SGS-THOMSON MICROELECTRONICS

**APPLICATION NOTE**

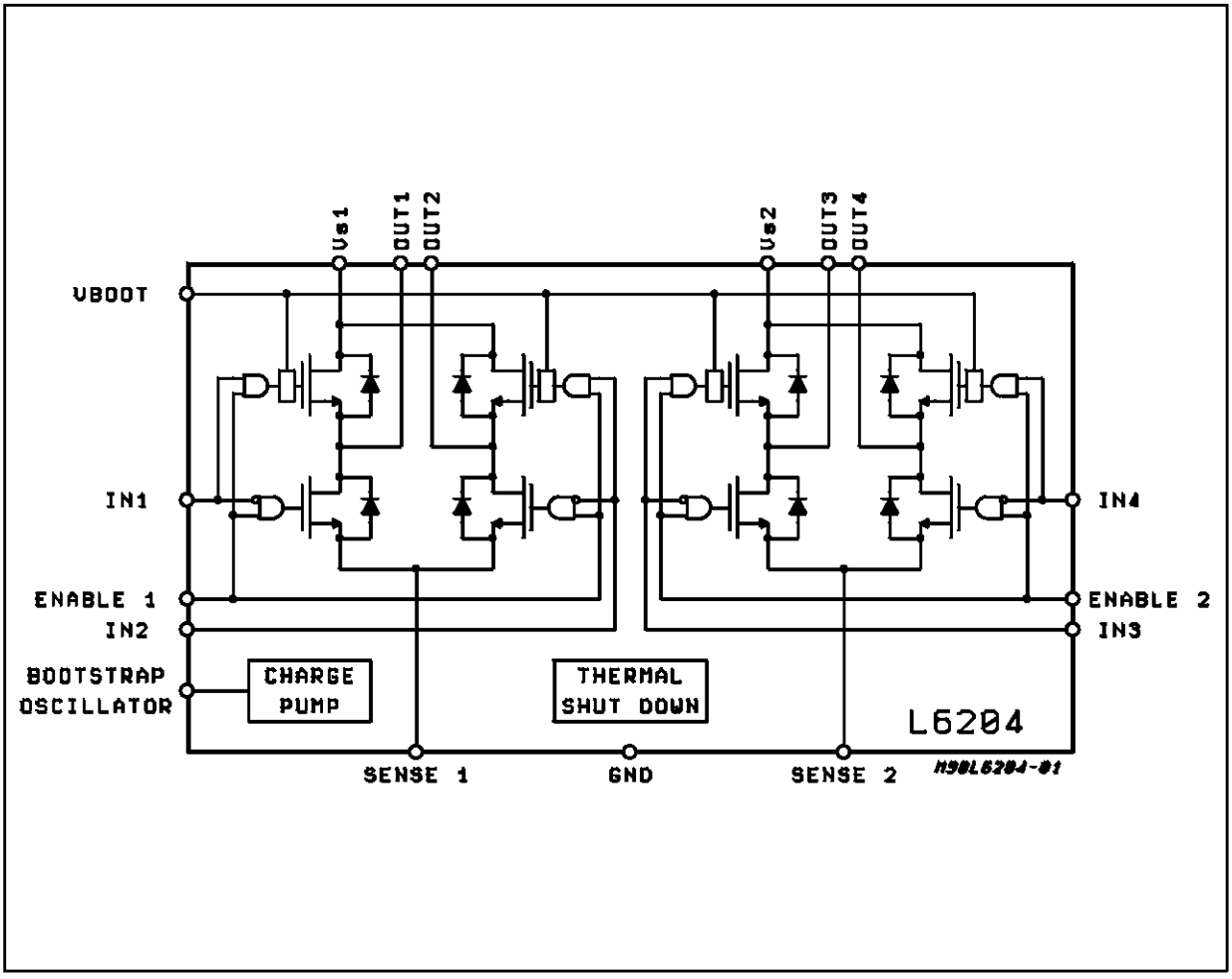
# USING THE L6204, A BIPOLAR STEPPER AND DC MOTOR DRIVER IN BCD TECHNOLOGY

**by E Balboni**

*Containing two H-bridge drivers, the L6204 is a compact and simple solution for driving two-phase bipolar stepper motors and in applications where two DC motors must be driven.*

The L6204 is a DMOS dual full bridge driver mainly designed to drive bipolar stepper motors. All the inputs are TTL/CMOS compatible and each bridge can be enabled by its own dedicated input. The windings current can be regulated by sensing the voltage drop across two low value resistors at the low end of both the bridge: this is the feedback for the current controller. To feed the gates of the upper DMOS, a peak to peak rectifier charges a capacitor in series with the Power Supply voltage at the optimum DC level defined by an on-board square wave oscillator. The L6204 , with 0.5 A drive capability without external heatsink up to 70°C, is packaged in a 20 leads PowerDip with four heat transfer pins. The Block diagram of the device is shown in fig.1.

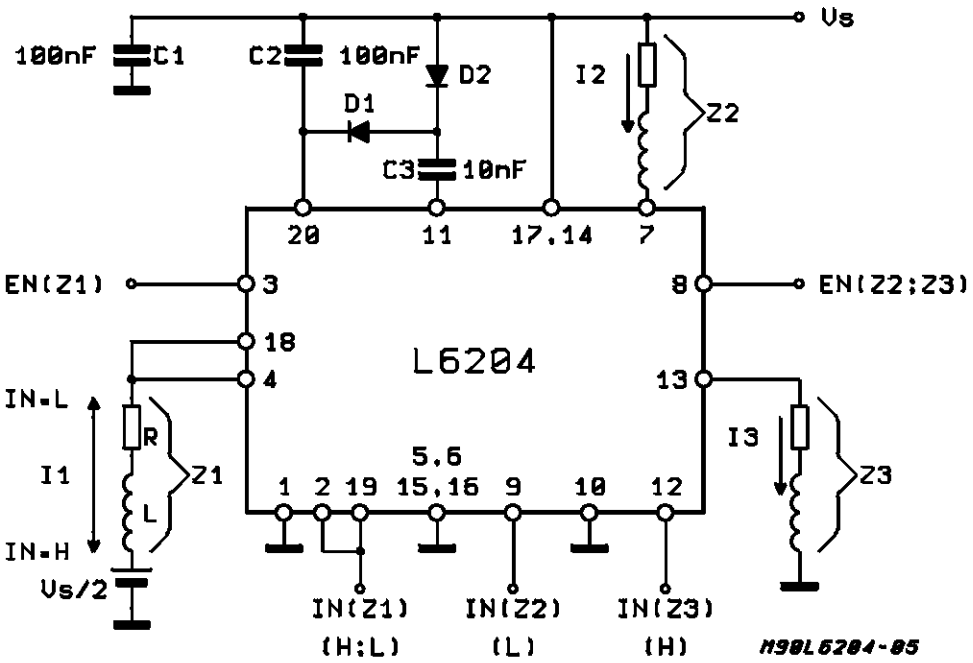
**Figure 1:** Block diagram of the L6204 single chip dual full bridge driver.



## GENERAL APPLICATIONS HINTS

The L6204 can be used in a very wide range of applications such as the drive of lamps, solenoids, DC motors or any other inductive loads. The drive of different loads in single-ended configuration is shown in fig.2. The current in the Load Z1, that may be a DC motor, can flow in both the directions but its peak amplitude cannot be controlled. By means of a change of the Duty Cycle of the input signal it is possible to vary in Open Loop Mode the steady state speed of the DC motor: this is possible because the average current in the winding is dependent from the Duty Cycle. The L/R ratio must be a few times shorter than the minimum DC. In a similar way it can be dimmed a lamp connected to the supply (Z2) or to ground (Z3). Very often, when a DC motor is driven, peak current and speed must be booth controlled in a Closed Loop Mode.

**Figure 2:** The L6204 is not intended only for Bipolar Stepper applications: here above three different driver configurations are shown. Z1 is a DC motor to be driven in both CW and CCW direction. Z2 can be solenoid like a relay or hammer. Z3 can be an alogen lamp which light intensity is controlled by variable Duty Cycle.




This is achieved by the configuration shown in fig.3A. The two independent motors (A and B) can be controlled by only one controller (L6506). The sensing resistor (RsA, RsB) generates a voltage proportional to the motor current, that is the feedback for the current control loop. A second loop, not shown in figure, can control the speed stability while the direction is defined by the Input state of the L6506. The Enable Input (ENA, ENB) can inhibit one motor or the other while the Power Enable acts on both at the same time. D1 and D2 (BAT41 or equivalent), C3 and C4, generates the bootstrap voltage by rectifiing the wave available at pin. 11 of the L6204. When more than one driver is used at the same Supply Voltage on a common Printed Circuit Board, the bootstrap voltage can be generated only by one of them (master) and used to supply all the other L6204 (slaves) saving diodes and capacitors. R1 C1 (R2 C2) is a snubber network that must be closely connected to the output pins and its use is recommended in all the application circuits using the L6204. The values can be calculated as it follows: R = Vs/Ip and C = Ip/(dV/dt), where Vs is the maximum Supply Voltage of the Application, Ip is the peak of the load current and dV/dt is the Slew Rate accepted as the optimum compromise between speed and transient generation/radiation (SR of 200 V/µS are commonly chosen). The network R5C5 sets the operating frequency according to $f = 1/(0.69\ R5C5)$ for $R5 \geq 10Kohm$. R3 and R4 are used to protect the comparator input inside the L6506 against possible negative transitions across the sensing resistor RsA or RsB. The L6204 can be used with paralleled inputs and outputs to double the current capability of the single bridge; for an optimized solution, however, 1.6 times the nominal current is recommended in-

stead of two. This configuration is shown in fig.2 to drive the load Z1. A more complex circuit, in wich one paralleled L6204 drives a DC motor, is shown in fig.3B; in this example the two chopper of the L6506 are used to implement two functions: 1) Current Control during speed variation at Ip max = 0.8A and 2) Current Control during brake and/or direction change at higher current level that depends from the brake repetition (it must be in the Max Ratings limit). The divider R6R7 defines the brake current intensity as V17/Rs while the product (Ip max.) x ( Rs) is the limit of the reference voltage V16 for speed control. The Enable function is driven via the L6506 . Since during the brake time the Enable of the L6506 is chopped, the motor current ricirculates via the Supply; because of this a suitable large capacitor must be connected in parallel to C2.

**Figure 3A:** Bidirectional DC motor drive. The L6204 can drive two motors.

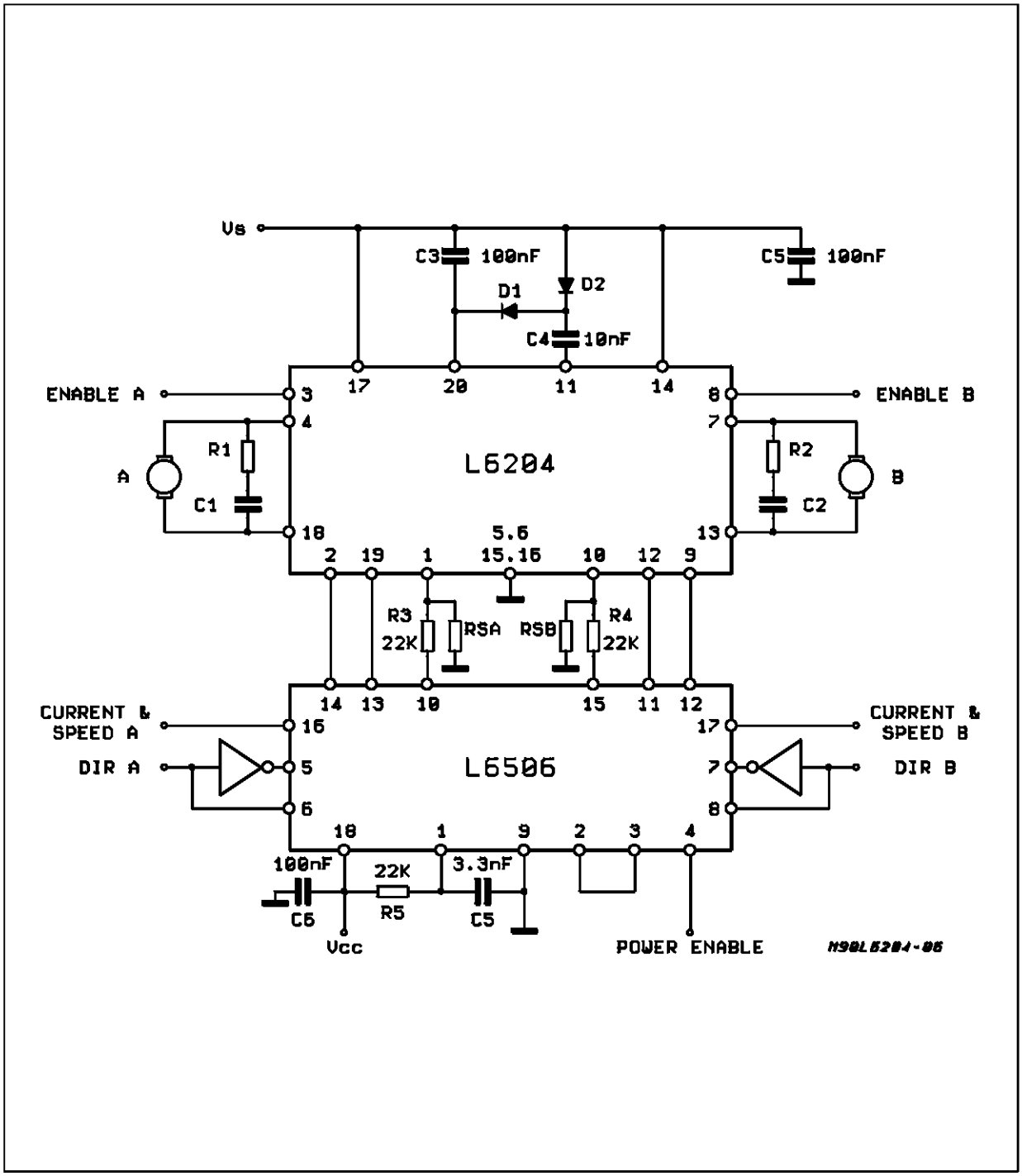
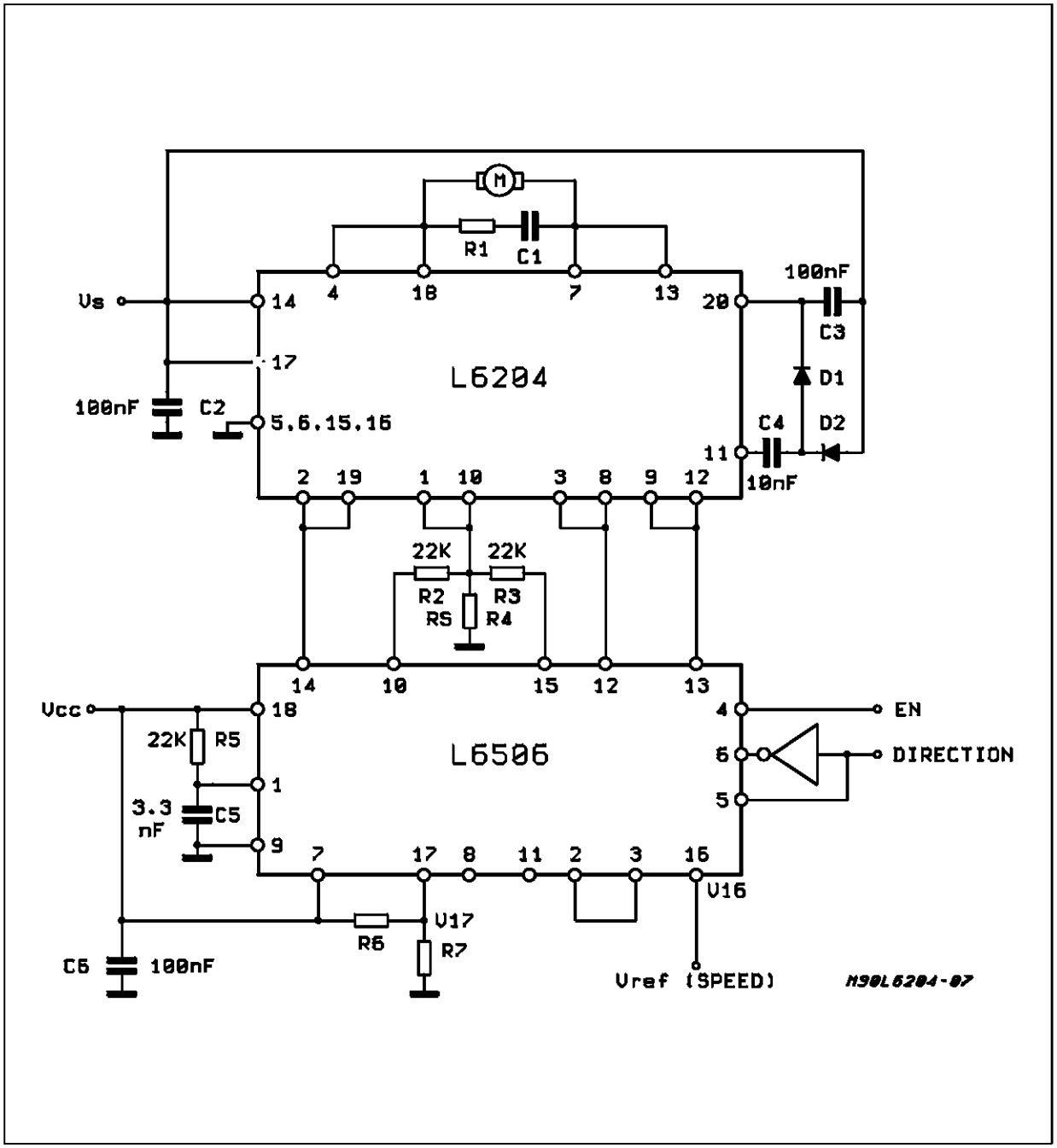


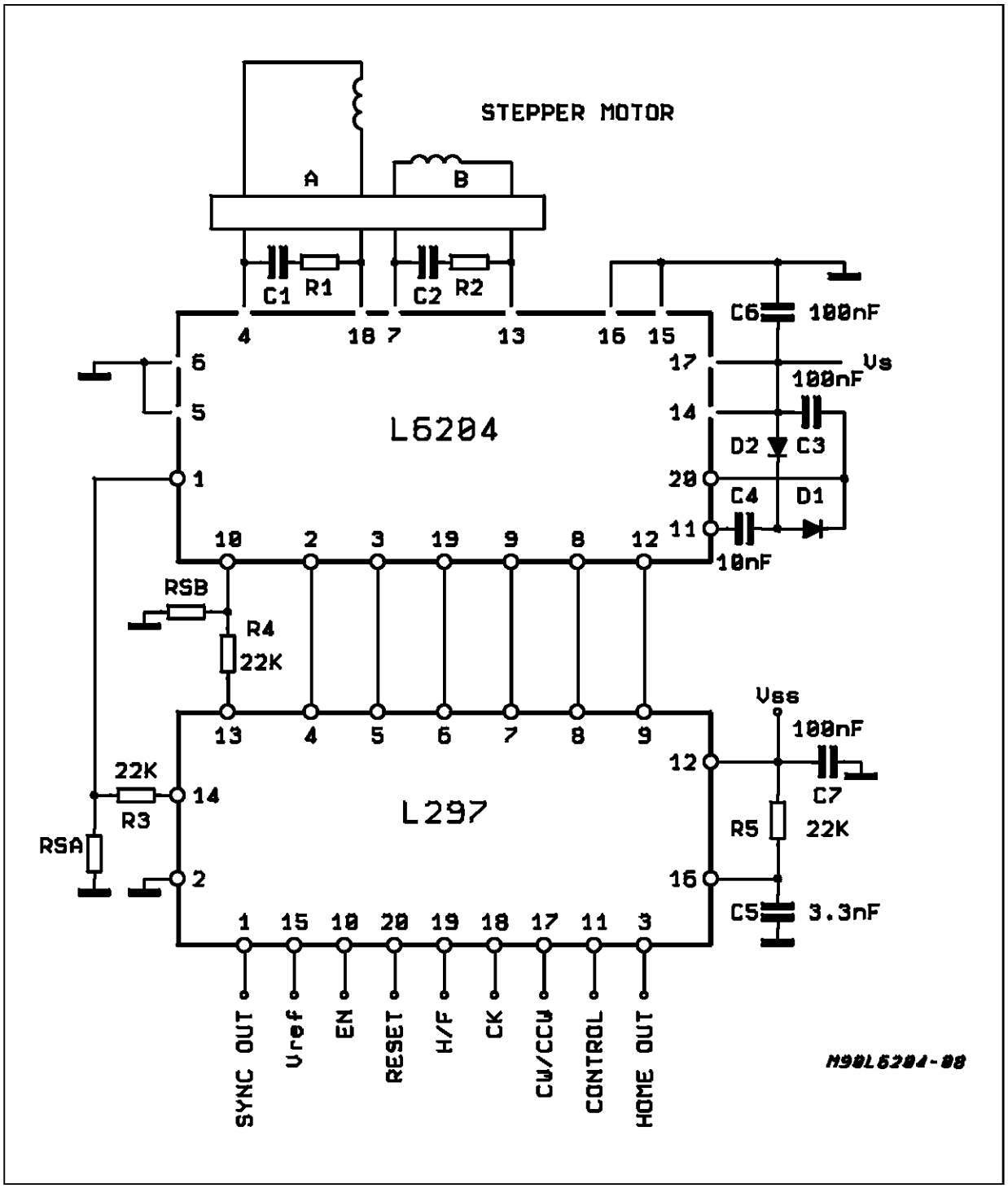
**Figure 3B:** Bidirectional DC motor drive. The L6204 can drive the motor in a paralleled configuration while the L6506 provides the peak current control both during normal rotation and during braking time.




### Stepping Motor Driving

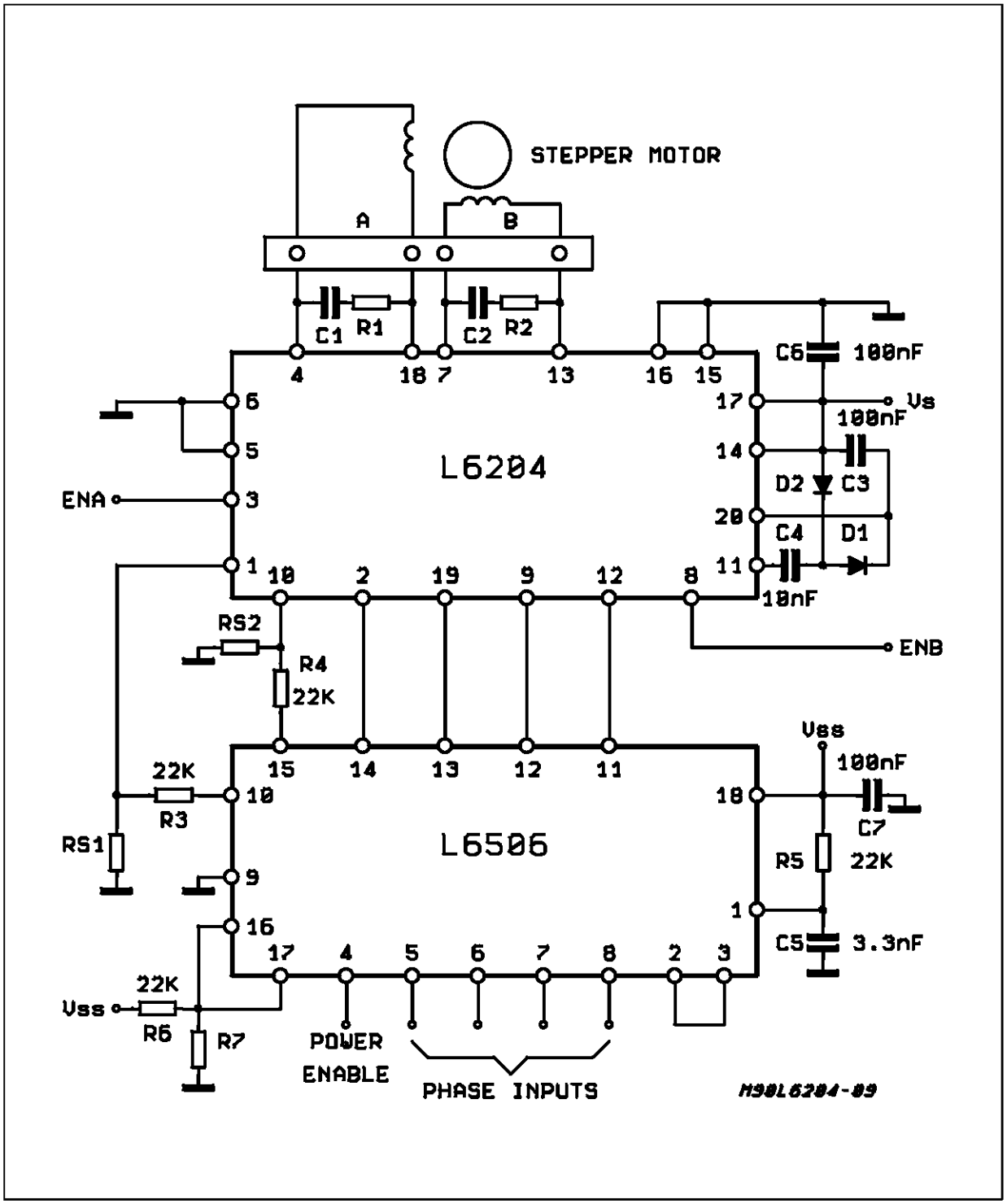
The drive of one stepping motor is shown in fig.4, where the controller L297 generates the requested signals to drive the motor in Half-Step Mode or in Full Step Mode.
The rotation speed or step change is controlled by a clock signal or a single clock pulse at pin.18 (CK). The Mode depends from the logical state of the H / F input while the state of the CW/CCW input defines the direction of the rotation. Depending on the numbered state, odd or even, of an internal clock pulse at the moment at wich the Full-Step Mode is selected, the motor is driven with two-phases-on or with one-phase-on respectively. An open collector output (home) indicates the translator state 0101 that occurs only during an odd numbered state of the internal clock.

**Figure 4:** Bipolar stepping motor drive: phase sequence generation and current peak control are achieved by means of the controller L297.




This last is obtained from the oscillator the frequency of which is fixed by the ratio 1/0.69 R5C5 about (R5 ≥ 10Kohm). The peak of the chopped current is given by the ratio of the reference voltage at pin.15 and the value of the sensing resistors Rs. When the four phase signals needed at the inputs of the L6204 are generated in any other way than by the L297 (for example, via µProcessor), the motor driver needs one interface to control the peak current. One possible solution is shown in fig.5.

**Figure 5:** The L6506 can be used to control the peak current in the windings of a bipolar stepper motor. The power is supplied by the L6204.




The motor can be driven in the Full-Step or in Half-Step Mode. The chopped current Ip is controlled at the value Vref/Rs where Vref is the output voltage of the divider R6 R7. The pins 16 and 17 (reference input voltage of the controller) can be driven with two different signals. This arrangement allows to keep constant the motor current and the torque during the Half-Step Mode revolution of the stepper. This behavior is well explained by the fig. 6.

**Figure 6:** Characteristics of the Half - Step Mode drive with constant torque control. It should be noted that the resultant current is constant while the current in the windings alternates between one-phase-on and two-phase-on with a ratio of $\sqrt{2}$.