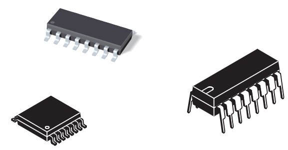


SLUS579 − OCTOBER, 2003

PROGRAMMABLE OUTPUT POWER FACTOR PREREGULATOR

FEATURES

- **Controls Boost Preregulator to Near-Unity Power Factor**
- **World Wide Line Operation**
- **Over-Voltage Protection**
- **Accurate Power Limiting**
- **Average Current Mode Control**
- **Improved Noise Immunity**
- **Improved Feed-Forward Line Regulation**
- **Leading Edge Modulation**
- **150-μA Typical Start-Up Current**
- **Low-Power BiCMOS Operation**
- **10.8-V to 17-V Operation**
- **Programmable Output Voltage (Tracking Boost Topology)**

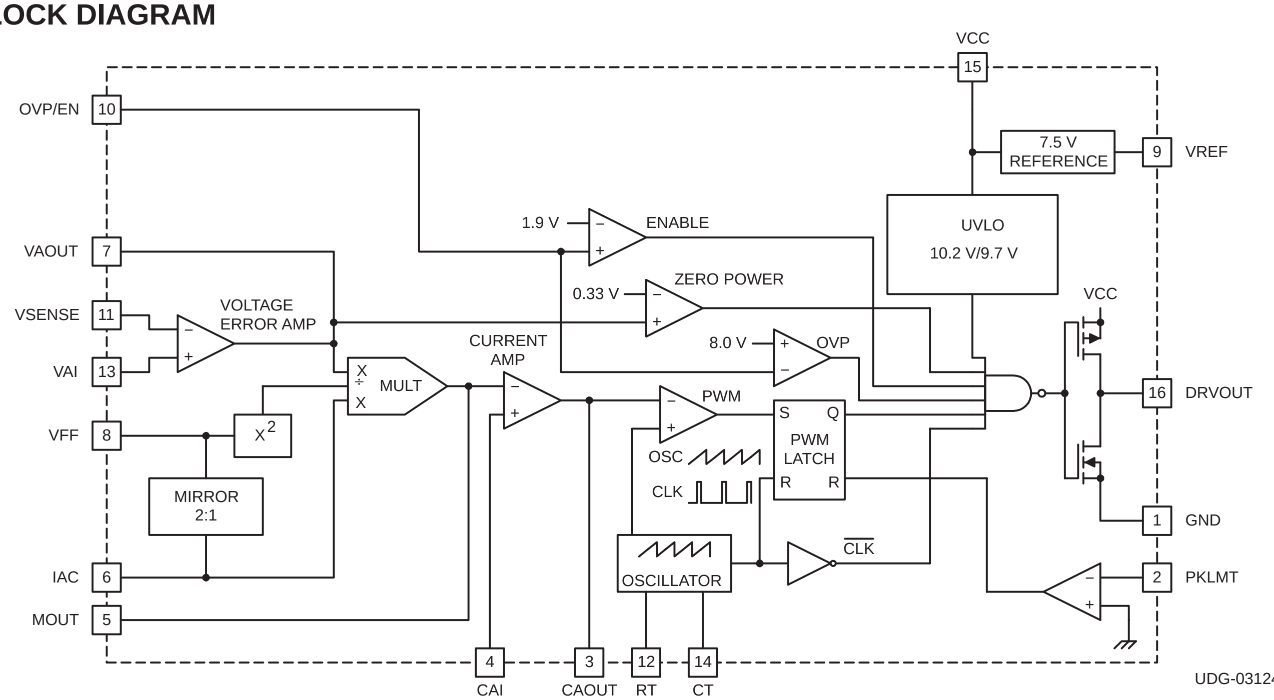
DESCRIPTION

The UCC2819A/UCC3819A provides all the functions necessary for active power factor corrected preregulators. The controller achieves near unity power factor by shaping the ac-input line current waveform to correspond to that of the ac-input line voltage. Average current mode control maintains stable, low distortion sinusoidal line current.

Designed in Texas Instrument's BiCMOS process, the UCC3819A offers new features such as lower start-up current, lower power dissipation, overvoltage protection, a shunt UVLO detect circuitry and a leading-edge modulation technique to reduce ripple current in the bulk capacitor.

The UCC3819A allows the output voltage to be programmed by bringing out the error amplifier noninverting input.

BLOCK DIAGRAM



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.

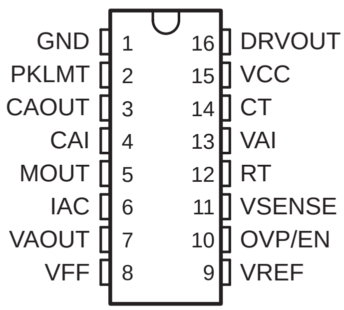
DESCRIPTION (CONTINUED)

The UCC3819A is directly pin for pin compatible with the UCC3819. Only the output stage of UCC3819A has been modified to allow use of a smaller external gate drive resistor values. For some power supply designs where an adequately high enough gate drive resistor can not be used, the UCC3819A offers a more robust output stage at the cost of increasing the internal gate resistances. The gate drive of the UCC3819A remains strong at ±1.2 A of peak current capability.

Available in the 16-pin D, N, and PW packages.

PIN CONNECTION DIAGRAM

D, N, AND PW PACKAGES
(TOP VIEW)



AVAILABLE OPTIONS TABLE

$T_A = T_J$	PACKAGE DEVICES		
	SOIC (D) PACKAGE(1)	PDIP (N) PACKAGE	TSSOP (PW) PACKAGE(1)
0°C to 70°C	UCC3819AD	UCC3819AN	UCC3819APW
−40°C to 85°C	UCC2819AD	UCC2819AN	UCC2819APW

NOTES: (1) The D and PW packages are available taped and reeled. Add R suffix to the device type (e.g. UCC3819ADR) to order quantities of 2,500 devices per reel (D package) and 2,000 devices per reel (for PW package). Bulk quantities are 40 units (D package) and 90 units (PW package) per tube.

THERMAL RESISTANCE TABLE

PACKAGE	θjc(°C/W)	θja(°C/W)
SOIC−16 (D)	22	40 to 70 (1)
PDIP−16 (N)	12	25 to 50 (1)
TSSOP−16 (PW)	14 (2)	123 to 147 (2)

NOTES: (1) Specified θja (junction to ambient) is for devices mounted to 5-inch^2 FR4 PC board with one ounce copper where noted. When resistance range is given, lower values are for 5 inch^2 aluminum PC board. Test PWB was 0.062 inch thick and typically used 0.635-mm trace widths for power packages and 1.3-mm trace widths for non-power packages with a 100-mil x 100-mil probe land area at the end of each trace.

(2) Modeled data. If value range given for θja, lower value is for 3x3 inch. 1 oz internal copper ground plane, higher value is for 1x1-inch. ground plane. All model data assumes only one trace for each non-fused lead.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature (unless otherwise noted)†

	UCCx81xA	UNIT
Supply voltage VCC	18	V
Gate drive current, continuous	0.2	A
Gate drive current	1.2	
Input voltage, CAI, MOUT, SS	8	V
Input voltage, PKLMT	5	
Input voltage, VSENSE, OVP/EN, VAI	10	
Input current, RT, IAC, PKLMT	10	mA
Maximum negative voltage, DRVOUT, PKLMT, MOUT	−0.5	V
Power dissipation	1	W
Junction temperature, T_J	−55 to 150	°C
Storage temperature, T_{stg}	−65 to 150	
Lead temperature, T_{sol} (soldering, 10 seconds)	300	

† 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.

ELECTRICAL CHARACTERISTICS

T_A = 0°C to 70°C for the UCC3819A, −40°C to 85°C for the UCC2819A, VCC = 12 V, R_T = 22 kΩ, C_T = 270 pF, (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current					
Supply current, off	VCC = (VCC turnon threshold −0.3 V)		150	300	µA
Supply current, on	VCC = 12 V, No load on DRVOUT	2	4	6	mA
UVLO					
VCC turnon threshold		9.7	10.2	10.8	V
VCC turnoff threshold		9.4	9.7		
UVLO hysteresis		0.3	0.5		
Voltage Amplifier					
VIO	VAOUT = 2.75 V, VCM = 3.75 V	−15		15	mV
VAI bias current	VAOUT = 2.75 V, VCM = 3.75 V		50	200	nA
V_{SENSE} bias current	VSENSE = VREF, VAOUT = 2.5 V		50	200	
CMRR	VCM = 1 V to 7.5 V	50	70		dB
Open loop gain	VAOUT = 2 V to 5 V	50	90		
High-level output voltage	I_L = −150 µA	5.3	5.5	5.6	V
Low-level output voltage	I_L = 150 µA	0	50	150	mV

NOTES: 1. Ensured by design, Not production tested.
2. Reference variation for V_{CC} < 10.8 V is shown in Figure 2.

ELECTRICAL CHARACTERISTICS

T_A = 0°C to 70°C for the UCC3819A, −40°C to 85°C for the UCC2819A, VCC = 12 V, R_T = 22 kΩ, C_T = 270 pF, (unless otherwise noted)

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNITS
Over Voltage Protection and Enable						
Over voltage reference			VREF +0.48	VREF +0.50	VREF +0.52	V
Hysteresis			300	500	600	mV
Enable threshold			1.7	1.9	2.1	V
Enable hysteresis			0.1	0.2	0.3	
Current Amplifier						
Input offset voltage	V_{CM} = 0 V,	V_{CAOUT} = 3 V	−3.5	0	2.5	mV
Input bias current	V_{CM} = 0 V,	V_{CAOUT} = 3 V		−50	−100	nA
Input offset current	V_{CM} = 0 V,	V_{CAOUT} = 3 V		25	100	
Open loop gain	V_{CM} = 0 V,	V_{CAOUT} = 2 V to 5 V	90			dB
Common-mode rejection ratio	V_{CM} = 0 V to 1.5 V,	V_{CAOUT} = 3 V	60	80		
High-level output voltage	I_L = −120 μA		5.6	6.5	6.8	V
Low-level output voltage	I_L = 1 mA		0.1	0.2	0.5	
Gain bandwidth product	See Note 1			2.5		MHz
Voltage Reference						
Input voltage, (UCC3819A)	T_A = 0°C to 70°C		7.387	7.5	7.613	V
Input voltage, (UCC2819A)	T_A = −40°C to 85°C		7.369	7.5	7.631	
Load regulation	I_{REF} = 1 mA to 2 mA		0		10	mV
Line regulation	VCC = 10.8 V to 15 V,	See Note 2	0		10	
Short-circuit current	V_{REF} = 0 V		−20	−25	−50	mA
Oscillator						
Initial accuracy	T_A = 25°C		85	100	115	kHz
Voltage stability	VCC = 10.8 V to 15 V		−1%		1%	
Total variation	Line, temp,	See Note 1	80		120	kHz
Ramp peak voltage			4.5	5	5.5	V
Ramp amplitude voltage (peak to peak)			3.5	4	4.5	
Peak Current Limit						
PKLMT reference voltage			−15		15	mV
PKLMT propagation delay			150	350	500	ns

NOTES: (1) Ensured by design, Not production tested.
(2) Reference variation for V_{CC} < 10.8 V is shown in Figure 2.

ELECTRICAL CHARACTERISTICS

T_A = 0°C to 70°C for the UCC3819A, −40°C to 85°C for the UCC2819A, VCC = 12 V, R_T = 22 kΩ, C_T = 270 pF, (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Multiplier					
I_{MOUT}, high line, low power output current, (0°C to 85°C)	I_{AC} = 500 µA, V_{FF} = 4.7 V, VAOUT = 1.25 V	0	−6	−20	µA
I_{MOUT}, high line, low power output current, (−40°C to 85°C)	I_{AC} = 500 µA, V_{FF} = 4.7 V, VAOUT = 1.25 V	0		−23	µA
I_{MOUT}, high line, high power output current	I_{AC} = 500 µA, V_{FF} = 4.7 V, VAOUT = 5 V	−70	−90	−105	µA
I_{MOUT}, low line, low power output current	I_{AC} = 150 µA, V_{FF} = 1.4 V, VAOUT = 1.25 V	−10	−19	−50	µA
I_{MOUT}, low line, high power output current	I_{AC} = 150 µA, V_{FF} = 1.4 V, VAOUT = 5 V	−268	−300	−346	µA
I_{MOUT}, IAC limited	I_{AC} = 150 µA, V_{FF} = 1.3 V, VAOUT = 5 V	−250	−300	−400	µA
Gain constant (K)	I_{AC} = 300 µA, V_{FF} = 3 V, VAOUT = 2.5 V	0.5	1	1.5	1/V
I_{MOUT}, zero current	I_{AC} = 150 µA, V_{FF} = 1.4 V, VAOUT = 0.25 V		0	−2	µA
I_{MOUT}, zero current	I_{AC} = 500 µA, V_{FF} = 4.7 V, VAOUT = 0.25 V		0	−2	µA
I_{MOUT}, zero current, (0°C to 85°C)	I_{AC} = 500 µA, V_{FF} = 4.7 V, VAOUT = 0.5 V		0	−3	µA
I_{MOUT}, zero current, (−40°C to 85°C)	I_{AC} = 500 µA, V_{FF} = 4.7 V, VAOUT = 0.5 V		0	−3.5	µA
Power limit (I_{MOUT} x V_{FF})	I_{AC} = 150 µA, V_{FF} = 1.4 V, VAOUT = 5 V	−375	−420	−485	µW
Feed-Forward					
VFF output current	I_{AC} = 300 µA	−140	−150	−160	µA
Gate Driver					
Pullup resistance	I_O = –100 mA to −200 mA		9	12	Ω
Pulldown resistance	I_O = 100 mA		4	10	Ω
Output rise time	C_L = 1 nF, R_L = 10 Ω, V_{DRVOUT} = 0.7 V to 9 V		25	50	ns
Output fall time	C_L = 1 nF, R_L = 10 Ω, V_{DRVOUT} = 9 V to 0.7 V		10	50	ns
Maximum duty cycle		93%	95%	100%	
Minimum controlled duty cycle	At 100 kHz			2%	
Zero Power					
Zero power comparator threshold	Measured on VAOUT	0.20	0.33	0.50	V

NOTES: (1) Ensured by design, Not production tested.
(2) Reference variation for V_{CC} < 10.8 V is shown in Figure 2.

PIN ASSIGNMENTS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
CAI	4	I	Current amplifier noninverting input
CAOUT	3	O	Current amplifier output
CT	14	I	Oscillator timing capacitor
DRVOUT	16	O	Gate drive
GND	1	−	Ground
IAC	6	I	Current proportional to input voltage
MOUT	5	I/O	Multiplier output and current amplifier inverting input
OVP/EN	10	I	Over-voltage/enable
PKLMT	2	I	PFC peak current limit
RT	12	I	Oscillator charging current
VAI	13	I	Voltage amplifier non-inverting input
VAOUT	7	O	Voltage amplifier output
VCC	15	I	Positive supply voltage
VFF	8	I	Feed-forward voltage
VSENSE	11	I	Voltage amplifier inverting input
VREF	9	O	Voltage reference output

Pin Descriptions

CAI: Place a resistor between this pin and the GND side of current-sense resistor. This input and the inverting input (MOUT) remain functional down to and below GND.

CAOUT: This is the output of a wide bandwidth operational amplifier that senses line current and commands the PFC pulse-width modulator (PWM) to force the correct duty cycle. Compensation components are placed between CAOUT and MOUT.

CT: A capacitor from CT to GND sets the PWM oscillator frequency according to:

$$f \approx \left(\frac{0.6}{RT \times CT}\right)$$

The lead from the oscillator timing capacitor to GND should be as short and direct as possible.

DRVOUT: The output drive for the boost switch is a totem-pole MOSFET gate driver on DRVOUT. To avoid the excessive overshoot of the DRVOUT while driving a capacitive load, a series gate current-limiting/damping resistor is recommended to prevent interaction between the gate impedance and the output driver. The value of the series gate resistor is based on the pulldown resistance ($R_{pulldown}$ which is 4-Ω typical), the maximum VCC voltage (VCC), and the required maximum gate drive current (Imax). Using the equation below, a series gate resistance of resistance 11 Ω would be required for a maximum VCC voltage of 18 V and for 1.2 A of maximum sink current. The source current will be limited to approximately 900 mA (based on the R_{pullup} of 9-Ω typical).

$$R_{GATE} = \frac{VCC - \left(I_{MAX} \times R_{pulldown}\right)}{I_{MAX}}$$

GND: All voltages measured with respect to ground. VCC and REF should be bypassed directly to GND with a 0.1-µF or larger ceramic capacitor.

Pin Descriptions (continued)

IAC: This input to the analog multiplier is a current proportional to instantaneous line voltage. The multiplier is tailored for very low distortion from this current input (I_{IAC}) to multiplier output. The recommended maximum I_{IAC} is 500 µA.

MOUT: The output of the analog multiplier and the inverting input of the current amplifier are connected together at MOUT. As the multiplier output is a current, this is a high-impedance input so the amplifier can be configured as a differential amplifier. This configuration improves noise immunity and allows for the leading-edge modulation operation. The multiplier output current is limited to $\left(2 \times I_{IAC}\right)$. The multiplier output current is given by the equation:

$$I_{MOUT} = \frac{I_{IAC} \times (V_{VAOUT} - 1)}{{V_{VFF}}^2 \times K}$$

where $K = \frac{1}{V}$ is the multiplier gain constant.

OVP/EN: A window comparator input that disables the output driver if the boost output voltage is a programmed level above the nominal or disables both the PFC output driver and resets SS if pulled below 1.9 V (typ).

PKLMT: The threshold for peak limit is 0 V. Use a resistor divider from the negative side of the current sense resistor to VREF to level shift this signal to a voltage level defined by the value of the sense resistor and the peak current limit. Peak current limit is reached when PKLMT voltage falls below 0 V.

RT: A resistor from RT to GND is used to program oscillator charging current. A resistor between 10 kΩ and 100 kΩ is recommended. Nominal voltage on this pin is 3 V.

VAI: This input can be tied to the VREF or any other voltage reference (≤7.5 V) to set the boost regulator output voltage.

VAOUT: This is the output of the operational amplifier that regulates output voltage. The voltage amplifier output is internally limited to approximately 5.5 V to prevent overshoot.

VCC: Connect to a stable source of at least 20 mA between 10 V and 17 V for normal operation. Bypass VCC directly to GND to absorb supply current spikes required to charge external MOSFET gate capacitances. To prevent inadequate gate drive signals, the output devices are inhibited unless V_{VCC} exceeds the upper under-voltage lockout voltage threshold and remains above the lower threshold.

VFF: The RMS voltage signal generated at this pin by mirroring 1/2 of the I_{IAC} into a single pole external filter. At low line, the VFF roll should be 14 V.

VSENSE: This is normally connected to a compensation network and to the boost converter output through a divider network.

VREF: VREF is the output of an accurate 7.5-V voltage reference. This output is capable of delivering 20 mA to peripheral circuitry and is internally short-circuit current limited. VREF is disabled and remains at 0 V when V_{VCC} is below the UVLO threshold. Bypass VREF to GND with a 0.1-µF or larger ceramic capacitor for best stability. Please refer to Figures 8 and 9 for VREF line and load regulation characteristics.

APPLICATION INFORMATION

The UCC3819A is based on the UCC3818 PFC preregulator. For a more detailed application information for this part, please refer to the UCC3818 datasheet product folder.

The main difference between the UCC3818 and the UCC3819A is that the non-inverting input of the voltage error amplifier is made available to the user through an external pin (VAI) in the UCC3819A. The SS pin and function were eliminated to accommodate this change.

The benefit of VAI pin is that it can be used to dynamically change the PFC output voltage based on the line voltage (RMS) level or other conditions. Figure 1 shows one suggested implementation of the tracking boost PFC converter as this approach is sometimes referred to. The VAI pin is tied to the VFF pin and hence output voltage scales up with the line voltage. The benefit of this approach is that at lower line voltages the output voltage is lower and that leads to smaller boost inductor value, lower MOSFET conduction losses and reduced component stresses. In order for this feature to work, the downstream converter has to operate over a wider input range.

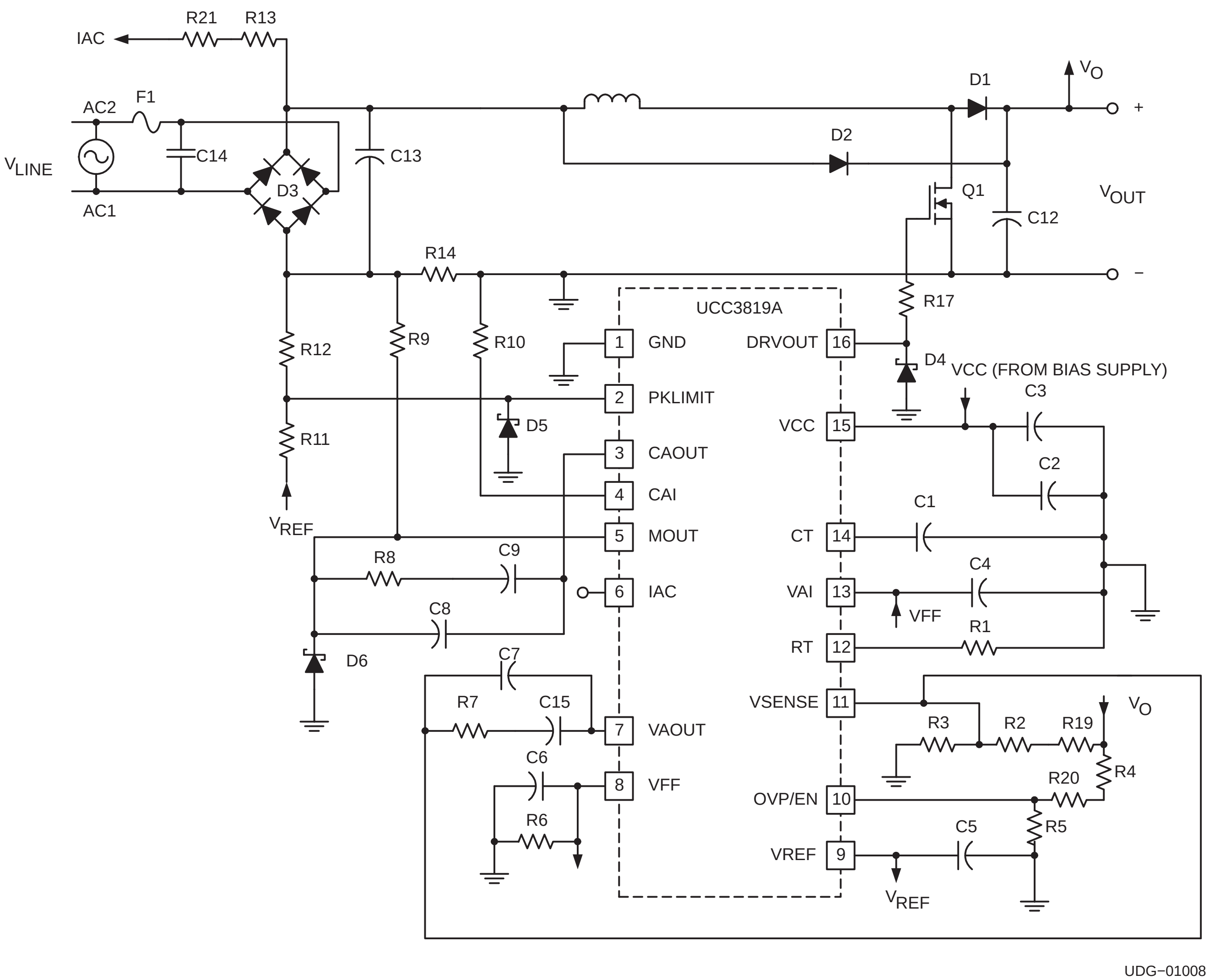


Figure 1. Suggested Implementation of UCC3819A in a Tracking Boost PFC Preregulator

APPLICATION INFORMATION

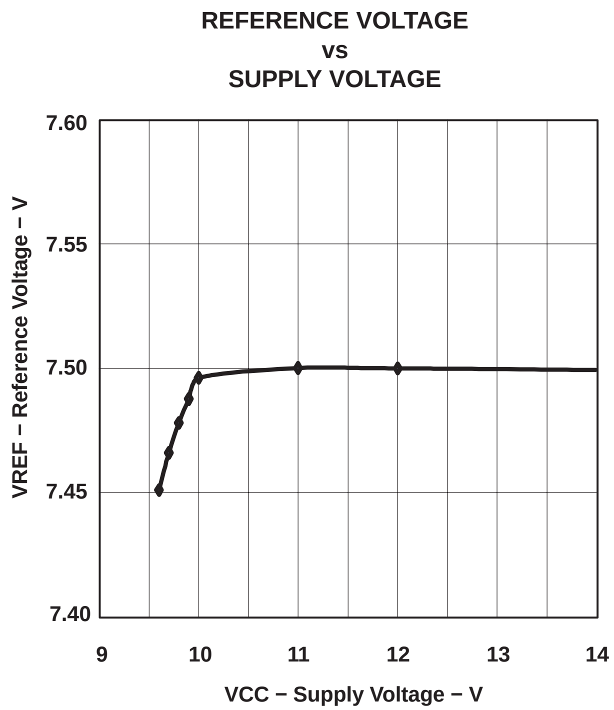


Figure 2

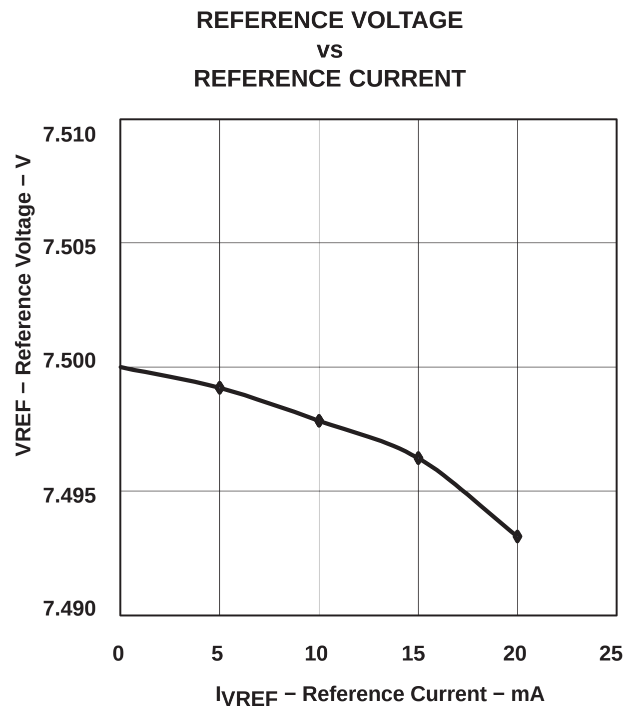


Figure 3

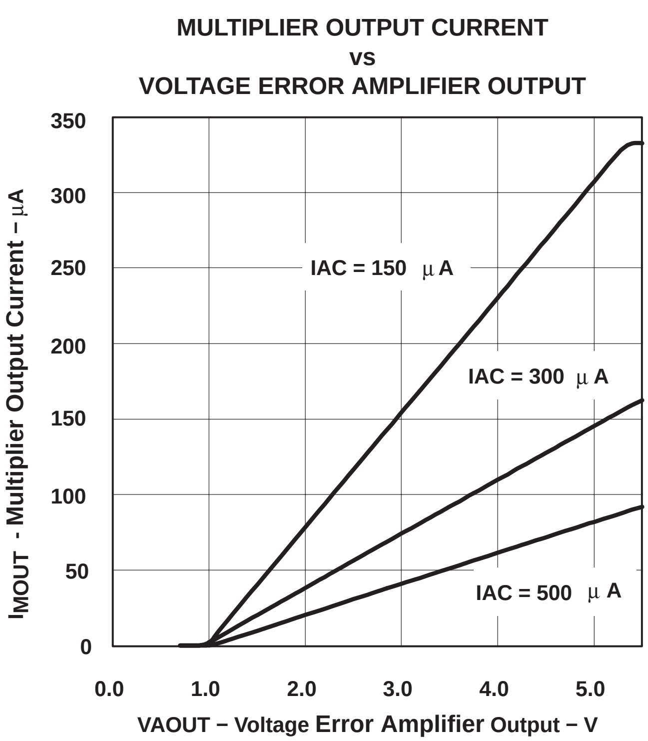


Figure 4

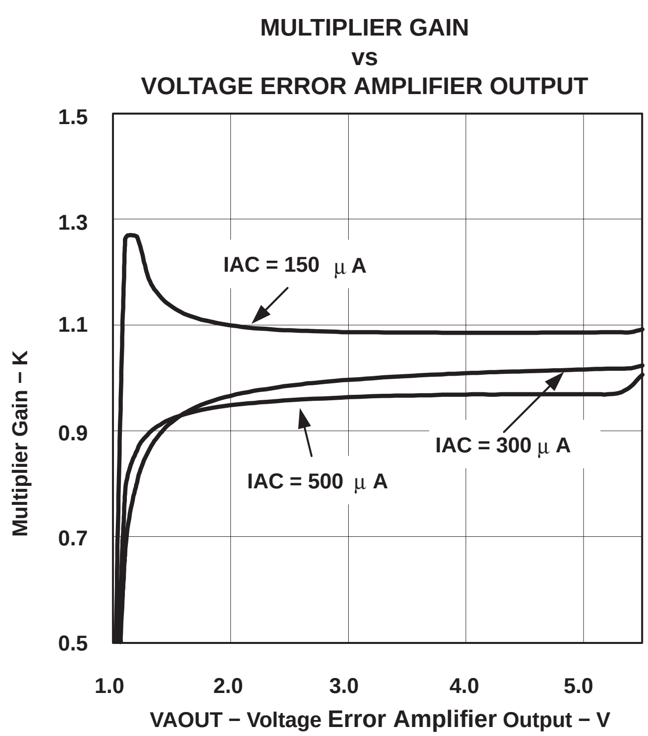


Figure 5

APPLICATION INFORMATION

MULTIPLIER CONSTANT POWER PERFORMANCE

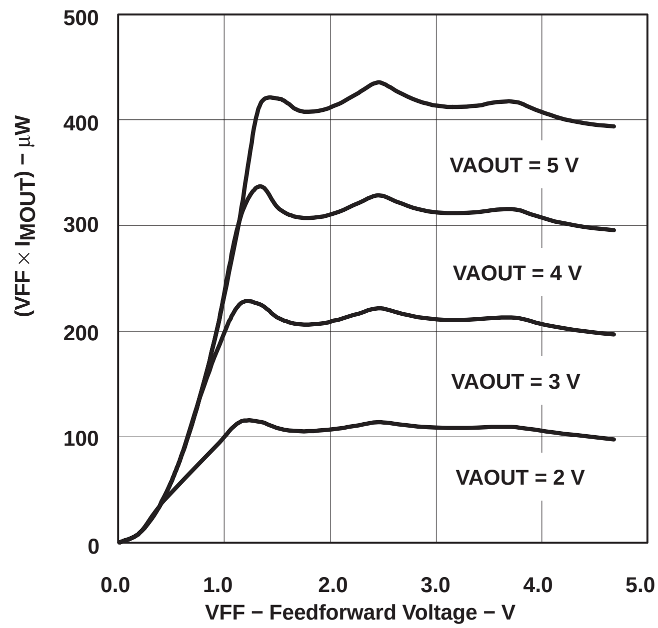


Figure 6

References and Resources:

Application Note: *Differences Between UCC3817A/18A/19A and UCC3817/18/19*, Texas Instruments Literature Number SLUA294

User’s Guide: *UCC3817 BiCMOS Power Factor Preregulator Evaluation Board*, Texas Instruments Literature Number SLUU077

Application Note: *Synchronizing a PFC Controller from a Down Stream Controller Gate Drive*, Texas Instruments Literature Number SLUA245

Seminar topic: *High Power Factor Switching Preregulator Design Optimization*, L.H. Dixon, SEM−700,1990.

Seminar topic: *High Power Factor Preregulator for Off−line Supplie*”, L.H. Dixon, SEM−600, 1988.

Related Products

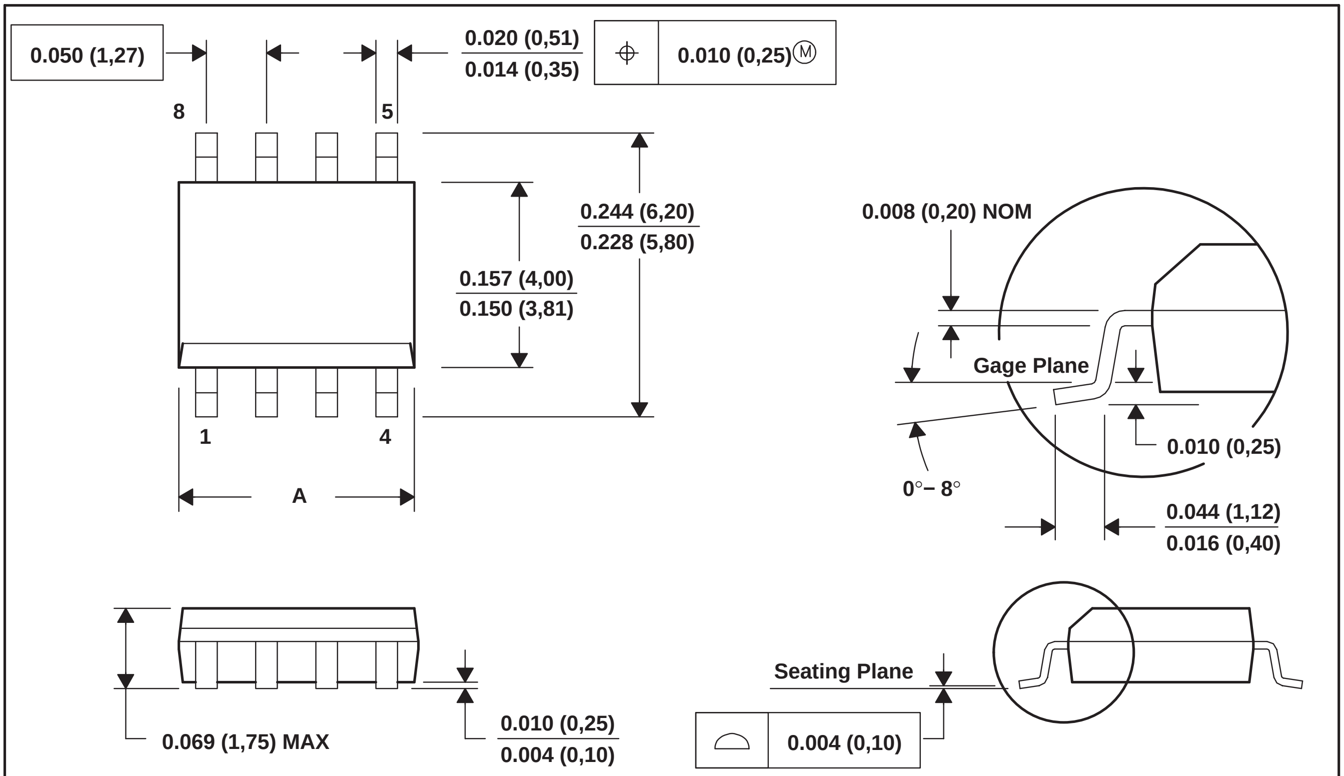
DEVICE	DESCRIPTION	CONTROL METHOD	TYPICAL POWER LEVEL
UCC3817/A,18/A	BiCMOS PFC controller	ACM(2)	75 W to 2 kW+
UC3854	PFC controller	ACM(2)	200 W to 2 kW+
UC3854A/B	Improved PFC controller	ACM(2)	200 W to 2 kW+
UC3855A/B	High performance soft switching PFC controller	ACM(2)	400 W to 2 kW+
UCC38050/1	Transition mode PFC controller	CRM(1)	50 W to 400 W
UCC28510/11/12/13	Advanced PFC+PWM combo controller	ACM(2)	75 W to 1kW+
UCC28514/15/16/17	Advanced PFC+PWM combo controller	ACM(2)	75 W to 1kW+

NOTES: (1). Critical conduction mode
(2). Average current mode

MECHANICAL DATA

D (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

8 PINS SHOWN



DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/E 09/01

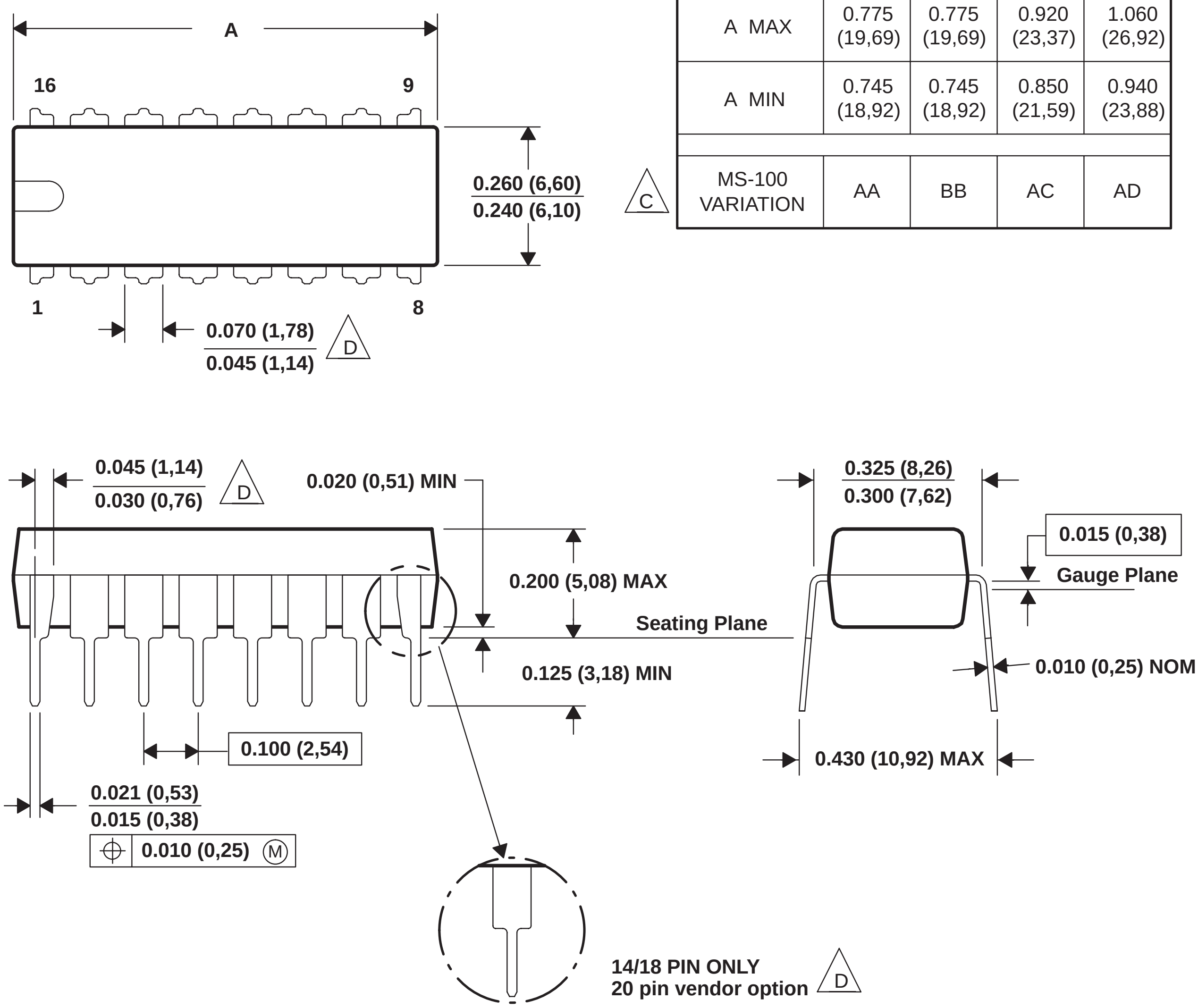
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).

MECHANICAL DATA

N (R-PDIP-T)** **PLASTIC DUAL-IN-LINE PACKAGE**

16 PINS SHOWN

PINS ** / DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-100 VARIATION	AA	BB	AC	AD



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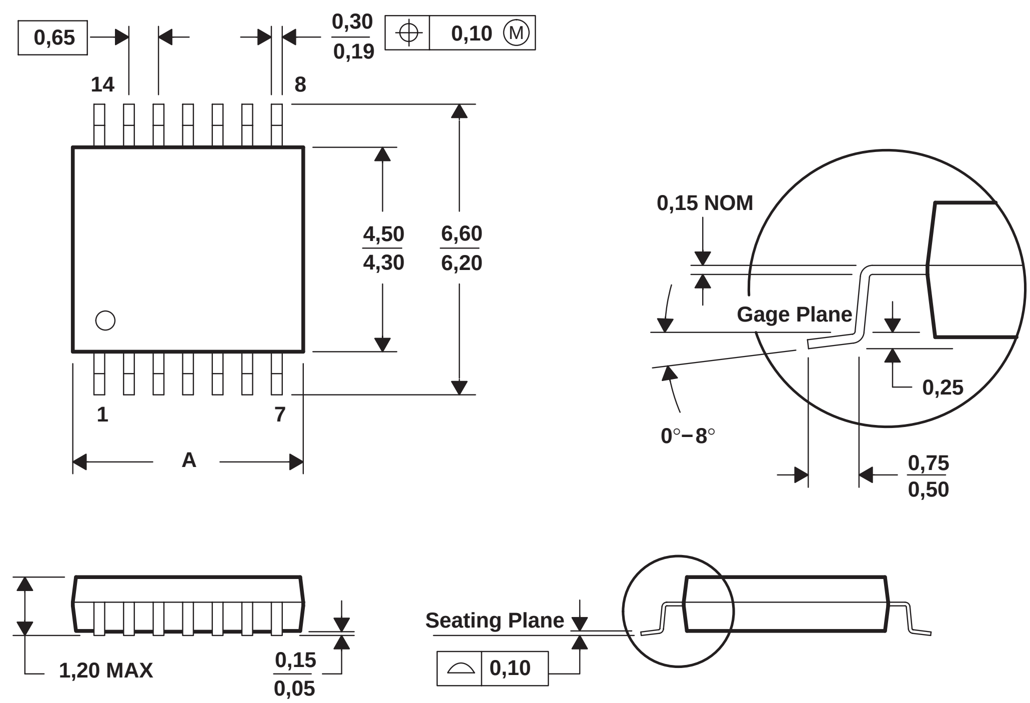
NOTES: D. All linear dimensions are in inches (millimeters).
E. This drawing is subject to change without notice.
F. Falls within JEDEC MS-001, except 18 and 20 pin minimum body lrngth (Dim A).
G. The 20 pin end lead shoulder width is a vendor option, either half or full width.

MECHANICAL DATA

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

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NOTES: H. All linear dimensions are in millimeters.
I. This drawing is subject to change without notice.
J. Body dimensions do not include mold flash or protrusion not to exceed 0,15.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
UCC2819AD	ACTIVE	SOIC	D	16	75	None	CU NIPDAU	Level-1-220C-UNLIM
UCC2819ADR	ACTIVE	SOIC	D	16	2500	None	CU NIPDAU	Level-1-220C-UNLIM
UCC2819ADRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2819AN	ACTIVE	PDIP	N	16	50	None	CU SNPB	Level-NA-NA-NA
UCC2819APW	ACTIVE	TSSOP	PW	16	90	None	CU NIPDAU	Level-2-220C-1 YEAR
UCC2819APWR	ACTIVE	TSSOP	PW	16	2000	None	CU NIPDAU	Level-2-220C-1 YEAR
UCC3819AD	ACTIVE	SOIC	D	16	40	None	CU NIPDAU	Level-1-220C-UNLIM
UCC3819ADR	ACTIVE	SOIC	D	16	75	None	CU NIPDAU	Level-1-220C-UNLIM
UCC3819AN	ACTIVE	PDIP	N	16	25	None	CU SNPB	Level-NA-NA-NA
UCC3819APW	ACTIVE	TSSOP	PW	16	90	None	CU NIPDAU	Level-2-220C-1 YEAR
UCC3819APWR	ACTIVE	TSSOP	PW	16	2000	None	CU NIPDAU	Level-2-220C-1 YEAR

(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 - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
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.
Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

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

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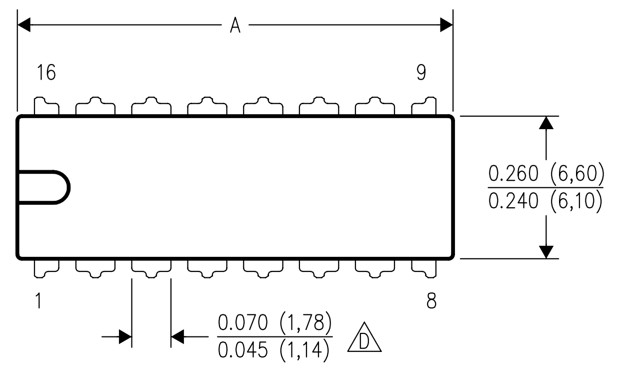
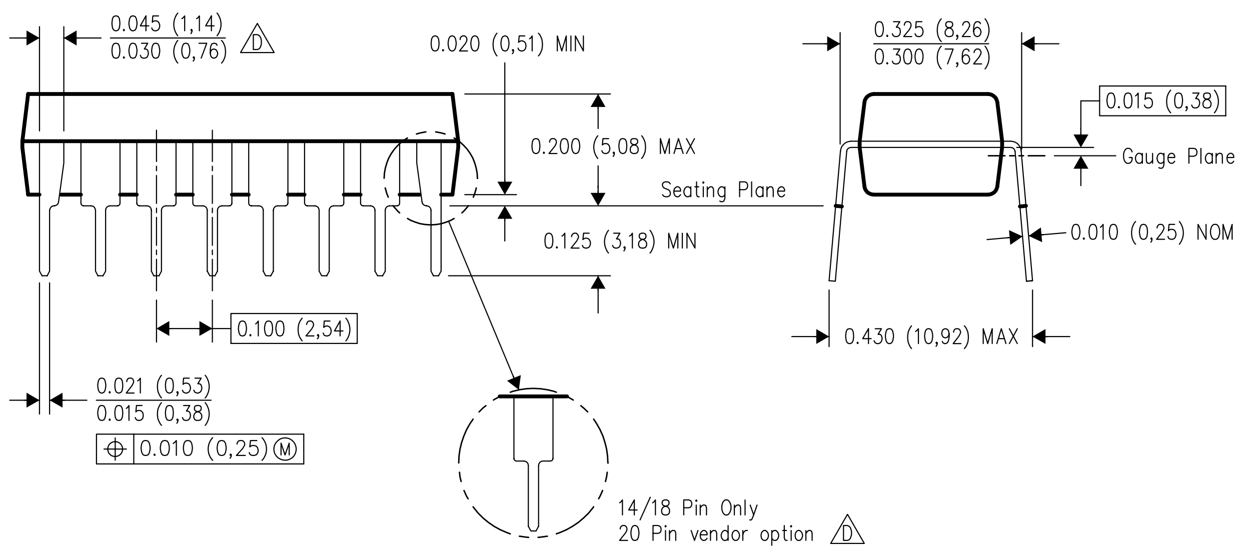
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

N (R–PDIP–T**) PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



PINS ** / DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
C MS–001 VARIATION	AA	BB	AC	AD



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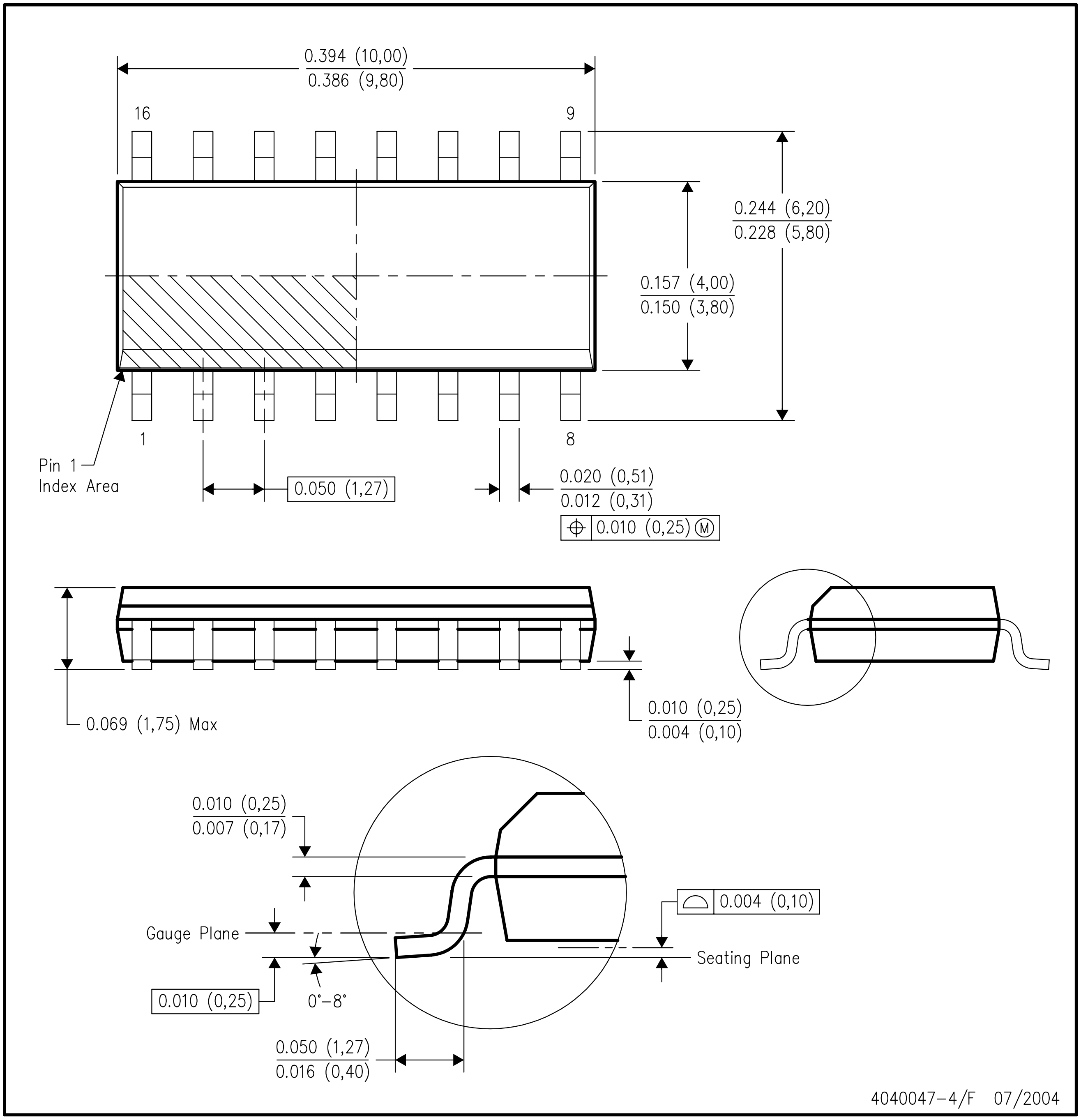
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

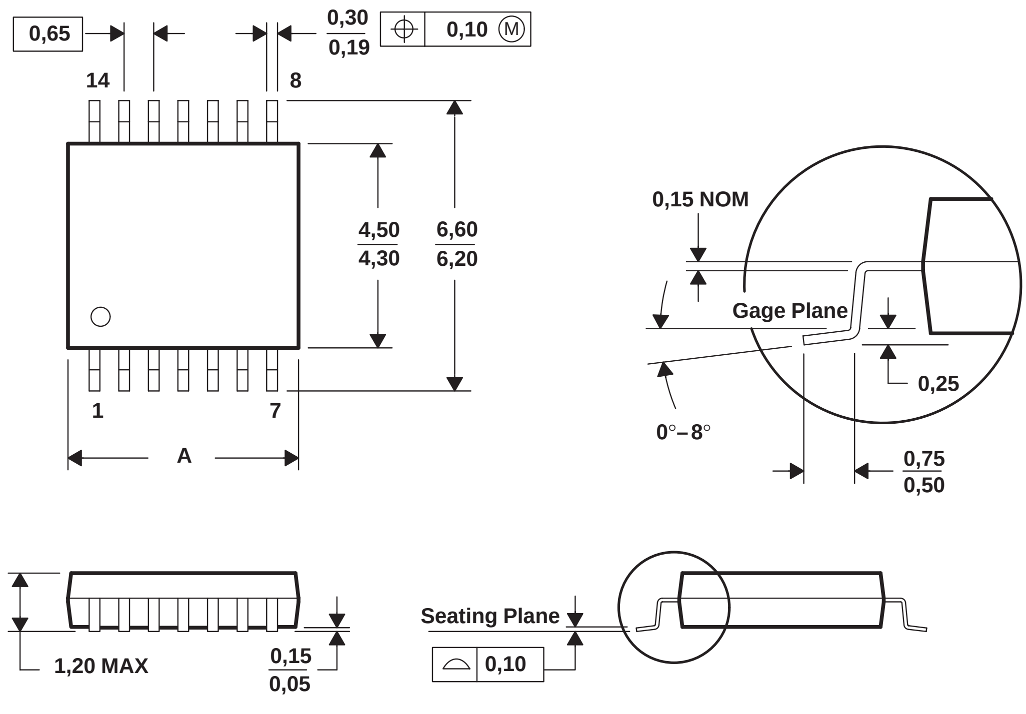
D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



NOTES: A. All linear dimensions are in inches (millimeters).
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–012 variation AC.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

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NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
- D. Falls within JEDEC MO-153

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
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Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
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