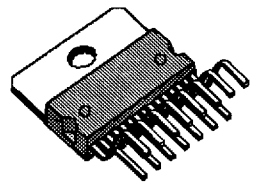
SGS-THOMSON MICROELECTRONICS

L9946

MULTIPLE HALF BRIDGE DRIVER

ADVANCE DATA

- 4.75A TOTAL OUTPUT CURRENT
- VERY LOW CONSUMPTION IN OFF STATE
- OVERLOAD DIAGNOSTIC
- OPEN LOAD DIAGNOSTIC
- GROUNDED CASE



Multiwatt15

ORDERING NUMBER: L9946

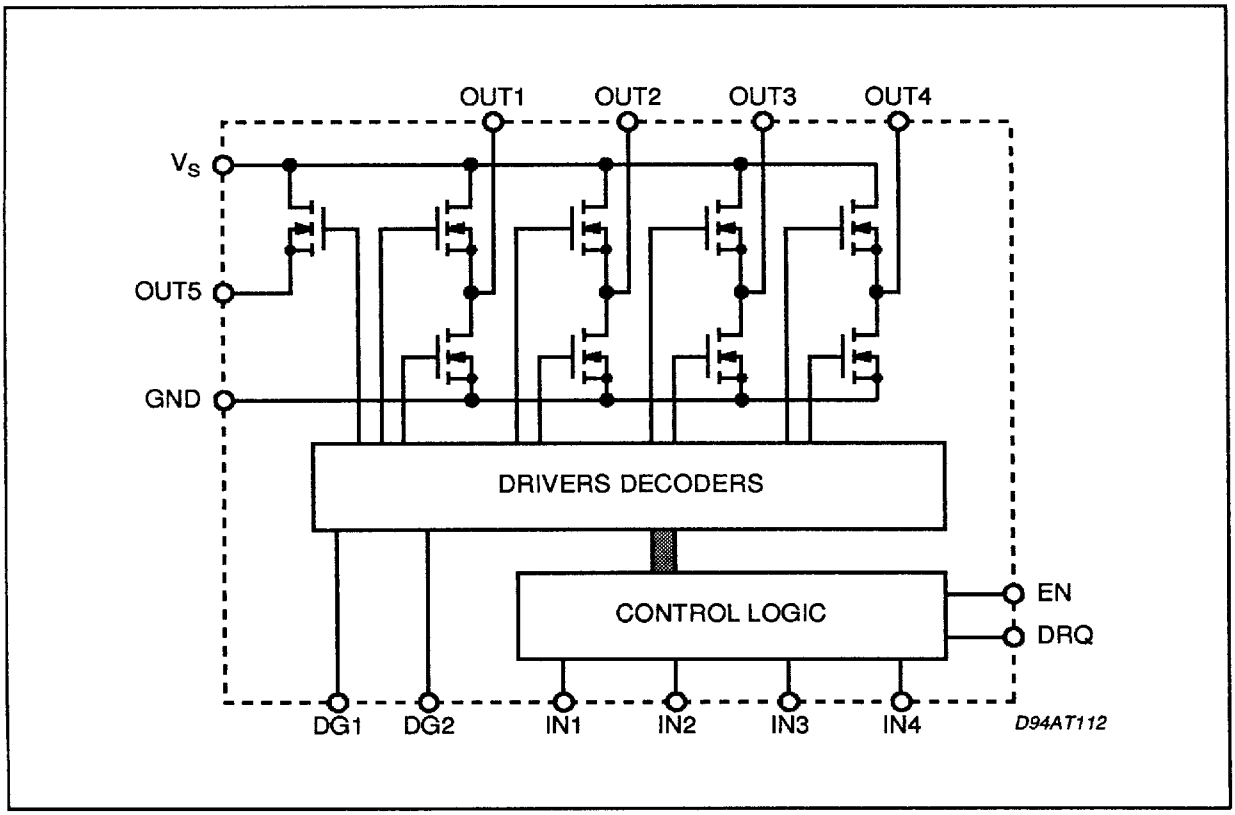
DESCRIPTION

The L9946 device is a quad half bridge plus an High Side Driver for bidirectional 3 motors and a grounded load driver applications realized in Multipower-BCD technology: it can deliver up to 4.75A output current.

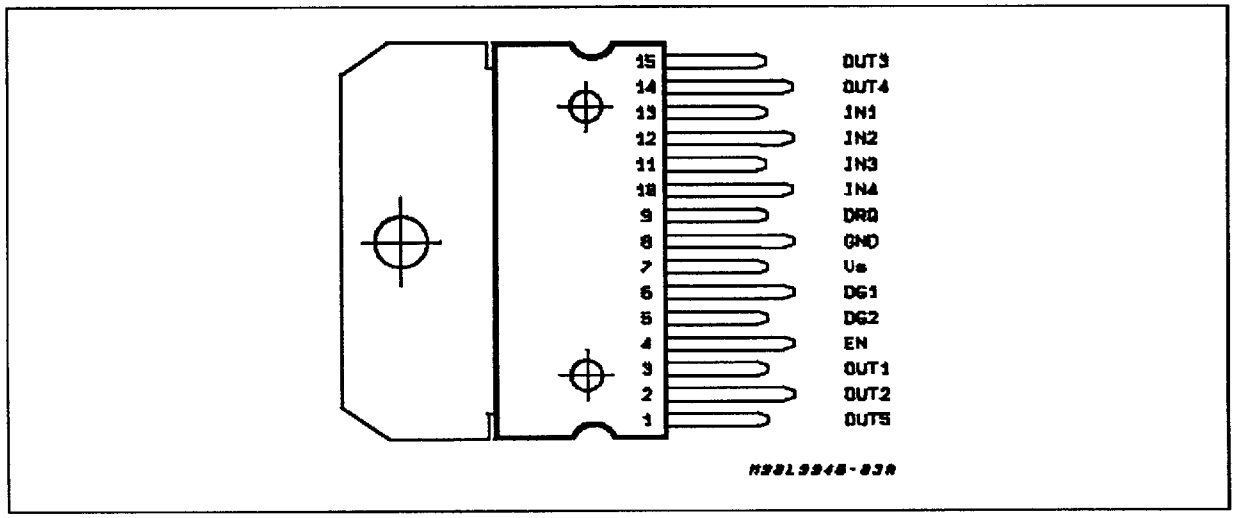
Multiple diagnostic informations are provided to monitor overload and open load conditions.

The device is assembled in the MULTIWATT15 package with the case connected to the ground terminal.

BLOCK DIAGRAM



PIN CONNECTION (Top view)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	50	V
EN	Enable	-0.3 to 20	V
IN1 - IN4	Command Inputs	-0.3 to 20	V
DRQ	Diagnostic Request Input	-0.3 to 20	V
DG1 - DG2	Diagnostic Outputs Voltage	-0.3 to 60	V
OUT1-OUT2	Half Bridges Output Current	±2.5	A
OUT3-OUT4	Half Bridges Output Current	±5	A
OUT5	High Side Driver Output Current	-5	A
T_{stg}, T_j	Storage and Junction Temperature	-40 to 150	°C
P_{tot}	Power Dissipation T_{CASE} = 85°C	26	W

THERMAL DATA

Symbol	Description		Value	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max	2.5	°C/W

PIN FUNCTIONS

Pins	Description
V_S	Positive supply voltage (to be connected after the reverse battery protection diode).
EN	Enable, switches the device between the low consumption and the operating mode.
IN1, IN2, IN3	Command inputs of the four half bridges.
IN4	Command input of the high side driver.
DRQ	Diagnostic request input.
DG1, DG2	Diagnostic output (open drain).
OUT1, OUT2, OUT3, OUT4	Outputs of the four half bridges.
OUT5	Output of the high side driver.
GND	Ground

ELECTRICAL CHARACTERISTICS (8V < V_S < 19V; -40 < T_j < 125°C, unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_S	Operating Supply Voltage	EN = H	8		19	V
I_{Vs}	Supply Current in Stand-by Mode	EN < 0.8V			100	µA
I_{Vs}	Supply Current	EN = H; IN1 = IN2 = IN3 = IN4 = X DRQ = L	1		10	mA
I_{Vs}	Supply Current Open Load Diagnostic	EN = DRQ = H; IN1 = IN2 = IN3 = IN4 = L		50		mA
V_{enH}	Enable Input Voltage High		2			V
V_{enL}	Enable Input Voltage Low				0.8	V
Venth	Enable Threshold Hysteresis		50			mV
I_{en}	Enable Input Current High	0 < V_{en} < 5.5V			80	µA
V_{inH} (1-4)	Input Voltage High		2			V
V_{inL} (1-4)	Input Voltage Low				0.8	V
V_{inth} (1-4)	Input Threshold Hysteresis		100			mV
I_{in} (1-4)	Input Current High	0 < V_{in} (1-4) < 5.5V			80	µA
V_{drqH}	Diagnostic Request Input Voltage High		2			V
V_{drqL}	Diagnostic Request Input Voltage Low				0.8	V
V_{drqth}	Diagnostic Req. Input Thr. Hysteresis		100			mV
I_{drq}	Diagnostic Req. Input Current	0 < V_{drq} < 5.5V			80	µA
V_{olDG1} V_{olDG2}	Saturation Voltage of Output Diagnostic pins	I(dg1) = I(dg2) = 2mA		160	400	mV
I_{dg1} I_{dg2}	Leakage Current of Output Diagnostic pins				10	µA
$R_{on\ OUT1}$	ON Resistance (to supply or to GND)	@ I_{OUT1} = I_{OUT2} = ± 0.3A		4	9	Ω
$R_{on\ OUT2}$				4	9	Ω
$R_{on\ OUT3}$		@ IOUT3 = I_{OUT4} = ± 3A		0.3	0.75	Ω
$R_{on\ OUT4}$				0.3	0.75	Ω
$R_{on\ OUT5}$	ON Resistance to supply	@ I_{OUT5} = 2.5A		0.6	1	Ω
$I_{out1\ o\ l}$ $I_{out2\ o\ l}$ $I_{out3\ o\ l}$	Output Current Sunk During Open Load Diagnostic	IN1 = IN2 = IN3 = IN4 = L; EN = DRQ = H; VOUT1 = V_{OUT2} = V_{OUT3} = 4V	5	12	18	mA
$I_{out4\ o\ l}$	Output Current Capability, Sourced During Open Load Diagnostic	IN1 = IN2 = IN3 = IN4 = L; EN = DRQ = H; VOUT4 = 4V	65	120	170	mA
$I_{out5\ o\ l}$	Output Current Sourced During Open Load Diagnostic	IN1 = IN2 = IN3 = IN4 = L; EN = DRQ = H; VOUT5 = 4V	5	12	18	mA
V_{oTH1} V_{oTH2} V_{oTH3}	Threshold for Open Load Detection on OUT 1,2,3	IN1 = IN2 = IN3 = IN4 = L; EN = DRQ = H;	1.5	1.8	2.1	V
V_{oTH5}	Threshold for Open Load Detection on OUT 5	IN1 = IN2 = IN3 = IN4 = L; EN = DRQ = H;	1.4	1.7	2	V

FUNCTIONAL DESCRIPTION

EN	IN1	IN2	IN3	IN4	DRQ	OUT1	OUT2	OUT3	OUT4	OUT5	CONDITION
0	X	X	X	X	X	T	T	T	T	OFF	Low consumption
1	0	0	0	0	0	T	T	T	T	OFF	Oper. mode OFF
1	0	0	0	0	1	*snk	*snk	*snk	*src	*src	* Open Load detection
1	0	0	1	0	X	src	T	T	snk	OFF	M1 right
1	1	1	0	0	0	snk	T	T	src	OFF	M1 left
1	1	0	1	0	0	T	src	T	snk	OFF	M2 right
1	0	1	0	0	0	T	snk	T	src	OFF	M2 left
1	0	1	1	0	X	T	T	src	snk	OFF	M3 right
1	1	0	0	0	0	T	T	snk	src	OFF	M3 left
1	1	1	1	0	X	snk	snk	snk	snk	OFF	Braking
1	0	0	1	1	X	src	T	T	snk	src	M1 right + HSD
1	1	1	0	1	0	snk	T	T	src	src	M1 left + HSD
1	1	0	1	1	0	T	src	T	snk	src	M2 right + HSD
1	0	1	0	1	0	T	snk	T	src	src	M2 left + HSD
1	0	1	1	1	X	T	T	src	snk	src	M3 right + HSD
1	1	0	0	1	0	T	T	snk	src	src	M3 left + HSD
1	1	1	1	1	X	snk	snk	snk	snk	src	Braking + HSD
1	0	0	0	1	X	T	T	T	T	src	HSD only

Note 1: T means high impedance condition; **snk** means sink condition of the output; **src** means source condition of the output

***Note 2:**
In the open load diagnostic condition the sink current of OUT1, OUT2 and OUT3 is typically +10mA. In the same condition the source current of OUT4 and OUT5 are respectively 100mA and 10mA.

Note 3:
To have an effective protection against short circuits to ground the pin DRQ must be set to zero when the OUT4 output source is active.

TRUTH TABLE OF THE DIAGNOSTIC FUNCTION

EN	IN1	IN2	IN3	IN4	DRQ	DG1	DG2	CONDITION
1	X	X	X	X	X	1	1	All ok
1	*			X	0	0	1	Overcurrent in the HB
1	X	X	X	1	0	1	0	Overcurrent in the HSD
1	0	0	0	0	1	0	1	Open Load in the HB
1	0	0	0	0	1	1	0	Open Load in the HSD
1	X	X	X	X	X	0	0	Overtemperature
1	*			1	0	0	0	Overcurrent in the HB and HSD or overtemperature
1	0	0	0	0	1	0	0	Open load in the HB and HSD or overtemperature

Notes:
*: Don't care but IN1, IN2 and IN3 must not be 0 at the same time.
HB: Half Bridges
HSD: High Side Driver

FUNCTIONAL DESCRIPTION (continued)

The L9946 is developed especially for the automotive application to drive three motors and a grounded load in full bridge configuration (see fig. 3). An implemented diagnostic signalizes overload and openload. Two internal capacitive charge pumps deliver 8V over the supply voltage to drive the power DMOS transistors whose drains are connected to supply voltage.
The charge pumps work with a clock frequency of 500KHz. One charge pump drives the four gates of the upper power DMOS transistors because there is only one of the DMOS switched on at the same time. A separate second one drives the highside driver OUT5.

Inputs:

All inputs are TTL-compatible with hysteresis and are ESD-protected. The enable input EN can disable all outputs of the chip independent from the other input levels. In this standby mode the current consumption is typical ≤100µA. IN1, IN2, IN3 drive the four halfbridges OUT1 to OUT4 so that only one upper and one lower transistor is switched on at the same time (see input/output truth table). There is no protection against cross current conduction of the halfbridges. To avoid cross current it is useful to have a break phase between the commutation. The highside OUT5 is driven by IN4. The DRQ input introduces the diagnostic request.

Outputs:

OUT1 and OUT2 are designed for typically ± 0.3A and OUT3 and OUT4 for ± 3A. Under this condition the sum of voltage drops is less than 2V over two power transistors in full bridge configuration. The typical output current of -2.5A produces a voltage drop of 2V at the highside driver OUT5.

The output current of OUT1 till OUT5 is not internally limited. If the diagnostic flags overcurrent then the power transistors must be switched off in t ≤100µs by the inputs to avoid destruction of the device.

Each power DMOS transistor has an intrinsic diode between drain and source. The lower transistors of the halfbridge have an intrinsic drain-substate diode. To reduce the current through the intrinsic drain-substrate diodes and its parasitic npn-transistors during the flyback of the motor it should be added a braking phase during the switch off or pole-changing of the motors.

Diagnostic:

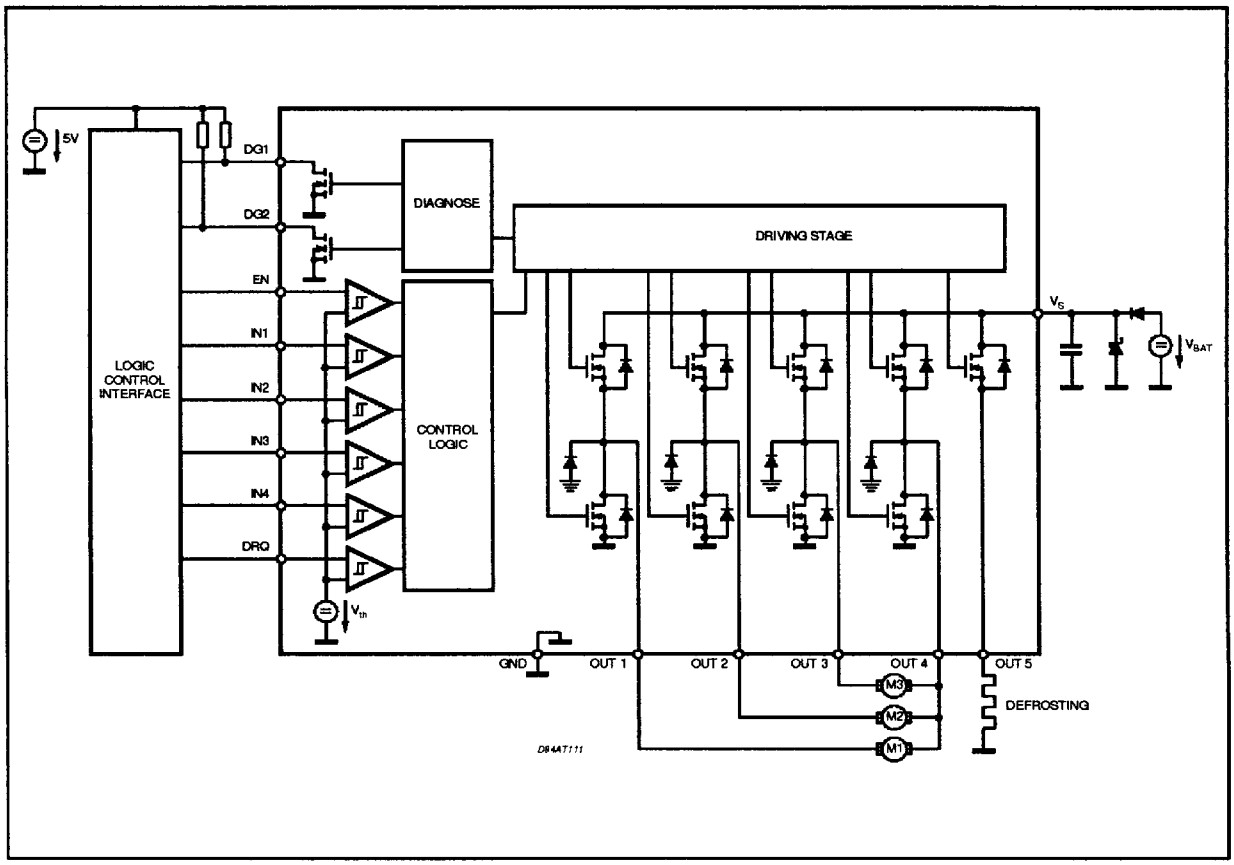
The open drain outputs DG1 and DG2 deliver the diagnostic information overcurrent, openload and overtemperature (see truth table of diagnostic function).

In the thermal overload condition all power transistors are disabled and the overtemperature is flagged at DG1, DG2.

If one or more outputs of OUT1 to OUT5 are in overcurrent DG1 becomes active mean while an overcurrent of OUT5 is flagged by DG2.

The openload detection is active if IN1 = IN2 = IN3 = IN4 = low and EN = DRQ = high. In this case OUT4 delivers an output current of typ. 120mA which flows through the loads M1, M2, M3 to the outputs OUt1, OUT2 and OUT3. Each of these outputs has a current sink capability of typ. 12mA. If one or more of the wire connections between the motor and L9946 have a bad connection so that the voltage drop at this output would be less than the threshold (typ. 1.5V to ground) the DG1 flags openload. Also OUT5 forces a current of typ. 10mA through its load. If the voltage drop at the load exceeds the threshold of typ. 1.5V the DG2 becomes active.

APPLICATION CIRCUIT



MULTIWATT15 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.66		0.75	0.026		0.030
G	1.02	1.27	1.52	0.040	0.050	0.060
G1	17.53	17.78	18.03	0.690	0.700	0.710
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.870	0.886
L2	17.65		18.1	0.695		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.63	5.08	5.53	0.182	0.200	0.218
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152