2.5V PROGRAMMABLE SKEW PLL DIFFERENTIAL CLOCK DRIVER TERACLOCK™

IDT5T9110

PRODUCT DISCONTINUATION NOTICE - LAST TIME BUY EXPIRES ON OCTOBER 28, 2014

FEATURES:

- 2.5 V_{DD}
- 6 pairs of programmable skew outputs
- Low skew: 100ps all outputs
- Selectable positive or negative edge synchronization
- Tolerant to spread spectrum input clock
- Synchronous output enable
- Selectable reference input
- Input frequency: 4.17MHz to 250MHz
- Output frequency: 12.5MHz to 250MHz
- 1.8V / 2.5V LVTTL: up to 250MHz
- HSTL / eHSTL: up to 250MHz
- Hot insertable and over-voltage tolerant inputs
- 3-level inputs for skew control
- 3-level inputs for selectable interface
- 3-level inputs for divide selection multiply/divide ratios of (1-6, 8, 10, 12) / (2, 4)
- Selectable HSTL, eHSTL, 1.8V/2.5V LVTTL, or LVEPECL input interface
- Selectable differential or single-ended inputs and six differential outputs
- PLL bypass for DC testing
- External differential feedback, internal loop filter
- Low Jitter: <75ps cycle-to-cycle
- Power-down mode
- Lock indicator
- Available in BGA package
- use replacement parts: 873995AYLF & 873996AYLF

DESCRIPTION:

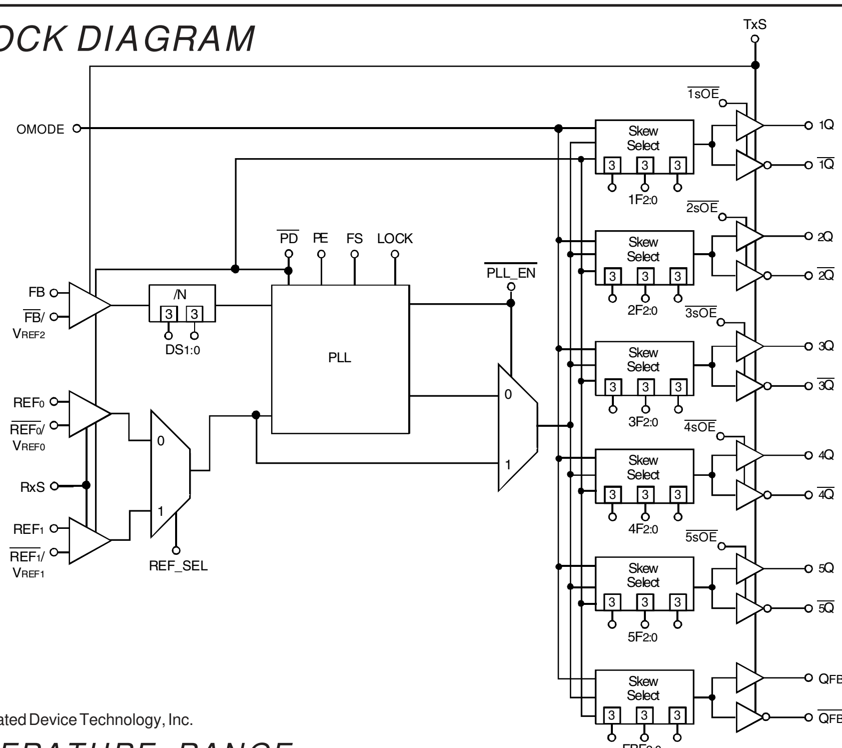
The IDT5T9110 is a 2.5V PLL differential clock driver intended for high performance computing and data-communications applications. A key feature of the programmable skew is the ability of outputs to lead or lag the REF input signal. The IDT5T9110 has six differential programmable skew outputs in six banks, including a dedicated differential feedback. Skew is controlled by 3-level input signals that may be hard-wired to appropriate high-mid-low levels. The redundant input capability allows for a smooth change over to a secondary clock source when the primary clock source is absent.

The feedback bank allows divide-by-functionality from 1 to 12 through the use of the DS[1:0] inputs. This provides the user with frequency multiplication 1 to 12 without using divided outputs for feedback. Each output bank also allows for a divide-by functionality of 2 or 4.

The IDT5T9110 features a user-selectable, single-ended or differential input to six differential outputs. The differential clock driver also acts as a translator from a differential HSTL, eHSTL, 1.8V/2.5V LVTTL, LVEPECL, or single-ended 1.8V/2.5V LVTTL input to HSTL, eHSTL, or 1.8V/2.5V LVTTL outputs. Selectable interface is controlled by 3-level input signals that may be hard-wired to appropriate high-mid-low levels. The differential outputs can be synchronously enabled/disabled.

Furthermore, when PE is held high, all the outputs are synchronized with the positive edge of the REF clock input. When PE is held low, all the outputs are synchronized with the negative edge of REF.

FUNCTIONAL BLOCK DIAGRAM



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INDUSTRIAL TEMPERATURE RANGE

MAY 2013

PIN CONFIGURATION

	1	2	3	4	5	6	7	8	9	10	11	12	
A	V_{DD}	$1F_2$	$\overline{1sOE}$	1Q	$\overline{1Q}$	GND	GND	$\overline{2Q}$	2Q	$\overline{2sOE}$	$2F_2$	V_{DDQ}	A
B	V_{DD}	V_{DD}	V_{DD}	$1F_0$	$1F_1$	GND	GND	$2F_1$	$2F_0$	V_{DDQ}	V_{DDQ}	$3F_2$	B
C	OMODE	V_{DD}	V_{DD}	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	V_{DDQ}	$\overline{3sOE}$	C
D	REF_ SEL	V_{DD}	V_{DD}	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	$3F_0$	3Q	D
E	REF_1	$\overline{REF_1}$ /V_{REF1}	NC	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	$3F_1$	$\overline{3Q}$	E
F	REF_0	$\overline{REF_0}$ /V_{REF0}	V_{DD}	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	V_{DDQ}	V_{DDQ}	F
G	FB	$\overline{FB}$ /V_{REF2}	V_{DD}	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	V_{DDQ}	V_{DDQ}	G
H	$\overline{PD}$	$\overline{PLL}$_ $\overline{EN}$	PE	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	$4F_1$	$\overline{4Q}$	H
J	RxS	TxS	V_{DD}	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	$4F_0$	4Q	J
K	LOCK	V_{DD}	V_{DD}	V_{DD}	GND	GND	GND	GND	V_{DDQ}	V_{DDQ}	V_{DDQ}	$\overline{4sOE}$	K
L	V_{DD}	V_{DD}	FS	FBF_0	FBF_1	GND	GND	$5F_1$	$5F_0$	V_{DDQ}	V_{DDQ}	$4F_2$	L
M	DS_1	DS_0	FBF_2	QFB	$\overline{QFB}$	GND	GND	$\overline{5Q}$	5Q	$\overline{5sOE}$	$5F_2$	V_{DDQ}	M
	1	2	3	4	5	6	7	8	9	10	11	12	

ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max	Unit
V_{DDQ}, V_{DD}	Power Supply Voltage(2)	–0.5 to +3.6	V
V_I	Input Voltage	–0.5 to +3.6	V
V_O	Output Voltage	–0.5 to V_{DDQ} +0.5	V
V_{REF}	Reference Voltage(3)	–0.5 to +3.6	V
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	–65 to +165	°C

NOTES:
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. V_{DDQ} and V_{DD} internally operate independently. No power sequencing requirements need to be met.
3. Not to exceed 3.6V.

CAPACITANCE (T_A = +25°C, f = 1MHz, V_{IN} = 0V)

Parameter	Description	Min.	Typ.	Max.	Unit
C_{IN}	Input Capacitance	2.5	3	3.5	pF
C_{OUT}	Output Capacitance	—	6.3	7	pF

NOTE:
1. Capacitance applies to all inputs except RxS, TxS, nF[2:0], FBF[2:0].and DS[1:0].

RECOMMENDED OPERATING RANGE

Symbol	Description	Min.	Typ.	Max.	Unit
T_A	Ambient Operating Temperature	–40	+25	+85	°C
V_{DD}(1)	Internal Power Supply Voltage	2.3	2.5	2.7	V
V_{DDQ}(1)	HSTL Output Power Supply Voltage	1.4	1.5	1.6	V
	Extended HSTL and 1.8V LVTTL Output Power Supply Voltage	1.65	1.8	1.95	V
	2.5V LVTTL Output Power Supply Voltage		V_{DD}		V
V_T	Termination Voltage		V_{DDQ} / 2		V

NOTE:
1. All power supplies should operate in tandem. If V_{DD} or V_{DDQ} is at maximum, then V_{DDQ} or V_{DD} (respectively) should be at maximum, and vice-versa.

PIN DESCRIPTION

Symbol	I/O	Type	Description
REF[1:0]	I	Adjustable(1)	Clock input. REF[1:0] is the "true" side of the differential clock input. If operating in single-ended mode, REF[1:0] is the clock input.
$\overline{REF}$[1:0]/ $V_{REF[1:0]}$	I	Adjustable(1)	Complementary clock input. $\overline{REF}$[1:0]/$V_{REF[1:0]}$ is the "complementary" side of REF[1:0] if the input is in differential mode. If operating in single-ended mode, $\overline{REF}$[1:0]/$V_{REF[1:0]}$ is left floating. For single-ended operation in differential mode, $\overline{REF}$[1:0]/$V_{REF[1:0]}$ should be set to the desired toggle voltage for REF[1:0]: 2.5V LVTTL — V_{REF} = 1250mV (SSTL2 compatible) 1.8V LVTTL, eHSTL — V_{REF} = 900mV HSTL — V_{REF} = 750mV LVEPECL — V_{REF} = 1082mV
FB	I	Adjustable(1)	Clock input. FB is the "true" side of the differential feedback clock input. If operating in single-ended mode, FB is the differential feedback clock input.
$\overline{FB}$/V_{REF2}	I	Adjustable(1)	Complementary feedback clock input. $\overline{FB}$/V_{REF2} is the "complementary" side of FB if the input is in differential mode. If operating in single-ended mode, $\overline{FB}$/V_{REF2} is left floating. For single-ended operation in differential mode, $\overline{FB}$/V_{REF2} should be set to the desired toggle voltage for FB: 2.5V LVTTL — V_{REF} = 1250mV (SSTL2 compatible) 1.8V LVTTL, eHSTL — V_{REF} = 900mV HSTL — V_{REF} = 750mV LVEPECL — V_{REF} = 1082mV

NOTE:
1. Inputs are capable of translating the following interface standards. User can select between:
   Single-ended 2.5V LVTTL levels
   Single-ended 1.8V LVTTL levels
   or
   Differential 2.5V/1.8V LVTTL levels
   Differential HSTL and eHSTL levels
   Differential LVEPECL levels

PIN DESCRIPTION, CONTINUED

Symbol	I/O	Type	Description
REF_SEL	I	LVTTL(1)	Reference clock select. When LOW, selects REF0 and $\overline{REF}$0/VREF0. When HIGH, selects REF1 and $\overline{REF}$1/VREF1.
$\overline{nsOE}$	I	LVTTL(1)	Synchronous output enable. When $\overline{nsOE}$ is HIGH, nQ and $\overline{nQ}$ are synchronously stopped. OMODE selects whether the outputs are gated LOW/HIGH or tri-stated. When OMODE is HIGH, PE determines the level at which the outputs stop. When PE is LOW/HIGH, the nQ is stopped in a HIGH/LOW state, while the $\overline{nQ}$ is stopped at a LOW/HIGH state. When OMODE is LOW, the outputs are tri-stated. Set $\overline{nsOE}$ LOW for normal operation.
QFB	O	Adjustable(2)	Feedback clock output
$\overline{QFB}$	O	Adjustable(2)	Complementary feedback clock output
nQ	O	Adjustable(2)	Clock outputs
$\overline{nQ}$	O	Adjustable(2)	Complementary clock outputs
RxS	I	3-Level(3)	Selects single-ended 2.5V LVTTL (HIGH), 1.8V LVTTL (MID) REF clock input or differential (LOW) REF clock input
TxS	I	3-Level(3)	Sets the drive strength of the output drivers and feedback inputs to be 2.5V LVTTL (HIGH), 1.8V LVTTL (MID) or eHSTL/HSTL (LOW) compatible. Used in conjuction with VDDQ to set the interface levels.
PE	I	LVTTL(1)	Selectable positive or negative edge control. When LOW/HIGH the outputs are synchronized with the negative/positive edge of the reference clock (has internal pull-up).
nF[2:0]	I	3-Level(3)	3-level inputs for selecting 1 of 18 skew taps or frequency functions (See Control Summary table)
FBF[2:0]	I	3-Level(3)	3-level inputs for selecting 1 of 18 skew taps or frequency functions (See Control Summary table)
FS	I	LVTTL	Selects appropriate oscillator circuit based on anticipated frequency range (See Programmable Skew Range table)
DS[1:0]	I	3-Level(3)	3-level inputs for feedback input divider selection (See Divide Selection table)
$\overline{PLL\_EN}$	I	LVTTL(1)	PLL enable/disable control. Set LOW for normal operation. When $\overline{PLL\_EN}$ is HIGH, the PLL is disabled and REF[1:0] goes to all outputs.
$\overline{PD}$	I	LVTTL(1)	Power down control. When $\overline{PD}$ is LOW, the inputs are disabled and internal switching is stopped. OMODE selects whether the outputs are gated LOW/HIGH or tri-stated. When OMODE is HIGH, PE determines the level at which the outputs stop. When PE is LOW/HIGH, the nQ and QFB are stopped in a HIGH/LOW state, while the $\overline{nQ}$ and $\overline{QFB}$ are stopped in a LOW/HIGH state. When OMODE is LOW, the outputs are tri-stated. Set $\overline{PD}$ HIGH for normal operation.
LOCK	O	LVTTL	PLL lock indication signal. HIGH indicates lock. LOW indicates that the PLL is not locked and outputs may not be synchronized to the inputs. (For more information on application specific use of the LOCK pin, please see AN237.)
OMODE	I	LVTTL(1)	Output disable control. Determines the outputs' disable state. Used in conjunction with $\overline{nsOE}$ and $\overline{PD}$. (See Output Enable/Disable and Powerdown tables.)
VDDQ		PWR	Power supply for output buffers. When using 2.5V LVTTL, VDDQ should be connected to VDD.
VDD		PWR	Power supply for phase locked loop, lock output, inputs, and other internal circuitry
GND		PWR	Ground

NOTES:
1. Pins listed as LVTTL inputs will accept 2.5V signals under all conditions. If the output is operating at 1.8V or 1.5V, the LVTTL inputs will accept the 1.8V LVTTL signals as well.
2. Outputs are user selectable to drive 2.5V, 1.8V LVTTL, eHSTL, or HSTL interface levels when used with the appropriate VDDQ voltage.
3. 3-level inputs are static inputs and must be tied to VDD or GND or left floating. These inputs are not hot-insertable or over voltage tolerant.

OUTPUT ENABLE/DISABLE

$\overline{nsOE}$	OMODE	Output
L	X	Normal Operation
H	L	Tri-State
H	H	Gated(1)

NOTE:
1. PE determines the level at which the outputs stop. When PE is LOW/HIGH, the nQ is stopped in a HIGH/LOW state while the $\overline{nQ}$ is stopped at a LOW/HIGH state.

POWERDOWN

$\overline{PD}$	OMODE	Output
H	X	Normal Operation
L	L	Tri-State
L	H	Gated(1)

NOTE:
1. PE determines the level at which the outputs stop. When PE is LOW/HIGH, the nQ and QFB are stopped in a HIGH/LOW state, while the $\overline{nQ}$ and $\overline{QFB}$ are stopped in a LOW/HIGH state.

PROGRAMMABLE SKEW

Output skew with respect to the $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ input is adjustable to compensate for PCB trace delays, backplane propagation delays or to accommodate requirements for special timing relationships between clocked components. Skew is selectable as a multiple of a time unit (t_U) which ranges from 250ps to 1.25ns (see Programmable Skew Range and Resolution Table). There are 18 skew/divide configurations available for each output pair. These configurations are chosen by the $nF_{[2:0]}/FBF_{[2:0]}$ control pins. In order to minimize the number of control pins, 3-level inputs (HIGH-MID-LOW) are used, they are intended for but not restricted to hard-wiring. Undriven 3-level inputs default to the MID level. The Control Summary Table shows how to select specific skew taps by using the $nF_{[2:0]}/FBF_{[2:0]}$ control pins.

EXTERNAL DIFFERENTIAL FEEDBACK

By providing a dedicated external differential feedback, the IDT5T9110 gives users flexibility with regard to skew adjustment. The FB and $\overline{FB}/V_{REF2}$ signals are compared with the input $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ signals at the phase detector in order to drive the VCO. Phase differences cause the VCO of the PLL to adjust upwards or downwards accordingly.

An internal loop filter moderates the response of the VCO to the phase detector. The loop filter transfer function has been chosen to provide minimal jitter (or frequency variation) while still providing accurate responses to input frequency changes.

PROGRAMMABLE SKEW RANGE AND RESOLUTION TABLE

	FS = LOW	FS = HIGH	Comments
Timing Unit Calculation (t_U)	1/(16 x F_{NOM})	1/(16 x F_{NOM})	
VCO Frequency Range (F_{NOM})(1,2)	50 to 125MHz	100 to 250MHz	
Skew Adjustment Range(3) Max Adjustment:	±8.75ns	±4.375ns	ns
	±157.5°	±157.5°	Phase Degrees
	±43.75%	±43.75%	% of Cycle Time
Example 1, F_{NOM} = 50MHz	t_U = 1.25ns	—	
Example 2, F_{NOM} = 75MHz	t_U = 0.833ns	—	
Example 3, F_{NOM} = 100MHz	t_U = 0.625ns	t_U = 0.625ns	
Example 4, F_{NOM} = 150MHz	—	t_U = 0.417ns	
Example 5, F_{NOM} = 200MHz	—	t_U = 0.313ns	
Example 6, F_{NOM} = 250MHz	—	t_U = 0.25ns	

NOTES:

1. The device may be operated outside recommended frequency ranges without damage, but functional operation is not guaranteed.
2. The level to be set on FS is determined by the nominal operating frequency of the VCO and Time Unit Generator. The VCO frequency always appears at nQ and $\overline{nQ}$ outputs when they are operated in their undivided modes. The frequency appearing at the $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ and FB and $\overline{FB}/V_{REF2}$ inputs will be F_{NOM} when the QFB and $\overline{QFB}$ are undivided and $DS_{[1:0]}$ = MM. The frequency of the $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ and FB and $\overline{FB}/V_{REF2}$ inputs will be F_{NOM} /2 or F_{NOM} /4 when the part is configured for frequency multiplication by using a divided QFB and $\overline{QFB}$ and setting $DS_{[1:0]}$ = MM. Using the $DS_{[1:0]}$ inputs allows a different method for frequency multiplication (see Divide Selection Table).
3. Skew adjustment range assumes that a zero skew output is used for feedback. If a skewed QFB and $\overline{QFB}$ output is used for feedback, then adjustment range will be greater. For example if a 4t_U skewed output is used for feedback, all other outputs will be skewed –4t_U in addition to whatever skew value is programmed for those outputs. 'Max adjustment' range applies to all output pairs where ±7t_U skew adjustment is possible and at the lowest F_{NOM} value.

DIVIDE SELECTION TABLE

DS[1:0]	Divide-by-n	Permitted Output Divide-by-n connected to FB and $\overline{FB}/V_{REF2}$[1]
LL	2	1, 2
LM	3	1
LH	4	1, 2
ML	5	1, 2
MM	1	1, 2, 4
MH	6	1, 2
HL	8	1
HM	10	1
HH	12	1

NOTE:
1. Permissible output division ratios connected to FB and $\overline{FB}/V_{REF2}$. The frequencies of the $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ inputs will be F_{NOM}/N when the parts are configured for frequency multiplication by using an undivided output for FB and $\overline{FB}/V_{REF2}$ and setting $DS_{[1:0]}$ to N (N = 1-6, 8, 10, 12).

CONTROL SUMMARY TABLE FOR ALL OUTPUTS[1]

nF_2/FBF_2	nF_1/FBF_1	nF_0/FBF_0	Output Skew
L	L	L	Divide by 2
L	L	M	$+7t_U$
L	L	H	$+6t_U$
L	M	L	$+5t_U$
L	M	M	$+4t_U$
L	M	H	$+3t_U$
L	H	L	$+2t_U$
L	H	M	$+1t_U$
L	H	H	Zero Skew
H	L	L	Inverted
H	L	M	$-1t_U$
H	L	H	$-2t_U$
H	M	L	$-3t_U$
H	M	M	$-4t_U$
H	M	H	$-5t_U$
H	H	L	$-6t_U$
H	H	M	$-7t_U$
H	H	H	Divide by 4

NOTE:
1. When $\overline{PLL\_EN}$ is HIGH, the PLL is disabled and the device is put into test mode. In test mode, 5F[2:0] must be set to MHL, the REF[1:0]/$\overline{REF}$[1:0] input frequency must be set to 1MHz or less, and nF[2:0]/FBF[2:0] pins should be set to LHH.

INPUT/OUTPUT SELECTION[(1)]

Input	Output
2.5V LVTTL SE	2.5V LVTTL
1.8V LVTTL SE	
2.5V LVTTL DSE	
1.8V LVTTL DSE	
LVEPECL DSE	
eHSTL DSE	
HSTL DSE	
2.5V LVTTL DIF	
1.8V LVTTL DIF	
LVEPECL DIF	
eHSTL DIF	
HSTL DIF	
2.5V LVTTL SE	1.8V LVTTL
1.8V LVTTL SE	
2.5V LVTTL DSE	
1.8V LVTTL DSE	
LVEPECL DSE	
eHSTL DSE	
HSTL DSE	
2.5V LVTTL DIF	
1.8V LVTTL DIF	
LVEPECL DIF	
eHSTL DIF	
HSTL DIF	

Input	Output
2.5V LVTTL SE	eHSTL
1.8V LVTTL SE	
2.5V LVTTL DSE	
1.8V LVTTL DSE	
LVEPECL DSE	
eHSTL DSE	
HSTL DSE	
2.5V LVTTL DIF	
1.8V LVTTL DIF	
LVEPECL DIF	
eHSTL DIF	
HSTL DIF	
2.5V LVTTL SE	HSTL
1.8V LVTTL SE	
2.5V LVTTL DSE	
1.8V LVTTL DSE	
LVEPECL DSE	
eHSTL DSE	
HSTL DSE	
2.5V LVTTL DIF	
1.8V LVTTL DIF	
LVEPECL DIF	
eHSTL DIF	
HSTL DIF	

NOTE:
1. The INPUT/OUTPUT SELECTION Table describes the total possible combinations of input and output interfaces. Single-Ended (SE) inputs in a single-ended mode require the $\overline{REF}_{[1:0]}$/$V_{REF[1:0]}$ and $\overline{FB}$/V_{REF2} pins to be left floating. Differential Single-Ended (DSE) is for single-ended operation in differential mode, requiring $V_{REF[1:0]}$ and V_{REF2}. Differential (DIF) inputs are used only in differential mode.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Symbol	Parameter	Test Conditions		Min.	Max	Unit
V_{IHH}	Input HIGH Voltage Level[(1)]	3-Level Inputs Only		V_{DD} – 0.4	—	V
V_{IMM}	Input MID Voltage Level[(1)]	3-Level Inputs Only		V_{DD}/2 – 0.2	V_{DD}/2 + 0.2	V
V_{ILL}	Input LOW Voltage Level[(1)]	3-Level Inputs Only		—	0.4	V
I_3	3-Level Input DC Current (RxS, TxS, $nF_{[2:0]}$, $FBF_{[2:0]}$, $DS_{[1:0]}$)	V_{IN} = V_{DD}	HIGH Level	—	200	µA
		V_{IN} = V_{DD}/2	MID Level	–50	+50	
		V_{IN} = GND	LOW Level	–200	—	
I_{PU}	Input Pull-Up Current (PE)	V_{DD} = Max., V_{IN} = GND		–100	—	µA

NOTE:
1. These inputs are normally wired to V_{DD}, GND, or left floating. Internal termination resistors bias unconnected inputs to V_{DD}/2. If these inputs are switched dynamically after powerup, the function and timing of the outputs may be glitched, and the PLL may require additional t_{LOCK} time before all datasheet limits are achieved.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE FOR HSTL(1)

Symbol	Parameter	Test Conditions		Min.	Typ.(7)	Max	Unit
Input Characteristics							
I_{IH}	Input HIGH Current	V_{DD} = 2.7V	V_I = V_{DDQ}/GND	—	—	±5	µA
I_{IL}	Input LOW Current	V_{DD} = 2.7V	V_I = GND/V_{DDQ}	—	—	±5	
V_{IK}	Clamp Diode Voltage	V_{DD} = 2.3V, I_{IN} = -18mA		—	- 0.7	- 1.2	V
V_{IN}	DC Input Voltage			- 0.3		+3.6	V
V_{DIF}	DC Differential Voltage(2,8)			0.2		—	V
V_{CM}	DC Common Mode Input Voltage(3,8)			680	750	900	mV
V_{IH}	DC Input HIGH(4,5,8)			V_{REF} + 100		—	mV
V_{IL}	DC Input LOW(4,6,8)			—		V_{REF} - 100	mV
V_{REF}	Single-Ended Reference Voltage(4,8)			—	750	—	mV
Output Characteristics							
V_{OH}	Output HIGH Voltage	I_{OH} = -8mA		V_{DDQ} - 0.4		—	V
		I_{OH} = -100µA		V_{DDQ} - 0.1		—	
V_{OL}	Output LOW Voltage	I_{OL} = 8mA		—		0.4	V
		I_{OL} = 100µA		—		0.1	
V_{OX}	FB/$\overline{FB}$ Output Crossing Point			V_{DDQ}/2 - 150	V_{DDQ}/2	V_{DDQ}/2 + 150	mV

NOTES:
1. See RECOMMENDED OPERATING RANGE table.
2. V_{DIF} specifies the minimum input differential voltage (V_{TR} - V_{CP}) required for switching where V_{TR} is the "true" input level and V_{CP} is the "complement" input level. Differential mode only. The DC differential voltage must be maintained to guarantee retaining the existing HIGH or LOW input. The AC differential voltage must be achieved to guarantee switching to a new state.
3. V_{CM} specifies the maximum allowable range of (V_{TR} + V_{CP}) /2. Differential mode only.
4. For single-ended operation, in differential mode, $\overline{REF}_{[1:0]}$/$V_{REF[1:0]}$ is tied to the DC voltage $V_{REF[1:0]}$.
5. Voltage required to maintain a logic HIGH, single-ended operation in differential mode.
6. Voltage required to maintain a logic LOW, single-ended operation in differential mode.
7. Typical values are at V_{DD} = 2.5V, V_{DDQ} = 1.5V, +25°C ambient.
8. The reference clock input is capable of HSTL, eHSTL, LVEPECL, 1.8V or 2.5V LVTTL operation independent of the device output. (See Input/Output Selection table.)

POWER SUPPLY CHARACTERISTICS FOR HSTL OUTPUTS(1)

Symbol	Parameter	Test Conditions(2)	Typ.	Max	Unit
I_{DDQ}	Quiescent V_{DD} Power Supply Current(3)	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, $DS_{[1:0]}$ = MM, $nF_{[2:0]}$ = LHH, $FBF_{[2:0]}$ = LHH, Outputs enabled, All outputs unloaded	100	150	mA
I_{DDQQ}	Quiescent V_{DDQ} Power Supply Current(3)	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, $DS_{[1:0]}$ = MM, $nF_{[2:0]}$ = LHH, $FBF_{[2:0]}$ = LHH, Outputs enabled, All outputs unloaded	0.75	50	µA
I_{DDPD}	Power Down Current	V_{DD} = Max., $\overline{PD}$ = LOW, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH	1.7	5	mA
I_{DDD}	Dynamic V_{DD} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	19	30	µA/MHz
I_{DDDQ}	Dynamic V_{DDQ} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	18	30	µA/MHz
I_{TOT}	Total Power V_{DD} Supply Current(4)	V_{DDQ} = 1.5V, F_{VCO} = 100MHz, C_L = 15pF	115	170	mA
		V_{DDQ} = 1.5V, F_{VCO} = 250MHz, C_L = 15pF	150	225	
I_{TOTQ}	Total Power V_{DDQ} Supply Current(4)	V_{DDQ} = 1.5V, F_{VCO} = 100MHz, C_L = 15pF	45	70	mA
		V_{DDQ} = 1.5V, F_{VCO} = 250MHz, C_L = 15pF	100	150	

NOTES:
1. These power consumption characteristics are for all the valid input interfaces and cover the worst case input and output interface combinations.
2. The termination resistors are excluded from these measurements.
3. If the differential input interface is used, the true input is held LOW and the complementary input is held HIGH.
4. FS = HIGH.

DIFFERENTIAL INPUT AC TEST CONDITIONS FOR HSTL

Symbol	Parameter	Value	Units
V_{DIF}	Input Signal Swing[1]	1	V
V_X	Differential Input Signal Crossing Point[2]	750	mV
V_{THI}	Input Timing Measurement Reference Level[3]	Crossing Point	V
t_R, t_F	Input Signal Edge Rate[4]	1	V/ns

NOTES:
1. The 1V peak-to-peak input pulse level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_{DIF} (AC) specification under actual use conditions.
2. A 750mV crossing point level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_X specification under actual use conditions.
3. In all cases, input waveform timing is marked at the differential cross-point of the input signals.
4. The input signal edge rate of 1V/ns or greater is to be maintained in the 20% to 80% range of the input waveform.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE FOR eHSTL[1]

Symbol	Parameter	Test Conditions	Min.	Typ.[7]	Max	Unit
Input Characteristics						
I_{IH}	Input HIGH Current	V_{DD} = 2.7V V_I = V_{DDQ}/GND	—	—	±5	μA
I_{IL}	Input LOW Current	V_{DD} = 2.7V V_I = GND/V_{DDQ}	—	—	±5	
V_{IK}	Clamp Diode Voltage	V_{DD} = 2.3V, I_{IN} = -18mA	—	- 0.7	- 1.2	V
V_{IN}	DC Input Voltage		- 0.3		+3.6	V
V_{DIF}	DC Differential Voltage[2,8]		0.2		—	V
V_{CM}	DC Common Mode Input Voltage[3,8]		800	900	1000	mV
V_{IH}	DC Input HIGH[4,5,8]		V_{REF} + 100		—	mV
V_{IL}	DC Input LOW[4,6,8]		—		V_{REF} - 100	mV
V_{REF}	Single-Ended Reference Voltage[4,8]		—	900	—	mV
Output Characteristics						
V_{OH}	Output HIGH Voltage	I_{OH} = -8mA	V_{DDQ} - 0.4		—	V
		I_{OH} = -100μA	V_{DDQ} - 0.1		—	V
V_{OL}	Output LOW Voltage	I_{OL} = 8mA	—		0.4	V
		I_{OL} = 100μA	—		0.1	V
V_{OX}	FB/$\overline{FB}$ Output Crossing Point		V_{DDQ}/2 - 150	V_{DDQ}/2	V_{DDQ}/2 + 150	mV

NOTES:
1. See RECOMMENDED OPERATING RANGE table.
2. V_{DIF} specifies the minimum input differential voltage (V_{TR} - V_{CP}) required for switching where V_{TR} is the "true" input level and V_{CP} is the "complement" input level. Differential mode only. The DC differential voltage must be maintained to guarantee retaining the existing HIGH or LOW input. The AC differential voltage must be achieved to guarantee switching to a new state.
3. V_{CM} specifies the maximum allowable range of (V_{TR} + V_{CP}) /2. Differential mode only.
4. For single-ended operation, in a differential mode, $\overline{REF}_{[1:0]}$/$V_{REF[1:0]}$ is tied to the DC voltage $V_{REF[1:0]}$.
5. Voltage required to maintain a logic HIGH, single-ended operation in differential mode.
6. Voltage required to maintain a logic LOW, single-ended operation in differential mode.
7. Typical values are at V_{DD} = 2.5V, V_{DDQ} = 1.8V, +25°C ambient.
8. The reference clock input is capable of HSTL, eHSTL, LVEPECL, 1.8V or 2.5V LVTTL operation independent of the device output. (See Input/Output Selection table.)

POWER SUPPLY CHARACTERISTICS FOR eHSTL OUTPUTS(1)

Symbol	Parameter	Test Conditions(2)	Typ.	Max	Unit
I_{DDQ}	Quiescent V_{DD} Power Supply Current(3)	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, $DS_{[1:0]}$ = MM, $nF_{[2:0]}$ = LHH, $FBF_{[2:0]}$ = LHH, Outputs enabled, All outputs unloaded	100	150	mA
I_{DDQQ}	Quiescent V_{DDQ} Power Supply Current(3)	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, $DS_{[1:0]}$ = MM, $nF_{[2:0]}$ = LHH, $FBF_{[2:0]}$ = LHH, Outputs enabled, All outputs unloaded	1.8	50	µA
I_{DDPD}	Power Down Current	V_{DD} = Max., $\overline{PD}$ = LOW, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH	1.7	5	mA
I_{DDD}	Dynamic V_{DD} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	19	30	µA/MHz
I_{DDDQ}	Dynamic V_{DDQ} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	20	30	µA/MHz
I_{TOT}	Total Power V_{DD} Supply Current(4)	V_{DDQ} = 1.8V, F_{VCO} = 100MHz, C_L = 15pF	115	170	mA
		V_{DDQ} = 1.8V, F_{VCO} = 250MHz, C_L = 15pF	150	225	
I_{TOTQ}	Total Power V_{DDQ} Supply Current(4)	V_{DDQ} = 1.8V, F_{VCO} = 100MHz, C_L = 15pF	55	80	mA
		V_{DDQ} = 1.8V, F_{VCO} = 250MHz, C_L = 15pF	140	210	

NOTES:
1. These power consumption characteristics are for all the valid input interfaces and cover the worst case input and output interface combinations.
2. The termination resistors are excluded from these measurements.
3. If the differential input interface is used, the true input is held LOW and the complementary input is held HIGH.
4. FS = HIGH.

DIFFERENTIAL INPUT AC TEST CONDITIONS FOR eHSTL

Symbol	Parameter	Value	Units
V_{DIF}	Input Signal Swing(1)	1	V
V_X	Differential Input Signal Crossing Point(2)	900	mV
V_{THI}	Input Timing Measurement Reference Level(3)	Crossing Point	V
t_R, t_F	Input Signal Edge Rate(4)	1	V/ns

NOTES:
1. The 1V peak-to-peak input pulse level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_{DIF} (AC) specification under actual use conditions.
2. A 900mV crossing point level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_X specification under actual use conditions.
3. In all cases, input waveform timing is marked at the differential cross-point of the input signals.
4. The input signal edge rate of 1V/ns or greater is to be maintained in the 20% to 80% range of the input waveform.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE FOR LVEPECL(1)

Symbol	Parameter	Test Conditions	Min.	Typ.(2)	Max	Unit
Input Characteristics						
I_{IH}	Input HIGH Current	V_{DD} = 2.7V V_I = V_{DDQ}/GND	—	—	±5	µA
I_{IL}	Input LOW Current	V_{DD} = 2.7V V_I = GND/V_{DDQ}	—	—	±5	
V_{IK}	Clamp Diode Voltage	V_{DD} = 2.3V, I_{IN} = -18mA	—	- 0.7	- 1.2	V
V_{IN}	DC Input Voltage		- 0.3	—	3.6	V
V_{CM}	DC Common Mode Input Voltage(3,5)		915	1082	1248	mV
V_{REF}	Single-Ended Reference Voltage(4,5)		—	1082	—	mV
V_{IH}	DC Input HIGH		1275	—	1620	mV
V_{IL}	DC Input LOW		555	—	875	mV

NOTES:
1. See RECOMMENDED OPERATING RANGE table.
2. Typical values are at V_{DD} = 2.5V, +25°C ambient.
3. V_{CM} specifies the maximum allowable range of (V_{TR} + V_{CP}) /2. Differential mode only.
4. For single-ended operation while in differential mode, $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ is tied to the DC voltage $V_{REF[1:0]}$.
5. The reference clock input is capable of HSTL, eHSTL, LVEPECL, 1.8V or 2.5V LVTTL operation independent of the device output. (See Input/Output Selection table.)

DIFFERENTIAL INPUT AC TEST CONDITIONS FOR LVEPECL

Symbol	Parameter	Value	Units
V_{DIF}	Input Signal Swing(1)	732	mV
V_X	Differential Input Signal Crossing Point(2)	1082	mV
V_{THI}	Input Timing Measurement Reference Level(3)	Crossing Point	V
t_R, t_F	Input Signal Edge Rate(4)	1	V/ns

NOTES:
1. The 732mV peak-to-peak input pulse level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_{DIF} (AC) specification under actual use conditions.
2. A 1082mV crossing point level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_X specification under actual use conditions.
3. In all cases, input waveform timing is marked at the differential cross-point of the input signals.
4. The input signal edge rate of 1V/ns or greater is to be maintained in the 20% to 80% range of the input waveform.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE FOR 2.5V LVTTL(1)

Symbol	Parameter	Test Conditions	Min.	Typ.(8)	Max	Unit
Input Characteristics						
I_{IH}	Input HIGH Current	V_{DD} = 2.7V V_I = V_{DDQ}/GND	—	—	±5	µA
I_{IL}	Input LOW Current	V_{DD} = 2.7V V_I = GND/V_{DDQ}	—	—	±5	
V_{IK}	Clamp Diode Voltage	V_{DD} = 2.3V, I_{IN} = -18mA	—	- 0.7	- 1.2	V
V_{IN}	DC Input Voltage		- 0.3		+3.6	V
Single-Ended Inputs(2)						
V_{IH}	DC Input HIGH		1.7		—	V
V_{IL}	DC Input LOW		—		0.7	V
Differential Inputs						
V_{DIF}	DC Differential Voltage(3,9)		0.2		—	V
V_{CM}	DC Common Mode Input Voltage(4,9)		1150	1250	1350	mV
V_{IH}	DC Input HIGH(5,6,9)		V_{REF} + 100		—	mV
V_{IL}	DC Input LOW(5,7,9)		—		V_{REF} - 100	mV
V_{REF}	Single-Ended Reference Voltage(5,9)		—	1250	—	mV
Output Characteristics						
V_{OH}	Output HIGH Voltage	I_{OH} = -12mA	V_{DDQ} - 0.4		—	V
		I_{OH} = -100µA	V_{DDQ} - 0.1		—	V
V_{OL}	Output LOW Voltage	I_{OL} = 12mA	—		0.4	V
		I_{OL} = 100µA	—		0.1	V

NOTES:

1. See RECOMMENDED OPERATING RANGE table.
2. For 2.5V LVTTL single-ended operation, the RxS pin is tied HIGH and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ is left floating. If TxS is HIGH, $\overline{FB}/V_{REF2}$ should be left floating.
3. V_{DIF} specifies the minimum input differential voltage (V_{TR} - V_{CP}) required for switching where V_{TR} is the "true" input level and V_{CP} is the "complement" input level. Differential mode only. The DC differential voltage must be maintained to guarantee retaining the existing HIGH or LOW input. The AC differential voltage must be achieved to guarantee switching to a new state.
4. V_{CM} specifies the maximum allowable range of (V_{TR} + V_{CP}) /2. Differential mode only.
5. For single-ended operation, in differential mode, $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ is tied to the DC voltage $V_{REF[1:0]}$.
6. Voltage required to maintain a logic HIGH, single-ended operation in differential mode.
7. Voltage required to maintain a logic LOW, single-ended operation in differential mode.
8. Typical values are at V_{DD} = 2.5V, V_{DDQ} = V_{DD}, +25°C ambient.
9. The reference clock input is capable of HSTL, eHSTL, LVEPECL, 1.8V or 2.5V LVTTL operation independent of the device output. (See Input/Output Selection table.)

POWER SUPPLY CHARACTERISTICS FOR 2.5V LVTTL OUTPUTS(1)

Symbol	Parameter	Test Conditions(2)	Typ.	Max	Unit
I_{DDQ}	Quiescent V_{DD} Power Supply Current(3)	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, DS[1:0] = MM, nF[2:0] = LHH, FBF[2:0] = LHH, Outputs enabled, All outputs unloaded	100	150	mA
I_{DDQQ}	Quiescent V_{DDQ} Power Supply Current(3)	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, DS[1:0] = MM, nF[2:0] = LHH, FBF[2:0] = LHH, Outputs enabled, All outputs unloaded	10	50	µA
I_{DDPD}	Power Down Current	V_{DD} = Max., $\overline{PD}$ = LOW, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH	1.7	5	mA
I_{DDD}	Dynamic V_{DD} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	21	30	µA/MHz
I_{DDDQ}	Dynamic V_{DDQ} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	33	40	µA/MHz
I_{TOT}	Total Power V_{DD} Supply Current(4)	V_{DDQ} = 2.5V., F_{VCO} = 100MHz, C_L = 15pF	115	170	mA
		V_{DDQ} = 2.5V., F_{VCO} = 250MHz, C_L = 15pF	155	230	
I_{TOTQ}	Total Power V_{DDQ} Supply Current(4)	V_{DDQ} = 2.5V., F_{VCO} = 100MHz, C_L = 15pF	80	120	mA
		V_{DDQ} = 2.5V., F_{VCO} = 250MHz, C_L = 15pF	235	350	

NOTES:
1. These power consumption characteristics are for all the valid input interfaces and cover the worst case input and output interface combinations.
2. The termination resistors are excluded from these measurements.
3. If the differential input interface is used, the true input is held LOW and the complementary input is held HIGH.
4. FS = HIGH.

DIFFERENTIAL INPUT AC TEST CONDITIONS FOR 2.5V LVTTL

Symbol	Parameter	Value	Units
V_{DIF}	Input Signal Swing(1)	V_{DD}	V
V_X	Differential Input Signal Crossing Point(2)	$V_{DD}/2$	V
V_{THI}	Input Timing Measurement Reference Level(3)	Crossing Point	V
t_R, t_F	Input Signal Edge Rate(4)	2.5	V/ns

NOTES:
1. A nominal 2.5V peak-to-peak input pulse level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_{DIF} (AC) specification under actual use conditions.
2. A nominal 1.25V crossing point level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_X specification under actual use conditions.
3. In all cases, input waveform timing is marked at the differential cross-point of the input signals.
4. The input signal edge rate of 2.5V/ns or greater is to be maintained in the 20% to 80% range of the input waveform.

SINGLE-ENDED INPUT AC TEST CONDITIONS FOR 2.5V LVTTL

Symbol	Parameter	Value	Units
V_{IH}	Input HIGH Voltage	V_{DD}	V
V_{IL}	Input LOW Voltage	0	V
V_{THI}	Input Timing Measurement Reference Level(1)	$V_{DD}/2$	V
t_R, t_F	Input Signal Edge Rate(2)	2	V/ns

NOTES:
1. A nominal 1.25V timing measurement reference level is specified to allow constant, repeatable results in an automatic test equipment (ATE) environment.
2. The input signal edge rate of 2V/ns or greater is to be maintained in the 10% to 90% range of the input waveform.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE FOR 1.8V LVTTL(1)

Symbol	Parameter	Test Conditions	Min.	Typ.(8)	Max	Unit
Input Characteristics						
I_{IH}	Input HIGH Current	V_{DD} = 2.7V V_I = V_{DDQ}/GND	—	—	±5	µA
I_{IL}	Input LOW Current	V_{DD} = 2.7V V_I = GND/V_{DDQ}	—	—	±5	
V_{IK}	Clamp Diode Voltage	V_{DD} = 2.3V, I_{IN} = -18mA	—	- 0.7	- 1.2	V
V_{IN}	DC Input Voltage		- 0.3		V_{DDQ} + 0.3	V
Single-Ended Inputs(2)						
V_{IH}	DC Input HIGH		1.073(10)		—	V
V_{IL}	DC Input LOW		—		0.683(11)	V
Differential Inputs						
V_{DIF}	DC Differential Voltage(3,9)		0.2		—	V
V_{CM}	DC Common Mode Input Voltage(4,9)		825	900	975	mV
V_{IH}	DC Input HIGH(5,6,9)		V_{REF} + 100		—	mV
V_{IL}	DC Input LOW(5,7,9)		—		V_{REF} - 100	mV
V_{REF}	Single-Ended Reference Voltage(5,9)		—	900	—	mV
Output Characteristics						
V_{OH}	Output HIGH Voltage	I_{OH} = -6mA	V_{DDQ} - 0.4		—	V
		I_{OH} = -100µA	V_{DDQ} - 0.1		—	V
V_{OL}	Output LOW Voltage	I_{OL} = 6mA	—		0.4	V
		I_{OL} = 100µA	—		0.1	V

NOTES:
1. See RECOMMENDED OPERATING RANGE table.
2. For 1.8V LVTTL single-ended operation, the RxS pin is MID and $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ is left floating. If TxS is MID, $\overline{FB}/V_{REF2}$ should be left floating.
3. V_{DIF} specifies the minimum input differential voltage (V_{TR} - V_{CP}) required for switching where V_{TR} is the "true" input level and V_{CP} is the "complement" input level. Differential mode only. The DC differential voltage must be maintained to guarantee retaining the existing HIGH or LOW input. The AC differential voltage must be achieved to guarantee switching to a new state.
4. V_{CM} specifies the maximum allowable range of (V_{TR} + V_{CP}) /2. Differential mode only.
5. For single-ended operation in differential mode, $\overline{REF}_{[1:0]}/V_{REF[1:0]}$ is tied to the DC voltage $V_{REF[1:0]}$. The input is guaranteed to toggle within ±200mV of $V_{REF[1:0]}$ when $V_{REF[1:0]}$ is constrained within +600mV and V_{DDI}-600mV, where V_{DDI} is the nominal 1.8V power supply of the device driving the $REF_{[1:0]}$ input. To guarantee switching in voltage range specified in the JEDEC 1.8V LVTTL interface specification, $V_{REF[1:0]}$ must be maintained at 900mV with appropriate tolerances.
6. Voltage required to maintain a logic HIGH, single-ended operation in differential mode.
7. Voltage required to maintain a logic LOW, single-ended operation in differential mode.
8. Typical values are at V_{DD} = 2.5V, V_{DDQ} = 1.8V, +25°C ambient.
9. The reference clock input is capable of HSTL, eHSTL, LVEPECL, 1.8V or 2.5V LVTTL operation independent of the device output. (See Input/Output Selection table.)
10. This value is the worst case minimum V_{IH} over the specification range of the 1.8V power supply. The 1.8V LVTTL specification is V_{IH} = 0.65 * V_{DD} where V_{DD} is 1.8V ± 0.15V. However, the LVTTL translator is supplied by a 2.5V nominal supply on this part. To ensure compliance with the specification, the translator was designed to accept the calculated worst case value (V_{IH} = 0.65 * [1.8 - 0.15V]) rather than reference against a nominal 1.8V supply.
11. This value is the worst case maximum V_{IL} over the specification range of the 1.8V power supply. The 1.8V LVTTL specification is V_{IL} = 0.35 * V_{DD} where V_{DD} is 1.8V ± 0.15V. However, the LVTTL translator is supplied by a 2.5V nominal supply on this part. To ensure compliance with the specification, the translator was designed to accept the calculated worst case value (V_{IL} = 0.35 * [1.8 + 0.15V]) rather than reference against a nominal 1.8V supply.

POWER SUPPLY CHARACTERISTICS FOR 1.8V LVTTL OUTPUTS[1]

Symbol	Parameter	Test Conditions[2]	Typ.	Max	Unit
I_{DDQ}	Quiescent V_{DD} Power Supply Current[3]	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, DS[1:0] = MM, nF[2:0] = LHH, FBF[2:0] = LHH, Outputs enabled, All outputs unloaded	100	150	mA
I_{DDQQ}	Quiescent V_{DDQ} Power Supply Current[3]	V_{DDQ} = Max., REF = LOW, $\overline{PD}$ = HIGH, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH, DS[1:0] = MM, nF[2:0] = LHH, FBF[2:0] = LHH, Outputs enabled, All outputs unloaded	1.8	50	µA
I_{DDPD}	Power Down Current	V_{DD} = Max., $\overline{PD}$ = LOW, $\overline{nSOE}$ = LOW, $\overline{PLL\_EN}$ = HIGH	1.7	5	mA
I_{DDD}	Dynamic V_{DD} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	22	30	µA/MHz
I_{DDDQ}	Dynamic V_{DDQ} Power Supply Current per Output	V_{DD} = Max., V_{DDQ} = Max., C_L = 0pF	23	30	µA/MHz
I_{TOT}	Total Power V_{DD} Supply Current[4]	V_{DDQ} = 1.8V., F_{VCO} = 100MHz, C_L = 15pF	120	180	mA
		V_{DDQ} = 1.8V., F_{VCO} = 250MHz, C_L = 15pF	160	240	
I_{TOTQ}	Total Power V_{DDQ} Supply Current[4]	V_{DDQ} = 1.8V., F_{VCO} = 100MHz, C_L = 15pF	55	80	mA
		V_{DDQ} = 1.8V., F_{VCO} = 250MHz, C_L = 15pF	165	250	

NOTES:
1. These power consumption characteristics are for all the valid input interfaces and cover the worst case input and output interface combinations.
2. The termination resistors are excluded from these measurements.
3. If the differential input interface is used, the true input is held LOW and the complementary input is held HIGH.
4. FS = HIGH.

DIFFERENTIAL INPUT AC TEST CONDITIONS FOR 1.8V LVTTL

Symbol	Parameter	Value	Units
V_{DIF}	Input Signal Swing[1]	V_{DDI}	V
V_X	Differential Input Signal Crossing Point[2]	$V_{DDI}/2$	mV
V_{THI}	Input Timing Measurement Reference Level[3]	Crossing Point	V
t_R, t_F	Input Signal Edge Rate[4]	1.8	V/ns

NOTES:
1. V_{DDI} is the nominal 1.8V supply (1.8V ± 0.15V) of the part or source driving the input. A nominal 1.8V peak-to-peak input pulse level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_{DIF} (AC) specification under actual use conditions.
2. A nominal 900mV crossing point level is specified to allow consistent, repeatable results in an automatic test equipment (ATE) environment. This device meets the V_X specification under actual use conditions.
3. In all cases, input waveform timing is marked at the differential cross-point of the input signals.
4. The input signal edge rate of 1.8V/ns or greater is to be maintained in the 20% to 80% range of the input waveform.

SINGLE-ENDED INPUT AC TEST CONDITIONS FOR 1.8V LVTTL

Symbol	Parameter	Value	Units
V_{IH}	Input HIGH Voltage[1]	V_{DDI}	V
V_{IL}	Input LOW Voltage	0	V
V_{THI}	Input Timing Measurement Reference Level[2]	$V_{DDI}/2$	mV
t_R, t_F	Input Signal Edge Rate[3]	2	V/ns

NOTES:
1. V_{DDI} is the nominal 1.8V supply (1.8V ± 0.15V) of the part or source driving the input.
2. A nominal 900mV timing measurement reference level is specified to allow constant, repeatable results in an automatic test equipment (ATE) environment.
3. The input signal edge rate of 2V/ns or greater is to be maintained in the 10% to 90% range of the input waveform.

AC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Symbol	Parameter		Min.	Typ.	Max	Unit
F_{NOM}	VCO Frequency Range		see Programmable Skew and Resolution Table			
t_{RPW}	Reference Clock Pulse Width HIGH or LOW		1	—	—	ns
t_{FPW}	Feedback Input Pulse Width HIGH or LOW		1	—	—	ns
t_U	Programmable Skew Time Unit		see Control Summary Table			
$t_{SK(O)}$	Output Skew (Rise-Rise, Fall-Fall, Nominal)[1,2]		—	—	100	ps
$t_{SK1}(\omega)$	Multiple Frequency Skew (Rise-Rise, Fall-Fall, Nominal-Divided, Divided-Divided)[1,2,3]		—	—	100	ps
$t_{SK2}(\omega)$	Multiple Frequency Skew (Rise-Fall, Nominal-Divided, Divided-Divided)[1,2,3]		—	—	300	ps
$t_{SK1(INV)}$	Inverting Skew (Nominal-Inverted)[1,2]		—	—	300	ps
$t_{SK2(INV)}$	Inverting Skew (Rise-Rise, Fall-Fall, Rise-Fall, Inverted-Divided)[1,2,3]		—	—	300	ps
$t_{SK(PR)}$	Process Skew[1,2,4]		—	—	300	ps
$t(\phi)$	REF Input to FB Static Phase Offset[5]		-100	—	100	ps
t_{ODCV}	Output Duty Cycle Variation from 50%[11,12]	1.8V LVTTL	-375	—	375	ps
		2.5V LVTTL	-275	—	275	
t_{ORISE}	Output Rise Time[6]	HSTL / eHSTL / 1.8V LVTTL	—	—	1.2	ns
		2.5V LVTTL	—	—	1	
t_{OFALL}	Output Fall Time[6]	HSTL / eHSTL / 1.8V LVTTL	—	—	1.2	ns
		2.5V LVTTL	—	—	1	
t_L	Power-up PLL Lock Time[7]		—	—	1	ms
$t_L(\omega)$	PLL Lock Time After Input Frequency Change[7]		—	—	1	ms
$t_{L(PD)}$	PLL Lock Time After Asserting $\overline{PD}$ Pin[7]		—	—	1	ms
$t_{L(REFSEL1)}$	PLL Lock Time After Change in REF_SEL[7,9]		—	—	100	µs
$t_{L(REFSEL2)}$	PLL Lock Time After Change in REF_SEL (REF_1 and REF_0 are different frequency)[7]		—	—	1	ms
$t_{JIT(CC)}$	Cycle-to-Cycle Output Jitter (peak-to-peak)[2,8]		—	50	75	ps
$t_{JIT(PER)}$	Period Jitter (peak-to-peak)[2,8]		—	—	75	ps
$t_{JIT(HP)}$	Half Period Jitter (peak-to-peak)[2,8,10]		—	—	125	ps
$t_{JIT(DUTY)}$	Duty Cycle Jitter (peak-to-peak)[2,8]		—	—	100	ps
V_{OX}	HSTL and eHSTL Differential True and Complementary Output Crossing Voltage Level		$V_{DDQ}/2$ - 150	$V_{DDQ}/2$	$V_{DDQ}/2$ + 150	mV

NOTES:
1. Skew is the time between the earliest and latest output transition among all outputs for which the same t_U delay has been selected, when all outputs are loaded with the specified load.
2. For differential LVTTL outputs, the measurement is made at $V_{DDQ}/2$, where the true outputs are only compared with other true outputs and the complementary outputs are only compared to other complementary outputs. For differential HSTL/eHSTL outputs, the measurement is made at the crossing point (V_{OX}) of the true and complementary signals.
3. There are three classes of outputs: nominal (multiple of t_U delay), inverted, and divided (divide-by-2 or divide-by-4 mode).
4. $t_{SK(PR)}$ is the output to corresponding output skew between any two devices operating under the same conditions (V_{DD} and V_{DDQ}, ambient temperature, air flow, etc.).
5. $t(\phi)$ is measured with REF and FB the same type of input, the same rise and fall times. For TxS/RxS = MID or HIGH, the measurement is taken from V_{THI} on REF to V_{THI} on FB. For TxS/RxS = LOW, the measurement is taken from the crosspoint of REF/$\overline{REF}$ to the crosspoint of FB/$\overline{FB}$. All outputs are set to $0t_U$, FB input divider is set to divide-by-one, and FS = HIGH.
6. Output rise and fall times are measured between 20% to 80% of the actual output voltage swing.
7. t_L, $t_L(\omega)$, $t_{L(REFSEL1)}$, $t_{L(REFSEL2)}$, and $t_{L(PD)}$ are the times that are required before the synchronization is achieved. These specifications are valid only after V_{DD}/V_{DDQ} is stable and within the normal operating limits. These parameters are measured from the application of a new signal at REF or FB, or after $\overline{PD}$ is (re)asserted until $t(\phi)$ is within specified limits.
8. The jitter parameters are measured with all outputs selected for $0t_U$, FB input divider is set to divide-by-one, and FS = HIGH.
9. Both REF inputs must be the same frequency, but up to ±180° out of phase.
10. For HSTL/eHSTL outputs only.
11. For LVTTL outputs only.
12. t_{ODCV} is measured with all outputs selected for zero delay.

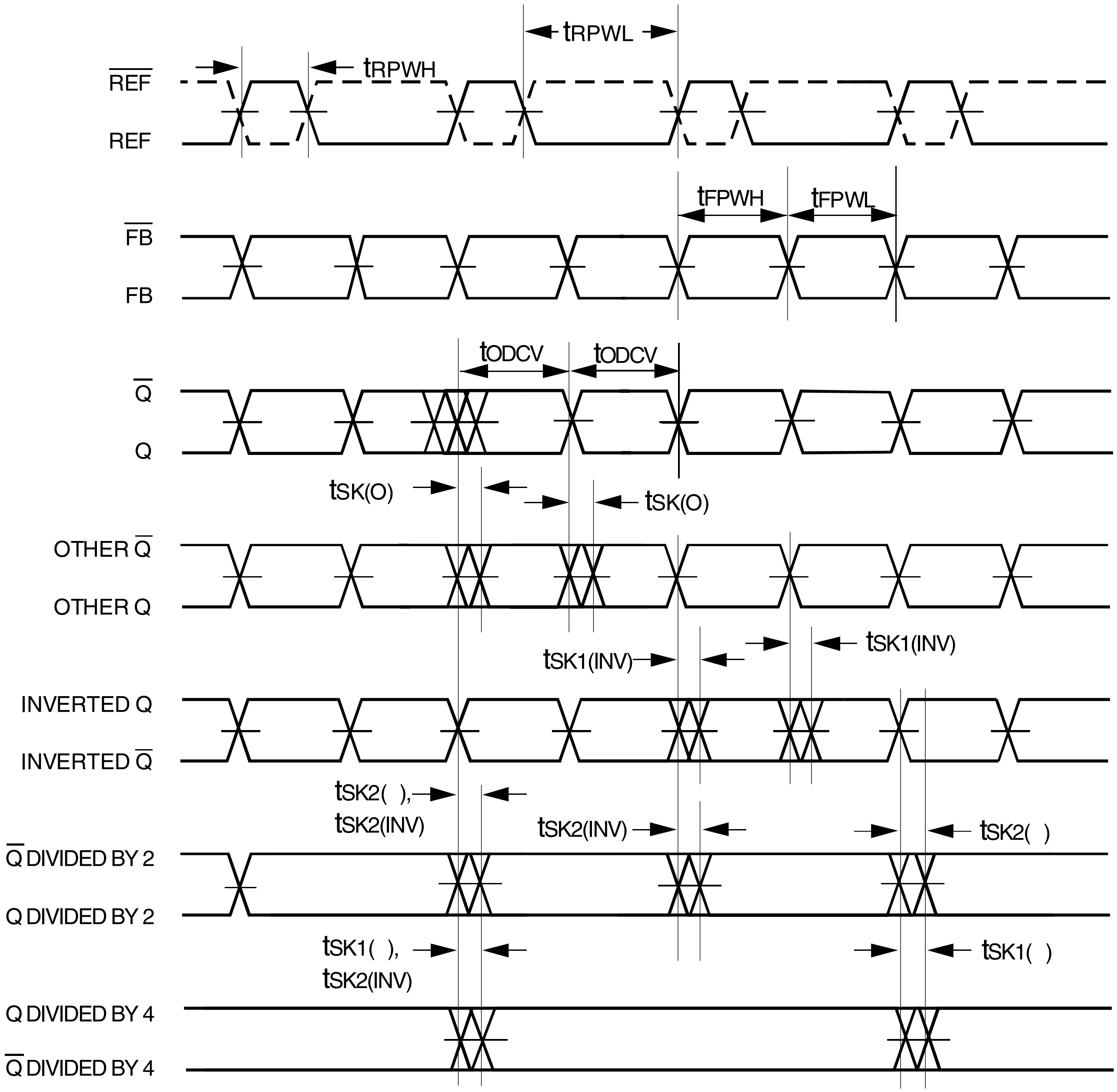
AC DIFFERENTIAL INPUT SPECIFICATIONS(1)

Symbol	Parameter	Min.	Typ.	Max	Unit
t_W	Reference/Feedback Input Clock Pulse Width HIGH or LOW (HSTL/eHSTL outputs)(2)	1	—	—	ns
	Reference/Feedback Input Clock Pulse Width HIGH or LOW (2.5V / 1.8V LVTTL outputs)(2)	1	—	—	
HSTL/eHSTL/1.8V LVTTL/2.5V LVTTL					
V_{DIF}	AC Differential Voltage(3)	400	—	—	mV
V_{IH}	AC Input HIGH(4,5)	Vx + 200	—	—	mV
V_{IL}	AC Input LOW(4,6)	—	—	Vx - 200	mV
LVEPECL					
V_{DIF}	AC Differential Voltage(3)	400	—	—	mV
V_{IH}	AC Input HIGH(4)	1275	—	—	mV
V_{IL}	AC Input LOW(4)	—	—	875	mV

NOTES:

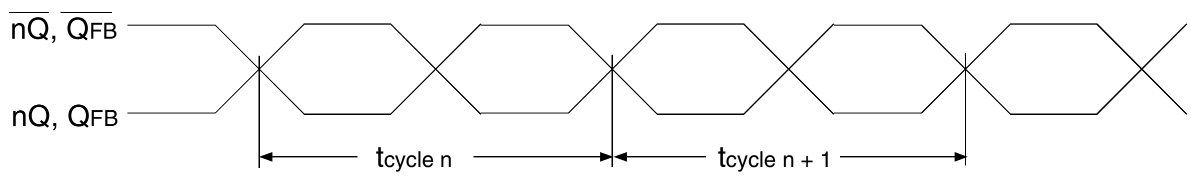
1. For differential input mode, RxS is tied to GND.
2. Both differential input signals should not be driven to the same level simultaneously. The input will not change state until the inputs have crossed and the voltage range defined by V_{DIF} has been met or exceeded.
3. Differential mode only. V_{DIF} specifies the minimum input voltage (V_{TR} - V_{CP}) required for switching where V_{TR} is the "true" input level and V_{CP} is the "complement" input level. The AC differential voltage must be achieved to guarantee switching to a new state.
4. For single-ended operation, $\overline{REF}_{[1:0]}$/$V_{REF[1:0]}$ is tied to the DC voltage $V_{REF[1:0]}$. Refer to each input interface's DC specification for the correct $V_{REF[1:0]}$ range.
5. Voltage required to switch to a logic HIGH, single-ended operation only.
6. Voltage required to switch to a logic LOW, single-ended operation only.

AC TIMING DIAGRAM



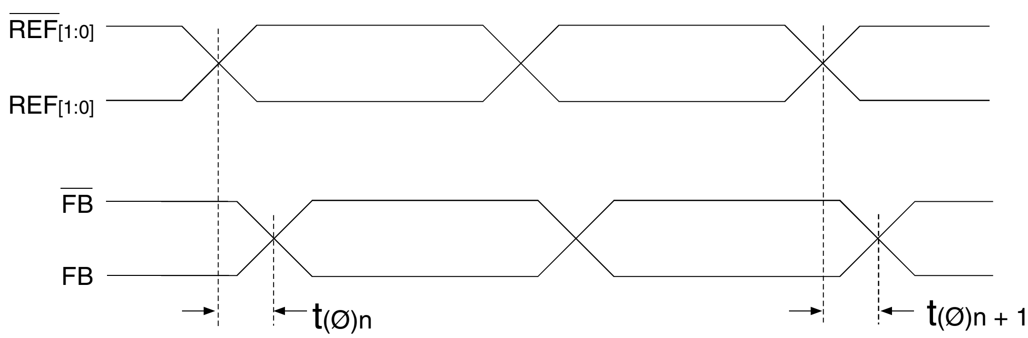
NOTE:
1. The AC TIMING DIAGRAM applies to PE = V_{DD}. For PE = GND, the negative edge of FB aligns with the negative edge of $REF_{[1:0]}$, divided outputs change on the negative edge of $REF_{[1:0]}$, and the positive edges of the divide-by-2 and divide-by-4 signals align.

JITTER AND OFFSET TIMING WAVEFORMS



$$t_{jit(cc)} = \left| t_{cycle\ n} - t_{cycle\ n+1} \right|$$

Cycle-to-Cycle jitter



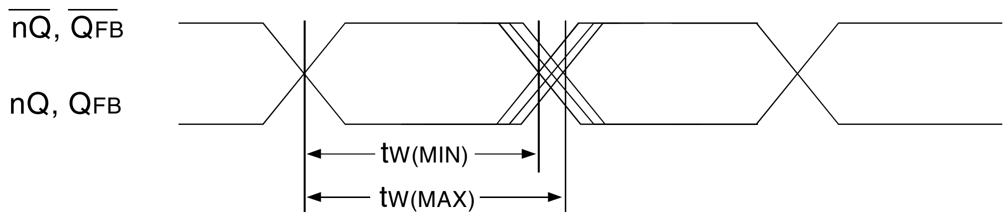
$$t_{(\varnothing)} = \frac{\sum_{1}^{n=N} t_{(\varnothing)n}}{N}$$

(N is a large number of samples)

Static Phase Offset

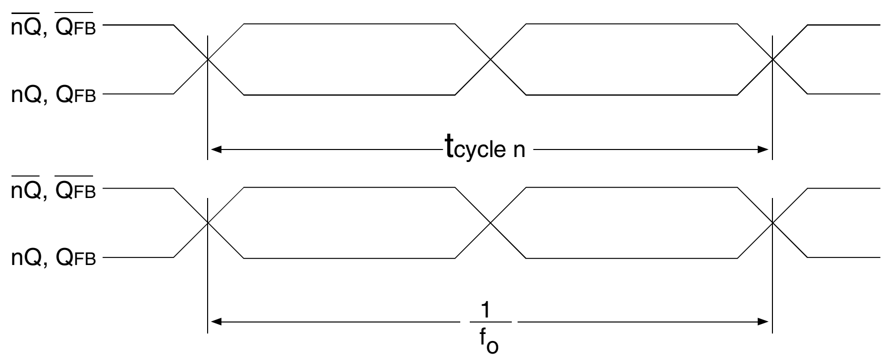
NOTE:
1. Diagram for PE = H and TxS/RxS = L.

JITTER AND OFFSET TIMING WAVEFORMS



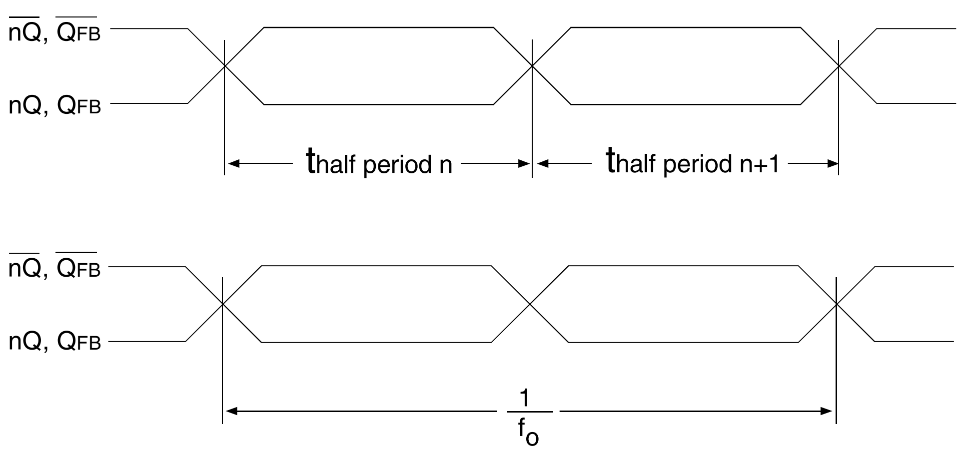
$$t_{JIT(DUTY)} = \left| t_{W(MAX)} - t_{W(MIN)} \right|$$

Duty-Cycle Jitter



$$t_{jit(per)} = \left| t_{cycle\ n} - \frac{1}{f_o} \right|$$

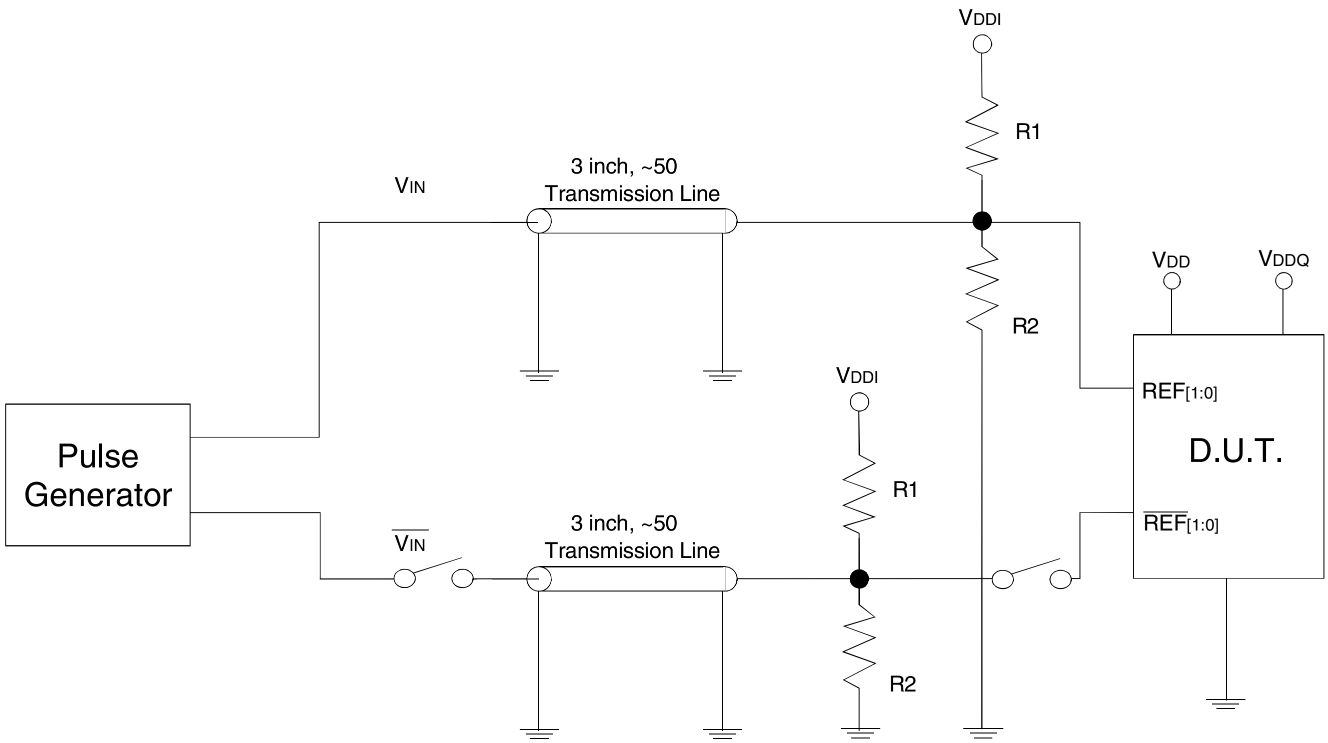
Period jitter



$$t_{jit(hper)} = \left| t_{half\ period\ n} - \frac{1}{2^*f_o} \right|$$

Half-Period jitter

TEST CIRCUITS AND CONDITIONS

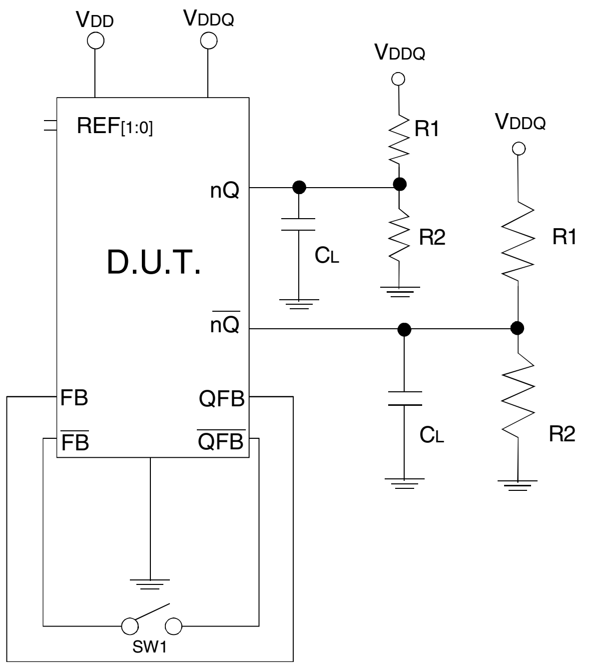


Test Circuit for Differential Input(1)

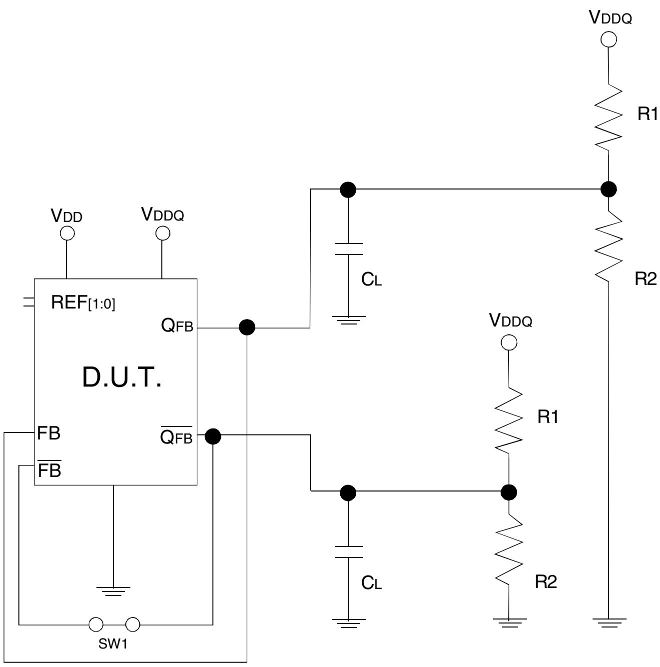
DIFFERENTIAL INPUT TEST CONDITIONS

Symbol	V_{DD} = 2.5V ± 0.2V	Unit
R1	100	Ω
R2	100	Ω
V_{DDI}	V_{CM}*2	V
V_{THI}	HSTL: Crossing of $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}$ eHSTL: Crossing of $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}$ LVEPECL: Crossing of $REF_{[1:0]}$ and $\overline{REF}_{[1:0]}$ 1.8V LVTTL: V_{DDI}/2 2.5V LVTTL: V_{DD}/2	V

NOTE:
1. This input configuration is used for all input interfaces. For single-ended testing, the $\overline{REF}_{[1:0]}$ must be left floating. For testing single-ended in differential input mode, the $\overline{V_{IN}}$ should be floating.



Test Circuit for Differential Outputs



Test Circuit for Differential Feedback

DIFFERENTIAL OUTPUT TEST CONDITIONS

Symbol	V_{DD} = 2.5V ± 0.2V V_{DDQ} = Interface Specified	Unit
C_L	15	pF
R1	100	Ω
R2	100	Ω
V_{OX}	HSTL: Crossing of nQ and $\overline{nQ}$ eHSTL: Crossing of nQ and $\overline{nQ}$	V
V_{THO}	1.8V LVTTL: $V_{DDQ}/2$ 2.5V LVTTL: $V_{DDQ}/2$	V
SW1	TxS = MID or HIGH	Open
	TxS = LOW	Closed

DIFFERENTIAL FEEDBACK TEST CONDITIONS

Symbol	V_{DD} = 2.5V ± 0.2V V_{DDQ} = Interface Specified	Unit
C_L	15	pF
R1	100	Ω
R2	100	Ω
V_{OX}	HSTL: Crossing of Q_{FB} and $\overline{Q_{FB}}$ eHSTL: Crossing of Q_{FB} and $\overline{Q_{FB}}$	V
V_{THO}	1.8V LVTTL: $V_{DDQ}/2$ 2.5V LVTTL: $V_{DDQ}/2$	V
SW1	TxS = MID or HIGH	Open
	TxS = LOW	Closed

ORDERING INFORMATION

IDT XXXXX XX X

Device Type Package Package

I	-40ºC to +85ºC (Industrial)
BBG	PBGA - Green
5T9110	2.5V Programmable Skew PLL Differential Clock Driver Teraclock

REVISION HISTORY

Rev	Table	Page	Discription of Change	Date
A		1	NRND - Not Recommended for New Designs	5/5/13
A		1	Product Discontinuation Notice - Last Time Buy Expires on October 28, 2014 - PDN# CQ-13-02	11/27/13

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