Infineon Drive IC solution with 1EDS-SRC(Slew Rate Control)

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ABSTRACT

In motor application, High efficiency is important. So Design engineer select small gate resistor for lower switching. But There is side effect with small gate resistor. It makes large dv/dt and system request large EMI filter. It makes price increase. This paper introduce about gate drive IC which have solution both of lower loss and EMI issue.

1. Introduction

Generally, Gate resistor selection is trade-off between lower loss and EMI. Small gate resistor is good at lower loss, But high EMI. This trade-off is one of important tuning for optimized design. Problem is optimized value is changed by load condition. Light-load feature is different with full load.

2. Gate resistor effect

1.1 EMI with Gate resistor

Turn-on gate resistor contribute significantly to the EMI characteristic.

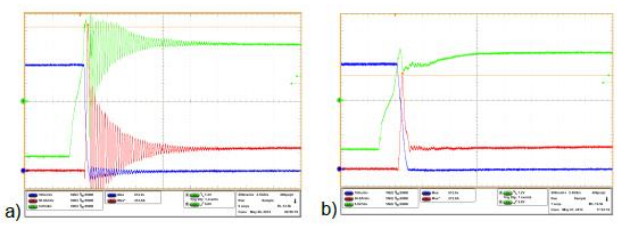

Figure 1 a) Rg_on=0Ω b) Rg_on=1.5Ω
Vdc=600V, Ic=60A, Vge=±15V

Figure1 show small gate resistor make high-frequency oscillation. It is different gate resistor value need Full load condition and light load condition.

1.2 drive IC with variable gate current output

Infineon 1EDS-SRC(Slew Rate Control) drive IC can change gate output current with analog input reference.

Gate output is changed by Speed Pin analog value.

	Voltage at terminal SPEED	Duty cycle for 3.3V PWM	% of preboost current
Level 1	3.03 V ≤ V_{SPEED} ≤ 3.3 V	91.8% ≤ d ≤ 100%	20%
Level 2	2.75 V ≤ V_{SPEED} ≤ 3.03 V	83.3% ≤ d ≤ 91.8%	28.90%
Level 3	2.48 V ≤ V_{SPEED} ≤ 2.75 V	75.1% ≤ d ≤ 83.3%	37.80%
Level 4	2.2 V ≤ V_{SPEED} ≤ 2.48 V	66.7% ≤ d ≤ 75.1%	46.70%
Level 5	1.93 V ≤ V_{SPEED} ≤ 2.2 V	58.5% ≤ d ≤ 66.7%	55.60%
Level 6	1.65 V ≤ V_{SPEED} ≤ 1.93 V	50.0% ≤ d ≤ 58.5%	64.40%
Level 7	1.38 V ≤ V_{SPEED} ≤ 1.65 V	41.8% ≤ d ≤ 50.0%	73.30%
Level 8	1.11 V ≤ V_{SPEED} ≤ 1.38 V	33.3% ≤ d ≤ 41.8%	82.20%
Level 9	0.83 V ≤ V_{SPEED} ≤ 1.11 V	25.2% ≤ d ≤ 33.3%	91.10%
Level 10	0.55 V ≤ V_{SPEED} ≤ 0.83 V	16.7% ≤ d ≤ 25.2%	100%
Level 11	0 ≤ V_{SPEED} ≤ 0.55 V	0 ≤ d ≤ 16.7%	157%

Figure 2 1EDS20I12SV gate output at speed pin with analog reference.

It can separate control light load and full load condition. Light load need slow switching with large gate resistor. Level 1 is small gate current. It is good at light load. Level 11 is big gate current. Big gate current effect is similar with small gate resistor effect. It is good at full load condition.

1EDS20I12SV have total 11step gate current output stage.

1.3 Improved Eon loss by controlling gate current

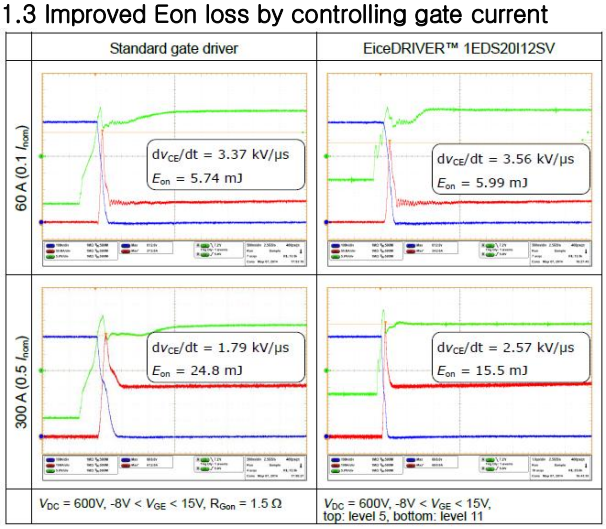

Figure 3 1EDS20I12SV and standard drive IC turn-on feature. Collector-emitter voltage(blue), Collector current(red), Gate-emitter voltage(green)

Figure3 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 Level5. Right bottom waveform is full load(50%, 300A) with Level11. 1EDS20I12SV Eon is 15.5mJ. It is 40% advanced with standard drive IC Eon(24.8mJ).

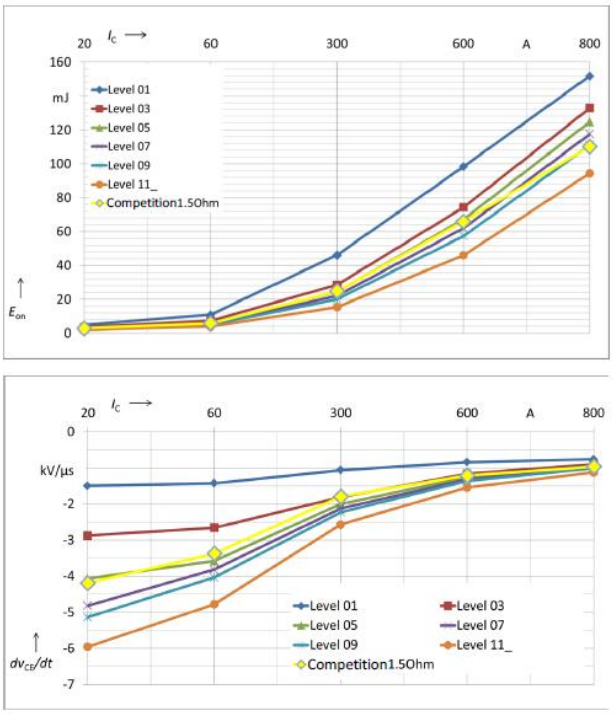

Figure 4 Example of dv/dt range and turn-on energy speed Level 1,3,5,7,9,11 with standard competitor drive IC.

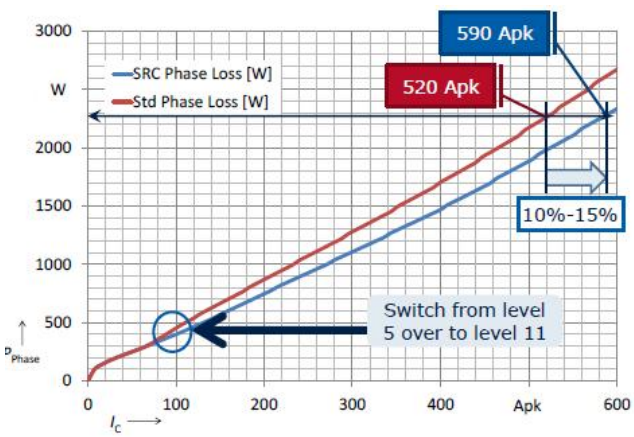

Figure 5 Calculate power loss per phase standard drive IC and 1EDS20I12SV.

Current density 10~15% in respect to output current with 1EDS20I12SV drive IC. It is possible to Increase current density same cooling condition.

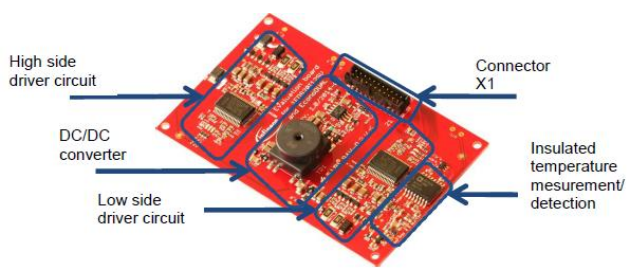

Figure 6 Evaluation board mounted to FF600R12ME4_B11 EconoDUAL3 module.

EconoDUAL3 module is standard pin configuration at IGBT module. It is easy to find 1EDS20I12SV performance gap between standard drive IC.

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 1EDS20I12SV, 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

[1] Wolfgang Frank, "Innovative EiceDRIVER IC resolves design dilemma of gate resistor selection", pp. 2,4,6.

[2] Infineon Application Note "1EDS20I12SV Evaluation Board for EconoDUAL3 modules", pp. 7,10.