

## IEEE P802.11 Wireless Access Methods and Physical Layer Specifications

---

### Implementation of EXIRLAN multichannel IR-PHY using existing semiconductor components

**Date:** March , 1994

**Author:** Peter Blomeyer  
AndroMeDa GmbH  
Benzstr. 30  
82178 Puchheim-Bhf  
Phone:xx49-89-8901480  
Fax: xx49-89-806040

---

ieee7.doc

## 1. General

EXIRLAN is an IR-PHY with essentially new features. Thus, no IC`s exist which perform exactly the required functions; true EXIRLAN-chips will be available only after it has been accepted as a standard.

But even with currently available semiconductor components, stemming from the wireless phone world, fully functional transmitters and receivers can be built at relatively low cost (component cost of the transmitter is about 23 US \$, and the reciever about 21 US \$) and require only a few square inches of real estate on a PCB. The existing prototype has been built to allow easy probing and is, therefore, not miniaturized. The prototype consists of a multichannel modulated carrier transmitter and receiver.

## 2. Technical features of the Multichannel Implementation

The EXIRLAN-concept bases on the combination of a low-cost baseband communication in the lower (electrical) frequency band and high-performance, multichannel carrier modulation communication in a higher (electrical) band.

For the base band part, commercially available solutions exist, using extremely power consumption efficient PPM and 16PPM modulation schemes.

The target of the EXIRLAN-implementation presented here is to show the technical feasibility and to inform about component cost considerations of the multichannel part of this proposal.

### 3. Implementation with presently available components

In Andromeda`s labs, a multichannel EXIRLAN configuration has been implemented, consisting of a transmitter and a receiver in the (electrical) target band.

In comparison to the target specification defined in [1], the band width has been enlarged to 3MHz. This move gives access to substantially higher data rates (up to 4.2 Mb/s in a first step, and to 10...12.6 Mb/s in a second step, see [2]). The baseband upper limit frequency has been moved to 6 MHz, providing compatibility to the IEC/CENELEC standard proposal [3].

Basing on this specifications, an implementation can be built today using a few commodity-components and two ASIC`s.

The IC`s are also used in mobile phone applications and, therefore, at very low cost. The two ASIC`s incorporate the specific modulation scheme, which allows the high data rate per available bandwidth.

A block schematic is shown in figure 1. It describes a transmitter module and a receiver module.

The transmitter consists of

- \* 4 commodity IC`s
- \* 1 ASIC
- \* 1 filter
- \* 2 VCO`s
- \* 1 power amplifier

The receiver consists of

- \* 3 commodity IC`s
- \* 1 ASIC
- \* 1 filter
- \* 1 VCO
- \* 1 receiving-diode circuitry

The data rate of this experimental circuitry is limited to 1 Mb/s (see figure 2).

There is no physical limitation, however, to blow it up to 12,6 Mb/s, providing a total channel capacity of more than 100 Mb/s.

The outstanding data rates in the limited bandwidth of the IR-diodes are possible by using present FQPSK-constant envelope NLA scheme in the 1st generation (see

figure 3 and 4) and QAM multilevel Offset FQPSK in the 2nd generation, using existing low-cost components and avoiding expensive linear amplifiers.

Figure 3 shows the excellent results of the FQPSK in form of Eye-diagrams, figure 4 in form of a Constellation-diagram.

The component count (and cost) of a real communication device will be lower than the sum of transmitter and receiver cost, because

- oscillators will be combined in 1 IC (or even disappear in some PHY-ASIC).
- all VCO`s/PLL`s of a device will be integrated in 1 IC (or disappear in the PHY-ASIC mentioned above)
- the ASIC`s for the transmit - and receive - path can be easily integrated into one digital IC

As a rough assumption, a complete transceiver will need about 6 IC`s, 2 filters, the IR-components and an oscillator for the "first step".

Again, chip count will be brought down still more according to the investment, chip manufacturers will be willing to do - there are no physical limits to this.

In other words: a standard on this base has a very good chance to open a very economic, powerful world to the computer community.

The achievable communication distance depends on the sensitivity of the receiver IC, the sensitive area of the receiving diodes, and the number of transmitting IR-LEDs. Thus, every equipment manufacturer is in the position to choose the ideal trade-off in power consumption and communication distance for his products.

#### 4. Further developments

As mentioned before, implementations of the first generation (which we propose as at least the first version of a present standard) can go up to 4,2 Mb/s (corresponding to more than 30 Mb/s channel capacity).

The second generation, providing more than **10 Mb/s PER CHANNEL** (which gives a total channel capacity of more than **100 Mb/s**), can be achieved by changes in existing commodity IC`s and by a more complex digital ASIC`s for the modulation/demodulation.

#### 5. Activities needed

The EXIRLAN-concept is strictly object-oriented, it does not base on commercial interest of a company to market its existing products.

It starts from the assumption, that every company involved in IR-communication **MUST** be interested in providing a technically and commercially fruitful solution.

**Such, this activity is open to any other company interested in this topic.**

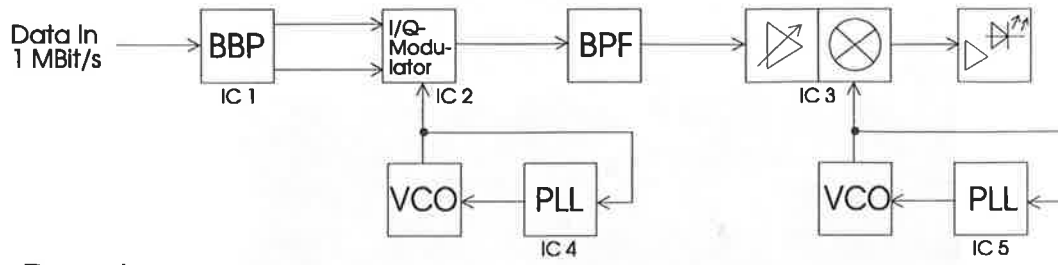
We would like to encourage you to join this activity to lead it to a useful, competitive standard - **contribute your inputs now !**

## 6. References

- [1] Peter Blomeyer, "EXIRLAN - a multichannel, high-speed, medium range Local Area Network, Doc. IEEE P802.11-93/217, Nov 2, 1993
- [2] Kamilo Feher, a modulation power efficient RF amplification proposal for increased spectral efficiency and capacity GMSK and  $\pi/4$ -QPSK compatible PHY standard, "Doc. IEEE P802-93/97, Denver, CO, July 13, 1993
- [3] IEC document 84 (sec) 340 Draft IECxxx: Transmission using Infra-red radiation, Part 1: General, Nov, 1993, page 23/24

### EXIRLAN Rev. 1.1

Transmitter:



Receiver:

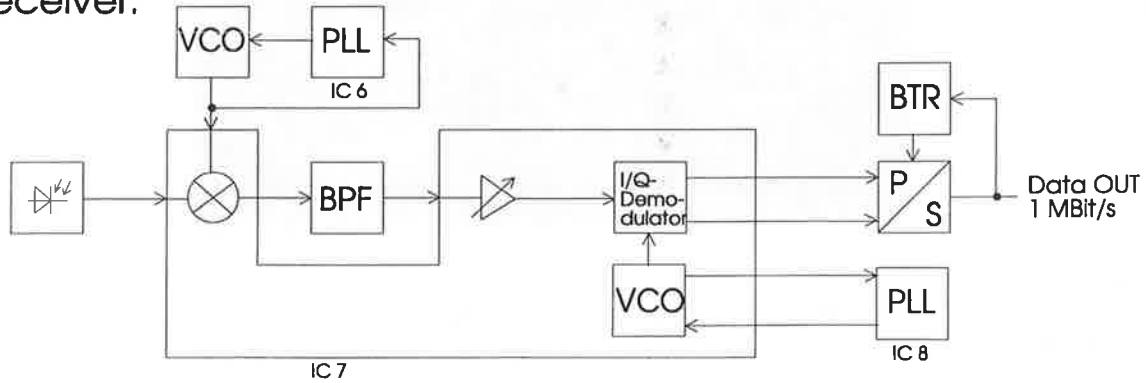


FIG. 1

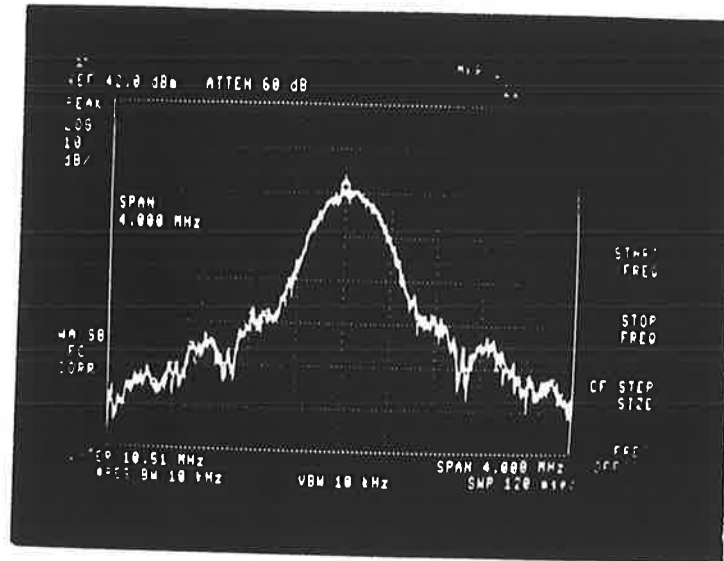


Figure 2  
Nonlinearly Amplified (NLA) "C-class" or hardlimited spectrum of Constant Envelope "FQPSK-I" at 1 Mb/s rate. Horizontal: 400 kHz/div; vertical: 10 dB/div

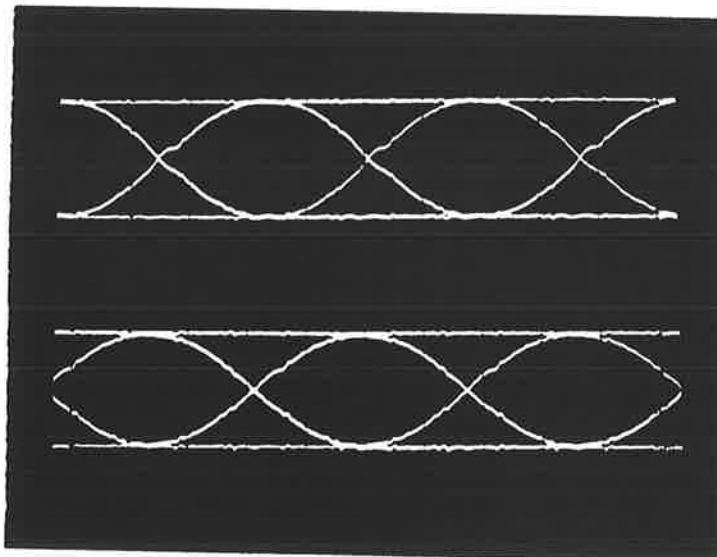


Figure 3  
In-phase "I" and Quadrature "Q" eye diagrams of DSP-generated 1 Mb/s rate (500 kBaud per I and Q) FQPSK-EXIRLAN system

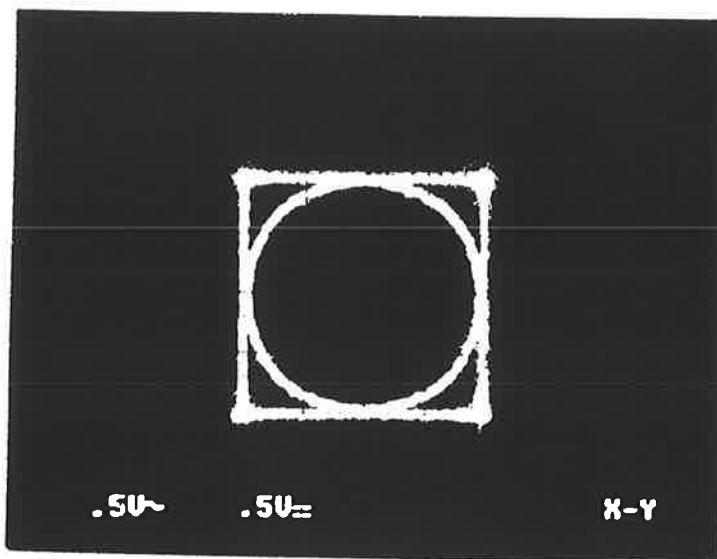


Figure 4  
"Constellation Diagram of FQPSK" nonlinear-IR system

