

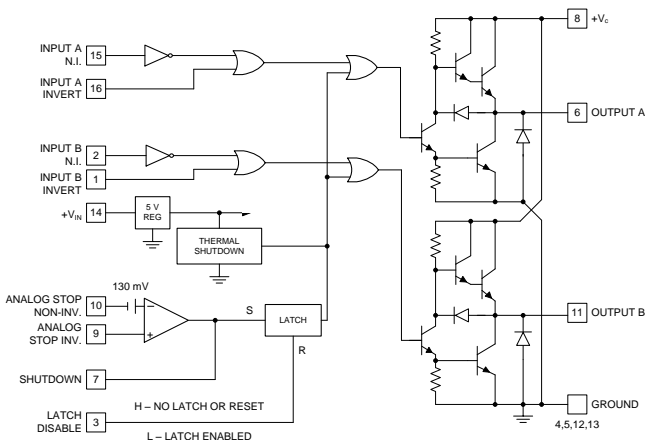
UC1707-SP Dual-Channel Power Driver

1 Features

- Rad-Tolerant: 50 kRad (Si) for 5962-8761903VEA, 5962-8761903VFA ⁽¹⁾
- QML-V Qualified, SMD (5962-8761901VEA, 5962-8761903VEA, 5962-8761903VFA, 5962-8761901V2A)
- Two Independent Drivers
- 1.5-A Totem Pole Outputs
- Inverting and Non-Inverting Inputs
- 40-ns Rise and Fall Into 1000 pF
- High-Speed, Power MOSFET Compatible
- Low Cross-Conduction Current Spike
- Analog Shutdown With Optional Latch
- Low Quiescent Current
- 5-V to 40-V Operation
- Thermal Shutdown Protection
- 16-Pin Dual-In-Line Package

2 Applications

- Switch Mode Power Supply
- DC-DC Converter
- Pulse Transformer Driver



(1) Radiation tolerance is a typical value based upon initial device qualification with dose rate = 10 mrad/s. Radiation Lot Acceptance Testing is available - contact factory for details.

3 Description

The UC1707-SP power driver is made with a high-speed Schottky process to interface between low-level control functions and high-power switching devices – particularly power MOSFETs. The UC1707-SP contains two independent channels, each of which can be activated by either a high or low input logic level signal. Each output can source or sink up to 1.5 A as long as power dissipation limits are not exceeded.

Although each output can be activated independently with its own inputs, it can be forced low in common through the action either of a digital high signal at the Shutdown terminal or a differential low-level analog signal. The Shutdown command from either source can either be latching or not, depending on the status of the Latch Disable pin.

Supply voltage for both V_{IN} and V_C can independently range from 5 to 40 V.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
UC1707-SP	CDIP (16)	6.92 mm x 19.56 mm
	CFP (16)	6.73 mm x 10.30 mm
	LCCC (20)	8.89 mm x 8.89 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Truth Table (Each Channel)⁽¹⁾

INV.	N.I.	OUT
H	H	L
L	H	H
H	L	L
L	L	L

(1) $\overline{OUT} = \overline{INV}$ and N.I.
 $\overline{OUT} = INV$ or N.I.



Table of Contents

1 Features	1	8.2 Functional Block Diagram	9
2 Applications	1	8.3 Feature Description	9
3 Description	1	8.4 Device Functional Modes	10
4 Revision History	2	9 Application and Implementation	11
5 Pin Configuration and Functions	3	9.1 Application Information	11
6 Specifications	4	9.2 Typical Application	11
6.1 Absolute Maximum Ratings	4	10 Power Supply Recommendations	13
6.2 ESD Ratings	4	11 Layout	13
6.3 Recommended Operating Conditions	4	11.1 Layout Guidelines	13
6.4 Thermal Information	4	11.2 Layout Example	13
6.5 Electrical Characteristics	4	12 Device and Documentation Support	14
6.6 Typical Switching Characteristics	5	12.1 Community Resources	14
7 Parameter Measurement Information	6	12.2 Trademarks	14
7.1 Simplified Internal Circuitry	6	12.3 Electrostatic Discharge Caution	14
8 Detailed Description	9	12.4 Glossary	14
8.1 Overview	9	13 Mechanical, Packaging, and Orderable Information	14

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

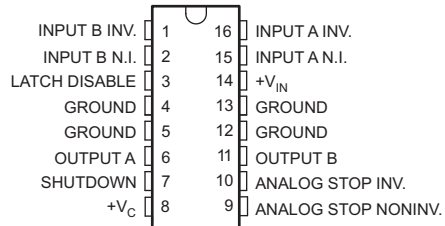
Changes from Original (March 2011) to Revision A

Page

• Added <i>ESD Ratings</i> table, <i>Recommended Operating Conditions</i> table, <i>Thermal Information</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section	1
• Corrected typos in <i>Pin Configuration and Functions</i>	3
• Deleted package thermal impedance in <i>Absolute Maximum Ratings</i> table	4
• Added <i>Community Resources</i>	14

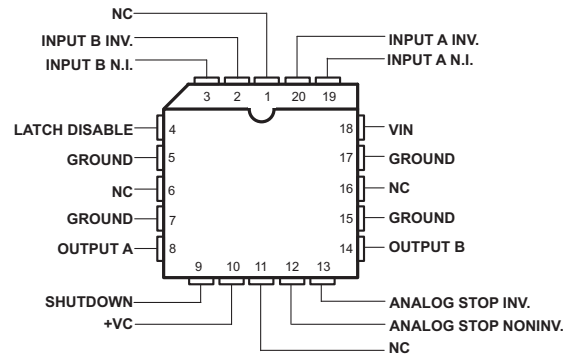
5 Pin Configuration and Functions

**J or W Package
16-Pin CDIP or CFP
Top View**



All four ground pins must be connected to a common ground.

**FK Package
20-Pin LCCC
Top View**



Pin Functions

NAME	PIN			I/O	DESCRIPTION
	CDIP	LCCC	CFP		
INPUT B INVERTING	1	2	1	I	Inverting TTL compatible input threshold.
INPUT B NONINVERTING	2	3	2	I	Non-Inverting TTL compatible input threshold.
LATCH DISABLE	3	4	3	I	Assuming SHUTDOWN pin is left open, a high on this pin disables the latching functionality of the analog stop shutdown.
GROUND	4	5	4	-	
GROUND	5	7	5	-	
OUTPUT A	6	8	6	O	Output is a 1.5 A totem-pole driver optimized for MOSFET gates.
SHUTDOWN	7	9	7	I	Used as an output of the analog stop circuit. Also used as an input to force shutdown or to force the device out of shutdown.
+V _C	8	10	8	I	Collector supply voltage.
ANALOG STOP (+)	9	12	9	I	This pin is normally connected to a reference voltage used for comparison with the sensed power supply output voltage level at the E/A (+) pin.
ANALOG STOP (-)	10	13	10	I	This pin is normally connected to the voltage divider resistors which sense the power supply output level.
OUTPUT B	11	14	11	O	Output is a 1.5 A totem-pole driver optimized for MOSFET gates.
GROUND	12	15	12	-	All voltages are measured with respect to ground (GND).
GROUND	13	17	13	-	All voltages are measured with respect to ground (GND).
+V _{IN}	14	18	14	I	Supply voltage.
INPUT A NONINVERTING	15	20	15	I	Non-Inverting TTL compatible input threshold.
INPUT A INVERTING	16	19	16	I	Inverting TTL compatible input threshold.
NC		16			
NC		11			
NC		6			
NC		1			

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT	
V _{IN}	Supply voltage		40	V	
V _C	Collector supply voltage		40	V	
	Digital inputs ⁽²⁾		5.5	V	
	Output current (each output, source or sink) steady-state		±500	mA	
	Peak transient		±1	A	
	Capacitive discharge energy		15	mJ	
	Analog stop inputs		V _{IN}		
T _J	Operating virtual-junction temperature		150	°C	
	Power dissipation at T _{case} = 25°C ⁽²⁾		13	W	
		J package		15	W
		FK package		13	W
	Lead temperature (soldering, 10 s)		300	°C	
	Operating temperature	–55	125	°C	
T _{stg}	Storage temperature	–65	150	°C	

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to the four ground pins which must be connected together. All currents are positive into, negative out of the specified terminal. Digital drive can exceed 5.5 V if input current is limited to 10 mA. Consult packaging section of datasheet for thermal limitations and considerations of package.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	V

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V _{IN}	Supply voltage	5	12	38	V
V _C	Supply voltage	5	12	38	V

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		UC1707-SP			UNIT
		J (CDIP)	FK (LCCC)	W (CFP)	
		16 PINS	20 PINS	16 PINS	
R _{θJC(top)}	Junction-to-case (top) thermal resistance	36	31.8	53.6	°C/W
R _{θJB}	Junction-to-board thermal resistance	55.2	31.3	105	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	9.5	2.8	4.2	°C/W

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

6.5 Electrical Characteristics

Unless otherwise stated, these specifications apply for T_A = –55°C to 125°C; V_{IN} = V_C = 20 V. T_A = T_J.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
V _{IN}	Supply current	V _{IN} = 40 V		12	15	mA

Electrical Characteristics (continued)

Unless otherwise stated, these specifications apply for $T_A = -55^{\circ}\text{C}$ to 125°C ; $V_{IN} = V_C = 20\text{ V}$. $T_A = T_J$.

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_C	Supply current	$V_C = 40\text{ V}$, outputs low			5.2	7.5	mA
V_C	Leakage current	$V_{IN} = 0$, $V_C - 30\text{ V}$, no load			0.05	0.1	mA
	Digital input low level					0.8	V
	Digital input high level			2.2			V
	Input current	$V_I = 0$			-0.06	-1.0	mA
	Input leakage	$V_I = 5\text{ V}$			0.05	0.1	mA
$V_C - V_O$	Output high sat	$I_O = -50\text{ mA}$				2.0	V
		$I_O = -500\text{ mA}$				2.5	V
V_O	Output low sat	$I_O = -50\text{ mA}$				0.4	V
		$I_O = -500\text{ mA}$				2.5	V
	Analog threshold	$V_{CM} = 0$ to 15 V	8761901	100	130	150	mV
			8761903	90	130	150	mV
	Input bias current	$V_{CM} = 0$			-10	-20	μA
	Thermal shutdown				155		$^{\circ}\text{C}$
	Shutdown threshold	Pin 7 input		0.4	1.0	2.2	V
	Latch disable threshold	Pin 3 input		0.8	1.2	2.2	V

6.6 Typical Switching Characteristics

$V_{IN} = V_C = 20\text{ V}$, $T_A = 25^{\circ}\text{C}$. Delays measured to 10% output change.

PARAMETER		TEST CONDITIONS		OUTPUT CL =			UNIT
FROM INV. INPUT TO OUTPUT				open	1.0	2.2	nF
	Rise time delay			40	50	60	ns
	10% to 90% rise			25	40	50	ns
	Fall time delay			30	40	50	ns
	90% to 10% fall			25	40	50	ns
FROM N.I. INPUT TO OUTPUT							
	Rise time delay			30	40	50	ns
	10% to 90% rise			25	40	50	ns
	Fall time delay			45	55	65	ns
	90% to 10% fall			25	40	50	ns
V_C	Cross-conduction current spike duration	Output rise		25			ns
		Output fall		0			ns
	Analog shutdown delay	Stop non-Inv. = 0 V		180			ns
		Stop Inv. = 0 to 0.5 V		180			ns
	Digital shutdown delay	2 V input on Pin 7		50			ns

7 Parameter Measurement Information

7.1 Simplified Internal Circuitry

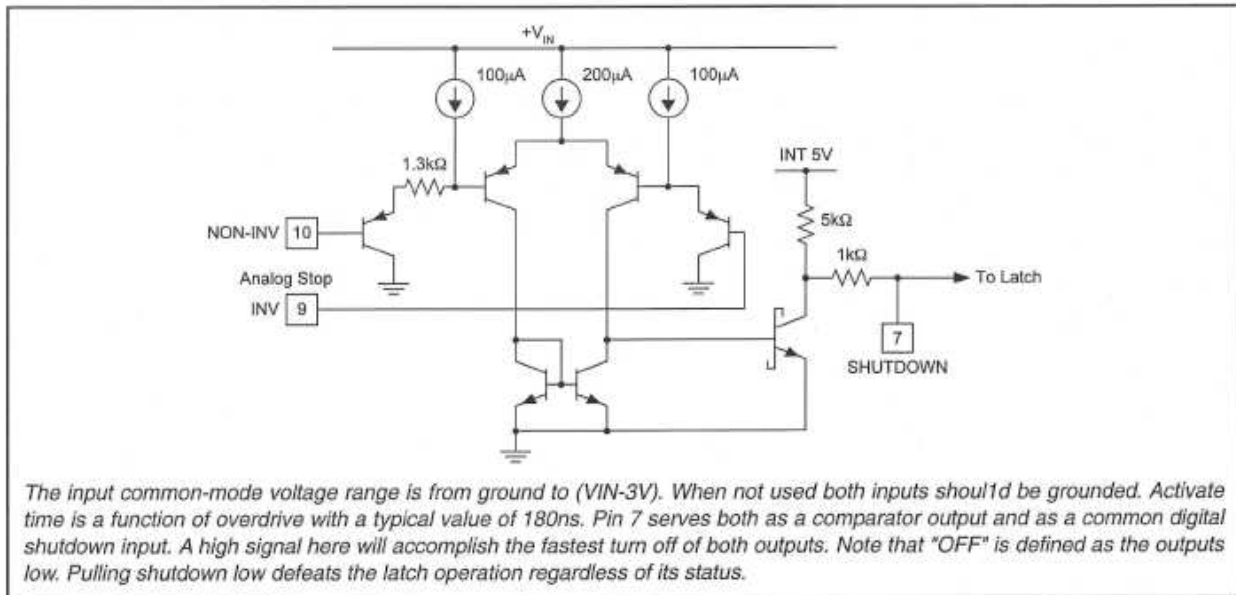


Figure 1. Typical Digital Input Gate

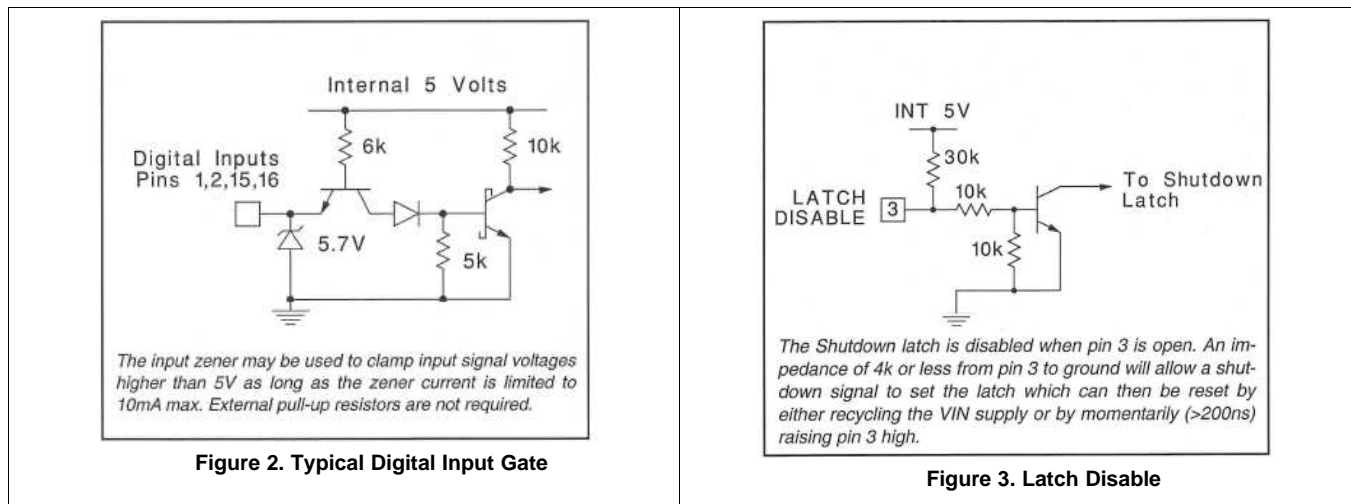


Figure 2. Typical Digital Input Gate

Figure 3. Latch Disable

Simplified Internal Circuitry (continued)

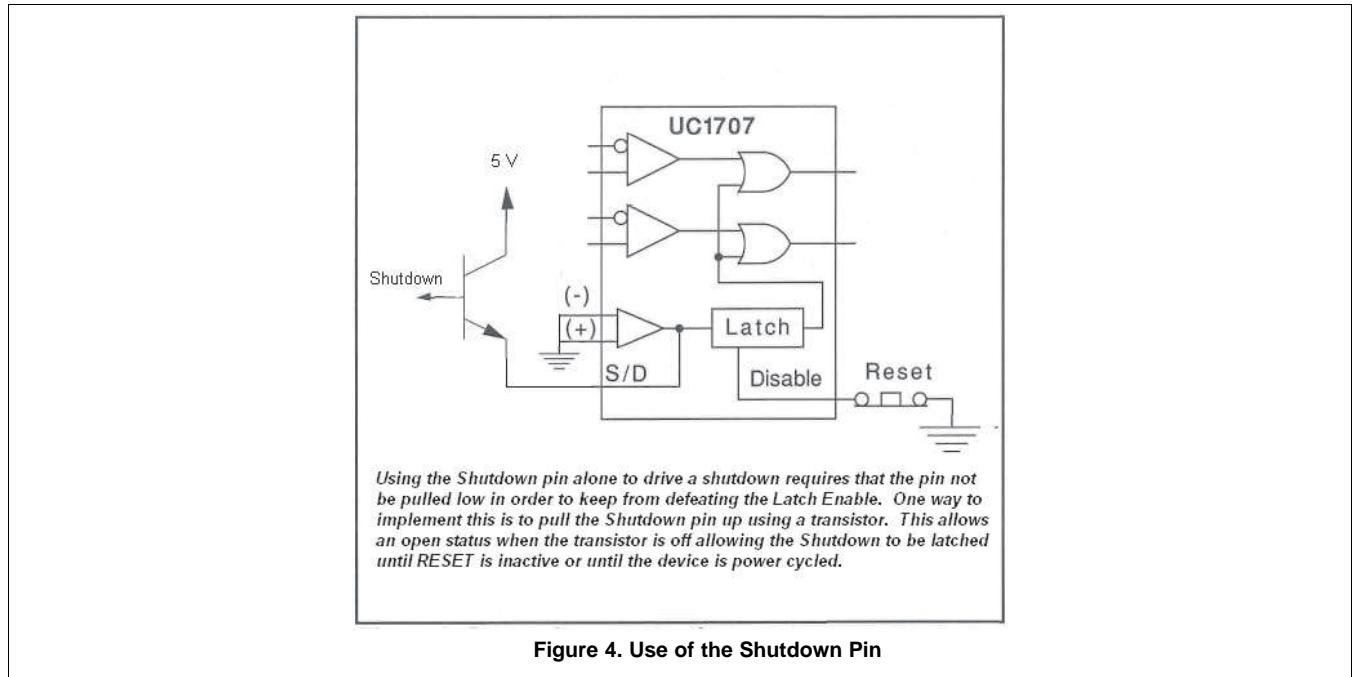


Figure 4. Use of the Shutdown Pin

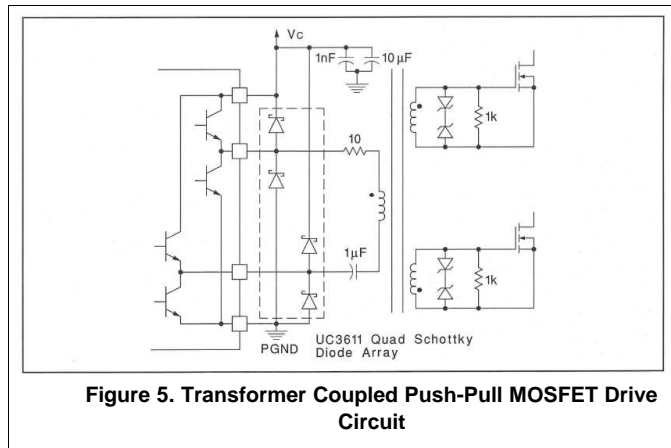


Figure 5. Transformer Coupled Push-Pull MOSFET Drive Circuit

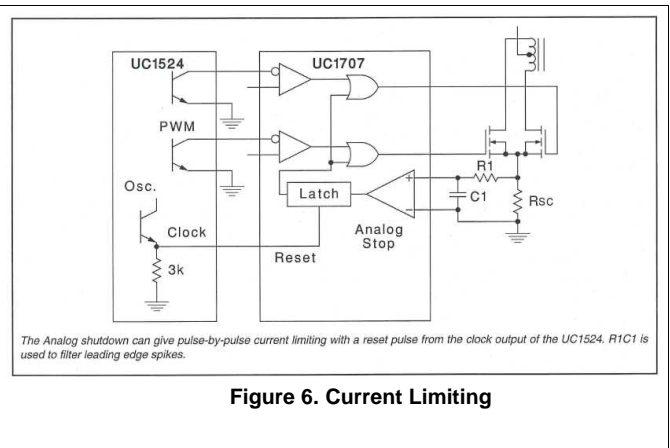


Figure 6. Current Limiting

Simplified Internal Circuitry (continued)

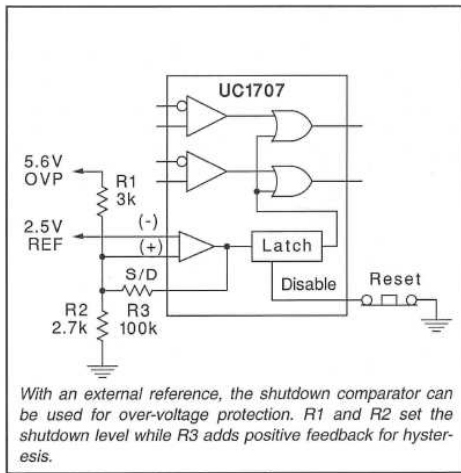


Figure 7. Overvoltage Protection

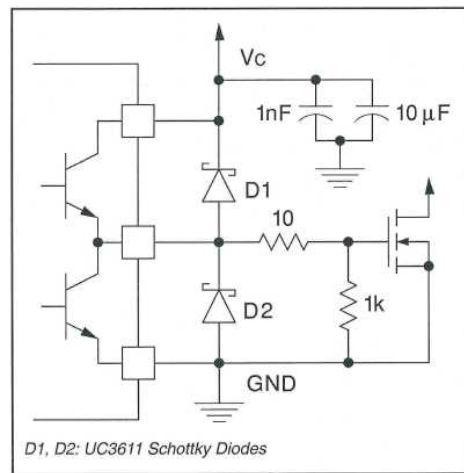


Figure 8. Power MOSFET Drive Circuit

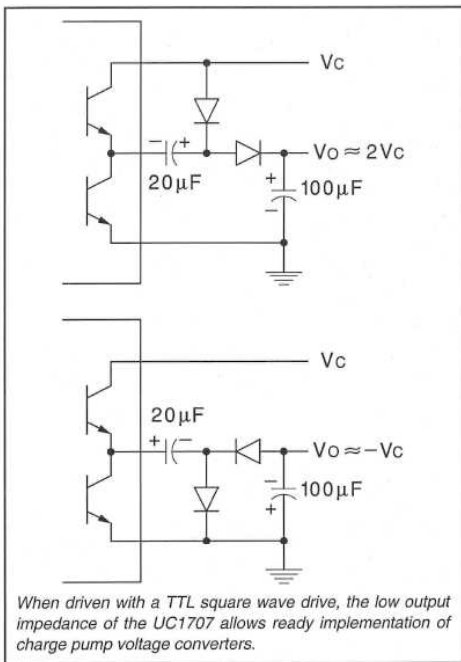


Figure 9. Charge Pump Circuits

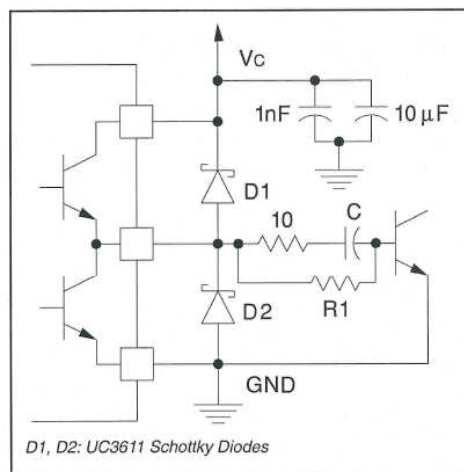


Figure 10. Power Bipolar Drive Circuit

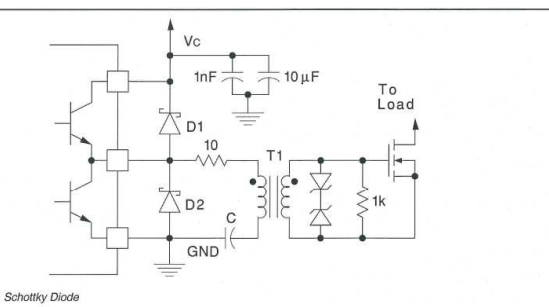


Figure 11. Transformer Coupled MOSFET Drive Circuit

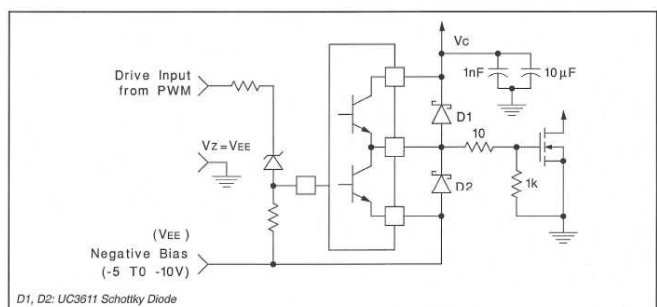


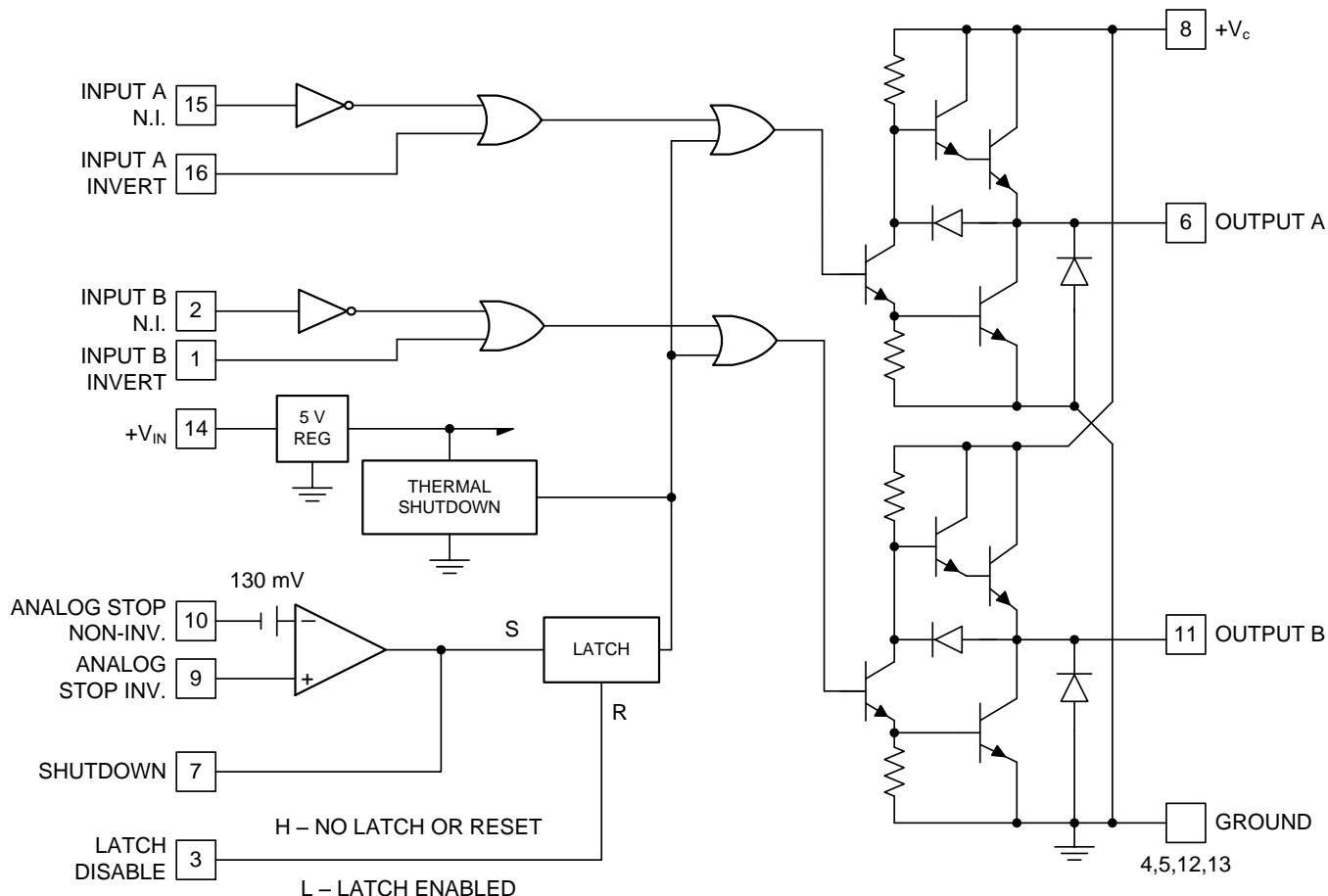
Figure 12. Power MOSFET Drive Circuit Using Negative Bias Voltage and Level Shifting to Ground Reference PWM

8 Detailed Description

8.1 Overview

UC1707-SP was designed specifically as a power MOSFET driver for switching-mode power supply applications. It is capable of providing fast transitions and high-peak current required by power MOSFETs. One of the most important factors while developing the UC1707-SP was to isolate the high speed switching noise from the low level analog signals at the PWM. Separate supply and return paths at the driver signal inputs and power outputs further enhance noise immunity.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Shutdown Circuit Description

The function of the circuitry is to be able to provide a shutdown of the device. This is defined as functionality that will drive both outputs to the low state. There are three different inputs that govern this shutdown capability.

- Analog Stop Pins — The differential inputs to this comparator provide a way to execute a shutdown.
- Latch Disable Pin — Assuming that the Shutdown pin is left open, a high on this pin disables the latching functionality of the Analog Stop shutdown. A low on this pin enables the latching functionality of the Analog Stop shutdown. If a shutdown occurs through the Analog Stop circuit while Latch Disable is high, then the outputs will go low, but will return to normal operation as soon as the Analog Stop circuit allows it. If a shutdown occurs through the Analog Stop circuit while Latch Disable is low, then the outputs will go low and remain low even if the Analog Stop circuit no longer drives the shutdown. The outputs will remain "latched" low (in shutdown) until the Latch Disable goes high and the Analog Stop circuit allows it to return from shutdown or the VIN voltage is cycled to 0 V and then returned above 5 V.

Feature Description (continued)

- Shutdown Pin — This pin serves two purposes.
 1. It can be used as an output of the Analog Stop circuit.
 2. It can be used as an input to force a shutdown or to force the device out of shutdown. This pin can override both the Analog Stop circuit as well as the Latch Disable Pin. When driving hard logic levels into the Shutdown pin, the Latch Disable functionality will be overridden and the Latch Disable will not function as it does when used in conjunction with the Analog Stop circuit. When the Shutdown pin is high, the outputs will be in the low state (shutdown). When the Shutdown pin is low (hard logic low) the outputs will operate normally, regardless of the state of the Latch Disable pin or the Analog Stop pins.

To use the Shutdown Pin with the Latch Disable functional it is necessary to use either a diode in series with the Shutdown signal or to use an open collector pullup so that the Shutdown pin is not pulled low. This configuration will allow the Latch Disable function to work with the Shutdown pin.

8.4 Device Functional Modes

Table 1. UG1707 Shutdown Truth Table

ANALOG STOP LOGIC	SHUTDOWN	LATCH DISABLE	PREVIOUS STATE OF OUTPUT	OUTPUT
X	0	X	X	Follows Input Logic
X	1	X	X	Low (Shutdown)
1	Open	X	X	Low (Shutdown)
0	Open	0	Shutdown	Latched Shutdown ⁽¹⁾
0	Open	0	Normal	Follows Input Logic
0	Open	1	X	Follows Input Logic

- (1) If the output was previously in Shutdown and Latch Disable was low and stays low, then even if the Analog Stop Logic is changed or the Shutdown pin is open, the outputs will remain in Shutdown.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

UC1707-SP MOSFET driver IC is designed to provide fast transition and high peak currents required for the MOSFETs. Each driver features TTL compatible input thresholds, undervoltage lockout, thermal shutdown and low cross conduction, high-speed output circuitry. The peak current of each totem-pole output, whether source or sink is 1.5 A. However, on dual output versions as in UC1707-SP both of the outputs can be paralleled for 3-A peak current.

9.2 Typical Application

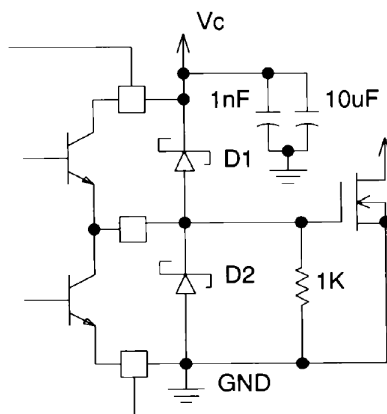


Figure 13. Power MOSFET Drive Circuit

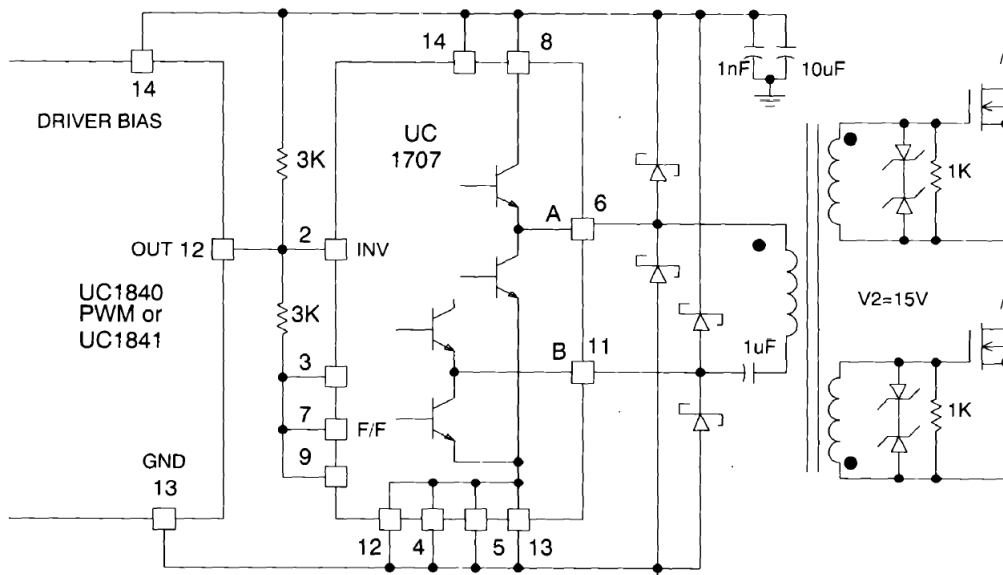


Figure 14. Convert Single Output PWMS High-Current Push-Pull Configuration

Typical Application (continued)

9.2.1 Design Requirements

Push-Pull Transformer coupling – driving MOSFETs with transformer coupled winding.

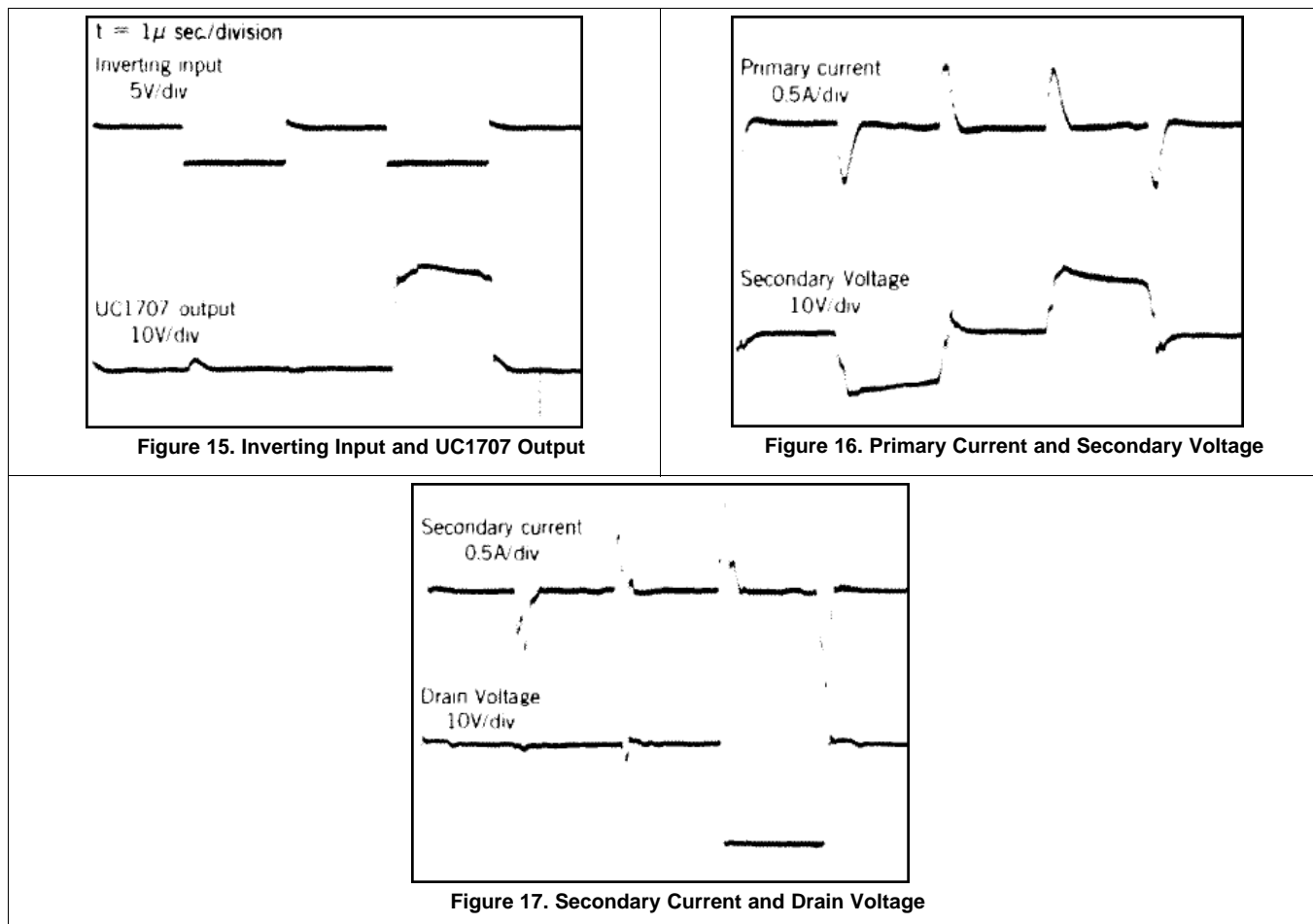
9.2.2 Detailed Design Procedure

The totem-pole outputs of the UC1707-SP can easily be configured for implementing the balanced transformer drive as shown in [Figure 14](#). Output A and B are alternating now as the internal flip-flop is active and the output frequency is halved. When the UC1707-SP output goes high, the other is held low during the dead time between output pulses. With balanced operation, no coupling capacitor on the primary is necessary since there is no net DC in the primary. Schottky clamp diodes on the primary side and back to back Zener diodes on the secondary are necessary to minimize the overshoot caused by the ringing of the gate capacitance with circuit inductances.

9.2.3 Application Curves

$t = 1 \mu\text{s}/\text{DIV}$.

The following waveforms refer to the application in [Figure 14](#).



10 Power Supply Recommendations

It is important that the localized capacitors be placed close to the driver V_C / V_{IN} pins.

Layout is critical to ensure that the driver is placed close to the MOSFETs that are being driven

Adding Schottky diodes prevent the negative transition (below ground) at the derived outputs.

11 Layout

11.1 Layout Guidelines

Directly connecting the MOSFET gate to the output of the driver is straightforward for testing purposes. It does not represent the "real" application which may include several inches of printed circuit board traces. Inductance will sharply degrade the transitions and cause substantial overshoot by ringing with the gate capacitance. This can cause the gate-to-source voltage to overshoot beyond the specified maximum ratings. Additionally, negative transitions (below ground) at the driver output can raise havoc with the internal circuitry, leading to undesirable performance.

Adding Schottky diodes to auxiliary supply rail can help address these concerns.

11.2 Layout Example

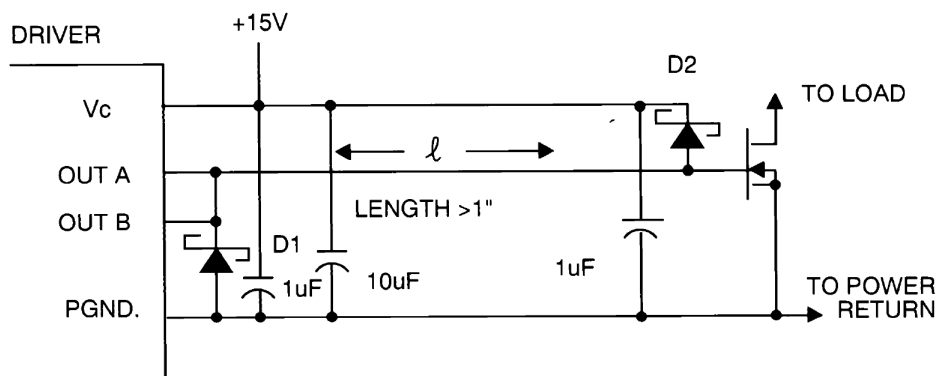


Figure 18. Layout

12 Device and Documentation Support

12.1 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.2 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-8761901V2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-8761901V2A UC1707L QMLV	Samples
5962-8761901VEA	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8761901VE A UC1707JQMLV	Samples
5962-8761903V2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-8761903V2A UC1707L-SP	Samples
5962-8761903VEA	ACTIVE	CDIP	J	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8761903VE A UC1707J-SP	Samples
5962-8761903VFA	ACTIVE	CFP	W	16	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-8761903VF A UC1707W-SP	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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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.

OTHER QUALIFIED VERSIONS OF UC1707-SP :

- Catalog: [UC1707](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

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 GDFP2-F16

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.

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

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced 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.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources 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.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.