CF4320H
CompactFlash™ BUS-INTERFACE CHIP WITH ±15-kV ESD PROTECTION, TRANSLATION, AND CARD-DETECT CIRCUITRY

SCES655A – APRIL 2006 – REVISED AUGUST 2006

FEATURES

- **±15-kV Human-Body Model (HBM) ESD Protection on Card Side**
- **Logic-Level Translation Between 1.8-V, 2.5-V, 3.3-V, and 5-V Supplies**
- **Integrated Card-Detect Circuitry**
- **Integrated Pullup/Pulldown Resistors Save Board Space and Cost**
- **Matched Pinout With CompactFlash™ (CF) Connector Pin Configurations to Optimize PCB Layout**
- **Input-Disable Feature Allows Floating Input Conditions**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Offered in 114-Ball LFBGA Package for Space-Constrained Applications**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **ESD Performance**
  - **– ±15-kV HBM**
  - **– ±4-kV IEC61000-4-2, Contact Discharge (Latch-Up Immune)**

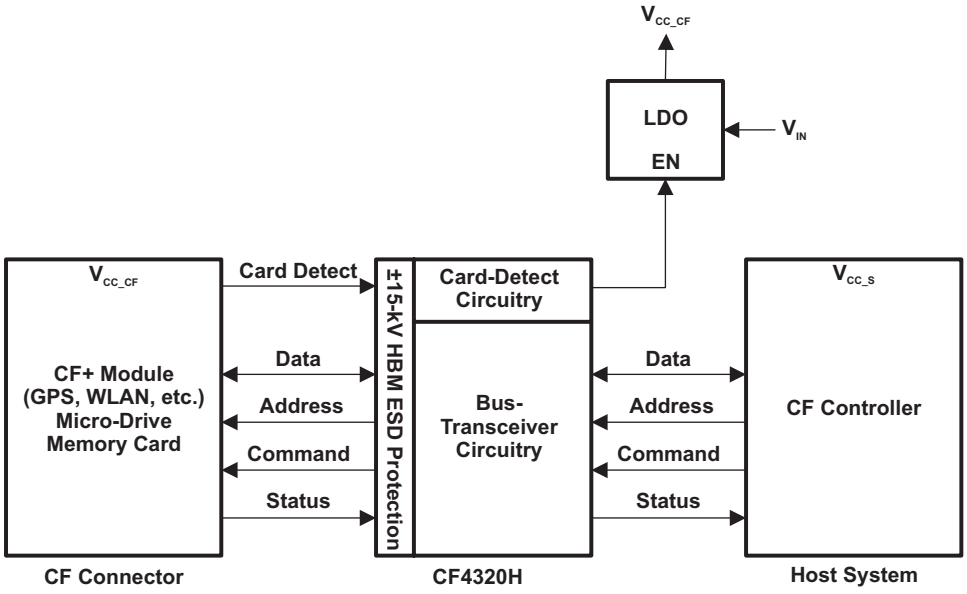
TARGET APPLICATIONS

- **GPS PDAs**
- **PDA Phones**
- **Industrial PDAs**
- **High-End Digital Cameras**

DESCRIPTION/ORDERING INFORMATION

The CF4320H is a CompactFlash™ (CF) interface device designed to provide a single-chip solution for CF card interfaces. Separate V_{CC} rails for the system-bus side and the CF connector-bus side allow voltage-level shifting. This is helpful for interfacing between a core chipset that may operate from 3.3 V down to 1.65 V, and CF cards that operate from 3.3-V or 5-V supply voltages. All the input buffers feature the input-disable function, which allows conditional floating input signals. The input, output, and I/O buffers on the CF connector side have been defined to comply with CF+ and CF specification revisions 1.4 and 2.0.

TYPICAL APPLICATION



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CARD-DETECT CIRCUIT

The CF4320H has an integrated card-detect circuit that generates a LOW card-detect signal when a CF card is plugged into the socket. This circuit is supplied by a separate power-supply pin, V_{CC_SD}, which operates from 1.65 V to 5.5 V. The card-detect signal can be used to control a voltage regulator, which may power the CF slot and the CF side of the CF4320H. The inputs to this circuitry ($\overline{CD1}$ and $\overline{CD2}$) have internal pullup resistors to pull them to a HIGH logic state if there is no card in the CF slot. V_{CC_SD} is particularly helpful when the core processor operates at a low V_{CC}, but the regulator needs a higher control-signal voltage.

CARD-DETECT SIGNALS

INPUTS		OUTPUT
$\overline{CD1}$	$\overline{CD2}$	$\overline{SCD}$
L	L	L
L	H	H
H	L	H
H	H	H

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	LFBGA – GKF	Tape and reel	CF4320HGKFR	CF4320
	LFBGA – ZKF	Tape and reel	CF4320HZKFR	CF4320

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

BUS-TRANSCEIVER CIRCUIT

Command and Status Bits

Most CF controllers are embedded in processors or microcontrollers and use GPIOs to send command signals and receive status signals from the card to manage operation. The CF interface consists of eight control signals and six status signals. The CF standard requires that each of these signals have a 100-kΩ pullup resistor. The CF4320H includes an internal 100-kΩ pullup resistor on the input of each of these signals, which saves board real estate and lowers overall system cost

**COMMAND LINE BUFFERS(1)
(BVD1, BVD2, $\overline{INPACK}$, $\overline{OE}$, $\overline{IORD}$, $\overline{IOWR}$,
READY, $\overline{REG}$, $\overline{CE1}$, $\overline{CE2}$, $\overline{WAIT}$, $\overline{WE}$, WP)**

INPUTS			OUTPUT
$\overline{MASTER\_EN}$	$\overline{BUF\_EN}$	INPUT	
L	L	H	H
L	L	L	L
L	H	X	Z, Command line buffer inputs can float.
H	X	X	Z, low-power mode

(1) X = H or L

RESET(1)

INPUTS		OUTPUT
$\overline{MASTER\_EN}$	SRESET	RESET
L	H	H
L	L	L
H	X	Z, low-power mode

(1) X = H or L

Data Bits

The CF4320H has 16 data lines organized as two groups of 8 bits each. The $\overline{ENL}$ signal controls the lower 8 bits (D07–D00), while the $\overline{ENH}$ signal controls the upper 8 bits (D15–D08).

LOWER 8-BIT DATA BUS TRANSCEIVERS(1)
(D07–D00, SD07–SD00)

INPUTS			OPERATION
$\overline{MASTER\_EN}$	$\overline{ENL}$	DIR ($\overline{S}$/CF)	
L	L	H	SD data to D bus
L	L	L	D data to SD bus
L	H	X	Isolation. D07–D00 and SD07–SD00 inputs can float.
H	X	X	Isolation, low-power mode

(1) X = H or L

UPPER 8-BIT DATA BUS TRANSCEIVERS(1)
(D15–D08, SD15–SD08)

INPUTS			OPERATION
$\overline{MASTER\_EN}$	$\overline{ENH}$	DIR ($\overline{S}$/CF)	
L	L	H	SD data to D bus
L	L	L	D data to SD bus
L	H	X	Isolation. D15–D08 and SD15–SD08 inputs can float.
H	X	X	Isolation, low-power mode

(1) X = H or L

Address Bits

The CF4320H has 11 unidirectional address bits flowing from the system to the CF card.

ADDRESS BUS BUFFERS(1)

INPUTS			OUTPUT A
$\overline{MASTER\_EN}$	$\overline{BUF\_EN}$	SA	
L	L	H	H
L	L	L	L
L	H	X	Z, SA inputs can float.
H	X	X	Z, low-power mode

(1) X = H or L

Direction Signal Bit

The DIR($\overline{S}$/CF) input controls the data direction between the system bus and the CF card. The CF4320H has circuitry to generate a DIR_OUT signal using the $\overline{SOE}$ and $\overline{SIORD}$ signals. DIR($\overline{S}$/CF) and DIR_OUT are placed adjacent to each other, which is convenient for connecting DIR($\overline{S}$/CF) and DIR_OUT, if DIR_OUT is used. This saves an additional signal from the system controller to control the data direction. When either $\overline{SOE}$ or $\overline{SIORD}$ is low, the data direction is from the CF card side to the system side (DIR_OUT = L).

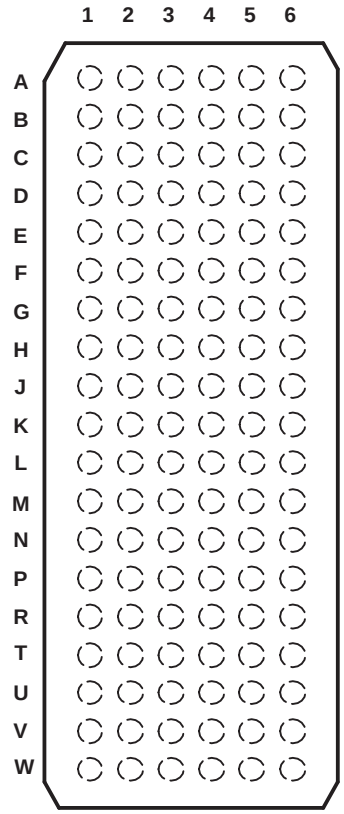
DIR_OUT(1)

INPUTS				OUTPUT DIR_OUT
$\overline{BUF\_EN}$	$\overline{MASTER\_EN}$	$\overline{SOE}$	$\overline{SIORD}$	
L	L	L	L	L
L	L	L	H	L
L	L	H	L	L
L	L	H	H	H
H	L	X	X	L
X	H	X	X	Z, low-power mode

(1) X = H or L

BOARD-OPTIMIZED PIN CONFIGURATION

GKF OR ZKF PACKAGE
(TOP VIEW)



TERMINAL ASSIGNMENTS

	1	2	3	4	5	6
A	D12	D04	D03	SD14	SD12	SD11
B	D13	D05	D11	SD13	SD10	SD09
C	D14	D06	SD15	$\overline{\text{SINPACK}}$	SD08	SD07
D	D15	D07	V_{CC_CF}	V_{CC_S}	SD06	SD05
E	$\overline{\text{CE2}}$	$\overline{\text{CE1}}$	GND	GND	SD04	SD03
F	$\overline{\text{OE}}$	A10	V_{CC_CF}	V_{CC_S}	SD02	SD01
G	A09	$\overline{\text{IORD}}$	GND	GND	SD00	$\overline{\text{SCE1}}$
H	A08	$\overline{\text{IOWR}}$	V_{CC_CF}	V_{CC_S}	$\overline{\text{ENL}}$	$\overline{\text{ENH}}$
J	A07	$\overline{\text{WE}}$	GND	GND	$\overline{\text{MASTER\_EN}}$	$\overline{\text{BUF\_EN}}$
K	A06	READY	A05	$\overline{\text{SCE2}}$	$\overline{\text{SOE}}$	$\overline{\text{SIORD}}$
L	A04	RESET	GND	GND	$\overline{\text{SWE}}$	$\overline{\text{SIOWR}}$
M	A03	$\overline{\text{WAIT}}$	V_{CC_CF}	V_{CC_S}	SREADY	SRESET
N	A02	$\overline{\text{INPACK}}$	GND	GND	$\overline{\text{SWAIT}}$	$\overline{\text{SREG}}$
P	A01	$\overline{\text{REG}}$	V_{CC_CF}	GND	SBVD2	SBVD1
R	A00	BVD2	V_{CC_CF}	V_{CC_S}	SA10	SWP
T	D00	BVD1	V_{CC_SD}	DIR($\overline{\text{S}}$/CF)	SA08	SA09
U	D01	D08	$\overline{\text{CD1}}$	DIR_OUT	SA06	SA07
V	D02	D09	$\overline{\text{CD2}}$	SA00	SA04	SA05
W	WP	D10	$\overline{\text{SCD}}$	SA01	SA02	SA03

TERMINAL FUNCTIONS

TERMINAL		DESCRIPTION	REFERENCED TO	I/O(1)
NO.	NAME			
A1	D12	Data bit 12 connected to card	V_{CC_CF}	I/O
B1	D13	Data bit 13 connected to card	V_{CC_CF}	I/O
C1	D14	Data bit 14 connected to card	V_{CC_CF}	I/O
D1	D15	Data bit 15 connected to card	V_{CC_CF}	I/O
E1	$\overline{CE2}$	Card enable connected to card	V_{CC_CF}	O
F1	$\overline{OE}$	Output enable connected to card	V_{CC_CF}	O
G1	A09	Address bit 9 connected to card	V_{CC_CF}	O
H1	A08	Address bit 8 connected to card	V_{CC_CF}	O
J1	A07	Address bit 7 connected to card	V_{CC_CF}	O
K1	A06	Address bit 6 connected to card	V_{CC_CF}	O
L1	A04	Address bit 4 connected to card	V_{CC_CF}	O
M1	A03	Address bit 3 connected to card	V_{CC_CF}	O
N1	A02	Address bit 2 connected to card	V_{CC_CF}	O
P1	A01	Address bit 1 connected to card	V_{CC_CF}	O
R1	A00	Address bit 0 connected to card	V_{CC_CF}	O
T1	D00	Data bit 0 connected to card	V_{CC_CF}	I/O
U1	D01	Data bit 1 connected to card	V_{CC_CF}	I/O
V1	D02	Data bit 2 connected to card	V_{CC_CF}	I/O
W1	WP	Write protect connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_CF}	I
A2	D04	Data bit 4 connected to card	V_{CC_CF}	I/O
B2	D05	Data bit 5 connected to card	V_{CC_CF}	I/O
C2	D06	Data bit 6 connected to card	V_{CC_CF}	I/O
D2	D07	Data bit 7 connected to card	V_{CC_CF}	I/O
E2	$\overline{CE1}$	Card enable connected to card	V_{CC_CF}	O
F2	A10	Address bit 10 connected to card	V_{CC_CF}	O
G2	$\overline{IORD}$	I/O read connected to card	V_{CC_CF}	O
H2	$\overline{IOWR}$	I/O write connected to card	V_{CC_CF}	O
J2	$\overline{WE}$	Write enable connected to card	V_{CC_CF}	O
K2	READY	Ready connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_CF}	I
L2	RESET	Reset connected to card	V_{CC_CF}	O
M2	$\overline{WAIT}$	Wait connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_CF}	I
N2	$\overline{INPACK}$	Input acknowledge connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_CF}	I
P2	$\overline{REG}$	Register connected to card	V_{CC_CF}	O
R2	BVD2	BVD2 connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_CF}	I
T2	BVD1	BVD1 connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_CF}	I
U2	D08	Data bit 8 connected to card	V_{CC_CF}	I/O
V2	D09	Data bit 9 connected to card	V_{CC_CF}	I/O
W2	D10	Data bit 10 connected to card	V_{CC_CF}	I/O
A3	D03	Data bit 3 connected to card	V_{CC_CF}	I/O
B3	D11	Data bit 11 connected to card	V_{CC_CF}	I/O
C3	SD15	Data bit 15 connected to controller	V_{CC_S}	I/O
D3	V_{CC_CF}	Card-side supply voltage. V_{CC_CF} powers all card-side inputs, outputs, and I/Os.		Power
E3	GND	Ground		
F3	V_{CC_CF}	Card-side supply voltage. V_{CC_CF} powers all card-side inputs, outputs, and I/Os.		Power
G3	GND	Ground		

(1) I = input, O = output, I/O = input/output

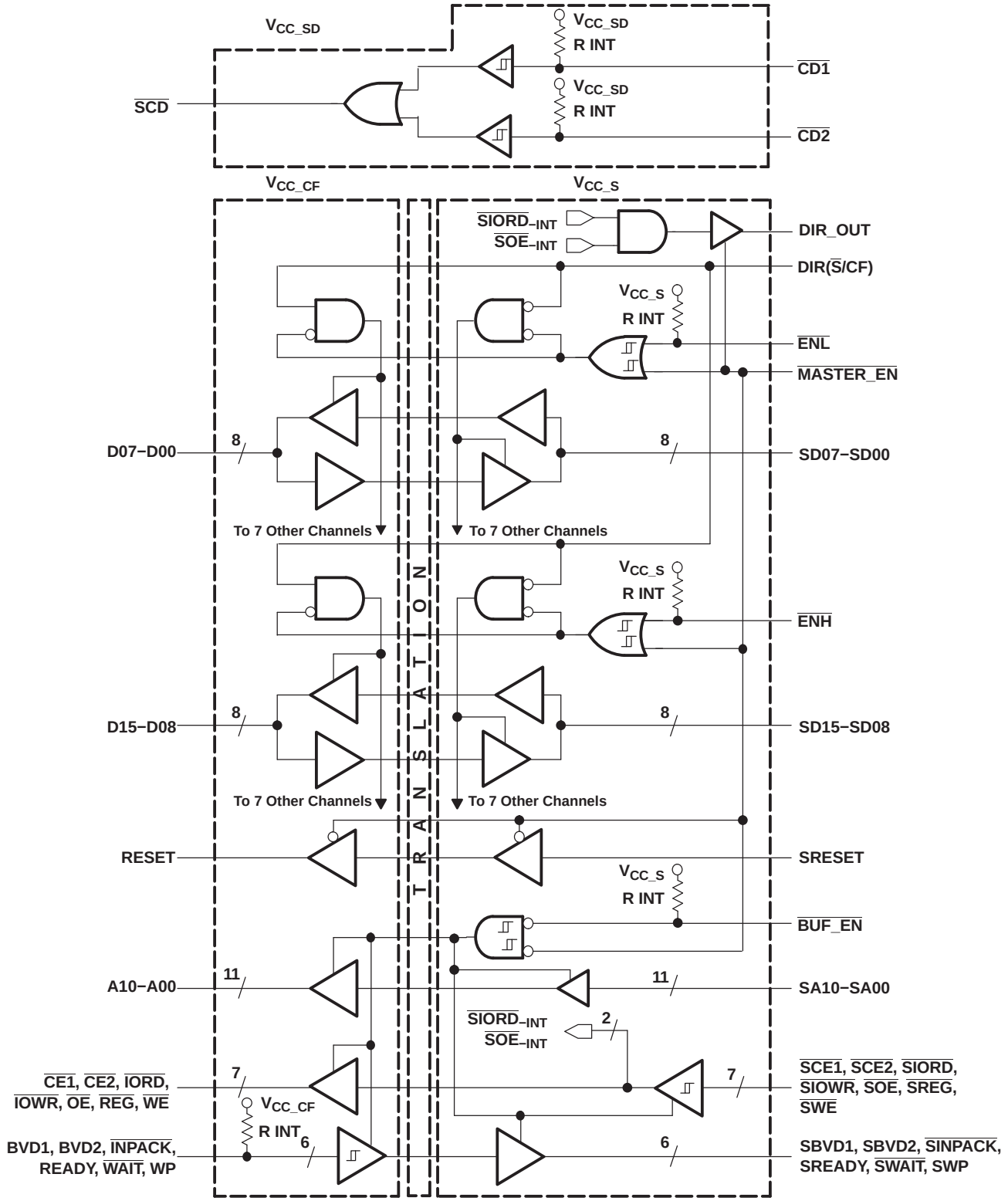
TERMINAL FUNCTIONS (continued)

TERMINAL		DESCRIPTION	REFERENCED TO	I/O(1)
NO.	NAME			
H3	V_{CC_CF}	Card-side supply voltage. V_{CC_CF} powers all card-side inputs, outputs, and I/Os.		Power
J3	GND	Ground		
K3	A05	Address bit 5 connected to card	V_{CC_CF}	O
L3	GND	Ground		
M3	V_{CC_CF}	Card-side supply voltage. V_{CC_CF} powers all card-side inputs, outputs, and I/Os.		Power
N3	GND	Ground		
P3	V_{CC_CF}	Card-side supply voltage. V_{CC_CF} powers all card-side inputs, outputs, and I/Os.		Power
R3	V_{CC_CF}	Card-side supply voltage. V_{CC_CF} powers all card-side inputs, outputs, and I/Os.		Power
T3	V_{CC_SD}	Card-detect supply voltage. V_{CC_SD} powers the card-detect circuitry.		Power
U3	$\overline{CD1}$	Card detect connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_SD}	I
V3	$\overline{CD2}$	Card detect connected to card. Pulled up to V_{CC_CF} through 100 kΩ.	V_{CC_SD}	I
W3	$\overline{SCD}$	Card detect connected to controller	V_{CC_SD}	O
A4	SD14	Data bit 14 connected to controller	V_{CC_S}	I/O
B4	SD13	Data bit 13 connected to controller	V_{CC_S}	I/O
C4	$\overline{SINPACK}$	Input acknowledge connected to controller	V_{CC_S}	I/O
D4	V_{CC_S}	Controller-side supply voltage. V_{CC_S} powers all controller-side inputs, outputs, and I/Os.		Power
E4	GND	Ground		
F4	V_{CC_S}	Controller-side supply voltage. V_{CC_S} powers all controller-side inputs, outputs, and I/Os.		Power
G4	GND	Ground		
H4	V_{CC_S}	Controller-side supply voltage. V_{CC_S} powers all controller-side inputs, outputs, and I/Os.		Power
J4	GND	Ground		
K4	$\overline{SCE2}$	Card enable connected to controller	V_{CC_S}	I
L4	GND	Ground		
M4	V_{CC_S}	Controller-side supply voltage. V_{CC_S} powers all controller-side inputs, outputs, and I/Os.		Power
N4	GND	Ground		
P4	GND	Ground		
R4	V_{CC_S}	Controller-side supply voltage. V_{CC_S} powers all controller-side inputs, outputs, and I/Os.		Power
T4	DIR($\overline{S}$/CF)	Direction controls flow of data from system to CF and vice-versa	V_{CC_S}	I
U4	DIR_OUT	Data direction generated by CF4320H. Can be connected to DIR($\overline{S}$/CF).	V_{CC_S}	O
V4	SAO0	Address bit 0 connected to controller	V_{CC_S}	I
W4	SAO1	Address bit 1 connected to controller	V_{CC_S}	I
A5	SD12	Data bit 12 connected to controller	V_{CC_S}	I/O
B5	SD10	Data bit 10 connected to controller	V_{CC_S}	I/O
C5	SD08	Data bit 8 connected to controller	V_{CC_S}	I/O
D5	SD06	Data bit 6 connected to controller	V_{CC_S}	I/O
E5	SD04	Data bit 4 connected to controller	V_{CC_S}	I/O
F5	SD02	Data bit 2 connected to controller	V_{CC_S}	I/O
G5	SD00	Data bit 0 connected to controller	V_{CC_S}	I/O
H5	$\overline{ENL}$	Enable for data bits 0–7. Pulled up to V_{CC_S} through 100 kΩ.	V_{CC_S}	I
J5	$\overline{MASTER\_EN}$	Enable for all transceivers and buffers except the card-detect circuitry	V_{CC_S}	I
K5	$\overline{SOE}$	Output enable connected to controller	V_{CC_S}	I
L5	$\overline{SWE}$	Write enable connected to controller	V_{CC_S}	I
M5	SREADY	Ready connected to controller	V_{CC_S}	O

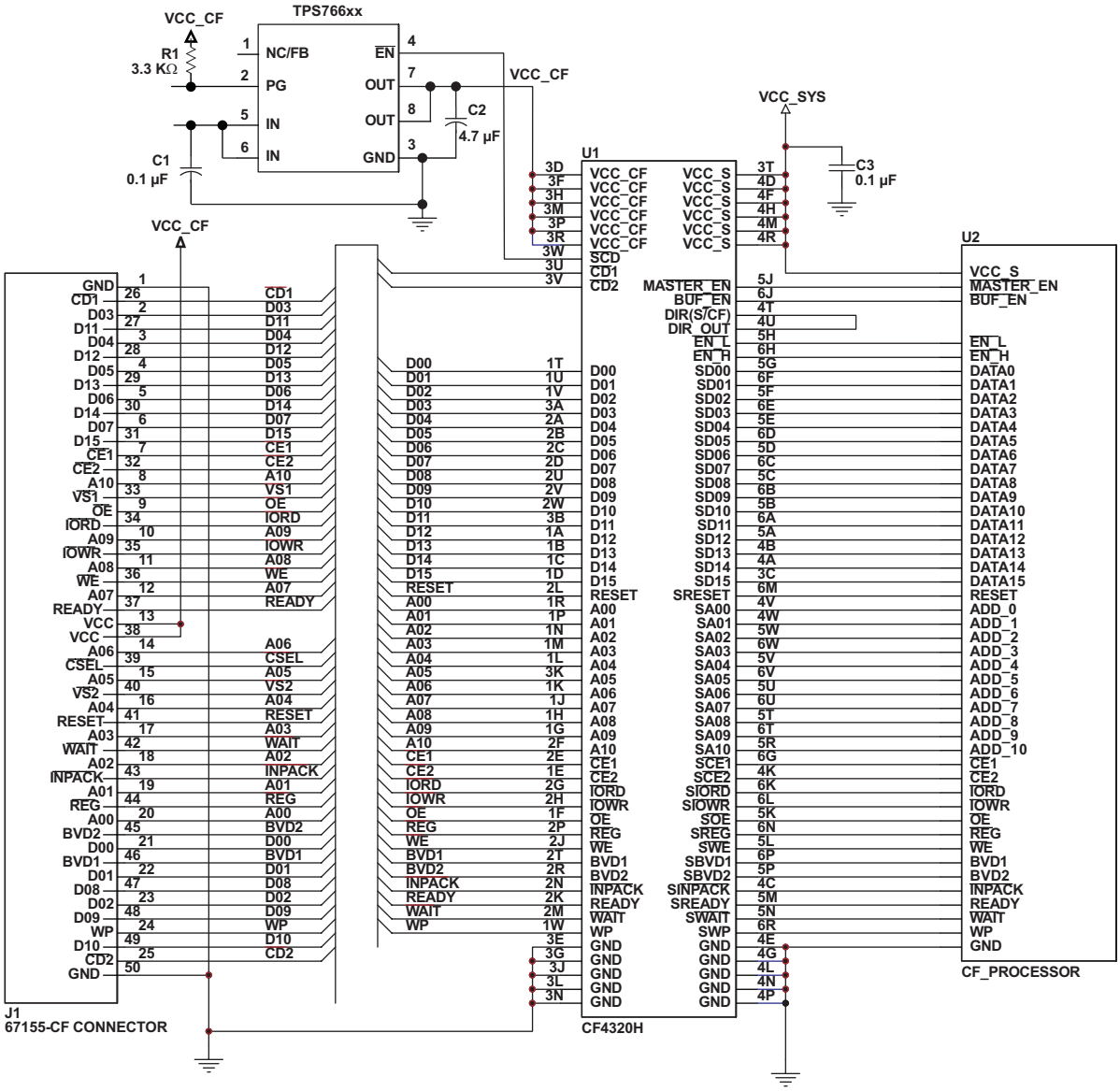
TERMINAL FUNCTIONS (continued)

TERMINAL		DESCRIPTION	REFERENCED TO	I/O(1)
NO.	NAME			
N5	$\overline{\text{SWAIT}}$	Wait connected to controller	V_{CC_S}	O
P5	SBVD2	BVD2 connected to controller	V_{CC_S}	O
R5	SA10	Address bit 10 connected to controller	V_{CC_S}	I
T5	SA08	Address bit 8 connected to controller	V_{CC_S}	I
U5	SA06	Address bit 6 connected to controller	V_{CC_S}	I
V5	SA04	Address bit 4 connected to controller	V_{CC_S}	I
W5	SA02	Address bit 2 connected to controller	V_{CC_S}	I
A6	SD11	Data bit 11 connected to controller	V_{CC_S}	I/O
B6	SD09	Data bit 9 connected to controller	V_{CC_S}	I/O
C6	SD07	Data bit 7 connected to controller	V_{CC_S}	I/O
D6	SD05	Data bit 5 connected to controller	V_{CC_S}	I/O
E6	SD03	Data bit 3 connected to controller	V_{CC_S}	I/O
F6	SD01	Data bit 1 connected to controller	V_{CC_S}	I/O
G6	$\overline{\text{SCE1}}$	Card enable connected to controller	V_{CC_S}	I
H6	$\overline{\text{ENH}}$	Enable for data bits 8–15. Pulled up to V_{CC_S} through 100 kΩ.	V_{CC_S}	I
J6	$\overline{\text{BUF\_EN}}$	Enable for address and control/status lines. Pulled up to V_{CC_S} through 100 kΩ.	V_{CC_S}	I
K6	$\overline{\text{SIORD}}$	I/O read connected to controller	V_{CC_S}	I
L6	$\overline{\text{SIOWR}}$	I/O write connected to controller	V_{CC_S}	I
M6	SRESET	Reset connected to controller	V_{CC_S}	I
N6	$\overline{\text{SREG}}$	Register connected to controller	V_{CC_S}	I
P6	SBVD1	BVD1 connected to controller	V_{CC_S}	O
R6	SWP	Write protect connected to controller	V_{CC_S}	O
T6	SA09	Address bit 9 connected to controller	V_{CC_S}	I
U6	SA07	Address bit 7 connected to controller	V_{CC_S}	I
V6	SA05	Address bit 5 connected to controller	V_{CC_S}	I
W6	SA03	Address bit 3 connected to controller	V_{CC_S}	I

LOGIC DIAGRAM



NOTE: R INT ≥ 100 kΩ


TPS766xx
VCC_CF
R1
3.3 KΩ
NC/FB
PG
IN
IN
EN
OUT
OUT
GND
C1
0.1 µF
C2
4.7 µF
VCC_SYS
C3
0.1 µF
U1
U2
J1
67155-CF CONNECTOR
CF4320H
CF_PROCESSOR

Absolute Maximum Ratings(1)

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

				MIN	MAX	UNIT
V_{CC_S}	Supply voltage range			–0.5	4.6	V
V_{CC_CF} V_{CC_SD}				–0.5	6.5	
V_I	Input voltage range	I/O ports	SD, SA(2)	–0.5	4.6	V
			D, A	–0.5	6.5	
		Input ports	$\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SOE}$, $\overline{SREG}$, $\overline{SWE}$	–0.5	4.6	
			BVD1, BVD2, READY, $\overline{INPACK}$, $\overline{WAIT}$, WP	–0.5	6.5	
		Control ports	DIR($\overline{S}$/CF), $\overline{MASTER\_EN}$, $\overline{ENL}$, $\overline{ENH}$	–0.5	4.6	
V_O	Voltage range applied to any output in the high-impedance or power-off state(2)	System port		–0.5	4.6	V
		CF port		–0.5	6.5	
V_O	Voltage range applied to any output in the high or low state(2)(3)	System port		–0.5	V_{CC_S} + 0.5	V
		CF port		–0.5	V_{CC_CF} + 0.5	
I_{IK}	Input clamp current	$V_I < 0$			–50	mA
I_{OK}	Output clamp current	$V_O < 0$			–50	mA
I_O	Continuous output current				±50	mA
	Continuous current through each V_{CC_S}, V_{CC_CF}, V_{CC_SD}, or GND				±100	mA
θ_{JA}	Package thermal impedance(4)				36	°C/W
T_{stg}	Storage temperature range			–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
(3) This value is limited to 6.5 V maximum.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions(1)(2)(3)

			V_{CCI}	V_{CCO}	MIN	MAX	UNIT
V_{CC_SD}	Card-detect supply voltage				1.65	5.5	V
V_{CC_S}	System-side supply voltage				1.65	V_{CC_CF}	V
V_{CC_CF}	CF-side supply voltage				3	5.5	V
V_{IH}	High-level input voltage	Card-detect inputs ($\overline{CD1}$, $\overline{CD2}$)	1.65 V to 5.5 V		$V_{CC\_SD} \times 0.65$		V
V_{IL}	Low-level input voltage	Card-detect inputs ($\overline{CD1}$, $\overline{CD2}$)	1.65 V to 5.5 V			$V_{CC\_SD} \times 0.35$	V
V_{IH}	High-level input voltage	System port (SD, SA, SRESET)	1.65 V to 1.95 V		$V_{CC\_S} \times 0.65$		V
			1.95 V to 2.7 V		1.7		
			2.7 V to 3.6 V		2		
V_{IL}	Low-level input voltage	System port (SD, SA, SRESET)	1.65 V to 1.95 V			$V_{CC\_S} \times 0.35$	V
			1.95 V to 2.7 V			0.7	
			2.7 V to 3.6 V			0.8	
V_{IH}	High-level input voltage	Control inputs (DIR, $\overline{MASTER\_EN}$, $\overline{ENL}$, $\overline{ENH}$, $\overline{BUF\_EN}$)	1.65 V to 1.95 V		$V_{CC\_S} \times 0.65$		V
			1.95 V to 2.7 V		1.7		
			2.7 V to 3.6 V		2		
V_{IL}	Low-level input voltage	Control inputs (DIR, $\overline{MASTER\_EN}$, $\overline{ENL}$, $\overline{ENH}$, $\overline{BUF\_EN}$)	1.65 V to 1.95 V			$V_{CC\_S} \times 0.35$	V
			1.95 V to 2.7 V			0.7	
			2.7 V to 3.6 V			0.8	
V_{IH}	High-level input voltage	CF port (D, A)	3 V to 3.6 V		2		V
			4.5 V to 5.5 V		$V_{CC\_CF} \times 0.7$		
V_{IL}	Low-level input voltage	CF port (D, A)	3 V to 3.6 V			0.8	V
			4.5 V to 5.5 V			$V_{CC\_CF} \times 0.3$	
V_O	Card-detect output voltage				0	V_{CC_SD}	V
	System-side output voltage				0	V_{CC_S}	
	CF-side output voltage				0	V_{CC_CF}	
I_{OH}	High-level output current	Card detect		1.65 V to 1.95 V		–2	mA
				1.95 V to 2.7 V		–4	
				2.7 V to 3.6 V		–8	
				4.5 V to 5.5 V		–12	
I_{OL}	Low-level output current	Card detect		1.65 V to 1.95 V		2	mA
				1.95 V to 2.7 V		4	
				2.7 V to 3.6 V		8	
				4.5 V to 5.5 V		12	
I_{OH}	High-level output current	System port		1.65 V to 1.95 V		2	mA
				1.95 V to 2.7 V		6	
				2.7 V to 3.6 V		12	
I_{OL}	Low-level output current	System port		1.65 V to 1.95 V		2	mA
				1.95 V to 2.7 V		6	
				2.7 V to 3.6 V		12	
I_{OH}	High-level output current	CF port		3 V to 3.6 V		12	mA
				4.5 V to 5.5 V		16	
I_{OL}	Low-level output current	CF port		3 V to 3.6 V		12	mA
				4.5 V to 5.5 V		16	

(1) V_{CCI} is the V_{CC} associated with the input port.
(2) V_{CCO} is the V_{CC} associated with the output port.
(3) All unused data inputs of the device must be held at V_{CCI} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

Recommended Operating Conditions (continued)

		V_{CCI}	V_{CCO}	MIN	MAX	UNIT
$\Delta t/\Delta v$	Input transition rise or fall rate	1.65 V to 2.7 V			>20	ns/V
		2.7 V to 3.6 V			>20	
		4.5 V to 5.5 V			>20	
T_A	Operating free-air temperature			–40	85	°C

Electrical Characteristics

over recommended operating free-air temperature range (CF card-detect logic) (unless otherwise noted)

PARAMETER		TEST CONDITIONS		V_{CC_SD}	T_A = 25°C			–40°C to 85°C		UNIT
					MIN	TYP	MAX	MIN	MAX	
V_{OH}		$V_I = V_{IH}$	I_{OH} = –100 µA	1.65 V to 5.5 V	V_{CC_SD} – 0.1			V_{CC_SD} – 0.2		V
			I_{OH} = –2 mA	1.65 V	1.2			1.2		
			I_{OH} = –4 mA	2.3 V	2			2		
			I_{OH} = –6 mA	2.7 V	2.3			2.3		
			I_{OH} = –8 mA	3 V	2.4			2.4		
			I_{OH} = –12 mA	4.5 V	3.8			3.8		
V_{OL}		$V_I = V_{IL}$	I_{OL} = 100 µA	1.65 V to 5.5 V			0.1		0.2	V
			I_{OL} = 2 mA	1.65 V			0.2		0.2	
			I_{OL} = 4 mA	2.3 V			0.2		0.2	
			I_{OL} = 6 mA	2.7 V			0.3		0.3	
			I_{OL} = 8 mA	3 V			0.4		0.4	
			I_{OL} = 12 mA	4.5 V			0.5		0.5	
I_I		$V_I = V_{CC\_SD}$		1.65 V to 5.5 V			±0.5		±1	µA
		V_I = 0 V					–55		–60	
I_{off}		V_I or V_O = 0 to 5.5 V		0 V			55		60	µA
R_{INT}		$\overline{CD1}$ = GND, $\overline{CD2}$ = GND		1.65 V to 5.5 V		150	300	100	300	kΩ
I_{CC_SD}		$\overline{CD1}$ and $\overline{CD2}$ = V_{CC_SD}, I_{O_SD} = 0		5.5 V			0.5		1	µA
		$\overline{CD1}$ or $\overline{CD2}$ = GND, $\overline{CD2}$ or $\overline{CD1}$ = V_{CC_SD}, I_{O_SD} = 0					10		10	
C_I	$\overline{CD1}$ or $\overline{CD2}$	$V_I = V_{CC\_SD}$ or GND		5.5 V		9				pF

Electrical Characteristics[1][2]

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

PARAMETER		TEST CONDITIONS		V_{CC_S}	V_{CC_CF}	T_A = 25°C			–40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
V_{T+}	$\overline{SOE}$, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SWE}$, $\overline{SREG}$			1.65 V	3 V to 5.5 V		0.95		0.6	1.4	V
				2.3 V			1.32		0.9	1.8	
				2.7 V			1.49		1	2	
				3 V			1.67		1.2	2.2	
$V_{T–}$	$\overline{SOE}$, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SWE}$, $\overline{SREG}$			1.65 V	3 V to 5.5 V		0.66		0.19	0.8	V
				2.3 V			0.87		0.39	1.15	
				2.7 V			0.98		0.49	1.32	
				3 V			1.08		0.59	1.5	
ΔV_T	$\overline{SOE}$, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SWE}$, $\overline{SREG}$			1.65 V	3 V to 5.5 V		0.31		0.1	0.7	V
				2.3 V			0.46		0.25	0.7	
				2.7 V			0.52		0.3	0.9	
				3 V			0.61		0.4	0.9	
V_{T+}	BVD1, BVD2, READY, $\overline{INPACK}$, $\overline{WAIT}$			1.65 V to 3.6 V	3 V		1.67		1.3	2.2	V
					4.5 V		2.44		1.9	3.1	
$V_{T–}$	BVD1, BVD2, READY, $\overline{INPACK}$, $\overline{WAIT}$, WP			1.65 V to 3.6 V	3 V		1.11		0.6	1.5	V
					4.5 V		1.43		1	2	
ΔV_T	BVD1, BVD2, READY, $\overline{INPACK}$, $\overline{WAIT}$			1.65 V to 3.6 V	3 V		0.58		0.35	1	V
					4.5 V		1.02		0.6	1.5	
V_{T+}	$\overline{BUF\_EN}$, $\overline{ENH}$, $\overline{ENL}$, MASTER_EN			1.65 V	3 V to 5.5 V		1		0.6	1.4	V
				2.3 V			1.37		1.1	1.8	
				2.7 V			1.54		1.1	2	
				3 V			1.72		1.3	2.2	
$V_{T–}$	$\overline{BUF\_EN}$, $\overline{ENH}$, $\overline{ENL}$, MASTER_EN			1.65 V	3 V to 5.5 V		0.34		0.15	1	V
				2.3 V			0.63		0.15	1.2	
				2.7 V			0.75		0.2	1.32	
				3 V			0.88		0.4	1.5	
ΔV_T	$\overline{BUF\_EN}$, $\overline{ENH}$, $\overline{ENL}$, MASTER_EN			1.65 V	3 V to 5.5 V		0.67		0.08	1.1	V
				2.3 V			0.76		0.2	1.2	
				2.7 V			0.8		0.26	1.3	
				3 V			0.86		0.3	1.4	
V_{OH_S}		$V_I = V_{IH}$	I_{OH} = –100 µA	1.65 V to 3.6 V	3 V to 5.5 V	V_{CC_S} – 0.1			V_{CC_S} – 0.2		V
			I_{OH} = –2 mA	1.65 V		1.2			1.2		
			I_{OH} = –4 mA	2.3 V		2			2		
			I_{OH} = –6 mA	2.7 V		2.3			2.3		
			I_{OH} = –12 mA	3 V		2.4			2.4		
V_{OL_S}		$V_I = V_{IL}$	I_{OL} = 100 µA	1.65 V to 3.6 V	3 V to 5.5 V			0.1		0.2	V
			I_{OL} = 2 mA	1.65 V				0.2		0.2	
			I_{OL} = 4 mA	2.3 V				0.2		0.2	
			I_{OL} = 6 mA	2.7 V				0.3		0.3	
			I_{OL} = 12 mA	3 V				0.5		0.5	

(1) V_{CCI} is the V_{CC} associated with the input port.
(2) V_{CCO} is the V_{CC} associated with the output port.

Electrical Characteristics[1][2] (continued)

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

PARAMETER		TEST CONDITIONS		V_{CC_S}	V_{CC_CF}	T_A = 25°C			–40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
V_{OH_CF}		$V_I = V_{IH}$	I_{OH} = –100 µA	1.65 V to 3.6 V	3 V to 5.5 V	V_{CC_CF} – 0.1			V_{CC_CF} – 0.2		V
			I_{OH} = 12 mA		3 V	2.4			2.4		
			I_{OH} = 16 mA		5.5 V	3.8			3.8		
V_{OL_CF}		$V_I = V_{IL}$	I_{OL} = 100 µA	1.65 V to 3.6 V	3 V to 5.5 V			0.1		0.2	V
			I_{OL} = 12 mA		3 V			0.5		0.5	
			I_{OL} = 16 mA		5.5 V			0.5		0.5	
I_I	Inputs without pullup resistor	V_I = GND to V_{CCI}[3]		1.65 V to 3.6 V	3.6 V to 5.5 V			±0.5		±1	µA
	Inputs with pullup resistor	$V_I = V_{CCI}$[3]			3 V to 5.5 V			±0.5		±1	
		V_I = 0 V						55		60	
I_{off}	S port	V_I or V_O = 0 to 5.5 V		0 V	0 to 5.5 V			±0.5		±1	µA
	CF port			0 to 3.6 V	0 V			±0.5		±1	
I_{OZ}[4]	S or CF output ports	$V_O = V_{CCO}$ or GND, $V_I = V_{CCI}$ or GND	$\overline{MASTER\_EN} = V_{IH}$	3.6 V	5.5 V			±0.5		±1	µA
	CF outputs		$\overline{MASTER\_EN}$ = don't care		0 V			±0.5		±1	
I_{CC_S}	Inputs (SD15–SD00, SA10–SA00, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SOE}$, $\overline{SREG}$, $\overline{SWE}$)	$V_I = V_{CC\_S}$ or GND	I_O = 0, $\overline{ENL} = V_{CC\_S}$, $\overline{ENH} = V_{CC\_S}$, $\overline{BUF\_EN} = V_{CC\_S}$, DIR($\overline{S}$/CF) = V_{CC_S}	1.65 V to 3.6 V	3.6 V to 5.5 V			1.5		3	µA
	Control inputs ($\overline{ENL}$, $\overline{ENH}$, BUF_EN)	$\overline{ENL} = \overline{ENH} = \overline{BUF\_EN} = V_{CC\_S}$	I_O = 0, DIR($\overline{S}$/CF) = V_{CC_S}, All other inputs = V_{CC_S} or GND					1.5		3	
		One of $\overline{ENL}$, $\overline{ENH}$, $\overline{BUF\_EN}$ = GND, Others = V_{CC_S}						36		36	

(1) V_{CCI} is the V_{CC} associated with the input port.
(2) V_{CCO} is the V_{CC} associated with the output port.
(3) $V_{CCI} = V_{CC\_S}$ for DIR($\overline{S}$/CF), $\overline{ENL}$, $\overline{ENH}$, SD15–SD00, SA10–SA00, $\overline{MASTER\_EN}$, SRESET, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SOE}$, $\overline{SREG}$, $\overline{SWE}$, $\overline{BUF\_EN}$
$V_{CCI} = V_{CC\_CF}$ for D15–D00, BVD1, BVD2, $\overline{INPACK}$, READY, $\overline{WAIT}$, WP
(4) For I/O ports, the parameter I_{OZ} includes the input leakage current.

Electrical Characteristics (continued)

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

PARAMETER		TEST CONDITIONS		V_{CC_S}	V_{CC_CF}	T_A = 25°C			–40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
I_{CC_CF}	Input (D15–D00)	$V_I = V_{CC\_CF}$ or GND	I_O = 0, DIR(S/CF) = GND, BVD1, BVD2, INPACK, READY, WAIT, WP = V_{CC_CF}	1.65 V to 3.6 V	3 V to 5.5 V			1.5		3	µA
	Inputs (BVD1, BVD2, INPACK, READY, WAIT, WP)	BVD1 = BVD2 = INPACK = READY WAIT = WP = V_{CC_CF}	I_O = 0, DIR(S/CF) = GND, D15–D00 = V_{CC_CF} or GND					1.5		3	
		One of BVD1, DVD2, INPACK, READY, WAIT, WP = GND, All others = V_{CC_CF}	I_O = 0, DIR(S/CF) = GND, D15–D00 = V_{CC_CF} or GND					60		60	
R_{INT}				1.65 V to 3.6 V	3 V to 5.5 V		150	300		300	kΩ
C_I	Control inputs	V_I = 3.3 V or GND		3.3 V	3.3 V		3				pF
	SAxx, SOE, SCE1, SCE2, SIORD, SIOWR, SREG, SWE						3				
	Axx, BVD1, BVD2, READY, INPACK, WAIT, WP						9				
C_{io}	S I/O ports	V_O = 3.3 V or GND		3.3 V	3.3 V		7				pF
	CF I/O ports						12				

Switching Characteristics

over recommended operating free-air temperature range ($\overline{CD1}$, $\overline{CD2}$) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC_SD}	T_A = 25°C			–40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	$\overline{CD1}$ or $\overline{CD2}$	$\overline{SCD}$	1.8 V ± 0.15 V	3.1	7.1	13.5	1.8	15.5	ns
			2.5 V ± 0.2 V	2.7	4.6	7.1	1.6	9.1	
			2.7 V	2.4	4	5.7	1.6	9.1	
			3.3 V ± 0.3 V	2	3.4	5.1	1.2	6.8	
			5 V ± 0.5 V	1.7	2.6	3.6	1	5.5	

Switching Characteristics

over recommended operating free-air temperature range (BVD1, BVD2, $\overline{INPACK}$, READY, $\overline{WAIT}$, WP) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	V_{CC_S}	V_{CC_CF}	T_A = 25°C			–40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
t_{pd}	CF input	S output	$\overline{MASTER\_EN}$ = $\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	3.1	6	10.2	2.4	12.9	ns
					5 V ± 0.5 V	2.9	5.6	9.6	2.2	13.9	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	2.7	4.6	6.5	1.9	10	
					5 V ± 0.5 V	2.5	4.2	5.8	1.7	8.6	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	2.5	4	5.6	1.6	8.8	
					5 V ± 0.5 V	2.3	3.6	4.9	1.5	7	
t_{en}	$\overline{MASTER\_EN}$	S output	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	11.1	18.9	30.7	9.2	35.5	ns
					5 V ± 0.5 V	11.1	19.3	30.9	8	35.6	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	9.9	12.9	17.4	6.9	22.6	
					5 V ± 0.5 V	9.9	13.1	17.4	7	22.6	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	9.5	11.2	13.4	6.3	18.3	
					5 V ± 0.5 V	9.5	11.3	13.5	6.3	18.2	
t_{dis}	$\overline{MASTER\_EN}$	S output	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	6.8	13.7	23.9	6	25.1	ns
					5 V ± 0.5 V	6.1	13.4	22	5.4	23.3	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	4.9	8.6	13.3	4	14.5	
					5 V ± 0.5 V	4.6	8.5	13.6	3.9	14.5	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	5	8.1	12.2	4.2	13.2	
					5 V ± 0.5 V	4.5	8	12.2	3.6	18.2	
t_{en}	$\overline{BUF\_EN}$	S output	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.7	17.7	33.2	7.6	35.5	ns
					5 V ± 0.5 V	10.7	18..3	29.3	8.7	35.6	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	9.6	12.4	16.6	6.6	22.6	
					5 V ± 0.5 V	9.6	12.6	16.7	6.6	22.6	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	9.2	10.9	13	6.1	18.3	
					5 V ± 0.5 V	9.2	10.9	13	6.1	18.2	
t_{dis}	$\overline{BUF\_EN}$	S output	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	6.9	12.9	22.3	5.9	24.2	ns
					5 V ± 0.5 V	5.4	12.4	20.5	4.8	22.8	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	4.4	8	12.7	3.6	14.5	
					5 V ± 0.5 V	4.2	7.9	12.8	3.6	14.2	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	4.6	7.7	11.7	3.8	12.3	
					5 V ± 0.5 V	4.1	7.6	11.7	3.3	12.4	

Switching Characteristics

over recommended operating free-air temperature range (data bus I/Os) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	V_{CC_S}	V_{CC_CF}	T_A = 25°C			–40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
t_{pd}	D	SD	$\overline{MASTER\_EN}$ = $\overline{ENL}$ = $\overline{ENH}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	4.2	7.2	11.8	3	13.7	ns
					5 V ± 0.5 V	3.7	6.4	10.7	2.7	13.9	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	3.8	5.7	8	2.4	10	
					5 V ± 0.5 V	3.3	4.9	6.8	2.1	12.4	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	3.5	5.1	6.9	2.2	8.8	
					5 V ± 0.5 V	3	4.3	5.7	1.8	7	
	SD	D		1.8 V ± 0.15 V	3.3 V ± 0.3 V	3.4	5.7	9.8	2.6	11.1	
					5 V ± 0.5 V	3.1	5.4	9.6	2.4	9.6	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	2.8	4.3	6.2	1.9	8.2	
					5 V ± 0.5 V	2.6	3.8	5.4	1.7	7	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	2.5	3.7	5.2	1.5	7.2	
					5 V ± 0.5 V	2.2	3.3	4.5	1.4	6	
t_{en}	$\overline{MASTER\_EN}$	D	$\overline{ENL}$ = $\overline{ENH}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	13.7	18.2	24.4	9.4	27.9	ns
					5.5 V ± 0.5 V	13.7	17.9	29.9	8	31	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	12.3	15.1	18.8	7.9	23	
					5.5 V ± 0.5 V	12.3	14.8	17.6	8	21.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	11.6	14	17.1	7.3	21.4	
					5.5 V ± 0.5 V	11.6	13.7	15.9	7.4	20.3	
		SD		1.8 V ± 0.15 V	3.3 V ± 0.3 V	11.6	19.6	31.8	9.4	36.3	
					5.5 V ± 0.5 V	11.7	20.1	32	9.5	36.2	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	10.3	13.4	18	7.2	22.6	
					5.5 V ± 0.5 V	10.3	13.6	18.1	7.1	22.6	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	9.8	11.6	14	6.4	18.3	
					5.5 V ± 0.5 V	9.8	11.7	14	6.4	18.2	
t_{dis}	$\overline{MASTER\_EN}$	D	$\overline{ENL}$ = $\overline{ENH}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.6	12.8	18.1	7.3	20.2	ns
					5.5 V ± 0.5 V	7.6	11.5	16.4	6.3	17.8	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	7.8	10.8	14.7	6.4	16.4	
					5.5 V ± 0.5 V	6.7	9.4	12.6	5.4	13.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	7.2	9.9	13.4	5.9	15	
					5.5 V ± 0.5 V	6.1	8.6	11.4	4.8	12.5	
		SD		1.8 V ± 0.15 V	3.3 V ± 0.3 V	6.9	12.9	21.7	6	24.2	
					5.5 V ± 0.5 V	6.1	12.6	20.8	5.3	22.8	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	4.9	7.9	11.8	4.1	14.5	
					5.5 V ± 0.5 V	4.7	7.8	11.7	3.9	14.2	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	5	7.1	9.8	4	12	
					5.5 V ± 0.5 V	4.7	7	9.8	3.8	18.2	

Switching Characteristics (continued)

over recommended operating free-air temperature range (data bus I/Os) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	V_{CC_S}	V_{CC_CF}	T_A = 25°C			–40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
t_{en}	$\overline{ENL}$ or $\overline{ENH}$	D	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	9.4	17.6	23.4	8.3	27.2	ns
					5.5 V ± 0.5 V	13.5	17.4	22.6	7.7	27.8	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	12.3	15	18.5	7.9	22.8	
					5.5 V ± 0.5 V	12.3	14.7	17.4	8	21.6	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	11.7	14.1	17	7.3	21.4	
					5.5 V ± 0.5 V	11.6	13.7	16	7.4	20.3	
		SD		1.8 V ± 0.15 V	3.3 V ± 0.3 V	9.5	18.7	30.5	9.1	35.5	
					5.5 V ± 0.5 V	9.6	19.1	30.5	9.1	35.6	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	10	13	17.4	6.8	22.6	
					5.5 V ± 0.5 V	10	13.2	17.4	6.8	22.6	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	9.6	11.3	13.6	6.2	18.3	
					5.5 V ± 0.5 V	9.6	11.4	13.6	6.3	18.2	
t_{dis}	$\overline{ENL}$ or $\overline{ENH}$	D	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.5	12.1	16.8	7.2	20.2	ns
					5.5 V ± 0.5 V	7.7	10.8	15	6.3	16.6	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	7.6	10.4	13.8	6.2	16.4	
					5.5 V ± 0.5 V	6.9	9.1	11.9	5.4	13.1	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	7.3	9.7	12.9	5.9	15	
					5.5 V ± 0.5 V	6.5	8.4	11	5.2	12	
		SD		1.8 V ± 0.15 V	3.3 V ± 0.3 V	6.5	12	20	5.7	24.2	
					5.5 V ± 0.5 V	5.7	11.8	19	5	22.8	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	4.6	7.4	11.1	3.8	14.5	
					5.5 V ± 0.5 V	4.4	7.3	11.1	3.7	14.2	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	4.9	6.8	9.3	4	12	
					5.5 V ± 0.5 V	4.3	6.7	9.2	3.5	18.2	

Switching Characteristics

over recommended operating free-air temperature range (SA10–SA00, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SOE}$, $\overline{SREG}$, $\overline{SWE}$) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	V_{CC_S}	V_{CC_CF}	T_A = 25°C			−40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
t_{pd}	S input	CF output (control)	$\overline{MASTER\_EN}$ = $\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	3.4	6.1	9.8	2.5	10.4	ns
					5 V ± 0.5 V	3	5.8	9.7	2.4	10.2	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	2.6	4.5	6.7	1.8	8.4	
					5 V ± 0.5 V	2.4	4.1	6	1.7	6.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	2.2	3.9	5.8	1.4	7	
					5 V ± 0.5 V	2	3.5	5	1.3	5.8	
		CF output (A pins)	$\overline{MASTER\_EN}$ = $\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	3.4	5.7	8.7	2.8	10.3	
					5 V ± 0.5 V	3.3	5.4	8.2	2.8	9.7	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	2.9	4.3	6.2	1.9	8.4	
					5 V ± 0.5 V	2.7	3.9	5.4	1.9	6.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	2.6	3.7	5.2	1.7	7	
					5 V ± 0.5 V	2.3	3.3	4.4	1.5	5.8	
t_{en}	$\overline{MASTER\_EN}$	CF output (control)	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	10.8	17.9	24.8	7.9	29.7	ns
					5 V ± 0.5 V	10.8	17.5	26.2	8.1	30.2	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	9.4	14.2	19.4	6.4	23.3	
					5 V ± 0.5 V	9.4	14.1	19.3	6.6	23.1	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	8.7	13.1	17.8	5.8	21.4	
					5 V ± 0.5 V	8.7	13	17.5	6	21.2	
t_{dis}	$\overline{MASTER\_EN}$	CF output (control)	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	7.3	13.8	22.5	6.2	25.8	ns
					5 V ± 0.5 V	6.8	12.1	19.7	5.9	26.3	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	6.1	11.8	19.2	4.9	20.2	
					5 V ± 0.5 V	5.9	10	16.3	4.6	19.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	5.6	11	18.3	4.6	19.1	
					5 V ± 0.5 V	5.4	9.2	15.5	3.9	18	
t_{en}	$\overline{BUF\_EN}$	CF output (A pins)	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	12.9	17.5	23.7	7.7	29.7	ns
					5 V ± 0.5 V	13.3	17.8	24.4	9.4	30.2	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	11.7	14.4	17.9	7.5	23.3	
					5 V ± 0.5 V	11.8	14.3	17.1	7.7	23.1	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	11	13.3	16.2	6.9	21.4	
					5 V ± 0.5 V	11.1	13.2	15.3	6.5	21.2	
t_{dis}	$\overline{BUF\_EN}$	CF output (A pins)	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.9	13.6	19.7	7.5	25.8	ns
					5 V ± 0.5 V	7.6	11.8	17.1	6.6	26.3	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	8	11.6	16	6.6	20.1	
					5 V ± 0.5 V	6.7	9.7	13.2	5	19.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	7.7	10.6	14.7	6	18.2	
					5 V ± 0.5 V	6.1	8.9	11.9	4.9	18	
t_{en}	$\overline{BUF\_EN}$	CF output (A pins)	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	12.3	16.4	21.9	7.7	27.2	ns
					5 V ± 0.5 V	12.6	16.7	22.6	8.6	29.1	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	11.2	13.8	17	7.1	21.7	
					5 V ± 0.5 V	11.4	13.7	16.3	7.3	21.5	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	10.7	12.9	15.6	6.7	19.5	
					5 V ± 0.5 V	10.8	12.8	14.8	6.5	19.6	

Switching Characteristics (continued)

over recommended operating free-air temperature range (SA10–SA00, $\overline{SCE1}$, $\overline{SCE2}$, $\overline{SIORD}$, $\overline{SIOWR}$, $\overline{SOE}$, $\overline{SREG}$, $\overline{SWE}$) (see Figure 1)

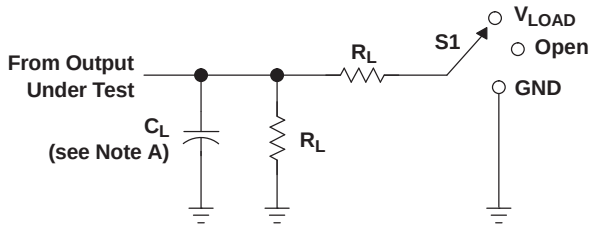
PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	V_{CC_S}	V_{CC_CF}	T_A = 25°C			−40°C to 85°C		UNIT
						MIN	TYP	MAX	MIN	MAX	
t_{dis}	$\overline{BUF\_EN}$	CF output (A pins)	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.4	13.9	21.2	7.2	23.2	ns
					5 V ± 0.5 V	7.6	12.3	18.5	6.6	23.7	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	7.7	12.3	18.2	6.4	19.8	
					5 V ± 0.5 V	6.7	10.6	15.3	5	18.4	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	7.2	11.5	16.4	5.9	18	
					5 V ± 0.5 V	6.4	10	14.3	4.9	17	
t_{en}	$\overline{BUF\_EN}$	CF output	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	12.5	16.6	22.3	8.7	27.2	ns
					5 V ± 0.5 V	12.8	17	23.1	8.8	29.1	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	11.4	14.1	17.5	7.3	21.7	
					5 V ± 0.5 V	11.6	14	16.9	7.4	21.5	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	10.9	13.2	16	6.8	20	
					5 V ± 0.5 V	11	13.1	15.3	6.5	19.6	
t_{dis}	$\overline{BUF\_EN}$	CF output	$\overline{MASTER\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.6	13.9	21.5	7.4	23.2	ns
					5 V ± 0.5 V	7.7	12.1	19.8	6.6	23.7	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	7.9	12.3	18.5	6.5	19.8	
					5 V ± 0.5 V	6.6	10.4	17.1	5	18.4	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	7.4	11.7	17.5	6.1	18.9	
					5 V ± 0.5 V	6.1	9.7	16.2	4.9	17	
t_{en}	$\overline{MASTER\_EN}$	DIR_OUT	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	6.1	14.2	29.6	4.9	32.8	ns
					5 V ± 0.5 V	6	14.2	30	4.9	33.2	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	4.8	8.8	15.4	3.4	19.3	
					5 V ± 0.5 V	4.8	8.8	15.5	3.4	19.3	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	4.2	6.9	11.1	2.7	14.4	
					5 V ± 0.5 V	4.2	6.9	11.1	2.6	14.4	
t_{dis}	$\overline{MASTER\_EN}$	DIR_OUT	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	5.4	10	16.6	4.2	32.6	ns
					5 V ± 0.5 V	5.4	9.9	16.1	4.8	32.6	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	3.9	6.5	10.5	1.5	19.3	
					5 V ± 0.5 V	3.9	6.6	10.4	1.7	19.3	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	4.4	6.7	10.3	1.4	14.4	
					5 V ± 0.5 V	4.3	6.7	10.1	1.5	14.4	
t_{pd}	$\overline{SIORD}$ or $\overline{SOE}$	DIR_OUT	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	5	9.3	15.7	4	17.9	ns
					5 V ± 0.5 V	5	9.3	15.7	4	17.9	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	3.9	6	8.5	2.8	11	
					5 V ± 0.5 V	3.9	6	8.5	2.8	11	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	3.3	4.7	6.2	2.2	8.2	
					5 V ± 0.5 V	3.3	4.7	6.2	2.2	8.2	
t_{pd}	$\overline{BUF\_EN}$	DIR_OUT	$\overline{BUF\_EN}$ = V_{IL}	1.8 V ± 0.15 V	3.3 V ± 0.3 V	8.9	19.5	35.9	7.1	39.2	ns
					5 V ± 0.5 V	8.9	19.5	35.8	7	39.3	
				2.5 V ± 0.2 V	3.3 V ± 0.3 V	6.8	11.9	19.1	5	22.8	
					5 V ± 0.5 V	6.8	11.9	19.2	4.9	22.8	
				3.3 V ± 0.3 V	3.3 V ± 0.3 V	5.8	9	13.3	4	15.8	
					5 V ± 0.5 V	5.8	9	13.3	3.9	15.9	

Operating Characteristics

V_{CCS} and V_{CC_CF} = 3.3 V, T_A = 25°C

PARAMETER				TEST CONDITIONS	TYP	UNIT
C_{pdS}	Power dissipation capacitance per transceiver	System-port input, CF-port output	Outputs enabled	C_L = 0, f = 10 MHz	1.93	pF
			Outputs disabled		0.04	
		CF-port input, system-port output	Outputs enabled		14.35	
			Outputs disabled		0.04	
C_{pdCF}	Power dissipation capacitance per transceiver	System-port input, CF-port output	Outputs enabled	C_L = 0, f = 10 MHz	22.85	pF
			Outputs disabled		0.04	
		CF-port input, system-port output	Outputs enabled		4.66	
			Outputs disabled		3.65	

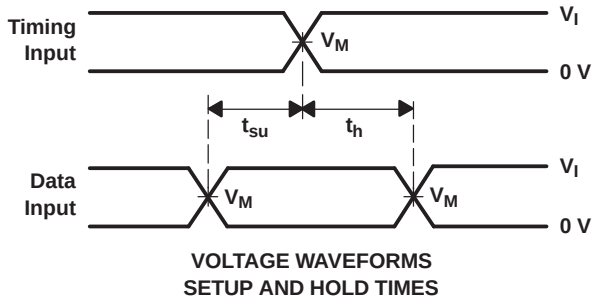
PARAMETER MEASUREMENT INFORMATION



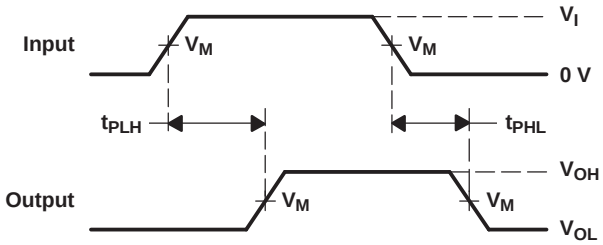
TEST	S1
t_{pd} t_{PLZ}/t_{PZL} t_{PHZ}/t_{PZH}	Open V_{LOAD} GND

LOAD CIRCUIT

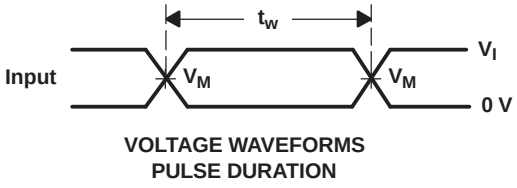
V_{CC}	INPUT		V_M	V_{LOAD}	C_L	R_L	V_Δ
	V_I	t_r/t_f					
1.8 V ± 0.15 V	V_{CC}	≤2 ns	$V_{CC}/2$	$2 \times V_{CC}$	15 pF	2 kΩ	0.15 V
2.5 ± 0.2 V	V_{CC}	≤2 ns	$V_{CC}/2$	$2 \times V_{CC}$	15 pF	2 kΩ	0.15 V
2.7 V	2.7 V	≤2.5 ns	1.5 V	6 V	15 pF	2 kΩ	0.3 V
3.3 V ± 0.3 V	2.7 V	≤2.5 ns	1.5 V	6 V	15 pF	2 kΩ	0.3 V
5.5 V ± 0.5 V	2.7 V	≤2.5 ns	1.5 V	6 V	15 pF	2 kΩ	0.5 V



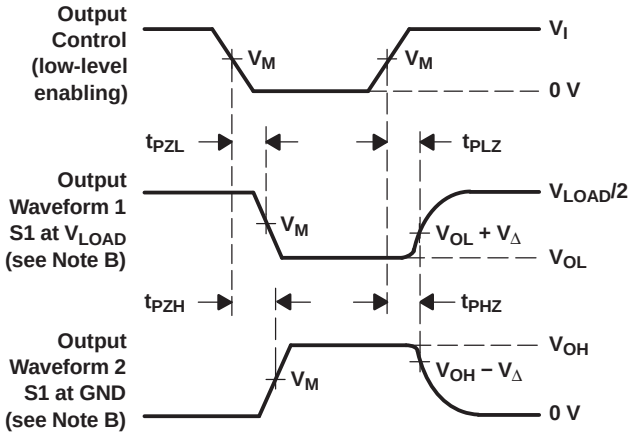
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω.
D. The outputs are measured one at a time, with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
CF4320HGKFR	NRND	LFBGA	GKF	114	1000	TBD	SNPB	Level-2-235C-1 YEAR
CF4320HZKFR	ACTIVE	LFBGA	ZKF	114	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR

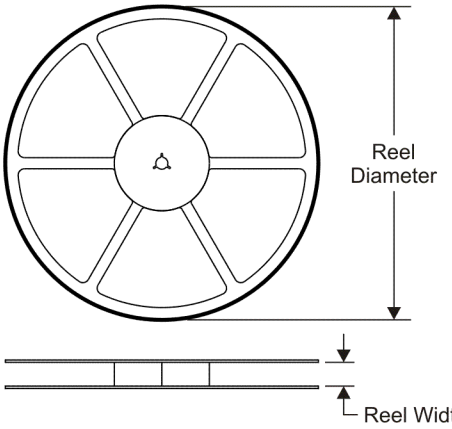
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

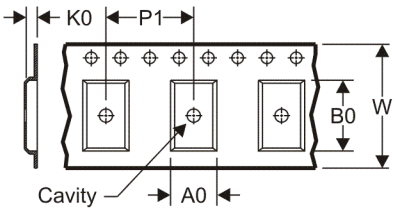
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

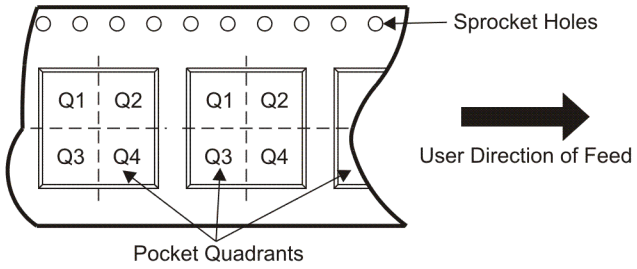


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

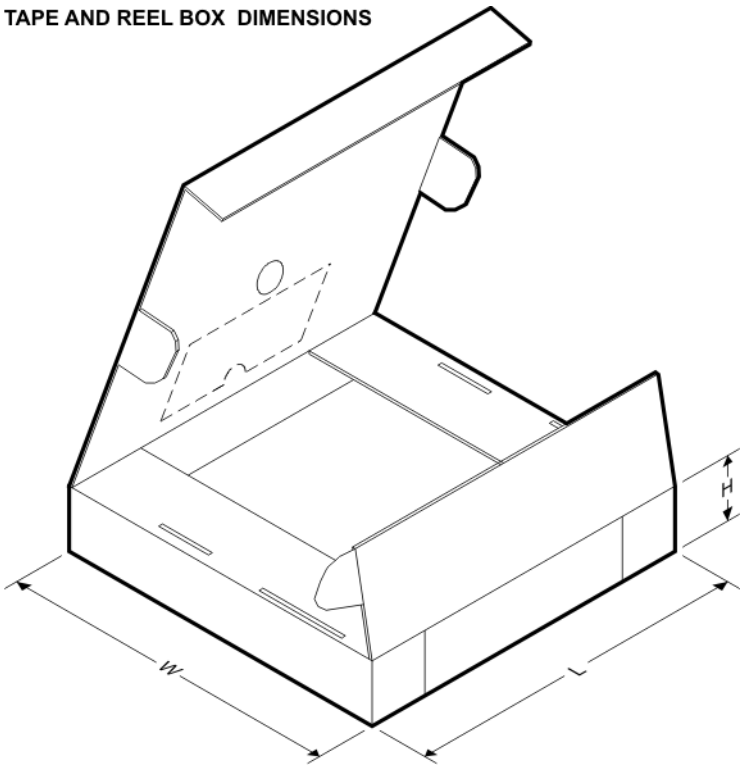
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CF4320HGKFR	LFBGA	GKF	114	1000	330.0	24.4	5.8	16.3	1.8	8.0	24.0	Q1
CF4320HZKFR	LFBGA	ZKF	114	1000	330.0	24.4	5.8	16.3	1.8	8.0	24.0	Q1

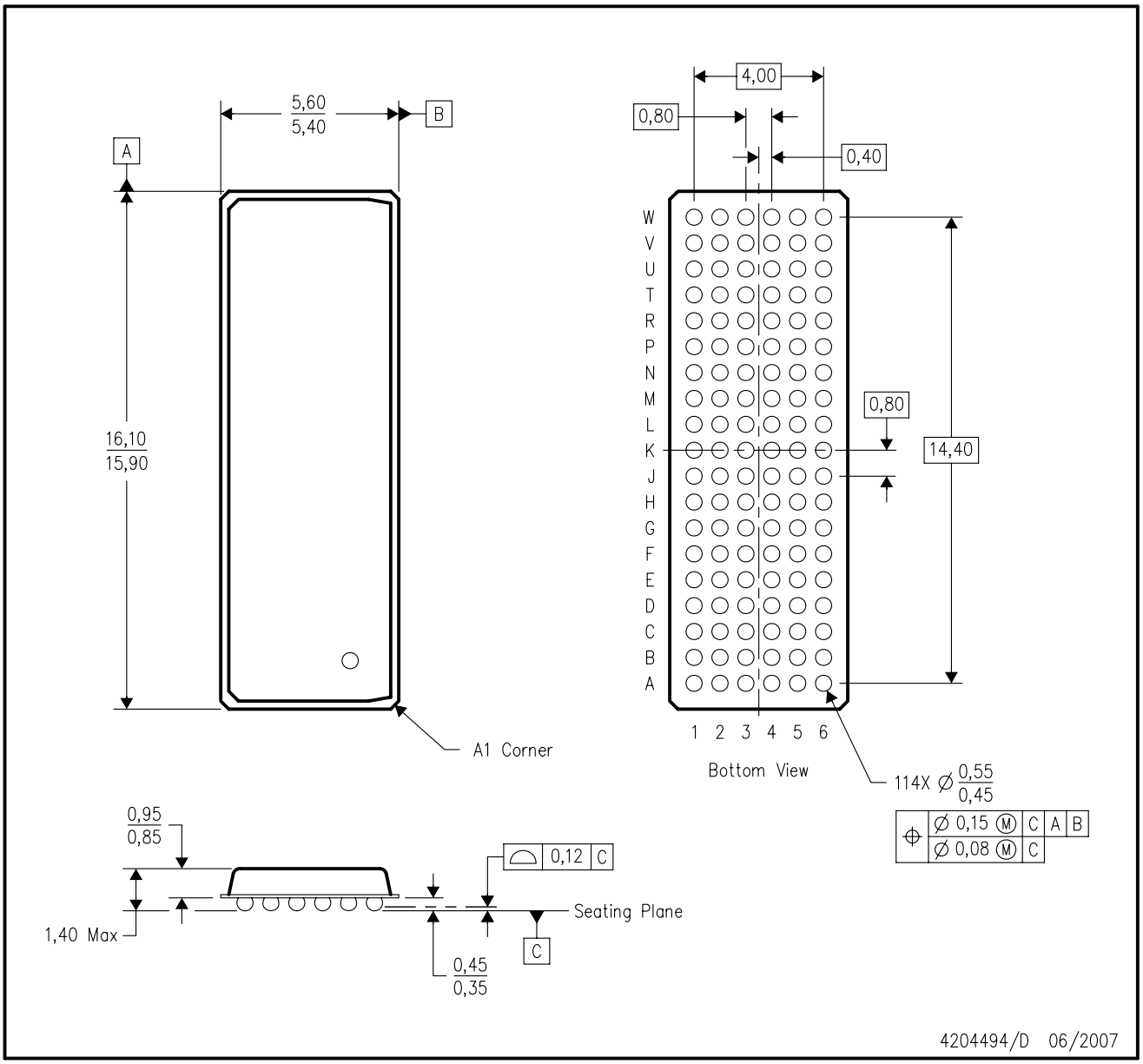
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

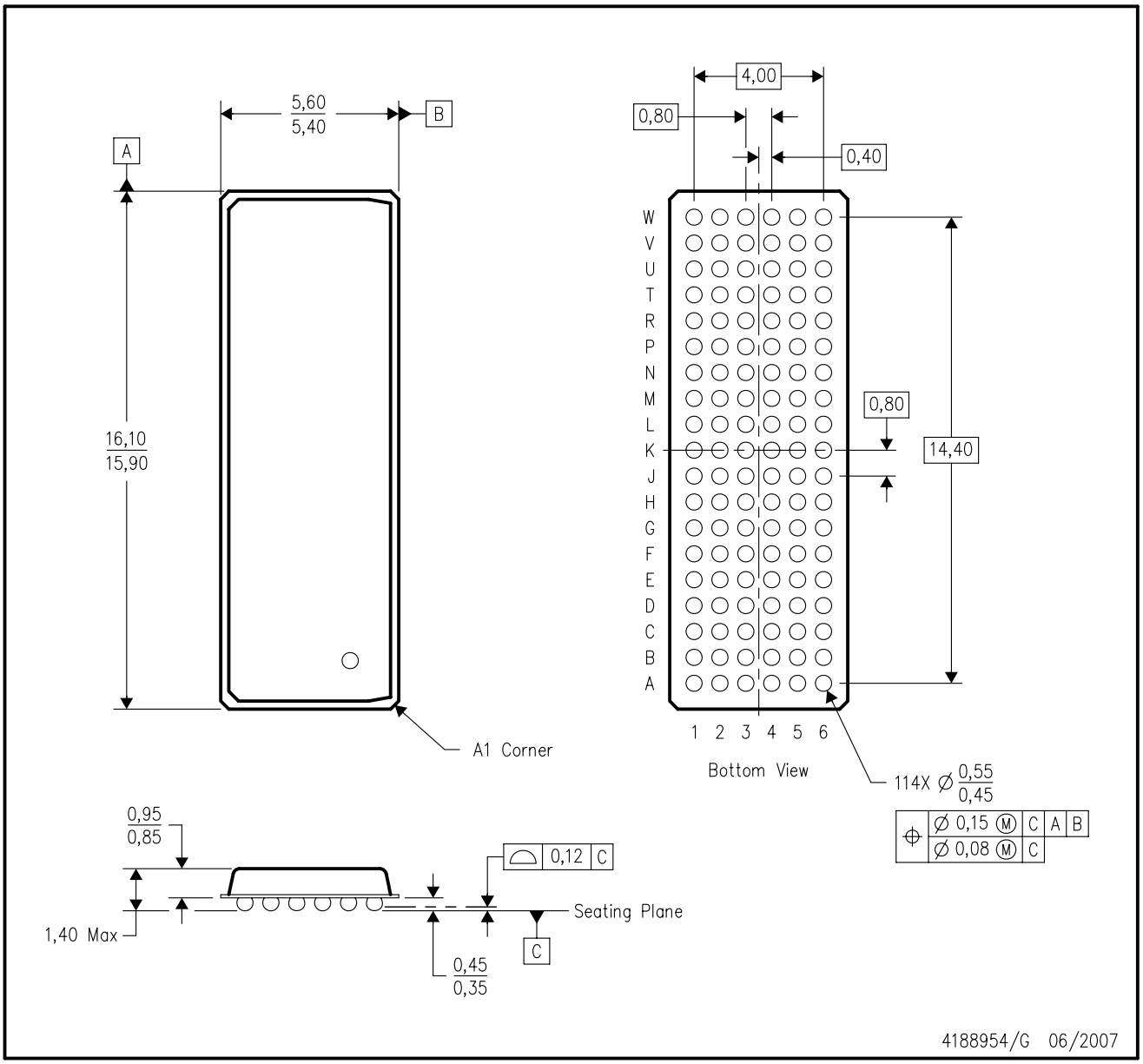
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CF4320HGKFR	LFBGA	GKF	114	1000	346.0	346.0	41.0
CF4320HZKFR	LFBGA	ZKF	114	1000	346.0	346.0	41.0

ZKF (R–PBGA–N114) PLASTIC BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO–205 variation DC.
D. This package is lead–free. Refer to the 114 GKF package (drawing 4188954) for tin–lead (SnPb).

GKF (R–PBGA–N114) PLASTIC BALL GRID ARRAY



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO–205 variation DC.
D. This package is tin–lead (SnPb). Refer to the 114 ZKF package (drawing 4204494) for lead–free.

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