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Power MOSfet selection guidelines for class-D power amplifiers with ultra-low distortion.

Selection of MOSfets using these guidelines can help the design of highly efficient full bridge class-D power amplifiers. This is achieved by carefully considering certain MOSfet parameters which contribute to the bridge losses and hence the efficiency of the amplifier.
This application note will provide you a simple calculation model that will show the influences of key parameters on power losses in the bridge.
There is a spreadsheet (see Mueta Application Note AN-003) available which is pre-programmed with these equations.

From marketing point of view, R_{dson} is probably the most emphasized data sheet parameter and, in static and very low frequency switching applications, this is the most determining parameter concerning power losses.
However, in high frequency switching application not only the conduction losses contribute but we also have to take in account the 'commutation on' losses and the 'commutation off' losses in the bridge.
So, in the MOSfet data sheet, you will find values for R_{dson} (in mΩ), I_{rate} (in A/µsec) and t_{rr} (in nsec) from the body diode. The total gate charge switching losses are for the driver to take in account, but nevertheless a very important parameter.
From the system parameters the Bridge rail supply (in V), the load (in Ω) and the switching frequency F_{pwm} (in Hz) are the determining parameters.

For the conduction losses we've the total load to take in account: two times the R_{dson} plus the R_{load} plus the resistance value from the filter, R_x.

The conduction current, I_{cd} can be calculated from: $I_{cd} = \dfrac{V_{rail}}{2 * R_{dson} + R_{load} + R_x}$

For simplicity we can split the total losses formula into three parts:

- conduction losses
- commutation on losses
- commutation off losses

$$P_{cd} = I^2_{cd} * R_{dson}$$

$$P_{cmon} = F_{pwm} * V_{rail} * 2 * \frac{I^2_{cd}}{I_{rate}} * \frac{2^2}{\pi^2}$$

$$P_{cmoff} = F_{pwm} * V_{rail} * I_{rate} * t^2_{rr}$$

$P_{bridge} = \quad P_{cd} + P_{cmon} + P_{cmoff}$

For example, using the HUF75321P3-55 from Fairchild Semiconductor with a 4Ω load, a bridge rail voltage of 40V, a switching frequency of 350kHz, a commutation rate of 100A/µsec, an R_{dson} of 28mΩ and a reverse recovery time t_{rr}, of 59nsec, would yield a total power loss of 18.6Watt. However, by selecting a MOSfet with a t_{rr} of 30nsec, the bridge loss reduces to just 15Watt.

In choosing MOSfets, you should also keep in mind that a larger die size can minimize the R_{dson} but the gate capacitance and t_{rr} will increase. From experience in our application lab, we advise you to select MOSfets with Input Capacitance C_{iss} values of well below 2nF (around 1.5nF typical).

In *Table 1.* an overview of some good candidates, worth testing and evaluating.

Fairchild Semiconductor			
Mosfets 55-60V		Mosfets 80-100V	
HUF75321		FQAF58N08	FQB33N10
HUFA75329			FQB44N10
			HUF75631
ST Microelectronics			
Mosfets 55-60V		Mosfets 80-100V	
	STB16NF06		STB30NF10
	STD20NF06		STD25NF10
	STP36NF06		
Vishay			
Mosfets 55-60V		Mosfets 80-100V	
	SUD23N06	Si7852	
	SUR23N06		
International Rectifier			
Mosfets 55-60V		Mosfets 80-100V	
IRFZ44Z		IRF6668	IRFI4212
IRFI4024			IRF6665

Table 1.

References:
1) George E. Danz, Harris Intelligent Power, Application Note AN-9525
2) Jorge Cerezo, International Rectifier, Application Note AN-1070
3) Jun Honda & Jonathan Adams, International Rectifier, Application Note AN-1071

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