



Resonant Fluorescent Lamp Driver

FEATURES

- 1 μ A ICC when Disabled
- PWM Control for LCD Supply
- Zero Voltage Switched (ZVS) on Push-Pull Drivers
- Open Lamp Detect Circuitry
- 4.5V to 20V Operation
- Non-saturating Transformer Topology
- Smooth 100% Duty Cycle on Buck PWM and 0% to 95% on Flyback PWM

DESCRIPTION

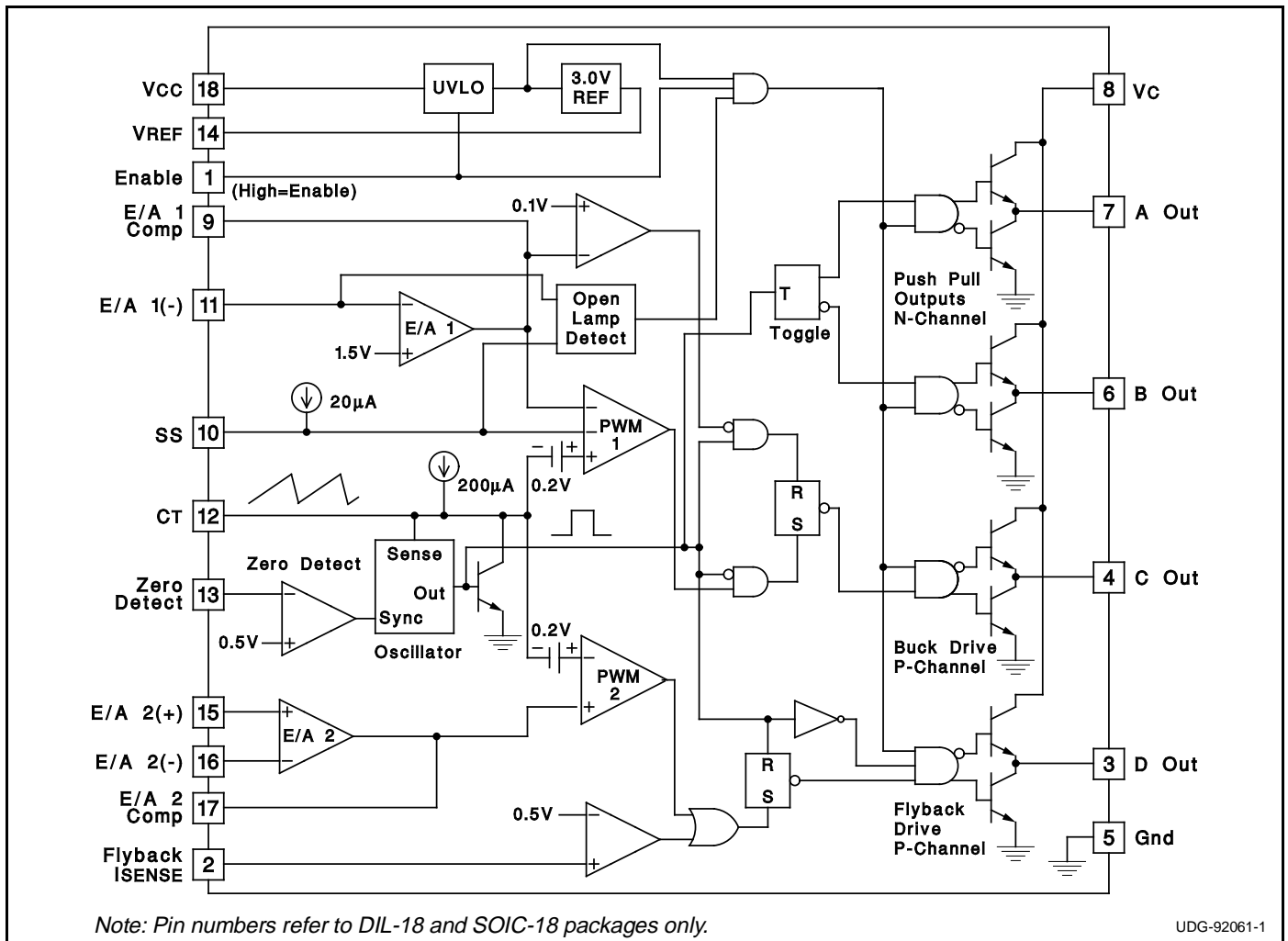
The UC1871 Family of IC's is optimized for highly efficient fluorescent lamp control. An additional PWM controller is integrated on the IC for applications requiring an additional supply, as in LCD displays. When disabled the IC draws only 1 μ A, providing a true disconnect feature, which is optimum for battery powered systems. The switching frequency of all outputs are synchronized to the resonant frequency of the external passive network, which provides Zero Voltage Switching on the Push-Pull drivers.

Soft-Start and open lamp detect circuitry have been incorporated to minimize component stress. An open lamp is detected on the completion of a soft-start cycle.

The Buck controller is optimized for smooth duty cycle control to 100%, while the flyback control ensures a maximum duty cycle of 95%.

Other features include a precision 1% reference, under voltage lockout, flyback current limit, and accurate minimum and maximum frequency control.

BLOCK DIAGRAM



UDG-92061-1

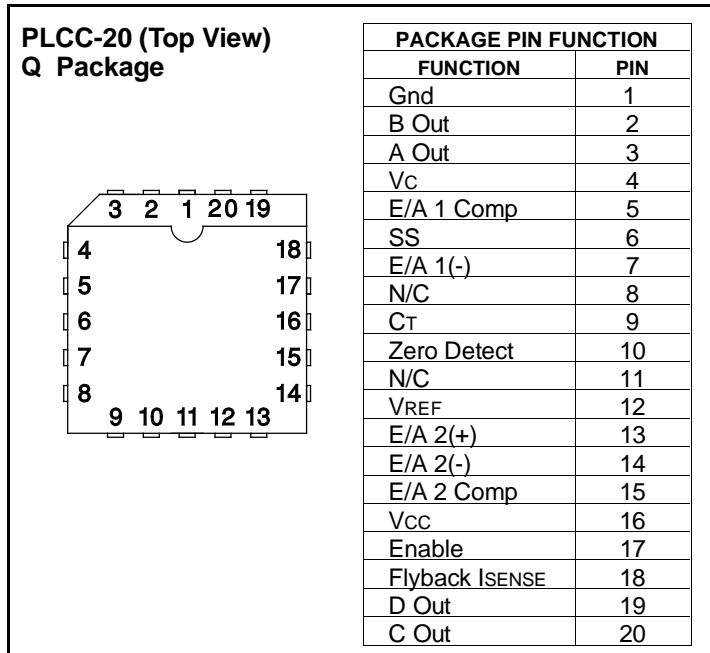
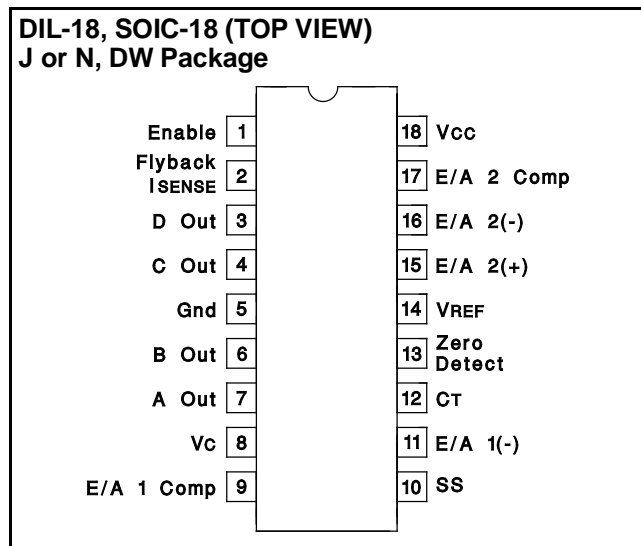
ABSOLUTE MAXIMUM RATINGS

| | |
|--------------------------------------|-----------------|
| Analog Inputs | -0.3 to +10V |
| Vcc, Vc Voltage | +20V |
| Zero Detect Input Current | |
| High Impedance Source | +10mA |
| Zero Detect | |
| Low Impedance Source | +20V |
| Power Dissipation at TA = 25°C | 1W |
| Storage Temperature | -65°C to +150°C |
| Lead Temperature | 300°C |

Note 1: Currents are positive into, negative out of the specified terminal.

Note 2: Consult Packaging Section of Databook for thermal limitations and considerations of package.

CONNECTION DIAGRAMS



ELECTRICAL CHARACTERISTICS Unless otherwise stated, these parameters apply for TA = -55°C to +125°C for the UC1871; -25°C to +85°C for the UC2871; 0°C to +70°C for the UC3871; Vcc = 5V, Vc = 15V, VENABLE = 5V, CT = 1nF, Zero Det = 1V.

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|----------------------------|------------------------|-------|-------|--------|-------|
| Reference Section | | | | | |
| Output Voltage | TJ=25°C | 2.963 | 3.000 | 3.037 | V |
| | Overtemp | 2.940 | 3.000 | 3.060 | V |
| Line Regulation | VCC = 4.75V to 18V | | | 10 | mV |
| Load Regulation | Io=0 to -5mA | | | 10 | mV |
| Oscillator Section | | | | | |
| Free Running Freq | TJ=25°C | 57 | 68 | 78 | kHz |
| Max Sync Frequency | TJ=25°C | 160 | 200 | 240 | kHz |
| Charge Current | VCT = 1.5V | 180 | 200 | 220 | µA |
| Voltage Stability | | | | 2 | % |
| Temperature Stability | | | 4 | 8 | % |
| Zero Detect Threshold | | 0.46 | 0.5 | 0.56 | V |
| Error Amp 1 Section | | | | | |
| Input Voltage | Vo = 2V | 1.445 | 1.475 | 1.505 | V |
| Input Bias Current | | | -0.4 | -2 | µA |
| Open Loop Gain | Vo = 0.5 to 3V | 65 | 90 | | dB |
| Output High | VEA(-) = 1.3V | 3.1 | 3.5 | 3.9 | V |
| Output Low | VEA(-) = 1.7V | | 0.1 | 0.2 | V |
| Output Source Current | VEA(-) = 1.3V, Vo = 2V | -350 | -500 | | µA |
| Output Sink Current | VEA(-) = 1.7V, Vo = 2V | 10 | 20 | | mA |
| Common Mode Range | | 0 | | VIN-1V | V |
| Unity Gain Bandwidth | TJ = 25°C (Note 4) | | 1 | | MHz |
| Maximum Source Impedance | Note 5 | | | 100k | Ω |

**ELECTRICAL
CHARACTERISTICS (cont.)**

Unless otherwise stated, these parameters apply for $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ for the UC1871; -25°C to $+85^{\circ}\text{C}$ for the UC2871; 0°C to $+70^{\circ}\text{C}$ for the UC3871; $V_{CC} = 5\text{V}$, $V_C = 15\text{V}$, $V_{ENABLE} = 5\text{V}$, $C_T = 1\text{nF}$, Zero Det = 1V.

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|--------------------------------------|--|-------|-------|--------------------|---------------|
| Open Lamp Detect Section | | | | | |
| Soft Start Threshold | $V_{EA(-)} = 0\text{V}$ | 2.9 | 3.4 | 3.8 | V |
| Error Amp Threshold | $V_{SS} = 4.2\text{V}$ | 0.7 | 1.0 | 1.3 | V |
| Soft Start Current | $V_{SS} = 2\text{V}$ | 10 | 20 | 40 | μA |
| Error Amp 2 Section | | | | | |
| Input Offset Voltage | $V_O = 2\text{V}$ | | 0 | 10 | mV |
| Input Bias Current | | | -0.2 | -1 | μA |
| Input Offset Current | | | | 0.5 | μA |
| Open Loop Gain | $V_O = 0.5$ to 3V | 65 | 90 | | dB |
| Output High | $V_{ID} = 100\text{mV}$, $V_O = 2\text{V}$ | 3.6 | 4 | 4.4 | V |
| Output Low | $V_{ID} = -100\text{mV}$, $V_O = 2\text{V}$ | | 0.1 | 0.2 | V |
| Output Source Current | $V_{ID} = 100\text{mV}$, $V_O = 2\text{V}$ | -350 | -500 | | μA |
| Output Sink Current | $V_{ID} = -100\text{mV}$, $V_O = 2\text{V}$ | 10 | 20 | | mA |
| Common Mode Range | | 0 | | $V_{IN}-2\text{V}$ | V |
| Unity Gain Bandwidth | $T_J = 25^{\circ}\text{C}$ (Note 4) | | 1 | | MHz |
| Isense Section | | | | | |
| Threshold | | 0.475 | 0.525 | 0.575 | V |
| Output Section | | | | | |
| Output Low Level | $I_{OUT} = 0$, Outputs A and B | | 0.05 | 0.2 | V |
| | $I_{OUT} = 10\text{mA}$ | | 0.1 | 0.4 | V |
| | $I_{OUT} = 100\text{mA}$ | | 1.5 | 2.2 | V |
| Output High Level | $I_{OUT} = 0$, Outputs C and D | 14.7 | 14.9 | | V |
| | $I_{OUT} = -10\text{mA}$ | 13.5 | 14.3 | | V |
| | $I_{OUT} = -100\text{mA}$ | 12.5 | 13.5 | | V |
| Rise Time | $T_J = 25^{\circ}\text{C}$, $C_I = 1\text{nF}$ (Note 4) | | 30 | 80 | ns |
| Fall Time | $T_J = 25^{\circ}\text{C}$, $C_I = 1\text{nF}$ (Note 4) | | 30 | 80 | ns |
| Output Dynamics | | | | | |
| Out A and B Duty Cycle | | 48 | 49.9 | 50 | % |
| Out C Max Duty Cycle | $V_{EA1(-)} = 1\text{V}$ | 100 | | | % |
| Out C Min Duty Cycle | $V_{EA1(-)} = 2\text{V}$ | | | 0 | % |
| Out D Max Duty Cycle | $V_{EA2(+)}- V_{EA2(-)} = 100\text{mV}$ | | 92 | 96 | % |
| Out D Min Duty Cycle | $V_{EA2(+)}- V_{EA2(-)} = -100\text{mV}$ | | | 0 | % |
| Under Voltage Lockout Section | | | | | |
| Start-Up Threshold | | 3.7 | 4.2 | 4.5 | V |
| Hysteresis | | 120 | 200 | 280 | mV |
| Enable Section | | | | | |
| Input High Threshold | | 2 | | | V |
| Input low Threshold | | | | 0.8 | V |
| Input Current | $V_{ENABLE} = 5\text{V}$ | | 150 | 400 | μA |
| Supply Current Section | | | | | |
| VCC Supply Current | $V_{CC} = 20\text{V}$ | | 8 | 14 | mA |
| VC Supply Current | $V_C=20\text{V}$ | | 7 | 12 | mA |
| ICC Disabled | $V_{CC} = 20\text{V}$, $V_{ENABLE} = 0\text{V}$ | | 1 | 10 | μA |

Note 3: Unless otherwise specified, all voltages are with respect to ground.

Currents are positive into, and negative out of the specified terminal.

Note 4: Guaranteed by design but not 100% tested in production.

Note 5: Impedance below specified maximum guarantees proper operation of the Open Lamp Detect.

TYPICAL APPLICATION

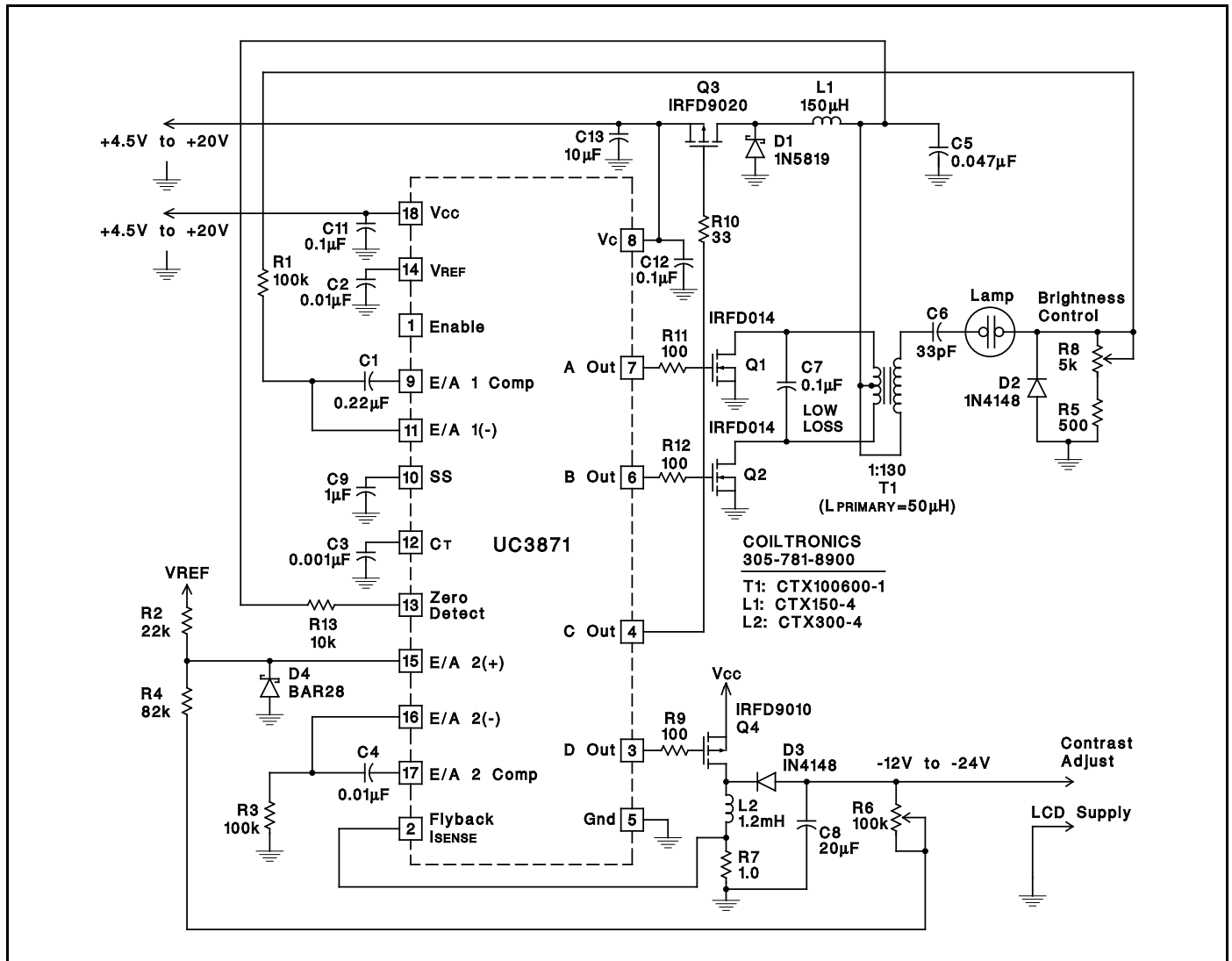


Figure 1

APPLICATION INFORMATION

Figure 1 shows a complete application circuit using the UC3871 Resonant Fluorescent lamp and LCD driver. The IC provides all drive, control and housekeeping functions to implement CCFL and LCD converters. The buck output voltage (transformer center-tap) provides the zero crossing and synchronization signal. The LCD supply modulator is also synchronized to the resonant tank.

The buck modulator drives a P-channel MOSFET directly, and operates over a 0-100% duty-cycle range. The modulation range includes 100%, allowing operation with minimal headroom. The LCD supply modulator also directly drives a P-channel MOSFET, but it's duty-cycle is limited to 95% to prevent flyback supply foldback.

The oscillator and synchronization circuitry are shown in Figure 2. The oscillator is designed to synchronize over a 3:1 frequency range. In an actual application however, the frequency range is only about 1.5:1. A zero detect

comparator senses the primary center-tap voltage, generating a synchronization pulse when the resonant waveform falls to zero. The actual threshold is 0.5 volts, providing a small amount of anticipation to offset propagation delay.

The synchronization pulse width is the time that the 4mA current sink takes to discharge the timing capacitor to 0.1 volts. This pulse width sets the LCD supply modulator minimum off time, and also limits the minimum linear control range of the buck modulator. The 200µA current source charges the capacitor to a maximum of 3 volts. A comparator blanks the zero detect signal until the capacitor voltage exceeds 1 volt, preventing multiple synchronization pulse generation and setting the maximum frequency. If the capacitor voltage reaches 3 volts (a zero detection has not occurred) an internal clock pulse is generated to limit the minimum frequency.

APPLICATION INFORMATION (cont.)

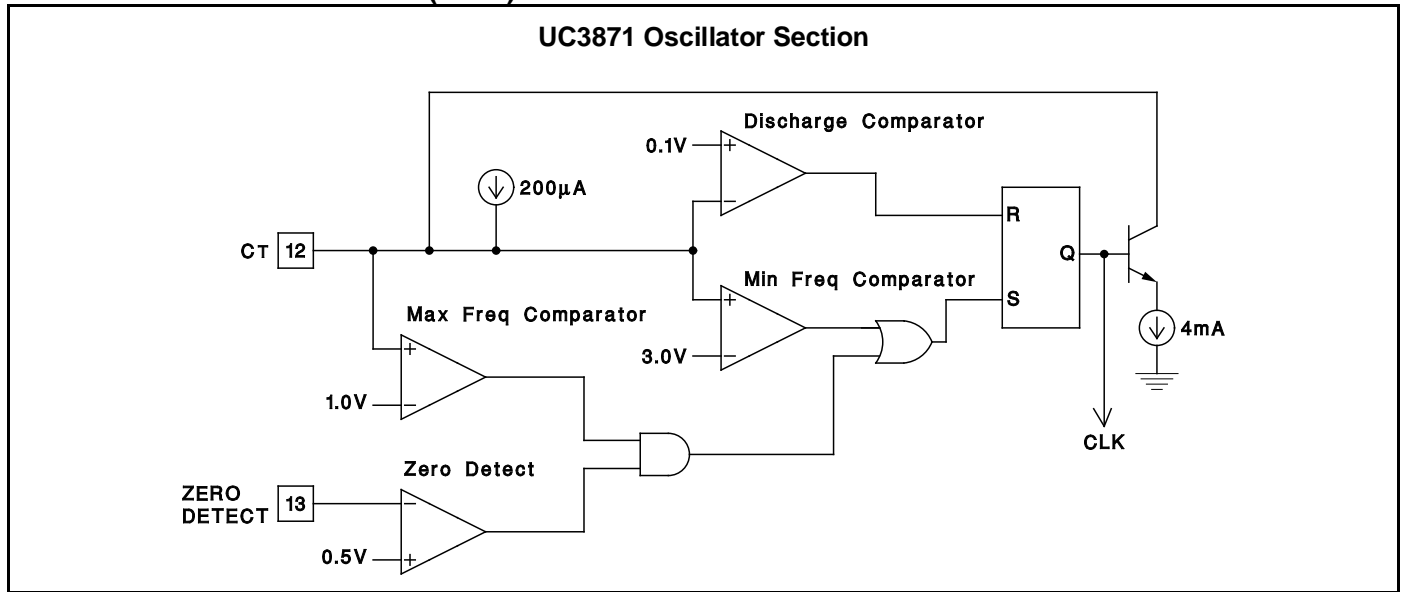


Figure 2

A unique protection feature incorporated in the UC3871 is the Open Lamp Detect circuit. An open lamp interrupts the current feedback loop and causes very high secondary voltage. Operation in this mode will usually breakdown the transformer's insulation, causing permanent damage to the converter. The open lamp detect circuit, shown in Figure 3 senses the lamp current feedback signal at the error amplifiers input, and shuts down the outputs if insufficient signal is present. Soft-start circuitry limits initial turn-on currents and blanks the open lamp detect signal.

Other features are included to minimize external circuitry

requirements. A logic level enable pin shuts down the IC, allowing direct connection to the battery. During shutdown, the IC typically draws less than 1µA. The UC3871, operating from 4.5V to 20V, is compatible with almost all battery voltages used in portable computers. Under-voltage lockout circuitry disables operation until sufficient supply voltage is available, and a 1% voltage reference insures accurate operation. Both inputs to the LCD supply error amplifier are uncommitted, allowing positive or negative supply loop closure without additional circuitry. The LCD supply modulator also incorporates cycle-by-cycle current limiting for added protection.

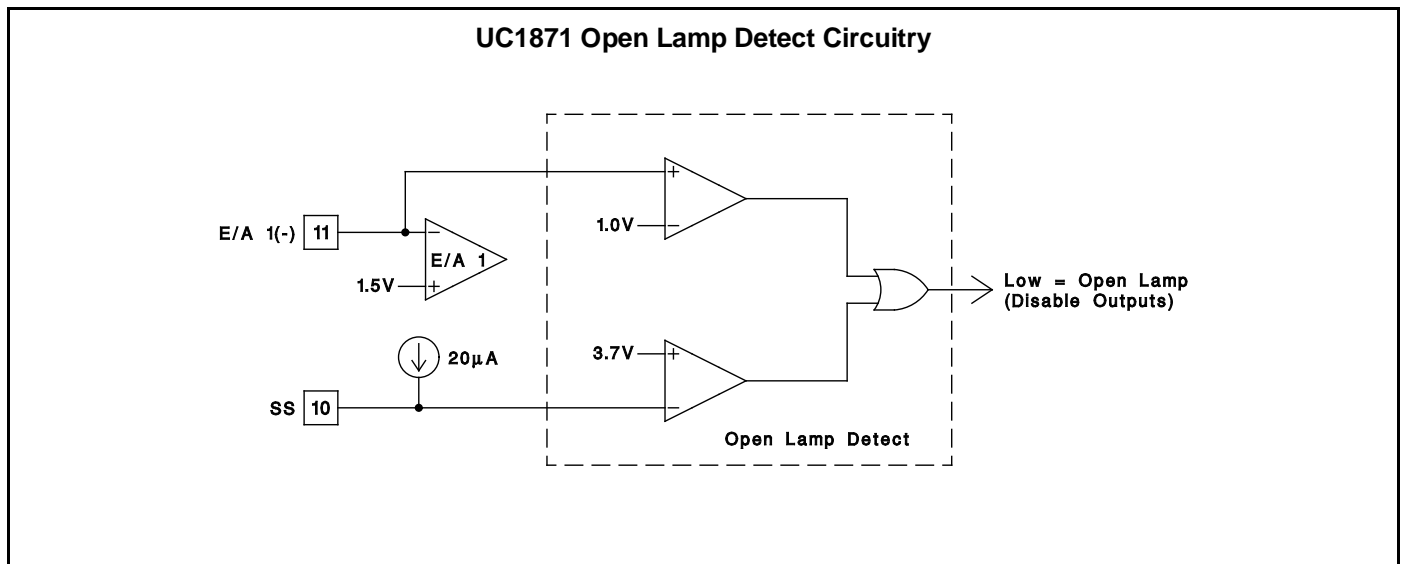


Figure 3

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 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|---------|
| 5962-9462201MVA | OBSOLETE | | | 18 | | TBD | Call TI | Call TI | -55 to 125 | | |
| 5962-9462201Q2A | OBSOLETE | LCCC | FK | 20 | | TBD | Call TI | Call TI | -55 to 125 | | |
| UC1871J | OBSOLETE | CDIP | J | 18 | | TBD | Call TI | Call TI | -55 to 125 | | |
| UC1871J883B | OBSOLETE | CDIP | J | 18 | | TBD | Call TI | Call TI | -55 to 125 | | |
| UC1871L883B | OBSOLETE | TO/SOT | L | 20 | | TBD | Call TI | Call TI | -55 to 125 | | |
| UC2871DW | ACTIVE | SOIC | DW | 18 | 40 | TBD | Call TI | Call TI | -40 to 85 | UC2871DW | Samples |
| UC2871DWG4 | ACTIVE | SOIC | DW | 18 | 40 | TBD | Call TI | Call TI | -40 to 85 | UC2871DW | Samples |
| UC3871DW | ACTIVE | SOIC | DW | 18 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | UC3871DW | Samples |
| UC3871DWG4 | ACTIVE | SOIC | DW | 18 | 40 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | UC3871DW | Samples |
| UC3871DWTR | ACTIVE | SOIC | DW | 18 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | UC3871DW | 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) 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 UC1871, UC3871 :

- Catalog: [UC3871](#)
- Military: [UC1871](#)

NOTE: Qualified Version Definitions:

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

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 |

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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| UC3871DWTR | SOIC | DW | 18 | 2000 | 330.0 | 24.4 | 10.9 | 12.0 | 2.7 | 12.0 | 24.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| UC3871DWTR | SOIC | DW | 18 | 2000 | 367.0 | 367.0 | 45.0 |

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.

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



| NO. OF TERMINALS ** | A | | B | |
|---------------------|------------------|------------------|------------------|------------------|
| | MIN | MAX | MIN | MAX |
| 20 | 0.342 (8,69) | 0.358 (9,09) | 0.307 (7,80) | 0.358 (9,09) |
| 28 | 0.442 (11,23) | 0.458 (11,63) | 0.406 (10,31) | 0.458 (11,63) |
| 44 | 0.640 (16,26) | 0.660 (16,76) | 0.495 (12,58) | 0.560 (14,22) |
| 52 | 0.740 (18,78) | 0.761 (19,32) | 0.495 (12,58) | 0.560 (14,22) |
| 68 | 0.938 (23,83) | 0.962 (24,43) | 0.850 (21,6) | 0.858 (21,8) |
| 84 | 1.141 (28,99) | 1.165 (29,59) | 1.047 (26,6) | 1.063 (27,0) |

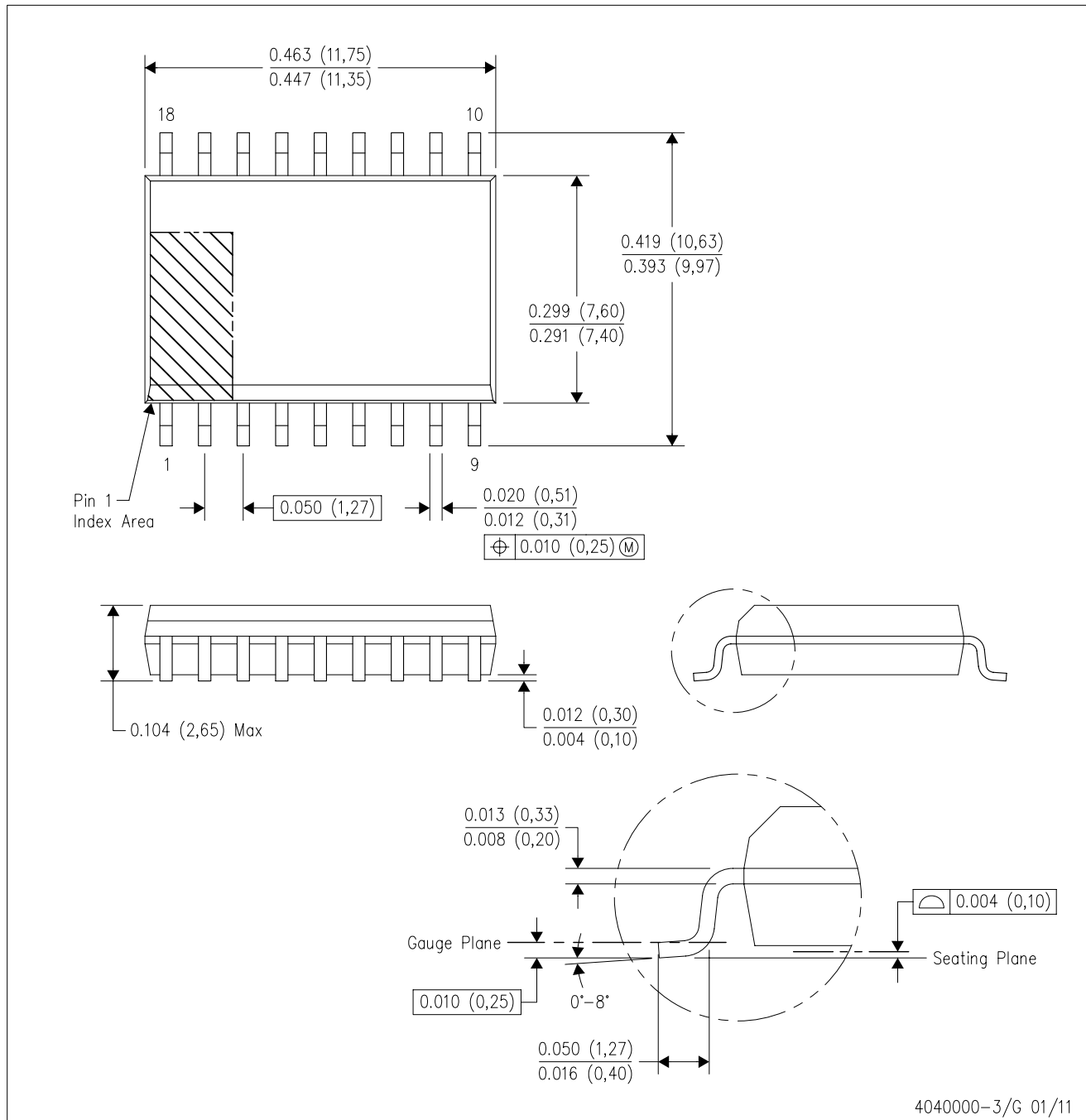


4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a metal lid.
 - Falls within JEDEC MS-004

DW (R-PDSO-G18)

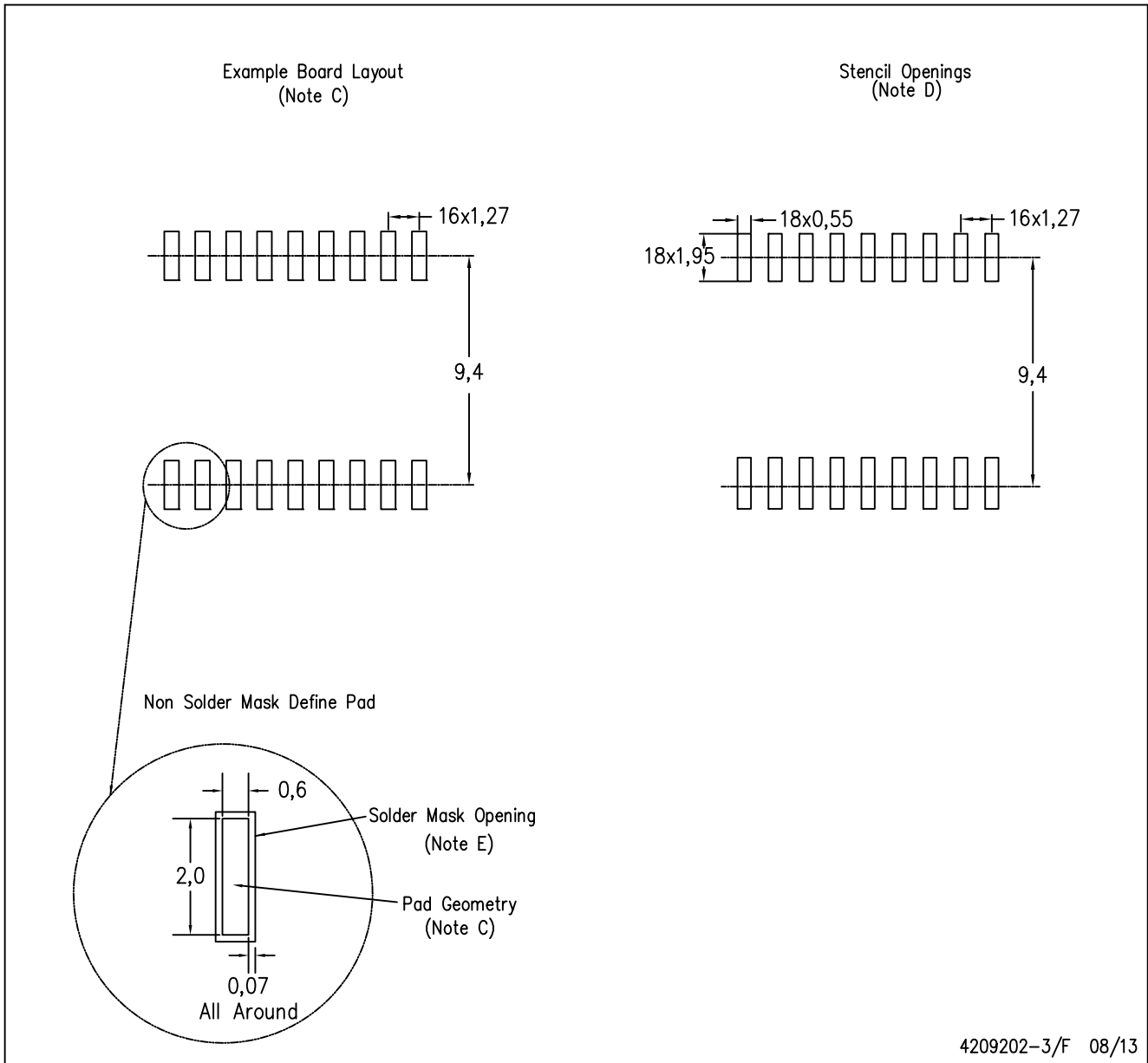
PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-013 variation AB.

DW (R-PDSO-G18)

PLASTIC SMALL OUTLINE



4209202-3/F 08/13

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Refer to IPC7351 for alternate board design.
 - D. 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
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
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| RFID | www.ti-rfid.com |
| OMAP Applications Processors | www.ti.com/omap |
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Applications

| | |
|-------------------------------|--|
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| Communications and Telecom | www.ti.com/communications |
| Computers and Peripherals | www.ti.com/computers |
| Consumer Electronics | www.ti.com/consumer-apps |
| Energy and Lighting | www.ti.com/energy |
| Industrial | www.ti.com/industrial |
| Medical | www.ti.com/medical |
| Security | www.ti.com/security |
| Space, Avionics and Defense | www.ti.com/space-avionics-defense |
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