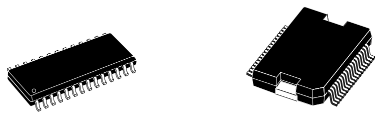
**L8219**

# HIGH CURRENT STEPPER MOTOR DRIVER

**PRODUCT PREVIEW**

- IMPROVED STEP ANGLE SPLITTING & TORQUE
- ABLE TO DRIVE BOTH WINDINGS OF BIPOLAR STEPPER MOTOR
- OUTPUT CURRENT UP TO 1.5A EACH WINDING
- WIDE VOLTAGE RANGE 10V TO 46V
- HALF-STEP, FULL-STEP AND MICROSTEPPING MODE
- BUILT-IN PROTECTION DIODES
- INTERNAL PWM CURRENT CONTROL
- LOW OUTPUT SATURATION VOLTAGE
- DESIGNED FOR UNSTABILIZED MOTOR SUPPLY VOLTAGE
- INTERNAL THERMAL SHUTDOWN
- TWO POWER PACKAGES ARE AVAILABLE:
  - SO28EP Exposed Pad
  - PowerSO36

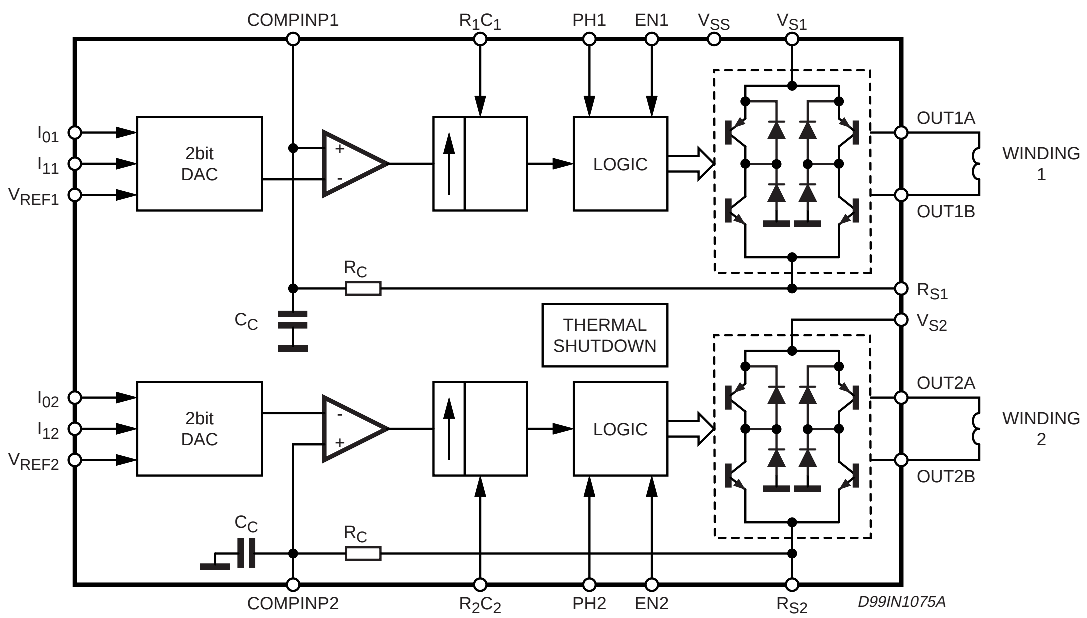


| SO28EP | PowerSO36 |
|---|---|
| **ORDERING NUMBERS:** | |
| L8219LP | L8219P |

## DESCRIPTION

The L8219 is a bipolar monolithic integrated circuits intended to control and drive both winding of a bipolar stepper motor or bidirectionally control two DC motors.The L8219 with a few external components form a complete control and drive circuit for LS-TTL or microprocessor controlled stepper motor system.The power stage is a dual full bridge capable of sustaining 46V and including four diodes for current recirculation.A cross conduction protection is provided to avoid simultaneous cross conduction during switching current direction.An internal pulse-width-modulation (PWM) controls the output current to 1.5A with peak start-up current up to 1.75A.Wide range of current control from 1.5A (each bridge) is permitted by means of two logic inputs and an external voltage reference. A phase input to each bridge determines the load current direction.A thermal protection circuitry disables the outputs if the chip temperature exceeds safe operating limits.

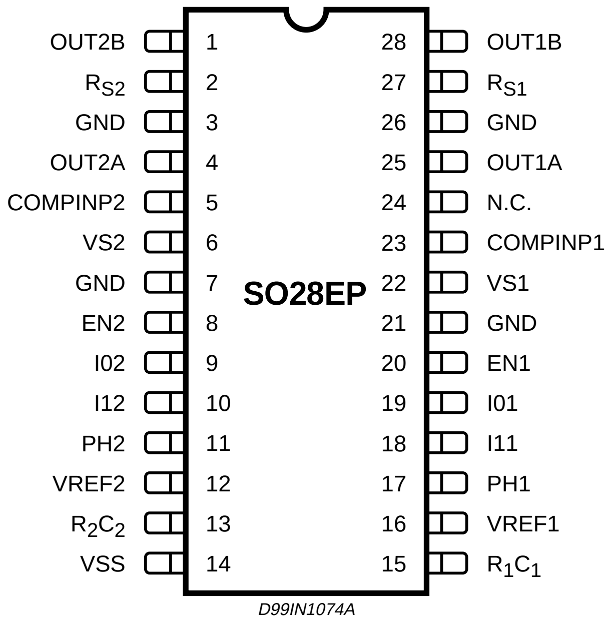
## BLOCK DIAGRAM

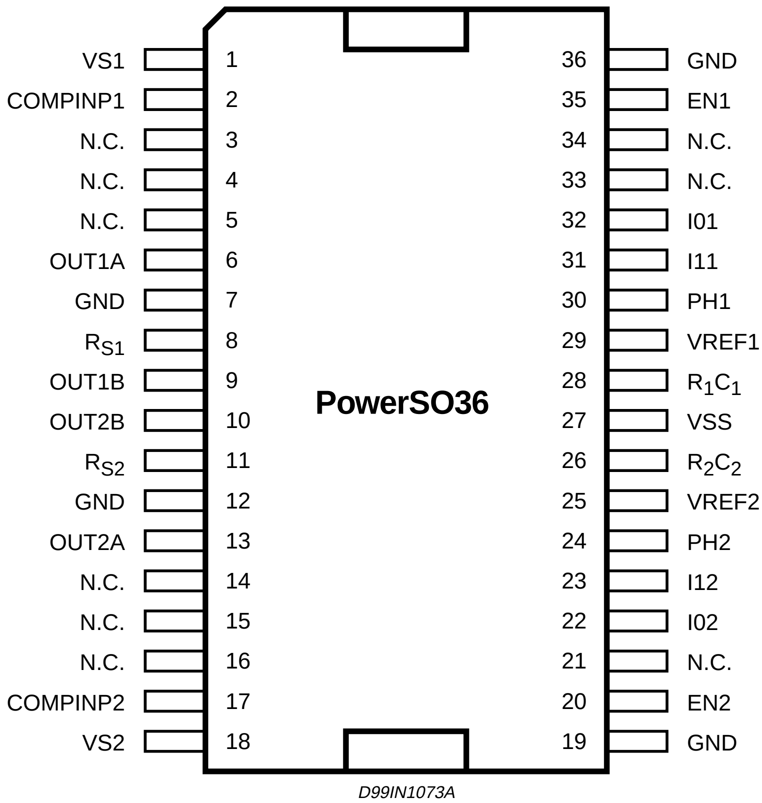





This is preliminary information on a new product now in development. Details are subject to change without notice.

**PINS CONNECTIONS** (Top views)

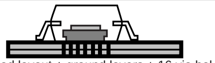
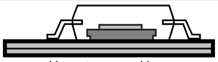
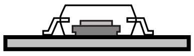


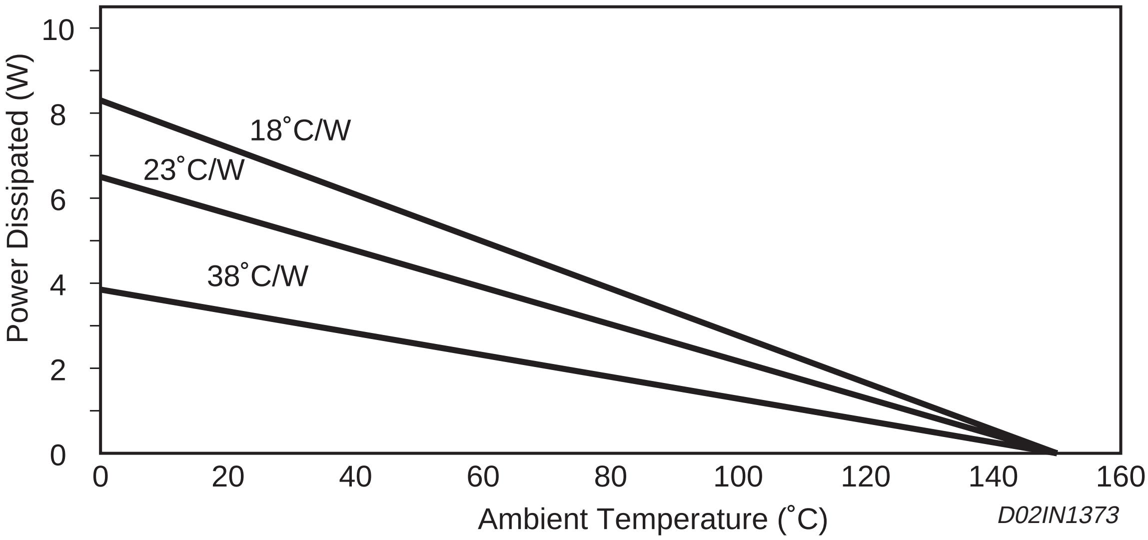
## PIN FUNCTION

| SO28 EP | PowerSO36 | Name | Description |
|---|---|---|---|
| 1 | 10 | OUT2B | Bridge-2<br>Ouput connection. The output stage is a "H" bridge formed by four transistors and four diodes connected to ground suitable for switching applications. |
| 2 | 11 | Rs2 | Bridge-2<br>Power stage sink transistors emitter connection.Sensing resistor is connected from this pin and ground. |
| 3 | 12 | GND2 | Ground |
| 4 | 13 | OUT2A | same as OUT2B |
| 5 | 17 | COMPI MP2 | Bridge-2<br>An internal low pass filter RcCc is integrated. |
| 6 | 18 | Vs2 | Bridge-2 Power supply voltage. |
| 7, 21 | 19,36 | GND | Ground |
| 8 | 20 | EN2 | Bridge2<br>When the enable input is set high the bridge is immediately switched-off skipping the delay time of the current control loop turning-off (I0=I1=H) |
| 9 | 22 | I02 | Bridge-2<br>Logic input to set up the output current level, which is also determined by the sensing resistor and reference voltage(see also Functional description and table 1). |
| 10 | 23 | I12 | same as I02 (see table 1) |
| 11 | 24 | PH2 | Bridge-2<br>This TTL-compatible logic inputs sets the direction of current flow through the load. A high level causes current to flow from OUTPUT A (source) to OUTPUT B (sink). A schmitt trigger on this input provides good noise immunity and a delay circuit prevents output stage short circuits during switching. |
| 12 | 25 | Vref2 | Bridge-2<br>A voltage applied to this pin sets the reference voltage of the comparators, this determinig the output current (also depending on Rs and the the two inputs INPUT 0 and INPUT 1). |
| 13 | 26 | R2C2 | Bridge-2<br>An external RC network connected to this pin sets the toff time of the higher power transistors.The pulse generator is a monostable triggerd by the output of the comparators (toff = 1.1 RTCT) |
| 14 | 27 | Vss | Supply voltage input for the logic circuitry. |
| 15 | 28 | R1C1 | Bridge-1 same as R2C2. |
| 16 | 29 | Vref1 | Bridge-1 same as Vref2 |
| 17 | 30 | PH1 | Bridge-1 same as PH2 |
| 18 | 31 | I11 | Bridge-1 same as I12 |
| 19 | 32 | I01 | Bridge-1 same as I02 |
| 20 | 35 | EN1 | Bridge-1 same as EN2 |
| 22 | 1 | Vs1 | Bridge-1 Power supply voltage. |
| 23 | 2 | COMPINP1 | Bridge-1<br>An internal low pass filter RcCc is integrated. Another RC external network will modify the blanking time (ss Functional Description) |
| 24 | 3,4,5,14,15, 16,21,33,34 | N.C. | Not connected |
| 25 | 6 | OUT1A | Bridge-1<br>Output connection. The output stage is a "H" bridge formed by four transistors and four diodes connected to ground suitable for switching applications |
| 26 | 7 | GND | Ground. |
| 27 | 8 | RS1 | Bridge-1<br>Power stage sink transistors emitter connection.Sensing resistor is connected from this pin and ground. |
| 28 | 9 | OUT1B | same as OUT1A |

## THERMAL CHARACTERISTICS - SO28EP

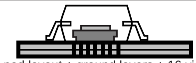
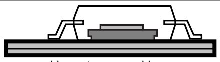
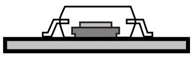
| *Conditions* | *Power Dissipated (W)* | *T Ambient (°C)* | *Thermal J-A resistance (°C/W)* |
|---|---|---|---|
|  pad layout + ground layers + 16 via hol PCB ref.: 4 LAYER cm 12 x 12 | 4.4 | 70 | 18 |
|  pad layout + ground layers PCB ref.: 4 LAYER cm 12 x 12 | 3.5 | 70 | 23 |
|  pad layout + 6cm2 on board heat sink PCB ref.: 2 LAYER cm 12 x 12 | 2.1 | 70 | 38 |

*D02IN1372*

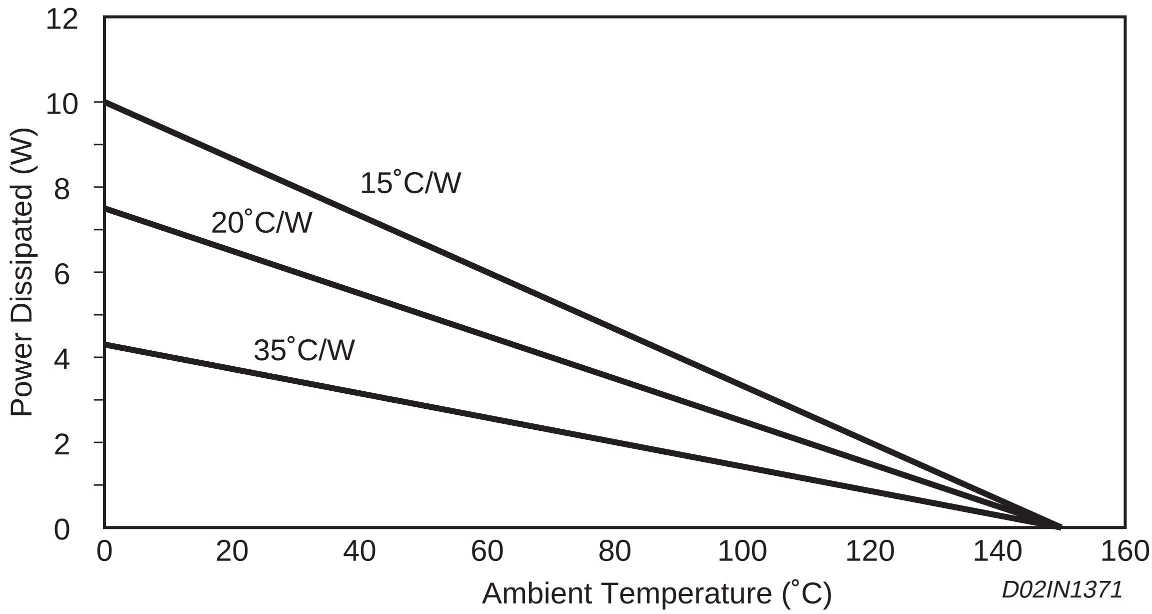



*D02IN1373*

**THERMAL CHARACTERISTICS - PowerSO36**

| *Conditions* | *Power Dissipated (W)* | *T Ambient (˚C)* | *Thermal J-A resistance (˚C/W)* |
|---|---|---|---|
|  pad layout + ground layers + 16 via hol PCB ref.: 4 LAYER cm 12 x 12 | 5.3 | 70 | 15 |
|  pad layout + ground layers PCB ref.: 4 LAYER cm 12 x 12 | 4.0 | 70 | 20 |
|  pad layout + 6cm2 on board heat sink PCB ref.: 2 LAYER cm 12 x 12 | 2.3 | 70 | 35 |

*D02IN1370*



## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_S$ | Supply Voltage | 50 | V |
| $I_o$ | Output Current (peak) non repetitive ton < 2µs | 2.5 | A |
| $I_o$ | Output Current repetitive ton < 10µs | 1.75 | A |
| $V_{SS}$ | Logic Supply Voltage | 7 | V |
| $V_{IN}$ | Logic Input Voltage Range | -0.3 to +7 | V |
| $V_{sense}$ | Sense Output Voltage | 1.5 | V |
| $T_J$ | Junction Temperature | +150 | °C |
| $T_{op}$ | Operating Temperature Range | 0 to 70 | °C |
| $T_{stg}$ | Storage Temperature Range | -55 to +150 | °C |

**ELECTRICAL CHARACTERISTICS** ($T_j$ = 25°C, $V_S$ = 46V, $V_{SS}$ = 4.75V to 5.25V, $V_{REF}$ = 5V; unless otherwise specified) See fig. 3.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **OUTPUT DRIVERS (OUT$_A$ or OUTB)** | | | | | | |
| $V_S$ | Motor Supply Range | | 10 | | 46 | V |
| $I_{CEX}$ | Output Leakage Current | $V_{OUT} = V_S$<br>$V_{OUT} = 0$ | -<br>- | <1<br><-1 | 100<br>-100 | µA<br>µA |
| $V_{CE(sat)}$ | Output Saturation Voltage | Sink Driver, $I_{OUT}$= +1A<br>Sink Driver, $I_{OUT}$ = +1.5A<br>Source Driver, $I_{OUT}$ = -1A<br>Source Driver, $I_{OUT}$ = -1.5A | -<br>-<br>-<br>- | 0.5<br>0.8<br>1.8<br>1.9 | 0.7<br>1<br>1.9<br>2.1 | V<br>V<br>V<br>V |
| $I_R$ | Clamp Diode Leakage Current | $V_R$ = 50V | - | <1 | 50 | µA |
| $V_F$ | Clamp Diode Forward Voltage | Sink Diode<br>Source Diode $I_F$ =1.5A | | 1.6<br>1.6 | 2<br>2 | V<br>V |
| $I_{S(on)}$ | Driver Supply Current | Both Bridges ON, No Load | - | 8 | 20 | mA |
| $I_{S(off)}$ | Driver Supply Current | Both Bridges OFF | - | 6 | 15 | mA |
| **CONTROL LOGIC** | | | | | | |
| $V_{IN(H)}$ | Input Voltage | All Inputs | 2.4 | - | - | V |
| $V_{IN(L)}$ | Input Voltage | All Inputs | - | - | 0.8 | V |
| $I_{IN(H)}$ | Input Current | $V_{IN}$ = 2.4V | - | <1 | 20 | mA |
| $I_{IN(L)}$ | Input Current | $V_{IN}$ = 0.84V | - | -3 | -200 | mA |
| $V_{REF}$ | Reference Voltage | Operating | 1.5 | - | 7.5 | V |
| $I_{SS(ON)}$ | Total Logic Supply Current | $I_o = I_1$ = 0.8V, No Load | - | 90 | 120 | mA |
| $I_{SS(OFF)}$ | Total Logic Supply Current | $I_o = I_1$ = 2.4V, No Load | - | 14 | 20 | mA |
| **COMPARATORS** | | | | | | |
| $V_{REF}$ / $V_{sense}$ | Current Limit Threshold (at trip point | $I_o = I_1$ = 0.8V | 9.5 | 10 | 10.5 | - |
| | | $I_o$ = 2.4V, $I_1$ = 0.8V | 12.7 | 14.1 | 15.6 | - |
| | | $I_o$ = 0.8V, $I_1$ = 2.4V | 20.7 | 24.4 | 28.1 | - |
| $t_{off}$ | Cutoff Time | $R_t$ = 56KΩ $C_t$ = 820pF | - | 50 | | µs |
| $t_d$ | Turn Off Delay | Fig. 1 | - | 1 | | µs |
| **PROTECTION** | | | | | | |
| $T_J$ | Thermal Shutdown Temperature | | - | 170 | - | °C |

## FUNCTIONAL DESCRIPTION

One L8219 is able to drive both windings of a bipolar stepper motor. Internal PWM control circuit sets the current in each motor's winding. The peak current in each winding is sensed and then controlled by an external sensing resistor (Rs), a reference voltage (Vref), and the 2 bit DAC. In addition, varying the Vref voltage can be provided a continous control of the peak load current fitting micro-stepping application needs.

### Logic ($I_0$ and $I_1$)

The current level in each motor winding is selected with two digital inputs. (See tab.1) producing four current Imax, 70.7%Imax, 41%Imax and zero current.

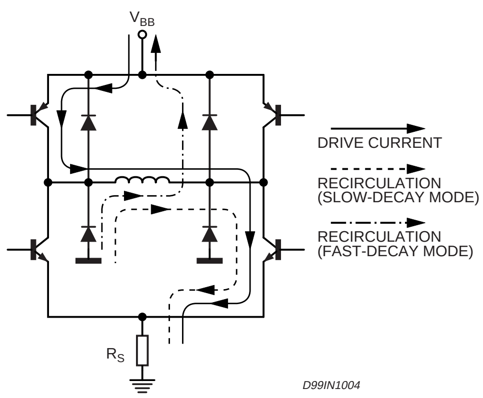
Eight step position can be produced at constant torque setting an Half-step mode and selecting 100% current when only one phase is ON and 70.7% when two phases are ON.

When the "Phase" signal change or when $I_0$=$I_1$=H the power bridge is turned off resulting in a fast current decay (see fig.1) through the internal output clamp and flyback diodes. The fast current decay is usefull for half-step and high speed application. If any of the logic inputs is left open, the circuit will treat it as a high level input. Due to the internal current control loop (sensing resistor, comparator, monostable) a delay time of ~2µsec exsist between the input of the digital comand and the real current implementation in the motor's winding. When the digital inputs are set to zero ($I_0$=$I_1$=L) the average current will be higher then zero for a time period of ~2µsec; to skip this problem there is the pin "**Enable**" which immediately turn off the bridge.

With the $I_0$ and $I_1$ digital input signals is also possible to implement the "holding torque" (reduced power dissipation), or the best "start-up" condition (maximum output current).

| Io | I1 | Current Leve |
|---|---|---|
| H | H | 0% Current |
| L | H | 41% Current |
| H | L | 70.7% Current |
| L | L | 100% Current |

### Figure 1.




### Internal PWM Current Control

Once an output current level has been set by the digital input the current in the motor winding begins to flow in the bridge (see fig.1) and the max peak current Imax can be defined by: Imax = Vref10 Rs. At the same time the voltage on sensing resistor increase and the bridge will be turned off again as soon as the voltage on the sensing resistor is equal to the value set by the DAC; at this stage the current recirculates through the ground-clamp diodes and sink transistor implementing the slow current decay.
Once the "toff" time has expired the source driver is turned on again and the cycle repeat itself keeping the desidered average current level.

**Figure 2.**

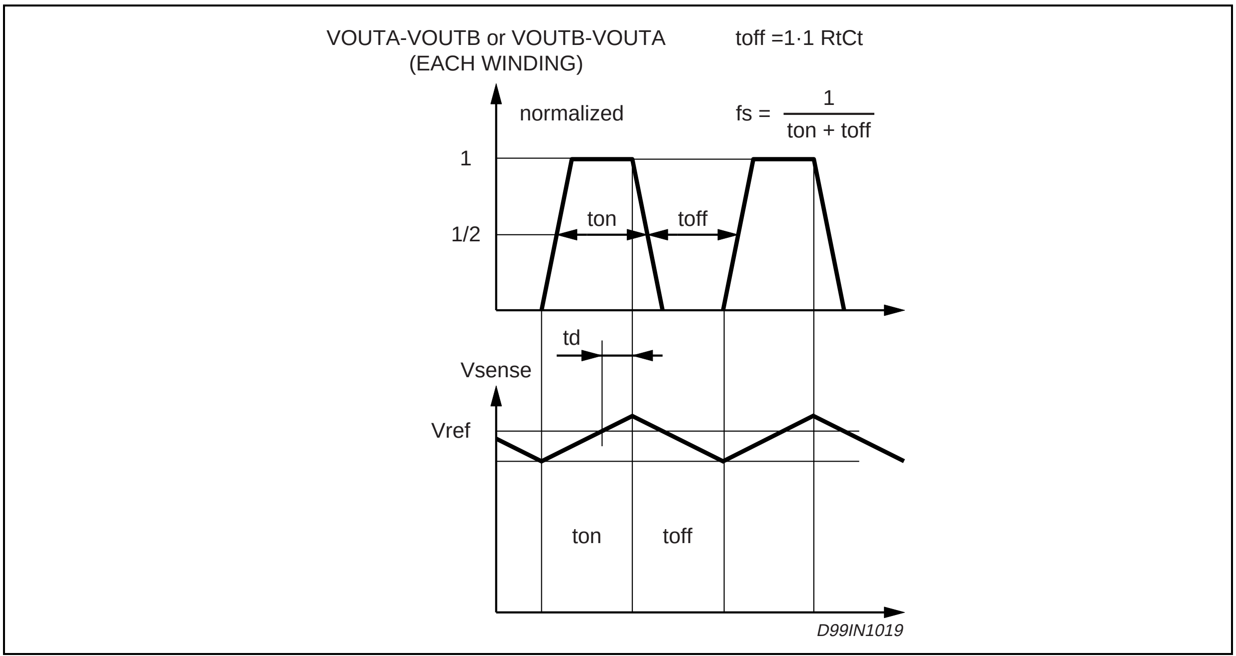
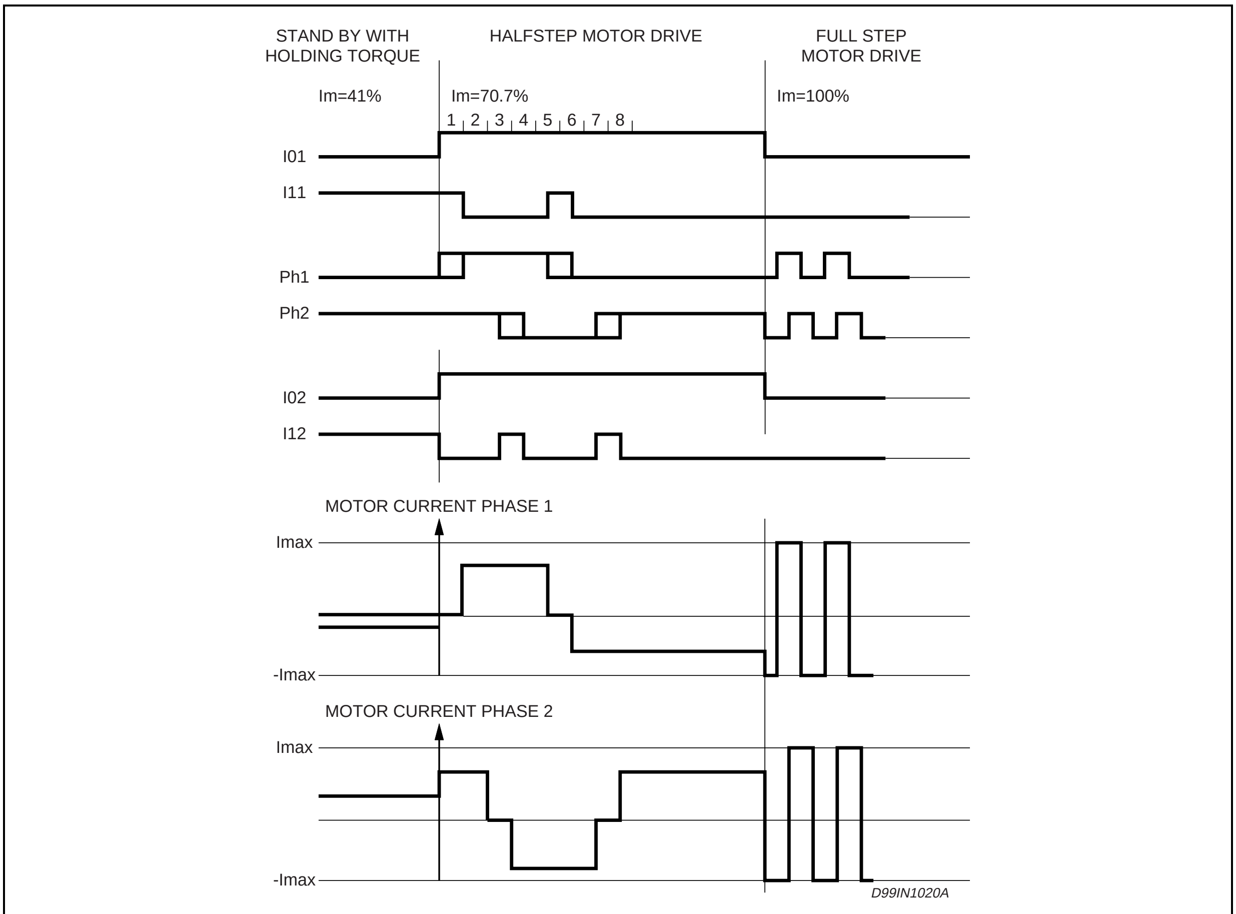



**Figure 3. Principle Operating Sequence**



**Phase**

This input determines the direction of current flow in the windings, depending on the motor connections. The signal is fed through a Schmidt-trigge for noise immunity, and through a time delay in order to guarantee that no short-circuit occurs in the output stage during phase-shift. High level on the PHASE input causes the motor current flow from Out A through the winding to Out B.

**Current Sensor**

This part contains a current sensing resistor ($R_S$), a low pass filter ($R_C$, $C_C$) and three comparators.Only one comparator is active at a time. It is activated by the input logic according to the current level chosen with signals $I_0$ and $I_1$.
The motor current flows through the sensing resistor $R_S$. When the current has increased so that the voltage across $R_S$ becomes higher than the reference voltage on the other comparator input, the comparator goes high, which triggers the pulse generator.
The max peak current Imax can be defined by:

$$I_{max} = \frac{V_{ref}}{10\ R_S}$$

**Single-pulse Generator**

The pulse generator is a monostable triggered on the positive going edge of the comparator output.
The monostable output is high during the pulse time, $t_{off}$ , which is determined by the time components $R_t$ and $C_t$.

$$t_{off} = 1.1 \cdot R_t C_t$$

The single pulse switches off the power feed to the motor winding, causing the winding current to decrease during $t_{off}$.

If a new trigger signal should occur during $t_{off}$, it is ignored.

**Output Stage**

The output stage contains four Darlington transistors (source drivers) four saturated transistors (sink drivers) and eight diodes, connected in two H bridge. The source transistors are used to switch the power supplied to the motor winding, thus driving a constant current through the winding.

**$V_S$, $V_{SS}$, $V_{Ref}$**

The circuit will stand any order of turn-on or turn-off the supply voltages $V_S$ and $V_{SS}$. Normal dV/dt values are then assumed. Preferably, $V_{Ref}$ should be tracking $V_{SS}$ during power-on and power-off if $V_S$ is established.

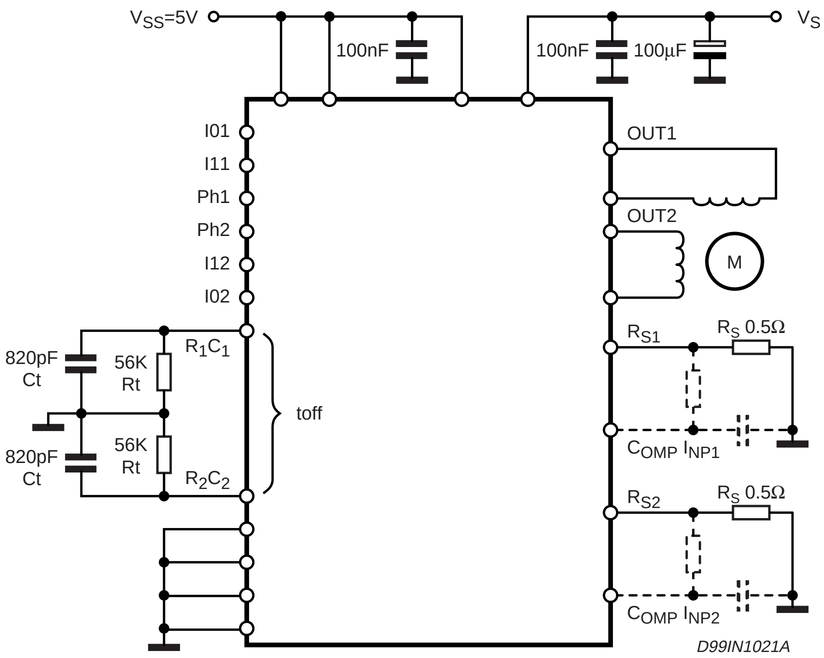
**Thermal Shutdown**

When the die temperature reach 170°C the thermal shutdown internal circuitry turns off the power stage (tristate), once the cause of the die increased temperature will be removed the L8219 re-turns on itself as soon as the die temperature reach 150°C.

**APPLICATION INFORMATIONS**

Some stepper motors are not designed for continuous operation at maximum current. As the circuit drives a constant current through the motor, its temperature might increase exceedingly both at low and high speed operation. Also, some stepper motors have such high core losses that they are not suited for switch mode current regulation. Unused inputs should be connected to proper voltage levels in order to get the highest noise immunity. As the circuit operates with switch mode current regulation, interference generation problems might arise in some applications. A good measure might then be to decouple the circuit with a 100nF capacitor, located near the package between power line and ground. The ground lead between Rs, and circuit GND should be kept as short as possible. A typical Application Circuit is shown in Fig. 4. Note that Ct must be NPO type or similar else. To sense the winding current, paralleled metal film resistors are recommended.

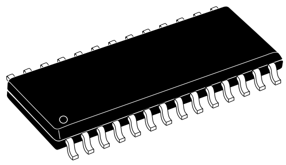
**Figure 4. Typical Application Circuit.**



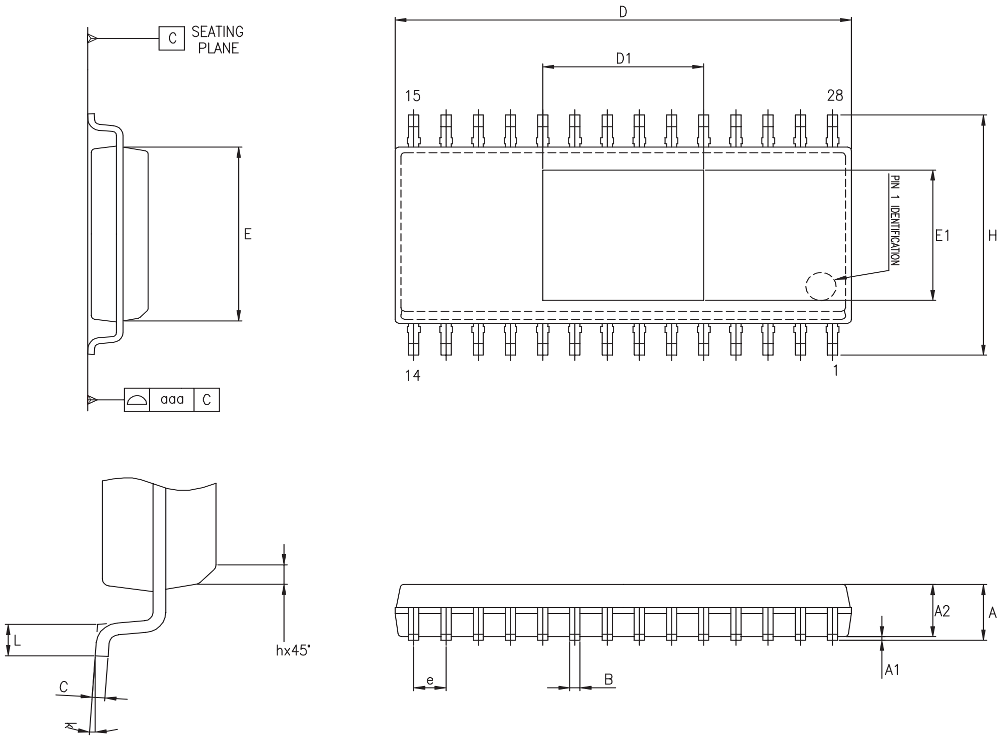
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.350 | | 2.650 | 0.092 | | 0.104 |
| A1 | 0.100 | | 0.300 | 0.004 | | 0.012 |
| A2 | 2.050 | | 2.550 | 0.080 | | 0.100 |
| b | 0.330 | | 0.510 | 0.013 | | 0.020 |
| c | 0.230 | | 0.320 | 0.009 | | 00.12 |
| D (1) | 17.70 | | 18.10 | 0.696 | | 0.712 |
| D1 | ACCORDING TO PAD SIZE | | | | | |
| E (2) | 7.400 | | 7.600 | 0.291 | | 0.299 |
| E1 | ACCORDING TO PAD SIZE | | | | | |
| e | | 1.270 | | | 0.05 | |
| H | 10.00 | | 10.65 | 0.394 | | 0.419 |
| h | 0.250 | | 0.750 | 0.010 | | 0.029 |
| L | 0.400 | | 1.270 | 0.016 | | 0.05 |
| k | 0° (min), 8° (max) | | | | | |
| ddd | | | 0.100 | | | 0.004 |

(1) Dimensions “D” does not include mold flash, protusions or gate burrs. Mold flash, protusions and gate shall not exeed 0.15mm per side.
(2) Dimensions “E” does not include inter-lead flash or protusions or gate burrs. Inter-lead flash or protusions shall not exeed 0.25mm per side.

## OUTLINE AND MECHANICAL DATA



## SO28EP (HSOP28 - Exposed Pad)

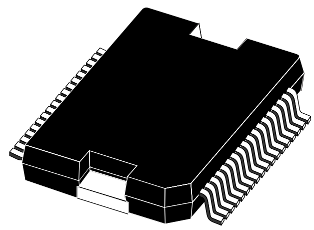



7165357

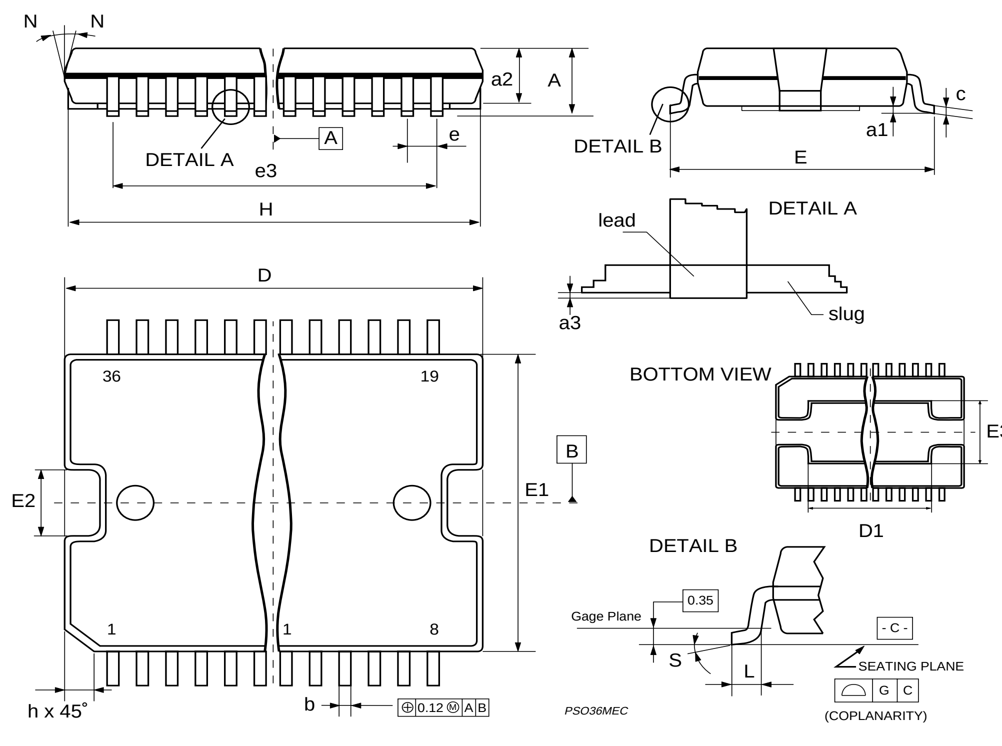
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 3.60 | | | 0.141 |
| a1 | 0.10 | | 0.30 | 0.004 | | 0.012 |
| a2 | | | 3.30 | | | 0.130 |
| a3 | 0 | | 0.10 | 0 | | 0.004 |
| b | 0.22 | | 0.38 | 0.008 | | 0.015 |
| c | 0.23 | | 0.32 | 0.009 | | 0.012 |
| D (1) | 15.80 | | 16.00 | 0.622 | | 0.630 |
| D1 | 9.40 | | 9.80 | 0.370 | | 0.385 |
| E | 13.90 | | 14.50 | 0.547 | | 0.570 |
| e | | 0.65 | | | 0.0256 | |
| e3 | | 11.05 | | | 0.435 | |
| E1 (1) | 10.90 | | 11.10 | 0.429 | | 0.437 |
| E2 | | | 2.90 | | | 0.114 |
| E3 | 5.80 | | 6.20 | 0.228 | | 0.244 |
| E4 | 2.90 | | 3.20 | 0.114 | | 0.126 |
| G | 0 | | 0.10 | 0 | | 0.004 |
| H | 15.50 | | 15.90 | 0.610 | | 0.626 |
| h | | | 1.10 | | | 0.043 |
| L | 0.80 | | 1.10 | 0.031 | | 0.043 |
| N | 10°(max.) | | | | | |
| S | 8 °(max.) | | | | | |

(1): "D" and "E1" do not include mold flash or protrusions
- Mold flash or protrusions shall not exceed 0.15mm (0.006 inch)
- Critical dimensions are "a3", "E" and "G".

## OUTLINE AND MECHANICAL DATA



## PowerSO36



STMicroelectronics GROUP OF COMPANIES
Australia - Brazil - Canada - China - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan -Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States.
**http://www.st.com**