

J2200A Optocoupler CTR Module

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1.0 Introduction and Application

Optocouplers and optoisolators are very common semiconductor devices that allow an electrical signal to be transmitted between two isolated circuits. These devices are used to isolate signals for protection and safety between a safe and a potentially hazardous or electrically noisy environment [1]. Some typical applications for optocouplers include microprocessor input/output switching, DC and AC power control, PC communications, signal isolation, and power supply regulation [2].

The gain of the optocoupler is expressed as the Current Transfer Ratio (CTR). CTR is an important parameter used to measure the performance of these semiconductor devices. When an optocoupler is used as part of a control loop in a system, the CTR now impacts the power supply rejection ratio (PSRR), step load response, and output impedance of that system. CTR is defined as the ratio of output current (I_C) to input current (I_F). This is typically expressed as a percentage, as shown by EQ(1).

$$CTR = \frac{I_C}{I_F} \times 100\% \quad (1)$$

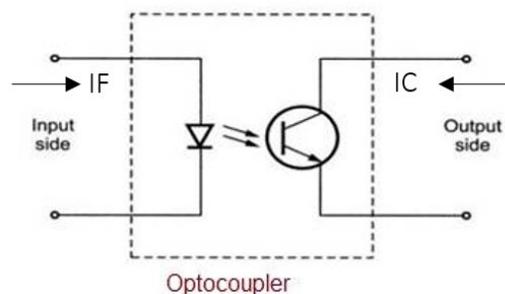


Fig. 1 - Typical Optocoupler Diagram.

Manufacturers of optocouplers characterize their devices for CTR, and an optocoupler's data sheet will list its CTR ranges, for example, 50% - 200%. Unfortunately, the general CTR range may be too wide for some applications, requiring a screen of incoming devices with a tighter tolerance, like a stable circuit system. Even worse is the fact that some optocoupler devices do not include their CTR parameters on their manufacturer's datasheet. However, determining an optocoupler's DC/ Δ CTR values can usually take time and/or require costly test equipment.

The plug-and-play J2200A facilitates the ability to acquire accurate parameters quickly and easily, primarily CTR, using the Picotest M3522A Digital Multimeter (DMM) or a Frequency Response Analyzer (FRA), such as the OMICRON Lab Bode 100 VNA.

1.1 J2200A Applications

The J2200A can be used as:

1. An internal quality control (IQC) tester for identifying real or fake optocoupler units
2. A classifier for factory workers to rank and mark the optocoupler's DC CTR values
3. A circuit-design tool for engineers and students to match one optocoupler's DC/ Δ CTR value with another

2.0 J2200A Optocoupler Socket

When inserting either a 4-pin or 6-pin optocoupler (DUT) into the J2200A socket, pin 1, indicated typically by a black point on the package and also indicated by the yellow arrow, as shown in Figure 2, needs to be plugged into the yellow point of the socket on the J2200A. In addition, as the DUT might require a 2-pin resistor under the 6-pin optocoupler's test, plug it into the white points shown in Figure 3 (the jacks for Pin 4 and Pin 8).



Fig. 2 - Depiction of 4-pin and 6-pin Optocoupler Packages.

When it's in place, push the bar down to fasten the DUT. The picture next to the socket is the allocation diagram of the socket.

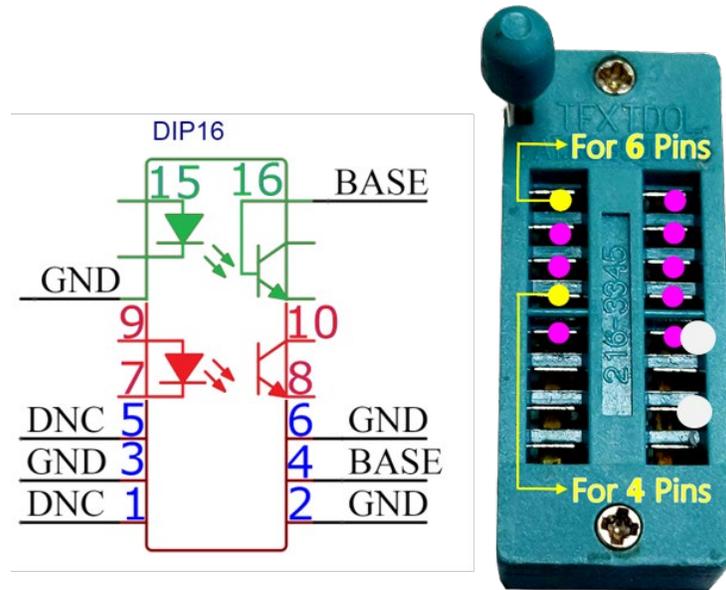


Fig. 3 - J2200A Socket Connection Diagram.

3.0 Measurement Setup J2200A with M3522A

3.1 Test Equipment List

Description	Model	QTY
Optocoupler CTR Module	Picotest J2200A [3]	1
6 ½ Digit Digital Multimeter (DMM)	Picotest M3522A [4]	1
USB Cable 3.0 Type-C Male to Type-A Male	Amazon Basics; See Link in references [6]	1



Fig. 4 - Measurement Setup with J2200A and M3522A.

The display of the M3522A switches to the CTR mode automatically when the CTR module is connected to it, as shown in Figures 4 and 5. The measurements are made by varying the forward current I_F and observing the CTR value.

As an example, we will be measuring the CTR for the LITEON CNY17F-1 optocoupler. From Figure 5, we see a CTR result of 69.1% when $V_{CE} = 5V$ and $I_F = 10mA$.

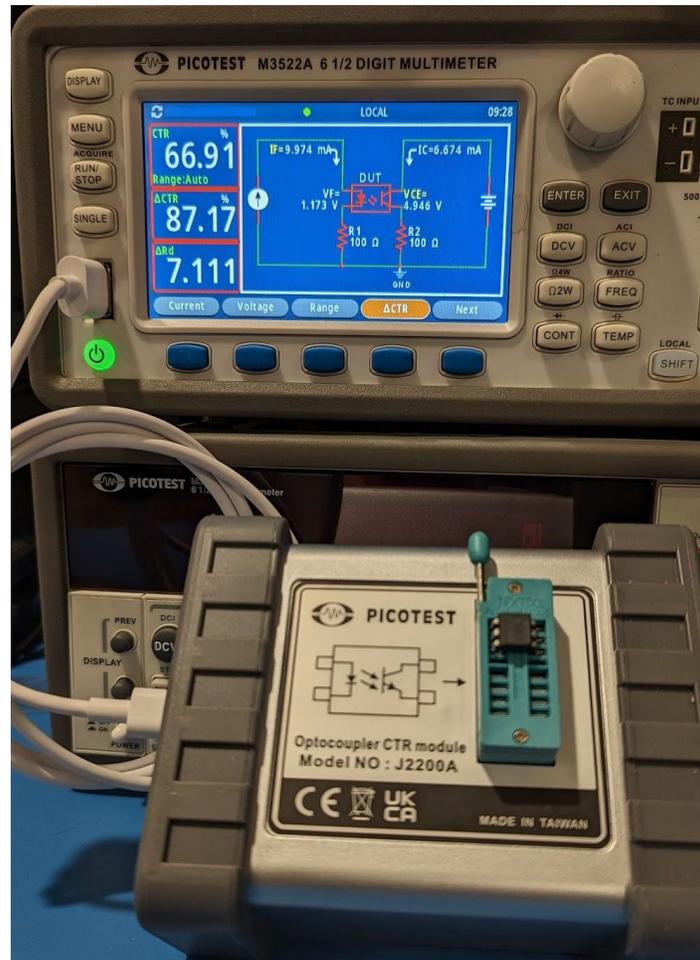


Fig. 5 - LITE-ON CNY17F-1 CTR Measurement Result on M3522A DMM.

When comparing the CTR result shown in Figure 5 to the datasheet CTR value shown in Figure 6, we can see that the CTR measured result (with $V_{CE} = 5V$ and $I_F = 10mA$) is within the datasheet range specified at 66.91%.

PARAMETER		SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
INPUT	Forward Voltage	VF	—	1.45	1.65	V	IF=60mA
	Reverse Current	IR	—	—	10	μA	VR=6V
	Terminal Capacitance	Ct	—	—	100	pF	V=0, f=1KHz
OUTPUT	Collector Dark Current	ICEO	—	—	50	nA	VCE=10V, IF=0
	Collector-Emitter Breakdown Voltage	BVCEO	70	—	—	V	IC=0.1mA IF=0
	Emitter-Collector Breakdown Voltage	BVECO	7	—	—	V	IE=10μA IF=0
Current *Transfer Ratio	CNY17F-1	CTR	40	—	80	%	IF=10mA VCE=5V
	CNY17F-2		63	—	125		
	CNY17F-3		100	—	200		
	CNY17F-4		160	—	320		

Fig. 6 - CNY17F Datasheet CTR [7].

Further analysis could also be performed to compare the datasheet's CTR vs. I_F response based on various V_{CE} values. This is easy to set up and execute on the M3522A. An example of this response is shown in Figure 7 below. Additional details on how to set up this configuration can be found in the J2200A Optocoupler CTR Module Quick Start Guide [8] and in the User's Guide for J2200A (20220412) - Optocoupler CTR Module [10].

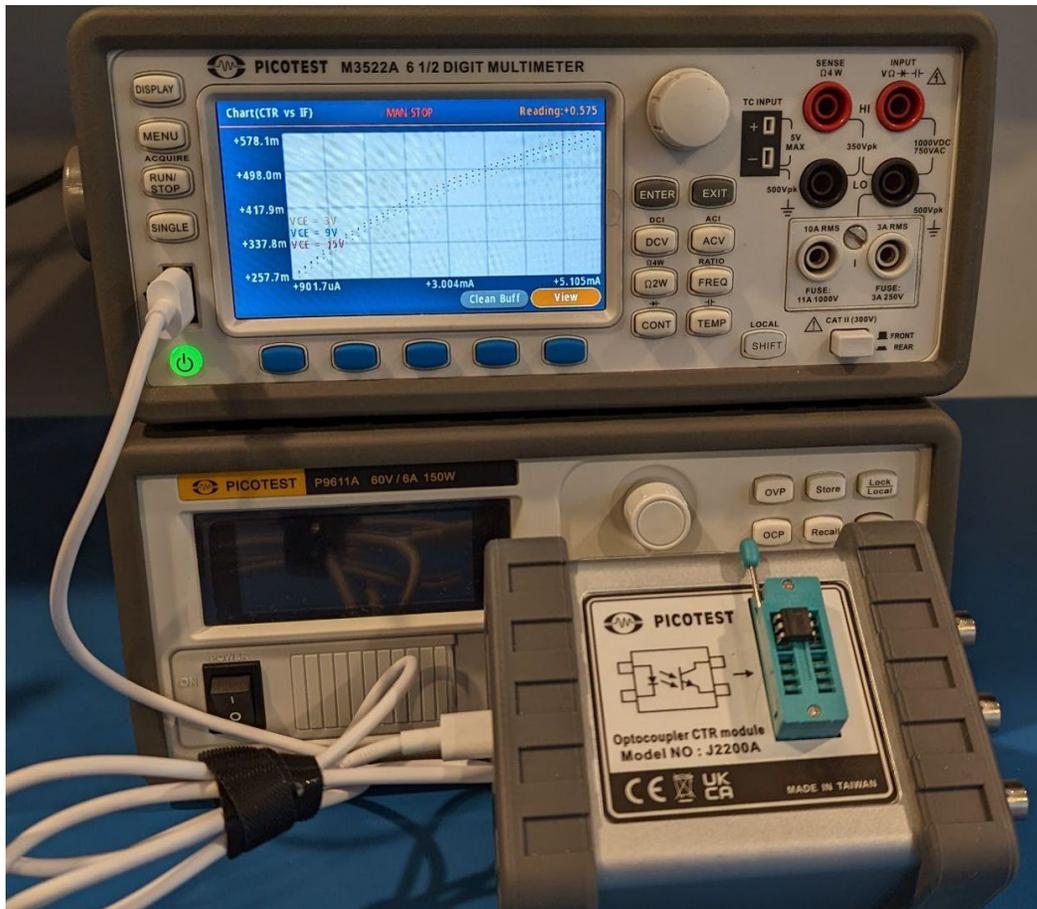


Figure 7 - CTR vs. I_F Result of CNY17F-1 Optocoupler.

If desired, this result could be compared to the datasheet CTR vs. I_F curve, where an example is shown for another optocoupler, the PC817X, in Figure 8. Here we see that the measurement and datasheet curve do not correlate exactly, but the measured result is well within the wide datasheet limits (50% to 600% at an input current of 5mA). This points out one of the main reasons to use the J2200A to test and verify your optocoupler's performance.

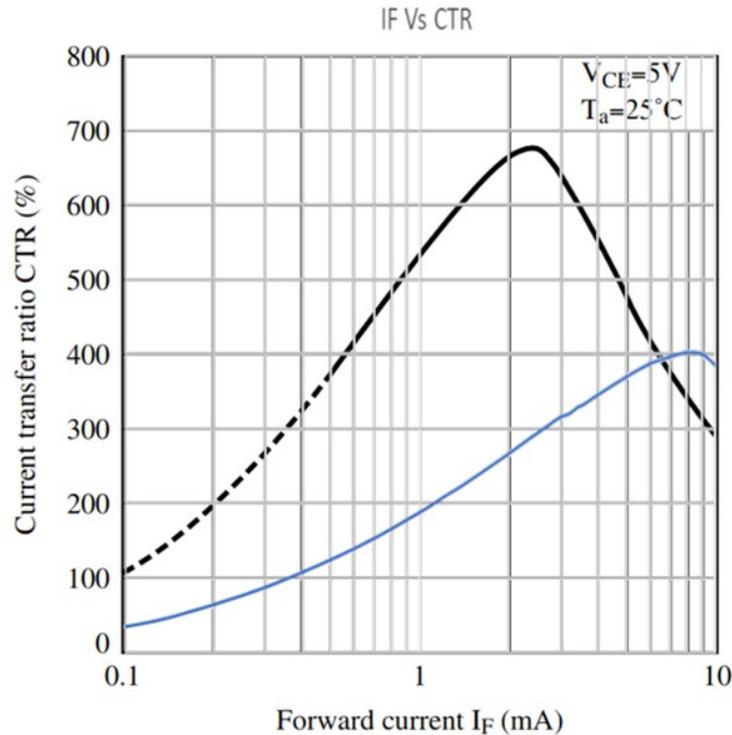


Figure 8 - PC817X Overlay of Measured CTR (blue) and Datasheet CTR (black).

Once measurements are finished, simply unplug the USB cable from the M3522A, and the DMM display will return to the DMM measurement state.

4.0 Measurement Setup J2200A with Bode 100 FRA

4.1 Test Equipment List

Description	Model	QTY
Optocoupler CTR Module	Picotest J2200A [3]	1
Frequency Response Analyzer (FRA)	OMICRON LAB Bode 100 FRA [9]	1
PDN Cable BNC-BNC	Picotest BNCJ/BNCJ-250 [5]	3

With the Bode 100, select the GAIN/PHASE measurement setup and perform a calibration of the PDN Cables® with the Bode 100, as shown by Figure 9.

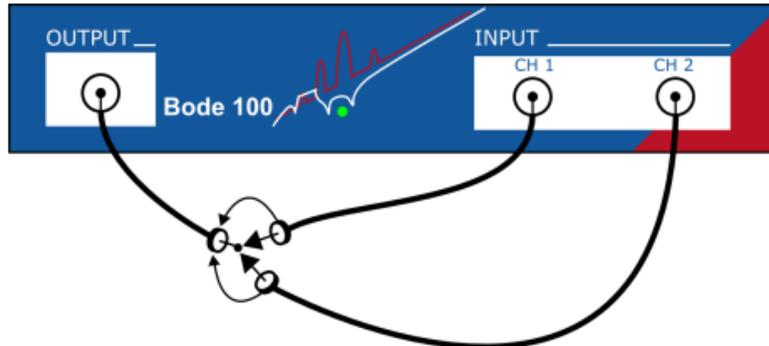


Fig. 9 - Bode 100 Calibration Setup.

The measurement setup with the J2200A and the Bode 100 is shown in Figure 10 below. Verify that the USB 5V power is applied to the J2200A, as shown in Figure 10.

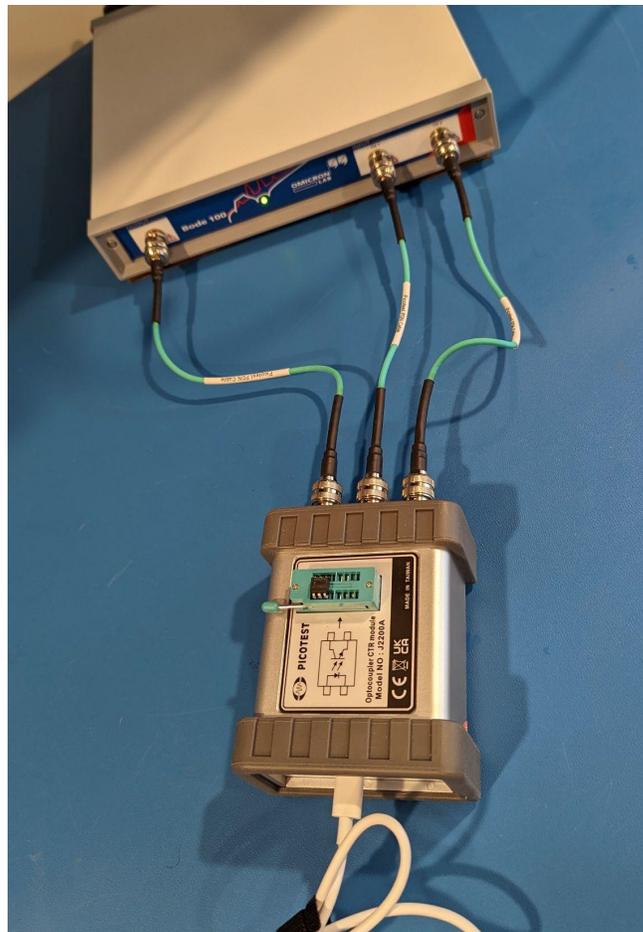


Fig. 10 - Measurement Setup with J2200A and Bode 100.

The gain and phase measurement result for the CNY17F-1 optocoupler is shown in Figure 11. Here we see a GAIN = 11.5dB with a 3dB bandwidth for this optocoupler at 21.385kHz. This low-frequency pole is a limit to the control loop bandwidth. With this data, the control loop can be optimized around the CTR of the optocoupler device, potentially resulting in significant improvement in the power supply or even system performance. Whereas without this accurate data, designers might end up with an unstable power supply.

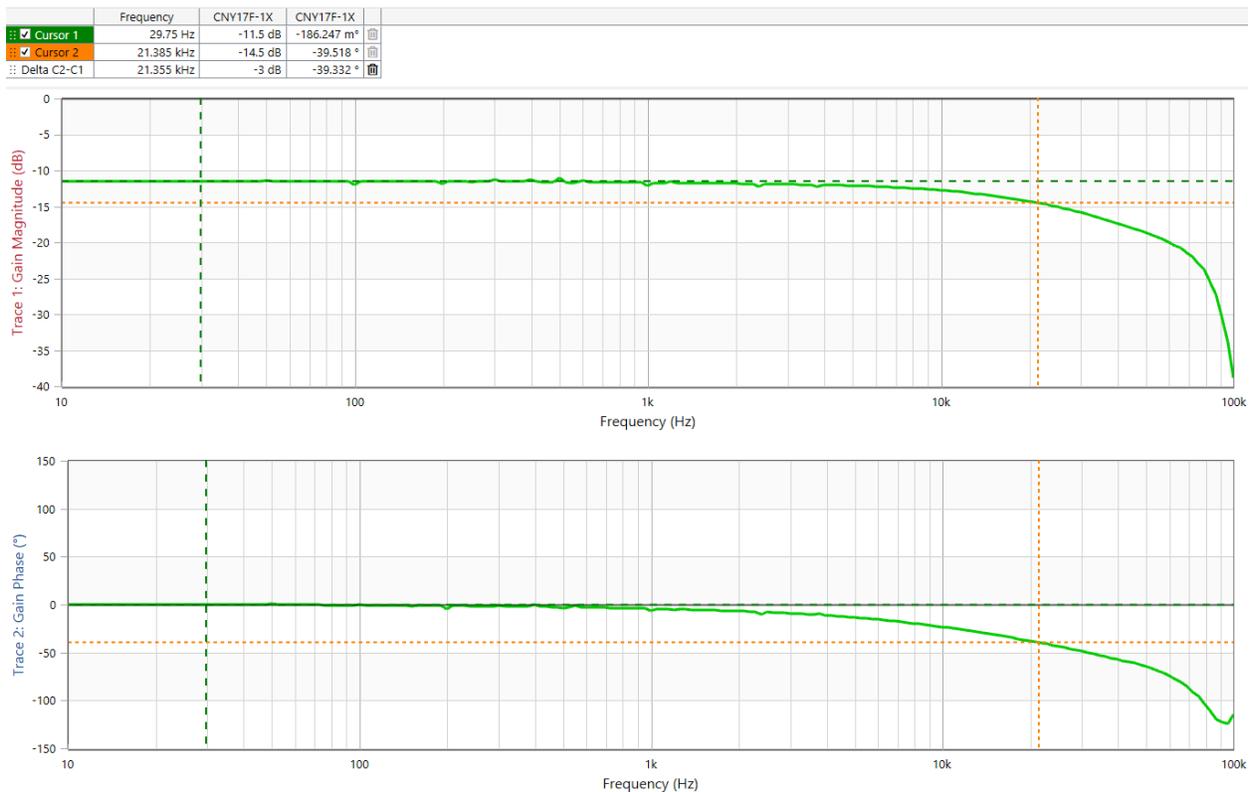


Fig. 11 - CNY17F-1 Gain and Phase Measurement Result with J2200A and Bode 100.

5.0 Conclusion

The Picotest M3522A 6 ½ Digit Multimeter combined with the J2200A offers a simple way of accurately determining the CTR values of the optocouplers.

In addition, an FRA, such as the Bode 100, combined with the J2200A, also offers a simple way to measure the AC CTR vs. frequency of the optocoupler. These measurement results can also be used to create a SPICE/ADS model, which can be used to perform simulations.

In summary, the J2200A accurately measures the CTR, Δ CTR, VF, and Δ Rd measurements for an optocoupler or optoisolator device.

6.0 References

1. [Vishay Application Note 02 - Optocouplers and Solid-State Relays](#)
2. [Electronics-tutorials - Optocoupler Tutorial](#)
3. Picotest J2200A Optocoupler CTR Modules - https://www.picotest.com/products_J2200A.html
4. Picotest M3522A DMM - <https://www.picotest.com.tw/h/ServiceDetail?key=770151152829&cont=294367>
5. Picotest PDN Cable® - <https://www.picotest.com/pdn-cable.html>
6. USB Cable 3.0 Type-C Male to Type-A Male - [Amazon Link](#)
7. [LITEON CNY17F Opto-Coupler Datasheet](#)
8. Picotest J2200A Optocoupler CTR Module Quick Start Guide
9. OMICRON LAB Bode 100 - https://www.picotest.com/products_BODE100.html
10. [Picotest J2200A Optocoupler CTR Module User's Guide](#)
11. [Measuring Optocouplers - Using Bode 100 and Picotest J2130 DC Bias Injector](#)
12. [Picotest M352XA User Manual](#)
13. [Jameco - What is an Optocoupler and How it Works](#)
14. [Toshiba - What is the current transfer ratio?](#)
15. [Vishay Application Note 45 - How to Use Optocoupler Normalized Curves](#)
16. [Electronics Believer - Opto Coupler CTR Explanation](#)
17. [Electronics Believer - Factors Affecting Current Transfer Ratio of Optocoupler](#)