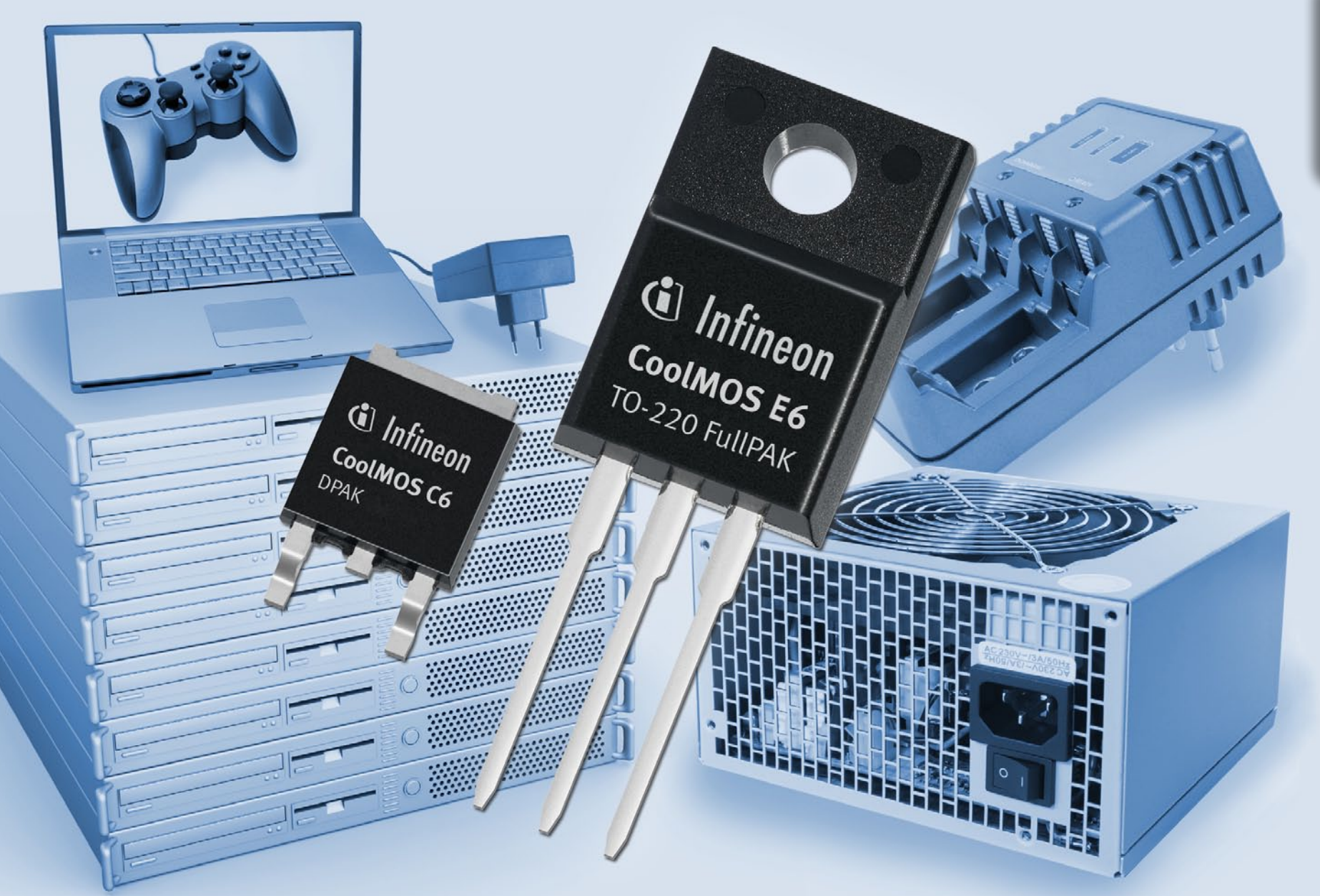



# CoolMOS™ New Generation 600V & 650 V C6/E6 replacements for C3


# CoolMOS™ 600V C6/E6 replacements for C3

| $R_{DS(on)}$ | TO-252 DPAK | | TO-263 D²PAK | | TO-220 | | TO-220 FullPAK | | TO-262 I²PAK | | TO-247 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C3 Original | C6/E6 Replacement | C3 Original | C6 Replacement | C3 Original | C6/E6 Replacement | C3 Original | C6 /E6 Replacement | C3 Original | C6 Replacement | C3 Original | C6/E6 Replacement |
| 3.3 Ω | SPD02N60C3 | IPD60R3k3C6 | | | | | | | | | | |
| 1.4 Ω | SPD03N60C3 | IPD60R1k4C6 | | | SPP03N60C3 | IPP60R1k4C6 | | | | | | |
| 0.95 Ω | SPD04N60C3 | IPD60R950C6 | SPB03N60C3 | IPB60R950C6 | SPP04N60C3 | IPP60R950C6 | SPA04N60C3 | IPA60R950C6 | | | | |
| 0.60 Ω | SPD07N60C3 | IPD60R600E6 | SPB07N60C3 | IPB60R600C6 | SPP07N60C3 | IPP60R600E6 | SPA07N60C3 | IPA60R600E6 | | | | |
| 0.38 Ω | SPD11N60C3 | IPD60R380C6 | SPB11N60C3 | IPB60R380C6 | SPP11N60C3 | IPP60R380E6 | SPA11N60C3 | IPA60R380E6 | SPI11N60C3 | IPI60R380C6 | | |
| 0.28 Ω | | | SPB15N60C3 | IPB60R280C6 | SPP15N60C3 | IPP60R280E6 | SPA15N60C3 | IPA60R280E6 | SPI15N60C3 | IPI60R280C6 | SPW15N60C3 | IPW60R280E6 |
| 0.19 Ω | | | SPB20N60C3 | IPB60R190C6 | SPP20N60C3 | IPP60R190E6 | SPA20N60C3 | IPA60R190E6 | SPI20N60C3 | IPI60R190C6 | SPW20N60C3 | IPW60R190E6 |
| 0.16 Ω | | | SPB24N60C3 | IPB60R160C6 | SPP24N60C3 | IPP60R160C6 | SPA24N60C3 | IPA60R160C6 | | | SPW24N60C3 | IPW60R160C6 |
| 0.10 Ω | | | | | | | | | | | SPW35N60C3 | IPW60R099C6 |
| 0.07 Ω | | | | | | | | | | | SPW47N60C3 | IPW60R070C6 |

# CoolMOS™ 650V C6/E6 replacements for C3

| $R_{DS(on)}$ | TO-220 | | TO-220 FullPAK | | TO-262 I²PAK | | TO-247 | |
|---|---|---|---|---|---|---|---|---|
| | C3 Original | E6 Replacement | C3 Original | E6 Replacement | C3 Original | C6 Replacement | C3 Original | C6 Replacement |
| 0.60 Ω | SPP07N65C3 | IPP65R600E6 | SPA07N65C3 | IPA65R600E6 | SPI07N65C3 | IPI65R600C6 | | |
| 0.38 Ω | SPP11N65C3 | IPP65R380E6 | SPA11N65C3 | IPA65R380E6 | SPI11N65C3 | IPI65R380C6 | | |
| 0.28 Ω | SPP15N65C3 | IPP65R280E6 | SPA15N65C3 | IPA65R280E6 | SPI15N65C3 | IPI65R280C6 | | |
| 0.19 Ω | SPP20N65C3 | IPP65R190E6 | SPA20N65C3 | IPA65R190E6 | SPI20N65C3 | IPI65R190C6 | SPW20N65C3 | IPW65R190C6 |
| 0.07 Ω | | | | | | | SPW47N65C3 | IPW65R070C6 [1)] |

[1)] Available Q4 2011

Order Number: B152-H9581-G1-X-7600-DB2011-0011
Date: 10/2011

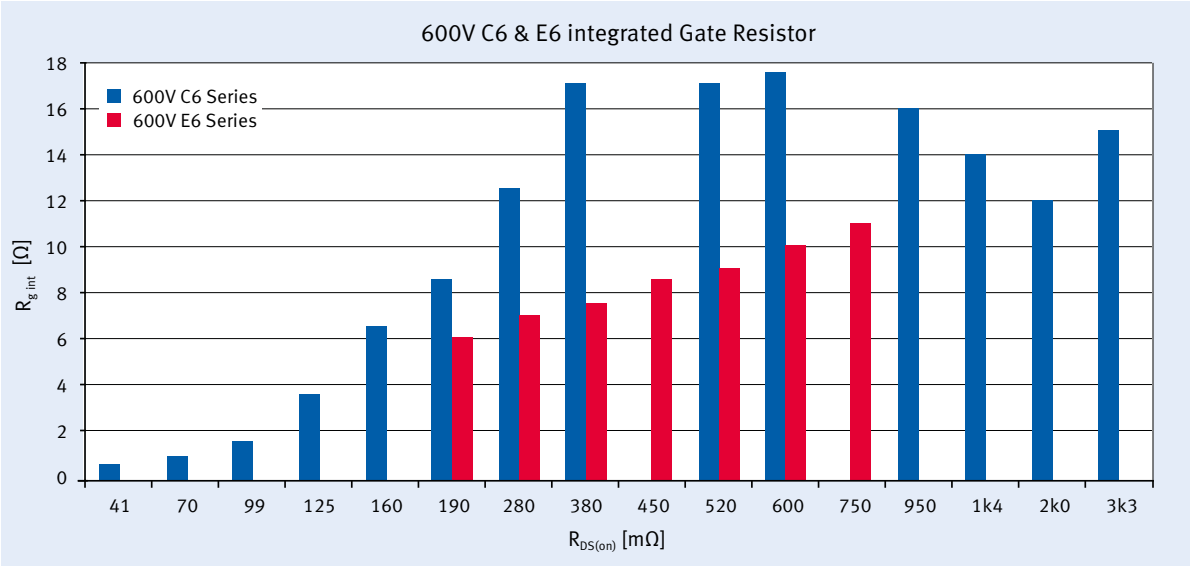
# C6/E6 technology

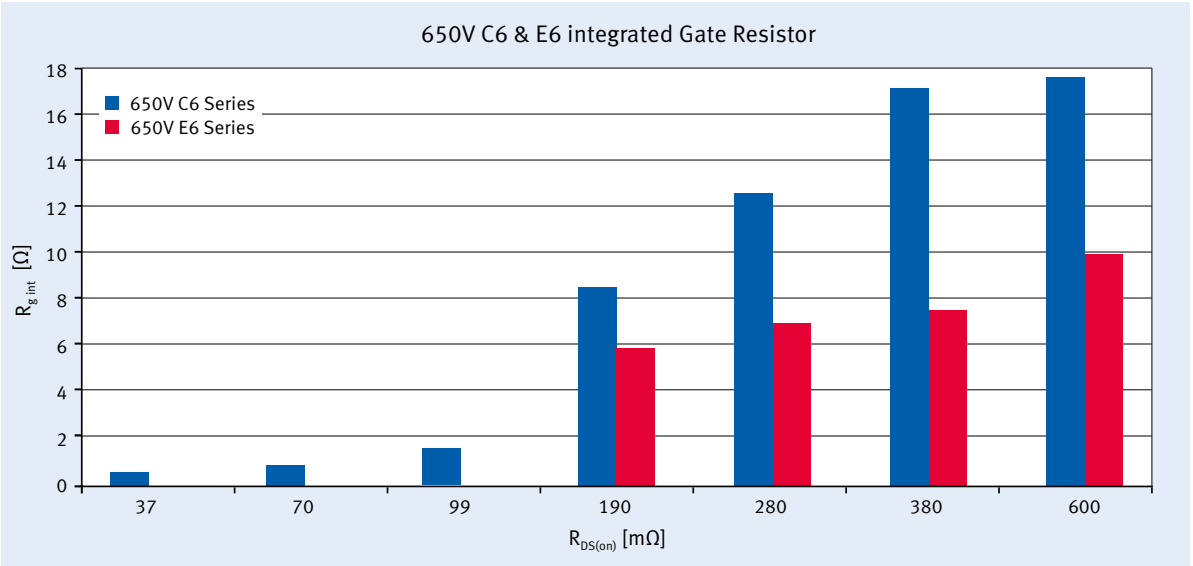
## What is the Difference between the CoolMOS™ C6 & E6 series?

The C6 and E6 are exactly the same technology, but with a different integrated resistor value. Please see charts for details.

The C6 series was first launched and optimized for ease of use, however for certain Discontinuous Conduction Mode (DCM) applications it was realized that increasing pressures on efficiency required an improvement. By carefully reducing the integrated gate resistor value will improve efficiency in these applications.

The E6 only covers a smaller range of parts as its specifically targeted for the above application, where there is no E6 range the C6 has already been fully optimized in terms of ease of use and efficiency.



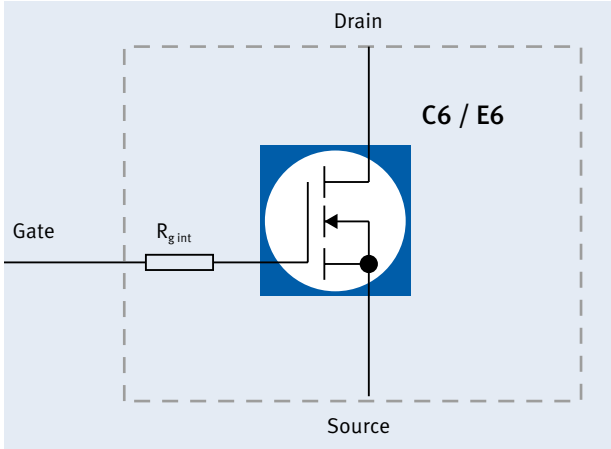



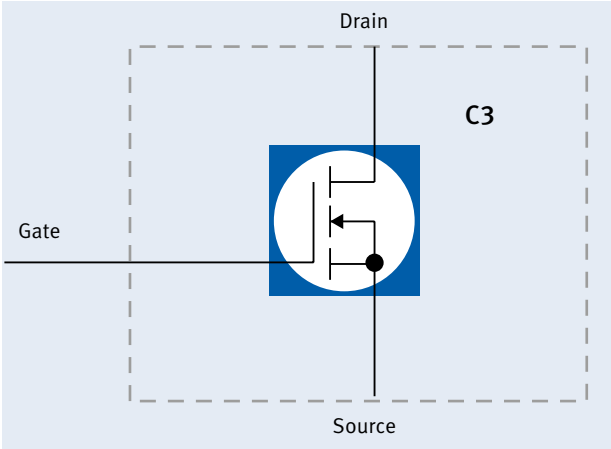
# What is the Difference between the CoolMOS™ C3 & C6/E6 series?

CoolMOS™ C6/E6 series was designed as a direct replacement for the well established C3 series of CoolMOS™. The series are both designed as a general easy to use part, but improvements have also been made for the C6/E6 on the earlier C3 series.

So what are the differences:

- Better light load efficiency due to:
  - Lower Gate Charge value ($Q_g$) (see table for example)
  - Energy stored in the output capacitance, as this parameter, is decisive for the efficiency in high line or light load conditions $E_{oss}$ (see table for example)
- Improved body diode control for use in hard commutation applications (i.e resonant topologies)
- Ease of driving the MOSFET by use of an integrated gate resistor
- More attractive price points



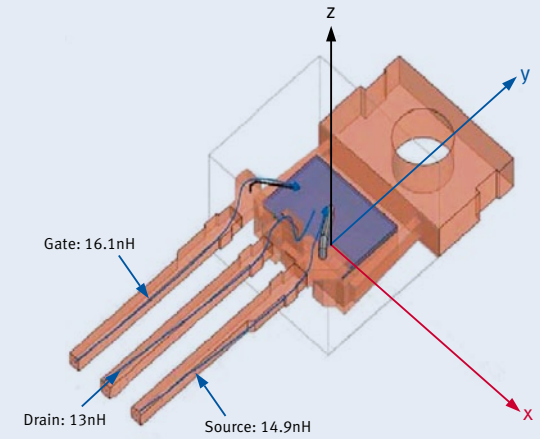




| Specification | Symbol | IPW60R190C6 | SPW20N60C3 | Benefits |
|---|---|---|---|---|
| On-state resistance: maximum rating, 25 °C | $R_{DS(on)}$ | 190 mΩ | 190 mΩ | - |
| Total Gate charge | $Q_g$ | 58 nC | 87 nC | improves low load efficiency |
| Energy stored in output: capacitance @ 400V | $E_{OSS}$ | 5 µJ | 10 µJ | Improves efficiency in hard switching applications |
| Body diode, reverse recovery charge | $Q_{rr}$ | 7 µC | 11 µC | Improved body diode for soft switching applications |
| Body diode, di/dt | $dI_f/dt$ | 1400 A/µs | 500 A/µs | |

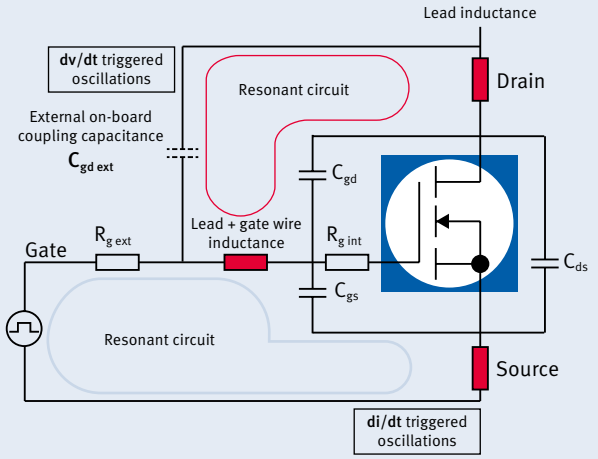
Ease of Use with integrated gate resistor:

- Helps self limiting di/dt and dv/dt behavior, beneficial in EMI and voltage overshoot.
- Reduces parasitic effects due to package and board layout. (see picture)
  - By adding in an integrated gate resistor this helps damp out resonant effects due to inherent package construction or board layout. This is more effective than an external gate resistor due to its positioning closer to the gate.

Disassembling a MOSFET package parasitics – TO-220




Parasitic L C influence: Damping effect of $R_{g\,int}$



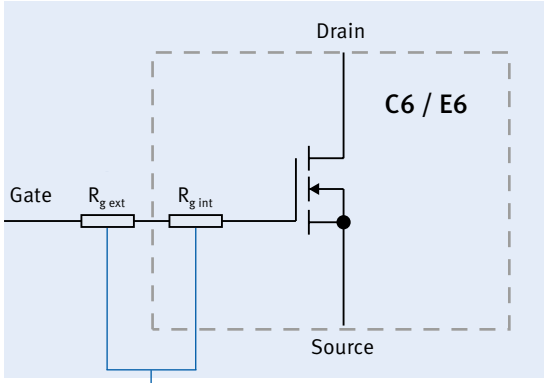
# C3 vs. E6 efficiency comparison in a CCM-PFC stage → 190mΩ @ 130kHz

## Gate Charge and Integrated Gate Resistor

CoolMOS™ C6 comes with an integrated gate resistor in order to achieve self-limiting di/dt and dv/dt characteristics. This integrated $R_g$ allows fast turn on and turn off at normal operating current conditions but limits the di/dt and dv/dt in case of peak current conditions. This helps to improve performance in hard commutation applications (i.e. resonant topologies).

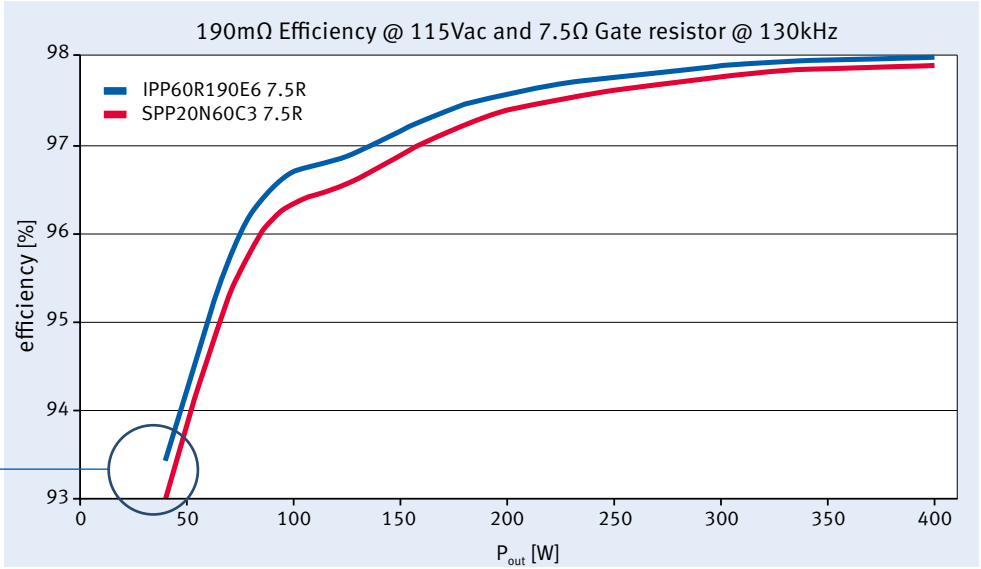
Due to low gate charge plus integrated gate resistors the gate current is relatively low; hence the use of low cost gate drivers is therefore possible.

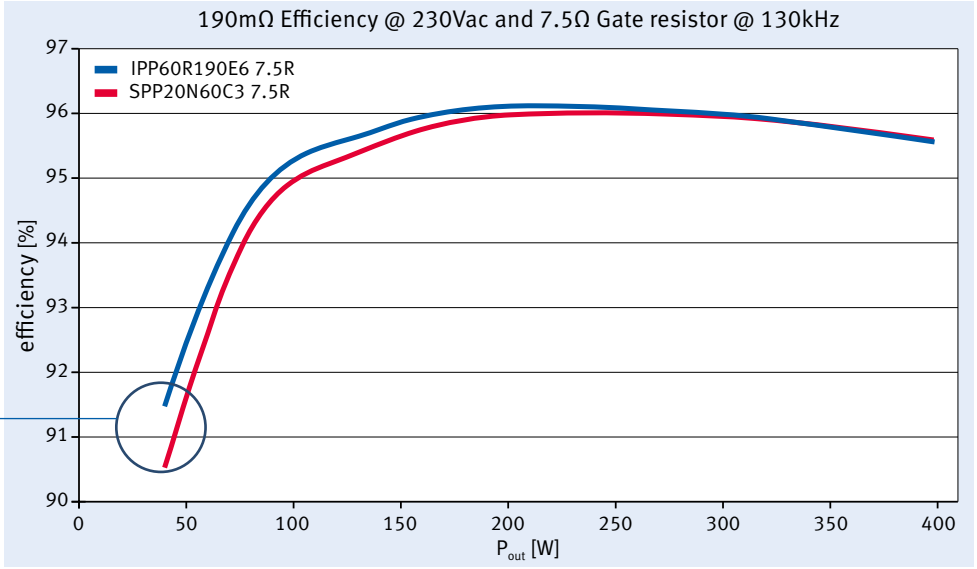
In combination with a relatively low total gate charge the losses dissipated in the driver are considerably lower as well. We recommand to use very small external gate resistors to achieve optimum efficiency across a wide range of load conditions.




Carefully choosing $R_{g\,ext}$ with $R_{g\,int}$ will give best efficiency

Significant light load efficiency improvement with E6 can then also be achieved compared to C3 due to the improved $Q_g$ and Eoss values; as seen in example device table.

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