

# LMK1D210xL Ultra Low Additive Jitter LVDS Buffer

## 1 Features

- High-performance LVDS clock buffer family: up to 2GHz
  - Dual 1:2 differential buffer
  - Dual 1:4 differential buffer
  - Dual 1:6 differential buffer
  - Dual 1:8 differential buffer
- Supply voltage: 1.71V to 3.465V
- Dual output common mode voltage operation:
  - Output common mode voltage: 0.7V at 1.8V supply voltage.
  - Output common mode voltage: 1.2V at 2.5V/3.3V supply voltage
- Low additive jitter:
  - < 17fs RMS typical in 12kHz to 20MHz at 1250.25MHz
  - < 22fs RMS typical in 12kHz to 20MHz at 625MHz
  - < 60fs RMS maximum in 12kHz to 20MHz at 156.25MHz
  - Very low phase noise floor: -164dBc/Hz (typical at 156.25MHz)
- Very low propagation delay: < 575ps maximum
- Output skew:
  - 15ps maximum (LMK1D2102, LMK1D2104)
  - 20ps maximum (LMK1D2106, LMK1D2106)
- Part to Part skew: 150ps
- High-swing LVDS (boosted mode): 500mV VOD typical when AMP\_SELA, AMP\_SELB= Floating
- Bank enable/disable using AMP\_SELA and AMP\_SELB [Section 8.4.1](#)
- Fail-safe input operation
- Universal inputs accept LVDS, LVPECL, LVCMOS, HCSL and CML signal levels
- LVDS reference voltage,  $V_{AC\_REF}$ , available for capacitive-coupled inputs
- Extended industrial temperature range: -40°C to 105°C

## 2 Applications

- [Telecommunications and networking](#)
- [Medical imaging](#)
- [Test and measurement](#)
- [Wireless infrastructure](#)
- [Pro audio, video and signage](#)

## 3 Description

The LMK1D210xL is a low noise dual clock buffer which distributes one input to a maximum of 2 (LMK1D2102L), 4 (LMK1D2104L), 6 (LMK1D2106L) or 8 (LMK1D2108L) LVDS outputs. The inputs can either be LVDS, LVPECL, HCSL, CML, or LVCMOS.

The LMK1D210xL is specifically designed for driving 50Ω transmission lines. When driving inputs in single-ended mode, apply the appropriate bias voltage to the unused negative input pin (see [Figure 8-8](#)).

LMK1D210xL buffer offers two output common mode operation (0.7V and 1.2V) for different operating supply. The device provides flexibility in design for DC-coupled mode applications.

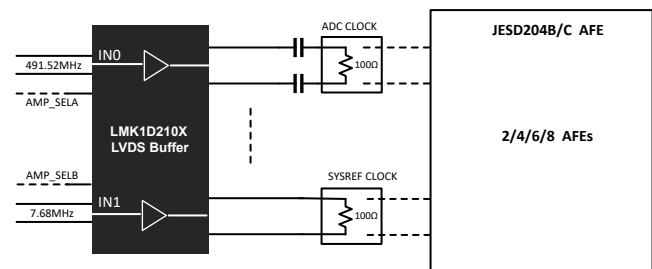
AMP\_SELA / AMP\_SELB control pin can be used to select different output amplitude LVDS (350mV) or boosted LVDS (500mV). In addition to amplitude selection, outputs can be disabled using the same pin.

The part also supports [Fail-Safe Input](#) function for clock and digital input pins. The device further incorporates an input hysteresis which prevents random oscillation of the outputs in the absence of an input signal.

### Package Information

PART NUMBER <sup>(1)</sup>	PACKAGE	PACKAGE SIZE <sup>(3)</sup>
LMK1D2102L	RGT (VQFN, 16)	3.00mm × 3.00mm
LMK1D2104L <sup>(2)</sup>	RHD (VQFN, 28)	5.00mm × 5.00mm
LMK1D2106L <sup>(2)</sup>	RHA (VQFN, 40)	6.00mm × 6.00mm
LMK1D2108L <sup>(2)</sup>	RGZ (VQFN, 48)	7.00mm × 7.00mm

- For all available packages, see the orderable addendum at the end of the data sheet.
- Preview only.
- The package size (length × width) is a nominal value and includes pins, where applicable.



Application Example



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## 4 Device Comparison

**Table 4-1. Device Comparison**

DEVICE	DEVICE TYPE	FEATURES	OUTPUT SWING	OUTPUT COMMON MODE	PACKAGE	PACKAGE SIZE
LMK1D2102L	Dual 1:2	Global output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (16)	3.00mm × 3.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
				1V		
LMK1D2104L	Dual 1:4	Global output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (28)	5.00mm × 5.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
				1V		
LMK1D2106L	Dual 1:6	Individual output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (40)	6.00mm × 6.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
				1V		
LMK1D2108L	Dual 1:6	Individual output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (48)	7.00mm × 7.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
				1V		
LMK1D2102	Dual 1:2	Global output enable control through pin control	350mV	1.2V	VQFN (16)	3.00mm × 3.00mm
LMK1D2104	Dual 1:4	Global output enable control through pin control	350mV	1.2V	VQFN (28)	5.00mm × 5.00mm
LMK1D2106	Dual 1:6	Global output enable and swing control through pin control	350mV	1.2V	VQFN (40)	6.00mm × 6.00mm
			500mV	1V		
LMK1D2108	Dual 1:8	Global output enable and swing control through pin control	350mV	1.2V	VQFN (48)	7.00mm × 7.00mm
			500mV	1V		
LMK1D1204	2:4	Global output enable control through pin control	350mV	1.2V	VQFN (16)	3.00mm × 3.00mm
LMK1D1204P	2:4	Global output enable control through pin control	350mV	1.2V	VQFN (28)	5.00mm × 5.00mm
LMK1D1208	2:8	Global output enable control through pin control	350mV	1.2V	VQFN (28)	5.00mm × 5.00mm
LMK1D1208P	2:8	Individual output enable control through pin control	350mV	1.2V	VQGN (40)	6.00mm × 6.00mm
			500mV	1V		
LMK1D1208I	2:8	Individual output enable, swing, bank and clock input selection control through I <sup>2</sup> C	350mV	1.2V	VQFN (40)	6.00mm × 6.00mm
			500mV	1V		
LMK1D1212	2:12	Global output enable and swing control through pin control	350mV	1.2V	VQFN (40)	6.00mm × 6.00mm
			500mV	1V		
LMK1D1216	2:16	Global output enable and swing control through pin control	350mV	1.2V	VQFN (48)	7.00mm × 7.00mm
			500mV	1V		
LMK1D1204I <sup>(1)</sup>	2:4	Individual output enable, swing, bank and clock input selection control through I <sup>2</sup> C	350mV	1.2V	VQFN (16)	3.00mm × 3.00mm
			500mV	1V		

**ADVANCE INFORMATION**

**Table 4-1. Device Comparison (continued)**

DEVICE	DEVICE TYPE	FEATURES	OUTPUT SWING	OUTPUT COMMON MODE	PACKAGE	PACKAGE SIZE
LMK1D1212I <sup>(1)</sup>	2:12	Individual output enable, swing, bank and clock input selection control through I <sup>2</sup> C	350mV	1.2V	VQFN (40)	6.00mm × 6.00mm
			500mV	1V		
LMK1D1216I <sup>(1)</sup>	2:16	Individual output enable, swing, bank and clock input selection control through I <sup>2</sup> C	350mV	1.2V	VQFN (48)	7.00mm × 7.00mm
			500mV	1V		
LMK1D1204L <sup>(1)</sup>	2:4	Global output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (16)	3.00mm × 3.00mm
				1.2V		
LMK1D1208L <sup>(1)</sup>	2:8	Global output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (28)	5.00mm × 5.00mm
				1.2V		
LMK1D1208PL <sup>(1)</sup>	2:8	Individual output enable control through pin control	350mV	0.7V <sup>(2)</sup>	VQFN (40)	6.00mm × 6.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
LMK1D1212L <sup>(1)</sup>	2:12	Individual output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (40)	6.00mm × 6.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
LMK1D1216L <sup>(1)</sup>	2:16	Individual output bank enable and swing control pin.	350mV	0.7V <sup>(2)</sup>	VQFN (48)	7.00mm × 7.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
LMK1D1212IL <sup>(1)</sup>	2:12	Individual output enable, swing, bank and clock input selection control through I <sup>2</sup> C	350mV	0.7V <sup>(2)</sup>	VQFN (40)	6.00mm × 6.00mm
				1V		
			500mV	0.7V <sup>(2)</sup>		
LMK1D1216IL <sup>(1)</sup>	2:16	Individual output enable, swing, bank and clock input selection control through I <sup>2</sup> C	350mV	0.7V <sup>(2)</sup>	VQFN (48)	7.00mm × 7.00mm
				1.2V		
			500mV	0.7V <sup>(2)</sup>		
				1V		

- (1) Contact TI for more information on the device.  
 (2) 0.7V output common mode is only supported for VDD = 1.8V ± 5%.

ADVANCE INFORMATION

## 5 Pin Configuration and Functions

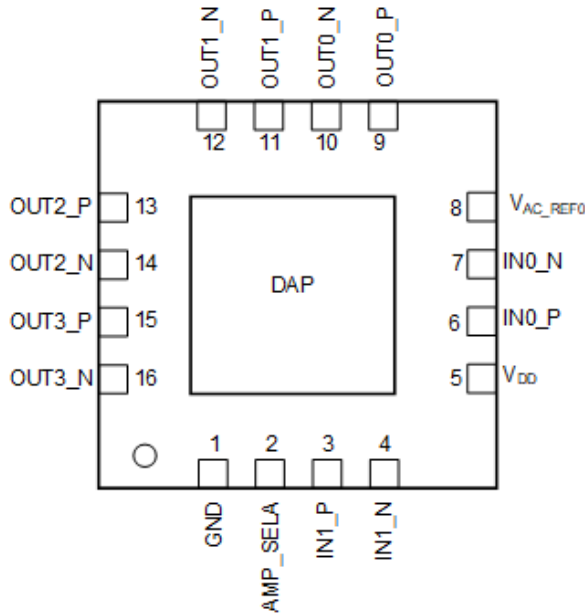


Figure 5-1. LMK1D2102L: RGT Package 16-Pin VQFN Top View

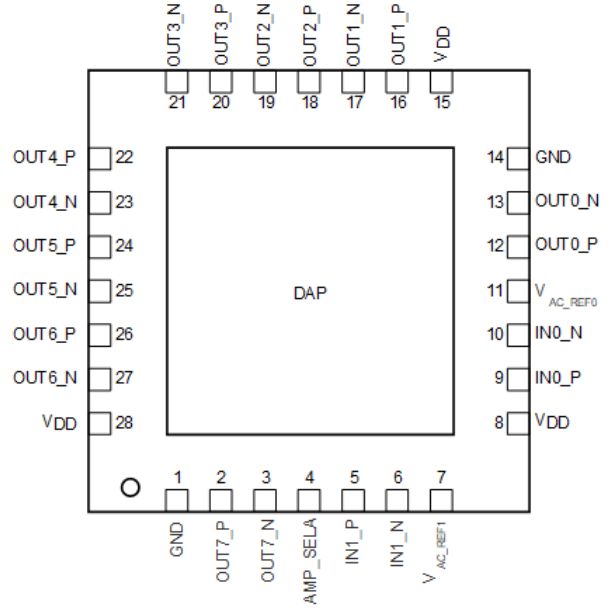


Figure 5-2. LMK1D2104L: RHD Package 28-Pin VQFN Top View

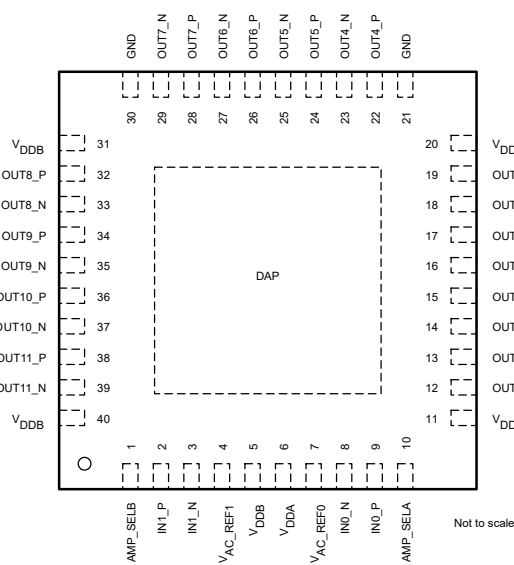


Figure 5-3. LMK1D2106L: RHA Package 40-Pin VQFN Top View

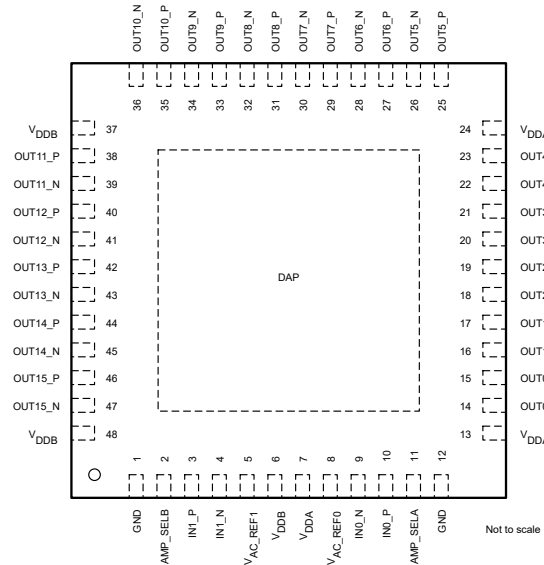


Figure 5-4. LMK1D2108L: RGZ Package 48-Pin VQFN Top View

**Table 5-1. Pin Functions**

NAME	PIN				TYPE <sup>(1)</sup>	DESCRIPTION
	LMK1D2102L	LMK1D2104L	LMK1D2106L	LMK1D2108L		
<b>DIFFERENTIAL/SINGLE-ENDED CLOCK INPUT</b>						
IN0_P, IN0_N	6, 7	9, 10	9, 8	10, 9	I	Primary: Differential input pair or single-ended input
IN1_P, IN1_N	3, 4	5, 6	2, 3	3, 4	I	Secondary: Differential input pair or single-ended input Note that INP0, INN0 are used indistinguishably with IN0_P, IN0_N.
<b>BANK ENABLE AND AMPLITUDE SELECT</b>						
AMP_SELA	2	4	10	11	I	Output bank enable/disable with an internal 500kΩ pullup and 320kΩ pulldown; (See <a href="#">Section 8.4.1</a> )
AMP_SELB	-	-	1	2	I	Output bank enable/disable with an internal 500kΩ pullup and 320kΩ pulldown; (See <a href="#">Section 8.4.1</a> )
<b>BIAS VOLTAGE OUTPUT</b>						
V <sub>AC_REF0</sub>	8	11	7	8	O	Bias voltage output for capacitive coupled inputs. If used, TI recommends using a 0.1μF capacitor to GND on this pin.
V <sub>AC_REF1</sub>	-	-	4	5	O	Bias voltage output for capacitive coupled inputs. If used, TI recommends using a 0.1μF capacitor to GND on this pin.
<b>DIFFERENTIAL CLOCK OUTPUT</b>						
OUT0_P, OUT0_N	9, 10	12, 13	12, 13	14, 15	O	Differential LVDS output pair number 0
OUT1_P, OUT1_N	11, 12	16, 17	14, 15	16, 17	O	Differential LVDS output pair number 1
OUT2_P, OUT2_N	13, 14	18, 19	16, 17	18, 19	O	Differential LVDS output pair number 2
OUT3_P, OUT3_N	15, 16	20, 21	18, 19	20, 21	O	Differential LVDS output pair number 3
OUT4_P, OUT4_N	-	22, 23	22, 23	22, 23	O	Differential LVDS output pair number 4
OUT5_P, OUT5_N	-	24, 25	24, 25	25, 26	O	Differential LVDS output pair number 5
OUT6_P, OUT6_N	-	26, 27	26, 27	27, 28	O	Differential LVDS output pair number 6
OUT7_P, OUT7_N	-	2, 3	28, 29	29, 30	O	Differential LVDS output pair number 7
OUT8_P, OUT8_N	-	-	32, 33	31, 32	O	Differential LVDS output pair number 8
OUT9_P, OUT9_N	-	-	34, 35	33, 34	O	Differential LVDS output pair number 9
OUT10_P, OUT10_N	-	-	36, 37	35, 36	O	Differential LVDS output pair number 10
OUT11_P, OUT11_N	-	-	38, 39	38, 39	O	Differential LVDS output pair number 11
OUT12_P, OUT12_N	-	-	-	40, 41	O	Differential LVDS output pair number 12
OUT13_P, OUT13_N	-	-	-	42, 43	O	Differential LVDS output pair number 13
OUT14_P, OUT14_N	-	-	-	44, 45	O	Differential LVDS output pair number 14
OUT15_P, OUT15_N	-	-	-	46, 47	O	Differential LVDS output pair number 15
<b>SUPPLY VOLTAGE</b>						
V <sub>DD</sub>	5	8, 15, 28	-	-	P	Device power supply (1.8V, 2.5V, or 3.3V) for Bank 0 and Bank 1
V <sub>DDA</sub>	-	-	6, 11, 20	7, 13, 24	P	Device power supply (1.8V, 2.5V, or 3.3V) for Bank 0
V <sub>ddb</sub>	-	-	5, 31, 40	6, 37, 48	P	Device power supply (1.8V, 2.5V, or 3.3V) for Bank 1
<b>GROUND</b>						
GND	1	1, 14	21, 30	1, 12	G	Ground
<b>MISC</b>						

ADVANCE INFORMATION

**Table 5-1. Pin Functions (continued)**

NAME	PIN				TYPE <sup>(1)</sup>	DESCRIPTION
	LMK1D2102L	LMK1D2104L	LMK1D2106L	LMK1D2108L		
DAP	DAP	DAP	DAP	DAP	G	Die Attach Pad. Connect to the printed circuit board (PCB) ground plane for heat dissipation.

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

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>DD</sub>	Supply voltage	-0.3	3.6	V
V <sub>IN</sub>	Input voltage	-0.3	3.6	V
V <sub>O</sub>	Output voltage	-0.3	V <sub>DD</sub> + 0.3	V
I <sub>IN</sub>	Input current	-20	20	mA
I <sub>O</sub>	Continuous output current	-50	50	mA
T <sub>J</sub>	Junction temperature		135	°C
T <sub>stg</sub>	Storage temperature <sup>(2)</sup>	-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

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>	±3000
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup>	±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.

### 6.3 Recommended Operating Conditions

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

			MIN	NOM	MAX	UNIT
V <sub>DD</sub>	Core supply voltage	3.3V supply	3.135	3.3	3.465	V
		2.5V supply	2.375	2.5	2.625	
		1.8V supply	1.71	1.8	1.89	
Supply Ramp	Supply voltage ramp	Requires monotonic ramp (10-90% of V <sub>DD</sub> )	0.1		20	ms
T <sub>A</sub>	Operating free-air temperature		-40		105	°C
T <sub>J</sub>	Operating junction temperature		-40		135	°C

## 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		LMK1D2102L	LMK1D2104L	LMK1D2106L	LMK1D2108L	UNIT
		VQFN	VQFN	VQFN	VQFN	
		16 PINS	28 PINS	40 PINS	48 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	48.7	38.9	30.3	30.5	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	56.4	32.1	21.6	21.2	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	23.6	18.7	13.1	12.9	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	1.6	1	0.4	0.4	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter	23.6	18.7	13	12.8	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	8.6	8.2	4.5	4.5	°C/W

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

## 6.5 Electrical Characteristics

VDD = 1.8V, 2.5V, 3.3V ± 5%, -40°C ≤ T<sub>A</sub> ≤ 105°C. Typical values are at VDD = 1.8V, 2.5V, 3.3V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>POWER SUPPLY CHARACTERISTICS</b>						
IDD <sub>100M</sub>	LMK1D2102L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA = 0		70	80	mA
IDD <sub>100M</sub>	LMK1D2104L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA = 0		80	105	mA
IDD <sub>100M</sub>	LMK1D2106L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA and AMP_SELB = 0		113	140	mA
IDD <sub>100M</sub>	LMK1D2108L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA and AMP_SELB = 0		134	160	mA
IDD <sub>100M</sub>	LMK1D2102L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA = Float		75	87	mA
IDD <sub>100M</sub>	LMK1D2104L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA = Float		85	115	mA
IDD <sub>100M</sub>	LMK1D2106L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA and AMP_SELB = Float		134	160	mA
IDD <sub>100M</sub>	LMK1D2108L	All-outputs enabled, R <sub>L</sub> = 100Ω, f = 100MHz, AMP_SELA and AMP_SELB = Float		155	180	mA
IDD <sub>POWER DOWN</sub>	LMK1D2102L	All-outputs disabled and unterminated, AMP_SELA = 1		50		mA
IDD <sub>POWER DOWN</sub>	LMK1D2102L	All-outputs disabled, R <sub>L</sub> = 100Ω, AMP_SELA = 1		65		mA
IDD <sub>POWER DOWN</sub>	LMK1D2104L	All-outputs disabled and unterminated, AMP_SELA = 1		55		mA
IDD <sub>POWER DOWN</sub>	LMK1D2104L	All-outputs disabled, R <sub>L</sub> = 100Ω, AMP_SELA = 1		80		mA
IDD <sub>POWER DOWN</sub>	LMK1D2106L	All-outputs disabled and unterminated, AMP_SELA and AMP_SELB = 1		75		mA



VDD = 1.8V, 2.5V, 3.3V ± 5%, -40°C ≤ T<sub>A</sub> ≤ 105°C. Typical values are at VDD = 1.8V, 2.5V, 3.3V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I <sub>DDPOWER DOWN</sub>	LMK1D2106L	All-outputs disabled, R <sub>L</sub> = 100Ω, AMP_SELA and AMP_SELB = 1		100		mA
I <sub>DDPOWER DOWN</sub>	LMK1D2108L	All-outputs disabled and unterminated, AMP_SELA and AMP_SELB = 1		80		mA
I <sub>DDPOWER DOWN</sub>	LMK1D2108L	All-outputs disabled, R <sub>L</sub> = 100Ω, AMP_SELA and AMP_SELB = 1		120		mA
<b>AMP_SELA / AMP_SELB INPUT CHARACTERISTICS</b>						
V <sub>dI3</sub>	3-state input	Open / floating		0.4*V <sub>CC</sub>		V
V <sub>IH</sub>	Input high voltage	Minimum input voltage for a logical "1" state	0.7*V <sub>CC</sub>	V <sub>CC</sub> + 0.3		V
V <sub>IL</sub>	Input low voltage	Maximum input voltage for a logical "0" state	-0.3	0.3*V <sub>CC</sub>		V
I <sub>IH</sub>	Input high current	V <sub>DD</sub> can be 1.8V/2.5V/3.3V with V <sub>IH</sub> = V <sub>DD</sub>			30	μA
I <sub>IL</sub>	Input low current	V <sub>DD</sub> can be 1.8V/2.5V/3.3V with V <sub>IH</sub> = V <sub>DD</sub>	-30			μA
R <sub>pull-up</sub>	Input pullup resistor (AMP_SELA, AMP_SELB)			500		kΩ
R <sub>pull-down</sub>	Input pulldown resistor (AMP_SELA, AMP_SELB)			320		kΩ
<b>SINGLE-ENDED LVCMOS/LVTTL CLOCK INPUT</b>						
f <sub>IN</sub>	Input frequency	Clock input	DC		250	MHz
V <sub>IN_S-E</sub>	Single-ended Input Voltage Swing	Assumes a square wave input with two levels	0.4		3.465	V <sub>PP</sub>
dVIN/dt	Input Slew Rate (20% to 80% of the amplitude)		0.05			V/ns
I <sub>IH</sub>	Input high current	V <sub>DD</sub> = 3.465V, V <sub>IH</sub> = 3.465V			50	μA
I <sub>IL</sub>	Input low current	V <sub>DD</sub> = 3.465V, V <sub>IL</sub> = 0V	-30			μA
C <sub>IN_SE</sub>	Input capacitance	at 25°C		3.5		pF
<b>DIFFERENTIAL CLOCK INPUT</b>						
f <sub>IN</sub>	Input frequency	Clock input			2	GHz
V <sub>IN,DIFF(P-P)</sub>	Differential input voltage peak-to-peak {2*(V <sub>INP</sub> -V <sub>INN</sub> )}	V <sub>ICM</sub> = 1V (V <sub>DD</sub> = 1.8V)	0.3		2.4	V <sub>PP</sub>
		V <sub>ICM</sub> = 1.25V (V <sub>DD</sub> = 2.5V/3.3V)	0.3		2.4	
V <sub>ICM</sub>	Input common mode voltage	V <sub>IN,DIFF(P-P)</sub> > 0.4V (V <sub>DD</sub> = 1.8V/2.5V/3.3V)	0.25		2.3	V
I <sub>IH</sub>	Input high current	V <sub>DD</sub> = 3.465V, V <sub>INP</sub> = 2.4V, V <sub>INN</sub> = 1.2V			30	μA
I <sub>IL</sub>	Input low current	V <sub>DD</sub> = 3.465 V, V <sub>INP</sub> = 0V, V <sub>INN</sub> = 1.2V	-30			μA
C <sub>IN_S-E</sub>	Input capacitance (Single-ended)	at 25°C		3.5		pF
<b>LVDS DC OUTPUT CHARACTERISTICS</b>						
VOD	Differential output voltage magnitude  V <sub>OUTP</sub> - V <sub>OUTN</sub>	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = 0	250	350	450	mV
VOD	Differential output voltage magnitude  V <sub>OUTP</sub> - V <sub>OUTN</sub>	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = Float	400	500	650	mV

VDD = 1.8V, 2.5V, 3.3V ± 5%, -40°C ≤ T<sub>A</sub> ≤ 105°C. Typical values are at VDD = 1.8V, 2.5V, 3.3V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ΔVOD	Change in differential output voltage magnitude. Per output, defined as the difference between VOD in logic hi/lo states.	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = 0	-15		15	mV
ΔVOD	Change in differential output voltage magnitude	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = Float	-20		20	mV
V <sub>OC(SS)</sub>	Steady-state common mode output voltage	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, V <sub>DD</sub> = 1.8V, AMP_SELA, AMP_SELB = 0	0.6	0.7	0.8	V
V <sub>OC(SS)</sub>	Steady-state common mode output voltage (LMK1D2104L, LMK1D2106L, LMK1D2108L)	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, V <sub>DD</sub> = 1.8V, AMP_SELA, AMP_SELB = Float	0.6	0.7	0.8	V
V <sub>OC(SS)</sub>	Steady-state common mode output voltage (LMK1D2102L)	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, V <sub>DD</sub> = 1.8V, AMP_SELA, AMP_SELB = Float, T <sub>A</sub> = -40°C to 105°C	0.6	0.7	0.82	V
V <sub>OC(SS)</sub>	Steady-state common mode output voltage (LMK1D2102L)	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, V <sub>DD</sub> = 1.8V, AMP_SELA, AMP_SELB = Float, T <sub>A</sub> = -40°C to 85°C	0.6	0.7	0.8	V
V <sub>OC(SS)</sub>	Steady-state common mode output voltage	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, V <sub>DD</sub> = 2.5V/3.3V, AMP_SELA, AMP_SELB = 0	1.1		1.375	V
V <sub>OC(SS)</sub>	Steady-state common mode output voltage	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, V <sub>DD</sub> = 2.5V/3.3V, AMP_SELA, AMP_SELB = Float	0.9		1.15	V
ΔV <sub>OC(SS)</sub>	Change in steady-state common mode output voltage	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = 0	-15		-15	mV
ΔV <sub>OC(SS)</sub>	Change in steady-state common mode output voltage	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = Float	-20		20	mV
<b>LVDS AC OUTPUT CHARACTERISTICS</b>						
V <sub>ring</sub>	Output overshoot and undershoot	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, f <sub>OUT</sub> ≤ 491.52MHz	-0.1		0.1	V <sub>OD</sub>
V <sub>OS</sub>	Output AC common mode	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = 0		50	100	mV <sub>pp</sub>
V <sub>OS</sub>	Output AC common mode	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω, AMP_SELA, AMP_SELB = Float		75	150	mV <sub>pp</sub>
V <sub>OS</sub>	Output AC common mode	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω		50	100	mV <sub>pp</sub>
I <sub>OS</sub>	Short-circuit output current (differential)	V <sub>OUTP</sub> = V <sub>OUTN</sub>	-12		12	mA
I <sub>OS(cm)</sub>	Short-circuit output current (common-mode)	V <sub>OUTP</sub> = V <sub>OUTN</sub> = 0	-24		24	mA
t <sub>PD</sub>	Propagation delay	V <sub>IN,DIFF(P-P)</sub> = 0.3V <sub>PP</sub> , R <sub>L</sub> = 100Ω <sup>(1)</sup>	0.3		0.575	ns
t <sub>SK, o</sub>	Output skew	Skew between outputs with the same load conditions			20	ps
t <sub>SK, b</sub>	Output bank skew	Skew between the outputs within the same bank (2102L/2104L) <sup>(2)</sup>			15	ps
t <sub>SK, b</sub>	Output bank skew	skew between the outputs within the same bank (2106L/2108L) <sup>(2)</sup>			17.5	ps

VDD = 1.8V, 2.5V, 3.3V ± 5%, -40°C ≤ T<sub>A</sub> ≤ 105°C. Typical values are at VDD = 1.8V, 2.5V, 3.3V, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>SK, PP</sub>	Part-to-part skew	Skew between outputs on different parts subjected to the same operating conditions with the same input and output loading.			150	ps
t <sub>SK, P</sub>	Pulse skew	50% duty cycle input, crossing point-to-crossing-point distortion (2)	-20		20	ps
t <sub>RJIT(ADD)</sub>	Random additive Jitter (rms)	f <sub>IN</sub> = 156.25MHz with 50% duty-cycle, Input slew rate = 1.5V/ns, Integration range = 12kHz - 20MHz, with output load R <sub>L</sub> = 100Ω		45	60	fs, RMS
Phase noise	Phase Noise for a carrier frequency of 156.25MHz with 50% duty-cycle, Input slew rate = 1.5V/ns with output load R <sub>L</sub> = 100Ω	PN <sub>1kHz</sub>		-143		dBc/Hz
		PN <sub>10kHz</sub>		-152		
		PN <sub>100kHz</sub>		-157		
		PN <sub>1MHz</sub>		-160		
		PN <sub>floor</sub>		-164		
MUX <sub>ISO</sub>	Mux Isolation	f <sub>IN</sub> = 156.25MHz. The difference in power level at f <sub>IN</sub> 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
SPUR	Spurious suppression between dual banks	Differential inputs with F <sub>IN0</sub> = 491.52MHz, F <sub>IN1</sub> = 61.44MHz; Measured between neighboring outputs		-60		dB
		Different inputs with F <sub>IN0</sub> = 491.52MHz, F <sub>IN1</sub> = 15.36MHz; Measured between neighboring outputs		-70		
ODC	Output duty cycle	With 50% duty cycle input	45		55	%
t <sub>R</sub> /t <sub>F</sub>	Output rise and fall time	20% to 80% with R <sub>L</sub> = 100Ω			300	ps
V <sub>AC_REF</sub>	Reference output voltage	VDD = 2.5V, I <sub>LOAD</sub> = 100μA	0.9	1.25	1.375	V
<b>POWER SUPPLY NOISE REJECTION (PSNR) V<sub>DD</sub> = 2.5V / 3.3V</b>						
PSNR	Power Supply Noise Rejection (f <sub>carrier</sub> = 156.25MHz)	10kHz, 100mVpp ripple injected on V <sub>DD</sub>		-95		dBc
		1MHz, 100mVpp ripple injected on V <sub>DD</sub>		-75		

- (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.

## 6.6 Typical Characteristics

LMK1D210xL buffer typical characteristics are shown for current consumption, phase noise performance and timing diagrams and output common mode operation.

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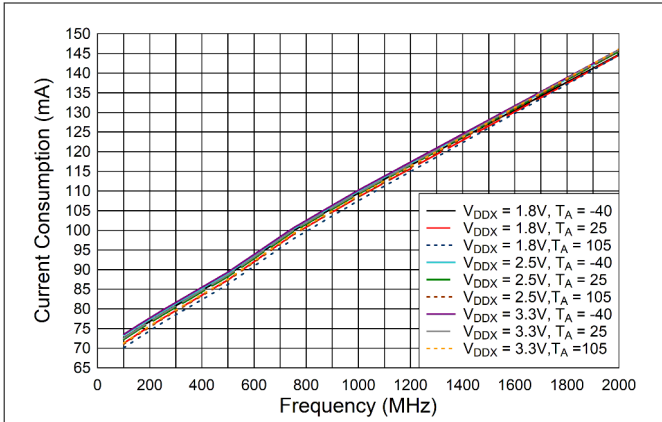


Figure 6-1. LMK1D2102 Current Consumption vs. Frequency, AMP\_SELA = 0

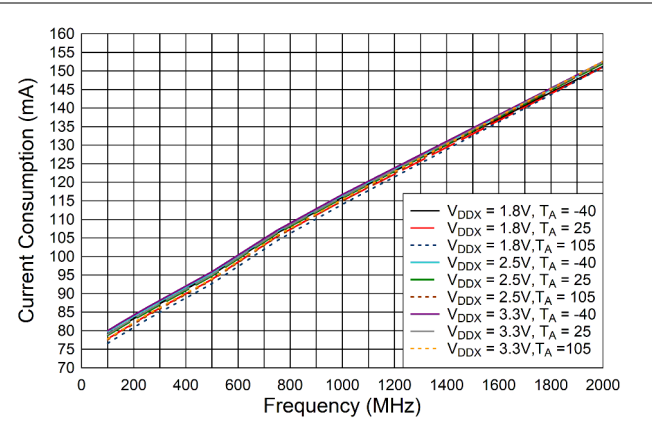


Figure 6-2. LMK1D2102 Current Consumption vs. Frequency, AMP\_SELA = Floating

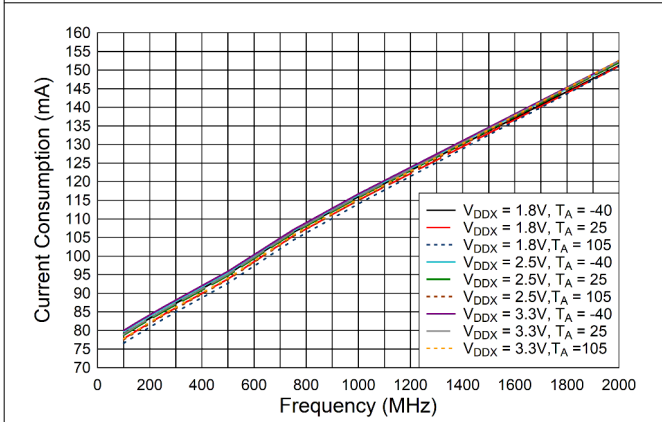


Figure 6-3. LMK1D2104 Current Consumption vs. Frequency, AMP\_SELA = 0

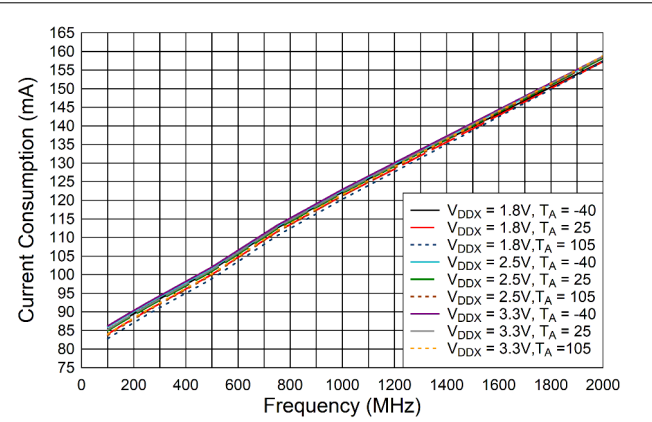


Figure 6-4. LMK1D2104 Current Consumption vs. Frequency, AMP\_SELA = Floating

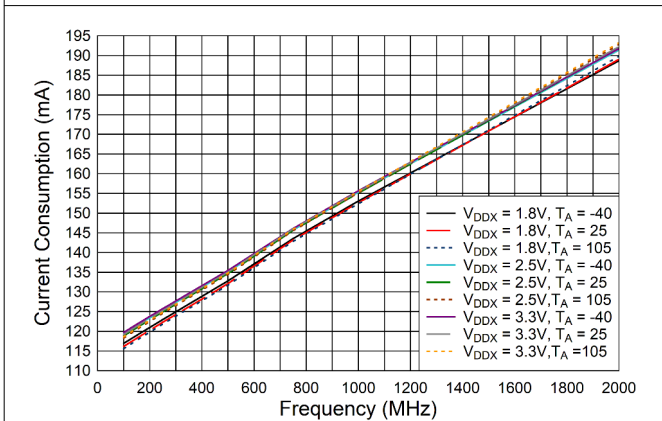


Figure 6-5. LMK1D2106 Current Consumption vs. Frequency, AMP\_SELA and AMP\_SELB = 0

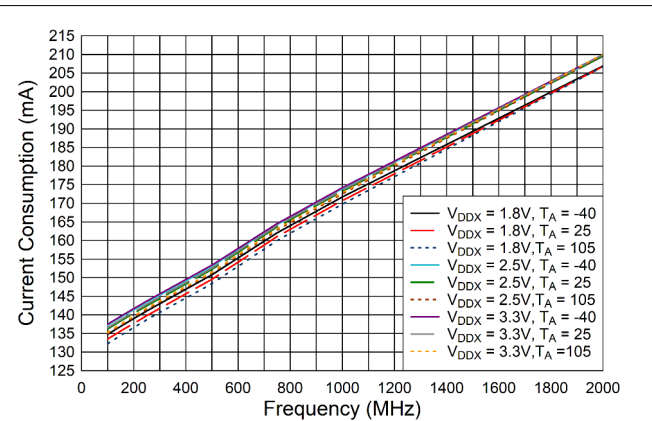


Figure 6-6. LMK1D2106 Current Consumption vs. Frequency, AMP\_SELA and AMP\_SELB = Floating

## 6.6 Typical Characteristics (continued)

LMK1D210xL buffer typical characteristics are shown for current consumption, phase noise performance and timing diagrams and output common mode operation.

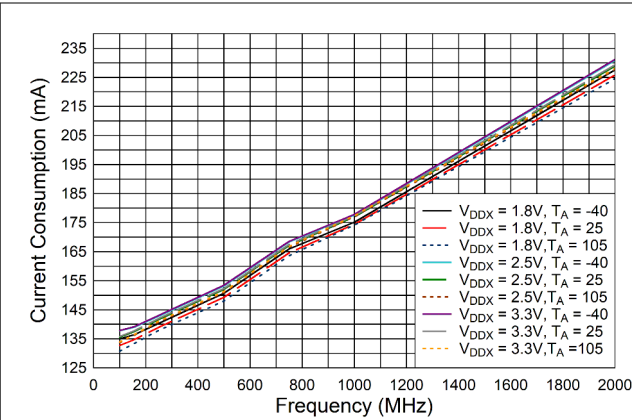


Figure 6-7. LMK1D2108 Current Consumption vs. Frequency, AMP\_SEL A and AMP\_SEL B = 0

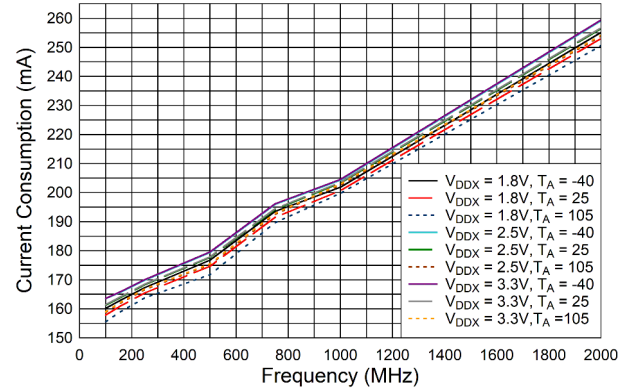


Figure 6-8. LMK1D2108 Current Consumption vs. Frequency, AMP\_SEL A and AMP\_SEL B = Floating

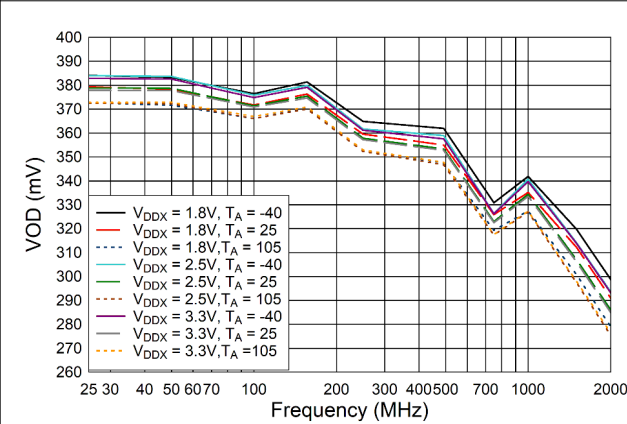


Figure 6-9. LMK1D210xL VOD vs. Frequency, AMP\_SEL A / AMP\_SEL B = 0

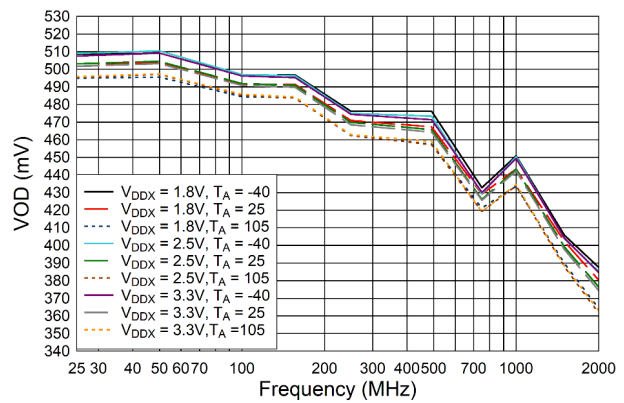


Figure 6-10. LMK1D210xL VOD vs. Frequency, AMP\_SEL A / AMP\_SEL B = Floating

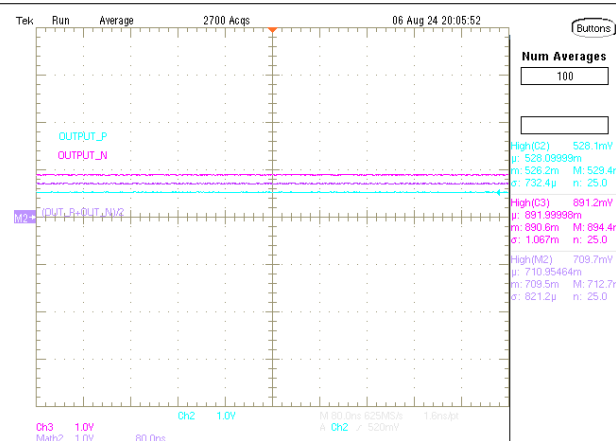


Figure 6-11. LMK1D210xL DC Output Common Mode at 1.8V Supply Condition, Differential Low (AMP\_SEL A / AMP\_SEL B = 0)

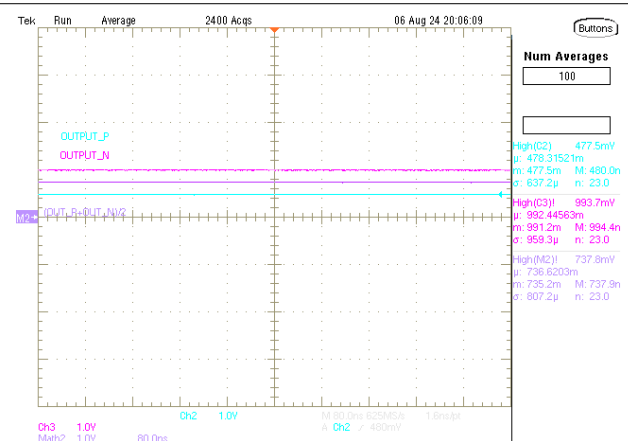


Figure 6-12. LMK1D210xL DC Output Common Mode at 1.8V Supply Condition, Differential Low (AMP\_SEL A / AMP\_SEL B = Float)

### 6.6 Typical Characteristics (continued)

LMK1D210xL buffer typical characteristics are shown for current consumption, phase noise performance and timing diagrams and output common mode operation.

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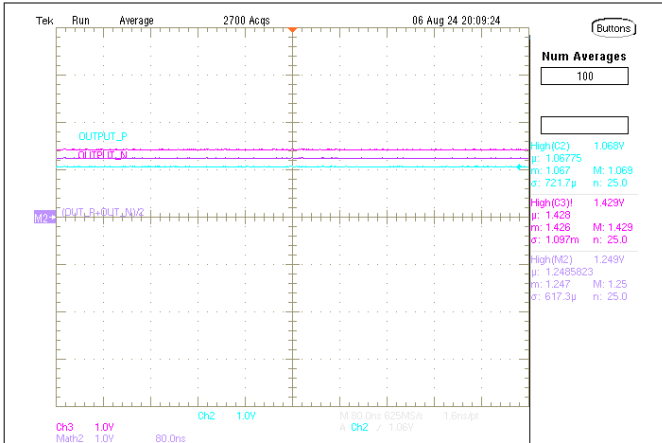


Figure 6-13. LMK1D210XL DC Output Common Mode at 2.5V/3.3V Supply Condition, Differential Low (AMP\_SELA / AMP\_SELB = 0)

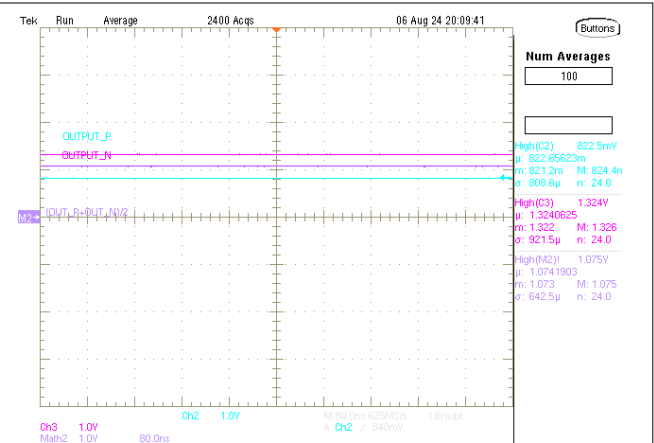


Figure 6-14. LMK1D210XL DC Output Common Mode at 2.5V/3.3V Supply Condition, Differential Low (AMP\_SELA / AMP\_SELB = Float)

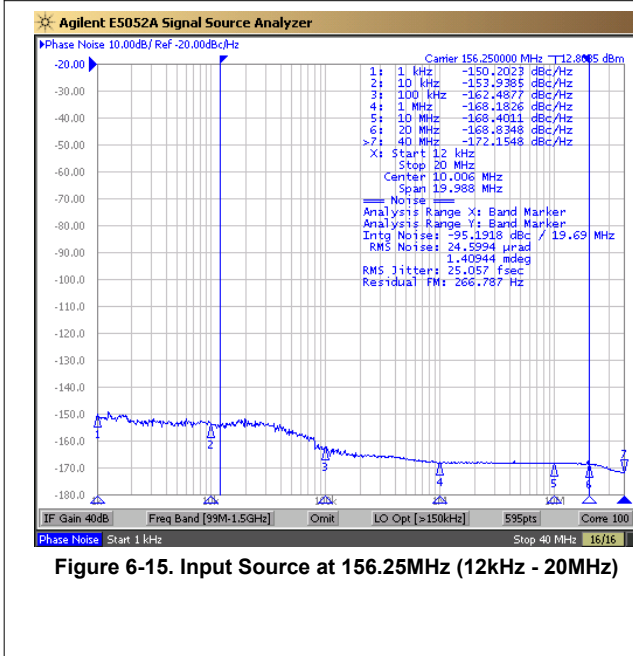
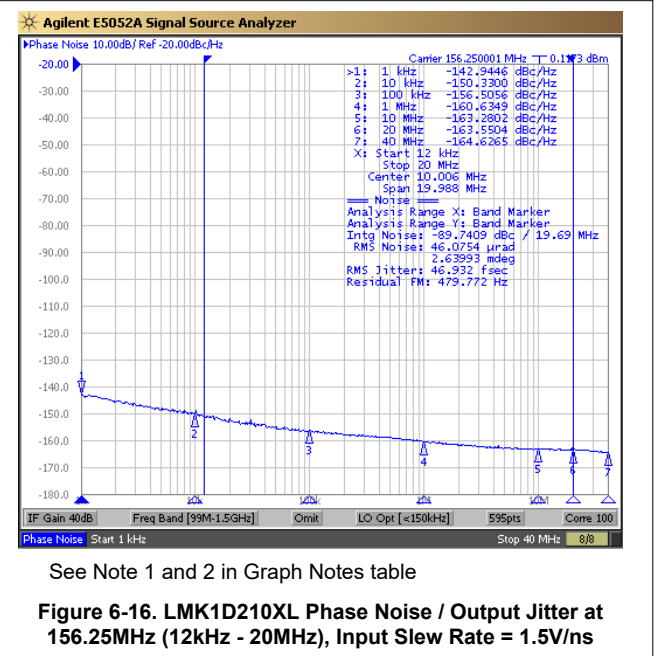


Figure 6-15. Input Source at 156.25MHz (12kHz - 20MHz)



See Note 1 and 2 in Graph Notes table

Figure 6-16. LMK1D210XL Phase Noise / Output Jitter at 156.25MHz (12kHz - 20MHz), Input Slew Rate = 1.5V/ns

## 6.6 Typical Characteristics (continued)

LMK1D210xL buffer typical characteristics are shown for current consumption, phase noise performance and timing diagrams and output common mode operation.

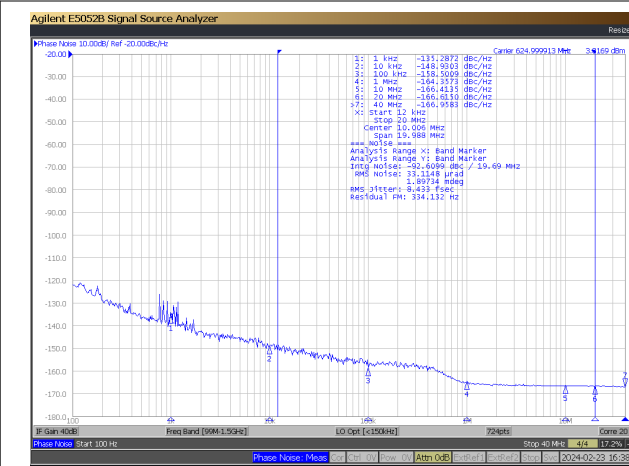
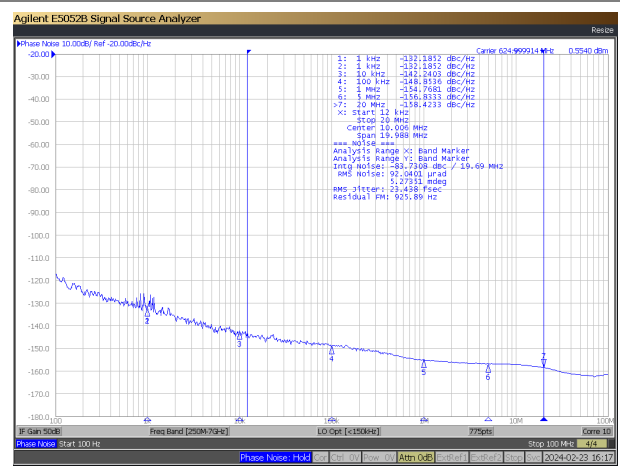


Figure 6-17. Input Source at 625MHz (12kHz - 20MHz)



See Note 1 and 3 in Graph Notes table

Figure 6-18. LMK1D210XL Phase Noise / Output Jitter at 625MHz (12kHz - 20MHz), Input Slew Rate >3V/ns

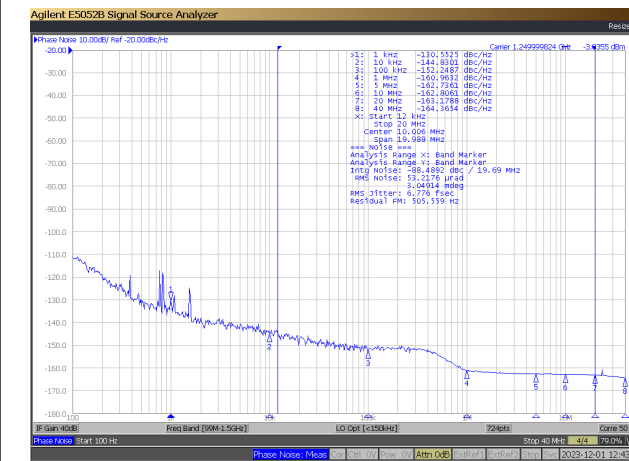
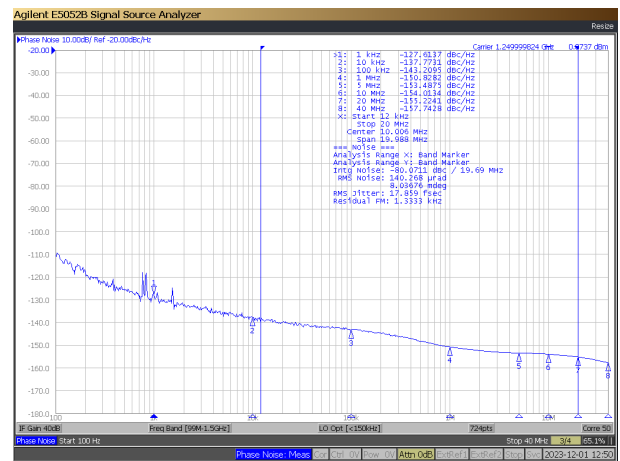


Figure 6-19. Input Source at 1250MHz (12kHz - 20MHz)



See Note 1 and 4 in Graph Notes table

Figure 6-20. LMK1D210XL Phase Noise / Output Jitter at 1250MHz (12kHz-20MHz), Input Slew Rate >3V/ns

Table 6-1. Graph Notes

NOTE	
(1)	The typical RMS jitter values in the plots show the total output RMS jitter ( $J_{OUT}$ ) for each frequency and the source clock RMS jitter ( $J_{SOURCE}$ ). From these values, the Additive RMS Jitter can be calculated as: $J_{ADD} = \text{SQRT}(J_{OUT}^2 - J_{SOURCE}^2)$ .
(2)	$J_{ADD}$ at 156.25MHz = $\text{SQRT}(46.932^2 - 25.057^2) = 39.68\text{fs}$ .
(3)	$J_{ADD}$ at 625MHz = $\text{SQRT}(23.438^2 - 8.433^2) = 21.87\text{fs}$ .
(4)	$J_{ADD}$ at 1250MHz = $\text{SQRT}(17.859^2 - 6.776^2) = 16.52\text{fs}$ .

## 7 Parameter Measurement Information

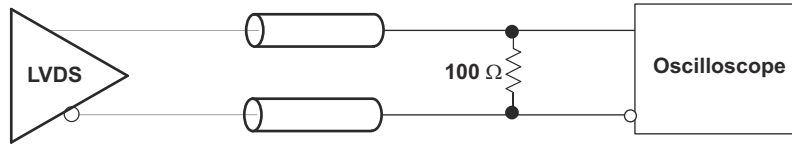


Figure 7-1. LVDS Output DC Configuration During Device Test

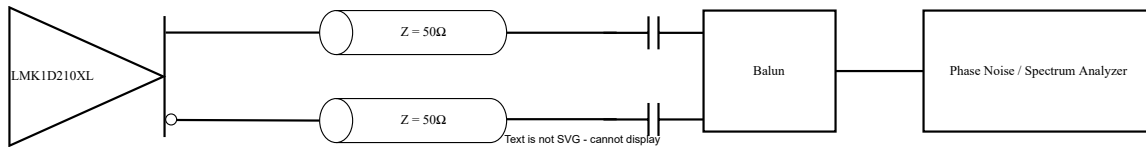


Figure 7-2. LVDS Output AC Configuration During Device Test

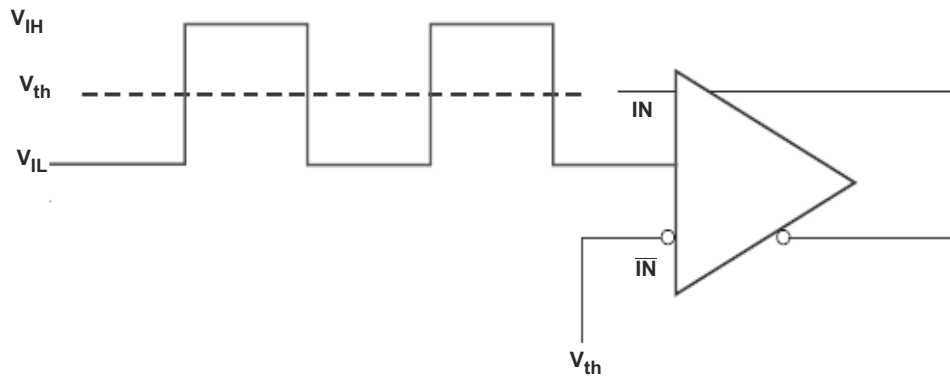


Figure 7-3. DC-Coupled LVCMOS Input During Device Test

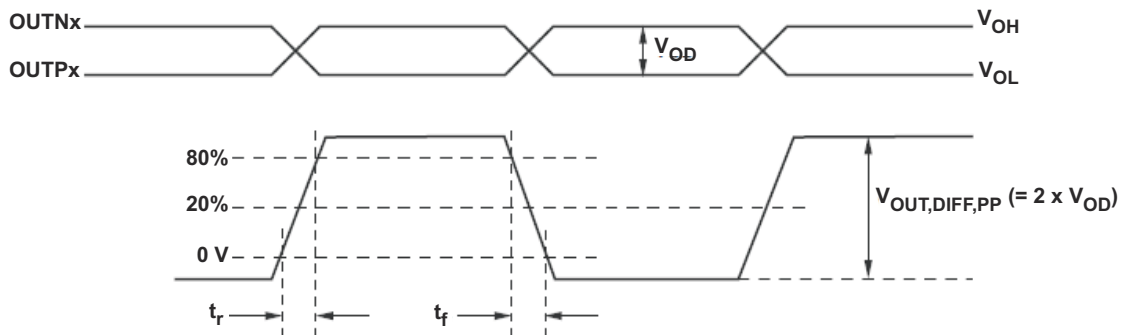
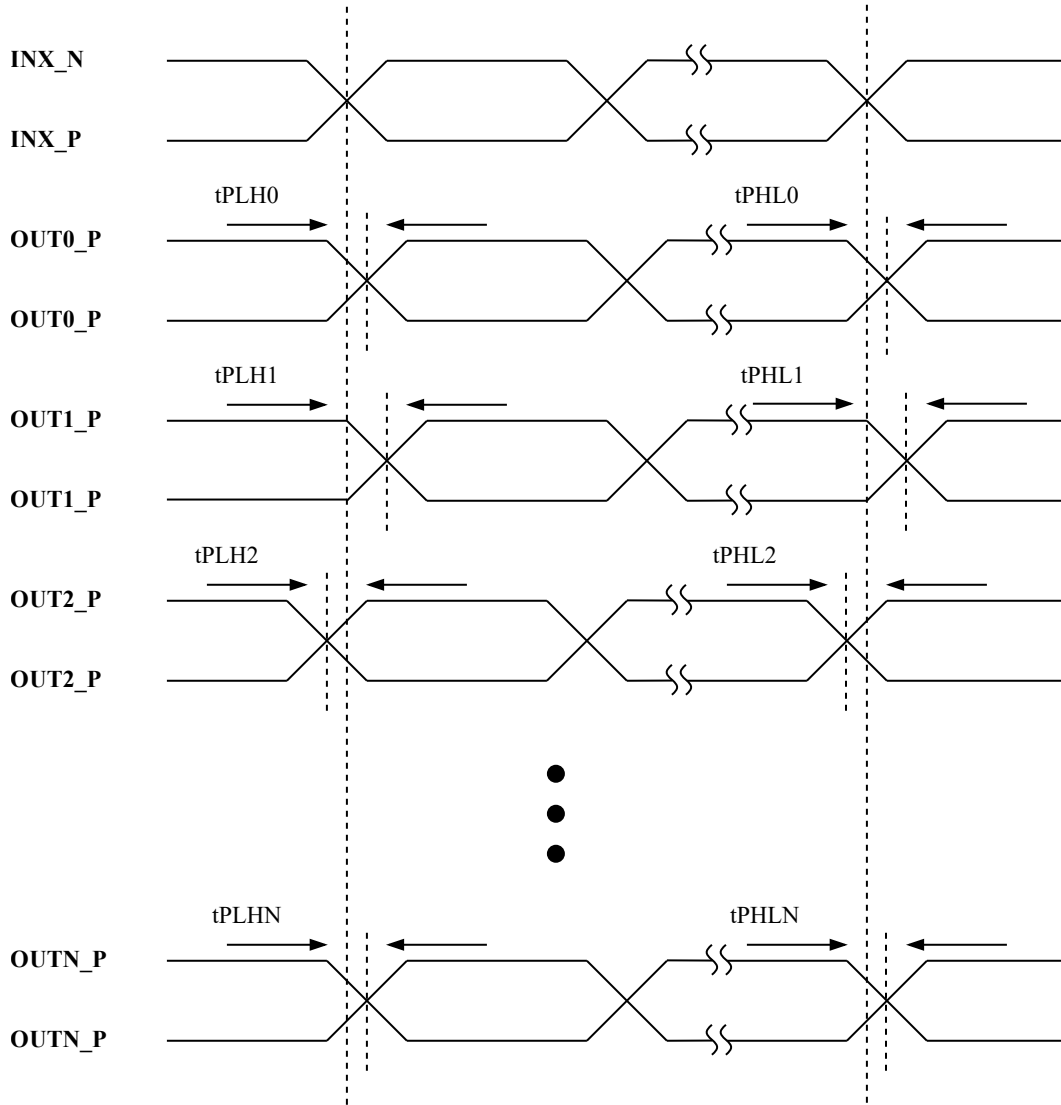


Figure 7-4. Output Voltage and Rise/Fall Time

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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  $t_{pHLn}$  ( $n = 0, 1, 2, \dots, N$ )
- 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 ( $n = 0, 1, 2, \dots, N$ )

**Figure 7-5. Output Skew and Part-to-Part Skew**

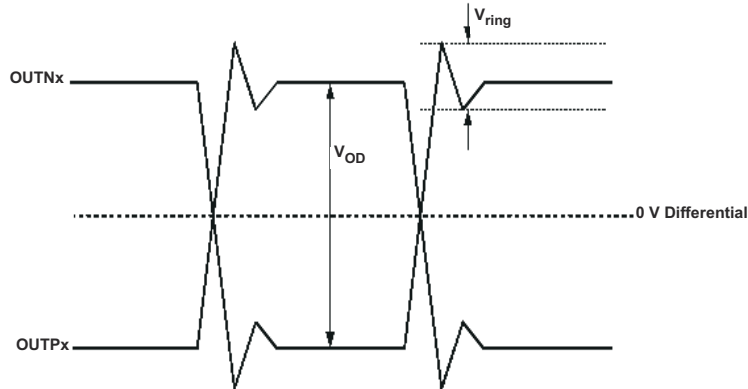


Figure 7-6. Output Overshoot and Undershoot

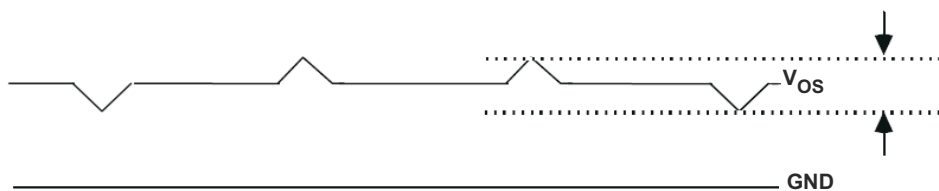


Figure 7-7. Output AC Common Mode

ADVANCE INFORMATION

## 7.1 Differential Voltage Measurement Terminology

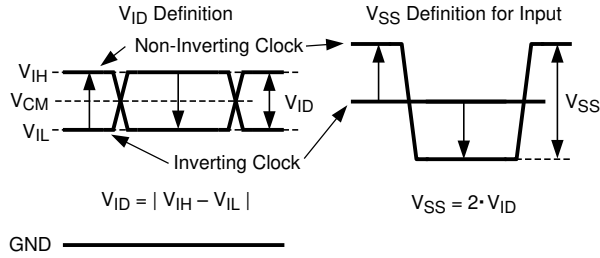
The differential voltage of a differential signal can be described by two different definitions causing confusion when reading data sheets or communicating with other engineers. This section addresses the measurement and description of a differential signal so that the reader is able to understand and discern between the two different definitions when used.

The first definition used to describe a differential signal is the absolute value of the voltage potential between the inverting and non-inverting signal. The symbol for this first measurement is typically  $V_{ID}$  or  $V_{OD}$  depending on if an input or output voltage is being described.

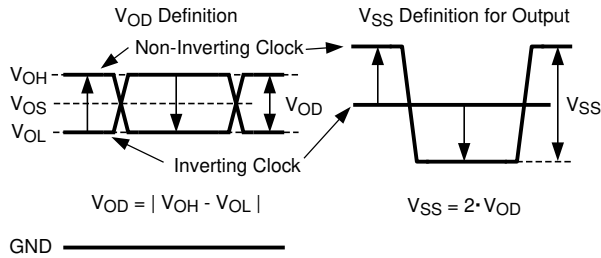
The second definition used to describe a differential signal is to measure the potential of the non-inverting signal with respect to the inverting signal. The symbol for this second measurement is  $V_{SS}$  and is a calculated parameter. Nowhere in the IC does this signal exist with respect to ground, this signal only exists in reference to the differential pair.  $V_{SS}$  can be measured directly by oscilloscopes with floating references, otherwise this value can be calculated as twice the value of  $V_{OD}$  as described in the first description.

Figure 7-8 illustrates the two different definitions side-by-side for inputs and Figure 7-9 illustrates the two different definitions side-by-side for outputs. The  $V_{ID}$  (or  $V_{OD}$ ) definition show the DC levels,  $V_{IH}$  and  $V_{OL}$  (or  $V_{OH}$  and  $V_{OL}$ ), that the non-inverting and inverting signals toggle between with respect to ground.  $V_{SS}$  input and output definitions show that if the inverting signal is considered the voltage potential reference, the non-inverting signal voltage potential is now increasing and decreasing above and below the non-inverting reference. Thus the peak-to-peak voltage of the differential signal can be measured.

$V_{ID}$  and  $V_{OD}$  are often defined as volts (V) and  $V_{SS}$  is often defined as volts peak-to-peak ( $V_{PP}$ ).



**Figure 7-8. Two Different Definitions for Differential Input Signals**



**Figure 7-9. Two Different Definitions for Differential Output Signals**

See also the [AN-912 Common Data Transmission Parameters and their Definitions](#) application note.

## 8 Detailed Description

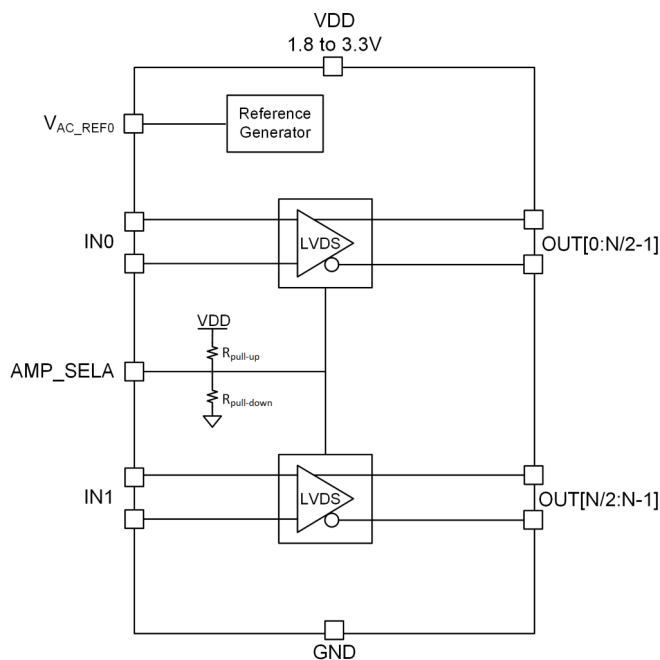
### 8.1 Overview

The LMK1D210xL LVDS drivers use CMOS transistors to control the output current. Therefore, proper biasing and termination are required to provide correct operation of the device and to maximize signal integrity.

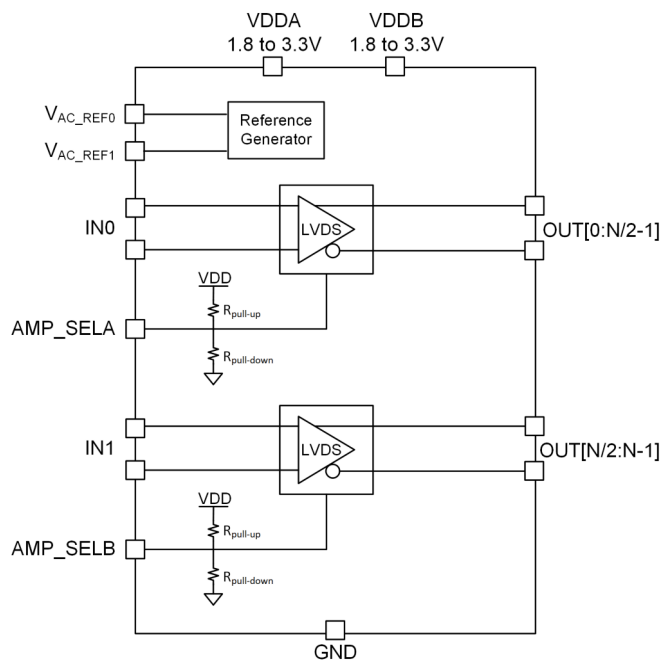
The proper LVDS termination for signal integrity over two 50Ω lines is 100Ω between the outputs on the receiver end. Either DC-coupled termination or AC-coupled termination can be used for LVDS outputs. TI recommends placing a termination resistor close to the receiver. If the receiver is internally biased to a voltage different than the output common-mode voltage of the LMK1D210xL, AC coupling must be used. If the LVDS receiver has internal 100Ω termination, external termination must be omitted.

### 8.2 Functional Block Diagram

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**Figure 8-1. LMK1D2102 and LMK1D2104 Functional Block Diagram**



**Figure 8-2. LMK1D2106 and LMK1D2108 Functional Block Diagram**

### 8.3 Feature Description

The LMK1D210xL is a low additive jitter LVDS fan-out buffer that can generate up to 2 (LMK1D2102L), 4 (LMK1D2104L), 6 (LMK1D2106L) or 8 (LMK1D2108L) LVDS copies of a single input that is either LVDS, LVPECL, HCSL, CML, or LVCMOS on each of the banks. The device has two banks, therefore this translates to a total of 4 (LMK1D2102L), 8 (LMK1D2104L), 12 (LMK1D2106L) or 16 (LMK1D2108L) pairs of outputs. Refer to the [Table 8-1](#) for output bank mapping. The reference clock frequencies can go up to 2GHz.

**Table 8-1. Output Bank**

Bank	LMK1D2102	LMK1D2104	LMK1D2106	LMK1D2108
0	OUT0 to OUT1	OUT0 to OUT3	OUT0 to OUT5	OUT0 to OUT7
1	OUT2 to OUT3	OUT4 to OUT7	OUT6 to OUT11	OUT8 to OUT15

#### 8.3.1 Output Common Mode

LMK1D210xL family of buffer have multiple output common mode operations for flexibility in DC-coupled applications. Desired output common mode can be selected through supply. For LMK1D2106L and LMK1D2108L, VDDA and VDDB bank supplies needs to have same supply voltage for correct output common mode operation. [Table 8-2](#) provides details on the output common mode over different supply options.

**Table 8-2. LMK1D210xL Output Common Mode Operation**

VDD = VDDA = VDDB ± 5% (V)	Output Amplitude (mV)	Output Common Mode (V)
1.8	350	0.7
2.5/3.3		1.2
1.8	500	0.7
2.5/3.3		1

#### 8.3.2 Fail-Safe Input

The LMK1D210xL family of devices is designed to support fail-safe input operation. This feature allows the user to drive the device inputs before VDD is applied without damaging the device. Refer to the [Section 6.1](#) for more information on the maximum input supported by the device. The device also incorporates an input hysteresis, which prevents random oscillation in absence of an input signal, allowing the input pins to be left open.

### 8.4 Device Functional Modes

The output banks of the LMK1D210xL can be selected through the control pin (see [Section 8.4.1](#)). Unused inputs can be left floating to reduce overall component cost. Both AC- and DC-coupling schemes can be used with the LMK1D210xL to provide greater system flexibility.

#### 8.4.1 Output Enable / Disable and Amplitude Selection

AMP\_SELA and AMP\_SELB pins can select different output swing and disable the outputs. LMK1D2102L and LMK1D2104L have only AMP\_SELA pin to control both output banks globally while LMK1D2106L and LMK1D2108L have two pins (AMP\_SELA, AMP\_SELB) to control individual output banks.

**Table 8-3. LMK1D2102L and LMK1D2104L Bank 0 and 1 AMP\_SELA**

AMP_SELA	Bank 0 and Bank 1 Output Amplitude (mV)
0	350
Float (default)	500
1	Outputs Disable (power-down)

**Table 8-4. LMK1D2106L and LMK1D2108L Bank 0 AMP\_SELA**

AMP_SELA	Bank 0 Output Amplitude (mV)
0	350
Float (default)	500
1	Outputs Disable (power-down)

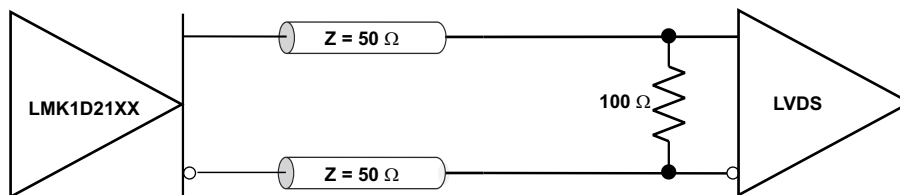
**Table 8-5. LMK1D2106L and LMK1D2108L Bank 1 AMP\_SELB**

AMP_SELB	Bank 1 Output Amplitude (mV)
0	350
Float (default)	500
1	Outputs Disable (power-down)

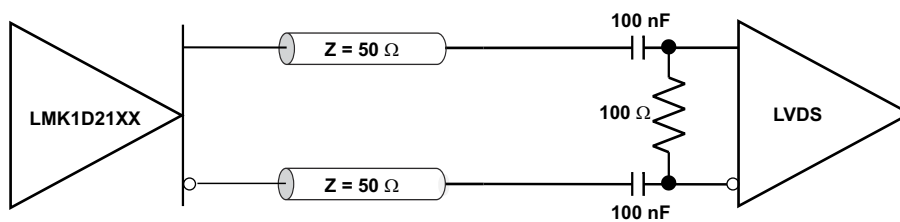
### 8.4.2 LVDS Output Termination

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

The LMK1D210xL can be connected to LVDS receiver inputs with DC and AC coupling as shown in [Figure 8-3](#) and [Figure 8-4](#), respectively.



**Figure 8-3. Output DC Termination**

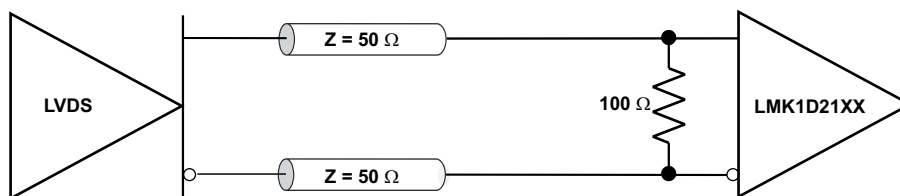


**Figure 8-4. Output AC Termination (With the Receiver Internally Biased)**

### 8.4.3 Input Termination

The LMK1D210xL inputs can be interfaced with LVDS, LVPECL, HCSL, or LVCMOS drivers.

LVDS drivers can be connected to LMK1D210xL inputs with DC and AC coupling as shown [Figure 8-5](#) and [Figure 8-6](#), respectively.



**Figure 8-5. LVDS Clock Driver Connected to LMK1D210xL Input (DC-Coupled)**

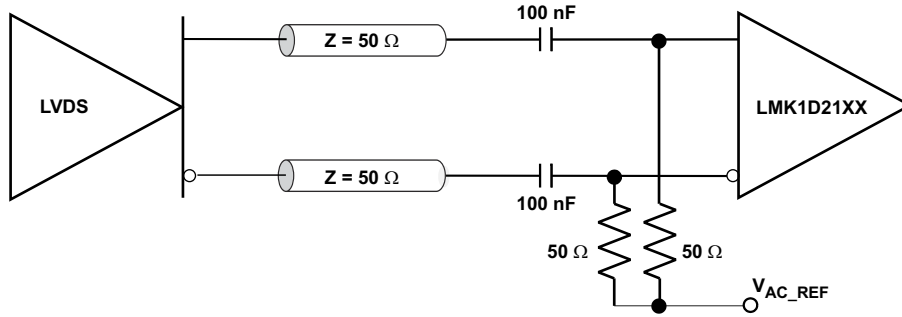


Figure 8-6. LVDS Clock Driver Connected to LMK1D210xL Input (AC-Coupled)

Figure 8-7 shows how to connect LVPECL inputs to the LMK1D210xL. The series resistors are required to reduce the LVPECL signal swing if the signal swing is  $>1.6V_{pp}$ .

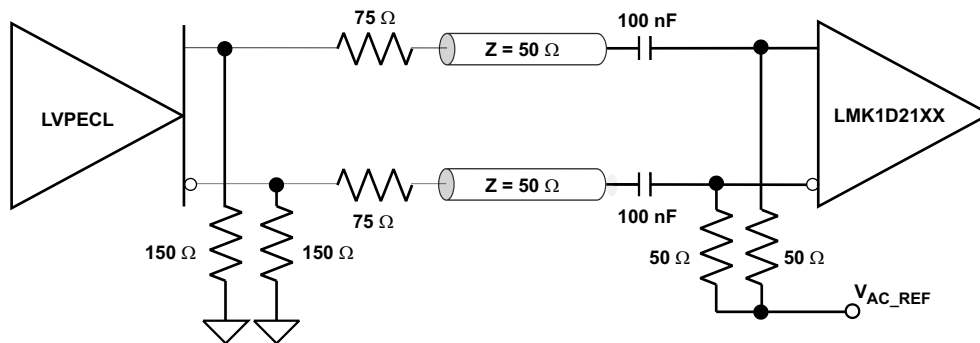


Figure 8-7. LVPECL Clock Driver Connected to LMK1D210xL Input

Figure 8-8 shows how to couple a LVCMOS clock input to the LMK1D210xL directly.

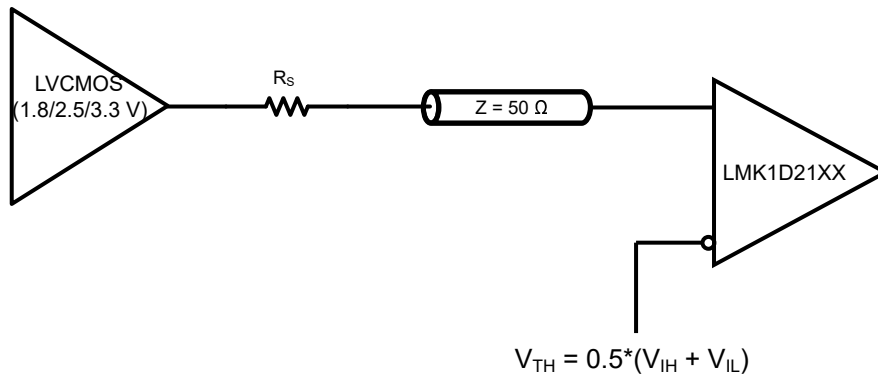


Figure 8-8. 1.8V, 2.5V, or 3.3V LVCMOS Clock Driver Connected to LMK1D210xL Input

For unused input, TI recommends grounding both input pins (INP, INN) using  $1k\Omega$  resistors.

## 9 Application and Implementation

### Note

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.

### 9.1 Application Information

The LMK1D210xL is a low additive jitter universal to LVDS fan-out buffer with dual inputs which fan-out to dual outputs bank. The small package size, 1.8-V power supply operation, low output skew, and low additive jitter is designed for applications that require high-performance clock distribution as well as for low-power and space-constraint applications.

### 9.2 Typical Application

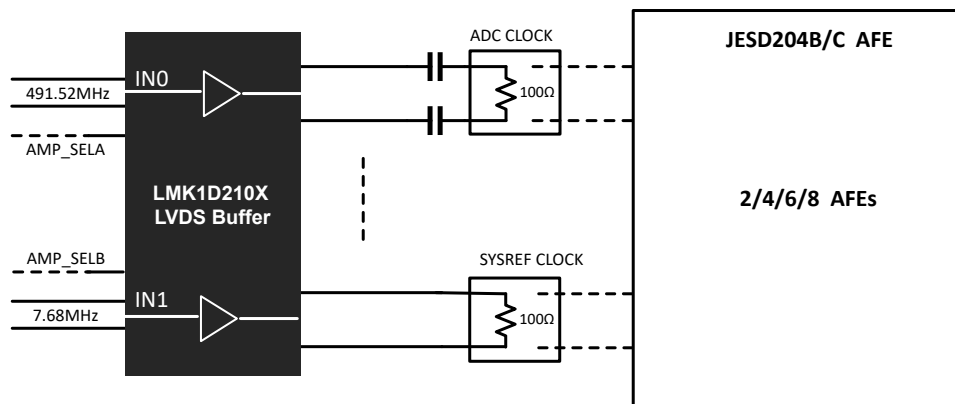


Figure 9-1. Fan-Out Buffer for ADC Device Clock and SYSREF Distribution

#### 9.2.1 Design Requirements

The LMK1D210xL shown in Figure 9-1 is configured to fan-out an ADC clock on the first output bank and SYSREF clock on the second output bank for a system using the JESD204B/C ADC. The low output-to-output skew, very low additive jitter and superior spurious suppression between dual banks makes the LMK1D210xL a simple, robust and low-cost solution for distributing various clocks to JESD204B/C AFE systems. The configuration example can drive up to 2 to 8 ADC clocks and 2 to 8 SYSREF clocks for a JESD204B/C receiver with the following properties:

- The ADC clock receiver module is typically AC-coupled with an LVDS driver such as the LMK1D210xL due to differences in common-mode voltage between the driver and receiver. Depending on the receiver, there can be an option for internal 100Ω differential termination in which case an external termination is not required for the LMK1D210xL.
- The SYSREF clock receiver module is typically DC-coupled provided the common-mode voltage of the LMK1D210xL outputs match with the receiver. An external termination is not always necessary in case of an internal termination in the receiver.
- Unused outputs of the LMK1D210xL device are terminated differentially with a 100Ω resistor for optimum performance.



### 9.2.2 Detailed Design Procedure

See [Input Termination](#) for proper input terminations, dependent on single-ended or differential inputs.

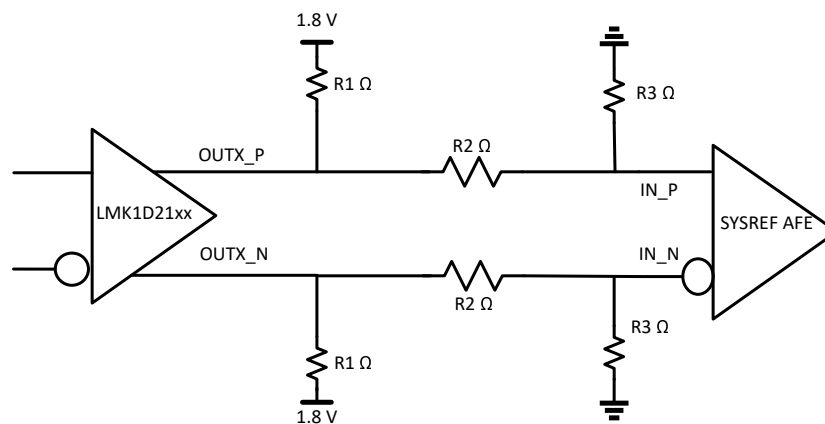
See [LVDS Output Termination](#) for output termination schemes depending on the receiver application.

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

In this application example, the ADC clock and SYSREF clocks require different output interfacing schemes. Power-supply filtering and bypassing is critical for low-noise applications.

LMK1D210xL offers multiple output common range to meet receiver requirement for an ADC or AFEs. In case of common-mode mismatch between the output voltage of the LMK1D210xL and the receiver, use AC coupling to fix the mismatch. AC coupling adds settling time associated with this AC-coupling network (High-pass filter), which can result in non-deterministic behavior during the initial transients. For such applications, DC-coupling the outputs is necessary and thus requires a scheme which can overcome the inherent mismatch between the common-mode voltage of the driver and receiver.

The application note [Interfacing LVDS Driver With a Sub-LVDS Receiver](#) discusses how to interface between a LVDS driver and sub-LVDS receiver. The same concept can be applied to interface the LMK1D210xL outputs to a receiver which has a lower common-mode voltage.



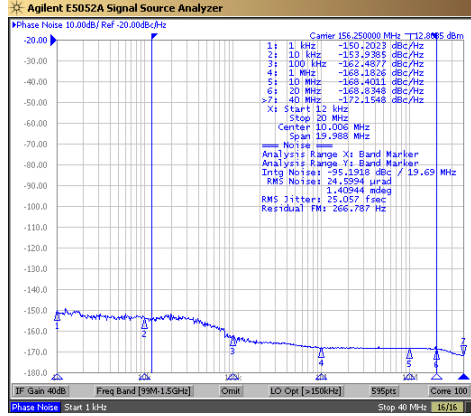
**Figure 9-2. Schematic for DC-Coupling LMK1D210x With Lower Common-Mode Receiver**

Figure 9-2 shows the resistor divider network for stepping down the common-mode voltage as explained in the previously mentioned application note. The resistors R1, R2 and R3 are selected according to the input common-mode voltage requirements of the receiver. As highlighted before, verify that the reduced swing is able to meet the requirements of the receiver. Higher swing mode (boosted LVDS swing mode) can be selected using the AMP\_SEL pin highlighted in [Section 8.4.1](#) to compensate for the reduced swing as the result of the resistor voltage divider.

### 9.2.3 Application Curves

The low additive noise of the LMK1D210xL. The low noise 156.25MHz source with 25fs RMS jitter, shown in Figure 9-3, drives the LMK1D210xL, resulting in 46.9fs RMS when integrated from 12kHz to 20MHz (Figure 9-4). The resultant additive jitter is a low 39.7-fs RMS for this configuration.

ADVANCE INFORMATION



Note: Reference signal is a low-noise Rhode and Schwarz SMA100B

Figure 9-3. LMK1D210xL Reference Phase Noise, 156.25MHz, 25fs RMS (12kHz to 20MHz)

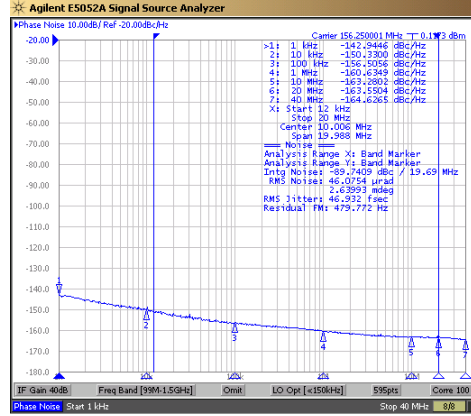


Figure 9-4. LMK1D210xL Output Phase Noise, 156.25MHz, 46.9fs RMS (12kHz to 20MHz)

### 9.3 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. Reducing noise from the system power supply is essential, 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, the capacitors 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, 0.1µF) 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 ferrite beads prevent the switching noise from leaking into the board supply. Choose an appropriate ferrite bead with low DC resistance because providing adequate isolation between the board supply and the chip supply is imperative, as well as to maintain a voltage at the supply pins that is greater than the minimum voltage required for proper operation.

Figure 9-5 shows this recommended power-supply decoupling method.

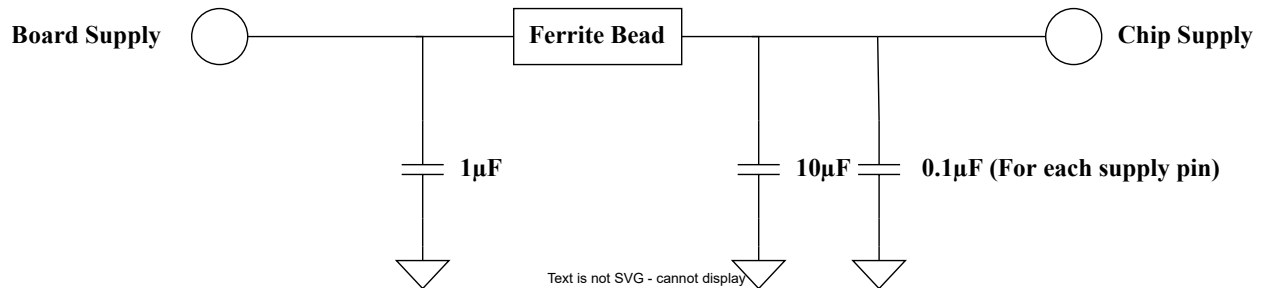


Figure 9-5. Power Supply Decoupling

### 9.4 Layout

#### 9.4.1 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 provide adequate heat conduction to of the package. Section 9.4.2 show the recommended top layer and via patterns for the different packages.

### 9.4.2 Layout Examples

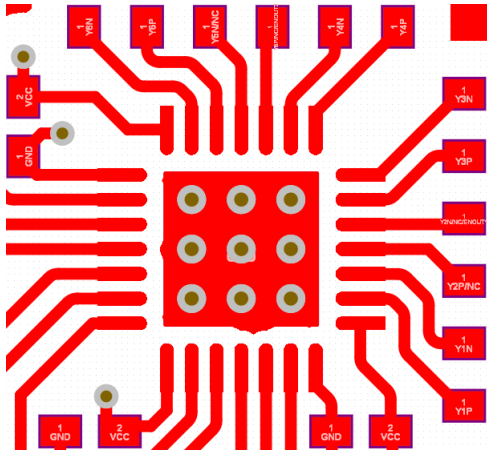


Figure 9-6. PCB Layout Example for LMK1D2104L, Top Layer

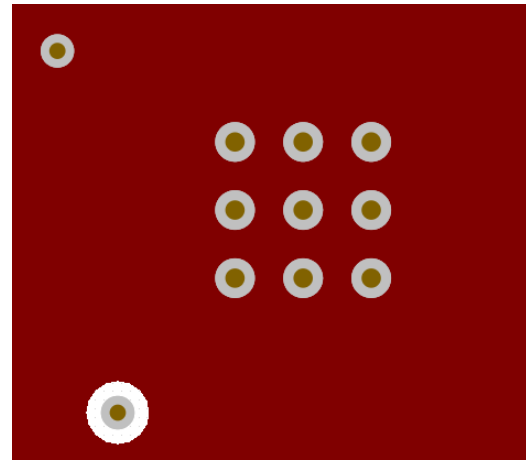


Figure 9-7. PCB Layout Example for LMK1D2104L, GND Layer

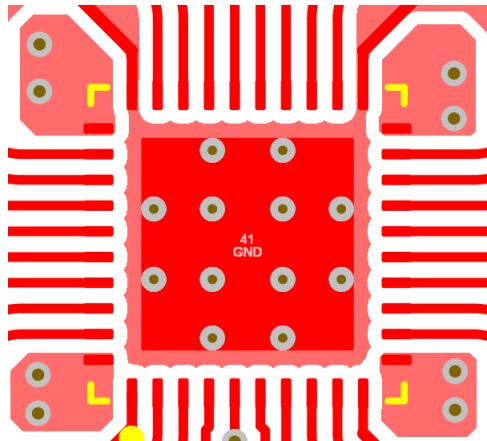


Figure 9-8. PCB Layout Example for LMK1D2106L, Top Layer

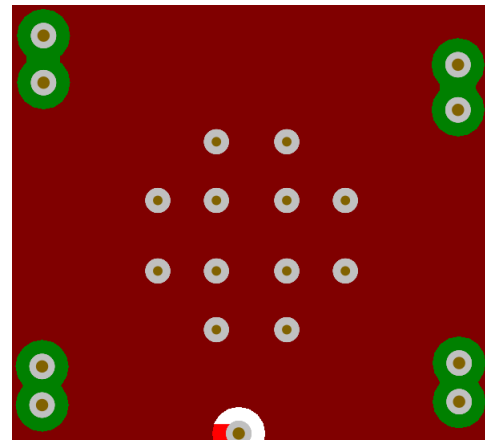


Figure 9-9. PCB Layout Example for LMK1D2106L, GND layer

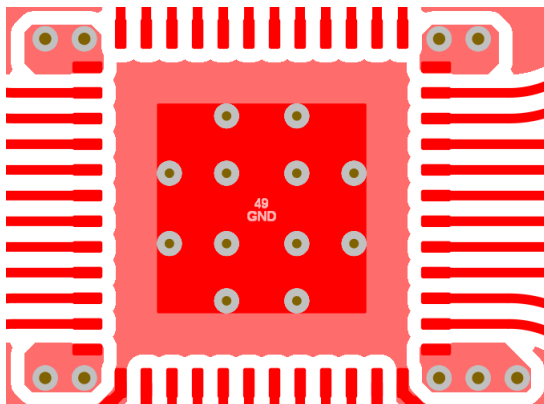


Figure 9-10. PCB Layout Example for LMK1D2108L, Top Layer

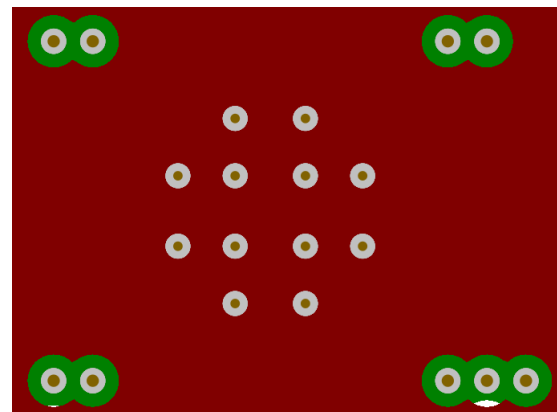


Figure 9-11. PCB Layout Example for LMK1D2108L, GND Layer

ADVANCE INFORMATION

## 10 Device and Documentation Support

### 10.1 Documentation Support

#### 10.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [Low-Additive Jitter, Four LVDS Outputs Clock Buffer Evaluation Board](#), user's guide
- Texas Instruments, [Power Consumption of LVPECL and LVDS](#), Analog design journal
- Texas Instruments, [Using Thermal Calculation Tools for Analog Components](#), application note

### 10.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.ti.com). Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 10.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

### 10.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.  
All trademarks are the property of their respective owners.

### 10.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 10.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 11 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
September 2024	*	Initial Release

## 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.

ADVANCE INFORMATION

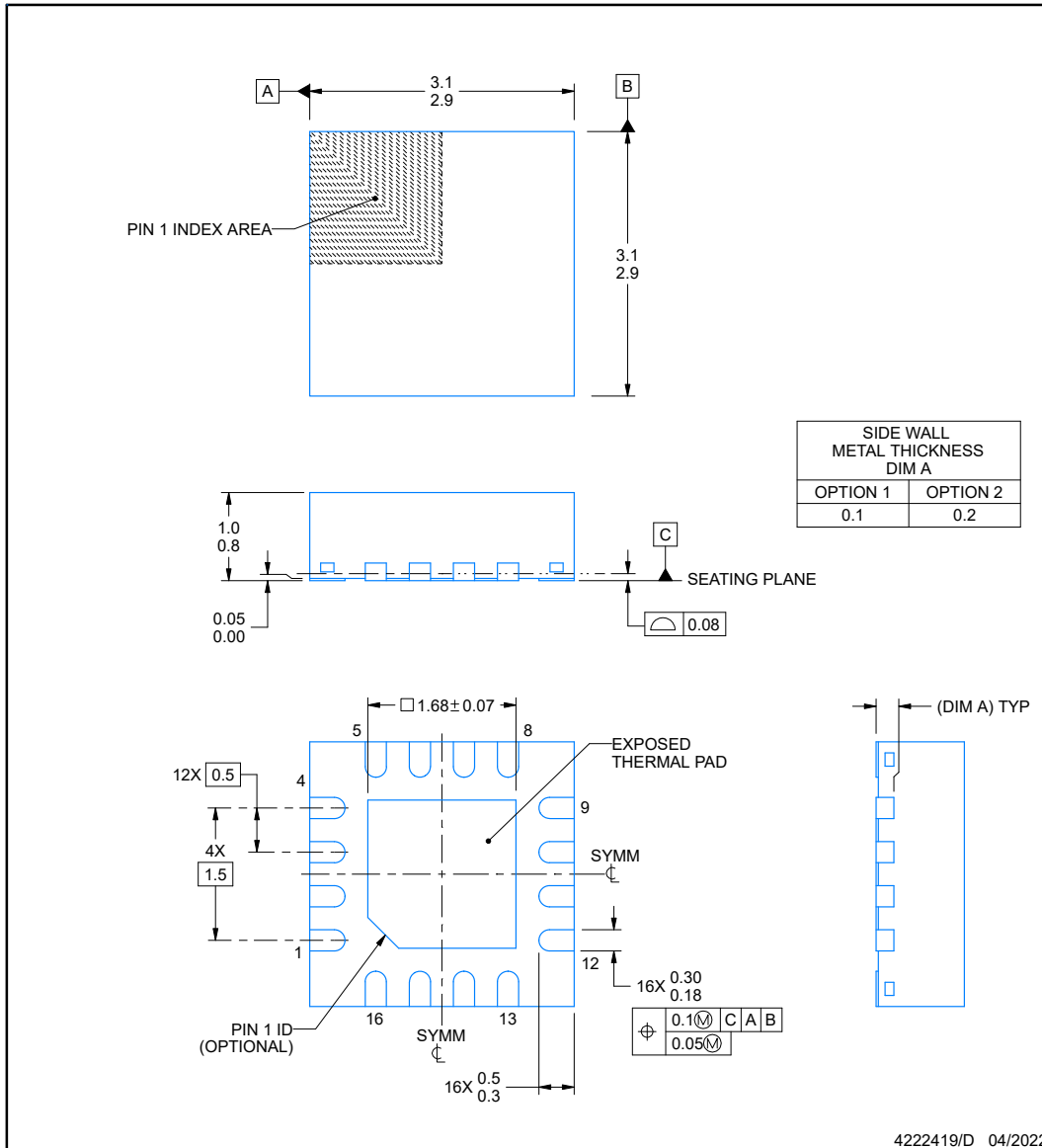
**RGT0016C**



**PACKAGE OUTLINE**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



**NOTES:**

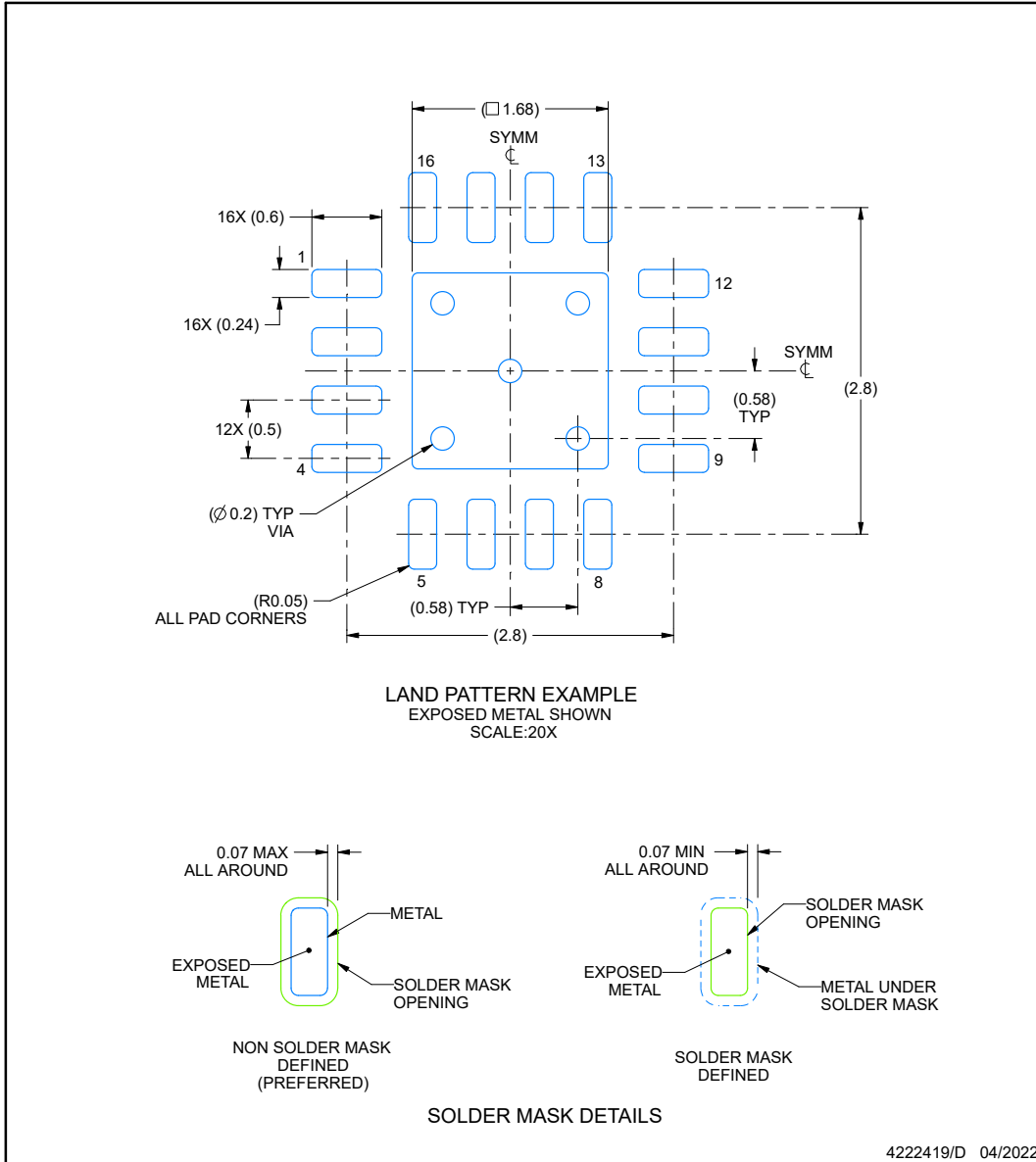
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

**EXAMPLE BOARD LAYOUT**

**RGT0016C**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

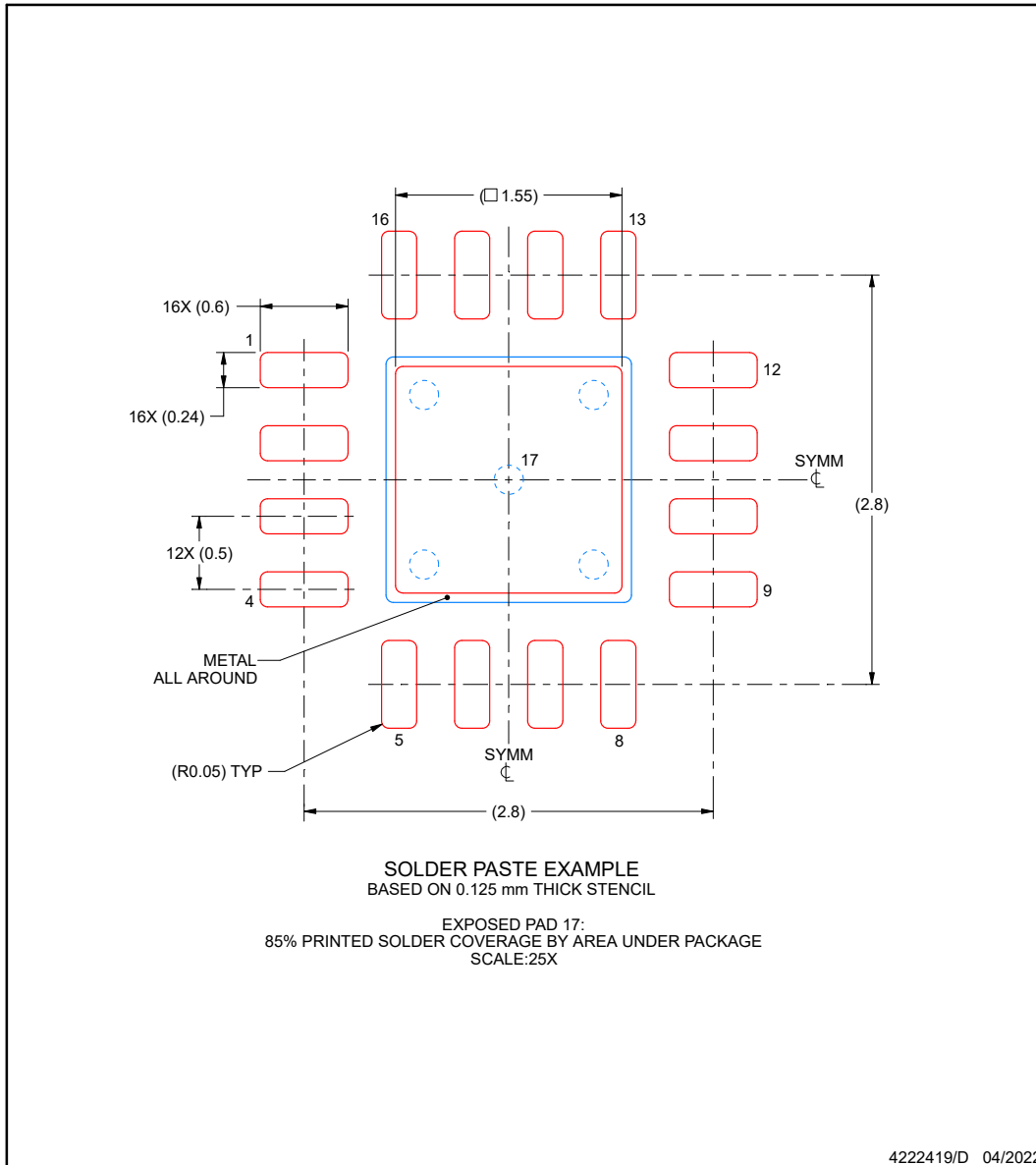
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**EXAMPLE STENCIL DESIGN**

**RGT0016C**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



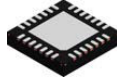
NOTES: (continued)

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



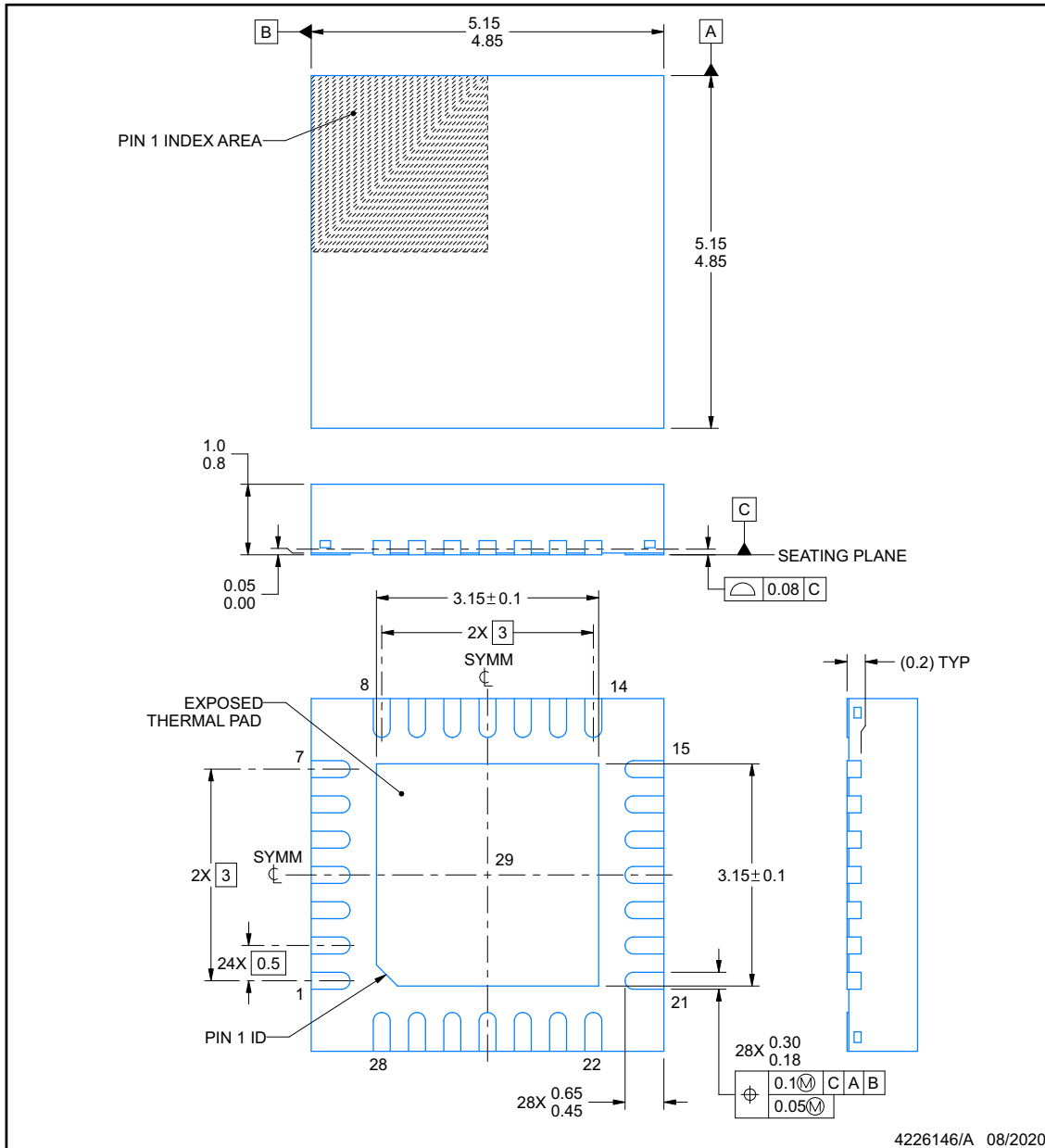
**PACKAGE OUTLINE**

**RHD0028B**



**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



4226146/A 08/2020

**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.

**ADVANCE INFORMATION**

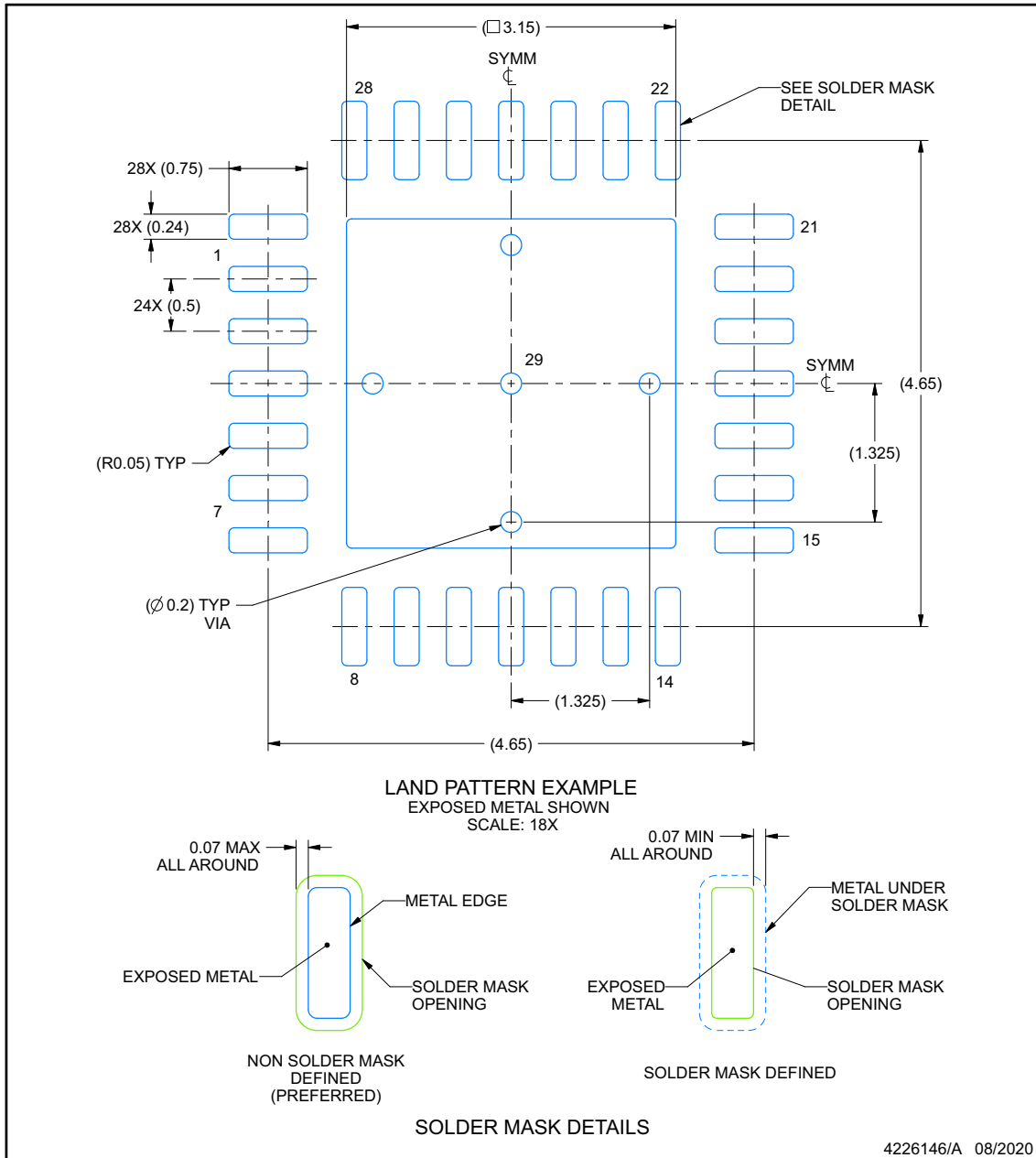
## EXAMPLE BOARD LAYOUT

**RHD0028B**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD

ADVANCE INFORMATION



NOTES: (continued)

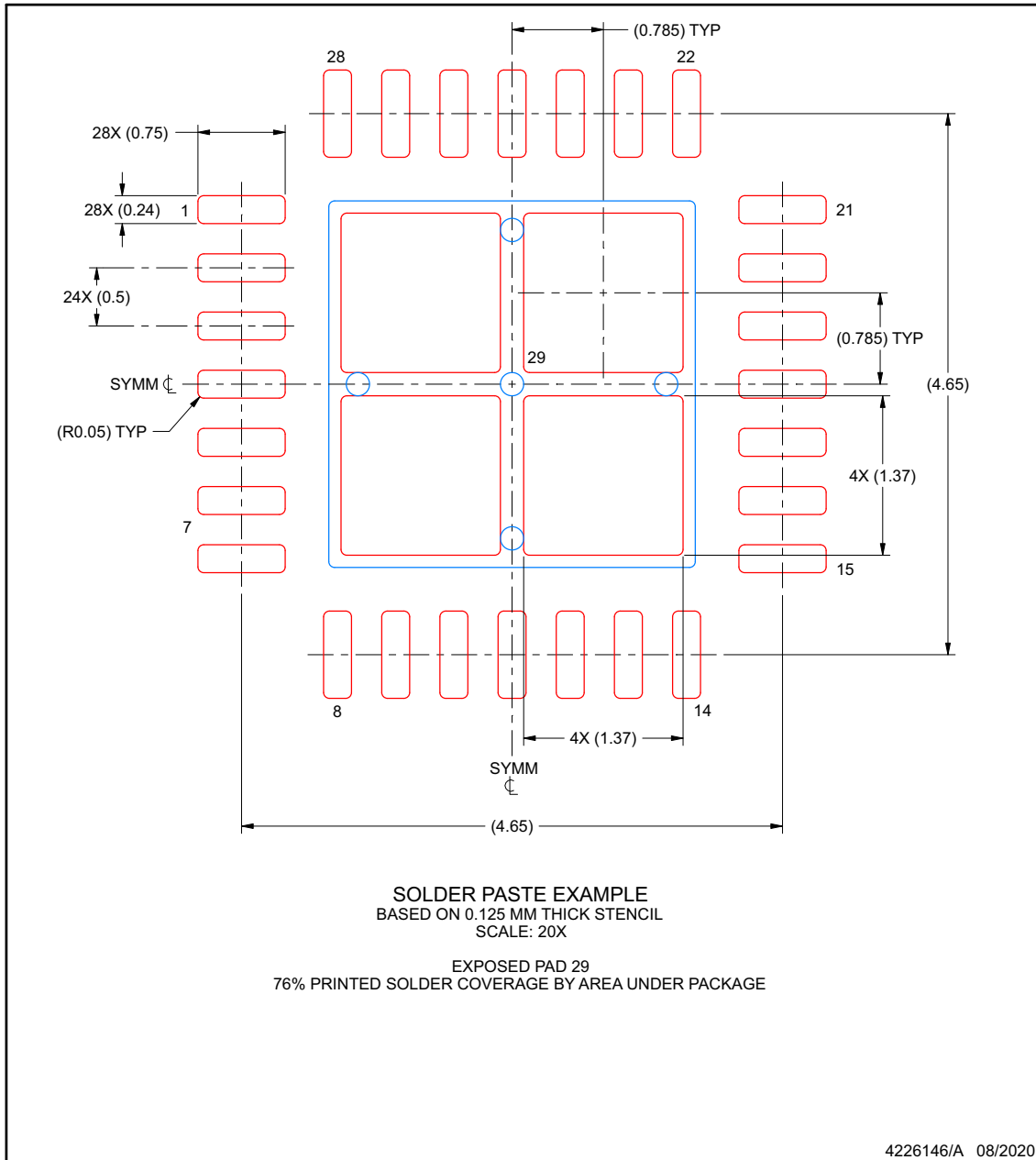
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

## EXAMPLE STENCIL DESIGN

**RHD0028B**

**VQFN - 1 mm max height**

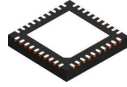
PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

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

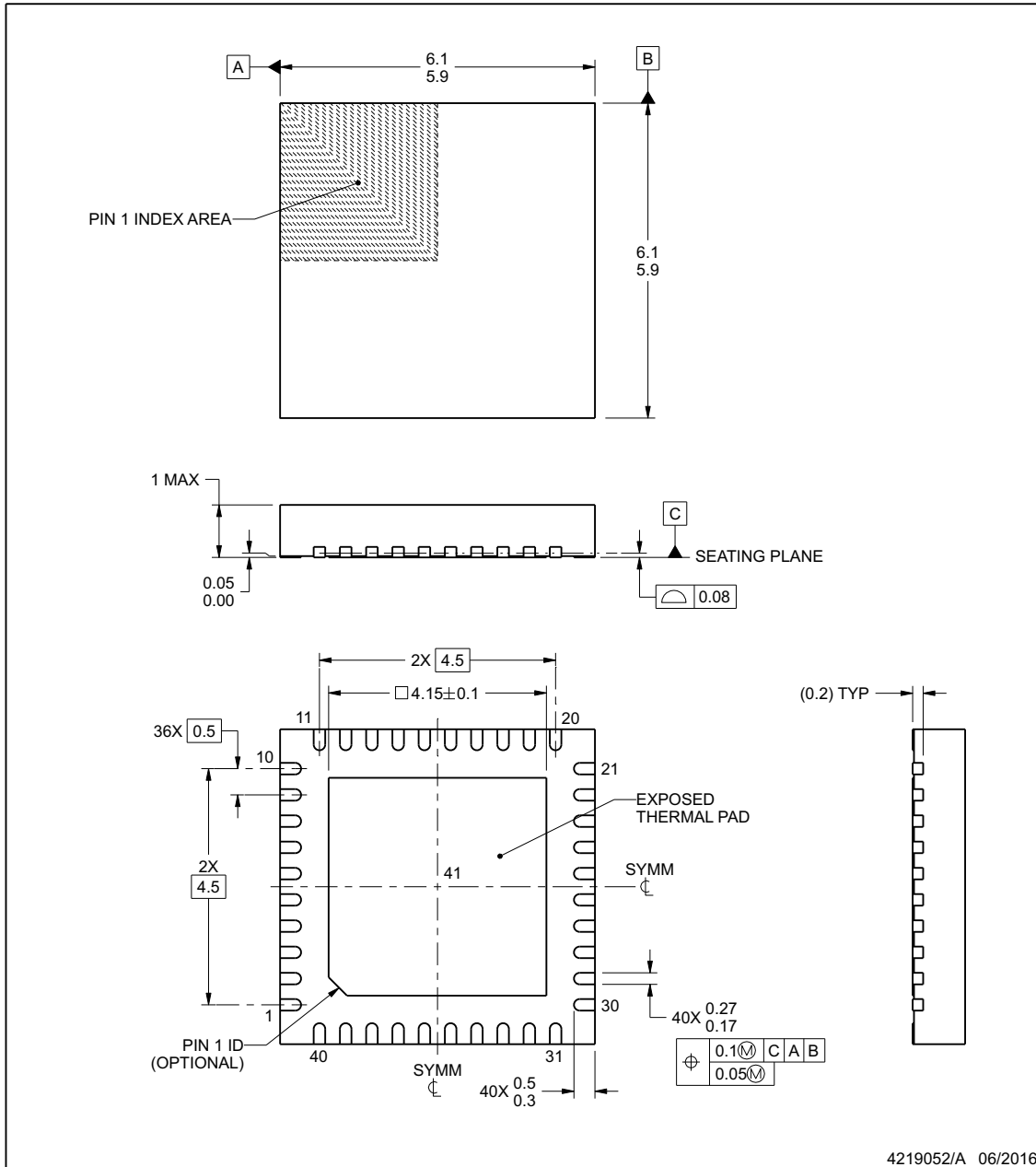
ADVANCE INFORMATION



**RHA0040B**

**PACKAGE OUTLINE**  
**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



**NOTES:**

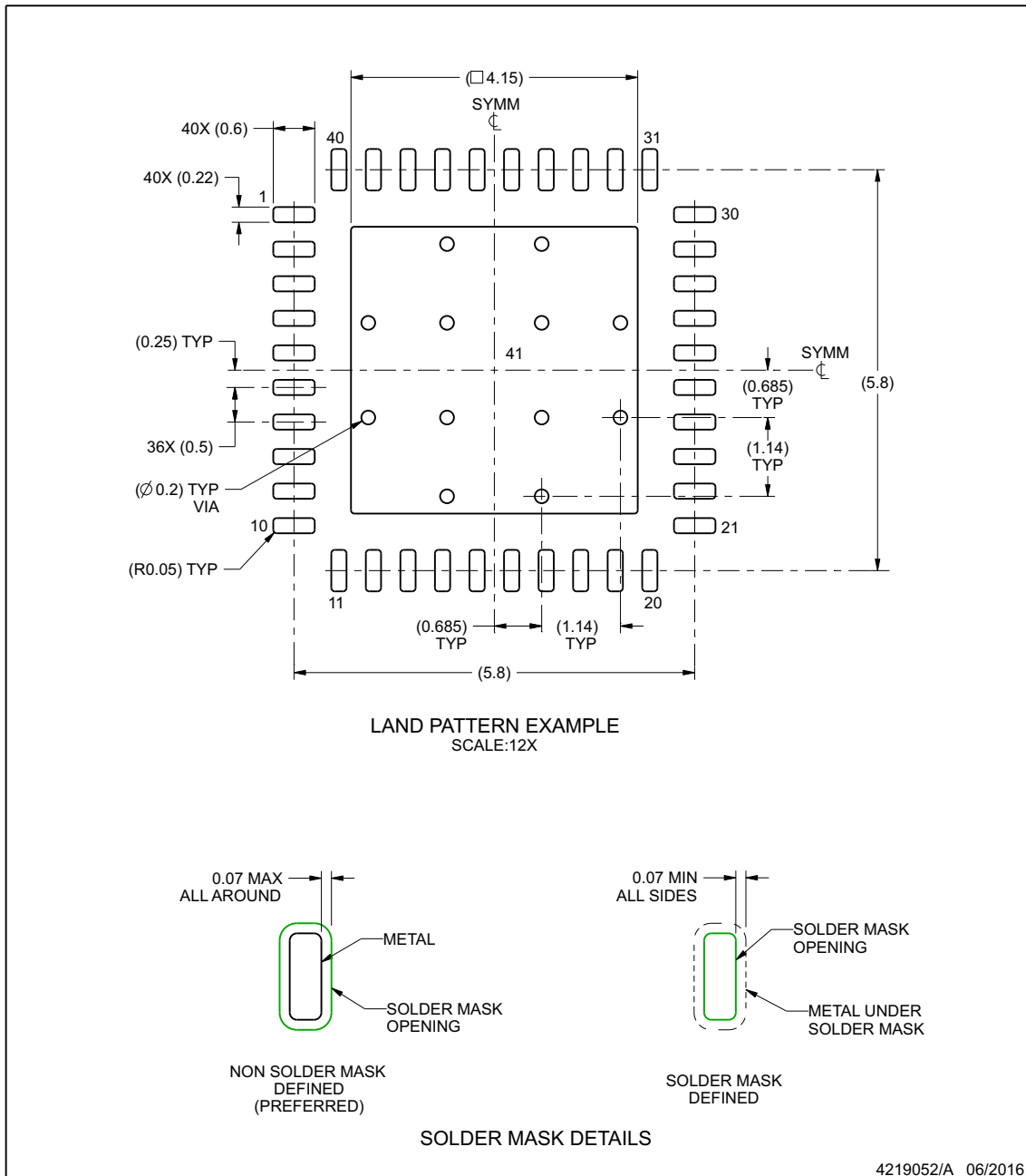
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

**EXAMPLE BOARD LAYOUT**

**RHA0040B**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



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).

www.ti.com

ADVANCE INFORMATION

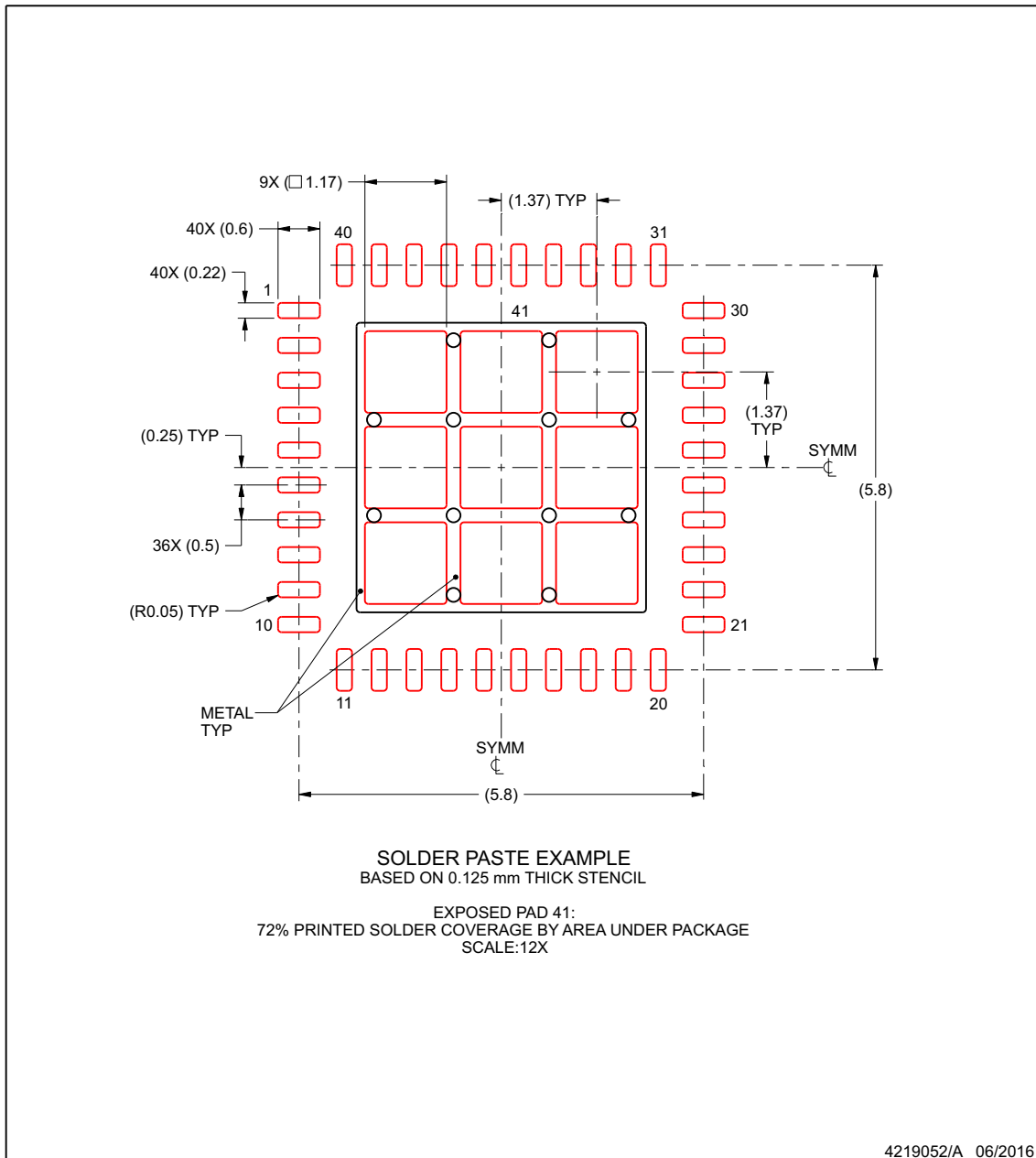
## EXAMPLE STENCIL DESIGN

**RHA0040B**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD

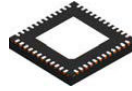
**ADVANCE INFORMATION**



NOTES: (continued)

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

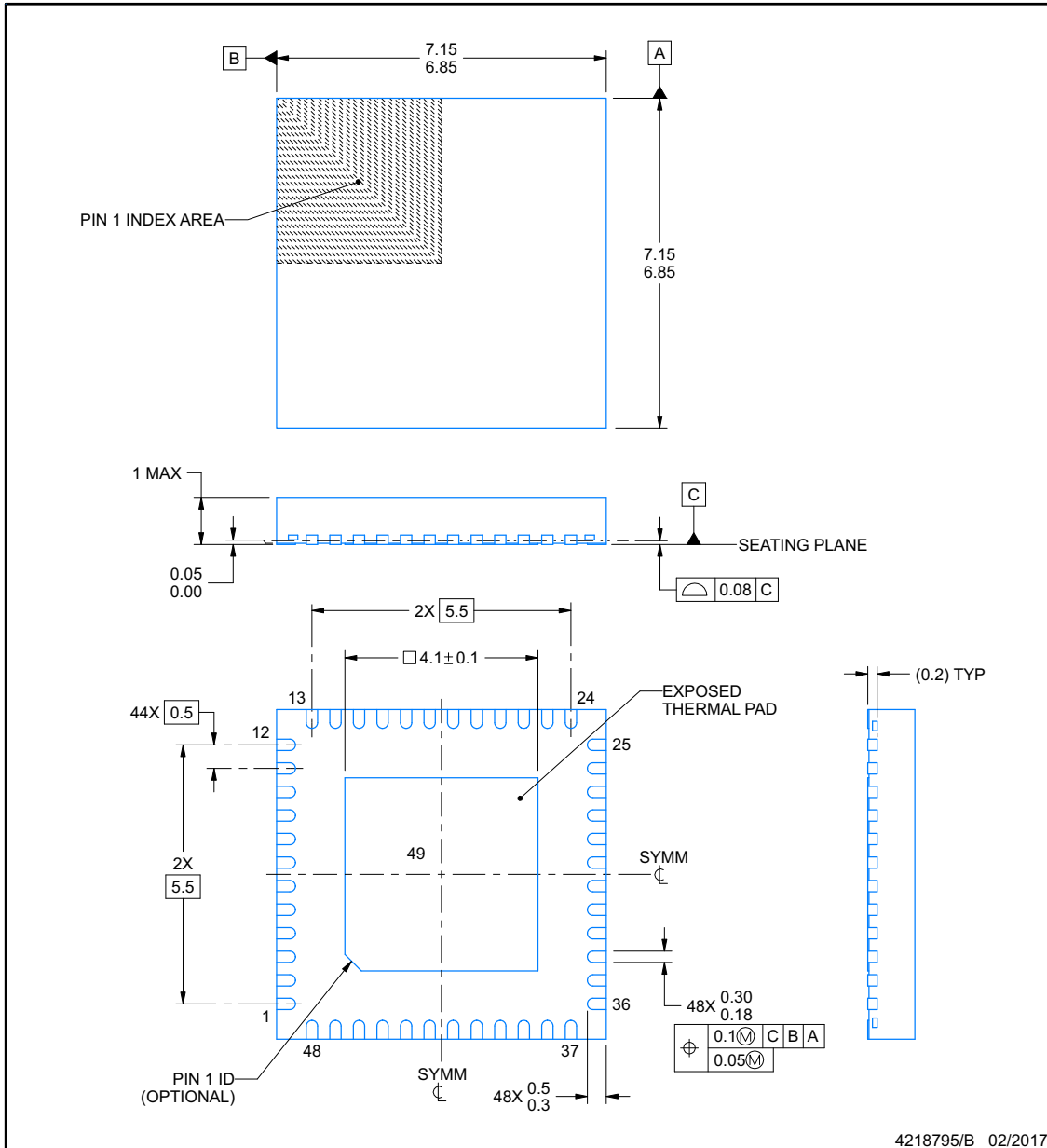
www.ti.com



**RGZ0048B**

**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.

ADVANCE INFORMATION

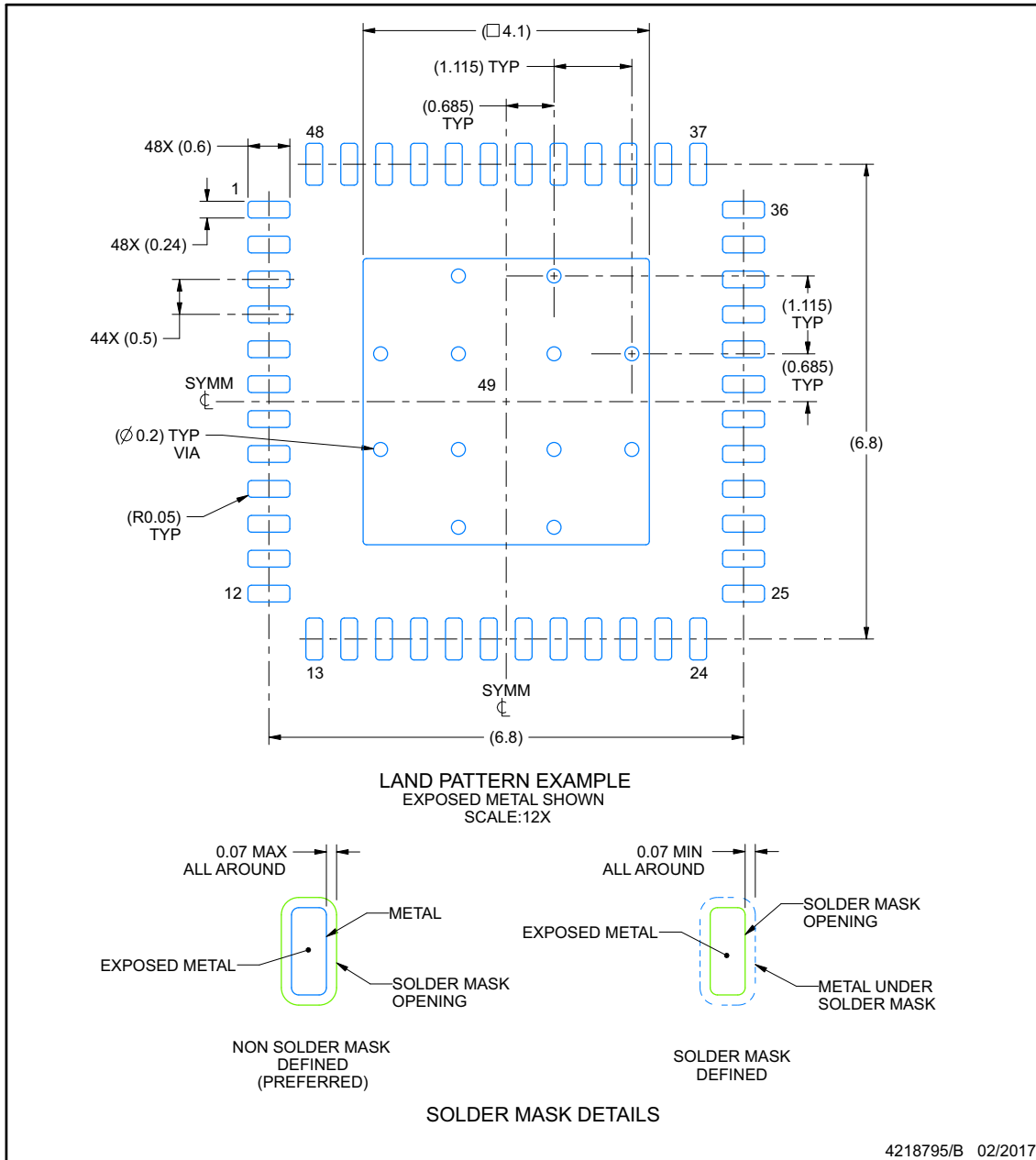
## EXAMPLE BOARD LAYOUT

**RGZ0048B**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD

ADVANCE INFORMATION



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](http://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.

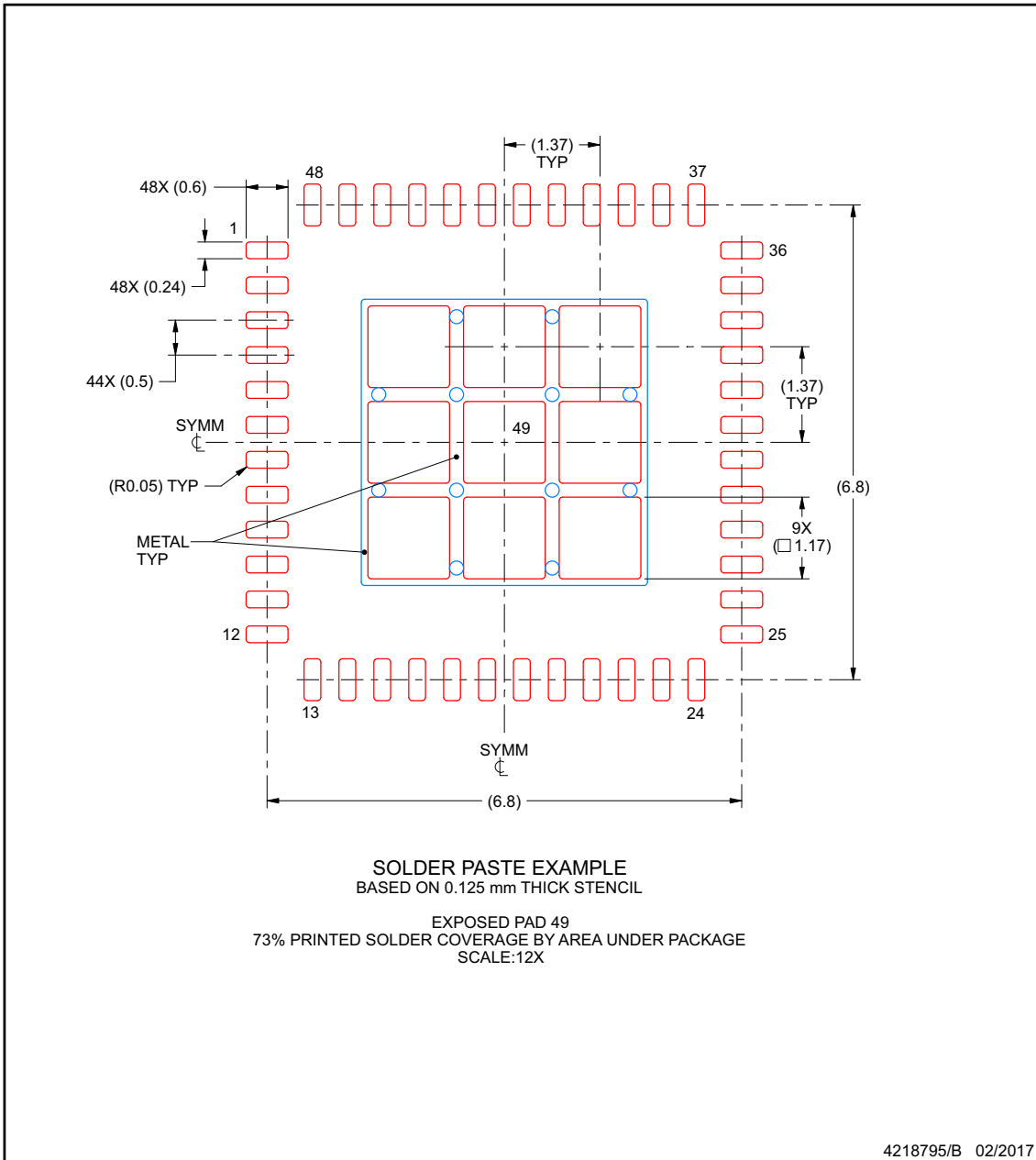


**EXAMPLE STENCIL DESIGN**

**RGZ0048B**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD

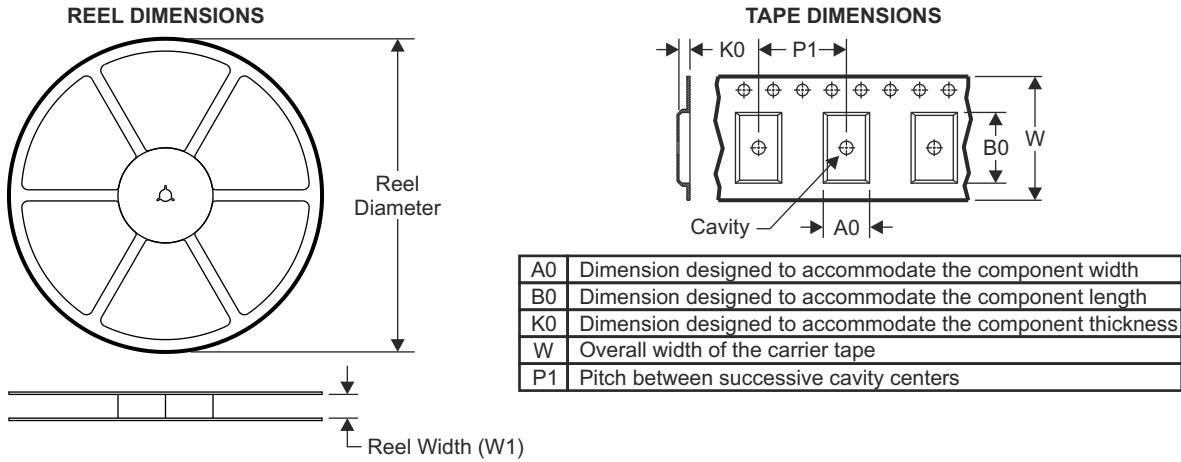


NOTES: (continued)

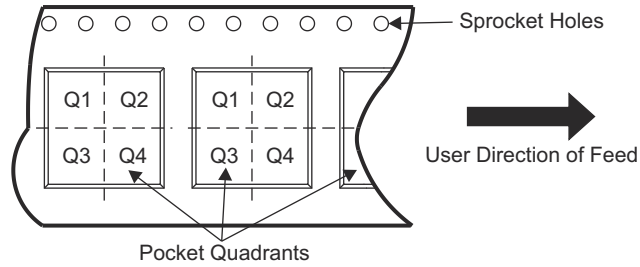
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

**ADVANCE INFORMATION**

## 12.1 Tape and Reel Information



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



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
LMK1D2102LRGTR	VQFN	RGT	16	3000	330	12.4	3.3	3.3	1.1	8	12	Q2
LMK1D2102LRGTT	VQFN	RGT	16	250	180	12.4	3.3	3.3	1.1	8	12	Q2

ADVANCE INFORMATION

**TAPE AND REEL BOX DIMENSIONS**



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMK1D2102LRGTR	VQFN	RGT	16	3000	367	367	35
LMK1D2102LRGTT	VQFN	RGT	16	250	210	185	35

**ADVANCE INFORMATION**

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMK1D2102RGTR	ACTIVE	VQFN	RGT	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD2102	<a href="#">Samples</a>
LMK1D2102RGTT	ACTIVE	VQFN	RGT	16	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LD2102	<a href="#">Samples</a>
LMK1D2104RHDR	ACTIVE	VQFN	RHD	28	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 2104	<a href="#">Samples</a>
LMK1D2104RHDT	ACTIVE	VQFN	RHD	28	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 2104	<a href="#">Samples</a>
LMK1D2106RHAR	ACTIVE	VQFN	RHA	40	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 2106	<a href="#">Samples</a>
LMK1D2106RHAT	ACTIVE	VQFN	RHA	40	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 105	LMK1D 2106	<a href="#">Samples</a>
LMK1D2108RGZR	ACTIVE	VQFN	RGZ	48	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	LMK1D 2108	<a href="#">Samples</a>
LMK1D2108RGZT	ACTIVE	VQFN	RGZ	48	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	LMK1D 2108	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices 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.

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