



THE DATASHEET OF UC3525BDW



Regulating Pulse Width Modulators

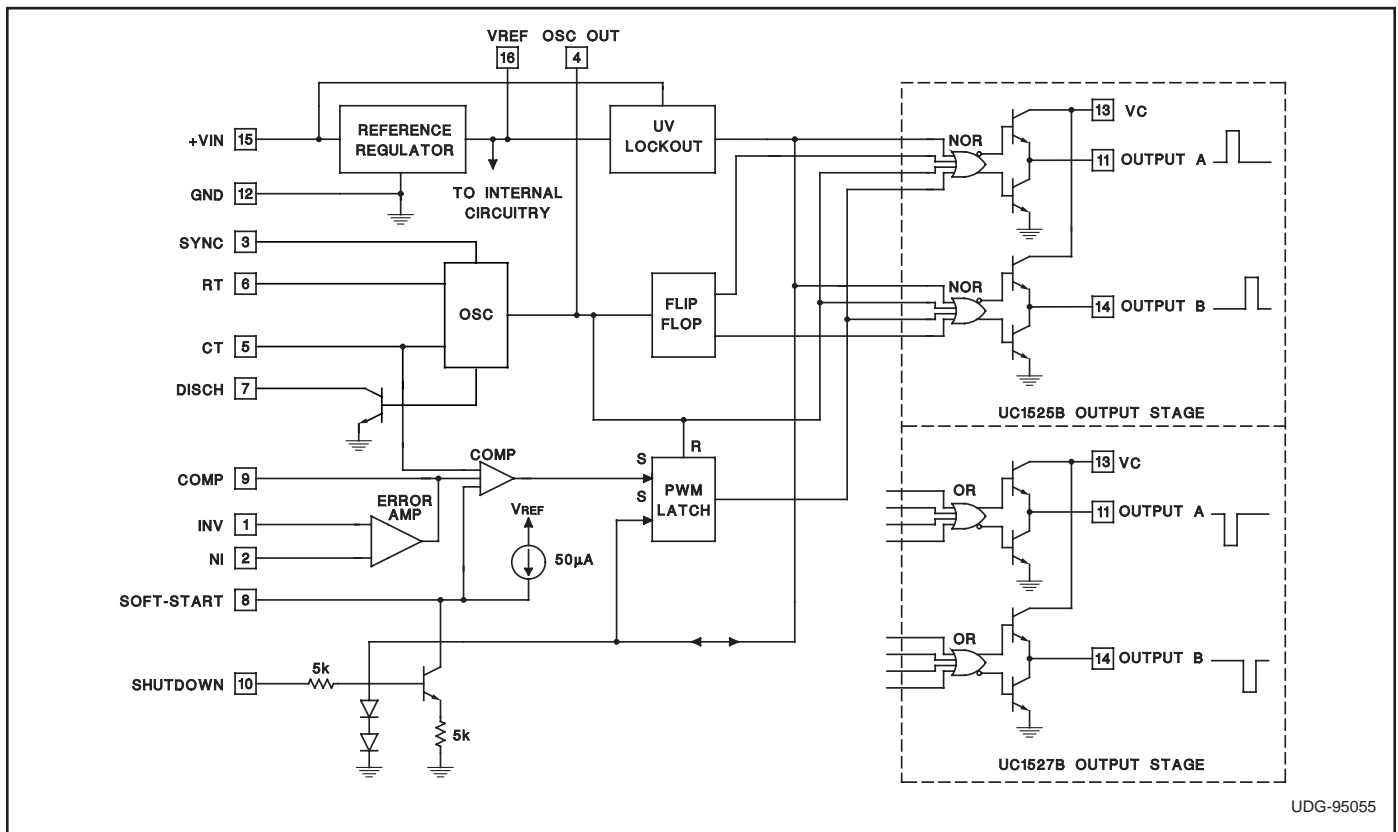
FEATURES

- 8 to 35V Operation
- 5.1V Buried Zener Reference Trimmed to $\pm 0.75\%$
- 100Hz to 500kHz Oscillator Range
- Separate Oscillator Sync Terminal
- Adjustable Deadtime Control
- Internal Soft-Start
- Pulse-by-Pulse Shutdown
- Input Undervoltage Lockout with Hysteresis
- Latching PWM to Prevent Multiple Pulses
- Dual Source/Sink Output Drivers
- Low Cross Conduction Output Stage
- Tighter Reference Specifications

DESCRIPTION

The UC1525B/1527B series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip +5.1V buried zener reference is trimmed to $\pm 0.75\%$ and the input common-mode range of the error amplifier includes the reference voltage, eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the CT and the discharge terminals provide a wide range of dead time adjustment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuitry and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for sub-normal input voltages. This lockout circuitry includes approximately 500mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200mA. The UC1525B output stage features NOR logic, giving a LOW output for an OFF state. The UC1527B utilizes OR logic which results in a HIGH output level when OFF.

BLOCK DIAGRAM



UDG-95055

ABSOLUTE MAXIMUM RATINGS

| | |
|--|-----------------|
| Supply Voltage, (+VIN) | +40V |
| Collector Supply Voltage (VC) | +40V |
| Logic Inputs | -0.3V to +5.5V |
| Analog Inputs | -0.3V to VIN |
| Output Current, Source or Sink | 500mA |
| Reference Output Current | 50mA |
| Oscillator Charging Current | 5mA |
| Power Dissipation at $T_A = +25^\circ\text{C}$ | 1000mW |
| Power Dissipation at $T_C = +25^\circ\text{C}$ | 2000mW |
| Operating Junction Temperature | -55°C to +150°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (Soldering, 10 sec.) | +300°C |

All currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.

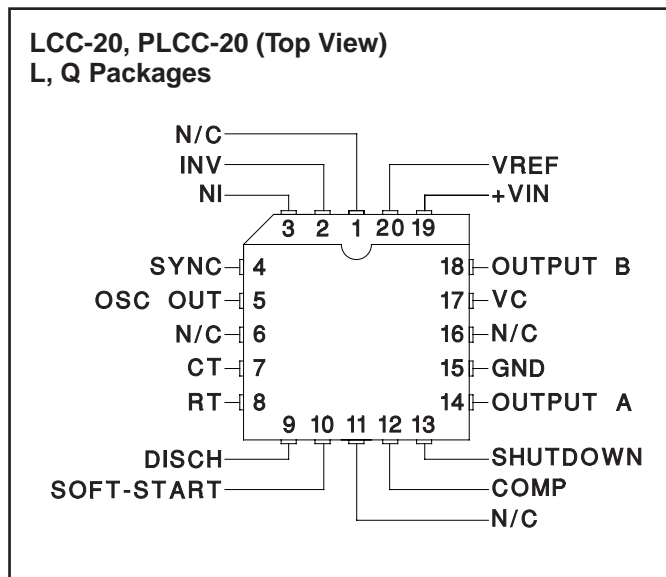
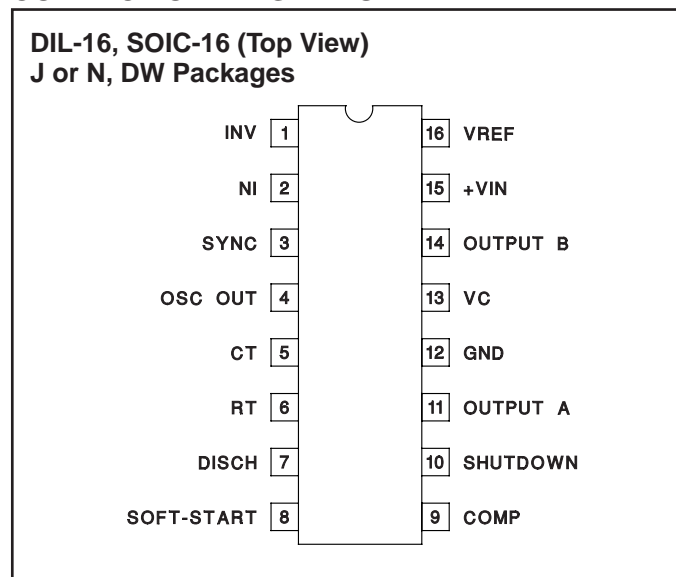
RECOMMENDED OPERATING CONDITIONS

(Note 1)

| | |
|---|--|
| Input Voltage (+VIN) | +8V to +35V |
| Collector Supply Voltage (VC) | +4.5V to +35V |
| Sink/Source Load Current (steady state) | 0 to 100mA |
| Sink/Source Load Current (peak) | 0 to 400mA |
| Reference Load Current | 0 to 20mA |
| Oscillator Frequency Range | 100Hz to 400kHz |
| Oscillator Timing Resistor | 2k Ω to 150k Ω |
| Oscillator Timing Capacitor | 0.001 μF to 0.1 μF |
| Dead Time Resistor Range | 0 Ω to 500 Ω |

Note 1: Range over which the device is functional and parameter limits are guaranteed.

CONNECTION DIAGRAMS



ELECTRICAL CHARACTERISTICS: Unless otherwise stated, these specifications apply for $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ for the UC1525B and UC1527B; -40°C to $+85^\circ\text{C}$ for the UC2525B and UC2527B; 0°C to $+70^\circ\text{C}$ for the UC3525B and UC3527B; $+VIN = 20\text{V}$, $T_A = T_J$.

| PARAMETER | TEST CONDITIONS | UC1525B/UC2525B UC1527B/UC2527B | | | UC3525B UC3527B | | | UNITS |
|--------------------------------|---|------------------------------------|------|-------|--------------------|------|-------|------------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Reference Section | | | | | | | | |
| Output Voltage | $T_J = 25^\circ\text{C}$ | 5.062 | 5.10 | 5.138 | 5.036 | 5.10 | 5.164 | V |
| Line Regulation | $V_{IN} = 8\text{V to }35\text{V}$ | | 5 | 10 | | 5 | 10 | mV |
| Load Regulation | $I_L = 0\text{mA to }20\text{mA}$ | | 7 | 15 | | 7 | 15 | mV |
| Temperature Stability (Note 2) | Over Operating Range | | 10 | 50 | | 10 | 50 | mV |
| Total Output Variation | Line, Load, and Temperature | 5.036 | | 5.164 | 5.024 | | 5.176 | V |
| Short Circuit Current | $V_{REF} = 0$, $T_J = 25^\circ\text{C}$ | | 80 | 100 | | 80 | 100 | mA |
| Output Noise Voltage (Note 2) | $10\text{Hz} \leq f \leq 10\text{kHz}$, $T_J = 25^\circ\text{C}$ | | 40 | 200 | | 40 | 200 | μVrms |
| Long Term Stability (Note 2) | $T_J = 125^\circ\text{C}$, 1000 Hrs. | | 3 | 10 | | 3 | 10 | mV |

ELECTRICAL CHARACTERISTICS: Unless otherwise stated, these specifications apply for $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ for the UC1525B and UC1527B; -40°C to $+85^\circ\text{C}$ for the UC2525B and UC2527B; 0°C to $+70^\circ\text{C}$ for the UC3525B and UC3527B; $+V_{IN} = 20\text{V}$, $T_A = T_J$.

| PARAMETER | TEST CONDITIONS | UC1525B/UC2525B UC1527B/UC2527B | | | UC3525B UC3527B | | | UNITS |
|--|--|------------------------------------|-----------|---------|--------------------|---------|---------|---------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Oscillator Section (Note 3) | | | | | | | | |
| Initial Accuracy (Notes 2 & 3) | $T_J = 25^\circ\text{C}$ | | ± 2 | ± 6 | | ± 2 | ± 6 | % |
| Voltage Stability (Notes 2 & 3) | $V_{IN} = 8\text{V}$ to 35V | | ± 0.3 | ± 1 | | ± 1 | ± 2 | % |
| Temperature Stability (Note 2) | Over Operating Range | | ± 3 | ± 6 | | ± 3 | ± 6 | % |
| Minimum Frequency | $R_T = 200\text{k}\Omega$, $C_T = 0.1\mu\text{F}$ | | | 120 | | | 120 | Hz |
| Maximum Frequency | $R_T = 2\text{k}\Omega$, $C_T = 470\text{pF}$ | 400 | | | 400 | | | kHz |
| Current Mirror | $I_{RT} = 2\text{mA}$ | 1.7 | 2.0 | 2.2 | 1.7 | 2.0 | 2.2 | mA |
| Clock Amplitude (Notes 2 & 3) | | 3.0 | 3.5 | | 3.0 | 3.5 | | V |
| Clock Width (Notes 2 & 3) | $T_J = 25^\circ\text{C}$ | 0.3 | 0.5 | 1.0 | 0.3 | 0.5 | 1.0 | μs |
| Sync Threshold | | 1.2 | 2.0 | 2.8 | 1.2 | 2.0 | 2.8 | V |
| Sync Input Current | Sync Voltage = 3.5V | | 1.0 | 2.5 | | 1.0 | 2.5 | mA |
| Error Amplifier Section (VCM = 5.1V) | | | | | | | | |
| Input Offset Voltage | | | 0.5 | 5 | | 2 | 10 | mV |
| Input Bias Current | | | 1 | 10 | | 1 | 10 | μA |
| Input Offset Current | | | | 1 | | | 1 | μA |
| DC Open Loop Gain | $R_L \geq 10\text{ Meg}\Omega$ | 60 | 75 | | 60 | 75 | | dB |
| Gain-Bandwidth Product (Note 2) | $A_V = 0\text{dB}$, $T_J = 25^\circ\text{C}$ | 1 | 2 | | 1 | 2 | | MHz |
| Output Low Level | | | 0.2 | 0.5 | | 0.2 | 0.5 | V |
| Output High Level | | 3.8 | 5.6 | | 3.8 | 5.6 | | V |
| Common Mode Rejection | $V_{CM} = 1.5\text{V}$ to 5.2V | 60 | 75 | | 60 | 75 | | dB |
| Supply Voltage Rejection | $V_{IN} = 8\text{V}$ to 35V | 50 | 60 | | 50 | 60 | | dB |
| PWM Comparator | | | | | | | | |
| Minimum Duty Cycle | | | | 0 | | | 0 | % |
| Maximum Duty Cycle (Note 3) | | 45 | 49 | | 45 | 49 | | % |
| Input Threshold (Note 3) | Zero Duty Cycle | 0.7 | 0.9 | | 0.7 | 0.9 | | V |
| Input Threshold (Note 3) | Maximum Duty Cycle | | 3.3 | 3.6 | | 3.3 | 3.6 | V |
| Input Bias Current (Note 2) | | | 0.05 | 1.0 | | 0.05 | 1.0 | μA |
| Shutdown Section | | | | | | | | |
| Soft Start Current | $V_{SHUTDOWN} = 0\text{V}$, $V_{SOFTSTART} = 0\text{V}$ | 25 | 50 | 80 | 25 | 50 | 80 | μA |
| Soft Start Low Level | $V_{SHUTDOWN} = 2.5\text{V}$ | | 0.4 | 0.7 | | 0.4 | 0.7 | V |
| Shutdown Threshold | To outputs, $V_{SOFTSTART} = 5.1\text{V}$, $T_J = 25^\circ\text{C}$ | 0.6 | 0.8 | 1.0 | 0.6 | 0.8 | 1.0 | V |
| Shutdown Input Current | $V_{SHUTDOWN} = 2.5\text{V}$ | | 0.4 | 1.0 | | 0.4 | 1.0 | mA |
| Shutdown Delay (Note 2) | $V_{SHUTDOWN} = 2.5\text{V}$, $T_J = 25^\circ\text{C}$ | | 0.2 | 0.5 | | 0.2 | 0.5 | μs |
| Output Drivers (Each Output) (Vc = 20V) | | | | | | | | |
| Output Low Level | $I_{SINK} = 20\text{mA}$ | | 0.2 | 0.4 | | 0.2 | 0.4 | V |
| | $I_{SINK} = 100\text{mA}$ | | 1.0 | 2.0 | | 1.0 | 2.0 | V |
| Output High Level | $I_{SOURCE} = 20\text{mA}$ | 18 | 19 | | 18 | 19 | | V |
| | $I_{SOURCE} = 100\text{mA}$ | 17 | 18 | | 17 | 18 | | V |
| Undervoltage Lockout | V_{COMP} and $V_{SOFTSTART} = \text{High}$ | 6 | 7 | 8 | 6 | 7 | 8 | V |
| Collector Leakage | $V_C = 35\text{V}$ | | | 200 | | | 200 | μA |

ELECTRICAL CHARACTERISTICS: Unless otherwise stated, these specifications apply for $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ for the UC1525B and UC1527B; -40°C to $+85^{\circ}\text{C}$ for the UC2525B and UC2527B; 0°C to $+70^{\circ}\text{C}$ for the UC3525B and UC3527B; $+V_{IN} = 20\text{V}$, $T_A = T_J$.

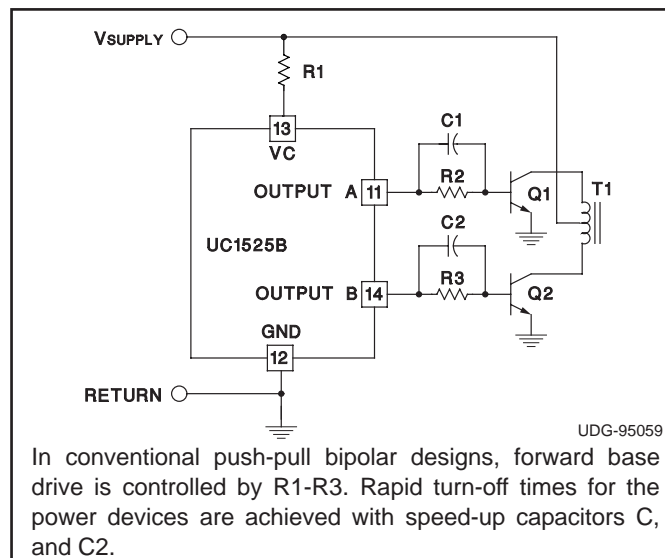
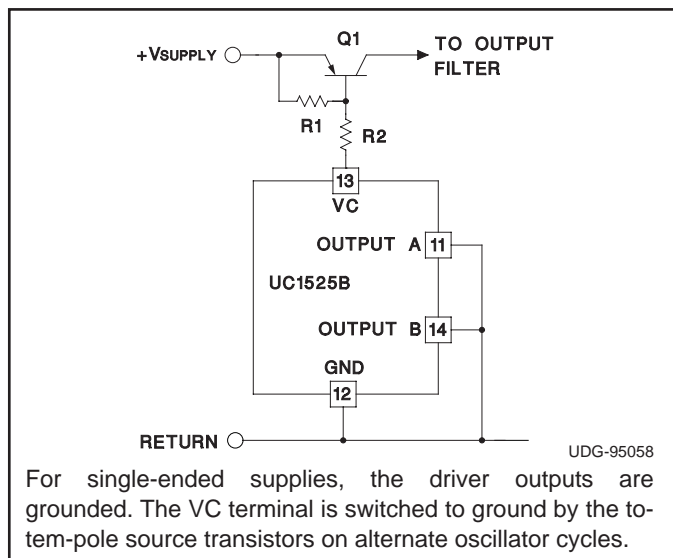
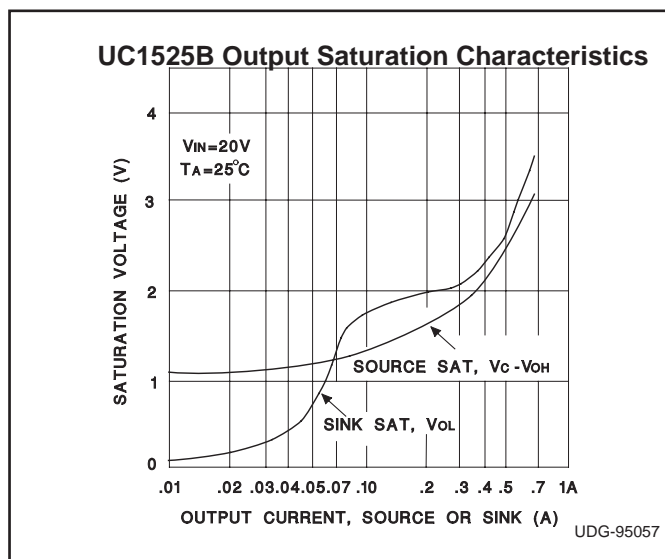
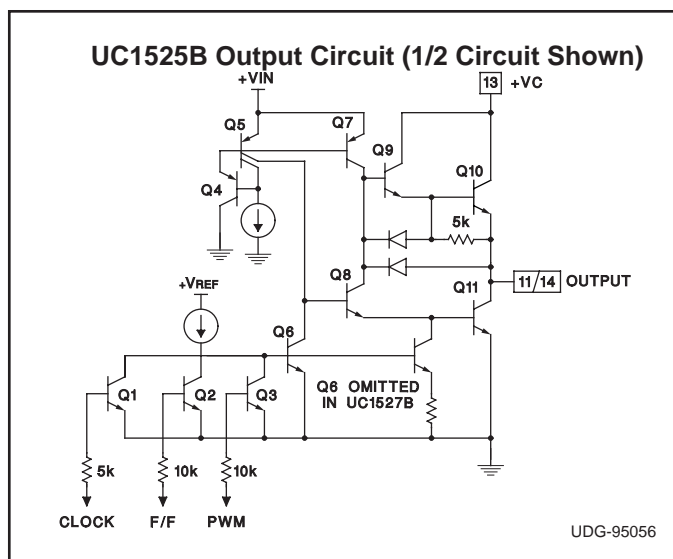
| PARAMETER | TEST CONDITIONS | UC1525B/UC2525B UC1527B/UC2527B | | | UC3525B UC3527B | | | UNITS |
|---|---|------------------------------------|-----|-----|--------------------|-----|-----|-------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Output Drivers (Each Output) ($V_C = 20\text{V}$) (cont.) | | | | | | | | |
| Rise Time (Note 2) | $C_L = 1\text{nF}$, $T_J = 25^{\circ}\text{C}$ | | 100 | 600 | | 100 | 600 | ns |
| Fall Time (Note 2) | $C_L = 1\text{nF}$, $T_J = 25^{\circ}\text{C}$ | | 50 | 300 | | 50 | 300 | ns |
| Cross conduction charge | Per cycle, $T_J = 25^{\circ}\text{C}$ | | 30 | | | 30 | | nc |
| Total Standby Current | | | | | | | | |
| Supply Current | $V_{IN} = 35\text{V}$ | | 14 | 20 | | 14 | 20 | mA |

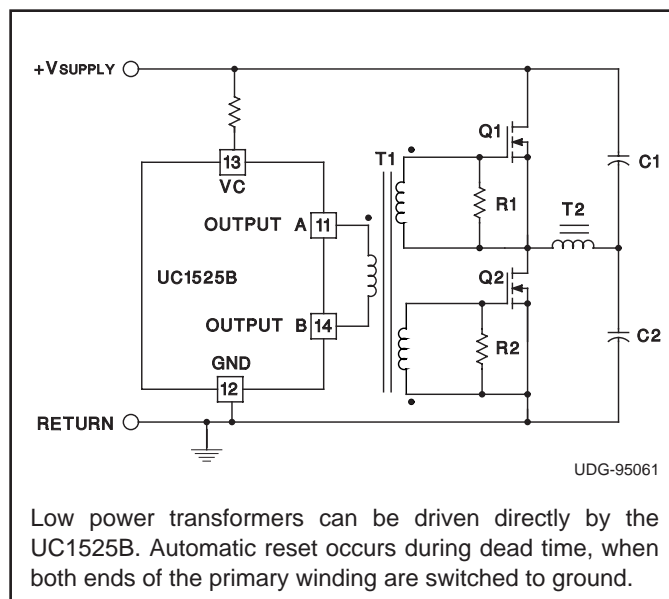
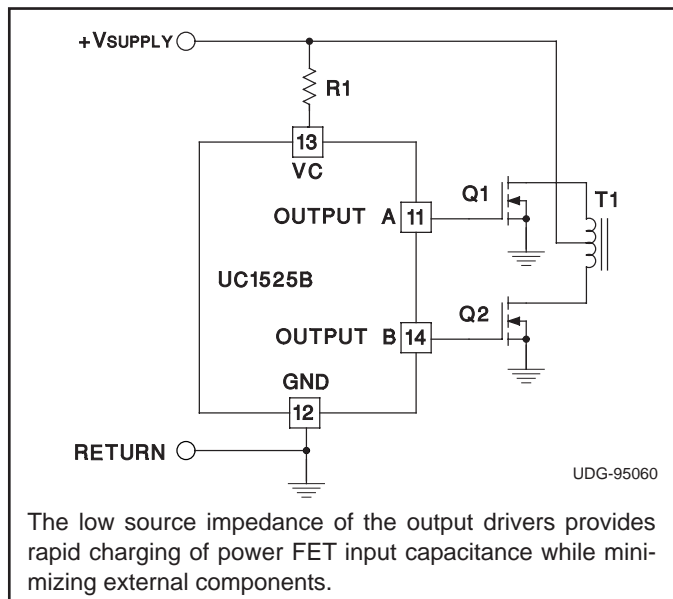
Note 2: Ensured by design. Not 100% tested in production.

Note 3: Tested at $f_{osc} = 40\text{kHz}$ ($R_T = 3.6\text{k}\Omega$, $C_T = 0.01\mu\text{F}$, $R_D = 0\Omega$). Approximate oscillator frequency is defined by:

$$f = \frac{1}{C_T \cdot (0.7 \cdot R_T + 3R_D)}$$

PRINCIPLES OF OPERATION AND TYPICAL CHARACTERISTICS





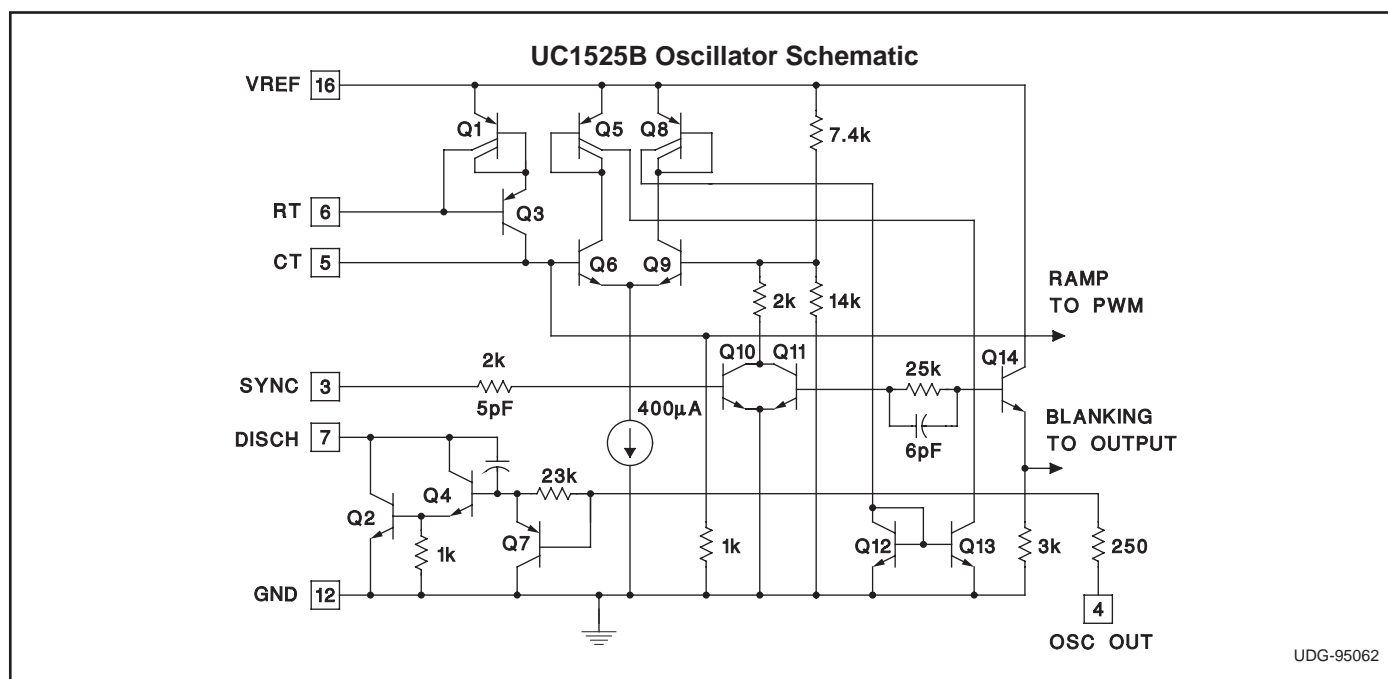
PRINCIPLES OF OPERATION AND TYPICAL CHARACTERISTICS

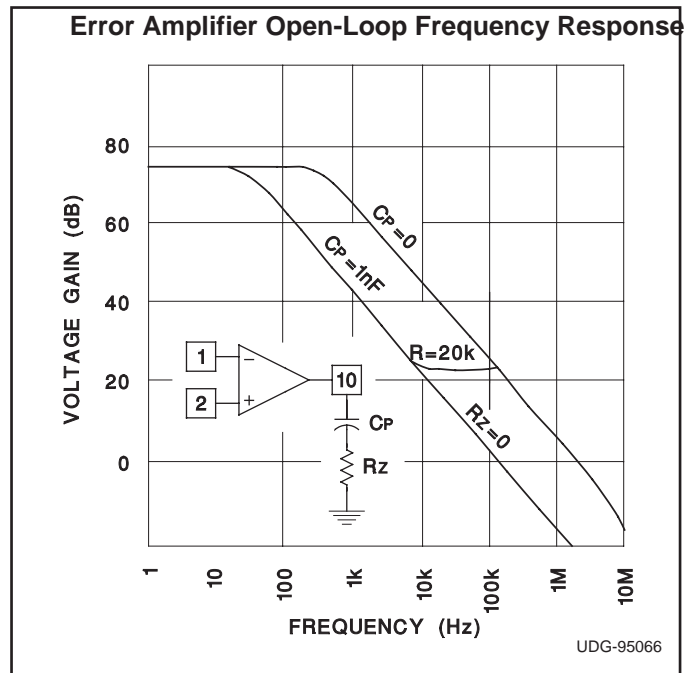
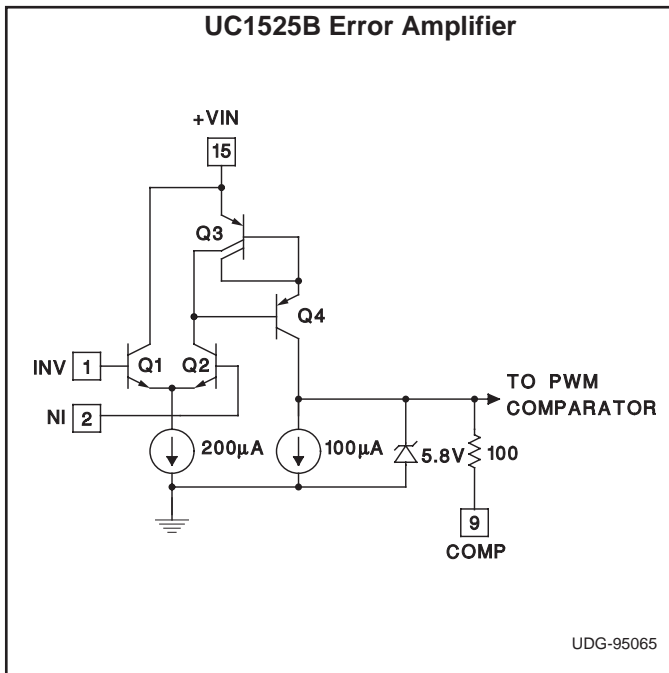
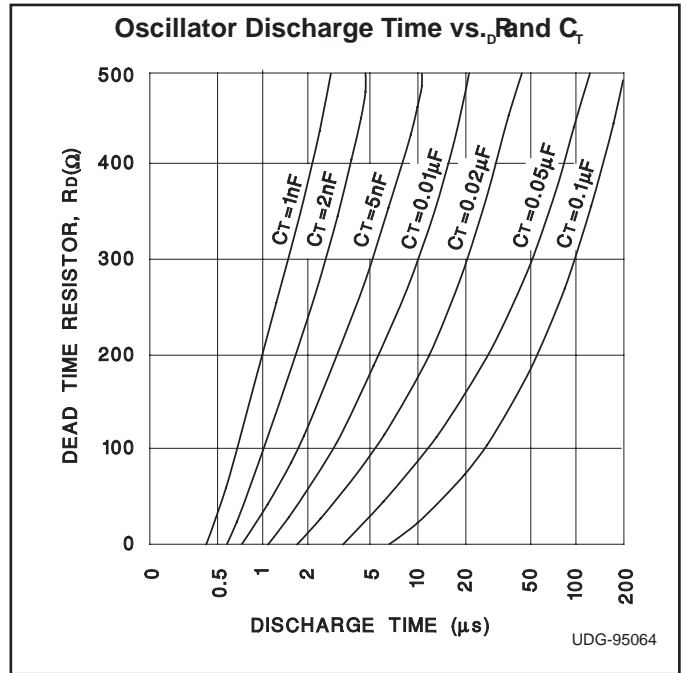
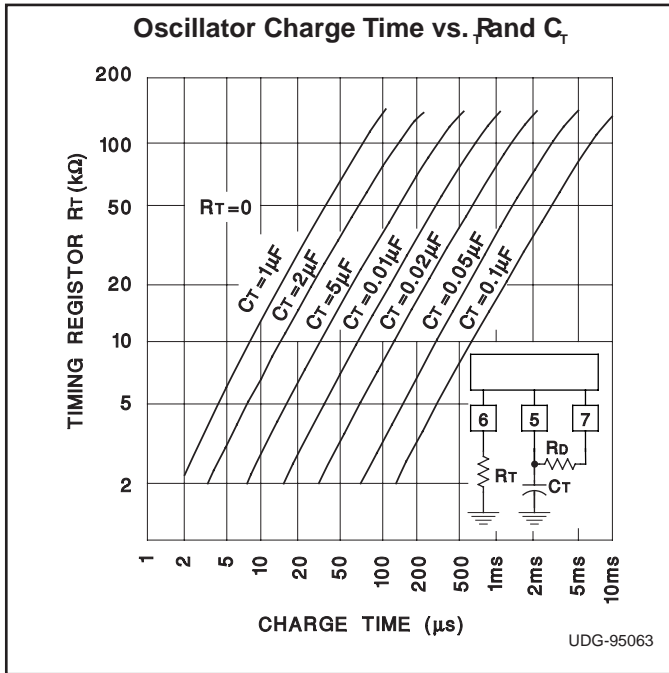
Shutdown Options (See Block Diagram)

Since both the compensation and soft-start terminals (Pins 9 and 8) have current source pull-ups, either can readily accept a pull-down signal which only has to sink a maximum of 100 μ A to turn off the outputs. This is subject to the added requirement of discharging whatever external capacitance may be attached to these pins.

An alternate approach is the use of the shutdown circuitry of Pin 10 which has been improved to enhance the available shutdown options. Activating this circuit by ap-

plying a positive signal on Pin 10 performs two functions: the PWM latch is immediately set providing the fastest turn-off signal to the external soft-start capacitor. If the shutdown command is short, the PWM signal is terminated without significant discharge of the soft-start capacitor, thus, allowing, for example, a convenient implementation of pulse-by-pulse current limiting. Holding Pin 10 high for a longer duration, however, will ultimately discharge this external capacitor, recycling slow turn-on upon release.





PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|----------------------------|-------------------------|----------------------|--------------|---------------------------------|-------------------------|
| 5962-8951105EA | ACTIVE | CDIP | J | 16 | 1 | TBD | A42 | N / A for Pkg Type | -55 to 125 | 5962-8951105EA UC1525BJ/883B | Samples |
| UC1525BJ | ACTIVE | CDIP | J | 16 | 1 | TBD | A42 | N / A for Pkg Type | -55 to 125 | UC1525BJ | Samples |
| UC1525BJ883B | ACTIVE | CDIP | J | 16 | 1 | TBD | A42 | N / A for Pkg Type | -55 to 125 | 5962-8951105EA UC1525BJ/883B | Samples |
| UC2525BDWTR | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | UC2525BDW | Samples |
| UC3525BDW | ACTIVE | SOIC | DW | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | UC3525BDW | Samples |
| UC3525BDWG4 | ACTIVE | SOIC | DW | 16 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | UC3525BDW | Samples |
| UC3525BDWTR | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | UC3525BDW | Samples |
| UC3525BN | ACTIVE | PDIP | N | 16 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | N / A for Pkg Type | 0 to 70 | UC3525BN | 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.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "--" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF UC1525B, UC3525B :

- Catalog: [UC3525B](#)

- Military: [UC1525B](#)

- Space: [UC1525B-SP](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

- Military - QML certified for Military and Defense Applications

- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

TAPE AND REEL INFORMATION



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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| UC2525BDWTR | 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) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| UC2525BDWTR | SOIC | DW | 16 | 2000 | 367.0 | 367.0 | 38.0 |

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---------------|------------------------|------------------------|------------------------|------------------------|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package is hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

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

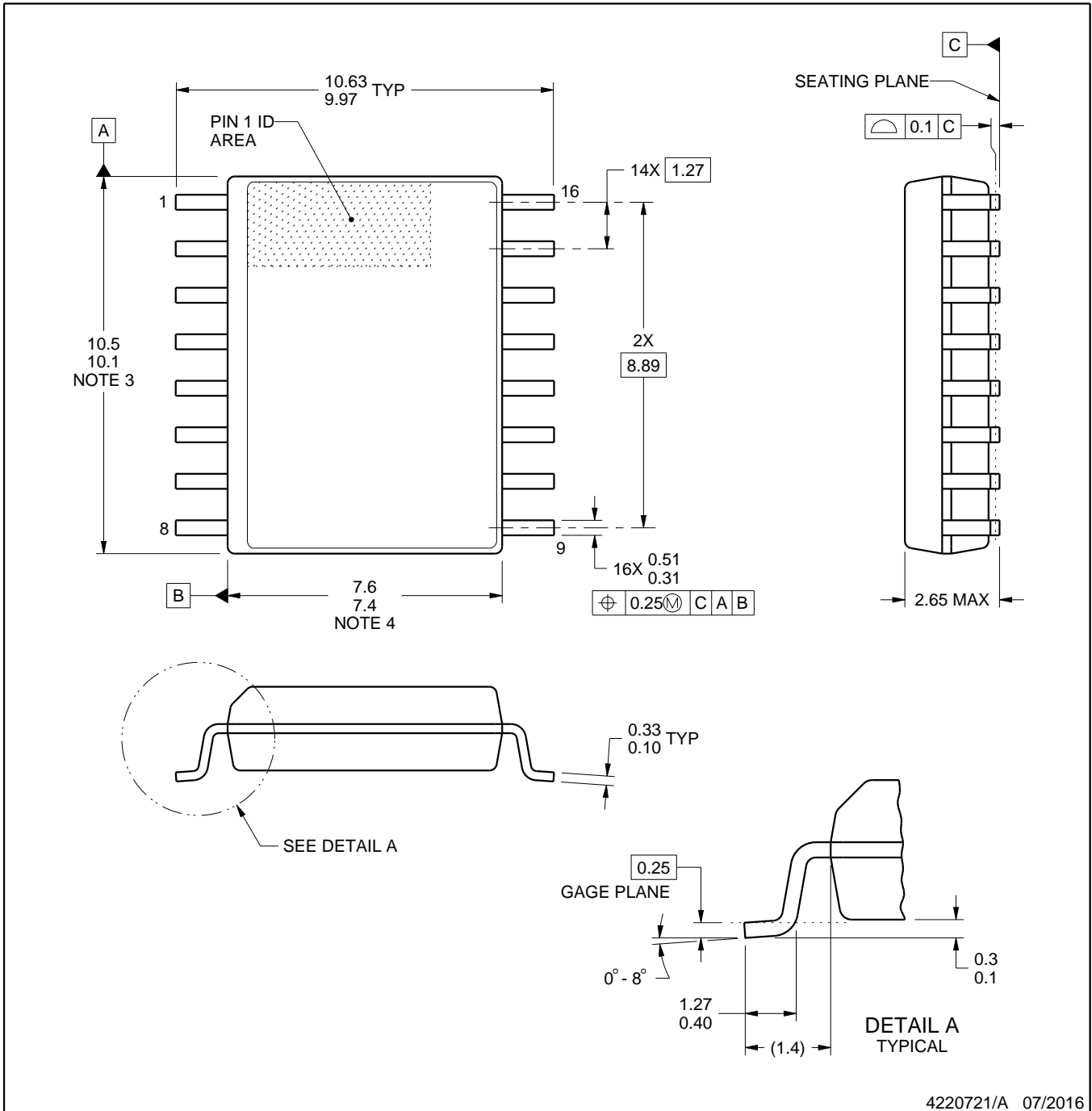


DW0016A

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.

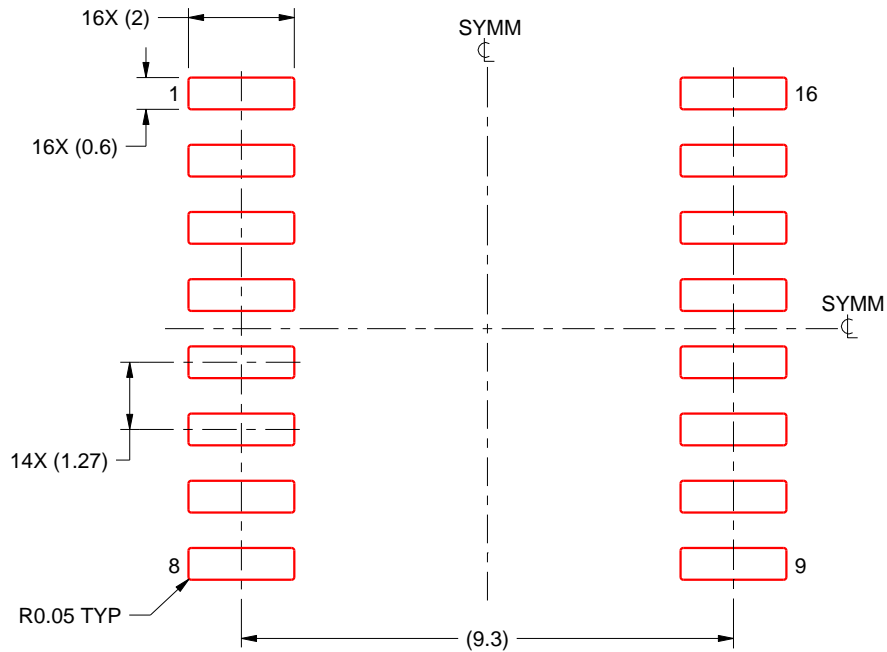
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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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