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MOTOROLA

TMOS

POWER MOSFET TRANSISTOR DATA

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Prepared by
Technical Information Center

Preface

After several years of development, Motorola introduced its first power MOSFETs in 1980. Several technologies were evaluated and the final choice was the double diffused (DMOS) process which Motorola has acronymed TMOS. This process is highly manufacturable and is capable of producing devices with the best characteristics for product needed for power control. Most suppliers of power MOSFETs use the basic DMOS process.

The key to success of power MOSFETs is the control of vertical current flow, which enables suppliers to reduce chip sizes comparable to bipolar transistors. This development opens a new dimension for designers of power control systems.

This manual is intended to give the users of power MOSFETs the basic information on the product, application ideas of power MOSFETs and data sheets of the broadest line of power MOSFETs with a variety of package configurations. The product offering is far from complete. New products will be introduced and old products will be improved, offering designers an even better selection of products for their designs.

Motorola has a long history of supplying high quality power transistors in large volume to the military, automotive, consumer, industrial and computer markets. Being the leading supplier of power transistors in the world, we strive to serve our customers' needs to maintain our leadership position.

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rises higher than 16 V; the transient suppressor protects the MOSFETs from supply spikes greater than 28 V.

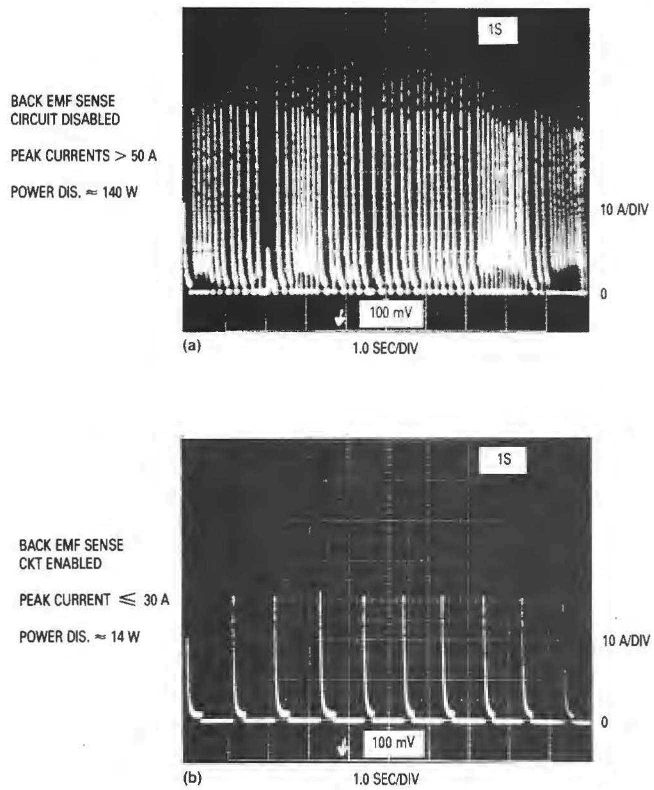
In this design, the MOSFETs require heat sinking to keep their junction temperatures less than 150°C in worst-case conditions (that could occur, for example, with a 16 V supply, 100°C ambient temperature and a stalled motor). As an option, a current-sensing circuit can be added to gate-off the power FETs after detecting a stall condition.

PWM Motor Speed Control

FETs can be used to considerable advantage for simplifying permanent-magnet motor speed control. The circuit shown in Figure 8-31 provides efficient pulse-width modulated control with a minimum number of components. The key feature is direct drive of the power FET from a CMOS control IC. The result is a control system with minimized parts count.

The control system is based upon the MC14528B dual monostable multivibrator. One-half of the monostable is connected in an astable mode, producing a pulse oscillator. The remaining half is then used as a one-shot, with its adjustable pulse-width determining the duty cycle and, therefore, motor speed.

In addition to its simplicity, the circuit of Figure 8-31 is notable for its low standby power drain. The combination CMOS control and TMOS power gives a very low quiescent current drain that is desirable in battery operated applications.



VERTICAL	HORIZONTAL
10 A/DIV	1.0 SEC/DIV

FIGURE 8-30 — COMPARISON OF "H" SWITCH PEAK CURRENTS DURING MAXIMUM FORWARD TO REVERSE SWITCHING WITH MANUAL TOGGLE SWITCH

Horizontal Deflection Circuits

Power MOSFETs can be a good alternative to bipolars in high resolution CRT sweep circuits. The most obvious advantage is simplicity. However, MOSFET horizontal outputs also offer significant benefits in terms of increased reliability and faster switching times.

Drive simplification with the MOSFET is even more significant than in the preceeding switching power supply examples. In most cases, a base-drive transformer is eliminated, as well as di/dt wave shaping networks.

The reliability issue is a little more complex, and relates to differences in SOA characteristics. It is normal design practice to exceed bipolar collector-emitter breakdown ratings during the retrace pulse transition. This is permissible if the base-emitter voltage is held negative during the retrace period. If, however, a positive noise pulse occurs during the retrace period, the bipolar base-emitter junction can become forward biased when collector-emitter voltage is greater than $V_{CEO(sus)}$. The bipolar's safe operating area is then violated, creating a substantial risk of failure. MOSFETs, on the other hand, will handle this type of stress quite readily, since their FBSOA capability extends beyond peak retrace voltage. Therefore, increased reliability with the MOSFET horizontal output is directly related to the probability of noise occurring in the drive circuitry.

Speed is also an important issue. At a 30 kHz scan rate, 1.0 μs of bipolar storage-time delay represents 3% of the horizontal line period, or a loss of 30 lines of data in a field of 1024 lines. In addition, bipolar storage time is not a fixed constant, but changes from device to device and with temperature. A horizontal phase locked loop can be added to compensate for the storage-time delays in the horizontal output stage. The active video data time may also be cut back, accordingly, to allow for internal horizontal timing delay.

Based upon these considerations, effective use of the bipolar transistor at high scan frequencies requires a complex base drive circuit, custom selection of the bipolar device for minimum storage-time variation, and an accurate phase locked loop to compensate for saturation time delays. Power MOSFETs, on the other hand, can be driven from a CMOS IC, do not require critical parameter screening, exhibit minimal turn-off delay, and do not require a phase locked loop for correcting device-induced timing errors.

Design Example

The power MOSFET, until recently, could not handle much current at voltages above 500 V. Recent technology developments have pushed this limit up to the 1000 V range with increased current ratings. Therefore, a power MOSFET can now be selected for computer CRT display systems with power supply requirements ranging from 12 V to 75 V.

The standard horizontal raster scan system is used in this design. That is, the horizontal yoke and flyback transformer are both switched by one output device. It should be pointed out that the power MOSFET has been switched up to 120 kHz scan rates, but due to other device constraints, the CRT anode high voltage network's performance is very marginal at this high frequency rate. Even a scan frequency of 30 kHz is pushing the limits of the high-voltage rectifier and associated components.

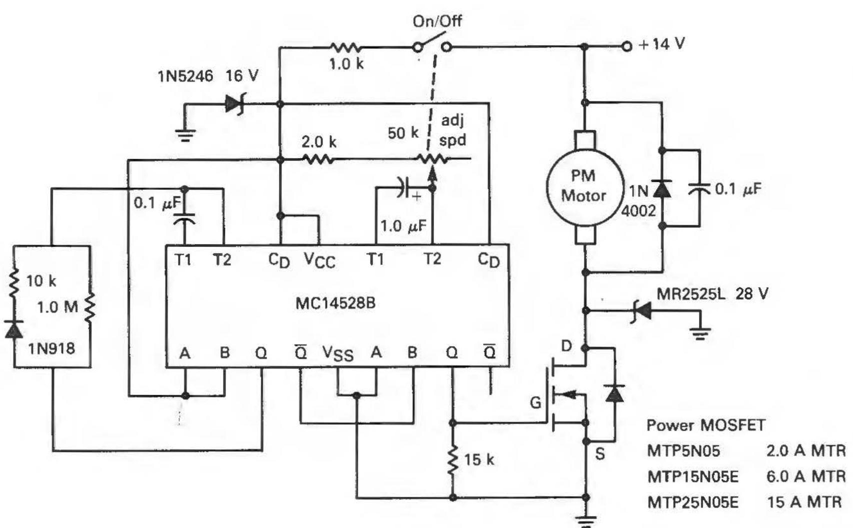


FIGURE 8-31 — POWER MOSFET MOTOR SPEED CONTROL CIRCUIT