High Power Factor Preregulator

FEATURES

- Complete 8-pin Power Factor Solution
- Reduced External Components
- RMS Line Voltage Compensation
- Precision Multiplier/Squarer/Divider
- Internal 63kHz Synchronizable Oscillator
- Average Current Mode PWM Control
- Overvoltage Protection Comparator
- High Current, Clamped Gate Driver

DESCRIPTION

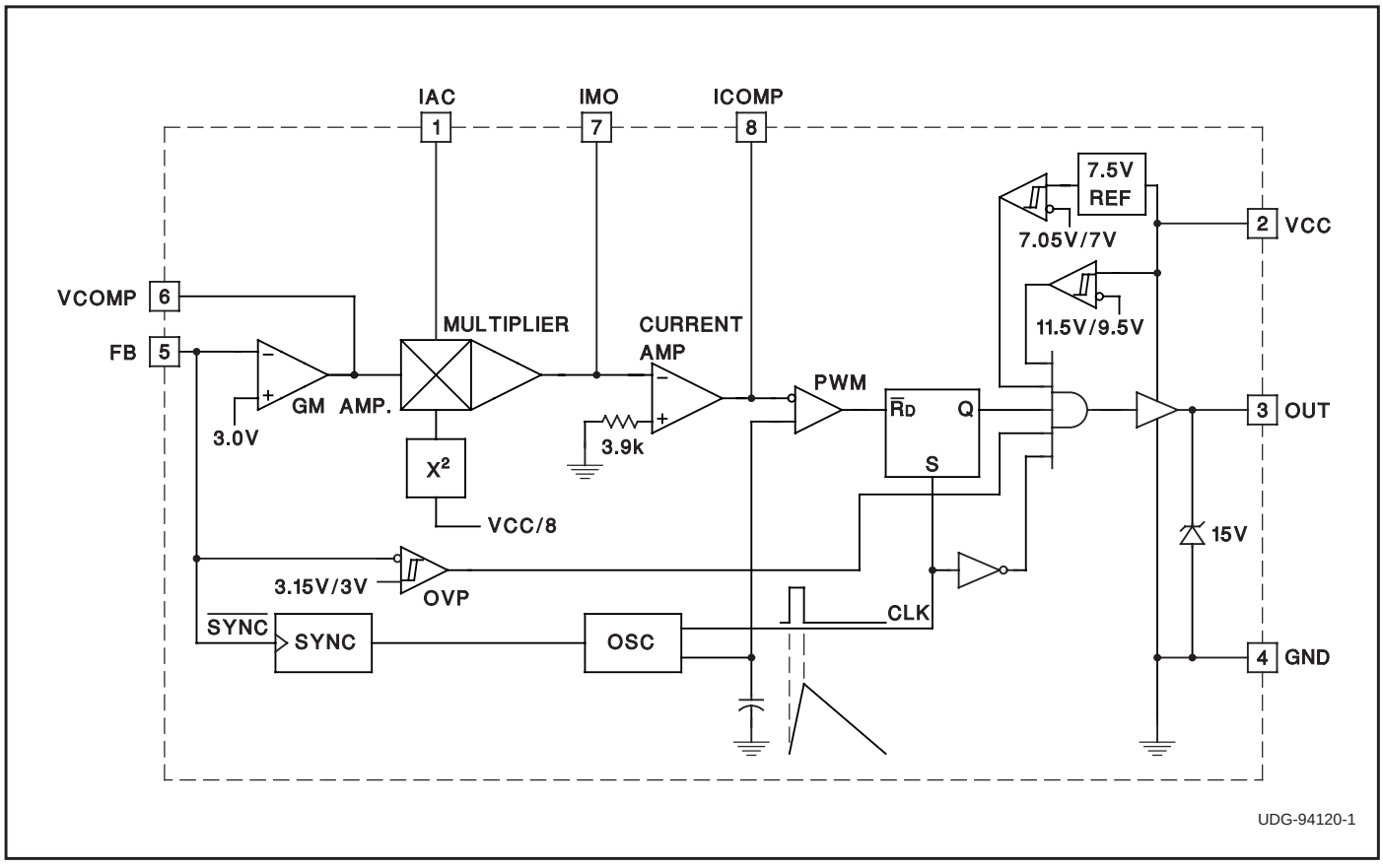
The UC2853A provides simple, yet high performance active power factor correction. Using the same control technique as the UC1854, this 8-pin device exploits a simplified architecture and an internal oscillator to minimize external component count. The UC2853A incorporates a precision multiplier/squarer/divider circuit, voltage and current loop error amplifiers, and a precision voltage reference to implement average current mode control with RMS line voltage compensation. This control technique maintains constant loop gain with changes in input voltage, which minimizes input line current distortion over the worldwide input voltage range.

The internal 63kHz oscillator includes an external clock input, allowing synchronization to downstream converters. Additionally, the device features an overvoltage protection comparator, a clamped MOSFET gate driver which self-biases low during undervoltage lockout, and low startup and supply current.

The UC2853A is identical to the UC2853 except the internal oscillator frequency has been reduced from 75kHz to 63kHz. The switching frequency is lowered in order to keep the second harmonic of the switching frequency below a 150kHz. For EMI specifications at 150kHz this makes it easier for a design to meet system requirements.

These devices are available in 8-pin PDIP (P) and SOIC (D) packages. The UC2853A is specified for operation from –40°C to 105°C.

BLOCK DIAGRAM

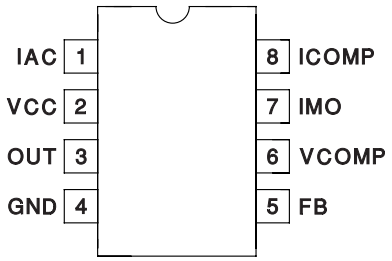


ABSOLUTE MAXIMUM RATINGS

Supply Voltage (VCC) 40V
Output Drive Current,
  Continuous 0.125A
  Peak 0.5A
Output Minimum Voltage . . . . . –0.3V
IAC Maximum Input Current 1mA
IMO Maximum Output Current . . . . . –2mA
IMO Minimum Voltage . . . . . –0.3V
FB Maximum Input Voltage 5V
VCOMP Maximum Voltage 6.2V
ICOMP Sourcing Current . . . . . Self-Limiting
ICOMP Sinking Current 20mA
ICOMP Maximum Voltage 7.2V
Storage Temperature . . . . . –65°C to +150°C
Junction Temperature . . . . . –55°C to +150°C
Lead Temperature (Soldering, 10 sec.) . . . . . +300°C
All voltages with respect to GND. Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.

CONNECTION DIAGRAM

PDIP-8, SOIC-8 (Top View)
P or D Package



ELECTRICAL CHARACTERISTICS

Unless otherwise stated, these parameters apply for T_A = –40°C to 105°C for the UC2853A; VCC = 16V, V_{FB} = 3V, I_{AC} = 100μA, V_{VCOMP} = 3.75V, V_{ICOMP} = 3V, T_A = T_J.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Undervoltage Lockout Section					
VCC Turn-on Threshold	V_{VCOMP}, V_{ICOMP} Open		11.5	13	V
Hysteresis		1.5	1.8	2.1	V
Supply Current Section					
I_{VCC} Startup	V_{CC} = 8V, IAC = 100μA; V_{VCOMP}, V_{ICOMP} Open		250	500	μA
I_{VCC}	IAC = 0μA, V_{ICOMP} = 0V		10	15	mA
Voltage Loop Error Amplifier Section					
Transconductance	IOUT = ± 20μA 0-70C	300	450	575	μmho
	Temperature	135		640	μmho
Input Voltage	0-70C	2.925	3	3.075	V
	Temperature	2.9		3.1	V
AVOL	V_{VCOMP} = 1V – 4V	50	60		dB
Output Sink Current	V_{FB} = 3.2V, V_{VCOMP} = 3.75V	20	50		μA
Output Source Current	V_{FB} = 2.8V, V_{VCOMP} = 3.75V		–50	–20	μA
Output Voltage High		5.5	6		V
Output Voltage Low			0.6	0.9	V
Current Loop Error Amplifier Section					
Offset Voltage		0		6	mV
Voltage Gain	V_{ICOMP} = 1V – 4V		70		dB
Sink Current	V_{IMO} = 100mV, V_{ICOMP} = 3V	1			mA
Source Current	V_{IMO} = –0.1V, V_{ICOMP} = 3V		–150	–80	μA
Output High	I_{ICOMP} = –50mA	6	6.8		V
Output Low	I_{ICOMP} = 50μA		0.3	0.8	V
PWM Modulator Gain	V_{ICOMP} = 2V – 3V (Note 1)		20		%/V

ELECTRICAL CHARACTERISTICS (continued)

Unless otherwise stated, these parameters apply for T_A = –40°C to 105°C for the UC2853A; VCC = 16V, V_{FB} = 3V, I_{AC} = 100µA, V_{VCOMP} = 3.75V, V_{ICOMP} = 3V, T_A = T_J.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Multiplier Section					
Output Current – IAC Limited	VCC = 11V, V_{VCOMP} = 6V	–230	–200	–170	µA
Output Current – Zero	IAC = 0µA	–2	–0.2	2	µA
Output Current – Power Limited	VCC = 12V, V_{VCOMP} = 5.5V	–236	–178	–168	µA
Output Current	VCC= 12V, V_{VCOMP} = 2V		–22		µA
	VCC= 12V, V_{VCOMP} = 5V		–156		µA
	VCC= 40V, V_{VCOMP} = 2V		–2		µA
	VCC= 40V, V_{VCOMP} = 5V		–14		µA
Multiplier Gain Constant	VCC= 12V, V_{VCOMP} = 5.5V (Note 2)	–1.05	–0.9	–0.75	V^{-1}
Oscillator Section					
Oscillator Initial Frequency	T_A = 25°C	56	63	70	kHz
Oscillator Frequency	Line, Load, Temperature	50	63	74	kHz
Synchronization Frequency Range				100	kHz
Synchronization Pulse Amplitude	Pulse slew rate = 100V/µsec (Note 3)		2		V
Output Driver Section					
Maximum Output Voltage	0mA load, VCC = 20V	12	15	17.5	V
Output High	0mA load, VCC = 12V, ref. to VCC	–2.7	–1.7		V
	–50mA load, VCC = 12V, ref. to VCC	–3	–2.2		V
Output Low (Device Inactive)	Vcc = 0V, 20mA load (Sinking)		0.9	2.0	V
Output Low (Device Active)	50mA load (Sinking)		0.5	1	V
OUT Rise Time	1nF from OUT to GND		55	100	ns
OUT Fall Time	1nF from OUT to GND		35	100	ns
OUT Maximum Duty Cycle	V_{ICOMP} = 0V	88	93		%
OVP Comparator Section					
Threshold Voltage	Volts Above EA Input V	90	150		mV
Hysteresis			80		mV

Note 1:

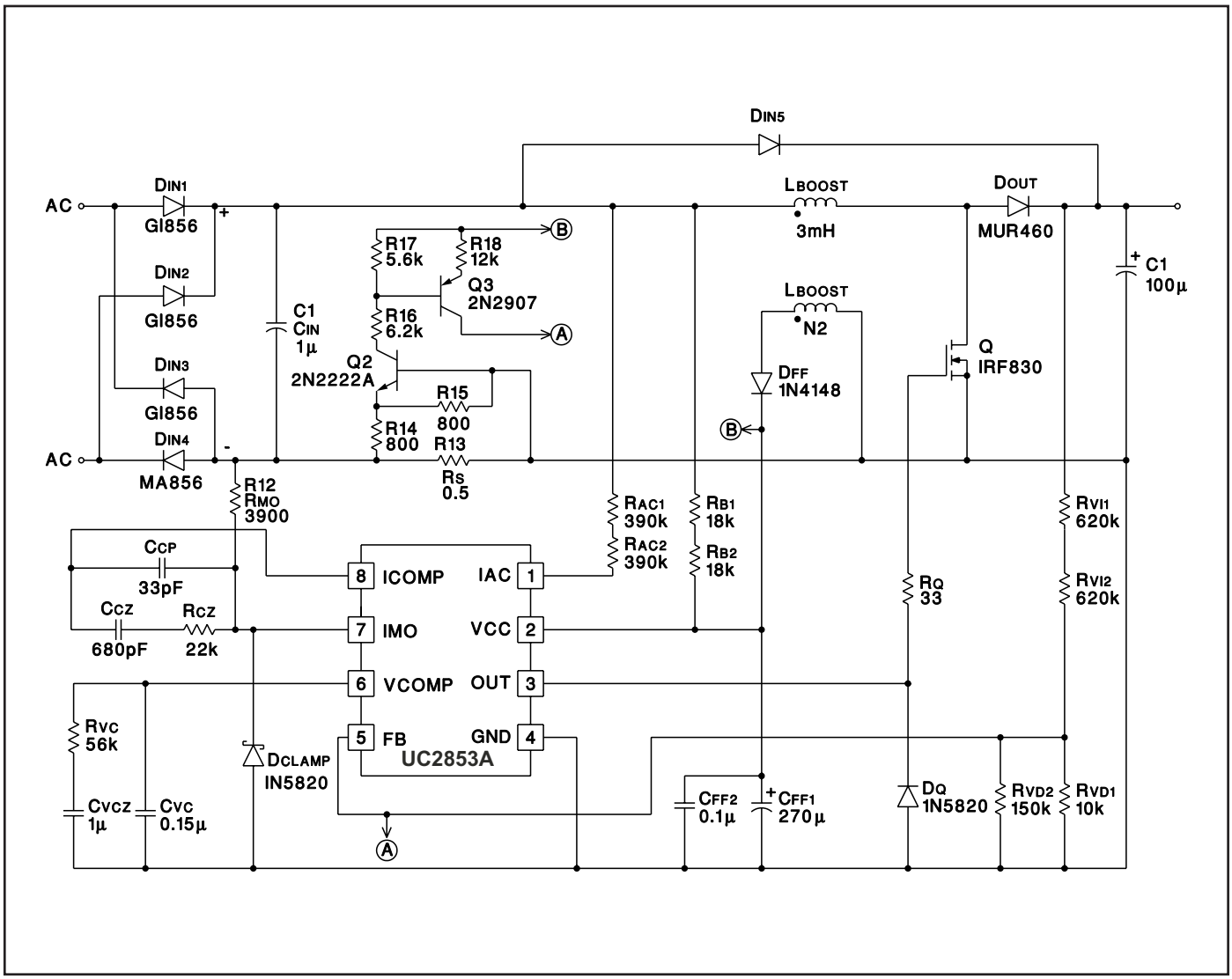
$$1 PWM\ modulator\ gain = \frac{\Delta DutyCycle}{\Delta V_{ICOMP}}$$

Note 2:

$$Gain\ constant\ (K) = \frac{IAC \bullet (VCOMP - 1.5V)}{IMO \bullet VCC \bullet \frac{VCC}{64}}$$, VCC = 12V.

Note 3.
Synchronization is accomplished with a falling edge of 2V magnitude and 100V/µsec slew rate.

UC2853A TYPICAL APPLICATION



Note: the application circuit shown is a 100W, 63KHz design. Additional application information can be found in Application Note U–159 (TI literature Number SLUA080) and Design Note DN–78.

PIN DESCRIPTIONS

FB: Voltage Amplifier Inverting Input, Overvoltage Comparator Input, Sync Input. This pin serves three functions. FB accepts a fraction of the power factor corrected output voltage through a voltage divider, and is nominally regulated to 3V. FB voltages 5% greater than nominal will trip the overvoltage comparator, and shut down the output stage until the output voltage drops 5%. The internal oscillator can be synchronized through FB by injecting a 2V clock signal though a capacitor. To prevent false tripping of the overvoltage comparator, the clock signal must have a fast falling edge, but a slow rising edge. See Application Note U-159 for more information.

GND: Ground. All voltages are measured with respect to GND. The VCC bypass capacitor should be connected to ground as close to the GND pin as possible.

IAC: AC Waveform Input. This input provides voltage waveform information to the multiplier. The current loop will try to produce a current waveform with the same shape as the IAC signal. IAC is a low impedance input, nominally at 2V, which accepts a current proportional to the input voltage. Connect a resistor from the rectified input line to IAC which will conduct 500μA at maximum line voltage.

IMO: Multiplier Output and Current Sense Inverting Input. The output of the multiplier and the inverting input of the current amplifier are connected together at IMO. Avoid bringing this input below –0.5V to prevent the internal protection diode from conducting. The multiplier output is a current, making this a summing node and allowing a differential current error amplifier configuration to reject ground noise. The input resistance at this node should be 3.9k to minimize input bias current induced offset voltage. See the Applications section for the recommended circuit configuration.

OUT: Gate Driver Output. OUT provides high current gate drive for the external power MOSFET. A 15V clamp prevents excessive MOSFET gate-to-source voltage so that the UC2853A can be operated with VCC and high as 40V. A series gate resistor of at least 5 ohms should be used to minimize clamp voltage overshoot. In addition, a Schottky diode such as a 1N5818 connected between OUT and GND may be necessary to prevent parasitic substrate diode conduction.

ICOMP: Current Loop Error Amplifier Output. The current loop error amplifier is a conventional operational amplifier with a 150μA current source class A output stage. Compensate the current loop by placing an impedance between ICOMP and IMO. This output can swing above the oscillator peak voltage, allowing zero duty cycle when necessary.

VCC: Input Supply Voltage. This pin serves two functions. It supplies power to the chip, and an input voltage level signal to the squarer circuit. When this input is connected to a DC voltage proportional to the AC input RMS voltage, the voltage loop gain is reduced by

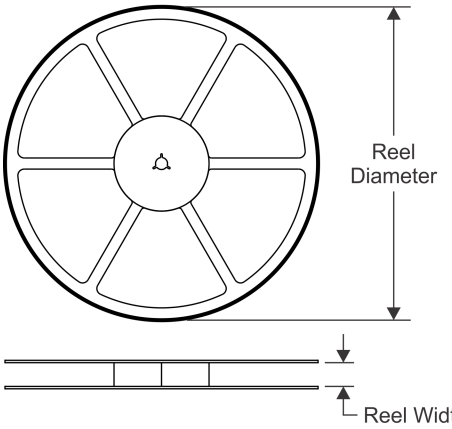
$$\frac{64}{V_{CC}{}^2}.$$

This configuration maintains constant loop gain. The UC2853A input voltage range extends from 12V to 40V, allowing an AC supply voltage range in excess of 85VAC to 265VAC. Bypass VCC with at least a 0.1μF ceramic capacitor to ensure proper operation. See the Applications section for the recommended circuit configuration.

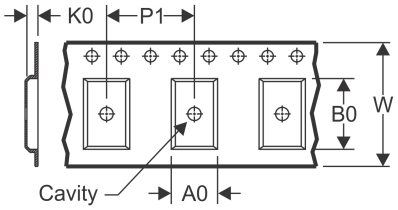
VCOMP: Voltage Loop Error Amplifier Output. The voltage loop error amplifier is a transconductance type operational amplifier. A feedback impedance between VCOMP and FB for loop compensation must be avoided to maintain proper operation of the overvoltage protection comparator. Instead, compensate the voltage loop with an impedance between VCOMP and GND. When VCOMP is below 1.5V, the multiplier output current is zero.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

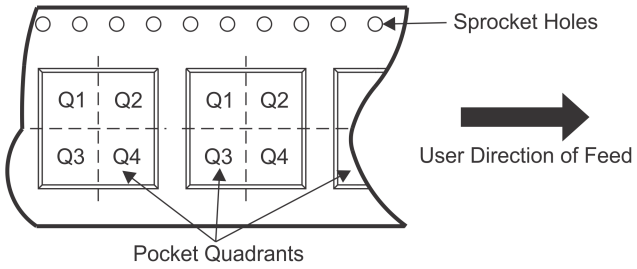


TAPE DIMENSIONS



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

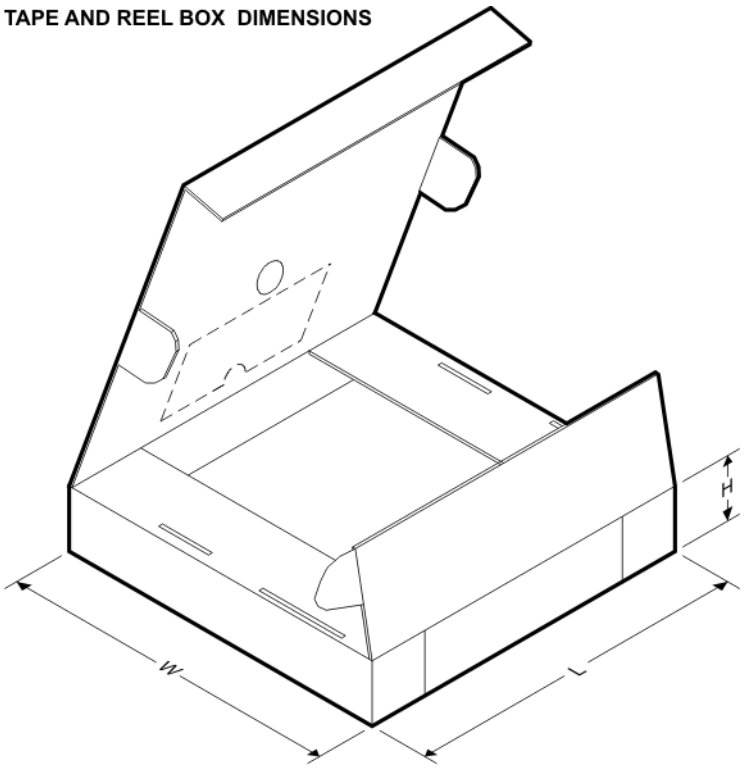
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
UC2853ADTR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

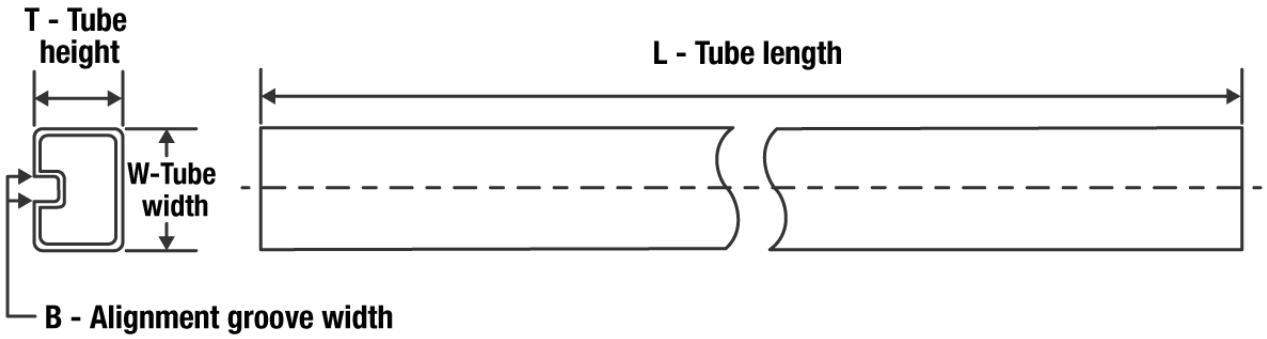
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

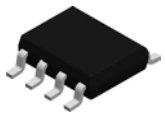
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UC2853ADTR	SOIC	D	8	2500	853.0	449.0	35.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
UC2853AD	D	SOIC	8	75	506.6	8	3940	4.32

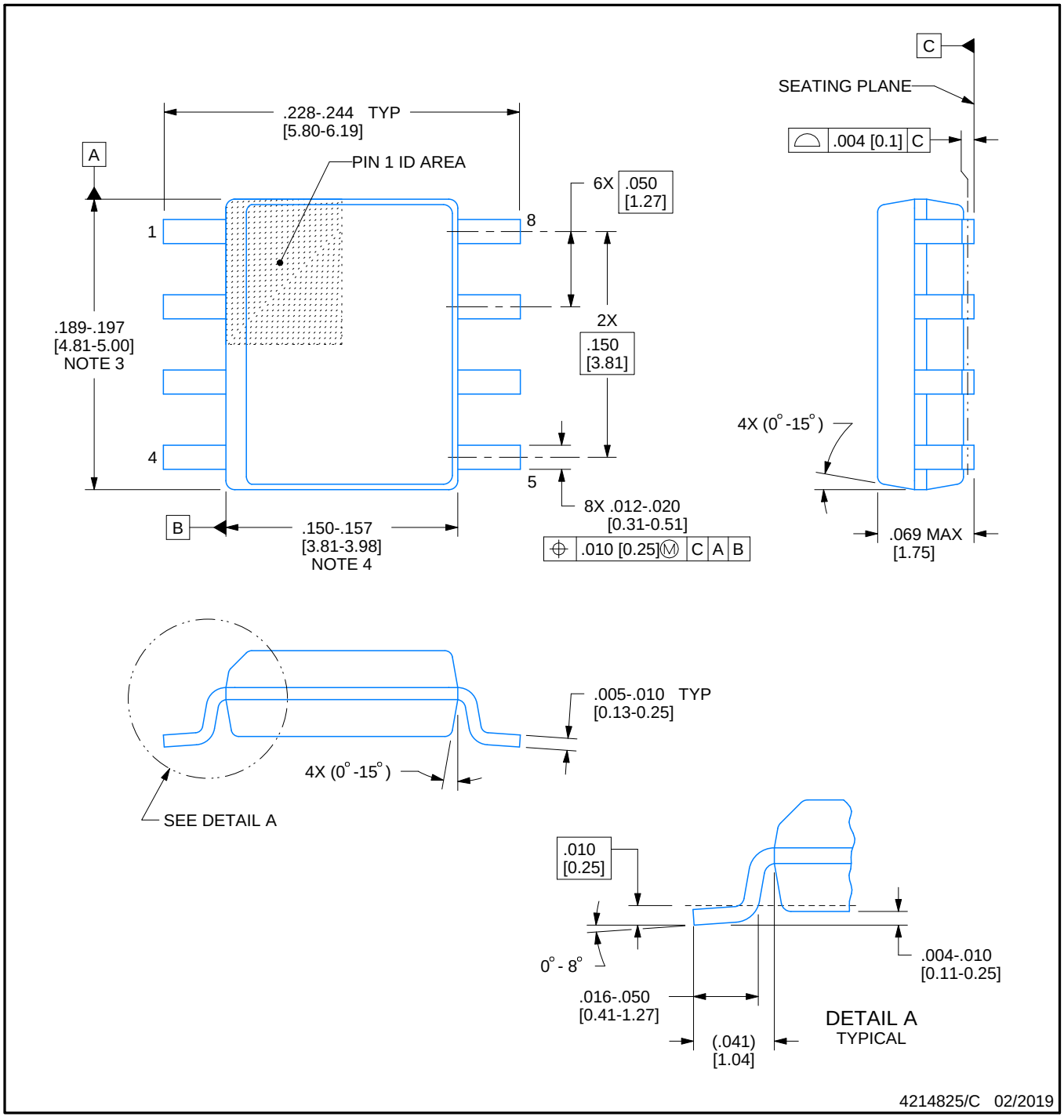


PACKAGE OUTLINE

D0008A

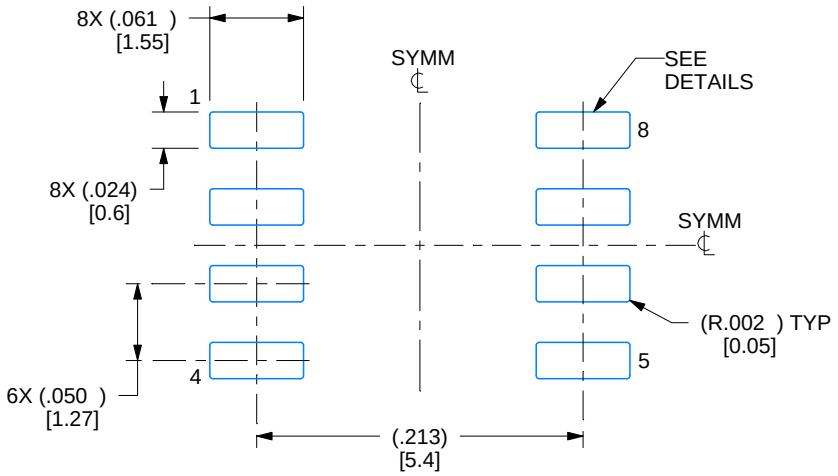
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

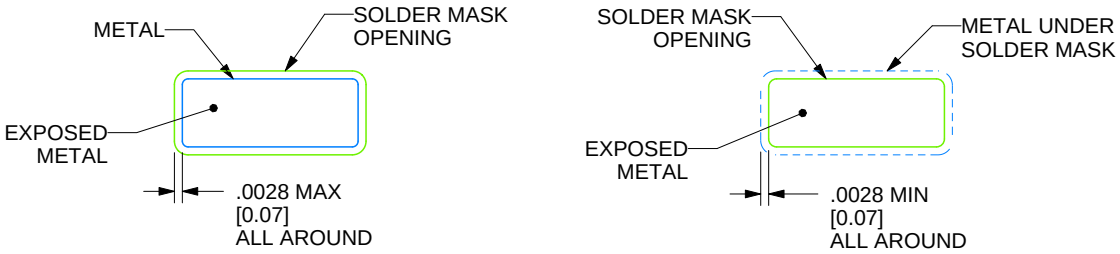


NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. 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 .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

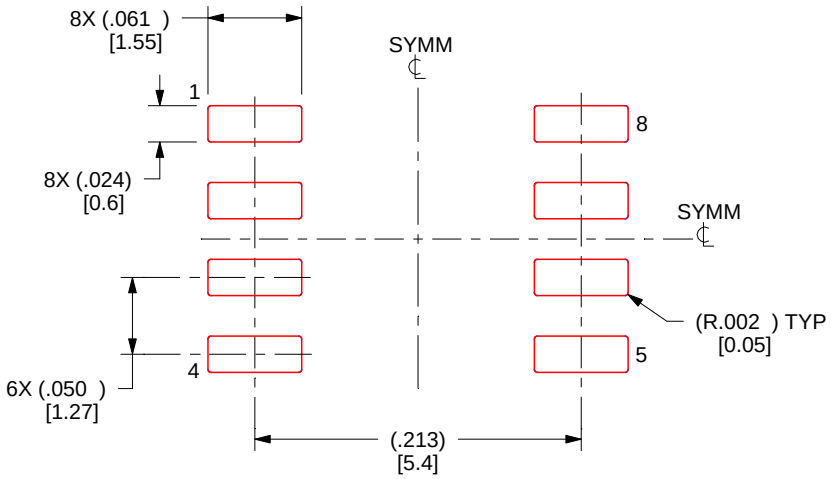
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

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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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