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Modifications of the MAX3867 for Burst-Mode Applications

MAXIM High-Frequency/Fiber Communications Group

Maxim Integrated Products

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Note: *Subsequent to the original posting of this design note, Maxim has released a fully integrated burst-mode laser driver, the MAX3656. The datasheet for this device is available for download from the Maxim website at www.maxim-ic.com.*

1 Background

The MAX3867 2.5Gbps laser driver has an "enable/startup delay" specification of 250ns (typical). This specification is interpreted as the time delay between the rising edge of the enable input and the startup of the modulation current output.

Independently confirmed measurements show a modulation current enable/startup delay of approximately 310ns. Additional measurements show that the enable/startup delay for the bias current is approximately 23.7ms and the disable/shutdown delay time for both bias and modulation currents is approximately 34ns. For most burst-mode applications, these delay times are not acceptable.

This design note outlines modifications that can be made to the MAX3867 in order to decrease the turn-on and turn-off times significantly.

Note that, for burst-mode applications, it is generally necessary to DC-couple the interface between the laser driver and the laser diode and, for DC-coupling, the MAX3867 needs a supply voltage (Vcc) of 5 volts. For more detailed information, refer to the application note Interfacing Maxim Laser Drivers with Laser Diodes.

2 Decreasing the Turn-On/Turn-Off Times

In order to decrease the turn-on and turn-off times, leave pin 14 (ENABLE) connected to Vcc. The bias current can be disabled by grounding pin 22 (APCFILT), and the modulation current can be disabled by grounding pin 21 (NC). Note that pin 21 is a test pin that is bonded internally to the modulation circuit.

The measurements included in this design note were made using a MAX3867 EV kit (electrical configuration) that was modified as shown in the schematic in Figure 6. Two MAX4644 analog switches (U4 and U5) were used to ground pins 21 and 22.

The first set of measurements was made with the automatic power control (APC) circuit in the "open-loop" mode. A square wave generator was used to control the state of the analog switches. Figures 1–3 are oscilloscope output plots used to make the measurements. (Note: In these figures, the MAX3867 is AC-coupled to the oscilloscope and the top trace is the square wave applied to DISABLE, the middle trace is the voltage drop across a 15Ω resistor due to the bias current, and the bottom trace is the voltage drop across a 25Ω resistor due to the modulation current.)

The results of these measurements show a turn-on time of 10.2ns and a turn-off time of 8.6ns.

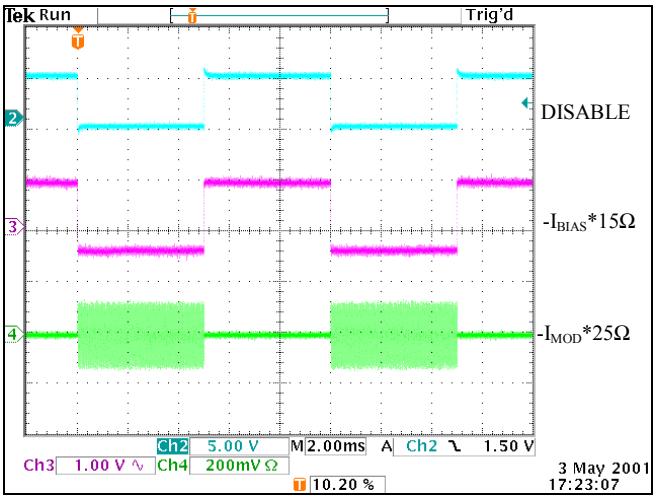

Figure 1. Oscilloscope plot showing overview of measured waveforms

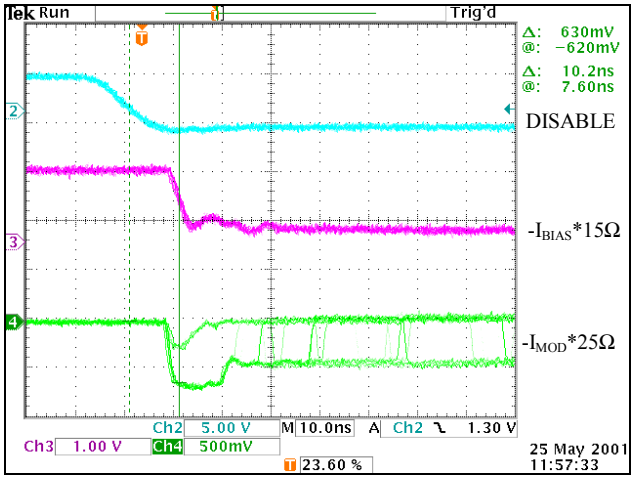

Figure 2. Oscilloscope plot of turn-on time measurements

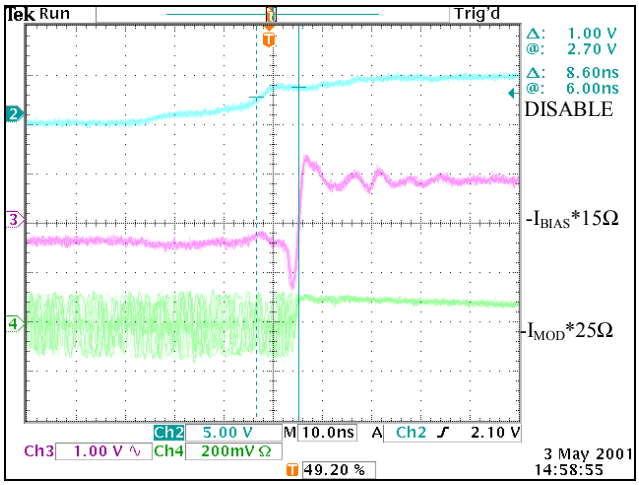

Figure 3. Oscilloscope plot of turn-off time measurements

3 Automatic Power Control Stabilization

Switching the bias current on and off (as described above) can cause the automatic power control (APC) circuit in the MAX3867 to malfunction. This is because the APC loop time constant (controlled by C_{APC}) is long compared to the burst time. While the bias current is disabled, the APC loop does not function, and the bias current increases toward $I_{BIASMAX}$. When the bias current is enabled (during a burst), the APC circuit will adjust the bias current toward I_{APCSET}. Thus, when the MAX3867 is operated with the APC circuit in the "closed-loop" mode, the bias current can change during each burst, as shown in Figure 4. The beginning and ending values of the bias current are determined by the length of the off/on times and by the value of C_{APC}, $R_{BIASMAX}$, and R_{APCSET}.

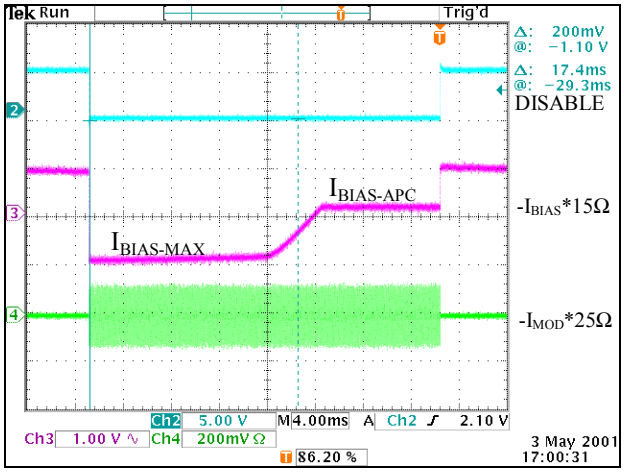

Figure 4. Oscilloscope plot showing bias current with nonstabilized APC loop

In order to stabilize the APC circuit, the charge on capacitor C_{APC} must remain constant during the turn-off time. This allows the APC loop to start the next burst where it left off with the previous burst. Also, the voltage at the CAPAPC pin must remain constant during the turn-off time.

APC loop stabilization is accomplished by the circuit illustrated by U6 and U7 in the schematic (Figure 6). This circuit connects the C_{APC} capacitor to the CAPAPC pin when the laser driver is enabled (during a burst) and disconnects the C_{APC} capacitor when the laser driver is disabled. Also, the voltage on the capacitor is maintained at the output of U7 and connected to the CAPAPC pin when the laser driver is disabled. Figure 5 shows an oscilloscope plot equivalent to the one in Figure 4, but with the APC loop stabilized so that the bias current begins the burst at the level set by R_{APCSET}.

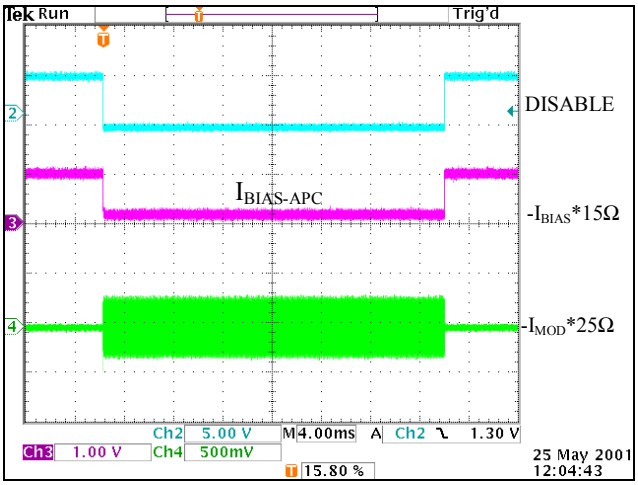

Figure 5. Oscilloscope plot showing bias current with stabilized APC loop

4 Electrical versus Optical Evaluation

The schematic of the test circuit, in Figure 6, shows the modifications that were made to the electrical configuration of a standard MAX3867 evaluation kit. The complete MAX3867 EV kit data sheet can be downloaded from http:// pdfserv.maxim-ic.com/arpdf/ MAX3867EVKIT.pdf. Note that the output of the electrical configuration of the evaluation kit is AC-coupled to facilitate the connection of an oscilloscope. In most burst-mode applications, the output should be DC-coupled. Also, the MAX3867 voltage supply (Vcc) must be 5 volts for DC-coupled operation.

Optical evaluation of the burst-mode modified MAX3867 was performed using the optical configuration of the MAX3867 evaluation kit, with the output DC-coupled to a Fujitsu FLD3C5LK laser diode. Modifications to the optical configuration of the evaluation kit are identical to those shown in the schematic of Figure 6, along with additional changes (not shown in the figure) such as:

1. Remove ferrite beads L1, L5, and L6.
2. Remove C7 and replace with a short length of wire (short circuit).
3. Remove C5, C23, and C16 from their normal locations on the evaluation kit printed-circuit board, and place them in the locations indicated by the schematic in Figure 6.

5 Optical Evaluation Results

Measured results of the optical evaluation are as follows:

Power-Supply Current = 65mA
- Burst turned off (DISABLE = high)
- Room temperature
- I_{BIAS} and I_{MOD} set to midrange
- Measured 180mA into the EV kit
- 19mA subtracted for EV kit LED
- 96mA subtracted for current through EV kit input termination resistors

I_{BIAS} and I_{MOD} Turn-On/Turn-Off Times ≈ 10ns
- Room temperature
- I_{BIAS} and I_{MOD} set to midrange
- Time measured from rising/falling edge of DISABLE to start/stop of optical output
- Approximately 25ns of transient bias current spike after start of optical output

Minimum Burst Length (APC open loop) < 1µs
- I_{BIAS} set by $R_{BIASMAX}$ (APC turned off)

Minimum Burst Length (APC closed loop) = 16µs
- I_{BIAS} set by R_{APCSET}.
- APC turned on and stabilized by using APC stabilization circuit shown in Figure 6.
- For burst-lengths < 16µs, APC circuit is unable to regulate I_{BIAS}, and I_{BIAS} goes to level set by $R_{BIASMAX}$.

Burst-mode MAX3867 EV kit

This schematic reflects changes that were made to the electrical configuration of the EV kit. Other changes (not in this schematic) include the following:

1. Remove op-amp U3, and insert a jumper between PC-board pads for U3 pin 3 and U3 pin 6.
2. Replace 15Ω resistor R46 with a 22Ω resistor.
3. Move C33, C34, and C42 from their normal locations on the PC board.

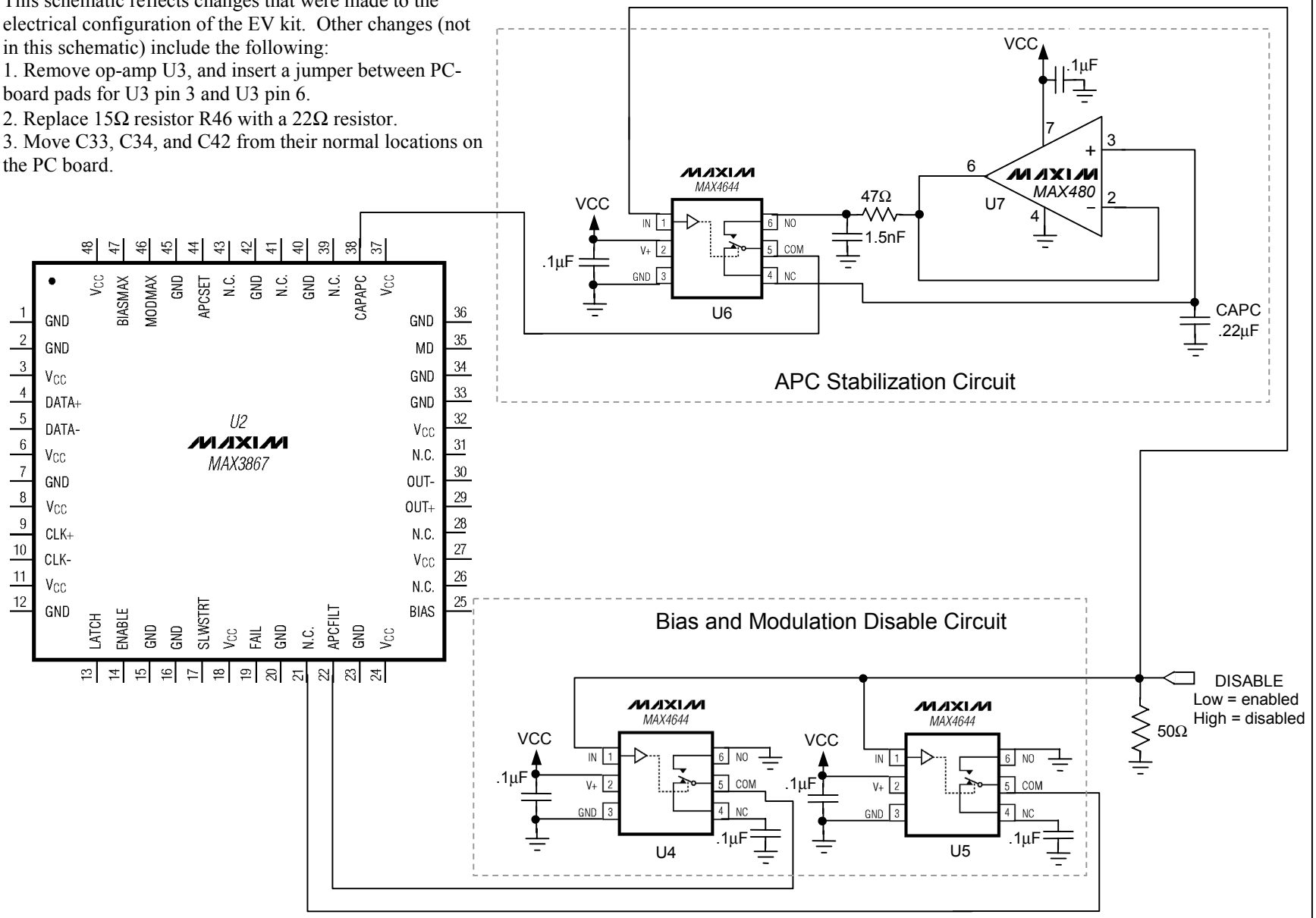

Figure 6. Schematic showing burst-mode modifications to the MAX3867 evaluation kit