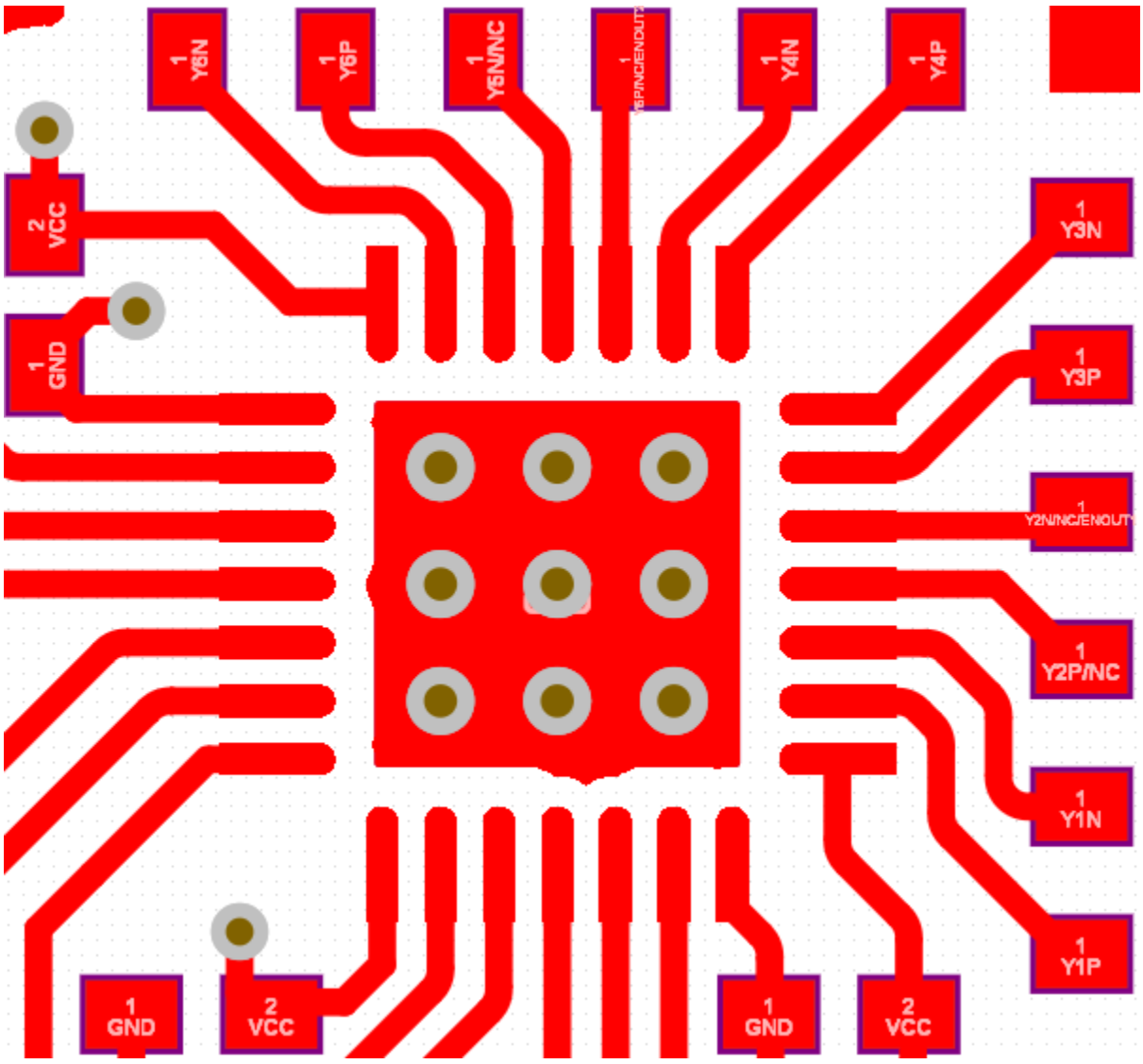

図 10-6. Recommended PCB Layout, Top Layer

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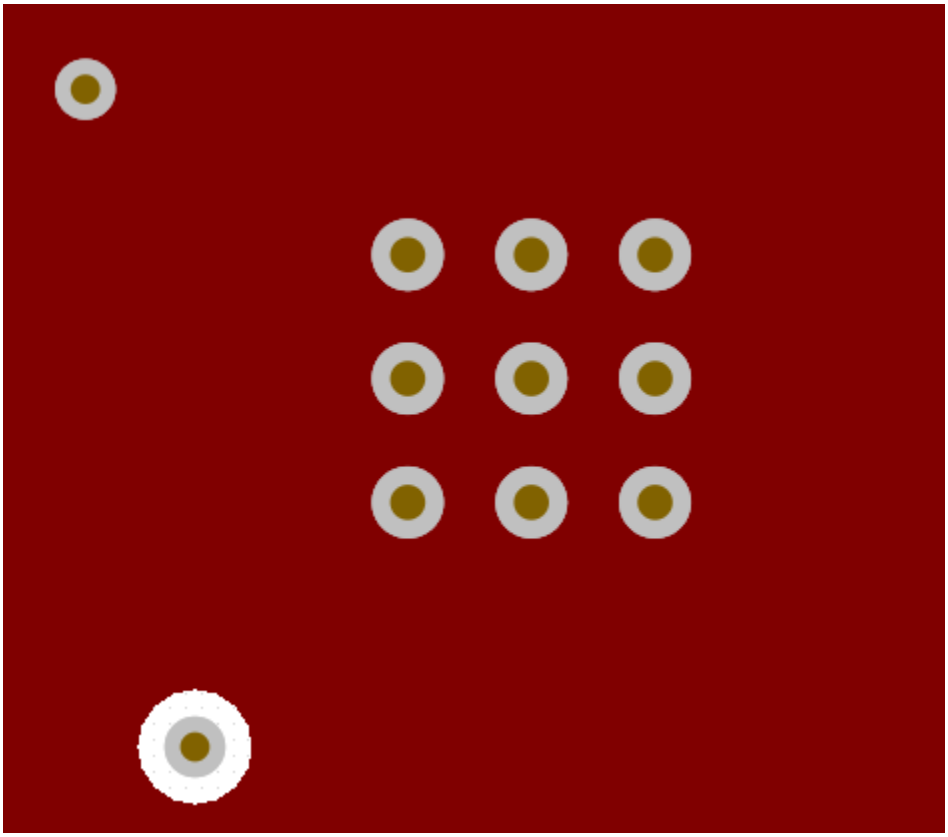

図 10-7. PCB Layout, GND Layer

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11 Device and Documentation Support

11.1 Documentation Support

11.1.1 Related Documentation

For related documentation see the following:

- *Low-Additive Jitter, Four LVDS Outputs Clock Buffer Evaluation Board* (SCAU043)
- *Power Consumption of LVPECL and LVDS* (SLYT127)
- *Semiconductor and IC Package Thermal Metrics* (SPRA953)
- *Using Thermal Calculation Tools for Analog Components* (SLUA556)

11.2 ドキュメントの更新通知を受け取る方法

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11.6 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。

12 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.

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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)
LMK1D1204RGTR	Active	Production	VQFN (RGT) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD1204
LMK1D1204RGTR.B	Active	Production	VQFN (RGT) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD1204
LMK1D1204RGTRG4.B	Active	Production	VQFN (RGT) | 16	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD1204
LMK1D1204RGTT	Active	Production	VQFN (RGT) | 16	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD1204
LMK1D1204RGTT.B	Active	Production	VQFN (RGT) | 16	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD1204
LMK1D1208RHDR	Active	Production	VQFN (RHD) | 28	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 1208
LMK1D1208RHDR.B	Active	Production	VQFN (RHD) | 28	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 1208
LMK1D1208RHDT	Active	Production	VQFN (RHD) | 28	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 1208
LMK1D1208RHDT.B	Active	Production	VQFN (RHD) | 28	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 1208
LMK1D1208RHDTG4.B	Active	Production	VQFN (RHD) | 28	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 1208

(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.

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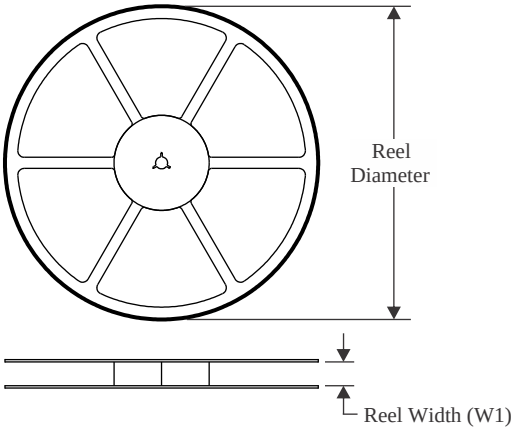
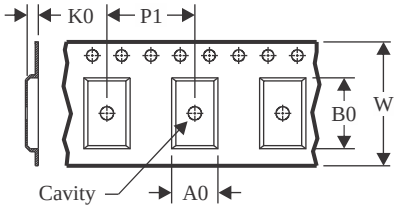
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

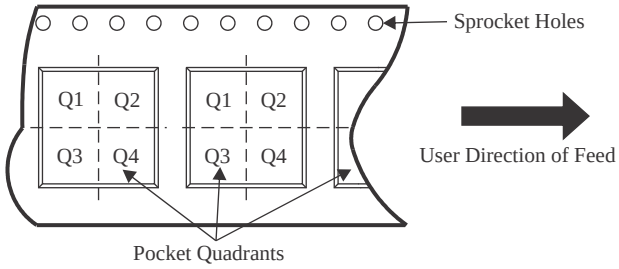


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

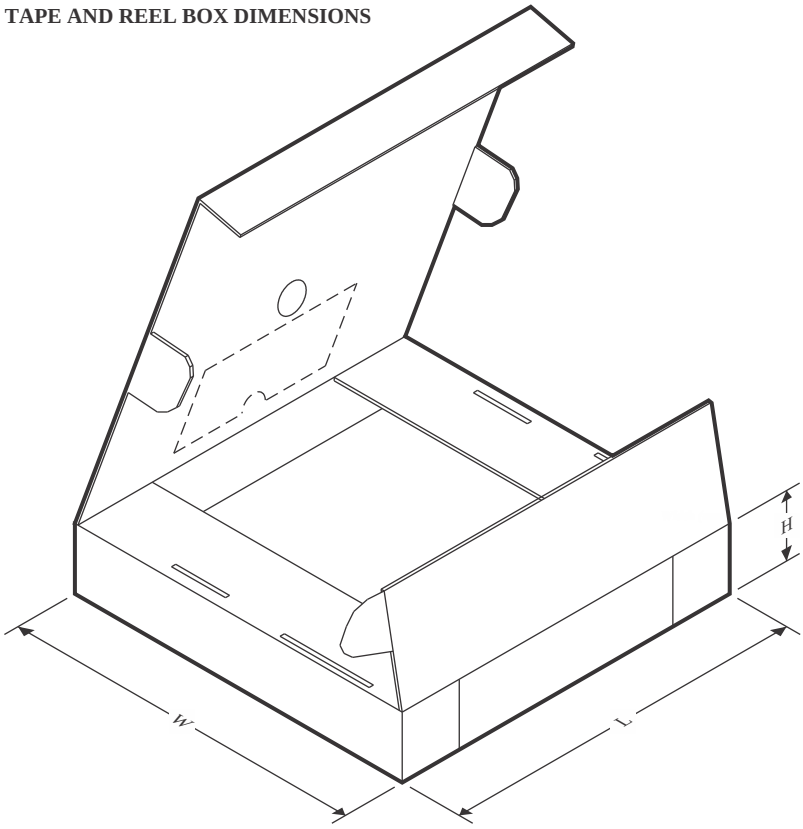
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMK1D1204RGTR	VQFN	RGT	16	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
LMK1D1204RGTT	VQFN	RGT	16	250	180.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
LMK1D1208RHDR	VQFN	RHD	28	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
LMK1D1208RHDT	VQFN	RHD	28	250	180.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMK1D1204RGTR	VQFN	RGT	16	3000	367.0	367.0	35.0
LMK1D1204RGTT	VQFN	RGT	16	250	210.0	185.0	35.0
LMK1D1208RHDR	VQFN	RHD	28	3000	367.0	367.0	35.0
LMK1D1208RHDT	VQFN	RHD	28	250	210.0	185.0	35.0

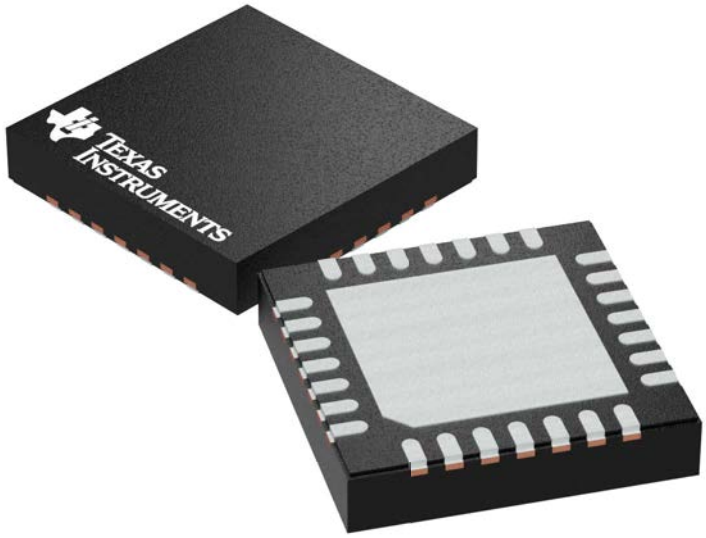
GENERIC PACKAGE VIEW

RHD 28

VQFN - 1 mm max height

5 x 5 mm, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

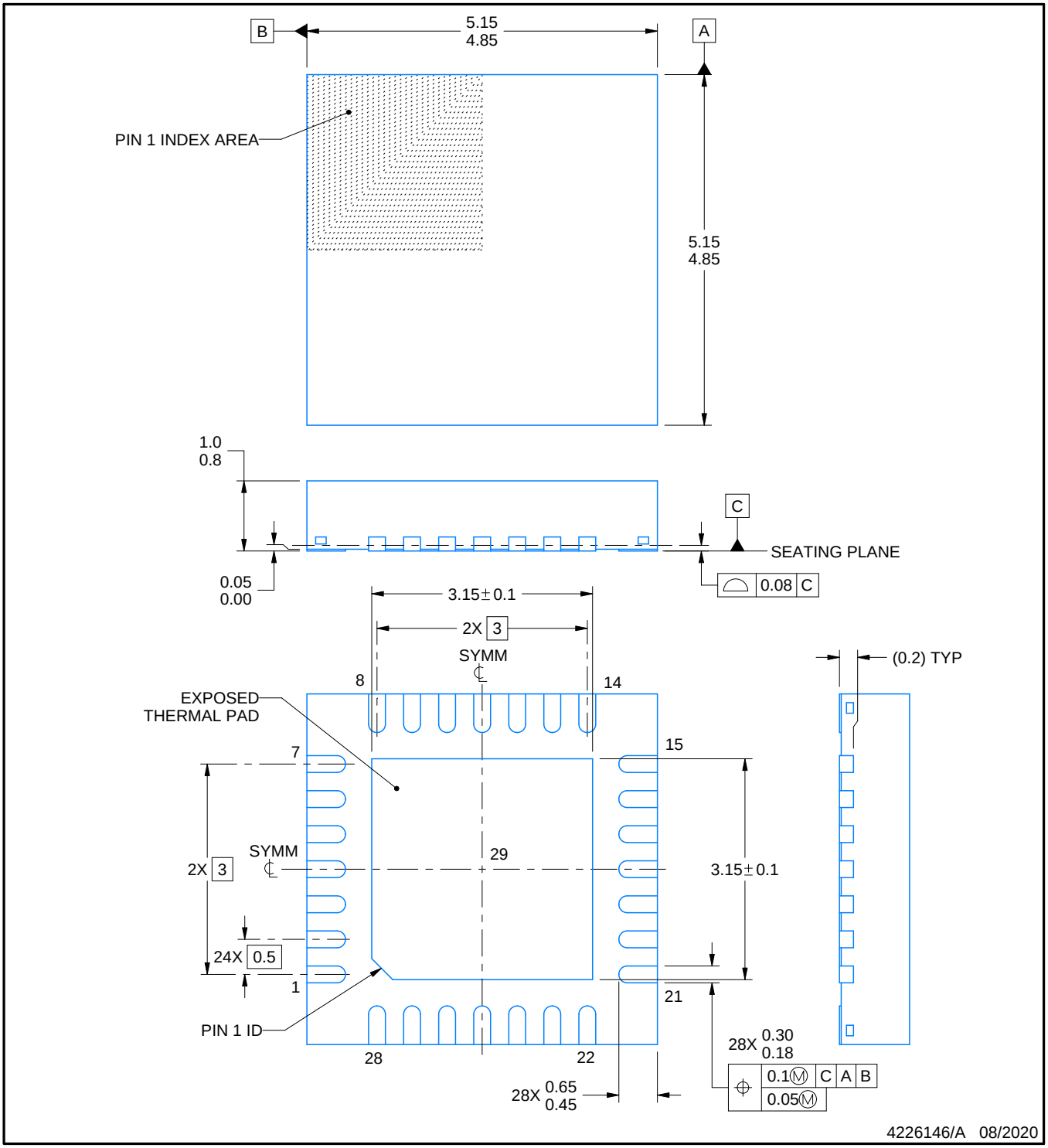
4204400/G

RHD0028B

PACKAGE OUTLINE

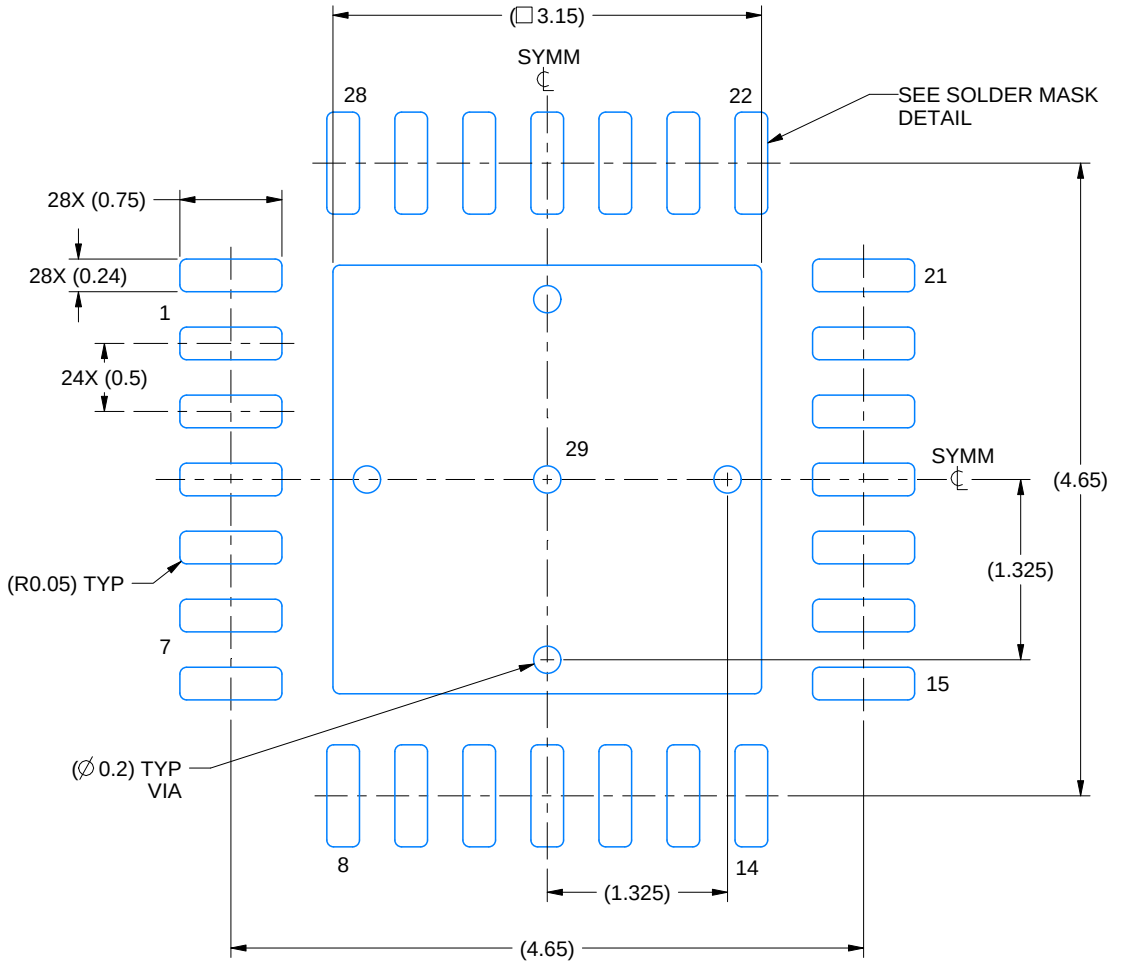
VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

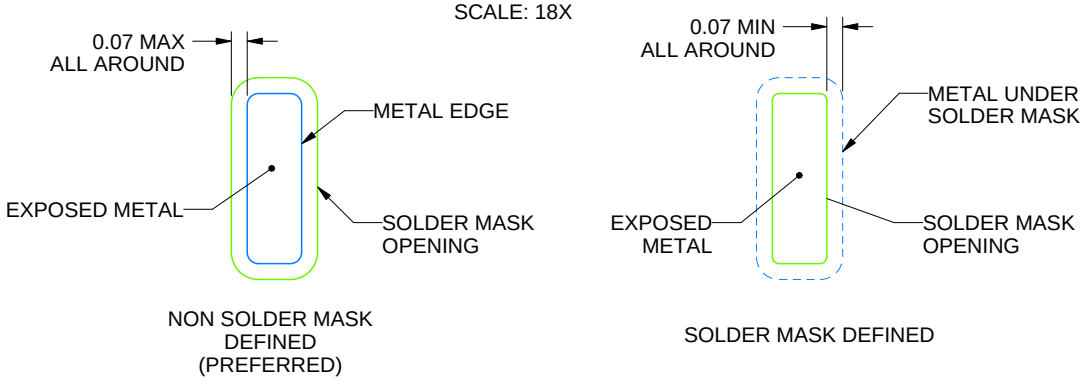


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 18X

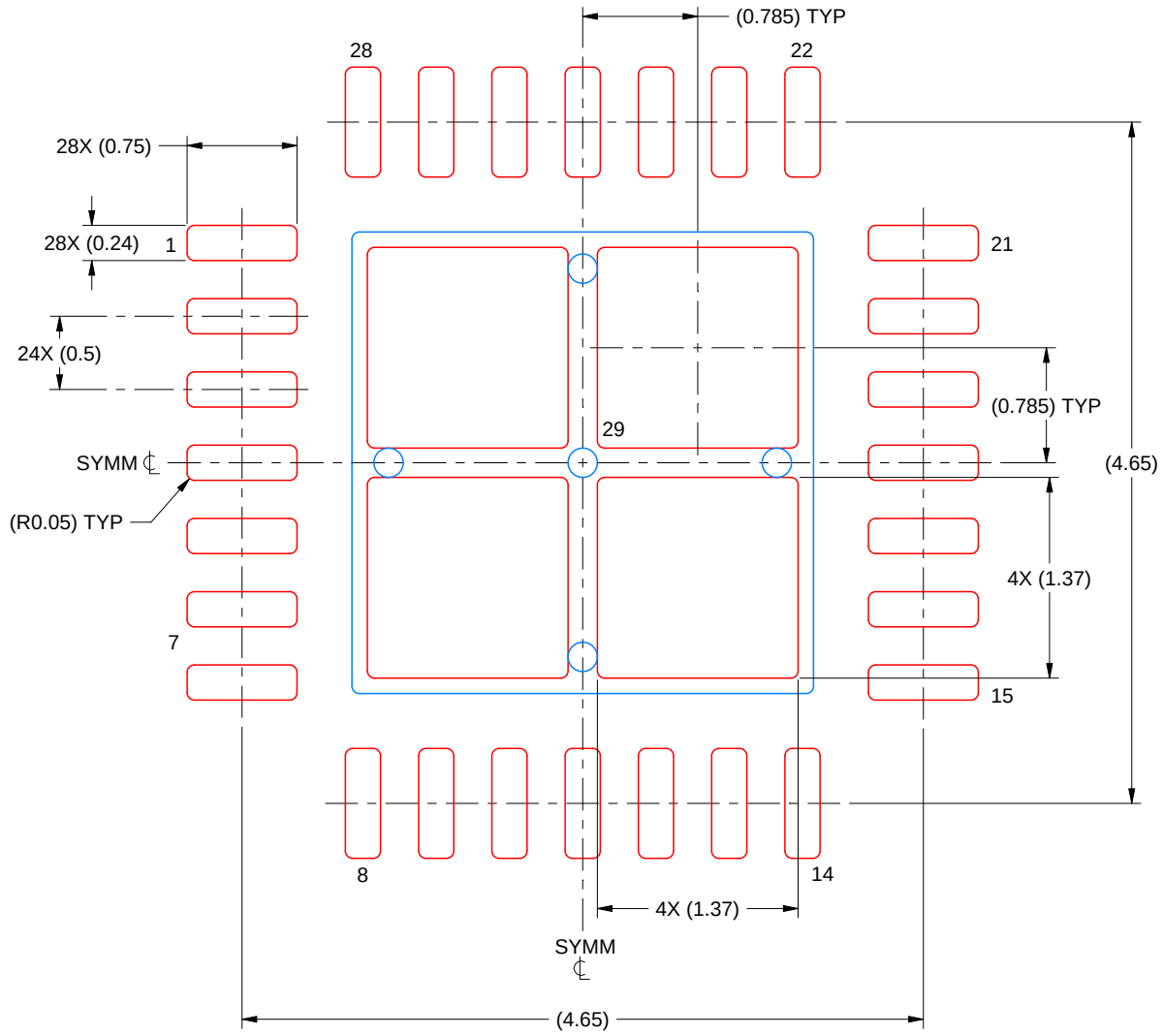


SOLDER MASK DETAILS

4226146/A 08/2020

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE: 20X

EXPOSED PAD 29
76% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE

4226146/A 08/2020

NOTES: (continued)

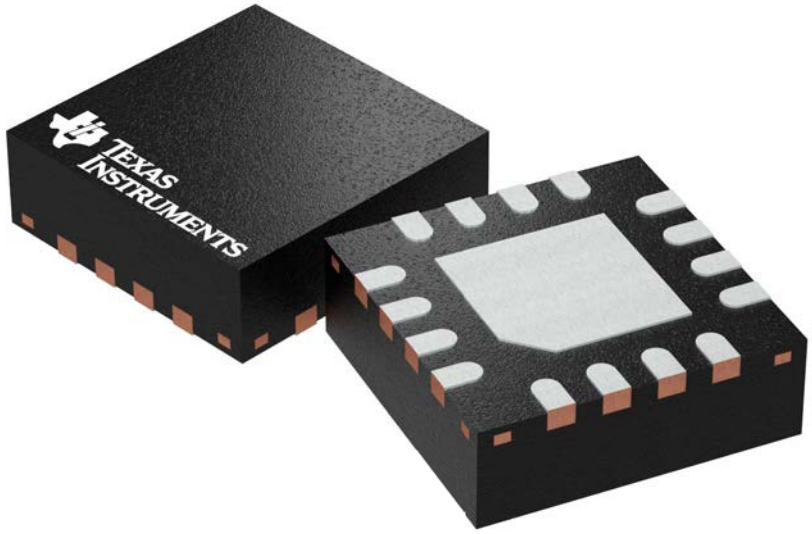
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

GENERIC PACKAGE VIEW

RGT 16

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

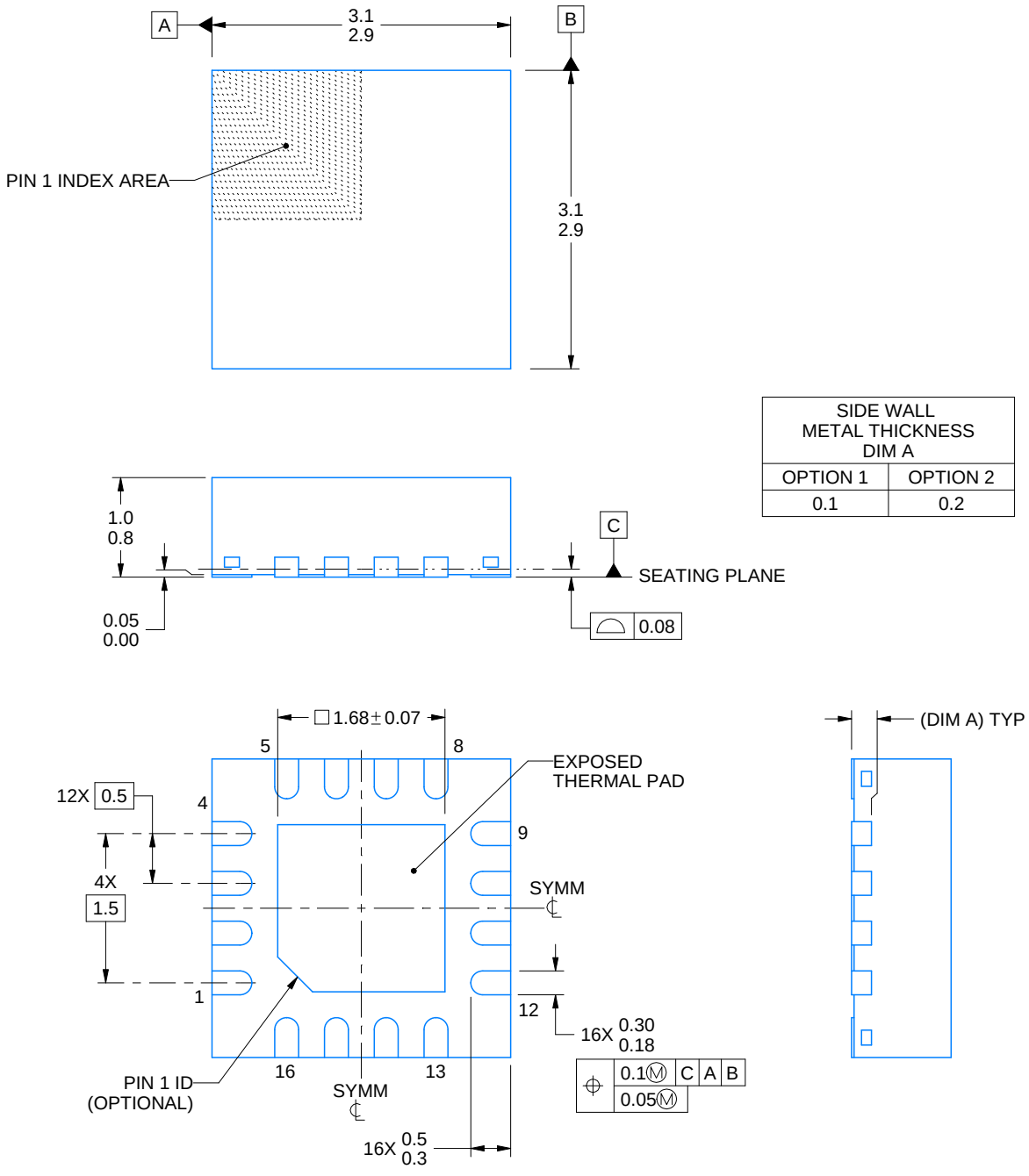
4203495/I

RGT0016C

PACKAGE OUTLINE

VQFN - 1 mm max height

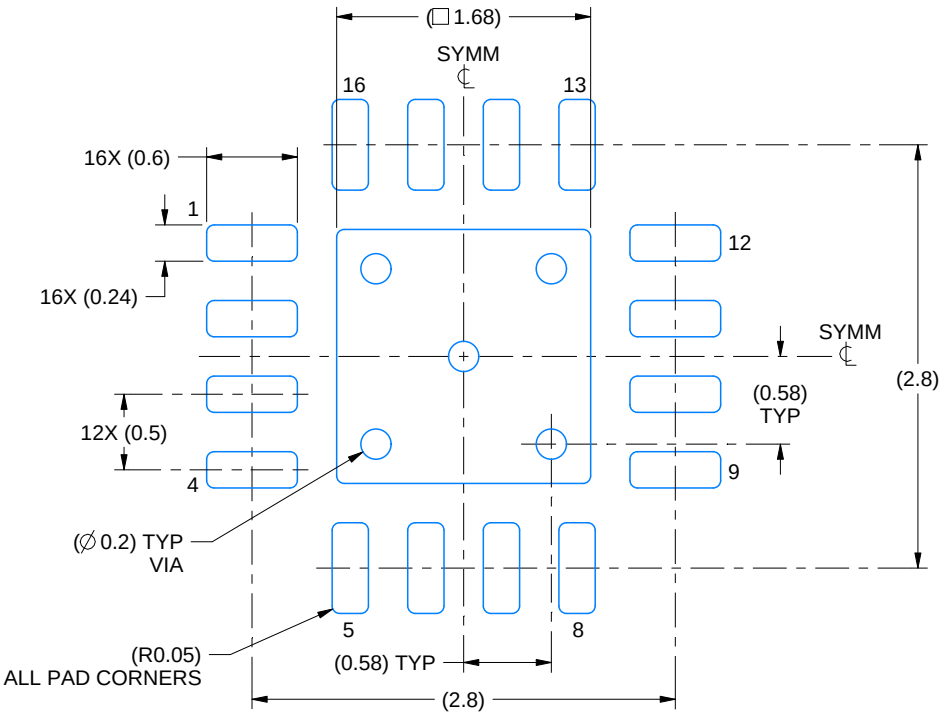
PLASTIC QUAD FLATPACK - NO LEAD



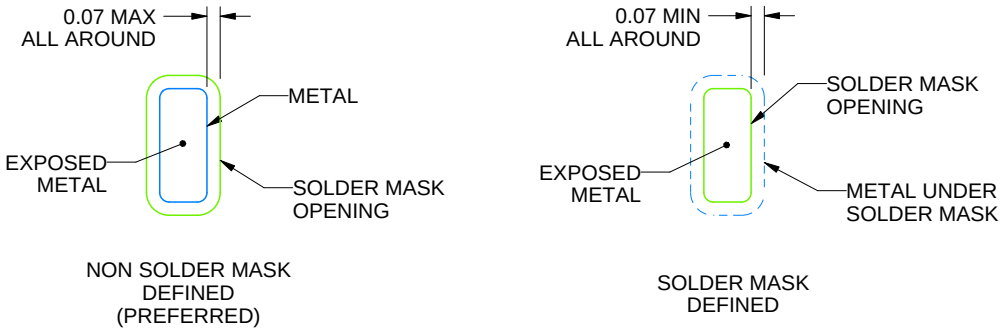
4222419/D 04/2022

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:20X

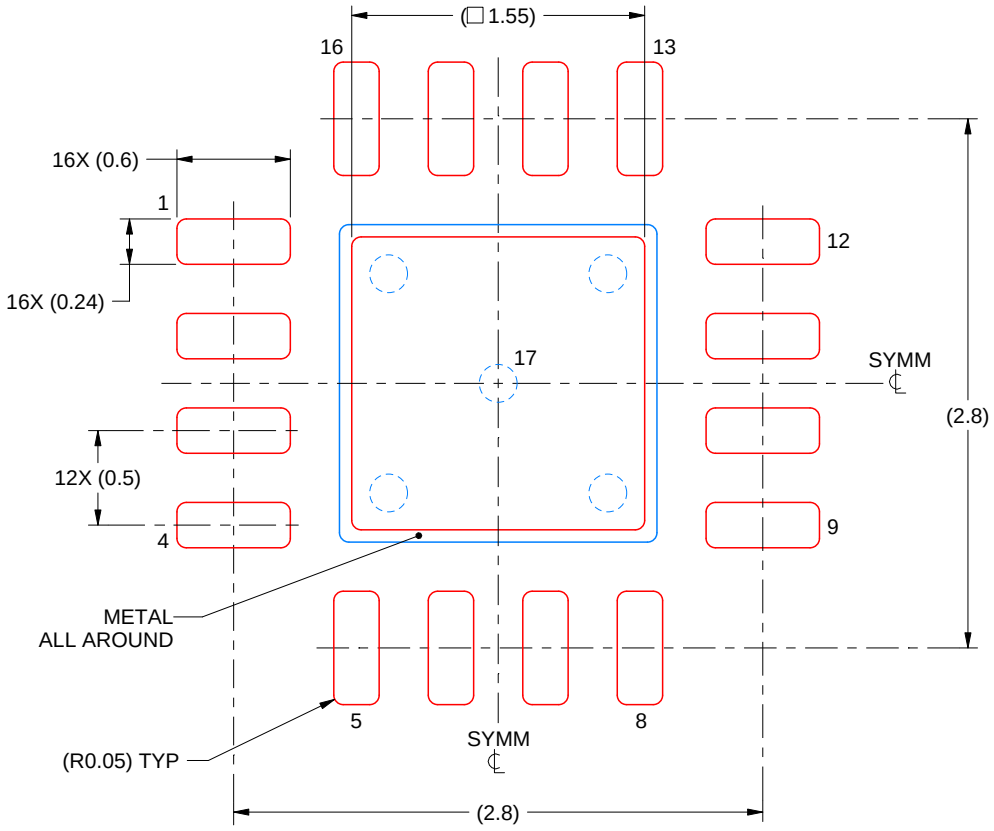


SOLDER MASK DETAILS

4222419/D 04/2022

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 17:
85% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:25X

4222419/D 04/2022

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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