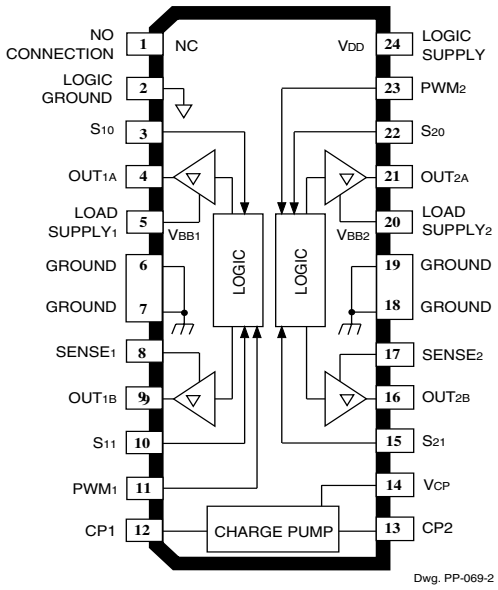
3971

Data Sheet
29319.32

ADVANCE INFORMATION
(Subject to change without notice)
May 2, 2000

DUAL DMOS FULL-BRIDGE DRIVER



Dwg. PP-069-2

ABSOLUTE MAXIMUM RATINGS

at T_A = +25°C

Load Supply Voltage, V_{BB} ..... **50 V**
Output Current, I_{OUT}
Transient (<500 ns) ..... **±5 A**
Logic Supply Voltage,
V_{DD} ..... **7.0 V**
Sense Voltage, V_{SENSE} ..... **0.5 V**
Logic Input Voltage Range,
V_{IN} ..... **-0.3 V to V_{DD} + 0.3 V**
High-Side Gate Voltage ..... **V_{BB} + 8 V**
Package Power Dissipation,
P_D ..... **2.2 W**
Operating Temperature Range,
T_A ..... **-20°C to +85°C**
Junction Temperature, T_J ..... **+150°C**
Storage Temperature Range,
T_S ..... **-55°C to +150°C**

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

Designed to interface between external PWM control logic and inductive loads such as relays, solenoids, dc motors, or stepper motors, each full bridge can operate with output currents to ±2.5 A and operating voltages to 50 V.

Low $r_{DS(on)}$ DMOS output drivers provide low power dissipation during PWM operation. Internal charge pump circuitry is used to create a boosted voltage to fully enhance the high-side DMOS switches.

Three TTL-compatible logic-input terminals per bridge allow flexibility in configuring PWM control.

Internal circuit protection includes thermal shutdown with hysteresis, and crossover-current protection. Special power -up sequencing is not required.

The A3971SLB is supplied in a 24-lead plastic SOIC with a copper batwing tab. The power tab is at ground potential and needs no electrical isolation.

FEATURES

- ±2.5 A Load Current Capability per Bridge
- Parallel Outputs for 5 A Load-Current Capability
- Low $r_{DS(on)}$ Outputs
  Typically 325 mΩ source, 175 mΩ sink
- Synchronous Rectification via Control Logic
- Internal Undervoltage Monitor
- Crossover-Current Protection
- Source Connections for External Current Sensing
- Thermal Shutdown Circuitry

Always order by complete part number: **A3971SLB**.

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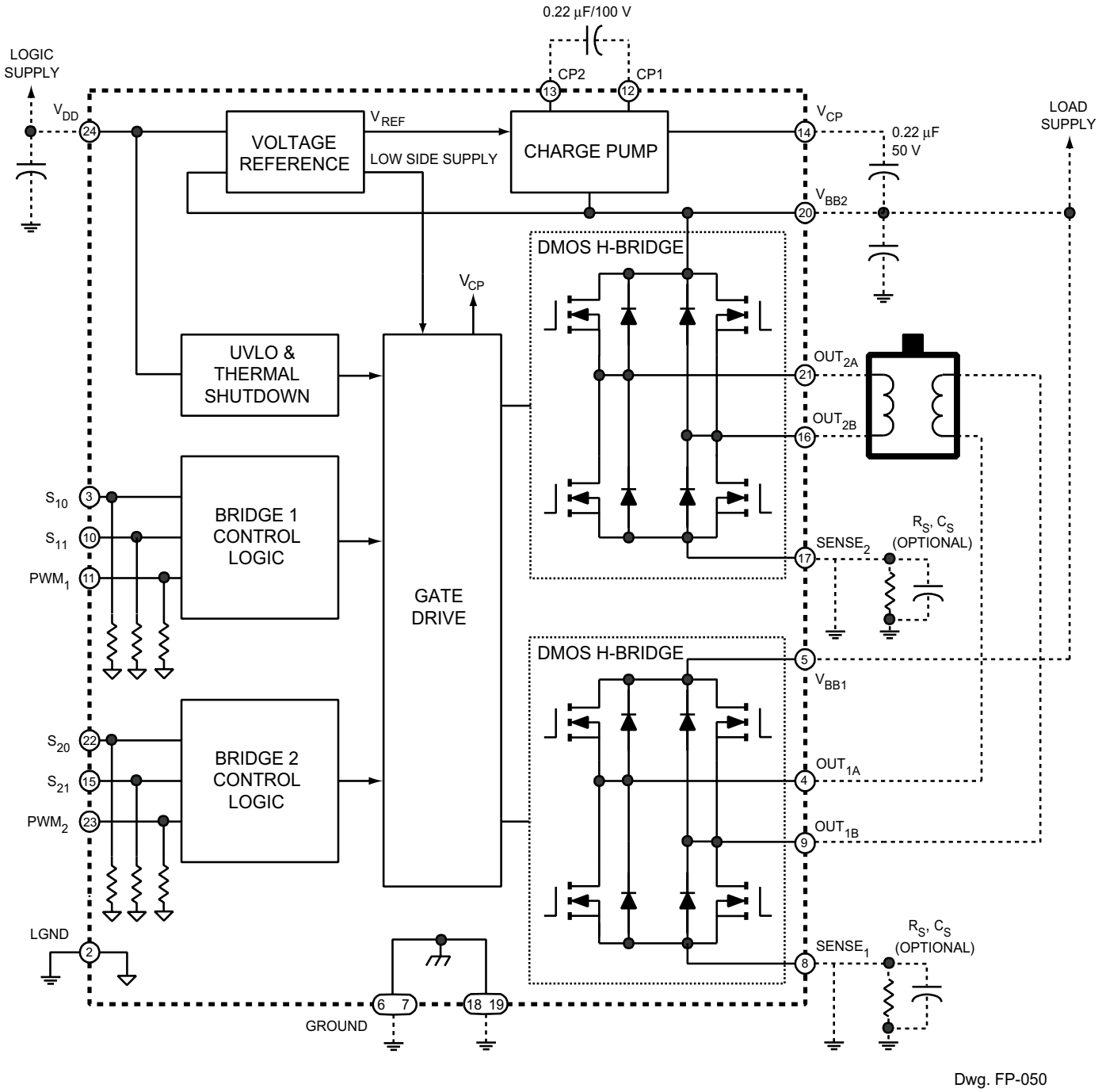
FUNCTIONAL BLOCK DIAGRAM



Dwg. FP-050

115 Northeast Cutoff, Box 15036
Worcester, Massachusetts 01615-0036 (508) 853-5000

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ELECTRICAL CHARACTERISTICS at T_A = +25°C, V_{BB} = 50 V, V_{DD} = 5.0 V (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Load Supply Voltage Range	V_{BB}	Operating	10	—	50	V
Logic Supply Voltage Range	V_{DD}	Operating	4.5	5.0	5.5	V
Load Supply Current	I_{BB}	Operating, each supply, no load	—	—	3.0	mA
Logic Supply Current	I_{DD}	Operating	—	—	5.0	mA
Output Drivers						
Output Leakage Current	I_{DSS}	$V_{OUT} = V_{BB}$	—	<1.0	20	µA
		V_{OUT} = 0 V	—	<-1.0	-20	mA
Output ON Resistance	$r_{DS(on)}$	High-side switch, I_{OUT} = -2.5 A	—	325	375	mΩ
		Low-side switch, I_{OUT} = 2.5 A	—	175	200	mΩ
Body Diode Forward Voltage	V_F	Source diode, I_F = 2.5 A	—	1.2	—	V
		Sink diode, I_F = 2.5 A	—	1.0	—	V
High-Side Gate Voltage	V_{CP}	C = 0.22 µF, reference V_{BB}	6.0	6.5	7.0	V
Control Logic						
Logic Input Voltage	$V_{IN(0)}$		—	—	0.8	V
	$V_{IN(1)}$		2.0	—	—	V
Logic Input Current	$I_{IN(0)}$	V_{IN} = 0 V	—	<1.0	-5.0	µA
	$I_{IN(1)}$	V_{IN} = 5.0 V	—	20	50	µA
Propagation Delay Time	t_{PD}	50% to 90%:				
		PWM change to source off	—	50	—	ns
		PWM change to sink off	—	60	—	ns
		PWM change to source on	—	565	—	ns
		PWM change to sink on	—	665	—	ns
		Disable to source on	—	150	—	ns
		Disable to sink on	—	250	—	ns
Thermal Shutdown Temperature	T_J		—	165	—	°C
Thermal Shutdown Hysteresis	ΔT_J		—	15	—	°C
UVLO Threshold	V_{UVLO}	Increasing V_{DD}	3.9	4.15	4.4	V
UVLO Hysteresis	ΔV_{UVLO}		—	0.15	—	V

NOTES: 1. Typical Data is for design information only.
2. Negative current is defined as coming out of (sourcing) the specified device terminal.

Logic Truth Table

PWM_x	S_{x0}	S_{x1}	OUT_{xA}	OUT_{xB}	Function
X	0	0	Z	Z	Disable
0	0	1	L	H	Forward
0	1	0	H	L	Reverse
0	1	1	L	L	Synchronous
1	0	1	L	L	Rectification/
1	1	1	L	L	Slow Decay
1	1	0	L	L	Chop

Terminal List

Terminal	Name	Description
1	NC	No (Internal) connection
2	LGND	Logic ground
3	S_{10}	Control input, bridge 1
4	OUT_{1A}	Output A, bridge 1
5	V_{BB1}	Load supply voltage, bridge 1
6, 7	GND	Ground
8	$SENSE_1$	Sense resistor, bridge 1
9	OUT_{1B}	Output B, bridge 1
10	S_{11}	Control input, bridge 1
11	PWM_1	Control input, bridge 1
12	CP1	Charge-pump capacitor
13	CP2	Charge-pump capacitor
14	V_{CP}	Reservoir capacitor
15	S_{21}	Control input, bridge 2
16	OUT_{2B}	Output B, bridge 2
17	$SENSE_2$	Sense resistor, bridge 2
18, 19	GND	Ground
20	V_{BB2}	Load supply voltage, bridge 2
21	OUT_{2A}	Output A, bridge 2
22	S_{20}	Control input, bridge 2
23	PWM_2	Control input, bridge 2
24	V_{DD}	Logic supply voltage

Functional Description

Charge Pump. The DMOS output stage requires a charge pump to bring the high-side gate-source voltage approximately 8 V above the V_{BB} supply. Two external components are required, a pumping capacitor connected between CP1 and CP2 and a reservoir capacitor connected between V_{BB} and V_{CP}. Ceramic 0.22 µF capacitors are recommended.

Control Logic. Each bridge is controlled by three TTL-compatible inputs. The inputs are resistively pulled to ground (via 250 kΩ). A crossover-delay circuit protects the outputs from a shoot-thru condition when going from a forward or reverse on state to synchronous rectification/ slow decay chop (both sink drivers on). If the logic is in the DISABLE state and changes to an on state the 415 ns crossover delay does not occur.

Protection Circuitry. In the event of a fault due to excessive junction temperature, or low voltage on V_{CP} or V_{DD}, the outputs of the device are disabled until the fault condition is removed.

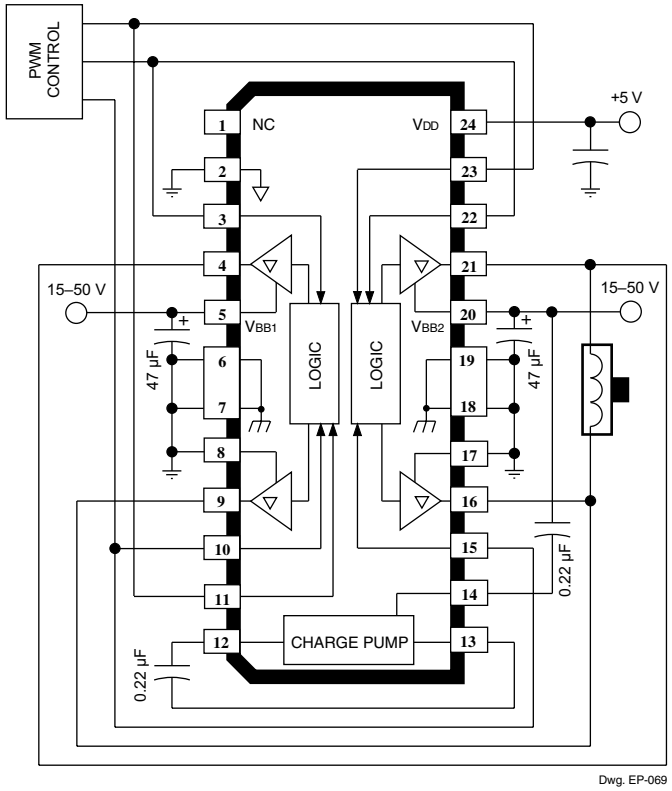
Current Sensing. If external current-sensing circuitry is used, the sense resistor should have an independent ground return to the ground terminal of the device. Due to current transients during switching, a 0.1 µF capacitor should be connected from the sense terminal to the batwing tab connection of the package. This capacitor reduces voltage swings at the terminal due to the fast di/dt, which in turn ensures that the sink driver gate-source voltage stays within the safe operating area. Allegro MicroSystems recommends a value of R_S given by:

$$R_S = 0.5/I_{TRIP} \text{ max.}$$

Thermal protection. Circuitry turns off all drivers when the junction temperature reaches 165°C, typically. It is intended only to protect the device from failures due to excessive junction temperatures and should not imply that output short circuits are permitted. Thermal shut-down has a hysteresis of approximately 15°C.

Layout. The printed wiring board should use a heavy ground plane. For optimum electrical and thermal performance, the driver should be soldered directly onto the board. If external current sensing is used, the ground side of R_S should have an individual path to the ground terminal(s) of the device. This path should be as short as is possible physically and should not have any other components connected to it. The load supply terminal should be decoupled with an electrolytic capacitor (>47 µF is recommended) placed as close to the device as is possible.

Parallel Operation. For high-power applications, the two DMOS full bridges in the A3971 may be connected in parallel as shown below. The current will be shared equally in each full bridge due to the positive temperature coefficient of the DMOS $r_{DS(on)}$.



Dwg. EP-069

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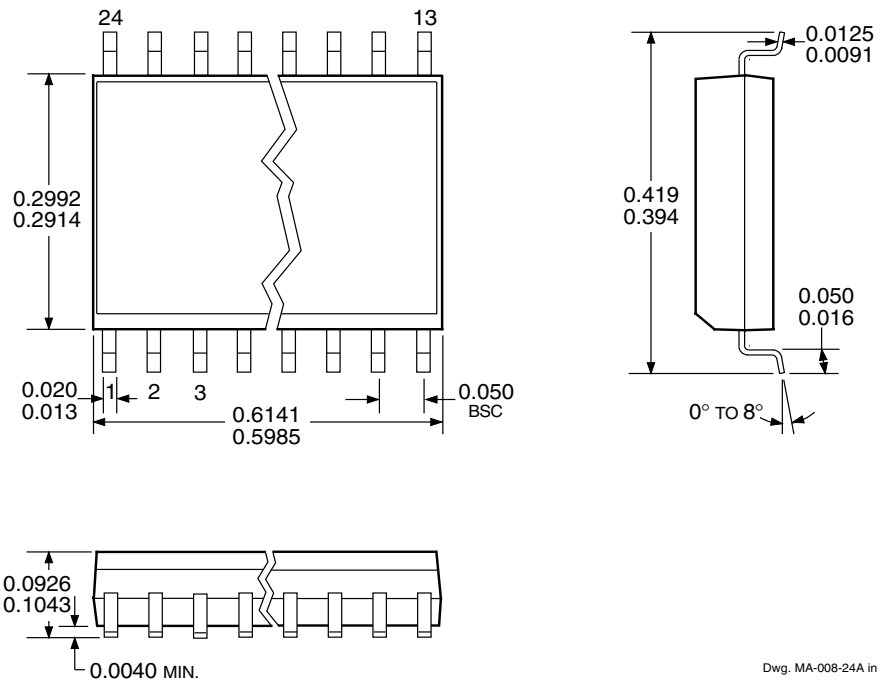
FULL-BRIDGE DRIVER

Dimensions in Inches
(for reference only)



Dwg. MA-008-24A in

NOTES: 1. Exact body and lead configuration at vendor's option within limits shown.
2. Lead spacing tolerance is non-cumulative
3. Webbed lead frame. Leads 6, 7, 18, and 19 are internally one piece.

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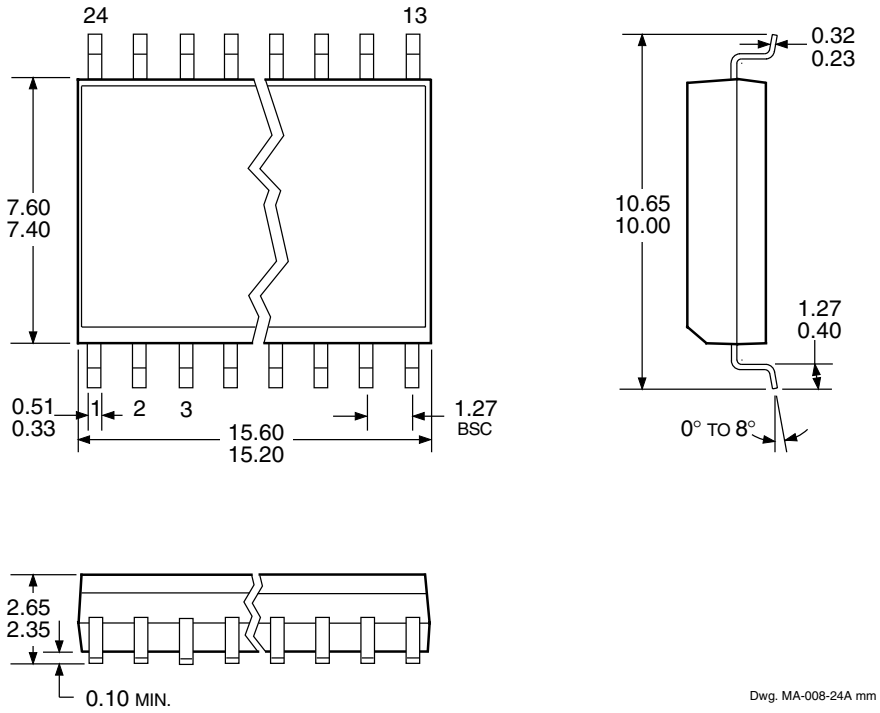
Dimensions in Millimeters
(controlling dimensions)



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