

MOTOR DRIVING DEVICE

This invention relates to motor driving devices.

5 A conventional stepping motor driving device for opening and closing a shutter of a camera is, as illustrated in Figure 3, typically composed of a battery source 11, a motor driving circuit 16 consisting of transistors Tr11 to Tr18 and diodes D11 to D18, for
10 driving a stepping motor 15, and a control circuit 12 for controlling the motor driving circuit 16.

A reference voltage generating circuit 13 in combination with an operational amplifier 14 and a bipolar transistor TR10, constitutes a voltage
15 regulator, the constant voltage Vcc of which is supplied to the motor driving circuit 16.

Signal processing circuits in the control circuit 12 are formed of C-MOS transistors. Circuits adapted to large electric currents in the motor driving circuit 16
20 for driving the stepping motor 15 are composed of bipolar transistors or bipolar ICs.

This type of motor driving device is based on an arrangement where a constant voltage Vcc is supplied to the motor driving circuit 16 from the voltage regulator.
25 The constant voltage Vcc is, in principle, generated by decreasing a source voltage V_E of the battery source 11. For this reason, in some cases depending upon the load of the stepping motor, the generation of the constant voltage involves the generation of heat to an extent that is not neglectable as compared with the heated
30 generated by circuit components of apparatus in which the motor driving device is used, e.g. in a camera. Because the control circuit 12 consists of C-MOS transistors, a relatively large number of components is

required and this presents drawbacks such as an undesired spatial factor of a printed circuit board or the like.

5 The present invention seeks to provide a motor driving device which is capable of ameliorating the spatial factor of a printed circuit board or the like by providing a smaller number of components, and which includes a motor driving circuit and a control circuit composed of C-MOS transistors so as to reduce heat
10 generation.

According to one particular aspect of the present invention, there is provided a motor driving device comprising: a converter for generating a stepped up source voltage stepped up from a battery source; a
15 driving circuit, to which said stepped up source voltage is supplied, for driving a motor; and a control circuit, to which said stepped up source voltage is supplied, for controlling said driving circuit, said driving and control circuits being each composed of C-MOS transistors and are integrated on the same chip.
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The motor driving device may include diodes for protecting the C-MOS transistors of the driving circuit.

The motor driving device may be in combination with a stepping motor.

25 The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a circuit diagram of a motor driving device according to the present invention;

Figure 2 is a circuit diagram of a converter of

the motor driving device of Figure 1;

Figure 3 is a circuit diagram of a conventional stepping motor driving device;

Figure 4 shows graphically the relationship
 5 between coil resistance and number of turns of a coil;
 and

Figure 5 shows graphically the relation between a gate/source voltage V_{gs} and ON-resistance R_{on} of a C-MOS transistor.

10 One embodiment of a motor driving device according to the present invention applied to a stepping motor for opening and closing a shutter of a camera will now be described with reference to Figure 1. The motor driving device has a battery source 1 with a source voltage V_E
 15 and a converter 2 for generating a source voltage V_{DD} stepped up from the source voltage V_E of the battery source 1. The stepped up source voltage V_{DD} is higher than the source voltage V_E . For instance, the source voltage V_E may be 3V whilst the stepped up source
 20 voltage V_{DD} may be 5V.

The motor driving device is constituted by a stepping motor driving circuit 5, to which the stepped up source voltage V_{DD} is supplied, for driving a
 25 stepping motor 4 and by a control circuit 3, to which the stepped up source voltage V_{DD} is likewise supplied, for controlling the driving circuit 5.

The driving circuit 5 includes a pair of C-MOS transistors Tr1, Tr2. The transistor Tr1 is a P-channel transistor, whereas the transistor Tr2 is a N-channel
 30 transistor. Provided between the stepped up source voltage V_{DD} and a reference voltage are a plurality of pairs of similar C-MOS transistors Tr3, Tr4, Tr5, Tr6, Tr7, Tr8. These transistors are disposed in corresponding positions to the transistors Tr11, Tr12,

Tr13, Tr14, Tr15, Tr16, Tr17, Tr18 of the conventional motor driving device of Figure 3, and are complementarily connected to each other.

5 Connected between drains and sources of the C-MOS transistors Tr1 to Tr8 are diodes D1 to D8 thereby protecting the respective transistors.

The control circuit 3 is also composed of C-MOS transistors. Since the circuitry of the control circuit 3 is well-known, a description of it is omitted.

10 Connected to the gates of the C-MOS transistors Tr1 to Tr8 are signal lines from the control circuit 3. Output pins of the pairs of the C-MOS transistors Tr1 to Tr8 are connected to armature windings 4a, 4b of the stepping motor 4.

15 The converter 2 is, as depicted in Figure 2, composed of a coil 21 connected to the battery source 1, a bipolar transistor Tr21, a diode D21, a pair of C-MOS transistors Tr22, Tr23, a Zener diode ZD1, a comparator 22 and a NAND circuit 23.

20 Upon input of a signal from a terminal a of the NAND circuit 23, the C-MOS transistors Tr22, Tr23 begin to function in accordance with outputs from the NAND circuit 23, thus switching the bipolar transistor Tr21. The thus switched alternating current is rectified by means of the diode D21 to become the stepped up source
25 voltage V_{DD} . The stepped up source voltage V_{DD} is compared with a reference voltage defined by the Zener diode ZD1. Based upon the results of comparison, the comparator 22 operates to stop the outputs of the NAND
30 circuit 23.

The converter 2, the driving circuit 5 and the control circuit 3 may be integrated on the same LSI chip.

When depressing a release switch (not shown), the

source voltage V_E of the battery source 1 is converted into the stepped up source voltage V_{DD} . The stepped up source voltage V_{DD} is compared with the reference voltage defined by the Zener diode ZD1. In accordance with the results of this comparison, the comparator 22 operates, whereby it comes to a constant voltage. Immediately when being supplied with the stepped up source voltage V_{DD} , the driving circuit 5 and the control circuit 3 start to function.

In general, if the configuration of a coil of a motor is fixed, then, as illustrated in Figure 4, coil resistance of the motor increases with increase in the number of turns T of the coil. Hence, the ampere-turns of the motor is set constant (i.e. without decreasing motor output torque) when being driven by the stepped up source voltage V_{DD} . It is, therefore, possible to drive the motor with a reduced consumption of electric current. As depicted in Figure 5, if the gate/source voltage V_{gs} of a C-MOS transistor is high, ON-resistance R_{ON} is typically reduced. Accordingly, it is feasible to reduce both the amount of electric power consumed and the size of the driving circuit 5 when the stepped up source voltage V_{DD} serves as the driving source.

It is to be noted that in the foregoing illustrated embodiment, the description has been focused on a motor driving device for driving a stepping motor, but the present invention can, as a matter of course, be applied to motor driving devices for driving other types of motor.

In the motor driving device according to the present invention and described above, the driving circuit 5 and the control circuit 3 are composed of C-MOS transistors which are integrated on the same chip. By virtue of this arrangement, the formation of a

printed circuit board or the like, for example for
incorporation into a camera or the like, can be
simplified. The spatial factor is thus improved. In
the present invention, there is no depressurising
5 regulator, and the driving current required is less than
that in the conventional bipolar transistor motor
driving device. Moreover the voltage is of a type of
low saturation, so that heat generation in the circuitry
can be reduced. Unlike the use of bipolar transistors,
10 no base current is required, and hence the amount of
current consumed by the driving circuit 5 can be
reduced. The circuits can be designed on the basis of
the converters each having a small capacity.

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C L A I M S

1. A motor driving device comprising: a converter for generating a stepped up source voltage stepped up from a battery source; a driving circuit, to which said stepped up source voltage is supplied, for driving a motor; and a control circuit, to which said stepped up source voltage is supplied, for controlling said driving circuit, said driving and control circuits being each composed of C-MOS transistors and are integrated on the same chip.
 - 10 2. A motor driving device as claimed in claim 1 including diodes for protecting the C-MOS transistors of the driving circuit.
 3. A motor driving device as claimed in claim 1 or 2 in combination with a stepping motor.
 - 15 4. A motor driving device substantially as herein described with reference to and as shown in Figures 1, 2 and 4 of the accompanying drawings.
 5. A motor driving device comprising: a battery source; a converter for generating a stepped up voltage source stepped up from said battery source; a driving circuit, to which said stepped up voltage source is supplied, for driving a motor; and a control circuit, to which said stepped up voltage source is likewise supplied, for controlling said driving circuit,
 - 20 characterised in that said driving and control circuits are each composed of C-MOS transistors and are also
 - 25 integrated on the same chip.
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