Evaluation of Infrared Transceivers for IrDA Compliance

Application Note 1110

Measurement of Transmitter Intensity and Receiver Sensitivity

Introduction

The IrDA Physical Layer Specification spells out strict requirements for transmitter intensity and receiver sensitivity based upon a power budget. This document covers measurement equipment and techniques for determining transmitter intensity and receiver sensitivity. Although other parameters are specified by IrDA for complete compliance, transmitter intensity and receiver sensitivity are the key parameters that should be checked first.

Required Equipment
• Calibrated Photodiode Detector Can be UDT model #10D, 1 cm^2 in area, with calibration data in Amps/Watt

    UDT Sensors Inc.
    12525 Chadron Ave.
    Hawthorn, California 90250
    310-978-0516
• 3 - 4 channel oscilloscope ≥250 MHz (HP 54542A)
• 2 channel pulse generator with data pattern programming capability (HP8110A)
• Optical bench test fixtures (Newport)
• DC power supplies

Summary of Measurements

1. Use the calibrated detector to calibrate the transmitter of an infrared transceiver module.
2. Use the calibrated detector to measure transmitted intensity IE vs. emitter current, from the transceiver under test.
3. Use the calibrated transmitter to measure receiver sensitivity of a transceiver under test for each desired data rate.

Measurement Details

Setting Up the Optical Bench
The measurements should be made on an optical bench that is stable and constructed for easy adjustments to link distance and half-angle. Link distance is the distance between the transmitter optical surface and the calibrated detector surface in centimeters. Half-angle is the angle formed by the optical center axis of the detector or transmitter and the angle at which the measurement is made. IrDA requires transmitter intensity to be maintained above a specific IE for half-angles of ±15 degrees. IrDA also requires receiver sensitivity to be maintained below a specific EI for half-angles of ±15 degrees. See Figure 1.
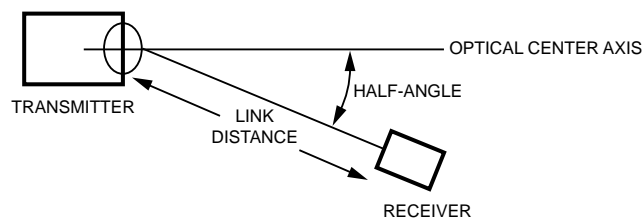

OPTICAL CENTER AXIS

HALF-ANGLE

TRANSMITTER

LINK DISTANCE

RECEIVER

Figure 1.

The optical bench could include a rail upon which receiving and transmitting fixtures are placed. The rail would allow easy adjustments of link distance. Rotation of the receiving or transmitting fixture would allow for adjustment of half-angle. See Figure 2.
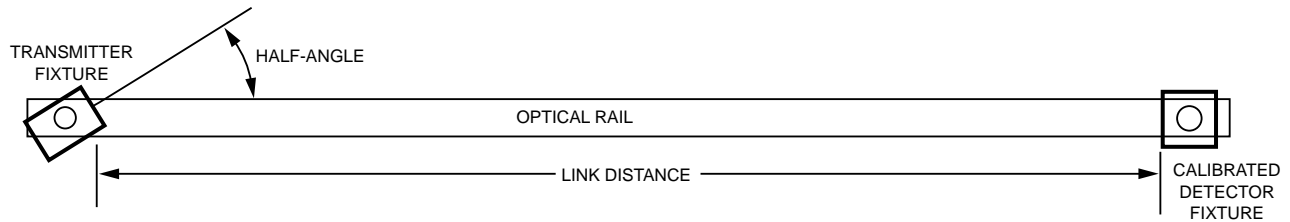

Figure 2.

Calibration of an Infrared Transmitter

The photodiode detector's calibration data should be in Amps/Watt. The detector's size of 1 cm^2 makes it easy to calculate detector input irradiance EI in μW/cm^2. Using the circuit shown in Figure 3 to detect the transmitter's signal, the detected signal EI = [(signal in mV)/500 ohms]/ [Cal factor in Amps/Watt] (μW/cm^2). Once EI is calculated, the transmitter intensity can be derived based on the measurement distance from the detector to the transmitter.

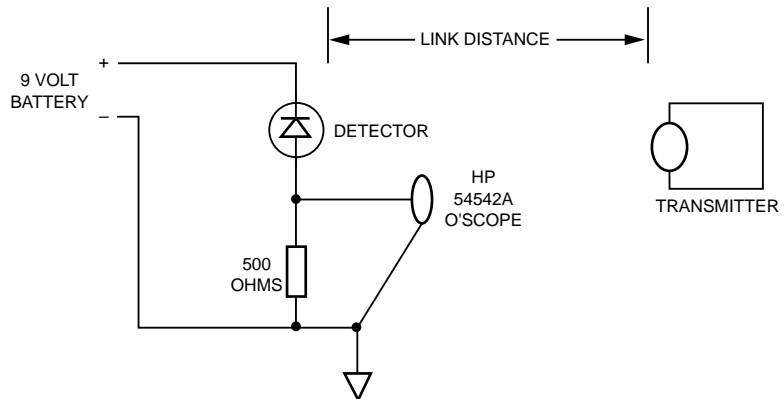Transmitter Intensity IE = EI • (Link Distance)^2 .

Figure 3.

See Table 1 and Figure 3 for an example.

Table 1. (calculations for 20 cm and 30 cm from detector to transmitter)

Cal Factor (Amps/Watt)	Link Distance (cm)	O'scope Signal (mV)	Photocurrent (μA)	Detected Signal (μW)	Transmitter Intensity @20 cm
0.5	20	50	100	200	80 mW/sr
0.5	30	50	100	200	180 mW/sr

Measurement of Transmitted Intensity

An infrared transmitter's intensity IE can be measured with the calibrated detector at various half-angles. The optical bench should be used to adjust for link distance and half-angle. The calibrated detector should be aligned facing the transmitter. The transmitter DUT (device under test) should be placed a link distance of 20 – 30 cm from the detector. The half-angle can be adjusted by rotating the transmitter DUT.

The measurement procedure is similar to that of calibrating a transmitter. The oscilloscope is used to measure detector photocurrent. The photocurrent is translated into detector irradiance EI (signal strength at the detector) using the calibration factor.

EI = [(signal in mV)/500 ohms]/[Cal factor in Amps/Watt] (μW/cm^2).

For a given link distance, transmitter intensity Intensity IE can be derived from irradiance EI.

Transmitter Intensity IE = EI • (Link Distance)^2 .

Table 2 shows examples of transmitter intensity IE derivations from photocurrent.

Table 2.

Link Distance (cm)	Photocurrent (μA)	Detector Irradiance EI (μW/cm^2)	Transmitter Intensity IE (mW/sr)
20	50	100	40
20	100	200	80
20	150	300	120
30	50	100	90
30	100	200	180

Calibrated Detector factor = 0.5 Amps/Watt

Measurement of Receiver Sensitivity

A transmitter calibrated with the calibrated detector can be used to accurately measure receiver sensitivity. The calibrated transmitter should be placed on the optical rail with its optical axis parallel to the rail. The receiver DUT should be placed a chosen link distance from the calibrated transmitter on the optical rail. The receiver DUT half-angle can be adjusted by rotating the receiver to a chosen angle.

Receiver sensitivity should be measured by checking received data for BER (Bit Error Rate), for pulse width errors, or for missing pulses. The calibrated transmitter should be driven with a worst case data pattern. Data on the Rxd pin of the receiver DUT should be observed for errors (as defined by the test). An error limit should be chosen to define the sensitivity limit.

The link distance can be set at 50 - 100 cm. The transmitter intensity IE should be decreased until the error limit is reached. Transmitter Intensity can be found by measuring the LED current at that point. Receiver sensitivity is then derived =

IE / (link distance in cm)^2 .

Table 3 shows examples of receiver sensitivities derived from LED current and link distance.

Table 3. Receiver Sensitivities derived from LED Current and Link Distance.
(For an example transmitter whose calibration factor = 0.5 mW/sr per mA.)

Minimum LED Current to Pass Error Limit (mA)	Transmitter Intensity IE (mW/sr)	Link Distance (cm)	Receiver Sensitivity (μW/cm^2)
5	2.5	50	1.0
10	5.0	50	2.0
20	10.0	50	4.0
50	25.0	50	10.0
20	10.0	100	4.0
200	100.0	100	10.0

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