

SN75DP130 支持链路协商的 DisplayPort™ 1:1 转接驱动器

1 特性

- 支持 DP v1.1a 和 DP v1.2 信令，包括高达 5.4Gbps 的 HBR2 数据速率
- 支持 TMDS 时钟频率高达 340MHz 的 HDMI 1.4b
- 具有可实现与 AMD、Intel 和 NVIDIA 图形处理器无缝连接的接口
- 通过链路协商实现自动配置
- 通过可调电压摆幅和预加强增益实现输出信号调节
- 高度可配置的输入可变均衡器
- 两个器件选项，包括可实现最低功率的双电源配置
- 2kV 静电放电 (ESD) 人体模型 (HBM) 保护
- 温度范围：0°C 至 85°C
- 48 引脚 7mm x 7mm 超薄型四方扁平无引线 (VQFN) 封装

2 应用范围

- 笔记本电脑
- 台式计算机
- 计算机扩展坞
- 计算机独立显卡

3 说明

SN75DP130 器件是一款单通道 DisplayPort™ (DP) 转接驱动器，可重新生成 DP 高速数字链路。该器件符合 VESA DisplayPort 标准版本 1.2，支持 4 通道主链路接口，允许每个通道以 5.4Gbps 的 HBR2 速率发送信号。该器件还支持 DP++ 双模，可提供 DVI 和全尺寸 HDMI 版本 1.4a 的 TMDS 信令。

器件会补偿 PCB 相关频率损耗和开关相关损耗，以在源设备和接收设备之间提供最佳 DP 电气性能。主链路信号输入具有可配置均衡器和可选升压设置。主链路输出提供四种初级差分输出电压摆幅 (VOD) 和四种初级预加强设置。通过 I²C 编程可进行二级升压调整，从而对主链接输出进行微调。该器件可监视 AUX 通道并根据链路协商命令自动调整输出信号电平和输入均衡器。此外，SN75DP130 输出信号调节和 EQ 参数完全可通过 I²C 接口进行编程。

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
SN75DP130	VQFN (48)	7.00mm x 7.00mm

(1) 要了解所有可用封装，请见数据表末尾的可订购产品附录。

简单应用



目录

1	特性	1	9.2	Functional Block Diagram	17
2	应用范围	1	9.3	Feature Description	18
3	说明	1	9.4	Device Functional Modes	23
4	修订历史记录	2	9.5	Programming	25
5	说明 (续)	4	9.6	Register Maps	26
6	Pin Configuration and Functions	4	10	Application and Implementation	33
7	Specifications	6	10.1	Application Information	33
7.1	Absolute Maximum Ratings	6	10.2	Typical Application	35
7.2	ESD Ratings	6	11	Power Supply Recommendations	38
7.3	Recommended Operating Conditions	7	11.1	SN75DP130 Power Sequencing	38
7.4	Thermal Information	8	12	Layout	41
7.5	Power Dissipation	8	12.1	Layout Guidelines	41
7.6	Electrical Characteristics	9	12.2	Layout Example	42
7.7	Switching Characteristics	11	13	器件和文档支持	43
7.8	Typical Characteristics	13	13.1	商标	43
8	Parameter Measurement Information	15	13.2	静电放电警告	43
9	Detailed Description	17	13.3	术语表	43
9.1	Overview	17	14	机械封装和可订购信息	43

4 修订历史记录

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

Changes from Revision D (July 2013) to Revision E	Page
<ul style="list-style-type: none"> 已添加 引脚配置和功能部分, ESD 额定值表, 特性描述部分, 器件功能模式部分, 应用和实施部分, 电源相关建议部分, 布局部分, 器件和文档支持部分以及机械、封装和可订购信息部分 	1

Changes from Revision C (January 2013) to Revision D	Page
<ul style="list-style-type: none"> Power-Down Sequence deleted: 1. De-assert EN to the device Power-Up Sequence deleted: 1. Assert RSTN and de-assert EN to the device Power-Up Sequence deleted: 5. Assert EN a minimum of 10 μs after RSTN has been de-asserted. Deleted the EN time line from 图 34 	38

Changes from Revision B (October 2011) to Revision C	Page
<ul style="list-style-type: none"> Added text to RSTN description in PIN FUNCTIONS Added RSTN pin row to V_{IH} in RECOMMENDED OPERATING CONDITIONS Added RSTN pin row to V_{IL} in RECOMMENDED OPERATING CONDITIONS 已添加 rows to Device power under normal operation in POWER DISSIPATION table 已更改 in Table 1 113.9 to 113.9 已删除 unnecessary tie dot in Block Diagram 已更改 表 3 已更改 图 17 已更改 图 18 已更改 SN75DP130 Local I²C Control and Status Registers 已添加 DP130 POWER SEQUENCING section 	38

Changes from Revision A (September 2011) to Revision B **Page**

- Deleted pins 37 and 43 from GND in the PIN FUNCTIONS table **6**
-

Changes from Original (April 2011) to Revision A **Page**

- Changed pin numbers in PIN FUNCTIONS table, VDDD_DREG and NC **6**
-

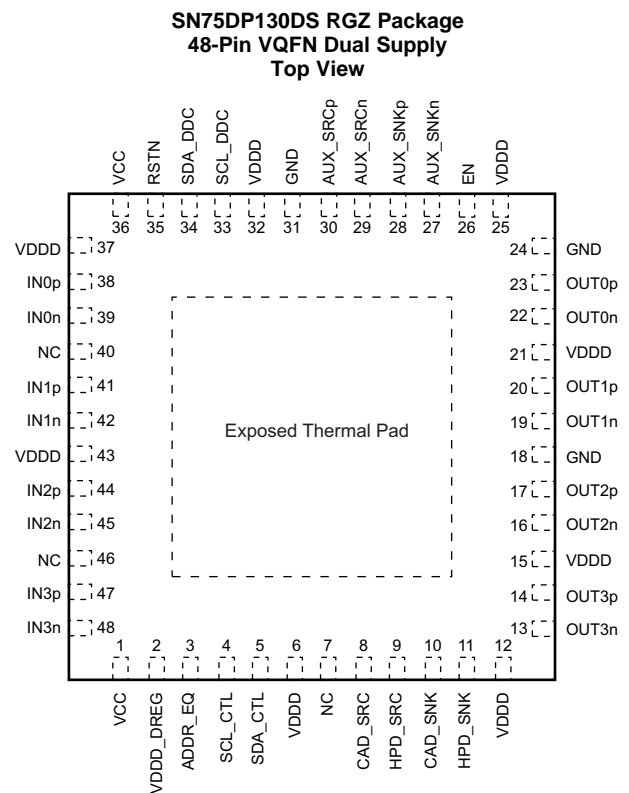
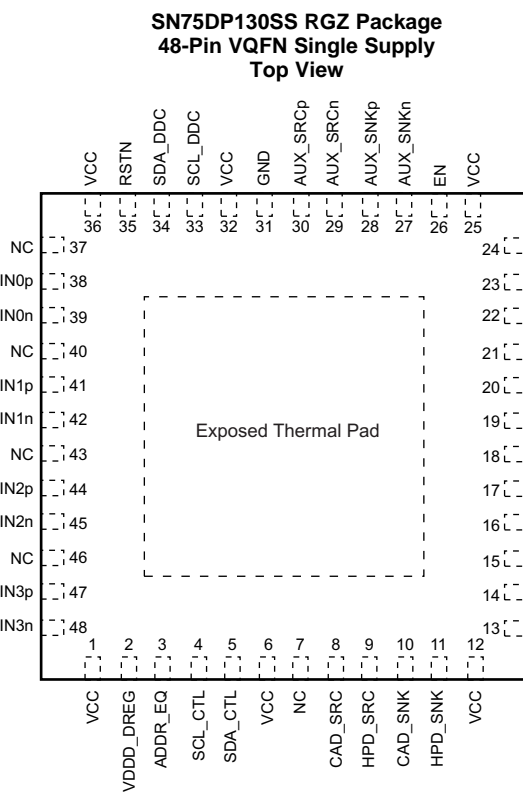
5 说明 (续)

SN75DP130 针对移动应用进行了优化，在主链路输入端配有一个活动检测电路，当不存在有效输入信号时会切换至低功耗输出禁用模式。该器件还支持待机模式等其他低功耗模式。在待机模式下，如果未连接视频接收设备（例如，监视器），功耗典型值仅为 2mW 左右。

此器件特有一个介于 0°C 和 85°C 之间的扩展运行温度范围。

SN75DP130 提供有用于连接 AUX 接收设备通道的独立 AUX 和 DDC 源设备接口。这样在与包含独立 DDC 和 AUX 接口的图形处理器 (GPU) 一起使用时，可最大限度减少元件数。对于具有组合 DDC/AUX 的 GPU，该器件可在连接到 TMDS 接收设备时作为 FET 开关将 AUX 通道交流耦合电容短路。热插拔检测 (HPD) 等其他边带电路已经过优化，旨在减少外部元件并实现与 Intel、AMD 和 NVIDIA 图形处理器的无缝连接。

6 Pin Configuration and Functions



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
MAIN LINK TERMINALS			
IN0n	39	Input (100-Ω diff)	DisplayPort Main Link Lane 0 Differential Input
IN0p	38		
IN1n	42		
IN1p	41		
IN2n	45		
IN2p	44		
IN3n	48		
IN3p	47		
OUT0n	22	Output (100-Ω diff)	DisplayPort Main Link Lane 0 Differential Output
OUT0p	23		
OUT1n	19		
OUT1p	20		
OUT2n	16		
OUT2p	17		
OUT3n	13		
OUT3p	14		
AUX CHANNEL AND DDC DATA TERMINALS			
AUX_SRCn	29	I/O (100-Ω diff)	Source Side Bidirectional DisplayPort Auxiliary Data Channel. If the AUX_SNK channel is used for monitoring only, these signals are not used and may be left open.
AUX_SRCp	30		
AUX_SNKn	27	I/O (100-Ω diff)	Sink Side Bidirectional DisplayPort Auxiliary Data Channel.
AUX_SNKp	28		
SDA_DDC	34	I/O	Bidirectional I ² C Display Data Channel (DDC) for TMDS mode. These signals may be used together with AUX_SNK to form a FET switch to short-circuit the AC coupling capacitors during TMDS operation in a DP++ Dual-Mode configuration. These terminals include integrated 60-kΩ pullup resistors
SCL_DDC	33		
HPD, CAD, AND CONTROL TERMINALS			
HPD_SRC	9	O	Hot Plug Detect Output to the DisplayPort Source.
HPD_SNK	11	I	DisplayPort Hot Plug Detect Input from Sink. This device input is 5-V tolerant. <i>Note: Pull this input high during compliance testing or use I²C control interface to go into compliance test mode and control HPD_SNK and HPD_SRC by software.</i>
CAD_SRC	8	O	DP Cable Adapter Detect Output. This output typically drives the GPU CAD input.
CAD_SNK	10	I	DisplayPort Cable Adapter Detect Input. This input tolerates a 5-V supply with a supply impedance higher than 90kΩ. A device internal zener diode limits the input voltage to 3.3 V. An external 1MΩ resistor to GND is recommended. This terminal is used to select DP mode or TMDS mode in a DP++ Dual-Mode application.
SCL_CTL	4	I/O	Bidirectional I ² C interface to configure the SN75DP130. This interface is active independent of the EN input but inactive when RSTN is low.
SDA_CTL	5		
RSTN	35	I	Active Low Device Reset. This input includes a 150-kΩ resistor to the VDDD core supply. An external capacitor to GND is recommended on the RSTN input to provide a power-up delay (see the V _{IL} and V _{IH} specifications in Recommended Operating Conditions). This signal is used to place the SN75DP130 into Shutdown mode for the lowest power consumption. When the RSTN input is asserted, all outputs (excluding HPD_SRC and CAD_SRC) are high-impedance, and inputs (excluding HPD_SNK and CAD_SNK) are ignored; all I ² C and DPCD registers are reset to their default values. At power up, the RSTN input must not be de-asserted until the VCC and VDDD supplies have reached at least the minimum recommended supply voltage level (see Figure 34 for timing requirements).
EN	26	I	Device Enable. This input incorporates an internal pullup of 200 kΩ.

Pin Functions (continued)

PIN		I/O	DESCRIPTION
NAME	NO.		
ADDR_EQ	3	3-level Input	I ² C Target Address Select and EQ Configuration Input. If the I ² C bus is used, this input setting selects the I ² C target address, as described in 图 19. This input also configures the input EQ to the device, as described in 表 3.
SUPPLY AND GROUND TERMINALS			
VDDD	SN75DP130DS 6, 12, 15, 21, 25, 32, 37, 43		Digital low voltage core and Main Link supply for SN75DP130DS device option. Nominally 1.1 V.
VCC	SN75DP130SS 1, 6, 12, 25, 32, 36		3.3-V Supply
	SN75DP130DS 1, 36		
VDDD_DREG	2		SN75DP130SS: Digital voltage regulator decoupling; install 1 μF to GND. SN75DP130DS: Treat same as VDDD; this pin will be most noisy of all VDDD terminals and needs a decoupling capacitor nearby.
GND	18, 24, 31, and Exposed Thermal Pad		Ground. Reference GND connections include the device package exposed thermal pad.
NC	SN75DP130SS 7, 15, 21, 37, 40, 43, 46		No Connect. These terminals may be left unconnected, or connect to GND.
	SN75DP130DS 7, 40, 46		

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Supply voltage	V _{CC}	-0.3	4	V
	V _{DDD} , V _{DDD_DREG}	-0.3	1.3	
Voltage	Main link I/O differential voltage	-0.3	1.3	V
	HPD_SNK	-0.3	5.5	
	All other terminals	-0.3	4	
Storage temperature, T _{stg}		-65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

7.2 ESD Ratings

		VALUE	UNIT
V _(ESD) Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±500	

(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

		MIN	NOM	MAX	UNIT		
V _{CC}	Supply voltage	3	3.3	3.6	V		
V _{DD}	Digital core and Main Link supply voltage	0.97	1.05	1.2	V		
T _A	Operating free-air temperature	0		85	°C		
T _{CASE}	Case temperature			103.1	°C		
V _{IH(HPD)}	High-level input voltage HPD_SNK	1.9		5.5	V		
V _{IH}	High-level input voltage for device control signals			3.6	V		
		RSTN pin (typical hysteresis of 80 mV)		0.75			
V _{IL}	Low-level input voltage for device control signals			0.8	V		
		RSTN pin (typical hysteresis of 80 mV)		0.3			
MAIN LINK TERMINALS							
V _{ID}	Peak-to-peak input differential voltage; RBR, HBR, HBR2	0.3		1.40	V _{pp}		
d _R	Data rate			5.4	Gbps		
C _{AC}	AC coupling capacitance (each input and each output line)	75		200	nF		
R _{tdiff}	Differential output termination resistance	80	100	120	Ω		
V _{Oterm}	Output termination voltage (AC coupled)	0		2	V		
t _{SK(in HBR2)}	Intra-pair skew at the input at 5.4 Gbps	When used as re-driver in DP source		20	ps		
		When used as receiver equalizer in DP sink		100			
t _{SK(in HBR)}	Intra-pair skew at the input at 2.7 Gbps			100	ps		
t _{SK(in RBR)}	Intra-pair skew at the input at 1.62 Gbps			300	ps		
AUX CHANNEL DATA TERMINALS							
V _{I-DC}	DC input voltage	AUX_SRCp and AUX_SNKp in DP mode		-0.5	0.3	0.4	V
		AUX_SRCn and AUX_SNKn in DP mode		2	3	3.6	
		AUX_SRCp/n and AUX_SNKp/n in TMDS mode		-0.5		3.6	
V _{ID}	Differential input voltage amplitude (DP mode only)	300		1400	mV _{pp}		
d _{R(AUX)}	Data rate (before Manchester encoding)	0.8	1	1.2	Mbps		
d _{R(FAUX)}	Data rate Fast AUX (300ppm frequency tolerance)		720		Mbps		
t _{jccin_adj}	Cycle-to-cycle AUX input jitter adjacent cycle (DP mode only)			0.05	UI		
t _{jccin}	Cycle-to-cycle AUX input jitter within one cycle (DP mode only)			0.1	UI		
C _{AC}	AUX AC coupling capacitance (DP mode only)	75		200	nF		
V _{srcCMM}	AUX source common mode voltage (only applies to DP mode) CAD = V _{IL} ; measured on AUX source and sink before AC coupling caps	0		2000	mV		
DDC AND I²C TERMINALS							
V _I	Input voltage	-0.5		3.6	V		
d _R	Data rate			100	kbps		
V _{IH}	High-level input voltage	0.7 V _{CC}			V		
V _{IL}	Low-level input voltage			0.3 V _{CC}	V		
f _{SCL}	SCL clock frequency standard I ² C mode			100	kHz		
t _{w(L)}	SCL clock low period standard I ² C mode	4.7			μs		
t _{w(H)}	SCL clock high period standard I ² C mode	4			μs		
C _{bus}	Total capacitive load for each bus line			400	pF		

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾		SN75DP130	UNIT
		RGZ (VQFN)	
		48 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	35.1	°C/W
$R_{\theta JCTop}$	Junction-to-case (top) thermal resistance	21.5	
$R_{\theta JB}$	Junction-to-board thermal resistance	11.7	
Ψ_{JT}	Junction-to-top characterization parameter, high-k board	1.2	
Ψ_{JB}	Junction-to-board characterization parameter, high-k board	11.9	
$R_{\theta JCbott}$	Junction-to-case (bottom) thermal resistance	6.7	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

7.5 Power Dissipation

See [SN75DP130 Power Sequencing](#).

PARAMETER		TEST CONDITIONS ⁽¹⁾	MIN	TYP	MAX	UNIT
P_N	Device power under normal operation	SN75DP130SS; 4 DP Lanes.		468	828	mW
		SN75DP130DS; 4 DP Lanes.		174	304	
		SN75DP130SS; 2 DP Lanes		252	450	
		SN75DP130DS; 2 DP Lanes.		102	178	
		SN75DP130SS; 1 DP Lanes		144	252	
		SN75DP130DS; 1 DP Lanes.		66	112	
P_{SD}	Shutdown mode power dissipation	SN75DP130SS; 4 DP Lanes.			14.4	mW
		SN75DP130DS; 4 DP Lanes.			7.2	
P_{SBY}	Standby mode power dissipation	SN75DP130SS; 4 DP Lanes.			14.4	mW
		SN75DP130DS; 4 DP Lanes.			7.2	
P_{D3}	D3 power down mode dissipation	SN75DP130SS; 4 DP Lanes.			54	mW
		SN75DP130DS; 4 DP Lanes.			46	
P_{OD}	Output disable (squelch) mode current	SN75DP130SS; 4 DP Lanes.		126	180	mW
		SN75DP130DS; 4 DP Lanes.		58	88	

(1) Test conditions correspond to Power Supply test conditions in [Electrical Characteristics](#)

7.6 Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER ⁽¹⁾		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
$I_{CCDP1HBR2}$	Supply Current 1 DP Lanes	Maximum conditions: IN/OUT at 5.4 Gbps PRBS, $V_{OD} = 510$ mVpp, $P_E = 6$ dB; AUX at 1 Mbps PRBS, $V_{ID} = 1000$ mVpp; EQ = 3.5 dB Typical Conditions: IN/OUT at 5.4 Gbps PRBS, $V_{OD} = 510$ mVpp, $P_E = 0$ dB AUX and I ² C Idle; EQ = 5.3 dB	40	70		mA
$I_{CCDP2HBR2}$	Supply Current 2 DP Lanes		70	125		mA
$I_{CCDP4HBR2}$	Supply Current 4 DP Lanes		130	230		mA
$I_{CCDP1HBR}$	Supply Current 1 DP Lanes	Main Link at 2.7Gbps PRBS, $V_{OD} = 510$ mVpp, $P_E = 0$ dB; AUX and I ² C Idle; EQ at 3 dB fixed gain	40			mA
$I_{CCDP2HBR}$	Supply Current 2 DP Lanes		70			mA
$I_{CCDP4HBR}$	Supply Current 4 DP Lanes		130			mA
I_{CCTMDS}	Supply Current TMD5 Mode	Main Link at 2.5 Gbps PRBS, $V_{ID} = V_{OD} = 600$ mVpp; AUX Idle			170	mA
I_{SD}	Shutdown supply current	Shutdown mode		3	4	mA
I_{SBY}	Standby supply current	Standby mode		3	4	mA
I_{D3}	D3 supply current	D3 power-down mode		10	15	mA
I_{OD}	Squelch supply current	Output disable (Squelch) mode		35	50	mA
MAIN LINK						
$V_{OD(L0)}$	Output differential voltage swing	$V_{PRE(L0)}$; 675 Mbps D10.2 Test Pattern; BOOST = 01	238	340	442	mV _{PP}
$V_{OD(L1)}$			357	510	663	
$V_{OD(L2)}$			484	690	897	
$V_{OD(L3)}$			700	1000	1300	
$V_{OD(TMDS)}$		675 Mbps D10.2 Test Pattern; BOOST = 01	420	600	780	
$\Delta V_{OD(L0L1)}$	Output peak-to-peak differential voltage delta	$\Delta V_{ODn} = 20 \times \log(V_{ODL(n+1)} / V_{ODL(n)})$ measured in compliance with PHY CTS1.1D15 section 3.2 at test point TP2 using special CTS test board	1.7	3.5	5.3	dB
$\Delta V_{OD(L1L2)}$			1.6	2.5	3.5	
$\Delta V_{OD(L2L3)}$			0.8	3.5	6	
$V_{PRE(L0)}$	Driver output pre-emphasis (default)	All V_{OD} options		0	0.25	dB
$V_{PRE(L1)}$		$V_{OD} = V_{OD(L0)}$, $V_{OD(L1)}$, or $V_{OD(L2)}$; BOOST = 01		3.5		
$V_{PRE(L2)}$		$V_{OD} = V_{OD(L0)}$ or $V_{OD(L1)}$; BOOST = 01		6		
$V_{PRE(L3)}$		$V_{OD} = V_{OD(L0)}$; BOOST = 01		9.5		
$V_{PRE(BOOST)}$	Output V_{PRE} boost	BOOST = 10		10%		dB
		BOOST = 00		-10%		
$\Delta V_{PRE(L1L0)}$	Pre-emphasis delta	Measured in compliance with PHY CTS1.1D15 section 3.3 at test point TP2 using special CTS test board	2			dB
$\Delta V_{PRE(L2L1)}$			1.6			
$\Delta V_{PRE(L3L2)}$			1.6			
$\Delta V_{ConsBit}$	Nontransition bit voltage variation	See CTS spec section 3.3.5			30%	
$A_{EQ(HBR)}$	Equalizer gain for RBR/HBR	See 表 3 for EQ setting details;			9	dB
$A_{EQ(HBR2)}$	Equalizer gain for HBR2	Max value represents the typical value for the maximum configurable EQ setting			18	
$A_{EQ(TMDS)}$	Equalizer gain for TMDS				3	
R_{OUT}	Driver output impedance			50		Ω
R_{IN}	Input termination impedance		40	50	60	Ω
V_{Iterm}	Input termination voltage	AC coupled; self-biased	0		2	V
$V_{OCM(SS)}$	Steady state output common-mode voltage		0		2	V

(1) Values are V_{DD} supply measurements; V_{CC} supply (DS package option) measurements are 5 mA (typical) and 8 mA (max), with zero current in shutdown and standby modes.

Electrical Characteristics (接下页)

over recommended operating conditions (unless otherwise noted)

PARAMETER ⁽¹⁾		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$\Delta V_{OCM(SS)}$	Change in steady state output common-mode voltage between logic levels	Tested in compliance to section 3.10 in CTS 1.1a		10		mV _{PP}
$V_{OCM(PP)}$	Output common-mode noise	HBR2		20 30		mV _{RMS}
$V_{SQUELCH}$	Squelch threshold voltage	Programmable through I ² C; default at 80 mVpp typical		80		mV _{PP}
$I_{TXSHORT}$	Short circuit current limit	Main Link outputs shorted to GND			50	mA
HPD_SRC, CAD_SRC						
V_{OH}	High-level output voltage	$I_{OH} = 500 \mu A$	2.7		3.6	V
V_{OL}	Low-level output voltage	$I_{OH} = 500 \mu A$	0		0.1	V
R_{outCAD}	CAD series output resistance ⁽²⁾	$EN = RSTN = V_{CC}; HPD_SNK = CAD_SNK = V_{CC}$		150		Ω
R_{outHPD}	HPD series output resistance	$EN = RSTN = V_{CC}; HPD_SNK = CAD_SNK = V_{CC}$		150		Ω
I_{LEAK}	Leakage current ⁽³⁾	$V_{CC} = 0 V, V(\text{pin}) = 1.2 V; RSTN$			20	μA
		$V_{CC} = 0 V, V(\text{pin}) = 3.3 V; SCL/SDA_CTL, AUX_SNKp/n$			20	
		$V_{CC} = 0 V, V(\text{pin}) = 3.3 V; HPD_SNK$			40	
		$V_{CC} = 0 V, V(\text{pin}) = 3.3 V; AUX_SRCp/n$			60	
HPD_SNK						
I_H	High-level input current	$V_{IH} = 1.9 V$ (leakage includes the 130-k Ω pull-down resistor)	-30		30	μA
I_L	Low-level input current	$V_{IL} = 0.8 V$ (leakage includes the 130-k Ω pull-down resistor)	-30		30	μA
V_{TH+}	Positive going input threshold voltage			1.4		V
R_{pdHPD}	HPD input termination to GND	$V_{CC} = 0 V$	100	130	160	k Ω
CAD_SNK						
I_H	High-level input current	$V_{IH} = 1.9 V$	-1		1	μA
I_L	Low-level input current	$V_{IL} = 0.8 V$	-1		1	μA
V_{TH+}	Positive going input threshold voltage			1.4		V
AUX/DDC/I²C						
V_{PASS}	DDC mode passthrough voltage	$V_{CAD_SNK} = V_{IH}; I_O = 100 \mu A$	1.9			V
C_{IO}	I/O capacitance	$V_{IO} = 0 V; f(\text{test}) = 1 \text{ MHz}$		10		pF
r_{ON}	On resistance AUX_SRCn to AUX_SNKn in DP mode	$V_{CC} = 3 V \text{ w/ } V_I = 2.85 V \text{ or } V_{CC} = 3.6 V \text{ w/ } V_I = 3.4 V; I_O = 5 \text{ mA}$		5	10	Ω
	On resistance SCL/SDA_DDC to AUX_SNK in TMDS mode	$I_O = 3 \text{ mA}$		15	30	
	On resistance AUX_SRC to AUX_SNK in TMDS mode	$I_O = 3 \text{ mA}$		10	20	
Δr_{ON}	On resistance variation with input signal voltage change in DP mode	$V_{CC} = 3.6 V, I_O = 5 \text{ mA}, V_I = 2.6 \text{ to } 3.4 V, V_{CC} = 3 V, I_O = 5 \text{ mA}, V_I = 0 \text{ to } 0.4 V$			5	Ω
$V_{ID(HYS)}$	Differential input hysteresis	By design (simulation only)		50		mV
I_H	High-level input current	$V_I = V_{CC}$	-5		5	μA

 (2) A series output resistance of 100k Ω may be added in series to the CAD_SRC output to mimic a cable adapter.

(3) Applies to failsafe inputs: RSTN, SDA_CTL, SCL_CTL, SDA_DDC, SCL_DDC, AUX_SNK P/N, AUX_SRC P/N, HPD_SNK

Electrical Characteristics (接下页)

over recommended operating conditions (unless otherwise noted)

PARAMETER ⁽¹⁾		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_L	Low-level input current	$V_I = \text{GND}; \text{CAD_SNK} = V_{IH}$	-5		5	μA
		$V_I = \text{GND}; \text{At DDC inputs}$			80	
$V_{\text{AUX+}}$	Voltage on the Aux+ for PHY-CTS 3.19	1M (5%) pullup to V_{CC} and 100-k Ω pulldown to GND on AUX+; $V_{CC} = 3.3 \text{ V}$	0		0.4	V
$V_{\text{AUX-}}$	Voltage on the Aux- for PHY-CTS 3.18	100 k Ω pullup to V_{CC} and 1M (5%) pulldown to GND on AUX-; $V_{CC} = 3.3 \text{ V}$	2.4		3.6	V
$ S_{1122} $	Differential line insertion loss	$V_{ID} = 400 \text{ mV}$, AC coupled; p-channel biasing 0.3 V and N-channel 3 V; 360-MHz sine wave; $\text{CAD_SNK} = V_{IL}$		1.6	3	dB
R_{DDC}	Switchable pul-lup resistor on DDC at source side (SCL_DDC, SDA_DDC)	$\text{CAD_SNK} = V_{IH}$	48	60	72	k Ω

7.7 Switching Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
MAIN LINK						
t_{PD}	Propagation delay time	See 图 10		300		ps
$t_{\text{SK}(1)}$	Intra-pair output skew	Signal input skew = 0ps; $d_R = 2.7 \text{ Gbps}$, $V_{\text{PRE}} = 0 \text{ dB}$, 800 mVp-p, D10.2 clock pattern at device input; See 图 11			20	ps
$t_{\text{SK}(2)}$	Inter-pair output skew				100	ps
Δt_{jit}	Total peak-to-peak residual jitter	$V_{\text{OD}(LO)}$; $V_{\text{PRE}(LO)}$; EQ = 8 dB; clean source; minimum input and output cabling; 1.62 Gbps, 2.7 Gbps, and 5.4 Gbps PRBS7 data pattern.			15	ps
$t_{\text{sq_enter}}$	Squelch entry time	Time from active DP signal turned off to ML output off with noise floor minimized	10		120	μs
$t_{\text{sq_exit}}$	Squelch exit time	Time from DP signal on to ML output on	0		1	μs
HPD/CAD						
$t_{\text{PD(HPD)}}$	Propagation delay HPD_SNK to HPD_SRC	$V_{CC} = 3 \text{ V}$; See 图 1			50	ns
$t_{\text{PD(CAD)}}$	Propagation delay CAD_SNK to CAD_SRC				50	ns
$t_{\text{T(HPD)}}$	HPD logic shut off time	$V_{CC} = 3 \text{ V}$; See 图 2			400	ms
AUX/DDC/I²C						
$t_{\text{sk(AUX)}}$	Intra-pair skew	$V_{ID} = 400 \text{ mV}$, AC coupled; p-channel biasing 0.3V and N-channel 3 V; See 图 13			400	ps
$t_{\text{PLH(DP)}}$	Propagation delay time, low to high	CAD = V_{IL} ; 1-Mbps pattern; See 图 14			3	ns
$t_{\text{PHL(DP)}}$	Propagation delay time, high to low				3	ns
$t_{\text{PLH(DDC)}}$	Propagation delay time, low to high	CAD = V_{IH} ; 100-kbps pattern			50	ns
$t_{\text{PHL(DDC)}}$	Propagation delay time, high to low				50	ns
$t_{\text{PU(AUX)}}$	Main Link D3 wake-up time	$V_{ID} = 0.1 \text{ V}$, $V_{\text{ICMM}} = 2\text{-V}$ source side (before AC coupling caps)			50	μs
I²C						
Refer to the I ² C-Bus Specification, Version 2.1 (January 2000); SN75DP130 meets the switching characteristics for standard mode transfers up to 100 kbps.						

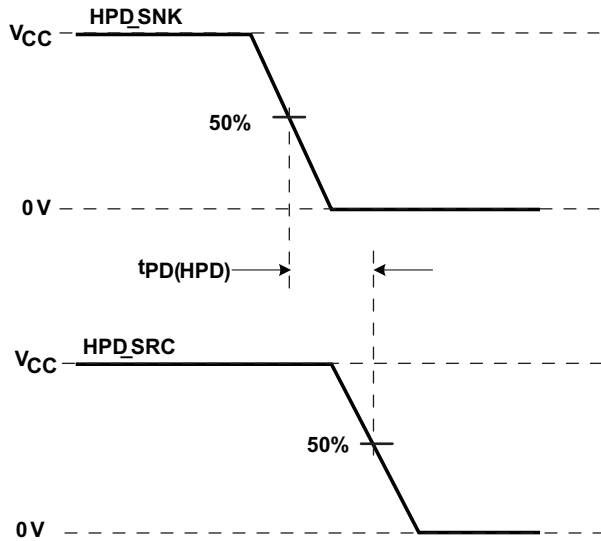


图 1. HPD Timing Diagram 1

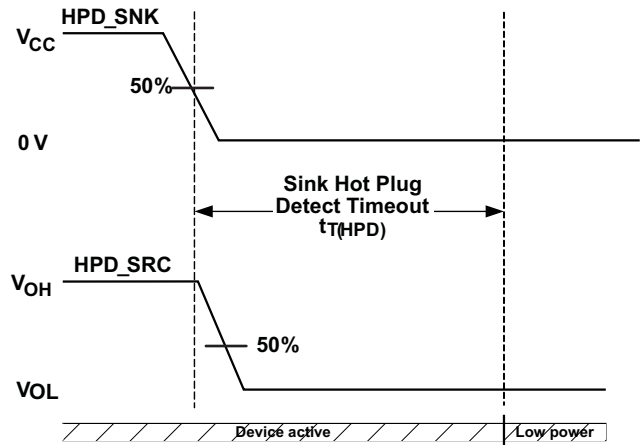
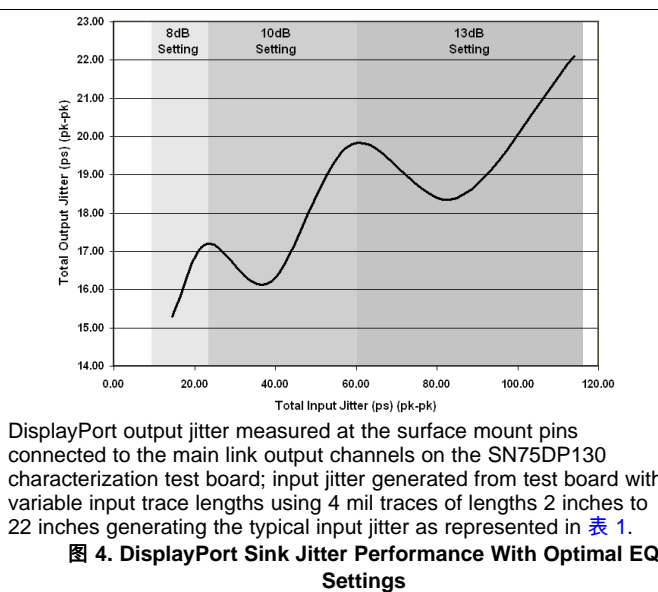
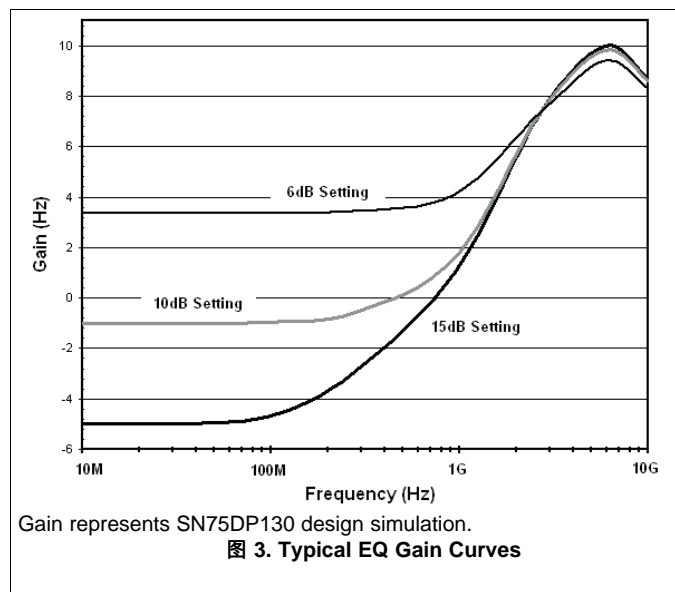


图 2. HPD Timing Diagram 2

7.8 Typical Characteristics

表 1. Characterization Test Board Trace Lengths Related to Input Jitter

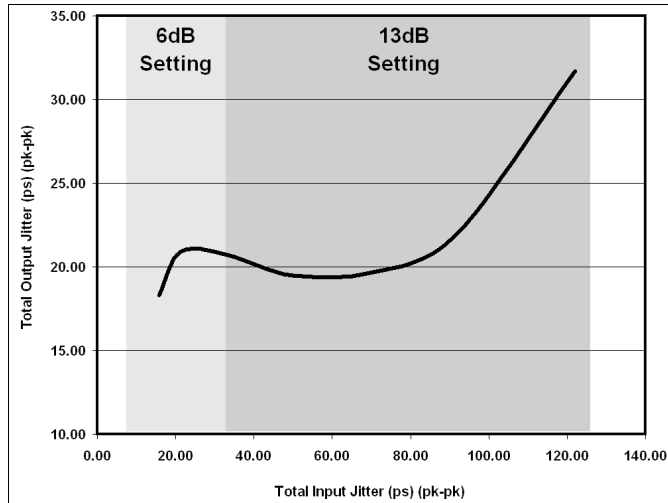
INPUT MODE	TRACE LENGTH (INCHES)	TOTAL INPUT JITTER (ps)	RECOMMENDED EQ SETTING
Display Port HBR2	2	14.4	8
	6	23.1	8
	10	38.8	10
	14	58.9	10
	18	84.8	13
	22	113.9	13
TMDS 3.4 Gbps	2	15.8	6
	6	21.3	6
	10	33.2	6
	14	49.9	13
	18	70.5	13
	22	91.5	13



SN75DP130

ZHCS202E – APRIL 2011 – REVISED MARCH 2015

www.ti.com.cn



DisplayPort output jitter measured at the surface mount pins connected to the main link output channels on the SN75DP130 characterization test board; input jitter generated from test board with variable input trace lengths using 4 mil traces of lengths 2 inches to 22 inches generating the typical input jitter as represented in Table 1.

图 5. TMDS Sink jitter Performance With Optimal EQ Settings

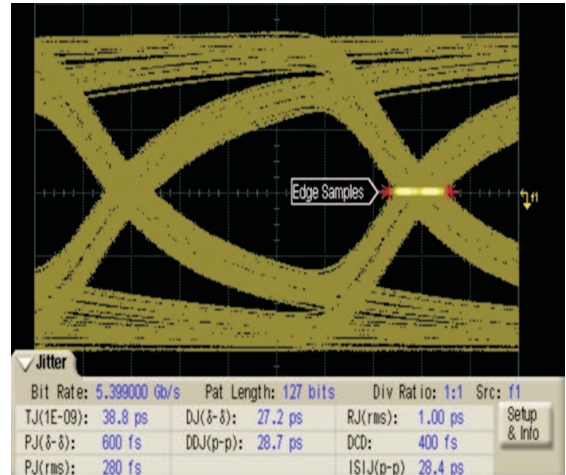


图 6. Main Link Input With 10-Inch Trace; DisplayPort Sink

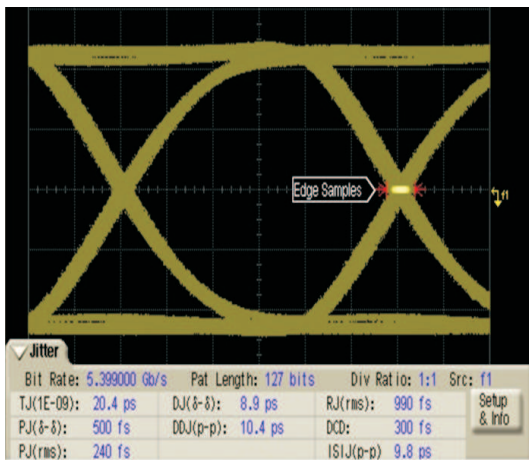


图 7. SN75DP130 Output; 10-Inch Input Trace; 13-dB EQ Setting; DP Sink

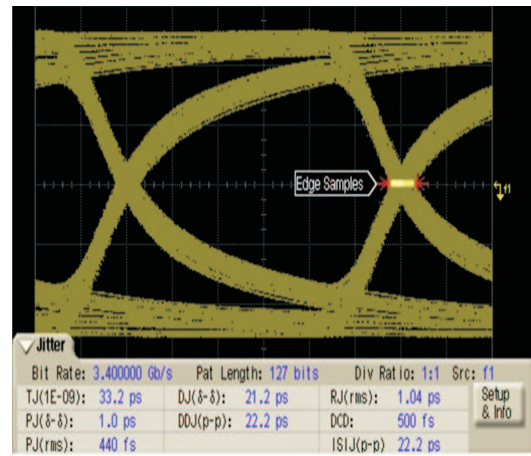


图 8. Main Link Input With 10-Inch Trace; TMSD Sink

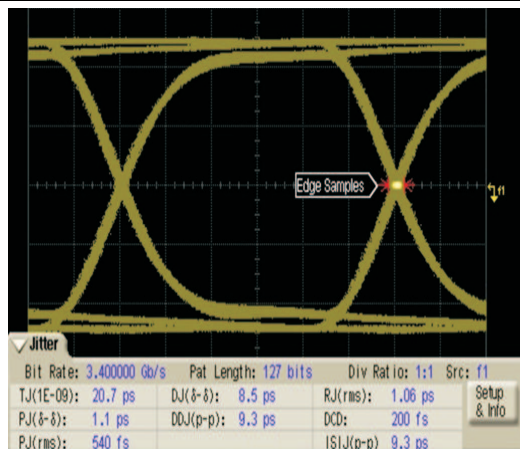


图 9. SN75DP130 Output; 10-Inch Input Trace; 13-dB EQ Setting; TMSD Sink

8 Parameter Measurement Information

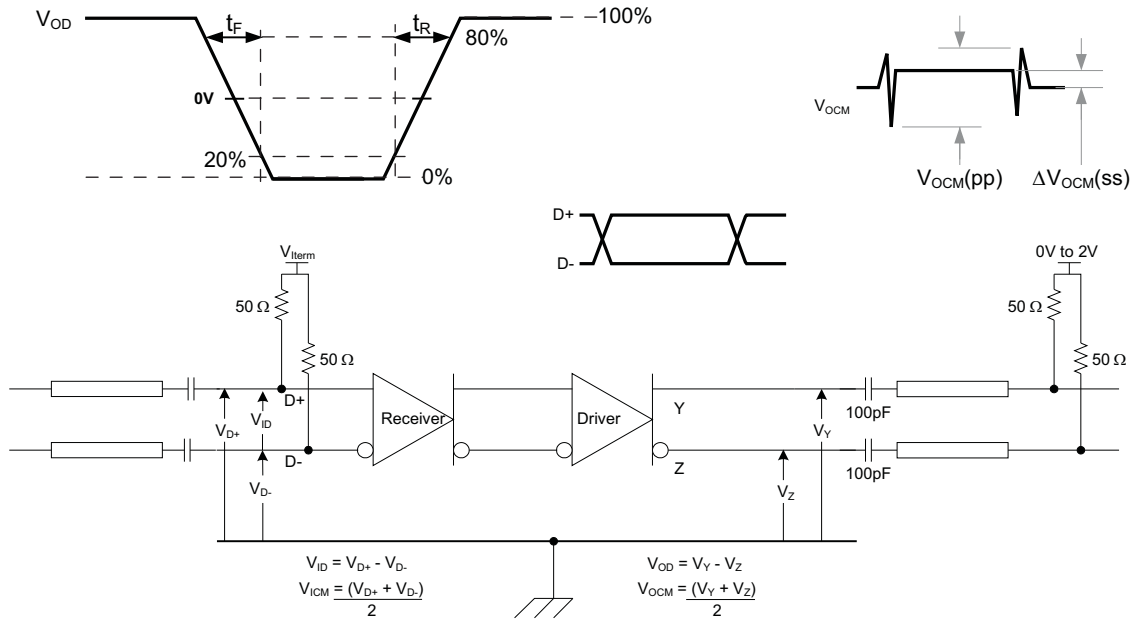


图 10. Main Link Test Circuit

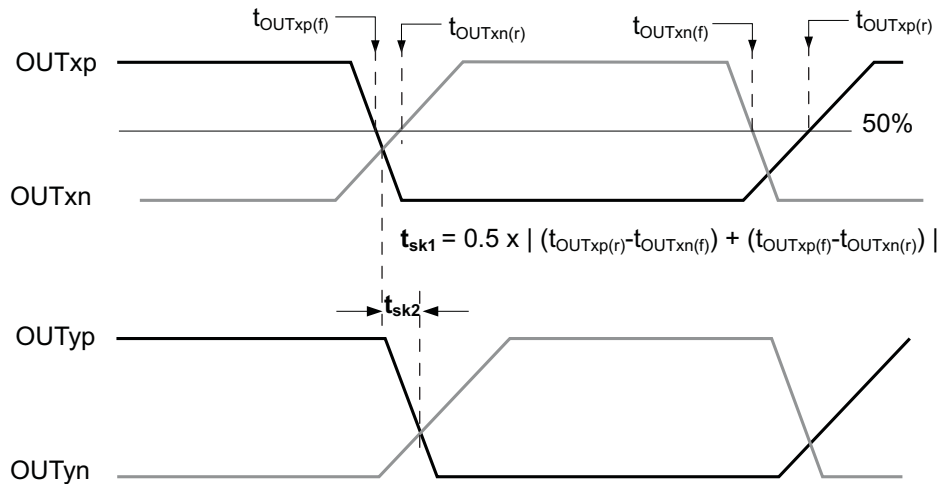


图 11. Main Link Skew Measurements

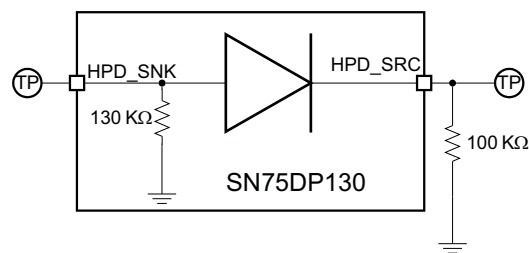


图 12. HPD Test Circuit

Parameter Measurement Information (接下页)

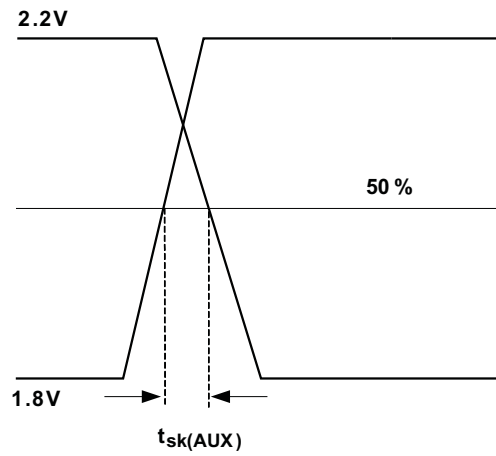


图 13. AUX Skew Measurement

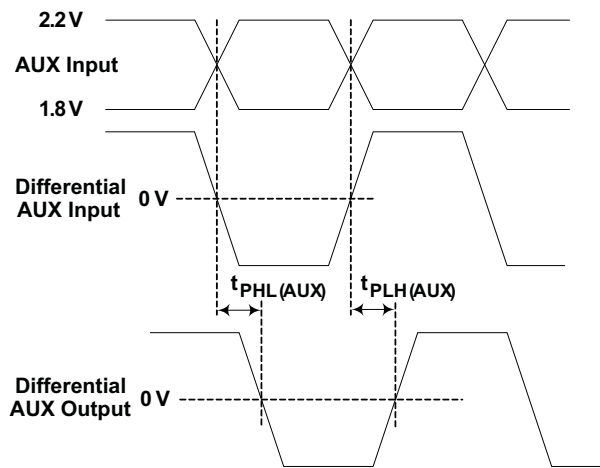


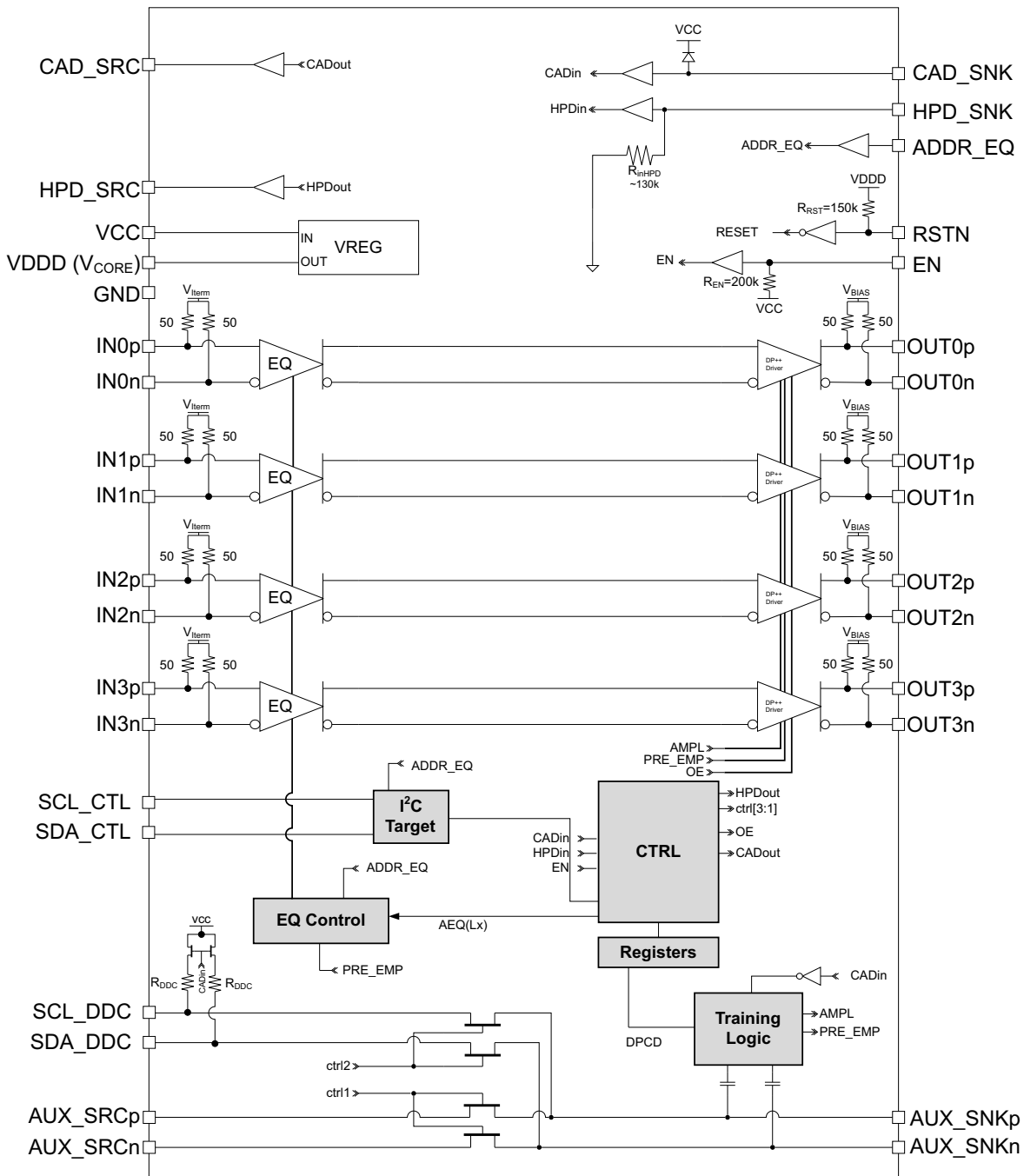
图 14. AUX Delay Measurement

9 Detailed Description

9.1 Overview

The SN75DP130 DisplayPort (DP) re-driver that regenerates the DP high-speed digital link. The device complies with the VESA DisplayPort Standard Version 1.2, and supports a 4-lane main link interface signaling up to HBR2 rates at 5.4 Gbps per lane. The device compensates for ISI loss across a transmission line to provide the optimum DP electrical performance from source to sink. The SN75DP130 is typically used in source applications either on a motherboard or in a docking station. With its large amount of equalization gain and ability to adjust its outputs levels, the DP130 can also be used in a sink application.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 Reset Signal

The SN75DP130 RSTN input gives control over the device reset and to place the device into shutdown mode. When RSTN is low, all DPCD registers are reset to their default values, and all Main Link lanes are disabled. When the RSTN input returns to a high logic level, the device comes out of the shutdown mode. To turn on the Main Link, it is necessary to either program the DPCD registers through the local I²C interface or to go through a full sequence of Link Training between DP source and DP sink.

It is critical to reset the digital logic of the SN75DP130 after the V_{DD} supply is stable (that is, V_{DD} has reached the minimum recommended operating voltage). This is achieved by asserting the RSTN input from low to high. A system may provide a control signal to the RSTN signal that transitions low to high after the V_{DD} supply is stable, or implement an external capacitor connected between RSTN and GND, to allow delaying the RSTN signal during power up. The implementations are shown in [图 15](#) and [图 16](#).

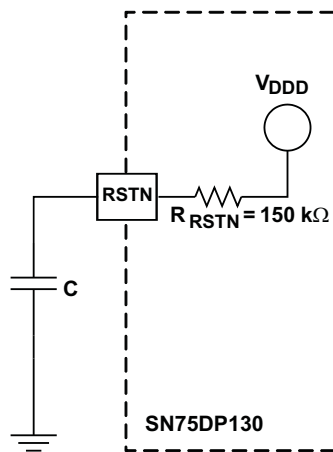


图 15. External Capacitor Controlled RSTN

When implementing the external capacitor, the size of the external capacitor depends on the power up ramp of the V_{DD} supply where a slower ramp-up results in a larger value external capacitor.

Refer to the latest reference schematic for the SN75DP130 device and/or consider approximately 200-nF capacitor as a reasonable first estimate for the size of the external capacitor.

When implementing a RSTN input from an active controller, it is recommended to use an open-drain driver if the RSTN input is driven. This protects the RSTN input from damage of an input voltage greater than V_{DD} .

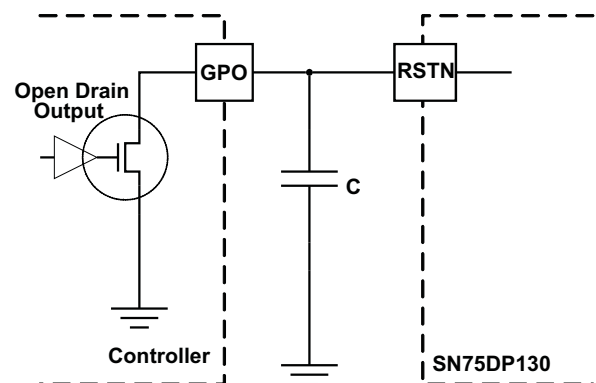


图 16. RSTN Input from Active Controller

9.3.2 Hot Plug Detect and Cable Adapter Detect

The SN75DP130 generates the Hot Plug Detect (HPD_SRC) signal to indicate to the source that a sink has been detected. A low HPD_SNK signal input indicates no sink device is connected. When HPD_SNK is high, the CAD_SNK signal indicates whether a DP sink (CAD_SNK=low) or a TMDS sink (CAD_SNK=high).

A sink device can request a source device interrupt by pulling the HPD_SNK signal low for a duration of 0.5 ms to 1 ms. The interrupt passes through the SN75DP130. If the HPD_SNK signal goes low for longer than 2 ms, the DP source determines that the sink device is disconnected. To conserve power, the SN75DP130 will go into a power saving Standby mode after the HPD signal went low for a duration of $t_{T(HPD)}$.

In the TMDS mode the AUX training logic is disabled and the Main Link transmits with a fixed output voltage swing of 600mVpp; the pre-emphasis level is set to 0 dB. Output swing and pre-emphasis level are also adjustable by I²C interface. In TMDS mode all four Main Link output lanes are enabled.

Through the local I²C interface it is also possible to force the device to ignore HPD_SNK and CAD_SNK, and control HPD_SRC and CAD_SRC directly.

9.3.3 AUX and DDC Configuration

The SN75DP130 offers an AUX source channel (AUX_SRC), AUX sink channel (AUX_SNK), a selectable DDC interface (SDA_DDC/SCL_DDC) for TMDS mode, and a local I²C control interface (SCL_CTL / SDA_CTL). Upon power-up, the SN75DP130 enables the connection between the AUX_SNK to the appropriate source interface based on CAD_SNK. 表 2 describes the switching logic, including the programmability through the local I²C interface.

The DDC interface incorporates 60-kΩ pull-up resistors on SDA_DDC and SCL_DDC, which are turned on when CAD_SNK is high (TMDS mode) but turned off when CAD_SNK is low (DP mode).

表 2. AUX and DDC Interface Configurations

HPD_SNK	I ² C REGISTER BIT 04.0	I ² C REGISTER BIT 04.1	CAD_SNK	AUX_SNK	AUX_SRC	DDC	AUX MONITOR	COMMENT
0	X	X	X	OFF	OFF	OFF	inactive	no sink detected; low power mode
1	0 (default; works for Intel, NVIDIA, and AMD)	0 (default)	0	ON	ON	OFF	active	DP sink detected; AUX_SNK connects to AUX_SRC
			1	ON	OFF	ON	inactive	TMDS cable adapter detected; DDC connects to AUX_SNK
	0		OFF	ON	OFF	active	DP sink detected; AUX_SNK disconnected from AUX_SRC; AUX_SNK monitors AUX training	
	1		ON	ON	OFF	inactive	TMDS cable adapter detected; AUX_SNK connects to AUX_SRC and can be used to short AC coupling caps	
	0	1	0	ON	ON	OFF	active	DP sink detected; AUX_SNK connects to AUX_SRC
			1				inactive	TMDS cable adapter detected; AUX_SRC connects to AUX_SNK
1	1		undetermined				mode not recommended	

9.3.4 Main Link Configuration

The EQ input stage is self-configuring based on Link Training. A variety of EQ settings are available through external pin configuration to accommodate for different PCB loss and GPU settings, and the I²C interface may be used to fully customize EQ configuration lane-by-lane beyond the input pin configurability options, as described in 表 3.

表 3. Main Link EQ Configurations

EQ_I2C_ENABLE (reg 05.7)	ADDR_EQ	CAD_SNK ⁽¹⁾ VIL = DP VIH = TMDS	LINK TRAINING ON/OFF (reg 04.2)	LINK TRAINING AEQ(Lx) ⁽²⁾ LANE 0 to 2	LINK TRAINING AEQ(Lx) ⁽²⁾ LANE 3	DESCRIPTION
0 (default)	VIL	VIL	1 (default)	AEQ(L0) = 8 dB at 2.7 GHz AEQ(L1) = 6 dB at 2.7 GHz AEQ(L2) = 3.5 dB at 2.7 GHz AEQ(L3) = 0 dB at 2.7 GHz	same as Lane 0 to 2	automatic low-range EQ gain based on link training; DP mode
			0	AEQ(Lx) = 6 dB at 2.7 GHz		DP mode; fixed EQ
		VIH	x	EQ(Lx) = 6 dB at 2.7 GHz	3 dB at 1.35 GHz	TMDS mode; fixed EQ
	VIM	VIL	1	AEQ(Lx) = 8 dB at 2.7 GHz	same as Lane 0 to 2	DP mode; fixed EQ
			0	AEQ(Lx) = 8 dB at 2.7 GHz		DP mode; fixed EQ
		VIH	x	EQ(Lx) = 8 dB at 2.7 GHz	3 dB at 1.35 GHz	TMDS mode; fixed EQ
	VIH	VIL	1	AEQ(L0) = 15 dB at 2.7 GHz AEQ(L1) = 13 dB at 2.7 GHz AEQ(L2) = 10 dB at 2.7 GHz AEQ(L3) = 6 dB at 2.7 GHz	same as Lane 0 to 2	automatic high-range EQ gain based on link training; DP mode
			0	AEQ(Lx) = 13 dB at 2.7 GHz		DP mode; fixed EQ
		VIH	x	EQ(Lx) = 13 dB at 2.7 GHz	3 dB at 1.35 GHz	TMDS mode; fixed EQ
1	x	VIL	1	AEQ(Lx) = 0 dB at 2.7 GHz AEQ(Lx) I ² C programmable	same as Lane 0 to 2	DP mode; EQ fully programmable for each training level; EQ disabled by default
			0	AEQ(L1) = 0 dB at 2.7 GHz AEQ(L1) I ² C programmable		DP mode; EQ fully programmable by AEQ(L1) levels; default AEQ(L1) EQ setting at 6 dB At 2.7 GHz
		VIH	x		3 dB at 1.35 GHz	TMDS mode; fixed EQ

(1) Setting CAD_TEST_MODE (Reg 17.0) forces the SN75DP130 into a TMDS test mode even if no external CAD signal is present

(2) EQ setting is adjusted based on the output pre-emphasis level setting; the EQ setting is indifferent to the level of V_{OD}.

9.3.5 Link Training and DPCD

The SN75DP130 monitors the auxiliary interface access to DisplayPort Configuration Data (DPCD) registers during Link Training in DP mode to select the output voltage swing V_{OD} , output pre-emphasis, and the EQ setting of the Main Link. The AUX monitor for SN75DP130 supports Link Training in 1Mbps Manchester mode, and is disabled during TMDS mode (CAD_SNK=VIH).

The AUX channel is further monitored for the DisplayPort D3 standby command.

The DPCD registers monitored by SN75DP130 are listed in 图 17. Bit fields not listed are reserved and values written to reserved fields are ignored.

图 17. DPCD Registers Used by the SN75DP130 AUX Monitor

7	6	5	4	3	2	1	0
x	x	x	x	x	x	x	x
R/W	RW	RW	RW	RW	RW	RW	RW

LEGEND: R/W = Read/Write; R = Read only; -n = value after reset

表 4. DPCD Registers Used by the SN75DP130 AUX Monitor

Address	Field	Type	Description
00100h	LINK_BW_SET	RW	Bits 7:0 = Link Bandwidth Setting Write Values: 06h – 1.62 Gbps per lane 0Ah – 2.7 Gbps per lane (default) 14h – 5.4 Gbps per lane <i>Note: any other value is reserved; the SN75DP130 will revert to 5.4 Gbps operation when any other value is written</i> Read Values: 00h – 1.62 Gbps per lane 01h – 2.7 Gbps per lane (default) 02h – 5.4 Gbps per lane
00101h	LANE_COUNT_SET	RW	Bits 4:0 = Lane Count Write Values: 00h – All lanes disabled (default) 01h – One lane enabled 02h – Two lanes enabled 04h – Four lanes enabled <i>Note: any other value is invalid and disables all Main Link output lanes</i> Read Values: 00h – All lanes disabled (default) 01h – One lane enabled 03h – Two lanes enabled 0Fh – Four lanes enabled
00103h	TRAINING_LANE0_SET	RW	Write Values: Bits 1:0 = Output Voltage V_{OD} Level 00 – Voltage swing level 0 (default) 01 – Voltage swing level 1 10 – Voltage swing level 2 11 – Voltage swing level 3 Bits 4:3 = Pre-emphasis Level 00 – Pre-emphasis level 0 (default) 01 – Pre-emphasis level 1 10 – Pre-emphasis level 2 11 – Pre-emphasis level 3 <i>Note: the following combinations are not allowed for bits [1:0]/[4:3]: 01/11, 10/10, 10/11, 11/01, 11/10, 11/11; setting to any of these invalid combinations disables all Main Link lanes until the register value is changed back to a valid entry</i> Read Values: Bits 1:0 = Output Voltage V_{OD} Level 00 – Voltage swing level 0 (default) 01 – Voltage swing level 1 10 – Voltage swing level 2 11 – Voltage swing level 3 Bits 3:2 = Pre-emphasis Level 00 – Pre-emphasis level 0 (default) 01 – Pre-emphasis level 1 10 – Pre-emphasis level 2 11 – Pre-emphasis level 3

表 4. DPCD Registers Used by the SN75DP130 AUX Monitor (接下页)

Address	Field	Type	Description
00104h	TRAINING_LANE1_SET	RW	Sets the V_{OD} and pre-emphasis levels for lane 1
00105h	TRAINING_LANE2_SET	RW	Sets the V_{OD} and pre-emphasis levels for lane 2
00106h	TRAINING_LANE3_SET	RW	Sets the V_{OD} and pre-emphasis levels for lane 3
0010F	TRAINING_LANE0_1_SET2	RW	Write Values: Bits 1:0 = Lane 0 Post Cursor 2 00 – IN0 expects post cursor2 level 0; OUT0 transmits at post cursor 2 level 0 01 – IN0 expects post cursor2 level 1; OUT0 transmits at post cursor 2 level 0 10 – IN0 expects post cursor2 level 2; OUT0 transmits at post cursor 2 level 0 11 – IN0 expects post cursor2 level 3; OUT0 transmits at post cursor 2 level 0 Bits 5:4 = Lane 1 Post Cursor 2 00 – IN1 expects post cursor2 level 0; OUT1 transmits at post cursor 2 level 0 01 – IN1 expects post cursor2 level 1; OUT1 transmits at post cursor 2 level 0 10 – IN1 expects post cursor2 level 2; OUT1 transmits at post cursor 2 level 0 11 – IN1 expects post cursor2 level 3; OUT1 transmits at post cursor 2 level 0 Read Values: Bits 1:0 = Lane 0 Post Cursor 2 00 – IN0 expects post cursor2 level 0; OUT0 transmits at post cursor 2 level 0 01 – IN0 expects post cursor2 level 1; OUT0 transmits at post cursor 2 level 0 10 – IN0 expects post cursor2 level 2; OUT0 transmits at post cursor 2 level 0 11 – IN0 expects post cursor2 level 3; OUT0 transmits at post cursor 2 level 0 Bits 3:2 = Lane 1 Post Cursor 2 00 – IN1 expects post cursor2 level 0; OUT1 transmits at post cursor 2 level 0 01 – IN1 expects post cursor2 level 1; OUT1 transmits at post cursor 2 level 0 10 – IN1 expects post cursor2 level 2; OUT1 transmits at post cursor 2 level 0 11 – IN1 expects post cursor2 level 3; OUT1 transmits at post cursor 2 level 0
0110F	TRAINING_LANE2_3_SET2	RW	Bit definition identical to that of TRAINING_LANE_0_1_SET2 but for lanes 2 (IN2/OUT2) and lane 3 (IN3/OUT3)
00600h	SET_POWER	RW	Bits 1:0 = Power Mode Write Values: 01 – Normal mode (default) 10 – Power down mode; D3 Standby Mode The Main Link and all analog circuits are shut down and the AUX channel is monitored during the D3 Standby Mode. The device exits D3 Standby Mode by access to this register, when CAD_SNK goes high, or if DP_HPD_SNK goes low for longer than $t_{T(HPD)}$, which indicates that the DP sink was disconnected, or that the PRIORITY control has selected the HDMI/DVI sink. <i>Note: setting the register to the invalid combination 0600h[1:0] = 00 or 11 is ignored by the device and the device remains in normal mode</i> Read Values: 00 – Normal mode (default) 01 – Power-down mode; D3 Standby Mode

9.3.6 Equalization

The SN75DP130 includes a flexible continuous time linear equalizer (CTLE) to compensate for trace or cable loss at its input. When the SN75DP130 is in DP mode, the equalization is self-configuring based on link training commands that are monitored on the AUX channel. The host can configure the desired equalization values, on a lane-by-lane basis, through I²C control. These I²C equalization values are then automatically implemented based on the results of link training.

When the SN75DP130 is in TMDS mode, the equalization applied is based on external pin settings and I²C settings. (See 表 3 for details.)

9.3.7 Configurable Outputs

The SN75DP130 driver on each channel provides flexibility in setting output voltage swing as well as driver de-emphasis. Four levels of output voltage swing and four levels of de-emphasis settings are independently available. Channel equalization coupled with output configurability allows for optimizing the device output eyes across a wide range of channel environments.

9.3.8 Squelch

The SN75DP130 incorporates selectable output signal squelch for conditions when the device input signal does not meet preset thresholds. Main link lane 0 incorporates an activity detector which is enabled through I²C control. The activity detection threshold is selectable, through I²C, from four predefined values ranging from 40 mVpp to 250 mVpp. When squelch is enabled and the activity monitor determines that the lane 0 input signal falls below the selected threshold, the device output drivers are disabled.

Device Functional Modes (接下页)
表 5. Description of SN75DP130 Operating Modes

MODE	CHARACTERISTICS	CONDITIONS
Shutdown Mode	Least amount of power consumption (most circuitry turned off); HPD_SRC reflects HPD_SNK state; all other outputs are high-impedance; if RSTN is high local I ² C IF remains active; if RSTN is low local I ² C interface is turned off, all other inputs are ignored, and AUX DPCD is reset. (EN=low does not reset DPCD)	EN or RSTN is low; Power on default mode
Standby Mode	Low power consumption (I ² C interface is active; AUX monitor is inactive); Main Link outputs are disabled;	EN and RSTN are high; HPD_SNK low longer than t _{T(HPD)}
D3 Power Down Mode	Low power consumption (I ² C interface is active; AUX monitor active in DP mode); Main Link outputs are disabled;	EN and RSTN are high; AUX cmd requested DP sink to enter D3 power saving mode
Active Mode	Data transfer (normal operation); The device is either in TMDS mode (CAD_SNK=high) or DP mode (CAD_SNK=low); In DP mode, the AUX monitor is actively monitoring for Link Training; the output signal swing and input equalization setting depend on the Link Training or I ² C settings; the AUX SRC channel is active; the AUX SNK and DDC are active unless disabled through I ² C interface. At power-up all Main Link outputs are disabled by default. AUX Link Training is necessary to overwrite the DPCD registers to enable Main Link outputs. In TMDS mode the output signal swing is 600mVpp unless this setting is adjusted by overwriting according registers through I ² C interface. Transactions on the AUX lines will be ignored.	EN and RSTN are high; HPD_SNK is high; HPD_SNK can also be low for less than t _{Z(HPD)} (e.g., sink interrupt request to source)
Compliance Test Mode	Through I ² C registers the device can be forced into ignoring HPD_SNK and CAD_SNK, HPD_SRC and CAD_SRC are programmable; output swing, pre-emphasis and EQ setting are programmable; automatic power down features can be disabled	EN and RSTN is high; I ² C selects HPD and/or CAD test mode
Output Disable Mode	DPCD write commands on the AUX bus detected by the SN75DP130 will also write to the local DPCD register. The DPCD register should always be written with a valid entry. If register 101h or 103h is written with a forbidden value, the SN75DP130 disables the Main Link output signals, forcing the DP sink to issue an interrupt. The DP source can now retrain the link using valued DPCD register values. As soon as all DPCD registers contain a valid entry, the SN75DP130 switches back into the appropriate mode of operation.	EN and RSTN are high; DPCD register 101h or 103h entry is invalid

表 6. Description of Operating Mode Transitions

MODE TRANSITION	USE CASE	TRANSITION SPECIFICS
Shutdown → Standby	Activate SN75DP130	EN and RSTN both transitioned high
Standby → Active	Turn on Main Link (DP sink plugged in)	HPD_SNK input asserts high
Active → D3 Power Down	DP source requests temporary power down for power savings	Receive D3 entry command on AUX
Active → Output Disable	Squelch event; inactive video stream	Main Link monitor detects the inactive video stream
D3 Power Down → Active	Exit temporary power down	Receive D3 exit command on AUX, or CAD_SNK input is asserted (high)
D3 Power Down → Standby	Exit temporary power down (DP sink unplugged)	HPD_SNK de-asserted to low for longer than t _{T(HPD)}
Active → Standby	Turn off Main Link (DP sink unplugged)	HPD_SNK de-asserted to low for longer than t _{T(HPD)}
Any → Shutdown	Turn off SN75DP130	EN or RSTN transitions low
Any → Output Disable	DPCD register access error condition	Invalid DPCD register access
Output Disable → Active	Squelch released; video stream reactivated	Main Link monitor detects active video stream
Output Disable → Any	DPCD register error condition is corrected	Appropriate operating mode is re-entered

9.5 Programming

9.5.1 I²C Interface Overview

The SN75DP130 I²C interface is enabled when EN and RSTN are input high. The SCL_CTL and SDA_CTL terminals are used for I²C clock and I²C data respectively. The SN75DP130 I²C interface conforms to the two-wire serial interface defined by the I²C Bus Specification, Version 2.1 (January 2000), and supports the standard mode transfer up to 100 kbps.

The device address byte is the first byte received following the START condition from the master device. The 7-bit device address for SN75DP130 is factory preset to 01011xx with the two least significant bits being determined by the ADDR_EQ 3-level control input. [图 19](#) clarifies the SN75DP130 target address.

图 19. SN75DP130 I²C Target Address Description

7 (MSB)	6	5	4	3	2	1	0 (W/R)
0	1	0	1	1	ADDR1	ADDR0	0/1

Note: ADDR_EQ = LOW: ADDR[1:0] = 00: W/R=58/59
 ADDR_EQ = V_{CC}/2: ADDR[1:0] = 01: W/R=5A/5B;
 ADDR_EQ = HIGH: ADDR[1:0] = 10: W/R=5C/5D

The following procedure is followed to write to the SN75DP130 I²C registers:

1. The master initiates a write operation by generating a start condition (S), followed by the SN75DP130 7-bit address and a zero-value "W/R" bit to indicate a write cycle
2. The SN75DP130 acknowledges the address cycle
3. The master presents the sub-address (I²C register within SN75DP130) to be written, consisting of one byte of data, MSB-first
4. The SN75DP130 acknowledges the sub-address cycle
5. The master presents the first byte of data to be written to the I²C register
6. The SN75DP130 acknowledges the byte transfer
7. The master may continue presenting additional bytes of data to be written, with each byte transfer completing with an acknowledge from the SN75DP130
8. The master terminates the write operation by generating a stop condition (P)

The following procedure is followed to read the SN75DP130 I²C registers:

1. The master initiates a read operation by generating a start condition (S), followed by the SN75DP130 7-bit address and a one-value "W/R" bit to indicate a read cycle
2. The SN75DP130 acknowledges the address cycle
3. The SN75DP130 transmit the contents of the memory registers MSB-first starting at register 00h.
4. The SN75DP130 will wait for either an acknowledge (ACK) or a not-acknowledge (NACK) from the master after each byte transfer; the I²C master acknowledges reception of each data byte transfer
5. If an ACK is received, the SN75DP130 transmits the next byte of data
6. The master terminates the read operation by generating a stop condition (P)

No sub-addressing is included for the read procedure, and reads start at register offset 00h and continue byte by byte through the registers until the I²C master terminates the read operation.

Refer to [SN75DP130 Local I²C Control and Status Registers](#) for SN75DP130 local I²C register descriptions. Reads from reserved fields not described return zeros, and writes are ignored.

9.6 Register Maps

9.6.1 SN75DP130 Local I²C Control and Status Registers

图 20. Local I²C Control and Status Registers

7	6	5	4	3	2	1	0
x	x	x	x	x	x	x	x
R/W	RW	RW	RW	RW	RW	RW	RW

LEGEND: R/W = Read/Write; R = Read only; -n = value after reset

表 7. Offset = 01h

Bit	Field	Type	Description
1	AUTO_POWERDOWN_DISABLE	RW	0 – The SN75DP130 automatically enters Standby mode based on HPD_SNK (default) 1 – The SN75DP130 will not automatically enter Standby mode
0	FORCE_SHUTDOWN_MODE	RW	0 – SN75DP130 is forced to Shutdown mode 1 – Shutdown mode is determined by EN input, normal operation (default)

表 8. Offset = 02h

Bit	Field	Type	Description
7:0	TI_TEST	RW	This field defaults to zero value, and should not be modified.

表 9. Offset = 03h

Bit	Field	Type	Description
5:4	SQUELCH_SENSITIVITY	RW	Main Link squelch sensitivity is selected by this field, and determines the transitions to and from the Output Disable mode. 00 – Main Link IN0p/n squelch detection threshold set to 40mVpp 01 – Main Link IN0p/n squelch detection threshold set to 80mVpp (default) 10 – Main Link IN0p/n squelch detection threshold set to 160mVpp 11 – Main Link IN0p/n squelch detection threshold set to 250mVpp
3	SQUELCH_ENABLE	RW	0 – Main Link IN0p/n squelch detection enabled (default) 1 – Main Link IN0p/n squelch detection disabled

表 10. Offset = 04h

Bit	Field	Type	Description
3	TI_TEST	RW	This field defaults to zero value, and should not be modified.
2	LINK_TRAINING_ENABLE	RW	0 – Link Training is disabled. V _{OD} and Pre-emphasis are configured through the I ² C register interface; the EQ is fixed when this bit is zero. 1 – Link Training is enabled (default)
1:0	AUX_DDC_MUX_CFG	RW	See 表 6 for details on the programming of this field. 00 – AUX_SNK is switched to AUX_SRC for DDC source side based on CAD_SNK (default) 01 – AUX_SNK is switched to AUX_SRC based on the CAD_SNK input, and used to short-circuit AC coupling capacitors in the TMDS operating mode. 10 – AUX_SNK is switched to AUX_SRC side based on the HPD_SNK input, while the DDC source interface remains disabled. 11 – Undefined operation

表 11. Offset = 05h

Bit	Field	Type	Description
7	EQ_I2C_ENABLE	RW	0 – EQ settings controlled by device inputs only (default) 1 – EQ settings controlled by I ² C register settings
6:4	AEQ_L0_LANE0_SET	RW	This field selects the EQ setting for Lane 0 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 0 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)
2:0	AEQ_L1_LANE0_SET	RW	This field selects the EQ setting for Lane 0 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 1 pre-emphasis. This field also selects the fixed EQ setting for the following non-AEQ modes: <ul style="list-style-type: none"> • I2C_EQ_ENABLE is set, the DisplayPort sink is selected, and Link Training is disabled • I2C_EQ_ENABLE is set and the TMDS sink is selected. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)

表 12. Offset = 06h

Bit	Field	Type	Description
6:4	AEQ_L2_LANE0_SET	RW	This field selects the EQ setting for Lane 0 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 2 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)
2:0	AEQ_L3_LANE0_SET	RW	This field selects the EQ setting for Lane 0 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 3 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)

表 13. Offset = 07h

Bit	Field	Type	Description
6:4	AEQ_L0_LANE1_SET	RW	This field selects the EQ setting for Lane 1 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 0 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)
2:0	AEQ_L1_LANE1_SET	RW	This field selects the EQ setting for Lane 1 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 1 pre-emphasis. This field also selects the fixed EQ setting for the following non-AEQ modes: <ul style="list-style-type: none"> • I2C_EQ_ENABLE is set, the DisplayPort sink is selected, and Link Training is disabled • I2C_EQ_ENABLE is set and the TMDS sink is selected. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)

表 14. Offset = 08h

Bit	Field	Type	Description
6:4	AEQ_L2_LANE1_SET	RW	This field selects the EQ setting for Lane 1 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 2 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)
2:0	AEQ_L3_LANE1_SET	RW	This field selects the EQ setting for Lane 1 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 3 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)

表 15. Offset = 09h

Bit	Field	Type	Description
6:4	AEQ_L0_LANE2_SET	RW	<p>This field selects the EQ setting for Lane 2 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 0 pre-emphasis.</p> <p>000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)</p>
2:0	AEQ_L1_LANE2_SET	RW	<p>This field selects the EQ setting for Lane 2 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 1 pre-emphasis. This field also selects the fixed EQ setting for the following non-AEQ modes:</p> <ul style="list-style-type: none"> • I2C_EQ_ENABLE is set, the DisplayPort sink is selected, and Link Training is disabled • I2C_EQ_ENABLE is set and the TMDS sink is selected. <p>000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)</p>

表 16. Offset = 0Ah

Bit	Field	Type	Description
6:4	AEQ_L2_LANE2_SET	RW	<p>This field selects the EQ setting for Lane 2 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 2 pre-emphasis.</p> <p>000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)</p>
2:0	AEQ_L3_LANE2_SET	RW	<p>This field selects the EQ setting for Lane 2 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 3 pre-emphasis.</p> <p>000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)</p>

表 17. Offset = 0Bh

Bit	Field	Type	Description
6:4	AEQ_L0_LANE3_SET	RW	This field selects the EQ setting for Lane 3 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 0 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)
2:0	AEQ_L1_LANE3_SET	RW	This field selects the EQ setting for Lane 3 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 1 pre-emphasis. This field also selects the fixed EQ setting for the following non-AEQ mode: <ul style="list-style-type: none"> • I2C_EQ_ENABLE is set, the DisplayPort sink is selected, and Link Training is disabled 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)

表 18. Offset = 0Ch

Bit	Field	Type	Description
6:4	AEQ_L2_LANE3_SET	RW	This field selects the EQ setting for Lane 3 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 2 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)
2:0	AEQ_L3_LANE3_SET	RW	This field selects the EQ setting for Lane 3 when I2C_EQ_ENABLE is set, the DisplayPort sink is selected, Link Training is enabled, and the Link Training results in Level 3 pre-emphasis. 000 – 0 dB EQ gain (default) 001 – 1.5 dB (HBR); 3.5 dB (HBR2) 010 – 3 dB (HBR); 6 dB (HBR2) 011 – 4 dB (HBR); 8 dB (HBR2) 100 – 5 dB (HBR); 10 dB (HBR2) 101 – 6 dB (HBR); 13 dB (HBR2) 110 – 7 dB (HBR); 15 dB (HBR2) 111 – 9 dB (HBR); 18 dB (HBR2)

表 19. Offset = 15h

Bit	Field	Type	Description
4:3	BOOST	RW	Controls the output pre-emphasis amplitude when the DisplayPort sink is selected; allows to reduce or increase all pre-emphasis settings by ~10%. Setting this field will impact V _{OD} when pre-emphasis is disabled. This setting also impacts the output in TMDS mode for the DisplayPort sink connection when the DisplayPort sink CAD_SNK input is high. 00 – Pre-emphasis reduced by ~10%; V _{OD} reduced by 10% if pre-emphasis is disabled. 01 – Pre-emphasis nominal (default) 10 – Pre-emphasis increased by ~10%; V _{OD} increased by 10% if pre-emphasis is disabled. 11 – Reserved
2	DP_TMDS_VOD	RW	Sets the target output swing in TMDS mode when the DisplayPort sink is selected, where CAD_SNK input is high. 0 – Low TMDS output swing (default) 1 – High TMDS output swing
1:0	DP_TMDS_VPRE	RW	Controls the output pre-emphasis in TMDS mode when the DisplayPort sink is selected, where CAD_SNK input is high. 00 – No TMDS pre-emphasis (default) 01 – Low TMDS pre-emphasis 10 – High TMDS pre-emphasis 11 – Reserved

表 20. Offset = 17h

Bit	Field	Type	Description
3	HPD_TEST_MODE	RW	0 – Normal HPD mode. HPD_SRC reflects the status of HPD_SNK (default) 1 – Test mode. HPD_SNK is pulled high internally, and the HPD_SRC output is driven high and the Main Link is activated, depending on the squelch setting. This mode allows execution of 17h certain tests on SN75DP130 without a connected display sink.
1	CAD_OUTPUT_INVERT	RW	0 – CAD_SRC output high means TMDS cable adapter detected (default) 1 – CAD_SRC output low means TMDS cable adapter detected
0	CAD_TEST_MODE	RW	0 – Normal CAD mode. CAD_SRC reflects the status of CAD_SNK, based on the value of CAD_OUTPUT_INVERT (default) 1 – Test mode. CAD_SRC indicates TMDS mode, depending on the value of CAD_OUTPUT_INVERT; CAD_SNK input is ignored. This mode allows execution of certain tests on SN75DP130 without a connected TMDS display sink.

表 21. Offset = 18h – 1Ah

Bit	Field	Type	Description
7:0	TL_TEST	RW	These registers shall not be modified.

表 22. Offset = 1Bh

Bit	Field	Type	Description
7	I2C_SOFT_RESET	WO	Writing a one to this register resets all I ² C registers to default values. Writing a zero to this register has no effect. Reads from this register return zero.
6	DPCD_RESET	WO	Writing a one to this register resets the DPCD register bits (corresponding to DPCD addresses 103h – 106h, the AEQ_Lx_LANEy_SET bits). Writing a zero to this register has no effect. Reads from this register return zero.

表 23. Offset = 1Ch

Bit	Field	Type	Description
3:0	DPCD_ADDR_HIGH	RW	This value maps to bits 19:16 of the 20-bit DPCD register address accessed through the DPCD_DATA register.

表 24. Offset = 1DH

Bit	Field	Type	Description
7:0	DPCD_ADDR_MID	RW	This value maps to bits 15:8 of the 20-bit DPCD register address accessed through the DPCD_DATA register.

表 25. Offset = 1Eh

Bit	Field	Type	Description
7:0	DPCD_ADDR_LOW	RW	This value maps to bits 7:0 of the 20-bit DPCD register address accessed through the DPCD_DATA register.

表 26. Offset = 1Fh

Bit	Field	Type	Description
7:0	DPCD_DATA	RW	This register contains the data to write into or read from the DPCD register addressed by DPCD_ADDR_HIGH, DPCD_ADDR_MID, and DPCD_ADDR_LOW.

表 27. Offset = 20h

Bit	Field	Type	Description
7:1	DEV_ID_REV.	RO	This field identifies the device and revision. 0000000 – SN75DP130 Revision 0
0	BIT_INVERT	R/W	The value read from this field is the inverse of that written. Default read value is zero.

表 28. Offset = 21h

Bit	Field	Type	Description
7:0	TI_TEST	R/W	These registers shall not be modified.

表 29. Offset = 22h – 27h

Bit	Field	Type	Description
7:0	TI_TEST_RESERVED	RO	These read only registers are reserved for test; writes are ignored.

10 Application and Implementation

注

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. Customers should validate and test their design implementation to confirm system functionality.

10.1 Application Information

The SN75DP130 offers separate AUX and DDC source interfaces that connect to a single AUX sink channel. This minimizes component count when implemented with a graphics processor (GPU) comprising separate DDC and AUX interfaces. For GPUs with combined DDC/AUX, the device can operate as a FET switch to short circuit the AUX channel AC coupling caps while connected to a TMDS sink device.

The configuration shown in 图 21 supports a GPU with separate DDC and AUX interfaces, and overcomes the need for an external AUX to DDC switch. This circuit provides back current protection into the GPU AUX, HPD, and CAD inputs.

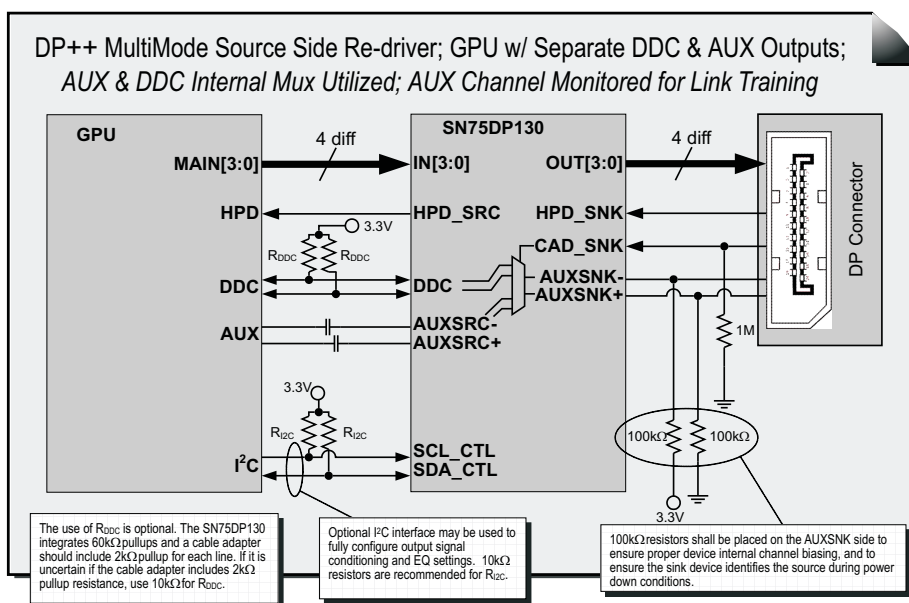


图 21. DP++ Dual-Mode in a Split AUX/DDC Configuration

Application Information (接下页)

The configuration shown in 图 22 is preferred to avoid very long AUX signal stub lines. Furthermore, this configuration provides isolation between the DP connector and the GPU.

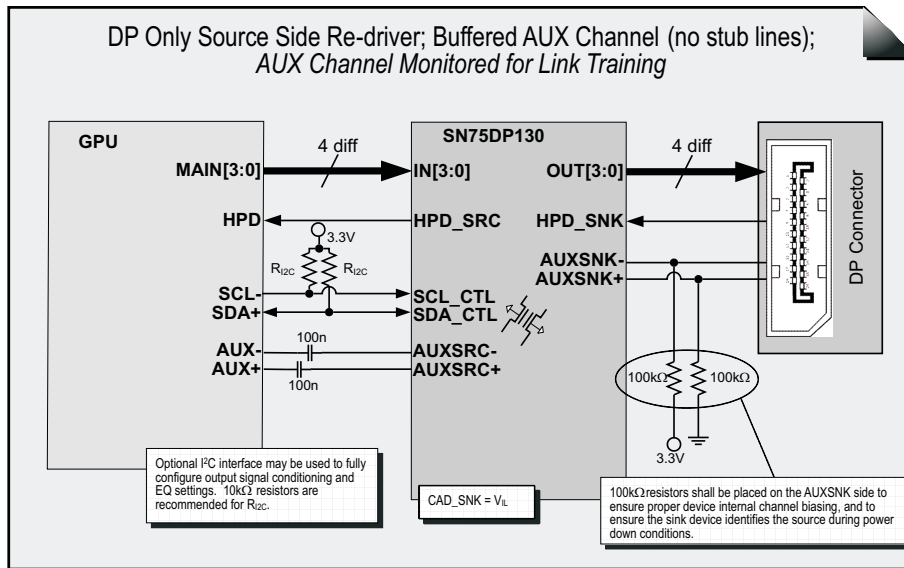


图 22. DP Only Configuration with AUX Pass Through

The configuration shown in 图 23 enables the SN75DP130 in DP++ Dual-Mode with the AUX input only monitoring the AUX channel. Use this setting when AUX stub lines can be kept short and minimum AUX attenuation is desired. For DP v1.1a, the stub length shall not exceed 4cm each, and for DP v1.2 with FAUX support each stub line shall be shorter than 1cm.

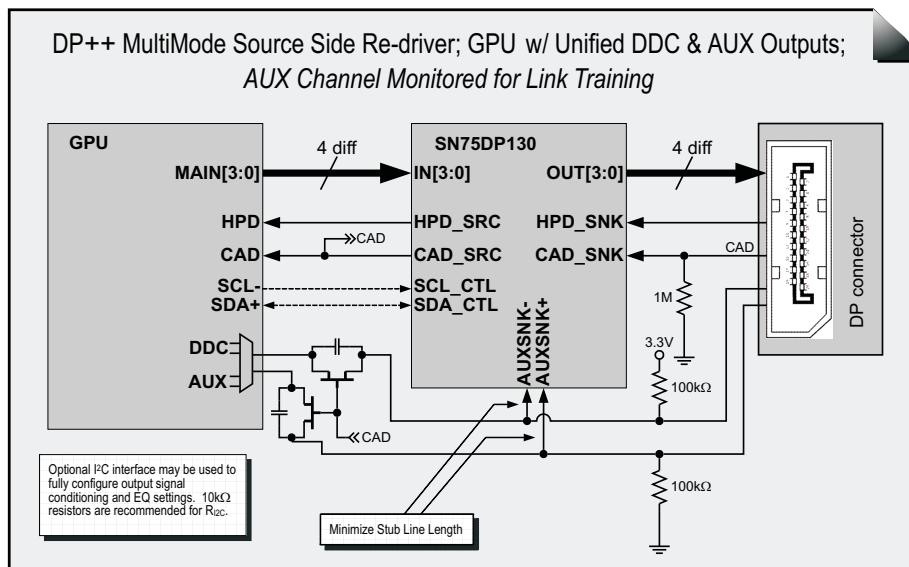


图 23. DP++ Dual-Mode Configuration with AUX Monitor

Application Information (接下页)

The alternate configuration shown in 图 24 allows a reduced BOM by eliminating the need for external FET switches while routing AUX and DDC externally, which eliminates any insertion loss cases of AUX is brought through the SN75DP130. For DP v1.2 with FAUX support each stub line shall be shorter than 1cm.

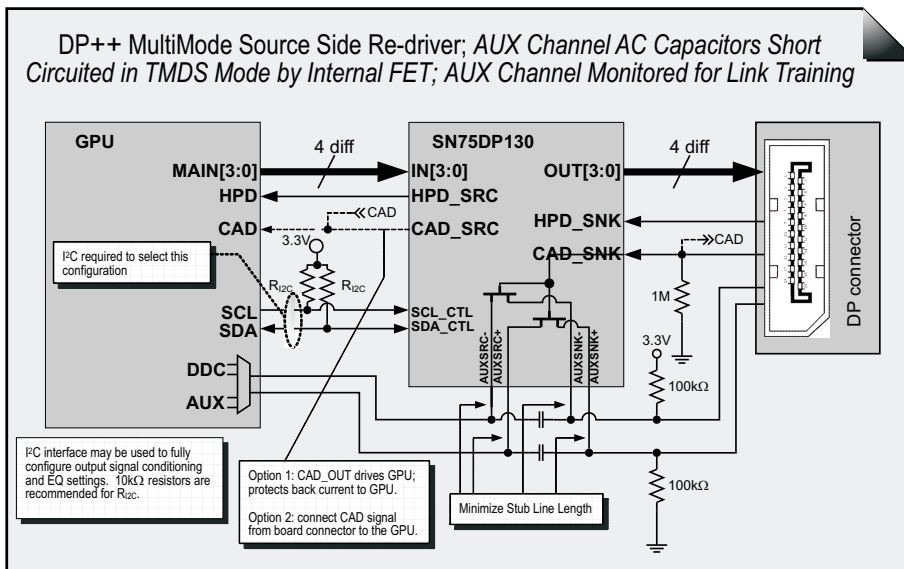


图 24. Alternate Low-BOM DP++ Dual-Mode Configuration

The previous application examples were specifically concerned with source side implementations of the SN75DP130. Even though source applications (notebook, docking station, and so forth) are the primary target application for the DP130A, the DP130A can also be used in a sink application, such as a DisplayPort monitor. The reader is referred to [SLLA349](#) (*Implementation Guide: DP130 in a Sink*) for a detailed discussions of the implementation guidelines for sink applications.

10.2 Typical Application

The configuration shown in 图 25 supports a GPU with unified AUX/DDC interfaces. This circuit provides back current protection into the GPU AUX, HPD, and CAD inputs.

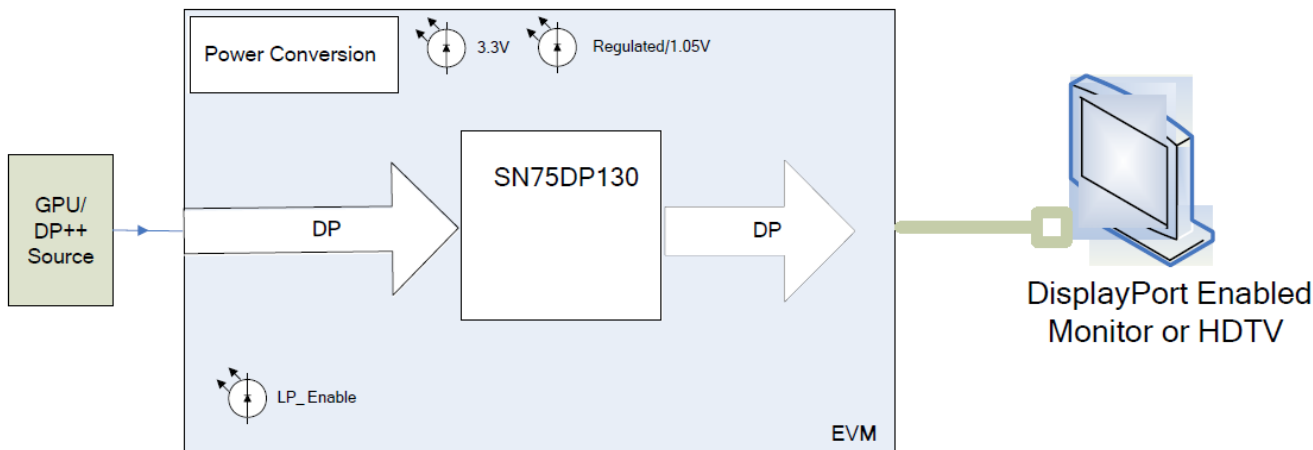


图 25. Typical Application Schematic

Typical Application (接下页)

10.2.1 Design Requirements

For this design example, use the parameters listed in 表 30 as the input parameters.

表 30. Design Parameters

DESIGN PARAMETERS	VALUE
VCC power supply	3.3 V
VDD power supply	1.1 V
DP single-ended impedance	50 Ω

10.2.2 Detailed Design Procedure

10.2.2.1 Logic I²C Interface

The internal registers of the SN75DP130 are accessed through the SCL_CTL pin and 3 SDA_CTL pin. The 7-bit I²C slave address of the DP130 is determined by the ADDR_EQ pin 4.

表 31. I²C Slave Address Selection

ADDR_EQ	7-BIT I ² C SLAVE ADDRESS	READ SLAVE ADDRESS	WRITE SLAVE ADDRESS
Low (VIL)	7'b0101100	'h59	'h58
VCC/2 (VIM)	7'b0101101	'h5B	'h5A
High (VIH)	7'b0101110	'h5D	'h5C

10.2.2.2 CAD Sink Over Ride

For testing and debug purposes, leave a place holder on the CAD_SNK input in order to have the option to independently set the DP130 in DP or TMDS mode. A 2k pull-up on this place holder will set the DP130 in TMDS mode independent of the Sink.

10.2.2.3 HPD Sink Over Ride

For testing and debug purposes, leave a place holder on the HPD_SNK input in order to have the option to force the presence of the sink. A 2k pull-up on this place holder will provide an indication of the sink presence.

10.2.3 Application Curves



图 26. Input Into DP130

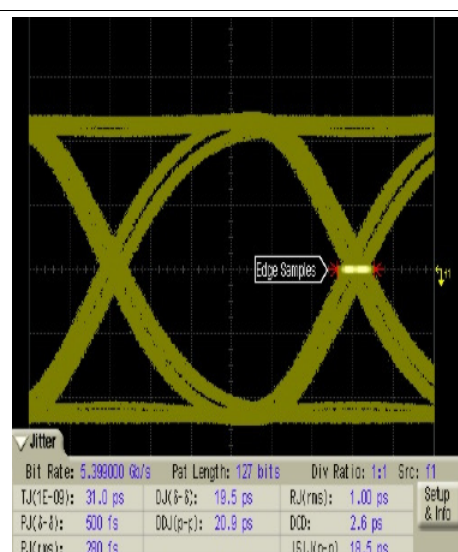


图 27. Eye Diagram (EQ = 3.5 dB)

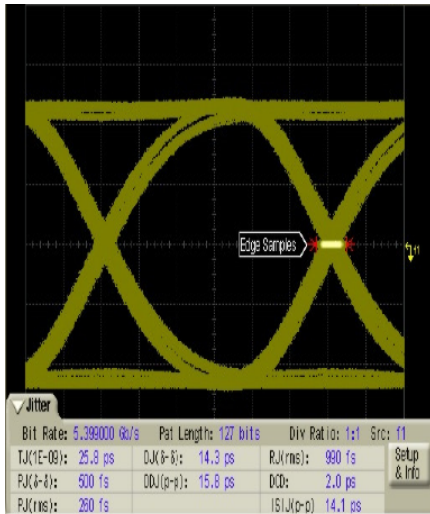


图 28. Eye Diagram (EQ = 6 dB)

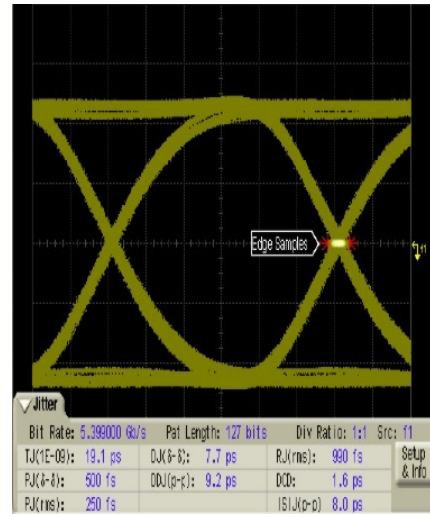


图 29. Eye Diagram (EQ = 8 dB)

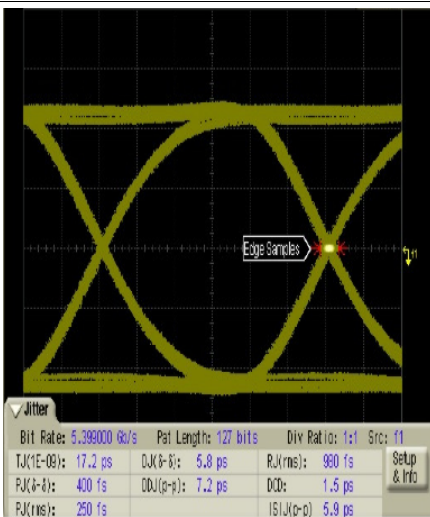


图 30. Eye Diagram (EQ = 10 dB)

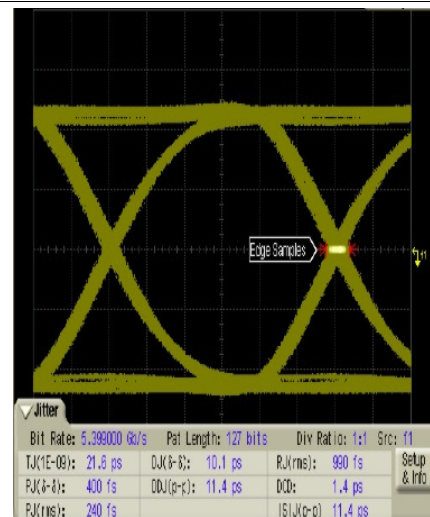


图 31. Eye Diagram (EQ = 13 dB)

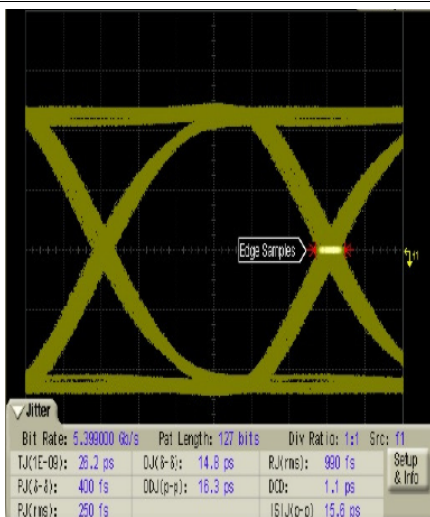


图 32. Eye Diagram (EQ = 15 dB)

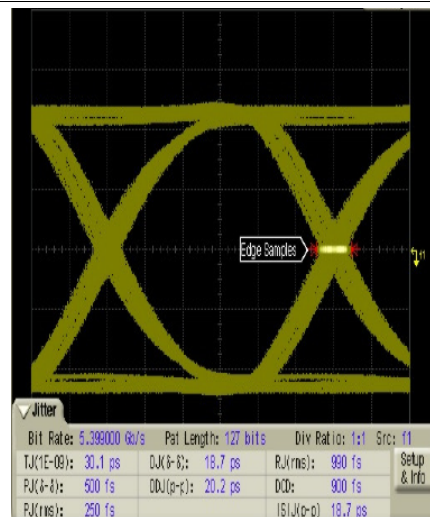


图 33. Eye Diagram (EQ = 18 dB)

11 Power Supply Recommendations

11.1 SN75DP130 Power Sequencing

The following power-up and power-down sequences describe how the RSTN signal is applied to the SN75DP130. See [Power Dissipation](#).

11.1.1 Power-Up Sequence:

1. Apply V_{CC} with less than a 10-ms ramp time for the SN75DP130 and for the SN75DP130, apply V_{DDd} then V_{CC} (both having less than 10-ms ramp time) devices. V_{DDd} must be asserted first and stable for greater than 10 μ s before V_{CC} is applied.
2. RSTN must remain asserted until V_{CC}/V_{DDd} voltage has reached minimum recommended operation for more than 100 μ s.
3. De-assert RSTN (Note: This RSTN is a 1.05-V interface and is internally connected to V_{DDd_dreg} through a 150-k Ω resistor).
4. Device will be available for operation approximately 400 ms after a valid reset.

11.1.2 Power-Down Sequence:

1. Assert RSTN to the device.
2. Remove V_{CC} and V_{DDd} .

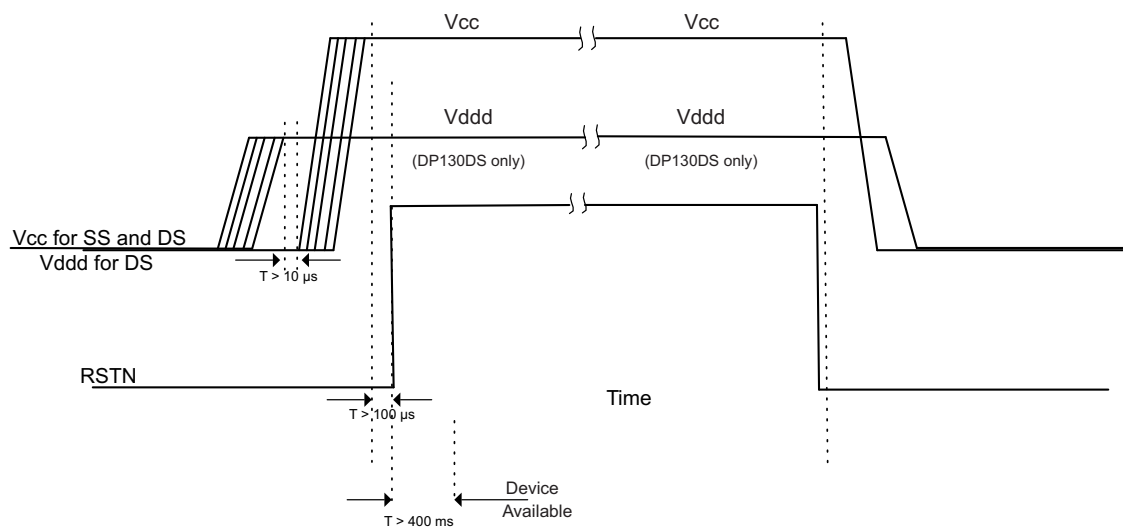


图 34. Power-Up and Power-Down Sequence

SN75DP130 Power Sequencing (接下页)

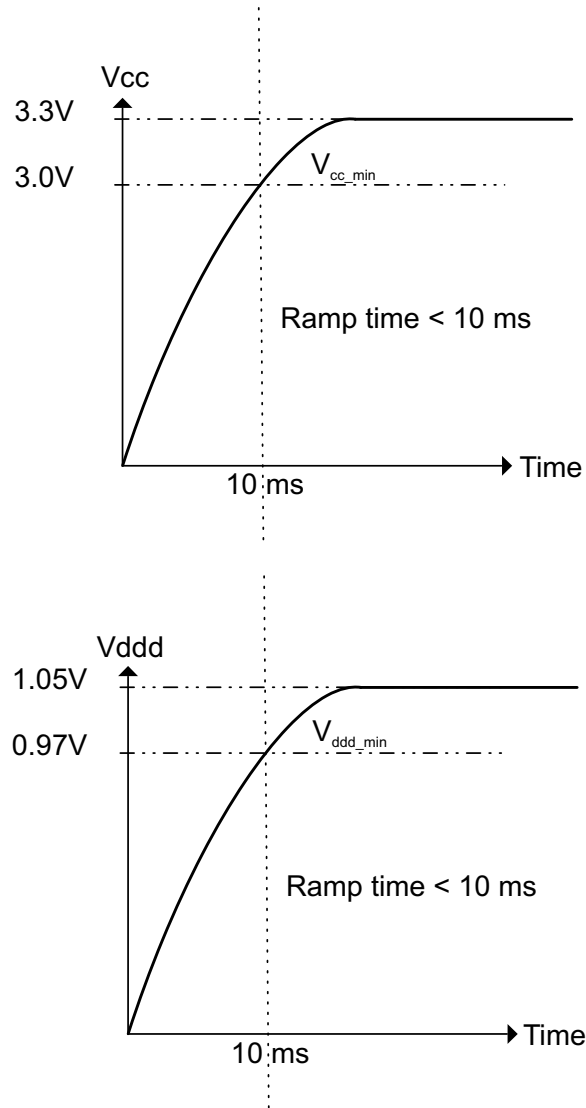


图 35. V_{CC}/V_{DDD} Ramp Recommendation

SN75DP130 Power Sequencing (接下页)

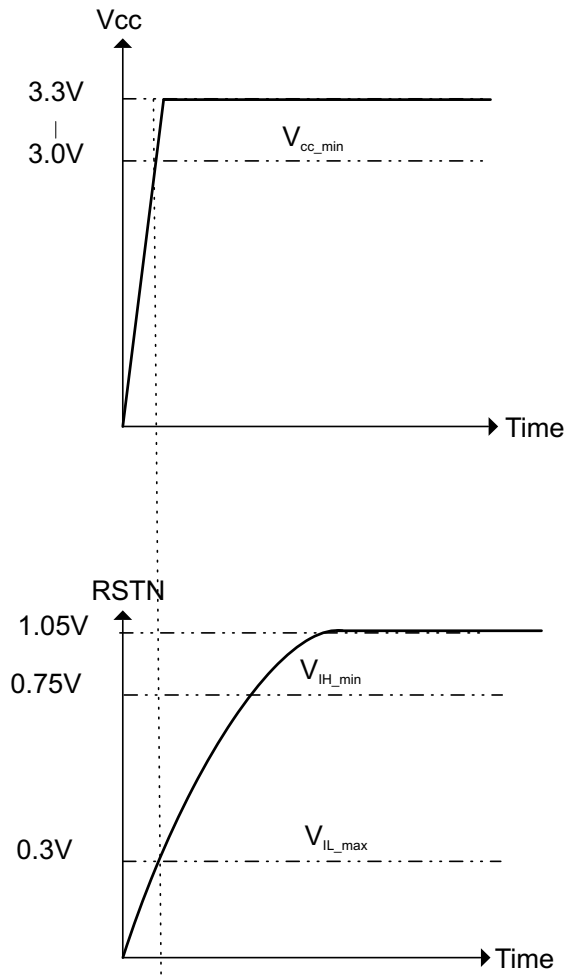


图 36. RSTN Voltage Thresholds

12 Layout

12.1 Layout Guidelines

- Decoupling with small current loops is recommended.
- TI recommends placing the decoupling capacitor as close as possible to the device and on the same side of the PCB.
- Choose the capacitor such that the resonant frequency of the capacitor does not align closely with 5.4 GHz.
- Also provide several GND vias to the thermal pad to minimize the area of current loops.

12.1.1 Layer Stack

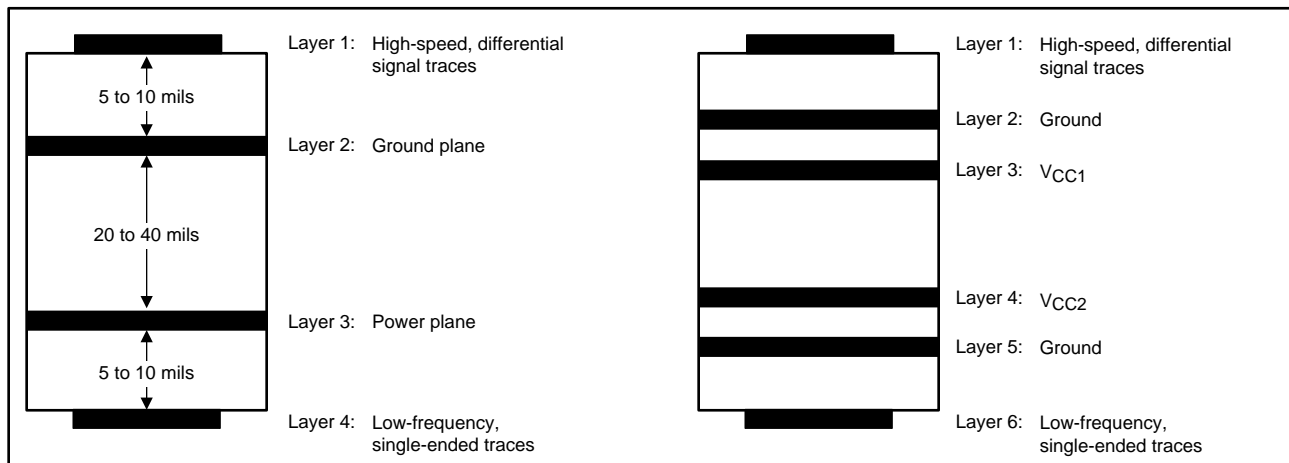


图 37. Recommended 4- or 6-Layer (0.062") Stack for a Receiver PCB Design

Routing the high-speed differential signal traces on the top layer avoids the use of vias (and the introduction of their inductances) and allows for clean interconnects from the DisplayPort connectors to the repeater inputs and from the repeater output to the subsequent receiver circuit.

Placing a solid ground plane next to the high-speed signal layer establishes controlled impedance for transmission line interconnects and provides an excellent low-inductance path for the return current flow.

Placing the power plane next to the ground plane creates additional high-frequency bypass capacitance.

Routing the fast-edged control signals on the bottom layer by prevents them from cross-talking into the high-speed signal traces and minimizes EMI.

If the receiver requires a supply voltage different from the one of the repeater, add a second power/ground plane system to the stack to keep it symmetrical. This makes the stack mechanically stable and prevents it from warping. Also, the power and ground plane of each power system can be placed closer together, thus increasing the high-frequency bypass capacitance significantly. Finally, a second power/ground system provides added isolation between the signal layers.

Layout Guidelines (接下页)

12.1.2 Differential Traces

Guidelines for routing PCB traces are necessary when trying to maintain signal integrity and lower EMI. Although there seems to be an endless number of precautions to be taken, this section provides only a few main recommendations as layout guidance.

1. Reduce intra-pair skew in a differential trace by introducing small meandering corrections at the point of mismatch.
2. Reduce inter-pair skew, caused by component placement and IC pinouts, by making larger meandering correction along the signal path. Use chamfered corners with a length-to-trace width ratio of between 3 and 5. The distance between bends should be 8 to 10 times the trace width.
3. Use 45-degree bends (chamfered corners), instead of right-angle (90°) bends. Right-angle bends increase the effective trace width, which changes the differential trace impedance creating large discontinuities. A 45-degree bend is seen as a smaller discontinuity.
4. When routing around an object, route both trace of a pair in parallel. Splitting the traces changes the line-to-line spacing, thus causing the differential impedance to change and discontinuities to occur.
5. Place passive components within the signal path, such as source-matching resistors or ac-coupling capacitors, next to each other. Routing as in case a) creates wider trace spacing than in b), the resulting discontinuity, however, is limited to a far narrower area.
6. When routing traces next to a via or between an array of vias, make sure that the via clearance section does not interrupt the path of the return current on the ground plane below.
7. Avoid metal layers and traces underneath or between the pads off the DisplayPort connectors for better impedance matching. Otherwise they will cause the differential impedance to drop below 75 Ω and fail the board during TDR testing.
8. Use the smallest size possible for signal trace vias and DisplayPort connector pads as they have less impact on the 100- Ω differential impedance. Large vias and pads can cause the impedance to drop below 85 Ω .
9. Use solid power and ground planes for 100- Ω impedance control and minimum power noise.
10. For 100- Ω differential impedance, use the smallest trace spacing possible, which is usually specified by the PCB vendor.
11. Keep the trace length between the DisplayPort connector and the DisplayPort device as short as possible to minimize attenuation.
12. Use good DisplayPort connectors whose impedances meet the specifications.
13. Place bulk capacitors (for example, 10 μF) close to power sources, such as voltage regulators or where the power is supplied to the PCB.
14. Place smaller 0.1- μF or 0.01- μF capacitors at the device.

12.2 Layout Example

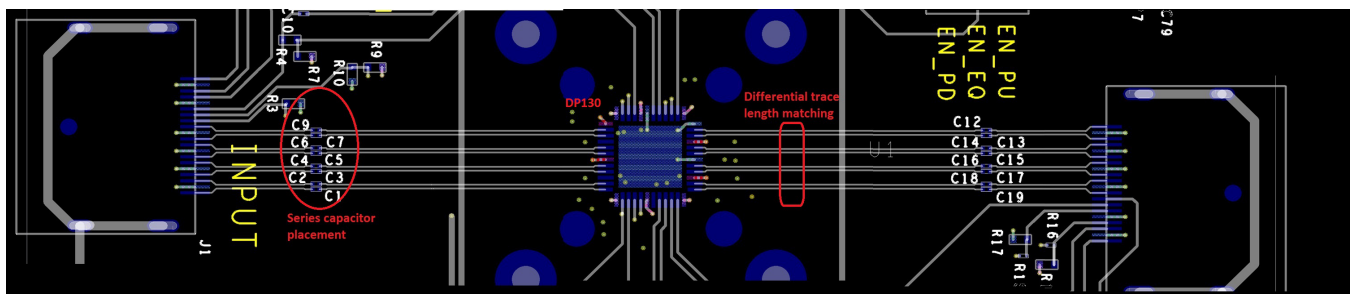


图 38. Layout Example

13 器件和文档支持

13.1 商标

DisplayPort is a trademark of VESA Standards Association.
All other trademarks are the property of their respective owners.

13.2 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

13.3 术语表

[SLYZ022](#) — *TI* 术语表。

这份术语表列出并解释术语、首字母缩略词和定义。

14 机械封装和可订购信息

以下页中包括机械封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

重要声明

德州仪器(TI)及其下属子公司有权根据 JESD46 最新标准,对所提供的产品和服务进行更正、修改、增强、改进或其它更改,并有权根据 JESD48 最新标准中止提供任何产品和服务。客户在下订单前应获取最新的相关信息,并验证这些信息是否完整且是最新的。所有产品的销售都遵循在订单确认时所提供的TI 销售条款与条件。

TI 保证其所销售的组件的性能符合产品销售时 TI 半导体产品销售条件与条款的适用规范。仅在 TI 保证的范围内,且 TI 认为有必要时才会使用测试或其它质量控制技术。除非适用法律做出了硬性规定,否则没有必要对每种组件的所有参数进行测试。

TI 对应用帮助或客户产品设计不承担任何义务。客户应对其使用 TI 组件的产品和应用自行负责。为尽量减小与客户产品和应用相关的风险,客户应提供充分的设计与操作安全措施。

TI 不对任何 TI 专利权、版权、屏蔽作品权或其它与使用了 TI 组件或服务的组合设备、机器或流程相关的 TI 知识产权中授予的直接或隐含权限作出任何保证或解释。TI 所发布的与第三方产品或服务有关的信息,不能构成从 TI 获得使用这些产品或服务的许可、授权、或认可。使用此类信息可能需要获得第三方的专利权或其它知识产权方面的许可,或是 TI 的专利权或其它知识产权方面的许可。

对于 TI 的产品手册或数据表中 TI 信息的重要部分,仅在没有对内容进行任何篡改且带有相关授权、条件、限制和声明的情况下才允许进行复制。TI 对此类篡改过的文件不承担任何责任或义务。复制第三方的信息可能需要服从额外的限制条件。

在转售 TI 组件或服务时,如果对该组件或服务参数的陈述与 TI 标明的参数相比存在差异或虚假成分,则会失去相关 TI 组件或服务的所有明示或暗示授权,且这是不正当的、欺诈性商业行为。TI 对任何此类虚假陈述均不承担任何责任或义务。

客户认可并同意,尽管任何应用相关信息或支持仍可能由 TI 提供,但他们将独力负责满足与其产品及其在应用中使用的 TI 产品相关的所有法律、法规和安全相关要求。客户声明并同意,他们具备制定与实施安全措施所需的全部专业技术和知识,可预见故障的危险后果、监测故障及其后果、降低有可能造成人身伤害的故障的发生机率并采取适当的补救措施。客户将全额赔偿因在此类安全关键应用中使用任何 TI 组件而对 TI 及其代理造成的任何损失。

在某些场合中,为了推进安全相关应用有可能对 TI 组件进行特别的促销。TI 的目标是利用此类组件帮助客户设计和创立其特有的可满足适用的功能安全性标准和要求的终端产品解决方案。尽管如此,此类组件仍然服从这些条款。

TI 组件未获得用于 FDA Class III (或类似的生命攸关医疗设备)的授权许可,除非各方授权官员已经达成了专门管控此类使用的特别协议。

只有那些 TI 特别注明属于军用等级或“增强型塑料”的 TI 组件才是设计或专门用于军事/航空应用或环境的。购买者认可并同意,对并非指定面向军事或航空航天用途的 TI 组件进行军事或航空航天方面的应用,其风险由客户单独承担,并且由客户独力负责满足与此类使用相关的所有法律和法规要求。

TI 已明确指定符合 ISO/TS16949 要求的产品,这些产品主要用于汽车。在任何情况下,因使用非指定产品而无法达到 ISO/TS16949 要求, TI 不承担任何责任。

	产品		应用
数字音频	www.ti.com.cn/audio	通信与电信	www.ti.com.cn/telecom
放大器和线性器件	www.ti.com.cn/amplifiers	计算机及周边	www.ti.com.cn/computer
数据转换器	www.ti.com.cn/dataconverters	消费电子	www.ti.com.cn/consumer-apps
DLP® 产品	www.dlp.com	能源	www.ti.com.cn/energy
DSP - 数字信号处理器	www.ti.com.cn/dsp	工业应用	www.ti.com.cn/industrial
时钟和计时器	www.ti.com.cn/clockandtimers	医疗电子	www.ti.com.cn/medical
接口	www.ti.com.cn/interface	安防应用	www.ti.com.cn/security
逻辑	www.ti.com.cn/logic	汽车电子	www.ti.com.cn/automotive
电源管理	www.ti.com.cn/power	视频和影像	www.ti.com.cn/video
微控制器 (MCU)	www.ti.com.cn/microcontrollers		
RFID 系统	www.ti.com.cn/rfidsys		
OMAP应用处理器	www.ti.com/omap		
无线连通性	www.ti.com.cn/wirelessconnectivity	德州仪器在线技术支持社区	www.deyisupport.com

邮寄地址: 上海市浦东新区世纪大道1568号, 中建大厦32楼邮政编码: 200122
Copyright © 2015, 德州仪器半导体技术(上海)有限公司

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
SN75DP130DSRGZR	ACTIVE	VQFN	RGZ	48	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	0 to 85	DP130DS	Samples
SN75DP130DSRGZT	ACTIVE	VQFN	RGZ	48	250	RoHS & Green	NIPDAU	Level-3-260C-168 HR	0 to 85	DP130DS	Samples
SN75DP130SSRGZR	ACTIVE	VQFN	RGZ	48	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	0 to 85	DP130SS	Samples
SN75DP130SSRGZT	ACTIVE	VQFN	RGZ	48	250	RoHS & Green	NIPDAU	Level-3-260C-168 HR	0 to 85	DP130SS	Samples

(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.

OBSOLETE: 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.

(5) 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.

(6) **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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and

continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

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
SN75DP130DSRGZR	VQFN	RGZ	48	2500	330.0	16.4	7.3	7.3	1.1	12.0	16.0	Q2
SN75DP130DSRGZT	VQFN	RGZ	48	250	180.0	16.4	7.3	7.3	1.1	12.0	16.0	Q2
SN75DP130SSRGZR	VQFN	RGZ	48	2500	330.0	16.4	7.3	7.3	1.1	12.0	16.0	Q2
SN75DP130SSRGZT	VQFN	RGZ	48	250	180.0	16.4	7.3	7.3	1.1	12.0	16.0	Q2

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN75DP130DSRGZR	VQFN	RGZ	48	2500	367.0	367.0	38.0
SN75DP130DSRGZT	VQFN	RGZ	48	250	210.0	185.0	35.0
SN75DP130SSRGZR	VQFN	RGZ	48	2500	367.0	367.0	38.0
SN75DP130SSRGZT	VQFN	RGZ	48	250	210.0	185.0	35.0

GENERIC PACKAGE VIEW

RGZ 48

VQFN - 1 mm max height

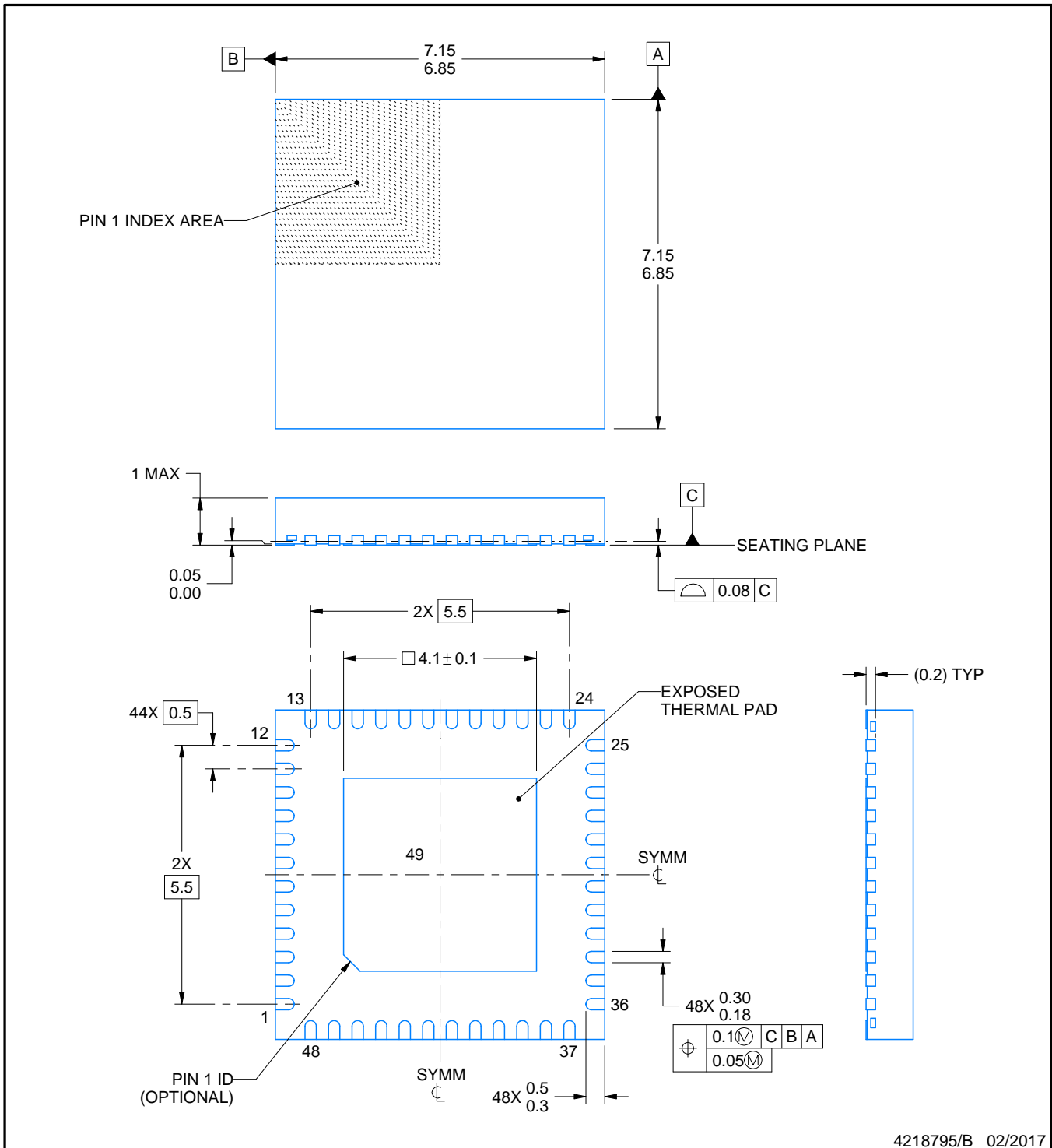
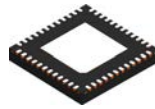
7 x 7, 0.5 mm pitch

PLASTIC QUADFLAT PACK- 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.

4224671/A



4218795/B 02/2017

NOTES:

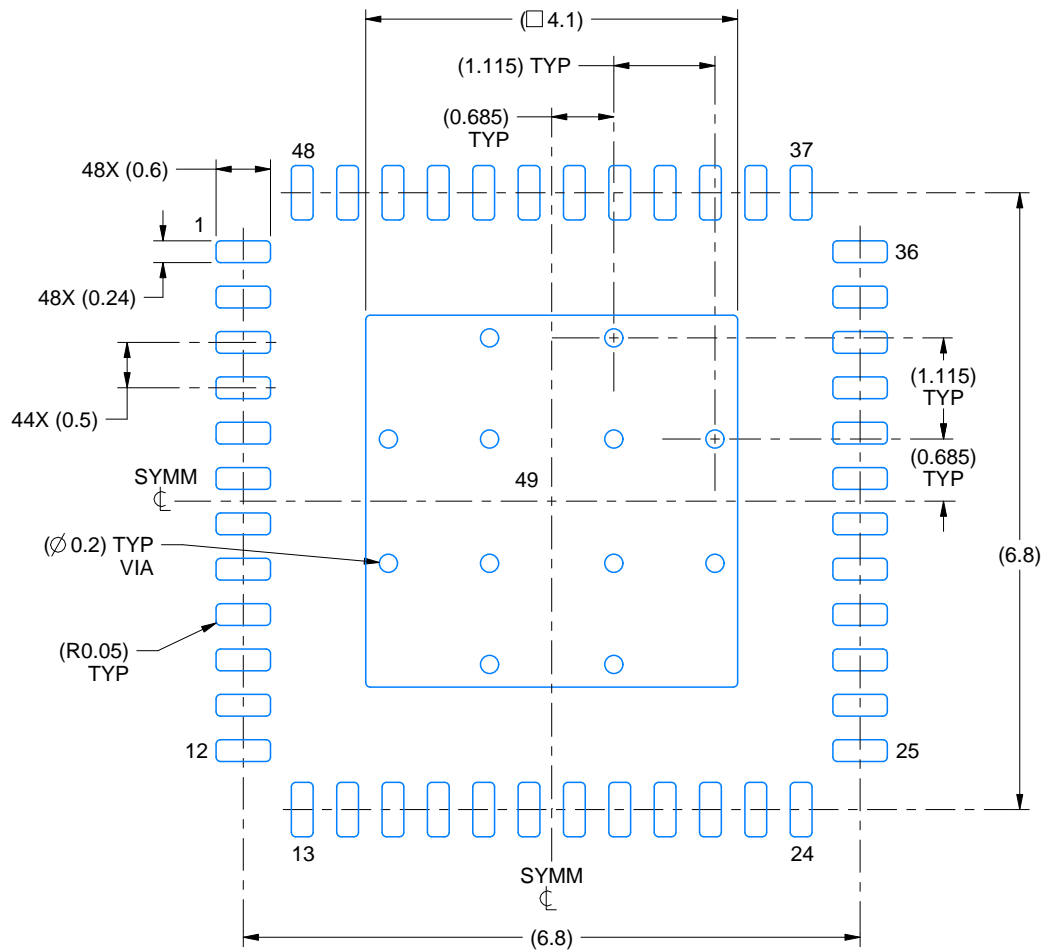
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

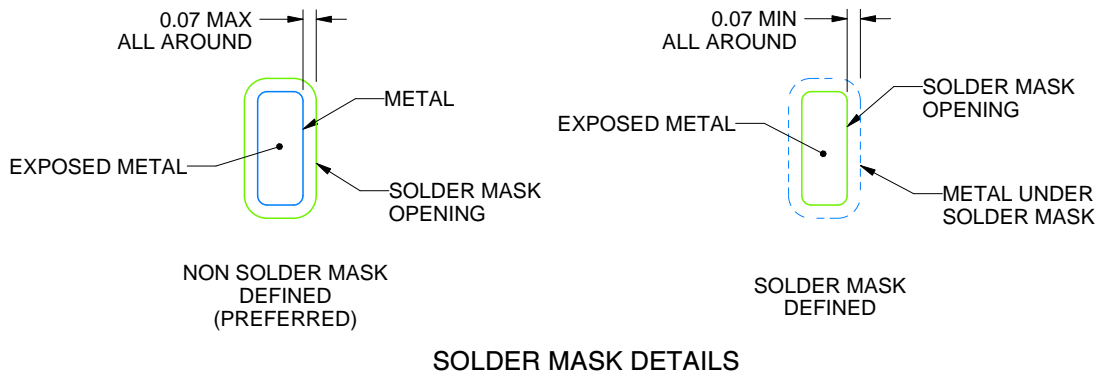
RGZ0048B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:12X



SOLDER MASK DETAILS

4218795/B 02/2017

NOTES: (continued)

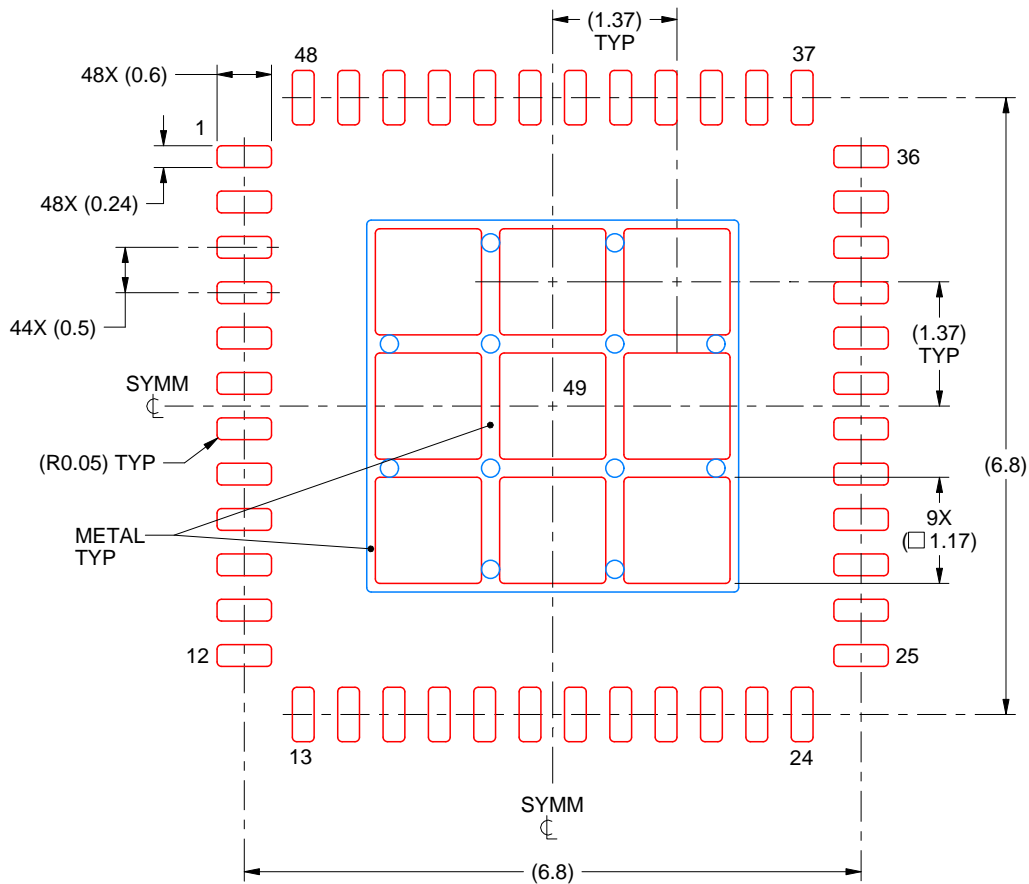
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown 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



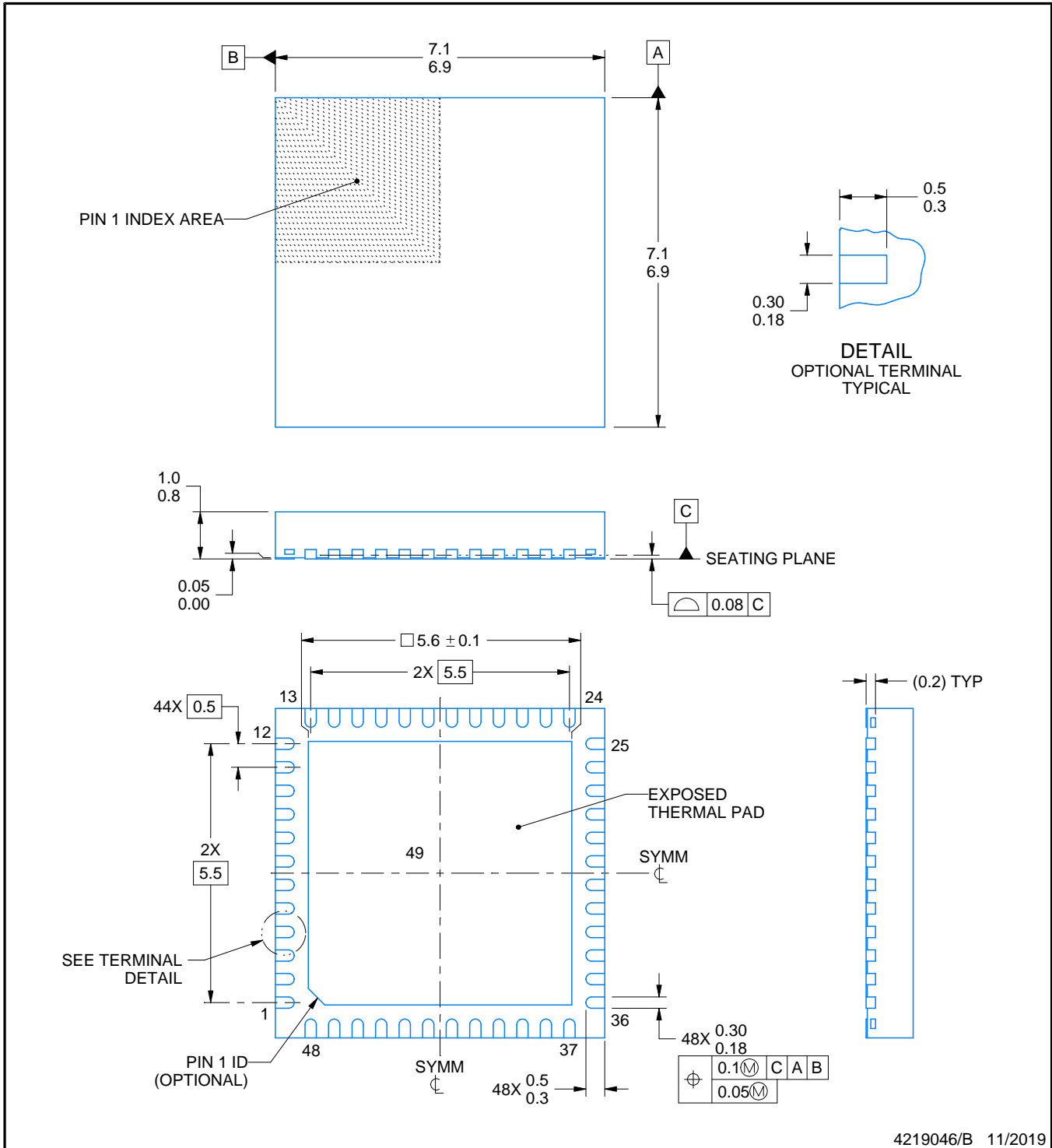
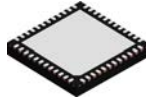
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 49
73% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:12X

4218795/B 02/2017

NOTES: (continued)

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



4219046/B 11/2019

NOTES:

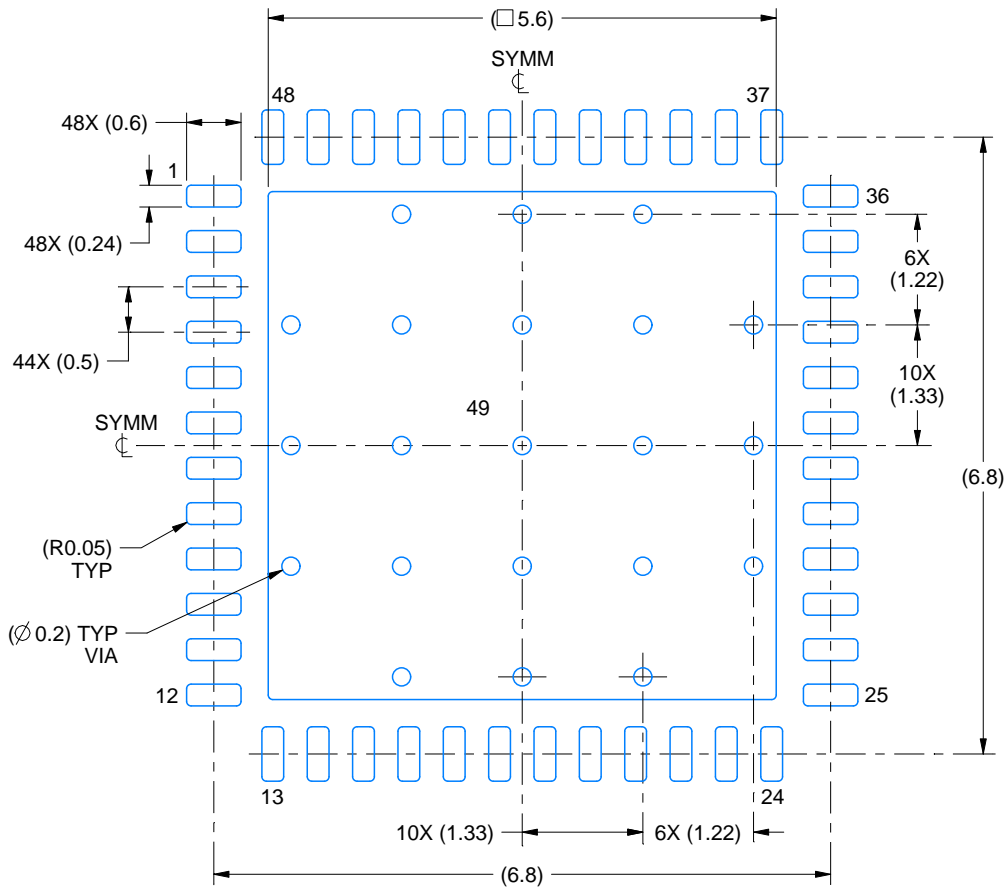
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

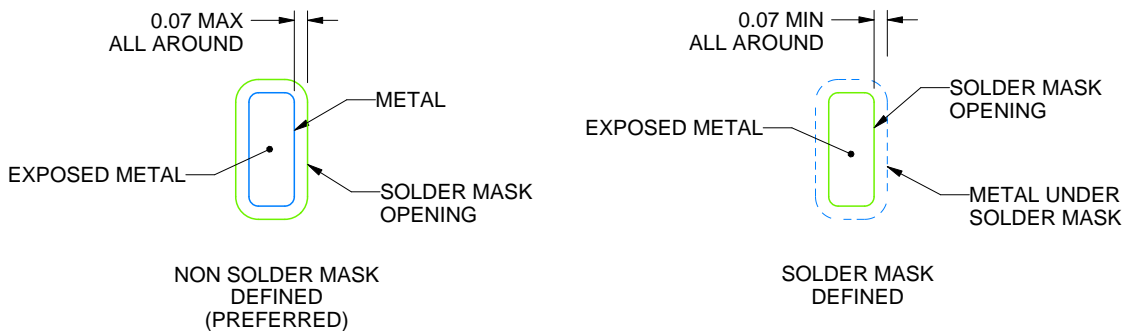
RGZ0048D

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:12X



SOLDER MASK DETAILS

4219046/B 11/2019

NOTES: (continued)

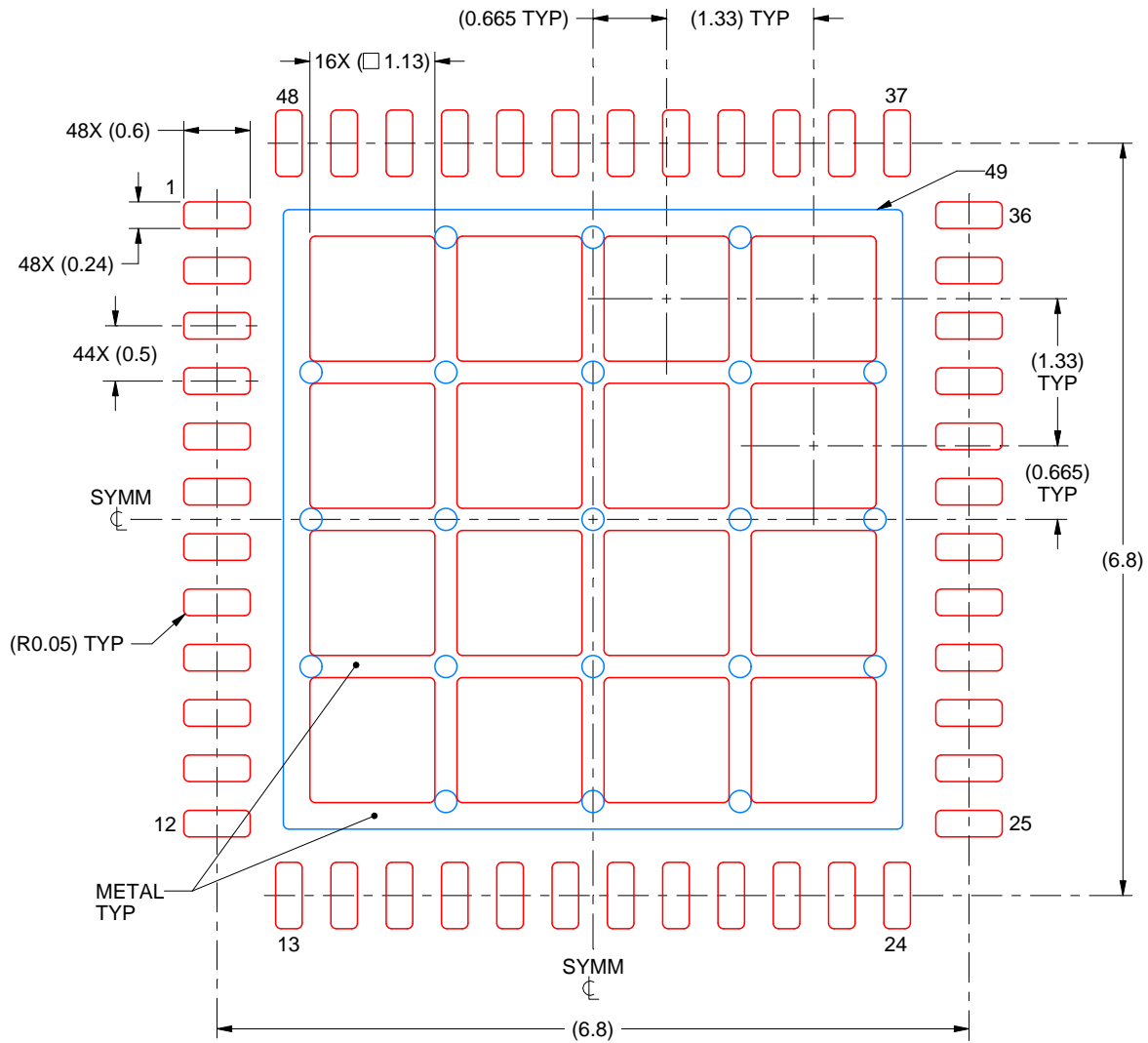
- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown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

EXAMPLE STENCIL DESIGN

RGZ0048D

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 49
66% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:15X

4219046/B 11/2019

NOTES: (continued)

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

重要声明和免责声明

TI 均以“原样”提供技术性及其可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证其中不含任何瑕疵，且不做任何明示或暗示的担保，包括但不限于对适销性、适合某特定用途或不侵犯任何第三方知识产权的暗示担保。

所述资源可供专业开发人员应用TI 产品进行设计使用。您将对以下行为独自承担全部责任：(1) 针对您的应用选择合适的TI 产品；(2) 设计、验证并测试您的应用；(3) 确保您的应用满足相应标准以及任何其他安全、安保或其他要求。所述资源如有变更，恕不另行通知。TI 对您使用所述资源的授权仅限于开发资源所涉及TI 产品的相关应用。除此之外不得复制或展示所述资源，也不提供其它TI 或任何第三方的知识产权授权许可。如因使用所述资源而产生任何索赔、赔偿、成本、损失及债务等，TI 对此概不负责，并且您须赔偿由此对TI 及其代表造成的损害。

TI 所提供产品均受TI 的销售条款 (<http://www.ti.com.cn/zh-cn/legal/termsofsale.html>) 以及ti.com.cn 上或随附TI 产品提供的其他可适用条款的约束。TI 提供所述资源并不扩展或以其他方式更改TI 针对TI 产品所发布的可适用的担保范围或担保免责声明。

邮寄地址：上海市浦东新区世纪大道 1568 号中建大厦 32 楼，邮政编码：200122

Copyright © 2020 德州仪器半导体技术（上海）有限公司