Measuring Optocouplers

Using Bode 100 and Picotest J2130 DC Bias Injector

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Note: Basic procedures such as setting-up, adjusting and calibrating the Bode 100 are described in the Bode 100 user manual. You can download the Bode 100 user manual at www.omicron-lab.com/bode-100/downloads#3

Note: All measurements in this application note have been performed with the Bode Analyzer Suite V3.0. Use this version or a higher version to perform the measurements shown in this document. You can download the latest version at www.omicron-lab.com/bode-100/downloads

1 Introduction

Many power supplies use optocouplers in the feedback loop. The stability and overall performance of the power supply are often dependent on the CTR[1] and the location of the poles (and zeros) of the optocoupler. It is also common for optocouplers to have a minimum specified CTR, but not a maximum. CTR curves vs. LED current are also not always provided. Therefore, measurements are required to determine the expected performance range. These measurements also support the creation of a SPICE model. To address these tasks, the Bode 100 Vector Network Analyzer can be used in conjunction with the Picotest J2130A DC Bias Injector.
The DC Bias injector will work over a reasonable frequency range of 10 Hz – 40 MHz, and limits the IF[2] current up to approximately 4mA. The objective is to provide DC+AC bias to the optocoupler while the Bode 100 controls the AC bias and measures the CTR over frequency.

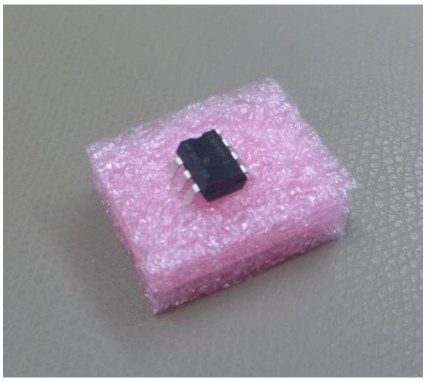

Figure 1: DUT - CNY17F-2

[1] Current Transfer Ratio
[2] forward current through diode

2 Measurement Setup & Result

2.1 Connection Setup

In this measurement the J2130A provides a DC bias to the Optocoupler LED, which returns to ground through a termination resistor. The optocoupler transistor collector is powered by a separate power supply and the emitter is terminated through a termination resistor to ground. We use equal valued termination resistors in order to normalize the CTR to 100%. The resistor value is not as critical as it is for the resistors to be the same value and type.
The CTR is measured according to the relation

$$CTR = \frac{i_2}{i_1} = \frac{v_{R_2}}{v_{R_1}} = \text{Gain} \qquad (1)$$

CTR...Current Transfer Ratio
i_1, i_2...AC ripple of the optocoupler input and output current
v_{R_1}, v_{R_2}...AC part of the voltage drop at resistor R_1 and R_2 respectively

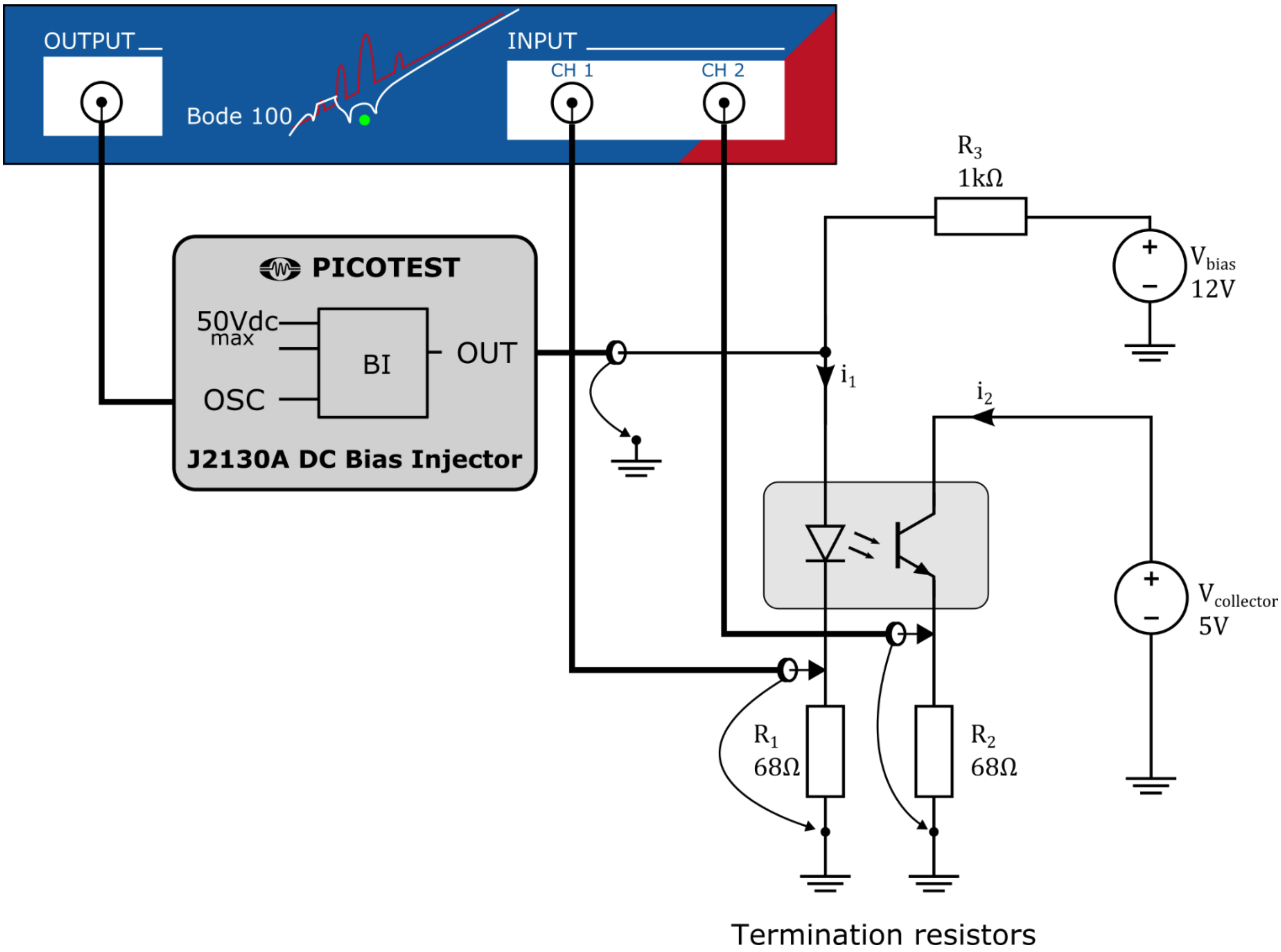

Figure 1: Schematic diagram for the DC Bias Injector the Bode 100 and the optocoupler.

2.2 Device Setup

To perform the measurement, the Bode 100 needs to be configured as shown in the following figures:

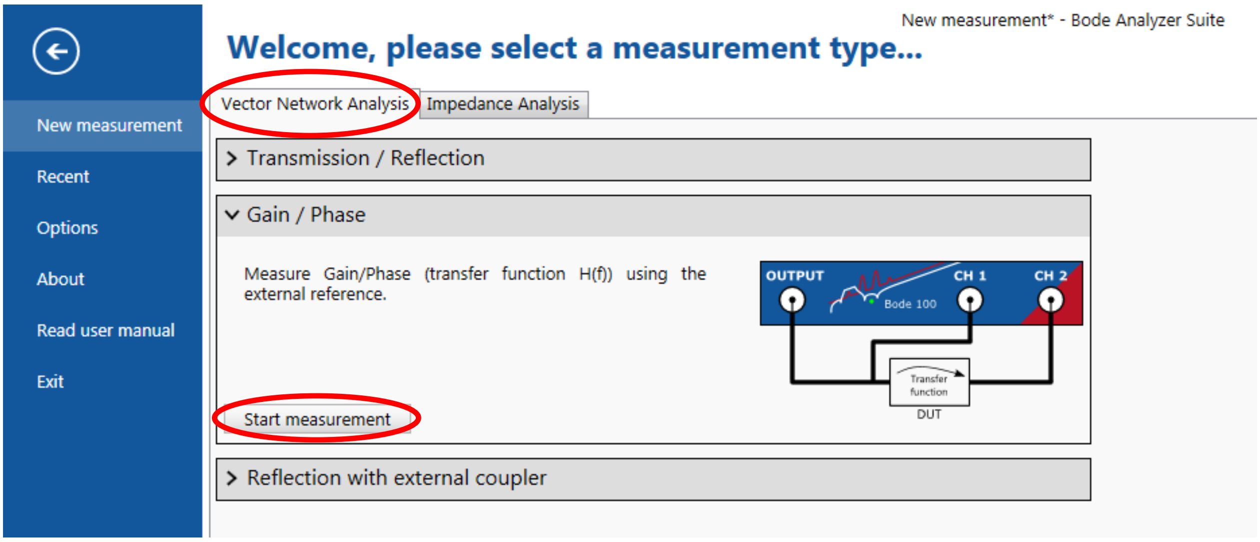

Figure 2: Start menu

- Start frequency: 100 Hz
- Stop frequency: 1 MHz
- Sweep mode: Logarithmic
- Source level: -20 dBm
- Attenuator CH1 & CH2: 0 dB
- Receiver bandwidth: 300 Hz

The following figure shows the setup used to measure the frequency response of the optocoupler. Please setup the Trace 1 and Trace 2 settings as shown in Figure 3 & Figure 34.

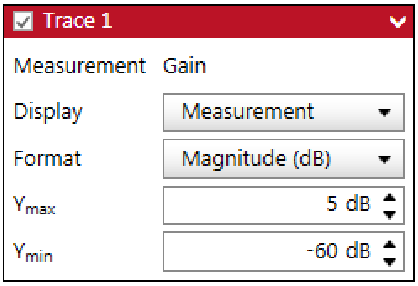

Figure 3: Settings Trace 1

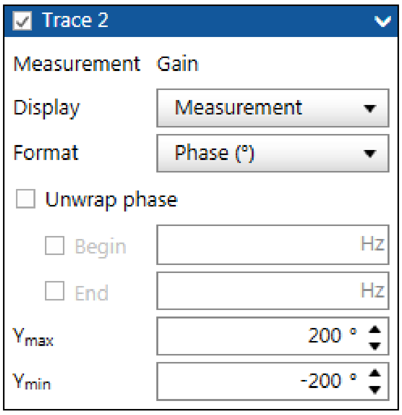

Figure 4: Settings Trace 2

To measure the optocoupler, we soldered it on a stripboard as shown in Figure 5.

Note: The stripes on the stripboard are running from the top left to the bottom right, just like the red line showing it. Because of this direction, we are able to connect the components on the board easier.

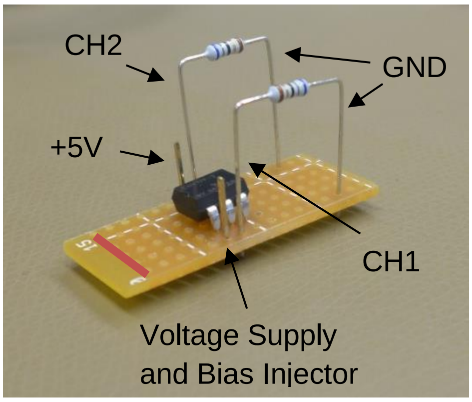

Figure 5: DUT on a stripboard

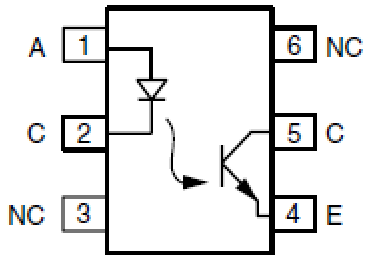

Figure 6: Optocoupler pins

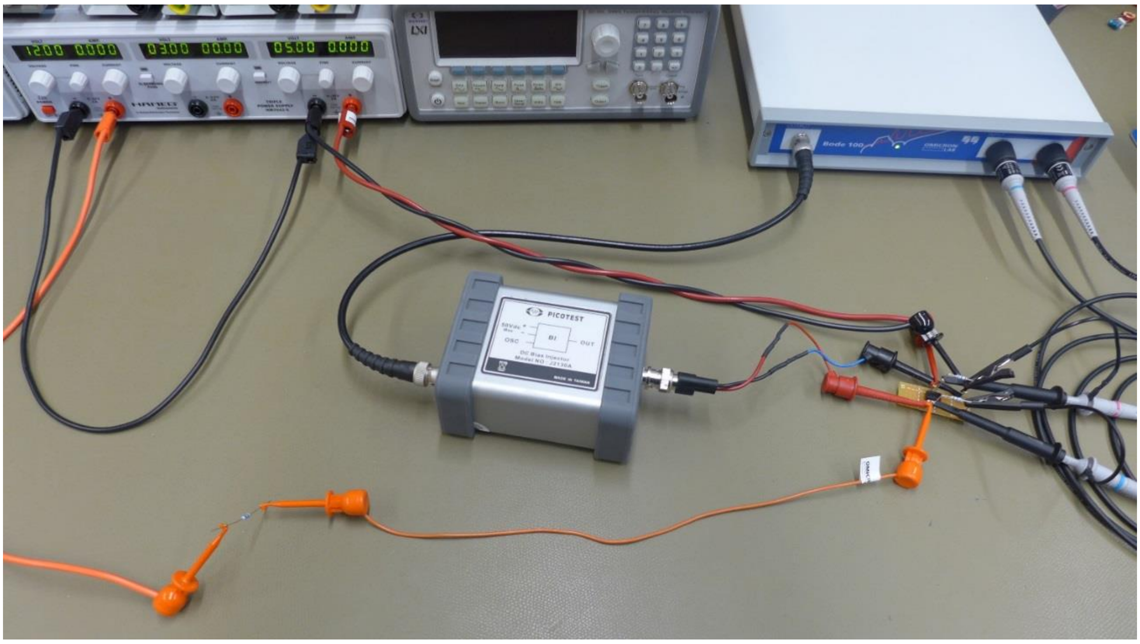

Figure 7: Measurement setup

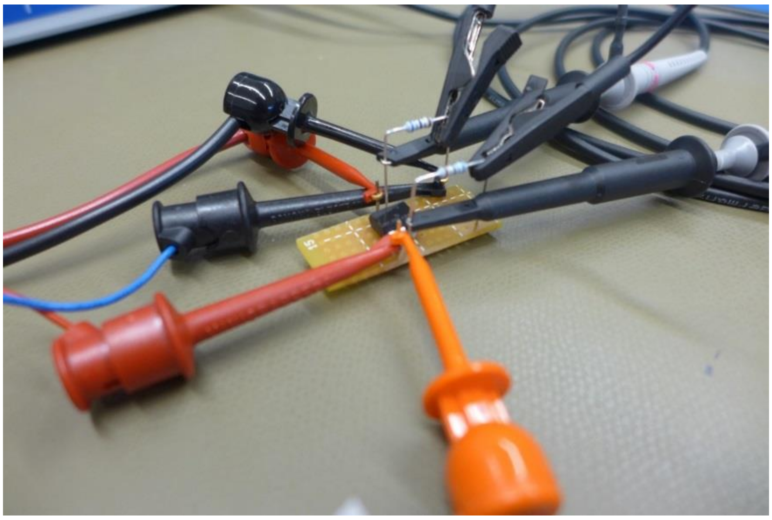

Figure 8: Measurement setup – board connection

Note: In Figure 8 all the cables are connected as shown in Figure 1 and Figure 5.

2.3 Calibration

This measurement uses two oscilloscope probes which, for optimum results require a Full-Range calibration in order to eliminate any differences between the two probes. To perform the Full-Range calibration, both probes are connected to the Bode 100 source signal and the calibration is started. The detailed instructions for the calibration are described in the Bode 100 user manual.

While you may use a digital multimeter to monitor the LED and collector currents of the optocoupler, you should NOT leave the meter connected during the CTR measurements or the calibration process. The meters can add capacitance that will distort the results.
The performance of the optocoupler can be dependent on the IF current and also the V_{CE} voltage, therefore you must make sure to measure the DUT over a variety of operating points the operating point close to the intended application.

2.4 Measurement results

Starting a single sweep leads to the following measurement result:

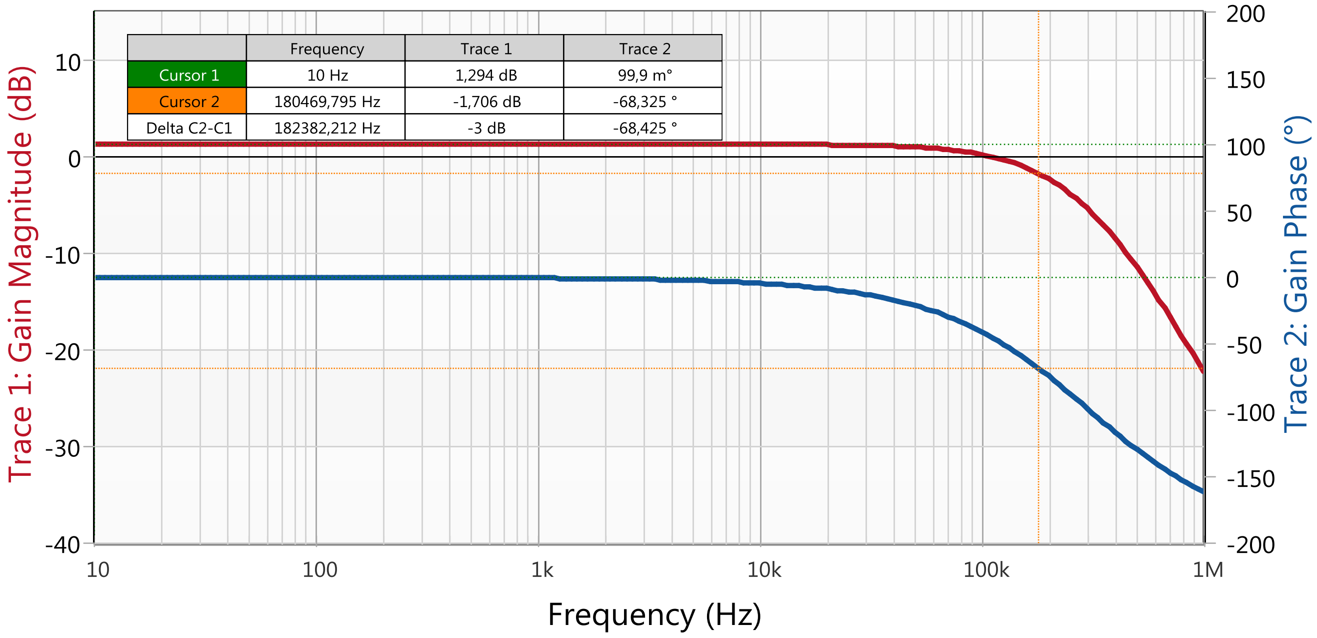

Figure 9: Measurement result - Magnitude (dB) and Phase (°)

The measurement result indicates a current transfer ratio of $CTR = 1.3\ \mathrm{dB} \approx 1.16$ or 116 % at a frequency of 10 Hz. The -3 dB cutoff frequency is approximately 180 kHz.

3 Conclusion

The OMICRON Lab Bode 100 Vector Network Analyzer, combined with the Picotest J2130A DC Bias Injector makes measuring optocoupler performance a quick and simple task. Since the tolerances of optocouplers tend to be quite large, it is generally best to measure a statistical sample of at least 5 or 6 devices.

In addition, the measurement results offer an easy way to create a Spice model which can be used to do simulations.

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