

## DDR 14-Bit Registered Buffer

### Recommended Applications:

- DDR Memory Modules
- Provides complete DDR DIMM logic solution with ICS93V857 or ICS95V857
- SSTL\_2 compatible data registers
- DDR400 recommended (backward compatible to DDR200/266/333)

### Product Features:

- Exceeds "SSTVN16857" performance
- Differential clock signal
- Meets SSTL\_2 signal data
- Supports SSTL\_2 class I & II specifications
- Low-voltage operation
  - $V_{DD} = 2.3V$  to  $2.7V$
- 48 pin TSSOP package

### Truth Table<sup>1</sup>

Inputs				Q Outputs
RESET#	CLK	CLK#	D	Q
L	X or Floating	X or Floating	X or Floating	L
H	↑	↓	H	H
H	↑	↓	L	L
H	L or H	L or H	X	$Q_0^{(2)}$

### Notes:

1. H = High Signal Level  
L = Low Signal Level  
↑ = Transition LOW-to-HIGH  
↓ = Transition HIGH-to-LOW  
X = Irrelevant
2. Output level before the indicated steady state input conditions were established.

### Pin Configuration

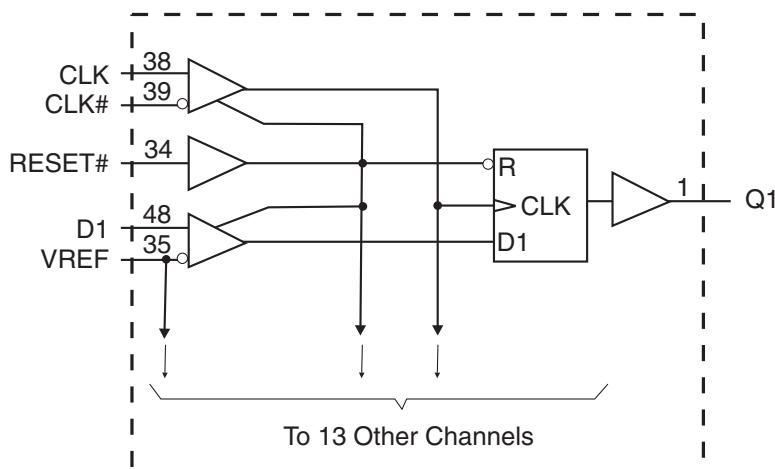
Q1	1	D1	48
Q2	2	D2	47
GND	3	GND	46
VDDQ	4	VDD	45
Q3	5	D3	44
Q4	6	D4	43
Q5	7	D5	42
GND	8	D6	41
VDDQ	9	D7	40
Q6	10	CLK#	39
Q7	11	CLK	38
VDDQ	12	VDD	37
GND	13	GND	36
Q8	14	VREF	35
Q9	15	RESET#	34
VDDQ	16	D8	33
GND	17	D9	32
Q10	18	D10	31
Q11	19	D11	30
Q12	20	D12	29
VDDQ	21	VDD	28
GND	22	GND	27
Q13	23	D13	26
Q14	24	D14	25

ICSSSTVA16857

### 48-Pin TSSOP

6.10 mm. Body, 0.50 mm. pitch = TSSOP

### Block Diagram



# ICSSSTVA16857

## General Description

The 14-bit **ICSSSTVA16857** is a universal bus driver designed for 2.3V to 2.7V V<sub>DD</sub> operation and SSTL\_2 I/O levels, except for the LVCMOS RESET# input.

Data flow from D to Q is controlled by the differential clock (CLK/CLK#) and a control signal (RESET#). The positive edge of CLK is used to trigger the data flow and CLK# is used to maintain sufficient noise margins where as RESET#, an LVCMOS asynchronous signal, is intended for use at the time of power-up only. **ICSSSTVA16857** supports low-power standby operation. A logic level “Low” at RESET# assures that all internal registers and outputs (Q) are reset to the logic “Low” state, and all input receivers, data (D) and clock (CLK/CLK#) are switched off. Please note that RESET# must always be supported with LVCMOS levels at a valid logic state because VREF may not be stable during power-up.

To ensure that outputs are at a defined logic state before a stable clock has been supplied, RESET# must be held at a logic “Low” level during power up.

In the DDR DIMM application, RESET# is specified to be completely asynchronous with respect to CLK and CLK#. Therefore, no timing relationship can be guaranteed between the two signals. When entering a low-power standby state, the register will be cleared and the outputs will be driven to a logic “Low” level quickly relative to the time to disable the differential input receivers. This ensures there are no glitches on the output. However, when coming out of low-power standby state, the register will become active quickly relative to the time to enable the differential input receivers. When the data inputs are at a logic level “Low” and the clock is stable during the “Low”-to-“High” transition of RESET# until the input receivers are fully enabled, the design ensures that the outputs will remain at a logic “Low” level.

## Pin Configuration

PIN NUMBER	PIN NAME	TYPE	DESCRIPTION
24, 23, 20, 19, 18, 15, 14, 11, 10, 7, 6, 5, 2, 1	Q (14:1)	OUTPUT	Data output
3, 8, 13, 22, 27, 36, 46	GND	PWR	Ground
4, 9, 12, 16, 21	VDDQ	PWR	Output supply voltage
25, 26, 29, 30, 31, 32, 33, 40, 41, 42, 43, 44, 47, 48	D (14:1)	INPUT	Data input
38	CLK	INPUT	Positive clock input
39	CLK#	INPUT	Negative clock input
28, 37, 45	VDD	PWR	Core supply voltage
34	RESET#	INPUT	Reset (active low)
35	VREF	INPUT	Input reference voltage

## Absolute Maximum Ratings

Storage Temperature .....	-65°C to +150°C
Supply Voltage .....	-0.5 to 3.6V
Input Voltage <sup>1</sup> .....	-0.5 to $V_{DD}$ +0.5
Output Voltage <sup>1,2</sup> .....	-0.5 to $V_{DDQ}$ +0.5
Input Clamp Current .....	$\pm 50$ mA
Output Clamp Current .....	$\pm 50$ mA
Continuous Output Current .....	$\pm 50$ mA
$V_{DD}$ , $V_{DDQ}$ or GND Current/Pin .....	$\pm 100$ mA
Package Thermal Impedance <sup>3</sup> .....	55°C/W

### 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  $V_0 > V_{DDQ}$ .
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 - DDRI/DDR33 (PC1600, PC2100, PC2700)

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
$V_{DD}$	Supply Voltage	2.3	2.5	2.7	V
$V_{DDQ}$	I/O Supply Voltage	2.3	2.5	2.7	
$V_{REF}$	Reference Voltage	1.15	1.25	1.35	
$V_{TT}$	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	$V_{REF} + 0.15$			
$V_{IH}$ (AC)	AC Input High Voltage	$V_{REF} + 0.31$			
$V_{IL}$ (DC)	DC Input Low Voltage			$V_{REF} - 0.15$	
$V_{IL}$ (DC)	AC Input Low Voltage			$V_{REF} - 0.31$	
$V_{IH}$	Input High Voltage Level	RESET#	1.7		
$V_{IL}$	Input Low Voltage Level			0.7	
$V_{ICR}$	Common mode Input Range	CLK, CLK#	0.97	1.53	mA
$V_{ID}$	Differential Input Voltage		0.36		
$V_{IX}$	Cross Point Voltage of Differential Clock Pair	$(V_{DDQ}/2) - 0.2$		$(V_{DDQ}/2) + 0.2$	
$I_{OH}$	High-Level Output Current			-16	
$I_{OL}$	Low-Level Output Current			16	
$T_A$	Operating Free-Air Temperature	0		70	°C

<sup>1</sup>Guaranteed by design, not 100% tested in production.

# ICSSSTVA16857

## Recommended Operating Conditions - DDRI-400 (PC3200)

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
$V_{DD}$	Supply Voltage	2.5	2.6	2.7	V
$V_{DDQ}$	I/O Supply Voltage	2.5	2.6	2.7	
$V_{REF}$	Reference Voltage	1.25	1.3	1.35	
$V_{TT}$	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	$V_{REF} + 0.15$		
$V_{IH(AC)}$	AC Input High Voltage		$V_{REF} + 0.31$		
$V_{IL(DC)}$	DC Input Low Voltage			$V_{REF} - 0.15$	
$V_{IL(DC)}$	AC Input Low Voltage			$V_{REF} - 0.31$	
$V_{IH}$	Input High Voltage Level	RESET#	1.7		
$V_{IL}$	Input Low Voltage Level			0.7	
$V_{ICR}$	Common mode Input Range	CLK, CLK#	0.97	1.53	
$V_{ID}$	Differential Input Voltage		0.36		
$V_{IX}$	Cross Point Voltage of Differential Clock Pair	$(V_{DDQ}/2) - 0.2$		$(V_{DDQ}/2) + 0.2$	
$I_{OH}$	High-Level Output Current			-16	mA
$I_{OL}$	Low-Level Output Current			16	
$T_A$	Operating Free-Air Temperature	0		70	°C

<sup>1</sup>Guaranteed by design, not 100% tested in production.

**DC Electrical Characteristics - DDRI/DDR333 (PC1600, PC2100, PC2700)** $T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 2.5 \pm 0.2\text{V}$ ,  $V_{DDQ} = 2.5 \pm 0.2\text{V}$ ; (unless otherwise stated)

SYMBOL	PARAMETERS	CONDITIONS	$V_{DDQ}$	MIN	TYP	MAX	UNITS
$V_{IK}$		$I_I = -18\text{mA}$	2.3V			-1.2	
$V_{OH}$		$I_{OH} = -100\mu\text{A}$	2.3V-2.7V	$V_{DDQ} = 2.5 \pm 0.2$			V
		$I_{OH} = -8\text{mA}$			1.95		
$V_{OL}$		$I_{OL} = 100\mu\text{A}$	2.3V-2.7V			0.2	
		$I_{OL} = 8\text{mA}$			2.3V		0.35
$I_I$	All Inputs	$V_I = V_{DD}$ or GND	2.7V			$\pm 5$	$\mu\text{A}$
$I_{DD}$	Standby (Static)	RESET# = GND	I <sub>O</sub> = 0	2.7V		0.01	$\mu\text{A}$
	Operating (Static)	$V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$ , RESET# = $V_{DD}$			25		mA
$I_{DDD}$	Dynamic operating (clock only)	RESET# = $V_{DD}$ , $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$ , CLK and CLK# switching 50% duty cycle.			30		$\mu\text{/clock}$ MHz
	Dynamic Operating (per each data input)	RESET# = $V_{DD}$ , $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$ , CLK and CLK# switching 50% duty cycle. One data input switching at half clock frequency, 50% duty cycle			10		$\mu\text{A/ clock}$ MHz/data
$r_{OH}$	Output High	$I_{OH} = -16\text{mA}$	2.3V-2.7V	7	13.5	20	$\Omega$
$r_{OL}$	Output Low	$I_{OL} = 16\text{mA}$	2.3V-2.7V	7	13	20	$\Omega$
$r_{O(D)}$	$[r_{OH} - r_{OL}]$ each separate bit	$I_O = 20\text{mA}$ , $T_A = 25^\circ\text{C}$	2.5V			4	$\Omega$
$C_i$	Data Inputs	$V_I = V_{REF} \pm 350\text{mV}$	2.5V	2.5		3.5	$\text{pF}$
	CLK and CLK#	$V_{ICR} = 1.25\text{V}$ , $V_{I(PP)} = 360\text{mV}$		2.5		3.5	

Notes:

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

# ICSSSTVA16857

## DC Electrical Characteristics - DDRI-400 (PC3200)

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 2.5 \pm 0.2\text{V}$ ,  $V_{DDQ} = 2.5 \pm 0.2\text{V}$ ; (unless otherwise stated)

SYMBOL	PARAMETERS	CONDITIONS	$V_{DDQ}$	MIN	TYP	MAX	UNITS
$V_{IK}$		$I_I = -18\text{mA}$	2.5V			-1.2	V
$V_{OH}$		$I_{OH} = -100\mu\text{A}$	2.5V-2.7V	$V_{DDQ} - 0.2$			
		$I_{OH} = -8\text{mA}$	2.7V	1.95			
$V_{OL}$		$I_{OL} = 100\mu\text{A}$	2.5V-2.7V			0.2	
		$I_{OL} = 8\text{mA}$	2.5V			0.35	
$I_I$	All Inputs	$V_I = V_{DD}$ or GND	2.7V			$\pm 5$	$\mu\text{A}$
$I_{DD}$	Standby (Static)	RESET# = GND	I <sub>O</sub> = 0			0.01	$\mu\text{A}$
	Operating (Static)	$V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$ , RESET# = $V_{DD}$			25		mA
$I_{DDD}$	Dynamic operating (clock only)	RESET# = $V_{DD}$ , $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$ , CLK and CLK# switching 50% duty cycle.			30		$\mu\text{/clock}$ MHz
	Dynamic Operating (per each data input)	RESET# = $V_{DD}$ , $V_I = V_{IH(\text{AC})}$ or $V_{IL(\text{AC})}$ , CLK and CLK# switching 50% duty cycle. One data input switching at half clock frequency, 50% duty cycle			10		$\mu\text{A/ clock}$ MHz/data
$r_{OH}$	Output High	$I_{OH} = -16\text{mA}$	2.5V-2.7V	7	13.5	20	$\Omega$
$r_{OL}$	Output Low	$I_{OL} = 16\text{mA}$	2.5V-2.7V	7	13	20	$\Omega$
$r_{O(D)}$	$[r_{OH} - r_{OL}]$ each separate bit	$I_O = 20\text{mA}$ , $T_A = 25^\circ\text{C}$	2.6V			4	$\Omega$
$C_i$	Data Inputs	$V_I = V_{REF} \pm 350\text{mV}$	2.6V	2.5		3.5	pF
	CLK and CLK#	$V_{ICR} = 1.25\text{V}$ , $V_{I(PP)} = 360\text{mV}$		2.5		3.5	

Notes:

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

## Timing Requirements<sup>1</sup>

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

SYMBOL	PARAMETERS		$V_{DDQ} = 2.5V \pm 0.2V$		UNITS
			MIN	MAX	
$f_{clock}$	Clock frequency			270	MHz
$t_{SL}$	Output slew rate		1	4	V/ns
$t_s$	Setup time, fast slew rate <sup>2 &amp; 4</sup>	Data before CLK↑, CLK#↓	0.4		ns
	Setup time, slow slew rate <sup>3 &amp; 4</sup>		0.6		ns
$T_h$	Hold time, fast slew rate <sup>2 &amp; 4</sup>	Data after CLK↑, CLK#↓	0.4		ns
	Hold time, slow slew rate <sup>3 &amp; 4</sup>		0.5		ns

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

2 - For data signal input slew rate of  $\geq 1V/ns$ .

3 - For data signal input slew rate of  $\geq 0.5V/ns$  and  $< 1V/ns$ .

4 - CLK, CLK# signals input slew rate of  $\geq 1V/ns$ .

## Switching Characteristics - DDRI/DDR333 (PC1600, PC2100, PC2700)

(over recommended operating free-air temperature range, unless otherwise noted) (see Figure 1)

SYMBOL	From (Input)	To (Output)	$V_{DD} = 2.5V \pm 0.2V$			UNITS
			MIN	TYP	MAX	
$f_{max}$			210			MHz
$t_{PD}$	CLK, CLK# (TSSOP)	Q	1.6	2.1	2.6	ns
$t_{phl}$	RESET#	Q			3.5	ns

## Switching Characteristics - DDRI-400 (PC3200)

(over recommended operating free-air temperature range, unless otherwise noted) (see Figure 1)

SYMBOL	From (Input)	To (Output)	$V_{DD} = 2.6V \pm 0.1V$			UNITS
			MIN	TYP	MAX	
$f_{max}$			210			MHz
$t_{PD}$	CLK, CLK# (TSSOP)	Q	1.1	1.6	1.89	ns
$t_{phl}$	RESET#	Q			3.5	ns

# ICSSSTVA16857

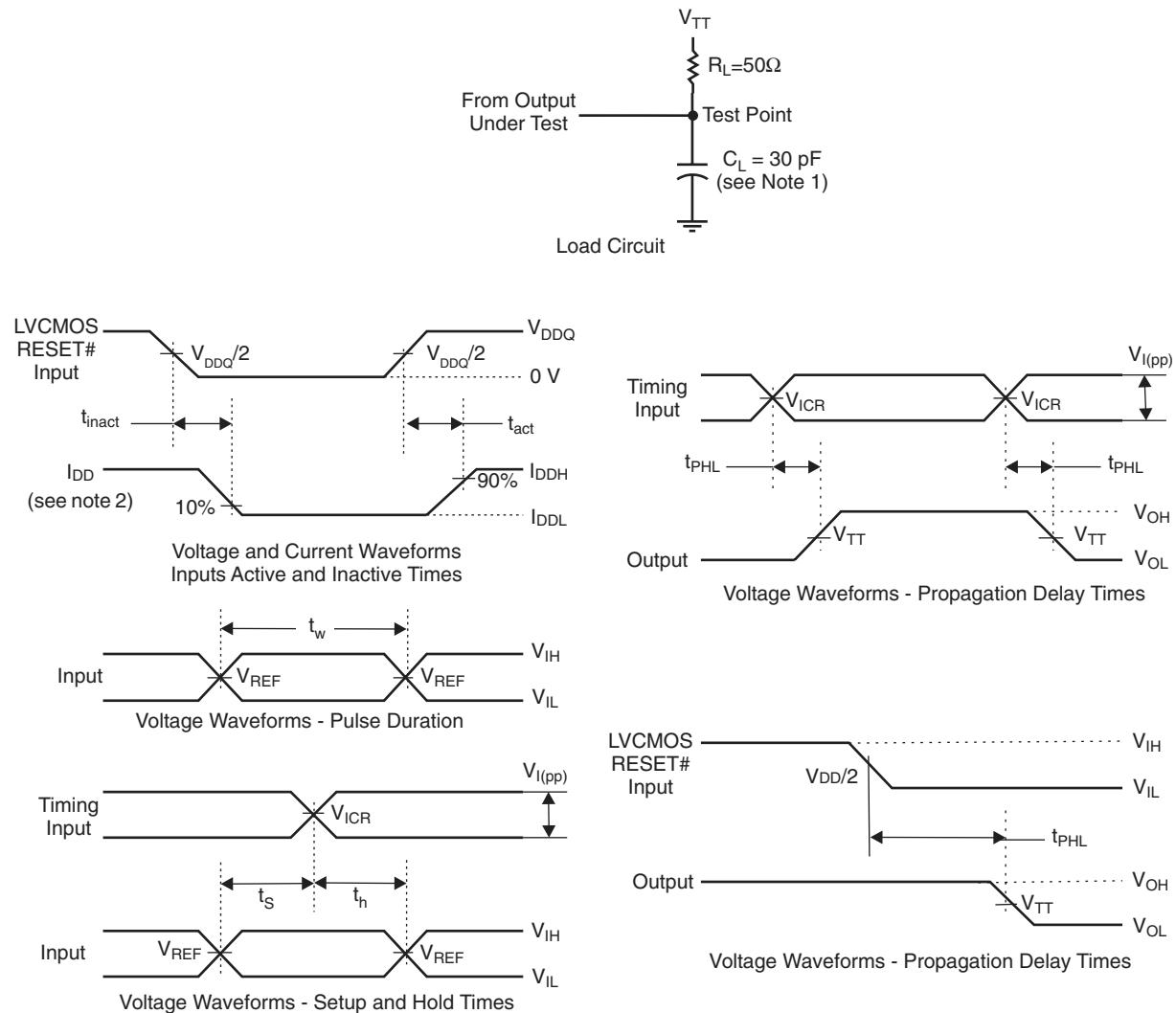
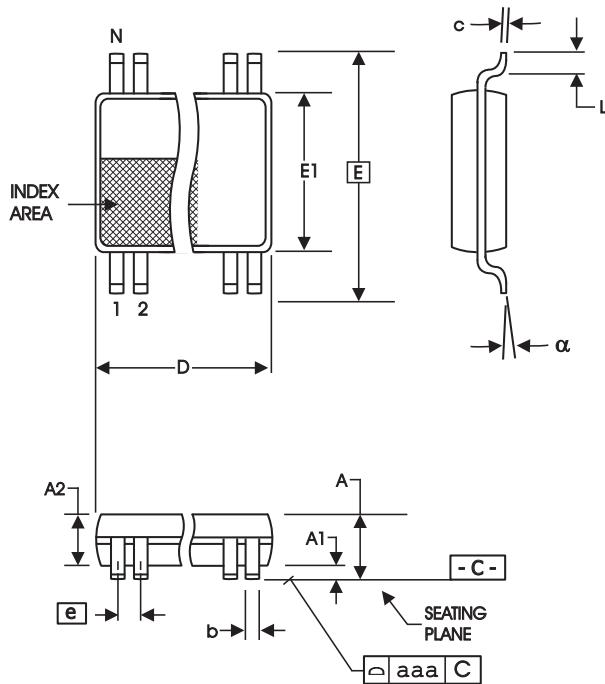


Figure 1 - Parameter Measurement Information ( $V_{DDQ} = 2.5V \pm 0.2V$ )

Notes:

1. CL includes probe and jig capacitance.
2.  $I_{DD}$  tested with clock and data inputs held at  $V_{DDQ}$  or GND, and  $I_O = 0$  mA.
3. All input pulses are supplied by generators having the following characteristics: PRR @ 10 MHz,  $Z_0=50\Omega$ , 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.  $V_{TT} = V_{REF} = V_{DDQ}/2$
6.  $V_{IH} = V_{REF} + 310\text{mV}$  (AC voltage levels) for differential inputs.  $V_{IH} = V_{DDQ}$  for LVCMS input.
7.  $V_{IL} = V_{REF} - 310\text{mV}$  (AC voltage levels) for differential inputs.  $V_{IL} = \text{GND}$  for LVCMS input.
8.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$



6.10 mm. Body, 0.50 mm. pitch TSSOP  
(240 mil) (0.020 mil)

SYMBOL	In Millimeters		In Inches	
	COMMON DIMENSIONS MIN	MAX	COMMON DIMENSIONS MIN	MAX
A	--	1.20	--	.047
A1	0.05	0.15	.002	.006
A2	0.80	1.05	.032	.041
b	0.17	0.27	.007	.011
c	0.09	0.20	.0035	.008
D	SEE VARIATIONS		SEE VARIATIONS	
E	8.10 BASIC		0.319 BASIC	
E1	6.00	6.20	.236	.244
e	0.50 BASIC		0.020 BASIC	
L	0.45	0.75	.018	.030
N	SEE VARIATIONS		SEE VARIATIONS	
alpha	0°	8°	0°	8°
aaa	--	0.10	--	.004

## VARIATIONS

N	D mm.		D (inch)	
	MIN	MAX	MIN	MAX
48	12.40	12.60	.488	.496

Reference Doc.: JEDEC Publication 95, MO-153

10-0039

## Ordering Information

**ICSSSTVA16857yGLF-T**

Example:

**ICS XXXX y G LF- T**

- Designation for tape and reel packaging
- Lead Free (Optional)
- Package Type  
G = TSSOP
- Revision Designator (will not correlate with datasheet revision)
- Device Type
- Prefix  
ICS = Standard Device

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