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APPLICATION NOTE 4190

Enhancing the Gate-Drive Capacity of the DS39xx CCFL Controllers

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Abstract: The DS3984, DS3988, DS3991, DS3992, and DS3994 are controllers for cold-cathode fluorescent lamps (CCFLs) that backlight liquid crystal displays (LCDs). Each controller channel drives two logic-level MOSFETs to convert a DC voltage to the high-voltage AC waveform required to power the CCFLs. In some applications power MOSFETs, that require more drive capacity and higher gate-source voltages, are used to drive multiple lamps in one channel. This application note describes how to enhance the drive capacity of the DS39xx controllers so that they can drive these large power MOSFETs effectively.

DS39xx Gate Drivers

Each channel of the DS3984, DS3988, DS3991, DS3992, and DS3994 controllers has two gate drivers. Each gate driver can drive one logic-level MOSFET. The gate-driver output charge loading is 20nC maximum, and the high-level output voltage is approximately V_{CC} (5V). This gate-drive capacity is sufficient for driving most logic-level MOSFETs.

As the physical size of the LCD monitors and TVs grows, however, many applications require each controller channel to drive multiple lamps. For example, the DS3991 could be used to control all the lamps in a large LCD TV. To drive a large number of lamps reliably, high-current power MOSFETs are needed. Other emerging applications use a very high DC input voltage (as high as 400V) to reduce the current in large TVs in which the CCFLs can use up to 200W. These latter applications also require high-voltage power MOSFETs to drive the lamps.

Power MOSFETs typically have more total gate charge than logic-level MOSFETs. Consequently, the gate drivers must provide high enough peak-drive current to charge and discharge the gate capacitance quickly. Power MOSFETs also require higher gate-source voltages to turn them on effectively.

The built-in gate drivers in the DS39xx controllers cannot drive large power MOSFETs directly. This problem can, however, be overcome. This application note explains how some simple external circuitry is used to enhance the DS39xx controllers' gate-drive capacity so these controllers can drive the power MOSFETs.

Circuitry Enhances Gate-Drive Capacity

Figure 1 details the circuitry used to enhance the gate-drive capacity.

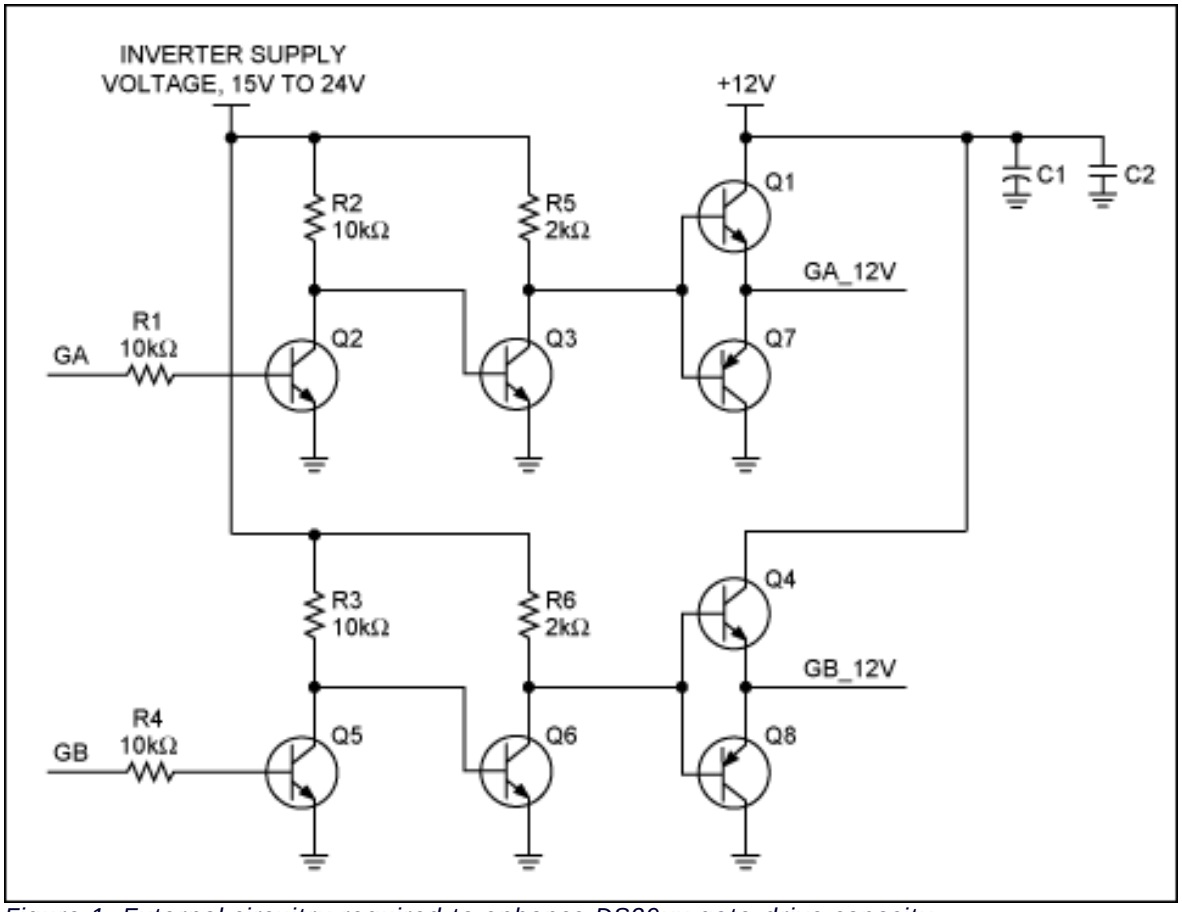

Figure 1. External circuitry required to enhance DS39xx gate-drive capacity.

In Figure 1, GA and GB are the gate-drive signals output by the CCFL controller. Q2/Q3/Q5/Q6 are NPN general-purpose transistors which shift the level of GA and GB from 5V to 12V. Then the signals are output by two totem-pole drivers, constituted by Q1/Q7 and Q4/Q8, respectively. The output drive signals are denoted as GA_12V and GB_12V. The totem-pole driver can charge a power MOSFET's gate capacitor very quickly when the MOSFET is turned on; it can also discharge the gate capacitor very quickly when the MOSFET is turned off. Q1/Q4/Q7/Q8 are medium-power transistors to ensure sufficient peak-current delivery.

Figure 2 shows the waveforms of GA and GB, and GA_12V and GB_12V.

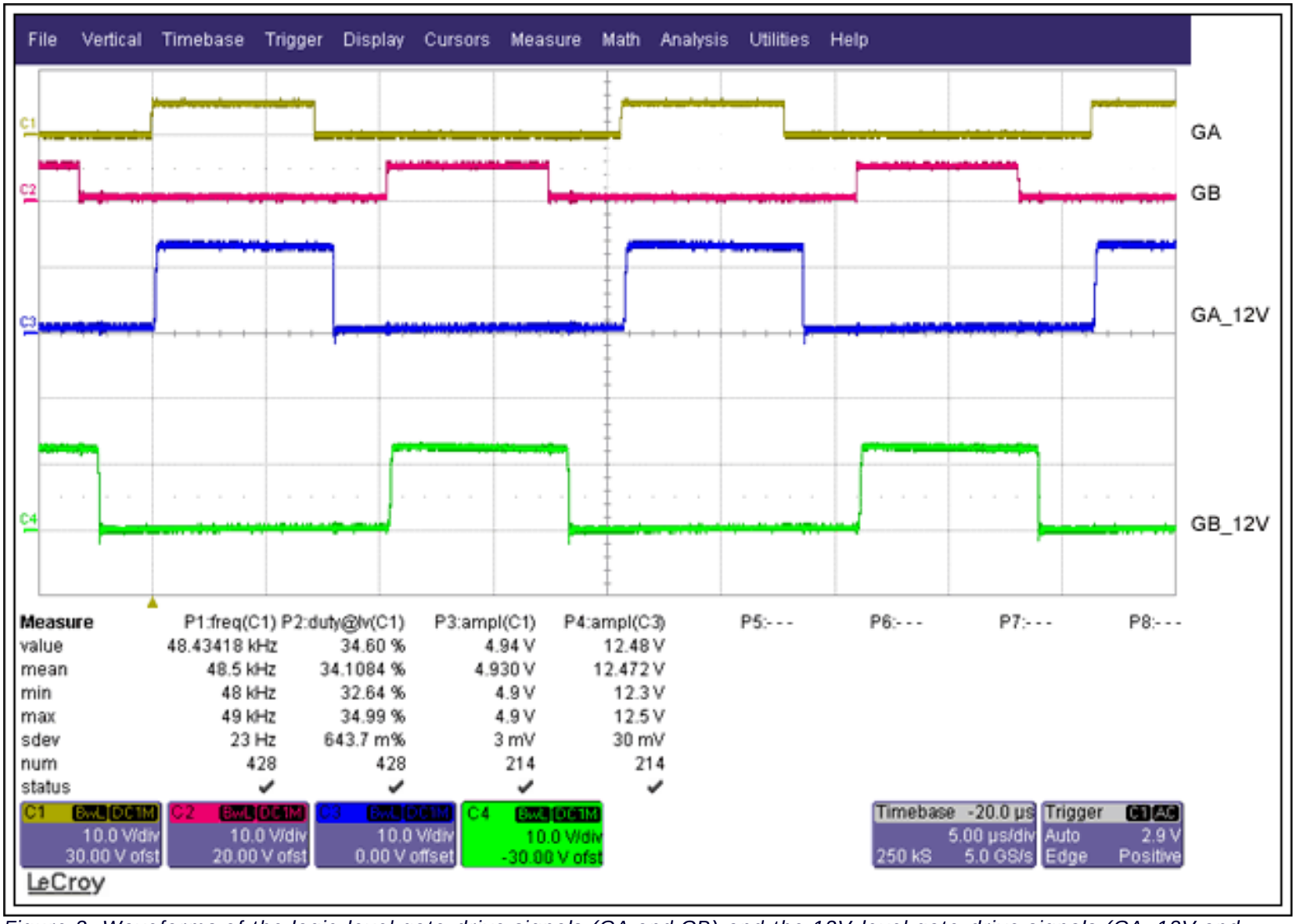

Figure 2. Waveforms of the logic-level gate-drive signals (GA and GB) and the 12V-level gate-drive signals (GA_12V and GB_12V).

GA_12V and GB_12V drive power MOSFETs in a push-pull architecture directly. With some additional circuitry, they can be used in a half-bridge architecture or a full-bridge architecture. (Contact the factory for more details.)

Suggested Transistor Part Numbers

Table 1 lists suggested part numbers for the transistors in Figure 1.

Table 1. Suggested Transistor Part Numbers

Designator	Description	Suggested Part Numbers
Q2/Q3/Q5/Q6	NPN general-purpose transistor	MMBT3904 or equivalent
Q1/Q4	NPN medium-power transistor	FMMT493, ZXTN2038F, or equivalent
Q7/Q8	PNP medium-power transistor	FMMT593, ZXTP2039F, or equivalent

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