# LB11696V

Monolithic Digital IC

Direct PWM Drive Brushless Motor Predriver IC

ON Semiconductor®

Overview

The LB11696V is a direct PWM drive predriver IC designed for three-phase power brushless motors. A motor driver circuit with the desired output power (voltage and current) can be implemented by adding discrete transistors in the output circuits. Furthermore, the LB11696V provides a full complement of protection circuits allowing it to easily implement high-reliability drive circuits. This device is optimal for driving all types of large-scale motors such as those used in air conditioners and on-demand water heaters.
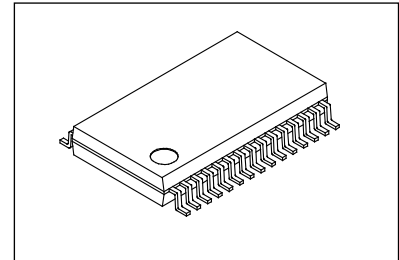
SSOP30 (275mil)

Features

- Three-phase bipolar drive
- Direct PWM drive (controlled either by control voltage or PWM variable duty pulse input)
- Built-in forward/reverse switching circuit
- Start/stop mode switching circuit (stop mode power saving function)
- Built-in input amplifier
- 5 V regulator output (VREG pin)
- Current limiter circuit (Supports 0.25 V (typical) reference voltage sensing based high-precision detection)
- Undervoltage protection circuit (The operating voltage can be set with a zener diode)
- Automatic recovery type constraint protection circuit with protection operating state discrimination output (RD pin)
- Four types of Hall signal pulse outputs
- Supports thermistor based thermal protection of the output transistors

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	unit
Supply voltage 1	V_{CC} max	V_{CC} pin	18	V
Output current	I_O max	UL, VL, WL, UH, VH, and WH pins	30	mA
LVS pin applied voltage	LVS max	LVS pin	18	V
Allowable power dissipation 1	Pd max 1	Independent IC	0.45	W
Allowable power dissipation 2	Pd max 2	When mounted on a 114.3 × 76.1 × 1.6 mm glass epoxy board	1.05	W
Operating temperature	Topr		−20 to +100	°C
Storage temperature	Tstg		−55 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

ORDERING INFORMATION

February, 2018 - Rev. 2

Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range 1-1	V_{CC}1-1	V_{CC} pin	8 to 17	V
Supply voltage range 1-2	V_{CC}1-2	V_{CC} pin, when V_{CC} is shorted to VREG.	4.5 to 5.5	V
Output current	I_O	UL, VL, WL, UH, VH, and WH pins	25	mA
5 V constant voltage output current	IREG		−30	mA
HP pin applied voltage	VHP		0 to 17	V
HP pin output current	IHP		0 to 15	mA
RD pin applied voltage	VRD		0 to 17	V
RD pin output current	IRD		0 to 15	mA

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

Electrical Characteristics at Ta = 25°C, V_{CC} = 12 V

Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Current drain 1	I_{CC}1			12	16	mA
Current drain 2	I_{CC}2	Stop mode		2.5	4	mA
[5 V Constant Voltage Output (VREG pin)]						
Output voltage	VREG		4.7	5.0	5.3	V
Line regulation	ΔVREG1	V_{CC} = 8 to 17 V		40	100	mV
Load regulation	ΔVREG2	I_O = −5 to −20 mA		10	30	mV
Temperature coefficient	ΔVREG3	Design target value		0		mV/°C
[Output Block]						
Output voltage 1-1	V_{OUT}1-1	Low level, I_O = 400 μA		0.2	0.5	V
Output voltage 1-2	V_{OUT}1-2	Low level, I_O = 10 mA		0.9	1.2	V
Output voltage 2	V_{OUT}2	High level, I_O = −20 mA	V_{CC} − 1.1	V_{CC} − 0.9		V
Output leakage current	$I_O$leak				10	μA
[Hall Amplifier Block]						
Input bias current	IHB (HA)		−2	−0.5		μA
Common-mode input voltage range 1	VICM1	When a Hall effect device is used	0.5		V_{CC} − 2.0	V
Common-mode input voltage range 2	VICM2	Single-sided input bias mode (when a Hall IC is used)	0		V_{CC}	V
Hall Input Sensitivity			80			mVp-p
Hysteresis	ΔVIN (HA)		15	24	40	mV
Input voltage low → high	VSLH (HA)		5	12	20	mV
Input voltage high → low	VSHL (HA)		−20	−12	−5	mV
[CTL Amplifier]						
Input offset voltage	V_{IO} (CTL)		−10		10	mV
Input bias current	I_B (CTL)		−1		1	μA
Common-mode input voltage range	VICM		0		VREG − 1.7	V
High-level output voltage	V_{OH} (CTL)	ITOC = −0.2 mA	VREG − 1.2	VREG − 0.8		V
Low-level output voltage	V_{OL} (CTL)	ITOC = 0.2 mA		0.8	1.05	V
Open-loop gain	G (CTL)	f (CTL) = 1 kHz	45	51		dB
[PWM Oscillator (PWM pin)]						
High-level output voltage	V_{OH} (PWM)		2.75	3.0	3.25	V
Low-level output voltage	V_{OL} (PWM)		1.2	1.35	1.5	V
External capacitor charge current	ICHG	VPWM = 2.1 V	−120	−90	−65	μA
Oscillator frequency	f (PWM)	C = 2000 pF		22		kHz
Amplitude	V (PWM)		1.4	1.6	1.9	Vp-p
[TOC pin]						
Input voltage 1	VTOC1	Output duty: 100%	2.68	3.0	3.34	V
Input voltage 2	VTOC2	Output duty: 0%	1.2	1.35	1.5	V
Input voltage 1 low	VTOC1L	Design target value, when VREG = 4.7 V, 100%	2.68	2.82	2.96	V
Input voltage 2 low	VTOC2L	Design target value, when VREG = 4.7 V, 0%	1.23	1.29	1.34	V
Input voltage 1 high	VTOC1H	Design target value, when VREG = 5.3 V, 100%	3.02	3.18	3.34	V
Input voltage 2 high	VTOC2H	Design target value, when VREG = 5.3 V, 0%	1.37	1.44	1.50	V
[HP Pin]						
Output saturation voltage	VHPL	I_O = 10 mA		0.2	0.5	V
Output leakage current	IHPleak	V_O = 18 V			10	μA

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Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
[CSD Oscillator (CSD pin)]						
High-level output voltage	V_{OH} (CSD)		2.7	3.0	3.3	V
Low-level output voltage	V_{OL} (CSD)		0.7	1.0	1.3	V
External capacitor charge current	ICHG1	VCSD = 2 V	−3.15	−2.5	−1.85	μA
External capacitor discharge current	ICHG2	VCSD = 2 V	0.1	0.14	0.18	μA
Charge/discharge current ratio	RCSD	(Charge current)/(discharge current)	15	18	21	times
[RD Pin]						
Low-level output voltage	VRDL	I_O = 10 mA		0.2	0.5	V
Output leakage current	I_L (RD)	V_O = 18 V			10	μA
[Current Limiter Circuit (RF pin)]						
Limiter voltage	VRF	RF-RFGND	0.225	0.25	0.275	V
[Undervoltage Protection Circuit (LVS pin)]						
Operating voltage	VSDL		3.5	3.7	3.9	V
Release voltage	VSDH		3.95	4.15	4.35	V
Hysteresis	ΔVSD		0.3	0.45	0.6	V
[PWMIN Pin]						
Input frequency	f (PI)				50	kHz
High-level input voltage	V_{IH} (PI)		2.0		VREG	V
Low-level input voltage	V_{IL} (PI)		0		1.0	V
Input open voltage	V_{IO} (PI)		VREG − 0.5		VREG	V
Hysteresis	V_{IS} (PI)		0.2	0.25	0.4	V
High-level input current	I_{IH} (PI)	VPWMIN = VREG	−10	0	+10	μA
Low-level input current	I_{IL} (PI)	VPWMIN = 0 V	−130	−90		μA
[S/S Pin]						
High-level input voltage	V_{IH} (SS)		2.0		VREG	V
Low-level input voltage	V_{IL} (SS)		0		1.0	V
Hysteresis	V_{IS} (SS)		0.2	0.25	0.4	V
High-level input current	I_{IH} (SS)	VS/S = VREG	−10	0	+10	μA
Low-level input current	I_{IL} (SS)	VS/S = 0 V	−10	−1		μA
[F/R Pin]						
High-level input voltage	V_{IH} (FR)		2.0		VREG	V
Low-level input voltage	V_{IL} (FR)		0		1.0	V
Input open voltage	V_{IO} (FR)		VREG − 0.5		VREG	V
Hysteresis	V_{IS} (FR)		0.2	0.25	0.4	V
High-level input current	I_{IH} (FR)	VF/R = VREG	−10	0	+10	μA
Low-level input current	I_{IL} (FR)	VF/R = 0 V	−130	−90		μA
[N1 Pin]						
High-level input voltage	V_{IH} (N1)		2.0		VREG	V
Low-level input voltage	V_{IL} (N1)		0		1.0	V
Input open voltage	V_{IO} (N1)		VREG − 0.5		VREG	V
High-level input current	I_{IH} (N1)	VN1 = VREG	−10	0	+10	μA
Low-level input current	I_{IL} (N1)	VN1 = 0 V	−130	−100		μA
[N2 Pin]						
High-level input voltage	V_{IH} (N2)		2.0		VREG	V
Low-level input voltage	V_{IL} (N2)		0		1.0	V
Input open voltage	V_{IO} (N2)		VREG − 0.5		VREG	V
High-level input current	I_{IH} (N2)	VN2 = VREG	−10	0	+10	μA
Low-level input current	I_{IL} (N2)	VN2 = 0 V	−130	−100		μA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

Three-Phase Logic Truth Table ("IN = 'H'" indicates the state where IN+ > IN−.)

	F/R = L			F/R = H			Output	
	IN1	IN2	IN3	IN1	IN2	IN3	PWM	—
1	H	L	H	L	H	L	VH	UL
2	H	L	L	L	H	H	WH	UL
3	H	H	L	L	L	H	WH	VL
4	L	H	L	H	L	H	UH	VL
5	L	H	H	H	L	L	UH	WL
6	L	L	H	H	H	L	VH	WL

S/S Pin

Input state	State
H	Stop
L	Start

PWMIN Pin

Input state	State
High or open	Output off
L	Output on

N1 and N2 Pins

Input state		HP output
N1 pin	N2 pin	
L	L	Single Hall sensor period divided by 2
L	High or open	Single Hall sensor period
High or open	L	Three Hall sensor synthesized period divided by 2
High or open	High or open	Three Hall sensor synthesized period

Since the S/S pin does not have an internal pull-up resistor, an external pull-up resistor or equivalent is required to set the IC to the stop state. If either the S/S or PWMIN pins are not used, the unused pin input must be set to the low-level voltage.

The HP output can be selected (by the N1 and N2 settings) to be one of the following four functions: the IN1 Hall input converted to a pulse output (one-Hall output), the one-Hall output divided by two, the three-phase output synthesized from the Hall inputs (three-Hall synthesized output) or the three-Hall synthesized output divided by two.

Pd max — Ta

114.3mm × 76.1mm × 1.6mm glass epoxy board

Independent

0.42

0.18

Allowable power dissipation, Pdmax Ñ W

Ambient temperature, Ta — °C
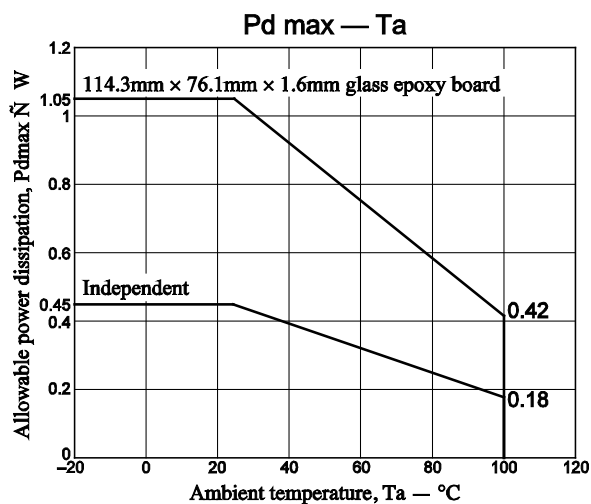
Package Dimensions

unit : mm

SSOP30 (275mil)
CASE 565AT
ISSUE A
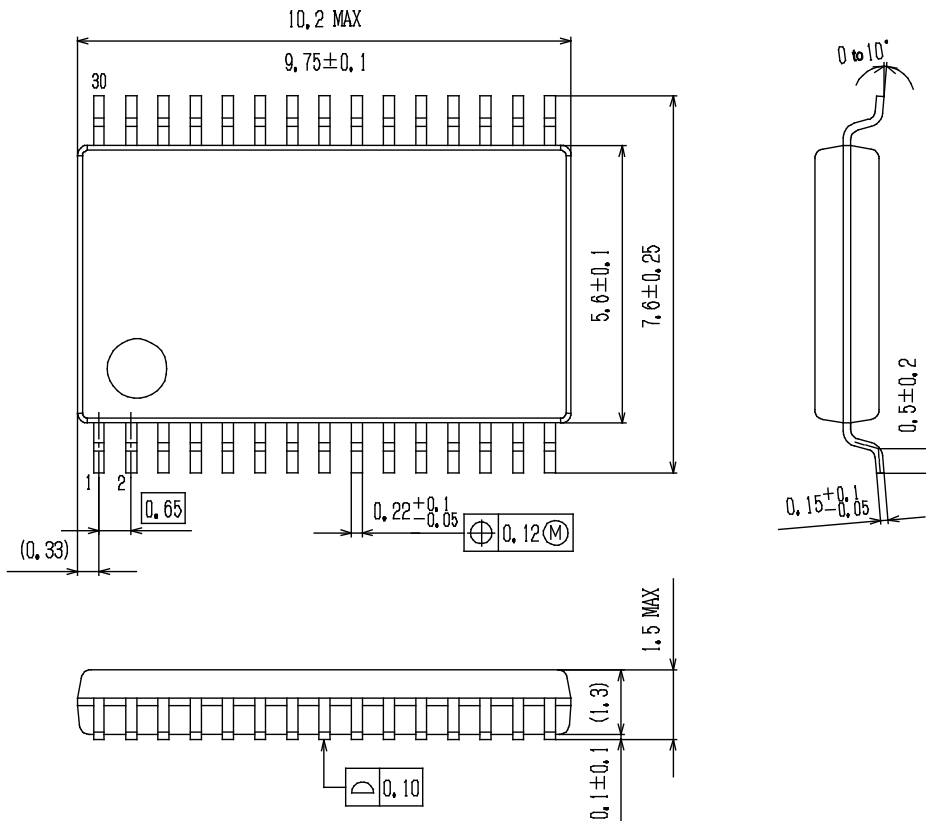
SOLDERING FOOTPRINT*

(Unit: mm)

1.00

7.00

0.65   0.32
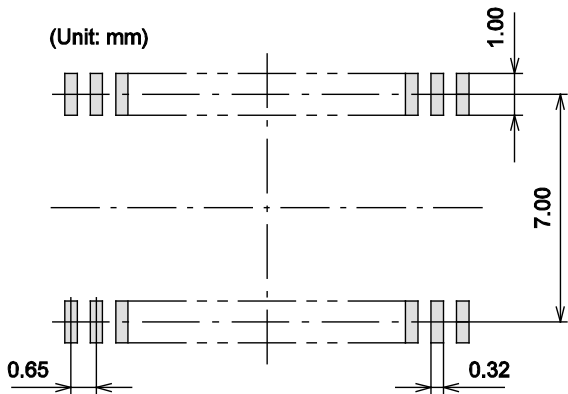
NOTE: The measurements are not to guarantee but for reference only.

   *For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

**GENERIC
MARKING DIAGRAM***
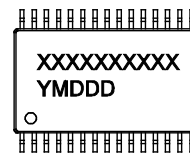
XXXXXXXXXX
YMDDD

XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

  *This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

ORDERING INFORMATION

Device	Package	Wire bond	Shipping (Qty / Packing)
LB11696V-MPB-E	SSOP30 (275mil) (Pb-Free)	Au wire	48 / Fan-Fold
LB11696V-TLM-E	SSOP30 (275mil) (Pb-Free)	Au wire	1000 / Tape & Reel
LB11696V-TRM-E	SSOP30 (275mil) (Pb-Free)	Au wire	1000 / Tape & Reel
LB11696V-TLM-H	SSOP30 (275mil) (Pb-Free / Halogen Free)	Au wire	1000 / Tape & Reel
LB11696V-W-AH	SSOP30 (275mil) (Pb-Free / Halogen Free)	Cu wire	1000 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel
  Packaging Specifications Brochure, BRD8011/D. http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF