19-2456; Rev 0; 11/07

EVALUATION KIT AVAILABLE

Low-Jitter, Precision Clock Generator with Two Outputs

General Description

The MAX3622 is a low-jitter precision clock generator optimized for networking applications. The device integrates a crystal oscillator and a phase-locked loop (PLL) clock multiplier to generate high-frequency clock outputs for Ethernet and other networking applications.

Maxim's proprietary PLL design features ultra-low jitter (0.36ps$_{RMS}$) and excellent power-supply noise rejection, minimizing design risk for network equipment.

The MAX3622 has one LVPECL output and one LVCMOS output. It is available in a 16-pin TSSOP package and operates over the 0°C to +70°C temperature range.

Applications

Ethernet Networking Equipment

Typical Application Circuit and Pin Configuration appear at end of data sheet.

Features

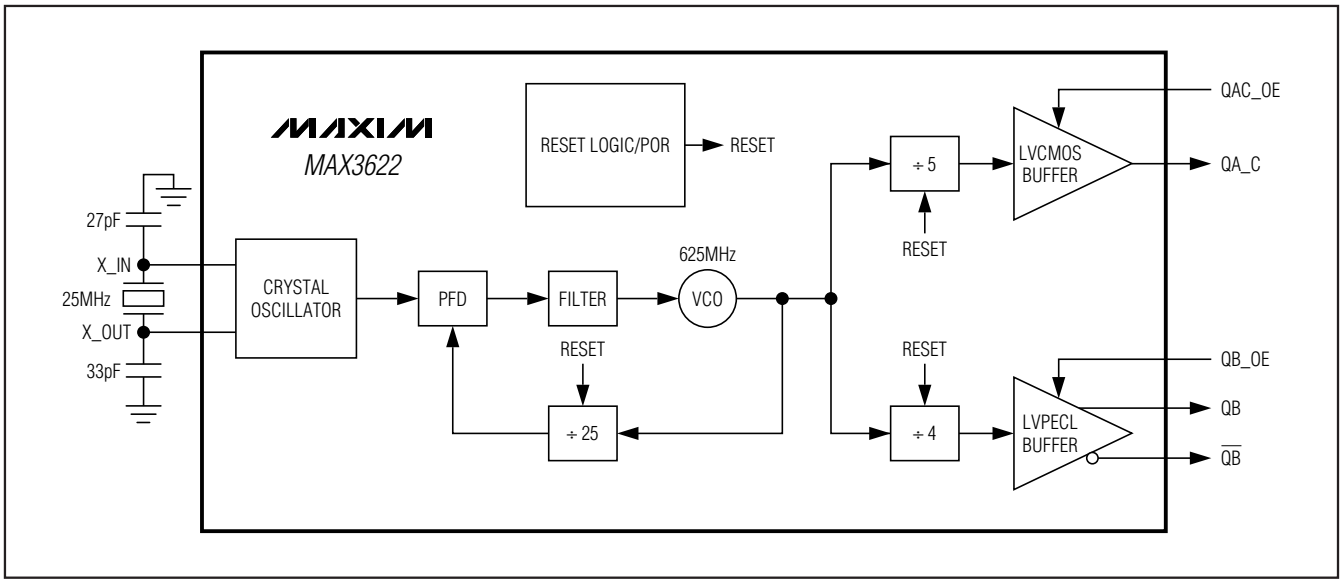
- **Crystal Oscillator Interface: 25MHz Typical**
- **Output Frequencies: 125MHz and 156.25MHz**
- **Low Jitter**
  - **0.14ps$_{RMS}$ (1.875MHz to 20MHz)**
  - **0.36ps$_{RMS}$ (12kHz to 20MHz)**
- **Excellent Power-Supply Noise Rejection**
- **No External Loop Filter Capacitor Required**

Ordering Information

		PIN-PACKAGE	PKG CODE
MAX3622CUE+	0°C to +70°C	16 TSSOP	U16-2

+Denotes a lead-free package.

Block Diagram



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Low-Jitter, Precision Clock Generator with Two Outputs

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Range V_{CC}, V_{CCA}, V_{DDO_A}, V_{CCO_B} .....-0.3V to +4.0V
Voltage Range at QAC_OE, QB_OE, RES1, RES2.....-0.3V to (V_{CC} + 0.3V)
Voltage Range at X_IN Pin .....-0.3V to +1.2V
Voltage Range at GNDO_A.....-0.3V to +0.3V
Voltage Range at X_OUT Pin .....-0.3V to (V_{CC} - 0.6V)
Current into QA_C .....±50mA
Current into QB, $\overline{QB}$.....-56mA
Continuous Power Dissipation (T_A = +70°C)
16-Pin TSSOP (derate 11.1mW/°C above +70°C) 889mW
Operating Junction Temperature Range.....-55°C to +150°C
Storage Temperature Range .....-65°C to +160°C

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.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.0V to +3.6V, T_A = 0°C to +70°C, unless otherwise noted. Typical values are at V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.) (Notes 1, 2)

Power-Supply Current	I_{CC}	(Note 3)		70	90	mA
CONTROL INPUT CHARACTERISTICS (QAC_OE, QB_OE PINS)						
Input Capacitance	C_{IN}			2		pF
Input Logic Bias Resistor	R_{BIAS}			50		kΩ
LVPECL OUTPUT SPECIFICATIONS (QB, $\overline{QB}$ PINS)						
Output High Voltage	V_{OH}		V_{CC} - 1.13	V_{CC} - 0.98	V_{CC} - 0.83	V
Output Low Voltage	V_{OL}		V_{CC} - 1.85	V_{CC} - 1.7	V_{CC} - 1.55	V
Peak-to-Peak Output-Voltage Swing (Single-Ended)			0.6	0.72	0.9	V_{P-P}
Output Rise/Fall Time		20% to 80%	200	350	600	ps
Output Duty-Cycle Distortion			48	50	52	%
LVCMOS/LVTTL INPUT SPECIFICATIONS (QAC_OE, QB_OE PINS)						
Input-Voltage High	V_{IH}		2.0			V
Input-Voltage Low	V_{IL}				0.8	V
Input High Current	I_{IH}	V_{IN} = V_{CC}			80	µA
Input Low Current	I_{IL}	V_{IN} = 0V	-80			µA
LVCMOS OUTPUT SPECIFICATIONS (QA_C PIN)						
Output High Voltage	V_{OH}	QA_C sourcing 12mA	2.6			V
Output Low Voltage	V_{OL}	QA_C sinking 12mA			0.4	V
Output Rise/Fall Time		(Note 4)	250	500	1000	ps
Output Duty-Cycle Distortion		(Note 4)	42	50	58	%
Output Impedance				14		Ω

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +3.0V to +3.6V, T_A = 0°C to +70°C, unless otherwise noted. Typical values are at V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.) (Notes 1, 2)

CLOCK OUTPUT AC SPECIFICATIONS						
VCO Frequency Range			620	625	648	MHz
Random Jitter	RJ_{RMS}	12kHz to 20MHz		0.36	1.0	ps_{RMS}
		1.875MHz to 20MHz		0.14		
Deterministic Jitter Induced by Power-Supply Noise (Notes 5, 6)		LVPECL output		4		ps_{P-P}
		LVCMOS output		19		
Spurs Induced by Power-Supply Noise (Note 6)		LVPECL output		-57		dBc
		LVCMOS output		-47		
Nonharmonic and Subharmonic Spurs				-70		dBc
Clock Output SSB Phase Noise at 125MHz		f = 1kHz		-124		dBc/Hz
		f = 10kHz		-126		
		f = 100kHz		-130		
		f = 1MHz		-145		
		f > 10MHz		-153		

Note 1: A series resistor of up to 10.5Ω is allowed between V_{CC} and V_{CCA} for filtering supply noise when system power-supply tolerance is V_{CC} = 3.3V ±5%. See Figure 2.
Note 2: LVPECL terminated with 50Ω load connected to $V_{TT} = V_{CC}$ - 2V.
Note 3: Both outputs enabled and unloaded.
Note 4: Measured using setup shown in Figure 1 with V_{CC} = 3.3V ±5%.
Note 5: Measured with Agilent DSO81304A 40GS/s real-time oscilloscope.
Note 6: Measured with 40mV_{P-P}, 100kHz sinusoidal signal on the supply with V_{CCA} connected as shown in Figure 2.

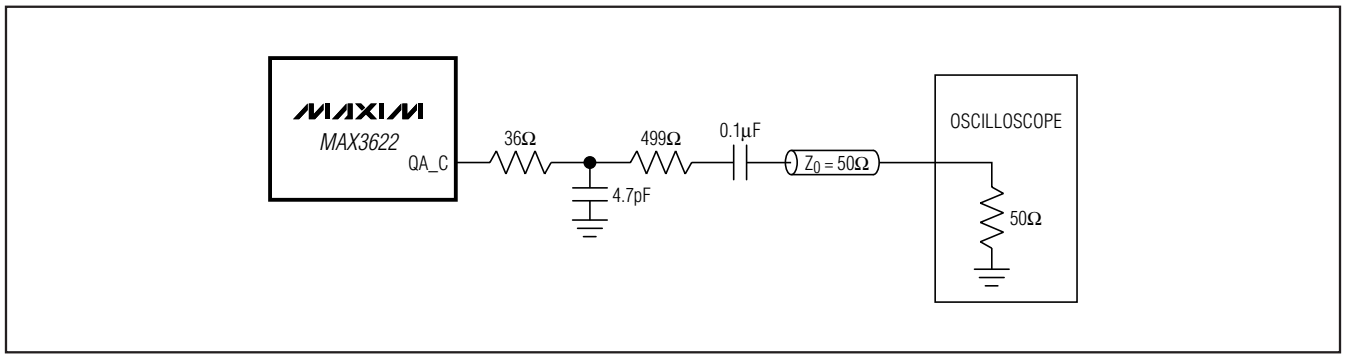


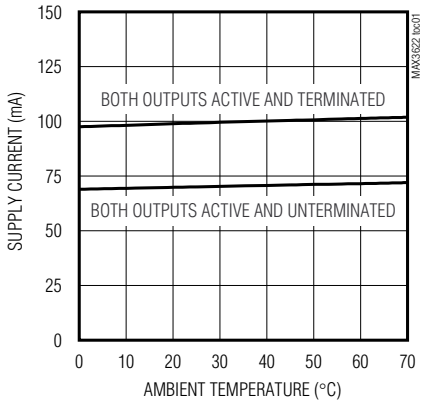
Figure 1. LVCMOS Output Measurement Setup

Low-Jitter, Precision Clock Generator with Two Outputs

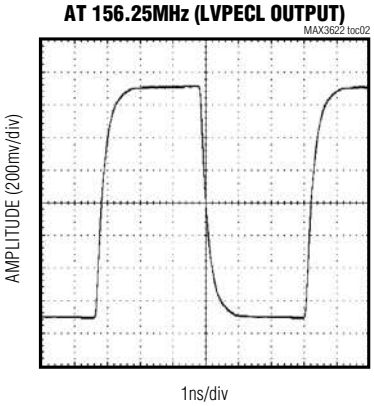
Typical Operating Characteristics

(Typical values are at V_{CC} = +3.3V, T_A = +25°C, crystal frequency = 25MHz.)

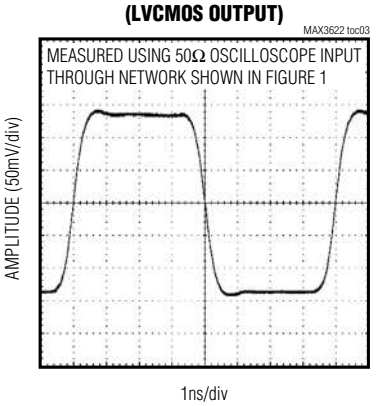
SUPPLY CURRENT vs. TEMPERATURE



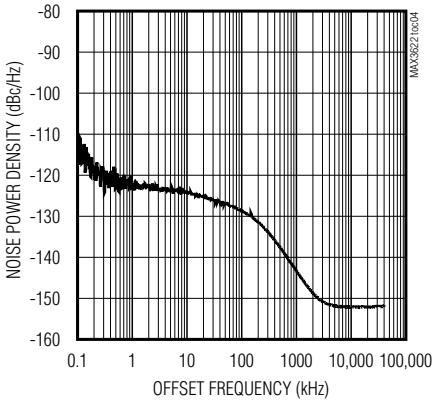
DIFFERENTIAL OUTPUT WAVEFORM AT 156.25MHz (LVPECL OUTPUT)



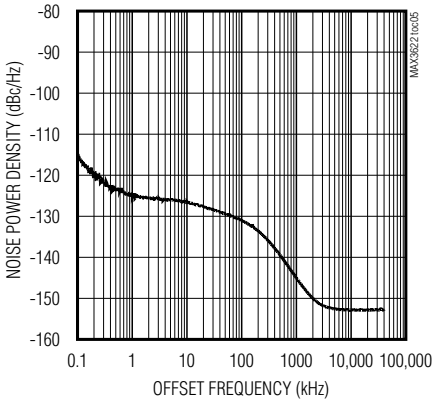
OUTPUT WAVEFORM AT 125MHz (LVCMOS OUTPUT)



QB PHASE NOISE (156.25MHz CLOCK FREQUENCY)



QA_C PHASE NOISE (125MHz CLOCK FREQUENCY)



Pin Description

Detailed Description

The MAX3622 is a low-jitter clock generator designed to operate at Ethernet frequencies. It consists of an on-chip crystal oscillator, PLL, LVCMOS output buffer, and an LVPECL output buffer. Using a 25MHz crystal as a reference, the internal PLL generates a high-frequency output clock with excellent jitter performance.

Crystal Oscillator

An integrated oscillator provides the low-frequency reference clock for the PLL. This oscillator requires a 25MHz crystal connected between X_IN and X_OUT.

PLL

The PLL takes the signal from the crystal oscillator and synthesizes a low-jitter, high-frequency clock. The PLL contains a phase-frequency detector (PFD), a lowpass filter, and a voltage-controlled oscillator (VCO). The VCO output is connected to the PFD input through a feedback divider. The PFD compares the reference frequency to the divided-down VCO output ($f_{VCO}/25$) and generates a control signal that keeps the VCO locked to the reference clock. The high-frequency VCO output clock is sent to the output dividers. To minimize noise-induced jitter, the VCO supply (V_{CCA}) is isolated from the core logic and output buffer supplies.

Output Dividers

The output dividers are set to divide-by-five for the LVCMOS output QA_C and divide-by-four for the LVPECL output QB.

LVPECL Driver

The differential PECL buffer (QB) is designed to drive transmission lines terminated with 50Ω to V_{CC} - 2.0V. The output goes to a logic 0 when disabled.

LVCMOS Driver

QA_C, the LVCMOS output, is designed to drive a single-ended high-impedance load. This output goes to a high-impedance state when disabled.

Reset Logic/POR

During power-on, the power-on reset (POR) signal is generated to synchronize all dividers.

Low-Jitter, Precision Clock Generator with Two Outputs

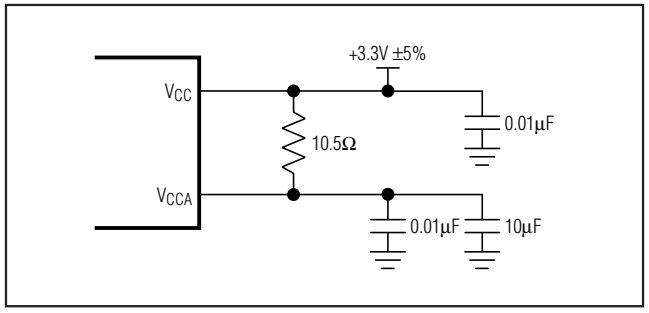


Figure 2. Analog Supply Filtering

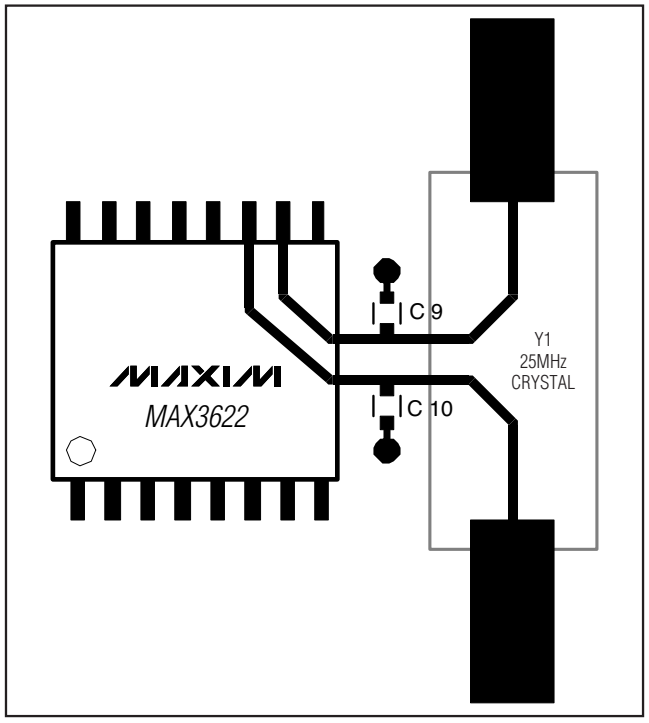


Figure 3. Crystal Layout

Applications Information

Power-Supply Filtering

The MAX3622 is a mixed analog/digital IC. The PLL contains analog circuitry susceptible to random noise. In addition to excellent on-chip power-supply noise rejection, the MAX3622 provides a separate power-supply pin, V_{CCA}, for the VCO circuitry. Figure 2 illustrates the recommended power-supply filter network for V_{CCA}. The purpose of this design technique is to ensure clean input power supply to the VCO circuitry and to improve the overall immunity to power-supply noise. This network requires that the power supply is +3.3V ±5%. Decoupling capacitors should be used on all other supply pins for best performance.

Crystal Selection

The crystal oscillator is designed to drive a fundamental mode, AT-cut crystal resonator. See Table 1 for recommended crystal specifications. See Figure 4 for external capacitor connection.

Crystal Input Layout and Frequency Stability

The crystal, trace, and two external capacitors should be placed on the board as close as possible to the MAX3622's X_IN and X_OUT pins to reduce crosstalk of active signals into the oscillator.

The layout shown in Figure 3 gives approximately 3pF of trace plus footprint capacitance per side of the crystal (Y1). The dielectric material is FR-4 and dielectric thickness of the reference board is 15 mils. Using a 25MHz crystal and the capacitor values of C10 = 27pF and C9 = 33pF, the measured output frequency accuracy is -10ppm at +25°C ambient temperature.

Table 1. Crystal Selection Parameters

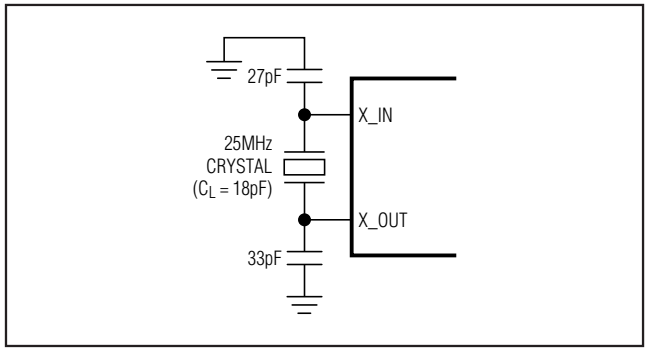


Figure 4. Crystal, Capacitors Connection

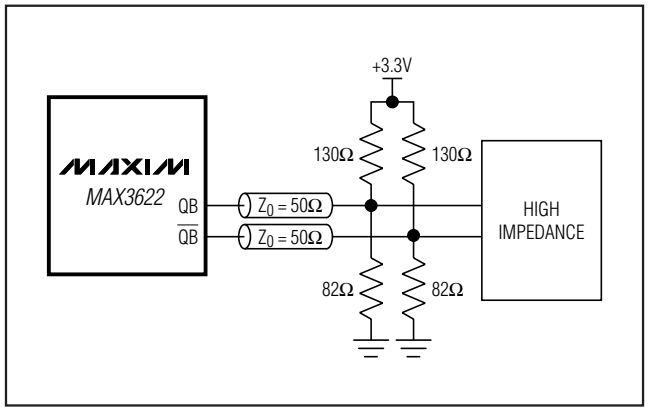


Figure 5. Thevenin Equivalent of Standard PECL Termination

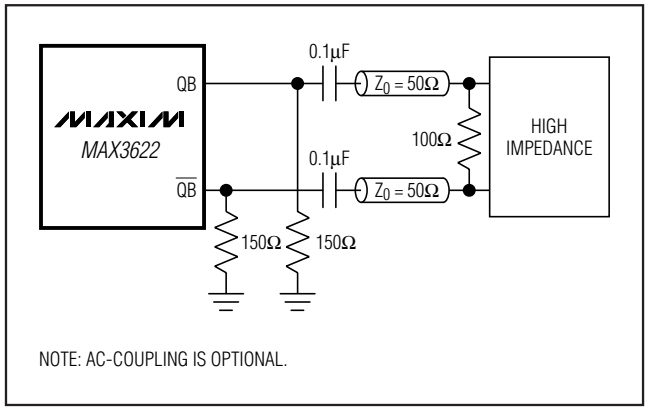


Figure 6. AC-Coupled PECL Termination

Interfacing with LVPECL Outputs

The equivalent LVPECL output circuit is given in Figure 7. This output is designed to drive a pair of 50Ω transmission lines terminated with 50Ω to $V_{TT} = V_{CC} - 2V$. If a separate termination voltage (V_{TT}) is not available, other termination methods can be used such as shown in Figures 5 and 6. Unused outputs should be disabled and may be left open. For more information on LVPECL terminations and how to interface with other logic families, refer to Maxim Application Note *HFAN-01.0: Introduction to LVDS, PECL, and CML*.

Interface Models

Figure 7 and Figure 8 show examples of interface models.

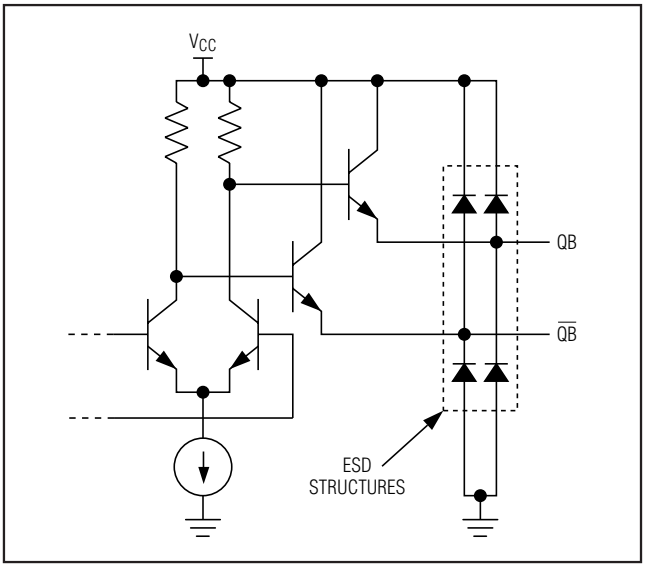


Figure 7. Simplified LVPECL Output Circuit Schematic

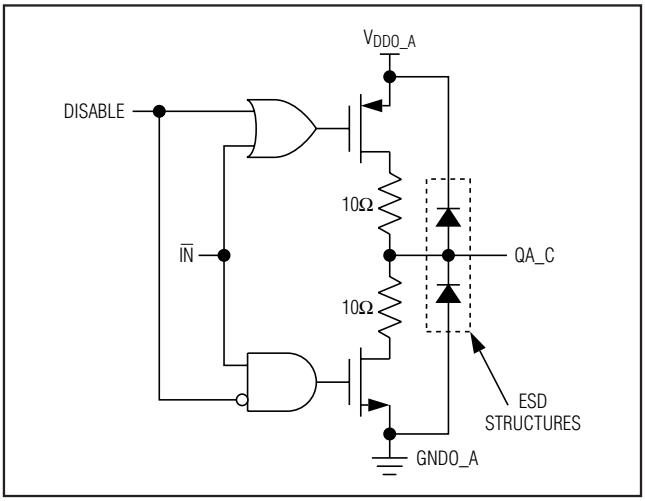


Figure 8. Simplified LVCMOS Output Circuit Schematic

Low-Jitter, Precision Clock Generator with Two Outputs

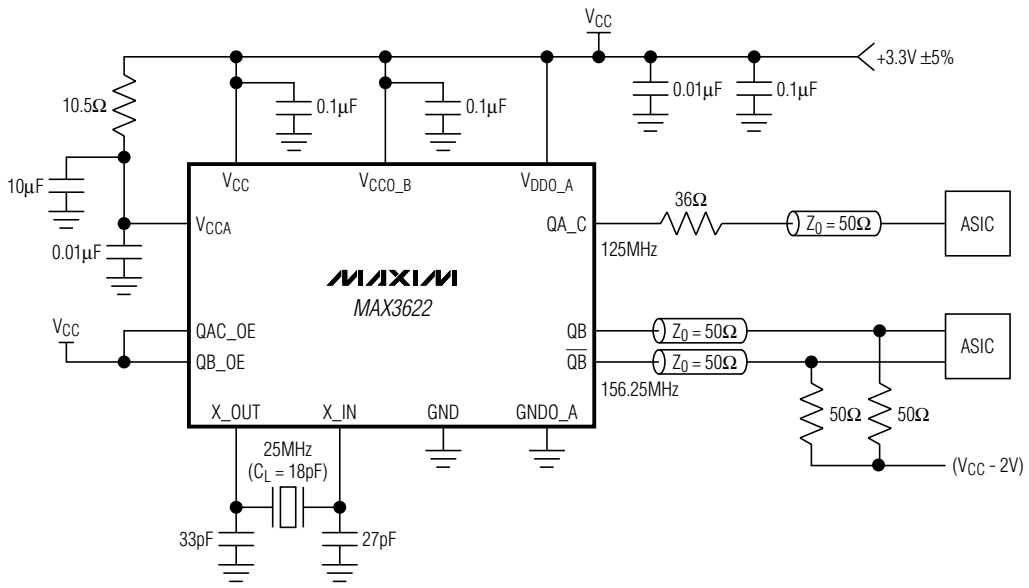
Layout Considerations

The inputs and outputs are critical paths for the MAX3622, and care should be taken to minimize discontinuities on these transmission lines. Here are some suggestions for maximizing the MAX3622's performance:

- An uninterrupted ground plane should be positioned beneath the clock I/Os.
- Supply and ground pin vias should be placed close to the IC and the input/output interfaces to allow a return current path to the MAX3622 and the receive devices.
- Supply decoupling capacitors should be placed close to the MAX3622 supply pins.
- Maintain 100Ω differential (or 50Ω single-ended) transmission line impedance out of the MAX3622.
- Use good high-frequency layout techniques and a multilayer board with an uninterrupted ground plane to minimize EMI and crosstalk.

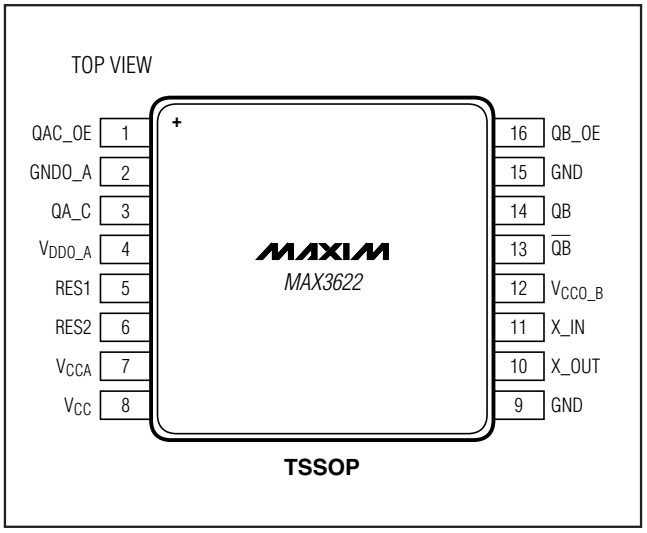
Refer to the MAX3622 Evaluation Kit for more information.

Typical Application Circuit



Low-Jitter, Precision Clock Generator with Two Outputs

Pin Configuration



Chip Information

TRANSISTOR COUNT: 10,490

PROCESS: BiCMOS

Package Information

For the latest package outline information, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	DOCUMENT NO.
16 TSSOP	**21-0066**

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