SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

TDB7910

By : J-C.BIELLI & T.PIERRE

In analog applications, the operational amplifier is certainly the most commonly employed component. However, when the configuration is to drive a load requiring several hundred milliamperes, the amplifier alone cannot provide such high current and requires the addition of a driver stage built using discrete transistors.

The TDB7910 Operational Amplifier manufactured by SGS-THOMSON is capable of providing output currents of as high as 500mA while requiring a minimum number of external components and is of excellent cost-effective solution.

The device also incorporates :

- External offset compensation
- Thermal protection of the output stage
- Short-circuit protection

CHARACTERISTICS

The device is encapsulated in BATWING package. Pins 1, 2, 4, 5, 12 and 13 connected to ground plane, are used to evacuate the heat.

The junction-to-case thermal resistance is 7.5°C/W.

The junction-to-ambient thermal resistance is 60°C/W without ground plane.

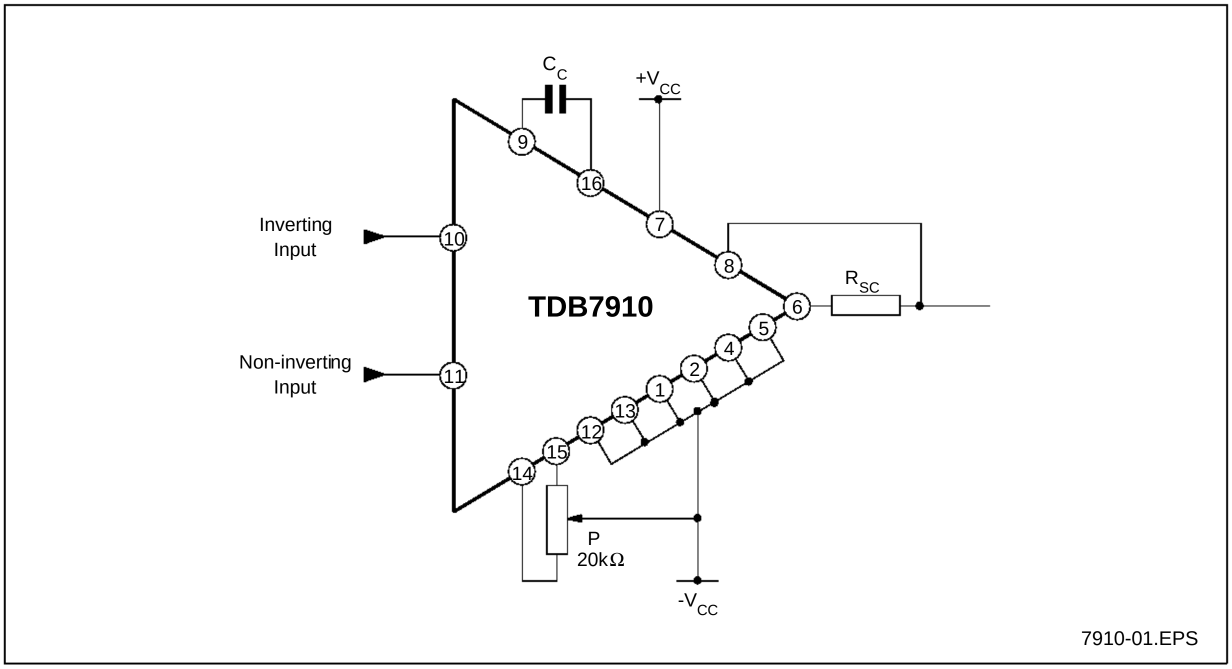
The device can be supplied by a symmetrical ± 18$V_{max.}$ or single 36$V_{max.}$ voltage sources. In the latter case, the supply voltage must be at least 18V so as to obtain a low level value of 0.65V.

The maximum peak current value is 750mA.

The Gain-Bandwidth Product is 1MHz.

BASIC CONFIGURATION

Figure 1



The "R_{SC}" resistor limits the maximum current value at $I_{MAX} = 0.75/R_{SC}$.

Frequency compensation capacitor "C_C" maintains a constant Gain-Bandwidth product of 1MHz.

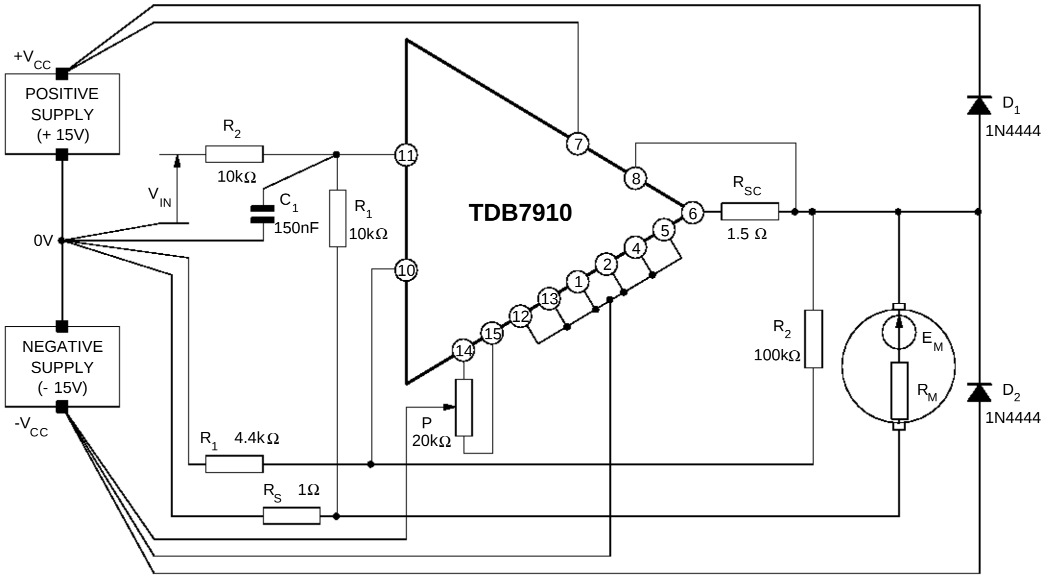
The potentiometer connected between pins 14, 15 and V_{CC}^- is used to compensate for output voltage offset.

APPLICATIONS AROUND TDB7910

Applications such as cassette recorders requiring constant motor speeds are commonplace.

This function is readily fulfilled by TDB7910.

FIgure 2 : Reversible DC Motor Controller with Servo Speed Control

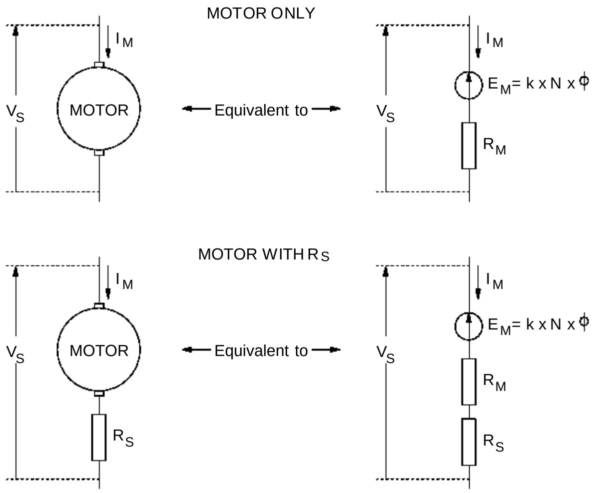


7910-02.EPS

- Capacitor C1 is used to filter the noise appearing across R_S. In fact, d.c. motors generate much noise due to the contact between brushes and the rotor.
- Diodes D1 and D2 allow rapid discharge of the magnetic circuit for sudden motor stoppage.

FUNCTIONAL ANALYSIS

FIgure 3



7910-03.EPS

Analysis of a d.c. motor yields the following expression :

$V_S = E_M + (R_M \times I_M)$ (1)

Where :

V_S : Motor supply voltage

E_M : Motor back e.m.f. ($E_M = k \times N \times \phi$)

- k : constant (depends on number of poles, brushes, etc ....)
- N : speed in revolutions/minute
- ϕ : useful flux per pole

R_M : Resistance per winding

I_M : Current absorbed by motor

In a permanent magnet motor, the magnetic flux can be considered constant; i.e. E_M is proportional to speed.

To maintain a constant speed, E_M must remain constant.

$E_M = V_S - (R_M \times I_M)$ (2)

The following influential factors must be also taken into account :

ΔV_S : Output voltage variations

ΔI_M : Motor current variations

Therefore, expression (2) becomes :

$E_M = V_S + \Delta V_S - (R_M \times I_M) - (R_M \times \Delta I_M)$ (3)

For E_M to be constant :

$\Delta V_S = R_M \times \Delta I_M$ (4)

A shunt ”R_S” is inserted in series with the motor the voltage drop across which represents an image of disturbances (”$R_S \times \Delta I_M$”). The ”V_S” voltage must therefore vary so as to compensate for such disturbances.

Equation (4) becomes :

$\Delta V_S = (R_M + R_S) \times \Delta I_M$ (5)

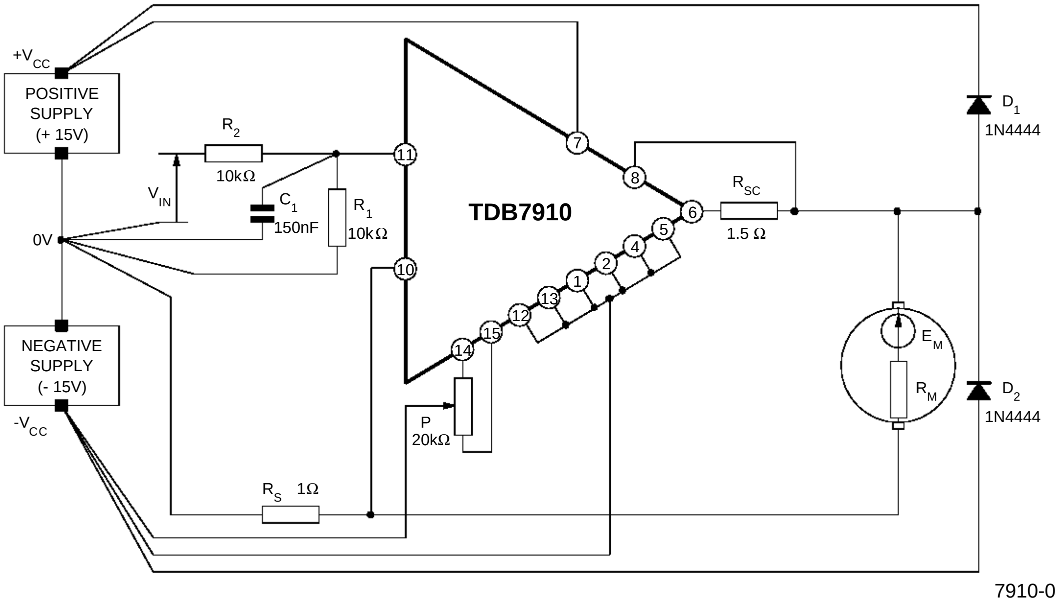
The loop gain is $(R_M + R_S) / R_S$ which is set by

$$\frac{R2 + R1}{2 \cdot R1}$$

Hence, $R_S = \dfrac{2 \cdot R_M \cdot R1}{R2 - R1}$ (6)

BI-DIRECTIONAL D.C. MOTOR CONTROL AT CONSTANT TORQUE

FIgure 4 : Reversible DC Motor Controller with Servo Torque Control



7910-04.EPS

- The motor current ”I_M” goes through the low-value resistor R_S. Consequently, the voltage drop across motor ”$V = R_M \times I_M$” will not exceed few hundred millivolts. It is therefore a good practice to use a voltage divider network on input ”V_{IN}”.

A constant motor control is interesting in applications involving delicate mechanical parts.

Motor is stopped by torque reversal. This type of control allows to limit the motor acceleration on initial motor start-up.

Such servo-control is readily implemented using the TDB 7910.

FUNCTIONAL ANALYSIS

The electromagnetic torque of a d.c. motor is given by :

$$T = \frac{P}{2 \pi N} \qquad (7)$$

Where :

- P : Electromagnetic power ($P = E_M \times I_M$)
- N : Rotor speed $\left(N = \frac{E_M}{k \cdot \phi} \right)$

[k : constant (depends on number of poles, brushes, etc ..)]

Substituting these factors into equation (7), the torque as a function of magnetic flux and the current absorbed, is given by :

$$T = k \times \phi \times I_M \qquad (8)$$

Assuming constant flux for a permanent magnet motor, in order to hold the torque at a constant level, all that required is to maintain the absorbed current constant.

With reference to the configuration given in Figure 4 :

$$\frac{V_{IN} \cdot R1}{R1 + R2} = R_S \cdot I_M \qquad (9)$$

Therefore :

$$I_M = \frac{V_{IN}}{R_S} \cdot \frac{R1}{R1 + R2} \qquad (10)$$

It follows that the torque is set by the value of the reference input ”V_{IN}”.

CONCLUSION

The TDB7910 is a power operational amplifier capable of delivering high currents for direct servo-control of applicable to a variety of systems.

Its high output current capability of ”500mA” makes it particularly suitable to drive small motors, lamps, relays, ...; the application areas are therefore by no means limited; offering **compact**, **simple**, and **low-cost** servo-control configurations.

SGS-THOMSON Microelectronics GROUP OF COMPANIES
Australia - Brazil - China - France - Hong Kong - Italy - Japan - Korea - Malaysia - Malta - Morocco - The Netherlands

ORDER CODE :