REDUCING LASER DRIVER OUTPUT NOISE WHEN NO INPUT SIGNAL IS APPLIED

If the inputs to a laser driver such as the MAX3738 or the MAX3656 are AC-coupled and not driven by a modulated signal source, the laser driver will amplify noise present at the input pins and apply it to the laser diode at its output. The amount of output swing will vary among device types, and also depends heavily on the system noise and crosstalk. Due to the large gain in the driver signal path, a significant amount of noise and transitions can often be seen on the output when no input signal is applied.

In most applications this performance is acceptable and correct operation. But for some applications it is desirable to reduce the noise and transitions when no input signal is applied. For these situations some laser drivers, such as the MAX3795, implement an internal feature called "squelch." If the MAX3795 detects that the input signal has dropped below a defined level, the output will be turned off (squelched).

This application brief describes a method for reducing, and potentially eliminating random noise and transitions at the output of laser drivers that do not have an internal squelch feature. The output for these cases will not be turned off, as is typically done with the internal squelch feature. Rather, the noise and transitions will be reduced when no input data is present. The MAX3738, MAX3656, MAX3646, and MAX3643 laser drivers serve as examples here.

The data input structure for each of these laser drivers is similar to that shown in **Figure 1**. To limit the noise transitions on the output, an offset can be applied to the input pins of the laser driver. This is done by using two external resistors (R1 and R2) in combination with the differential termination resistor (R3), as shown in **Figure 2**. For the

methods to work properly, the input should be AC-coupled to the signal source. Care must also be taken to ensure that the common-mode voltage is not significantly shifted by the external network.

With no offset applied, the input signals are biased by a voltage-divider that is created by a 16kΩ and 24kΩ resistor. For a +3.3V supply voltage this equates to:

$$3.3 \times (24k/(16k+24k)) = 1.98V$$

The common-mode voltage should be approximately 1.98V after applying the offset network. This voltage can be attained through careful selection of R1 and R2 (Figure 2).

Figure 2 illustrates a negative offset of -8mV (forcing the output to an optical zero level*), and **Figure 3** illustrates how to apply a positive offset of +8mV (forcing the output to an optical one level*). **Table 1** lists various resistor values and the offset that will be achieved. All of these values maintain a common-mode voltage of approximately 1.98V.

The offset applied on the input will cause increased pulse-width distortion on the output of the laser driver. The offset should, therefore, be made as small as possible while still applying enough offset to limit noise and transitions on the output. For 2.5Gbps applications, the suggested offset should be 8mV or less; for 1.25Gbps applications, the offset should be approximately 16mV or less. In each of these cases, one should carefully evaluate and measure the response to determine the overall performance in their system.

See Additional Notes below.

Additional Notes

When applying an offset to the input of the laser driver, the following additional points should be considered.

1. If the APC loop is active in the MAX3738 or the MAX3646, or if the external APC loop is active when using the MAX3643 and the laser is DC-coupled to the laser driver, the output will not remain at a logic one or zero level indefinitely. The APC loop will compensate the laser bias current as much as possible to bring the output power back to the set average level.

2. The MAX3656 has an internal mark-density APC loop-compensation circuit. This circuitry will allow the user to force the output to an optical one or zero (by applying the appropriate offset) that will not be changed by the APC loop

(assuming that the laser is DC-coupled to the laser driver). Therefore, the APC loop will not compensate for power since there are no data transitions.

3. When the data input signal returns, the optical output may overshoot the nominal optical one power level for a brief time period.

4. In any case, the system should be carefully evaluated and measured for eye-safe conditions, as a static optical one level or a long period at an optical one level could be present at the output. Laser heating, safety/fault limits, data transition operation, and maximum continuous operating conditions should also be considered.
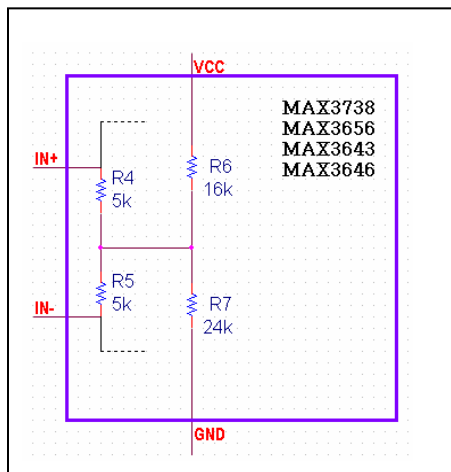

Figure 1: Input bias network.

Table 1. Offset values

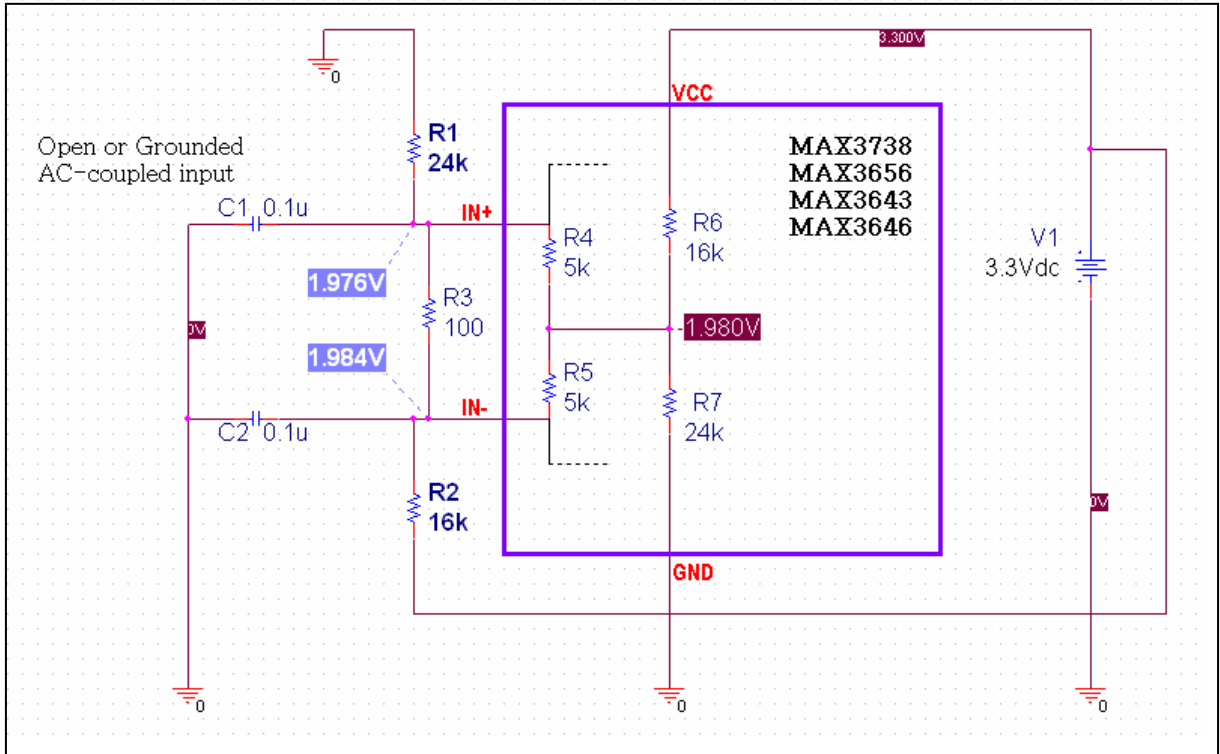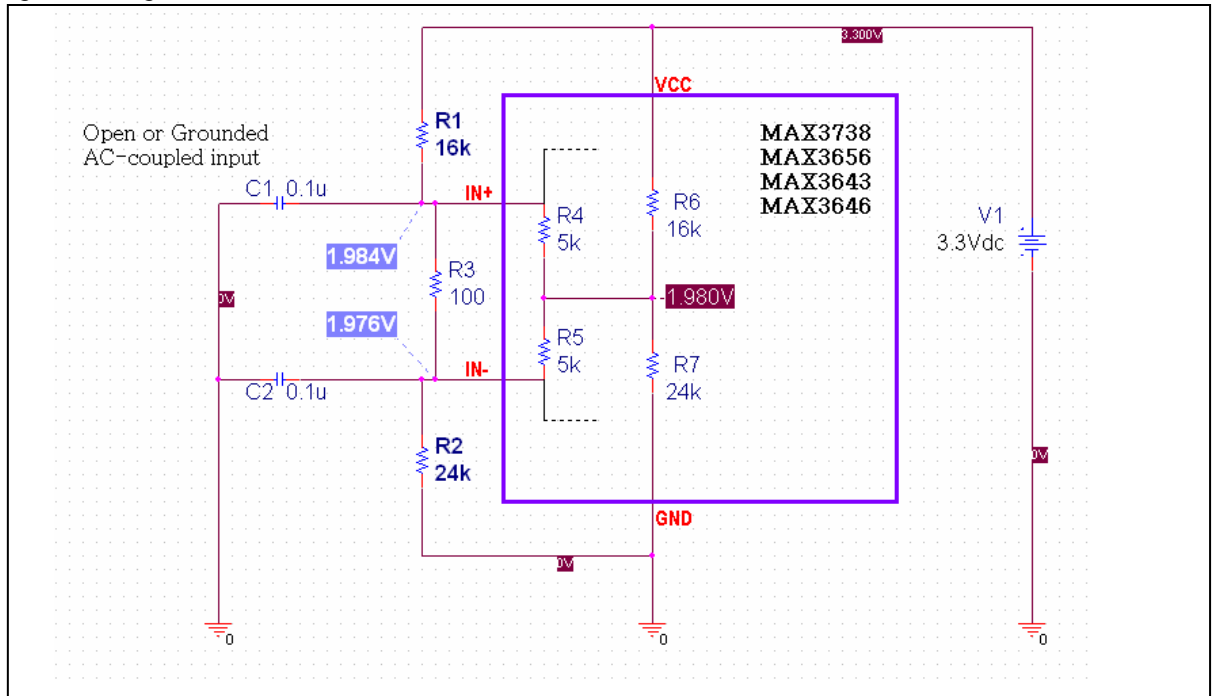| Negative Offset (Figure 2)		
R1 (kΩ)	R2 (kΩ)	Offset (mV)
48	32	-4
24	16	-8
12	8	-16
Positive Offset (Figure 3)		
R1 (kΩ)	R2 (kΩ)	Offset (mV)
32	48	4
16	24	8
8	12	16

Figure 2. Negative offset.

Figure 3. Positive offset.

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