AN30

Matching MOSFET Drivers to MOSFETs

INTRODUCTION

Microchip offers many sizes of MOSFET drivers. This allows the designer to best match the switching performance of the driver/ MOSFET to the application.

MOSFET DIE SIZES

Unlike bipolar transistors in which die size is primarily a function of current, MOSFETs have die sizes that are a function of both current and voltage.

DIE SIZE EFFECT ON GATE CAPACITANCE

As can be expected, the larger the die size, the larger the effective gate capacitance. As an illustration of this, look through any manufacturer's databook and relate die size to C_{GS} and C_{RSS} and you will find that die size determines both these parameters, not the voltage or current rating of the device.

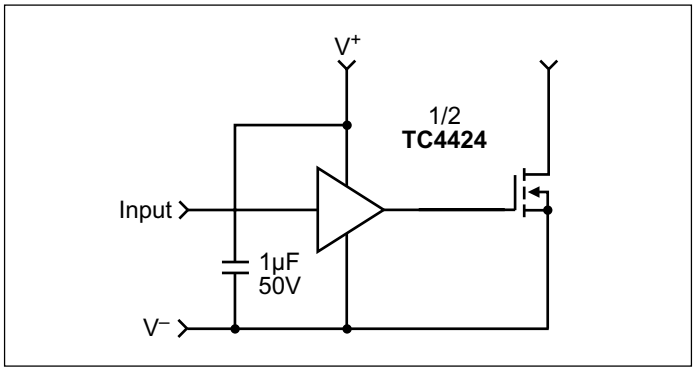


FIGURE 1: *Typical drive circuit.*

The industry has, in general, adopted International Rectifier's die size description technique. Instead of referring to “mils on a side” to describe the die size, they have used simple numeric indicators 0 through 6. Thus, a Hex 0 is the smallest die, while a Hex 6 is the largest in standard MOSFET offerings. Some other manufacturers (IXYS) are offering sizes as large as Hex 9. Parallel-MOSFET modules can be even larger.

PEAK CURRENT REQUIREMENTS

One can now view the driving function in terms of the peak current required to obtain the required rise time for any application (in view of the capacitance thus die size). From [(dV) x C]/I = dT we can determine the trade-offs in any driving circuit. The optimum rise time in any application is based on many requirements, such as EMI, heat dissipation, lead/circuit inductance, etc. Thus, there can be no universal driver that fits all applications.

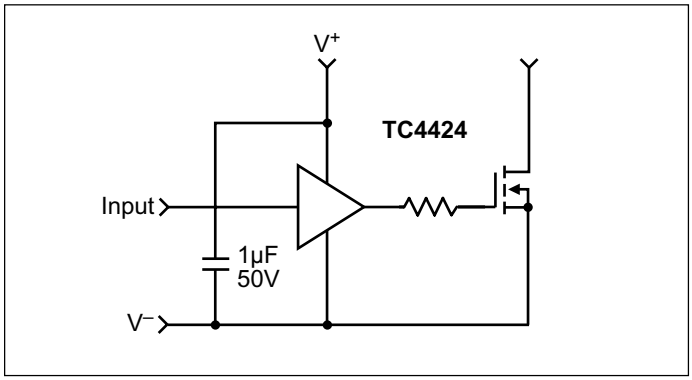


FIGURE 2: *Use of a resistor to limit peak control.*

DRIVER FAMILIES

There are several families of Microchip MOSFET drivers. They are:

TC426-29
TC1410-13
TC1426-28
TC4403-05
TC4420-29
TC4431/32
TC4467-69
TC4626/27

The TC426 was the world’s first CMOS MOSFET driver. It was a dual output device capable of up to 1.5A at 18V. It came in two other versions, the dual non-inverting TC427 driver, and one inverting plus one non-inverting in the TC428 driver.

The TC4426 family is the second generation of the 426 family, but through improved processing and design has less propagation delay, and draws half the power of the first generation. These improvements have been incorporated into all drivers with four numeric digits in the part number.

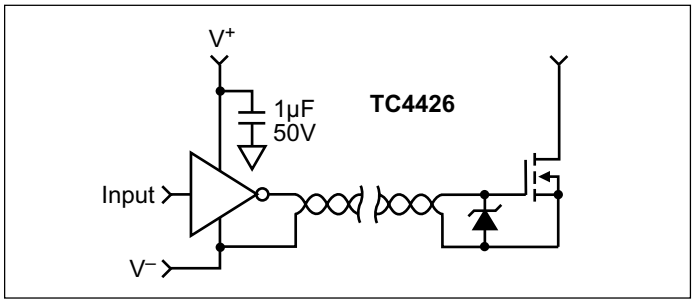


FIGURE 3: *Use of zener diode to clamp voltage on long output lines.*

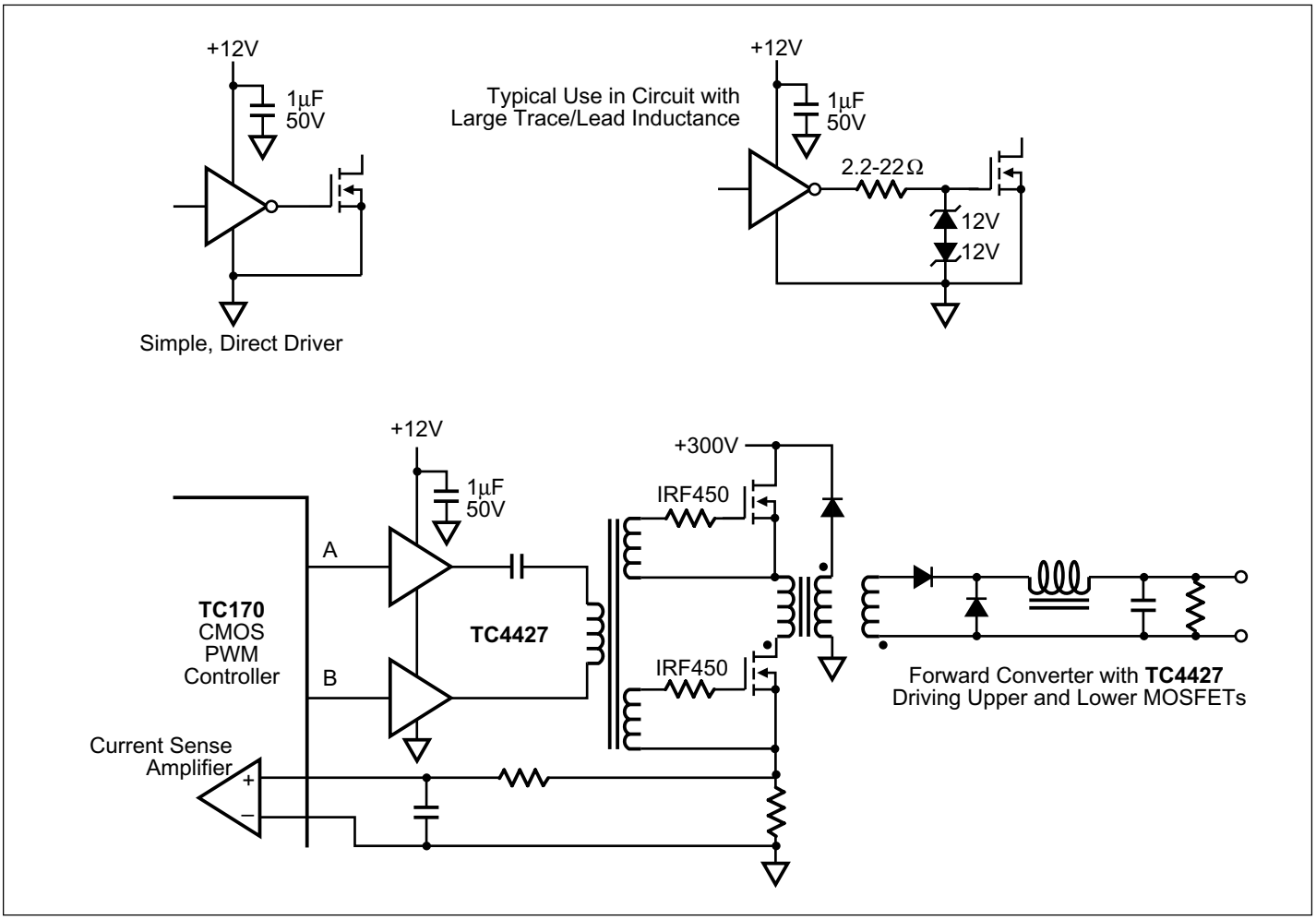


FIGURE 4: *Typical applications.*

Another important improvement in the second generation families is their ability to have the input signal go below the negative rail by as much as 5V. This guaranteed parameter is very useful in systems where the control circuit ground is not closely tied to the power or source ground of the MOSFET. These two grounds often move relative to one another.

The TC1426 is a special, low-cost version of the 426 family that does not have the below-rail protection on the input. It is a good choice for large volume OEMs.

Following the same part numbering pattern as the 1.5A TC426 family, the TC4423 family of dual drivers has a 3A output capacity. The TC4424 is a dual non-inverting driver and the TC4425 is one inverting plus one non-inverting driver.

The TC4429 is a single inverting driver (like its predecessor the TC429), while the TC4420 is non-inverting. This family has a 6A drive capability at 18V. The TC4429 can slew a 10,000pF load at 18V in 65nsec typically.

The table on the following page shows the performance of the various drivers under production test methods. The characteristics of the drivers are more fully described in their individual data sheets. This table is intended only as a guide for comparing specifications. Refer to the individual data sheets for more complete information.

The following families of power drivers are made with a CMOS process to interface between low-level control functions and high-power switching devices, particularly power MOSFETs. The devices are also an optimum choice for capacitive drivers where 1.2A–9A may be switched. With both inverting and non-inverting outputs available, logic signals of either polarity may be accepted.

Device No.	Drive Current (Peak)	Number of Outputs and Type Inverting	Non-Invert.	Time @ Rated Load (pF)	Rise Time @ Rated Load (nsec)	Fall Edge Rated Load (nsec)	Rising Edge Prop. Delay (nsec)	Falling Edge Prop. Delay (nsec)	Latch-Up Proof	Input Protected to 5V Below Gnd Rail
TC1426	1.2A	Dual		1000	35	25	75	75	Yes	No
TC1427	1.2A		Dual	1000	35	25	75	75	Yes	No
TC1428	1.2A	Single	Single	1000	35	25	75	75	Yes	No
TC4426	1.5A	Dual		1000	19	19	20	40	Yes	Yes
TC4427	1.5A		Dual	1000	19	19	20	40	Yes	Yes
TC4428	1.5A	Single	Single	1000	19	19	20	40	Yes	Yes
TC4423	3.0A	Dual		1800	23	25	33	38	Yes	Yes
TC4424	3.0A		Dual	1800	23	25	33	38	Yes	Yes
TC4425	3.0A	Single	Single	1800	23	25	33	38	Yes	Yes
TC4420	6.0A		Single	2500	25	25	55	55	Yes	Yes
TC4429	6.0A	Single		2500	25	25	55	55	Yes	Yes
TC4421	9.0A	Single		10,000	60	60	30	33	Yes	Yes
TC4422	9.0A		Single	10,000	60	60	30	33	Yes	Yes
TC4467	1.2A	— Quad NAND —		470	15	15	40	40	Yes	Yes
TC4468	1.2A	— Quad AND —		470	15	15	40	40	Yes	Yes
TC4469	1.2A	— Quad —		470	15	15	40	40	Yes	Yes

TABLE 1: *Selecting MOSFET drivers.*

MOSFET Size	Die Size (mm)	Total C of MOSFET (pF)	Suggested MOSFET Driver (@ 12V)	Faster Rise/Fall Times
Hex 0	0.89 x 1.09	400	TC1426-28/4426-28/4467-69	
Hex 1	1.75 x 2.41	750	TC1426-28/4426-28/4467-69	
Hex 2	3.40 x 2.21	1500	TC1426-28/4426-28/4467-69	TC4423-25
Hex 3	4.44 x 2.79	3000	TC1426-28/4426-28	TC4423-25
Hex 4	7.04 x 4.32	6000	TC4423-25	TC4420/29
Hex 5	6.45 x 6.45	12,000	TC4423-25	TC4420/29
Hex 6	283 x 321 mil	15,000	TC4420/29	TC4421/22
Hex 7	283 x 348 mil	16,000	TC4420/29	TC4421/22
Parallel Modules	Various	Up to 48,000	TC4421/22	

TABLE 2: *MOSFET die size suggested driver families.*

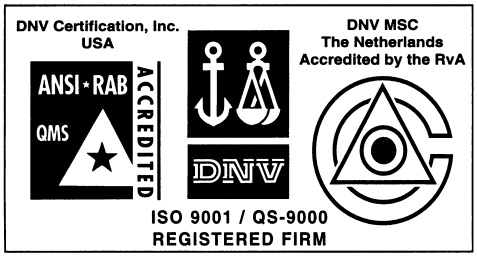
CONCLUSIONS

To match any MOSFET to its proper driver, use the chart above (which will take care of the largest number of applications), or use the simple formula: rise time (dt) = driver supply voltage (dV), times capacitance (C), all divided by driver peak current (I); restated:

$$dt = [(dV) \times C]/I$$

If you need to drive any power MOSFET, there is a Microchip driver to do the job.

Trademarks



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