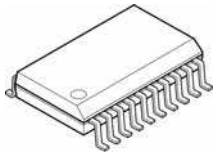
STEPPER MOTOR DRIVER

■ GENERAL DESCRIPTION

NJM37770 is a stepper motor driver, which consists of a LS-TTL compatible logic input stage, a current sensor, a monostable multivibrator and a high power H-bridge output stage. The **NJM37770** is a high power version and pincompatible with the **NJM37717** and also **NJM37770** is a high voltage version with **NJM3770A**. Two **NJM37770** and a small number of external components form a complete control and drive unit stepper motor systems.

■ PACKAGE OUTLINE



NJM37770E2
(SOP20-E2)

■ FEATURES

- Half-step and full-step operation
- Switched mode bipolar constant current drive

● Wide range of current control	5 to 1500mA
● Wide voltage range	10 to 60 V
● Thermal overload protection	
● Packages	SOP20-E2 JEDEC 300mil

■ BLOCK DIAGRAM

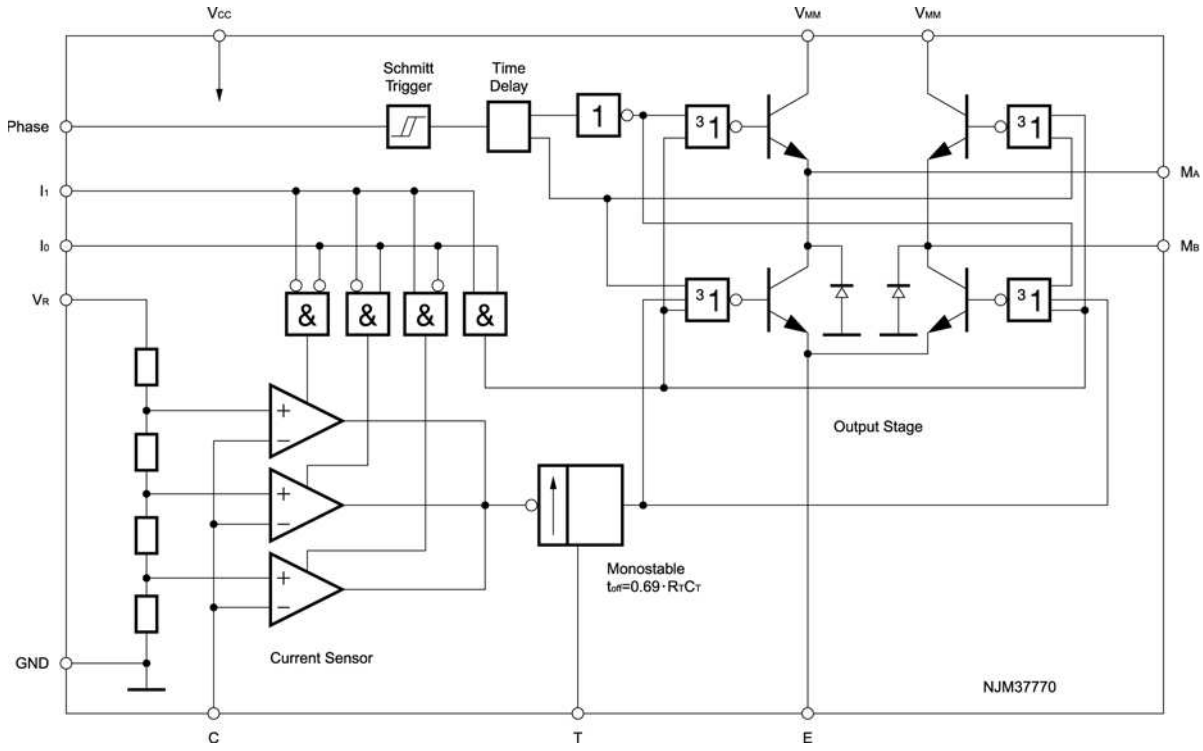


Figure 1. Block diagram

■ PIN CONFIGURATION

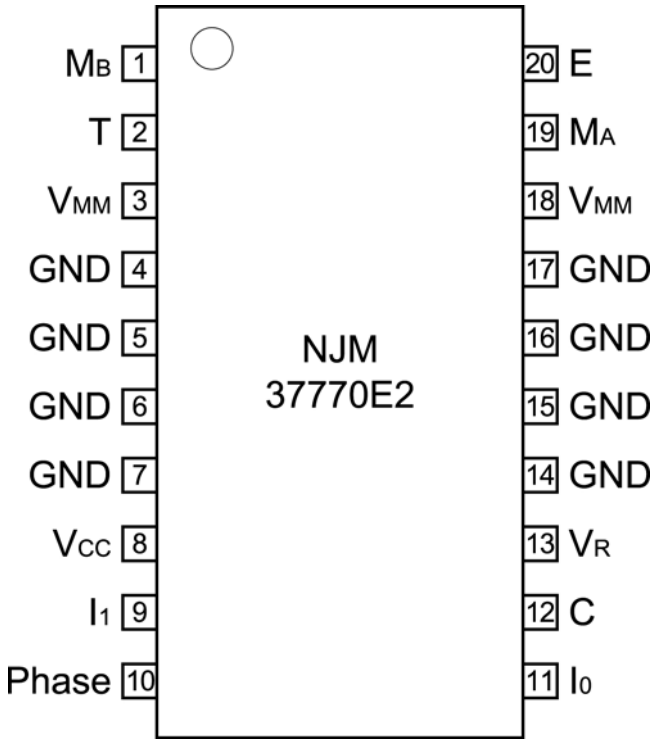


Figure 2. Pin configuration

■ PIN DESCRIPTION

SOP	Symbol	Description
1	M_B	Motor output B, Motor current flows from M_A to M_B when Phase is high.
2	T	Clock oscillator. Timing pin connect a 56 kΩ resistor and a 820 pF in parallel between T and Ground.
3,18	V_{MM}	Motor supply voltage, 10 to 40 V. Pin 3 and pin 18 should be wired together.
4-7 14-17	GND	Ground and negative supply. Note these pins are used for heatsinking. Make sure that all ground pins are soldered onto a suitable large copper ground plane for efficient heat sinking.
8	V_{CC}	Logic voltage supply normally +5 V.
9	I_1	Logic input. It controls, together with the I0 input, the current level in the output stage. The controllable levels are fixed to 100, 60, 20, 0%.
10	Phase	Controls the direction of the motor current of M_A and M_B outputs. Motor current flows from M_A to M_B when the phase input is high.
11	I_0	Logic input. It controls, together with the I_1 input, the current level in the output stage. The controllable levels are fixed to 100, 60, 20, 0%.
12	C	Comparator input. This input senses the instantaneous voltage across the sensing resistor, filtered through a RC Network.
13	V_R	Reference voltage. Controls the threshold voltage of the comparator and hence the output current. Input resistance: typically 6.8 kΩ ±20%.
19	M_A	Motor output A, Motor current flows from M_A to M_B when Phase is high.
20	E	Common emitter. Connect the Sense resistor between this pin and ground.

■ FUNCTIONAL DESCRIPTION

The **NJM37770** is intended to drive a bipolar constant current through one winding of a 2-phase stepper motor.
Current control is achieved through switched-mode regulation, see figure 3 and 4.
Three different current levels and zero current can be selected by the input logic.
The circuit contains the following functional blocks:

- Input logic
- Current sense
- Single-pulse generator
- Output stage

Input logic

Phase input

The phase input determines the direction of the current in the motor winding. High input forces the current from terminal M_A to M_B and low input from terminal M_B to M_A. A Schmitt trigger provides noise immunity and a delay circuit eliminates the risk of cross conduction in the output stage during a phase shift.

Half- and full-step operation is possible.

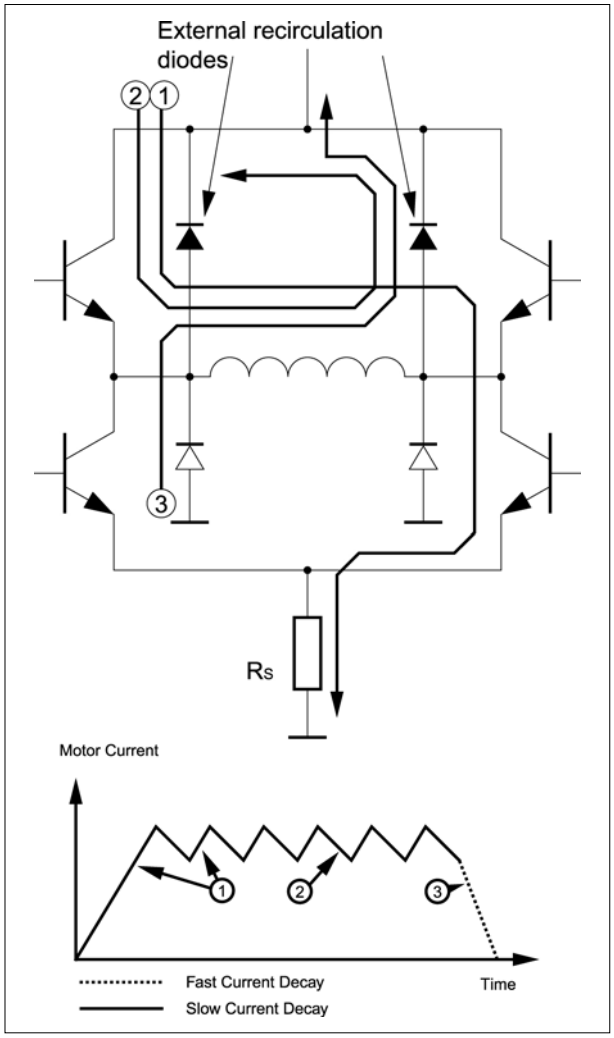


Figure 3. Output stage with current pathsfor fast and slow current decay.

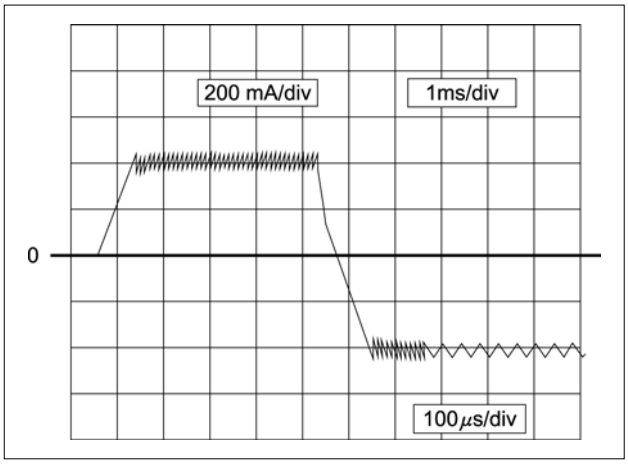


Figure 4. Motor current (I_M), Vertical : 200 mA/div, Horizontal: 1 ms/div, expanded part 100 μs/div.

Current level selection.

The status of I_0 and I_1 inputs determines the current level in the motor winding. Three fixed current levels can be selected according to the table below.

Motor current		**I_0**	**I_1**
High level	100%	L	L
Medium level	60%	H	L
Low level	20%	L	H
Zero current	0%	H	H

The specific values of the different current levels are determined by the reference voltage V_R together with the value of the sensing resistor R_S.

The peak motor current can be calculated as follows:

$i_m = (V_R \bullet 0.080) / R_S$ [A], at 100% level

The motor current can also be continuously varied by modulating the voltage reference input.

Current sensor

The current sensor contains a reference voltage divider and three comparators for measuring each of the selectable current levels. The motor current is sensed as a voltage drop across the current sensing resistor, R_S, and compared with one of the voltage references from the divider. When the two voltages are equal, the comparator triggers the single-pulse generator. Only one comparator at a time is activated by the input logic.

Single-pulse generator

The pulse generator is a monostable multivibrator triggered on the positive edge of the comparator output. The multivibrator output is high during the pulse time, t_{off} , which is determined by the timing components R_T and C_T.

$t_{off} = 0.69 \bullet R_T \bullet C_T$

The single pulse switches off the power feed to the motor winding, causing the winding 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 transistors and two diodes, connected in an H-bridge. Note that the upper recirculation diodes are connected to the circuit externally. The two sinking transistors are used to switch the power supplied to the motor winding, thus driving a constant current through the winding. See figures 3 and 4.

Overload protection

The circuit is equipped with a thermal shut-down function, which will limit the junction temperature. The output current will be reduced if the maximum permissible junction temperature is exceeded. It should be noted, however, that it is not short circuit protected.

Operation

When a voltage V_{MM} is applied across the motor winding, the current rise follows the equation:

$i_m = (V_{MM} / R) \bullet (1 - e^{-(R \bullet t)/L})$

R = Winding resistance

L = Winding inductance

t = time

(see figure 3, arrow 1)

The motor current appears across the external sensing resistor, R_S, as an analog voltage. This voltage is fed through a low-pass filter, $R_C C_C$, to the voltage comparator input (SOP pin 12). At the moment the sensed voltage rises above the comparator threshold voltage, the monostable is triggered and its output turns off the conducting sink transistor.The polarity across the motor winding reverses and the current is forced to circulate through the appropriate upper protection diode back through the source transistor (see figure 3, arrow 2).

After the monostable has timed out, the current has decayed and the analog voltage across the sensing resistor is below the comparator threshold level.The sinking transistor then turns on and the motor current starts to increase again, The cycle is repeated until the current is turned off via the logic inputs.When both I_1 and I_0 are high, all four transistors in the output H-bridge are turned off, which means that inductive current recirculates through two opposite free-wheeling diodes (see figure 3, arrow 3). this method of turning off the current results in a faster current decay than if only one transistor was turned off and will therefore improve speed performance in half-stepping mode.