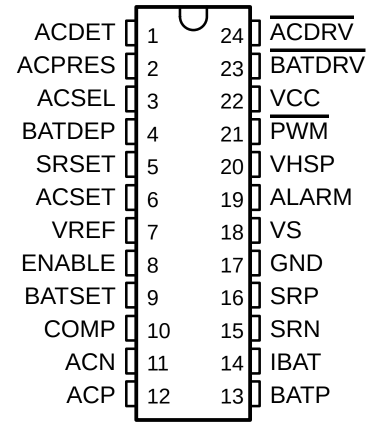
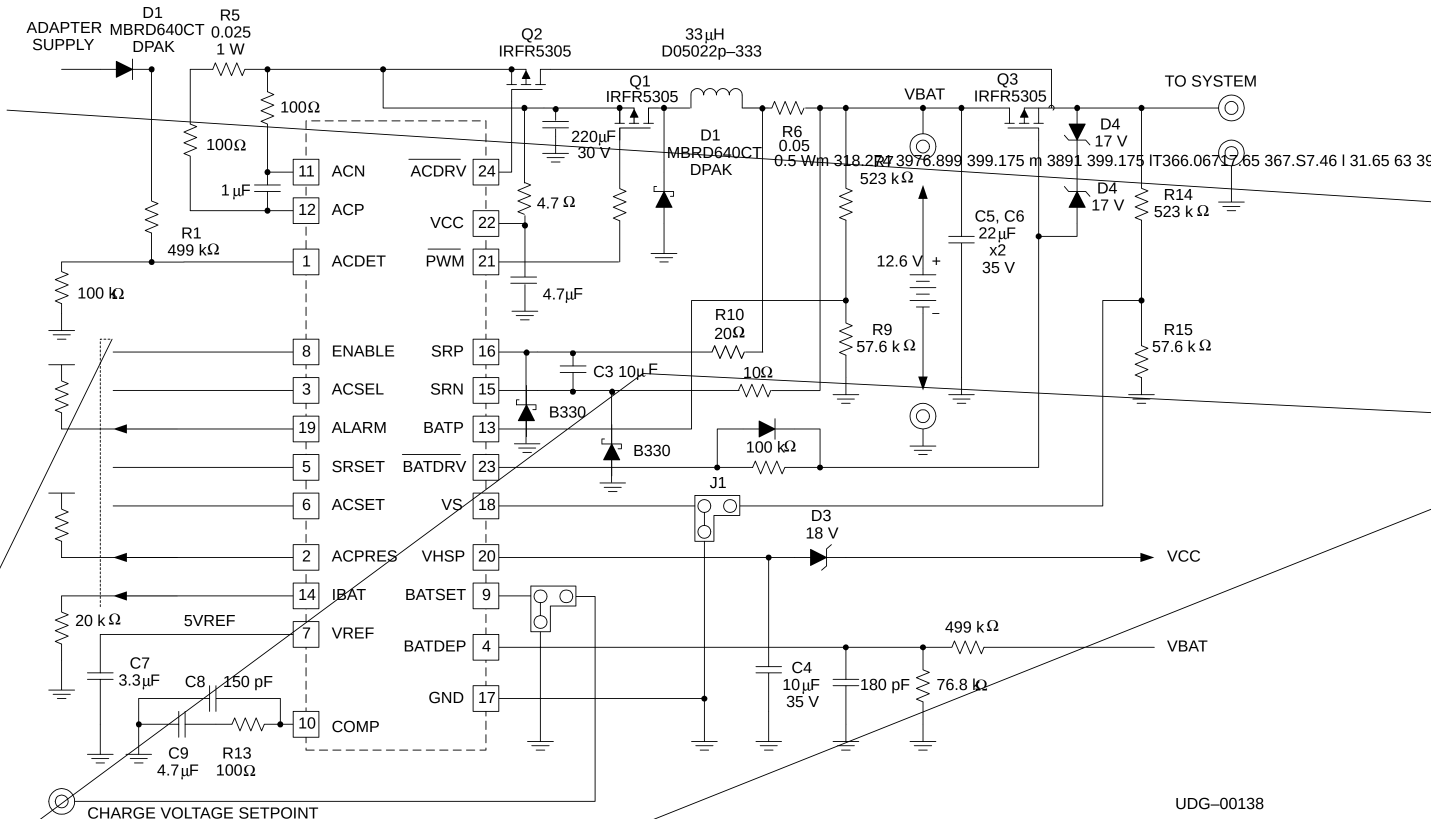
- Dynamic Power Management, DPM Minimizes Battery Charge Time
- Integrated Selector Supports Battery Conditioning and Smart Battery Learn Cycle
- Selector Feedback Circuit Insures Break-Before-Make Transition
- ±0.4% Charge Voltage Accuracy, Suitable for Charging Li-Ion Cells
- ±4% Charge Current Accuracy
- 300-kHz Integrated PWM Controller for High-Efficiency Buck Regulation
- Depleted Battery Detection and Indication to Protect Battery From Over Discharge
- 15-µA Sleep Mode Current for Low Battery Drain
- Designed for Charge Management of NiCd/NiMH and Li-Ion/Li-Pol Battery Packs
- 24-Pin TSSOP Package

PW PACKAGE
(TOP VIEW)



application schematic

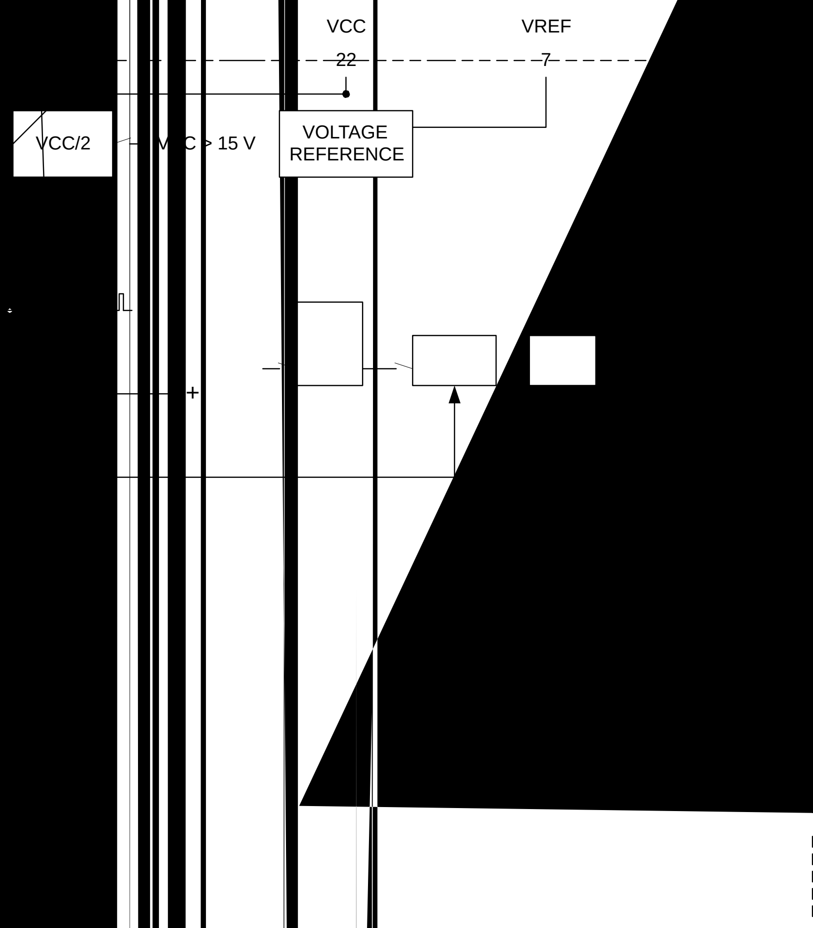


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA i f ai i c e a f blica i da e. P d c c f ecifica i e he e f Te a I e a dad a a . P d ci ce i g d e ece ail i cl de e i g f all a a ee .

Copyright © 2002, Texas Instruments Incorporated

TEXAS INSTRUMENTS


VCC
22
VREF
7
VCC/2
VCC > 15 V
VOLTAGE
REFERENCE
+

×

electrical characteristics ($T_A = T_{OPR}$, 7.0 Vdc V_{CC} 20.0 Vdc, all voltages relative to V_{SS}) (unless otherwise specified) (continued)

adapter current-sense amplifier

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
g_m	Transconductance gain		90	150	210	mA/V
CMRR	Common-mode rejection ratio	See Note 1		90		dB
V_{ICR}	Common-mode input voltage range (ACP)		7.0		V_{CC}+0.2	V
I_{SINK}	Sink current (COMP)	COMP = 1 V, (ACP – ACN) = 10 mV	0.5	1.5	2.5	mA
I_{IB}	Input bias current (ACP, ACN)	ACP = ACN = 20 V, SRSET = 0 V, VCC = 20 V, ACSET = 1.25 V	15	25	35	µA
	Input bias current accuracy ratio (ACP, ACN)	ACP = ACN = 20 V, VCC = 20 V, ACSET = 1.25 V	0.95	1.00	1.05	
V_{SET}	AC current programming voltage (ACSET)		0		2.5	V
A_V	AC current set gain	0.65 V ≤ ACSET ≤ 2.5 V, 12 V ≤ ACP ≤ 20 V, –40°C ≤ T_A ≤ 85°C, See Note 4	24.5	25.5	26.5	V/V
	Total ac current-sense mid-scale accuracy	ACSET = 1.25 V, T_A = 25°C, See Note 5	–5%		5%	
		ACSET = 1.25 V, –40°C ≤ T_A ≤ 85°C, See Note 5	–6%		6%	
	Total ac current-sense full-scale accuracy	ACSET = 2.5 V, T_A = 25°C, See Note 5	–3.5%		3.5%	
		ACSET = 2.5 V, –40°C ≤ T_A ≤ 85°C, See Note 5	–4%		4%	

battery voltage error amplifier

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
g_m	Transconductance gain		75	135	195	mA/V
CMRR	Common-mode rejection ratio	See Note 1		90		dB
V_{ICR}	BATSET common-mode input voltage range		1		2.5	V
V_{IT}	Internal reference override input threshold voltage		0.20	0.25	0.30	V
I_{SINK}	Sink current COMP	COMP = 1 V, (BATP – BATSET) = 10 mV, BATSET = 1.25 V	0.5	1.5	2.5	mA
V_{FB}	Error-amplifier precision reference voltage	T_A = 25°C	1.241	1.246	1.251	V
		0°C ≤ T_A ≤ 70°C	1.239	1.246	1.252	
		–40°C ≤ T_A ≤ 85°C	1.234	1.246	1.254	

NOTES: 1. Ensured by design. Not production tested.

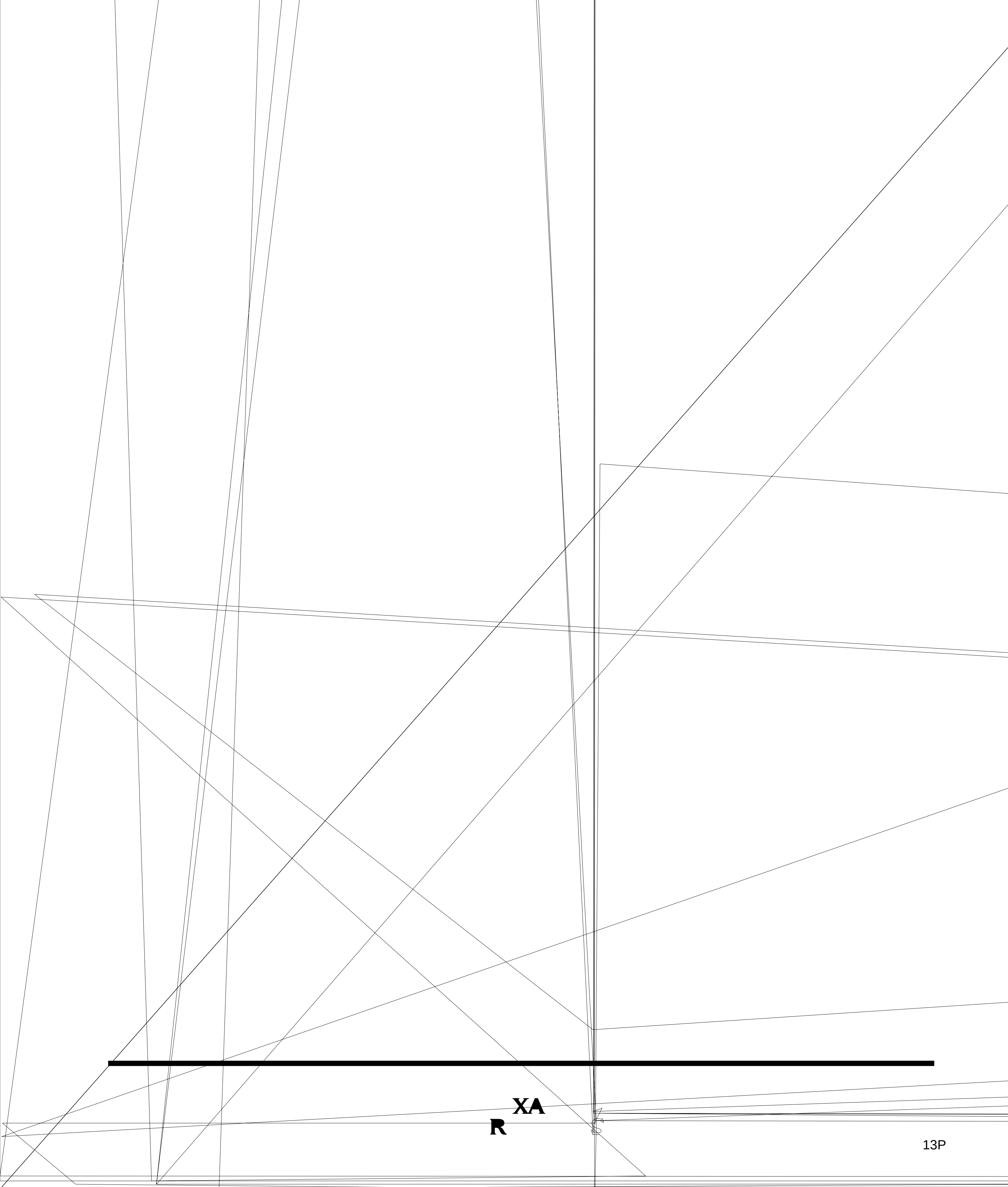
2. $I_{BAT} = \frac{SRSET}{R_{SENSE}} \times \frac{1}{A_V}$

3. Total battery-current set is based on the measured value of (SRP–SRN) =

electrical characteristics ($T_A = T_{OPR}$, 7.0 Vdc V_{CC} 20.0 Vdc, all voltages relative to V_{SS}) (unless otherwise specified) (continued)

MOSFET gate drive

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	AC driver $R_{DS(on)}$ high	V_{CC} = 18 V		150	250	Ω
	AC driver $R_{DS(on)}$ low	V_{CC} = 18 V		60	120	Ω
	Battery driver $R_{DS(on)}$ high	V_{CC} = 18 V		200	370	Ω
	Battery driver $R_{DS(on)}$ low	V_{CC} = 18 V		100	170	Ω
t_{Da}	Time delay from ac driver off to battery driver on	ACSEL 2.4 V ⇓ 0.2 V		0.5	1.5	µs
t_{Db}	Time delay from battery driver off to ac driver on	ACSEL 0.2 V ⇑ 2.4 V		1.0	2.0	µs
V_{OH}	PWM driver high-level output voltage	I_{OUT} = –10 mA, VCC = 18 V	–0.12	–0.07		V
		I_{OUT} = –100 mA, VCC = 18 V	–1.2	–0.7		


XA
R

m amplifiers are tied … e, internally biased

APPLICATION INFORMATION

R_S

UDG–00117

APPLICATION INFORMATION

The RMS current through the MOSFET is defined as:

$$I_{IN}(RMS) = I_{IN}(avg) \times \sqrt{\frac{1}{D}} \;\; A_{RMS}$$

Schottky rectifier (freewheeling)

The freewheeling Schottky rectifier must also be selected to withstand the input voltage, V_{IN}. The average current can be approximated from:

$$I_{D1}(avg) = I_O \times (1 - D) \;\; A$$

choosing an inductance

Low inductance values result in a steep current ramp or slope. Steeper current slopes result in the converter operating in the discontinuous mode at a higher power level. Steeper current slopes also result in higher output ripple current, which may require a higher number, or more expensive capacitors to filter the higher ripple current.

In addition, the higher ripple current results in an error in the sensed battery current particularly at lower charging currents. It is recommended that the ripple current not exceed 20% to 30% of full scale dc current.

$$L = \frac{\left(V_{IN} - V_{BAT}\right) \times V_{BAT}}{fs \times 0.2 \times I_{FS} \times V_{IN}}$$

Too large an inductor value results in the current waveform of Q1 and D1 in Figure 8 approximating a

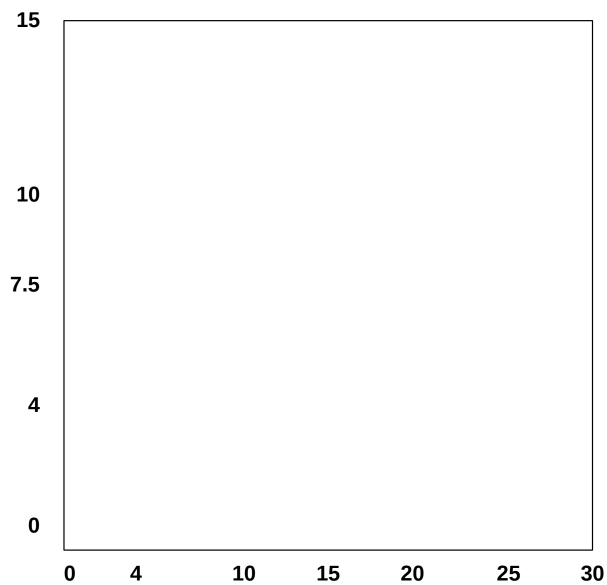
I

APPLICATION INFORMATION

PWM selector switch gate drive

Because the external P-channel MOSFETs (as well as the internal MOSFETs) have a maximum gate-source voltage limitation of 20 V, the input voltage, VCC, cannot be used directly to drive the MOSFET gate under all input conditions. To provide safe MOSFET-gate-drive at input voltages of less than 20 V, an intermediate gate drive voltage rail was established (VSHP). As shown in Figure 11, VSHP has a stepped profile. For VCC voltages of less than 15 V, VSHP = 0 and the full VCC voltage is used to drive the MOSFET gate. At input voltages of greater than 15 V, VSHP steps to approximately one-half the VCC voltage. This ensures adequate enhancement voltage across all operating conditions.

The gate drive voltage, Vgs, vs VCC for the PWM, and ac selector P-channel MOSFETs are shown in Figure 11.



TYPICAL CHARACTERISTICS

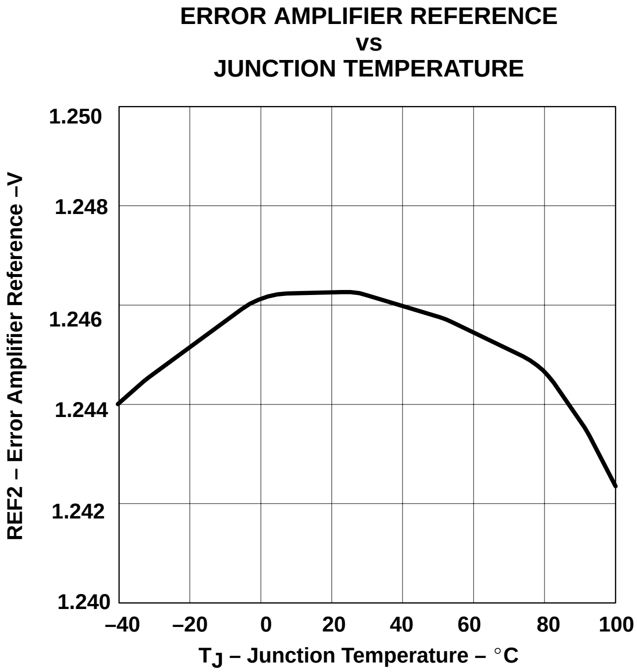


Figure 12

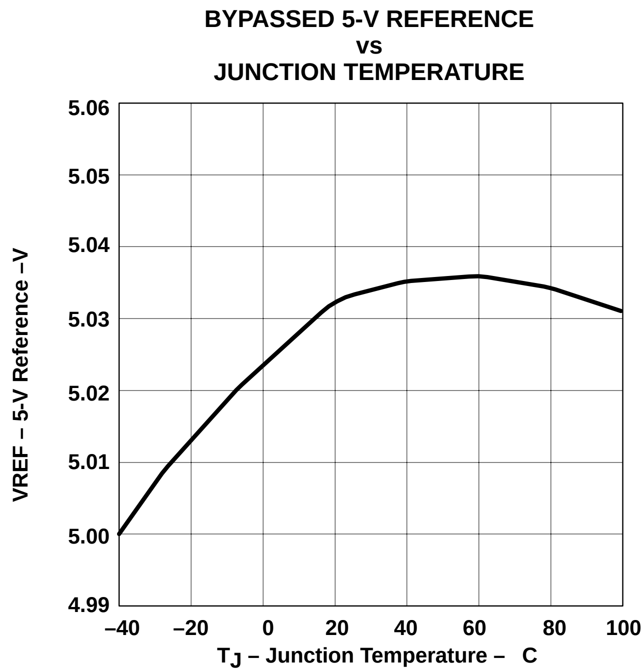


Figure 13

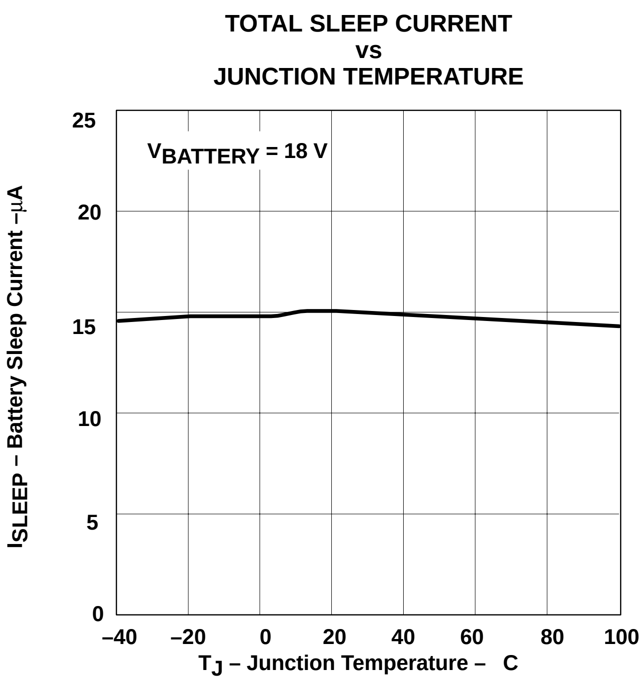


Figure 14

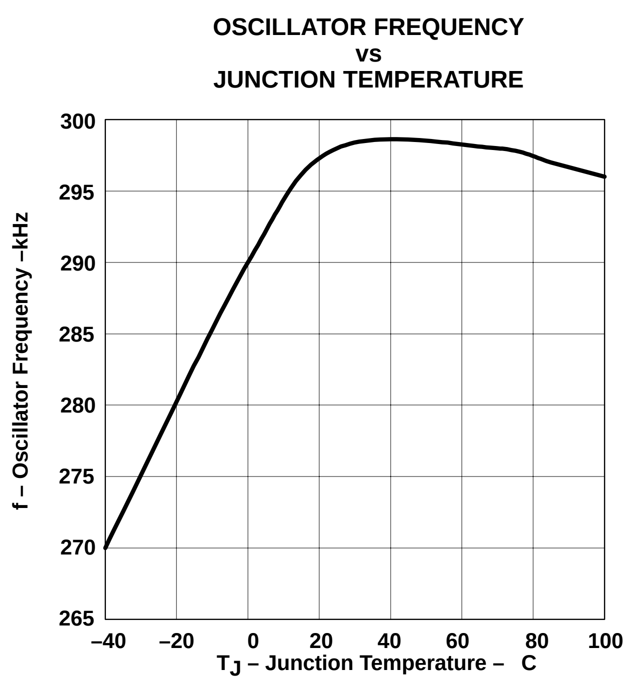


Figure 15

[redacted]

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
BQ24700PW	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI
BQ24700PWR	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI
BQ24700PWRG4	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI
BQ24701PW	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI
BQ24701PWG4	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI
BQ24701PWR	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI
BQ24701PWRG4	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI

(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.

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**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com	Wireless	www.ti.com/wireless-apps
RF/IF and ZigBee® Solutions	www.ti.com/lprf		
		TI E2E Community Home Page	e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated