

- Member of the Texas Instruments Widebus™ Family
- High-Bandwidth Data Path (Up To 500 MHz†)
- 5-V Tolerant I/Os with Device Powered Up or Powered Down
- Low and Flat ON-State Resistance (r_{on}) Characteristics Over Operating Range ($r_{on} = 5\ \Omega$ Typical)
- Rail-to-Rail Switching on Data I/O Ports
 - 0-V to 5-V Switching With 3.3-V V_{CC}
 - 0-V to 3.3-V Switching With 2.5-V V_{CC}
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low Input/Output Capacitance Minimizes Loading and Signal Distortion ($C_{io(OFF)} = 4\text{ pF}$ Typical)
- Fast Switching Frequency ($f_{OE} = 20\text{ MHz}$ Max)
- Data and Control Inputs Provide Undershoot Clamp Diodes
- Low Power Consumption ($I_{CC} = 1\text{ mA}$ Typical)
- V_{CC} Operating Range From 2.3 V to 3.6 V
- Data I/Os Support 0-V to 5-V Signaling Levels (0.8 V, 1.2 V, 1.5 V, 1.8 V, 2.5 V, 3.3 V, 5 V)
- Control Inputs Can be Driven by TTL or 5-V/3.3-V CMOS Outputs
- I_{off} Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
 - 2000-V Human-Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)
- Supports Both Digital and Analog Applications: PCI Interface, Differential Signal Interface, Memory Interleaving, Bus Isolation, Low-Distortion Signal Gating

† For additional information regarding the performance characteristics of the CB3Q family, refer to the TI application report, *CBT-C*, *CB3T*, and *CB3Q Signal-Switch Families*, literature number SCDA008.

DGG, DGV, OR DL PACKAGE
(TOP VIEW)

NC	1	56	1OE
1A1	2	55	2OE
1A2	3	54	1B1
1A3	4	53	1B2
1A4	5	52	1B3
1A5	6	51	1B4
1A6	7	50	1B5
GND	8	49	GND
1A7	9	48	1B6
1A8	10	47	1B7
1A9	11	46	1B8
1A10	12	45	1B9
1A11	13	44	1B10
1A12	14	43	1B11
2A1	15	42	1B12
2A2	16	41	2B1
V_{CC}	17	40	2B2
2A3	18	39	2B3
GND	19	38	GND
2A4	20	37	2B4
2A5	21	36	2B5
2A6	22	35	2B6
2A7	23	34	2B7
2A8	24	33	2B8
2A9	25	32	2B9
2A10	26	31	2B10
2A11	27	30	2B11
2A12	28	29	2B12

NC – No internal connection



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SN74CB3Q16211

24-BIT SWITCH

2.5-V/3.3-V LOW-VOLTAGE FET BUS SWITCH

SCDS167 – MAY 2004

description/ordering information

The SN74CB3Q16211 is a high-bandwidth FET bus switch utilizing a charge pump to elevate the gate voltage of the pass transistor, providing a low and flat ON-state resistance (r_{on}). The low and flat ON-state resistance allows for minimal propagation delay and supports rail-to-rail switching on the data input/output (I/O) ports. The device also features low data I/O capacitance to minimize capacitive loading and signal distortion on the data bus. Specifically designed to support high-bandwidth applications, the SN74CB3Q16211 provides an optimized interface solution ideally suited for broadband communications, networking, and data-intensive computing systems.

The SN74CB3Q16211 is organized as two 12-bit bus switches with separate output-enable ($\overline{1OE}$, $\overline{2OE}$) inputs. It can be used as two 12-bit bus switches or as one 24-bit bus switch. When $\overline{OE}$ is low, the associated 12-bit bus switch is ON and the A port is connected to the B port, allowing bidirectional data flow between ports. When $\overline{OE}$ is high, the associated 12-bit bus switch is OFF, and a high-impedance state exists between the A and B ports.

This device is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry prevents damaging current backflow through the device when it is powered down.

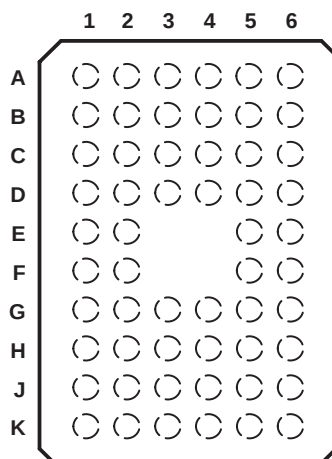
To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

ORDERING INFORMATION

T_A	PACKAGE [†]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SSOP – DL	Tube	SN74CB3Q16211DL	CB3Q16211
		Tape and reel	SN74CB3Q16211DLR	
	TSSOP – DGG	Tape and reel	SN74CB3Q16211DGGR	CB3Q16211
	TVSOP – DGV	Tape and reel	SN74CB3Q16211DGVR	BW211
	VFBGA – GQL	Tape and reel	SN74CB3Q16211GQLR	

[†] Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

GQL PACKAGE
(TOP VIEW)



terminal assignments

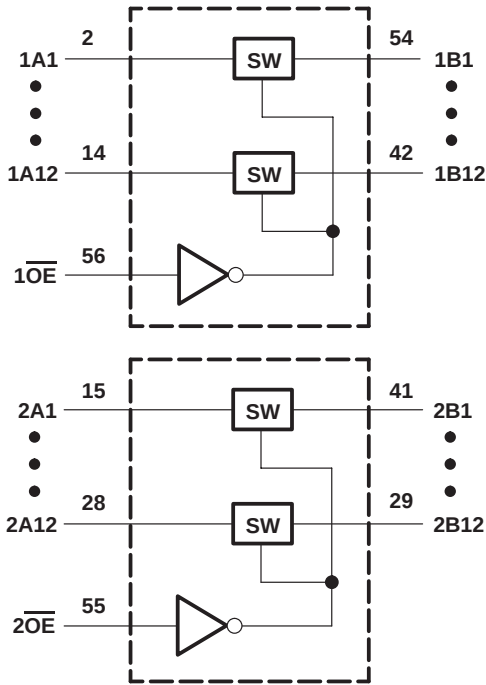
	1	2	3	4	5	6
A	1A2	1A1	NC	$\overline{1OE}$	$\overline{2OE}$	1B1
B	1A5	1A4	1A3	1B2	1B3	1B4
C	1A7	GND	1A6	1B5	GND	1B6
D	1A10	1A8	1A9	1B8	1B7	1B9
E	1A12	1A11			1B10	1B11
F	2A1	2A2			2B1	1B12
G	V_{CC}	GND	2A3	2B3	GND	2B2
H	2A4	2A5	2A6	2B6	2B5	2B4
J	2A7	2A8	2A9	2B9	2B8	2B7
K	2A10	2A11	2A12	2B12	2B11	2B10

NC – No internal connection

FUNCTION TABLE
(each 12-bit bus switch)

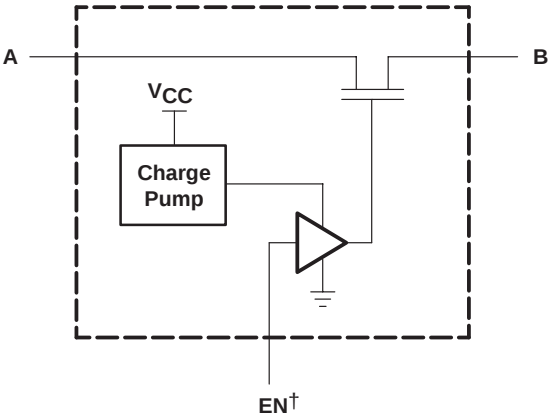
INPUT $\overline{\text{OE}}$	INPUT/OUTPUT A	FUNCTION
L	B	A port = B port
H	Z	Disconnect

logic diagram (positive logic)



Pin numbers shown are for the DGG, DGV, and DL packages.

simplified schematic, each FET switch (SW)



† EN is the internal enable signal applied to the switch.

SN74CB3Q16211

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2.5-V/3.3-V LOW-VOLTAGE FET BUS SWITCH

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

Supply voltage range, V_{CC} (see Note 1)	–0.5 V to 4.6 V
Control input voltage range, V_{IN} (see Notes 1 and 2)	–0.5 V to 7 V
Switch I/O voltage range, $V_{I/O}$ (see Notes 1, 2, and 3)	–0.5 V to 7 V
Control input clamp current, I_{IK} ($V_{IN} < 0$)	–50 mA
I/O port clamp current, $I_{I/OK}$ ($V_{I/O} < 0$)	–50 mA
ON-state switch current, $I_{I/O}$ (see Note 4)	±64 mA
Continuous current through V_{CC} or GND terminals	±100 mA
Package thermal impedance, θ_{JA} (see Note 5): DGG package	64°C/W
DGV package	48°C/W
DL package	56°C/W
GQL package	42°C/W
Storage temperature range, T_{stg}	–65°C to 150°C

[†] 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.

- NOTES:
1. All voltages are with respect to ground unless otherwise specified.
 2. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
 3. V_I and V_O are used to denote specific conditions for $V_{I/O}$.
 4. I_I and I_O are used to denote specific conditions for $I_{I/O}$.
 5. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 3)

		MIN	MAX	UNIT
V_{CC}	Supply voltage	2.3	3.6	V
V_{IH}	High-level control input voltage	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	1.7	5.5
		$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	2	5.5
V_{IL}	Low-level control input voltage	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	0	0.7
		$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	0	0.8
$V_{I/O}$	Data input/output voltage	0	5.5	V
T_A	Operating free-air temperature	–40	85	°C

NOTE 6: All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



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

PARAMETER		TEST CONDITIONS		MIN	TYP [†]	MAX	UNIT
V_{IK}		$V_{CC} = 3.6\text{ V}$,	$I_I = -18\text{ mA}$			-1.8	V
I_{IN}	Control inputs	$V_{CC} = 3.6\text{ V}$,	$V_{IN} = 0\text{ to }5.5\text{ V}$			± 1	μA
$I_{OZ}^{\ddagger}$		$V_{CC} = 3.6\text{ V}$,	$V_O = 0\text{ to }5.5\text{ V}$, $V_I = 0$, Switch OFF, $V_{IN} = V_{CC}\text{ or GND}$			± 1	μA
I_{off}		$V_{CC} = 0$,	$V_O = 0\text{ to }5.5\text{ V}$, $V_I = 0$			1	μA
I_{CC}		$V_{CC} = 3.6\text{ V}$,	$I_{I/O} = 0$, Switch ON or OFF, $V_{IN} = V_{CC}\text{ or GND}$		1	3	mA
$\Delta I_{CC}^{\S}$	Control inputs	$V_{CC} = 3.6\text{ V}$,	One input at 3 V, Other inputs at $V_{CC}\text{ or GND}$			30	μA
$I_{CCD}^{\parallel}$	Per control input	$V_{CC} = 3.6\text{ V}$,	A and B ports open, Control input switching at 50% duty cycle		0.15	0.25	mA/MHz
C_{in}	Control inputs	$V_{CC} = 3.3\text{ V}$,	$V_{IN} = 5.5\text{ V}$, 3.3 V, or 0		3.5	5	pF
$C_{io(OFF)}$		$V_{CC} = 3.3\text{ V}$,	Switch OFF, $V_{IN} = V_{CC}\text{ or GND}$, $V_{I/O} = 5.5\text{ V}$, 3.3 V, or 0		4	5	pF
$C_{io(ON)}$		$V_{CC} = 3.3\text{ V}$,	Switch ON, $V_{IN} = V_{CC}\text{ or GND}$, $V_{I/O} = 5.5\text{ V}$, 3.3 V, or 0		10	12.5	pF
$r_{on}^{\#}$		$V_{CC} = 2.3\text{ V}$, TYP at $V_{CC} = 2.5\text{ V}$	$V_I = 0$, $I_O = 30\text{ mA}$		5	8	Ω
			$V_I = 1.7\text{ V}$, $I_O = -15\text{ mA}$		5	9	
		$V_{CC} = 3\text{ V}$	$V_I = 0$, $I_O = 30\text{ mA}$		5	6.5	
			$V_I = 2.4\text{ V}$, $I_O = -15\text{ mA}$		5	8	

NOTE 7: V_{IN} and I_{IN} refer to control inputs. V_I , V_O , I_I , and I_O refer to data pins.

[†] All typical values are at $V_{CC} = 3.3\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

[‡] For I/O ports, the parameter I_{OZ} includes the input leakage current.

[§] This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.

^{||} This parameter specifies the dynamic power-supply current associated with the operating frequency of a single control input (see Figure 2).

[#] Measured by the voltage drop between the A and B terminals at the indicated current through the switch. ON-state resistance is determined by the lower of the voltages of the two (A or B) terminals.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			MIN	MAX	MIN	MAX	
$f_{OE}^{\parallel}$	$\overline{OE}$	A or B		10		20	MHz
$t_{pd}^{\star}$	A or B	B or A		0.15		0.25	ns
t_{en}	$\overline{OE}$	A or B	1.5	8	1.5	8	ns
t_{dis}	$\overline{OE}$	A or B	1	7.5	1	7.5	ns

^{||} Maximum switching frequency for control input ($V_O > V_{CC}$, $V_I = 5\text{ V}$, $R_L \geq 1\text{ M}\Omega$, $C_L = 0$)

[☆] The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).

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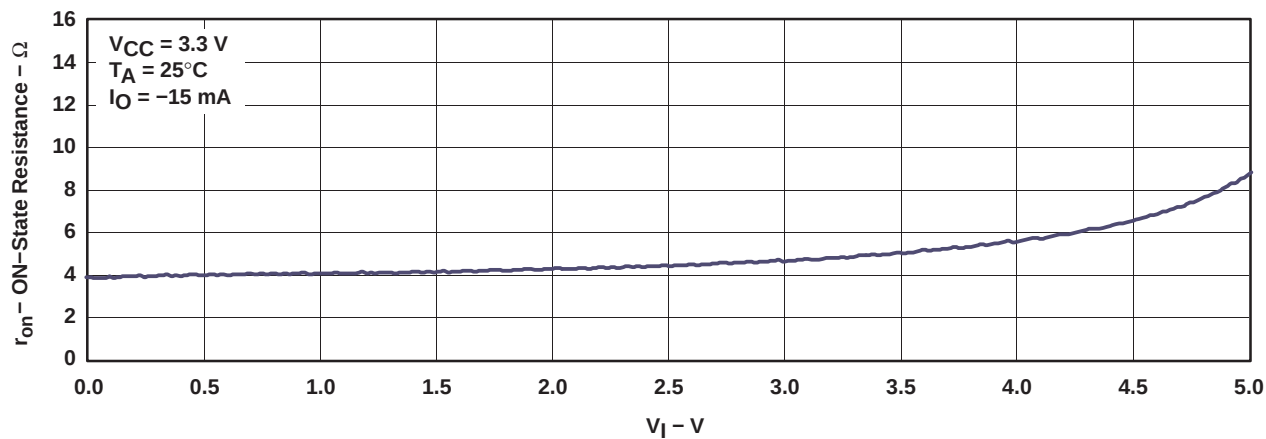


Figure 1. Typical r_{on} vs V_I

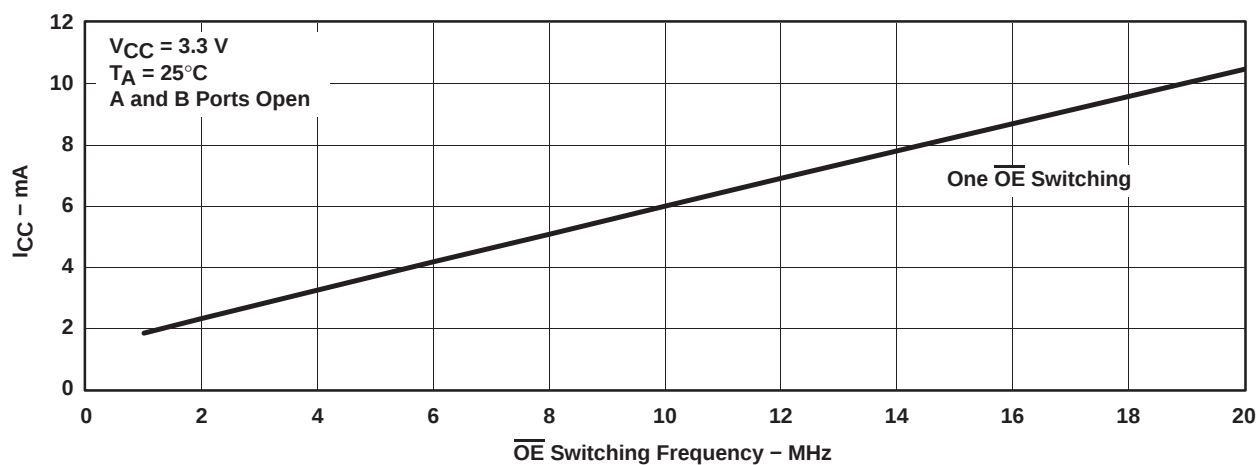
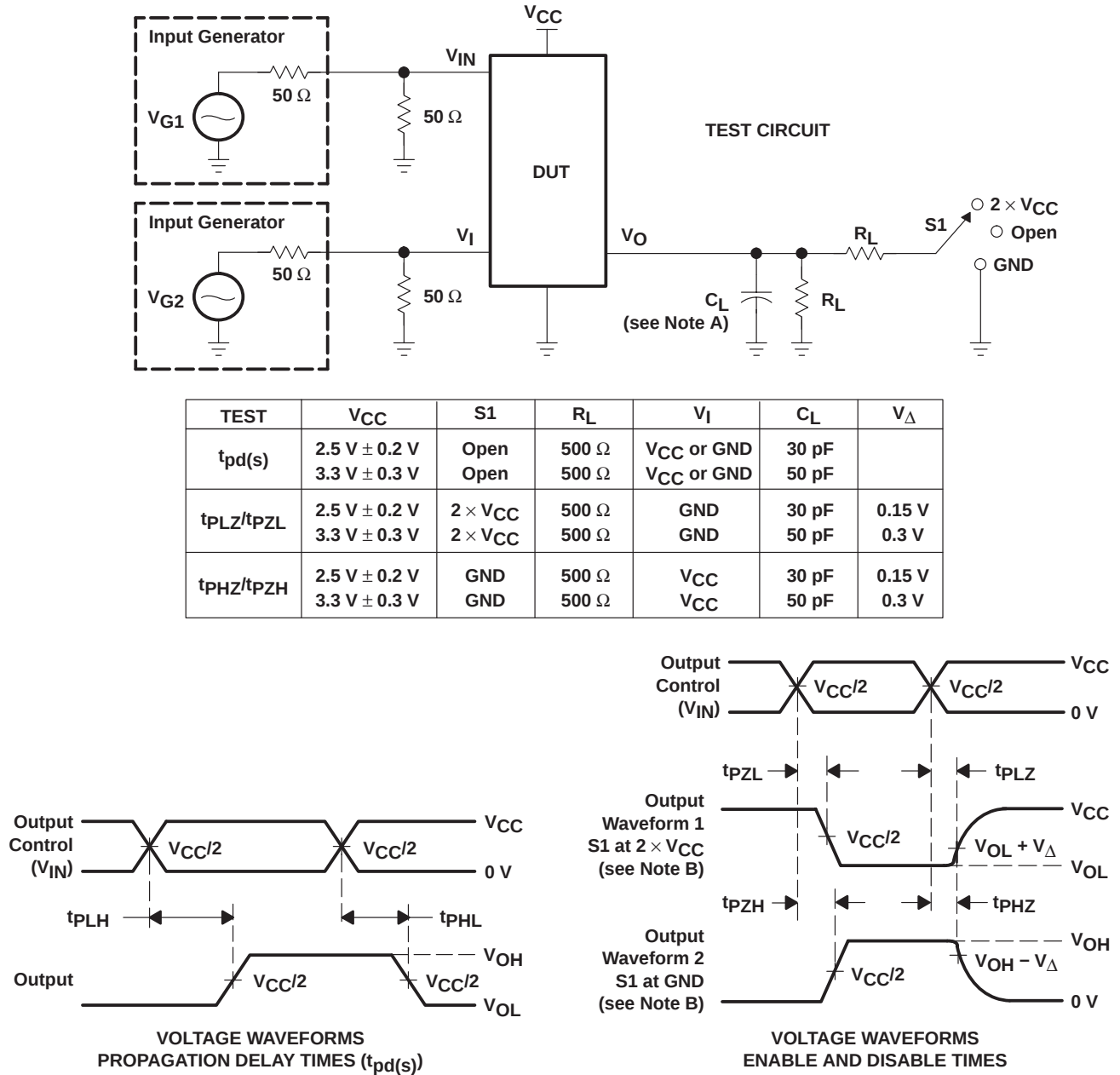


Figure 2. Typical I_{CC} vs $\overline{OE}$ Switching Frequency

PARAMETER MEASUREMENT INFORMATION



- 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, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
 - 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}(s). The t_{pd} propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).
 - H. All parameters and waveforms are not applicable to all devices.

Figure 3. Test Circuit and Voltage Waveforms

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

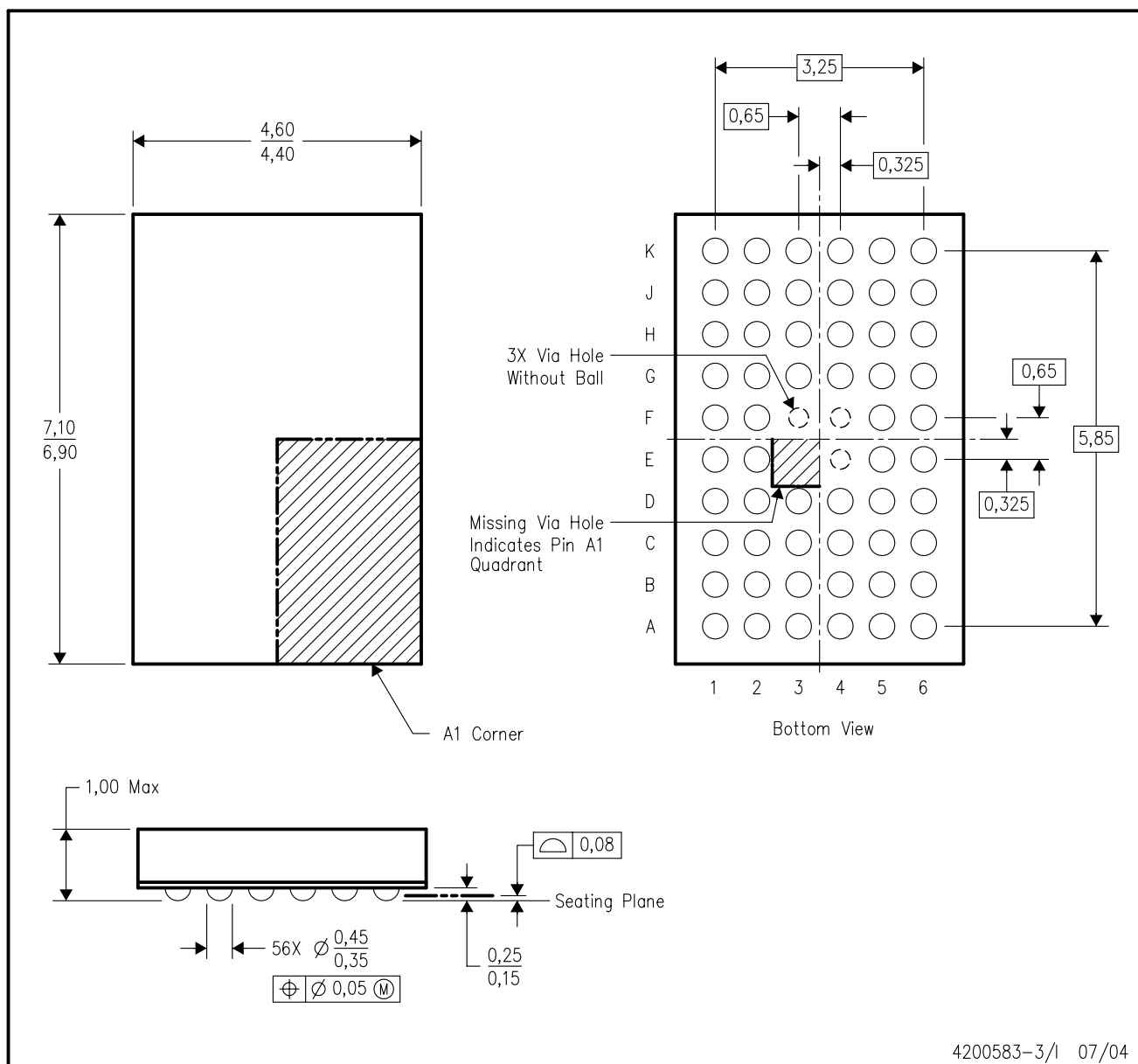
24 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

GQL (R-PBGA-N56)

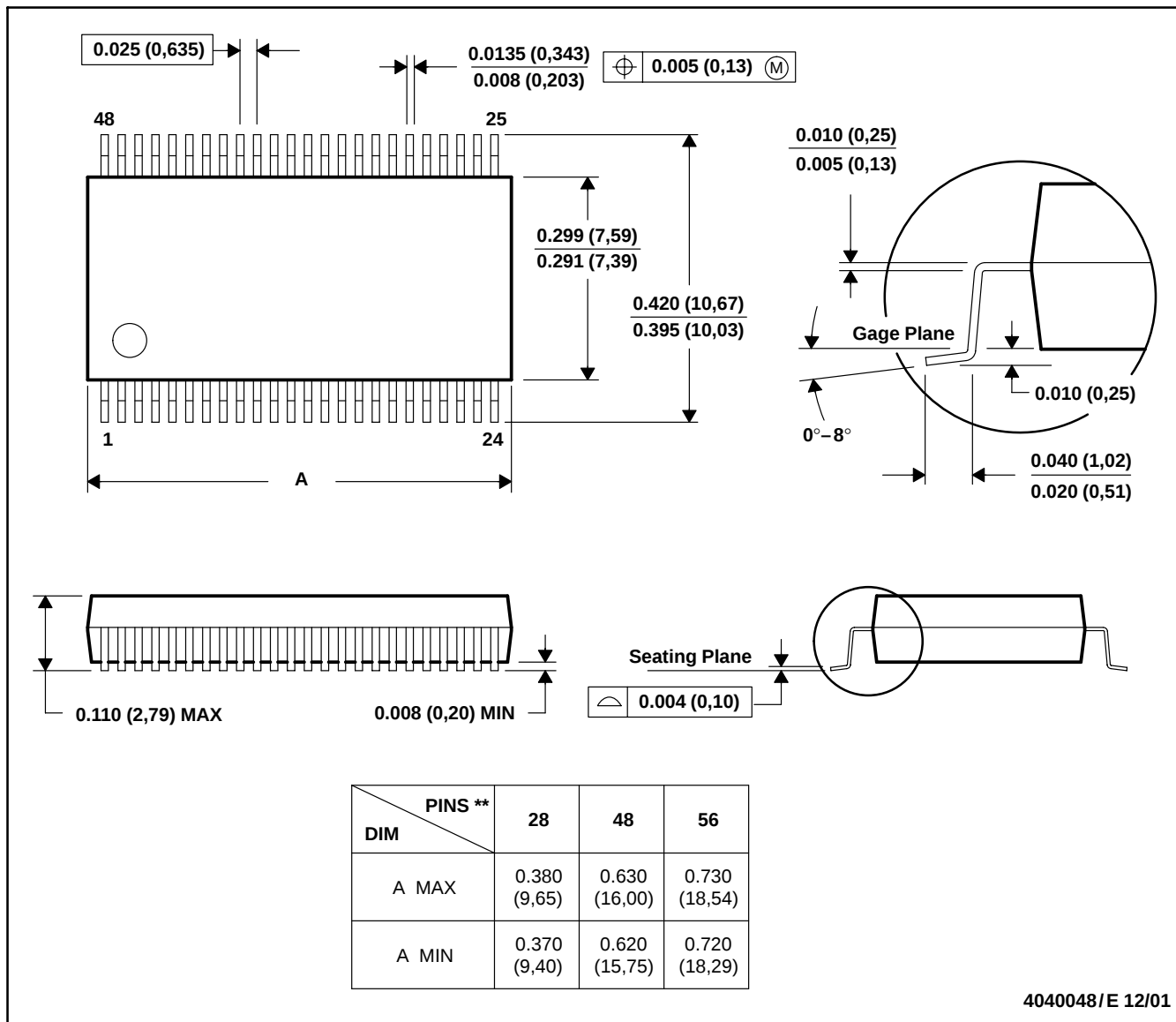
PLASTIC BALL GRID ARRAY



DL (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 D. Falls within JEDEC MO-118

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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