

# LM8335 General Purpose Output Expander with MIPI® RFFE Host Interface

Check for Samples: [LM8335](#)

## FEATURES

- MIPI RFFE Interface Version 1.10 Compliant
- Supports Output Expansion
- Host Interface Address Select Pin:
  - ADR=GND, USID[3:0]=0001
  - ADR=VDD, USID[3:0]=1001
- Pin-Configurable Initial State: VIO
  - CFG=GND, GPO High-z, with Weak Internal Pull-Down Resistor Enabled; GPO\_OUT\_DATA is Unmasked
  - CFG=VDD, GPO High-z, with Weak Internal Pull-Down Resistor Enabled; GPO\_OUT\_DATA is Masked
- Three Sources for Chip Reset:
  - VIO Input Pin
  - POR
  - Software-Commanded Reset

## APPLICATIONS:

- Smart Handheld Devices
- RF Transceiver Applications

## KEY SPECIFICATIONS

- $1.8 \pm 0.15\text{V}$  MIPI RFFE Operation (VIO)
- $1.8 \pm 0.15\text{V}$  Core Supply ( $V_{DD}$ )
- 1.65 to 3.6V GPO Supply ( $V_{DDIO}$ )
- Low Standby and Active Current
- On-Chip Power-On Reset (POR)
- $-30$  to  $+85^{\circ}\text{C}$  Ambient Temperature Range
- 16-Bump DSBGA Package
  - 1.965 mm x 1.965 mm x 0.6 mm, 0.5 mm Pitch (Nominal)

## DESCRIPTION

The LM8335 General Purpose Output Expander is a dedicated device to provide flexible and general purpose, host programmable output expansion functions. This device communicates with a host processor through a MIPI® RFFE Interface (Mobile Industry Processor Interface RF Front-End).

Eight general purpose outputs (GPO) can be configured by the host controller as drive high/low/high-z. Weak pull-ups (PU) or weak pull-downs (PD) can be enabled.

Upon power-on, the LM8335 default configuration is for all GPO to be set based on the state of the CFG pin.

After startup, any changes to the default configuration must be sent from the host via the MIPI RFFE host interface..

The LM8335 is available in a 16-bump lead-free DSBGA package of size 1.965 mm x 1.965 mm x 0.6 mm (0.5 mm pitch).

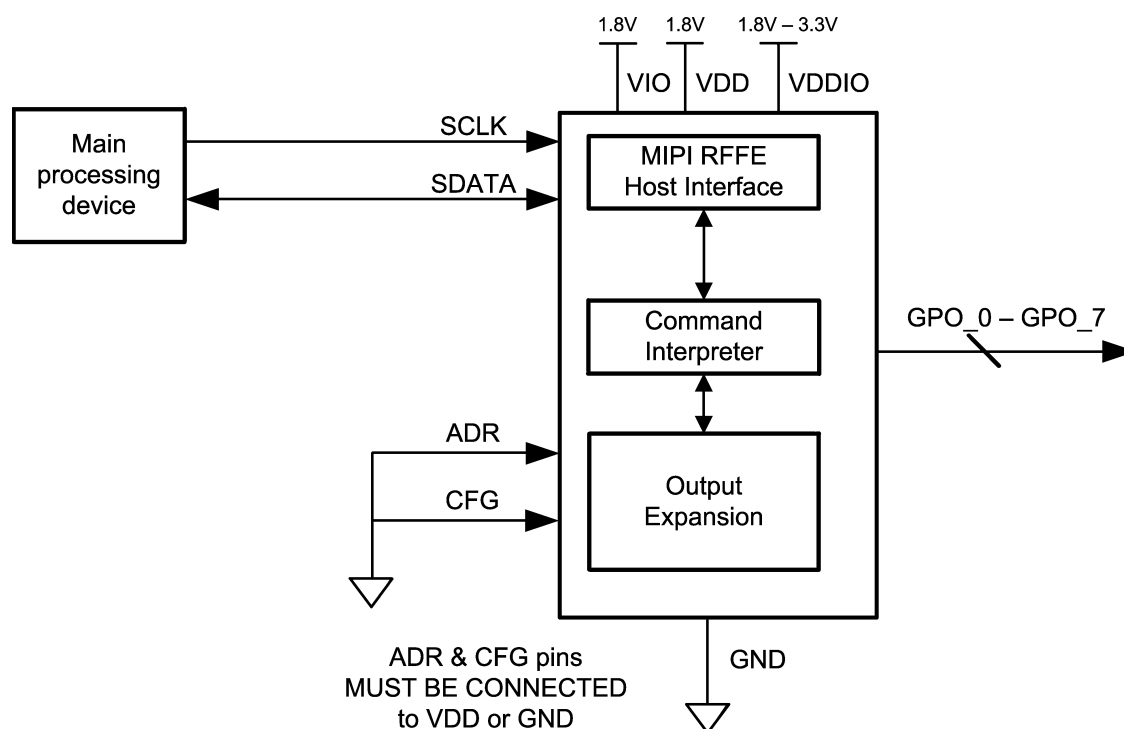


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

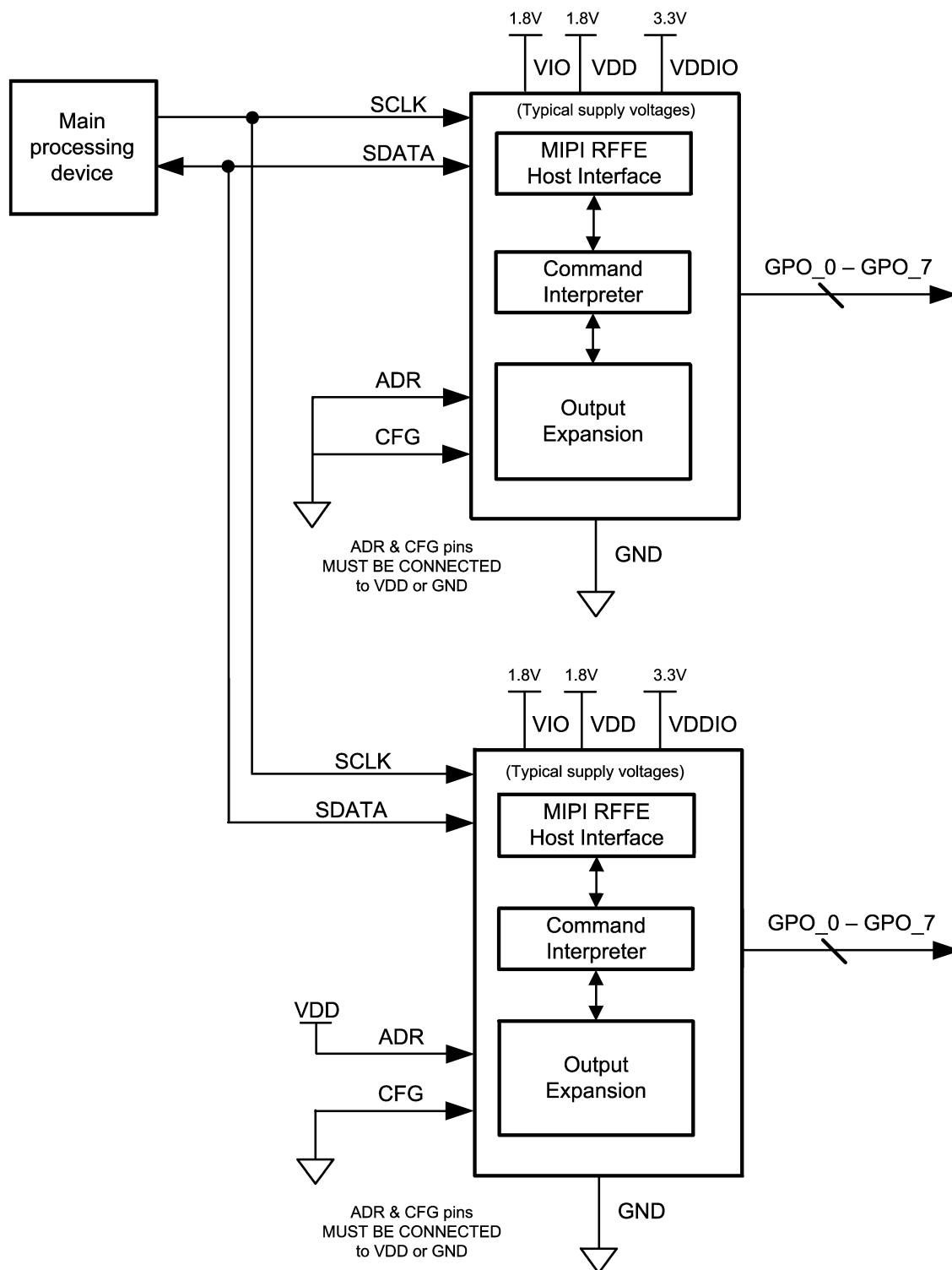
All trademarks are the property of their respective owners.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

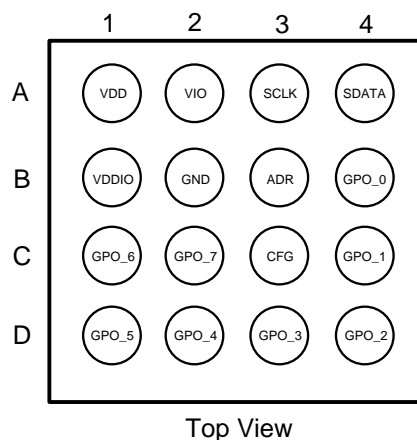
Copyright © 2012–2013, Texas Instruments Incorporated

**Single RFFE Slave Application Block Diagram**

## Dual RFFE Slave Application Block Diagram

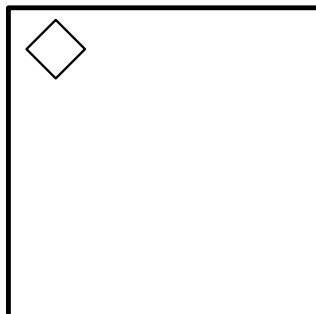


## Connection Diagram and Package Mark Information



**Figure 1. 16-Bump DSBGA Pinout**  
**1.965mm x 1.965mm x 0.6mm (nom), 0.5mm pitch**  
**See Package Number YZR0016**

PIN A1  
IDENTIFIER



**Figure 2. A1 Pin Identifier**

### PIN DESCRIPTIONS

Pin Number	Name	Description
8	GPO_0 through GPO_7	General purpose outputs
1	SCLK	RFFE clock input
1	SDATA	RFFE data input
1	ADR	RFFE chip address input ADR = VDD: USID[3:0] = b1001 ADR = GND: USID[3:0] = b0001
1	CFG	Initial configuration select CFG = VDD: GPO high-z with weak internal pull-down resistor enabled, GPO_OUT_DATA masked CFG = GND: GPO high-z, with weak internal pull-down resistor enabled, GPO_OUT_DATA unmasked
1	VIO	MIPI RFFE VIO (1.8V ± 0.15V)
1	VDD	Core supply VDD (1.8V ± 0.15V)
1	VDDIO	GPO supply VDDIO (1.65V to 3.6V)
1	GND	Ground

## ADR INPUT PIN

The state of the ADR pin determines the MIPI RFFE USID as described in the table above. This enables two devices to be used on the same RFFE bus thereby doubling the number of GPOs available in the system (see [Dual RFFE Slave Application Block Diagram](#)).

## DEFAULT GPO\_x PIN CONFIGURATION

Upon power-on all GPOs will default based on the state of the CFG pin.

### CFG INPUT PIN = GND

The CFG0 mode is an automatic initialization mode. It allows the host to not have to first configure any registers before writing the GPO\_OUT\_DATA register to set the GPOs high or low. In this mode, the GPOs will default as high-z with weak pull-down resistors enabled and the GPO\_OUT\_DATA will be unmasked. When the host writes the GPO\_OUT\_DATA register, the weak pull-down resistor will be disabled. The output driver will immediately be enabled and will drive high or low based on the value written to the GPO\_OUT\_DATA register. In configuration mode CFG0 the GPO data mask function is available but the GPO pull resistor, and high-z functions cannot be changed. Writing to the GPO\_PULL\_DIR, GPO\_PULL\_ENABLE, and GPO\_OUT\_HIGH\_CFG registers will have no effect. If control of the GPO pull resistor or output configuration is required then the CFG1 mode must be used.

### CFG INPUT PIN = VDD

The CFG1 mode is a more general purpose mode where the outputs must be configured during initialization prior to use. In this mode, the GPOs will default as high-z with internal pull-down resistors enabled and GPO\_OUT\_DATA will be masked. During initialization, the host must first write to the GPO\_OUT\_DATA register (Note: this will transition all of the GPOs from high-z with internal pull-down to Full-Buffer driven low with internal pull-down regardless of the value written to the GPO\_OUT\_DATA register). The host must then write to the GPO\_PULL\_DIR, GPO\_PULL\_ENABLE, & GPO\_OUT\_HIGH\_CFG registers to configure each GPO into the desired output configuration. Once that is complete, the host then writes the GPO\_DATA\_MASK and GPO\_OUT\_DATA registers to set the GPO outputs in the desired state. Refer to [Figure 8](#).



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## ABSOLUTE MAXIMUM RATINGS <sup>(1)(2)</sup>

RFFE Supply Voltage (VIO)	–0.3V to 2.2V
Core Supply Voltage (VDD)	–0.3V to 2.2V
GPO Supply Voltage (VDDIO)	–0.3V to 4.0V
DC Input Voltage for SCLK & SDATA pins	–0.3V to (VIO+0.3V)
DC Input Voltage for ADR & CFG pins	–0.3V to (VDD+0.3V)
DC Output Voltage for GPO pins	–0.3V to (VDDIO+0.3V)
Storage Temperature Range	–40°C to +125° C
Operating Ambient Temperature (TA)	–0°C to +85°C
Lead Temperature (TL) (Soldering, 10 sec.)	260°C
ESD Rating (CZAP=120 pF, RZAP=1500Ω)	
Human Body Model <sup>(3)</sup>	1000V
Charge Device Model:	250V

- (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) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.

## OPERATING RATINGS

	Min	Max	Unit
RFFE Supply Voltage (VIO)	1.65	1.95	V
RFFE Supply Noise (VIO)		25	mVpp
Core Supply Voltage (VDD)	1.65	1.95	V
Core Supply Noise (VDD)		25	mVpp
GPO Supply Voltage (VDDIO)	1.65	3.60	V
GPO Supply Noise (VDDIO)		50	mVpp

## DC ELECTRICAL CHARACTERISTICS: GENERAL (ADR, CFG)<sup>(1)(2)</sup>

T<sub>A</sub>: –30°C to +85°C, VIO = 1.8V ± 0.15V, VDD = 1.8V ± 0.15V, VDDIO = 3.3V ± 0.3V (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V <sub>IH</sub>	Minimum high-level input voltage (ADR, CFG)		0.7 * V <sub>DD</sub>		V <sub>DD</sub> + 0.2	V
V <sub>IL</sub>	Maximum low-level input voltage (ADR, CFG)		–0.2		0.3 * V <sub>DD</sub>	
I <sub>IH</sub>	Logic high-level input current (ADR, CFG)	V <sub>IN</sub> = V <sub>DD</sub>			2	μA
I <sub>IL</sub>	Logic low-level input current (ADR, CFG)	V <sub>IN</sub> = GND	–2			

- (1) All voltages are with respect to the GND pin.
- (2) Min and Max Limits are verified by design, test, or statistical analysis. Typical (Typ.) numbers are not specified, but do represent the most likely norm. Unless otherwise specified conditions for typical specifications are: VDD = 1.8V, VDDIO = 3.3V, VIO = 1.8V, T<sub>A</sub> = +25°C.

## DC ELECTRICAL CHARACTERISTICS: GPO (GPO\_X, VDD, VDDIO)<sup>(1)(2)</sup>

T<sub>A</sub>: -30°C to +85°C, V<sub>IO</sub> = 1.8V ± 0.15V, V<sub>DD</sub> = 1.8V ± 0.15V; V<sub>DDIO</sub> = 3.3V ± 0.3V (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V <sub>OH</sub>	Minimum high-level output voltage	I <sub>OH</sub> = -12 mA (V <sub>DDIO</sub> = 3.3V ± 0.3V)	0.7 * V <sub>DDIO</sub>			V
		I <sub>OH</sub> = -4 mA (V <sub>DDIO</sub> = 1.8V ± 0.15V)				
		I <sub>OH</sub> = -10 µA	V <sub>DDIO</sub> - 0.2			
V <sub>OL</sub>	Maximum low-level output voltage	I <sub>OL</sub> = 12 mA (V <sub>DDIO</sub> = 3.3V ± 0.3V)			0.4	V
		I <sub>OL</sub> = 4 mA (V <sub>DDIO</sub> = 1.8V ± 0.15V)			0.4	
		I <sub>OL</sub> = 10 µA			0.2	
I <sub>OH</sub>	Logic high-level output current	(V <sub>DDIO</sub> = 3.3V ± 0.3V)	-12			mA
		(V <sub>DDIO</sub> = 1.8V ± 0.15V)	-4			
I <sub>OL</sub>	Logic low-level output current	(V <sub>DDIO</sub> = 3.3V ± 0.3V)			12	mA
		(V <sub>DDIO</sub> = 1.8V ± 0.15V)			4	
I <sub>OZ</sub>	High-Z leakage current	0 < V <sub>PIN</sub> < V <sub>DDIO</sub>	-2		2	µA
I <sub>PU</sub>	Pull-Up current	(V <sub>DDIO</sub> = 3.3V ± 0.3V)	-60		-200	µA
		(V <sub>DDIO</sub> = 1.8V ± 0.15V)	-9		-60	
I <sub>PD</sub>	Pull-Down current	(V <sub>DDIO</sub> = 3.3V ± 0.3V)	60		200	µA
		(V <sub>DDIO</sub> = 1.8V ± 0.15V)	9		60	
I <sub>STBY</sub>	V <sub>DD</sub> supply standby current	T <sub>A</sub> = 25°C, V <sub>IO</sub> = 1.8V, V <sub>DD</sub> = 1.8V, V <sub>DDIO</sub> = 3.3V, GPO_X = high-z, PU & PD disabled SCLK = Low			2.5	µA
I <sub>STBYIO</sub>	V <sub>DDIO</sub> supply standby current				2.5	
I <sub>VDD</sub>	V <sub>DD</sub> supply current	T <sub>A</sub> = 25°C, V <sub>DD</sub> = 1.8V		225	400	µA
I <sub>VDDIO</sub>	V <sub>DDIO</sub> supply current	T <sub>A</sub> = 25°C V <sub>DDIO</sub> = 3.3V		200	450	

(1) All voltages are with respect to the GND pin.

(2) Min and Max Limits are verified by design, test, or statistical analysis. Typical (Typ.) numbers are not specified, but do represent the most likely norm. Unless otherwise specified conditions for typical specifications are: V<sub>DD</sub> = 1.8V, V<sub>DDIO</sub> = 3.3V, V<sub>IO</sub> = 1.8V, T<sub>A</sub> = +25°C.

## DC ELECTRICAL CHARACTERISTICS: RFFE (SCLK, SDATA, VIO)<sup>(1)(2)</sup>

T<sub>A</sub>: -30°C to +85°C, V<sub>IO</sub> = 1.8V ± 0.15V, V<sub>DD</sub> = 1.8V ± 0.15V; V<sub>DDIO</sub> = 3.3V ± 0.3V (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Units
C <sub>IN</sub>	Input pin capacitance (SCLK, SDATA) <sup>(2)</sup>				2.5	pF
V <sub>TP</sub>	Positive edge threshold voltage (SCLK, SDATA)		0.4 * V <sub>IO</sub>		0.7 * V <sub>IO</sub>	V
V <sub>TN</sub>	Negative edge threshold voltage (SCLK, SDATA)		0.3 * V <sub>IO</sub>		0.6 * V <sub>IO</sub>	
V <sub>HYST</sub>	Input hysteresis voltage (SDATA)		0.1 * V <sub>IO</sub>		0.4 * V <sub>IO</sub>	
V <sub>IORST</sub>	RFFE I/O voltage reset voltage level	V <sub>IO</sub> toggled low			0.2	µA
I <sub>INVIO</sub>	Input current (VIO)	0 < V <sub>IO</sub> < 0.2V	-1		1	
I <sub>IN</sub>	Input current (SCLK, SDATA)	V <sub>IO</sub> = Max, 0.2 * V <sub>IO</sub> < V <sub>IN</sub> < 0.8 * V <sub>IO</sub>	-1		1	
I <sub>VIO</sub>	VIO supply input current	V <sub>IO</sub> = 1.8, RFFE write only mode			100	

(1) All voltages are with respect to the GND pin.

(2) Min and Max Limits are verified by design, test, or statistical analysis. Typical (Typ.) numbers are not specified, but do represent the most likely norm. Unless otherwise specified conditions for typical specifications are: V<sub>DD</sub> = 1.8V, V<sub>DDIO</sub> = 3.3V, V<sub>IO</sub> = 1.8V, T<sub>A</sub> = +25°C.

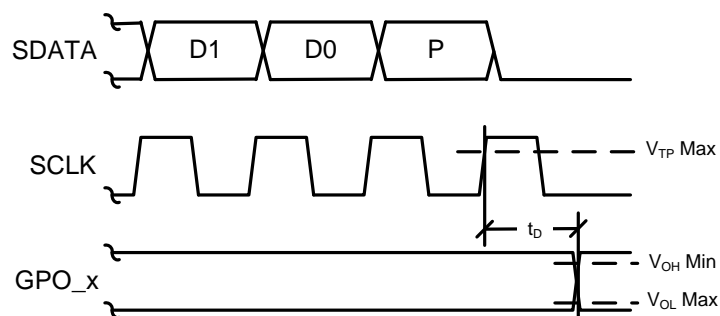
**AC ELECTRICAL CHARACTERISTICS: INTERNAL POR, VIO, GPO\_X, SCLK<sup>(1)(2)</sup>**

$T_A$ :  $-30^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{IO} = 1.8\text{V} \pm 0.15\text{V}$ ,  $V_{DD} = 1.8\text{V} \pm 0.15\text{V}$ ;  $V_{DDIO} = 3.3\text{V} \pm 0.3\text{V}$  (unless otherwise specified).

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PORC1}$	VDD POR reset complete	$V_{DD}$ ramp rate = $100\text{ }\mu\text{S}$			1	mS
$t_{PORC2}$	VDDIO POR reset complete	$V_{DDIO}$ ramp rate = $100\text{ }\mu\text{S}$			1	
$t_{READY}$	VIO input signal reset delay time	$V_{IO} = 1.65\text{V}$ , SCLK, SDATA = Low, $t_{PORC1}$ , $t_{PORC2}$ = complete			120	nS
$f_{SCLK}$	SCLK frequency		0.032		26	MHz
$t_D$	GPO_x output delay time	$V_{DDIO} = 1.8\text{V} \pm 0.15\text{V}$ , $C_{LOAD} = 10\text{ pF}$			25	nS

(1) All voltages are with respect to the GND pin.

(2) Min and Max Limits are verified by design, test, or statistical analysis. Typical (Typ.) numbers are not specified, but do represent the most likely norm. Unless otherwise specified conditions for typical specifications are:  $V_{DD} = 1.8\text{V}$ ,  $V_{DDIO} = 3.3\text{V}$ ,  $V_{IO} = 1.8\text{V}$ ,  $T_A = +25^{\circ}\text{C}$ .



**Figure 3. GPO Delay Timing**



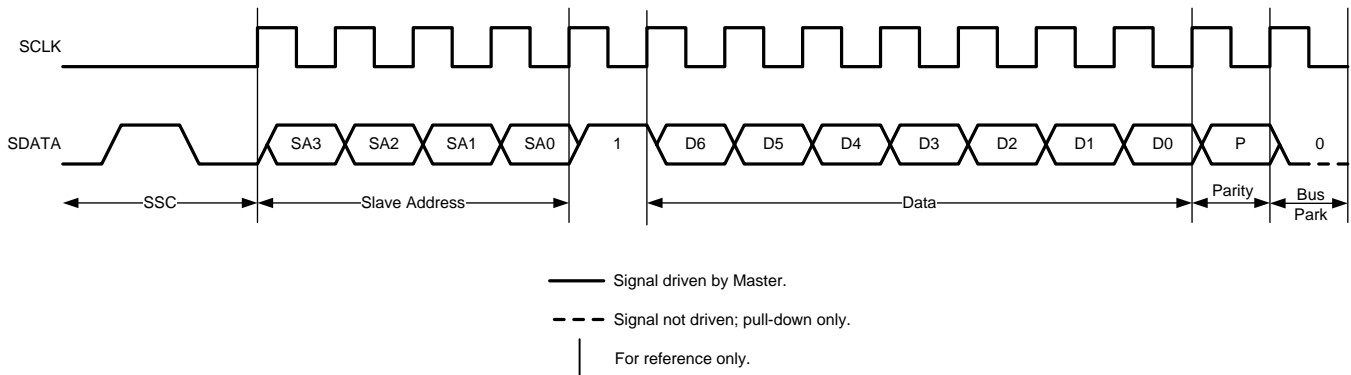
## MIPI RFFE INTERFACE

The LM8335 provides RFFE compatible slave access to the device specific and RFFE defined registers on a single master bidirectional serial bus interface. The LM8335 uses the three interface signals SCLK, SDATA, and VIO as defined in MIPI RFFE Version 1.10 – 26 July 2011. The VIO voltage supply provides power to the LM8335 RFFE Interface and doubles as an asynchronous enable and reset. Whenever VIO is low the SCLK and SDATA lines must be held low. When the VIO voltage is applied, the LM8335 enables the slave interface and resets the user defined slave registers to the default settings. The LM8335 enters the power down mode via the asynchronous VIO signal. The LM8335 does not support read access.

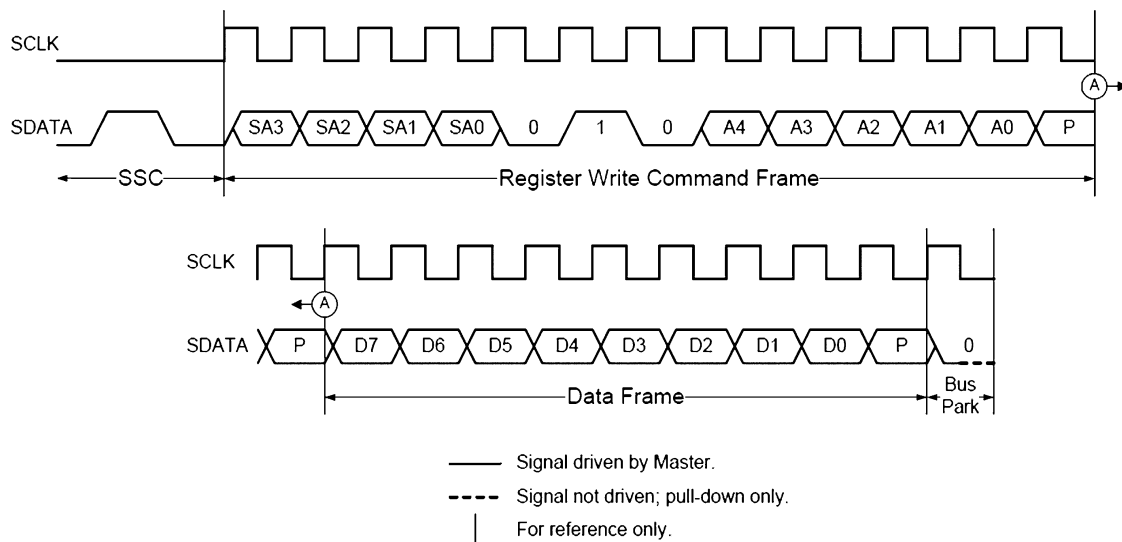
The LM8335 contains fewer than 28 user defined registers but supports the Extended Register Write Command to allow a burst write of configuration registers during initialization. Any write outside of the range from 0x00 to 0x1F will have no effect on device operation.

The LM8335 recognizes the broadcast Slave Identifier (SID) of 0000b and is configured internally with a Unique Slave Identifier (USID) and a Group Slave Identifier (GSID). The USID is set based on the state of the ADR pin and the GSID is set to 0000b. The USID may be reprogrammed via the RFFE Interface by performing the Register Write USID Command Sequence.

The LM8335 supports only the 1.8V VIO supply levels. The LM8335 utilizes a power-detect reset circuit that resets the RFFE interface and internal registers when VIO is removed.



**Figure 4. Register 0 Write Command Sequence**



**Figure 5. Register Write Command Sequence**

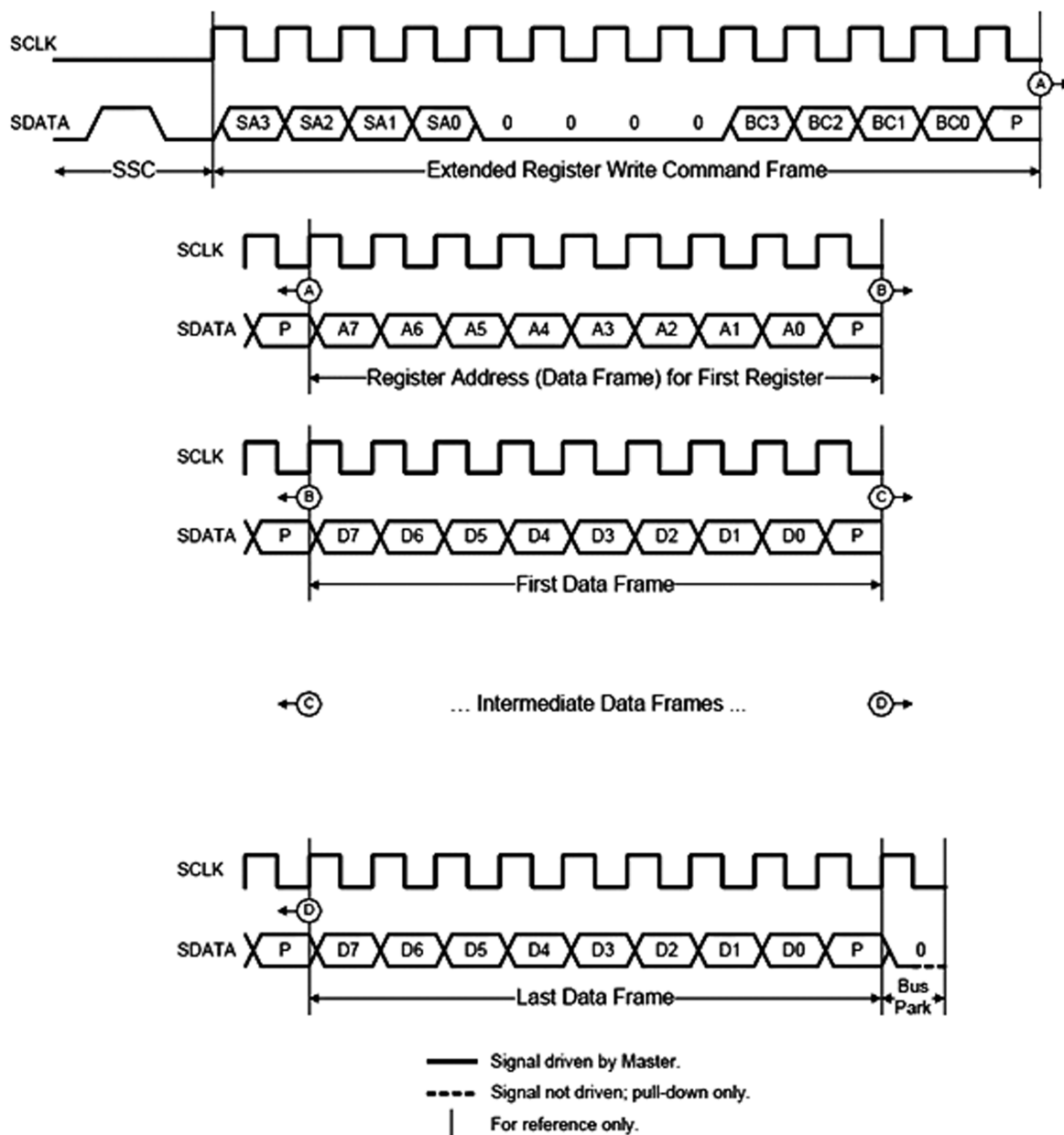
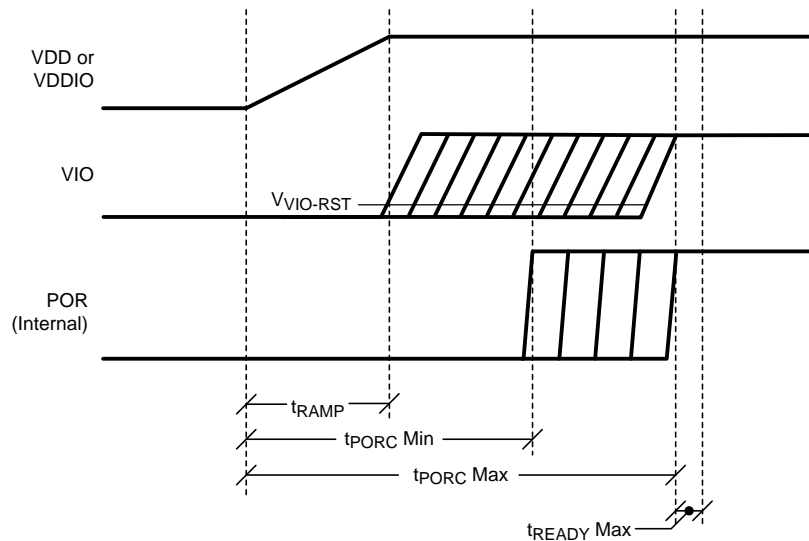


Figure 6. Extended Register Write Command Sequence

## INTERNAL POR OPERATION

There are two internal POR circuits: one on the VDD supply and one on the VDDIO supply that initialize the LM8335 when power is applied. The duration of the reset is an RC delay which is based on the ramp rate and not a threshold voltage of the VDD/VDDIO supply. VIO can be activated as soon as VDD and VDDIO have reached their minimum respective voltage levels however the LM8335 may still be in reset due to the internal POR timing. When VIO is asserted after VDD and VDDIO  $t_{PORC}$  Max, the device reset will be released based on the VIO  $t_{READY}$  timing.



**Figure 7. Internal VDD or VDDIO POR Timing**

## Register Information

**Table 1. Register Listing**

Register Name	Addr	Bit	Default	Description
CNTL_REG	0x00	7:0	0x00	Software reset register Bit 0 = 0, no effect Bit 0 = 1, reset registers to default values (self-clearing)
GPO_PULL_DIR	0x01	7:0	0x00	GPO pin pull resistor direction 0 = pull-down 1 = pull-up Note: When CFG = GND, writing to this register has no effect. The pull-down resistor will be disabled after the first write to the GPO_OUT_DATA register.
GPO_PULL_ENABLE	0x02	0xFF	0xFF	GPO pin internal pull resistor enable 0 = disabled 1 = enabled Note: GPO_PULL_DIR register selects if the resistor is a pull-up or a pull-down. When CFG = GND, writing to this register has no effect. The pull-down resistor will be disabled after the first write to the GPO_OUT_DATA register.
GPO_OUT_HIGH_CFG	0x03	7:0	0xFF	GPO output high state (full buffer or high-z). 0 = full buffer 1 = high-z (open-drain behavior) Note: When CFG = GND, writing to this register has no effect. The pull-down resistor will be disabled, and all GPO outputs will be in the actively driven state (not high-z) after the first write to the GPO_OUT_DATA register.

**Table 1. Register Listing (continued)**

Register Name	Addr	Bit	Default	Description
GPO_OUT_MASK	0x04	7:0	0xFF (CFG=0) or 0x00 (CFG=1)	GPO output data mask 0 = GPO_OUT_DATA masked 1 = GPO_OUT_DATA unmasked  Note: Only the GPO_OUT_DATA register write is affected by the GPO_OUT_MASK register. When the GPO_OUT_MASK bit is set low (masked), writing to GPO_OUT_DATA register will leave the pin state unchanged. When the GPO_OUT_MASK bit is set high (unmasked), the GPO output will be updated when the GPO_OUT_DATA is written (only GPOs that are unmasked will be changed).
GPO_OUT_DATA	0x05	7:0	0x00	GPO output data 0 = pin set low 1 = pin set high  Note: GPO_OUT_HIGH_CFG register selects if the pin is driven or high-z. The pin state will follow GPO_OUT_DATA only if the corresponding bit is unmasked in the GPO_OUT_MASK register.
PM_TRIG	0x1C	7:0	0x00	MIPI RFFE power mode and trigger register Bits 7:6 = PWR_MODE Bits 5:0 = TRIG_REG
PROD_ID	0x1D	7:0	0xC4	This is a MIPI RFFE reserved read only register and can not be read since readback is not supported on this device. Bits 7:0 = PRODUCT_ID [7:0]  The product ID is provided as information only to support the RFFE USID programming feature.
MAN_ID	0x1E	7:0	0x02	This is a MIPI RFFE reserved read-only register and can not be read since readback is not supported on this device. Bits 7:0 = MANUFACTURER_ID [7:0]  The manufacturer ID is provided as information only to support the RFFE USID programming feature.
USID_REG	0x1F	7:0	0x11 (ADR=0) or 0x19 (ADR=1)	This MIPI RFFE reserved register Bits 7:6 = SPARE Bits 5:4 = MANUFACTURER_ID [9:8] = 1 Bits 3:0 = Programmable Unique Slave Identifier — ADR=Low, USID[3:0]=0001 — ADR=High, USID[3:0]=1001  Note: The USID is initially set based on the state of the ADR pin (default value when ADR=Low shown). This register can not be read since readback is not supported on this device. USID_REG[5:4] are provided as information only to support the RFFE USID programming feature.

**Table 2. General Bit Field Layout for GPO\_x Registers**

7	6	5	4	3	2	1	0
GPO_7	GPO_6	GPO_5	GPO_4	GPO_3	GPO_2	GPO_1	GPO_0

**Table 3. CNTL\_REG Register Bit Fields**

7	6	5	4	3	2	1	0
rsvd	rsvd	rsvd	rsvd	rsvd	rsvd	rsvd	SW_RESET

LM8335 CFG Input Pin = VDD  
INITIALIZATION SEQUENCE

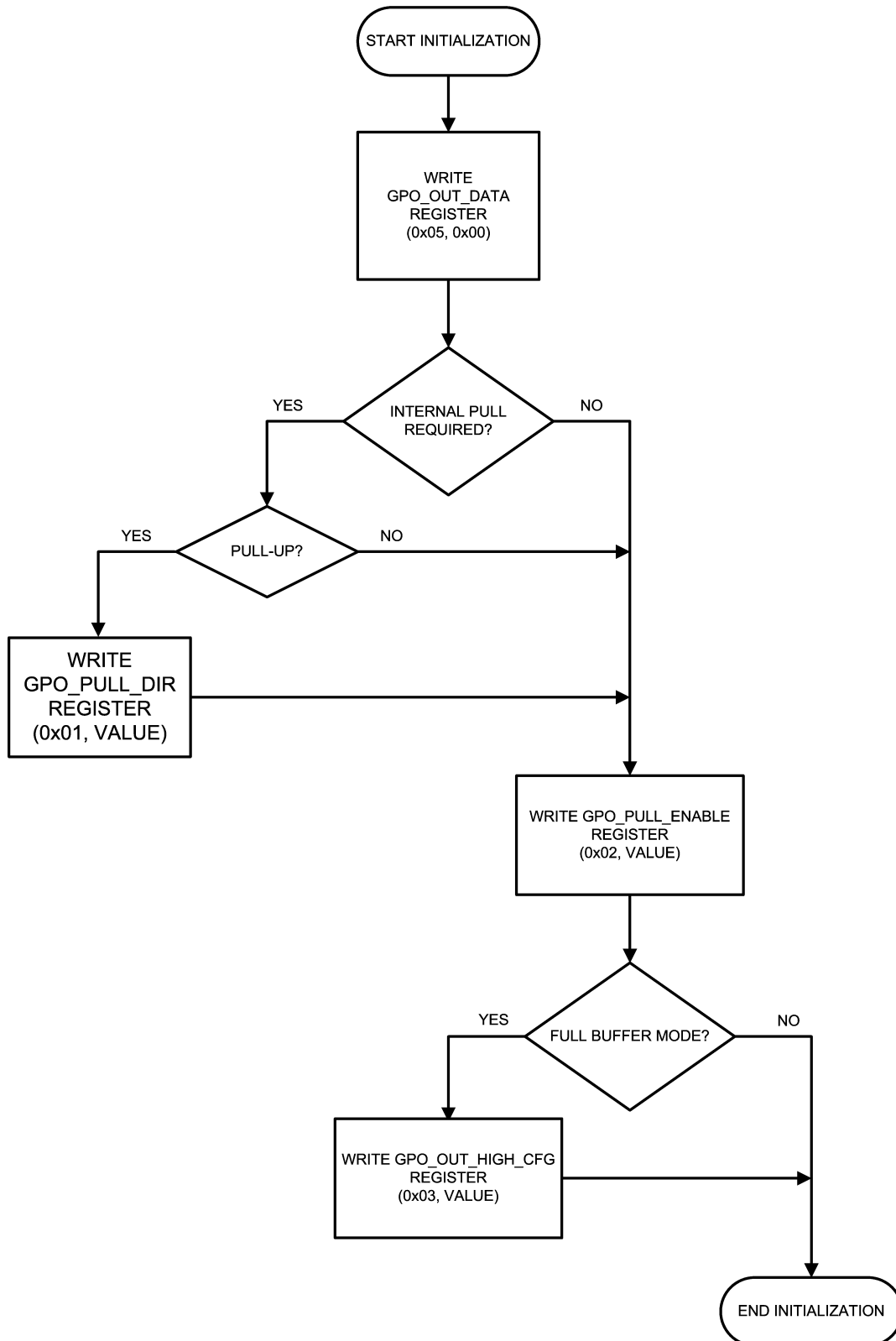


Figure 8. CFG1 MODE Recommended Initialization Sequence

## LM8335 UPDATE GPO PIN STATE

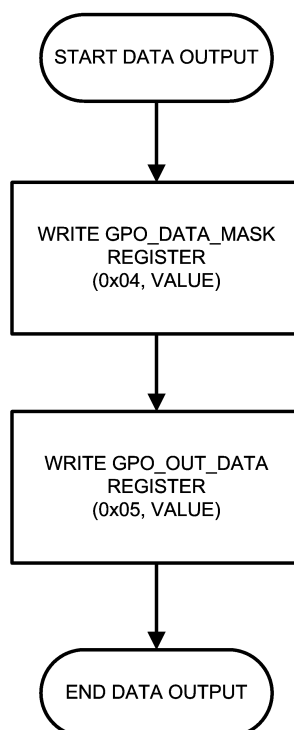


Figure 9. Update GPO Pin State Sequence

## REVISION HISTORY

Changes from Revision A (May 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format .....	<a href="#">14</a>

## PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">LM8335TLE/NOPB</a>	Active	Production	DSBGA (YZR)   16	250   SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-30 to 85	8335
<a href="#">LM8335TLX/NOPB</a>	Active	Production	DSBGA (YZR)   16	3000   LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-30 to 85	8335

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.



## TAPE AND REEL INFORMATION



\*All dimensions are nominal

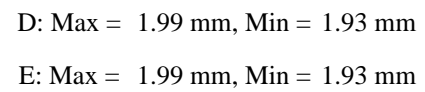
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM8335TLE/NOPB	DSBGA	YZR	16	250	178.0	8.4	2.08	2.08	0.76	4.0	8.0	Q1
LM8335TLX/NOPB	DSBGA	YZR	16	3000	178.0	8.4	2.08	2.08	0.76	4.0	8.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM8335TLE/NOPB	DSBGA	YZR	16	250	208.0	191.0	35.0
LM8335TLX/NOPB	DSBGA	YZR	16	3000	208.0	191.0	35.0



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.

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

Copyright © 2025, Texas Instruments Incorporated