

# SSTUG32866

1.8 V 25-bit 1 : 1 or 14-bit 1 : 2 configurable registered buffer with parity for DDR2-1G RDIMM applications

Rev. 01 — 29 June 2007

Product data sheet

## 1. General description

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The SSTUG32866 is a 1.8 V configurable register specifically designed for use on DDR2 memory modules requiring a parity checking function. It is defined in accordance with the JEDEC standard for the SSTUG32866 registered buffer. The register is configurable (using configuration pins C0 and C1) to two topologies: 25-bit 1 : 1 or 14-bit 1 : 2, and in the latter configuration can be designated as Register A or Register B on the DIMM.

The SSTUG32866 accepts a parity bit from the memory controller on its parity bit (PAR\_IN) input, compares it with the data received on the DIMM-independent D-inputs and indicates whether a parity error has occurred on its open-drain  $\overline{QERR}$  pin (active LOW). The convention is even parity, that is, valid parity is defined as an even number of ones across the DIMM-independent data inputs combined with the parity input bit.

The SSTUG32866 is packaged in a 96-ball, 6 × 16 grid, 0.8 mm ball pitch LFBGA package (13.5 mm × 5.5 mm).

## 2. Features

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- Configurable register supporting DDR2 up to 800 MT/s Registered DIMM applications
- Configurable to 25-bit 1 : 1 mode or 14-bit 1 : 2 mode
- Controlled output impedance drivers enable optimal signal integrity and speed
- Meets or exceeds SSTUG32866 JEDEC standard speed performance
- Supports up to 550 MHz clock frequency of operation
- Optimized pinout for high-density DDR2 module design
- Chip-selects minimize power consumption by gating data outputs from changing state
- Supports SSTL\_18 data inputs
- Checks parity on the DIMM-independent data inputs
- Partial parity output and input allows cascading of two SSTUG32866s for correct parity error processing
- Differential clock (CK and  $\overline{CK}$ ) inputs
- Supports LVCMOS switching levels on the control and  $\overline{RESET}$  inputs
- Single 1.8 V supply operation (1.7 V to 2.0 V)
- Available in 96-ball, 13.5 mm × 5.5 mm, 0.8 mm ball pitch LFBGA package

## 3. Applications

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- 400 MT/s to 800 MT/s and higher DDR2 registered DIMMs desiring parity checking functionality

## 4. Ordering information

Table 1. Ordering information

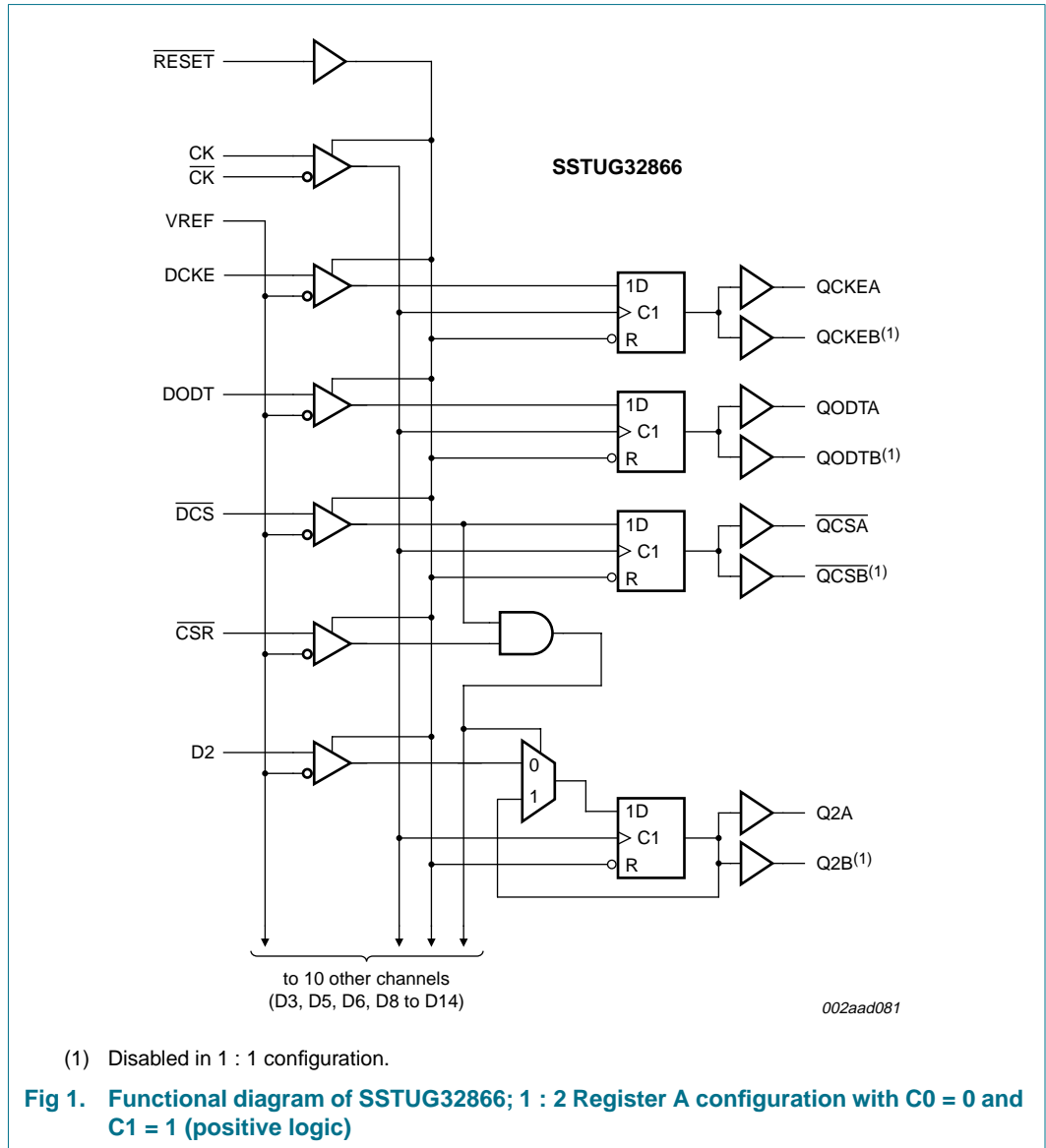
Type number	Solder process	Package		
		Name	Description	Version
SSTUG32866EC/G	Pb-free (SnAgCu solder ball compound)	LFBGA96	plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 × 5.5 × 1.05 mm	SOT536-1
SSTUG32866EC/S	Pb-free (SnAgCu solder ball compound)	LFBGA96	plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 × 5.5 × 1.05 mm	SOT536-1

### 4.1 Ordering options

Table 2. Ordering options

Type number	Temperature range
SSTUG32866EC/G	T <sub>amb</sub> = 0 °C to +70 °C
SSTUG32866EC/S	T <sub>amb</sub> = 0 °C to +85 °C

5. Functional diagram



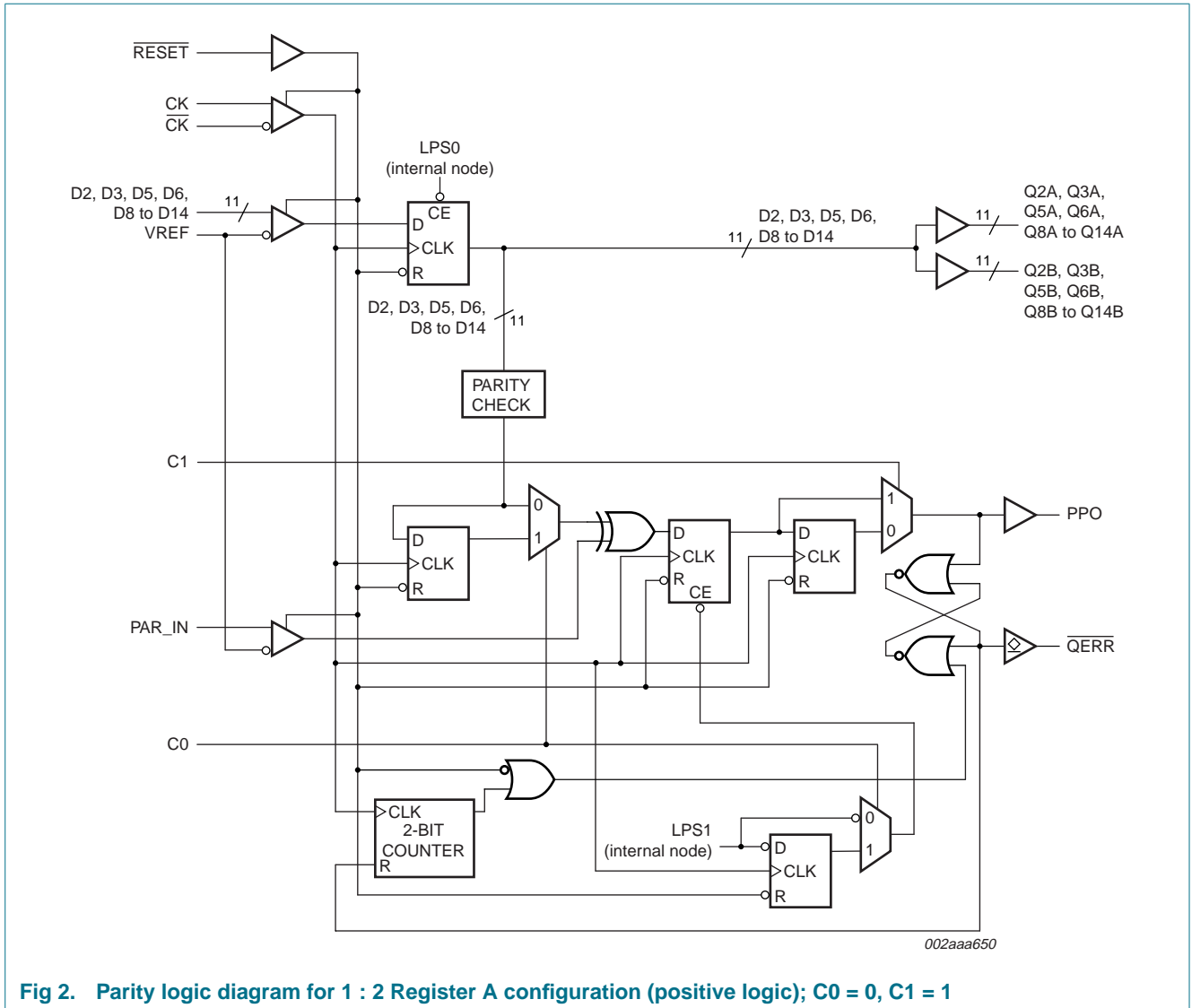
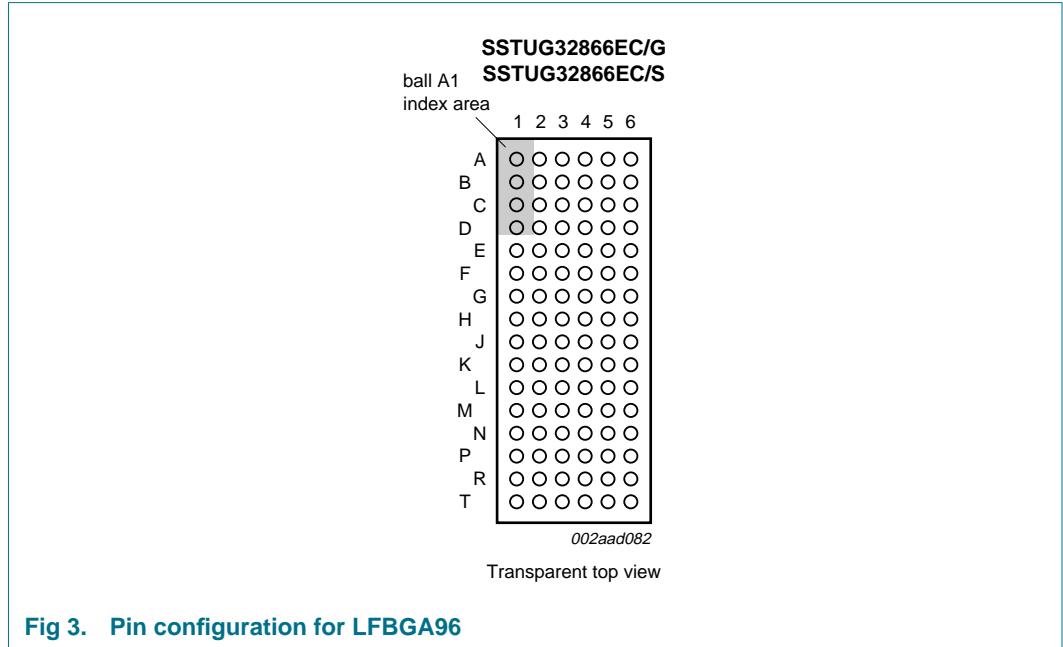


Fig 2. Parity logic diagram for 1 : 2 Register A configuration (positive logic); C0 = 0, C1 = 1

## 6. Pinning information

### 6.1 Pinning



	1	2	3	4	5	6
A	DCKE	PPO	VREF	V <sub>DD</sub>	QCKE	DNU
B	D2	D15	GND	GND	Q2	Q15
C	D3	D16	V <sub>DD</sub>	V <sub>DD</sub>	Q3	Q16
D	DODT	$\overline{QERR}$	GND	GND	QODT	DNU
E	D5	D17	V <sub>DD</sub>	V <sub>DD</sub>	Q5	Q17
F	D6	D18	GND	GND	Q6	Q18
G	PAR_IN	$\overline{RESET}$	V <sub>DD</sub>	V <sub>DD</sub>	C1	C0
H	CK	$\overline{DCS}$	GND	GND	$\overline{QCS}$	DNU
J	$\overline{CK}$	$\overline{CSR}$	V <sub>DD</sub>	V <sub>DD</sub>	n.c.	n.c.
K	D8	D19	GND	GND	Q8	Q19
L	D9	D20	V <sub>DD</sub>	V <sub>DD</sub>	Q9	Q20
M	D10	D21	GND	GND	Q10	Q21
N	D11	D22	V <sub>DD</sub>	V <sub>DD</sub>	Q11	Q22
P	D12	D23	GND	GND	Q12	Q23
R	D13	D24	V <sub>DD</sub>	V <sub>DD</sub>	Q13	Q24
T	D14	D25	VREF	V <sub>DD</sub>	Q14	Q25

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**Fig 4. Ball mapping, 1 : 1 register (C0 = 0, C1 = 0)**

	1	2	3	4	5	6
A	DCKE	PPO	VREF	V <sub>DD</sub>	QCKEA	QCKEB
B	D2	DNU	GND	GND	Q2A	Q2B
C	D3	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q3A	Q3B
D	DODT	$\overline{QERR}$	GND	GND	QODTA	QODTB
E	D5	n.c.	V <sub>DD</sub>	V <sub>DD</sub>	Q5A	Q5B
F	D6	n.c.	GND	GND	Q6A	Q6B
G	PAR_IN	$\overline{RESET}$	V <sub>DD</sub>	V <sub>DD</sub>	C1	C0
H	CK	$\overline{DCS}$	GND	GND	$\overline{QCSA}$	$\overline{QCSB}$
J	$\overline{CK}$	$\overline{CSR}$	V <sub>DD</sub>	V <sub>DD</sub>	n.c.	n.c.
K	D8	DNU	GND	GND	Q8A	Q8B
L	D9	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q9A	Q9B
M	D10	DNU	GND	GND	Q10A	Q10B
N	D11	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q11A	Q11B
P	D12	DNU	GND	GND	Q12A	Q12B
R	D13	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q13A	Q13B
T	D14	DNU	VREF	V <sub>DD</sub>	Q14A	Q14B

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**Fig 5. Ball mapping, 1 : 2 Register A (C0 = 0, C1 = 1)**

	1	2	3	4	5	6
A	D1	PPO	VREF	V <sub>DD</sub>	Q1A	Q1B
B	D2	DNU	GND	GND	Q2A	Q2B
C	D3	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q3A	Q3B
D	D4	$\overline{QERR}$	GND	GND	Q4A	Q4B
E	D5	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q5A	Q5B
F	D6	DNU	GND	GND	Q6A	Q6B
G	PAR_IN	$\overline{RESET}$	V <sub>DD</sub>	V <sub>DD</sub>	C1	C0
H	CK	$\overline{DCS}$	GND	GND	$\overline{QCSA}$	$\overline{QCSB}$
J	$\overline{CK}$	$\overline{CSR}$	V <sub>DD</sub>	V <sub>DD</sub>	n.c.	n.c.
K	D8	DNU	GND	GND	Q8A	Q8B
L	D9	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q9A	Q9B
M	D10	DNU	GND	GND	Q10A	Q10B
N	DODT	DNU	V <sub>DD</sub>	V <sub>DD</sub>	QODTA	QODTB
P	D12	DNU	GND	GND	Q12A	Q12B
R	D13	DNU	V <sub>DD</sub>	V <sub>DD</sub>	Q13A	Q13B
T	DCKE	DNU	VREF	V <sub>DD</sub>	QCKEA	QCKEB

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**Fig 6. Ball mapping, 1 : 2 Register B (C0 = 1, C1 = 1)**

## 6.2 Pin description

**Table 3. Pin description**

Symbol	Pin	Type	Description
GND	B3, B4, D3, D4, F3, F4, H3, H4, K3, K4, M3, M4, P3, P4	ground input	ground
V <sub>DD</sub>	A4, C3, C4, E3, E4, G3, G4, J3, J4, L3, L4, N3, N4, R3, R4, T4	1.8 V nominal	power supply voltage
VREF	A3, T3	0.9 V nominal	input reference voltage
CK	H1	differential input	positive master clock input
$\overline{\text{CK}}$	J1	differential input	negative master clock input
C0	G6	LVC MOS inputs	Configuration control inputs; Register A or Register B and 1 : 1 mode or 1 : 2 mode select.
C1	G5		
$\overline{\text{RESET}}$	G2	LVC MOS input	Asynchronous reset input (active LOW). Resets registers and disables VREF data and clock.
$\overline{\text{CSR}}$	J2	SSTL_18 input	Chip select inputs (active LOW). Disables D1 to D25 <sup>[1]</sup> outputs switching when both inputs are HIGH.
$\overline{\text{DCS}}$	H2		
D1 to D25	<sup>[2]</sup>	SSTL_18 input	Data input. Clocked in on the crossing of the rising edge of CK and the falling edge of $\overline{\text{CK}}$ .
DODT	<sup>[2]</sup>	SSTL_18 input	The outputs of this register bit will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control.
DCKE	<sup>[2]</sup>	SSTL_18 input	The outputs of this register bit will not be suspended by the DCS and CSR control.
PAR_IN	G1	SSTL_18 input	Parity input. Arrives one clock cycle after the corresponding data input.
Q1 to Q25, Q1A to Q14A, Q1B to Q14B	<sup>[2]</sup>	1.8 V CMOS outputs	Data outputs that are suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control. <sup>[3]</sup>
PPO	A2	1.8 V CMOS output	Partial parity out. Indicates odd parity of inputs D1 to D25. <sup>[1]</sup>
$\overline{\text{QCS}}$ , $\overline{\text{QCSA}}$ , $\overline{\text{QCSB}}$	<sup>[2]</sup>	1.8 V CMOS output	Data output that will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control.
QODT, QODTA, QODTB	<sup>[2]</sup>	1.8 V CMOS output	Data output that will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control.
QCKE, QCKEA, QCKEB	<sup>[2]</sup>	1.8 V CMOS output	Data output that will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control.
$\overline{\text{QERR}}$	D2	open-drain output	Output error bit (active LOW). Generated one clock cycle after the corresponding data output.
n.c.	<sup>[2]</sup>	-	Not connected. Ball present but no internal connection to the die.
DNU	<sup>[2]</sup>	-	Do not use. Inputs are in standby-equivalent mode and outputs are driven LOW.

[1] Data inputs = D2, D3, D5, D6, D8 to D25 when C0 = 0 and C1 = 0.  
 Data inputs = D2, D3, D5, D6, D8 to D14 when C0 = 0 and C1 = 1.  
 Data inputs = D1 to D6, D8 to D10, D12, D13 when C0 = 1 and C1 = 1.

[2] Depends on configuration. See [Figure 4](#), [Figure 5](#), and [Figure 6](#) for ball number.

- [3] Data outputs = Q2, Q3, Q5, Q6, Q8 to Q25 when C0 = 0 and C1 = 0.  
 Data outputs = Q2, Q3, Q5, Q6, Q8 to Q14 when C0 = 0 and C1 = 1.  
 Data outputs = Q1 to Q6, Q8 to Q10, Q12, Q13 when C0 = 1 and C1 = 1.

## 7. Functional description

The SSTUG32866 is a 25-bit 1 : 1 or 14-bit 1 : 2 configurable registered buffer with parity, designed for 1.7 V to 2.0 V  $V_{DD}$  operation.

All clock and data inputs are compatible with the JEDEC standard for SSTL\_18. The control and reset ( $\overline{RESET}$ ) inputs are LVCMOS. All data outputs are 1.8 V CMOS drivers that have been optimized to drive the DDR2 DIMM load, and meet SSTL\_18 specifications. The error ( $\overline{QERR}$ ) output is 1.8 V open-drain driver.

The SSTUG32866 operates from a differential clock (CK and  $\overline{CK}$ ). Data are registered at the crossing of CK going HIGH, and  $\overline{CK}$  going LOW.

The C0 input controls the pinout configuration for 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).

The SSTUG32866 accepts a parity bit from the memory controller on its parity bit (PAR\_IN) input, compares it with the data received on the DIMM-independent D-inputs and indicates whether a parity error has occurred on its open-drain  $\overline{QERR}$  pin (active LOW). The convention is even parity, that is, valid parity is defined as an even number of ones across the DIMM-independent data inputs combined with the parity input bit.

When used as a single device, the C0 and C1 inputs are tied LOW. In this configuration, parity is checked on the PAR\_IN input which arrives one cycle after the input data to which it applies. The Partial-Parity-Out (PPO) and  $\overline{QERR}$  signals are produced three cycles after the corresponding data inputs.

When used in pairs, the C0 input of the first register is tied LOW and the C0 input of the second register is tied HIGH. The C1 input of both registers are tied HIGH. Parity, which arrives one cycle after the data input to which it applies, is checked on the PAR\_IN input of the first device. The PPO and  $\overline{QERR}$  signals are produced on the second device three clock cycles after the corresponding data inputs. The PPO output of the first register is cascaded to the PAR\_IN of the second register. The  $\overline{QERR}$  output of the first register is left floating and the valid error information is latched on the  $\overline{QERR}$  output of the second register.

If an error occurs and the  $\overline{QERR}$  output is driven LOW, it stays latched LOW for two clock cycles or until  $\overline{RESET}$  is driven LOW. The DIMM-dependent signals (DCKE,  $\overline{DCS}$ , DODT, and  $\overline{CSR}$ ) are not included in the parity check computation.

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



The device also supports low-power active operation by monitoring both system chip select ( $\overline{DCS}$  and  $\overline{CSR}$ ) inputs and will gate the Qn and PPO outputs from changing states when both  $\overline{DCS}$  and  $\overline{CSR}$  inputs are HIGH. If either  $\overline{DCS}$  or  $\overline{CSR}$  input is LOW, the Qn and PPO outputs will function normally. The  $\overline{RESET}$  input has priority over the  $\overline{DCS}$  and  $\overline{CSR}$  control and when driven LOW will force the Qn and PPO outputs LOW, and the  $\overline{QERR}$  output HIGH. If the  $\overline{DCS}$  control functionality is not desired, then the  $\overline{CSR}$  input can be hard-wired to ground, in which case, the setup time requirement for  $\overline{DCS}$  would be the same as for the other Dn data inputs. To control the low-power mode with  $\overline{DCS}$  only, then the  $\overline{CSR}$  input should be pulled up to  $V_{DD}$  through a pull-up resistor.

To ensure defined outputs from the register before a stable clock has been supplied,  $\overline{RESET}$  must be held in the LOW state during power-up.

In the DDR2 RDIMM application,  $\overline{RESET}$  is specified to be completely asynchronous with respect to CK and  $\overline{CK}$ . Therefore, no timing relationship can be guaranteed between the two. When entering reset, the register will be cleared and the Qn 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  $\overline{RESET}$  until the input receivers are fully enabled, the design of the SSTUG32866 must ensure that the outputs will remain LOW, thus ensuring no glitches on the output.

### 7.1 Function table

**Table 4. Function table (each flip-flop)**

L = LOW voltage level; H = HIGH voltage level; X = don't care;  $\uparrow$  = LOW-to-HIGH transition;  $\downarrow$  = HIGH-to-LOW transition.

Inputs						Outputs <sup>[1]</sup>		
RESET	DCS	CSR	CK	$\overline{CK}$	Dn, DODTn, DCKEn	Qn	$\overline{QCS}$	QODT, QCKE
H	L	L	$\uparrow$	$\downarrow$	L	L	L	L
H	L	L	$\uparrow$	$\downarrow$	H	H	L	H
H	L	L	L or H	L or H	X	Q <sub>0</sub>	Q <sub>0</sub>	Q <sub>0</sub>
H	L	H	$\uparrow$	$\downarrow$	L	L	L	L
H	L	H	$\uparrow$	$\downarrow$	H	H	L	H
H	L	H	L or H	L or H	X	Q <sub>0</sub>	Q <sub>0</sub>	Q <sub>0</sub>
H	H	L	$\uparrow$	$\downarrow$	L	L	H	L
H	H	L	$\uparrow$	$\downarrow$	H	H	H	H
H	H	L	L or H	L or H	X	Q <sub>0</sub>	Q <sub>0</sub>	Q <sub>0</sub>
H	H	H	$\uparrow$	$\downarrow$	L	Q <sub>0</sub>	H	L
H	H	H	$\uparrow$	$\downarrow$	H	Q <sub>0</sub>	H	H
H	H	H	L or H	L or H	X	Q <sub>0</sub>	Q <sub>0</sub>	Q <sub>0</sub>
L	X or floating	X or floating	X or floating	X or floating	X or floating	L	L	L

[1] Q<sub>0</sub> is the previous state of the associated output.

**Table 5. Parity and standby function table**

L = LOW voltage level; H = HIGH voltage level; X = don't care; ↑ = LOW-to-HIGH transition; ↓ = HIGH-to-LOW transition.

Inputs							Outputs <sup>[1]</sup>	
RESET	DCS	CSR	CK	CK	Σ of inputs = H (D1 to D25)	PAR_IN <sup>[2]</sup>	PPO <sup>[3]</sup>	QERR <sup>[4]</sup>
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	L	H	L
H	H	L	↑	↓	even	H	H	L
H	H	L	↑	↓	odd	H	L	H
H	H	H	↑	↓	X	X	PPO <sub>0</sub>	QERR <sub>0</sub>
H	X	X	L or H	L or H	X	X	PPO <sub>0</sub>	QERR <sub>0</sub>
L	X or floating	X or floating	X or floating	X or floating	X or floating	X or floating	L	H

- [1] PPO<sub>0</sub> is the previous state of output PPO; QERR<sub>0</sub> is the previous state of output QERR.
- [2] Data inputs = D2, D3, D5, D6, D8 to D25 when C0 = 0 and C1 = 0.  
Data inputs = D2, D3, D5, D6, D8 to D14 when C0 = 0 and C1 = 1.  
Data inputs = D1 to D6, D8 to D10, D12, D13 when C0 = 1 and C1 = 1.
- [3] PAR\_IN arrives one clock cycle (C0 = 0), or two clock cycles (C0 = 1), after the data to which it applies.
- [4] This condition assumes QERR is HIGH at the crossing of CK going HIGH and CK going LOW. If QERR is LOW, it stays latched LOW for two clock cycles or until RESET is driven LOW.

## 8. Limiting values

**Table 6. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD</sub>	supply voltage		-0.5	+2.5	V
V <sub>I</sub>	input voltage	receiver	-0.5 <sup>[1]</sup>	+2.5 <sup>[2]</sup>	V
V <sub>O</sub>	output voltage	driver	-0.5 <sup>[1]</sup>	V <sub>DD</sub> + 0.5 <sup>[2]</sup>	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < 0 V or V <sub>I</sub> > V <sub>DD</sub>	-	-50	mA
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < 0 V or V <sub>O</sub> > V <sub>DD</sub>	-	±50	mA
I <sub>O</sub>	output current	continuous; 0 V < V <sub>O</sub> < V <sub>DD</sub>	-	±50	mA
I <sub>BDC</sub>	continuous current through each V <sub>DD</sub> or GND pin		-	±100	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
V <sub>esd</sub>	electrostatic discharge voltage	Human Body Model (HBM); 1.5 kΩ; 100 pF	2	-	kV
		Machine Model (MM); 0 Ω; 200 pF	200	-	V

- [1] The input and output negative voltage ratings may be exceeded if the input and output clamping current ratings are observed.
- [2] This value is limited to 2.5 V maximum.

## 9. Recommended operating conditions

**Table 7. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DD}$	supply voltage		1.7	-	2.0	V
$V_{ref}$	reference voltage		$0.49 \times V_{DD}$	$0.50 \times V_{DD}$	$0.51 \times V_{DD}$	V
$V_T$	termination voltage		$V_{ref} - 0.040$	$V_{ref}$	$V_{ref} + 0.040$	V
$V_I$	input voltage		0	-	$V_{DD}$	V
$V_{IH(AC)}$	AC HIGH-level input voltage	data (Dn), $\overline{CSR}$ , and PAR_IN inputs	$V_{ref} + 0.250$	-	-	V
$V_{IL(AC)}$	AC LOW-level input voltage	data (Dn), $\overline{CSR}$ , and PAR_IN inputs	-	-	$V_{ref} - 0.250$	V
$V_{IH(DC)}$	DC HIGH-level input voltage	data (Dn), $\overline{CSR}$ , and PAR_IN inputs	$V_{ref} + 0.125$	-	-	V
$V_{IL(DC)}$	DC LOW-level input voltage	data (Dn), $\overline{CSR}$ , and PAR_IN inputs	-	-	$V_{ref} - 0.125$	V
$V_{IH}$	HIGH-level input voltage	$\overline{RESET}$ , Cn	[1] $0.65 \times V_{DD}$	-	-	V
$V_{IL}$	LOW-level input voltage	$\overline{RESET}$ , Cn	[1] -	-	$0.35 \times V_{DD}$	V
$V_{ICR}$	common mode input voltage range	CK, $\overline{CK}$	[2] 0.675	-	1.125	V
$V_{ID}$	differential input voltage	CK, $\overline{CK}$	[2] 600	-	-	mV
$I_{OH}$	HIGH-level output current		-	-	-8	mA
$I_{OL}$	LOW-level output current		-	-	8	mA
$T_{amb}$	ambient temperature	operating in free air				
		SSTUG32866EC/G	0	-	70	°C
		SSTUG32866EC/S	0	-	85	°C

[1] The  $\overline{RESET}$  and Cn inputs of the device must be held at valid levels (not floating) to ensure proper device operation.

[2] The differential inputs must not be floating, unless  $\overline{RESET}$  is LOW.

## 10. Characteristics

**Table 8. Characteristics**

At recommended operating conditions (see [Table 7](#)); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{OH}$	HIGH-level output voltage	$I_{OH} = -6 \text{ mA}$ ; $V_{DD} = 1.7 \text{ V}$	1.2	-	-	V
$V_{OL}$	LOW-level output voltage	$I_{OL} = 6 \text{ mA}$ ; $V_{DD} = 1.7 \text{ V}$	-	-	0.5	V
$I_I$	input current	all inputs; $V_I = V_{DD}$ or GND; $V_{DD} = 2.0 \text{ V}$	-	-	$\pm 5$	$\mu\text{A}$
$I_{DD}$	supply current	static Standby mode; $\overline{\text{RESET}} = \text{GND}$ ; $I_O = 0 \text{ mA}$ ; $V_{DD} = 2.0 \text{ V}$	-	-	2	mA
		static Operating mode; $\overline{\text{RESET}} = V_{DD}$ ; $I_O = 0 \text{ mA}$ ; $V_{DD} = 2.0 \text{ V}$ ; $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$	-	-	40	mA
$I_{DD}$	dynamic operating current per MHz	clock only; $\overline{\text{RESET}} = V_{DD}$ ; $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$ ; CK and $\overline{\text{CK}}$ switching at 50 % duty cycle; $I_O = 0 \text{ mA}$ ; $V_{DD} = 1.8 \text{ V}$	-	16	-	$\mu\text{A}$
		per each data input, 1 : 1 mode; $\overline{\text{RESET}} = V_{DD}$ ; $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$ ; CK and $\overline{\text{CK}}$ switching at 50 % duty cycle; one data input switching at half clock frequency, 50 % duty cycle; $I_O = 0 \text{ mA}$ ; $V_{DD} = 1.8 \text{ V}$	-	11	-	$\mu\text{A}$
		per each data input, 1 : 2 mode; $\overline{\text{RESET}} = V_{DD}$ ; $V_I = V_{IH(AC)}$ or $V_{IL(AC)}$ ; CK and $\overline{\text{CK}}$ switching at 50 % duty cycle; one data input switching at half clock frequency, 50 % duty cycle; $I_O = 0 \text{ mA}$ ; $V_{DD} = 1.8 \text{ V}$	-	19	-	$\mu\text{A}$
$C_i$	input capacitance	data and $\overline{\text{CSR}}$ inputs; $V_I = V_{ref} \pm 250 \text{ mV}$ ; $V_{DD} = 1.8 \text{ V}$	2.5	-	3.5	pF
		CK and $\overline{\text{CK}}$ inputs; $V_{ICR} = 0.9 \text{ V}$ ; $V_{i(p-p)} = 600 \text{ mV}$ ; $V_{DD} = 1.8 \text{ V}$	2	-	3	pF
		$\overline{\text{RESET}}$ input; $V_I = V_{DD}$ or GND; $V_{DD} = 1.8 \text{ V}$	3	-	4	pF
$Z_o$	output impedance	instantaneous	[1]	15	-	$\Omega$
		steady-state	-	53	-	$\Omega$

[1] Instantaneous is defined as within < 2 ns following the output data transition edge.

**Table 9. Timing requirements**

At recommended operating conditions (see [Table 7](#)), unless otherwise specified. See [Section 11.1](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f <sub>clock</sub>	clock frequency		-	-	550	MHz
t <sub>W</sub>	pulse width	CK, $\overline{CK}$ HIGH or LOW	1	-	-	ns
t <sub>ACT</sub>	differential inputs active time		[1][2]	-	10	ns
t <sub>INACT</sub>	differential inputs inactive time		[1][3]	-	15	ns
t <sub>su</sub>	setup time	$\overline{DCS}$ before CK $\uparrow$ , $\overline{CK}$ $\downarrow$ , $\overline{CSR}$ HIGH; $\overline{CSR}$ before CK $\uparrow$ , $\overline{CK}$ $\downarrow$ , $\overline{DCS}$ HIGH	0.6	-	-	ns
		$\overline{DCS}$ before CK $\uparrow$ , $\overline{CK}$ $\downarrow$ , $\overline{CSR}$ LOW	0.5	-	-	ns
		DODT, DCKE and data (Dn) before CK $\uparrow$ , CK $\downarrow$	0.5	-	-	ns
		PAR_IN before CK $\uparrow$ , $\overline{CK}$ $\downarrow$	0.5	-	-	ns
t <sub>h</sub>	hold time	$\overline{DCS}$ , DODT, DCKE and data (Dn) after CK $\uparrow$ , $\overline{CK}$ $\downarrow$	0.4	-	-	ns
		PAR_IN after CK $\uparrow$ , $\overline{CK}$ $\downarrow$	0.4	-	-	ns

[1] This parameter is not necessarily production tested.

[2] VREF must be held at a valid input voltage level and data inputs must be held LOW for a minimum time of t<sub>ACT(max)</sub> after  $\overline{RESET}$  is taken HIGH.

[3] VREF, data and clock inputs must be held at valid levels (not floating) a minimum time of t<sub>INACT(max)</sub> after  $\overline{RESET}$  is taken LOW.

**Table 10. Switching characteristics**

At recommended operating conditions (see [Table 7](#)), unless otherwise specified. See [Section 11.1](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
f <sub>max</sub>	maximum input clock frequency		550	-	-	MHz	
t <sub>PDM</sub>	peak propagation delay	single bit switching; from CK $\uparrow$ and $\overline{CK}$ $\downarrow$ to Qn	[1]	1.0	-	1.4	ns
t <sub>PD</sub>	propagation delay	from CK $\uparrow$ and $\overline{CK}$ $\downarrow$ to PPO	0.5	-	1.7	ns	
t <sub>LH</sub>	LOW-to-HIGH delay	from CK $\uparrow$ and $\overline{CK}$ $\downarrow$ to $\overline{QERR}$	1.2	-	3	ns	
t <sub>HL</sub>	HIGH-to-LOW delay	from CK $\uparrow$ and $\overline{CK}$ $\downarrow$ to $\overline{QERR}$	1	-	2.4	ns	
t <sub>PDMS</sub>	simultaneous switching peak propagation delay	from CK $\uparrow$ and $\overline{CK}$ $\downarrow$ to Qn	[1][2]	-	-	1.5	ns
t <sub>PHL</sub>	HIGH-to-LOW propagation delay	from $\overline{RESET}$ $\downarrow$ to Qn $\downarrow$	-	-	3	ns	
		from $\overline{RESET}$ $\downarrow$ to PPO $\downarrow$	-	-	3	ns	
t <sub>PLH</sub>	LOW-to-HIGH propagation delay	from $\overline{RESET}$ $\downarrow$ to $\overline{QERR}$ $\uparrow$	-	-	3	ns	

[1] Includes 350 ps of test load transmission line delay.

[2] This parameter is not necessarily production tested.

**Table 11. Data output edge rates**

At recommended operating conditions (see [Table 7](#)), unless otherwise specified. See [Section 11.2](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
dV/dt <sub>r</sub>	rising edge slew rate	from 20 % to 80 %	1	-	4	V/ns
dV/dt <sub>f</sub>	falling edge slew rate	from 80 % to 20 %	1	-	4	V/ns
dV/dt <sub>Δ</sub>	absolute difference between dV/dt <sub>r</sub> and dV/dt <sub>f</sub>	from 20 % or 80 % to 80 % or 20 %	-	-	1	V/ns

10.1 Timing diagrams

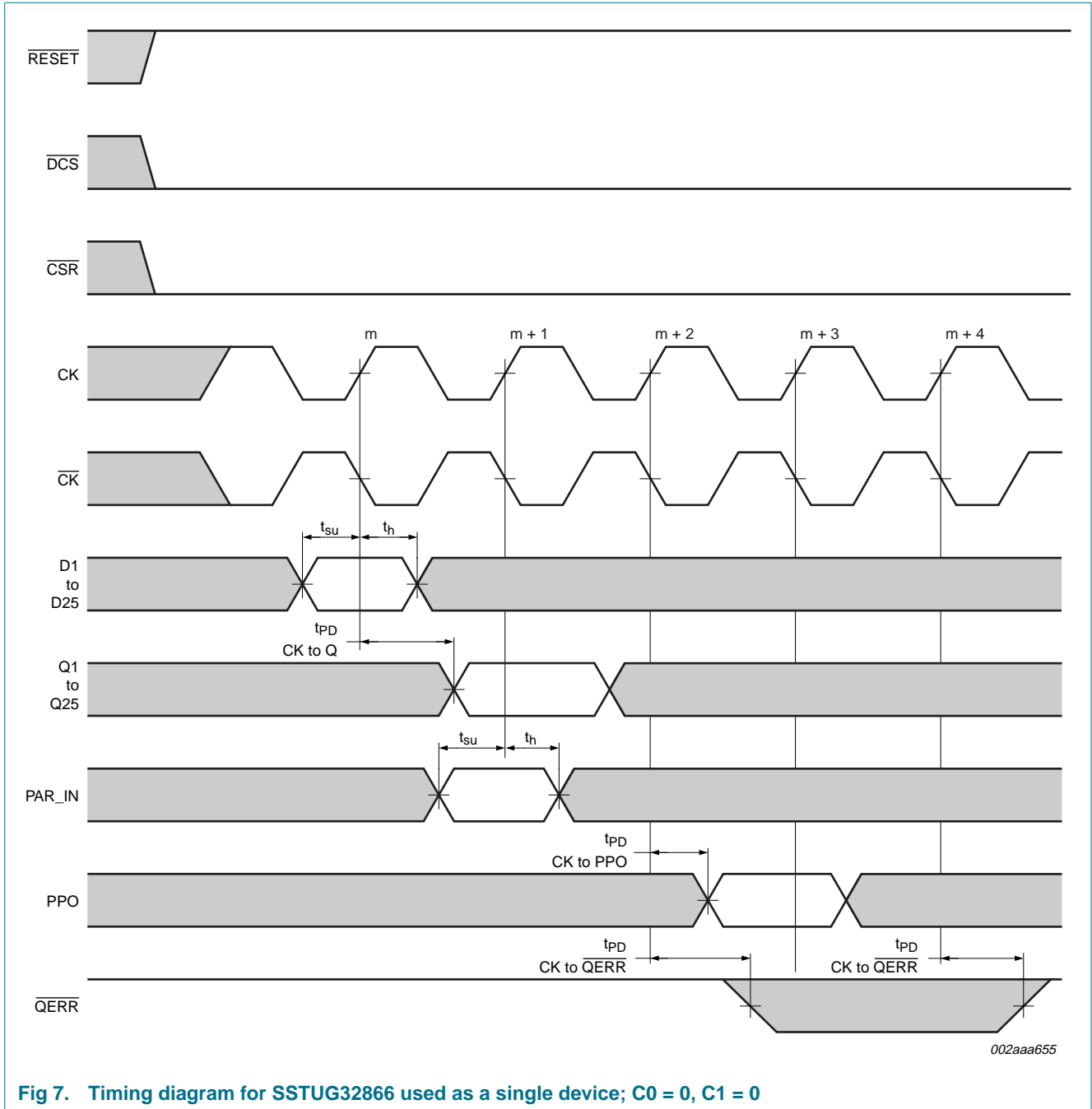
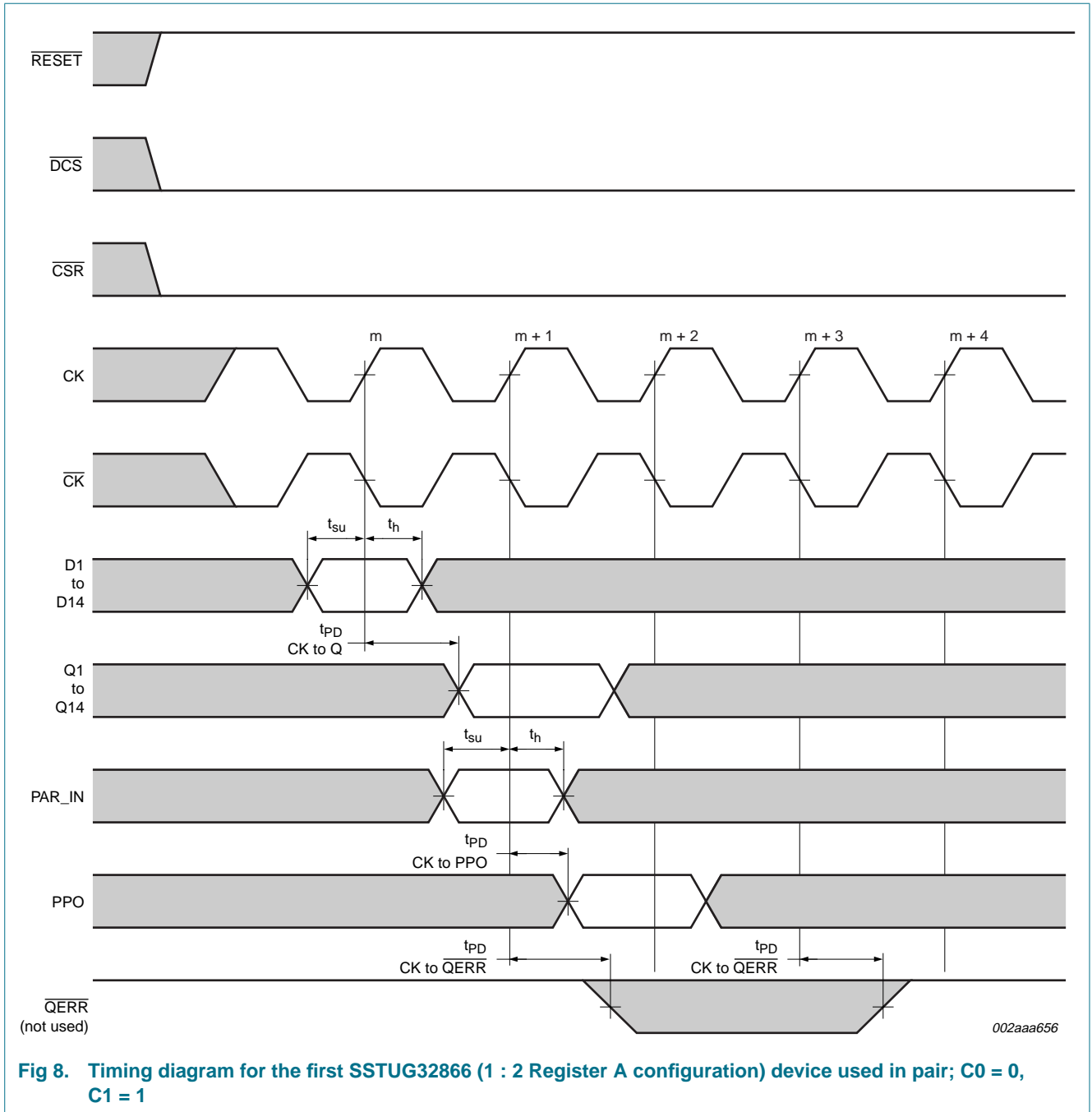
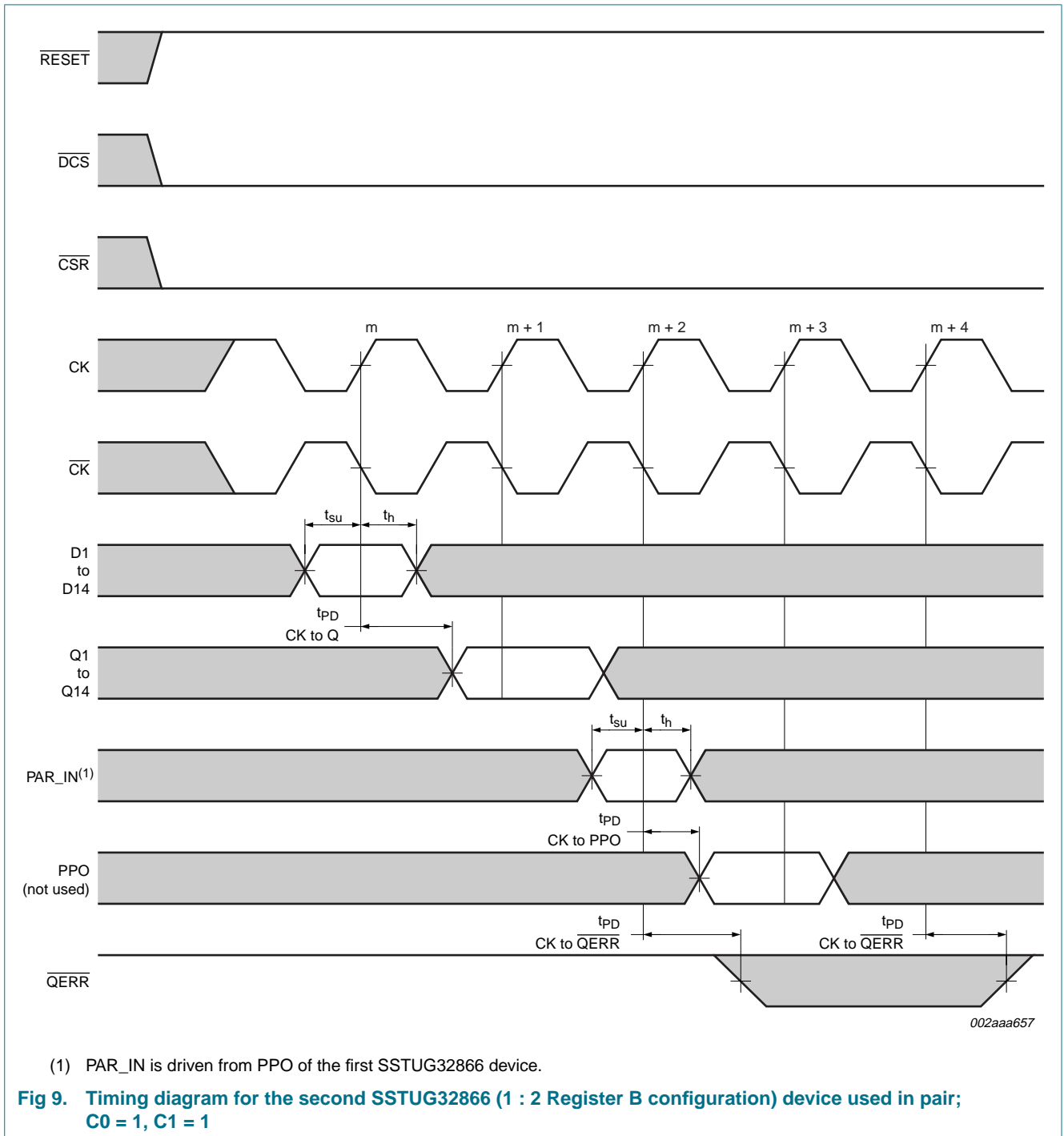


Fig 7. Timing diagram for SSTUG32866 used as a single device; C0 = 0, C1 = 0







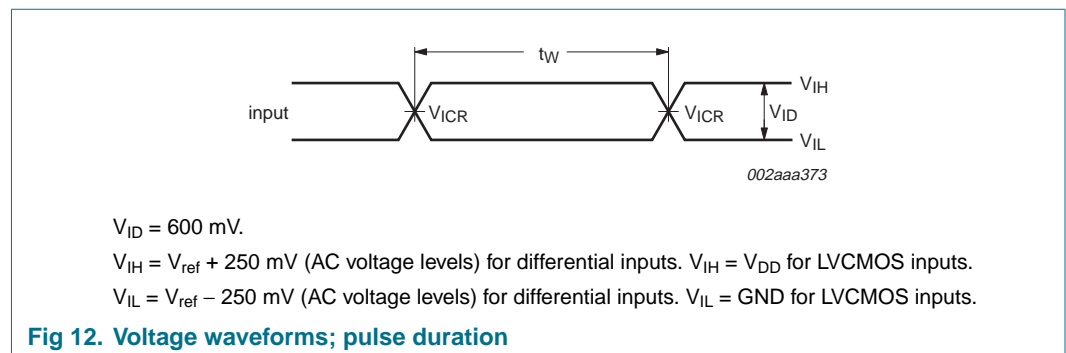
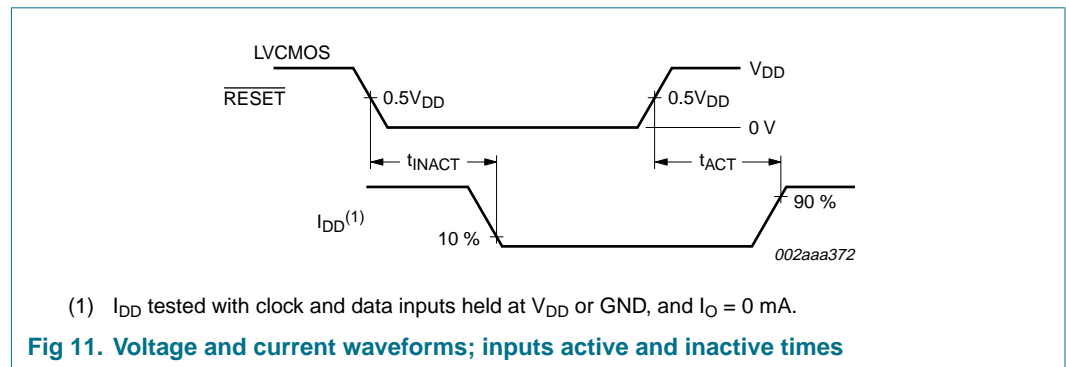
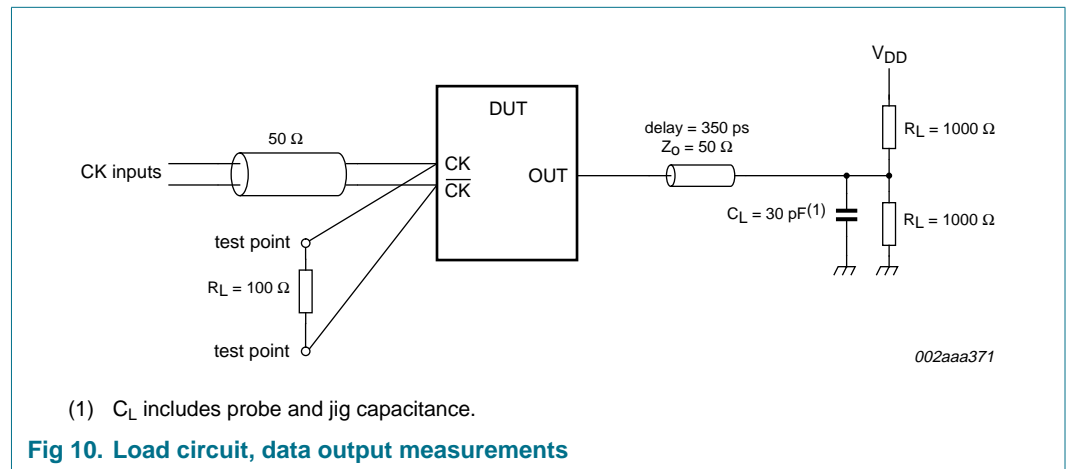
## 11. Test information

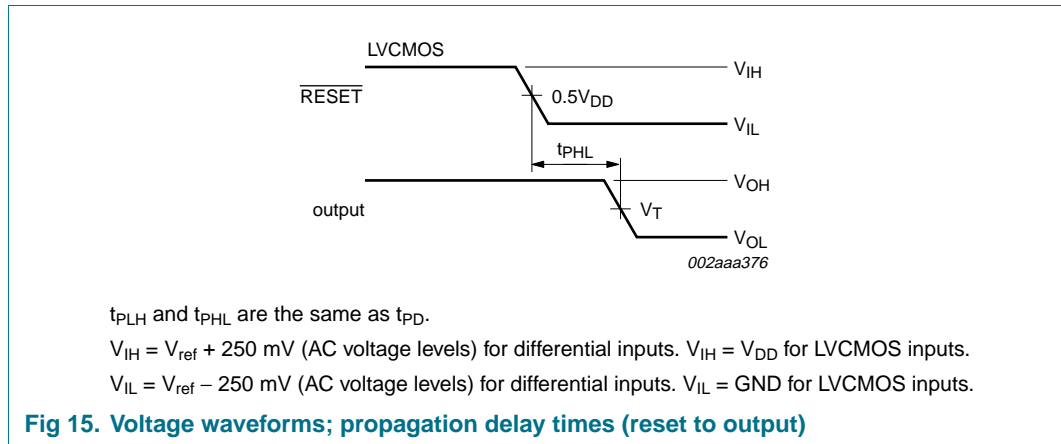
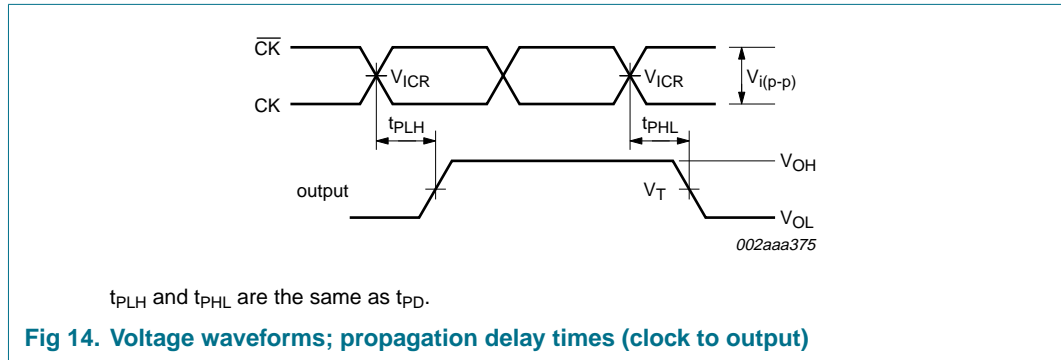
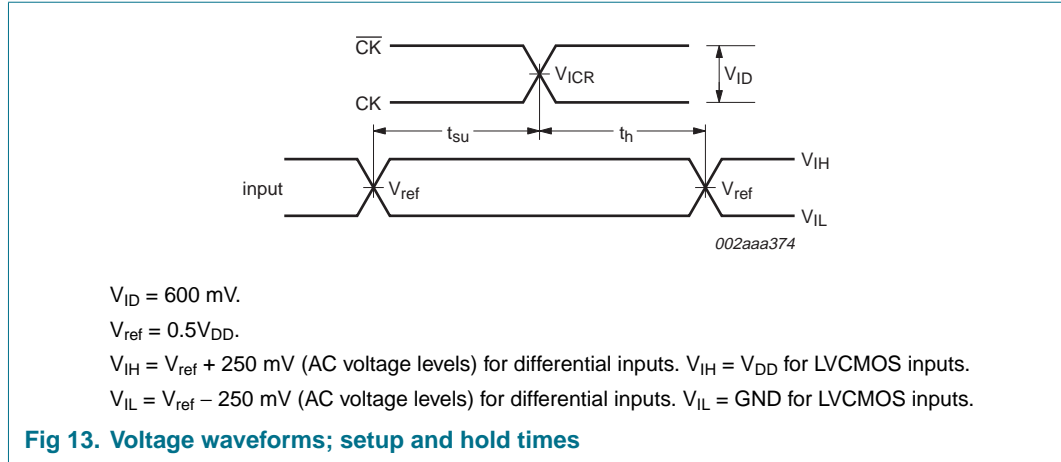
### 11.1 Parameter measurement information for data output load circuit

$V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$ .

All input pulses are supplied by generators having the following characteristics:  
 PRR  $\leq 10 \text{ MHz}$ ;  $Z_o = 50 \Omega$ ; input slew rate =  $1 \text{ V/ns} \pm 20 \%$ , unless otherwise specified.

The outputs are measured one at a time with one transition per measurement.

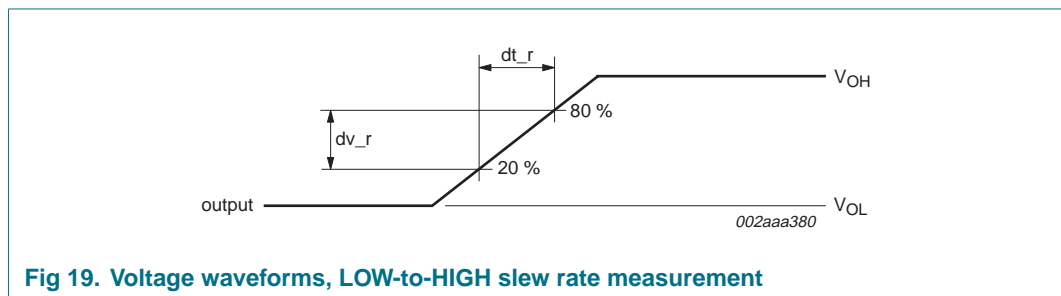
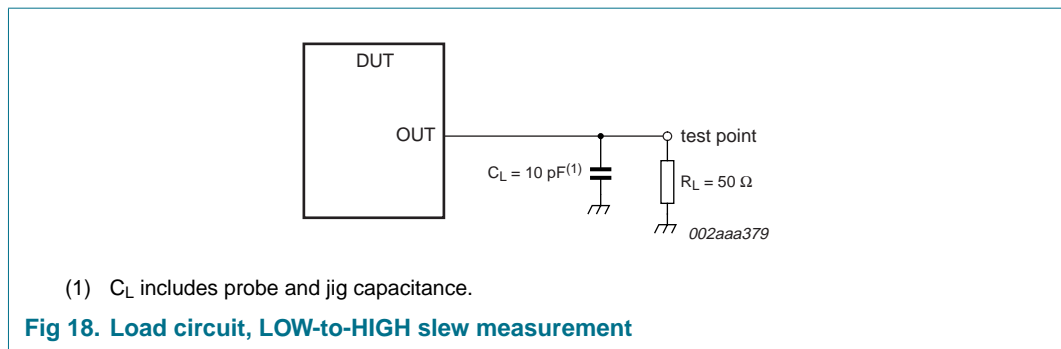
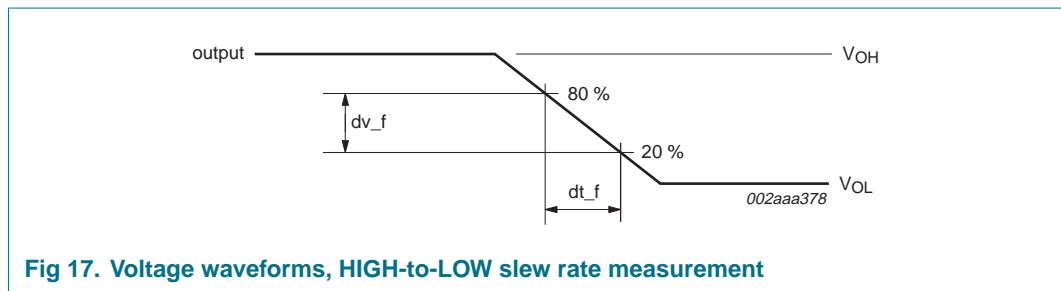
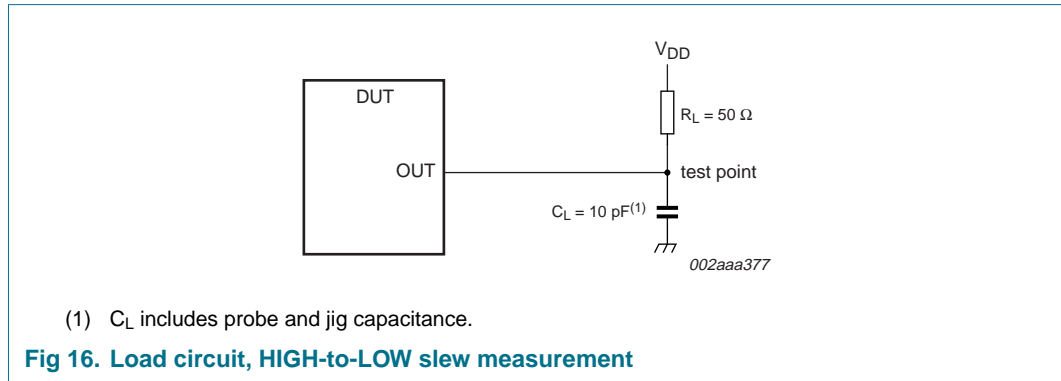




11.2 Data output slew rate measurement information

$V_{DD} = 1.8 V \pm 0.1 V$ .

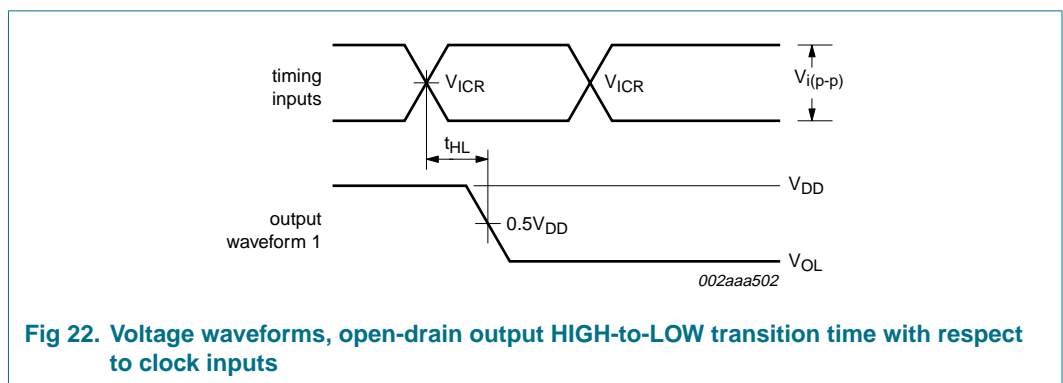
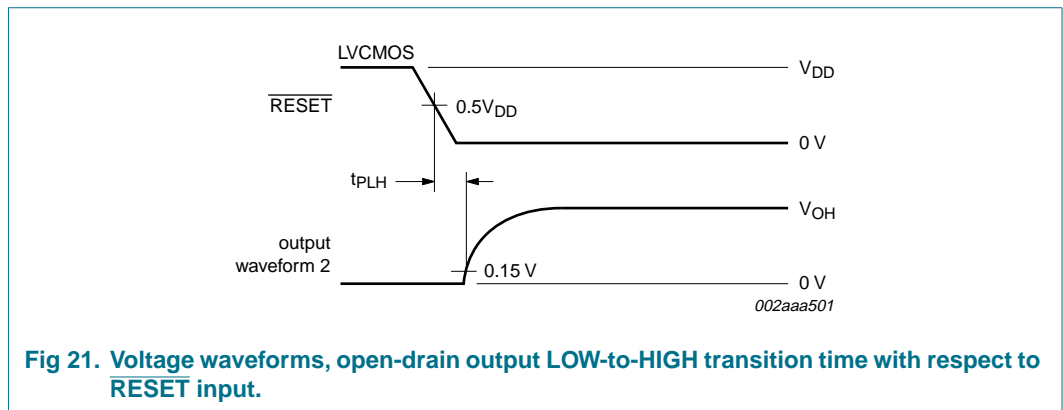
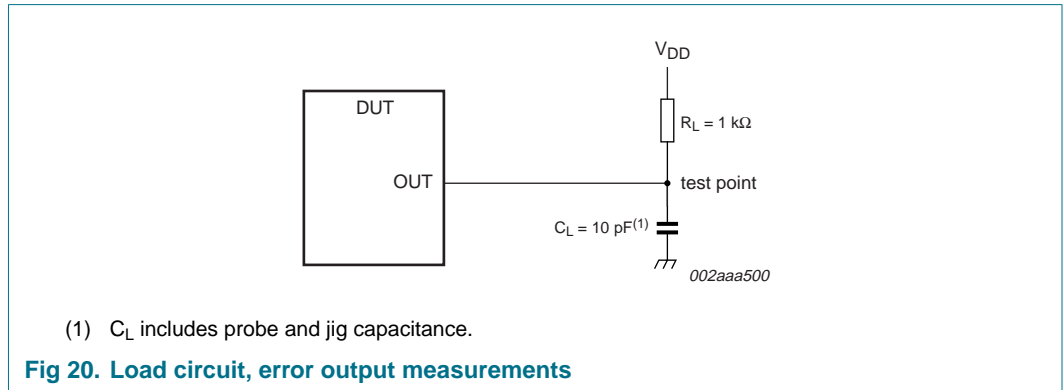
All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ;  $Z_o = 50 \Omega$ ; input slew rate =  $1 \text{ V/ns} \pm 20 \%$ , unless otherwise specified.



### 11.3 Error output load circuit and voltage measurement information

$V_{DD} = 1.8\text{ V} \pm 0.1\text{ V}$ .

All input pulses are supplied by generators having the following characteristics:  
 PRR  $\leq 10\text{ MHz}$ ;  $Z_o = 50\ \Omega$ ; input slew rate =  $1\text{ V/ns} \pm 20\%$ , unless otherwise specified.



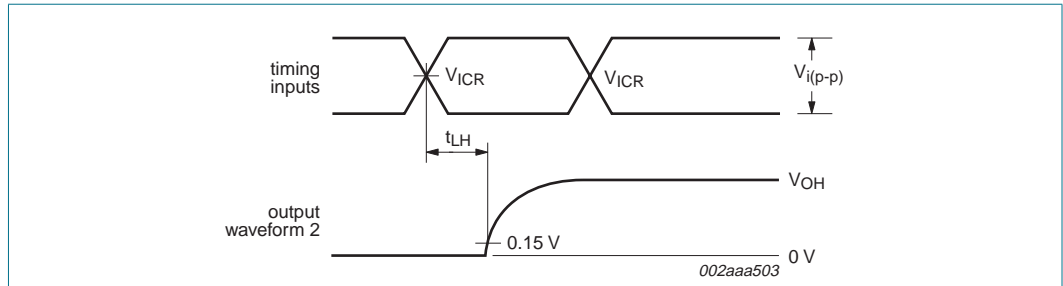


Fig 23. Voltage waveforms, open-drain output LOW-to-HIGH transition time with respect to clock inputs

### 11.4 Partial parity out load circuit and voltage measurement information

$V_{DD} = 1.8 \text{ V} \pm 0.1 \text{ V}$ .

All input pulses are supplied by generators having the following characteristics:  
 PRR  $\leq 10 \text{ MHz}$ ;  $Z_o = 50 \Omega$ ; input slew rate =  $1 \text{ V/ns} \pm 20 \%$ , unless otherwise specified.

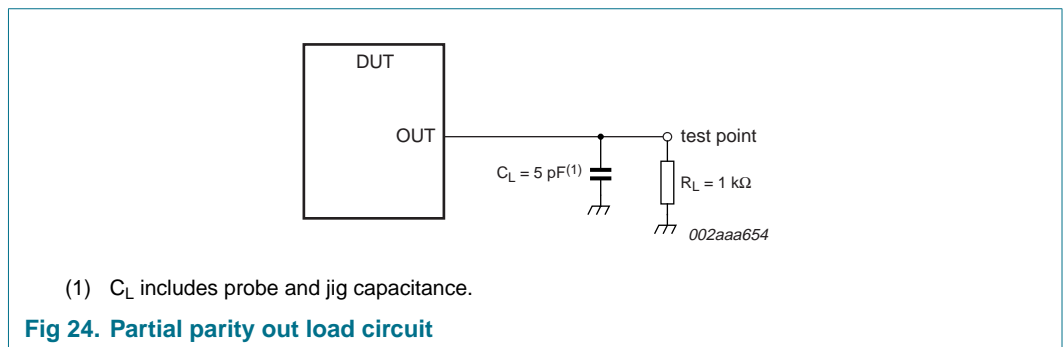


Fig 24. Partial parity out load circuit

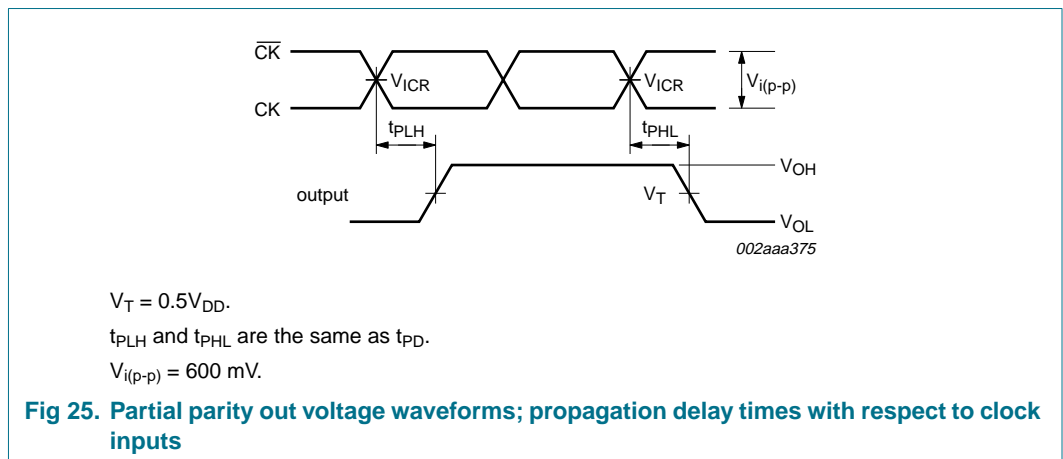
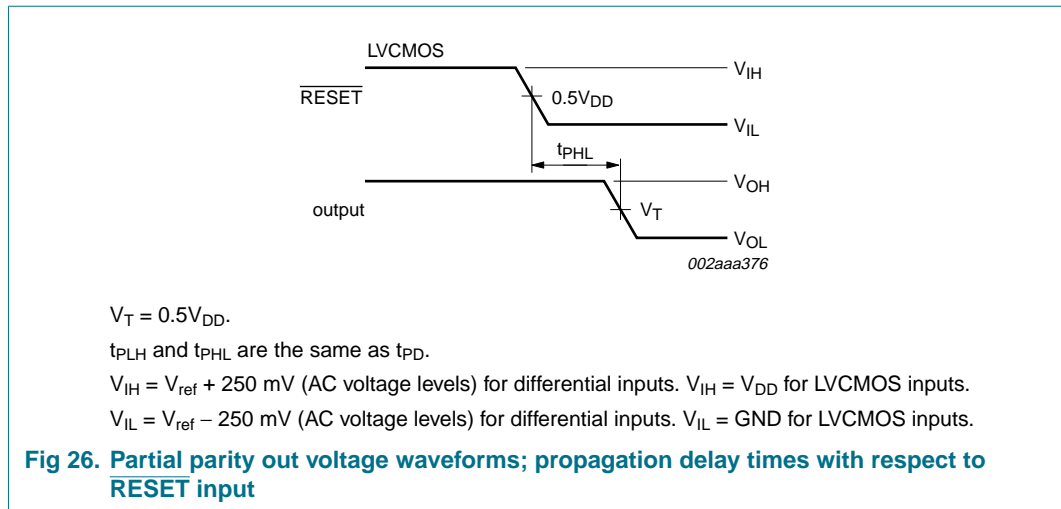


Fig 25. Partial parity out voltage waveforms; propagation delay times with respect to clock inputs



## 12. Package outline

LFBGA96: plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 x 5.5 x 1.05 mm SOT536-1

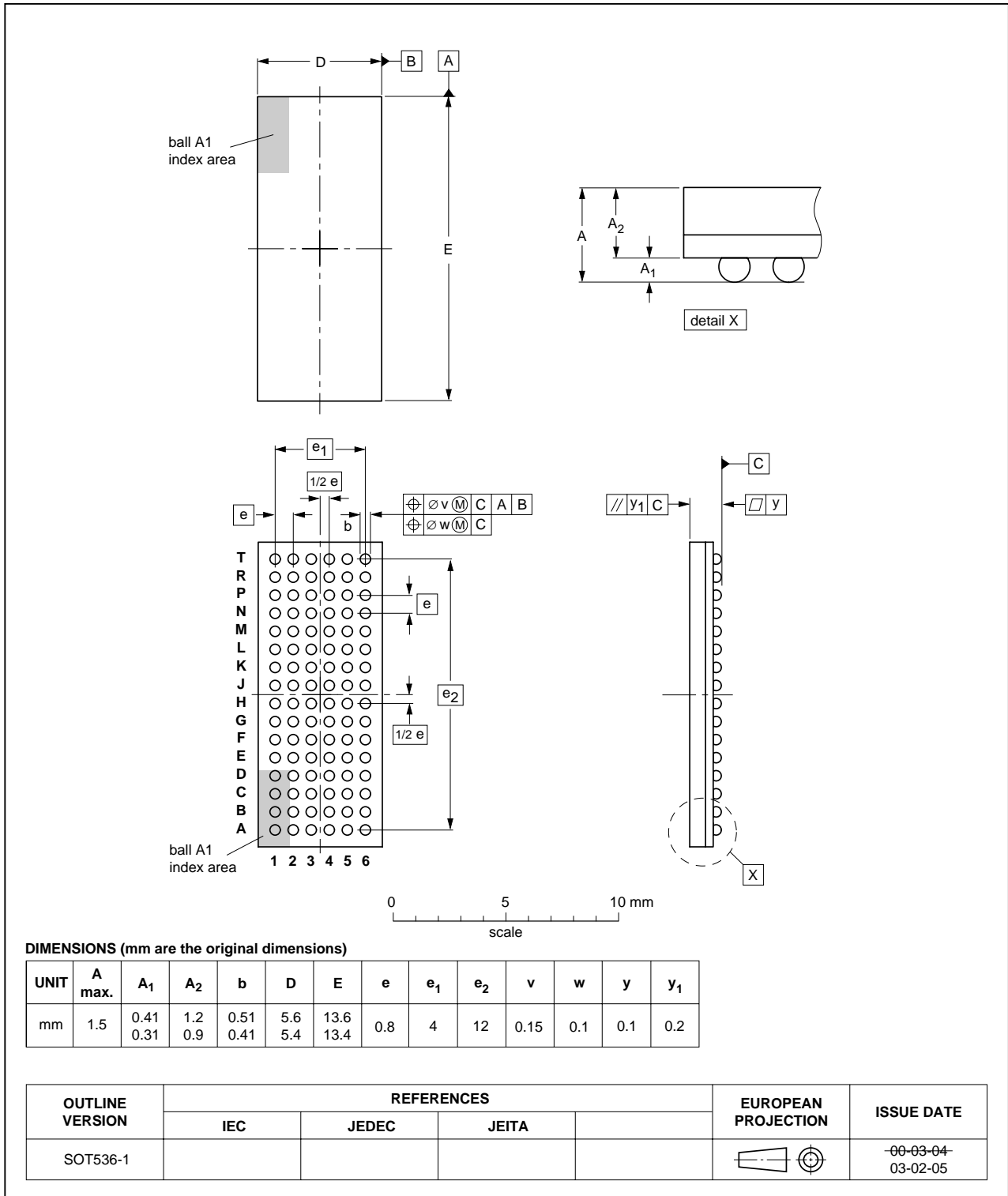


Fig 27. Package outline SOT536-1 (LFBGA96)

## 13. Soldering

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 13.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 13.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus PbSn soldering

### 13.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities



### 13.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 28](#)) than a PbSn process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 12](#) and [13](#)

**Table 12. SnPb eutectic process (from J-STD-020C)**

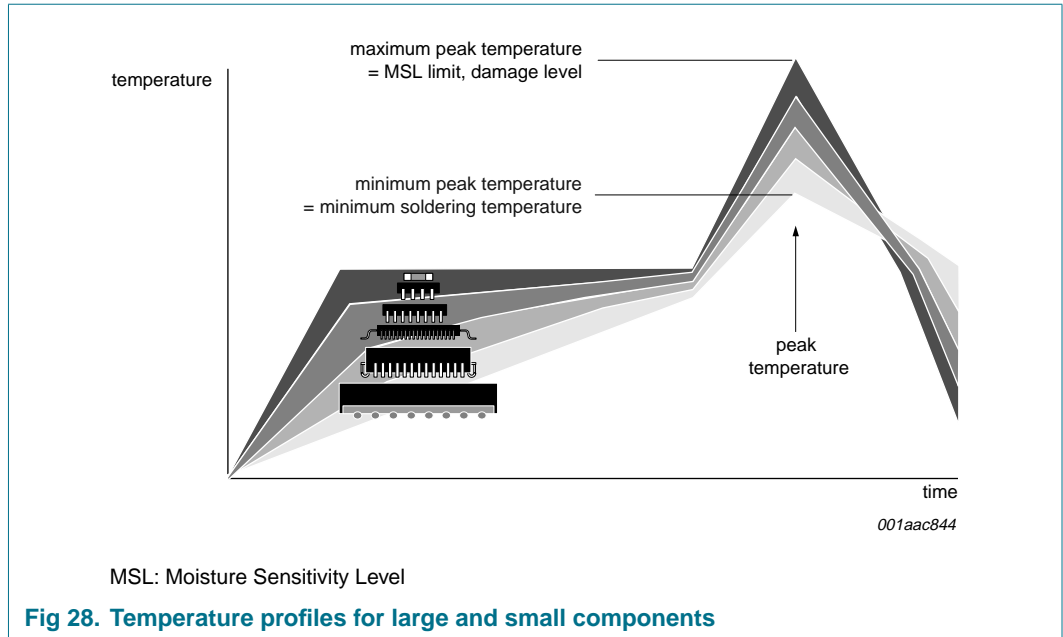
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm <sup>3</sup> )	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

**Table 13. Lead-free process (from J-STD-020C)**

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm <sup>3</sup> )		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 28](#).



For further information on temperature profiles, refer to Application Note AN10365 “Surface mount reflow soldering description”.

## 14. Abbreviations

**Table 14. Abbreviations**

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
DDR	Double Data Rate
DIMM	Dual In-line Memory Module
LVC MOS	Low Voltage Complementary Metal Oxide Semiconductor
PPO	Partial-Parity-Out
PRR	Pulse Repetition Rate
RDIMM	Registered Dual In-line Memory Module
SSTL	Stub Series Terminated Logic

## 15. Revision history

**Table 15. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
SSTUG32866_1	20070629	Product data sheet	-	-

## 16. Legal information

### 16.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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