Integrated Circuit Systems, Inc.

ICSSSTU32866
Advance Information

25-Bit Configurable Registered Buffer

Recommended Application:

- DDR2 Memory Modules
- Provides complete DDR DIMM logic solution with ICS97U877

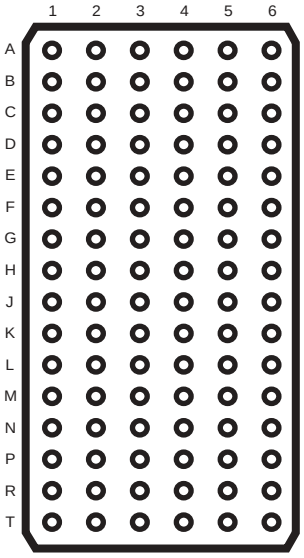
Product Features:

- 25-bit 1:1 or 14-bit 1:2 configurable registered buffer with parity check functionality
- Supports SSTL_18 JEDEC specification on data inputs and outputs
- Supports LVCMOS switching levels on CSR# and RESET# inputs
- Low voltage operation V_{DD} = 1.7V to 1.9V
- Available in 96 BGA package

Functionality Truth Table

Inputs						Outputs		
RST#	DCS#	CSR#	CK	CK#	Dn, DODT, DCKE	Qn	QCS#	QODT, QCKE
H	L	L	↑	↓	L	L	L	L
H	L	L	↑	↓	H	H	L	H
H	L	L	L or H	L or H	X	Q_0	Q_0	Q_0
H	L	H	↑	↓	L	L	L	L
H	L	H	↑	↓	H	H	L	H
H	L	H	L or H	L or H	X	Q_0	Q_0	Q_0
H	H	L	↑	↓	L	L	H	L
H	H	L	↑	↓	H	H	H	H
H	H	L	L or H	L or H	X	Q_0	Q_0	Q_0
H	H	H	↑	↓	L	Q_0	H	L
H	H	H	↑	↓	H	Q_0	H	H
H	H	H	L or H	L or H	X	Q_0	Q_0	Q_0
L	X or Floating	X or Floating	X or Floating	X or Floating	X or Floating	L	L	L

Pin Configuration



96 Ball BGA
(Top View)

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Ball Assignments

25 bit 1:1 Register

	1	2	3	4	5	6
A	DCKE	PPO	V_{REF}	V_{DD}	QCKE	NC
B	D2	D15	GND	GND	Q2	Q15
C	D3	D16	V_{DD}	V_{DD}	Q3	Q16
D	DODT	QERR#	GND	GND	QODT	NC
E	D5	D17	V_{DD}	V_{DD}	Q5	Q17
F	D6	D18	GND	GND	Q6	Q18
G	PAR_IN	RST#	V_{DD}	V_{DD}	C1	C0
H	CK	DCS#	GND	GND	QCS#	NC
J	CK#	CSR#	V_{DD}	V_{DD}	ZOH	ZOL
K	D8	D19	GND	GND	Q8	Q19
L	D9	D20	V_{DD}	V_{DD}	Q9	Q20
M	D10	D21	GND	GND	Q10	Q21
N	D11	D22	V_{DD}	V_{DD}	Q11	Q22
P	D12	D23	GND	GND	Q12	Q23
R	D13	D24	V_{DD}	V_{DD}	Q13	Q24
T	D14	D25	V_{REF}	V_{DD}	Q14	Q25

C0 = 0, C1 = 0

14 bit 1:2 Registers

	1	2	3	4	5	6
A	DCKE	PPO	V_{REF}	V_{DD}	QCKEA	QCKEB
B	D2	NC	GND	GND	Q2A	Q2B
C	D3	NC	V_{DD}	V_{DD}	Q3A	Q3B
D	DODT	QERR#	GND	GND	QODTA	QODTB
E	D5	NC	V_{DD}	V_{DD}	Q5A	Q5B
F	D6	NC	GND	GND	Q6A	Q6B
G	PAR_IN	RST#	V_{DD}	V_{DD}	C1	C0
H	CK	DCS#	GND	GND	QCSA#	QCSB#
J	CK#	CSR#	V_{DD}	V_{DD}	ZOH	ZOL
K	D8	NC	GND	GND	Q8A	Q8B
L	D9	NC	V_{DD}	V_{DD}	Q9A	Q9B
M	D10	NC	GND	GND	Q10A	Q10B
N	D11	NC	V_{DD}	V_{DD}	Q11A	Q11B
P	D12	NC	GND	GND	Q12A	Q12B
R	D13	NC	V_{DD}	V_{DD}	Q13A	Q13B
T	D14	NC	V_{REF}	V_{DD}	Q14A	Q14B

Register A (C0 = 0, C1 = 1)

	1	2	3	4	5	6
A	D1	PPO	V_{REF}	V_{DD}	Q1A	Q1B
B	D2	NC	GND	GND	Q2A	Q2B
C	D3	NC	V_{DD}	V_{DD}	Q3A	Q3B
D	D4	QERR#	GND	GND	Q4A	Q4B
E	D5	NC	V_{DD}	V_{DD}	Q5A	Q5B
F	D6	NC	GND	GND	Q6A	Q6B
G	PAR_IN	RST#	V_{DD}	V_{DD}	C1	C0
H	CK	DCS#	GND	GND	QCSA#	QCSB#
J	CK#	CSR#	V_{DD}	V_{DD}	ZOH	ZOL
K	D8	NC	GND	GND	Q8A	Q8B
L	D9	NC	V_{DD}	V_{DD}	Q9A	Q9B
M	D10	NC	GND	GND	Q10A	Q10B
N	DODT	NC	V_{DD}	V_{DD}	QODTA	QODTB
P	D12	NC	GND	GND	Q12A	Q12B
R	D13	NC	V_{DD}	V_{DD}	Q13A	Q13B
T	DCKE	NC	V_{REF}	V_{DD}	QCKEA	QCKEB

Register B (C0 = 1, C1 = 1)

General Description

This 25-bit 1:1 or 14-bit 1:2 configurable registered buffer is designed for 1.7-V to 1.9-V VDD operation.

All clock and data inputs are compatible with the JEDEC standard for SSTL_18. The control inputs are LVCMOS. All outputs are 1.8-V CMOS drivers that have been optimized to drive the DDR-II DIMM load. **ICSSSTU32866** operates from a differential clock (CK and CK#). Data are registered at the crossing of CK going high, and CK# going low.

The C0 input controls the pinout configuration of the 1:2 pinout from A configuration (when low) to B configuration (when high). The C1 input controls the pinout configuration from 25-bit 1:1 (when low) to 14-bit 1:2 (when high).

A - Pair Configuration (CO_1 = 0, CI_1 = 1 and CO_2 = 0, CI_2 = 1)

Parity that arrives one cycle after the data input to which it applies is checked on the PAR_IN of the first register. The second register produces to PPO and QERR# signals. The QERR# of the first register is left floating. The valid error information is latched on the QERR# output of the second register. If an error occurs QERR# is latched low for two cycles or until Reset# is low.

B - Single Configuration (CO = 0, C1 = 0)

The device supports low-power standby operation. When the reset input (RST#) is low, the differential input receivers are disabled, and undriven (floating) data, clock and reference voltage (VREF) inputs are allowed. In addition, when RST# is low all registers are reset, and all outputs are forced low. The LVCMOS RST# and Cn inputs 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, RST# must be held in the low state during power up.

In the DDR-II RDIMM application, RST# is specified to be completely asynchronous with respect to CK and CK#. 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 RST# until the input receivers are fully enabled, the design of the **ICSSSTU32866** must ensure that the outputs will remain low, thus ensuring no glitches on the output.

The device monitors both DCS# and CSR# inputs and will gate the Qn outputs from changing states when both DCS# and CSR# inputs are high. If either DCS# or CSR# input is low, the Qn outputs will function normally. The RST input has priority over the DCS# and CSR# control and will force the outputs low. If the DCS#-control functionality is not desired, then the CSR# 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. Package options include 96-ball LFBGA (MO-205CC).

Parity and Standby Functionality Truth Table

Inputs							Outputs	
Reset#	DCS#	CSR#	CK	CK#	Sum of Inputs = H (D1 - D25)	PAR_IN	PPO	QERR#
H	L	X	↑	↓	Even	L	L	H
H	L	X	↑	↓	Odd	L	H	L
H	L	X	↑	↓	Even	H	H	L
H	L	X	↑	↓	Odd	H	L	H
H	H	L	↑	↓	Even	L	L	H
H	H	L	↑	↓	Odd	H	H	L
H	H	H	↑	↓	X	X	PPO_0	$QERR_0$#
H	X	X	L or H	L or H	X	X	PPO_0	$QERR_0$#
L	X or Floating	X or Floating	X or Floating	X or Floating	X or Floating	X or Floating	L	H

1. CO = 0 and CI = 0, Data inputs are D2, D3, D5, D6, D8 - D25.
   CO = 0 and CI = 1, Data inputs are D2, D3, D5, D6, D8 - D14
   CO = 1 and CI = I, Data inputs are D1 - D6, D8 - D10, D12, D13
2. PAR_IN arrives one clock cycle after the data to which it applies when CO = 0.
3. PAR_IN arrives two clock cycles after the data to which it applies when CO = 1.
4. Assume QERR# is high at the CK↑ and CK#↓ crossing. If QERR# is low it stays latched low for two clock cycles on until Reset# is low.

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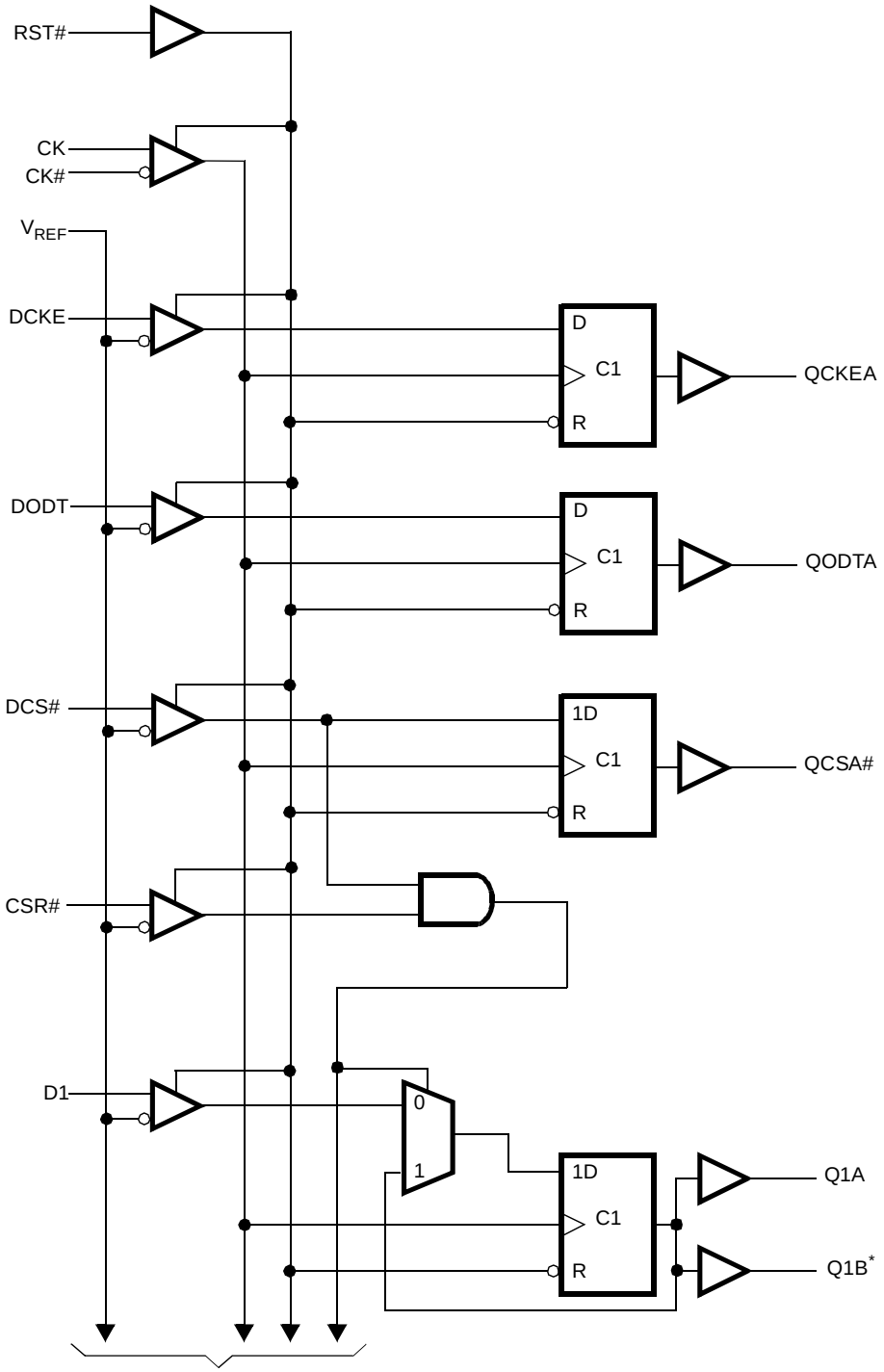
Ball Assignment

Terminal Name	Description	Electrical Characteristics
GND	Ground	Ground input
V_{DD}	Power supply voltage	1.8V nominal
V_{REF}	Input reference voltage	0.9V nominal
Z_{OH}	Reserved for future use	Input
Z_{OL}	Reserved for future use	Input
CK	Positive master clock input	Differential input
CK	Negative master clock input	Differential input
C0, C1	Configuration control inputs	LVCMOS inputs
RST#	Asynchronous reset input - resets registers and disables V_{REF} data and clock differential-input receivers	LVCMOS input
CSR#, DCS#	Chip select inputs - disables D1 - D24 outputs switching when both inputs are high	SSTL_18 input
D1 - D25	Data input - clock in on the crossing of the rising edge of CK and the falling edge of CK#	SSTL_18 input
DODT	The outputs of this register bit will not be suspended by the DCS# and CSR# control	SSTL_18 input
DCKE	The outputs of this register bit will now be suspended by the DCS# and CSR# control	SSTL_18 input
Q1 - Q25	Data ouputs that are suspended by the DCS# and CSR# control	1.8V CMOS
QCS#	Data output that will not be suspended by the DCS# and CSR# control	1.8V CMOS
QODT	Data output that will not be suspended by the DCS# and CSR# control	1.8V CMOS
QCKE	Data output that will not be suspended by the DCS# and CSR# control	1.8V CMOS
PPO	Partial parity out indicates off parity of inputs D1 - D25.	1.8V CMOS
PAR_IN	Parity input arrives one clock cycle after the corresponding data input	SSTL_18 input
QERR#	Output error bit-generated one clock cycle after the corresponding data output	Open drain output

Block Diagram for 1:1 mode (positive logic)



*Note: Disabled in 1:1 configuration

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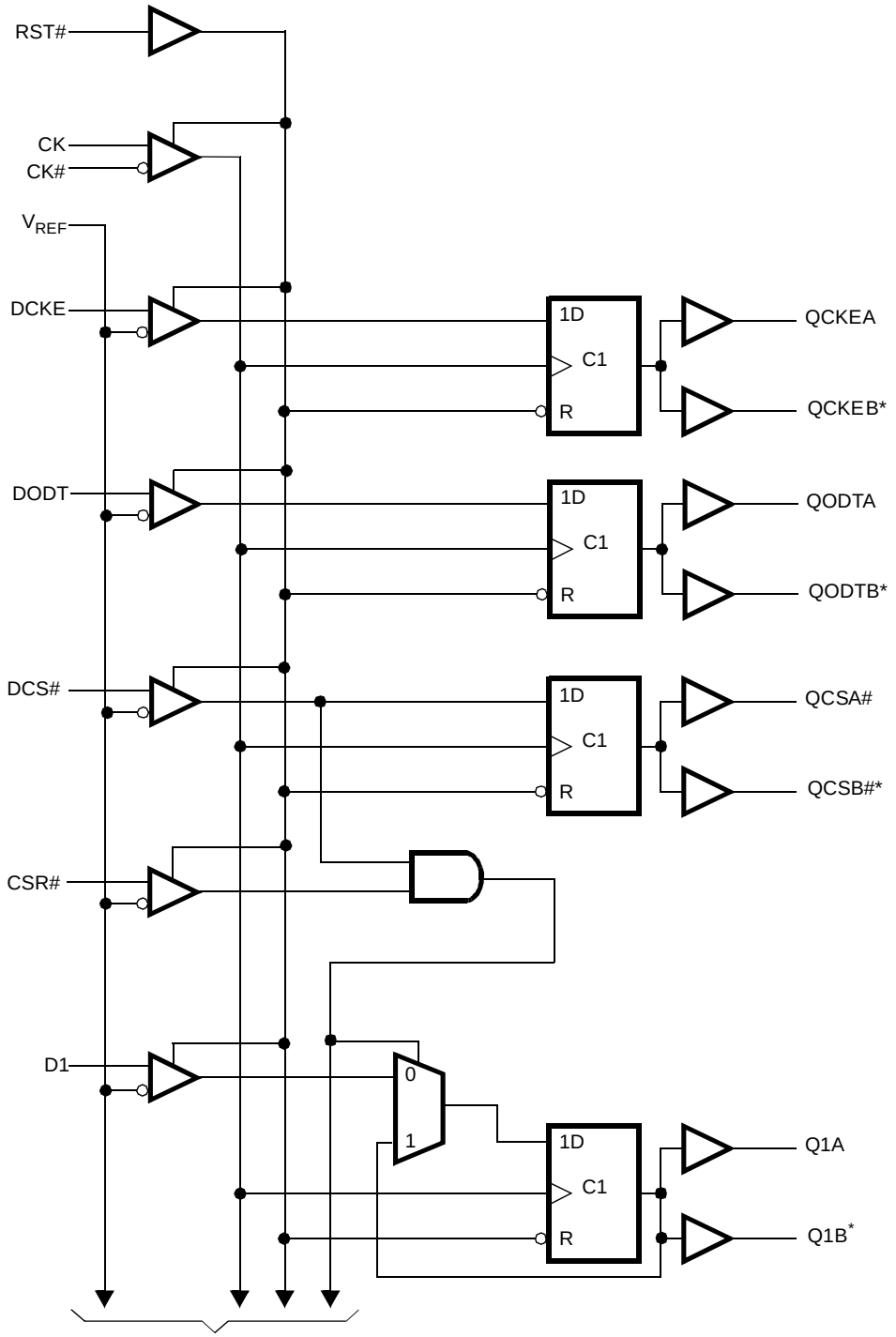
Block Diagram for 1:2 mode (positive logic)



*Note: Disabled in 1:1 configuration

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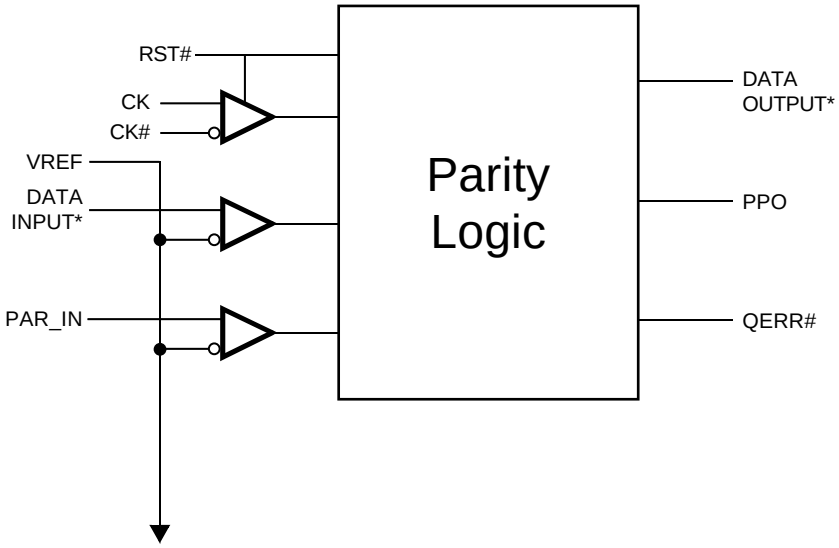
Parity Functionality Block Diagram



* Register Configurations

DATA INPUT:	DATA OUTPUT:	CO	CI
D2, D3, D5, D6, D8 - D25	D2, D3, D5, D6, D8 - D25	0	0
D2, D3, D5, D6, D8 - D14	D2, D3, D5, D6, D8 - D14	0	1
D1 - D6, D8 - D10, D12, D13	D1 - D6, D8 - D10, D12, D13	1	1

Absolute Maximum Ratings

Storage Temperature	–65°C to +150°C
Supply Voltage	-0.5 to 2.5V
Input Voltage[1]	-0.5 to VDD + 2.5V
Output Voltage[1,2]	-0.5 to VDDQ + 0.5
Input Clamp Current	±50 mA
Output Clamp Current	±50mA
Continuous Output Current	±50mA
VDDQ or GND Current/Pin	±100mA
Package Thermal Impedance[3]	36°C

Notes:
1. The input and output negative voltage ratings may be excluded if the input and output clamp ratings are observed.
2. This current will flow only when the output is in the high state level $V_O > V_{DDQ}$.
3. The package thermal impedance is calculated in accordance with JESD 51.

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

Recommended Operating Conditions

PARAMETER	DESCRIPTION		MIN	TYP	MAX	UNITS
V_{DDQ}	I/O Supply Voltage		1.7	1.8	1.9	V
V_{REF}	Reference Voltage		0.49 x V_{DD}	0.5 x V_{DD}	0.51 x V_{DD}	
V_{TT}	Termination Voltage		V_{REF} - 0.04	V_{REF}	V_{REF} + 0.04	
V_I	Input Voltage		0		V_{DDQ}	
$V_{IH\ (DC)}$	DC Input High Voltage	Data Inputs	V_{REF} + 0.125			
$V_{IH\ (AC)}$	AC Input High Voltage		V_{REF} + 0.250			
$V_{IL\ (DC)}$	DC Input Low Voltage				V_{REF} - 0.125	
$V_{IL\ (DC)}$	AC Input Low Voltage		V_{REF} + 0.250			
V_{IH}	Input High Voltage Level	RESET#, C0, C1	0.65 x V_{DDQ}			
V_{IL}	Input Low Voltage Level				0.35 x V_{DDQ}	
V_{ICR}	Common mode Input Range	CLK, CLK#	0.675		1.125	
V_{ID}	Differential Input Voltage		0.600			
I_{OH}	High-Level Output Current				-8	mA
I_{OL}	Low-Level Output Current				8	
T_A	Operating Free-Air Temperature		0		70	°C

[1]Guaranteed by design, not 100% tested in production.

Note: Reset# and Cn inputs must be helf at valid logic levels (not floating) to ensure proper device operation. The differential inputs must not be floating unless Reset# is low.

Electrical Characteristics - DC

T_A = 0 - 70°C; V_{DD} = 2.5 +/-0.2V, V_{DDQ}=2.5 +/-0.2V; (unless otherwise stated)

SYMBOL	PARAMETERS	CONDITIONS		V_{DDQ}	MIN	TYP	MAX	UNITS
V_{IK}		I_I = -18mA					-1.2	V
V_{OH}		I_{OH} = -100µA		1.7V - 1.9V	V_{DDQ} - 0.2			
		I_{OH} = -16mA		1.7V	1.95			
V_{OL}		I_{OL} = 100µA		1.7V - 1.9V			0.2	
		I_{OL} = 16mA		1.7V			0.35	
I_I	All Inputs	$V_I = V_{DD}$ or GND		1.9V			±5	µA
I_{DD}	Standby (Static)	RESET# = GND	I_O = 0	1.9V			0.01	µA
	Operating (Static)	$V_I = V_{IH(AC)}$ or $V_{IL(AC)}$, RESET# = V_{DD}				TBD		mA
I_{DDD}	Dynamic operating (clock only)	RESET# = V_{DD}, $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$, CLK and CLK# switching 50% duty cycle.		1.8V		TBD		µ/clock MHz
	Dynamic Operating (per each data input)	RESET# = V_{DD}, $V_I = V_{IH(AC)}$ or $V_{IL\ (AC)}$, CLK and CLK# switching 50% duty cycle. One data input switching at half clock frequency, 50% duty cycle				TBD		µA/ clock MHz/data
r_{OH}	Output High	I_{OH} = -20mA						Ω
r_{OL}	Output Low	I_{OL} = 20mA						Ω
$r_{O(D)}$	[r_{OH} - r_{OL}] each separate bit	I_O = 20mA, T_A = 25° C					4	Ω
C_i	Data Inputs	$V_I = V_{REF}$ ±350mV			2.5		3.5	pF
	CLK and CLK#	V_{ICR} = 1.25V, $V_{I(PP)}$ = 360mV			2		3	
	RESET#	$V_I = V_{DDQ}$ or GND				2.5		

Notes:
1 - Guaranteed by design, not 100% tested in production.

Output Buffer Characteristics

Output edge rates over recommended operating free-air temperature range (See figure 7)

PARAMETER	V_{DD} = 1.8V ± 0.1V		UNIT
	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)

Timing Requirements

(over recommended operating free-air temperature range, unless otherwise noted)

SYMBOL	PARAMETERS		V_{DD} = 1.8V ±0.1V		UNITS
			MIN	MAX	
f_{clock}	Clock frequency			300	MHz
t_S	Setup time	Data before CLK↑, CLK#↓	0.75		ns
			0.9		
		DCS# before CK↑, CK#↓, CSR# high	0.7		
		CSR# before CK↑, CK#↓, DCS# high	0.7		
		DCS# before CK↑, CK#↓, CSR# low	0.5		
		DODT, DCKE and Q before CK↑, CK#↓	0.5		
		PAR_IN before CK↑, CK#↓	0.5		
t_H	Hold time	DCS#, DODT, DCKE and Q after CK↑, CK#↓	0.50		ns
	Hold time	PAR_IN after CK↑, CK#↓	0.50		ns

Notes: 1 - Guaranteed by design, not 100% tested in production.
2 - For data signal input slew rate of 1V/ns.
3 - For data signal input slew rate of 0.5V/ns and < 1V/ns.
4 - CLK/CLK# signal input slew rate of 1V/ns.

Switching Characteristics

(over recommended operating free-air temperature range, unless otherwise noted)

Symbol	Parameter	Measurement Conditions	MIN	MAX	Units
fmax	Max input clock frequency		270		MHz
t_{PDM}	Propagation delay, single bit switching	CK↑ to CK#↓QN	1.41	215	ns
t_{PD}	Propagation delay	CK↑ to CK#↓to PPO	0.5	1.8	ns
t_{LH}	Low to High propagation delay	CK↑ to CK#↓to QERR#	1.2	3	ns
t_{HL}	High to low propagation delay	CK↑ to CK#↓to QERR#	1	2.4	ns
t_{PDMSS}	Propagation delay simultaneous switching	CK↑ to CK#↓QN		2.35	ns
t_{PHL}	High to low propagation delay	Reset#↓ to QN↓		3	ns
t_{PHL}	High to low propagation delay	Reset#↓ to PPO↓		3	ns
t_{PLH}	Low to High propagation delay	Reset#↓ to QERR#↑		3	ns

2. Guaranteed by design, not 100% tested in production.

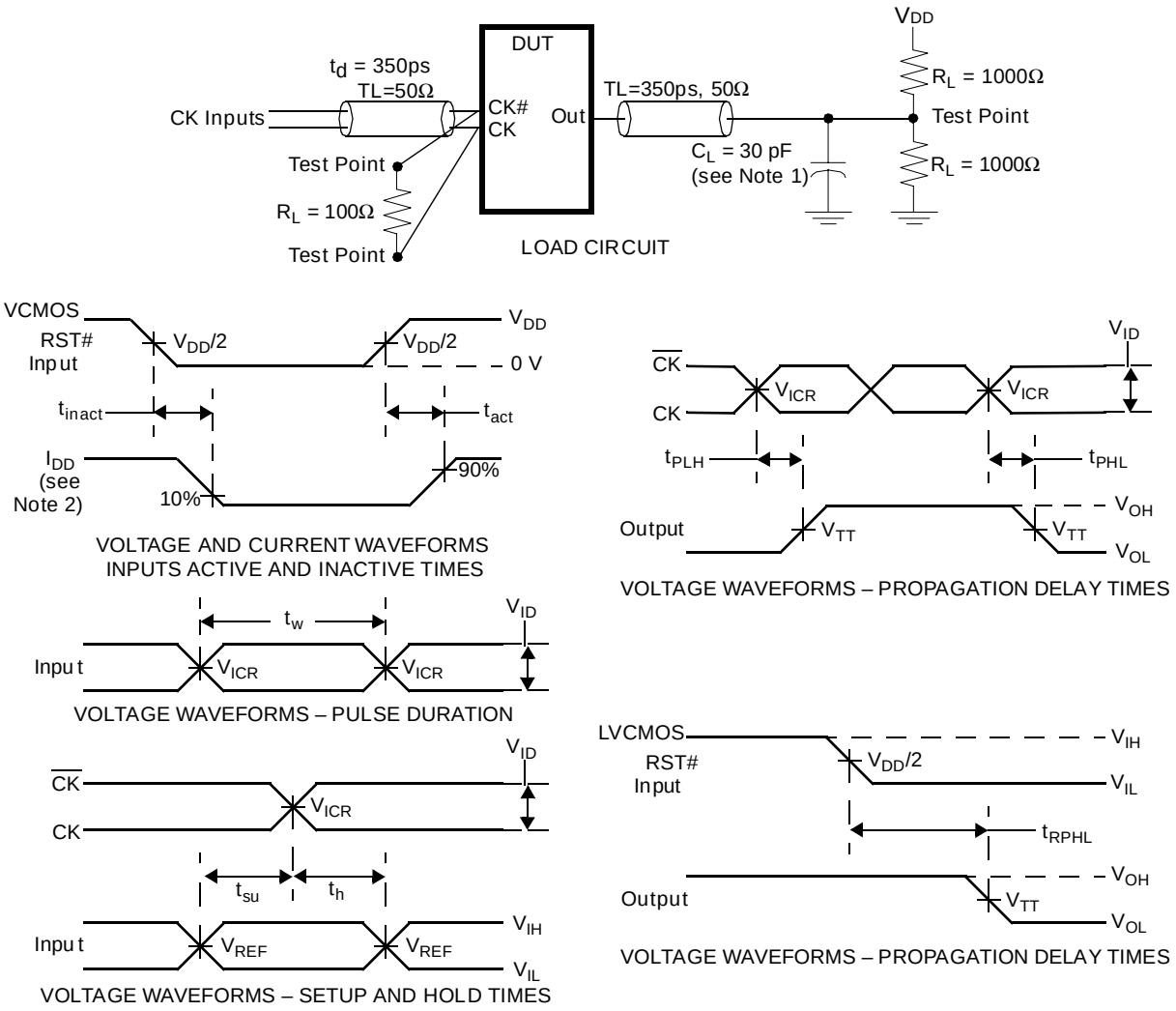
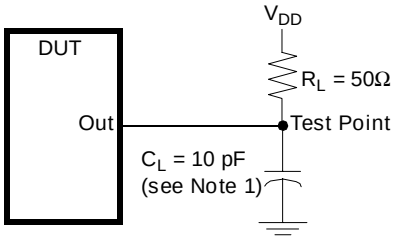


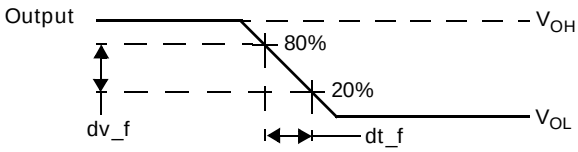
Figure 6 — Parameter Measurement Information (V_{DD} = 1.8 V ±0.1 V)

Notes: 1. C_L incluces probe and jig capacitance.

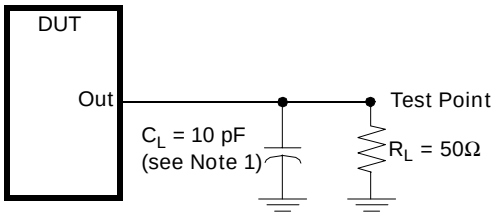
2. I_{DD} tested with clock and data inputs held at V_{DD} or GND, and Io = 0mA.
3. All input pulses are supplied by generators having the following chareacteristics: PRR ≤10 MHz, Zo=50Ω, input slew rate = 1 V/ns ±20% (unless otherwise specified).
4. The outputs are measured one at a time with one transition per measurement.
5. $V_{REF} = V_{DD}/2$
6. $V_{IH} = V_{REF}$ + 250 mV (ac voltage levels) for differential inputs. $V_{IH} = V_{DD}$ for LVCMOS input.
7. $V_{IL} = V_{REF}$ - 250 mV (ac voltage levels) for differential inputs. V_{IL} = GND for LVCMOS input.
8. V_{ID} = 600 mV
9. t_{PLH} and t_{PHL} are the same as t_{PDM}.



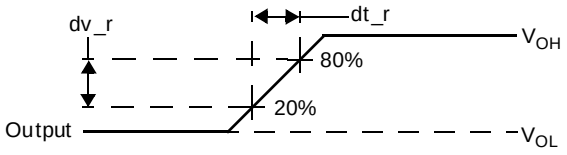
LOAD CIRCUIT – HIGH-TO-LOW SLEW-RATE MEASUREMENT



VOLTAGE WAVEFORMS – HIGH-TO-LOW SLEW-RATE MEASUREMENT



LOAD CIRCUIT – LOW-TO-HIGH SLEW-RATE MEASUREMENT

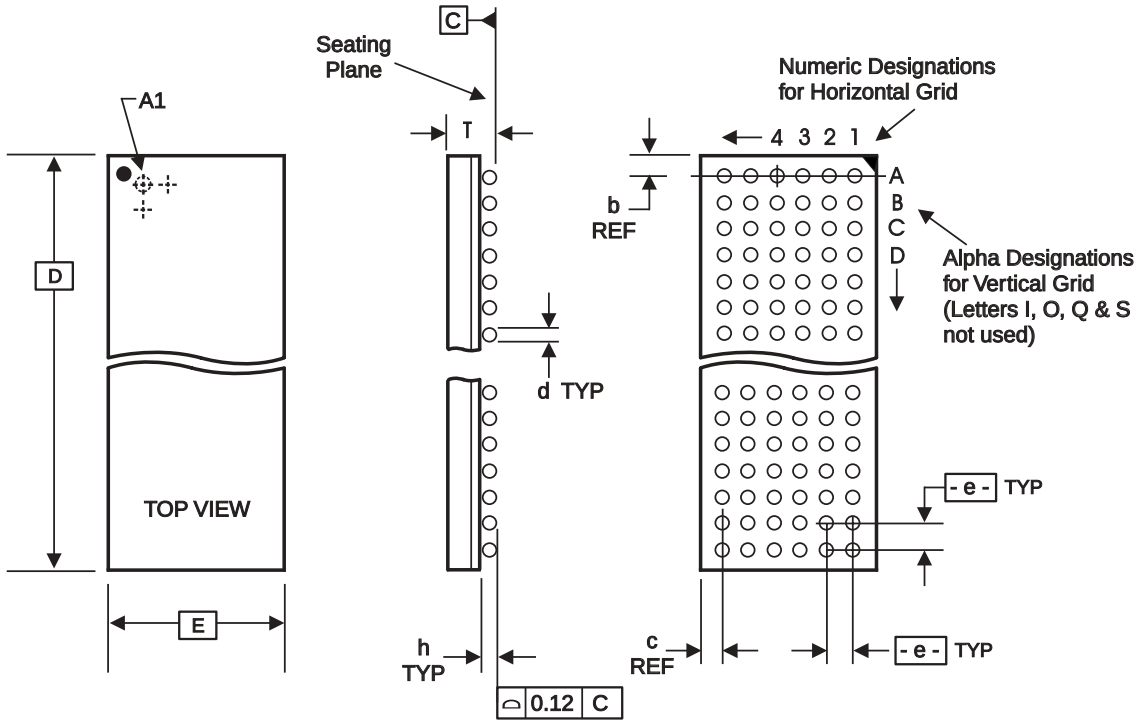


VOLTAGE WAVEFORMS – LOW-TO-HIGH SLEW-RATE MEASUREMENT

Figure 7 — Output Slew-Rate Measurement Information (V_{DD} = 1.8 V ± 0.1 V)

Notes: 1. C_L includes probe and jig capacitance.

2. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10MHz, Z_O = 50Ω, input slew rate = 1 V/ns ±20% (unless otherwise specified).



ALL DIMENSIONS IN MILLIMETERS

D	E	T	e	----- BALL GRID ----- HORIZ	VERT	Max. TOTAL	d	h	REF. DIMENSIONS b	c
		Min/Max					Min/Max	Min/Max		
16.00 Bsc	5.50 Bsc	1.30/1.50	0.80 Bsc	6	19	114	0.40/0.50	0.31/0.41	0.80	0.75
13.50 Bsc	5.50 Bsc	1.30/1.50	0.80 Bsc	6	16	96	0.40/0.50	0.25/0.41	0.75	0.75
7.00 Bsc	4.50 Bsc	0.86/1.00	0.65 Bsc	6	10	60	0.35/0.45	0.15/0.21	0.575	0.625

Note: Ball grid total indicates maximum ball count for package. Lesser quantity may be used.

* Source Ref.: JEDEC Publication 95, MO-205

10-0055C

Ordering Information

ICSSSTU32866yHT

Example:

ICS XXXX y H - T

- **Designation for tape and reel packaging**
- **Package Type**
  H = BGA
- **Revision Designator** (will not correlate with datasheet revision)
- **Device Type**
- **Prefix**
  ICS = Standard Device

0850—08/27/03