

HIGH SPEED PWM CONTROLLER

FEATURES

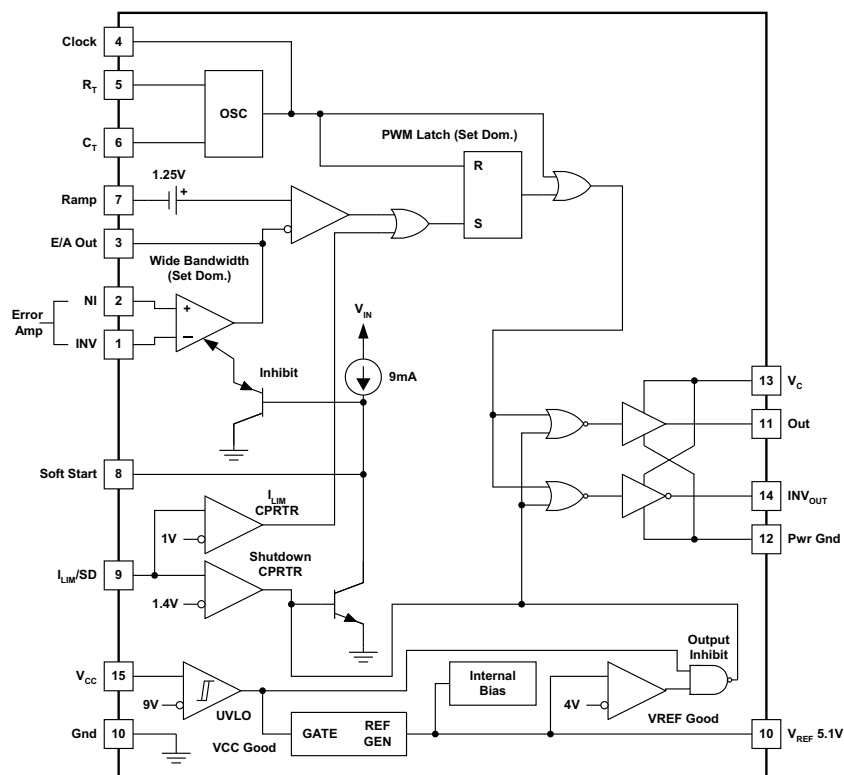
- Complementary Outputs
- Practical Operation Switching Frequencies to 1 MHz
- 50-ns Propagation Delay to Output
- High Current Dual Totem Pole Outputs (1.5 A Peak)
- Wide Bandwidth Error Amplifier
- Fully Latched Logic With Double Pulse Suppression
- Pulse-by-Pulse Current Limiting
- Soft Start/Maximum Duty Cycle Control
- Under-Voltage Lockout with Hysteresis
- Low Start Up Current (1.1 mA)
- Trimmed Bandgap Reference (5.1 V \pm 1%)

DESCRIPTION

The UC1824 family of PWM control devices 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 1-V threshold, a TTL compatible shutdown port, and a soft-start pin which doubles 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 800 mV of hysteresis assures low start up current. During under-voltage lockout, the outputs are high impedance.

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)

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.

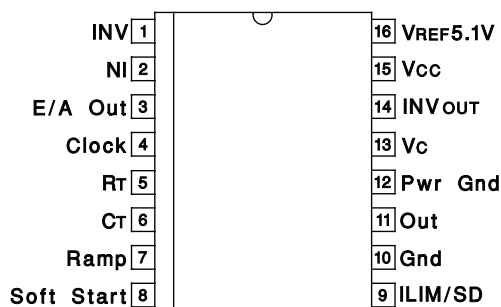
ABSOLUTE MAXIMUM RATINGS⁽¹⁾⁽²⁾

	VALUE	UNIT
Supply voltage (pins 13, 15)	30	V
Output current, source or sink (pins 11, 14)		
DC	0.5	A
Pulse (0.5 ms)	2	
Analog inputs		
(Pins 1, 2, 7)	–0.3 TO 7	V
(Pin 8, 9)	–0.3 TO 6	
Clock output current (pin 4)	–5	mA
Error amplifier output current (pin 3)	5	
Soft start sink current (pin 8)	20	
Oscillator charging current (pin 5)	–5	
Power dissipation	1	W
Storage temperature range	–65 to 150	°C
Lead temperature (soldering, 10 seconds)	300	

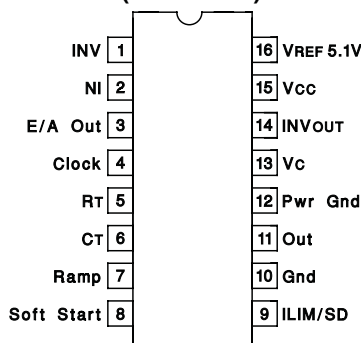
(1) All voltages are with respect to GND (Pin 10); all currents are positive into, negative out of part; pin numbers refer to DIL-16 package.

(2) Consult Unitorde Integrated Circuit Databook for thermal limitations and considerations of package.

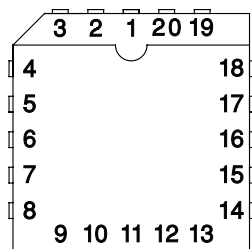
SOIC-16 DW PACKAGE (TOP VIEW)



DIL-16 J OR N PACKAGE (TOP VIEW)



PLCC-20 AND LCC-20
Q AND L PACKAGES
(TOP VIEW)



PACKAGE PIN FUNCTION	
FUNCTION	PIN
N/C	1
INV	2
NI	3
E/A Out	4
Clock	5
N/C	6
R _T	7
C _T	8
Ramp	9
Soft Start	10
N/C	11
ILIM/SD	12
Gnd	13
Out	14
Pwr Gnd	15
N/C	16
V _c	17
INVOUT	18
V _{CC}	19
VREF 5.1V	20

ELECTRICAL CHARACTERISTICS

Unless otherwise stated, these specifications apply for, $R_T = 3.65\text{ k}\Omega$, $C_T = 1\text{ nF}$, $V_{CC} = 15\text{ V}$, $-55^\circ\text{C} < T_A < 125^\circ\text{C}$ for the UC1824, $-40^\circ\text{C} < T_A < 85^\circ\text{C}$ for the UC2824, and $0^\circ\text{C} < T_A < 70^\circ\text{C}$ for the UC3824, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1824 UC2824			UC3824			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
Reference Section								
Output voltage	T _J = 25°C, I _O = 1 mA	5.05	5.10	5.15	5	5.10	5.20	V
Line regulation	10 V < V _{CC} < 30 V		2	20		2	20	mV mV
Load regulation	1 mA < I _O < 10 mA		5	20		5	20	
Temperature stability ⁽¹⁾	T _{MIN} < T _A < T _{MAX}		0.2	0.4		0.2	0.4	mV/°C
Total output variation ⁽¹⁾	Line, Load, Temperature	5		5.20	4.95		5.25	V
Output noise voltage ⁽¹⁾	10 Hz < f < 10 kHz		50			50		μV
long term stability ⁽¹⁾	T _J = 125°C, 1000 hrs.		5	25		5	25	mV
Short circuit current	V _{REF} = 0 V	−15	−50	−100	−15	−50	−100	mA
Oscillator Section								
Initial accuracy ⁽¹⁾	T _J = 25°C	360	400	440	360	400	440	kHz
Voltage stability ⁽¹⁾	10 V < V _{CC} < 30 V		0.2%	2%		0.2%	2%	
Temperature stability ⁽¹⁾	T _{MIN} < T _A < T _{MAX}		5%			5%		
Total variation ⁽¹⁾	Line, Temperature	340		460	340		460	kHz
Clock out high		3.9	4.5		3.9	4.5		V
Clock out low			2.3	2.9		2.3	2.9	
Ramp peak ⁽¹⁾		2.6	2.8	3	2.6	2.8	3	
Ramp valley ⁽¹⁾		0.7	1	1.25	0.7	1	1.25	
Ramp valley to peak ⁽¹⁾		1.6	1.8	2	1.6	1.8	2	
Error Amplifier Section								
Input offset voltage				10			15	mV
Input bias current			0.6	3		0.6	3	μA
Input offset current			0.1	1		0.1	1	μA
Open loop gain	1 V < V _O < 4 V	60	95		60	95		dB
CMRR	1.5 V < V _{CM} < 5.5 V	75	95		75	95		
PSRR	10 V < V _{CC} < 30 V	85	110		85	110		
Output sink current	V _{PIN 3} = 1 V	1	2.5		1	2.5		mA
Output source current	V _{PIN 3} = 4 V	−0.5	−1.3		−0.5	−1.3		
Output high voltage	I _{PIN 3} = −0.5 mA	4	4.7	5	4	4.7	5	V
Output low voltage	I _{PIN 3} = 1 mA	0	0.5	1	0	0.5	1	
Unity gain bandwidth ⁽¹⁾		3	5.5		3	5.5		MHz
Slew rate ⁽¹⁾		6	12		6	12		V/μs
PWM Comparator Section								
Pin 7 bias current	V _{PIN 7} = 0 V		−1	−5		−1	−5	μA
Duty cycle range		0		80	0		85	%
Pin 3 zero dc threshold	V _{PIN 7} = 0 V	1.1	1.25		1.1	1.25		V
Delay to output ⁽¹⁾			50	80		50	80	ns
Soft-Start Section								
Charge current	V _{PIN 8} = 0.5 V	3	9	20	3	9	20	μA
Discharge current	V _{PIN 8} = 1 V	1			1			mA
Current Limit/Shutdown Section								
Pin 9 bias current	0 < V _{PIN 9} < 4 V			15			10	μA

(1) This parameter not 100% tested in production but guaranteed by design.

ELECTRICAL CHARACTERISTICS (continued)

Unless otherwise stated, these specifications apply for, $R_T = 3.65k$, $C_T = 1\text{ nF}$, $V_{CC} = 15\text{ V}$, $-55^\circ\text{C} < T_A < 125^\circ\text{C}$ for the UC1824, $-40^\circ\text{C} < T_A < 85^\circ\text{C}$ for the UC2824, and $0^\circ\text{C} < T_A < 70^\circ\text{C}$ for the UC3824, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1824 UC2824			UC3824			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
Current limit threshold		0.9	1	1.1	0.9	1	1.1	V
Shutdown threshold		1.25	1.40	1.55	1.25	1.40	1.55	
Delay to output			50	80		50	80	ns
Output Section								
Output low level	I _{OUT} = 20 mA		0.25	0.40		0.25	0.40	V
	I _{OUT} = 200 mA		1.2	2.2		1.2	2.2	
Output high level	I _{OUT} = −20 mA	13	13.5		13	13.5		
	I _{OUT} = −200 mA	12	13		12	13		
Collector leakage	V _C = 30 V		100	500		10	500	μA
Rise/fall time ⁽²⁾	CL = 1 nF		30	60		30	60	ns
Under-Voltage Lockout Section								
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	
Supply Current Section								
Start up current	V _{CC} = 8 V		1.1	2.5		1.1	2.5	mA
ICC	V _{PIN 1} , V _{PIN 7} , V _{PIN 9} = 0 V; V _{PIN 2} = 1 V		22	33		22	33	

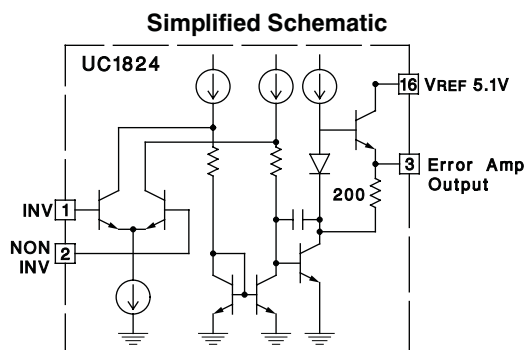
(2) This parameter not 100% tested in production but guaranteed by design.

UC1824 Printed Circuit Board Layout Considerations

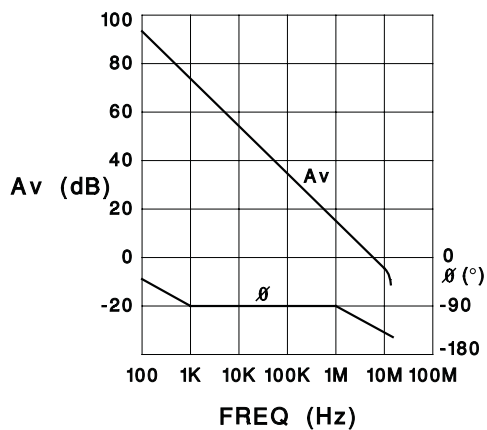
High speed circuits demand careful attention to layout and component placement. To assure proper performance of the UC1824 follow these rules:

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-A Schottky diode at the output pin serves this purpose.
3. Bypass V_{CC} , V_C , and V_{REF} . Use 0.1- μF 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, C_T , like a bypass capacitor.

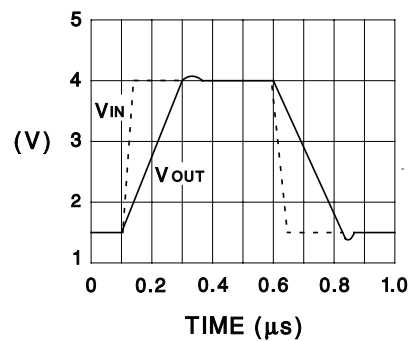
Error Amplifier Circuit



Open Loop Frequency Response

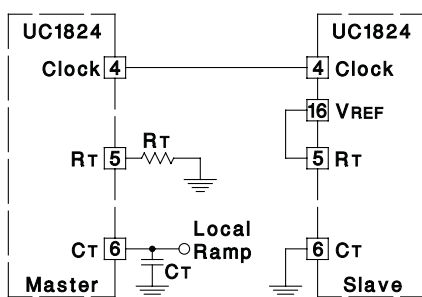


Unity Gain Slew Rate

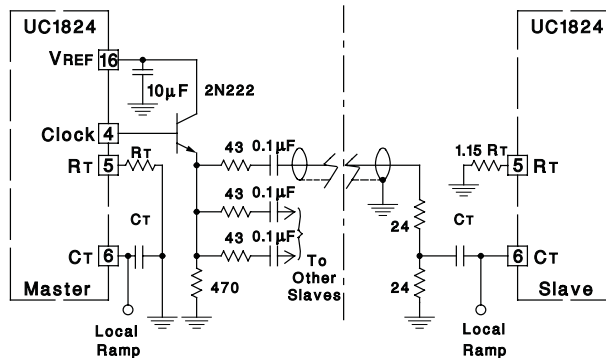


Synchronized Operation

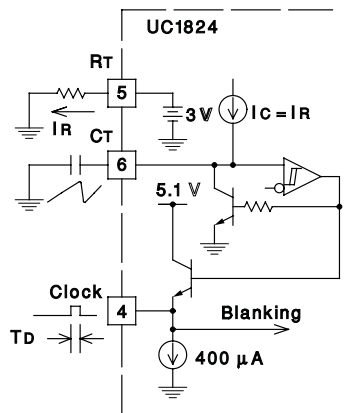
Two Units in Close Proximity



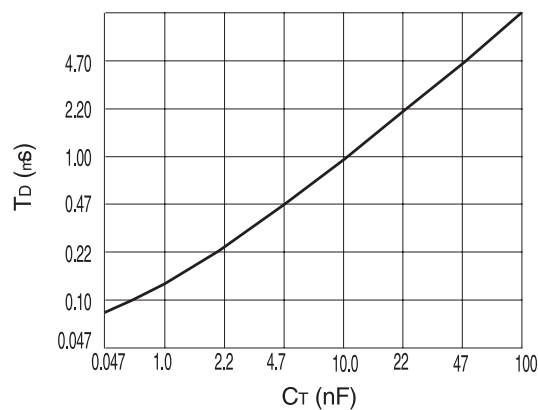
Generalized Synchronization



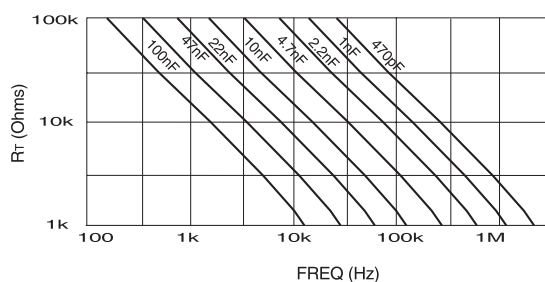
Oscillator Circuit



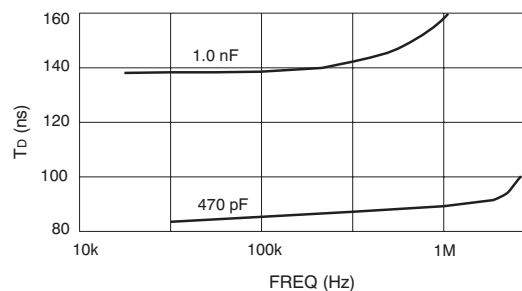
Primary Output Deadtime vs C_T ($3k \leq R_T \leq 100k$)



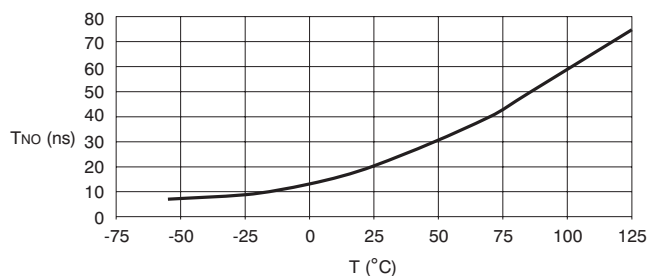
Timing Resistance vs Frequency



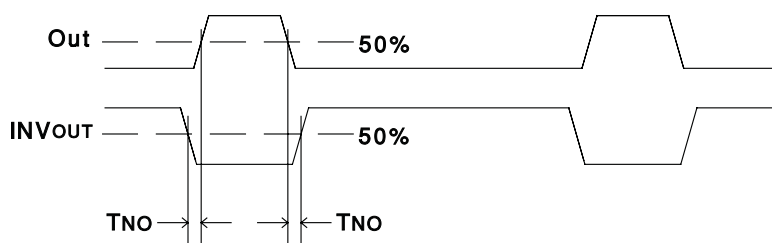
Primary Output Deadtime vs Frequency



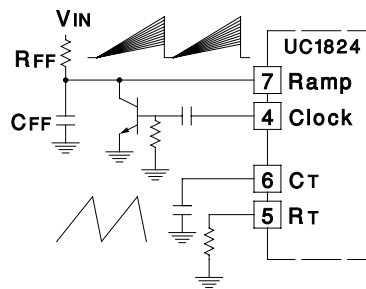
Typical Non-Overlap Time (T_{NO}) Over Temperature



Non-Overlap Time (T_{NO})

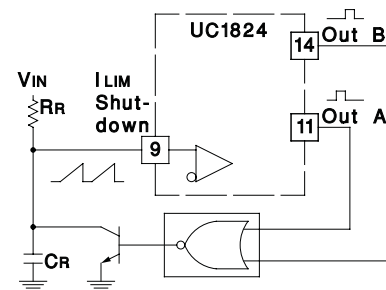


Forward Technique for Off-Line Voltage Mode Application

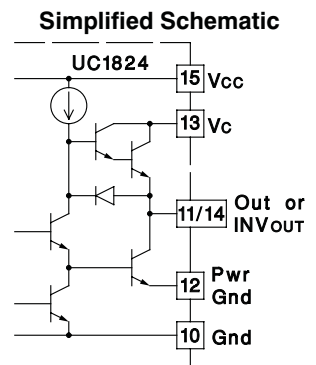


Constant Volt-Second Clamp Circuit

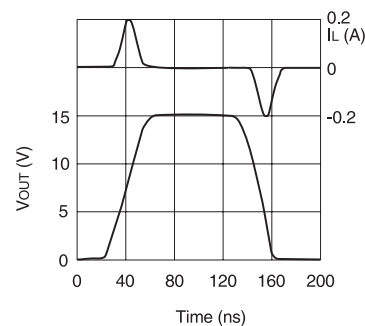
The circuit shown here will achieve a constant volt-second product clamp over varying input voltages. The ramp generator components, R_T and C_T are chosen so that the ramp at Pin 9 crosses the 1V threshold at the same time the desired maximum volt-second product is reached. The delay through the functional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



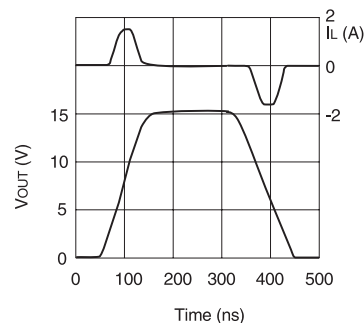
Output Section



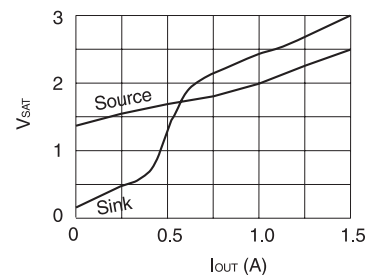
Rise/Fall Time ($C_L=1\text{ nF}$)



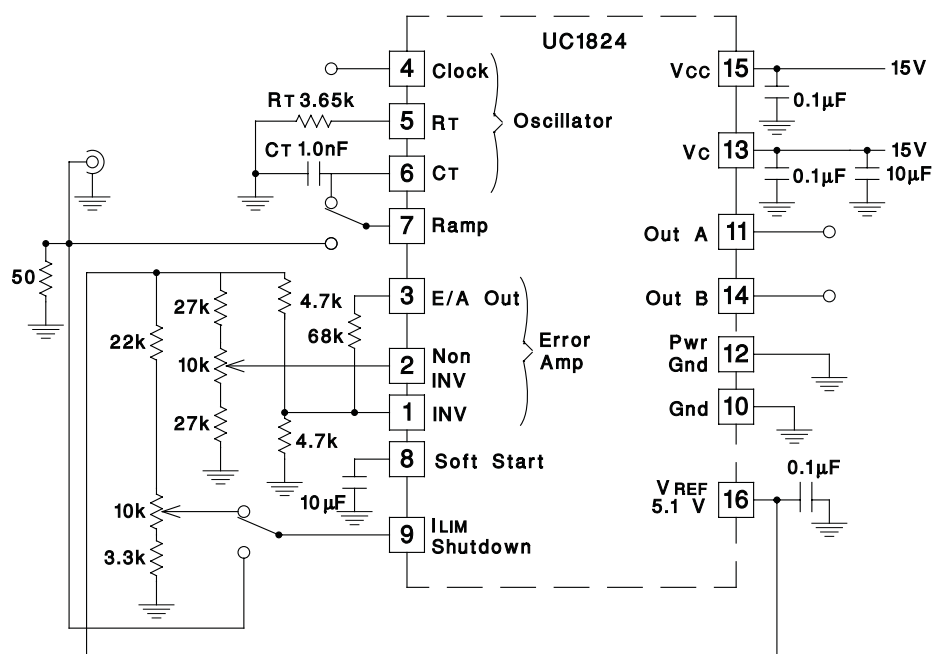
Rise/Fall Time ($C_L=10\text{ nF}$)



Saturation Curves



Open-Loop Laboratory Test Fixture



UDG-92036-2

This test fixture is useful for exercising many of the UC1824's functions and measuring their specifications. As with any wideband circuit, careful grounding and bypass procedures should be followed. The use of a ground plane is highly recommended.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
UC2824DW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Request Free Samples
UC2824DWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Request Free Samples
UC2824DWTR	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Purchase Samples
UC2824DWTRG4	ACTIVE	SOIC	DW	16		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Purchase Samples
UC2824N	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	Purchase Samples
UC2824NG4	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	Purchase Samples
UC3824DW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Request Free Samples
UC3824DWG4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Request Free Samples
UC3824DWTR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Purchase Samples
UC3824DWTRG4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Purchase Samples
UC3824N	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
UC3824NG4	ACTIVE	PDIP	N	16	25	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	Request Free 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.

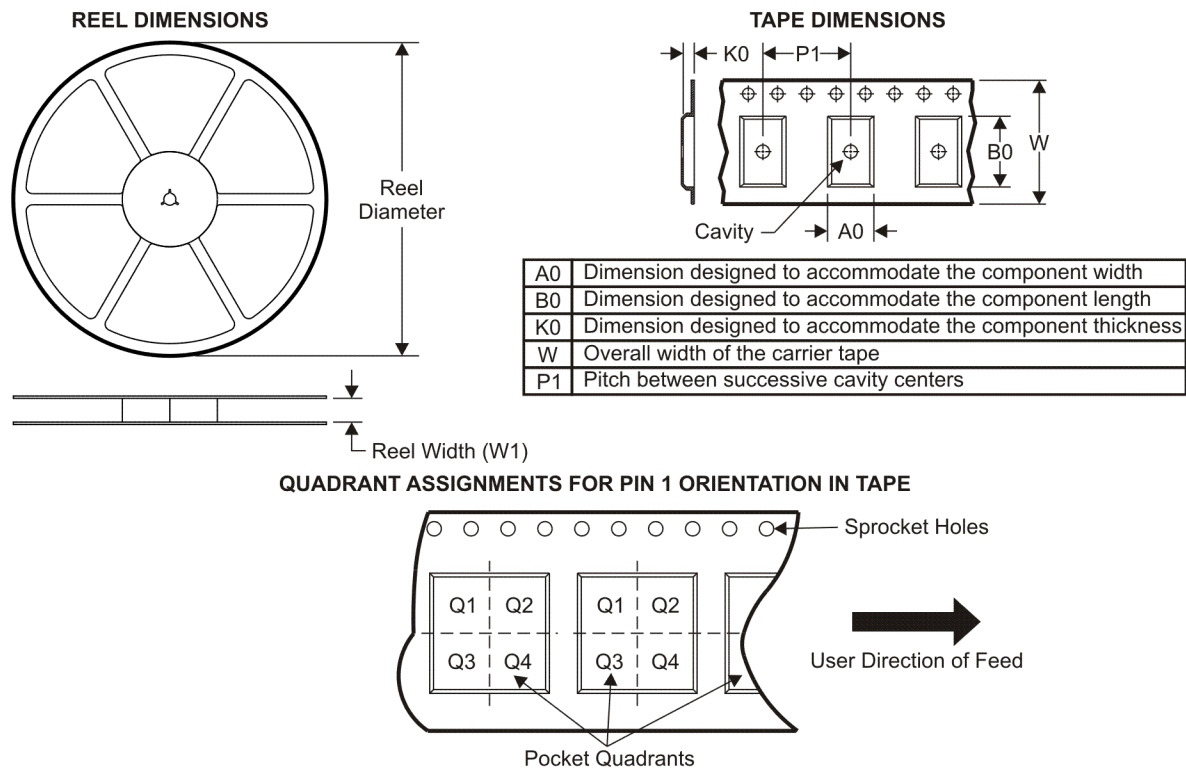
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

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
UC3824DWTR	SOIC	DW	16	2000	330.0	16.4	10.85	10.8	2.7	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)
UC3824DWTR	SOIC	DW	16	2000	346.0	346.0	33.0

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps