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Simplify Automotive Powertrain Design with Distributed Power Supply

Electronic Design
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Conventionally, a centralized power supply is applied in an automotive powertrain through a multichannel transformer that converts 12-V dc power from the battery to supply six, isolated gate-drive circuits *(Fig. 1)*.

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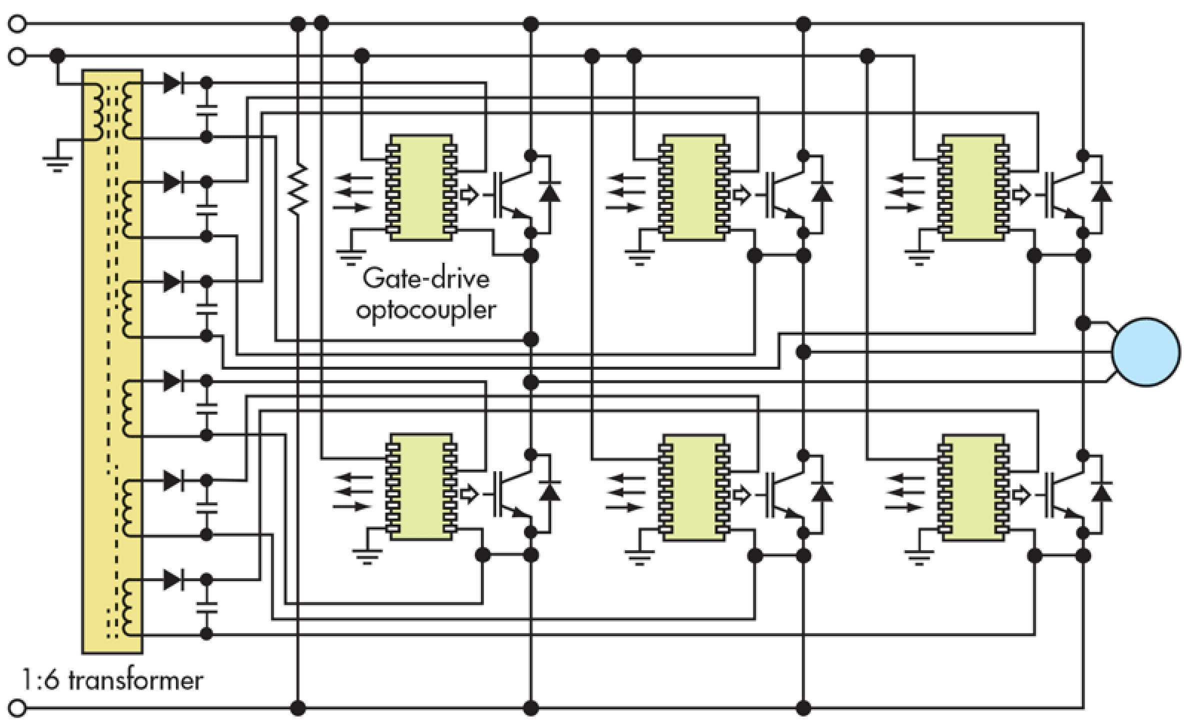
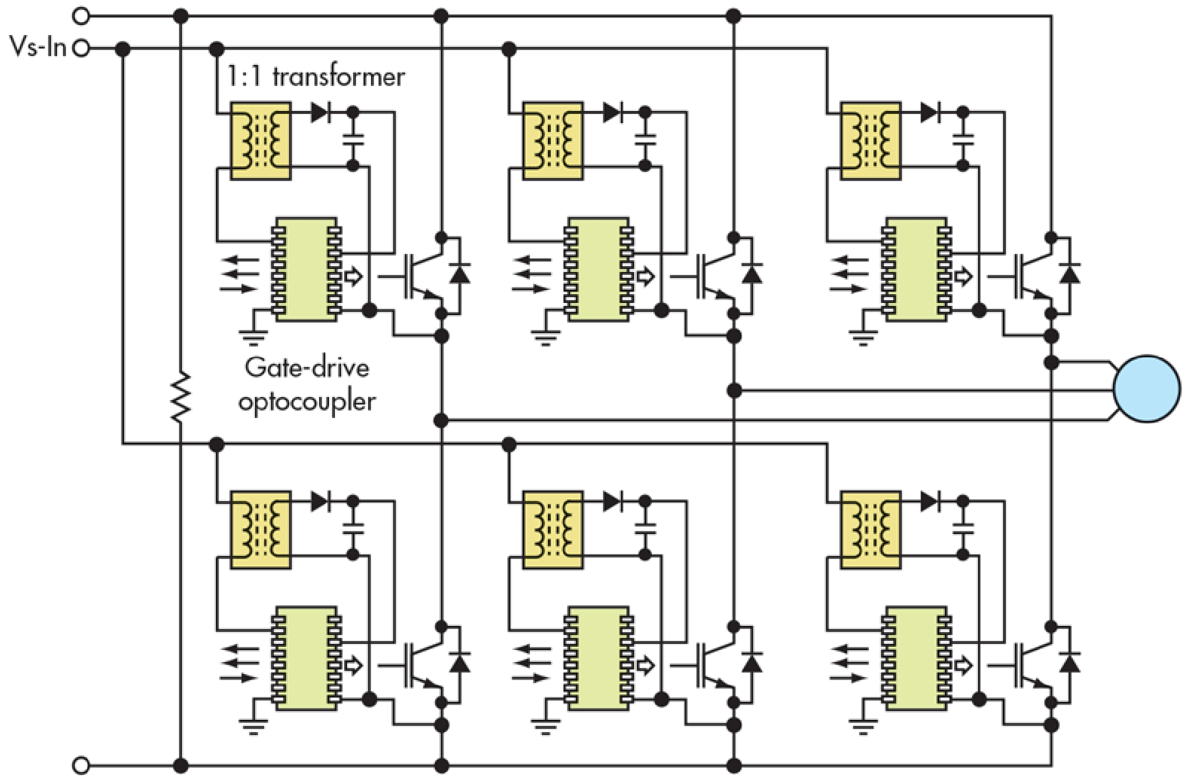
Designers face many challenges in a centralized transformer model, including layout complexity and electromagnetic interference (EMI). There are also challenges associated with larger board space and higher printed-circuit-board (PCB) cost, as more layers are needed to route isolated signal/power lines.

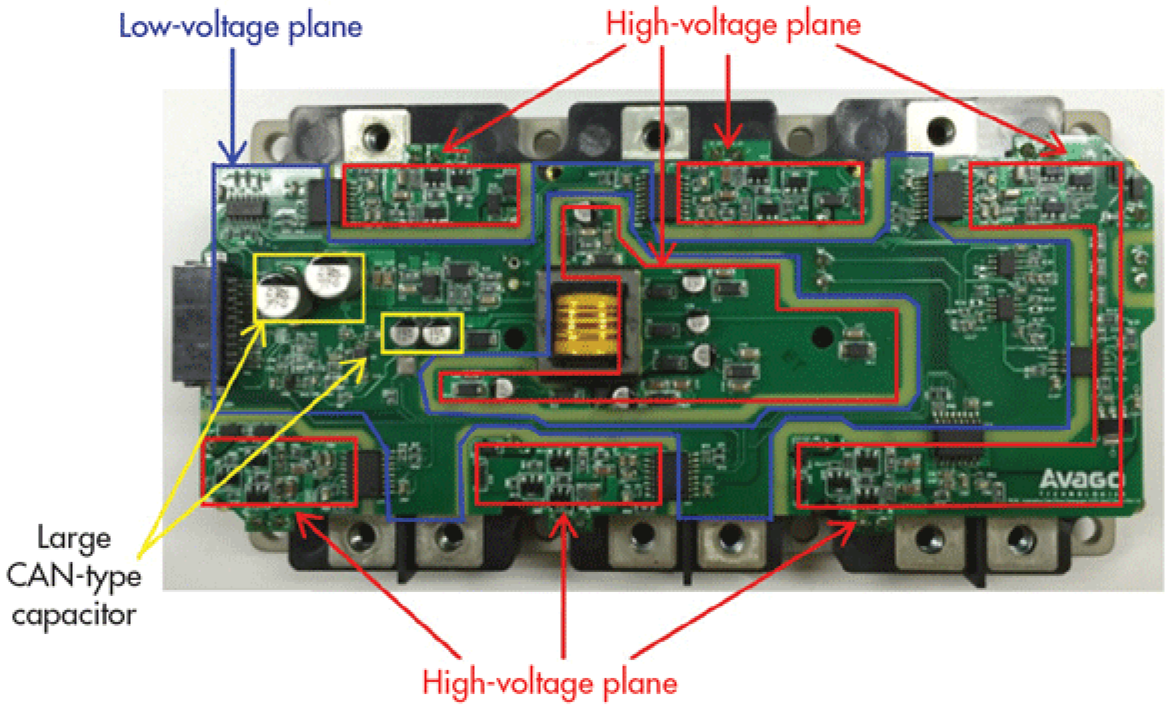


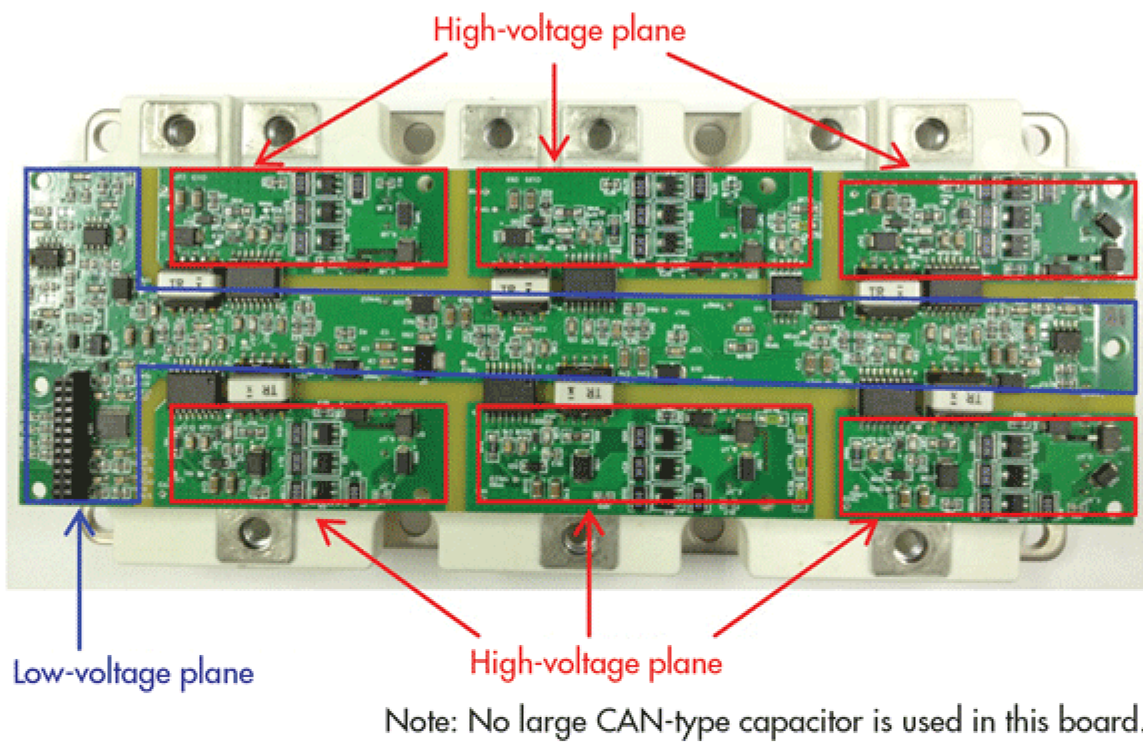
A distributed power supply can be easily built using a few discrete components and a small high-efficiency transformer placed next to the IC integrating an automotive-grade smart gate drive with integrated flyback troller *(Fig. 2)*. This reduces the overall footprint and minimizes EMI and noise coupling between ulated-gate bipolar transistor (IGBT) channels.



Design Simplicity

With a distributed-power-supply architecture, designers have more flexibility in planning the circuit layout; the low-voltage plane can be distinguished and isolated easily from the high-voltage plane. In addition, overall PCB routing becomes more manageable and straightforward.

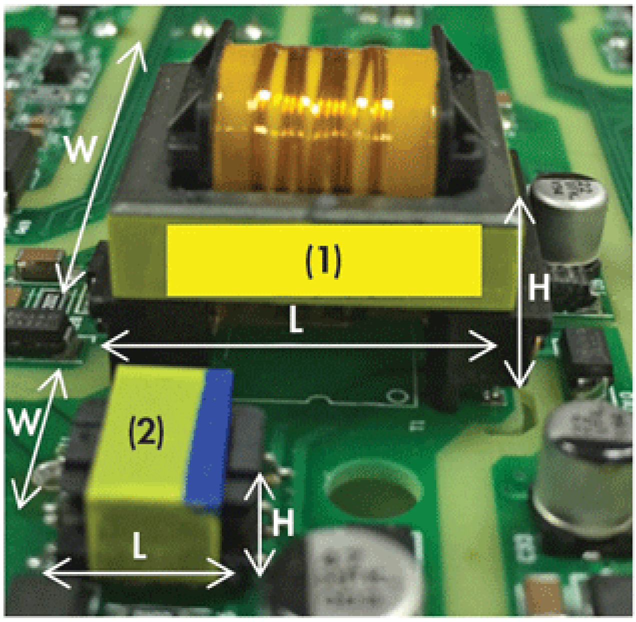




Figures 3 and *4*, respectively, compare a six-channel IGBT gate-driver board based on a centralized power supply versus one based a distributed power supply. It's obvious that a distributed-power-supply architecture offers a simplified PCB layout and more efficient routing. There are no PCB traces or power planes crossing between low- and high-voltage circuits, enhancing the signal integrity and avoiding unfavorable noise disturbance to the signal lines.

Robustness

transformer in a distributed power supply is typically 14 times smaller in volume versus a centralized nsformer. *Figure 5* shows an individual transformer placed next to a centralized transformer. The *table* shows actual dimensions of a centralized transformer and an individual transformer.



A low-profile single transformer for each driver also improves reliability and robustness, compared to heavier, higher-profile transformers that are more vulnerable to mechanical vibration. While the power-supply capacitors used in a centralized-power-supply architecture tend to be larger and in a radial CAN package with a high profile, designers choose a smaller SMD package capacitor for a distributed power supply. The voltage ratings required for these capacitors is at least 10 to 20 V lower than those required for a conventional centralized-power-supply circuit.

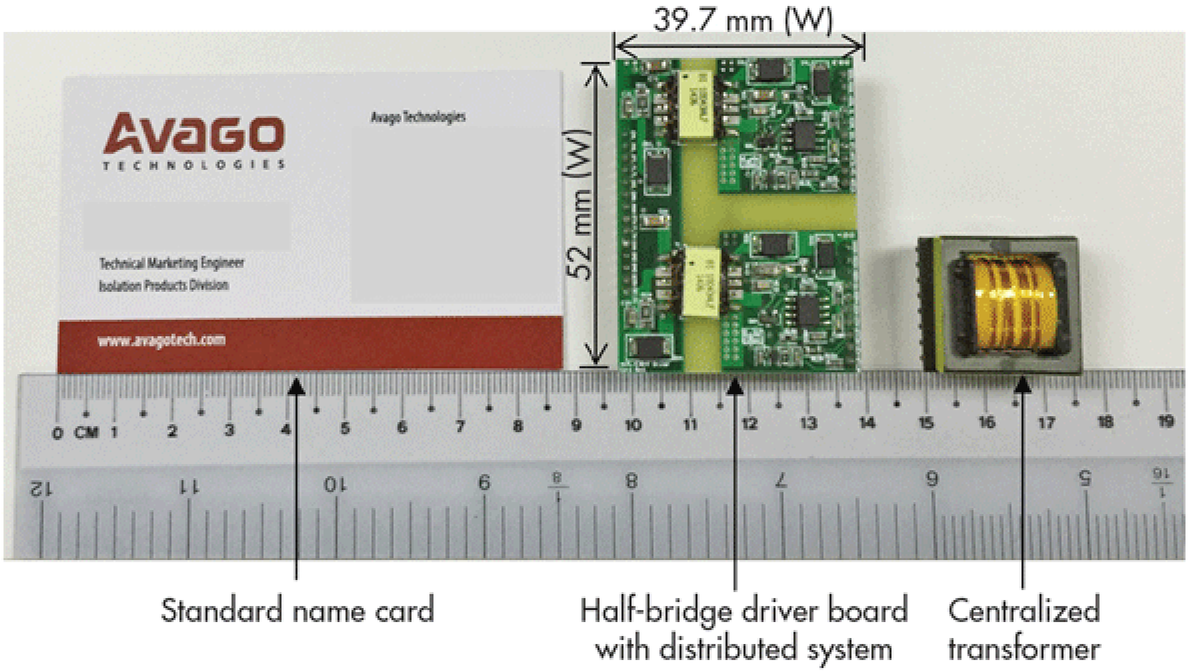
Cost Savings

On top of design simplicity and robustness, another benefit of choosing a distributed power supply is cost savings through the minimization of overall board size and PCB layers. A distributed system of drivers and a single transformer allows these components to be placed closer together, saving critical board space.

TRANSFORMER DIMENSIONS

	Length (mm)	Width (mm)	Height (mm)
Centralized transformer (single input/ six output)	26	22	18
Individual transformer (single input/single output)	11	11	6

Figure 6 shows an example of a well-designed half-bridge gate-driver circuit (top and bottom channel), placed within a 39.7 mm (width) by 52 mm (length) area, that's less than 50% of a standard card's size. In this instance, a six-channel gate-driver circuit may only require a PCB area of one and a half that of a standard card's size.

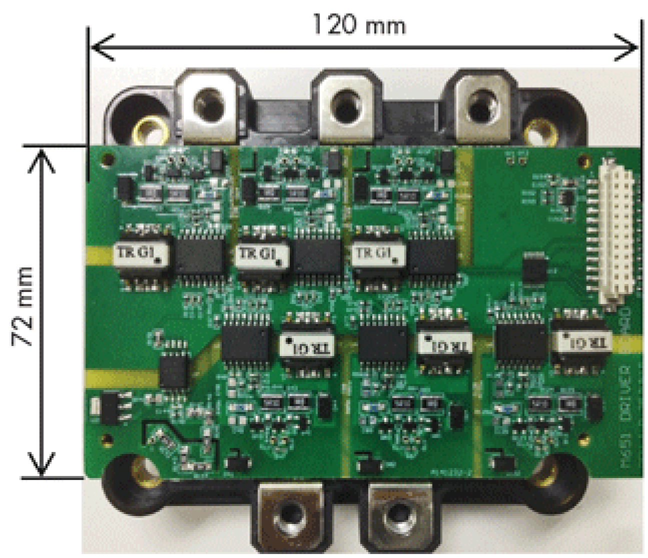


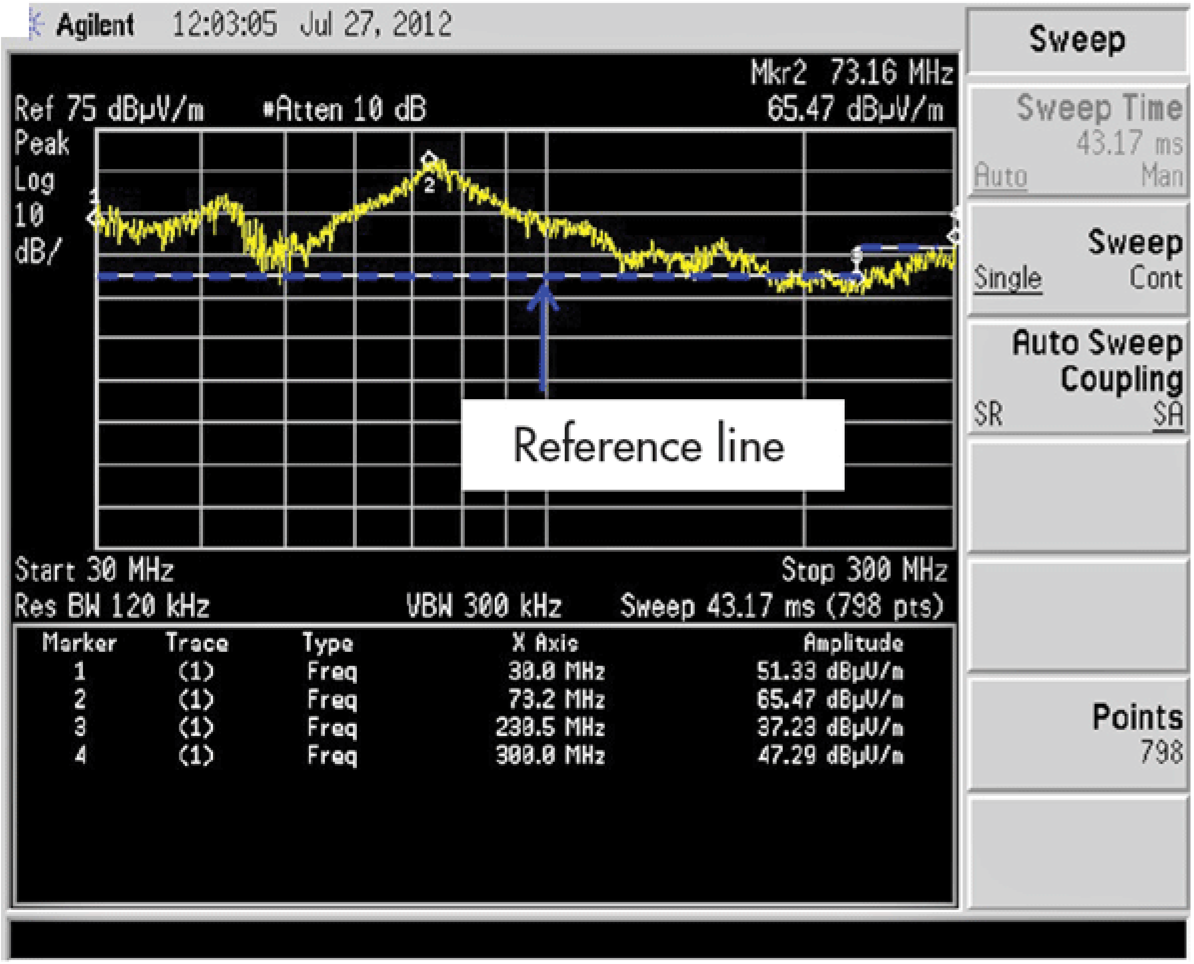
A distributed system also helps reduce the number of PCB layers because there's no crossing of low-voltage traces/planes between the high-voltage traces/planes. This ensures that no extra layers are needed for passing the crossing signals. *Figure 7* shows an example of a compact six-channel gate-driver board designed for the Fuji M651 IGB that uses only four layers of PCB.

Better EMI Performance

A large six-channel transformer in a centralized power system typically emits a lot more EMI noise than individual small transformers. In a distributed power supply, each smart gate-drive optocoupler drives an individual transformer with an integrated dc-dc controller to provide power to the secondary side for driving the IGBT arm.

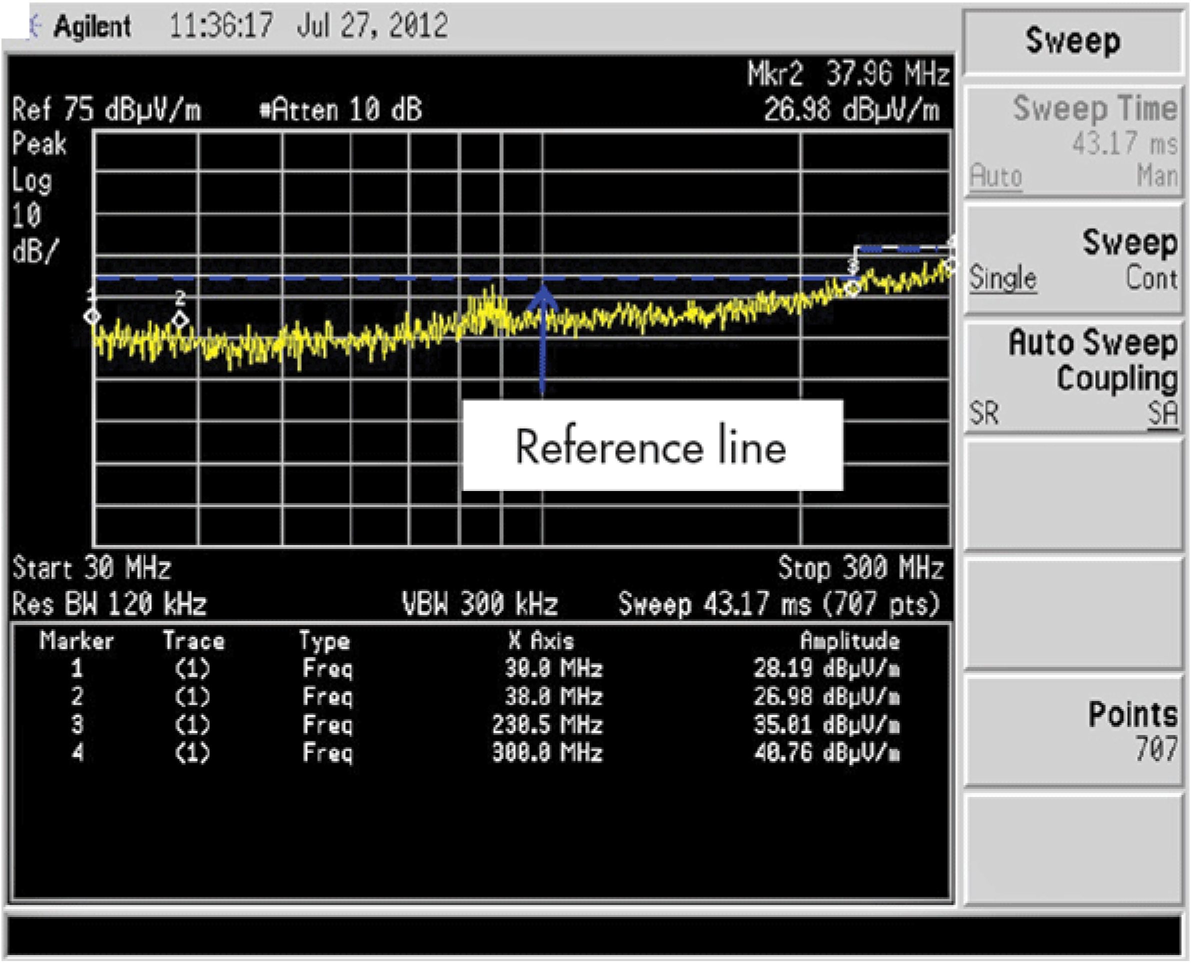
Measurements show significantly higher EMI noise from a centralized six-channel transformer *(Fig. 8)* as compared to small individual transformers *(Fig. 9)*.





Conclusion

A distributed power supply further simplifies automotive multichannel IGBT gate-drive design versus that of a gate-drive board using a centralized power supply. Furthermore, it improves robustness, EMI performance, and module cost when compared to a conventional centralized-power-supply architecture.



References:

"Automotive R²Coupler Smart Gate Drive Optocoupler," Broadcom Limited, 2016.

"AV02-4412EN Design of Isolated Flyback Converter for IGBT Gate Driver," Application Note, Avago Technologies, December 2015

"IGBT Modules for EV, HEV," Fuji Electric, 2016.

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