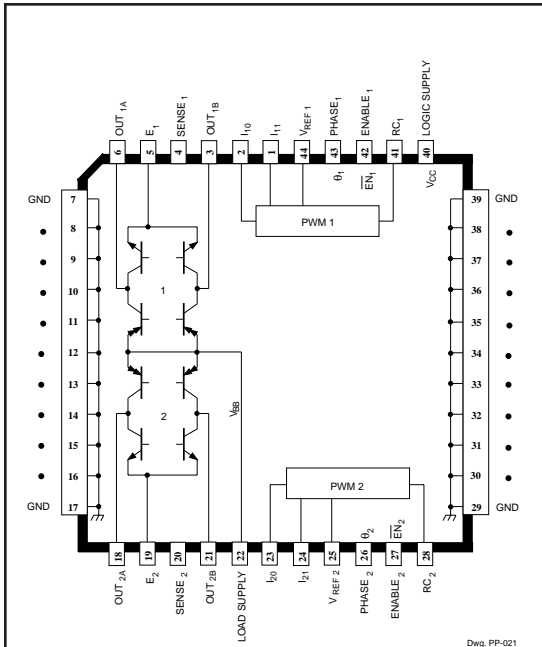


## PRELIMINARY INFORMATION

(Subject to change without notice)

September 16, 1997

## DUAL FULL-BRIDGE PWM MOTOR DRIVER



### ABSOLUTE MAXIMUM RATINGS at $T_J \leq +150^\circ\text{C}$

Motor Supply Voltage, $V_{BB}$ .....	<b>50 V</b>
Output Current, $I_{OUT}$ .....	<b><math>\pm 1.5</math> A</b>
Logic Supply Voltage, $V_{CC}$ .....	<b>7.0 V</b>
Logic Input Voltage Range, $V_{IN}$ .....	<b>-0.3 V to +7.0 V</b>
Output Emitter Voltage, $V_E$ .....	<b>1.0 V</b>
Package Power Dissipation, $P_D$ .....	<b>See Graph</b>
Operating Temperature Range, $T_A$ .....	<b>-20°C to +85°C</b>
Storage Temperature Range, $T_S$ .....	<b>-55°C to +150°C</b>

Output current rating may be limited by duty cycle, ambient temperature, and heat sinking. Under any set of conditions, do not exceed the specified peak current rating or a junction temperature of +150°C.

The A2927SEB motor driver is designed to drive both windings of a bipolar stepper motor or bidirectionally control two dc motors. Both bridges are capable of sustaining 50 V and include internal pulse-width modulation (PWM) control of the output current to 1.5 A.

For PWM current control, the maximum output current is determined by the user's selection of a reference voltage and sensing resistor. Two logic-level inputs select output current limits of 0, 33%, 67%, or 100% of the maximum level. A PHASE input to each bridge determines load current direction. Active-low ENABLE inputs control the four drivers in each bridge.

Internally generated delays prevent cross-over currents when switching current direction. Special power-up sequencing is not required. Thermal protection circuitry disables the outputs if the chip temperature exceeds safe operating limits.

The A2927SEB is supplied in a 44-lead power PLCC for surface-mount applications. Its batwing construction provides for maximum package power dissipation in the smallest possible construction.

### FEATURES

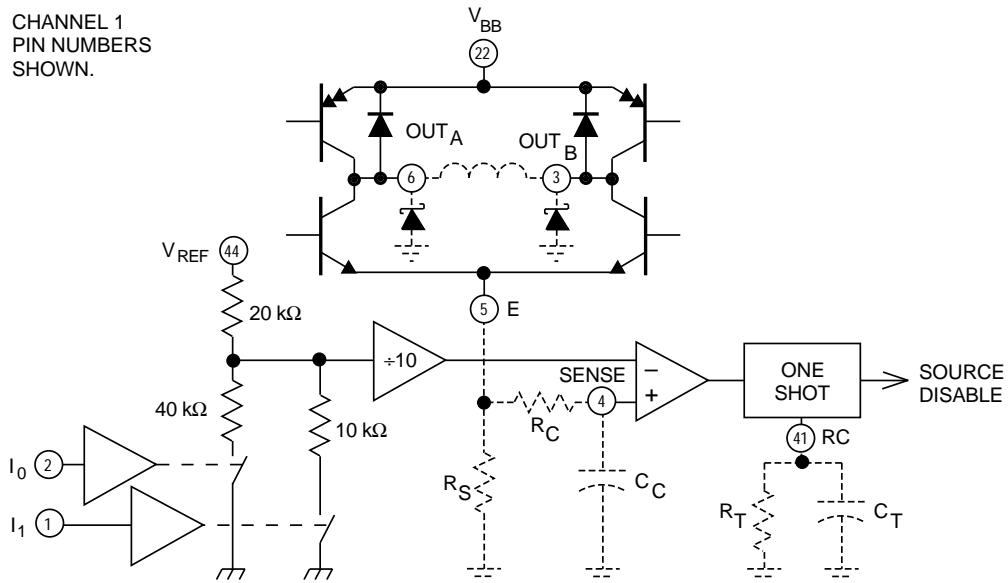
- 1.5 A Output Current
- 50 V Output Sustaining Voltage
- Internal Flyback Diodes
- Digital Control of Output Current
- Undervoltage Lockout
- Internal Thermal Shutdown Circuitry

Always order by complete part number: **A2927SEB**.

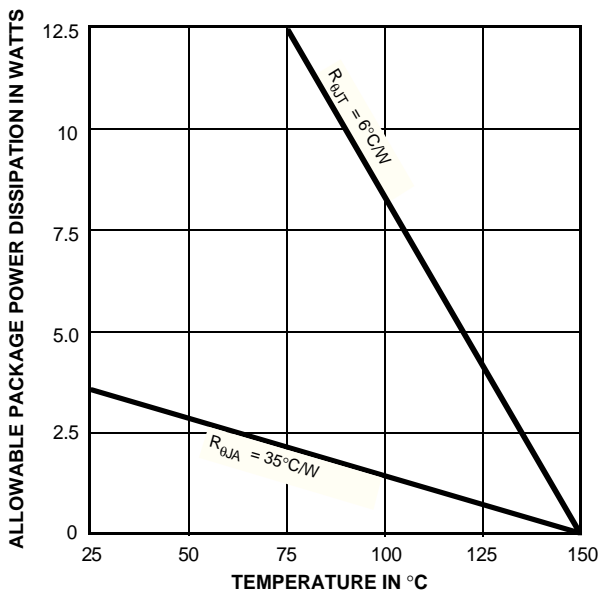
# 2927 DUAL FULL-BRIDGE PWM MOTOR DRIVER

## PWM CURRENT-CONTROL CIRCUITRY

CHANNEL 1  
PIN NUMBERS  
SHOWN.



Dwg. EP-007-4



Dwg. GP-020-1

## TRUTH TABLE

Enable	Phase	Out <sub>A</sub>	Out <sub>B</sub>
L	H	H	L
L	L	L	H
H	X	Z	Z

X = Don't care

Z = High impedance

# 2927

## DUAL FULL-BRIDGE PWM MOTOR DRIVER

**ELECTRICAL CHARACTERISTICS at  $T_A = +25^\circ\text{C}$ ,  $V_{BB} = 50\text{ V}$ ,  $V_{CC} = 5.0\text{ V}$ ,  $V_{REF} = 5.0\text{ V}$  (unless otherwise noted).**

Characteristic	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
<b>Output Drivers (OUT<sub>A</sub> or OUT<sub>B</sub>)</b>						
Motor Supply Range	$V_{BB}$	$I_{OUT} = \pm 1.5\text{ A}$ , $L = 15\text{ mH}$	10	—	50	V
Output Leakage Current	$I_{CEX}$	$V_{OUT} = V_{BB}$	—	<1.0	5.0	$\mu\text{A}$
		$V_{OUT} = 0$	—	<-1.0	-5.0	$\mu\text{A}$
Output Saturation Voltage	$V_{CE(SAT)}$	Sink Driver, $I_{OUT} = +1.0\text{ A}^*$	—	0.5	0.7	V
		Sink Driver, $I_{OUT} = +1.5\text{ A}^*$	—	0.8	0.9	V
		Source Driver, $I_{OUT} = -1.0\text{ A}^*$	—	1.8	1.9	V
		Source Driver, $I_{OUT} = -1.5\text{ A}^*$	—	1.9	2.0	V
Flyback Diode Forward Volt.	$V_F$	$I_F = 1.5\text{ A}$	—	1.6	2.0	V
Driver Supply Current	$I_{BB(ON)}$	Both Bridges ON, No Load	—	6.5	9.0	mA
	$I_{BB(OFF)}$	Both Bridges OFF	—	4.0	4.0	mA
<b>Control Logic</b>						
Input Voltage	$V_{IN(1)}$	All Inputs	2.4	—	—	V
	$V_{IN(0)}$	All Inputs	—	—	0.8	V
Input Current	$I_{IN(1)}$	$V_{IN} = 2.4\text{ V}$	—	<1.0	20	$\mu\text{A}$
	$I_{IN(0)}$	$V_{IN} = 0.8\text{ V}$	—	-3.0	-200	$\mu\text{A}$
Reference Voltage Range	$V_{REF}$	Operating	1.5	—	7.5	V
Current Limit Threshold (at trip point)	$V_{REF}/V_{SENSE}$	$I_0 = I_1 = 0.8\text{ V}$	9.5	10	10.5	—
		$I_0 = 2.4\text{ V}$ , $I_1 = 0.8\text{ V}$	13.5	15	16.5	—
		$I_0 = 0.8\text{ V}$ , $I_1 = 2.4\text{ V}$	25.5	30	34.5	—
Thermal Shutdown Temp.	$T_J$		—	170	—	$^\circ\text{C}$
Total Logic Supply Current	$I_{CC(ON)}$	$I_0 = I_1 = V_{EN} = 0.8\text{ V}$ , No Load	—	90	105	mA
	$I_{CC(OFF)}$	$I_0 = I_1 = 2.4\text{ V}$ , No Load	—	10	12	mA

Negative current is defined as coming out of (sourcing) the specified device pin.

Typical Data is for design information only.

\* Pulse test (<10 ms).

# 2927 DUAL FULL-BRIDGE PWM MOTOR DRIVER

## APPLICATIONS INFORMATION

### PWM CURRENT CONTROL:

The UDN2927EB dual bridge is designed to drive both windings of a bipolar stepper motor. Output current is sensed and controlled independently in each bridge by an external sense resistor ( $R_S$ ), internal comparator, and monostable multivibrator.

When the bridge is turned ON, current increases in the motor winding and it is sensed by the external sense resistor until the sense voltage ( $V_{SENSE}$ ) reaches the level set at the comparator's input:

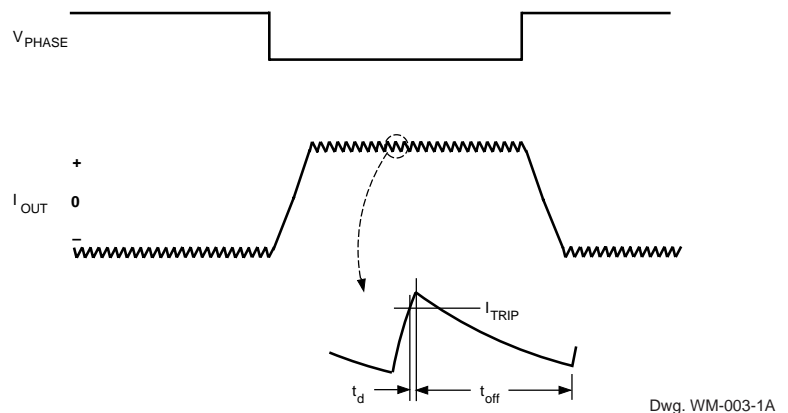
$$I_{TRIP} = V_{REF}/10 R_S$$

The comparator then triggers the monostable which turns OFF the source driver of the bridge. The actual load current peak will be slightly higher than the trip point (especially for low-inductance loads) because of the internal logic and switching delays. This delay ( $t_d$ ) is typically 2  $\mu$ s. After turn-off, the motor current will normally decay, circulating through the external ground clamp diode and sink transistor. The source driver's OFF time (and therefore the magnitude of the current decrease) is determined by the monostable's external RC timing components, where  $t_{off} = R_T C_T$  within the range of 20 k $\Omega$  to 100 k $\Omega$  and 200 pF to 500 pF.

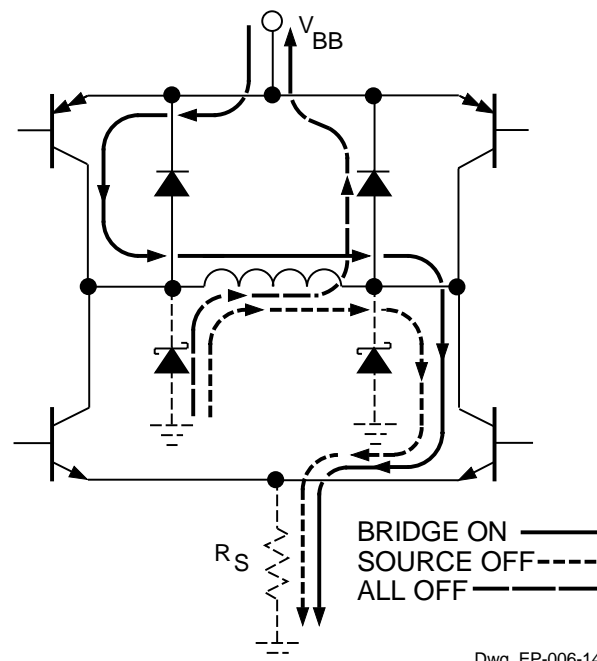
When the source driver is re-enabled, the winding current (the sense voltage) is again allowed to rise to the comparator's threshold. This cycle repeats itself, maintaining the average motor winding current at the desired level.

Special circuitry has been included to prevent runaway current control when the fixed OFF time ( $t_{off}$ ) is set too short. This circuitry prevents the source driver from being re-enabled until the load current has decayed to below the  $I_{TRIP}$  level.

### PWM OUTPUT CURRENT WAVEFORM



### LOAD CURRENT PATHS



## CURRENT-CONTROL TRUTH TABLE

$I_0$	$I_1$	Output Current
L	L	$V_{REF}/10 R_S = I_{TRIP}$
H	L	$V_{REF}/15 R_S = 2/3 I_{TRIP}$
L	H	$V_{REF}/30 R_S = 1/3 I_{TRIP}$
H	H	0

Loads with high distributed capacitances may result in high turn-ON current peaks. This peak (appearing across  $R_S$ ) will attempt to trip the comparator, resulting in erroneous current control or high-frequency oscillations. An external  $R_C C_C$  low-pass filter may be needed to delay the action of the comparator.

### LOGIC CONTROL OF OUTPUT CURRENT:

Two logic level inputs ( $I_0$  and  $I_1$ ) allow digital selection of the motor winding current at 100%, 67%, 33%, or 0% of the maximum level per the table. The 0% output current condition turns OFF all drivers in the bridge and can be used as an output enable function. These logic level inputs greatly enhance the implementation of  $\mu$ P-controlled drive formats.

During half-step operations, the  $I_0$  and  $I_1$  inputs allow the  $\mu$ P to control the motor at a constant torque between all positions in an eight-step sequence. This is accomplished by digitally selecting 100% drive current when only one phase is ON and 67% drive current when two phases are ON.

The logic control inputs can also be used to select a reduced current level (and reduced power dissipation) for 'hold' conditions and/or increased current (and available torque) for start-up conditions.

### GENERAL:

Both bridges have internal flyback diodes (connected from the outputs to  $V_{BB}$ ) for protection against inductive transients. External ground-clamp diodes (connected from the outputs to ground) are required; Schottky ground-clamp diodes are recommended to minimize on-chip power dissipation.

To avoid excessive voltage spikes on the LOAD SUPPLY terminal ( $V_{BB}$ ), a large-value capacitor ( $\geq 47 \mu\text{F}$ ) should be connected from  $V_{BB}$  to ground as close as possible to the device. Under no circumstances should the voltage at LOAD SUPPLY exceed 50 V. A low-value (0.1  $\mu\text{F}$ ) ceramic capacitor at this terminal may be used for high-frequency noise suppression.

The PHASE input to each bridge determines the direction motor winding current flows. An internally generated deadtime (approximately 3  $\mu\text{s}$ ) prevents crossover currents that can occur when switching the PHASE input.

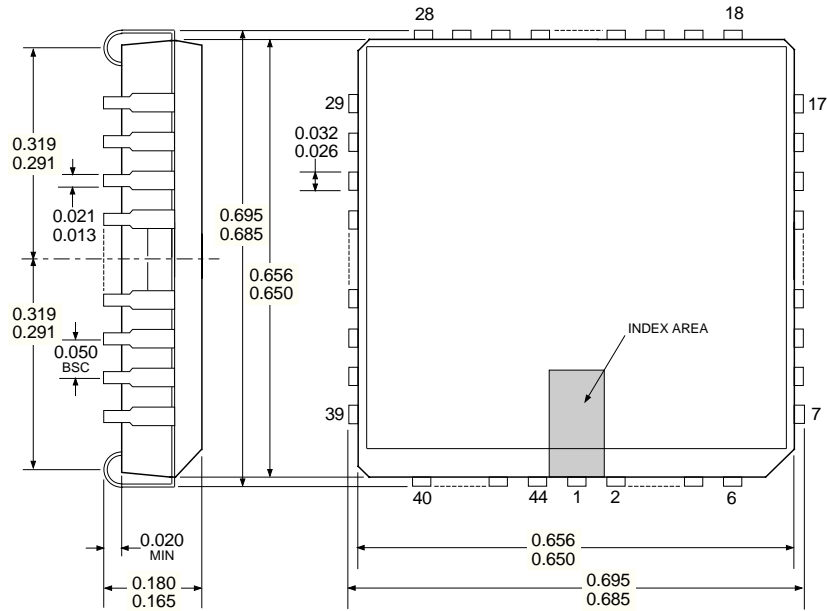
All four drivers in the bridge output can be turned OFF ( $V_{EN} \geq 2.4 \text{ V}$  or  $I_0 = I_1 \geq 2.4 \text{ V}$ ), resulting in a fast current decay through the internal flyback and external ground-clamp diodes. The fast current decay is desirable in half-step and high-speed applications. All logic inputs float high; the ENABLE input must be tied low if it is not used.

Varying the reference voltage ( $V_{REF}$ ) provides continuous control of the peak load current for micro-stepping applications, within the specified limits for  $V_{REF}$ .

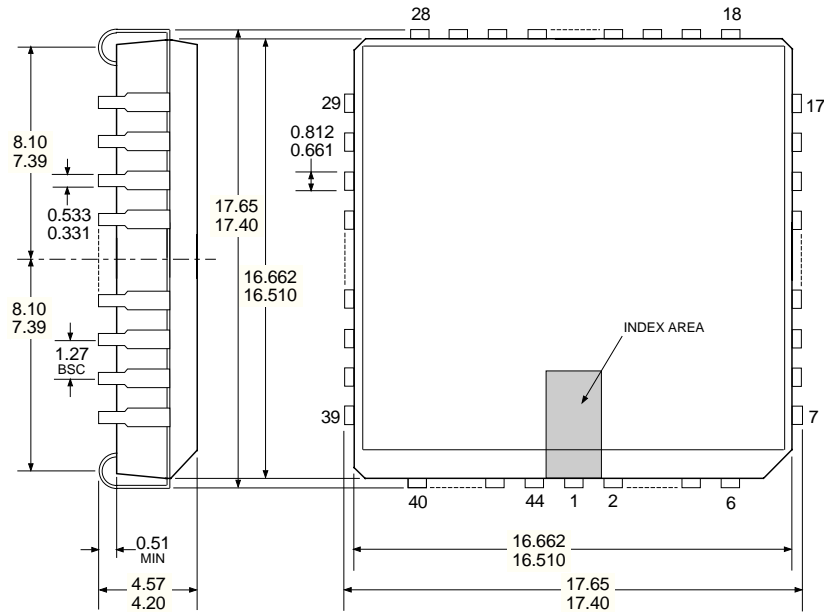
Thermal protection circuitry turns OFF all drivers when the junction temperature reaches approximately  $+170^\circ\text{C}$ . It is only intended to protect the device from failures due to excessive junction temperature and should not imply that output short circuits are permitted. The output drivers are reenabled when the junction temperature cools to approximately  $+160^\circ\text{C}$ .

# 2927 DUAL FULL-BRIDGE PWM MOTOR DRIVER

## Dimensions in Inches (controlling dimensions)



## Dimensions in Millimeters (for reference only)



- NOTES: 1. Exact body and lead configuration at vendor's option within limits shown.  
2. Lead spacing tolerance is non-cumulative.

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**2927**  
**DUAL FULL-BRIDGE**  
**PWM MOTOR DRIVER**

**BRIDGE & HALF-BRIDGE DRIVERS**  
**SELECTION GUIDE**

IN ORDER OF 1) OUTPUT CURRENT AND 2) OUTPUT VOLTAGE

Output Ratings *		Description	Features			Part Number †
mA	V		Internal Diodes	Outputs	Internal Protection	
±650	30	Dual PWM Full Bridge	X	Bipolar	X	3966
	30	Dual PWM Full Bridge	X	Bipolar	X	3968
±750	45	Dual PWM Full Bridge	X	Bipolar	X	2916
	45	Dual PWM Full Bridge	X	Bipolar	X	2919
	45	Dual PWM Full Bridge	X	Bipolar	X	6219
±800	33	Dual PWM Full Bridge	X	Bipolar	X	3964
±900	14	3-Ø Back-EMF Controller/Driver	X	DMOS	X	8902-A
±1000	7.0	3-Ø Back-EMF Controller/Driver	X	NMOS	X	8984
±1300	50	PWM Full Bridge	X	Bipolar	X	3953
±1500	45	Dual PWM Full Bridge	X	Bipolar	X	2917
	45	Dual PWM Full Bridge	X	Bipolar	X	2918
	50	PWM Microstepping Full Bridge	X	Darlington/Satlington™	X	3955
	50	PWM Microstepping Full Bridge	X	Darlington/Satlington™	X	3957
±2000	45	3-Ø Brushless Controller/Driver	X	Darlington	X	2936
	50	Dual Full Bridge	X	Darlington	X	2998
	50	PWM Full-Bridge	X	Darlington	X	3951
	50	PWM Full-Bridge	X	Darlington	X	3952
±3000	45	PWM Control	X	Darlington	–	2962
±3400	45	PWM Control	X	Bipolar	X	2961
±4000	14	3-Ø Brushless Controller/Driver	X	DMOS	X	8925

\* Current is maximum specified test condition, voltage is maximum rating. See specification for sustaining voltage limits or over-current protection voltage limits.

† Complete part number includes additional characters to indicate operating temperature range and package style.

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