

# High Speed PWM Controller

## FEATURES

- Compatible with Voltage or Current Mode Topologies
- Practical Operation Switching Frequencies to 1MHz
- 50ns Propagation Delay to Output
- High Current Dual Totem Pole Outputs (1.5A Peak)
- Wide Bandwidth Error Amplifier
- Fully Latched Logic with Double Pulse Suppression
- Pulse-by-Pulse Current Limiting
- Soft Start / Max. Duty Cycle Control
- Under-Voltage Lockout with Hysteresis
- Low Start Up Current (1.1mA)

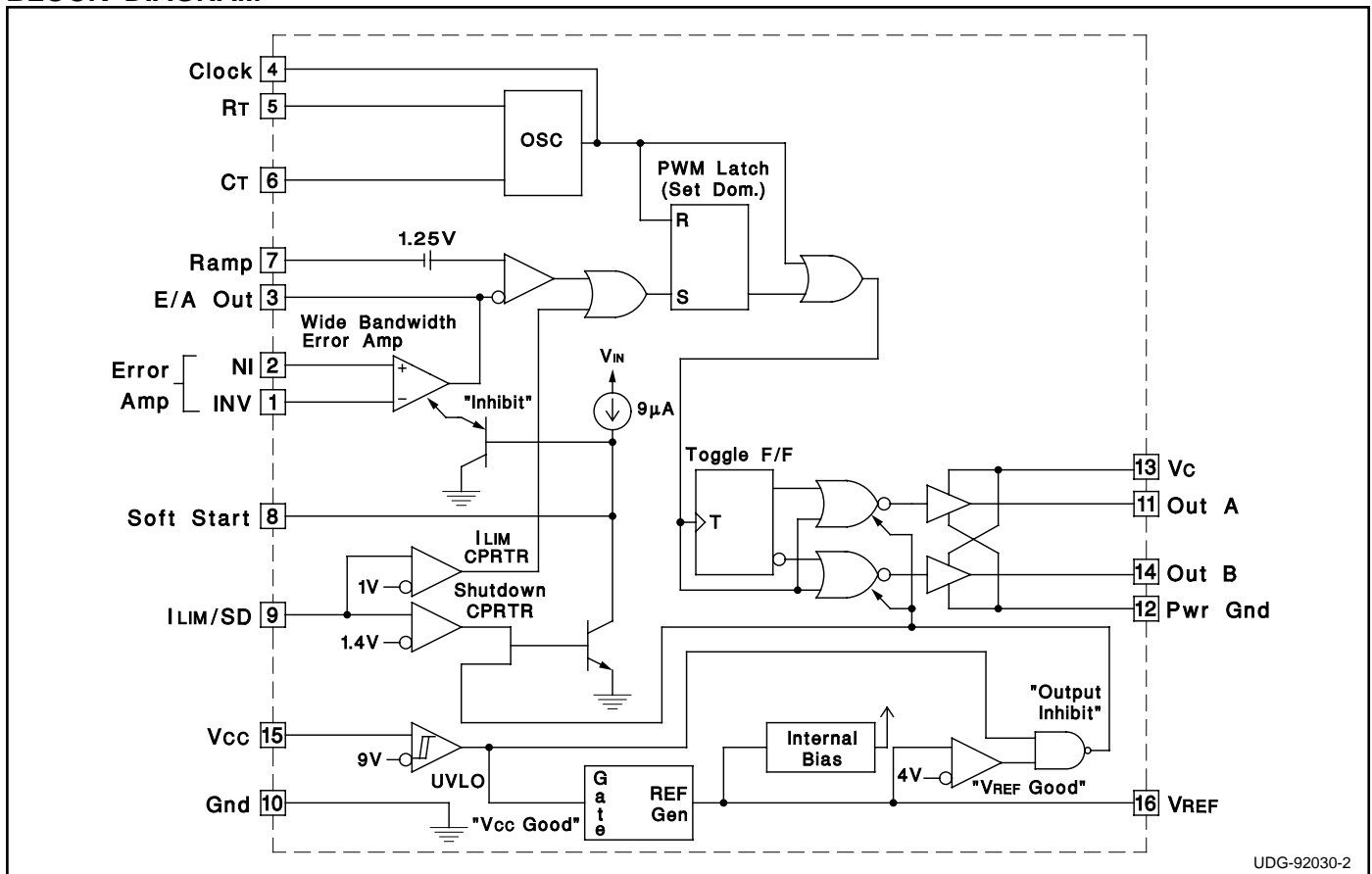
## DESCRIPTION

The UC1825 family of PWM control ICs is optimized for high frequency switched mode power supply applications. Particular care was given to minimizing propagation delays through the comparators and logic circuitry while maximizing bandwidth and slew rate of the error amplifier. This controller is designed for use in either current-mode or voltage mode systems with the capability for input voltage feed-forward.

Protection circuitry includes a current limit comparator with a 1V threshold, a TTL compatible shutdown port, and a soft start pin which will double as a maximum duty cycle clamp. The logic is fully latched to provide jitter free operation and prohibit multiple pulses at an output. An under-voltage lockout section with 800mV of hysteresis assures low start up current. During under-voltage lockout, the outputs are high impedance.

These devices feature totem pole outputs designed to source and sink high peak currents from capacitive loads, such as the gate of a power MOSFET. The on state is designed as a high level.

## BLOCK DIAGRAM



UDG-92030-2

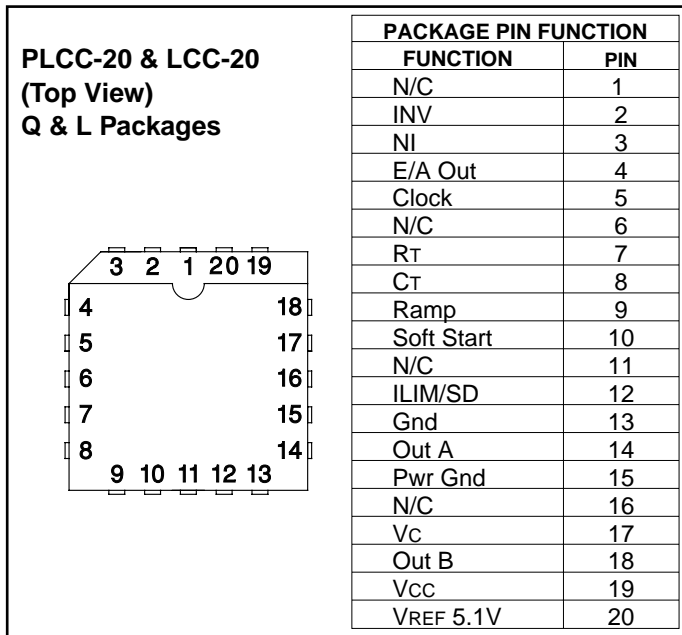
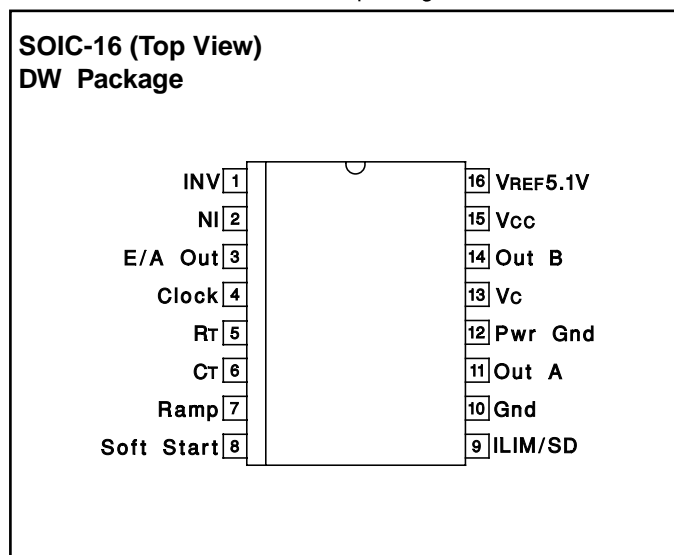
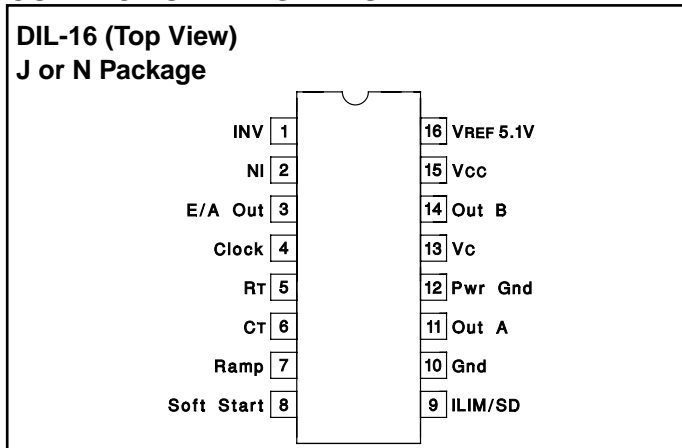
### ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (Pins 13, 15)	30V
Output Current, Source or Sink (Pins 11, 14)	
DC	0.5A
Pulse (0.5 s)	2.0A
Analog Inputs	
(Pins 1, 2, 7)	-0.3V to 7V
(Pin 8, 9)	-0.3V to 6V
Clock Output Current (Pin 4)	-5mA
Error Amplifier Output Current (Pin 3)	5mA
Soft Start Sink Current (Pin 8)	20mA
Oscillator Charging Current (Pin 5)	-5mA
Power Dissipation	1W
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1: All voltages are with respect to GND (Pin 10); all currents are positive into, negative out of part; pin numbers refer to DIL-16 package.

Note 3: Consult Unitrode Integrated Circuit Databook for thermal limitations and considerations of package.

### CONNECTION DIAGRAMS



### THERMAL RATINGS TABLE

Package	$\Theta_{JA}$	$\Theta_{JC}$
DIL-16J	80-120	28 <sup>(2)</sup>
DIL-16N	90 <sup>(1)</sup>	45
PLCC-20	43-75(1)	34
LCC-20	70-80	20 <sup>(2)</sup>
SOIC-16	50-120 <sup>(1)</sup>	35

(1) Specified  $\Theta_{JA}$  (junction to ambient) is for devices mounted to 5in<sup>2</sup> FR4 PC board with one ounce copper where noted. When resistance range is given, lower values are for 5in<sup>2</sup> aluminum PC board. Test PWB was 0.062in thick and typically used 0.635mm trace widths for power packages and 1.3mm trace widths for non-power packages with 100 x 100 mil probe land area at the end of each trace.

(2)  $\Theta_{JC}$  data values stated were derived from MIL-STD-1835B. MIL-STD-1835B states that the baseline values shown are worst case (mean +2s) for a 60 x 60mil microcircuit device silicon die and applicable for devices with die sizes up to 14400 square mils. For device die sizes greater than 14400 square mils use the following values; dual-in-line, 11°C/W; flat pack 10°C/W; pin grid array, 10°C/W.

**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, these specifications apply for ,  $R_T = 3.65k$ ,  $C_T = 1nF$ ,  $V_{CC} = 15V$ ,  $-55^{\circ}C < T_A < 125^{\circ}C$  for the UC1825,  $-40^{\circ}C < T_A < 85^{\circ}C$  for the UC2825, and  $0^{\circ}C < T_A < 70^{\circ}C$  for the UC3825,  $T_A = T_O$ .

PARAMETERS	TEST CONDITIONS	UC1825 UC2825			UC3825			UNITS
		MIN	TOP	MAX	MIN	TOP	MAX	
<b>Reference Section</b>								
Output Voltage	$T_O = 25^{\circ}C$ , $I_O = 1mA$	5.05	5.10	5.15	5.00	5.10	5.20	V
Line Regulation	$10V < V_{CC} < 30V$		2	20		2	20	mV
Load Regulation	$1mA < I_O < 10mA$		5	20		5	20	mV
Temperature Stability*	$T_{MIN} < T_A < T_{MAX}$		0.2	0.4		0.2	0.4	mV/ $^{\circ}C$
Total Output Variation*	Line, Load, Temperature	5.00		5.20	4.95		5.25	V
Output Noise Voltage*	$10Hz < f < 10kHz$		50			50		$\mu V$
Long Term Stability*	$T_J = 125^{\circ}C$ , 1000hrs.		5	25		5	25	mV
Short Circuit Current	$V_{REF} = 0V$	-15	-50	-100	-15	-50	-100	mA
<b>Oscillator Section</b>								
Initial Accuracy*	$T_J = 2^{\circ}C$	360	400	440	360	400	440	kHz
Voltage Stability*	$10V < V_{CC} < 30V$		0.2	2		0.2	2	%
Temperature Stability*	$T_{MIN} < T_A < T_{MAX}$		5			5		%
Total Variation*	Line, Temperature	340		460	340		460	kHz
<b>Oscillator Section (cont.)</b>								
Clock Out High		3.9	4.5		3.9	4.5		V
Clock Out Low			2.3	2.9		2.3	2.9	V
Ramp Peak*		2.6	2.8	3.0	2.6	2.8	3.0	V
Ramp Valley*		0.7	1.0	1.25	0.7	1.0	1.25	V
Ramp Valley to Peak*		1.6	1.8	2.0	1.6	1.8	2.0	V
<b>Error Amplifier Section</b>								
Input Offset Voltage				10			15	mV
Input Bias Current			0.6	3		0.6	3	$\mu A$
Input Offset Current			0.1	1		0.1	1	$\mu A$
Open Loop Gain	$1V < V_O < 4V$	60	95		60	95		dB
CMRR	$1.5V < V_{CM} < 5.5V$	75	95		75	95		dB
PSRR	$10V < V_{CC} < 30V$	85	110		85	110		dB
Output Sink Current	$V_{PIN3} = 1V$	1	2.5		1	2.5		mA
Output Source Current	$V_{PIN3} = 4V$	-0.5	-1.3		-0.5	-1.3		mA
Output High Voltage	$I_{PIN3} = -0.5mA$	4.0	4.7	5.0	4.0	4.7	5.0	V
Output Low Voltage	$I_{PIN3} = 1mA$	0	0.5	1.0	0	0.5	1.0	V
Unity Gain Bandwidth*		3	5.5		3	5.5		MHz
Slew Rate*		6	12		6	12		V/ $\mu s$

**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, these specifications apply for ,  $R_T = 3.65k$ ,  $C_T = 1nF$ ,  $V_{CC} = 15V$ ,  $-55^{\circ}C < T_A < 125^{\circ}C$  for the UC1825,  $-40^{\circ}C < T_A < 85^{\circ}C$  for the UC2825, and  $0^{\circ}C < T_A < 70^{\circ}C$  for the UC3825,  $T_A = T_J$ .

PARAMETERS	TEST CONDITIONS	UC1825 UC2825			UC3825			UNITS
		MIN	TOP	MAX	MIN	TOP	MAX	
<b>PWM Comparator Section</b>								
Pin 7 Bias Current	$V_{PIN 7} = 0V$		-1	-5		-1	-5	$\mu A$
Duty Cycle Range		0		80	0		85	%
Pin 3 Zero DC Threshold	$V_{PIN 7} = 0V$	1.1	1.25		1.1	1.25		V
Delay to Output*			50	80		50	80	ns
<b>Soft-Start Section</b>								
Charge Current	$V_{PIN 8} = 0.5V$	3	9	20	3	9	20	$\mu A$
Discharge Current	$V_{PIN 8} = 1V$	1			1			mA
<b>Current Limit / Shutdown Section</b>								
Pin 9 Bias Current	$0 < V_{PIN 9} < 4V$			15			10	$\mu A$
Current Limit Threshold		0.9	1.0	1.1	0.9	1.0	1.1	V
Shutdown Threshold		1.25	1.40	1.55	1.25	1.40	1.55	V
Delay to Output			50	80		50	80	ns
<b>Output Section</b>								
Output Low Level	$I_{OUT} = 20mA$		0.25	0.40		0.25	0.40	V
	$I_{OUT} = 200mA$		1.2	2.2		1.2	2.2	V
Output High Level	$I_{OUT} = -20mA$	13.0	13.5		13.0	13.5		V
	$I_{OUT} = -200mA$	12.0	13.0		12.0	13.0		V
Collector Leakage	$V_C = 30V$		100	500		10	500	$\mu A$
Rise/Fall Time*	$CL = 1nF$		30	60		30	60	ns
<b>Under-Voltage Lockout Section</b>								
Start Threshold		8.8	9.2	9.6	8.8	9.2	9.6	V
UVLO Hysteresis		0.4	0.8	1.2	0.4	0.8	1.2	V
<b>Supply Current Section</b>								
Start Up Current	$V_{CC} = 8V$		1.1	2.5		1.1	2.5	mA
ICC	$V_{PIN 1}, V_{PIN 7}, V_{PIN 9} = 0V; V_{PIN 2} = 1V$		22	33		22	33	mA

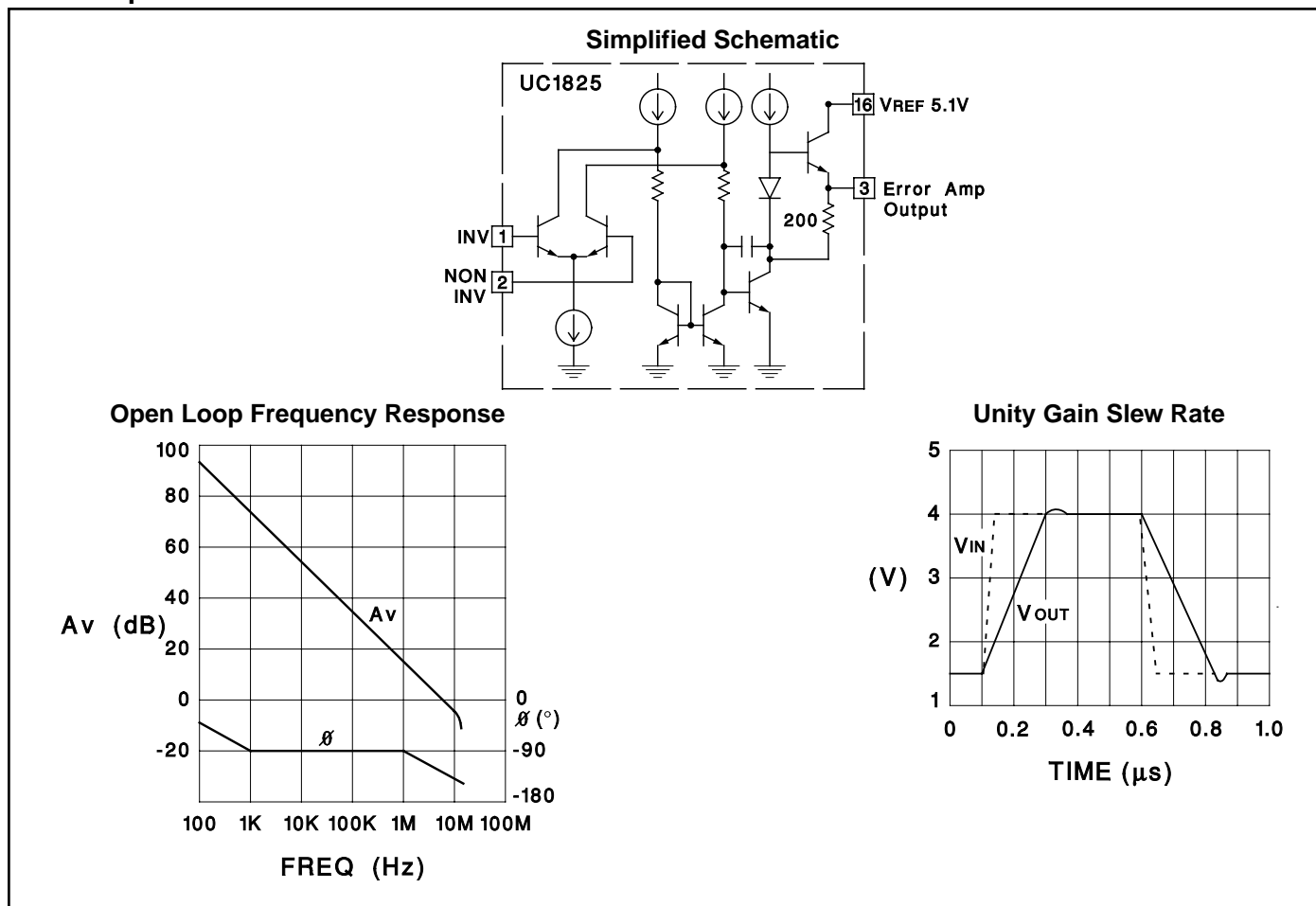
\* This parameter not 100% tested in production but guaranteed by design.

### Printed Circuit Board Layout Considerations

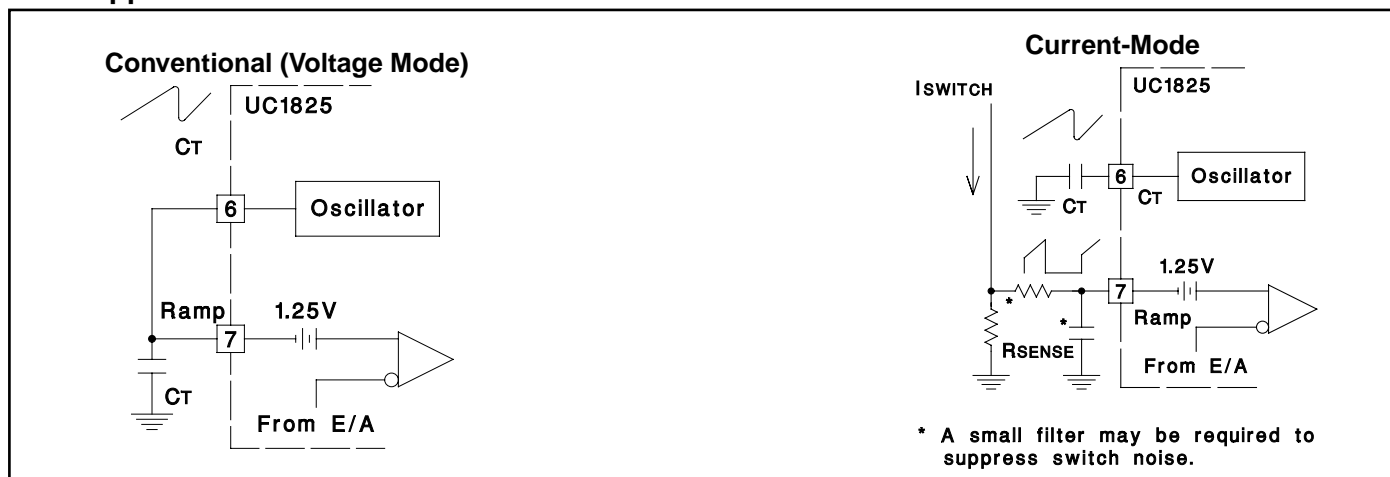
High speed circuits demand careful attention to layout and component placement. To assure proper performance of the UC1825 follow these rules: 1) Use a ground plane. 2) Damp or clamp parasitic inductive kick energy from the gate of driven MOSFETs. Do not allow the output pins to ring below ground. A series gate resistor or a shunt 1 Amp Schottky diode at the output pin will serve

this purpose. 3) Bypass VCC, VC, and VREF. Use 0.1 $\mu$ F monolithic ceramic capacitors with low equivalent series inductance. Allow less than 1 cm of total lead length for each capacitor between the bypassed pin and the ground plane. 4) Treat the timing capacitor, CT, like a bypass capacitor.

### Error Amplifier Circuit

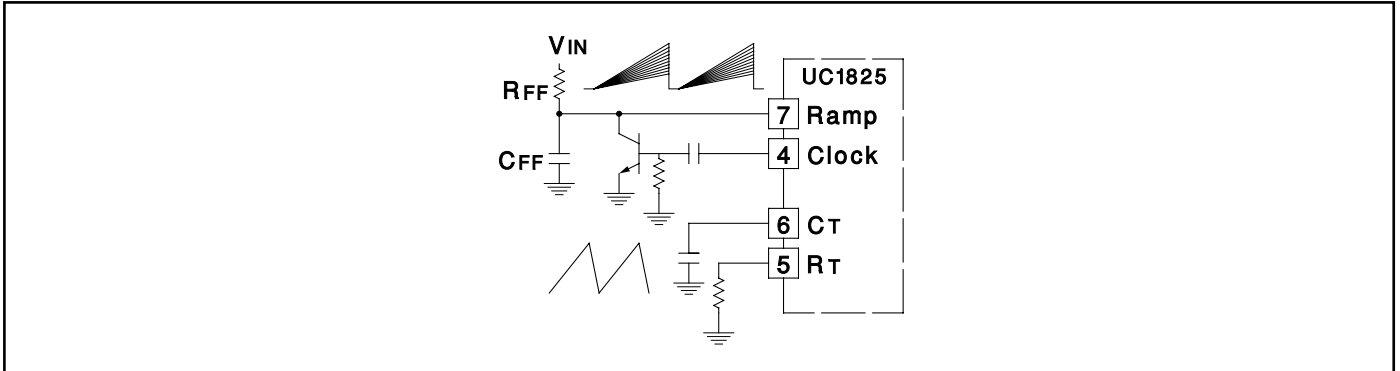


### PWM Applications



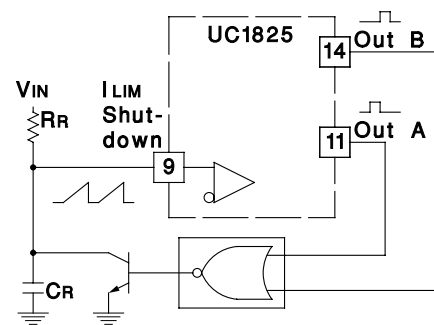


### Forward Technique for Off-Line Voltage Mode Application



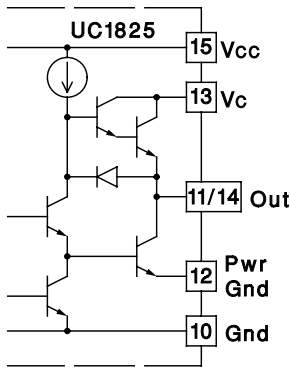
### Constant Volt-Second Clamp Circuit

The circuit shown here will achieve a constant volt-second product clamp over varying input voltages. The ramp generator components,  $R_T$  and  $C_R$  are chosen so that the ramp at Pin 9 crosses the 1V threshold at the same time the desired maximum volt-second product is reached. The delay through the functional nor block must be such that the ramp capacitor can be completely discharged during the minimum deadtime.

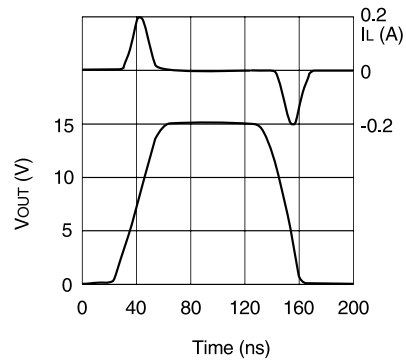


### Output Section

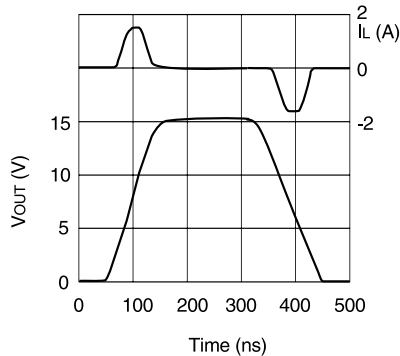
#### Simplified Schematic



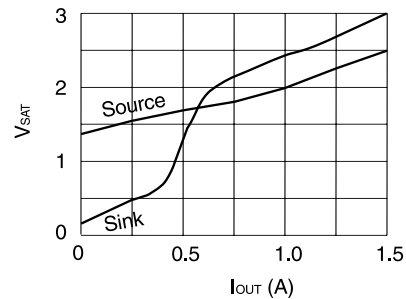
#### Rise/Fall Time ( $C_L=1nF$ )



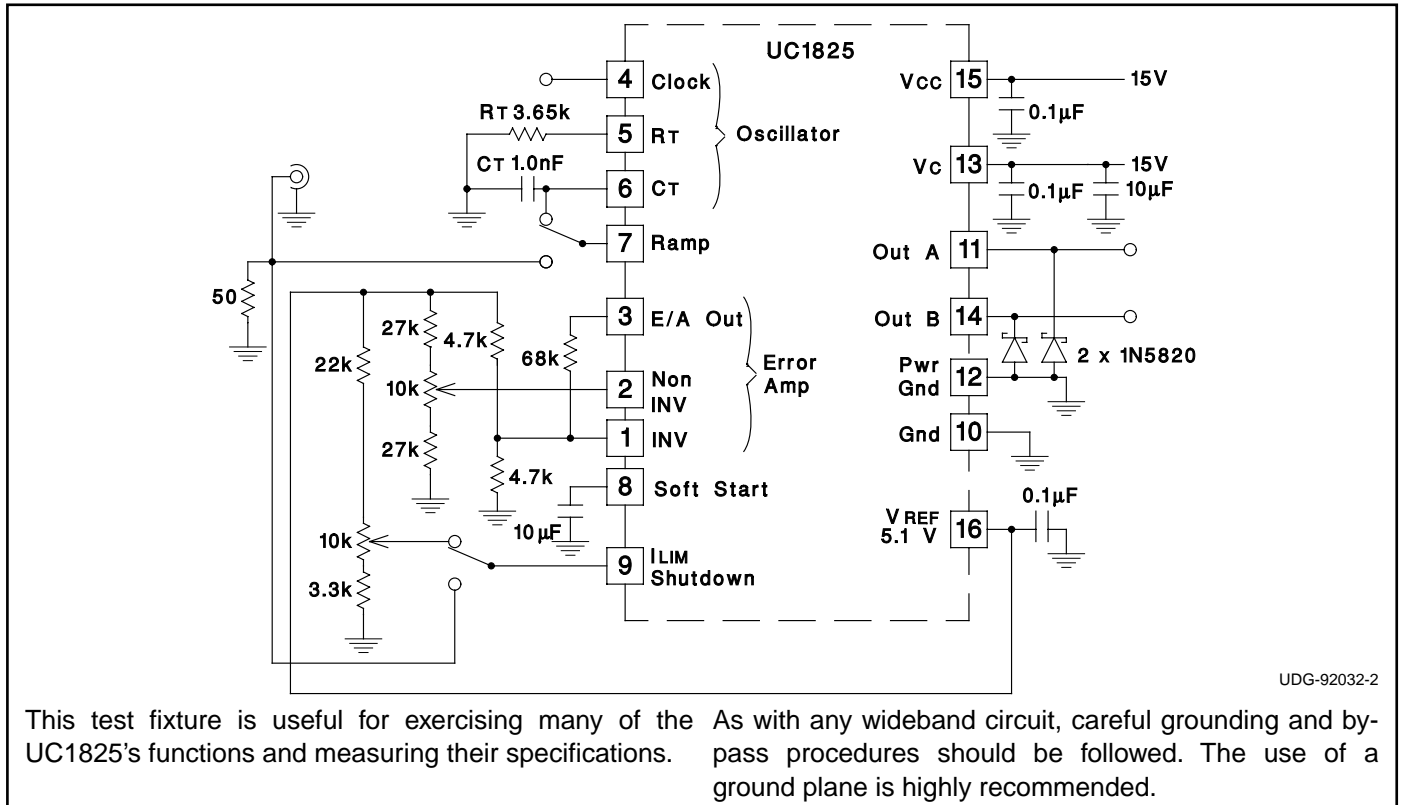
#### Rise/Fall Time ( $C_L=10nF$ )



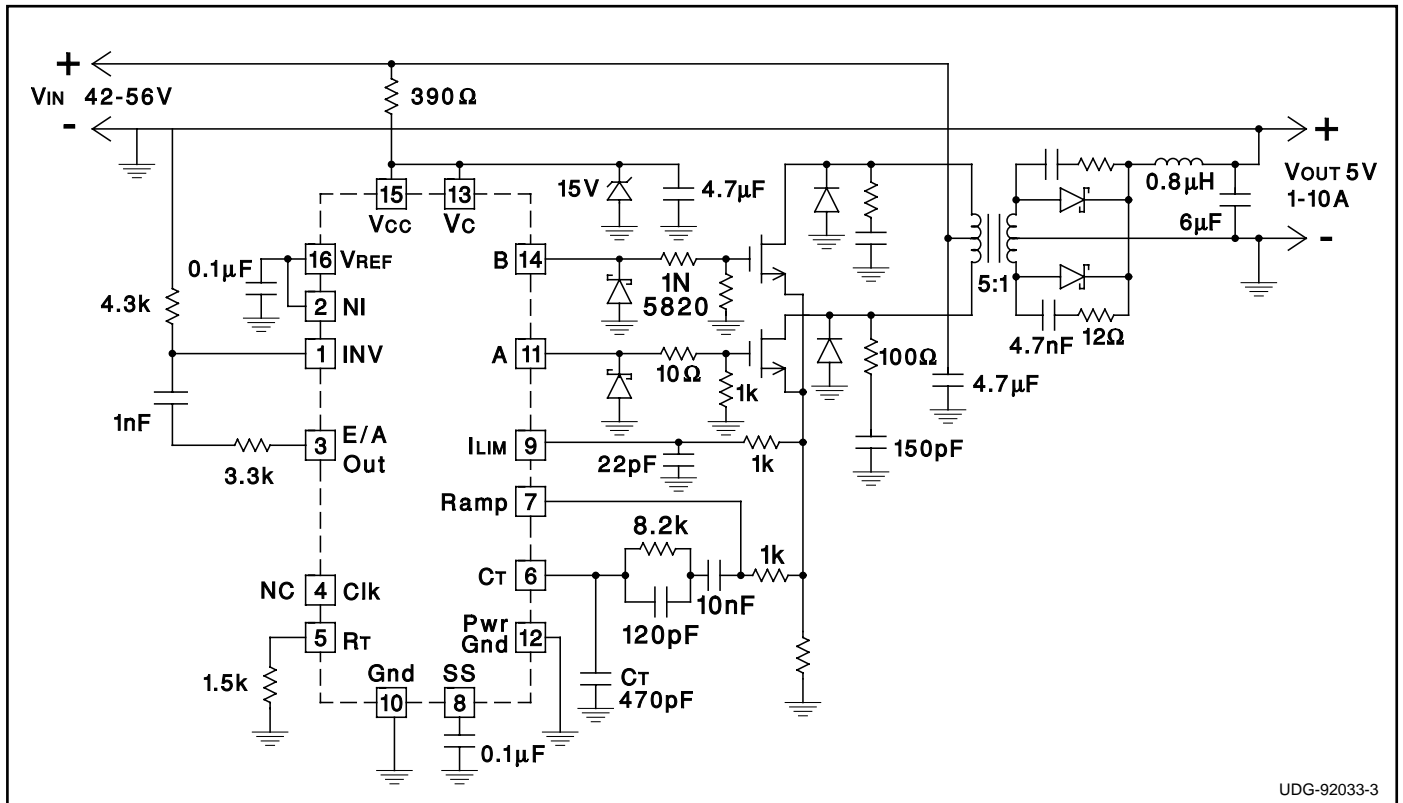
#### Saturation Curves



Open Loop Laboratory Test Fixture



Design Example: 50W, 48V to 5V DC to DC Converter - 1.5MHz Clock Frequency





**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>	Samples (Requires Login)
5962-87681012A	ACTIVE	LCCC	FK	20	1	TBD	Call TI	Call TI	
5962-8768101EA	ACTIVE	CDIP	J	16	1	TBD	Call TI	Call TI	
5962-8768101QFA	ACTIVE	CFP	W	16	1	TBD	Call TI	Call TI	
UC1825J	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	
UC1825J883B	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	
UC1825L	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	
UC1825L883B	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	
UC1825W883B	ACTIVE	CFP	W	16	1	TBD	A42	N / A for Pkg Type	
UC2825DW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC2825DW/1	PREVIEW	SOIC	DW	16		TBD	Call TI	Call TI	
UC2825DW/1G4	PREVIEW	SOIC	DW	16		TBD	Call TI	Call TI	
UC2825DWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC2825DWTR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC2825DWTRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC2825J	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	
UC2825N	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	
UC2825NG4	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	
UC2825Q	ACTIVE	PLCC	FN	20	46	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	
UC2825QG3	ACTIVE	PLCC	FN	20	46	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	
UC2825QTR	ACTIVE	PLCC	FN	20		TBD	Call TI	Call TI	
UC2825QTRG3	ACTIVE	PLCC	FN	20		TBD	Call TI	Call TI	
UC3825DW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	

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>	Samples (Requires Login)
UC3825DWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC3825DWTR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC3825DWTRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UC3825J	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	
UC3825N	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	
UC3825NG4	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	
UC3825Q	ACTIVE	PLCC	FN	20	46	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	
UC3825QG3	ACTIVE	PLCC	FN	20	46	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	
UC3825QTR	ACTIVE	PLCC	FN	20	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	
UC3825QTRG3	ACTIVE	PLCC	FN	20	1000	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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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.

**OTHER QUALIFIED VERSIONS OF UC1825, UC2825, UC2825M, UC3825, UC3825M :**

- Catalog: [UC3825](#), [UC2825](#), [UC3825M](#), [UC3825](#)
- Military: [UC2825M](#), [UC1825](#)
- Space: [UC1825-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**
**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
UC2825DWTR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
UC3825DWTR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
UC3825QTR	PLCC	FN	20	1000	330.0	16.4	10.3	10.3	4.9	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)
UC2825DWTR	SOIC	DW	16	2000	367.0	367.0	38.0
UC3825DWTR	SOIC	DW	16	2000	367.0	367.0	38.0
UC3825QTR	PLCC	FN	20	1000	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.

W (R-GDFP-F16)

CERAMIC DUAL FLATPACK



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only.
  - E. Falls within MIL STD 1835 GDFP1-F16 and JEDEC MO-092AC

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



N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

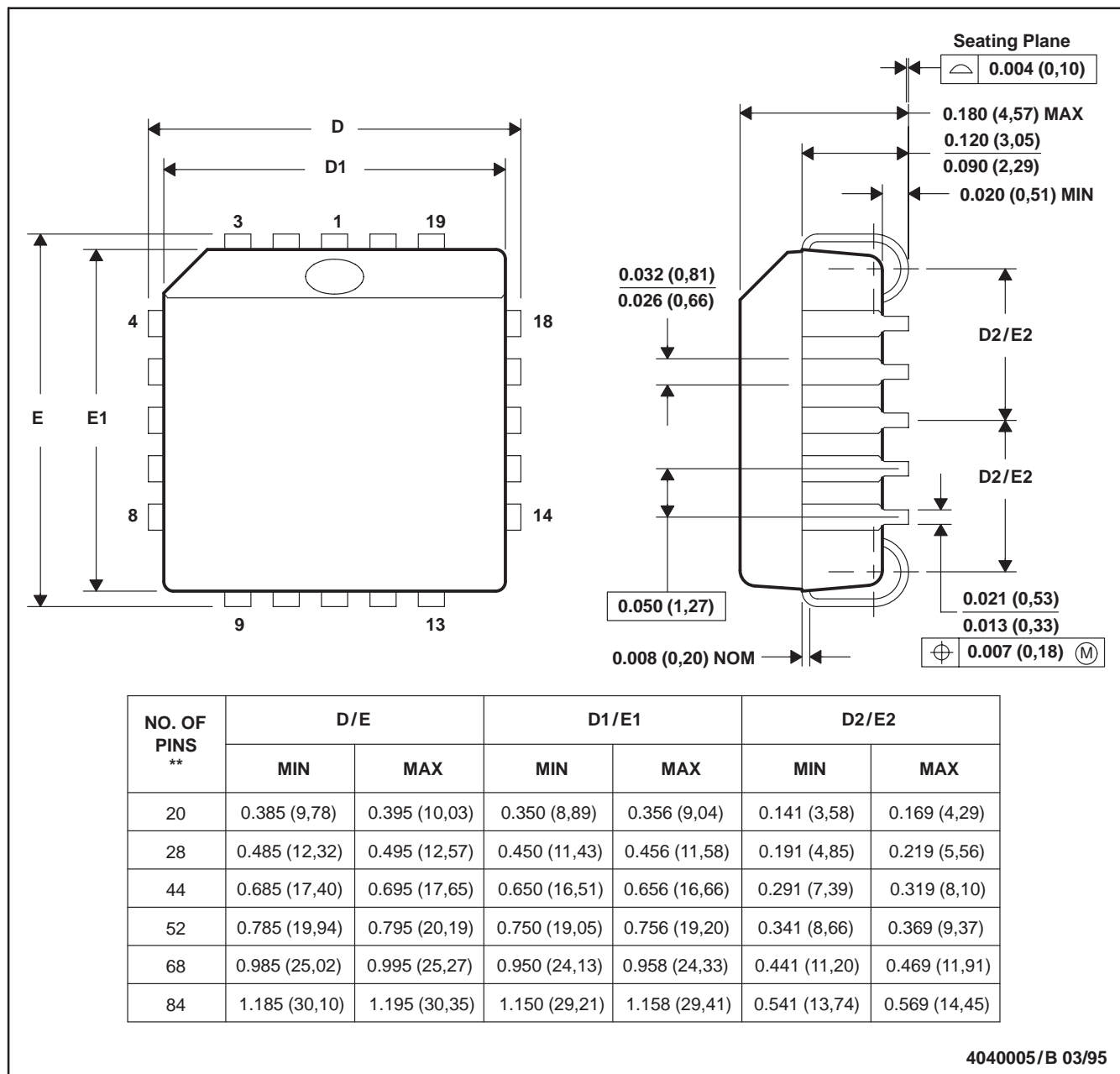


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

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

DW (R-PDSO-G16)

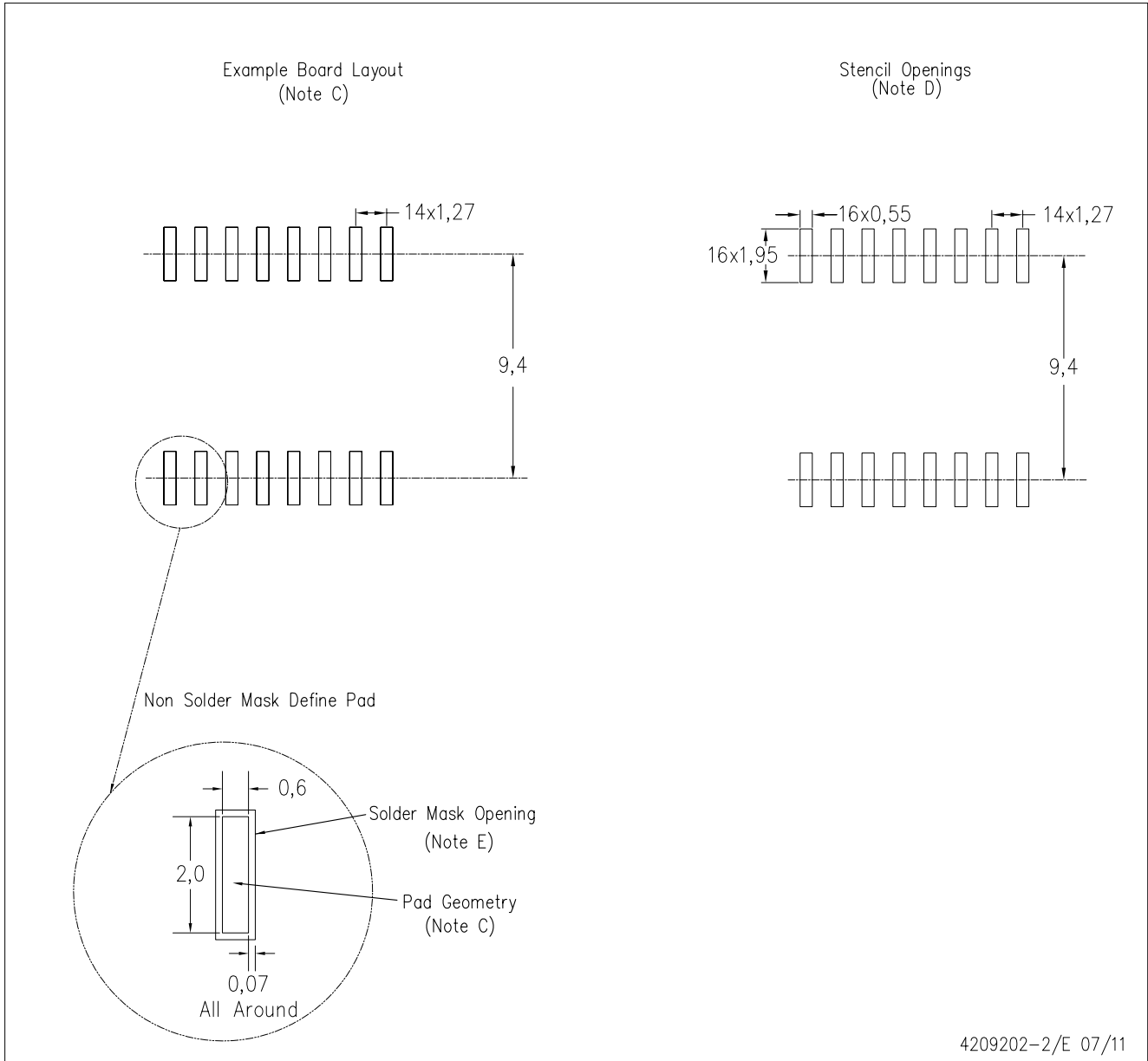
PLASTIC SMALL OUTLINE



- 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 AA.

DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4209202-2/E 07/11

- 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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