

Description

This 28-bit 1:2 registered buffer with parity is designed for 1.7V to 1.9V VDD operation.

All clock and data inputs are compatible with the JEDEC standard for SSTL_18. The control inputs are LVCMS. All outputs are 1.8 V CMOS drivers that have been optimized to drive the DDR2 DIMM load. The ICSSSTUAF32865A operates from a differential clock (CLK and CLK). Data are registered at the crossing of CLK going high, and CLK going low.

The device supports low-power standby operation. When the reset input (RESET) is low, the differential input receivers are disabled, and undriven (floating) data, clock and reference voltage (VREF) inputs are allowed. In addition, when RESET is low all registers are reset, and all outputs except PTYERR are forced low. The LVCMS RESET input must always be held at a valid logic high or low level.

To ensure defined outputs from the register before a stable clock has been supplied, RESET must be held in the low state during power up.

In the DDR2 RDIMM application, RESET is specified to be completely asynchronous with respect to CLK and CLK. Therefore, no timing relationship can be guaranteed between the two. When entering reset, the register will be cleared and the outputs will be driven low quickly, relative to the time to disable the differential input receivers. However, when coming out of reset, the register will become active quickly, relative to the time to enable the differential input receivers. As long as the data inputs are low, and the clock is stable during the time from the low-to-high transition of RESET until the input receivers are fully enabled, the design of the ICSSSTUAF32865A must ensure that the outputs will remain low, thus ensuring no glitches on the output.

The device monitors both DCS0 and DCS1 inputs and will gate the Qn outputs from changing states when both DCS0 and DCS1 are high. If either DCS0 and DCS1 input is low, the Qn outputs will function normally. The RESET input has priority over the DCS0 and DCS1 control and will force the Qn outputs low and the PTYERR output high. If the DCS-control functionality is not desired, then the CSGateEnable input can be hardwired to ground, in which case, the setup-time requirement for DCS would be the same as for the other D data inputs.

The ICSSSTUAF32865A includes a parity checking function. The ICSSSTUAF32865A accepts a parity bit from the memory controller at its input pin PARIN, compares it with the data received on the D-inputs and indicates whether a parity error has occurred on its open-drain PTYERR pin (active LOW).

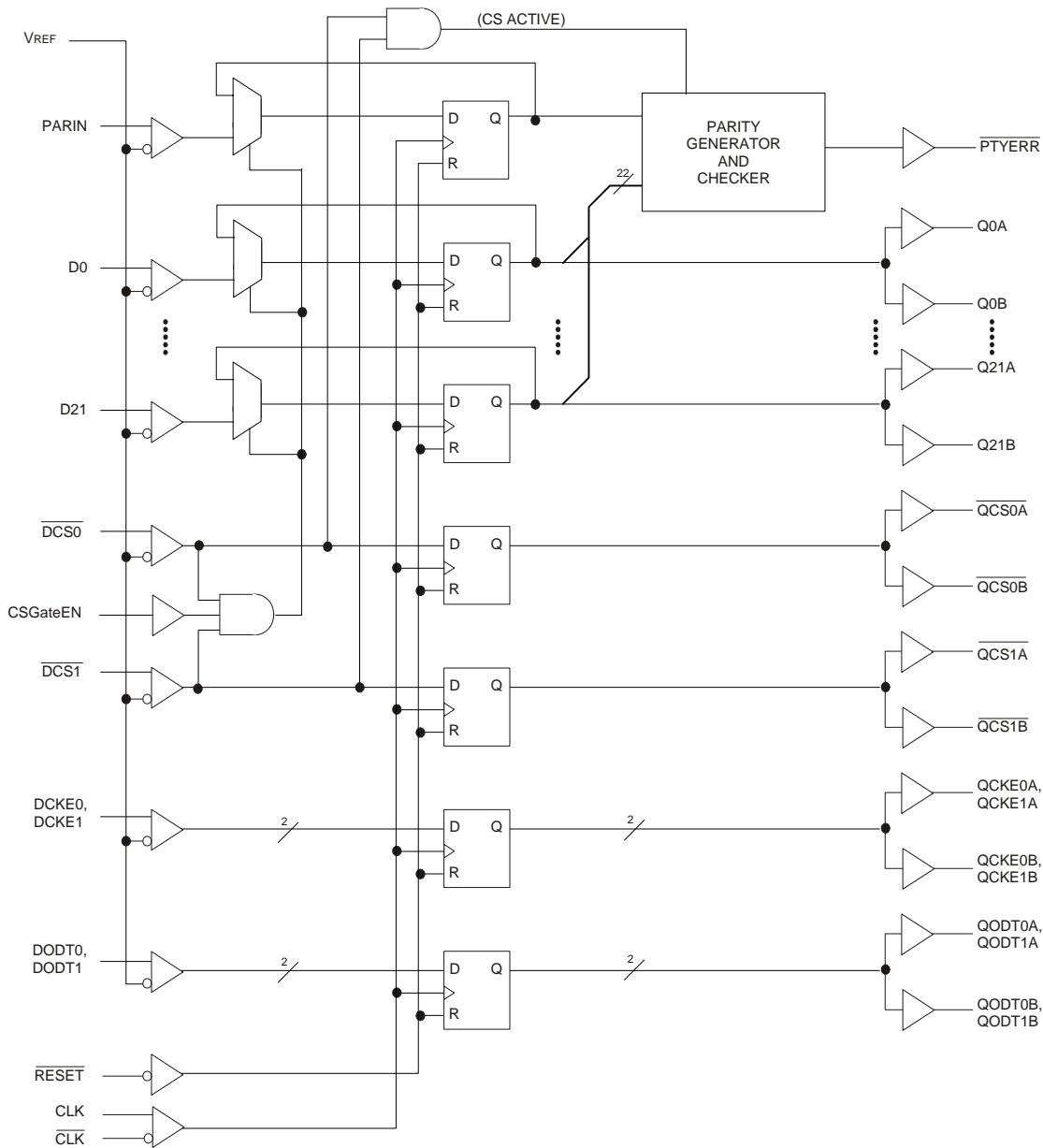
Features

- 28-bit 1:2 registered buffer with parity check functionality
- Supports SSTL_18 JEDEC specification on data inputs and outputs
- Supports LVCMS switching levels on CSGateEN and RESET inputs
- Low voltage operation: VDD = 1.7V to 1.9V
- Available in 160-ball LFBGA package

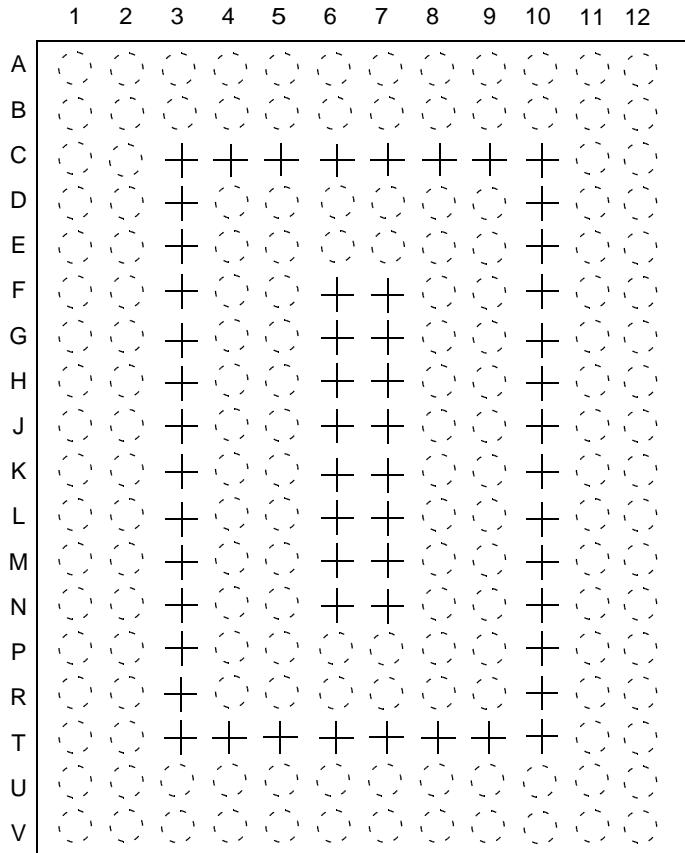
Applications

- DDR2 Memory Modules
- Provides complete DDR DIMM solution with ICS98ULPA877A or IDTCSPUA877A
- Ideal for DDR2 400, 533, and 667

Block Diagram



Pin Configuration



	1	2	3	4	5	6	7	8	9	10	11	12
A												
B												
C	+	+	+	+	+	+	+					
D	+						+					
E	+						+					
F	+			+	+	+	+					
G	+			+	+	+	+					
H	+			+	+	+	+					
J	+			+	+	+	+					
K	+			+	+	+	+					
L	+			+	+	+	+					
M	+			+	+	+	+					
N	+			+	+	+	+					
P	+			+			+					
R	+			+			+					
T	+	+	+	+	+	+	+					
U												
V												

NOTE:

1. An empty cell indicates no ball is populated at that gridpoint. NC denotes a no-connect (ball present but not connected to the die). MCL denotes a pin that Must be Connected LOW. MCH denotes a pin that Must be Connected HIGH.

**160-Ball BGA
TOP VIEW**

**160-Ball BGA
TOP VIEW**

Ball Assignment

Signal Group	Signal Name	Type	Description
Ungated Inputs	DCKE0, DCKE1, DODT0, DODT1	SSTL_18	DRAM function pins not associated with Chip Select.
Chip Select Gated Inputs	D0 ... D21	SSTL_18	DRAM inputs, re-driven only when Chip Select is LOW.
Chip Select Inputs	<u>DCS0</u> , <u>DCS1</u>	SSTL_18	DRAM Chip Select signals. These pins initiate DRAM address/command decodes, and as such at least one will be low when a valid address/command is present. The register can be programmed to re-drive all D-inputs only (CSGateEN high) when at least one Chip Select input is LOW.
Re-Driven	Q0A...Q21A, Q0B...Q21B, <u>QCSnA,B</u> QCKEnA,B, QODTnA,B	SSTL_18	Outputs of the register, valid after the specified clock count outputs and immediately following a rising edge of the clock.
Parity Input	PARIN	SSTL_18	Input parity is received on pin PARIN and should maintain odd parity across the D0...D21 inputs, at the rising edge of the clock.
Parity Error	<u>PTYERR</u>	Open Drain	When LOW, this output indicates that a parity error was output identified associated with the address and/or command inputs. <u>PTYERR</u> will be active for two clock cycles, and delayed by an additional clock cycle for compatibility with final parity out timing on the industry-standard DDR-II register with parity (in JEDEC definition).
Program Inputs	CSGateEN	1.8V LVC MOS	Chip Select Gate Enable. When HIGH, the D0..D21 inputs will be latched only when at least one Chip Select input is LOW during the rising edge of the clock. When LOW, the D0...D21 inputs will be latched and redriven on every rising edge of the clock.
Clock Inputs	CLK, <u>CLK</u>	SSTL_18	Differential master clock input pair to the register. The register operation is triggered by a rising edge on the positive clock input (CLK).
Miscellaneous Inputs	MCL, MCH		Must be connected to a logic LOW or HIGH.
	<u>RESET</u>	SSTL_18	Asynchronous reset input. When LOW, it causes a reset of the internal latches, thereby forcing the outputs LOW. <u>RESET</u> also resets the <u>PTYERR</u> signal.
	VREF	0.9V nominal	Input reference voltage for the SSTL_18 inputs. Two pins (internally tied together) are used for increased reliability.

Function Table

Inputs ¹							Outputs			
RESET	DCS0	DCS1	CSGate EN	CLK	CLK	Dn, DODTn, DCKEn	Qn	QCS0x	QCS1x	QODT, QCKE
H	L	L	X	↑	↓	L	L	L	L	L
H	L	L	X	↑	↓	H	H	L	L	H
H	L	L	X	L or H	L or H	X	Q ₀	Q ₀	Q ₀	Q ₀
H	L	H	X	↑	↓	L	L	L	H	L
H	L	H	X	↑	↓	H	H	L	H	H
H	L	H	X	L or H	L or H	X	Q ₀	Q ₀	Q ₀	Q ₀
H	H	L	X	↑	↓	L	L	H	L	L
H	H	L	X	↑	↓	H	H	H	L	H
H	H	L	X	L or H	L or H	X	Q ₀	Q ₀	Q ₀	Q ₀
H	H	H	L	↑	↓	L	L	H	H	L
H	H	H	L	↑	↓	H	H	H	H	H
H	H	H	L	L or H	L or H	X	Q ₀	Q ₀	Q ₀	Q ₀
H	H	H	H	↑	↓	L	Q ₀	H	H	L
H	H	H	H	↑	↓	H	Q ₀	H	H	H
H	H	H	H	L or H	L or H	X	Q ₀	Q ₀	Q ₀	Q ₀
L	X or Floating	L	L	L	L					

1 H = HIGH Voltage Level

L = LOW Voltage Level

X = Don't Care

↑ = LOW to HIGH

↓ = HIGH to LOW

Parity and Standby Function Table

Inputs ¹						Outputs	
RESET	DCS0	DCS1	CLK	CLK	Σ of Inputs = H (D1 - D21)	PARIN ²	PTYERR ³
H	L	X	↑	↓	Even	L	H
H	L	X	↑	↓	Odd	L	L
H	L	X	↑	↓	Even	H	L
H	L	X	↑	↓	Odd	H	H
H	X	L	↑	↓	Even	L	H
H	X	L	↑	↓	Odd	L	L
H	X	L	↑	↓	Even	H	L
H	X	L	↑	↓	Odd	H	H
H	H	H	↑	↓	X	X	$\overline{\text{PTYERR}}_0$
H	X	X	L or H	L or H	X	X	$\overline{\text{PTYERR}}_0$
L	X or Floating	X or Floating	H				

1 H = HIGH Voltage Level

L = LOW Voltage Level

X = Don't Care

↑ = LOW to HIGH

↓ = HIGH to LOW

2 PARIN arrives one clock cycle after the data to which it applies.

3 This transition assumes $\overline{\text{PTYERR}}$ is HIGH at the crossing of CLK going HIGH and $\overline{\text{CLK}}$ going LOW. If $\overline{\text{PTYERR}}$ is LOW, it stays latched LOW for two clock cycles or until RESET is driven LOW.

Absolute Maximum Ratings

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.

Item	Rating	
Supply Voltage, VDD	-0.5V to 2.5V	
Input Voltage Range, Vi ¹	-0.5V to VDD + 2.5V	
Output Voltage Range, Vo ^{1,2}	-0.5V to VDDQ + 0.5V	
Input Clamp Current, I _{IK}	±50mA	
Output Clamp Current, I _{OK}	±50mA	
Continuous Output Clamp Current, I _O	±50mA	
Continuous Current through each VDD or GND	±100mA	
Package Thermal Impedance (θ_{JA}) ³	0m/s Airflow	44.3°C/W
	1m/s Airflow	38.1°C/W
Storage Temperature	-65 to +150°C	

1 The input and output negative voltage ratings may be exceeded if the ratings of the I/P and O/P clamp current are observed.

2 This current will flow only when the output is in the high state level $Vo > VDDQ$.

3 The package thermal impedance is calculated in accordance with JESD 51.

Operating Characteristics

The $\overline{\text{RESET}}$ and CSGateEN inputs of the device must be held at valid levels (not floating) to ensure proper device operation. The differential inputs must not be floating unless $\overline{\text{RESET}}$ is LOW.

Symbol	Parameter		Min.	Typ.	Max.	Units
VDD	I/O Supply Voltage		1.7	1.8	1.9	V
VREF	Reference Voltage		$0.49 * \text{VDD}$	$0.5 * \text{VDD}$	$0.51 * \text{VDD}$	V
VTT	Termination Voltage		$\text{VREF} - 0.04$	VREF	$\text{VREF} + 0.04$	V
VI	Input Voltage		0		VDD	V
VIH	AC High-Level Input Voltage	Dn, PARIN, $\overline{\text{DCSn}}$, $\overline{\text{DCKEn}}$, $\overline{\text{DODTn}}$	$\text{VREF} + 0.25$			V
VIL	AC Low-Level Input Voltage				$\text{VREF} - 0.25$	
VIH	DC High-Level Input Voltage		$\text{VREF} + 0.125$			
VIL	DC Low-Level Input Voltage				$\text{VREF} - 0.125$	
VIH	High-Level Input Voltage	$\overline{\text{RESET}}$, CSGateEN	$0.65 * \text{VDDQ}$			V
VIL	Low-Level Input Voltage				$0.35 * \text{VDDQ}$	
VICR	Common Mode Input Range	CLK, $\overline{\text{CLK}}$	0.675		1.125	V
VID	Differential Input Voltage		600			mV
IOH	High-Level Output Current				-8	mA
IOL	Low-Level Output Current				8	
I _{ERROL}	PTYERR LOW Level Output Current		25			mA
TA	Operating Free-Air Temperature		0		+70	°C

DC Electrical Characteristics Over Operating Range

Following Conditions Apply Unless Otherwise Specified:

Operating Condition: $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{DD} = 1.8\text{V} \pm 0.1\text{V}$.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_{OH}	Output HIGH Voltage	$I_{OH} = -6\text{mA}$, $V_{DDQ} = 1.7\text{V}$	1.2			V
V_{OL}	Output LOW Voltage	$I_{OL} = 6\text{mA}$, $V_{DDQ} = 1.7\text{V}$			0.5	V
V_{ERROL}	PTYERR Output LOW Voltage	$I_{ERROL} = 25\text{mA}$, $V_{DD} = 1.7\text{V}$			0.5	V
I_{IL}	All Inputs	$V_I = V_{DD}$ or GND; $V_{DD} = 1.9\text{V}$	-5		+5	μA
I_{DD}	Static Standby	$I_O = 0$, $V_{DD} = 1.9\text{V}$, $\overline{\text{RESET}} = \text{GND}$		200		μA
	Static Operating	$I_O = 0$, $V_{DD} = 1.9\text{V}$, $\overline{\text{RESET}} = V_{DD}$, $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$, $\text{CLK} = \overline{\text{CLK}} = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$			10	mA
		$I_O = 0$, $V_{DD} = 1.9\text{V}$, $\overline{\text{RESET}} = V_{DD}$, $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$, $\text{CLK} = V_{IH(\text{AC})}$, $\overline{\text{CLK}} = V_{IL(\text{AC})}$		120		
I_{DDD}	Dynamic Operating (clock only)	$I_O = 0$, $V_{DD} = 1.8\text{V}$, $\overline{\text{RESET}} = V_{DD}$, $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$, CLK and $\overline{\text{CLK}}$ switching 50% duty cycle		300		$\mu\text{A/Clock MHz}$
	Dynamic Operating (per each data input)	$I_O = 0$, $V_{DD} = 1.8\text{V}$, $\overline{\text{RESET}} = V_{DD}$, $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$, CLK and $\overline{\text{CLK}}$ switching 50% duty cycle. One data input switching at half clock frequency, 50% duty cycle.		40		$\mu\text{A/Clock MHz/ Data}$
C_{IN}	D_n , PARIN	$V_I = V_{REF} \pm 350\text{mV}$	2		3	pF
	CLK and $\overline{\text{CLK}}$	$V_{ICR} = 1.25\text{V}$, $V_{IPP} = 360\text{mV}$	2.5		3.5	
	$\overline{\text{RESET}}$	$V_I = V_{DD}$ or GND		5		

Timing Requirements Over Recommended Operating Free-Air Temperature Range

Symbol	Parameter	$V_{DD} = 1.8V \pm 0.1V$		Units
		Min.	Max.	
fCLOCK	Clock Frequency		410	MHz
tW	Pulse Duration; CLK, \overline{CLK} HIGH or LOW	1		ns
tACT	Differential Inputs Active Time ¹		10	ns
tINACT	Differential Inputs Inactive Time ²		15	ns
tsu	Setup Time	DCS0 before CLK \uparrow , CLK \downarrow , DCS and CSGateEN HIGH; DCS1 before CLK \uparrow , CLK \downarrow , DCS0 and CSGateEN HIGH	0.7	ns
		DCSn, DODT, DCKE, and Dn after CLK \uparrow , CLK \downarrow	0.5	
		PARIN after CLK \uparrow , CLK \downarrow	0.5	
tH	Hold Time	DCSn, DODT, DCKE, and Dn after CLK \uparrow , CLK \downarrow	0.5	ns
		PARIN after CLK \uparrow , CLK \downarrow	0.5	

1 VREF must be held at a valid input voltage level and data inputs must be held at valid logic levels for a minimum time of tACT(max) after RESET is taken HIGH.

2 VREF, data, and clock inputs must be held at a valid input voltage levels (not floating) for a minimum time of tINACT(max) after RESET is taken LOW.

Switching Characteristics Over Recommended Free Air Operating Range (unless otherwise noted)

Symbol	Parameter	$V_{DD} = 1.8V \pm 0.1V$		Units
		Min.	Max.	
fMAX	Max Input Clock Frequency	410		MHz
tPDM	Propagation Delay, single bit switching, CLK \uparrow to \overline{CLK} \downarrow to Qn	1.3	1.9	ns
tPDMSS	Propagation Delay, simultaneous switching, CLK \uparrow to \overline{CLK} \downarrow to Qn		2	ns
tLH	LOW to HIGH Propagation Delay, CLK \uparrow to \overline{CLK} \downarrow to PTYERR	1.2	3	ns
tHL	HIGH to LOW Propagation Delay, CLK \uparrow to \overline{CLK} \downarrow to PTYERR	1	3	ns
tPHL	HIGH to LOW Propagation Delay, RESET \downarrow to Qn \downarrow		3	ns
tPLH	LOW to HIGH Propagation Delay, RESET \downarrow to PTYERR \uparrow		3	ns

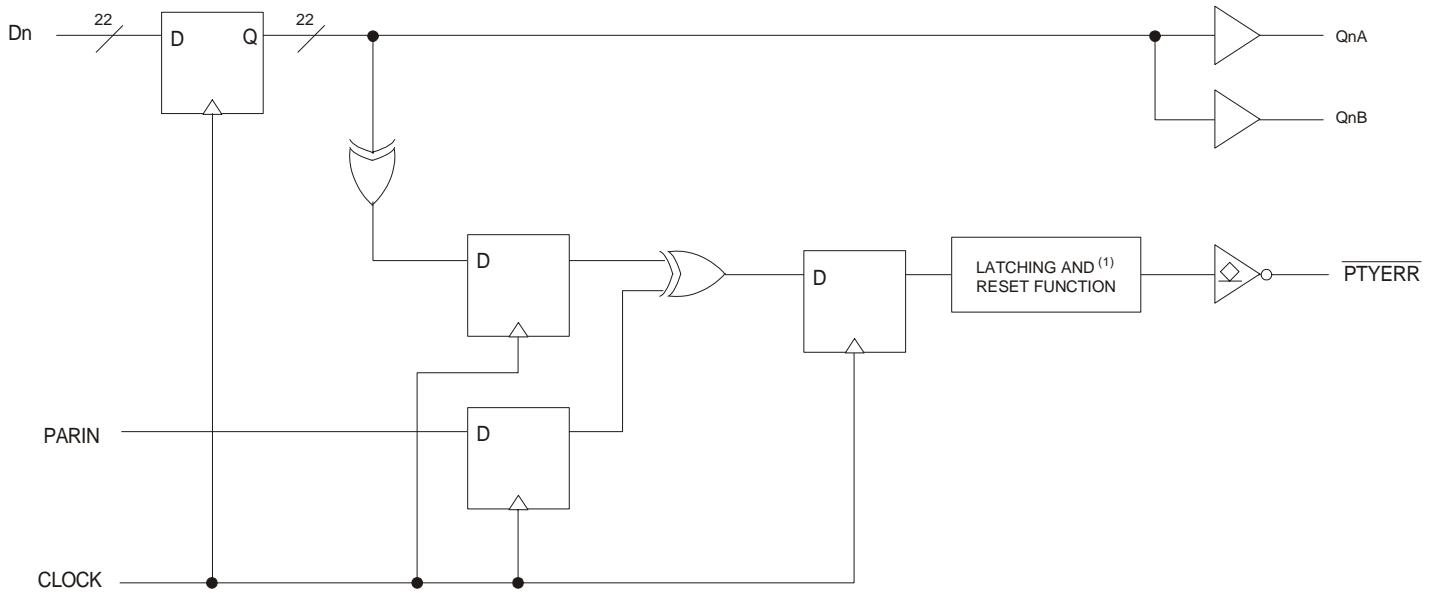
Output Buffer Characteristics

Output edge rates over recommended operating free-air temperature range

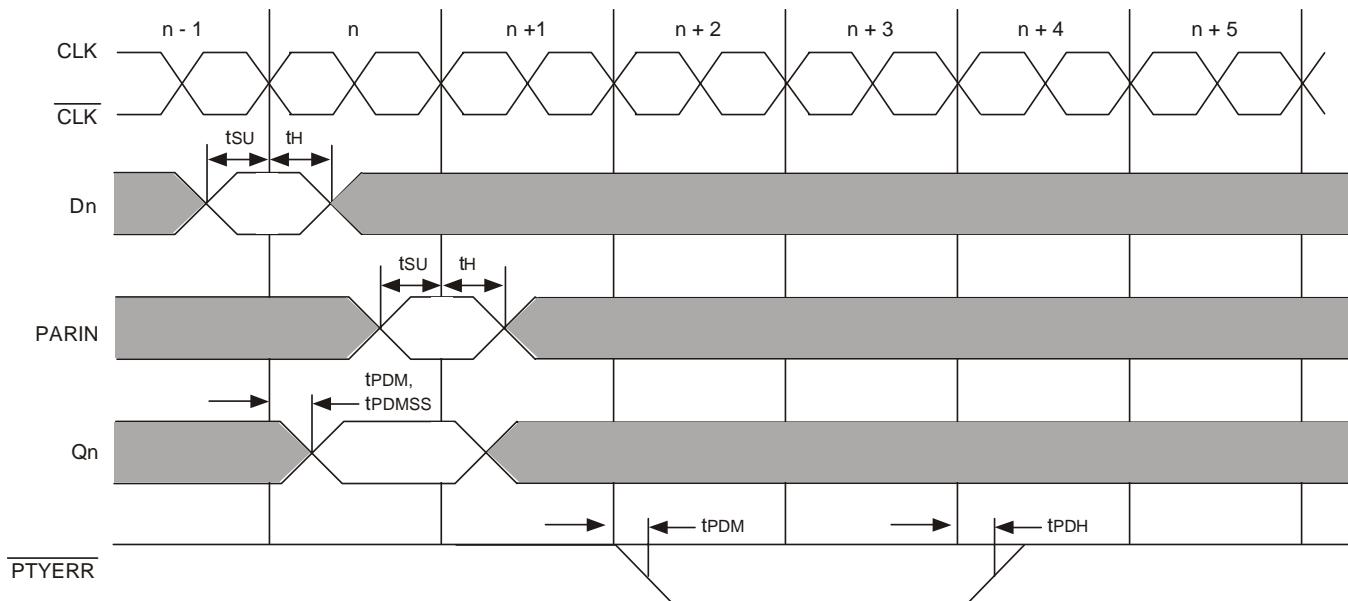
Parameter	$V_{DD} = 1.8V \pm 0.1V$		Units
	Min.	Max.	
dV/dt_r	1	4	V/ns
dV/dt_f	1	4	V/ns
dV/dt _Δ ¹		1	V/ns

1 Difference between dV/dt_r (rising edge rate) and dV/dt_f (falling edge rate).

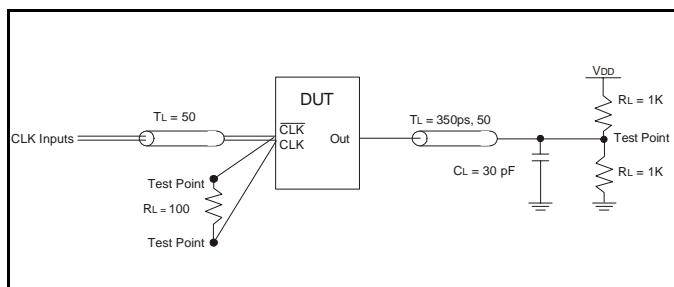
Parity Logic Diagram



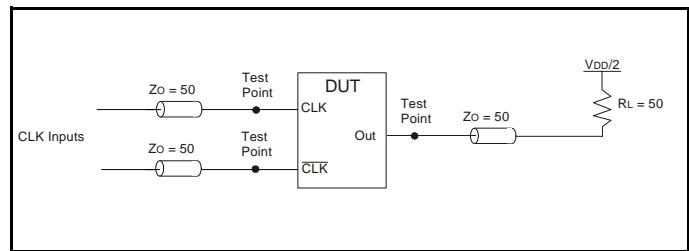
Register Timing



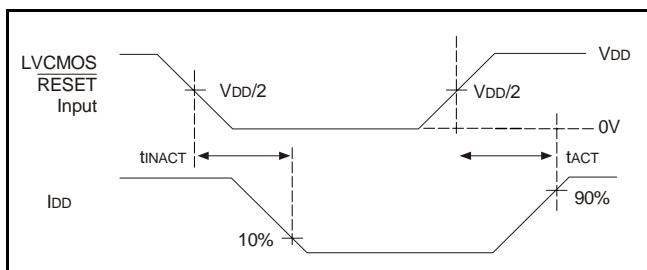
Test Circuits and Waveforms ($V_{DD} = 1.8V \pm 0.1V$)



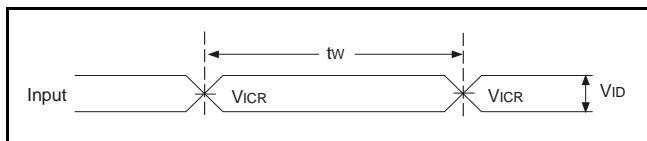
Simulation Load Circuit



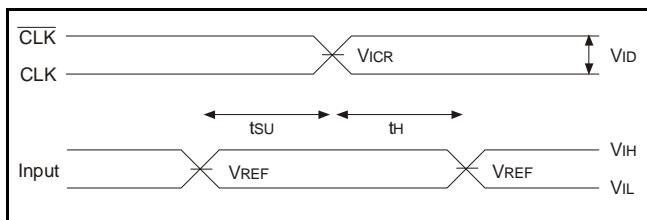
Production-Test Load Circuit



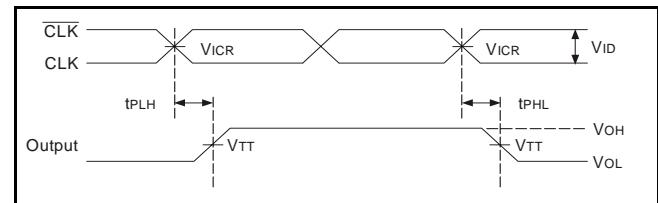
Voltage and Current Waveforms Inputs Active and Inactive Times



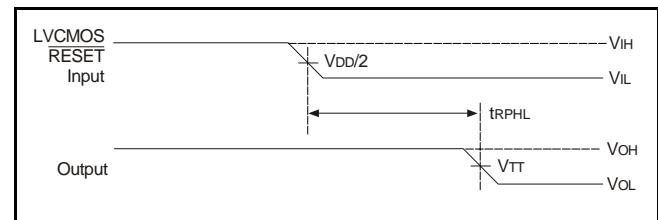
Voltage Waveforms - Pulse Duration



Voltage Waveforms - Setup and Hold Times



Voltage Waveforms - Propagation Delay Times

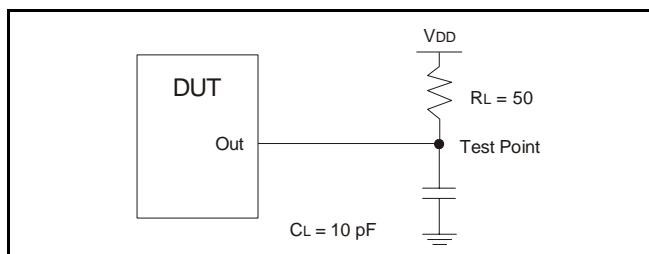


Voltage Waveforms - Propagation Delay Times

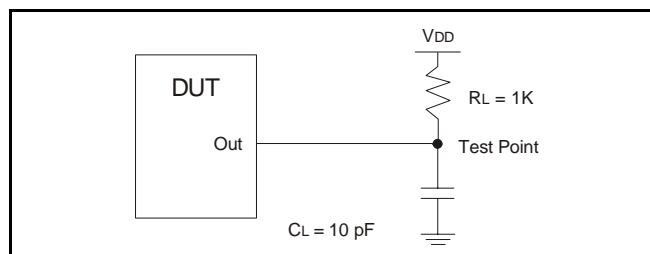
NOTES:

1. CL includes probe and jig capacitance.
2. IDD tested with clock and data inputs held at V_{DD} or GND, and $I_o = 0mA$
3. All input pulses are supplied by generators having the following characteristics: PRR $\leq 10MHz$, $Z_0 = 50\Omega$, input slew rate = 1 V/ns $\pm 20\%$ (unless otherwise specified).
4. The outputs are measured one at a time with one transition per measurement.
5. $V_{TT} = V_{REF} = V_{DD}/2$
6. $V_{IH} = V_{REF} + 250mV$ (AC voltage levels) for differential inputs. $V_{IH} = V_{DD}$ for LVCMS input.
7. $V_{IL} = V_{REF} - 250mV$ (AC voltage levels) for differential inputs. $V_{IL} = GND$ for LVCMS input.
8. $VID = 600mV$.
9. t_{PLH} and t_{PHL} are the same as t_{PDH} .

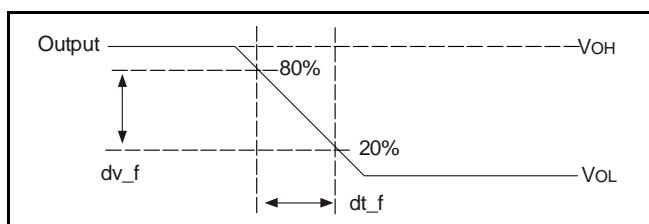
Test Circuits and Waveforms ($V_{DD} = 1.8V \pm 0.1V$)



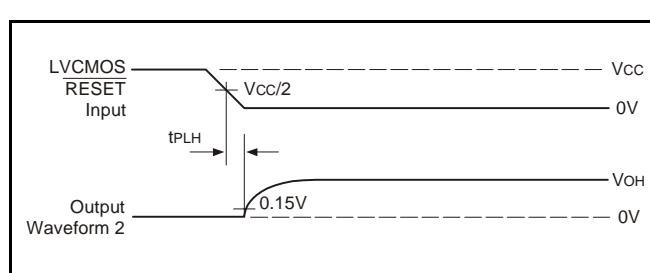
Load Circuit: High-to-Low Slew-Rate Adjustment



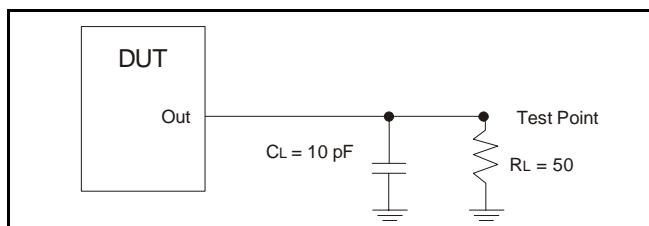
Load Circuit: Error Output Measurements



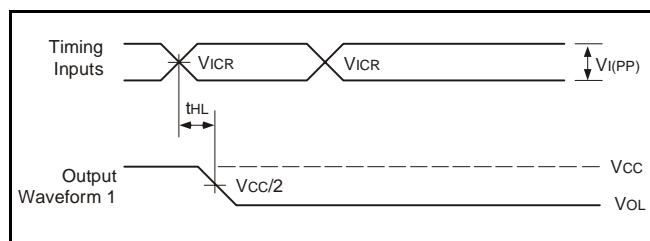
Voltage Waveforms: High-to-Low Slew-Rate Adjustment



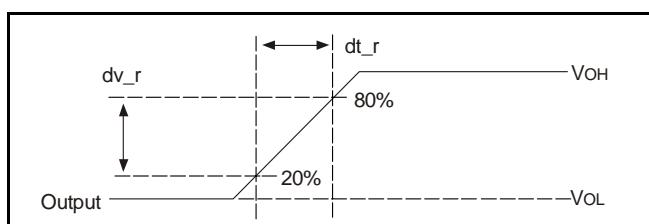
Voltage Waveforms: Open Drain Output Low-to-High Transition Time (with respect to RESET input)



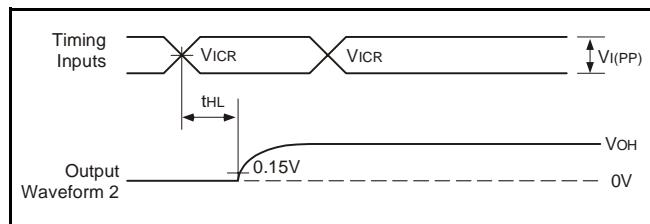
Load Circuit: Low-to-High Slew-Rate Adjustment



Voltage Waveforms: Open Drain Output High-to-Low Transition Time (with respect to clock inputs)



Voltage Waveforms: Low-to-High Slew-Rate Adjustment

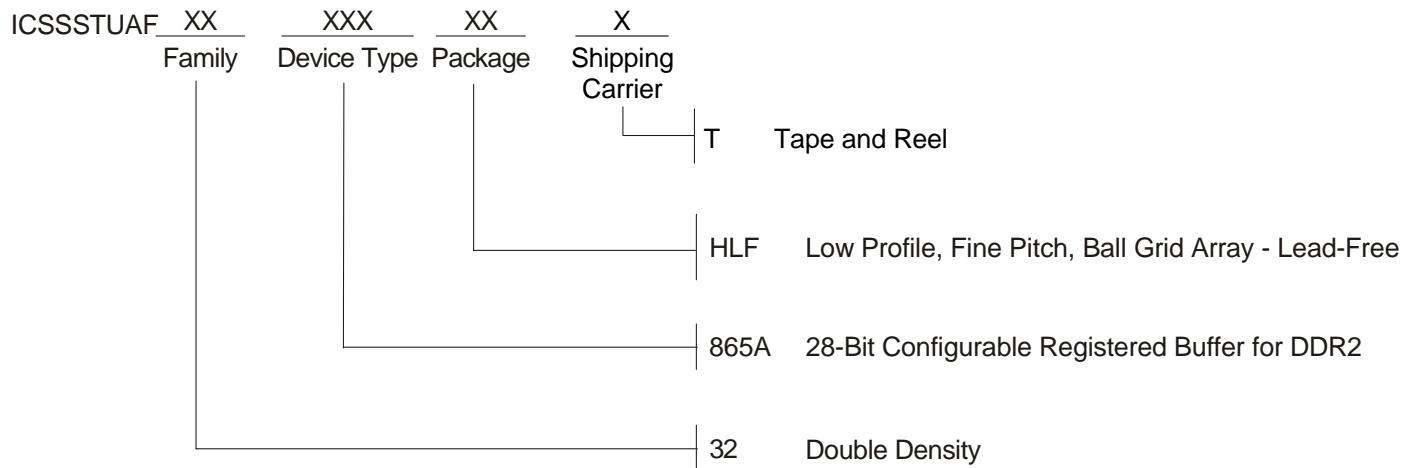


Voltage Waveforms: Open Drain Output Low-to-High Transition Time (with respect to clock inputs)

NOTES:

1. CL includes probe and jig capacitance.
2. All input pulses are supplied by generators having the following characteristics: PRR ≤ 0 MHz, $Z_0 = 50\Omega$, input slew rate = 1 V/ns $\pm 20\%$ (unless otherwise specified).

Ordering Information



ICSSSTUAF32865A

28-BIT CONFIGURABLE REGISTERED BUFFER FOR DDR2

COMMERCIAL TEMPERATURE GRADE

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