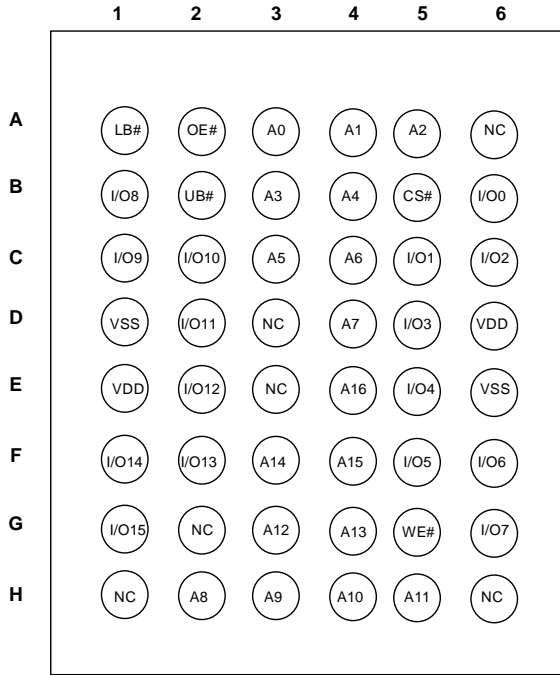


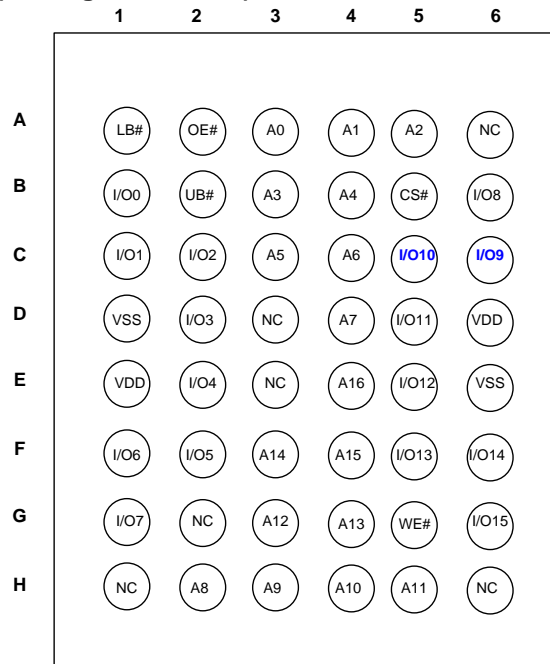


**PIN CONFIGURATIONS**

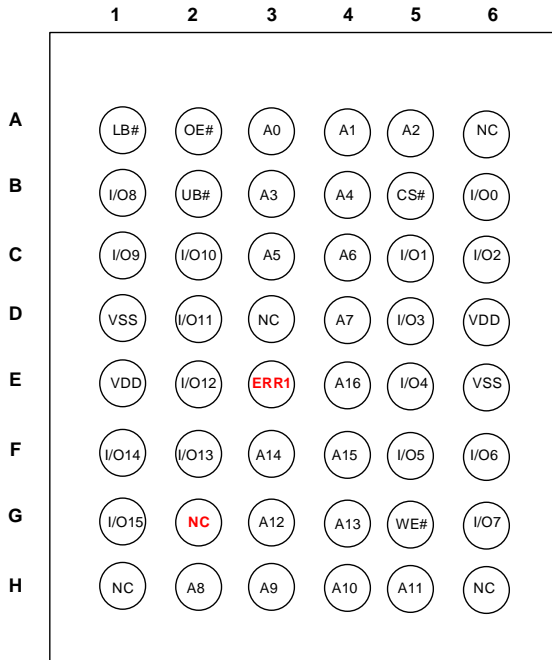
**48-Ball mini BGA(6mm x 8mm),**  
**(Package Code : B)**



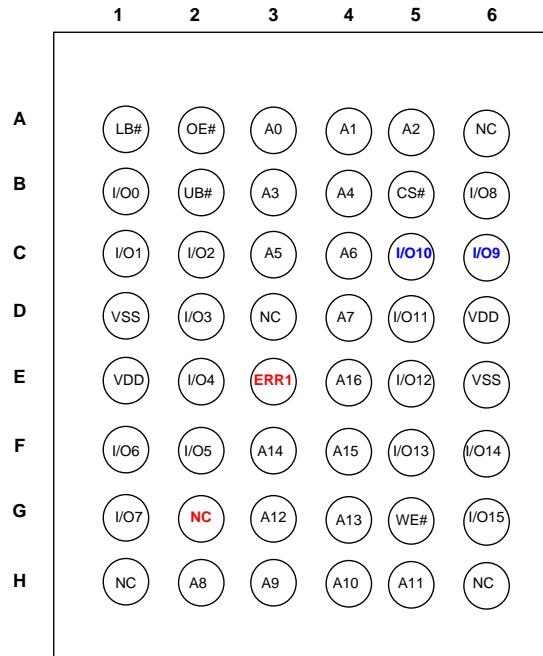
**48-Ball mini BGA (6mm x 8mm)**  
**(Package Code : B2)**



**48-Ball mini BGA(6mm x 8mm), ERR1**  
**(Package Code : B3)**



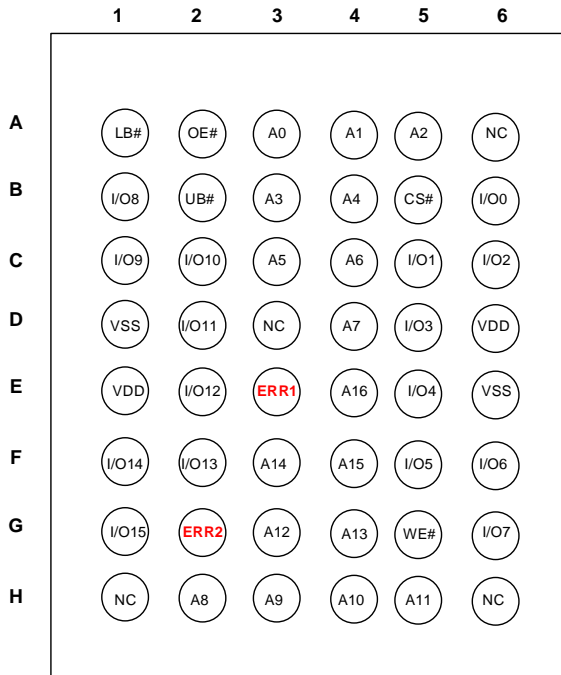
**48-Ball mini BGA(6mm x 8mm), ERR1, Switched IO**  
**(Package Code : B4)**



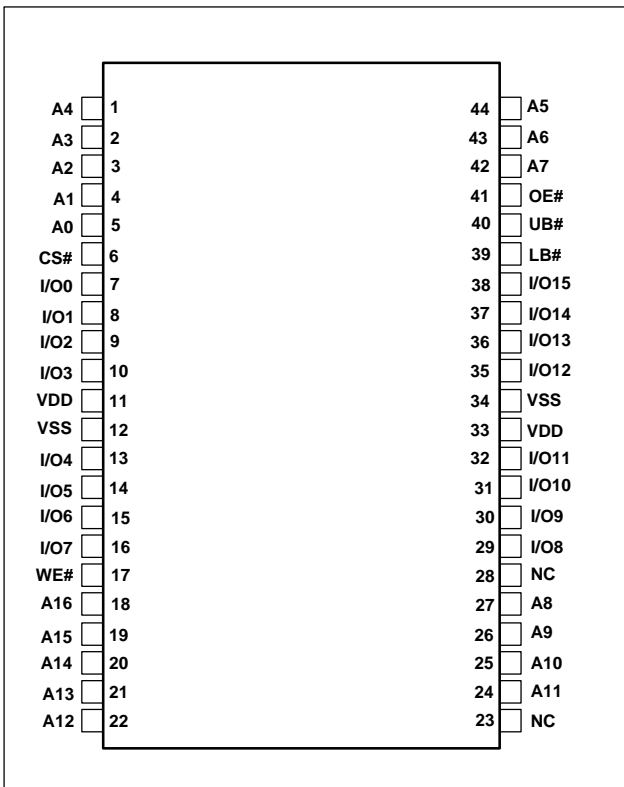
# IS61/64WV12816EFALL IS61/64WV12816EFBLL



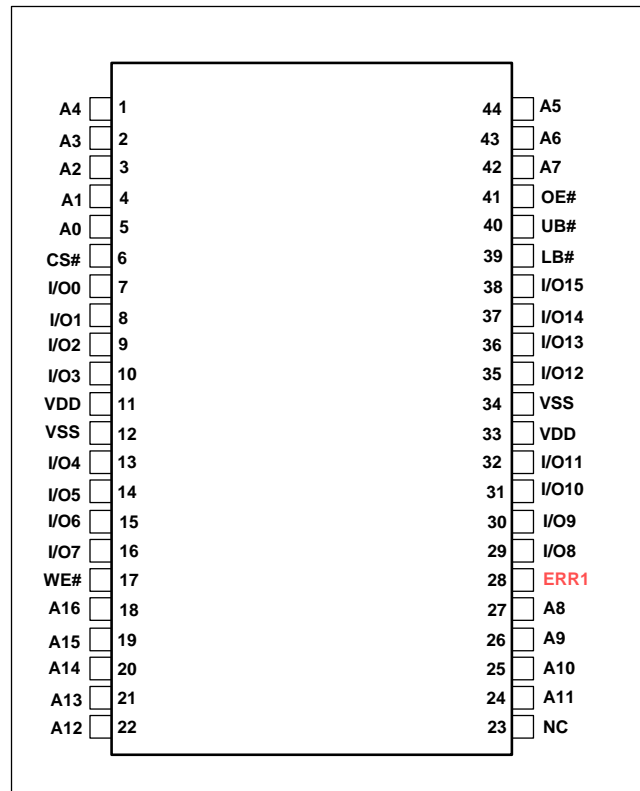
48-Ball mini BGA(6mm x 8mm), ERR1/2  
(Package Code : B5)



44-Pin TSOP-II, (Package Code : T)



44-Pin TSOP-II with ERR1, (Package Code : T2)



---

**PIN DESCRIPTIONS**

A0-A16	Address Inputs
I/O0-I/O15	Data Inputs/Outputs
CS#	Chip Enable Input
OE#	Output Enable Input
WE#	Write Enable Input
LB#	Lower-byte Control (I/O0-I/O7)
UB#	Upper-byte Control (I/O8-I/O15)
ERR1	1-bit Error Detection and Correction Signal
ERR2	2-bit ERR Detection Signal
NC	No Connection
VDD	Power
VSS	Ground

## FUNCTION DESCRIPTION

SRAM is one of random access memories. Each byte or word has an address and can be accessed randomly. SRAM has three different modes supported. Each function is described below with Truth Table.

### STANDBY MODE

Device enters standby mode when deselected (CS# HIGH). The input and output pins (I/O0-15) are placed in a high impedance state. CMOS input in this mode will maximize saving power.

### WRITE MODE

Write operation issues with Chip selected (CS#) and Write Enable (WE#) input LOW. The input and output pins (I/O0-15) are in data input mode. Output buffers are closed during this time even if OE# is LOW. UB# and LB# enables a byte write feature. By enabling LB# LOW, data from I/O pins (I/O0 through I/O7) are written into the location specified on the address pins. And with UB# being LOW, data from I/O pins (I/O8 through I/O15) are written into the location.

### READ MODE

Read operation issues with Chip selected (CS# LOW) and Write Enable (WE#) input HIGH. When OE# is LOW, output buffer turns on to make data output. Any input to I/O pins during READ mode is not permitted. UB# and LB# enables a byte read feature. By enabling LB# LOW, data from memory appears on I/O0-7. And with UB# being LOW, data from memory appears on I/O8-15.

In the READ mode, output buffers can be turned off by pulling OE# HIGH. In this mode, internal device operates as READ but I/Os are in a high impedance state. Since device is in READ mode, active current is used.

### ERROR DETECTION AND ERROR CORRECTION

- Independent ECC per each byte
  - detect and correct one bit error per byte or detect 2-bit error per byte
- Optional ERR1 output signal indicates 1-bit error detection and correction
- Optional ERR2 output signal indicates 2-bit error detection.
- Controller can use either ERR1 or ERR2 to monitor ECC event. Unused pins (ERR1 or ERR2) can be left floating.
- Better reliability than parity code schemes which can only detect an error but not correct an error
- Backward Compatible: Drop in replacement to current in industry standard devices (without ECC)

### ERR1, ERR2 OUTPUT SIGNAL BEHAVIOR

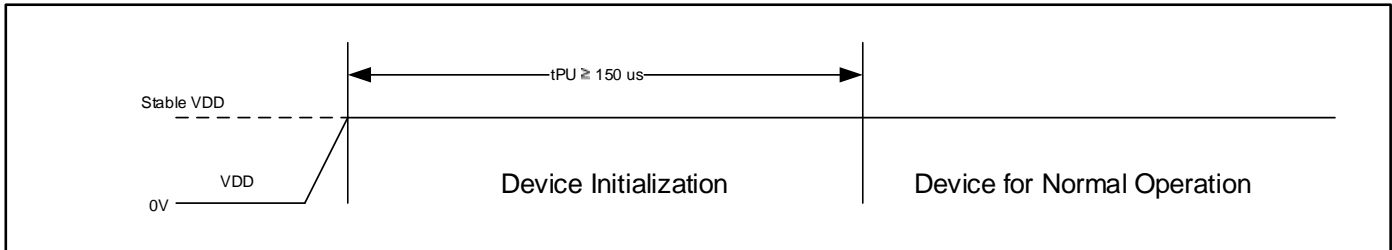
ERR1	ERR2	DQ pin	Status	Remark
0	0	Valid Q	No Error	
1	0	Valid Q	1-Bit Error only	1-bit error per byte detected and corrected
0	1	In-Valid Q	2-Bit Error only	No 1-bit error. 2-bit error per byte detected (out of 2 bytes)
1	1	In-Valid Q	1-bit & 2-bit error	1-bit error detected and corrected at one byte, and 2-bit error detected at another byte.
High-Z	High-Z	Valid D	Non-Read	Write operation or Output Disabled

**TRUTH TABLE**

Mode	CS#	WE#	OE#	LB#	UB#	I/O0-I/O7	I/O8-I/O15	VDD Current
Not Selected	H	X	X	X	X	High-Z	High-Z	I <sub>SB1</sub> , I <sub>SB2</sub>
Output Disabled	L	H	H	L	L	High-Z	High-Z	ICC
	L	H	H	H	L	High-Z	High-Z	
Read	L	H	L	L	H	DOUT	High-Z	ICC
	L	H	L	H	L	High-Z	DOUT	
	L	H	L	L	L	DOUT	DOUT	
Write	L	L	X	L	H	DIN	High-Z	ICC
	L	L	X	H	L	High-Z	DIN	
	L	L	X	L	L	DIN	DIN	

**POWER UP INITIALIZATION**

The device includes on-chip voltage sensor used to launch POWER-UP initialization process. When VDD reaches stable level, the device requires 150us of t<sub>PU</sub> (Power-Up Time) to complete its self-initialization process. When initialization is complete, the device is ready for normal operation.



## ABSOLUTE MAXIMUM RATINGS AND OPERATING RANGE

### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Parameter	Value	Unit
V <sub>term</sub>	Terminal Voltage with Respect to VSS	-0.5 to V <sub>DD</sub> + 0.5V	V
V <sub>DD</sub>	V <sub>DD</sub> Related to VSS	-0.3 to 4.0	V
t <sub>Stg</sub>	Storage Temperature	-65 to +150	°C
P <sub>T</sub>	Power Dissipation	1.0	W

Note:

- Stress 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.

### PIN CAPACITANCE <sup>(1)</sup>

Parameter	Symbol	Test Condition	Max	Units
Input capacitance	C <sub>IN</sub>	T <sub>A</sub> = 25°C, f = 1 MHz, V <sub>DD</sub> = V <sub>DD</sub> (typ)	6	pF
DQ capacitance (IO0–IO15)	C <sub>I/O</sub>		8	pF

Note:

- These parameters are guaranteed by design and tested by a sample basis only.

### OPERATING RANGE<sup>(1)</sup>

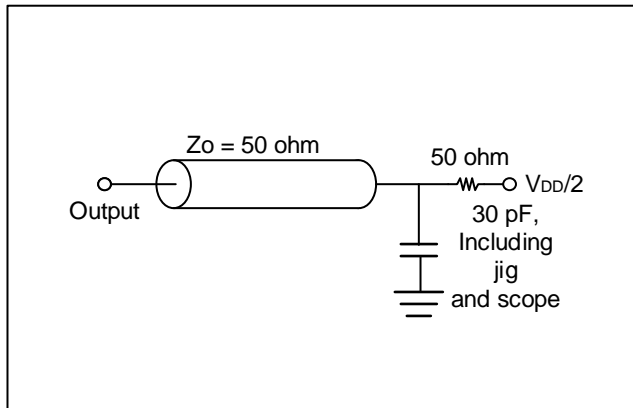
Range	Ambient Temperature	PART NUMBER	VDD	SPEED (MAX)
Commercial	0°C to +70°C	IS61WV12816EFALL	1.65V – 2.2V	10 ns
		IS61WV12816EFBLL	2.4V – 3.6V	
				3.3V+/-10%
Industrial	-40°C to +85°C	IS61WV12816EFALL	1.65V – 2.2V	10 ns
		IS61WV12816EFBLL	2.4V – 3.6V	
				3.3V+/-10%
Automotive (A3)	-40°C to +125°C	IS64WV12816EFALL	1.65V – 2.2V	10 ns
		IS64WV12816EFBLL	2.4V – 3.6V	

**AC TEST CONDITIONS (OVER THE OPERATING RANGE)**

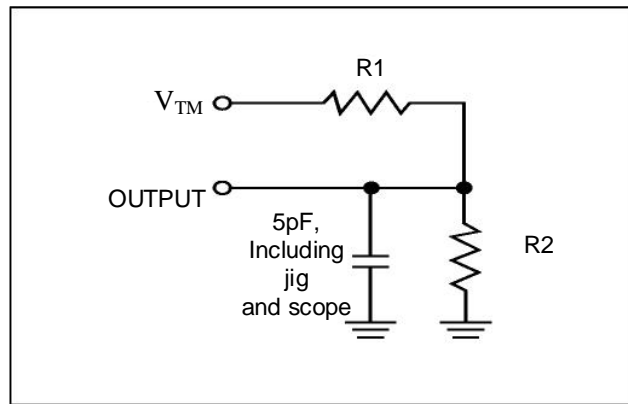
Parameter	Unit (1.65V~2.2V)	Unit (2.4V~3.6V)	Unit (3.3V +/-10%)
Input Pulse Level	0V to $V_{DD}$	0V to $V_{DD}$	0V to $V_{DD}$
Input Rise and Fall Time	1.5 ns	1.5 ns	1.5 ns
Output Timing Reference Level	$\frac{1}{2} V_{DD}$	$\frac{1}{2} V_{DD}$	$\frac{1}{2} V_{DD}$
R1 (ohm)	13500	319	319
R2 (ohm)	10800	353	353
$V_{TM}$ (V)	$V_{DD}$	$V_{DD}$	$V_{DD}$
Output Load Conditions	Refer to Figure 1 and 2		

**AC TEST LOADS**

**FIGURE 1**



**FIGURE 2**





## DC ELECTRICAL CHARACTERISTICS

### DC ELECTRICAL CHARACTERISTICS (OVER THE OPERATING RANGE)

#### IS61/64WV12816EFALL (VDD = 1.65V – 2.2V)

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	I <sub>OH</sub> = -0.1 mA	1.4	—	V
V <sub>OL</sub>	Output LOW Voltage	I <sub>OL</sub> = 0.1 mA	—	0.2	V
V <sub>IH</sub> ( <sup>1</sup> )	Input HIGH Voltage		1.4	V <sub>DD</sub> + 0.2	V
V <sub>IL</sub> ( <sup>1</sup> )	Input LOW Voltage		-0.2	0.4	V
I <sub>LI</sub>	Input Leakage	GND < V <sub>IN</sub> < V <sub>DD</sub>	-1	1	μA
I <sub>LO</sub>	Output Leakage	GND < V <sub>IN</sub> < V <sub>DD</sub> , Output Disabled	-1	1	μA

Note:

- V<sub>ILL</sub>(min) = -1.0V AC (pulse width < 10ns). Not 100% tested.  
V<sub>IHH</sub>(max) = V<sub>DD</sub> + 1.0V AC (pulse width < 10ns). Not 100% tested.

#### IS61/64WV12816EFBLL (VDD = 2.4V – 3.6V)

Symbol	Parameter	Test Conditions	Min.	Max.	Unit	
V <sub>OH</sub>	Output HIGH Voltage	2.4V ~ 2.7V	V <sub>DD</sub> = Min., I <sub>OH</sub> = -1.0 mA	2.0	—	V
		2.7V ~ 3.6V	V <sub>DD</sub> = Min., I <sub>OH</sub> = -4.0 mA	2.2		
V <sub>OL</sub>	Output LOW Voltage	2.4V ~ 2.7V	V <sub>DD</sub> = Min., I <sub>OL</sub> = 2.0 mA	—	0.4	V
		2.7V ~ 3.6V	V <sub>DD</sub> = Min., I <sub>OL</sub> = 8.0 mA	—	0.4	
V <sub>IH</sub> ( <sup>1</sup> )	Input HIGH Voltage	2.4V ~ 2.7V		2.0	V <sub>DD</sub> + 0.3	V
		2.7V ~ 3.6V		2.0		
V <sub>IL</sub> ( <sup>1</sup> )	Input LOW Voltage	2.4V ~ 2.7V		-0.3	0.6	V
		2.7V ~ 3.6V		-0.3	0.8	
I <sub>LI</sub>	Input Leakage	V <sub>SS</sub> < V <sub>IN</sub> < V <sub>DD</sub>	-2	2	μA	
I <sub>LO</sub>	Output Leakage	V <sub>SS</sub> < V <sub>IN</sub> < V <sub>DD</sub> , Output Disabled	-2	2	μA	

Note:

- V<sub>IL</sub>(min) = -0.3V DC ; V<sub>IL</sub>(min) = -2.0V AC (pulse width 2.0ns). Not 100% tested.  
V<sub>IH</sub>(max) = V<sub>DD</sub> + 0.3V DC ; V<sub>IH</sub>(max) = V<sub>DD</sub> + 2.0V AC (pulse width 2.0ns). Not 100% tested.

**POWER SUPPLY CHARACTERISTICS-II FOR POWER (OVER THE OPERATING RANGE)**

Symbol	Parameter	Test Conditions	Grade	-8 <sup>(3)</sup> Max.	-10 Max.	-12 Max.	Unit
ICC	V <sub>DD</sub> Dynamic Operating Supply Current	V <sub>DD</sub> = MAX, I <sub>OUT</sub> = 0 mA, f = f <sub>MAX</sub>	Com.	40	30	30	mA
			Ind.	45	35	35	
			Auto.	-	40	40	
ICC1	Operating Supply Current	V <sub>DD</sub> = MAX, I <sub>OUT</sub> = 0 mA, f = 0	Com.	20	20	20	mA
			Ind.	25	25	25	
			Auto.	-	35	35	
ISB1	TTL Standby Current (TTL Inputs)	V <sub>DD</sub> = MAX, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> CS# ≥ V <sub>IH</sub> , f = 0	Com.	15	15	15	mA
			Ind.	20	20	20	
			Auto.	-	30	30	
ISB2	CMOS Standby Current (CMOS Inputs)	V <sub>DD</sub> = MAX, CS# ≥ V <sub>DD</sub> - 0.2V V <sub>IN</sub> ≥ V <sub>DD</sub> - 0.2V, or V <sub>IN</sub> ≤ 0.2V , f = 0	Com.	8	8	8	mA
			Ind.	10	10	10	
			Auto.	-	20	20	
			Typ. <sup>(2)</sup>	3			

Notes:

1. At f = f<sub>MAX</sub>, address and data inputs are cycling at the maximum frequency, f = 0 means no input line change.
2. Typical value indicate the value for the center of distribution, measured at V<sub>DD</sub> = 3.0V/1.8V, T<sub>A</sub> = 25 °C, and not 100% tested.
3. 8ns is at V<sub>DD</sub>=3.3V +/-10%

## AC CHARACTERISTICS (OVER OPERATING RANGE)

### READ CYCLE AC CHARACTERISTICS

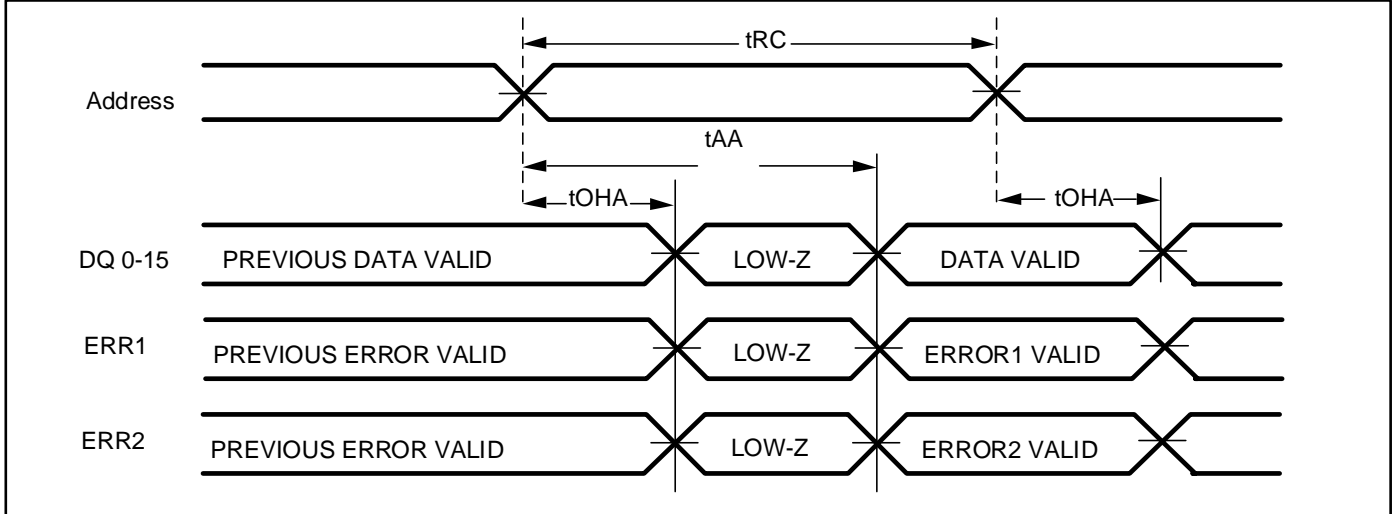
Parameter	Symbol	-8 <sup>(3)</sup>		-10		-12		unit	notes
		Min	Max	Min	Max	Min	Max		
Read Cycle Time	tRC	8	-	10	-	12	-	ns	
Address Access Time	tAA	-	8	-	10	-	12	ns	
Output Hold Time	tOHA	2.0	-	2.5	-	2.5	-	ns	
CS# Access Time	tACE	-	8	-	10	-	12	ns	
OE# Access Time	tDOE	-	4.5	-	6	-	7	ns	
OE# to High-Z Output	tHZOE	0	3	0	5	0	6	ns	2
OE# to Low-Z Output	tLZOE	0	-	0	-	0	-	ns	2
CS# to High-Z Output	tHZCE	0	3	0	5	0	6	ns	2
CS# to Low-Z Output	tLZCE	3	-	3	-	3	-	ns	2
UB#, LB# Access Time	tBA	-	5.5	-	6	-	7	ns	
UB#, LB# to High-Z Output	tHZB	0	3	0	5	0	6	ns	2
UB#, LB# to Low-Z Output	tLZB	0	-	0	-	0	-	ns	2

Notes:

1. Test conditions assume signal transition times of 1.5 ns or less, timing reference levels of  $V_{DD}/2$ , input pulse levels of 0V to  $V_{DD}$  and output loading specified in Figure 1.
2. Tested with the load in Figure 2. Transition is measured  $\pm 500$  mV from steady-state voltage. Not 100% tested.
3. 8ns is at  $V_{DD}=3.3V \pm 10\%$

## AC WAVEFORMS

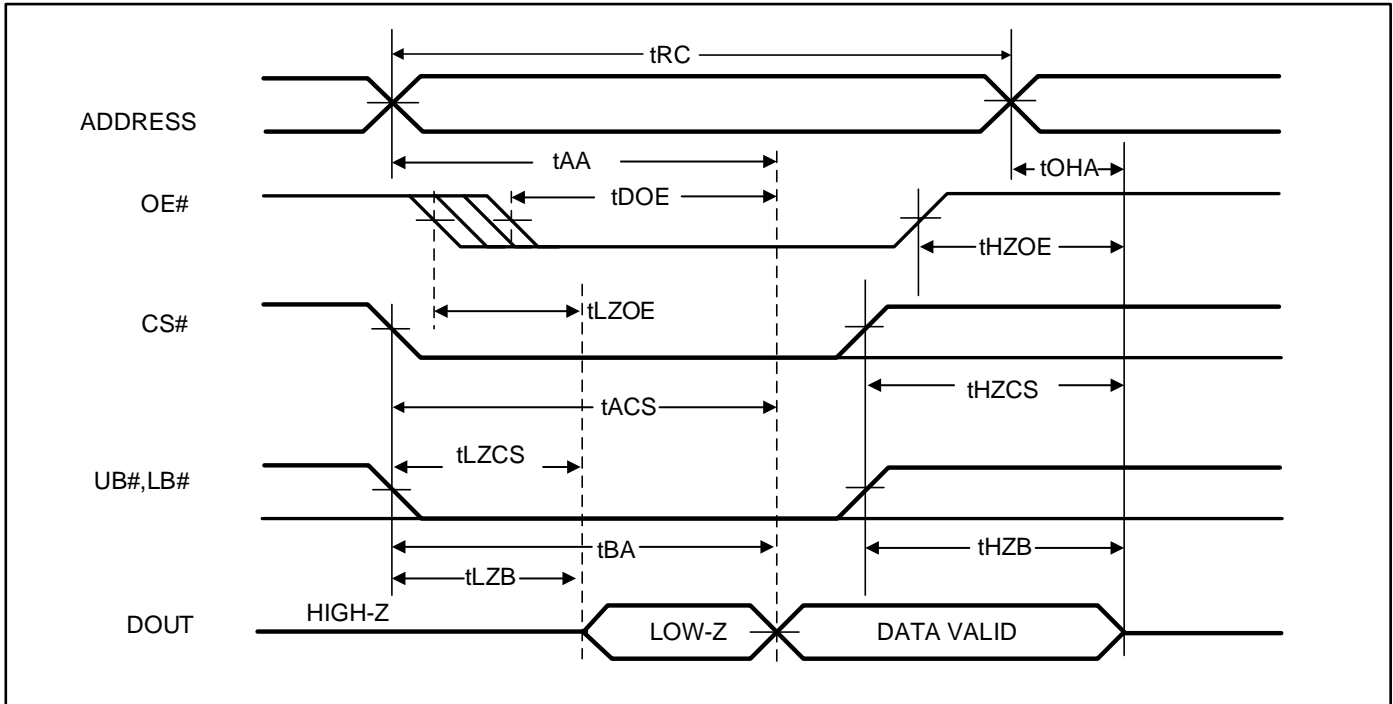
### READ CYCLE NO. 1<sup>(1,2)</sup> (ADDRESS CONTROLLED, CS# = OE# = UB# = LB# = LOW, WE# = HIGH)



Notes:

1. The device is continuously selected.
2. ERR1, ERR2 signals act like a Read Data Q during Read Operation.

### READ CYCLE NO. 2<sup>(1)</sup> (OE# CONTROLLED, WE# = HIGH)



Note:

1. Address is valid prior to or coincident with CS# LOW transition.

## WRITE CYCLE AC CHARACTERISTICS

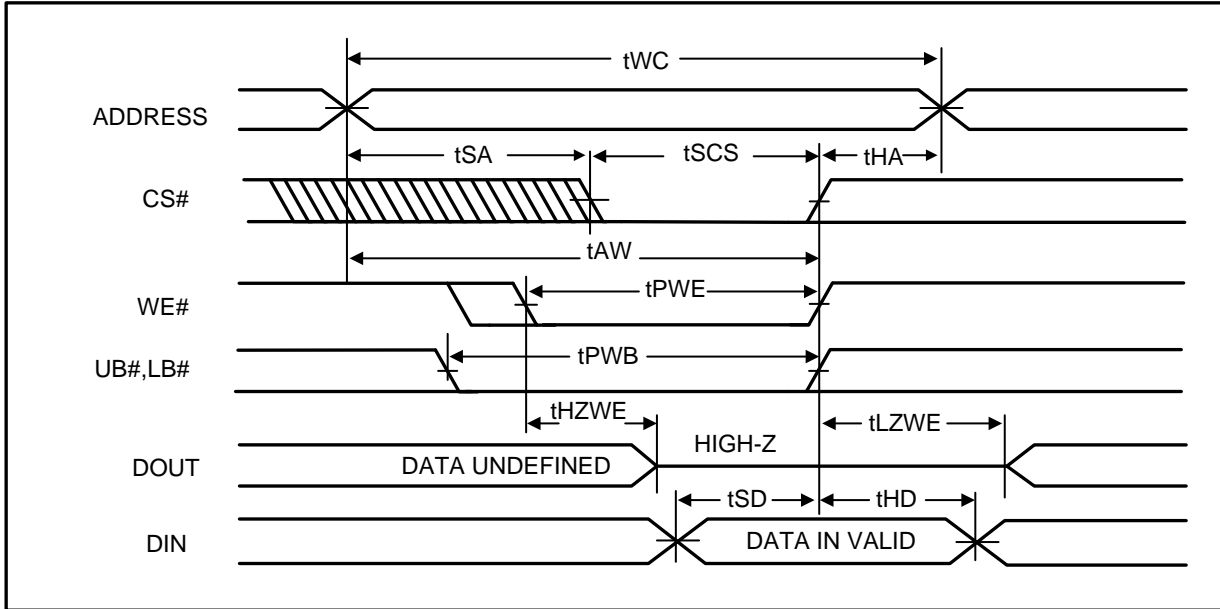
Parameter	Symbol	-8 <sup>(3)</sup>		-10		-12		unit	notes
		Min	Max	Min	Max	Min	Max		
Write Cycle Time	tWC	8	-	10	-	12	-	ns	
CS# to Write End	tSCS	6.5	-	8	-	9	-	ns	
Address Setup Time to Write End	tAW	6.5	-	8	-	9	-	ns	
UB#,LB# to Write End	tPWB	6.5	-	8	-	9	-	ns	
Address Hold from Write End	tHA	0	-	0	-	0	-	ns	
Address Setup Time	tSA	0	-	0	-	0	-	ns	
WE# Pulse Width	tPWE1	6.5	-	8	-	9	-	ns	
WE# Pulse Width (OE# = LOW)	tPWE2	8	-	10	-	12	-	ns	2
Data Setup to Write End	tSD	5	-	6	-	7	-	ns	
Data Hold from Write End	tHD	0	-	0	-	0	-	ns	
WE# LOW to High-Z Output	tHZWE	-	3.5	-	4	-	5	ns	
WE# HIGH to Low-Z Output	tLZWE	2	-	2	-	2	-	ns	

Notes:

- 1 The internal write time is defined by the overlap of CS# = LOW, UB# or LB# = LOW, and WE# = LOW. All conditions must be in valid states to initiate a Write, but any condition can go inactive to terminate the Write. The Data Input Setup and Hold timing are referenced to the rising or falling edge of the signal that terminates the write.
- 2 tPWE > tHZWE + tSD when OE# is LOW.
- 3 8ns is at VDD=3.3V +/-10%

## AC WAVEFORMS

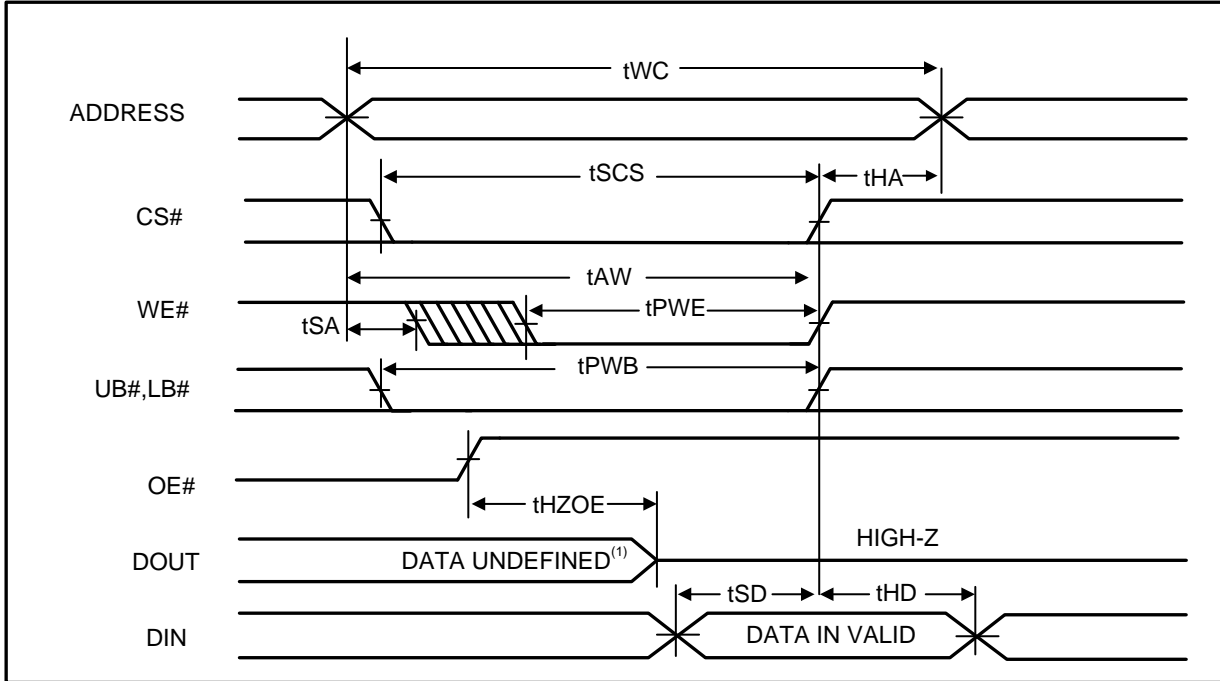
### WRITE CYCLE NO. 1<sup>(1)</sup>(CS# CONTROLLED, OE# = HIGH OR LOW)



Note:

1. I/O will assume the High-Z state if CS# =  $V_{IH}$  or OE# =  $V_{IH}$ .

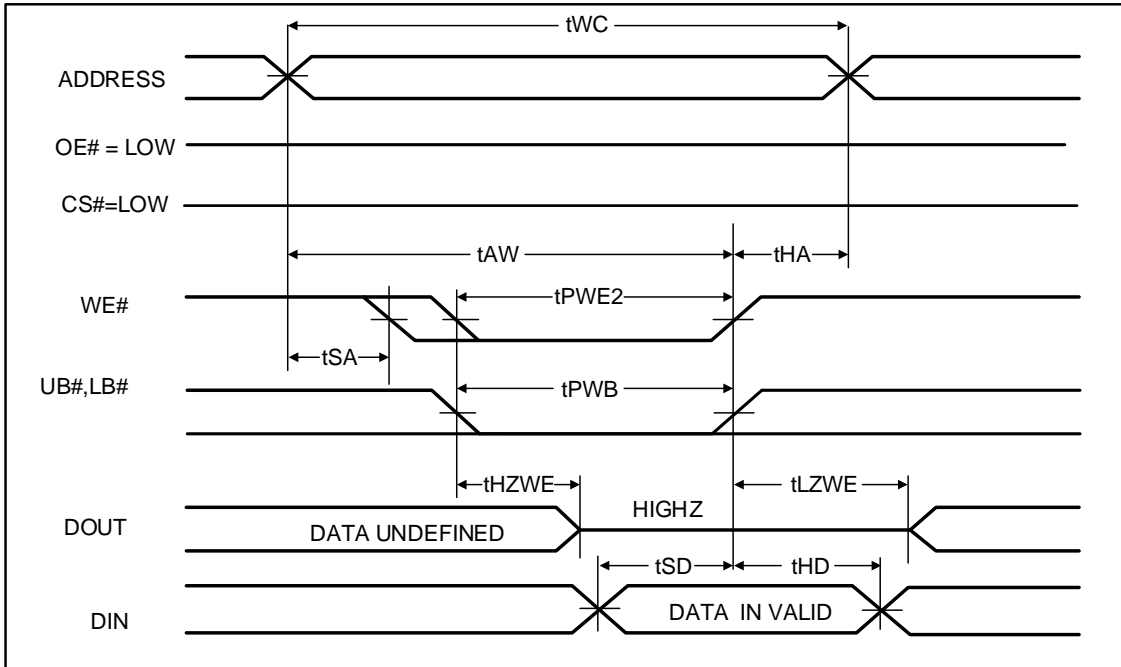
**WRITE CYCLE NO. 2<sup>(1)</sup> (WE# CONTROLLED: OE# IS HIGH DURING WRITE CYCLE)**



Note:

1. tHZOE is the time DOUT goes to High-Z after OE# goes high. During this period the I/Os are in output state. Do not apply input signals.

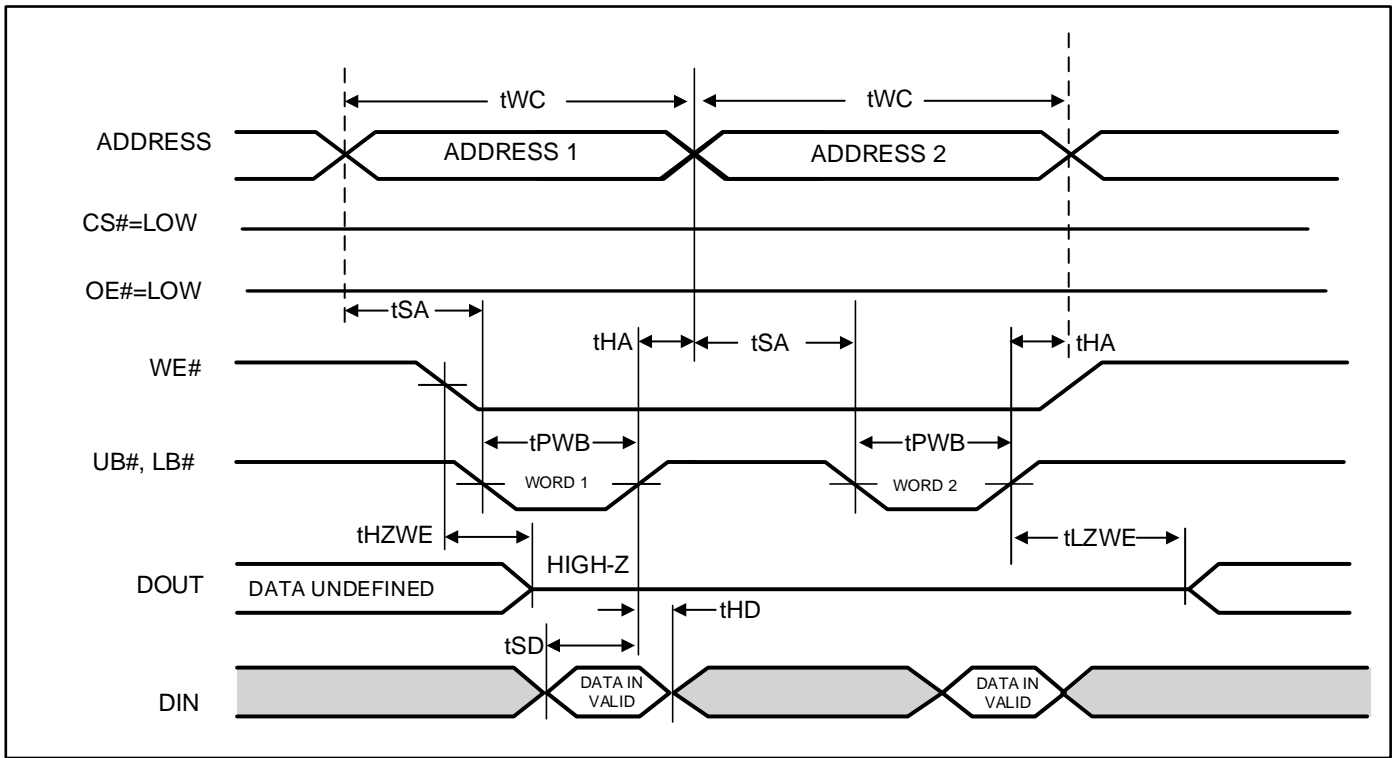
**WRITE CYCLE NO. 3<sup>(1)</sup> (WE# CONTROLLED: OE# IS LOW DURING WRITE CYCLE)**



Note:

1. I/O will assume the High-Z state if CS# = V<sub>IH</sub> or OE# = V<sub>IH</sub>.

WRITE CYCLE NO. 4<sup>(1, 2, 3)</sup> (UB# & LB# Controlled, CS# = OE# = LOW)



Notes:

- 1 If OE# is low during write cycle, tHZWE must be met in the application. Do not apply input signal during this period. Data output from the previous READ operation will drive IO BUS.
- 2 Due to the restriction of note1, OE# is recommended to be HIGH during write period.
- 3 WE# stays LOW in this example. If WE# toggles, tPWE and tHZWE must be considered.



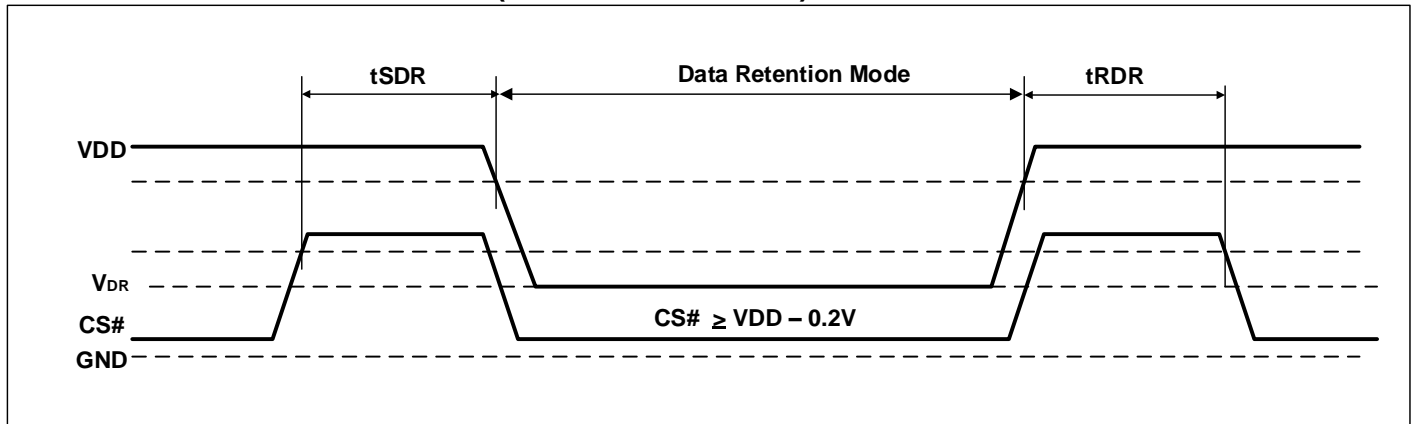
## DATA RETENTION CHARACTERISTICS<sup>(2)</sup>

Symbol	Parameter	Test Condition	OPTION	Min.	Typ.	Max.	Unit
V <sub>DR</sub>	V <sub>DD</sub> for Data Retention	See Data Retention Waveform	V <sub>DD</sub> = 2.4V to 3.6V	2.0		-	V
			V <sub>DD</sub> = 1.65V to 2.2V	1.2		-	
I <sub>DR</sub>	Data Retention Current	V <sub>DD</sub> = V <sub>DR</sub> (min.), CS# ≥ V <sub>DD</sub> - 0.2V, VIN ≤ 0.2V or VIN ≥ V <sub>DD</sub> - 0.2V	Com.	-	3 <sup>(1)</sup>	8	mA
			Ind.	-	-	10	
			Auto	-	-	20	
t <sub>SDR</sub>	Data Retention Setup Time	See Data Retention Waveform		0	-	-	ns
t <sub>RDR</sub>	Recovery Time	See Data Retention Waveform		t <sub>RC</sub>	-	-	ns

Notes:

1. Typical value indicates the value for the center of distribution, measured at V<sub>DD</sub> = V<sub>DR</sub> (min.), T<sub>A</sub> = 25 °C and not 100% tested.
2. VDD power down slope must be longer than 100 us/volt when enter into Data Retention Mode.

## DATA RETENTION WAVEFORM (CS# CONTROLLED)



## ORDERING INFORMATION

### Industrial Range: -40°C to +85°C, Voltage Range: 1.65V to 2.2V

Speed (ns)	Order Part No.	Package
10	IS61WV12816EFALL-10BLI	48-ball mini BGA (6mm x 8mm), Lead-free
10	IS61WV12816EFALL-10B2LI	48-ball mini BGA (6mm x 8mm), Switched IO, Lead-free
10	IS61WV12816EFALL-10B3LI	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Lead-free
10	IS61WV12816EFALL-10B4LI	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Switched IO, Lead-free
10	IS61WV12816EFALL-10B5LI	48-ball mini BGA mini BGA (6mm x 8mm), ERR1/ERR2 Pins, Lead-free
10	IS61WV12816EFALL-10TLI	TSOP (Type II) , Lead-free
10	IS61WV12816EFALL-10T2LI	TSOP (Type II), ERR1 Pin , Lead-free

### Industrial Range: -40°C to +85°C, Voltage Range: 2.4V to 3.6V

Speed (ns) <sup>(1)</sup>	Order Part No.	Package
10 (8)	IS61WV12816EFBLL-10BLI	48-ball mini BGA (6mm x 8mm), Lead-free
10 (8)	IS61WV12816EFBLL-10B2LI	48-ball mini BGA (6mm x 8mm), Switched IO, Lead-free
10 (8)	IS61WV12816EFBLL-10B3LI	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Lead-free
10 (8)	IS61WV12816EFBLL-10B4LI	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Switched IO, Lead-free
10 (8)	IS61WV12816EFBLL-10B5LI	48-ball mini BGA mini BGA (6mm x 8mm), ERR1/ERR2 Pins, Lead-free
10 (8)	IS61WV12816EFBLL-10TLI	TSOP (Type II) , Lead-free
10 (8)	IS61WV12816EFBLL-10T2LI	TSOP (Type II), ERR1 Pin , Lead-free

Note:

1. Speed = 8ns when VDD = 3.3V +/-10%. Speed = 10ns when VDD = 2.4V to 3.6V

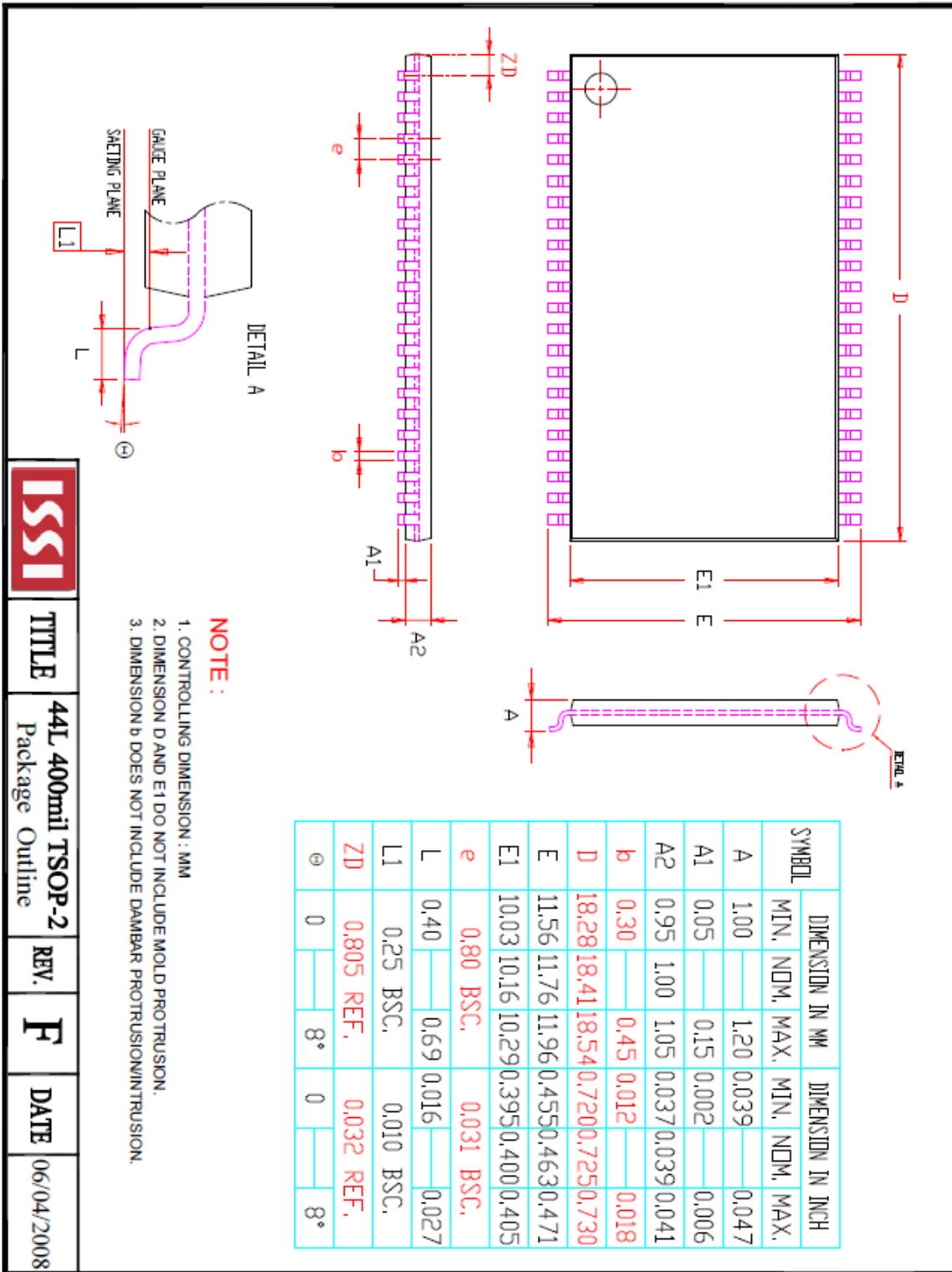
**Automotive (A3) Range: -40°C to +125°C, Voltage Range: 1.65V to 2.2V**

Speed (ns)	Order Part No.	Package
12	IS64WV12816EFALL-12BLA3	48-ball mini BGA (6mm x 8mm), Lead-free
12	IS64WV12816EFALL-12B2LA3	48-ball mini BGA (6mm x 8mm), Switched IO, Lead-free
12	IS64WV12816EFALL-12B3LA3	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Lead-free
12	IS64WV12816EFALL-12B4LA3	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Switched IO, Lead-free
12	IS64WV12816EFALL-12B5LA3	48-ball mini BGA mini BGA (6mm x 8mm), ERR1/ERR2 Pins, Lead-free
12	IS64WV12816EFALL-12CTLA3	TSOP (Type II) , Copper Lead-frame, Lead-free
12	IS64WV12816EFALL-12CT2LA3	TSOP (Type II), ERR1 Pin , Copper Lead-frame ,Lead-free

**Automotive (A3) Range: -40°C to +125°C, Voltage Range: 2.4V to 3.6V**

Speed (ns)	Order Part No.	Package
10	IS64WV12816EFBLL-10BLA3	48-ball mini BGA (6mm x 8mm), Lead-free
10	IS64WV12816EFBLL-10B2LA3	48-ball mini BGA (6mm x 8mm), Switched IO, Lead-free
10	IS64WV12816EFBLL-10B3LA3	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Lead-free
10	IS64WV12816EFBLL-10B4LA3	48-ball mini BGA (6mm x 8mm), ERR1 Pin, Switched IO, Lead-free
10	IS64WV12816EFBLL-10B5LA3	48-ball mini BGA mini BGA (6mm x 8mm), ERR1/ERR2 Pins, Lead-free
10	IS64WV12816EFBLL-10CTLA3	TSOP (Type II) , Copper Lead-frame, Lead-free
10	IS64WV12816EFBLL-10CT2LA3	TSOP (Type II), ERR1 Pin , Copper Lead-frame ,Lead-free

PACKAGE INFORMATION



TITLE

44L 400mil TSOP-2  
Package Outline

REV.

F

DATE

06/04/2008