

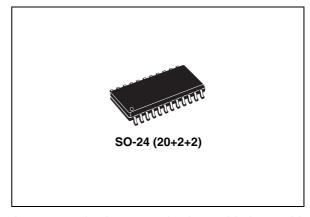
Stepper motor driver

Features

- Able to drive both windings of bipolar stepper motor
- Output current up to 500 mA each winding
- Wide voltage range 4.5 V to 10 V
- 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

Description

The L6219R 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 L6219R 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 10 V 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 500mA with peak start-up current up to 1 A. Wide range of current control from 500 mA (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.

Table 1. Device summary

Part number	Package	Packing
L6219R	SO-24	Tube
L6219R013TR	SO-24	Tape & reel
E-L6219R ⁽¹⁾	SO-24	Tube
E-L6219R013TR ⁽¹⁾	SO-24	Tape & reel

^{1.} Lead free package (ECOPACK®) see Chapter 5.

Table of contents L6219R

Table of contents

1	Bloc	k diagram and pins description	. 5
2	Elec	trical specifications	. 7
	2.1	Absolute maximum ratings	. 7
	2.2	Thermal data	. 7
	2.3	Electrical characteristics	. 8
3	Fund	ctional description	10
	3.1	Input logic (I0 and I1)	10
	3.2	Phase	10
	3.3	Current sensor	10
	3.4	Single-pulse generator	11
	3.5	Output stage	11
	3.6	VS, VSS, VRef	11
4	Арр	lication informations	12
	4.1	Electrical characteristics curves	13
5	Pack	rage informations	14
8	Revi	sion history	15

L6219R List of tables

List of tables

Table 1.	Device summary	1
Table 2.	Pin description	6
Table 3.	Absolute maximum ratings	1
Table 4.	Thermal data	7
	Electrical characteristics	٤
	Input logic current level10	
Table 7.	Document revision history	٤

List of figures L6219R

List of figures

Figure 1.	Block diagram	. 5
Figure 2.	Pin connection (top view)	
Figure 3.	Windings of a bipolar stepper motor	
Figure 4.	Principle operating sequence	
Figure 5.	Typical application circuit	
Figure 6.	Maximum output current vs. supply voltage (DAC=100%)	13
Figure 7.	Maximum reference voltages vs. supply voltage	13
Figure 8.	Maximum output current vs. reference voltage (DAC=100%)	
Figure 9.	SO-24 mechanical data and package dimensions	14

1 Block diagram and pins description

Figure 1. Block diagram

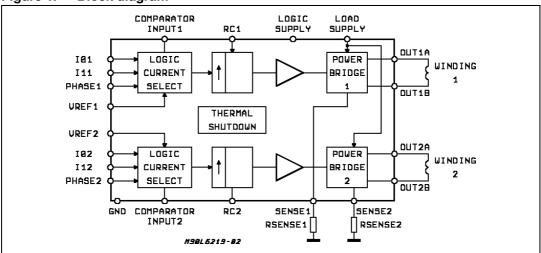


Figure 2. Pin connection (top view)

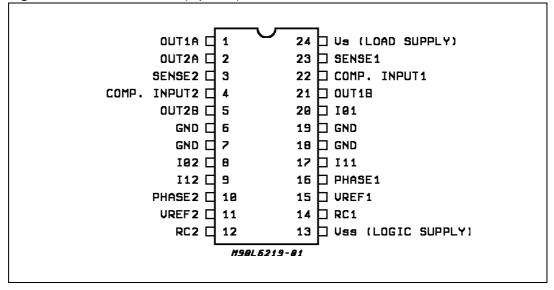


Table 2. Pin description

Pin #	Name	Description
1,2	Output A	See pins 5,21
3,23	Sense resistor	Connection to lower emitters of output stage for insertion of current sense resistor
4,22	Comparator input	Input connected to the comparators. The voltage across the sense resistor is feedback to this input throught the low pass filter RC CC. The higher power transistors are disabled when the sense voltage exceeds the reference voltage of the selected comparator. When this occurs the current decays for a time set by RT CT (toff = 1.1 RT CT). See <i>Figure 4</i>
5,21	Output B	Output connection. The output stage is a H bridge formed by four transistors and four diodes suitable for switching applications
6,19	Ground	See pins 7,18
7,18	Ground	Ground connection. With pins 6 and 19 also conducts heat from die to printed circuit copper
8,20	Input 0	See input 1 (pins 9,17)
9,17	Input 1	These pins and pins 8,20 (input 0) are logic inputs which select the outputs of the comparators to set the current level. Current also depends on the sensing resistor and reference voltage. See funcional description
10,16	Phase	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
11,15	Reference voltage	A voltage applied to this pin sets the reference voltage of the comparators, this determining the output current (also thus depending on Rs and the two inputs input 0 and input 1)
12,14	RC	A parallel RC network connected to this pin sets the OFF time of the higher power transistors. The pulse generator is a monostable triggered by the output of the comparators (toff = 1.1 RT CT)
13	Vss - Logic supply	Supply voltage input for logic circuitry
24	Vs - Load supply	Supply voltage input for the output stages

Note: ESD on GND, Vs, Vss, OUT 1 A and OUT 2 A is guaranteed up to 1.5 KV (human body model, 1500 W, 100 pF).

2 Electrical specifications

2.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V _S	Supply voltage	30	V
I _o	Output current (peak)	±1	Α
Io	Output current (continuous)	±0.5	Α
V _{SS}	Logic supply voltage	7	V
V_{IN}	Logic input voltage range	-0.3 to V _{SS}	V
V _{sense}	Sense output voltage	1.5	V
T _J	Junction temperature	+150	°C
T _{op}	Operating temperature range	-20 to +85	°C
T _{stg}	Storage temperature range	-55 to +150	°C

2.2 Thermal data

Table 4. Thermal data

Symbol	Description	Value	Unit
R _{thj-case}	Thermal resistance junction-case Max.	18	°C/W
R _{thj-amb}	Thermal resistance junction-ambient Max.	75 ⁽¹⁾	°C/W

^{1.} With minimized copper area.

2.3 Electrical characteristics

Table 5. Electrical characteristics $(T_j = 25 \, ^{\circ}\text{C}, \, V_S = 4.5 \, \text{V}, \, V_{SS} = 4.75 \, \text{V} \text{ to } 5.25 \, \text{V}, \, V_{REF} = 2 \, \text{V}, \, \text{unless otherwise specified})$

V _S Motor I _{CEX} Outor I _{CEX} Outor I _{CE(sat)} Outor I _{S(on)} Driv	otor supply range utput leakage current utput saturation voltage amp diode forward voltage	$V_S = 30 \text{ V}, V_{OUT} = V_S,$ $V_S = 30 \text{ V}, V_{OUT} = 0$ Sink driver, $I_{OUT} = +300 \text{ mA}$ Sink driver, $I_{OUT} = +500 \text{ mA}$ Source driver, $I_{OUT} = -300 \text{ mA}$ Source driver, $I_{OUT} = -500 \text{ mA}$	4.5 - -50 - -	<1 <-1 0.3 0.7	10 50	V μA μA
I _{CEX} Out V _{CE(sat)} Out V _F Cla I _{S(on)} Driv	utput leakage current utput saturation voltage	$V_s = 30 \text{ V}, V_{OUT} = 0$ Sink driver, $I_{OUT} = +300 \text{ mA}$ Sink driver, $I_{OUT} = +500 \text{ mA}$ Source driver, $I_{OUT} = -300 \text{ mA}$	- -50 - -	<-1 0.3	50	μΑ
V _{CE(sat)} Out V _F Cla I _{S(on)} Driv	utput saturation voltage	$V_s = 30 \text{ V}, V_{OUT} = 0$ Sink driver, $I_{OUT} = +300 \text{ mA}$ Sink driver, $I_{OUT} = +500 \text{ mA}$ Source driver, $I_{OUT} = -300 \text{ mA}$	-50 - - -	<-1 0.3		•
V _F Cla		Sink driver, $I_{OUT} = +500 \text{ mA}$ Source driver, $I_{OUT} = -300 \text{ mA}$	-		0.6	
I _{S(on)} Driv	amp diode forward voltage		_	1.1 1.3	1 1.4 1.6	V V V
3(6)		Sink diode Source diode $I_F = 500 \text{ mA}$		1 1	1.5 1.5	V V
I _{S(off)} Driv	river supply current	Both bridges ON, no load $V_s = 10 \text{ V}$	-	8	15	mA
	iver supply current	Both bridges OFF, V _s = 10 V	-	6	10	mA
CONTROL LO	CONTROL LOGIC					
V _{IN(H)} Inpo	put voltage	All inputs	2.4	-	-	V
V _{IN(L)} Inpu	put voltage	All inputs	-	-	0.8	V
I _{IN(H)} Inpo	put current	V _{IN} = 2.4 V	-	<1	20	μΑ
I _{IN(L)} Inpo	put current	V _{IN} = 0.84 V	-	-3	-200	μΑ
V _{REF} Ref	eference voltage	Operating (1) (2)	1.5	-	2	٧
I _{SS(ON)} Tota	tal logic supply current	$I_0 = I_1 = 0.8 \text{ V}$, no load	-	44	60	mA
I _{SS(OFF)} Tota	tal logic supply current	$I_0 = I_1 = 2.4 \text{ V}$, no load	-	10	14	mA
COMPARATORS						
		$I_0 = I_1 = 0.8 \text{ V}$	9.5	10	10.5	-
	urrent limit threshold (at trip	$I_0 = 2.4 \text{ V}, I_1 = 0.8 \text{ V}$	13.5	15	16.5	-
V _{sense} poir	point)	I _o = 0.8 V, I ₁ = 2.4 V	25.5	30	34.5	-
t _{off} Cut	utoff time	$R_t = 56 \text{ K}\Omega C_t = 820 \text{ pF}$	-	50		μs
	rn off delay	see Figure 1	-	1		μs
PROTECTION	PROTECTION					
T _J The	N					

^{1.} The maximum reference voltage accepted by the device depends from the supply voltage Vs (see Figure 7).

^{2.} To reduce the switching losses the base bias of the bridge's low side NPN transistor is proportional to the DAC output, then the output current driving capability is also proportional to the DAC output voltage (see *Figure 6* and *Figure 8* for DAC=100%, it is proportional for lower percentages).

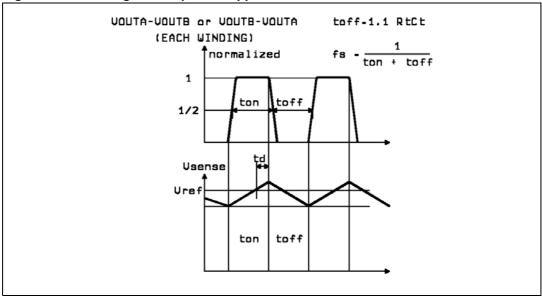


Figure 3. Windings of a bipolar stepper motor

3 Functional description

The circuit is intended to drive both windings of a bipolar stepper motor.

The peak current control is generated through switch mode regulation. There is a choice of three different current levels with the two logic inputs I_{01} - I_{11} for winding 1 and I_{02} - I_{12} for winding 2.

The current can also be switched off completely

3.1 Input logic (I_0 and I_1)

The current level in the motor winding is selected with these inputs. (See *Figure 4*) If any of the logic inputs is left open, the circuit will treat it has a high level input.

Table 6. Input logic current level

I ₀	I ₁	Current level
Н	Н	No current
L	Н	Low current 1/3 I _O max
Н	L	Medium current 2/3 I _O max
L	L	Maximum current I _O max

3.2 Phase

This input determines the direction of current flow in the windings, depending on the motor connections. The signal is fed through a schmidt-trigger 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

3.3 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 RS. 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:

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

See figures Figure 3, 4 and 5 for maximum allowable output current and reference voltage versus $V_{\rm S}$ supply.

3.4 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, toff , 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 toff. If a new trigger signal should occur during toff, it is ignored.

3.5 Output stage

The output stage contains four darlington transistors (source drivers) four saturated transistors (sink drivers) and eight diodes, connected in two H bridge.

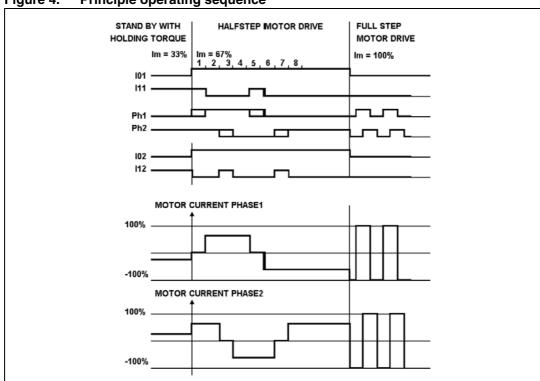


Figure 4. Principle operating sequence

The source transistors are used to switch the power supplied to the motor winding, thus driving a constant current through the winding. It should be noted however, that is not permitted to short circuit the outputs.

Internal circuitry is added in order to increase the accuracy of the motor current particularly with low current levels.

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.

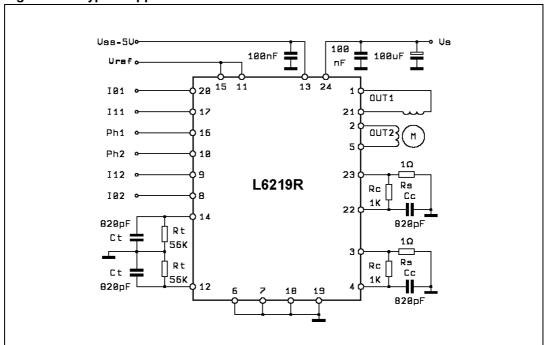
Preferably, V_{Ref} should be tracking V_{SS} during power-on and power-off if V_{S} is established.

4 Application informations

Some stepper motors are not designed for contin-uous 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 100 nF 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 *Figure 5*. Note that Ct must be NPO type or similar else. To sense the winding current, paralleled metal film resistors are recommended (R_s)





4.1 Electrical characteristics curves

Figure 6. Maximum output current vs. supply Figure 7. Maximum reference voltages vs. voltage (DAC=100%) Supply voltage

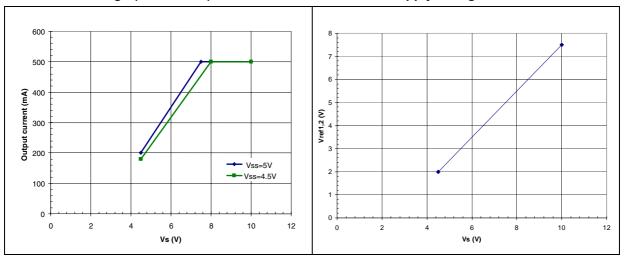
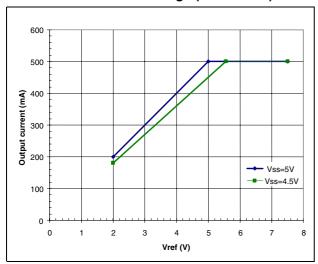


Figure 8. Maximum output current vs. reference voltage (DAC=100%)

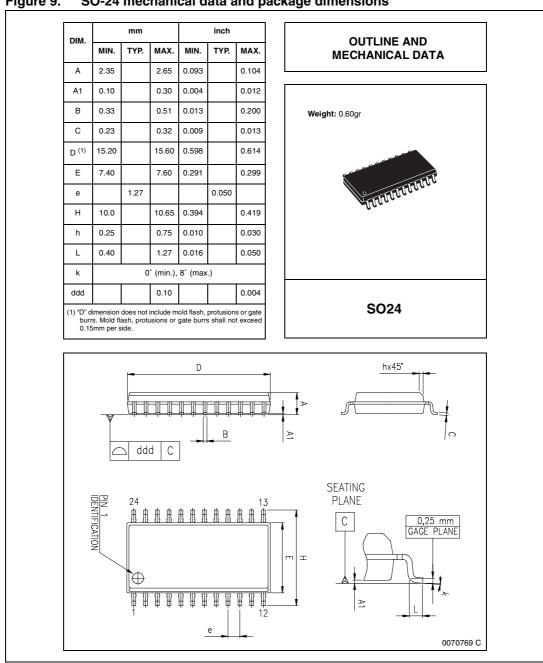


5 **Package informations**

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark.

ECOPACK specifications are available at: www.st.com.

Figure 9. SO-24 mechanical data and package dimensions



L6219R Revision history

6 Revision history

Table 7. Document revision history

Date	Revision	Changes
09-Jan-2003	1	First Issue
06-May-2005	2	Modified Table 2 on page 6.
22-Jun-2006	3	Changed look anf fill. Changed value of the Output Current (continuous) in <i>Table 3</i> . Changed the curve diagrams of the <i>Figure 6</i> and <i>7</i> .
05-Sep-2008	4	Added note 1 and 2 in Table 5 on page 8.

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