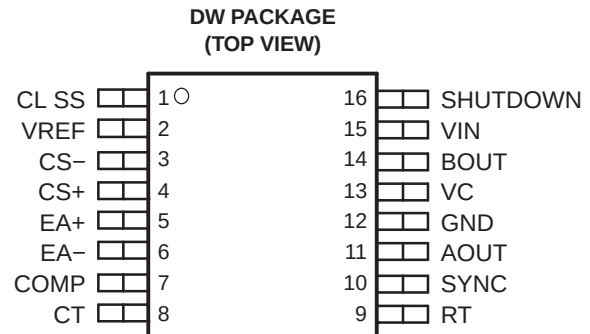


IMPROVED CURRENT-MODE PWM CONTROLLER

Check for Samples: [UC2856-Q1](#)

FEATURES

- Qualified for Automotive Applications
- Pin-for-Pin Compatible With the UC2846
- 65-ns Typical Delay From Shutdown to Outputs and 50-ns Typical Delay From Sync to Outputs
- Improved Current Sense Amplifier With Reduced Noise Sensitivity
- Differential Current Sense With 3-V Common-Mode Range
- Trimmed Oscillator Discharge Current for Accurate Deadband Control
- Accurate 1-V Shutdown Threshold
- High Current Dual Totem Pole Outputs (1.5-A Peak)
- TTL Compatible Oscillator SYNC Pin Thresholds
- ESD Protection
 - 4-kV Human-Body Model (HBM)
 - 500-V Charged-Device Model (CDM)



P0008-01

DESCRIPTION

The UC2856 is a high performance version of the popular UC2846 series of current mode controllers, and is intended for both design upgrades and new applications where speed and accuracy are important. All input to output delays have been minimized, and the current sense output is slew rate limited to reduce noise sensitivity. Fast 1.5-A peak output stages have been added to allow rapid switching of power FETs.

A low impedance TTL compatible sync output has been implemented with a 3-state function when used as a sync input.

Internal chip grounding has been improved to minimize internal noise caused when driving large capacitive loads. This, in conjunction with the improved differential current-sense amplifier, results in enhanced noise immunity.

Other features include a trimmed oscillator current (8%) for accurate frequency and dead-time control, a 1-V 5% shutdown threshold, and 4-kV minimum ESD protection (HBM) on all pins.

ORDERING INFORMATION⁽¹⁾

T _A	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOP – DW	Reel of 2000	UC2856QDWRQ1	UC2856Q1

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



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.

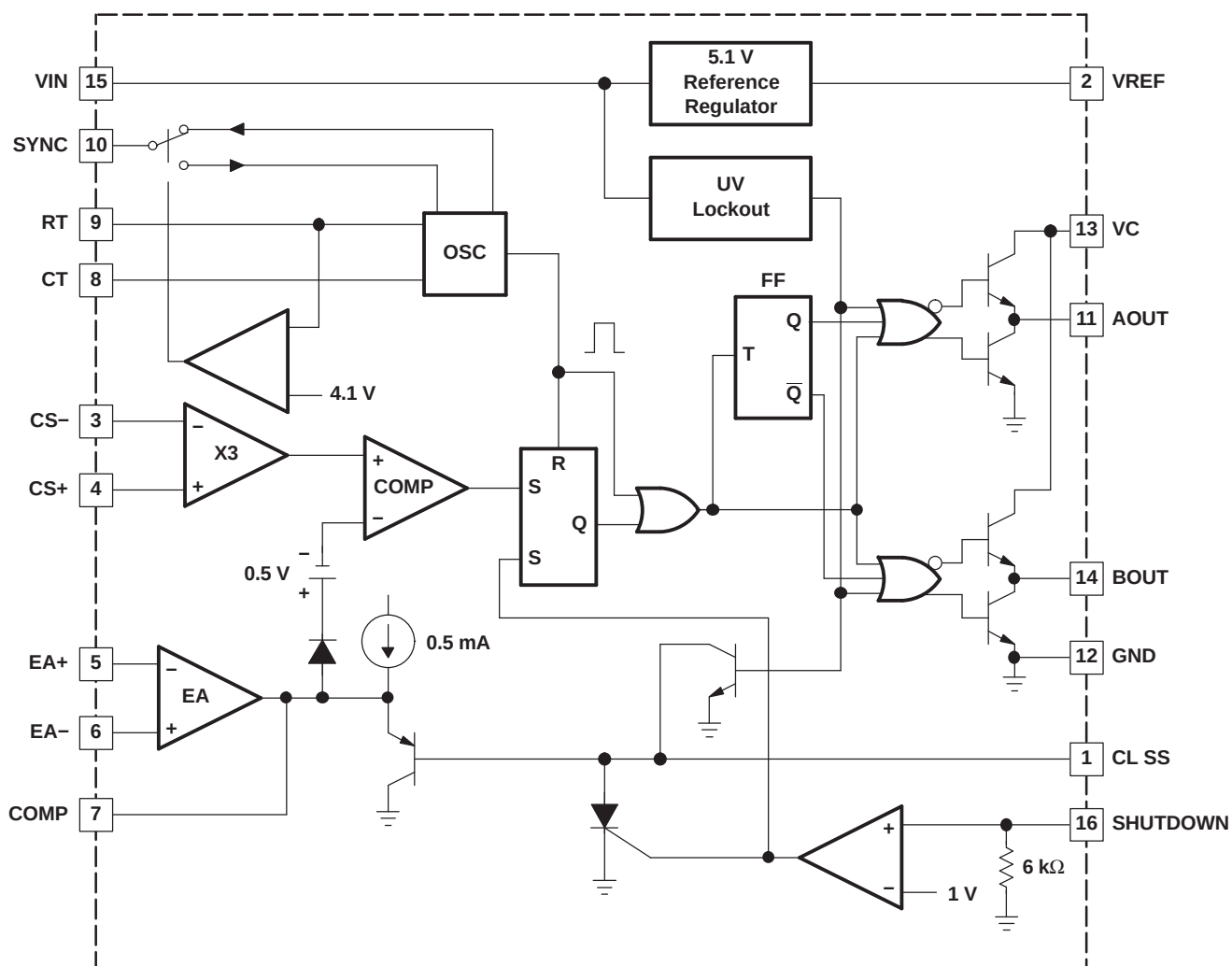
PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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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.

BLOCK DIAGRAM



B0010-01

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)^{(1) (2)}

			UNIT
Supply voltage			40 V
Collector supply voltage			40 V
I _O	Output current (sink or source)	DC	0.5 A
		Pulse (0.5 ms)	2 A
Error amplifier input voltage			–0.3 V to VIN
Shutdown input voltage			–0.3 V to 10 V
Current sense input voltage			–0.3 V to 3 V
SYNC output current			±10 mA
Error amplifier output current			–5 mA
Soft start sink current			50 mA
Oscillator charging current			5 mA
	Power dissipation	T _A = 25°C	1 W
		T _C = 25°C	2 W
T _J	Operating junction temperature range		–55°C to 150°C
T _{stg}	Storage temperature range		–65°C to 150°C
ESD	Electrostatic discharge protection	Human-Body Model (HBM)	4000 V
		Charged-Device Model (CDM)	500 V

- (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) Unless otherwise indicated, voltages are reference to ground and currents are positive into and negative out of the specified terminals.

ELECTRICAL CHARACTERISTICS

T_A = –40°C to 125°C, VIN = 15 V, RT = 10 kΩ, CT = 1 nF, and T_A = T_J (unless otherwise stated)⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reference Section					
Output voltage	I _O = 1 mA, T _J = 25°C	5.05	5.1	5.15	V
Line regulation voltage	VIN = 8 V to 40 V			20	mV
Load regulation voltage	I _O = –1 mA to –10 mA			15	mV
Total output variation	Over line, load, and temperature	5		5.2	V
Output noise voltage	f = 10 Hz to 10 kHz, T _J = 25°C		50		μV
Long term stability	1000 hours, ⁽²⁾ T _J = 25°C		5	25	mV
Short circuit current	VREF = 0 V	–25	–45	–65	mA
Oscillator Section					
Initial accuracy	T _J = 25°C	180	200	220	kHz
	T _J = Full range	170		230	
Voltage stability	VIN = 8 V to 40 V			2	%
Discharge current	VCT = 2 V, T _J = 25°C	7.5	8	8.8	mA
	VCT = 2 V	6.7	8	8.8	
Sync output high level voltage	I _O = –1 mA	2.4	3.6		V
Sync output low level voltage	I _O = 1 mA		0.2	0.4	V
Sync input high level voltage	CT = 0 V, RT = VREF	2	1.5		V
Sync input low level voltage	CT = 0 V, RT = VREF		1.5	0.8	V
Sync input current	CT = 0 V, RT = VREF, V _{SYNC} = 5 V		1	10	μA
Sync delay to outputs	CT = 0 V RT = VREF, V _{SYNC} = 0.8 V to 2 V		50	100	ns

- (1) All voltages are with respect to GND. Currents are positive into, negative out of the specified terminal.
- (2) This parameter, although specified over the recommended operating conditions, is not 100% tested in production.

ELECTRICAL CHARACTERISTICS (continued)
 $T_A = -40^{\circ}\text{C}$ to 125°C , $V_{IN} = 15\text{ V}$, $R_T = 10\text{ k}\Omega$, $C_T = 1\text{ nF}$, and $T_A = T_J$ (unless otherwise stated)⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Error Amplifier Section					
Input offset voltage	$V_{CM} = 2\text{ V}$			5	mV
Input bias current				–1	μA
Input offset current				500	nA
Common mode range	$V_{IN} = 8\text{ V}$ to 40 V	0		$V_{IN}-2$	V
Open loop gain	$V_O = 1.2\text{ V}$ to 3 V	80	100		dB
Unity gain bandwidth	$T_J = 25^{\circ}\text{C}$	1	1.5		MHz
CMRR	$V_{CM} = 0\text{ V}$ to 38 V , $V_{IN} = 40\text{ V}$	75	100		dB
PSRR	$V_{IN} = 8\text{ V}$ to 40 V	80	100		dB
Output sink current	$V_{ID} = -15\text{ mV}$ $V_{COMP} = 1.2\text{ V}$	5	10		mA
Output source current	$V_{ID} = 15\text{ mV}$ $V_{COMP} = 2.5\text{ V}$	–0.4	–0.5		mA
High-level output voltage	$V_{ID} = 50\text{ mV}$, $R_L(\text{COMP}) = 15\text{ k}\Omega$	4.3	4.6	4.9	V
Low-level output voltage	$V_{ID} = -50\text{ mV}$, $R_L(\text{COMP}) = 15\text{ k}\Omega$		0.7	1	V
Current Sense Amplifier Section					
Amplifier gain	$V_{CS-} = 0\text{ V}$, CL SS Open ^{(3) (4)}	2.5	2.75	3	V/V
Maximum differential input signal ($V_{CS+} - V_{CS-}$)	CL SS Open 3, $R_L(\text{COMP}) = 15\text{ k}\Omega$	1.1	1.2		V
Input offset voltage	$V_{CL\text{ SS}} = 0.5\text{ V}$ COMP open ⁽³⁾		5	35	mV
CMRR	$V_{CM} = 0\text{ V}$ to 3 V	60			dB
PSRR	$V_{IN} = 8\text{ V}$ to 40 V	60			dB
Input bias current	$V_{CL\text{ SS}} = 0.5\text{ V}$, COMP open ⁽³⁾	–1		1	μA
Input offset current	$V_{CL\text{ SS}} = 0.5\text{ V}$, COMP open ⁽³⁾	–1		1	μA
Input common mode range		0		3	V
Delay to outputs	$V_{EA+} = V_{REF}$, $EA- = 0\text{ V}$, $CS+ - CS- = 0\text{ V}$ to 1.5 V		120	250	ns
Current Limit Adjust Section					
Current limit offset	$V_{CS-} = 0\text{ V}$, $V_{CS+} = 0\text{ V}$, COMP open ⁽³⁾	0.4	0.5	0.6	V
Input bias current	$V_{EA+} = V_{REF}$, $V_{EA-} = 0\text{ V}$		–10	–30	μA
SHUTDOWN Terminal Section					
Threshold voltage		0.95	1.00	1.05	V
Input voltage range		0		5	V
Minimum latching current ($I_{CL\text{ SS}}$)		⁽⁵⁾ 3	1.5		mA
Maximum non-latching current ($I_{CL\text{ SS}}$)			⁽⁶⁾ 1.5	0.8	mA
Delay to outputs	$V_{SHUTDOWN} = 0\text{ V}$ to 1.3 V		65	110	ns

(3) Parameter measured at trip point of latch with $V_{EA+} = V_{REF}$, $V_{EA-} = 0\text{ V}$.

$$G = \frac{\Delta V_{COMP}}{\Delta V_{CS+}}; \Delta V_{CS-} = 0\text{ V} \pm 1\text{ V}.$$

(4) Amplifier gain defined as:

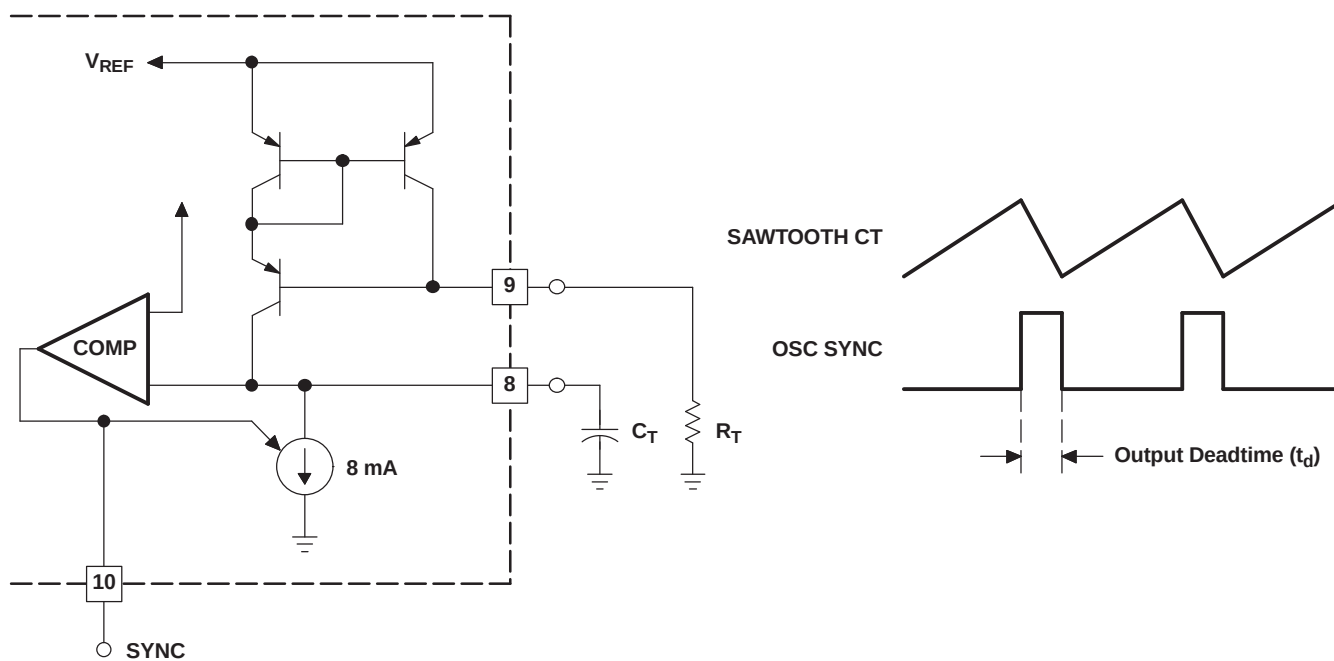
(5) Current into CL SS assured to latch circuit into shutdown state.

(6) Current into CL SS assured not to latch circuit into shutdown state.

ELECTRICAL CHARACTERISTICS (continued)
 $T_A = -40^{\circ}\text{C}$ to 125°C , $V_{IN} = 15\text{ V}$, $R_T = 10\text{ k}\Omega$, $C_T = 1\text{ nF}$, and $T_A = T_J$ (unless otherwise stated)⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Section					
Collector-emitter voltage		40			V
Off-state bias current	$V_C = 40\text{ V}$			250	μA
Output low level voltage	$I_{OUT} = 20\text{ mA}$		0.1	0.5	V
	$I_{OUT} = 200\text{ mA}$		0.5	2.6	
Output high level voltage	$I_{OUT} = -20\text{ mA}$	12.5	13.2		V
	$I_{OUT} = -200\text{ mA}$	12	13.1		
Rise time	$C_1 = 1\text{ nF}$		40	80	ns
Fall time	$C_1 = 1\text{ nF}$		40	80	ns
UVLO low saturation	$V_{IN} = 0\text{ V}$, $I_{OUT} = 20\text{ mA}$		0.8	1.5	V
PWM Section					
Maximum duty cycle		45	47	50	%
Minimum duty cycle				0	%
Undervoltage Lockout Section					
Startup threshold			7.7	8	V
Threshold hysteresis			0.7		V
Total Standby Current					
Supply current			18	23	mA

APPLICATION AND OPERATION INFORMATION



NOTE: Output deadtime is determined by the size of the external capacitor, C_T , according to the formula: $T_d = \frac{2C_T}{8 \text{ mA} - \frac{3.6}{R_T}}$

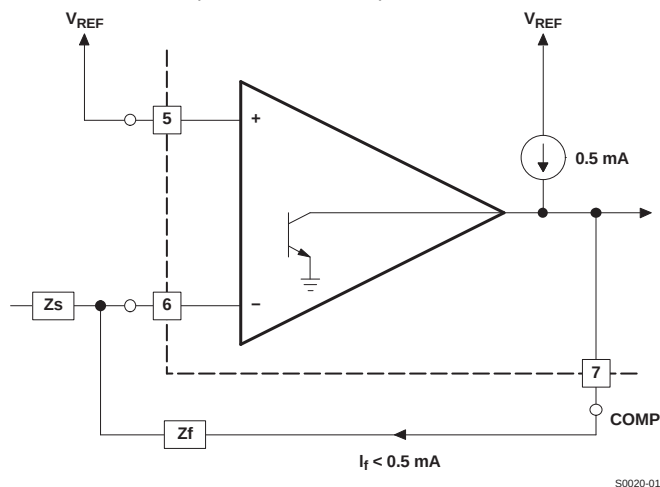
For large values of R_T : $T_d = 250 C_T$

Oscillator frequency is approximated by the formula: $f_T = \frac{2}{R_T \times C_T}$

S0019-01

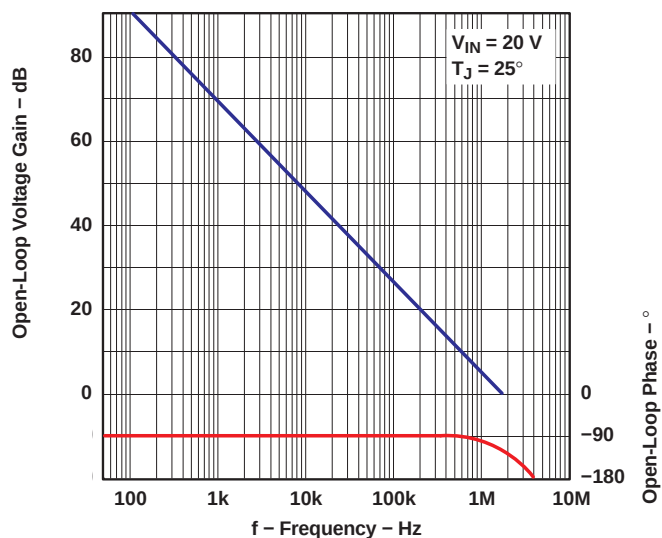
Figure 1. Oscillator Circuit

NOTE: Error Amplifier can source up to 0.5 mA.



S0020-01

Figure 2. Error Amplifier Output Configuration



G001

Figure 3. Error Amplifier Gain and Phase vs Frequency

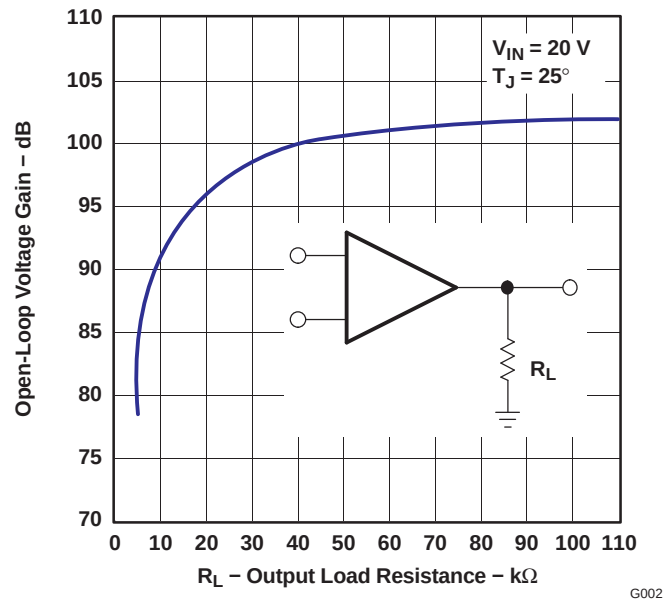
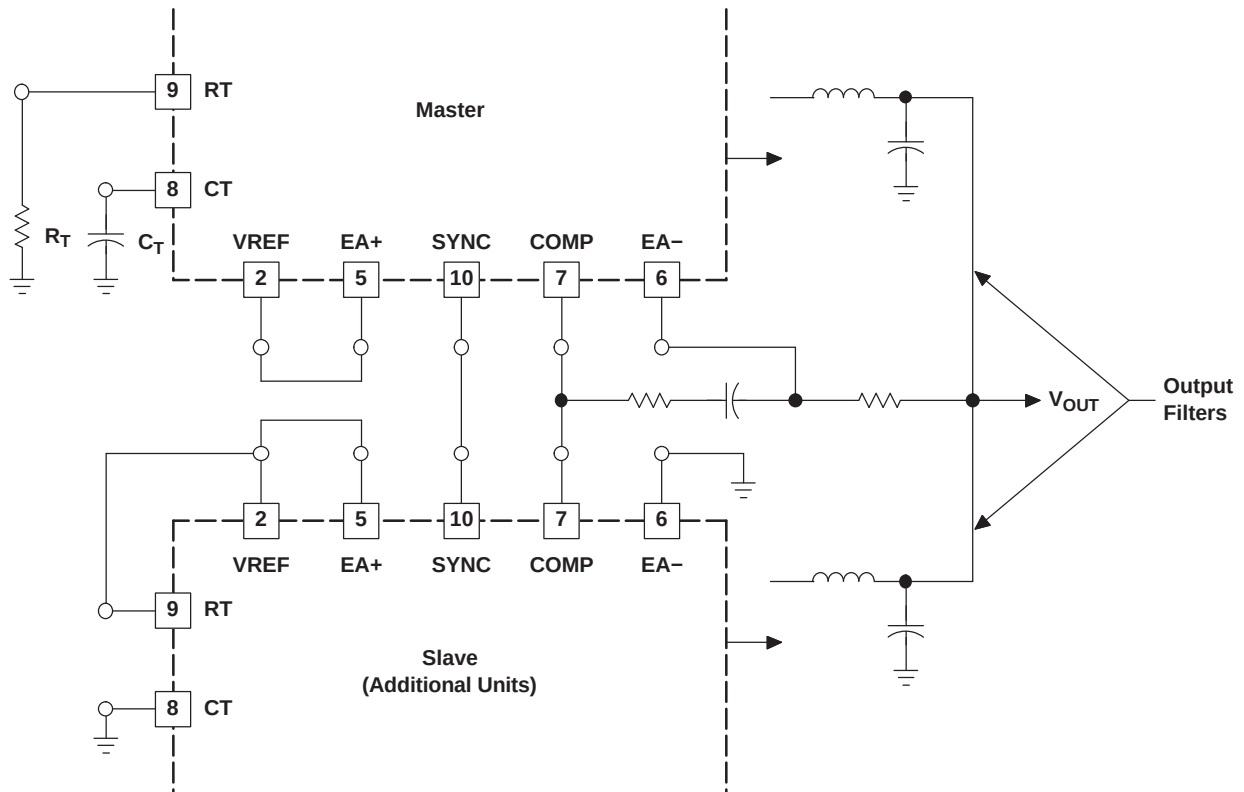


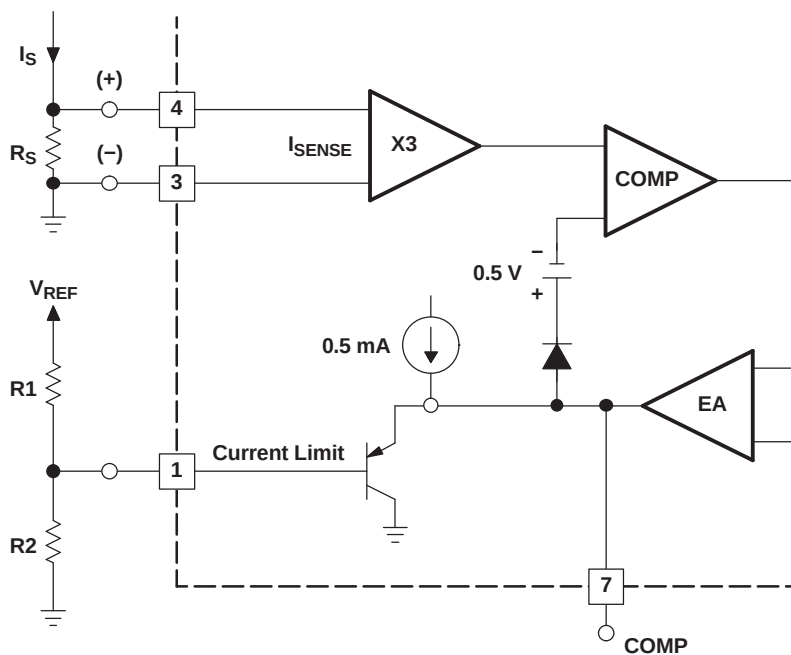
Figure 4. Error Amplifier Open-Loop DC Gain vs Load Resistance



NOTE: Slaving allows parallel operation of two or more units with equal current sharing.

Figure 5. Parallel Operation

S0021-01

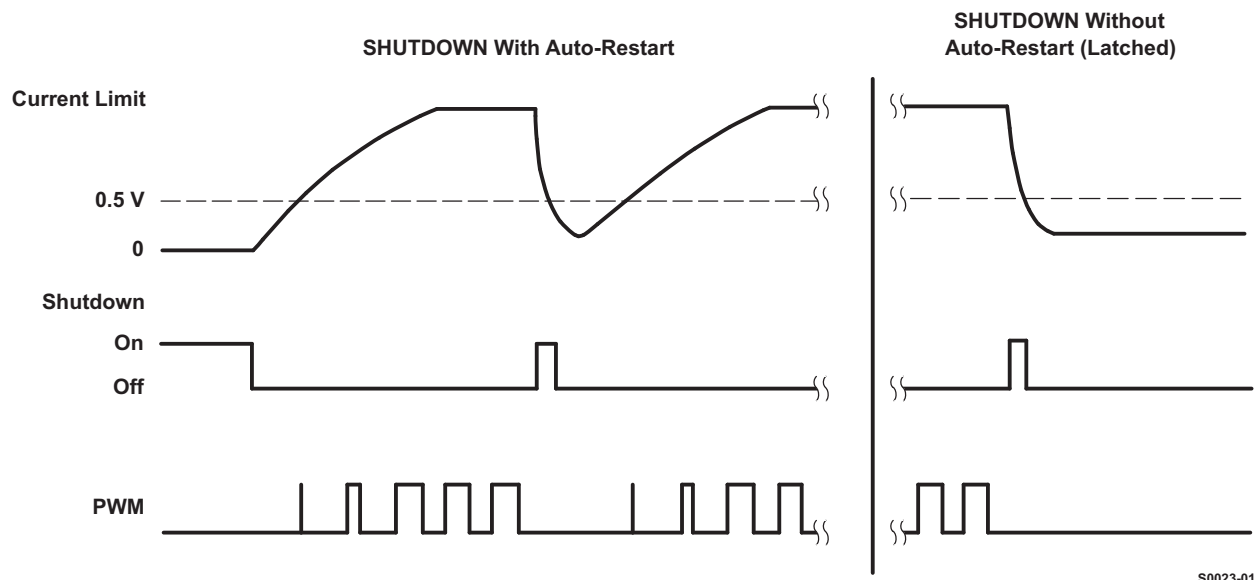
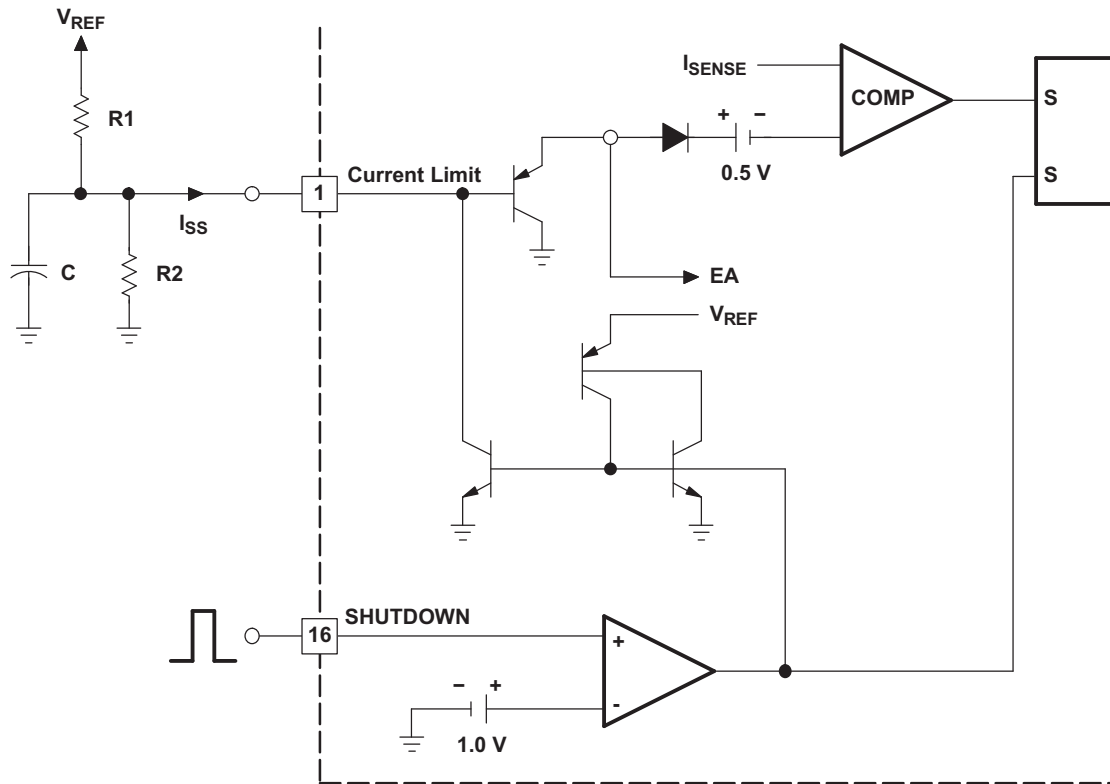


S0022-01

$$I_S = \frac{\left(R_2 \times \frac{V_{REF}}{R_1 + R_2} \right) - 0.5}{3R_S}$$

NOTE: Peak current (I_S) is determined by the formula:

Figure 6. Pulse by Pulse Current Limiting



NOTE: If $V_{REF} / R1 < 0.8 \text{ mA}$, the shutdown latch commutates when $I_{SS} = 0.8 \text{ mA}$, and a restart cycle is initiated. If $V_{REF} / R1 > 3 \text{ mA}$, the device latches off until power is cycled.

Figure 7. Shutdown

S0023-01

REVISION HISTORY

Changes from Original (June 2008) to Revision A	Page
---	------

- | | |
|--|---|
| • Changed the Input bias current Min Value From: - To: -1 and the Max Value From: -1 To: 1 | 4 |
| • Changed the Input offset current Min Value From: - To: -1 | 4 |
-

Changes from Revision A (October 2010) to Revision B	Page
--	------

- | | |
|--|---|
| • Changed the polarity of the comparator connected to pin 16 in Figure 7 | 9 |
|--|---|
-

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)
UC2856QDWRQ1	Active	Production	SOIC (DW) 16	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	UC2856Q1
UC2856QDWRQ1.A	Active	Production	SOIC (DW) 16	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	UC2856Q1

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

⁽²⁾ **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.

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

⁽⁴⁾ **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.

⁽⁵⁾ **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.

⁽⁶⁾ **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.

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OTHER QUALIFIED VERSIONS OF UC2856-Q1 :

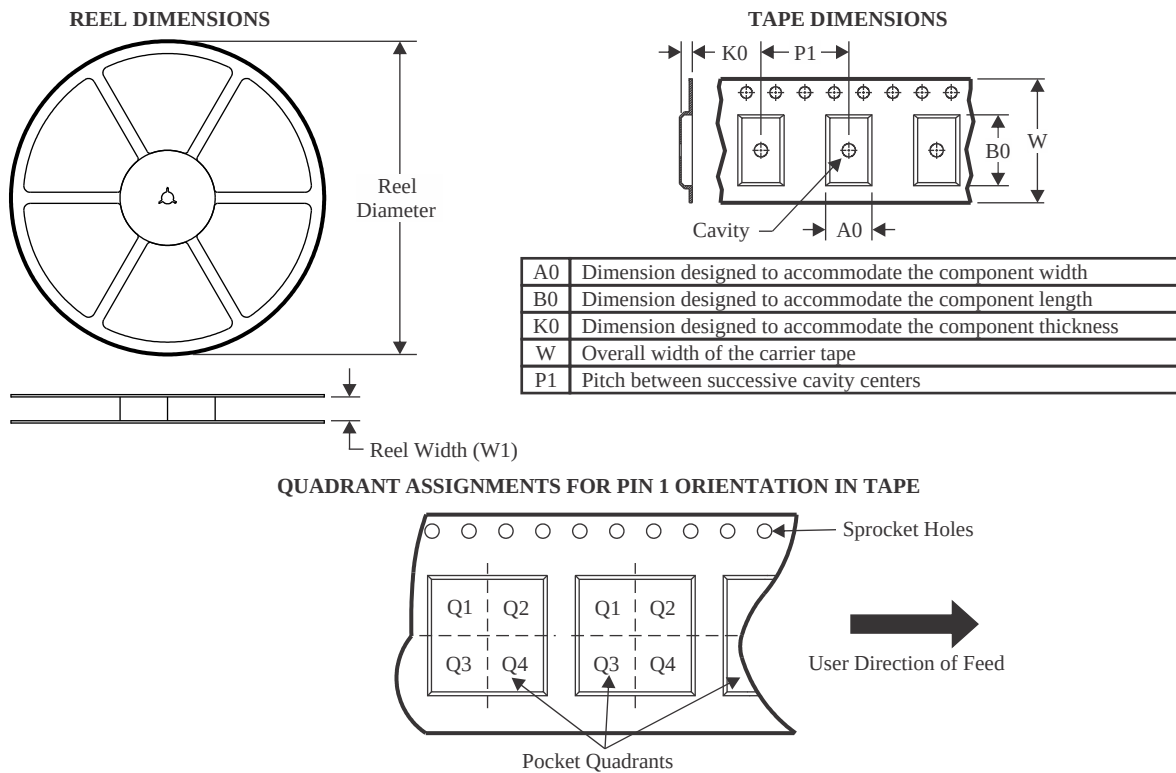
- Catalog : [UC2856](#)

- Military : [UC2856M](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

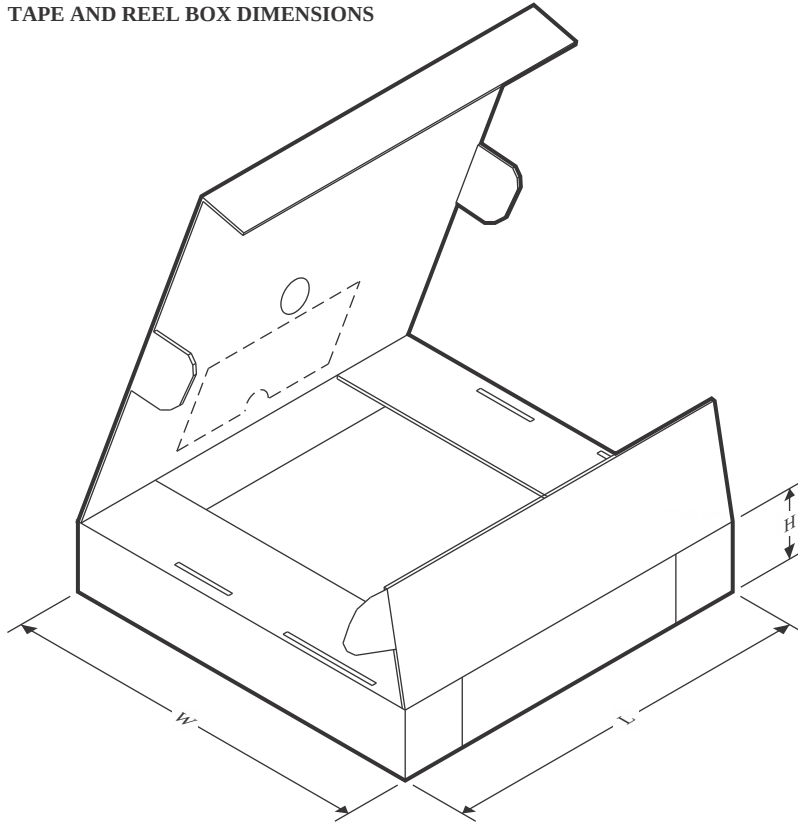
TAPE AND REEL INFORMATION



*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
UC2856QDWRQ1	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UC2856QDWRQ1	SOIC	DW	16	2000	356.0	356.0	35.0

GENERIC PACKAGE VIEW

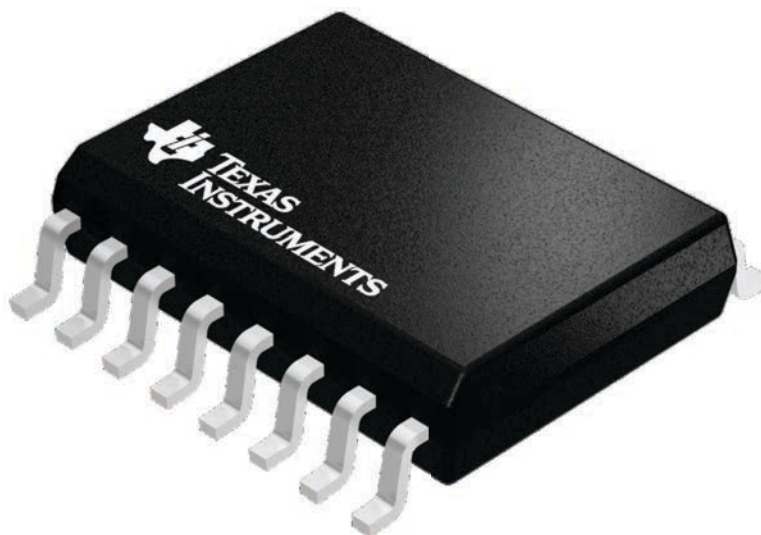
DW 16

SOIC - 2.65 mm max height

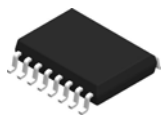
7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4224780/A

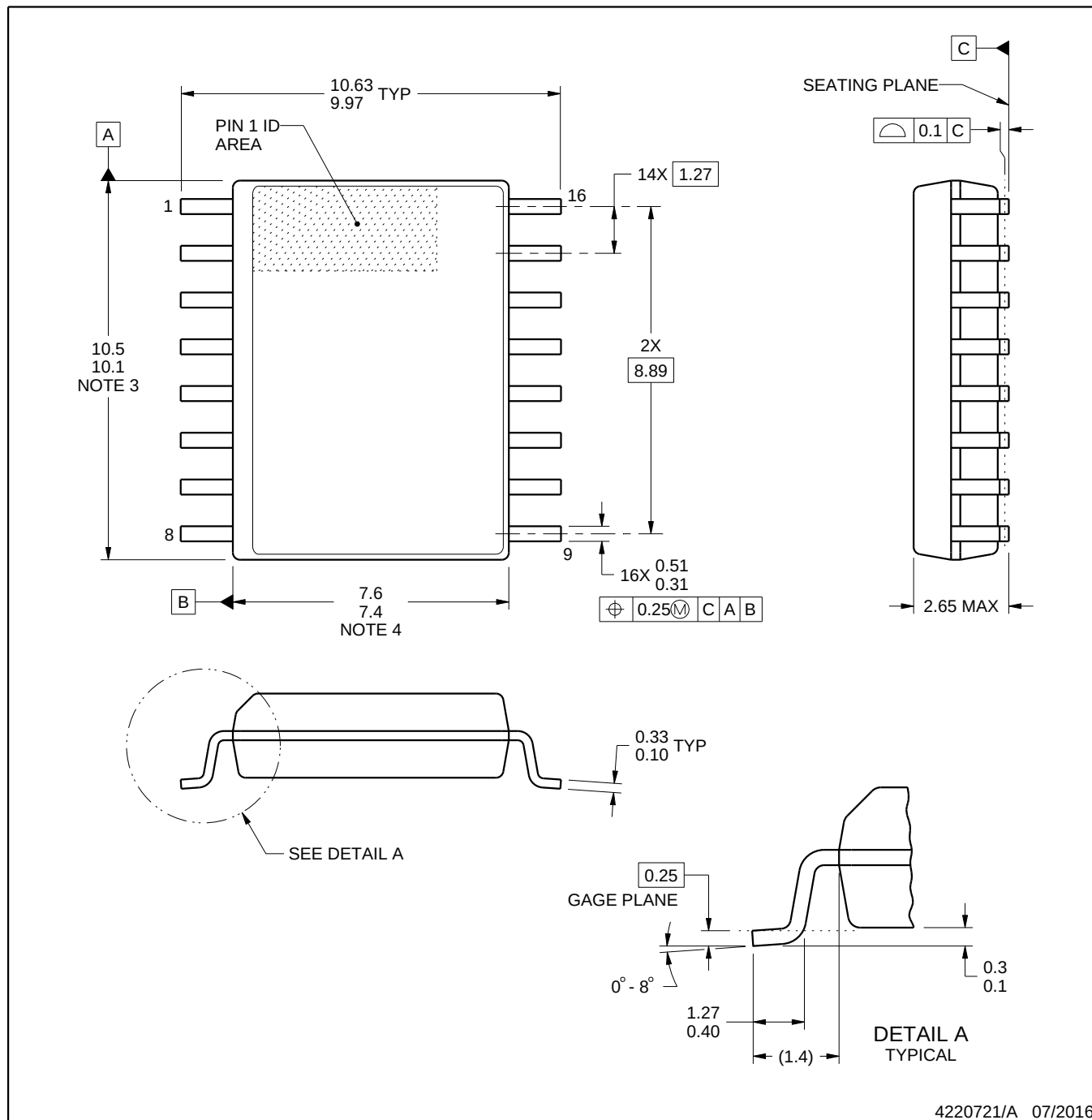


DW0016A

PACKAGE OUTLINE

SOIC - 2.65 mm max height

SOIC



4220721/A 07/2016

NOTES:

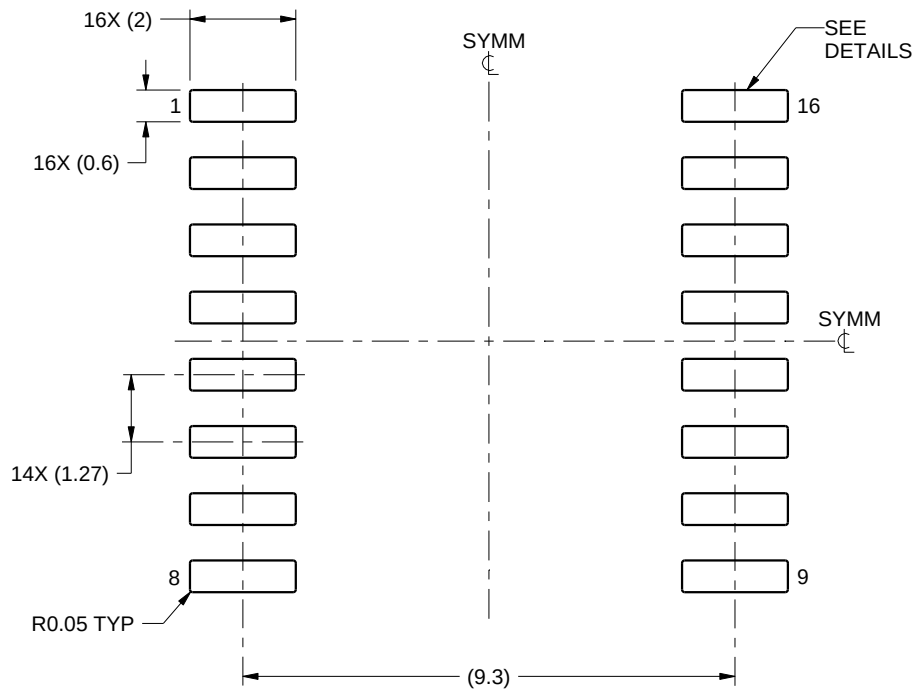
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.

EXAMPLE BOARD LAYOUT

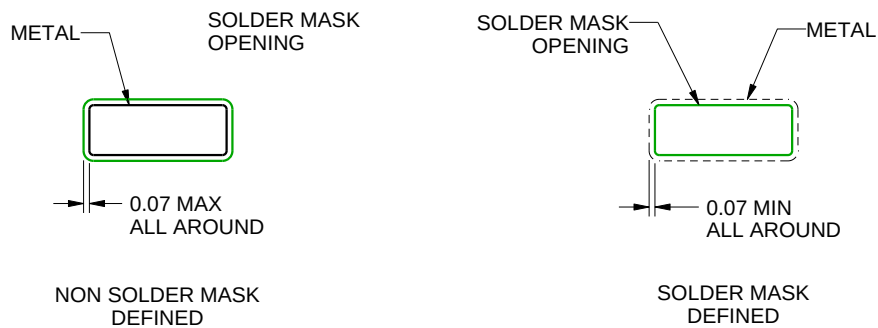
DW0016A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:7X



SOLDER MASK DETAILS

4220721/A 07/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

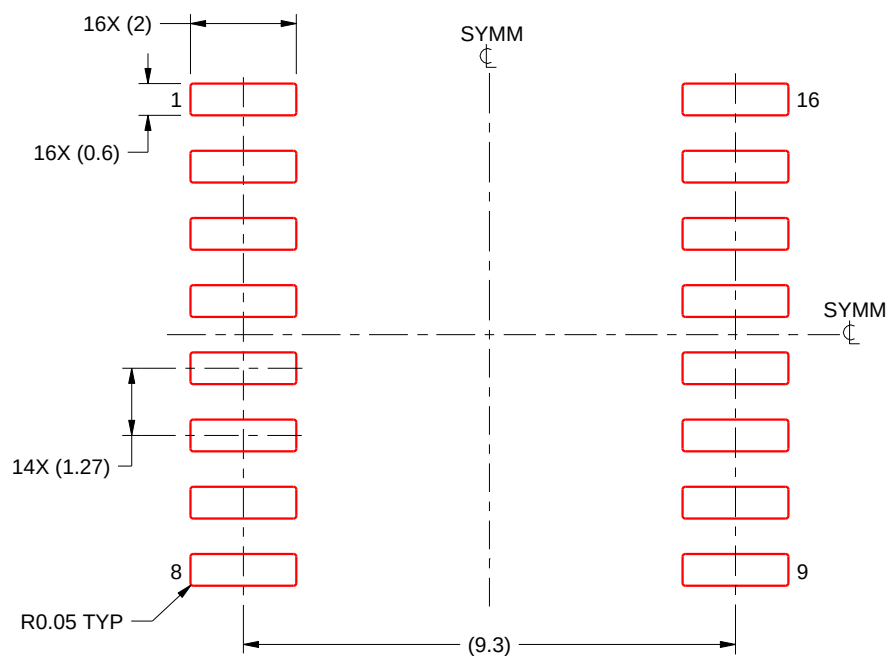
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DW0016A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220721/A 07/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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