# Resolving IrDA Physical Layer Implementation Problems

## Application Note 1120

### Introduction

System hardware design engineers need to be aware of several common issues that can cause malfunction or degraded performance in an IrDA physical layer implementation. These issues concern the implementation of Hewlett-Packard's component products in the IrDA physical layer, but do not cover issues specific to non-HP I/O chips or controllers. The system designer should be aware of the issues presented in the Design Requirements section. Once evaluation of the initial design has begun, the Problem Resolution section is useful for diagnosing specific problems.

Figure 1 shows two general implementations of IrDA using Hewlett-Packard components.

### Design Requirements

*Half Duplex*

IrDA transceivers, including Hewlett-Packard transceivers, are inherently half-duplex due to their construction. The transmitter's electrical and optical signal is always detected by the receiver due to the construction of the part. Attempting to use the IR transceivers in full duplex mode will greatly reduce receiver sensitivity, and therefore link distance. Use of the system hardware in full duplex mode will fill the receive buffer with unwanted data, and may generate unwanted interrupts to the microprocessor. The system design must allow for this half-duplex characteristic as follows:

- The I/O chip or IR Controller should disable the receive data line while transmitting frames to the IR transceiver. I/O chips and IR Controller chips will be treated the same for this issue. During the transmission of a frame, the IR receiver will detect the IR transmitter's frame and send it back to the I/O chip (or IR Controller) receive buffer. If the I/O chip's receiver is enabled, the data in the receive buffer will trigger unwanted interrupts to the microprocessor. Also, if the I/O chip's receiver is enabled, unnecessary data will fill up the receive buffer.
- In the other implementation using an Encode-Decode (EnDec) chip, the UART, microprocessor, or microcontroller should disable its serial input during transmission of a frame. If the serial input is enabled during transmission of a frame, unwanted interrupts to the microprocessor or microcontroller will be generated.
- A latency period must be allowed for between the reception of a data frame and

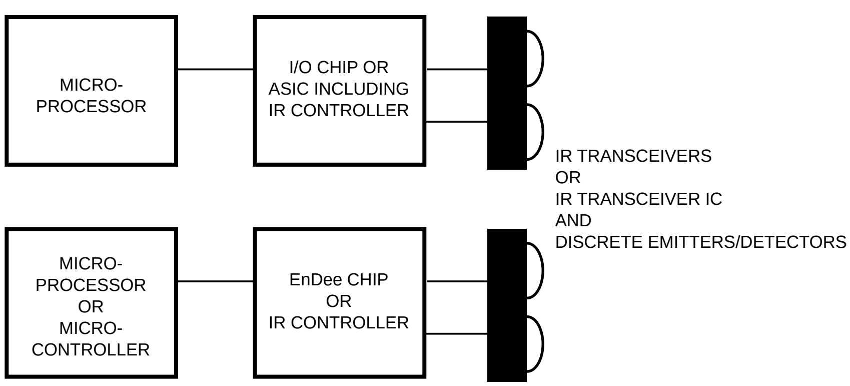


**Figure 1.**

the transmission of a data frame. Your IR system must include the latency time period between reception of data and transmission of data, so that the other IR system in the communication link can regain full sensitivity. An IR receiver is blinded by the IR transmitter during transmission of a data frame. The latency time period is necessary for the IR receiver to regain full sensitivity. The IrDA Physical Layer Specification calls for an initial latency period of 10 ms. The latency period can be reduced below 10 ms if so negotiated in the IrDA frames.

- Application software or evaluation software must drive the hardware in half-duplex fashion, and provide the 10 ms latency period between reception and transmission of data.

*Data Modulation*
Microprocessor or microcontroller data needs to be modulated for infrared data communication. Whether or not IrDA modulation is used, the IR transceiver requires discrete pulses to represent data bits. Microprocessor and microcontroller data bits are expressed in NRZ data format. Not-Return to Zero (NRZ) data is 100% duty cycle, and so does not contain discrete pulses representing data bits. See Figure 2.

If NRZ data were sent directly to the IR transmitter, the IR emitter would dissipate power for several bit periods in the case of a long sequence of 1 bits. The lengthy power dissipation could overstress the IR emitter if longer than the datasheet's absolute maximum ratings. Emitter current for infrared transmission is typically in the 100's of milliamps, and bulk resistance of typical IR emitters is 1-3 ohms. Power dissipation as heat in the IR emitter can be as high as 0.7-1.5 watts for continuous bias. Return to Zero (RZ) data made up ≤ 50% duty cycle pulses would limit the heating time period, and allow for IR emitter cooling after each pulse. IrDA data modulations use ≤ 25% duty cycle RZ pulses for all data rates.

Infrared RZ pulses representing data bits would consume a fraction of the power that infrared NRZ bits would consume, while sending out a data frame at a given infrared signal intensity. A short duty cycle RZ pulse can represent a bit with the same infrared signal intensity as a 100% duty cycle NRZ data bit. The infrared intensities would be the same, and only the duration of the signal would be longer for the NRZ data. The power consumed to send RZ pulses would be equal to 0.xx * $Power_{NRZ}$, where the duty cycle of the RZ pulses is xx%, and $Power_{NRZ}$ is the power consumed to send infrared NRZ data. See Table 1.

NRZ data inherently consumes more power to transmit data than Return to Zero (RZ) data. Note: For NRZ data, AC coupling of the microprocessor or microcontroller directly to the IR transmitter would resolve the IR emitter power dissipation issues, but would distort the data irrecoverably. If AC coupling is used for NRZ data, an IR pulse would be transmitted only at the beginning of a sequence of 1 bits, and no information would be conveyed as to how many 1 bits are in that sequence.

*Non-IrDA Data Modulation*
Modulation formats other than those specified by IrDA can be used with Hewlett-Packard's infrared transceivers. Some properties of the transceivers will allow certain modulation formats while excluding other formats. Below is a list of transceiver properties which will effect feasibility of a modulation format:

The 9.6-115.2 kbits/s receive channel has a bandwidth of approximately 300 kHz. Receiver sensitivity decreases as the infrared pulse rate increases above 200 kHz. Data modulation such as 500 kHz carrier ASK can be received, but sensitivity is reduced

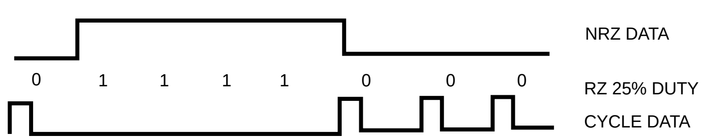


**Figure 2.**

**Table 1.**

| Data Size | Data Rate | Modulation Method | Duty Cycle | Power Consumption for $V_{CC}$ = 5V, ILED = 250 mA |
|---|---|---|---|---|
| 115 kbits | 115 kb/s | UART/NRZ | 100% | 625 mW |
| 115 kbits | 115 kb/s | IrDA 3/16 | 19% | 117 mW |
| 4 Mbits | 4 Mb/s | UART/NRZ | 100% | 625 mW |
| 4 Mbits | 4 Mb/s | IrDA 4PPM | 25% | 313 mW |

below the sensitivity at 9.6-115.2 kbits/s.

The 4 Mbits/s receive channel has a bandwidth of approximately 6 MHz, and is capable of receiving IrDA modulated data from 9.6 kb/s up to 4 Mbits/s. The receiver sensitivity of the 4 Mbits/s channel at the 9.6-115.2 kbits/s data rates is less than that of the 9.6-115.2 kbits/s receive channel.

Both receive channels are AC coupled with digital outputs (non-linear). The outputs are not linear representations of detected signal strength.

The 4 Mbits/s channel detection scheme causes the receive output to begin responding to 2-4 Mbits/s infrared signal approximately 4-10 µs into the pulse stream. The IrDA 4 Mb/s 4 PPM modulation format allows for the loss of the first 10 µs of pulses. At 1 Mbits/s all pulses in the pulse stream should appear on the receive output, at the specified minimum sensitivity.

*PC Board Layout*
Optimum transceiver performance can only be achieved with correct PC board layout as described in the Hewlett-Packard IrDA Design Guide, and in the application note Infrared Transceiver PC Board Layout for Noise Immunity. General PC board guidelines are as follows:

- $V_{CC}$ bypass capacitors and filtering should be placed as close as possible to the $V_{CC}$ and Gnd pins of the transceiver.
- A ground plane should be provided underneath the transceiver and at least 1 cm outward from the transceiver.
- The transceiver ground should be connected separately to the board ground from other noisy grounds.
- The transceiver should be located as far from DC-DC converters or switching power supplies as possible.

## Problem Resolution

Below are possible symptoms that can occur with incorrect implementation of Hewlett-Packard's infrared transceivers.

*Symptom: No infrared transmitted signal*
Use an oscilloscope to observe the Txd and LEDA pins of the infrared transceiver. A positive going pulse should appear on Txd for every transmitted pulse. If no pulse appears on Txd, then either check the connection from the modulator circuit (HSDL-7xxx) to Txd, and check whether Txd is shorted to ground.

If the proper pulse appears on Txd, a negative going pulse should be observed on LEDA. If no pulse appears on LEDA, then check the connection of LEDA to RLED and to $V_{CC}$. If LEDA remains constant at $V_{CC}$ when pulses appear on Txd, then the transceiver's LED is most likely failed open, and should be replaced.

*Symptom: Transceiver's LED is constantly turned on (emitting light).*
Remove the connection from the IrDA modulator output to Txd (leaving Txd open circuit). If the LED is now off (not emitting light), then the problem is most likely the logic driving Txd. Txd should not be driven high for periods of time > 200 µs. If the software or firmware cannot be changed to avoid driving Txd high for periods of time > 200 µs, then Txd should be AC coupled to the IrDA modulator. If the LED remains turned on with Txd open circuit, then most likely the transmitter portion of the transceiver has failed, and should be replaced.

*Symptom: Achievable link distance is much less than 1 meter.*
Make sure that the software is running in half-duplex mode and that 10 ms of latency is allowed for between transmitting and receiving.

Check the LED current ILED. Measure the pulse amplitude at LEDA with an oscilloscope during transmission of data. Divide the pulse amplitude by RLED to get ILED. Compare measured ILED to that recommended in the datasheet.

Check the transmitter signal power in mW/sr using a calibrated detector, as described in the application note Evaluation of Infrared Transceivers for IrDA Compliance.

Stop all infrared transmission and use an oscilloscope to look for noise pulses on the receiver output Rxd. Refer to the application note Infrared Transceiver PC Board Layout for Noise Immunity. Pulses on Rxd with no infrared signal are most likely due to noise (EM noise, power supply noise, or ground noise). Noise issues can be resolved by proper PC board layout.

*Symptom: Pulses appear on the receiver output Rxd when no infrared signal is transmitted.*
Pulses on Rxd with no infrared signal are most likely due to noise (EM noise, power supply noise, or ground noise). Noise issues can be resolved by proper PC board layout. Refer to the application note Infrared Transceiver PC Board Layout for Noise Immunity.

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Data Subject to Change



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