DESIGN NOTES

IR LocalTalk Link Has Superior Range and Ambient Rejection

Design Note 118

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Infrared links are becoming increasingly popular for wireless point-to-point communication between portable computers, PDAs (Personal Digital Assistants), desktop computers and peripherals. A key element in processing these signals for minimum error rate and maximum range is the photodiode receiver. The function of the receiver is to transform modulated photodiode current to a voltage and to process this voltage before converting it back to a digital signal. Processing includes amplification, filtering, clamping and thresholding. The LT®1319 is a flexible, general purpose building block that contains all the active circuitry necessary to build the receiver except the photodiode itself[1].

LocalTalk® is a 230kBd, biphased encoded, serial communications standard developed by Apple Computer, Inc. for hardwired peripheral connection. Infrared LocalTalk uses modified pulse position modulation (PPM) to encode two bits of information in a time frame 8.7μs long. PPM is a method of modulating data by encoding its value as the position of a pulse within a time interval. Extending the maximum range of a data link and at the same time minimizing errors, IR LocalTalk improves on simple PPM. The improvement is made by sending a burst of narrow pulses instead of a single pulse. Each burst consists of a group of four 125ns pulses spaced 125ns apart. Sending a burst instead of a single pulse also reduces the LED duty cycle allowing higher peak current and consequently more range. Because the burst has a more complicated structure than a simple pulse, digital pattern recognition (done in the digital decoder) can be used to improve the minimum discernible signal level and reject false signals, thereby increasing the maximum error-free range of the link.

Compared to industry standard IrDA-SIR (Infrared Data Association Serial Infrared), IR LocalTalk serial links provide superior range, data rate and rejection of ambient light interference. The spectrum used by IR serial links is full of interference from sunlight, TV remotes and fluorescent lights. The new high efficiency fluorescent lights are a significant source of light interference at frequencies from 40kHz to 80kHz because of their switched mode active ballast circuits. Results of tests comparing IrDA-SIR and IR LocalTalk are summarized in Table 1.

Table 1

MODULATION	RANGE	DATA RATE	AMBIENT REJECTION
IR LocalTalk	2m	230kbps	Reject a 15W 80kHz Fluorescent at 25cm
IrDA-SIR	1m	115kbps	Reject a 15W 80kHz Fluorescent at 1.1m

As shown in Figure 1, the time frame is divided into four 2.18μs sections. As the baud rate for IR LocalTalk is fixed at 230kBd, one bit of information is transmitted every 4.35μs and two bits are transmitted in the complete 8.7μs frame. Each frame begins with a burst that is used for synchronizing. The position (or absence) of the subsequent burst within the frame encodes the two bits to be transmitted. One important thing to note about this waveform is that the duty cycle is relatively constant. This is important because the receiver is AC coupled. A very wide range of duty cycles will make it difficult to choose a good compromise for the highpass break frequency. A mismatch between the AC-coupling time constants and the

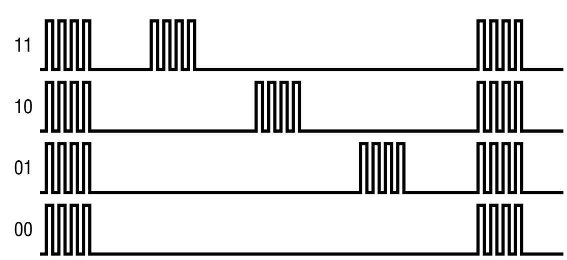

Figure 1. Pulse Position Coding for IR LocalTalk

[1]The LT1319 is designed to have great flexibility to accommodate communication standards that are just emerging or not yet defined. The ability to change the external photodiode helps accomplish this task by allowing the user to choose the ideal photodiode for the application. The LED transmitter is also external to the LT1319 for the same reason.

duty cycle of the receive pulse can cause baseline shifts and false triggering when the signals are converted to digital levels.

Figure 2 is a block diagram of the LT1319 and the necessary components to construct an IR LocalTalk link. The LT1319 is intended to function in a wide range of applications, but this note will focus only on IR LocalTalk because of limited space. A low noise ($2pA/\sqrt{Hz}$), high bandwidth (7MHz) current-to-voltage converter formed by the preamplifier and its associated components transforms the reverse current from an external photodiode to a voltage. Although the 7MHz bandwidth of the preamp supports 4Mbit data rates, a lowpass filter on the preamp output is used to reduce the bandwidth to just the required amount in order to reduce noise. Proper filtering and the low noise of the preamp allow for links of two meters or more.

As shown in Figure 2, capacitor C_{F1} sets the break frequency of an AC highpass loop around the preamp to 180kHz. This loop rejects unwanted ambient light pollution, including sunlight, incandescent and fluorescent lights.

The preamp stage is followed by two separate channels each containing a high impedance filter buffer, two gain stages, highpass loops and a comparator. The only difference between the two channels is the response time of the comparators: 25ns and 60ns. For the 125ns pulses of IR LocalTalk, the 25ns comparator with its active pull-up output is used. The low frequency comparator with its open collector output (with 5kΩ internal pull-up) is suitable for more modest speeds such as the 1.6µs pulses or IrDA-SIR. Each gain path has an AC coupling loop similar to the one on the preamp. Capacitor CF5 sets the highpass corner at 140kHz for IR LocalTalk. The loops serve the additional purpose here of maintaining an accurate threshold for the comparators by forcing the DC level of the differential gain stages to zero.

As the preamp output is brought out and the inputs to the two comparator channels are buffered, the user is free to construct the exact filter required for the application by the careful selection of external components. R_{F1}, C_{F2}, C_{F3}, R_{F2}, C_{F4} and R_{F3} form a bandpass filter with a center frequency of 3.5MHz and 3dB points of 1MHz and 12MHz. Together with the highpass AC loop in the preamp and the 7MHz response of the preamp, this forms an optimal filter response for IR LocalTalk.

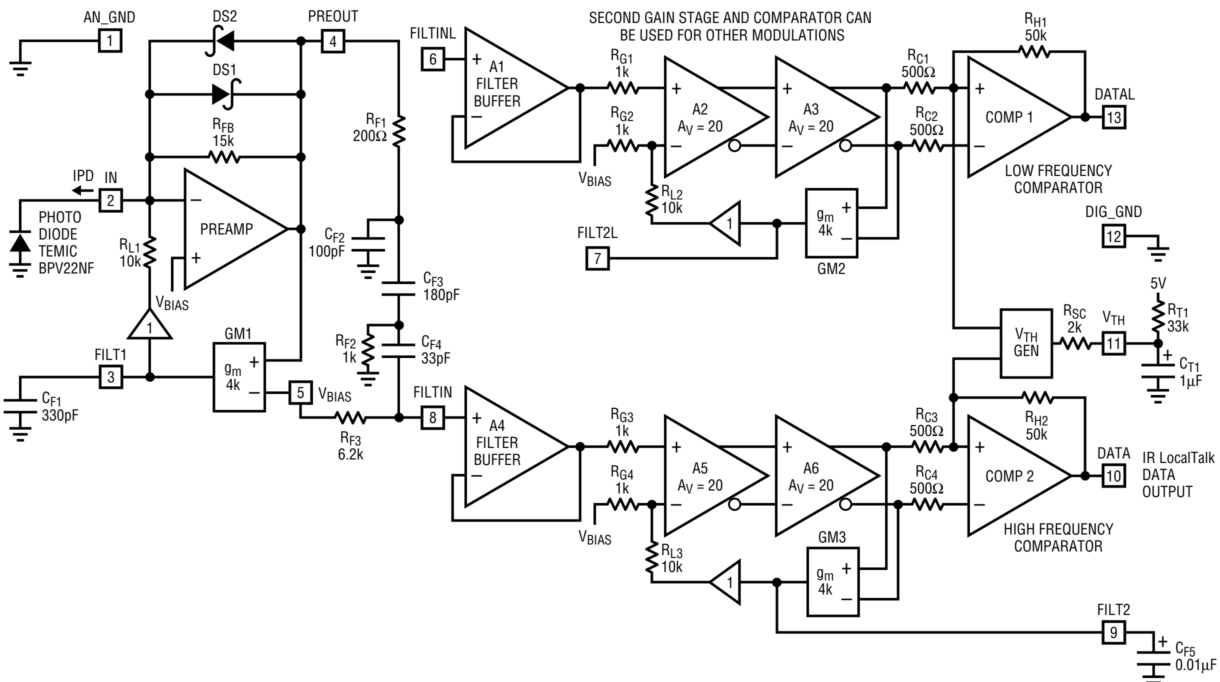

Figure 2. IR LocalTalk Infrared Receiver

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