



10-Bit, Low-Power, 10MHz-to-20MHz Serializer and Deserializer Chipset

General Description

The MAX9225/MAX9226 serializer/deserializer chipset reduces wiring by serializing 10 bits onto a single differential pair. Ten bits are serialized in each cycle of the parallel input clock resulting in a 100Mbps to 200Mbps net serial-data rate. The MAX9225 serializes the 8-bit YUV, HSYNC and VSYNC outputs from a camera mounted in the flip part of the phone, reducing wiring through the hinge to the baseband processor in the base of the phone. The 2-wire serial interface uses low-current differential signaling (LCDS) for low EMI, high common-mode noise immunity, and ground-shift tolerance. The MAX9225/MAX9226 automatically identify the word boundary in the serial data in case of signal interruption. The MAX9226 power-down is controlled by the MAX9225. The MAX9225/MAX9226 consume 3.5 μ A or less in power-down mode.

The MAX9225 serializer operates from a single +2.375V to +3.465V supply and accepts +1.71V to +3.465V inputs. The MAX9226 deserializer operates from a +2.375V to +3.465V core supply and has a separate output buffer supply (VDDO), allowing +1.71V to +3.465V output high levels.

The MAX9225/MAX9226 are specified over the -40°C to +85°C extended temperature range and are available in 16-pin TQFN (3mm x 3mm x 0.8mm) packages with an exposed paddle.

Applications

Cell Phone Cameras
Digital Cameras

Features

- ◆ Ideal for Serializing Cell Phone Camera Parallel Interface
- ◆ MAX9225 Serializes 8-Bit YUV, HSYNC, and VSYNC
- ◆ LCDS Rejects Common-Mode Noise
- ◆ Automatic Location of Word Boundary After Signal Interruption
- ◆ Power-Down Control Through the Serial Link
- ◆ Power-Down Supply Current
0.5 μ A (max) for MAX9225
3.0 μ A (max) for MAX9226
- ◆ +2.375V to +3.465V Core Supply Voltage
- ◆ Parallel I/O Interfaces Directly to 1.8V to 3.3V Logic
- ◆ ± 15 kV Human Body Model ESD Protection
- ◆ -40°C to +85°C Operating Temperature Range

Ordering Information

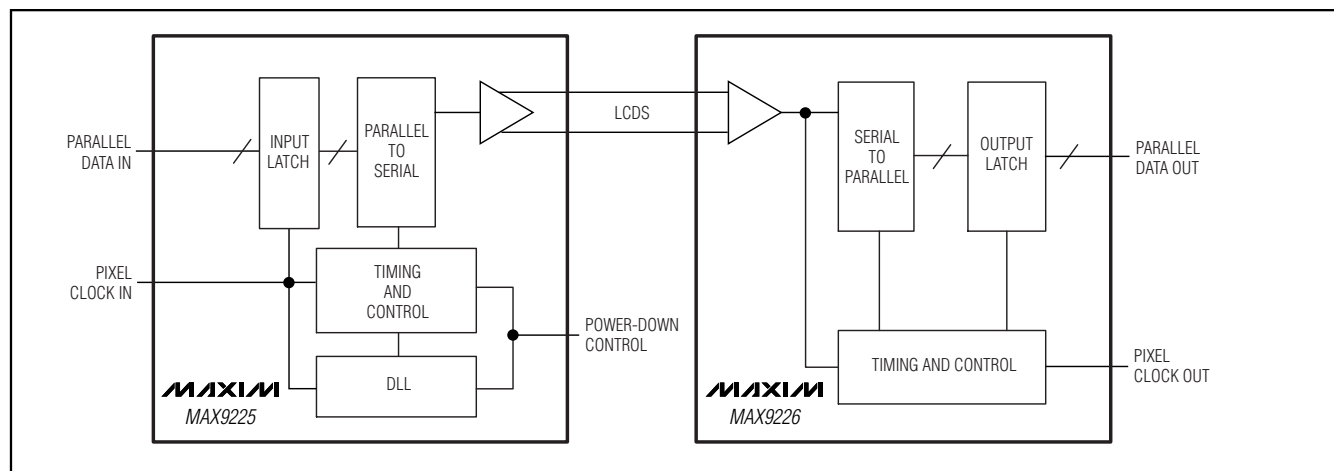
PART	TEMP RANGE	PIN-PACKAGE	PKG CODE	TOP MARK
MAX9225ETE	-40°C to +85°C	16 TQFN-EP*	T1633-4	ADO
MAX9225ETE+	-40°C to +85°C	16 TQFN-EP*	T1633-4	ADO
MAX9226ETE	-40°C to +85°C	16 TQFN-EP*	T1633-4	ADX
MAX9226ETE+	-40°C to +85°C	16 TQFN-EP*	T1633-4	ADX

+ Denotes lead-free package.

*EP = Exposed paddle.

Pin Configurations appear at end of data sheet.

Typical Application Circuit



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ABSOLUTE MAXIMUM RATINGS

V _{DD} to GND	-0.5V to +4.0V
V _{DDO} to GND.....	-0.5V to +4.0V
Serial Interface (SDO+, SDO-, SDI+, SDI-) to GND	-0.5V to +4.0V
Single-Ended Inputs (DIN_, PCLKIN, PWRDN) to GND	-0.5V to (V _{DD} + 0.5V)
Single-Ended Outputs (DOUT_, PCLKOUT) to GND	-0.5V to (V _{DDO} + 0.5V)
Continuous Power Dissipation (T _A = +70°C)	
16-Pin TQFN (3mm x 3mm x 0.8mm)	
Multilayer PC Board (derate 20.8mW/°C above +70°C).....	1667mW
Single-Layer PC Board (derate 15.6mW/°C above +70°C).....	1250mW

Storage Temperature Range	-65°C to +150°C
Junction Temperature.....	+150°C
Lead Temperature (soldering, 10s)	+300°C
ESD Protection (Human Body Model)	
SDO+, SDO-, SDI+, SDI- to GND	> ±15kV
All Other Pins to GND	> ±2kV

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS (MAX9225)

(V_{DD} = +2.375V to +3.465V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = +2.5V, T_A = +25°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SINGLE-ENDED INPUTS (PCLKIN, DIN_, PWRDN)							
High-Level Input Voltage	V _{IH}			1.19	V _{DD} + 0.3		V
Low-Level Input Voltage	V _{IL}			-0.3	+0.3		V
Input Current	I _{IN}	V _{IN} = 0V to V _{DD}		-20	+20		μA
		-0.3V ≤ V _{IN} < 0V		-100	+100		
		V _{DD} < V _{IN} ≤ (V _{DD} + 0.3V)					
LCDS OUTPUT (SDO+, SDO-)							
Differential Output Current	I _{ODH}	High level		575	643	880	μA
	I _{ODL}	Low level		200	229	300	
Output Short-Circuit Current	I _{OS}	Shorted to 0V or V _{DD}		880			μA
POWER SUPPLY							
Supply Current	I _{DD}	V _{DD} = 2.5V	PCLKIN = 10MHz, 100Mbps	4.7		8.2	mA
			PCLKIN = 20MHz, 200Mbps	6.2		8.2	
Worst-Case Pattern Supply Current	I _{DDW}	V _{DD} = 2.5V, Figure 1	PCLKIN = 10MHz, 100Mbps	4.7		10.6	mA
			PCLKIN = 20MHz, 200Mbps	6.2		10.6	
Power-Down Supply Current	I _{DDZ}	All inputs = low		0.5			μA

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MAX9225/MAX9226

DC ELECTRICAL CHARACTERISTICS (MAX9226)

($V_{DD} = +2.375V$ to $+3.465V$, $V_{DDO} = +1.71V$ to $+3.465V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{DD} = V_{DDO} = +2.5V$, $T_A = +25^{\circ}C$.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SINGLE-ENDED OUTPUTS (PCLKOUT, DOUT_)							
High-Level Output Voltage	VOH	VDDO = +2.375V to +3.465V, IOH = -1mA		0.8 x VDDO			V
Low-Level Output Voltage	VOL	VDDO = +2.375V to +3.465V, IOL = 1mA		0.2			V
Output Short-Circuit Current	IOS	Output shorted to ground	VDDO = 2.375V	-2			mA
			VDDO = 3.135V	-9			
			VDDO = 3.465V	-20			
LCDS INPUT (SDI+, SDI-)							
Differential Input-Current Threshold	IID			400			µA
Common-Mode Input Current	IIC			-300	±400	+300	µA
Differential Input Impedance	ZID	IIC = 0µA, VDD = 3.3V ±5%		69	90	114	Ω
		IIC = 0µA, VDD = 2.8V ±5%		82	108	137	
		IIC = 0µA, VDD = 2.5V ±5%		95	125	161	
		IIC = ±300µA, VDD = 3.3V ±5%		67	91	117	
		IIC = ±300µA, VDD = 2.8V ±5%		86	108	141	
Common-Mode Input Impedance	ZIC	IIC = ±300µA		90	167	375	Ω
Input Capacitance	CIN	SDI+ or SDI- to ground		2			pF
POWER SUPPLY							
Supply Current	ITOT	VDD = VDDO = 2.5V (Note 4)	PCLKOUT = 10MHz, 100Mbps	8.4		12	mA
			PCLKOUT = 20MHz, 200Mbps	9.1		12	
Worst-Case Pattern Supply Current	ITOTW	CL = 5pF, VDD = VDDO = 2.5V, Figure 2 (Note 4)	PCLKOUT = 10MHz, 100Mbps	9.7		12	mA
			PCLKOUT = 20MHz, 200Mbps	11.6		13	
Power-Down Supply Current	ITOTZ	(Note 4)		0.3		3.0	µA
Supply Difference	VSD	MAX9225 VDD to MAX9226 VDD		-5		+5	%
GROUND POTENTIAL							
Ground Difference	VGD	MAX9225 to MAX9226 ground difference		-0.2		+0.2	V

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AC ELECTRICAL CHARACTERISTICS (MAX9225)

($V_{DD} = +2.375V$ to $+3.465V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{DD} = +2.5V$, $T_A = +25^{\circ}C$.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
PCLKIN INPUT REQUIREMENTS (Figure 3)						
Input Rise Time	t_R				2	ns
Input Fall Time	t_F				2	ns
PCLKIN Period	t_P		50		100	ns
High-Level Pulse Width	t_{PWH}		$0.3 \times t_P$		$0.7 \times t_P$	ns
Low-Level Pulse Width	t_{PWL}		$0.3 \times t_P$		$0.7 \times t_P$	ns
Setup Time	t_S		3			ns
Hold Time	t_H		1			ns

AC ELECTRICAL CHARACTERISTICS (MAX9226)

($V_{DD} = V_{DDO} = +2.375V$ to $+3.465V$, $C_L = 5pF$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{DD} = V_{DDO} = +2.5V$, $T_A = +25^{\circ}C$.) (Notes 3, 5)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
PCLKOUT Period	t_P	Figure 4	50		100	ns
High-Level Pulse Width	t_{PWH}	Figure 4	$0.4 \times t_P$		$0.6 \times t_P$	ns
Low-Level Pulse Width	t_{PWL}	Figure 4	$0.4 \times t_P$		$0.6 \times t_P$	ns
Data Valid Before PCLKOUT	t_{VB}	Figure 4	5			ns
Data Valid After PCLKOUT	t_{VA}	Figure 4	5			ns
SERIALIZER AND DESERIALIZER LINK						
Power-Up Time	t_{PU1}	From $V_{DD} = V_{DDO} = 2.375V$ when supplies are ramping up			$11,264 \times t_P$	ns
	t_{PU2}	From \overline{PWRDN} low to high			$4096 \times t_P$	
Power-Down Time	t_{PWRDN}	From \overline{PWRDN} high to low		2.8	10	μs

Note 1: Current into a pin is defined as positive. Current out of a pin is defined as negative. All voltages are referenced to ground.

Note 2: Maximum and minimum limits over temperature are guaranteed by design and characterization. Devices are production tested at $T_A = +85^{\circ}C$.

Note 3: Parameters are guaranteed by design and characterization and are not production tested. Limits are set at ± 6 sigma.

Note 4: $I_{TOT} = I_{DD} + I_{DDO}$.

Note 5: C_L includes probe and test jig capacitance.

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Test Circuits/Timing Diagrams

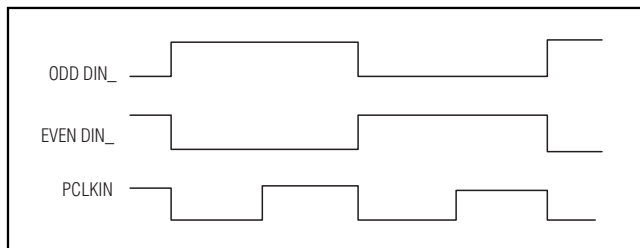


Figure 1. Serializer Worst-Case Switching Pattern

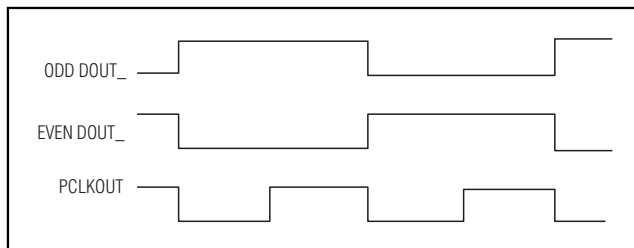


Figure 2. Deserializer Worst-Case Switching Pattern

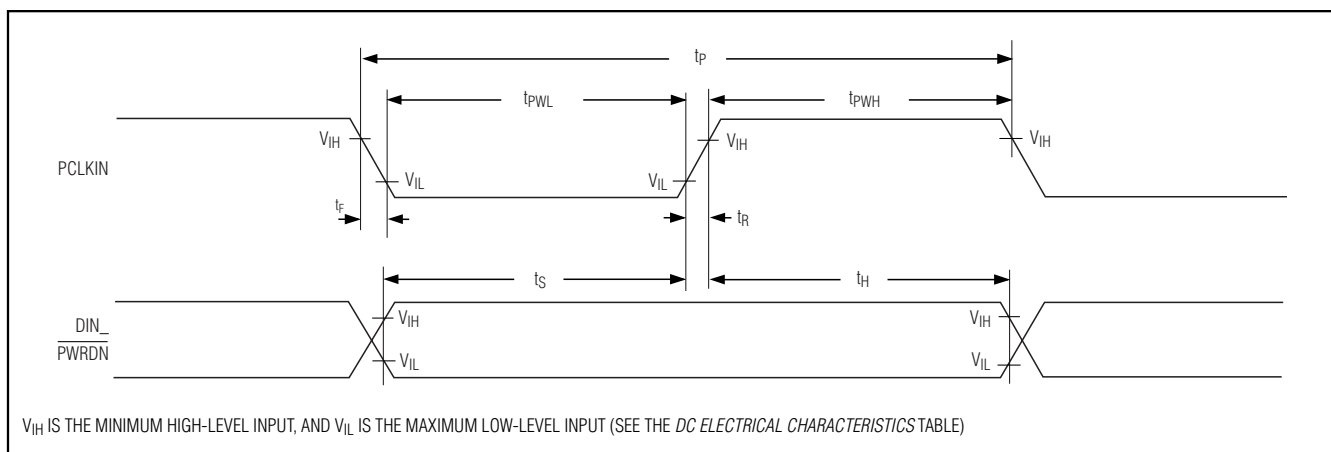


Figure 3. Serializer Input Timing

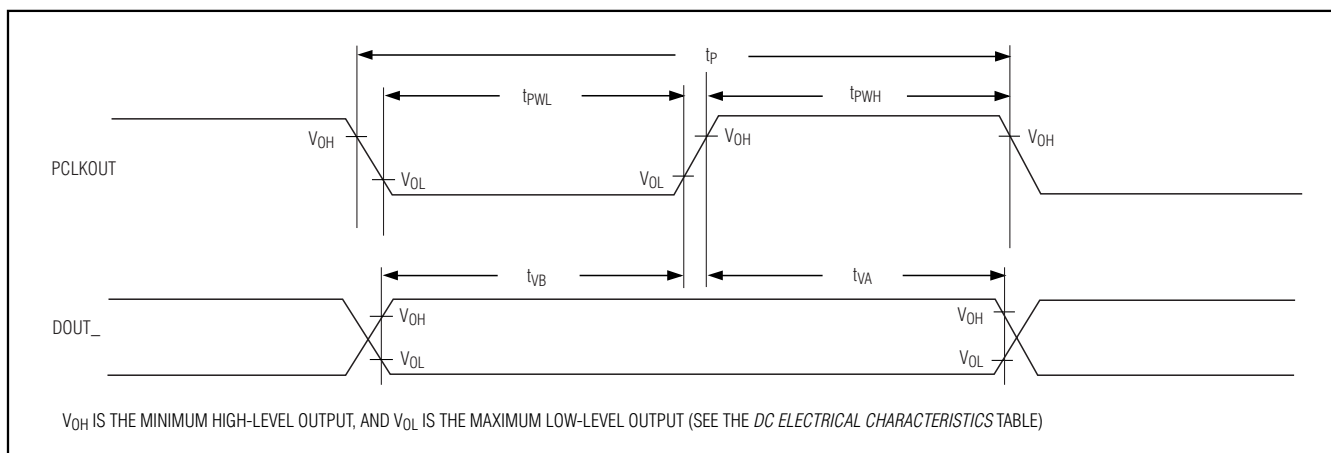
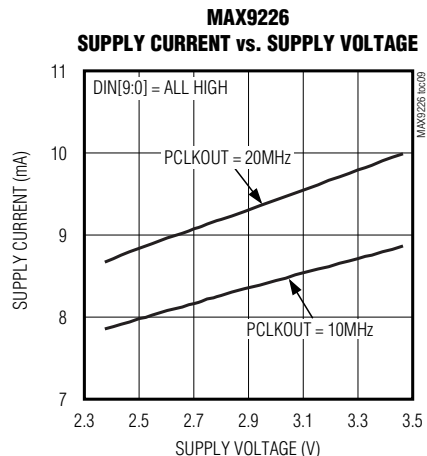
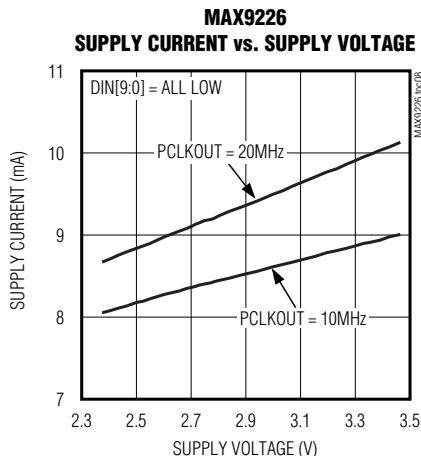
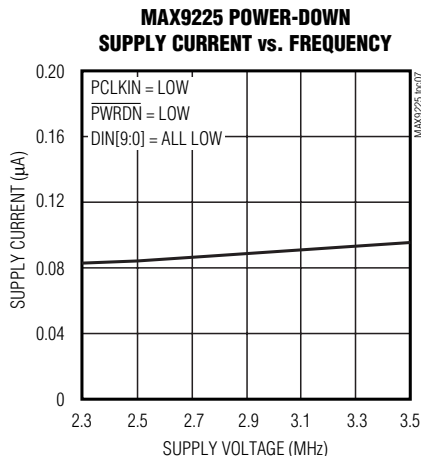
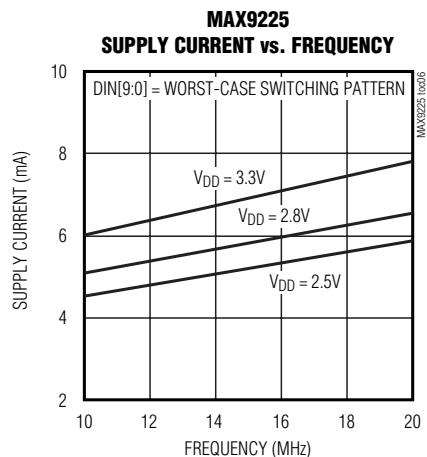
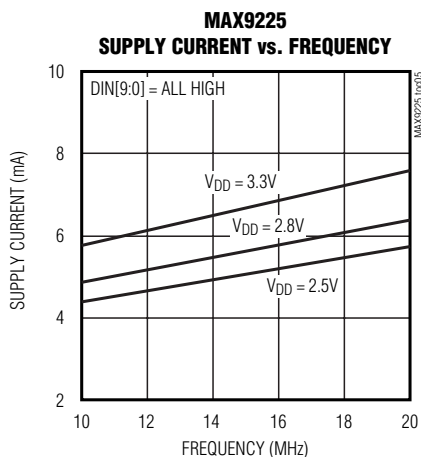
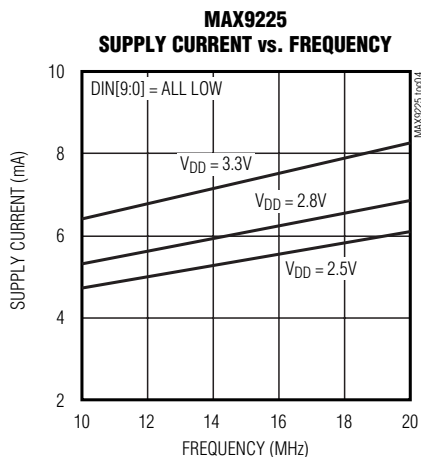
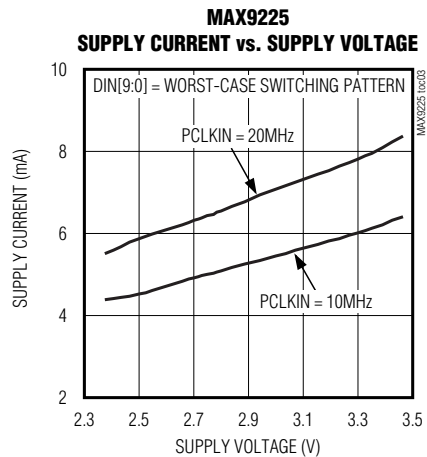
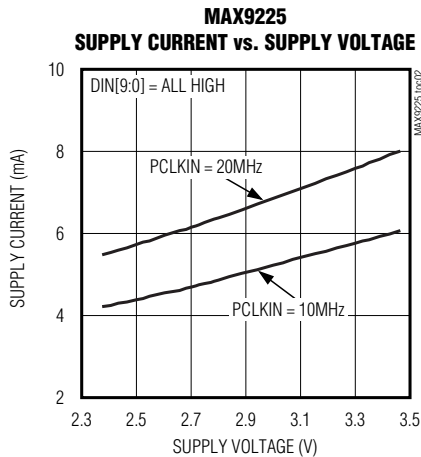
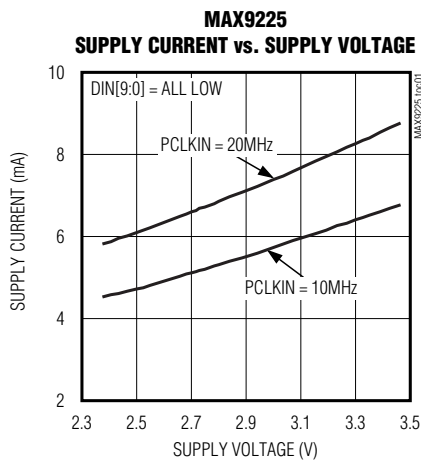


Figure 4. Deserializer Output Timing

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Typical Operating Characteristics

($V_{DD} = V_{DDO} = +2.8V$, logic input levels = 0 to +2.8V, logic output load $C_L = 5pF$, $T_A = +25^\circ C$, unless otherwise noted.)

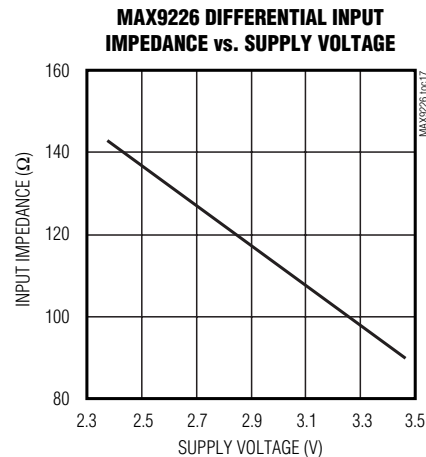
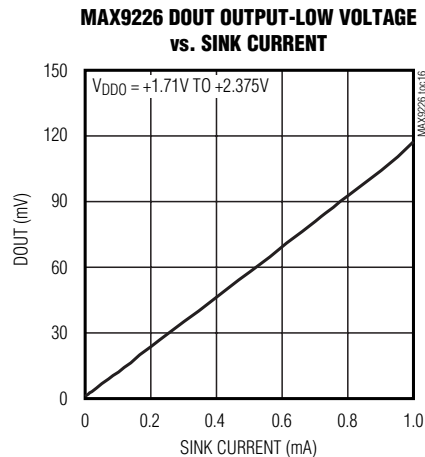
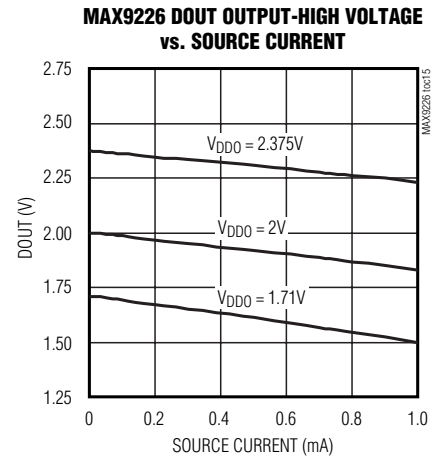
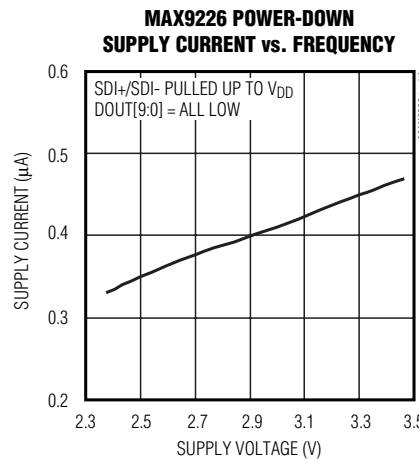
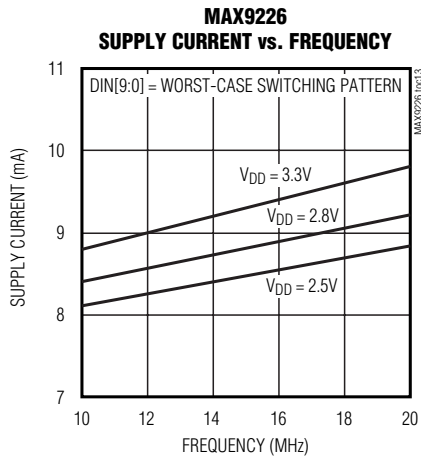
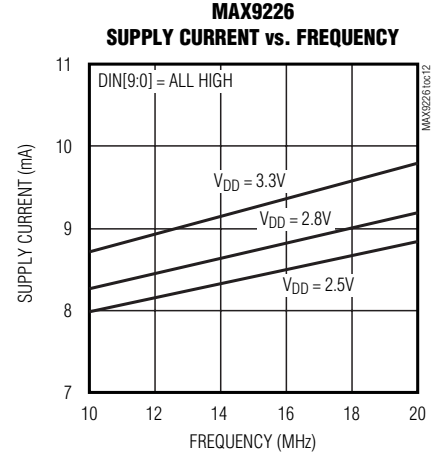
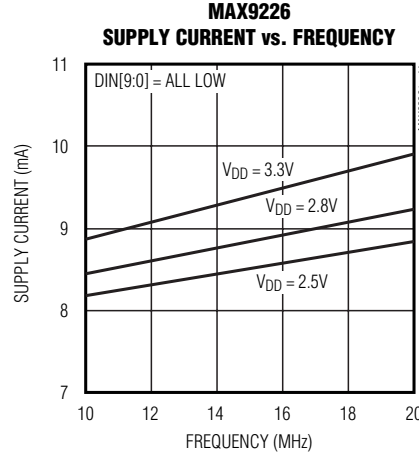
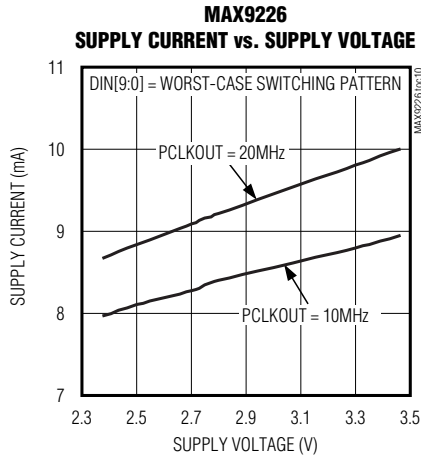


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Typical Operating Characteristics (continued)

($V_{DD} = V_{DDO} = +2.8V$, logic input levels = 0 to +2.8V, logic output load $C_L = 5pF$, $T_A = +25^\circ C$, unless otherwise noted.)

MAX9225/MAX9226



10-Bit, Low-Power, 10MHz-to-20MHz Serializer and Deserializer Chipset

Pin Description (MAX9225)

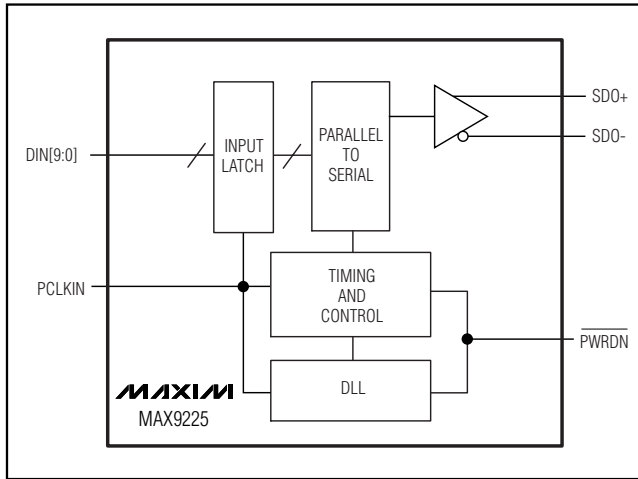
PIN	NAME	FUNCTION
1–7, 14, 15, 16	DIN6–DIN0, DIN9, DIN8, DIN7	Single-Ended Parallel Data Inputs. The 10 data bits are loaded into the input latch on the rising edge of PCLKIN. 1.71V to 3.465V tolerant. Internally pulled down to GND.
8	PCLKIN	Parallel Clock Input. The rising edge of PCLKIN (typically the pixel clock) latches the parallel data input. Internally pulled down to GND.
9	PWRDN	Power-Down Input. Pull PWRDN low to place the MAX9225/MAX9226 in power-down mode. Drive PWRDN high for normal operation. Internally pulled down to GND.
10	SDO-	Inverting LCDS Serial-Data Output
11	SDO+	Noninverting LCDS Serial-Data Output
12	GND	Ground
13	VDD	Core Supply Voltage. Bypass to GND with 0.1μF and 0.01μF capacitors in parallel as close to the device as possible with the smallest value capacitor closest to the supply pin.
—	EP	Exposed Paddle. Connect EP to ground.

Pin Description (MAX9226)

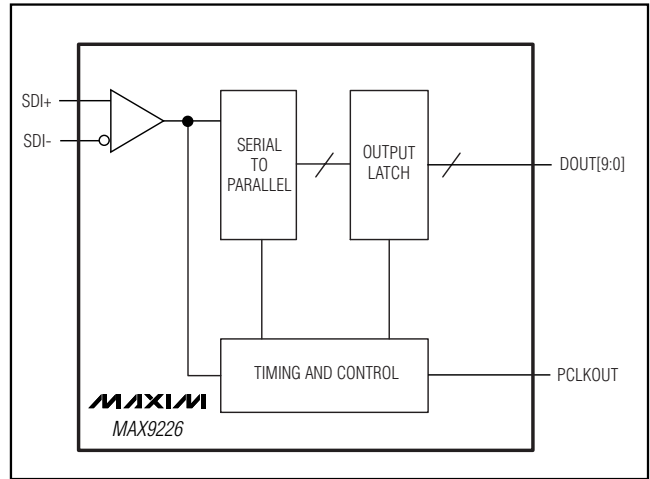
PIN	NAME	FUNCTION
1	GND	Ground
2	SDI+	Noninverting LCDS Serial-Data Input
3	SDI-	Inverting LCDS Serial-Data Input
4	VDD	Core Supply Voltage. Bypass to GND with 0.1μF and 0.01μF capacitors in parallel as close to the device as possible, with the smallest value capacitor closest to the supply pin.
5	PCLKOUT	Parallel Clock Output. Parallel output data are valid on the rising edge of PCLKOUT (typically the pixel clock).
6–15	DOUT0–DOUT9	Single-Ended Parallel Data Output. DOUT[9:0] are valid on the rising edge of PCLKOUT.
16	VDDO	Output Supply Voltage. Bypass to GND with 0.1μF and 0.01μF capacitors in parallel as close to the device as possible with the smallest value capacitor closest to the supply pin.
—	EP	Exposed Paddle. Connect EP to ground.

10-Bit, Low-Power, 10MHz-to-20MHz Serializer and Deserializer Chipset

Functional Diagram (MAX9225)



Functional Diagram (MAX9226)



MAX9225/MAX9226

Detailed Description

The MAX9225 serializer operates at a 10MHz-to-20MHz parallel clock frequency, serializing 10 bits of parallel input data DIN[9:0] in each cycle of the parallel clock. DIN[9:0] are latched on the rising edge of PCLKIN. The data and internally generated serial clock are combined and transmitted through SDO+/SDO- using multilevel LCDS. The MAX9226 deserializer receives the LCDS signal on SDI+/SDI-. The deserialized data and recovered parallel clock are available at DOUT[9:0] and PCLKOUT. Output data is valid on the rising edge of PCLKOUT.

Bit 0 (DIN[0]) is transmitted first. Boundary bits OH1 and OH2 are used by the MAX9226 deserializer to identify the word boundary. OH1 is the inverse polarity of data bit 9 (DIN[9]), and OH2 is the inverse polarity of OH1. Therefore, at least two level transitions are guaranteed in one word. The clock is recovered from the serial input.

Serial word format:

0	1	2	3	4	5	6	7	8	9	OH1	OH2
---	---	---	---	---	---	---	---	---	---	-----	-----

LCDS

The MAX9225/MAX9226 use a proprietary multilevel LCDS interface. Figure 5 provides a representation of the data and clock in the multilevel LCDS interface. This interface offers advantages over other chipsets, such as requiring only one differential pair as the transmission medium, the inherently aligned data and clock, and much smaller current levels than the 4mA typically found in traditional LVDS interfaces.

MAX9225/MAX9226 Handshaking

The handshaking function of the MAX9225/MAX9226 provides bidirectional communication between the two devices in case a word boundary error is detected. Prior to data transmission, the MAX9225 serializer adds boundary bits (OH) to the end of the latched word. These boundary bits are the inverse of the last bit of the latched word. During data transmission, the MAX9226 deserializer continuously monitors the state of the boundary bits of each word. If a word boundary error is detected, the serial link is pulled up to V_{CC} and the MAX9226 powers down. The MAX9225 detects the pullup of the serial link and powers down for 1.0μs. After 1.0μs, the MAX9225 powers up, causing the power-up of the MAX9226. Then the word boundary is reestablished, and data transfer resumes. The handshaking function is disabled when PWRDN is pulled low.

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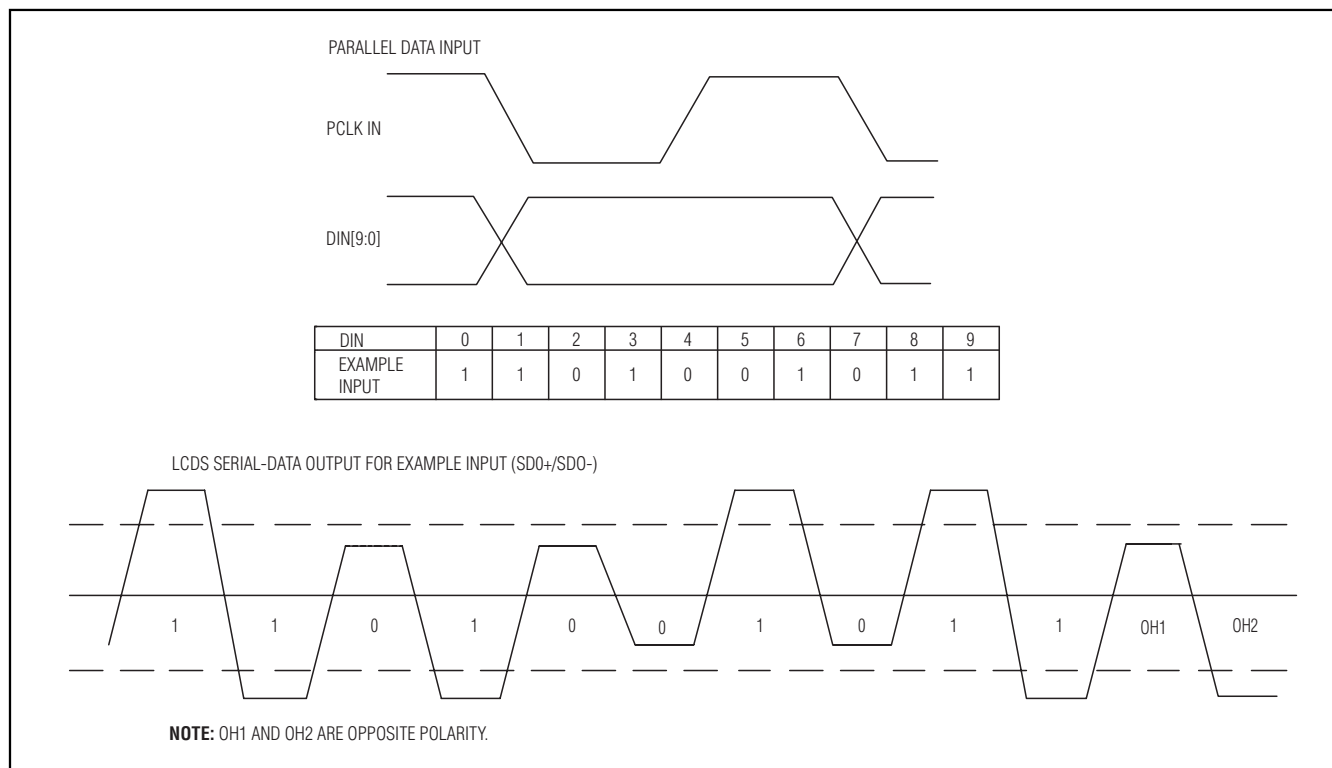


Figure 5. Multilevel LCDS Output Representation

Applications Information

PCLKIN Latch Edge

The parallel data input of the MAX9225 serializer is latched on the rising edge of PCLKIN. Figure 3 shows the serializer input timing.

PCLKOUT Strobe

The serial-data output of the MAX9226 deserializer is valid on the rising edge of PCLKOUT. Figure 4 shows the deserializer output timing.

Power-Down and Power-Off

Driving $\overline{\text{PWRDN}}$ low puts the MAX9225 in power-down mode and sends a pulse to power down the MAX9226. In power-down mode, the DLL is stopped, SDO+/SDO- are high impedance to ground and differential, and the LCDS link is weakly biased around ($V_{DD} - 0.8V$). With $\overline{\text{PWRDN}}$ and all inputs low, the combined MAX9225/MAX9226 supply current is reduced to 3.5 μ A or less.

Driving $\overline{\text{PWRDN}}$ high starts DLL lock to PCLKIN and initiates a MAX9226 power-up sequence. The MAX9225

LCDS output is not driven until the DLL locks. 11,264 clock cycles are required for the power-up and link synchronization before valid DIN can be latched. See Figure 6 for an overall power-up and power-down timing diagram. For normal operation, PCLKIN must be running and settled before driving $\overline{\text{PWRDN}}$ high.

If $V_{DD} = 0$, the LCDS outputs are high impedance to ground and differential.

Ground-Shift Tolerance

The MAX9225/MAX9226 are designed to function normally in the event of a slight shift in ground potential. However, the MAX9226 deserializer ground must be within $\pm 0.2V$ relative to the MAX9225 serializer ground to maintain proper operation.

MAX9226 Output Buffer Supply (V_{DDO})

The MAX9226 parallel outputs are powered from V_{DDO} , which accepts a +1.71V to +3.465V supply, allowing direct interface to inputs with 1.8V to 3.3V logic levels.

10-Bit, Low-Power, 10MHz-to-20MHz Serializer and Deserializer Chipset

MAX9225/MAX9226

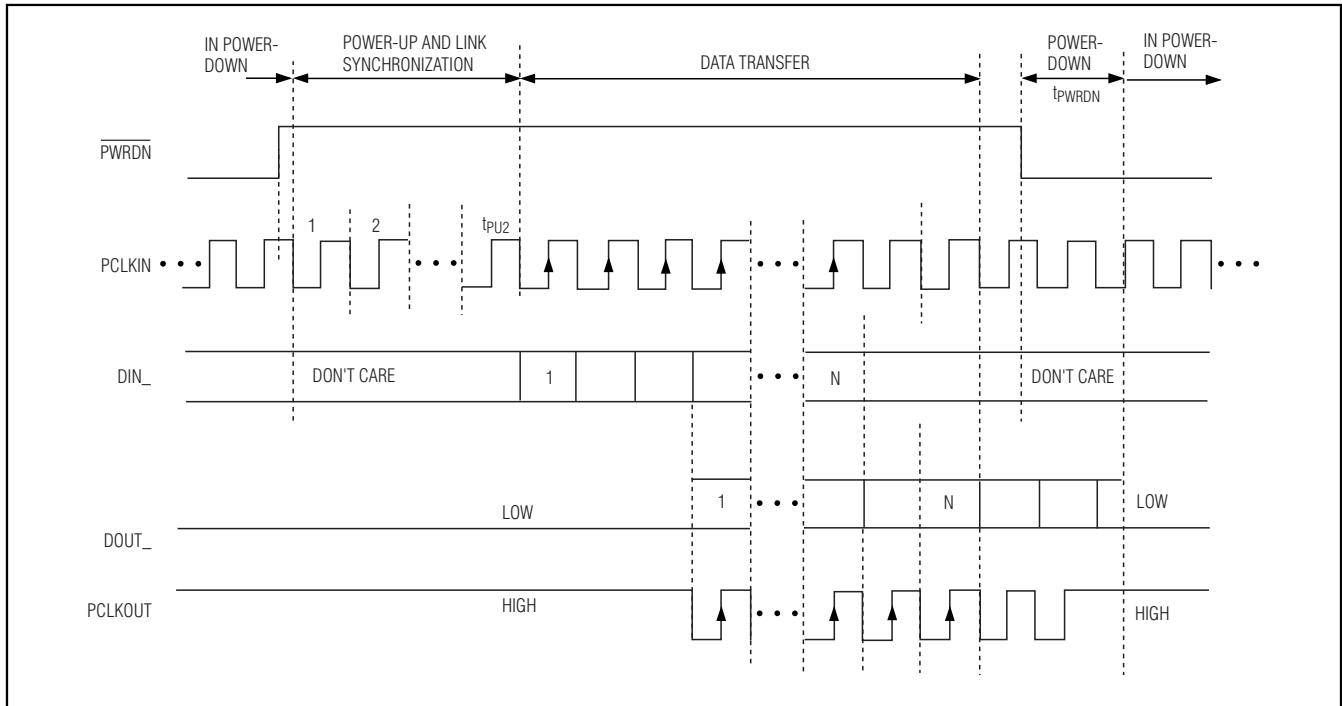


Figure 6. MAX9225/MAX9226 Power-Up/Power-Down Sequence

Flex Cable, PC Board Interconnect, and Connectors

Interconnect for LCDs typically has a differential impedance of 100Ω. Use interconnect and connectors that have matched differential impedance to minimize impedance discontinuities.

Board Layout and Supply Bypassing

Separate the LVTTL/LVCMOS and LCDS signals to prevent crosstalk. A PC board or flex with separate layers for power, ground, and signals is recommended.

Bypass each VDD and VDDO pin with high-frequency, surface-mount ceramic 0.1μF and 0.01μF capacitors in parallel as close to the device as possible, with the smallest value capacitor closest to the supply pin.

ESD Protection

The MAX9225/MAX9226 are rated for ±15kV ESD protection using the Human Body Model. The Human Body Model discharge components are $C_S = 100\text{pF}$ and $R_D = 1.5\text{k}\Omega$ (Figure 7).

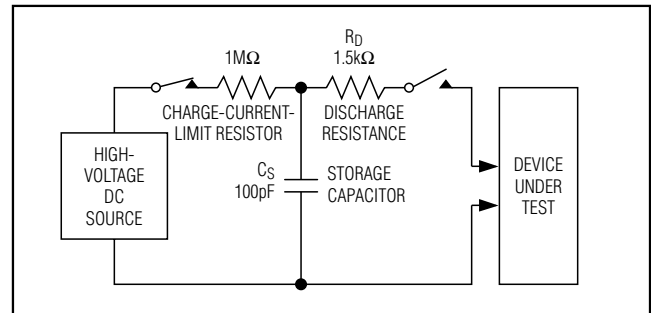


Figure 7. Human Body Model ESD Test Circuit

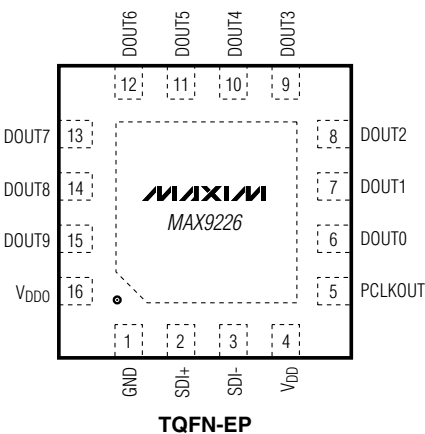
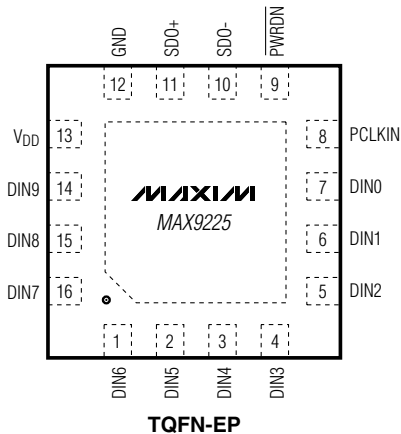
Chip Information

PROCESS: CMOS

10-Bit, Low-Power, 10MHz-to-20MHz Serializer and Deserializer Chipset

Pin Configurations

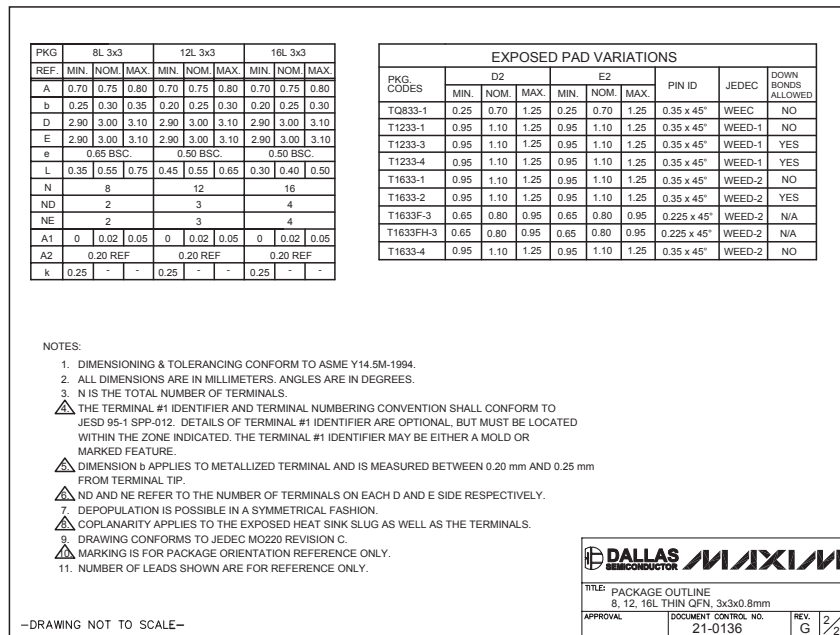
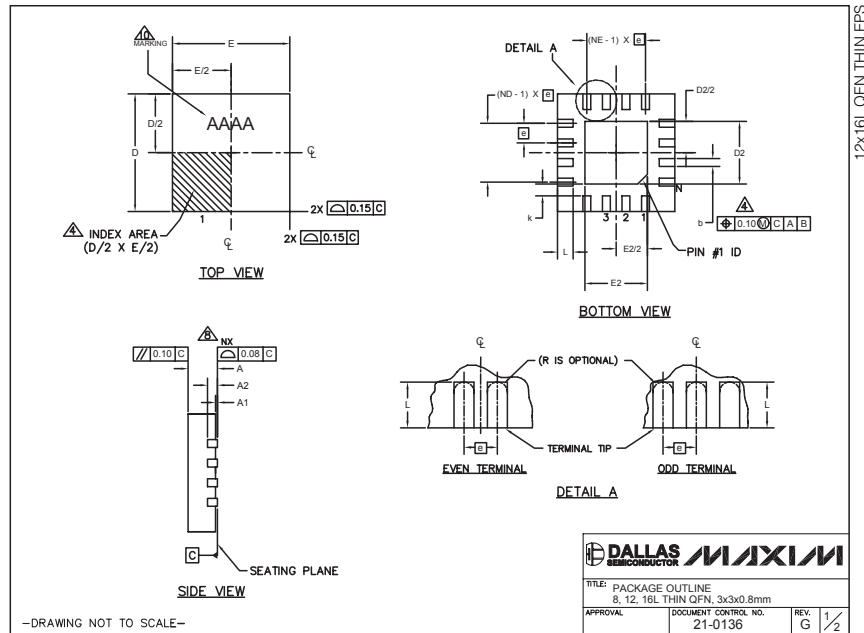
TOP VIEW



10-Bit, Low-Power, 10MHz-to-20MHz Serializer and Deserializer Chipset

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to www.maxim-ic.com/packages.)



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Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 13