

### General Description

The ICS849S625I is a high frequency clock generator. The ICS849S625I uses an external 25MHz crystal to synthesize 625MHz, 312.5MHz, 156.25MHz and 125MHz clocks. The ICS849S625I has excellent cycle-to-cycle and RMS phase jitter performance.

The ICS849S625I operates at full 3.3V supply mode and is available in a fully RoHS compliant 48-lead TQFP, E-Pad package.

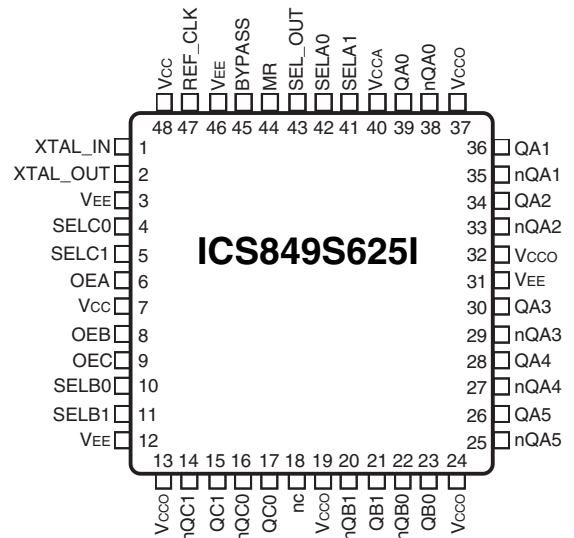
### Features

- Ten selectable differential LVPECL or LVDS outputs
- Output frequencies of 625MHz, 312.5MHz, 156.25MHz or 125MHz using a 25MHz crystal.
- Crystal interface designed for a 25MHz, parallel resonant crystal
- Cycle-to-cycle jitter: 25ps (maximum)
- RMS phase jitter at 156.25MHz (1MHz - 20MHz): 0.375ps (typical), LVDS outputs
- Output duty cycle: 53% (maximum)
- Full 3.3V supply mode
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) packaging

### Frequency Table for Bank A, B and C Outputs

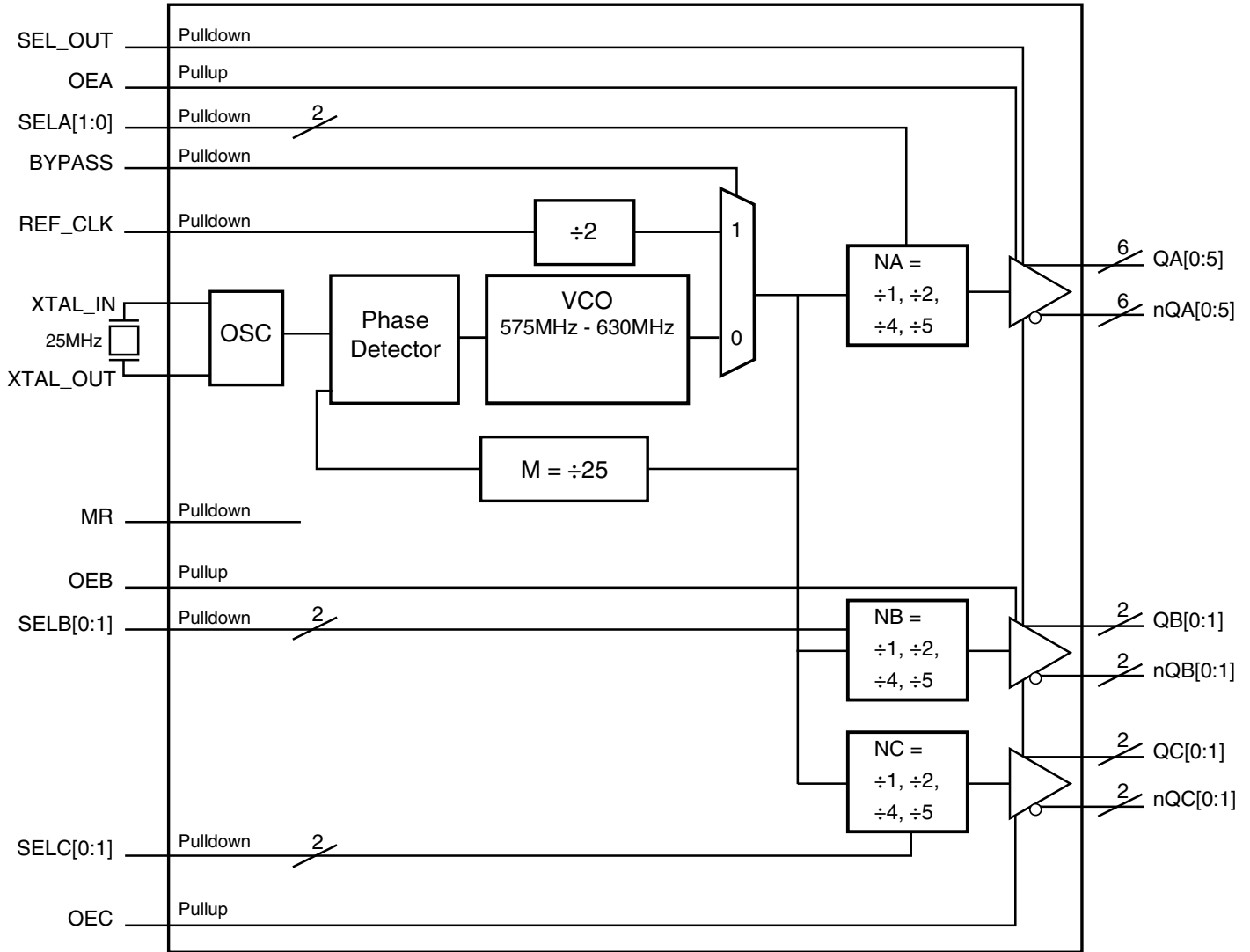
Crystal Frequency (MHz)	M Feedback Divider	VCO Frequency (MHz)	Nx Output Divider	Output Frequency (MHz)
25	25	625	1	625
25	25	625	2	312.5
25	25	625	4	156.25
25	25	625	5	125

### Pin Assignment



**48 Lead TQFP, E-Pad**  
**7mm x 7mm x 1.0mm package body**  
**Y Package**  
**Top View**

### Block Diagram



**Table 1. Pin Descriptions**

Number	Name	Type		Description
1, 2	XTAL_IN XTAL_OUT	Input		Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output.
3, 12, 31, 46	V <sub>EE</sub>	Power		Negative supply pins.
4, 5	SELC0, SELC1	Input	Pulldown	Selects the output divider value. See Table 3D. LVCMOS/LVTTL interface levels.
6	OEA	Input	Pullup	Active high output enable. When logic HIGH, Bank A outputs are enabled and active. When logic LOW, the outputs are disabled and forced to HIGH/LOW. LVCMOS/LVTTL interface levels.
7, 48	V <sub>CC</sub>	Power		Core supply pins.
8	OEB	Input	Pullup	Active high output enable. When logic HIGH, Bank B outputs are enabled and active. When logic LOW, the outputs are disabled and forced to HIGH/LOW. LVCMOS/LVTTL interface levels.
9	OEC	Input	Pullup	Active high output enable. When logic HIGH, Bank C outputs are enabled and active. When logic LOW, the outputs are disabled and forced to HIGH/LOW. LVCMOS/LVTTL interface levels.
10, 11	SELB0, SELB1	Input	Pulldown	Selects the output divider value. See Table 3C. LVCMOS/LVTTL interface levels.
13, 19, 24, 32, 37	V <sub>CCO</sub>	Power		Output supply pins.
14, 15	nQC1, QC1	Output		Differential output pair. LVPECL or LVDS interface levels.
16, 17	nQC0, QC0	Output		Differential output pair. LVPECL or LVDS interface levels.
18	nc	Unused		No connect.
20, 21	nQB1, QB1	Output		Differential output pair. LVPECL or LVDS interface levels.
22, 23	nQB0, QB0	Output		Differential output pair. LVPECL or LVDS interface levels.
25, 26	nQA5, QA5	Output		Differential output pair. LVPECL or LVDS interface levels.
27, 28	nQA4, QA4	Output		Differential output pair. LVPECL or LVDS interface levels.
29, 30	nQA3, QA3	Output		Differential output pair. LVPECL or LVDS interface levels.
33, 34	nQA2, QA2	Output		Differential output pair. LVPECL or LVDS interface levels.
35, 36	nQA1, QA1	Output		Differential output pair. LVPECL or LVDS interface levels.
38, 39	nQA0, QA0	Output		Differential output pair. LVPECL or LVDS interface levels.
40	V <sub>CCA</sub>	Power		Analog supply pin.
41, 42	SELA1, SELA0	Input	Pulldown	Selects the output divider value. See Table 3B. LVCMOS/LVTTL interface levels.
43	SEL_OUT	Input	Pulldown	Selects between either LVDS or LVPECL output levels. See Table 3A. LVCMOS/LVTTL interface levels.
44	MR	Input	Pulldown	Master Reset. LVCMOS/LVTTL interface levels.
45	BYPASS	Input	Pulldown	PLL BYPASS mode select pin. See Table 3F. LVCMOS/LVTTL interface levels.
47	REF_CLK	Input	Pulldown	Single-ended reference clock input. LVCMOS/LVTTL interface levels.

NOTE: *Pullup and Pulldown* refer to internal input resistors. See Table 2, *Pin Characteristics*, for typical values.

**Table 2. Pin Characteristics**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
C <sub>IN</sub>	Input Capacitance			2		pF
R <sub>PULLUP</sub>	Input Pullup Resistor			51		kΩ
R <sub>PULLDOWN</sub>	Input Pulldown Resistor			51		kΩ

**Function Tables****Table 3A. SEL\_OUT Function Table**

Input	Output Levels
SEL_OUT	
0 (default)	LVDS
1	LVPECL

**Table 3E. MR Function Table**

Input	Device Function
MR	
0 (default)	Normal
1	Master Reset

**Table 3B. SELA Function Table**

Inputs		NA Bank A Output Divider
SELA0	SELA1	
0 (default)	0 (default)	÷1
0	1	÷2
1	0	÷4
1	1	÷5

**Table 3F. BYPASS Function Table**

Input	Device Function
BYPASS	
0 (default)	PLL mode. The output frequency is the VCO frequency divided by the selected output divider.
1	Bypass mode. The output frequency is the REF_CLK frequency divided by two and then divided by the selected output divider.

**Table 3C. SELB Function Table**

Inputs		NB Bank B Output Divider
SELB0	SELB1	
0 (default)	0 (default)	÷1
0	1	÷2
1	0	÷4
1	1	÷5

**Table 3D. SELC Function Table**

Inputs		NC Bank C Output Divider
SELC0	SELC1	
0 (default)	0 (default)	÷1
0	1	÷2
1	0	÷4
1	1	÷5

## Absolute Maximum Ratings

NOTE: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

Item	Rating
Supply Voltage, $V_{CC}$	4.6V
Inputs, $V_I$ XTAL_IN Other Inputs	0V to $V_{CC}$ -0.5V to $V_{CC} + 0.5V$
Outputs, LVPECL $I_O$ Continuos Current Surge Current	50mA 100mA
Outputs, LVDS $I_O$ Continuos Current Surge Current	10mA 15mA
Package Thermal Impedance, $\theta_{JA}$	33.1°C/W (0 mps)
Storage Temperature, $T_{STG}$	-65°C to 150°C

## DC Electrical Characteristics

**Table 4A. LVDS Power Supply DC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{CC}$	Core Supply Voltage		3.135	3.3	3.465	V
$V_{CCA}$	Analog Supply Voltage		$V_{CC} - 0.16$	3.3	$V_{CC}$	V
$V_{CCO}$	Output Supply Voltage		3.135	3.3	3.465	V
$I_{CC}$	Power Supply Current				107	mA
$I_{CCA}$	Analog Supply Current				16	mA
$I_{CCO}$	Output Supply Current				228	mA

NOTE: Outputs configured as LVDS (SEL\_OUT = 0).

NOTE: For the Power Supply Voltage Sequence Information, see Applications Information section.

**Table 4B. LVPECL Power Supply DC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{CC}$	Core Supply Voltage		3.135	3.3	3.465	V
$V_{CCA}$	Analog Supply Voltage		$V_{CC} - 0.16$	3.3	$V_{CC}$	V
$V_{CCO}$	Output Supply Voltage		3.135	3.3	3.465	V
$I_{EE}$	Power Supply Current				181	mA
$I_{CCA}$	Analog Supply Current				16	mA

NOTE: Outputs configured as LVPECL (SEL\_OUT = 1).

NOTE: For the Power Supply Voltage Sequence Information, see Applications Information section.

**Table 4C. LVCMOS/LVTTL DC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage	$V_{CC} = 3.3V$	2.2		$V_{CC} + 0.3$	V
$V_{IL}$	Input Low Voltage	$V_{CC} = 3.3V$	-0.3		0.8	V
$I_{IH}$	Input High Current	REF_CLK, BYPASS, MR, SELA[1:0], SELB[1:0], SELC[1:0], SEL_OUT	$V_{CC} = V_{IN} = 3.465V$		150	$\mu A$
		OEA, OEB, OEC	$V_{CC} = V_{IN} = 3.465V$		10	$\mu A$
$I_{IL}$	Input Low Current	REF_CLK, BYPASS, MR, SELA[1:0], SELB[1:0], SELC[1:0], SEL_OUT	$V_{CC} = 3.465V$ , $V_{IN} = 0V$	-10		$\mu A$
		OEA, OEB, OEC	$V_{CC} = 3.465V$ , $V_{IN} = 0V$	-150		$\mu A$

**Table 4D. LVPECL DC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OH}$	Output High Voltage		$V_{CCO} - 1.2$		$V_{CCO} - 0.7$	V
$V_{OL}$	Output Low Voltage		$V_{CCO} - 2.0$		$V_{CCO} - 1.5$	V
$V_{SWING}$	Peak-to-Peak Output Voltage Swing		0.6		1.0	V

**Table 4E. LVDS DC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OD}$	Differential Output Voltage		268		475	mV
$\Delta V_{OD}$	$V_{OD}$ Magnitude Change				50	mV
$V_{OS}$	Offset Voltage		1.125		1.375	V
$\Delta V_{OS}$	$V_{OS}$ Magnitude Change				50	mV

## AC Electrical Characteristics

**Table 5A. LVPECL AC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency	$Qx = \div 1$	575	625	630	MHz
		$Qx = \div 2$	287.5	312.5	315	MHz
		$Qx = \div 4$	143.75	156.25	157.5	MHz
		$Qx = \div 5$	115	125	126	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter (Random); NOTE 1	156.25MHz, Integration Range: (1MHz – 20MHz)		0.373	0.422	ps
		156.25MHz, Integration Range: (12kHz – 20MHz)		0.694	1.04	ps
$f_{jit}(cc)$	Cycle-to-Cycle Jitter; NOTE 2				25	ps
$t_R / t_F$	Output Rise/Fall Time	10% to 90%	65	180	350	ps
odc	Output Duty Cycle		47		53	%
$t_{LOCK}$	PLL Lock Time				130	ms

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE: Outputs configured as LVPECL (SEL\_OUT = 1).

NOTE 1: Refer to the Phase Noise Plot.

NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.

**Table 5B. LVDS AC Characteristics,  $V_{CC} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency	$Qx = \div 1$	575	625	630	MHz
		$Qx = \div 2$	287.5	312.5	315	MHz
		$Qx = \div 4$	143.75	156.25	157.5	MHz
		$Qx = \div 5$	115	125	126	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter (Random); NOTE 1	156.25MHz, Integration Range: (1MHz – 20MHz)		0.375	0.413	ps
		156.25MHz, Integration Range: (12kHz – 20MHz)		0.712	1.26	ps
$f_{jit}(cc)$	Cycle-to-Cycle Jitter; NOTE 2				20	ps
$t_R / t_F$	Output Rise/Fall Time	10% to 90%	65	190	350	ps
odc	Output Duty Cycle		47		53	%
$t_{LOCK}$	PLL Lock Time				130	ms

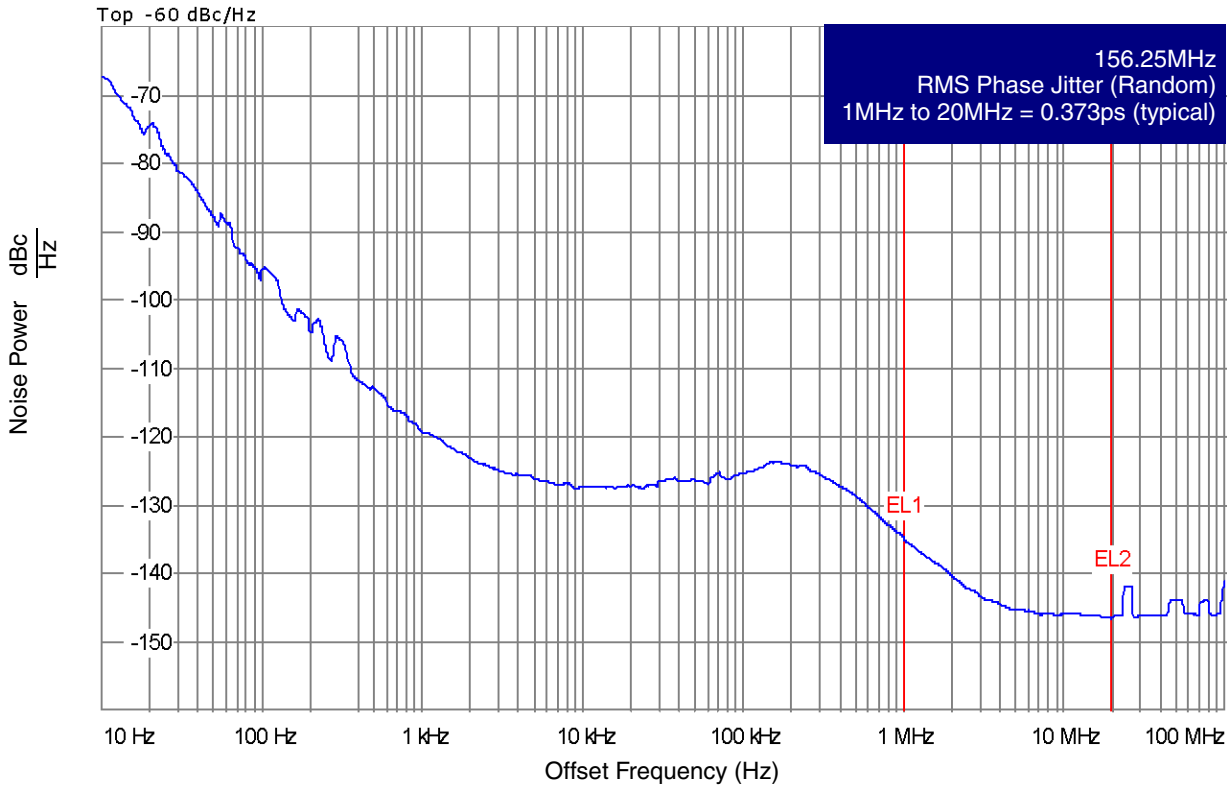
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE: Outputs configured as LVDS (SEL\_OUT = 0).

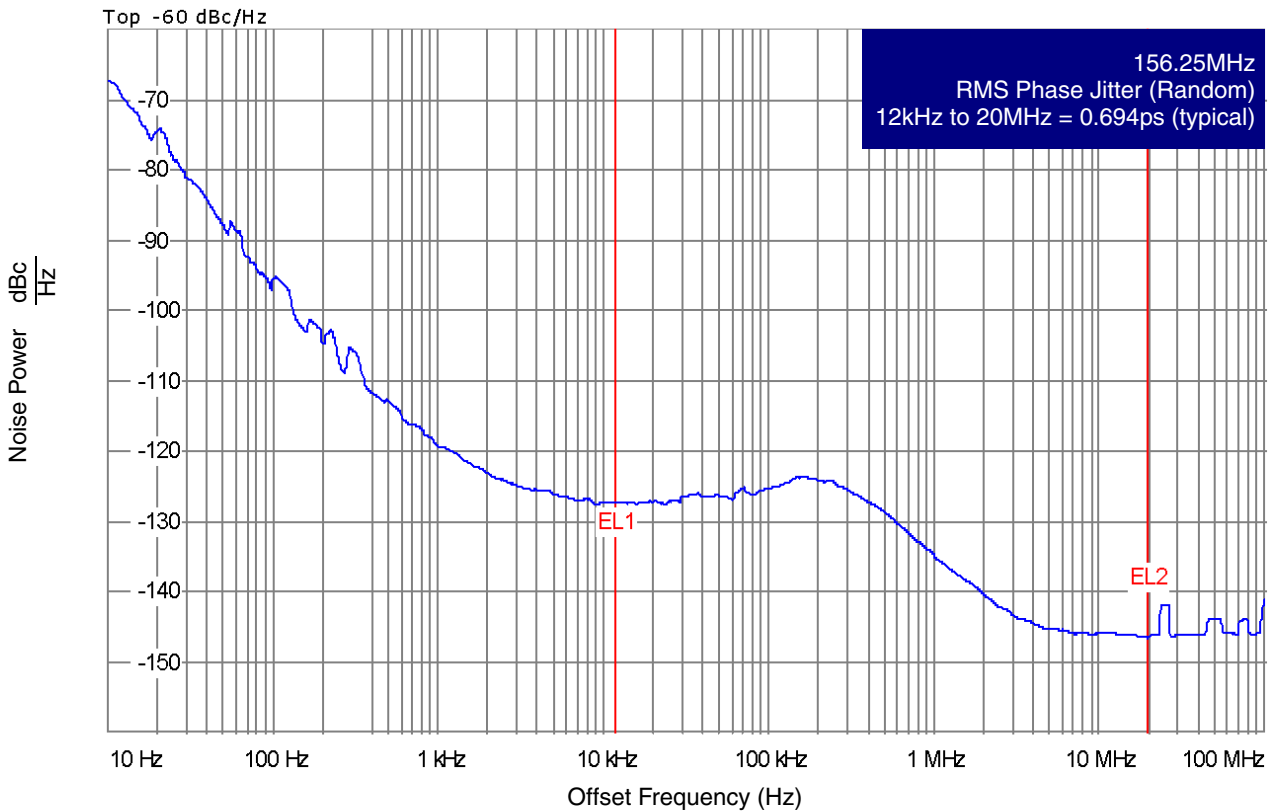
NOTE 1: Refer to the Phase Noise Plot.

NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.

### Typical Phase Noise at 156.25MHz (LVPECL)

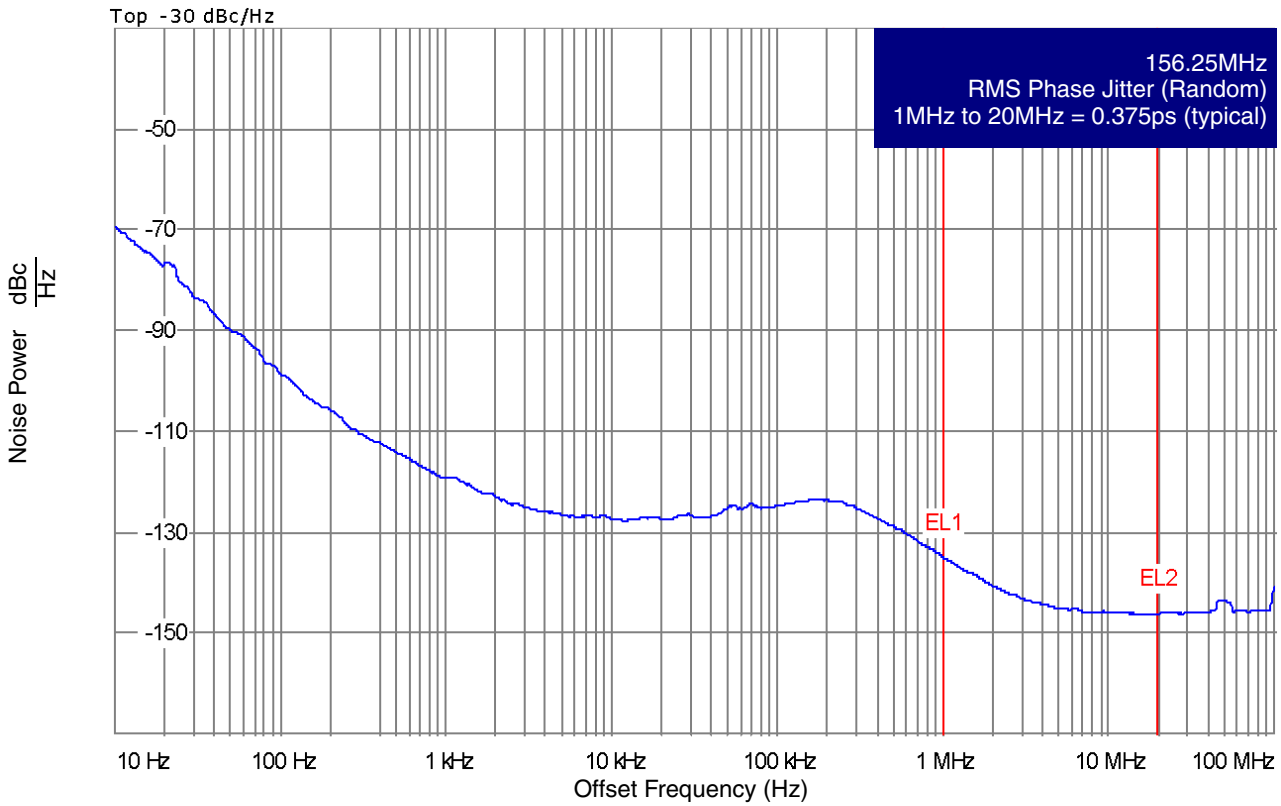


### Typical Phase Noise at 156.25MHz (LVPECL)

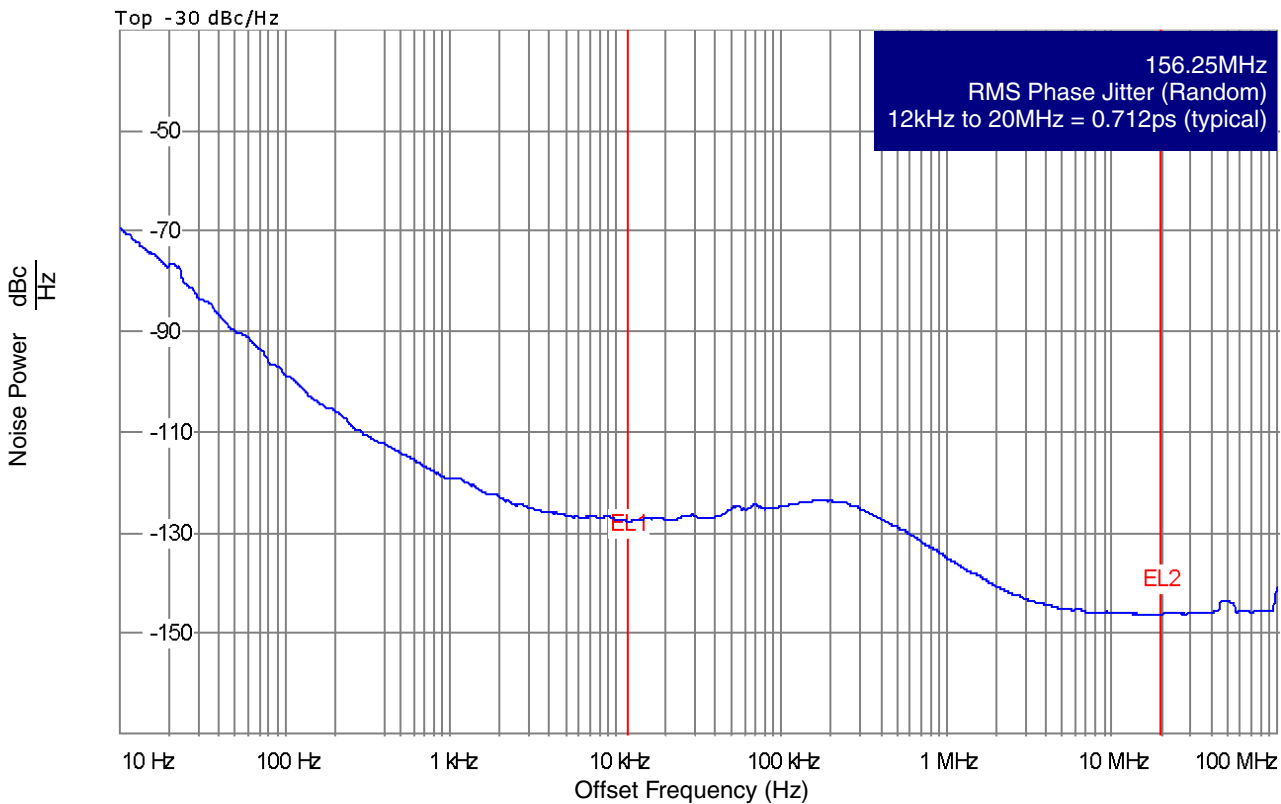




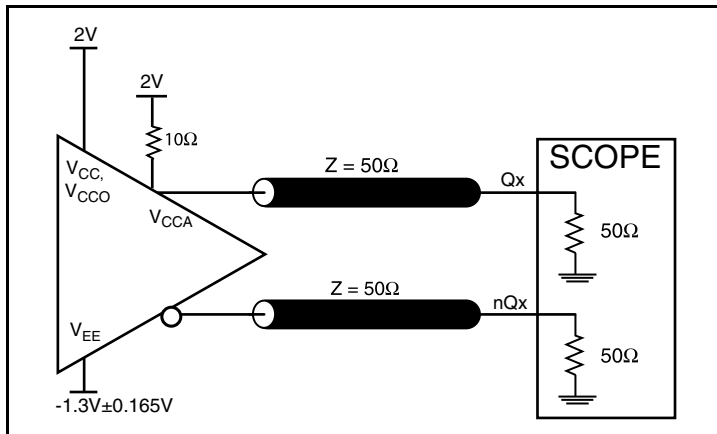
### Typical Phase Noise at 156.25MHz (LVDS)



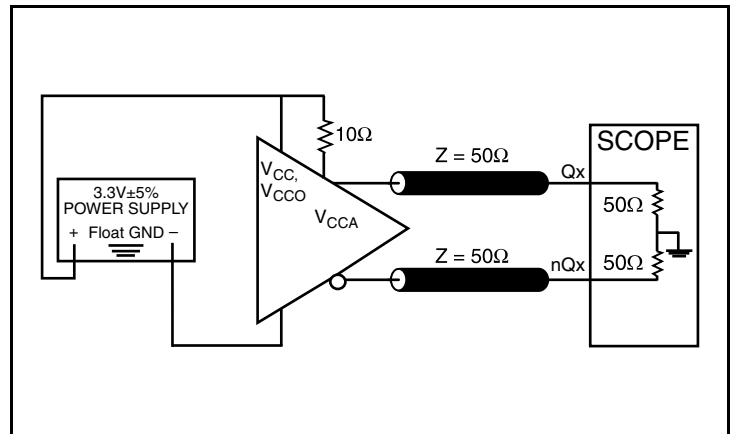
### Typical Phase Noise at 156.25MHz (LVDS)



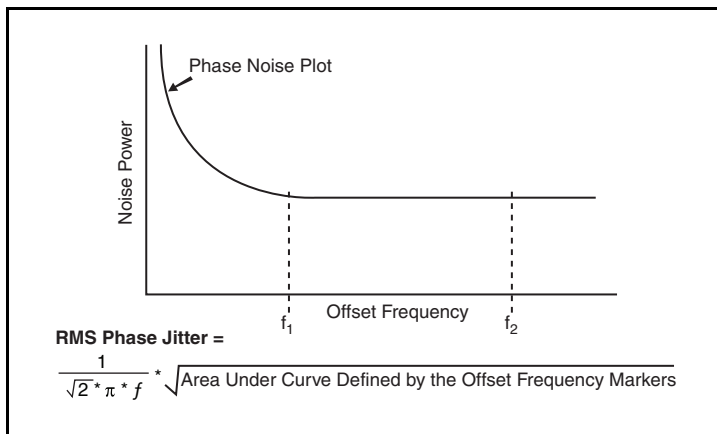
## Parameter Measurement Information



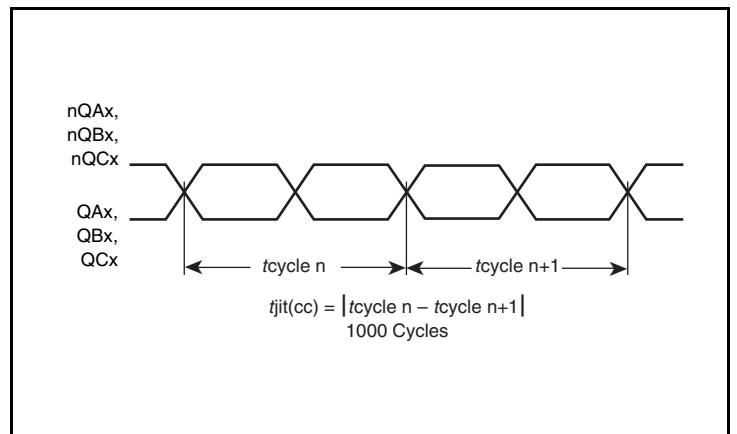
LVPECL Output Load AC Test Circuit



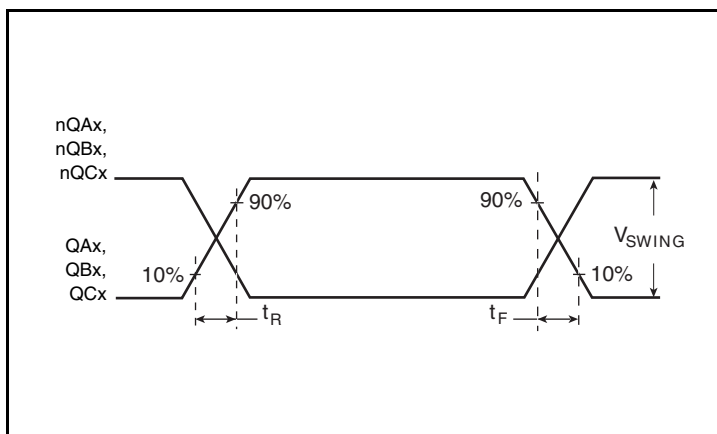
LVDS Output Load AC Test Circuit



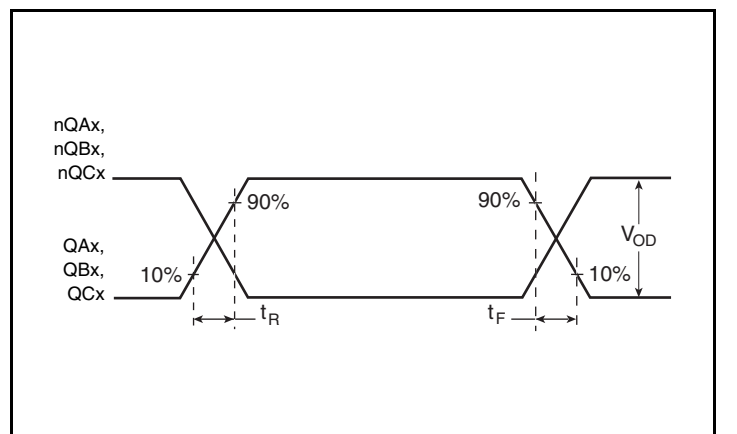
RMS Phase Jitter



Cycle-to-Cycle Jitter

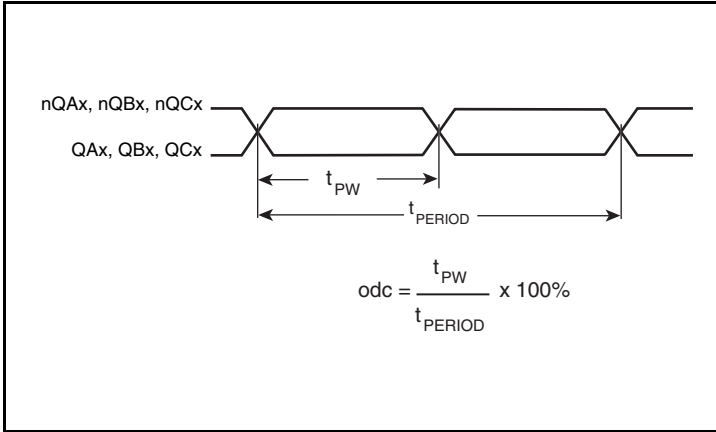


LVPECL Output Rise/Fall Time

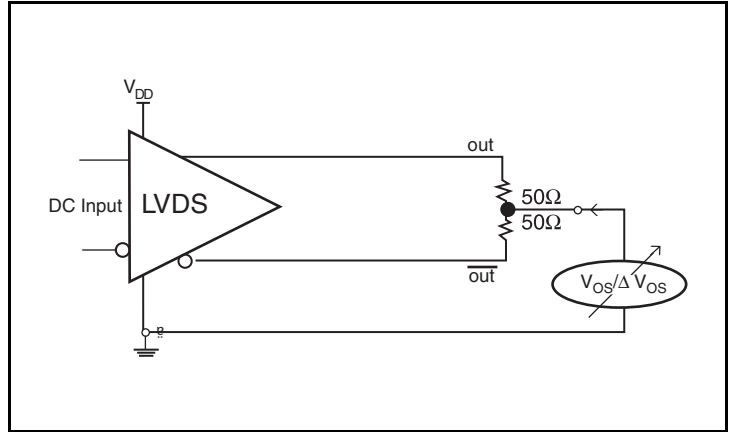


LVDS Output Rise/Fall Time

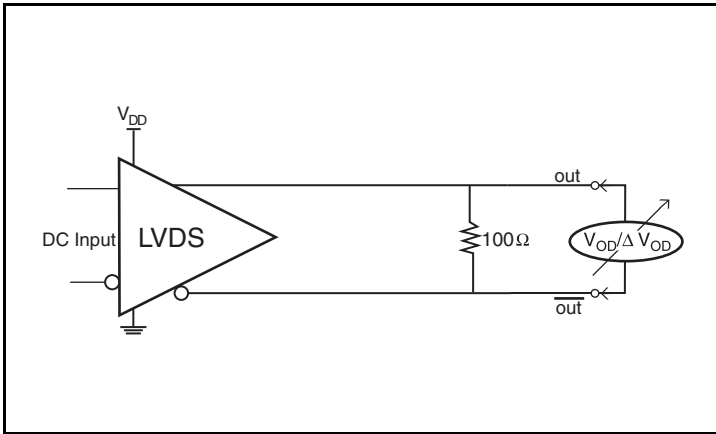
### Parameter Measurement Information, continued



**Output Duty Cycle/Pulse Width/Period**



**Offset Voltage Setup**



**Differential Output Voltage Setup**

## Applications Information

### Recommendations for Unused Input and Output Pins

#### Inputs:

##### REF\_CLK Input

For applications not requiring the use of the reference clock, it can be left floating. Though not required, but for additional protection, a 1k $\Omega$  resistor can be tied from the REF\_CLK to ground.

##### Crystal Inputs

For applications not requiring the use of the crystal oscillator input, both XTAL\_IN and XTAL\_OUT can be left floating. Though not required, but for additional protection, a 1k $\Omega$  resistor can be tied from XTAL\_IN to ground.

##### LVC MOS Control Pins

All control pins have internal pullups or pulldowns; additional resistance is not required but can be added for additional protection. A 1k $\Omega$  resistor can be used.

#### Outputs:

##### LVPECL Outputs

All unused LVPECL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

##### LVDS Outputs

All unused LVDS output pairs can be either left floating or terminated with 100 $\Omega$  across. If they are left floating, there should be no trace attached.

**Table 6. Recommended Crystal Specifications**

Symbol	Parameter	Value
	Crystal Cut	Fundamental at Cut
	Resonance	Parallel Resonance
$f_T$	Frequency Tolerance	$\pm 25$ ppm at 25 $^{\circ}$ C
$f_S$	Frequency Stability	$\pm 25$ ppm over -40 $^{\circ}$ C to +85 $^{\circ}$ C
$C_L$	Load Capacitance	18pF
$C_O$	Shunt Capacitance	5pF - 7pF
ESR	Equivalent Series Resistance	20 $\Omega$ - 50 $\Omega$
	Aging @ 25 $^{\circ}$ C	$\pm 15$ ppm/10 Years Maximum

NOTE: External tuning capacitors must be used for proper operation.

### Power Supply Voltage Sequence Information

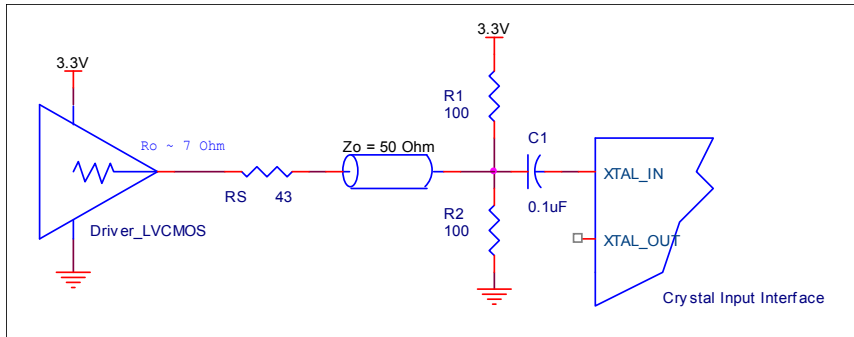
No power sequence restrictions apply if  $V_{CC}$  and  $V_{CCA}$  are supplied by the same power plane and the recommended  $V_{CCA}$  filter is used (see Figure 6).  $V_{CCO}$  may be applied at any time before or after  $V_{CC}$

and  $V_{CCA}$  are applied. If  $V_{CC}$  and  $V_{CCA}$  are not supplied by the same power plane,  $V_{CCA}$  must be powered on before or at the same time  $V_{CC}$  is applied. The  $V_{CCO}$  supply voltage may be applied at any time.

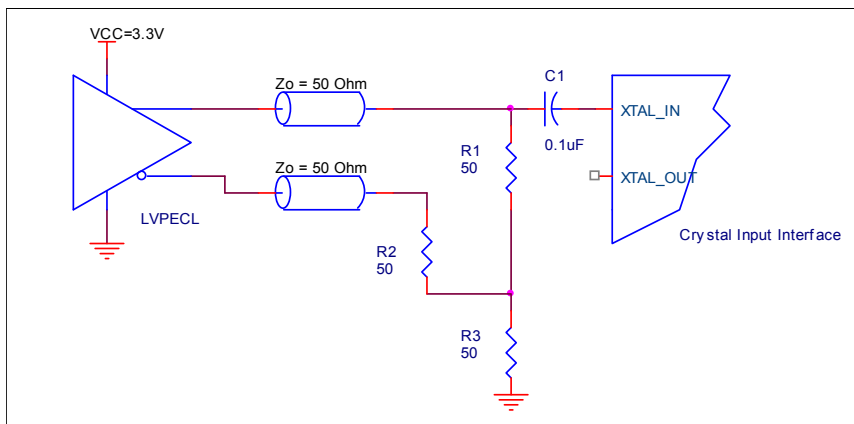
## Overdriving the XTAL Interface

The XTAL\_IN input can accept a single-ended LVCMOS signal through an AC coupling capacitor. A general interface diagram is shown in *Figure 1A*. The XTAL\_OUT pin can be left floating. The maximum amplitude of the input signal should not exceed 2V and the input edge rate can be as slow as 10ns. This configuration requires that the output impedance of the driver ( $R_o$ ) plus the series resistance ( $R_s$ ) equals the transmission line impedance. In addition,

matched termination at the crystal input will attenuate the signal in half. This can be done in one of two ways. First,  $R_1$  and  $R_2$  in parallel should equal the transmission line impedance. For most 50 $\Omega$  applications,  $R_1$  and  $R_2$  can be 100 $\Omega$ . This can also be accomplished by removing  $R_1$  and making  $R_2$  50 $\Omega$ . By overdriving the crystal oscillator, the device will be functional, but note, the device performance is guaranteed by using a quartz crystal.



**Figure 1A. General Diagram for LVCMOS Driver to XTAL Input Interface**

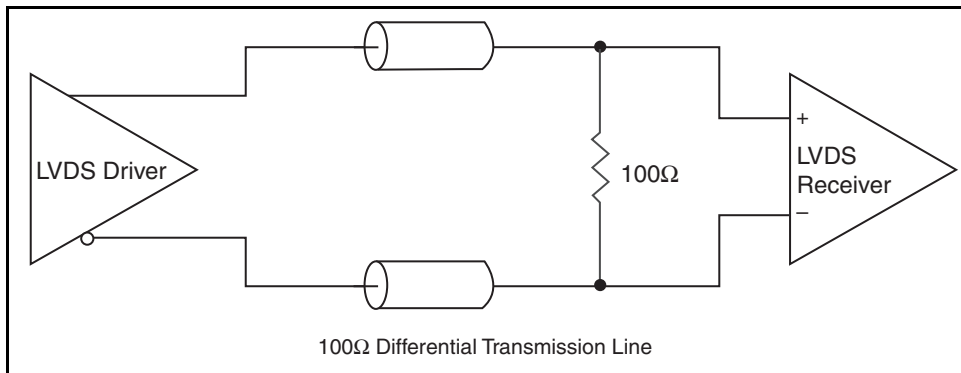


**Figure 1B. General Diagram for LVPECL Driver to XTAL Input Interface**

## LVDS Driver Termination

A general LVDS interface is shown in *Figure 2*. Standard termination for LVDS type output structure requires both a 100Ω parallel resistor at the receiver and a 100Ω differential transmission line environment. In order to avoid any transmission line reflection issues, the 100Ω resistor must be placed as close to the receiver as possible. IDT offers a full line of LVDS compliant devices with two types of output structures: current source and voltage source. The standard

termination schematic as shown in *Figure 2* can be used with either type of output structure. If using a non-standard termination, it is recommended to contact IDT and confirm if the output is a current source or a voltage source type structure. In addition, since these outputs are LVDS compatible, the input receivers amplitude and common mode input range should be verified for compatibility with the output.



**Figure 2. Typical LVDS Driver Termination**

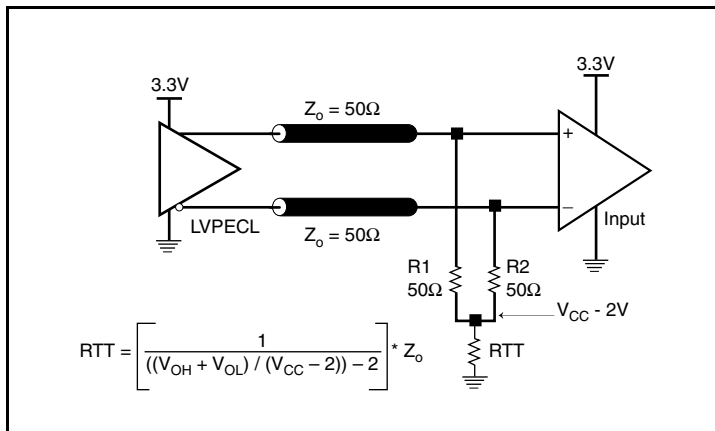
## Termination for 3.3V LVPECL Outputs

The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

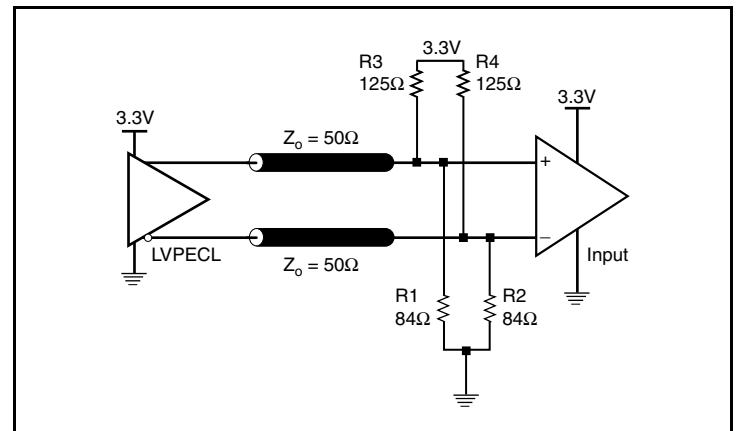
The differential outputs are low impedance follower outputs that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to drive 50Ω

transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion.

*Figures 3A and 3B* show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.



**Figure 3A. 3.3V LVPECL Output Termination**



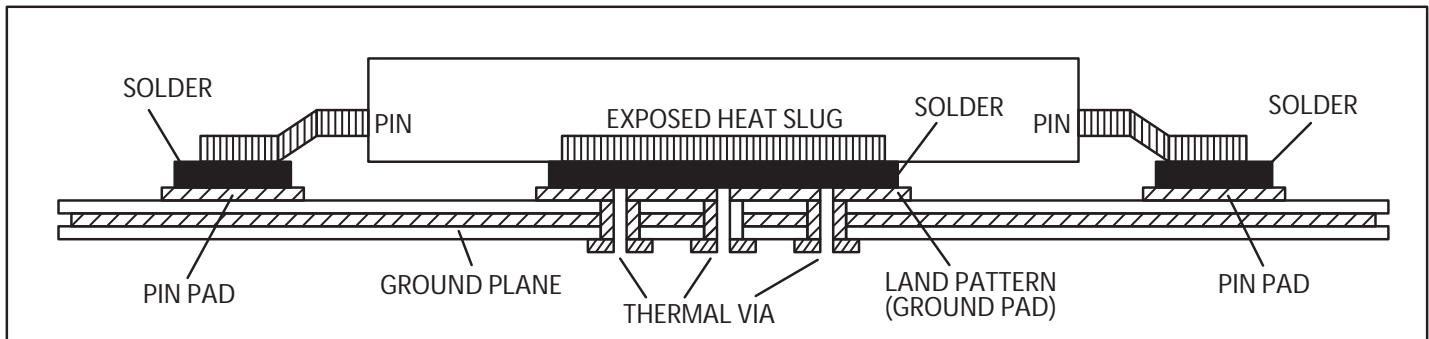
**Figure 3B. 3.3V LVPECL Output Termination**

## EPAD Thermal Release Path

In order to maximize both the removal of heat from the package and the electrical performance, a land pattern must be incorporated on the Printed Circuit Board (PCB) within the footprint of the package corresponding to the exposed metal pad or exposed heat slug on the package, as shown in *Figure 4*. The solderable area on the PCB, as defined by the solder mask, should be at least the same size/shape as the exposed pad/slug area on the package to maximize the thermal/electrical performance. Sufficient clearance should be designed on the PCB between the outer edges of the land pattern and the inner edges of pad pattern for the leads to avoid any shorts.

While the land pattern on the PCB provides a means of heat transfer and electrical grounding from the package to the board through a solder joint, thermal vias are necessary to effectively conduct from the surface of the PCB to the ground plane(s). The land pattern must be connected to ground through these vias. The vias act as “heat pipes”. The number of vias (i.e. “heat pipes”) are application specific

and dependent upon the package power dissipation as well as electrical conductivity requirements. Thus, thermal and electrical analysis and/or testing are recommended to determine the minimum number needed. Maximum thermal and electrical performance is achieved when an array of vias is incorporated in the land pattern. It is recommended to use as many vias connected to ground as possible. It is also recommended that the via diameter should be 12 to 13mils (0.30 to 0.33mm) with 1oz copper via barrel plating. This is desirable to avoid any solder wicking inside the via during the soldering process which may result in voids in solder between the exposed pad/slug and the thermal land. Precautions should be taken to eliminate any solder voids between the exposed heat slug and the land pattern. Note: These recommendations are to be used as a guideline only. For further information, refer to the Application Note on the *Surface Mount Assembly* of Amkor’s Thermally/Electrically Enhance Leadframe Base Package, Amkor Technology.



**Figure 4. Assembly for Exposed Pad Thermal Release Path - Side View (drawing not to scale)**

### Application Schematic Example

Figure 5 shows an example of ICS849S625I application schematic. In this example, the device is operated at  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V$ . An 18pF parallel resonant 25MHz crystal is used. The load capacitance  $C1 = 27pF$  and  $C2 = 27pF$  are recommended for frequency accuracy. Depending on the parasitics of the printed circuit board layout, these values might required slight adjustment to optimize the frequency accuracy. Crystals with other load capacitance specifications can be used. This will require adjusting  $C1$  and  $C2$ . For this device, the crystal load capacitors are required for proper operation.

As with any high speed analog circuitry, the power supply pins are vulnerable to noise. To achieve optimum jitter performance, power supply isolation is required. The ICS849S625I provides separate power supplies to isolate from coupling into the internal PLL.

In order to achieve the best possible filtering, it is recommended that the placement of the filter components be on the device side of the PCB as close to the power pins as possible. If space is limited, the 0.1uF capacitor in each power pin filter should be placed on the device side of the PCB and the other components can be placed on the opposite side.

Power supply filter recommendations are a general guideline to be used for reducing external noise from coupling into the devices. The filter performance is designed for wide range of noise frequencies. This low-pass filter starts to attenuate noise at approximately 10kHz. If a specific frequency noise component is known, such as switching power supply frequencies, it is recommended that component values be adjusted and if required, additional filtering be added. Additionally, good general design practices for power plane voltage stability suggests adding bulk capacitances in the local area of all devices.

The schematic example focuses on functional connections and is not configuration specific. Refer to the pin description and functional tables in the datasheet to ensure the logic control inputs are properly set.

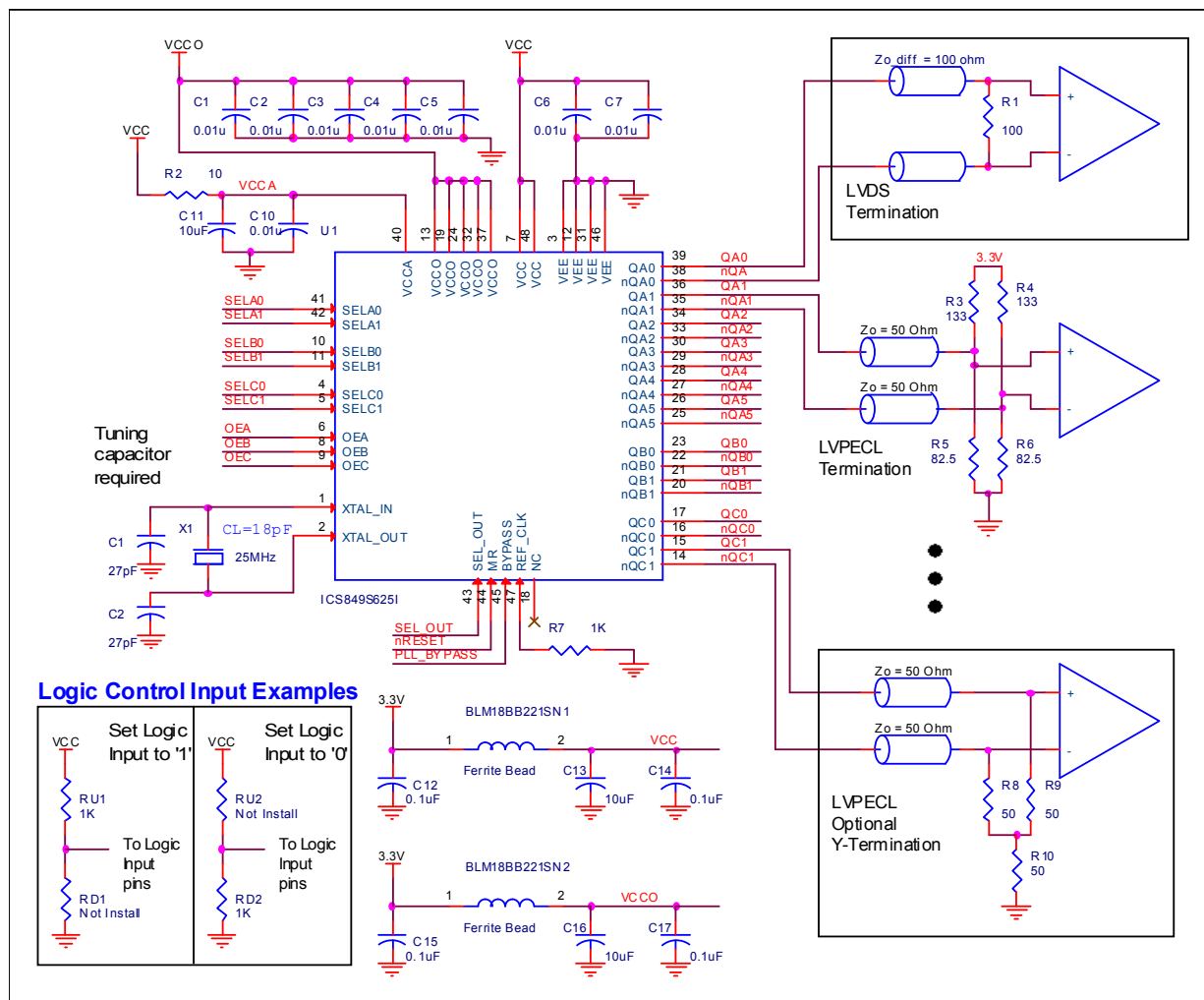


Figure 5. ICS849S625I Application Schematic



## LVPECL Power Considerations

This section provides information on power dissipation and junction temperature for the ICS849S625I. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS849S625I is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{CC} = 3.3V + 5\% = 3.465V$ , which gives worst case results.

NOTE: Please refer to Section 3 for details on calculating power dissipated in the load.

The maximum current at 85°C is as follows:

$$I_{EE\_MAX} = 170mA$$

- Power (core)<sub>MAX</sub> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 170mA = 589.05mW$
- Power (outputs)<sub>MAX</sub> = **33.2mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $10 * 33.2mW = 332mW$

$$\text{Total Power}_{MAX} (3.465V, \text{ with all outputs switching}) = 589.05mW + 332mW = 921.05mW$$

### 2. Junction Temperature.

Junction temperature,  $T_j$ , is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature,  $T_j$ , to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for  $T_j$  is as follows:  $T_j = \theta_{JA} * Pd\_total + T_A$

$T_j$  = Junction Temperature

$\theta_{JA}$  = Junction-to-Ambient Thermal Resistance

$Pd\_total$  = Total Device Power Dissipation (example calculation is in section 1 above)

$T_A$  = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is 33.1°C/W per Table 7 below.

Therefore,  $T_j$  for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ C + 0.921W * 33.1^\circ C/W = 115.5^\circ C. \text{ This is below the limit of } 125^\circ C.$$

This calculation is only an example.  $T_j$  will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

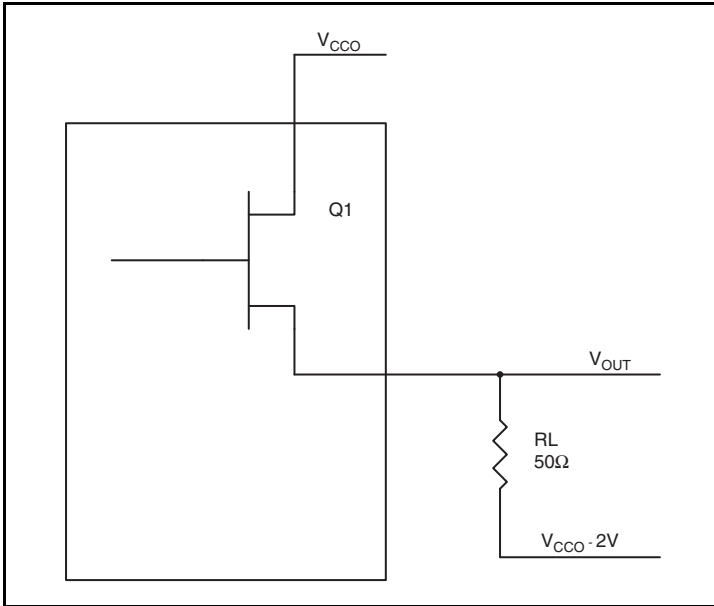
**Table 7. Thermal Resistance  $\theta_{JA}$  for 48 Lead TQFP, E-Pad, Forced Convection**

Meters per Second	$\theta_{JA}$ by Velocity		
	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	33.1°C/W	27.2°C/W	25.7°C/W

### 3. Calculations and Equations.

The purpose of this section is to calculate the power dissipation for the LVPECL output pair.

LVPECL output driver circuit and termination are shown in *Figure 6*.



**Figure 6. LVPECL Driver Circuit and Termination**

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination voltage of  $V_{CCO} - 2V$ .

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CCO\_MAX} - 0.7V$   
 $(V_{CCO\_MAX} - V_{OH\_MAX}) = 0.7V$
- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CCO\_MAX} - 1.5V$   
 $(V_{CCO\_MAX} - V_{OL\_MAX}) = 1.5V$

$Pd\_H$  is power dissipation when the output drives high.

$Pd\_L$  is the power dissipation when the output drives low.

$$Pd\_H = [(V_{OH\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - 0.7V)/50\Omega] * 0.7V = \mathbf{18.2mW}$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - 1.5V)/50\Omega] * 1.5V = \mathbf{15mW}$$

Total Power Dissipation per output pair =  $Pd\_H + Pd\_L = \mathbf{33.2mW}$

## LVDS Power Considerations

This section provides information on power dissipation and junction temperature for the ICS849S625I. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS849S625I is the sum of the core power plus the analog power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{CC} = 3.3V + 5\% = 3.465V$ , which gives worst case results.

The maximum current at 85°C is as follows:

$$I_{CC\_MAX} = 100mA$$

$$I_{CCA\_MAX} = 15mA$$

$$I_{CCO\_MAX} = 212mA$$

- Power (core)<sub>MAX</sub> =  $V_{CC\_MAX} * (I_{CC\_MAX} + I_{CCA\_MAX}) = 3.465V * (100mA + 15mA) = \mathbf{398.475mW}$
- Power (outputs)<sub>MAX</sub> =  $V_{CCO\_MAX} * I_{CCO\_MAX} = 3.465V * 212mA = \mathbf{734.58mW}$

$$\mathbf{Total\ Power_{MAX} = 398.475mW + 734.58mW = 1133.1mW}$$

### 2. Junction Temperature.

Junction temperature,  $T_j$ , is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature,  $T_j$ , to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

$$\text{The equation for } T_j \text{ is as follows: } T_j = \theta_{JA} * Pd_{total} + T_A$$

$T_j$  = Junction Temperature

$\theta_{JA}$  = Junction-to-Ambient Thermal Resistance

$Pd_{total}$  = Total Device Power Dissipation (example calculation is in section 1 above)

$T_A$  = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is 33.1°C/W per Table 8 below.

Therefore,  $T_j$  for an ambient temperature of 85°C with all outputs switching is:

$$85^\circ C + 1.133W * 33.1^\circ C/W = 122.5^\circ C. \text{ This is below the limit of } 125^\circ C.$$

This calculation is only an example.  $T_j$  will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

**Table 8. Thermal Resistance  $\theta_{JA}$  for 48 Lead TQFP, E-Pad, Forced Convection**

$\theta_{JA}$ by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	33.1°C/W	27.2°C/W	25.7°C/W

## Reliability Information

**Table 9.  $\theta_{JA}$  vs. Air Flow Table for a 48 Lead TQFP, E-Pad**

$\theta_{JA}$ vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	33.1°C/W	27.2°C/W	25.7°C/W

## Transistor Count

The transistor count for ICS849S625I is: 3696

## Package Outline and Package Dimensions

### Package Outline - Y Suffix for 48 Lead TQFP, E-Pad

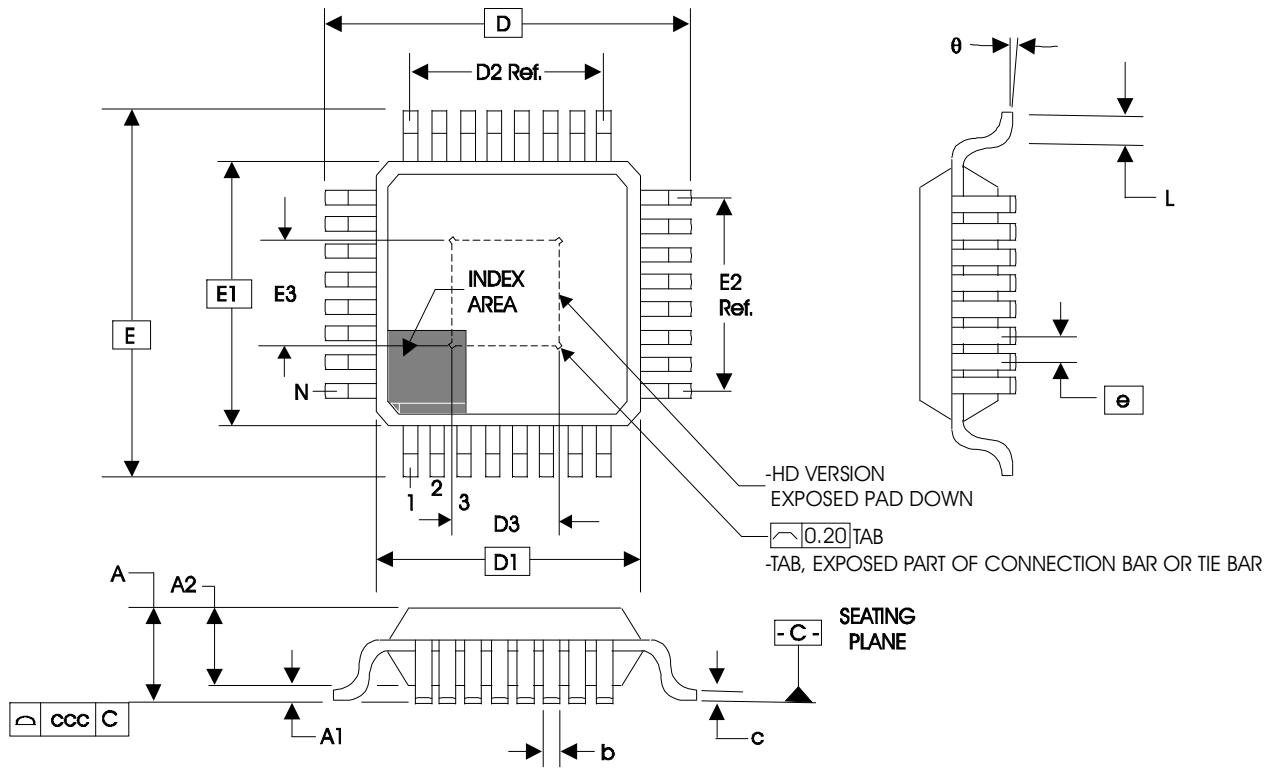


Table 10. Package Dimensions for 48 Lead TQFP, E-Pad

JEDEC Variation: BBC - HD			
All Dimensions in Millimeters			
Symbol	Minimum	Nominal	Maximum
N		48	
A			1.20
A1	0.05	0.10	0.15
A2	0.95	1.00	1.05
b	0.17	0.22	0.27
c	0.09		0.20
D & E		9.00 Basic	
D1 & E1		7.00 Basic	
D2 & E2		5.50 Ref.	
D3 & E3		3.5	
e		0.5 Basic	
L	0.45	0.60	0.75
$\theta$	0°		7°

Reference Document: JEDEC Publication 95, MS-026

## Ordering Information

**Table 11. Ordering Information**

<b>Part/Order Number</b>	<b>Marking</b>	<b>Package</b>	<b>Shipping Packaging</b>	<b>Temperature</b>
849S625BYILF	ICS49S625BIL	"Lead-Free" 48 Lead TQFP, E-Pad	Tray	-40°C to 85°C
849S625BYILFT	ICS49S625BIL	"Lead-Free" 48 Lead TQFP, E-Pad	Tape & Reel	-40°C to 85°C

## Revision History Sheet

Rev	Table	Page	Description of Change	Date
A	T4E	6	VOD: changed units from V to mV	10/1/12
	T11	22	Deleted quantity from Tape & Rreel. Deleted Lead-Free note.	

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