ABSTRACT

In motor application, high efficiency is important. So, design engineers select small gate resistors for lower switching. But there is a side effect with small gate resistors. It makes large dv/dt and system request large EMI filters. It makes the price increase. This paper introduces gate drive ICs that have solutions for both lower loss and EMI issues.

1. Introduction

Generally, gate resistor selection is a trade-off between lower loss and EMI. Small gate resistors are good for lower loss, but high EMI. This trade-off is one of the important tuning factors for optimized design. The optimal value is changed by load condition. Light-load feature is different from full load.

2. Gate Resistor Effect

1.1 EMI with Gate Resistor

Turn-on gate resistors contribute significantly to the EMI characteristics.

![Figure 1](a) $R_{on}=0 \Omega$, (b) $R_{on}=1.5 \Omega$

$V_{dc}=600V$, $I_{c}=60A$, $V_{ge}=\pm15V$

Figure 1 shows small gate resistors make high-frequency oscillation. It is different for gate resistor values needed for full load and light load conditions.

1.2 Drive IC with Variable Gate Current Output

Infineon 1EDS-SRC (Slew Rate Control) drive ICs can change gate output current with analog input reference. Gate output is changed by Speed Pin analog value.

![Figure 2](1EDS20I12SV gate output at speed pin with analog reference)

It can separate control light load and full load conditions. Light load needs slower switching with large gate resistors. Level 1 is a small gate current, good for light load. Level 11 is a big gate current. Big gate current effect is similar with small gate resistor effect. It is good for full load conditions. 1EDS20I12SV has a total of 11 gate current output stages.

1.3 Improved Eon Loss by Controlling Gate Current

![Figure 3](1EDS20I12SV and standard drive IC turn-on feature. Collector-emitter voltage (blue), Collector current (red), Gate-emitter voltage (green))

Figure 3 left side waveform are turn-on feature standard drive IC. This is 1.5Ω for FF600R12ME4 (600A 1200V Infineon IGBT module). Right top waveform is Light load (10%, 60A) with Level 5. Right bottom waveform is full load (50%, 300A) with Level 11. 1EDS20I12SV Eon is 15.5mJ. It is 40% advanced with standard drive IC Eon (24.8mJ).
3. Conclusion

Gate resistor selection have already dilemma: Small gate resistor is good at lower loss and large gate resistor is good at good EMI. By 1EDS20112SV, turn-on properties can be adjusted pulse by pulse in real time control. Finally, result can help to reduce motor and EMI filter size and therefore reduce the system cost significantly, while increasing system efficiency. Calculation of inverter loss, possible to reduce heatsink size or 10~15% increase current density in application.

Reference
