

DMOS DRIVER FOR BIPOLAR STEPPER MOTOR

- OPERATING SUPPLY VOLTAGE FROM 8 TO 52V
- 5.6A OUTPUT PEAK CURRENT (2.8A RMS)
- $R_{DS(ON)}$ 0.3 Ω TYP. VALUE @ $T_j = 25^\circ\text{C}$
- OPERATING FREQUENCY UP TO 100KHz
- NON DISSIPATIVE OVERCURRENT PROTECTION
- DUAL INDEPENDENT CONSTANT t_{OFF} PWM CURRENT CONTROLLERS
- FAST/SLOW DECAY MODE SELECTION
- FAST DECAY QUASI-SYNCHRONOUS RECTIFICATION
- DECODING LOGIC FOR STEPPER MOTOR FULL AND HALF STEP DRIVE
- CROSS CONDUCTION PROTECTION
- THERMAL SHUTDOWN
- UNDER VOLTAGE LOCKOUT
- INTEGRATED FAST FREE WHEELING DIODES

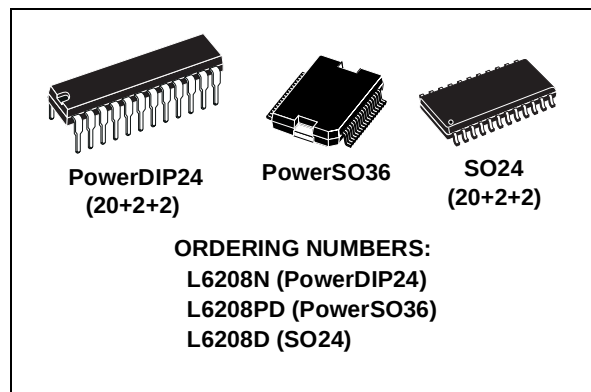
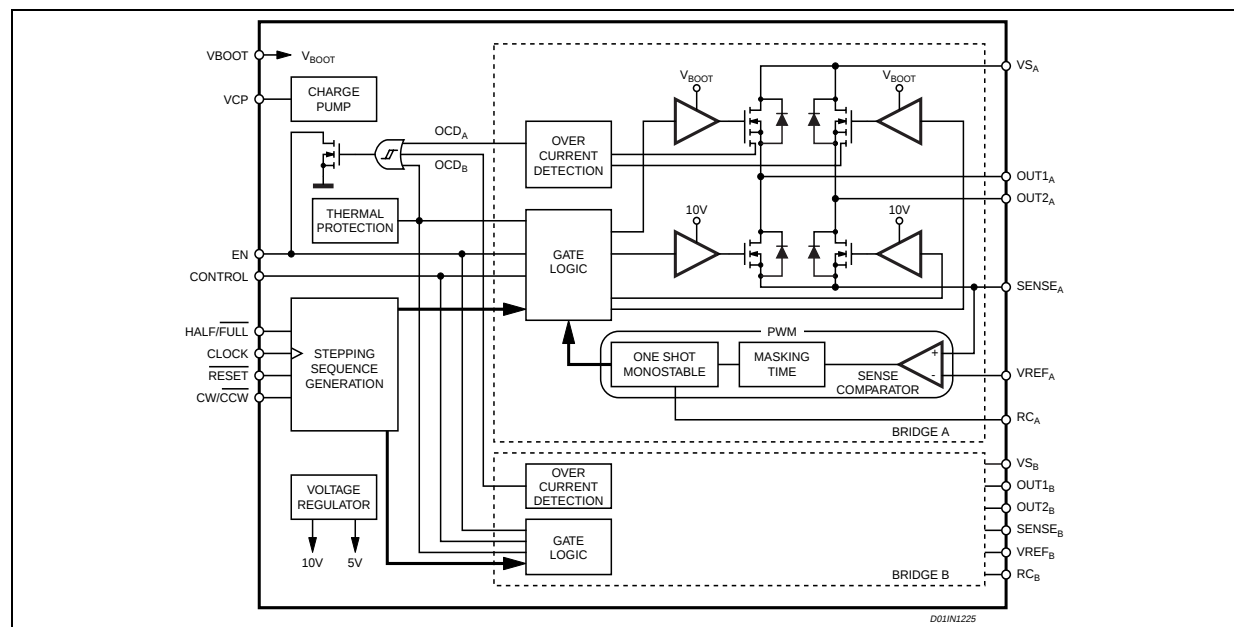
TYPICAL APPLICATIONS

- BIPOLAR STEPPER MOTOR

DESCRIPTION

The L6208 is a DMOS Fully Integrated Stepper Motor Driver with non-dissipative Overcurrent Protection, realized in MultiPower-BCD technology, which com-

BLOCK DIAGRAM



bines isolated DMOS Power Transistors with CMOS and bipolar circuits on the same chip. The device includes all the circuitry needed to drive a two-phase bipolar stepper motor including: a dual DMOS Full Bridge, the constant off time PWM Current Controller that performs the chopping regulation and the Phase Sequence Generator, that generates the stepping sequence. Available in PowerDIP24 (20+2+2), PowerSO36 and SO24 (20+2+2) packages, the L6208 features a non-dissipative overcurrent protection on the high side Power MOSFETs and thermal shutdown.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Test conditions	Value	Unit
V_S	Supply Voltage	$V_{SA} = V_{SB} = V_S$	60	V
V_{OD}	Differential Voltage between V_{SA} , OUT1 _A , OUT2 _A , SENSE _A and V_{SB} , OUT1 _B , OUT2 _B , SENSE _B	$V_{SA} = V_{SB} = V_S = 60V$; $V_{SENSEA} = V_{SENSEB} = GND$	60	V
V_{BOOT}	Bootstrap Peak Voltage	$V_{SA} = V_{SB} = V_S$	$V_S + 10$	V
V_{IN}, V_{EN}	Input and Enable Voltage Range		-0.3 to +7	V
V_{REFA} , V_{REFB}	Voltage Range at pins V_{REFA} and V_{REFB}		-0.3 to +7	V
V_{RCA} , V_{RCB}	Voltage Range at pins RC_A and RC_B		-0.3 to +7	V
V_{SENSEA} , V_{SENSEB}	Voltage Range at pins SENSE _A and SENSE _B		-1 to +4	V
$I_{S(peak)}$	Pulsed Supply Current (for each V_S pin), internally limited by the overcurrent protection	$V_{SA} = V_{SB} = V_S$; $t_{PULSE} < 1ms$	7.1	A
I_S	RMS Supply Current (for each V_S pin)	$V_{SA} = V_{SB} = V_S$	2.8	A
T_{stg}, T_{OP}	Storage and Operating Temperature Range		-40 to 150	°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Test Conditions	MIN	MAX	Unit
V_S	Supply Voltage	$V_{SA} = V_{SB} = V_S$	8	52	V
V_{OD}	Differential Voltage Between V_{SA} , OUT1 _A , OUT2 _A , SENSE _A and V_{SB} , OUT1 _B , OUT2 _B , SENSE _B	$V_{SA} = V_{SB} = V_S$; $V_{SENSEA} = V_{SENSEB}$		52	V
V_{REFA} , V_{REFB}	Voltage Range at pins V_{REFA} and V_{REFB}		-0.1	5	V
V_{SENSEA} , V_{SENSEB}	Voltage Range at pins SENSE _A and SENSE _B	(pulsed $t_W < t_{rr}$) (DC)	-6 -1	6 1	V V
I_{OUT}	RMS Output Current			2.8	A
T_j	Operating Junction Temperature		-25	+125	°C
f_{sw}	Switching Frequency			100	KHz

THERMAL DATA

Symbol	Description	PowerDIP24	SO24	PowerSO36	Unit
$R_{th-j-pins}$	Maximum Thermal Resistance Junction-Pins	18	14	-	°C/W
$R_{th-j-case}$	Maximum Thermal Resistance Junction-Case	-	-	1	°C/W
$R_{th-j-amb1}$	Maximum Thermal Resistance Junction-Ambient ⁽¹⁾	43	51	-	°C/W
$R_{th-j-amb1}$	Maximum Thermal Resistance Junction-Ambient ⁽²⁾	-	-	35	°C/W
$R_{th-j-amb1}$	Maximum Thermal Resistance Junction-Ambient ⁽³⁾	-	-	15	°C/W
$R_{th-j-amb2}$	Maximum Thermal Resistance Junction-Ambient ⁽⁴⁾	58	77	62	°C/W

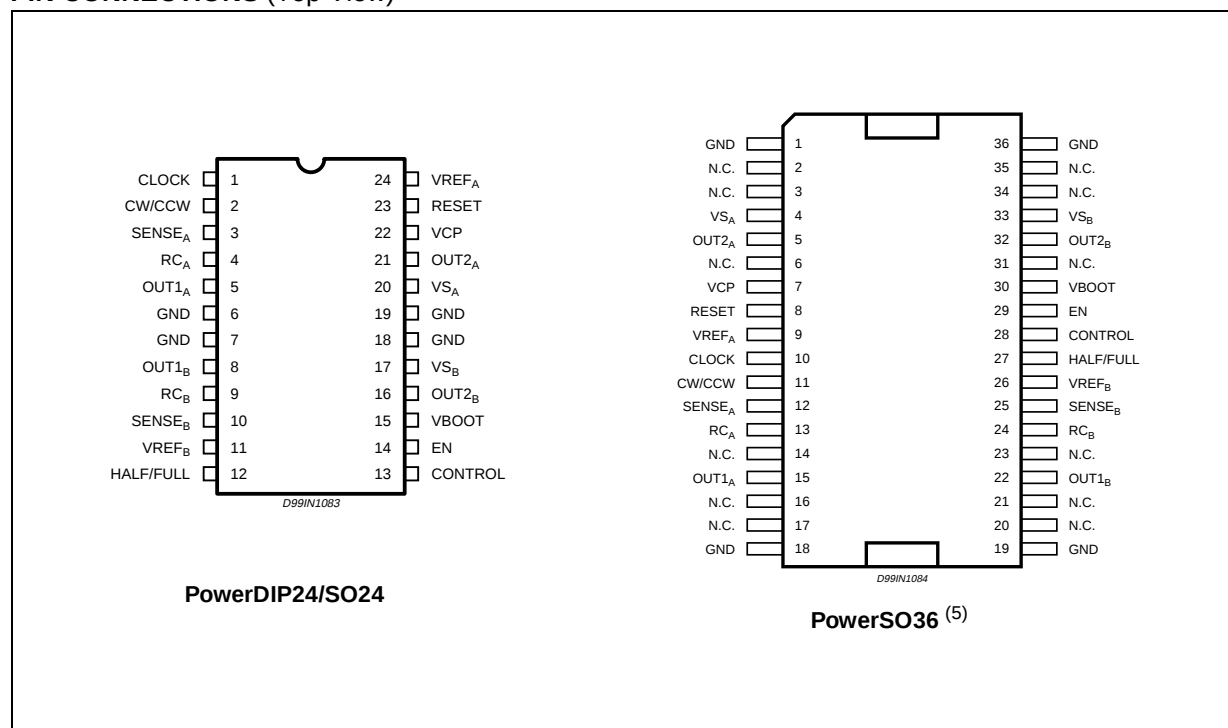
(1) Mounted on a multi-layer FR4 PCB with a dissipating copper surface on the bottom side of 6cm² (with a thickness of 35µm).

(2) Mounted on a multi-layer FR4 PCB with a dissipating copper surface on the top side of 6cm² (with a thickness of 35µm).

(3) Mounted on a multi-layer FR4 PCB with a dissipating copper surface on the top side of 6cm² (with a thickness of 35µm), 16 via holes and a ground layer.

(4) Mounted on a multi-layer FR4 PCB without any heat sinking surface on the board.

PIN CONNECTIONS (Top View)



(5) The slug is internally connected to pins 1, 18, 19 and 36 (GND pins).

PIN DESCRIPTION

PACKAGE		Name	Type	Function
SO24/ PowerDIP24	PowerSO36			
PIN #	PIN #			
1	10	CLOCK	Logic Input	Step Clock input. The state machine makes one step on each rising edge.
2	11	CW/CCW	Logic Input	Selects the direction of the rotation. HIGH logic level sets clockwise direction, whereas LOW logic level sets counterclockwise direction. If not used, it has to be connected to GND or +5V.
3	12	SENSE _A	Power Supply	Bridge A Source Pin. This pin must be connected to Power Ground through a sensing power resistor.
4	13	RC _A	RC Pin	RC Network Pin. A parallel RC network connected between this pin and ground sets the Current Controller OFF-Time of the Bridge A.
5	15	OUT1 _A	Power Output	Bridge A Output 1.
6, 7, 18, 19	1, 18, 19, 36	GND	GND	Ground terminals. In PowerDIP24 and SO24 packages, these pins are also used for heat dissipation toward the PCB. On PowerSO36 package the slug is connected to these pins.
8	22	OUT1 _B	Power Output	Bridge B Output 1.
9	24	RC _B	RC Pin	RC Network Pin. A parallel RC network connected between this pin and ground sets the Current Controller OFF-Time of the Bridge B.
10	25	SENSE _B	Power Supply	Bridge B Source Pin. This pin must be connected to Power Ground through a sensing power resistor.
11	26	VREF _B	Analog Input	Bridge B Current Controller Reference Voltage. Do not leave this pin open or connected to GND.
12	27	HALF/FULL	Logic Input	Step Mode Selector. HIGH logic level sets HALF STEP Mode, LOW logic level sets FULL STEP Mode. If not used, it has to be connected to GND or +5V.
13	28	CONTROL	Logic Input	Decay Mode Selector. HIGH logic level sets SLOW DECAY Mode, LOW logic level sets FAST DECAY Mode. If not used, it has to be connected to GND or +5V.
14	29	EN	Logic Input ⁽⁶⁾	Chip Enable. LOW logic level switches OFF all Power MOSFETs of both Bridge A and Bridge B. This pin is also connected to the collector of the Overcurrent and Thermal Protection to implement over current protection. If not used, it has to be connected to +5V through a resistor.
15	30	VBOOT	Supply Voltage	Bootstrap Voltage needed for driving the upper Power MOSFETs of both Bridge A and Bridge B.
16	32	OUT2 _B	Power Output	Bridge B Output 2.
17	33	VS _B	Power Supply	Bridge B Power Supply Voltage. It must be connected to the Supply Voltage together with pin VS _A
20	4	VS _A	Power Supply	Bridge A Power Supply Voltage. It must be connected to the Supply Voltage together with pin VS _B

PIN DESCRIPTION (continued)

PACKAGE		Name	Type	Function
SO24/ PowerDIP24	PowerSO36			
PIN #	PIN #			
21	5	OUT2 _A	Power Output	Bridge A Output 2.
22	7	VCP	Output	Charge Pump Oscillator Output.
23	8	RESET	Logic Input	Reset Pin. LOW logic level restores the <i>Home</i> State (State 1) on the Phase Sequence Generator State Machine. If not used, it has to be connected to +5V.
24	9	VREF _A	Analog Input	Bridge A Current Controller Reference Voltage. Do not leave this pin open or connected to GND.

- (6) Also connected at the output drain of the Over current and Thermal protection MOSFET. Therefore, it has to be driven putting in series a resistor with a value in the range of 2.2K Ω - 180K Ω , recommended 100K Ω .

ELECTRICAL CHARACTERISTICS

(T_{amb} = 25°C, V_S = 48V, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{Sth(ON)}	Turn-on Threshold		6.6	7	7.4	V
V _{Sth(OFF)}	Turn-off Threshold		5.6	6	6.4	V
I _S	Quiescent Supply Current	All Bridges OFF; T _j = -25°C to 125°C ⁽⁷⁾		5	10	mA
T _{j(OFF)}	Thermal Shutdown Temperature			165		°C

Output DMOS Transistors

R _{DS(ON)}	High-Side Switch ON Resistance	T _j = 25 °C		0.34	0.4	Ω
		T _j = 125 °C ⁽⁷⁾		0.53	0.59	Ω
	Low-Side Switch ON Resistance	T _j = 25 °C		0.28	0.34	Ω
		T _j = 125 °C ⁽⁷⁾		0.47	0.53	Ω
I _{DSS}	Leakage Current	EN = Low; OUT = V _S			2	mA
		EN = Low; OUT = GND	-0.15			mA

Source Drain Diodes

V _{SD}	Forward ON Voltage	I _{SD} = 2.8A, EN = LOW		1.15	1.3	V
t _{rr}	Reverse Recovery Time	I _f = 2.8A		300		ns
t _{fr}	Forward Recovery Time			200		ns

Logic Inputs (EN, CONTROL, HALF/FULL, CLOCK, RESET, CW/CCW)

V _{IL}	Low level logic input voltage		-0.3		0.8	V
V _{IH}	High level logic input voltage		2		7	V

ELECTRICAL CHARACTERISTICS (continued)(T_{amb} = 25°C, V_S = 48V, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I _{IL}	Low Level Logic Input Current	GND Logic Input Voltage	-10			μA
I _{IH}	High Level Logic Input Current	7V Logic Input Voltage			10	μA
V _{th(ON)}	Turn-on Input Threshold			1.8	2.0	V
V _{th(OFF)}	Turn-off Input Threshold		0.8	1.3		V
V _{th(HYS)}	Input Threshold Hysteresis		0.25	0.5		V

Switching Characteristics

t _{D(ON)EN}	Enable to Output Turn-on Delay Time ⁽⁸⁾	I _{LOAD} = 2.8A, Resistive Load	100	250	400	ns
t _{D(OFF)EN}	Enable to Output Turn-off Delay Time ⁽⁸⁾	I _{LOAD} = 2.8A, Resistive Load	300	550	800	ns
t _{RISE}	Output Rise Time ⁽⁸⁾	I _{LOAD} = 2.8A, Resistive Load	40		250	ns
t _{FALL}	Output Fall Time ⁽⁸⁾	I _{LOAD} = 2.8A, Resistive Load	40		250	ns
t _{DCLK}	Clock to Output Delay Time ⁽⁹⁾	I _{LOAD} = 2.8A, Resistive Load		2		μs
t _{CLK(min)L}	Minimum Clock Time ⁽¹⁰⁾				1	μs
t _{CLK(min)H}	Minimum Clock Time ⁽¹⁰⁾				1	μs
f _{CLK}	Clock Frequency				100	KHz
t _{S(MIN)}	Minimum Set-up Time ⁽¹¹⁾				1	μs
t _{H(MIN)}	Minimum Hold Time ⁽¹¹⁾				1	μs
t _{R(MIN)}	Minimum Reset Time ⁽¹¹⁾				1	μs
t _{RCLK(MIN)}	Minimum Reset to Clock Delay Time ⁽¹¹⁾				1	μs
t _{DT}	Dead Time Protection		0.5	1		μs
f _{CP}	Charge Pump Frequency	T _j = -25°C to 125°C ⁽⁷⁾		0.6	1	MHz

PWM Compararator and Monostable

I _{RCA} , I _{RCB}	Source Current at pins RC _A and RC _B	V _{RCA} = V _{RCB} = 2.5V	3.5	5.5		mA
V _{offset}	Offset Voltage on Sense Comparator	V _{REFA} , V _{REFB} = 0.5V		±5		mV
t _{PROP}	Turn OFF Propagation Delay ⁽¹²⁾			500		ns
t _{BLANK}	Internal Blanking Time on SENSE pins			1		μs
t _{ON(MIN)}	Minimum On Time			1.5	2	μs

ELECTRICAL CHARACTERISTICS (continued)(T_{amb} = 25°C, V_S = 48V, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t _{OFF}	PWM Recirculation Time	R _{OFF} = 20KΩ; C _{OFF} = 1nF		13		μs
		R _{OFF} = 100KΩ; C _{OFF} = 1nF		61		μs
I _{BIAS}	Input Bias Current at pins VREF _A and VREF _B				10	μA

Over Current Protection

I _{SOVER}	Input Supply Overcurrent Protection Threshold	T _j = -25°C to 125°C ⁽⁷⁾	4	5.6	7.1	A
R _{OPDR}	Open Drain ON Resistance	I = 4mA		40	60	Ω
t _{OCD(ON)}	OCD Turn-on Delay Time (13)	I = 4mA; C _{EN} < 100pF		200		ns
t _{OCD(OFF)}	OCD Turn-off Delay Time (13)	I = 4mA; C _{EN} < 100pF		100		ns

(7) Tested at 25°C in a restricted range and guaranteed by characterization.

(8) See Fig. 1.

(9) See Fig. 2.

(10) See Fig. 3.

(11) See Fig. 4.

(12) Measured applying a voltage of 1V to pin SENSE and a voltage drop from 2V to 0V to pin VREF.

(13) See Fig. 5.

Figure 1. Switching Characteristic Definition