

# Resonant Fluorescent Lamp Driver

## FEATURES

- 1 $\mu$ 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

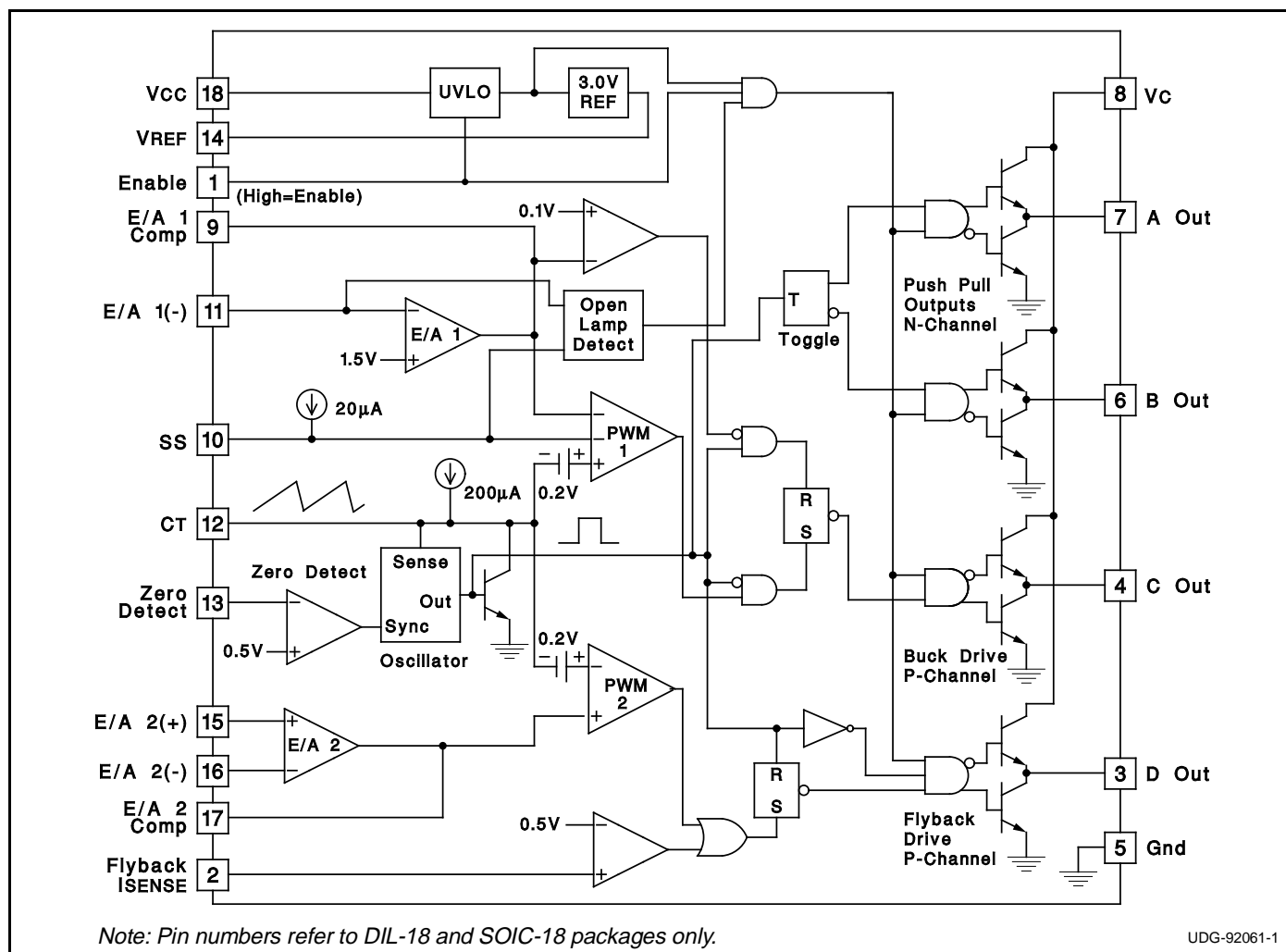
The UC1871 Family of IC's is optimized for highly efficient fluorescent lamp control. An additional PWM controller is integrated on the IC for applications requiring an additional supply, as in LCD displays. When disabled the IC draws only 1 $\mu$ A, providing a true disconnect feature, which is optimum 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



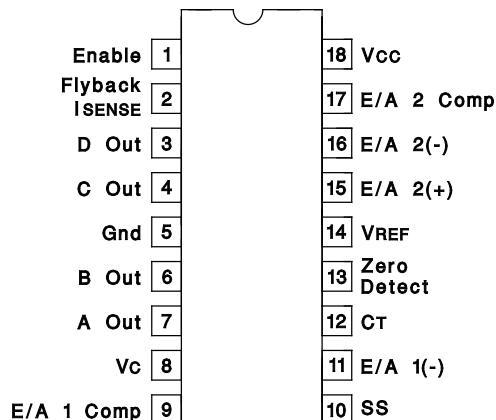
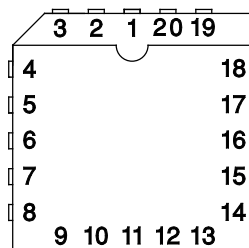
UDG-92061-1

**ABSOLUTE MAXIMUM RATINGS**

Analog Inputs	−0.3 to +10V
V <sub>CC</sub> , V <sub>C</sub> Voltage	+20V
Zero Detect Input Current	
High Impedance Source	+10mA
Zero Detect	
Low Impedance Source	+20V
Power Dissipation at T <sub>A</sub> = 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****DIL-18, SOIC-18 (TOP VIEW)****J or N, DW Package****PLCC-20 (Top View)**  
**Q Package****PACKAGE PIN FUNCTION**

FUNCTION	PIN
Gnd	1
B Out	2
A Out	3
V <sub>C</sub>	4
E/A 1 Comp	5
SS	6
E/A 1(-)	7
N/C	8
CT	9
Zero Detect	10
N/C	11
VREF	12
E/A 2(+)	13
E/A 2(-)	14
E/A 2 Comp	15
V <sub>CC</sub>	16
Enable	17
Flyback ISENSE	18
D Out	19
C Out	20

**ELECTRICAL CHARACTERISTICS**

Unless otherwise stated, these parameters apply for T<sub>A</sub> = −55°C to +125°C for the UC1871; −25°C to +85°C for the UC2871; 0°C to +70°C for the UC3871; V<sub>CC</sub> = 5V, V<sub>C</sub> = 15V, V<sub>ENABLE</sub> = 5V, C<sub>T</sub> = 1nF, Zero Det = 1V.

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

# **ELECTRICAL CHARACTERISTICS (cont.)**

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
<b>Open Lamp Detect Section</b>					
Soft Start Threshold	VEA(-) = 0V	2.9	3.4	3.8	V
Error Amp Threshold	VSS = 4.2V	0.7	1.0	1.3	V
Soft Start Current	VSS = 2V	10	20	40	μA
<b>Error Amp 2 Section</b>					
Input Offset Voltage	Vo = 2V		0	10	mV
Input Bias Current			-0.2	-1	μA
Input Offset Current				0.5	μA
Open Loop Gain	Vo = 0.5 to 3V	65	90		dB
Output High	VID = 100mV, Vo = 2V	3.6	4	4.4	V
Output Low	VID = -100mV, Vo = 2V		0.1	0.2	V
Output Source Current	VID = 100mV, Vo = 2V	-350	-500		μA
Output Sink Current	VID = -100mV, Vo = 2V	10	20		mA
Common Mode Range		0		VIN-2V	V
Unity Gain Bandwidth	TJ = 25°C (Note 4)		1		MHz
<b>Isense Section</b>					
Threshold		0.475	0.525	0.575	V
<b>Output Section</b>					
Output Low Level	IOUT = 0, Outputs A and B		0.05	0.2	V
	IOUT = 10mA		0.1	0.4	V
	IOUT = 100mA		1.5	2.2	V
Output High Level	IOUT = 0, Outputs C and D	14.7	14.9		V
	IOUT = -10mA	13.5	14.3		V
	IOUT = -100mA	12.5	13.5		V
Rise Time	TJ = 25°C, Cl = 1nF (Note 4)		30	80	ns
Fall Time	TJ = 25°C, Cl = 1nF (Note 4)		30	80	ns
<b>Output Dynamics</b>					
Out A and B Duty Cycle		48	49.9	50	%
Out C Max Duty Cycle	VEA1(-) = 1V	100			%
Out C Min Duty Cycle	VEA1(-) = 2V			0	%
Out D Max Duty Cycle	VEA2(+)- VEA2(-) = 100mV		92	96	%
Out D Min Duty Cycle	VEA2(+)- VEA2(-) = -100mV			0	%
<b>Under Voltage Lockout Section</b>					
Start-Up Threshold		3.7	4.2	4.5	V
Hysteresis		120	200	280	mV
<b>Enable Section</b>					
Input High Threshold		2			V
Input low Threshold				0.8	V
Input Current	VENABLE = 5V		150	400	μA
<b>Supply Current Section</b>					
VCC Supply Current	VCC = 20V		8	14	mA
VC Supply Current	VC=20V		7	12	mA
ICC Disabled	VCC = 20V, VENABLE = 0V		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

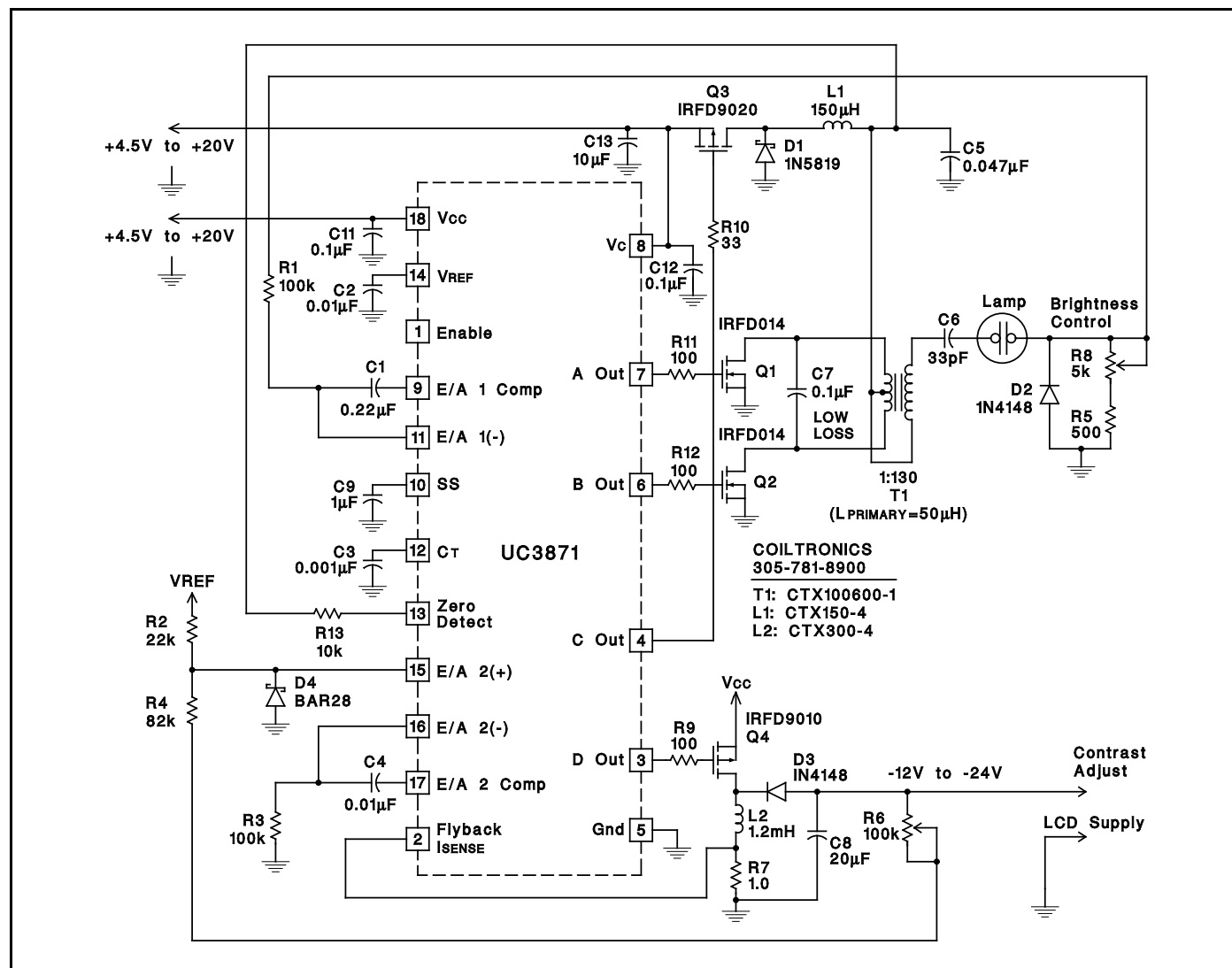


Figure 1

## 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 its 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.



Other features are included to minimize external circuitry

## UC1871 Open Lamp Detect Circuitry



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
5962-9462201MVA	OBSOLETE			18		TBD	Call TI	Call TI
5962-9462201Q2A	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI
UC1871J	OBSOLETE	CDIP	J	18		TBD	Call TI	Call TI
UC1871J883B	OBSOLETE	CDIP	J	18		TBD	Call TI	Call TI
UC1871L883B	OBSOLETE	TO/SOT	L	20		TBD	Call TI	Call TI
UC2871DW	ACTIVE	SOIC	DW	18	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2871DWG4	ACTIVE	SOIC	DW	18	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC2871N	ACTIVE	PDIP	N	18	20	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC2871NG4	ACTIVE	PDIP	N	18	20	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC3871DW	ACTIVE	SOIC	DW	18	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3871DWG4	ACTIVE	SOIC	DW	18	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3871DWTR	ACTIVE	SOIC	DW	18	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3871DWTRG4	ACTIVE	SOIC	DW	18	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UC3871N	ACTIVE	PDIP	N	18	20	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC3871NG4	ACTIVE	PDIP	N	18	20	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UC3871Q	ACTIVE	PLCC	FN	20	46	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR
UC3871QG3	ACTIVE	PLCC	FN	20	46	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

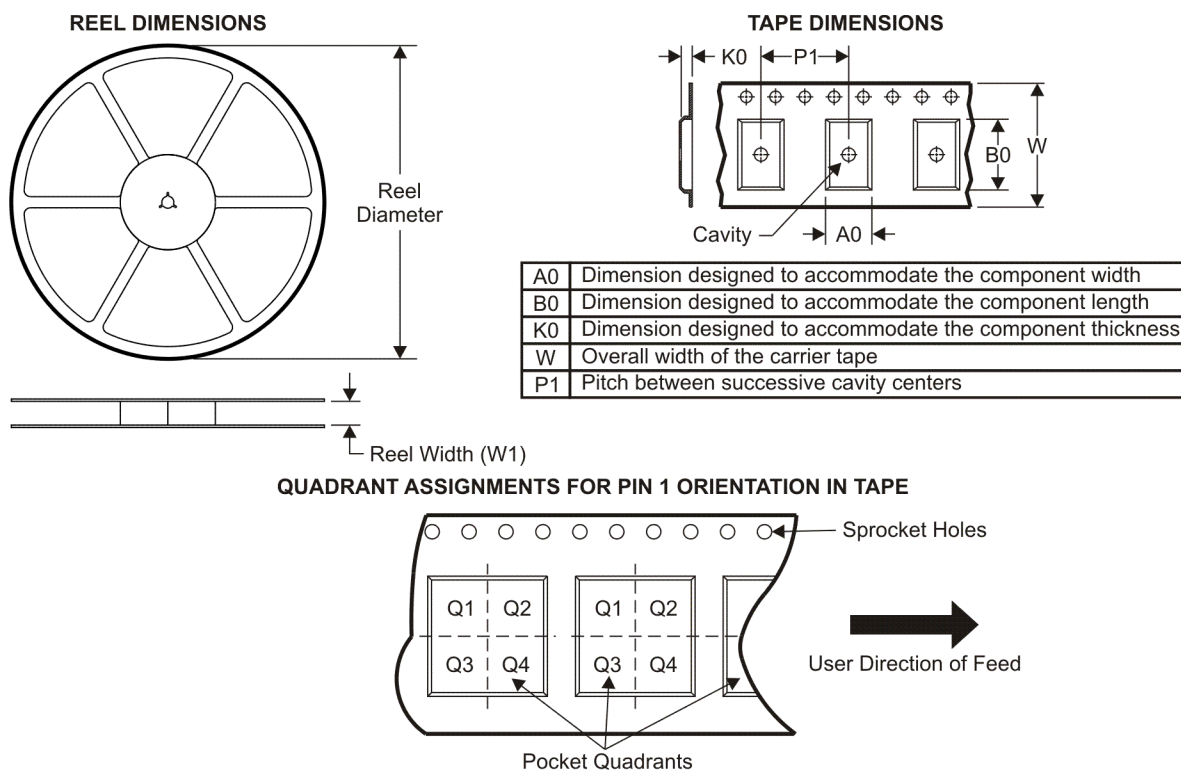
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**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)

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

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**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	346.0	346.0	41.0

J (R-GDIP-T\*\*)

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



PINS ** DIM	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:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. 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)

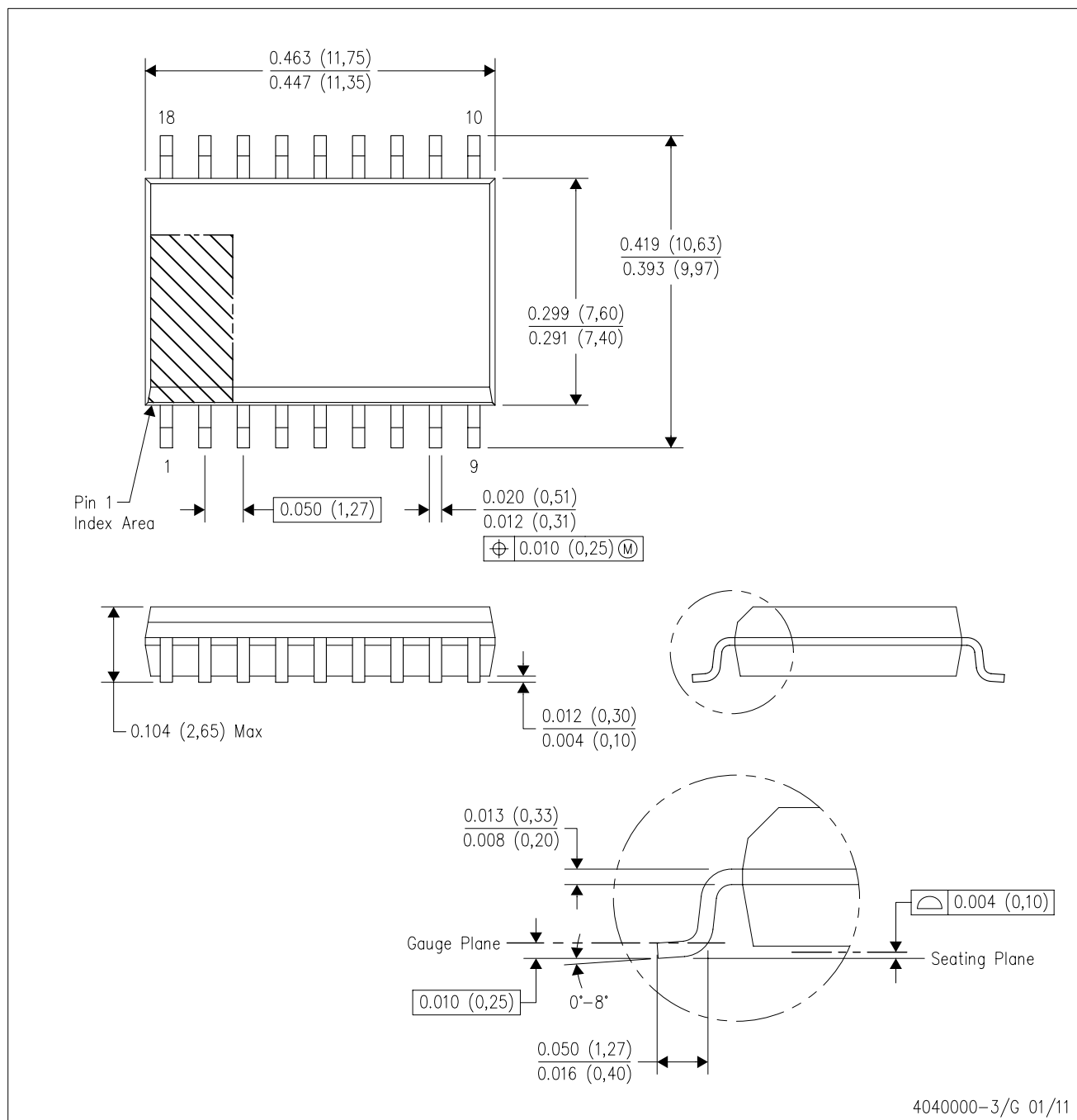


4040140/D 01/11

- 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)

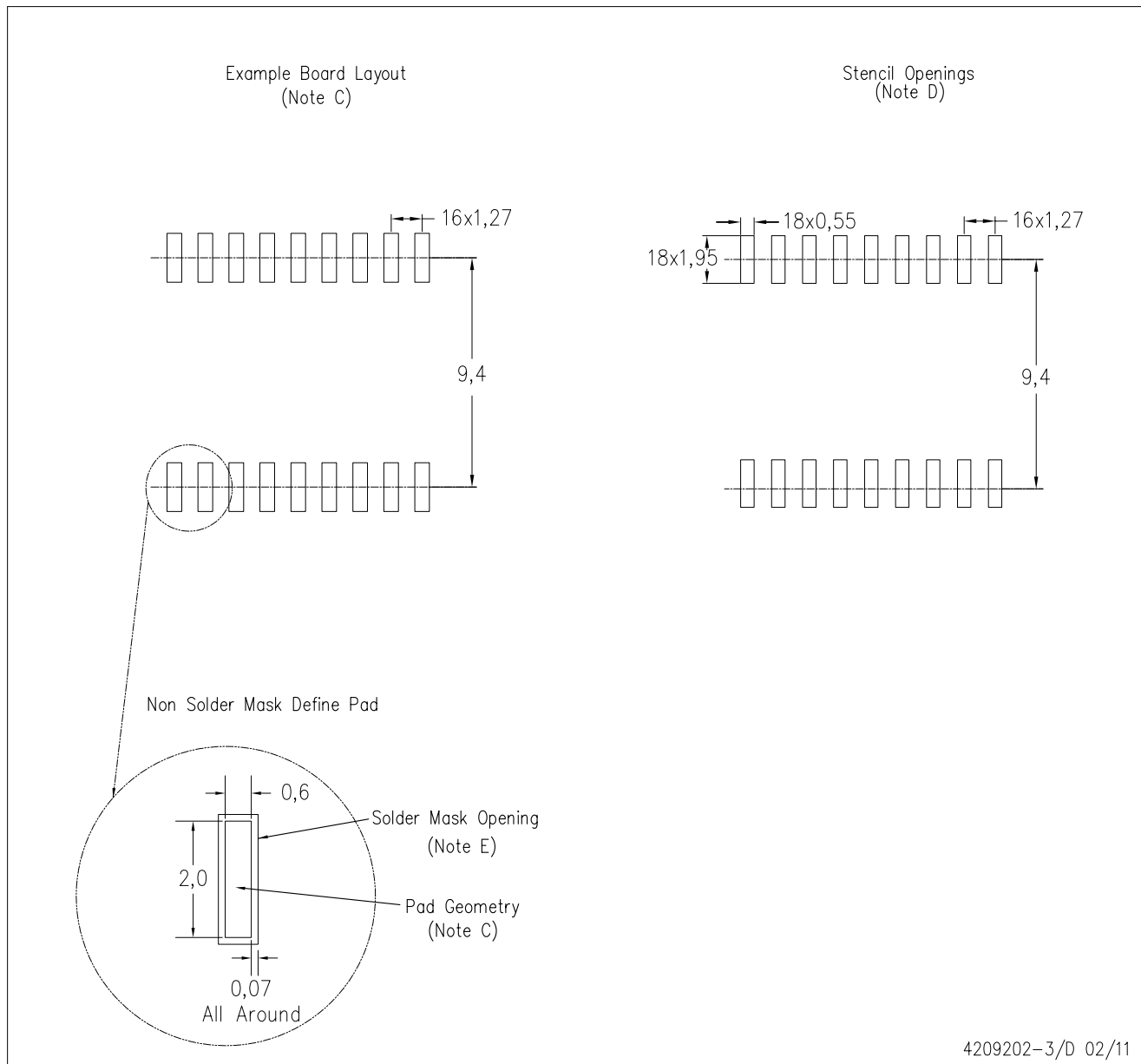
PLASTIC SMALL OUTLINE



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

DW (R-PDSO-G18)

PLASTIC SMALL OUTLINE

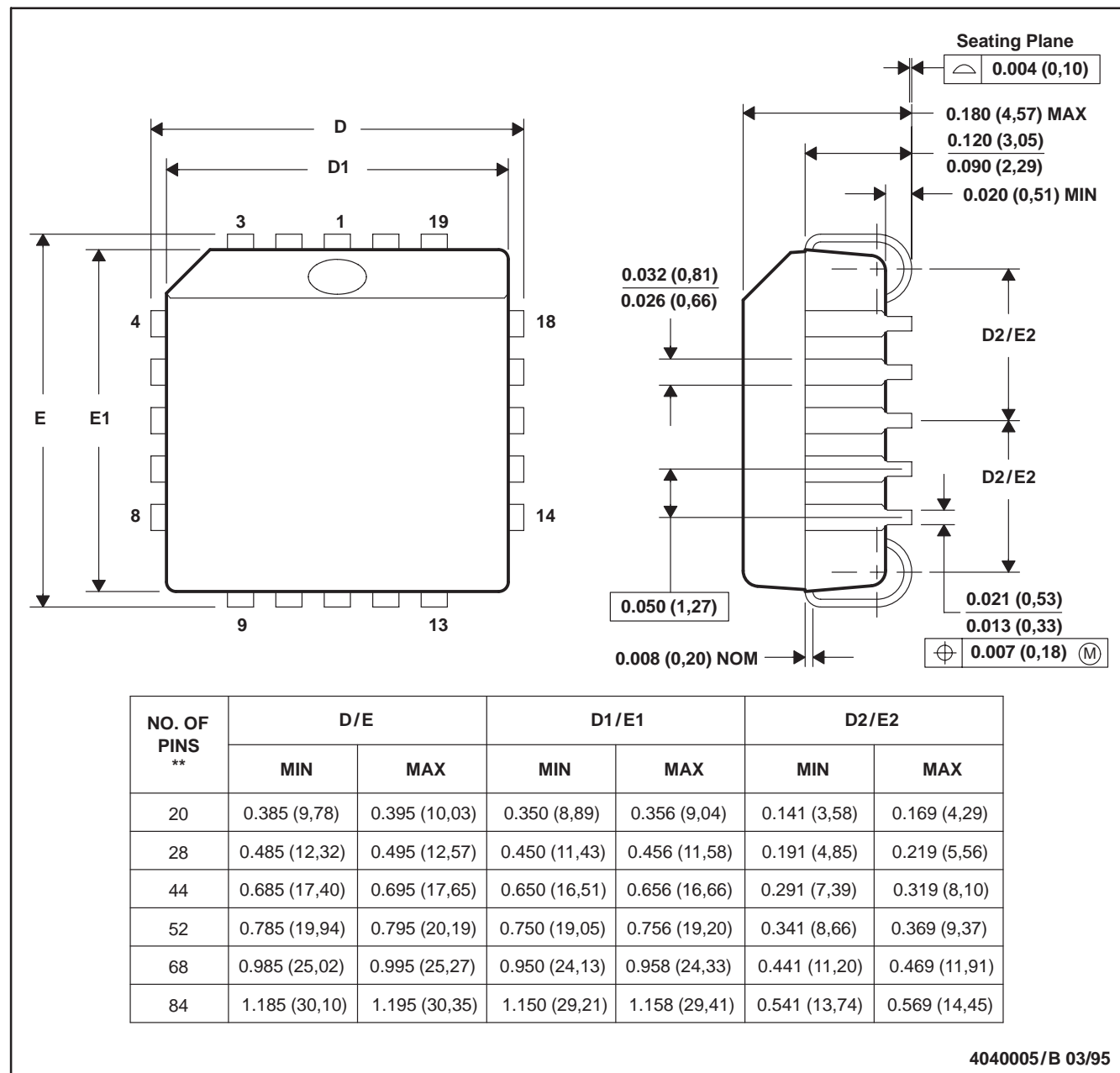


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Refer to IPC7351 for alternate board design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

FN (S-PQCC-J\*\*)

PLASTIC J-LEADED CHIP CARRIER

20 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-018

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