Haptic Driver for DC Motors (ERMs) and Linear Vibrators (LRAs) with Ultra-Fast Turn-On

Check for Samples: DRV8601

FEATURES

- **High Current Output: 400 mA**
- **Wide Supply Voltage (2.5 V to 5.5 V) for Direct Battery Operation**
- **Low Quiescent Current: 1.7 mA Typical**
- **Fast Startup Time: 100 μs**
- **Low Shutdown Current: 10 nA**
- **Output Short-Circuit Protection**
- **Thermal Protection**
- **Enable Pin is 1.8 V Compatible**
- **Available Package Options**
    - **2 mm x 2 mm MicroStar Junior™ BGA Package (ZQV)**
    - **3 mm x 3 mm QFN Package (DRB)**
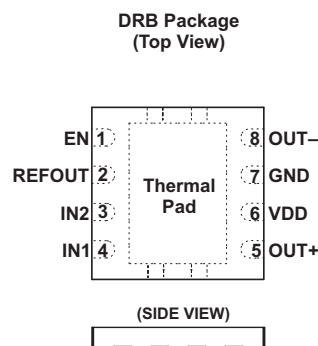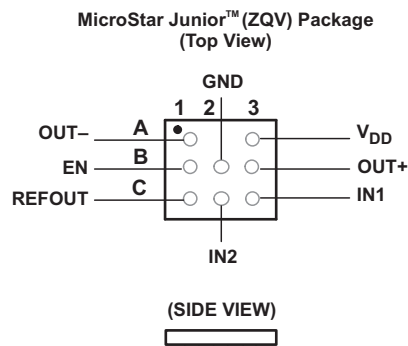
APPLICATIONS

- **Mobile Phones**
- **Tablets**
- **Portable Gaming Consoles**
- **Portable Navigation Devices**
- **Appliance Consoles**

DESCRIPTION

The DRV8601 is a single-supply haptic driver that is optimized to drive a DC motor (also known as Eccentric Rotating Mass or ERM in haptics terminology) or a linear vibrator (also known as Linear Resonant Actuator or LRA in haptics terminology) using a single-ended PWM input signal. With a fast turn-on time of 100 μs, the DRV8601 is an excellent haptic driver for use in mobile phones and other portable electronic devices.

The DRV8601 drives up to 400 mA from a 3.3 V supply. Near rail-to-rail output swing under load ensures sufficient voltage drive for most DC motors. Differential output drive allows the polarity of the voltage across the output to be reversed quickly, thereby enabling motor speed control in both clockwise and counter-clockwise directions, allowing quick motor stopping. A wide input voltage range allows precise speed control of both DC motors and linear vibrators.

With a typical quiescent current of 1.7 mA and a shutdown current of 10 nA, the DRV8601 is ideal for portable applications. The DRV8601 has thermal and output short-circuit protection to prevent the device from being damaged during fault conditions.

MicroStar Junior™ (ZQV) Package
(Top View)

DRB Package
(Top View)

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.

Pin Functions

PIN			INPUT/OUTPUT/ POWER (I/O/P)	DESCRIPTION
NAME	BALL (ZQV)	PIN (DRB)		
IN1	C3	4	I	Input to driver
IN2	C2	3	I	Input to driver
OUT+	B3	5	O	Positive output
OUT-	A1	8	O	Negative output
REFOUT	C1	2	O	Reference voltage output
EN	B1	1	I	Chip enable
VDD	A3	6	P	Supply voltage
GND	B2	7	P	Ground

ORDERING INFORMATION

	MicroStar Junior™ (ZQV)	QFN Package (DRB)
Device	DRV8601ZQVR[1][2]	DRV8601DRB[2]
Symbolization	HSMI	8601

(1) The ZQV packages are only available taped and reeled. The suffix R designates taped and reeled parts in quantities of 2500.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document or visit the TI website at www.ti.com

THERMAL INFORMATION

THERMAL METRIC[1]		DRV8601		UNITS
		ZQV (8 BALLS)	DRB (8 PINS)	
θ_{JA}	Junction-to-ambient thermal resistance	78	52.8	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	155	63	
θ_{JB}	Junction-to-board thermal resistance	65	28.4	
ψ_{JT}	Junction-to-top characterization parameter	5	2.7	
ψ_{JB}	Junction-to-board characterization parameter	50	28.6	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance	n/a	11.4	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

Product Folder Link(s): *DRV8601*

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range, $T_A \leq 25°C$ unless otherwise noted[1]

		VALUE / UNIT
VDD	Supply voltage	–0.3 V to 6 V
V_I	Input voltage	INx, EN	–0.3 V to V_{DD} + 0.3 V
	Output continuous total power dissipation	See Thermal InformationTable
T_A	Operating free-air temperature range	–40°C to 85°C
T_J	Operating junction temperature range	–40°C to 150°C
T_{stg}	Storage temperature	–65°C to 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.

RECOMMENDED OPERATING CONDITIONS

			MIN	TYP	MAX	UNIT
V_{DD}	Supply voltage		2.5		5.5	V
V_{IH}	High-level input voltage	EN	1.15			V
V_{IL}	Low-level input voltage	EN			0.5	V
T_A	Operating free-air temperature		–40		85	°C
Z_L	Load impedance		6.4			Ω

ELECTRICAL CHARACTERISTICS

T_A = 25°C, Gain = 2 V/V, R_L= 10 Ω (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$|V_{OO}|$	Output offset voltage (measured differentially)	V_I = 0 V, V_{DD} = 2.5 V to 5.5 V				9	mV
$V_{OD,N}$	Negative differential output voltage (V_{OUT+}-V_{OUT-})	V_{IN+} = V_{DD}, V_{IN-} = 0 V or V_{IN+} = 0 V, V_{IN-} = V_{DD}	V_{DD} = 5.0 V, I_o = 400 mA		-4.55		V
			V_{DD} = 3.3 V, I_o = 300 mA		-2.87		
			V_{DD} = 2.5 V, I_o = 200 mA		-2.15		
$V_{OD,P}$	Positive differential output voltage (V_{OUT+}-V_{OUT-})	V_{IN+} = V_{DD}, V_{IN-} = 0 V or V_{IN+} = 0 V, V_{IN-} = V_{DD}	V_{DD} = 5.0 V, I_o = 400 mA		4.55		V
			V_{DD} = 3.3 V, I_o = 300 mA		2.87		
			V_{DD} = 2.5 V, I_o = 200 mA		2.15		
$|I_{IH}|$	High-level EN input current	V_{DD} = 5.5 V, V_I = 5.8 V				1.2	µA
$|I_{IL}|$	Low-level EN input current	V_{DD} = 5.5 V, V_I = –0.3 V				1.2	µA
$I_{DD(Q)}$	Supply current	V_{DD} = 2.5 V to 5.5 V, No load, EN = V_{IH}			1.7	2	mA
$I_{DD(SD)}$	Supply current in shutdown mode	EN = V_{IL} , V_{DD} = 2.5 V to 5.5 V, No load			0.01	0.9	µA

OPERATING CHARACTERISTICS

T_A = 25°C, Gain = 2 V/V, R_L = 10 Ω (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Z_I	Input impedance			2		MΩ
Z_O	Output impedance	Shutdown mode (EN = V_{IL})	>10			kΩ

TYPICAL CHARACTERISTICS

Pseudo-Differential Feedback with Internal Reference, ZQV Package, V_{DD} = 3.3 V, R_I = 100 kΩ, R_F = 100 kΩ, C_R = 0.001 µF, C_F = None, T_A = 25°C, unless otherwise specified.

Table of Graphs

		FIGURE
Output voltage (High)	vs Load current	1
Output voltage (Low)	vs Load current	2
Output voltage	vs Input voltage, R_L = 10 Ω	3
Output voltage	vs Input voltage, R_L = 20 Ω	4
Supply current	vs Supply voltage	5
Shutdown supply current	vs Supply voltage	6
Power dissipation	vs Supply voltage	7
Slew rate	vs Supply voltage	8
Output transition	vs Time	9, 10
Startup	vs Time	11
Shutdown	vs Time	12

Product Folder Link(s): *DRV8601*

DRV8601

SLOS629B – JULY 2010 – REVISED JANUARY 2012

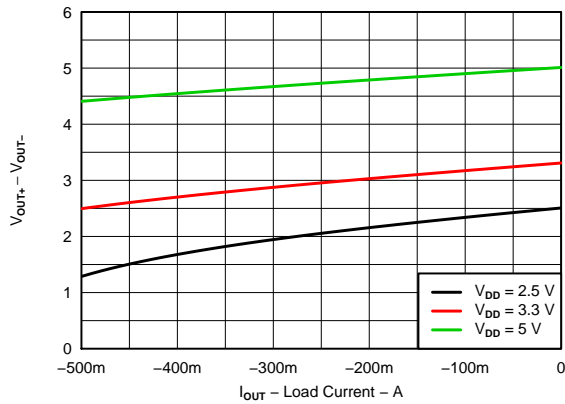**OUTPUT VOLTAGE (HIGH) vs LOAD CURRENT**

Figure 1.

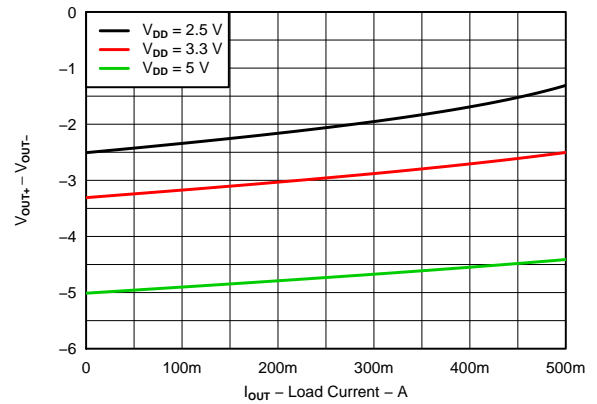**OUTPUT VOLTAGE (LOW) vs LOAD CURRENT**

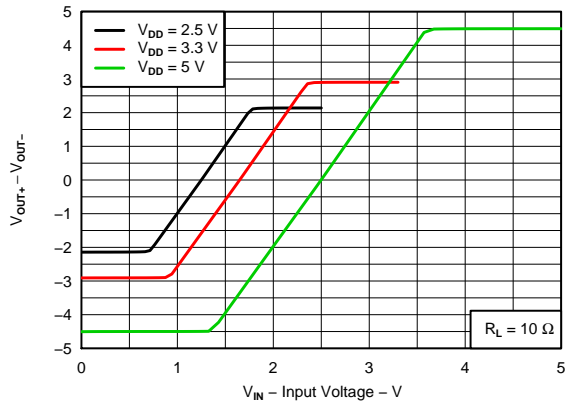Figure 2.

OUTPUT VOLTAGE vs INPUT VOLTAGE

Figure 3.

OUTPUT VOLTAGE vs INPUT VOLTAGE
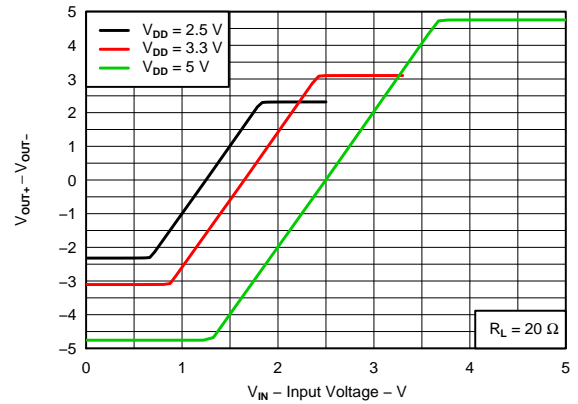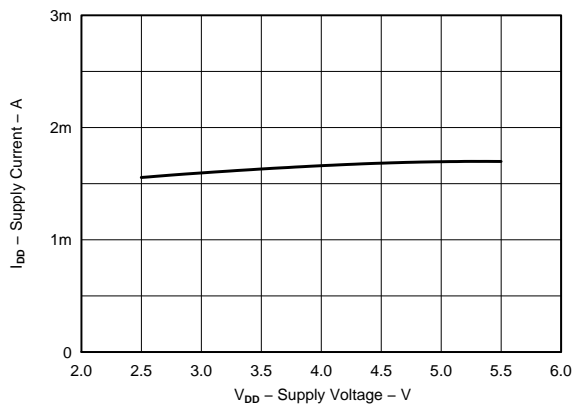
Figure 4.

SUPPLY CURRENT vs SUPPLY VOLTAGE
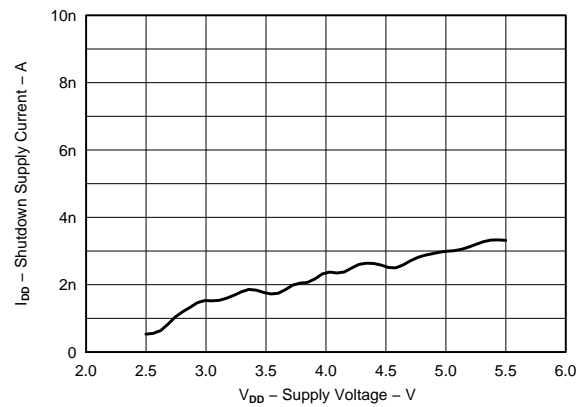
Figure 5.

SHUTDOWN SUPPLY CURRENT vs SUPPLY VOLTAGE

Figure 6.

Copyright © 2010–2012, Texas Instruments Incorporated

Submit Documentation Feedback 5

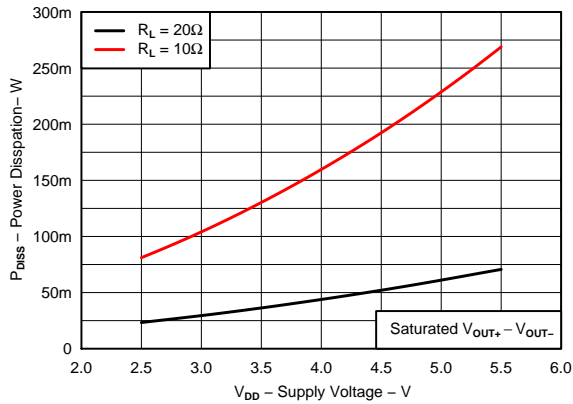Product Folder Link(s): DRV8601

POWER DISSIPATION vs
SUPPLY VOLTAGE

Figure 7.

SLEW RATE vs
SUPPLY VOLTAGE
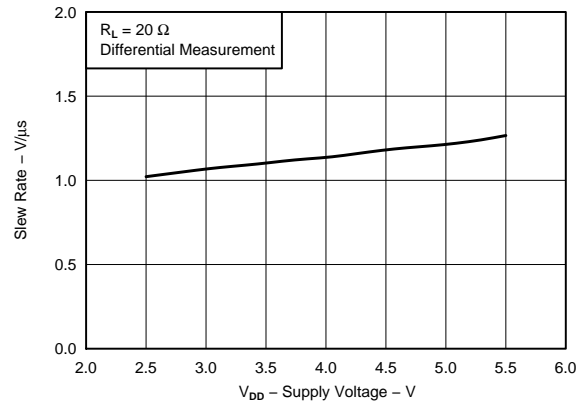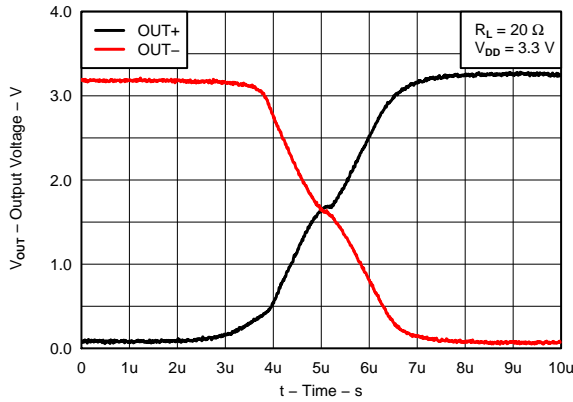

Figure 8.

OUTPUT TRANSITION vs
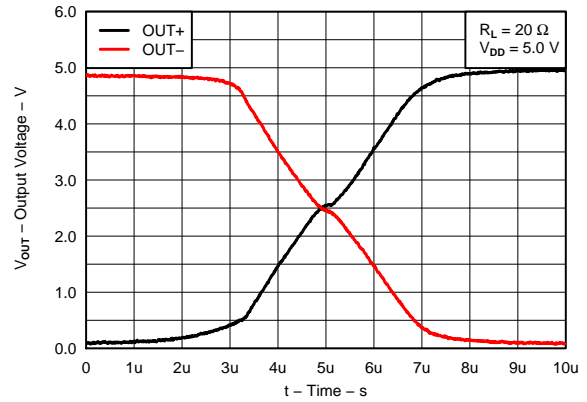TIME

Figure 9.

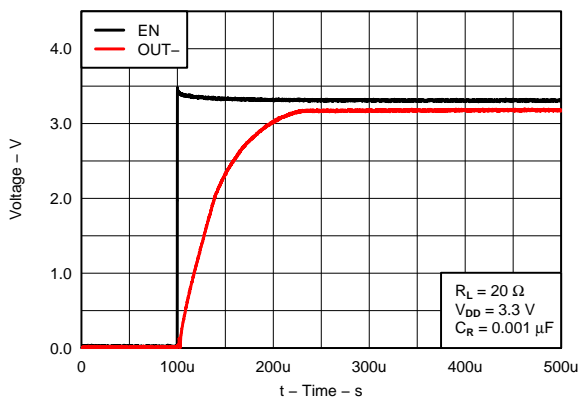OUTPUT TRANSITION vs
TIME

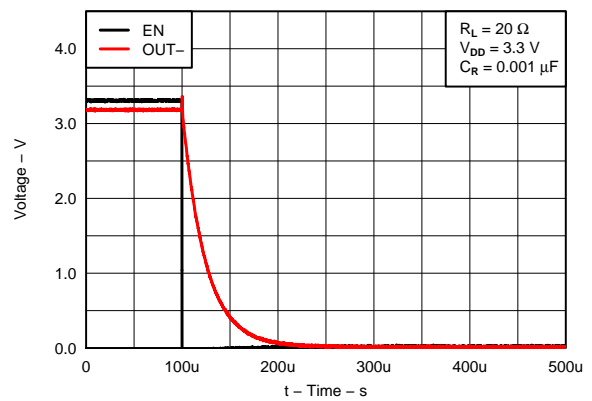Figure 10.

STARTUP vs
TIME

Figure 11.

SHUTDOWN vs
TIME

Figure 12.

APPLICATION INFORMATION

DRIVING DC MOTORS USING THE DRV8601

The DRV8601 is designed to drive a DC motor (also known as Eccentric Rotating Mass or ERM in haptics terminology) in both clockwise and counter-clockwise directions, as well as to stop the motor quickly. This is made possible because the outputs are fully differential and capable of sourcing and sinking current. This feature helps eliminate long vibration tails which are undesirable in haptic feedback systems.
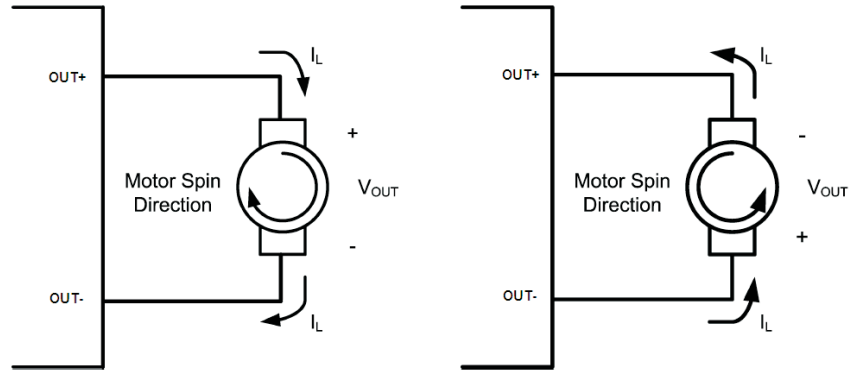

Figure 13. Reversal of Direction of Motor Spin Using DRV8601

Another common approach to driving DC motors is the concept of overdrive voltage. To overcome the inertia of the motor's mass, they are often *overdriven* for a short amount of time before returning to the motor's rated voltage to sustain the motor's rotation. The DRV8601 can overdrive a motor up to the VDD voltage. Overdrive is also used to stop (or brake) a motor quickly. The DRV8601 can brake up to a voltage of -VDD. Please reference the motor's datasheet for safe and reliable overdrive voltage and duration.

The DRV8601 can accept a single-ended PWM source or single-ended DC control voltage and perform single-ended to differential conversion. A PWM signal is typically generated using software, and many different advanced haptic sensations can be produced by inputting different types of PWM signals into the DRV8601.

DRIVING LINEAR VIBRATORS USING THE DRV8601

Linear vibrators (also known as Linear Resonant Actuators or LRA in haptics terminology) vibrate only at their resonant frequency. Usually, linear vibrators have a high-Q frequency response due to which there is a rapid drop in vibration performance at offsets of 3-5 Hz from the resonant frequency. Therefore, while driving a linear vibrator with the DRV8601, ensure that the commutation of the input PWM signal is within the prescribed frequency range for the chosen linear vibrator. Vary the duty cycle of the PWM signal symmetrically above and below 50% to vary the strength of the vibration. As in the case of DC motors, the PWM signal is typically generated using software, and many different advanced haptic sensations can be produced by applying different PWM signals into the DRV8601.
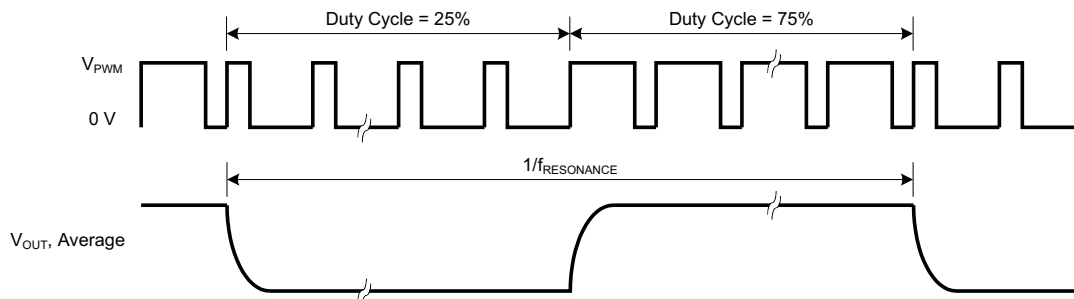

Figure 14. LRA Example for 1/2 Full-Scale Drive

Submit Documentation Feedback 7

PSEUDO-DIFFERENTIAL FEEDBACK WITH INTERNAL REFERENCE

In the pseudo-differential feedback configuration (Figure 15), feedback is taken from only one of the output pins, thereby reducing the number of external components required for the solution. The DRV8601 has an internal reference voltage generator which keeps the REFOUT voltage at VDD/2. The internal reference voltage can be used if and only if the PWM voltage is the same as the supply voltage of the DRV8601 (i.e., if V_{PWM} = VDD, as assumed in this section).

Having V_{PWM}= VDD ensures that there is no voltage signal applied to the motor at a PWM duty cycle of 50%. This is a convenient way of temporarily stopping the motor without powering off the DRV8601. Also, this configuration ensures that the direction of rotation of the motor changes when crossing a PWM duty cycle of 50% in both directions. For example, if an ERM motor rotates in the clockwise direction at 20% duty cycle, it will rotate in the counter-clockwise direction at 80% duty cycle at nearly the same speed.

Mathematically, the output voltage is given by Equation 1 (where s is the Laplace Transform variable and V_{IN} is the single-ended input voltage):

$$V_{O,DIFF} = 2 \times \left(V_{IN} - \frac{Vdd}{2} \right) \times \frac{R_F}{R_I} \times \frac{1}{1 + sR_FC_F}$$

(1)

R_F is normally set equal to R_I ($R_F = R_I$) so that an overdrive voltage of VDD is achieved when the PWM duty cycle is set to 100%. The optional feedback capacitor C_F forms a low-pass filter together with the feedback resistor R_F, and therefore, the output differential voltage is a function of the average value of the input PWM signal. When driving a motor, design the cutoff frequency of the low-pass filter to be sufficiently *lower than* the PWM frequency in order to eliminate the PWM frequency and its harmonics from entering the motor. This is desirable when driving motors which do not sufficiently reject the PWM frequency by themselves. When driving a linear vibrator in this configuration, if the feedback capacitor C_F is used, care must be taken to make sure that the low-pass cutoff frequency is *higher than* the resonant frequency of the linear vibrator.

When driving motors which can sufficiently reject the PWM frequency by themselves, the feedback capacitor may be eliminated. For this example, the output voltage is given by:

$$V_{O,DIFF} = 2 \times \left(V_{IN} - \frac{Vdd}{2} \right) \times \frac{R_F}{R_I}$$

(2)

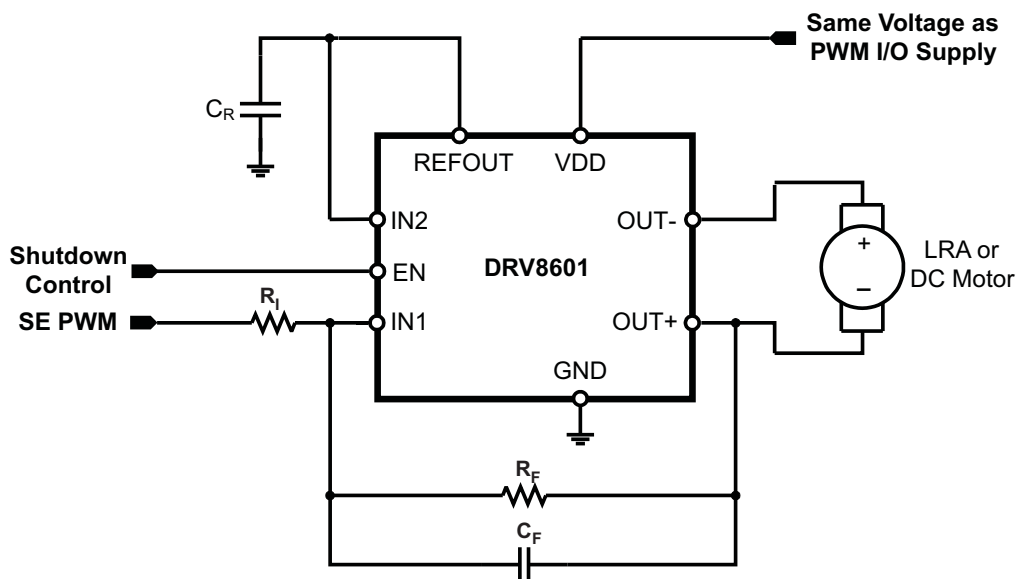where the only difference from Equation 1 is that the filtering action of the capacitor is not present.

Figure 15. Pseudo-Differential Feedback with Internal Reference

Product Folder Link(s): *DRV8601*

PSEUDO-DIFFERENTIAL FEEDBACK WITH LEVEL-SHIFTER

This configuration is desirable when a regulated supply voltage for the DRV8601 (VDD) is availble, but that voltage is different than the PWM input voltage (V_{PWM}). A single NPN transistor can be used as a low-cost level shifting solution. This ensures that V_{IN} = VDD even when $V_{PWM} \neq$ VDD. A regulated supply for the DRV8601 is still recommended in this scenario. If the supply voltage varies, the PWM level shifter output will follow, and this will, in turn, cause a change in vibration strength. However, if the variance is acceptable, the DRV8601 will still operate properly when connected directly to a battery, for example. A 50% duty cycle will still translate to zero vibration strength across the life cycle of the battery. R_F is normally set equal to R_I ($R_F = R_I$) so that an overdrive voltage of VDD is achieved when the PWM duty cycle is set to 100%.
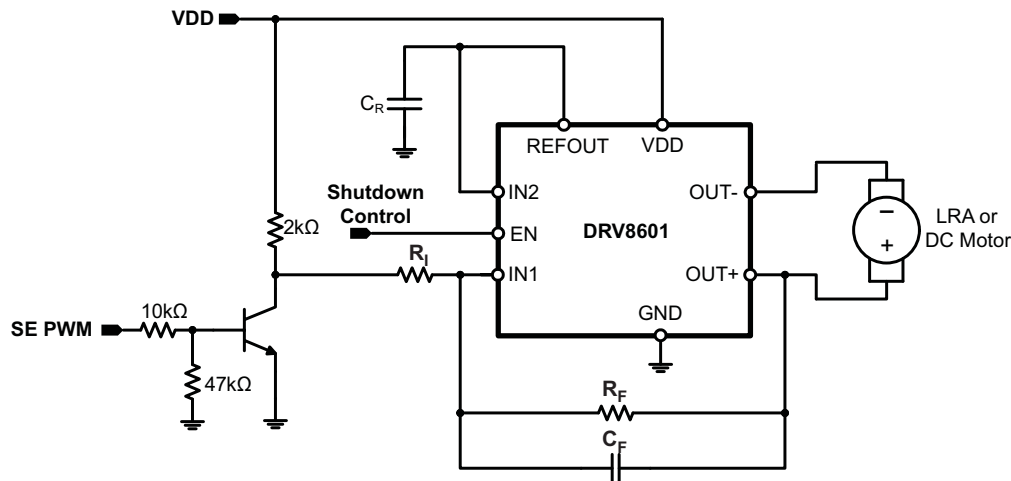

Figure 16. Pseudo-Differential Feedback with Level-Shifter

DIFFERENTIAL FEEDBACK WITH EXTERNAL REFERENCE

This configuration is useful for connecting the DRV8601 to an unregulated power supply, most commonly a battery. The gain can then be independently set so that the required motor overdrive voltage can be achieved even when V_{PWM} < VDD. This is often the case when V_{PWM} = 1.8 V, and the desired overdrive voltage is 3.0 V or above. Note that VDD must be greater than or equal to the desired overdrive voltage. A resistor divider can be used to create a V_{PWM}/2 reference for the DRV8601. If the shutdown control voltage is driven by a GPIO in the same supply domain as V_{PWM}, it can be used to supply the resistor divider as in Figure 17 so that no current is drawn by the divider in shutdown.

In this configuration, feedback is taken from both output pins. The output voltage is given by Equation 3 (where s is the Laplace Transform variable and V_{IN} is the single-ended input voltage):

$$V_{O,DIFF} = \left(V_{IN} - \frac{V_{PWM}}{2} \right) \times \frac{R_F}{R_I} \times \frac{1}{1 + sR_F C_F}$$

(3)

Note that this differs from Equation 1 for the pseudo-differential configuration by a factor of 2 because of differential feedback. The optional feedback capacitor C_F forms a low-pass filter together with the feedback resistor R_F, and therefore, the output differential voltage is a function of the average value of the input PWM signal V_{IN}. When driving a motor, design the cutoff frequency of the low-pass filter to be sufficiently *lower than* the PWM frequency in order to eliminate the PWM frequency and its harmonics from entering the motor. This is desirable when driving motors which do not sufficiently reject the PWM frequency by themselves. When driving a linear vibrator in this configuration, if the feedback capacitor C_F is used, care must be taken to make sure that the low-pass cutoff frequency is *higher than* the resonant frequency of the linear vibrator.

Submit Documentation Feedback   9

When driving motors which can sufficiently reject the PWM frequency by themselves, the feedback capacitor may be eliminated. For this example, the output voltage is given by:

$$V_{O,DIFF} = \left(V_{IN} - \frac{V_{PWM}}{2} \right) \times \frac{R_F}{R_I}$$

(4)

where the only difference from Equation 3 is that the filtering action of the capacitor is not present.
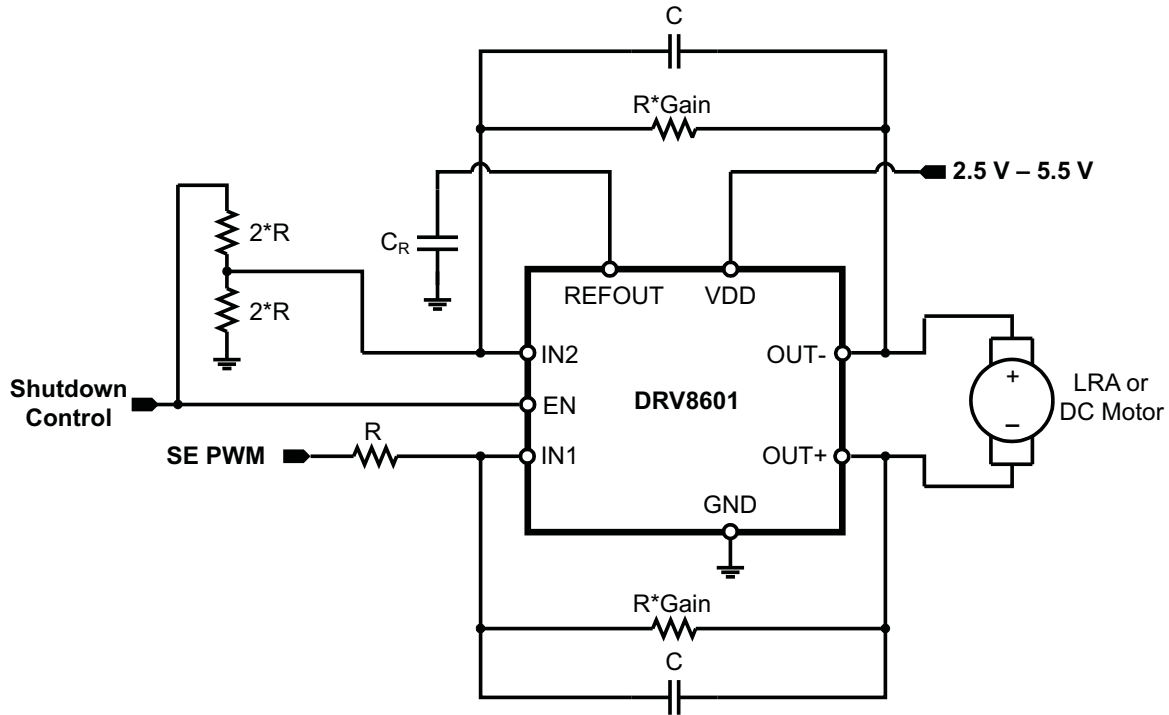
Figure 17. Differential Feedback with External Reference

SELECTING COMPONENTS

Resistors R_I and R_F

Choose R_F and R_I in the range 20 kΩ – 100 kΩ for stable operation.

Capacitor C_R

This capacitor filters any noise on the reference voltage generated by the DRV8601 on the REFOUT pin, thereby increasing noise immunity. However, a high value of capacitance results in a large turn-on time. A typical value of 1 nF is recommended for a fast turn-on time. All capacitors should be X5R dielectric or better.

Product Folder Link(s): *DRV8601*

ZQV LAND PATTERN
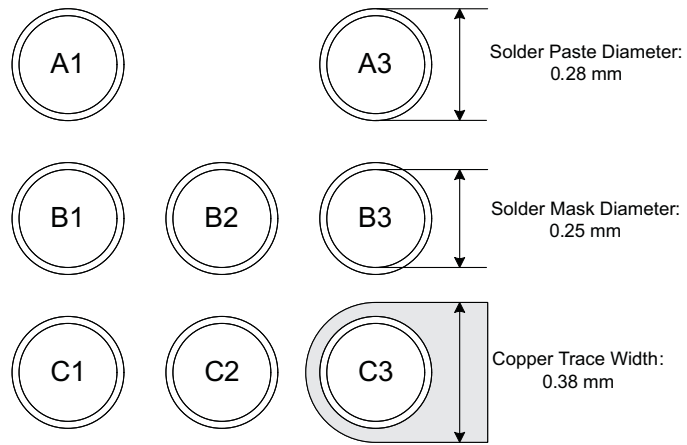
REVISION HISTORY

Note: Page numbers of current version may differ from previous versions.

Product Folder Link(s): *DRV8601*

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
DRV8601DRBR	ACTIVE	SON	DRB	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	8601	Samples
DRV8601DRBT	ACTIVE	SON	DRB	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	8601	Samples
DRV8601ZQVR	ACTIVE	BGA MICROSTAR JUNIOR	ZQV	8	2500	Green (RoHS & no Sb/Br)	SNAGCU	Level-2-260C-1 YEAR	-40 to 85	HSMI	Samples

(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.

(4) Only one of markings shown within the brackets will appear on the physical 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.

PACKAGE MATERIALS INFORMATION

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
DRV8601DRBR	SON	DRB	8	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
DRV8601DRBT	SON	DRB	8	250	180.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
DRV8601ZQVR	BGA MICROSTAR JUNIOR	ZQV	8	2500	330.0	8.4	2.3	2.3	1.4	4.0	8.0	Q1
DRV8601ZQVR	BGA MICROSTAR JUNIOR	ZQV	8	2500	330.0	8.4	2.3	2.3	1.4	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)
DRV8601DRBR	SON	DRB	8	3000	367.0	367.0	35.0
DRV8601DRBT	SON	DRB	8	250	210.0	185.0	35.0
DRV8601ZQVR	BGA MICROSTAR JUNIOR	ZQV	8	2500	338.1	338.1	20.6
DRV8601ZQVR	BGA MICROSTAR JUNIOR	ZQV	8	2500	338.1	338.1	20.6

ZQV (S–PBGA–N8)   PLASTIC BALL GRID ARRAY
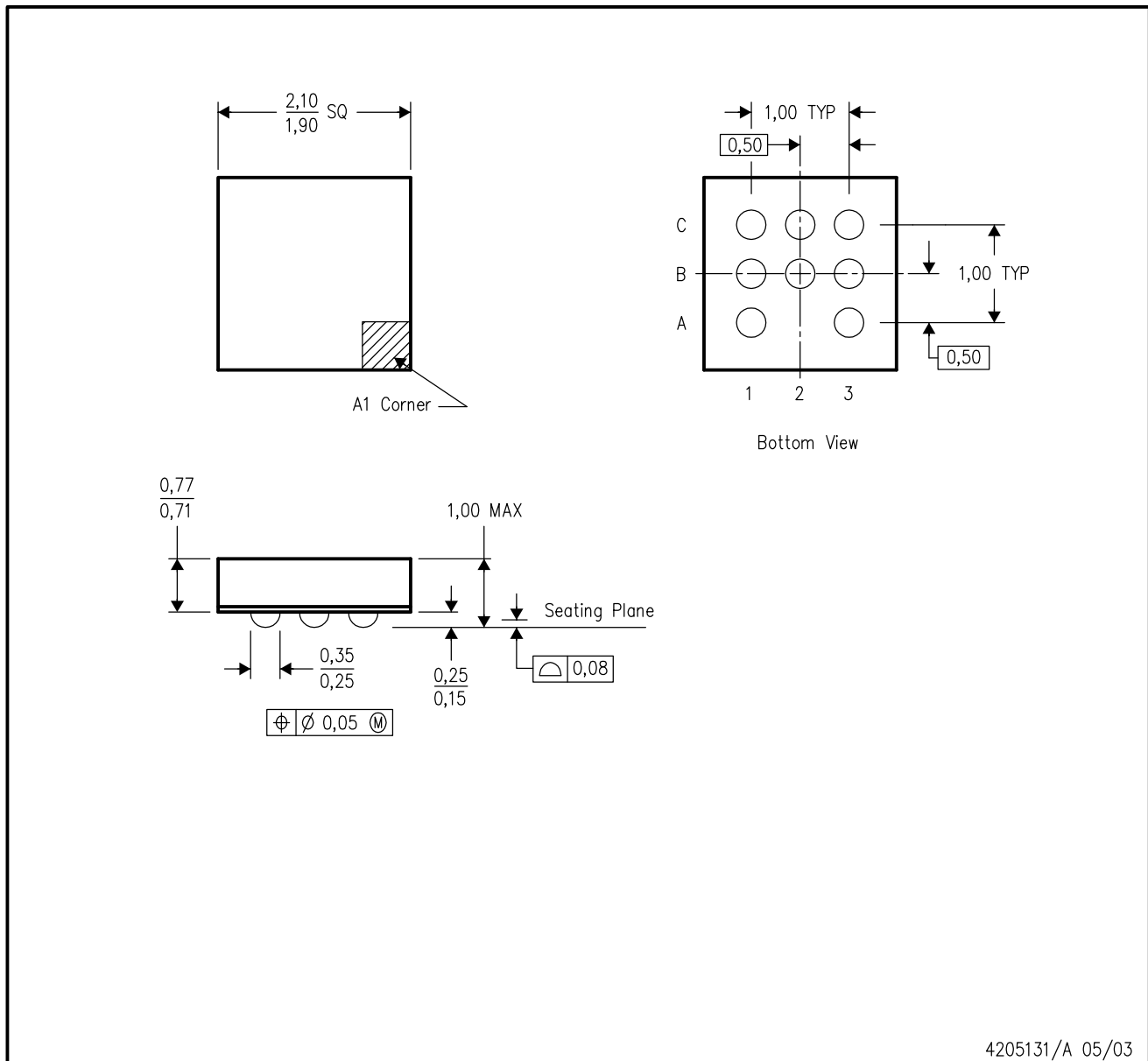
$\frac{2,10}{1,90}$ SQ

A1 Corner

1,00 TYP

0,50

C

B

A

1   2   3

Bottom View

1,00 TYP

0,50

$\frac{0,77}{0,71}$

1,00 MAX

Seating Plane

$\frac{0,35}{0,25}$

$\frac{0,25}{0,15}$

0,08

⊕ Ø 0,05 Ⓜ

4205131/A 05/03
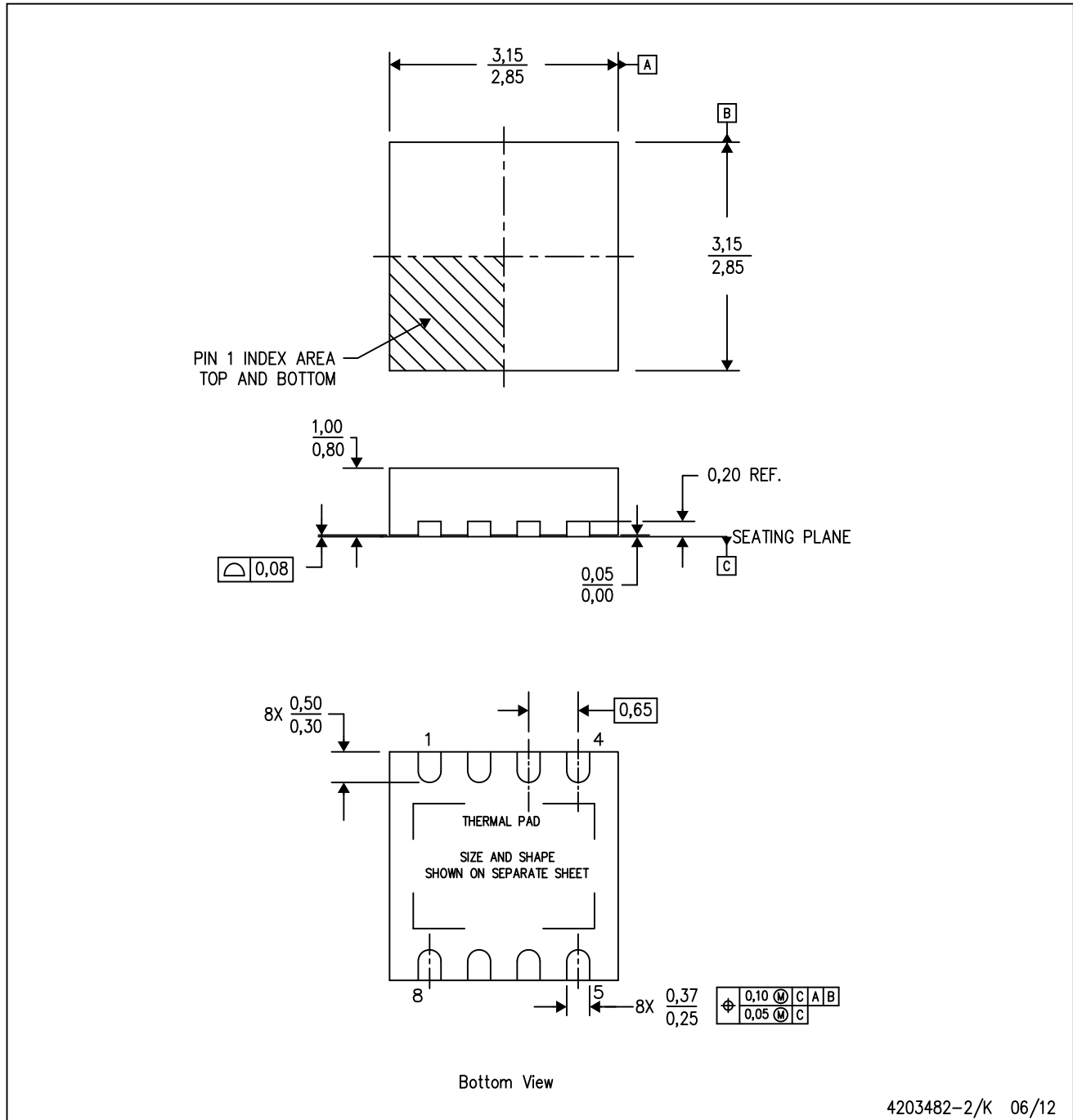
NOTES: A.   All linear dimensions are in millimeters.
         B.   This drawing is subject to change without notice.
         C.   MicroStar Junior configuration
         D.   Falls within JEDEC MO–225
         E.   This package is lead–free.

DRB (S−PVSON−N8)   PLASTIC SMALL OUTLINE NO−LEAD

3,15
2,85   ⒶA

ⒷB

3,15
2,85

PIN 1 INDEX AREA
TOP AND BOTTOM

1,00
0,80

0,20 REF.

SEATING PLANE

▱ 0,08

0,05
0,00   ⒸC

8X 0,50
    0,30

0,65

1   4

THERMAL PAD

SIZE AND SHAPE
SHOWN ON SEPARATE SHEET

8   5

8X 0,37
    0,25

⊕ 0,10 Ⓜ C A B
  0,05 Ⓜ C

Bottom View

4203482−2/K 06/12

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. Small Outline No−Lead (SON) package configuration.

         D. The package thermal pad must be soldered to the board for thermal and mechanical performance.

         E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.

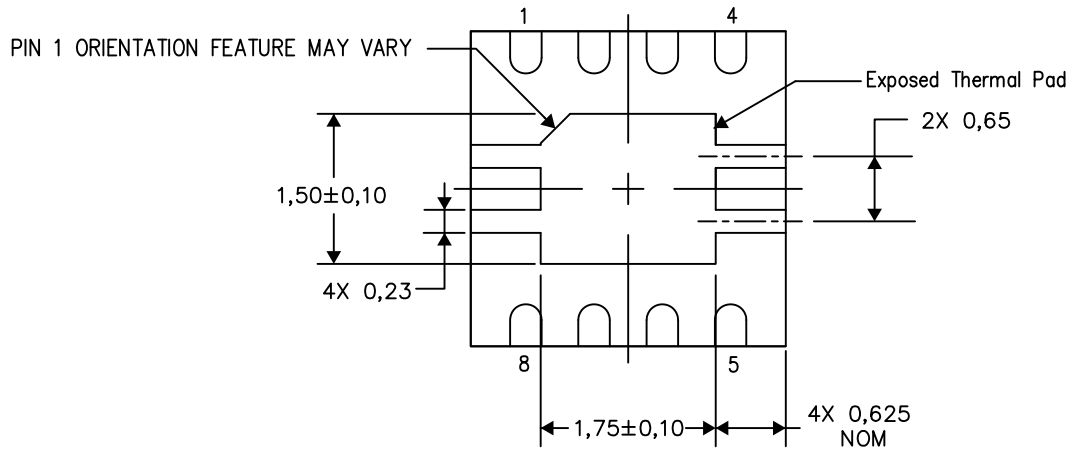DRB (S-PVSON-N8)   PLASTIC SMALL OUTLINE NO-LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.

PIN 1 ORIENTATION FEATURE MAY VARY
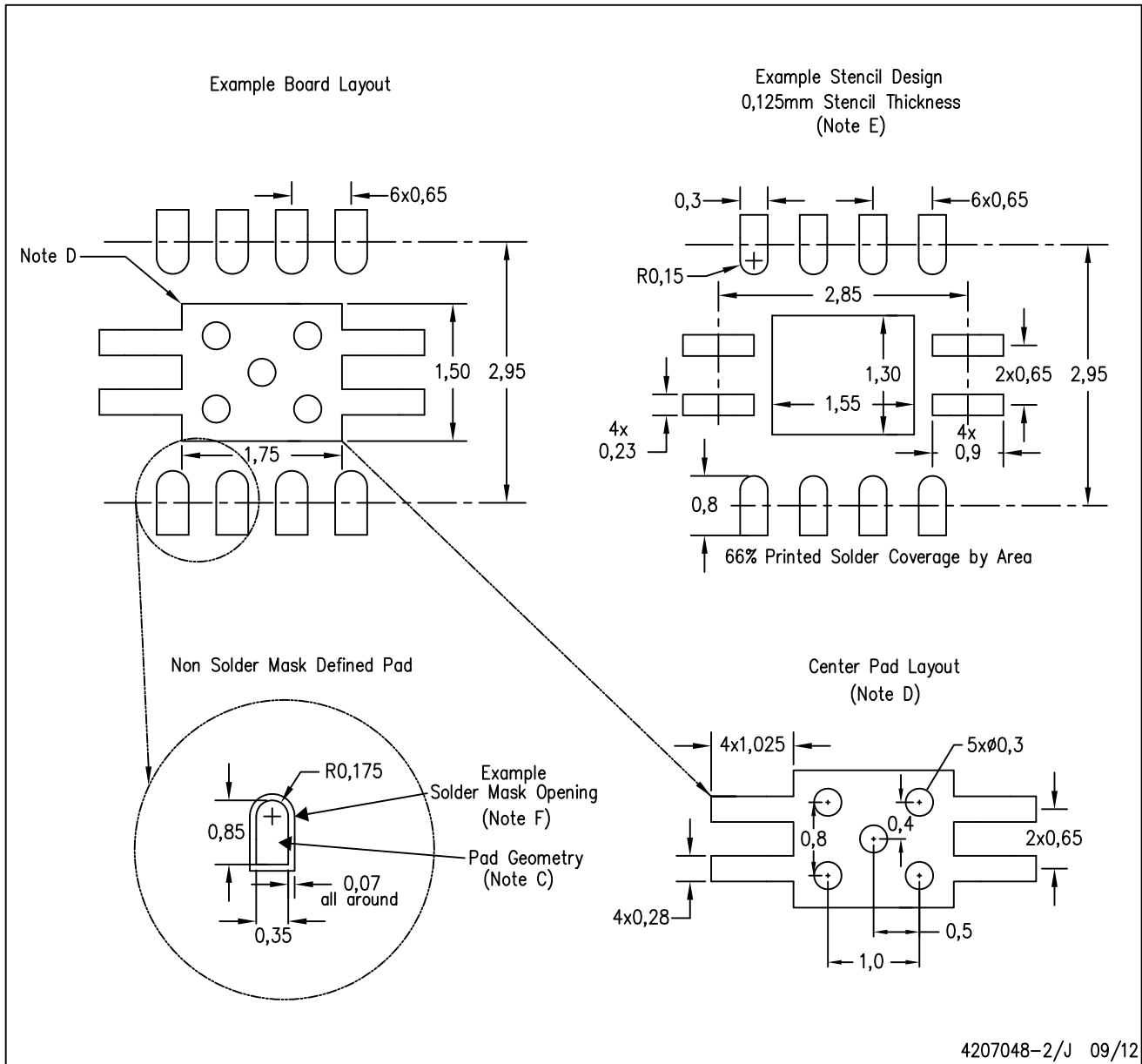
Exposed Thermal Pad

2X 0,65

1,50±0,10

4X 0,23

1,75±0,10

4X 0,625
NOM

Bottom View

Exposed Thermal Pad Dimensions

4206340-2/N 09/12

NOTE: All linear dimensions are in millimeters

TEXAS
INSTRUMENTS
www.ti.com

DRB (S−PVSON−N8)   PLASTIC SMALL OUTLINE NO−LEAD

Example Board Layout

Example Stencil Design
0,125mm Stencil Thickness
(Note E)

Note D

6x0,65

1,50   2,95

1,75

0,3

6x0,65

R0,15

2,85

1,30

1,55

2x0,65   2,95

4x
0,23

4x
0,9

0,8

66% Printed Solder Coverage by Area

Non Solder Mask Defined Pad

Center Pad Layout
(Note D)

R0,175

0,85

Example
Solder Mask Opening
(Note F)

Pad Geometry
(Note C)

0,07
all around

0,35

4x1,025

0,8

0,4

5x∅0,3

2x0,65

4x0,28

0,5

1,0

4207048−2/J 09/12

NOTES: A. All linear dimensions are in millimeters.
        B. This drawing is subject to change without notice.
        C. Publication IPC−7351 is recommended for alternate designs.
        D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN
            Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets
            for specific thermal information, via requirements, and recommended board layout. These documents are available at
            www.ti.com <http://www.ti.com>.
        E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should
            contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
        F. Customers should contact their board fabrication site for solder mask tolerances.

Texas
Instruments
www.ti.com

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have *not* been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		Applications	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		