

July 1994

doc.: IEEE P802.11-94/146a

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## Low Power, High Speed FQPSK Solution for Infrared and Other Wireless Systems

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## Agenda

- Assumption and Issues
- Review of FQPSK Carrier Modulated Design
- FPGA and Analog/RF ASIC Components
- Test Results
- Summary and Comments

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### Assumptions

- ✓ **Combined Baseband and Multichannel IR-PHY for EXIRLAN**
- ✓ **4/16 Level PPM for Baseband Modulation and FQPSK for Carrier Modulation**
- ✓ **Proposed Data Transfer Rate in the 1 Mb/s to 10 Mb/s range**
- ✓ **Low Cost/High Power Infrared Transmit Diodes support DC to 30 MHz range**
- ✓ **There is a need for low power, high performance solutions suitable for implementing EXIRLAN**

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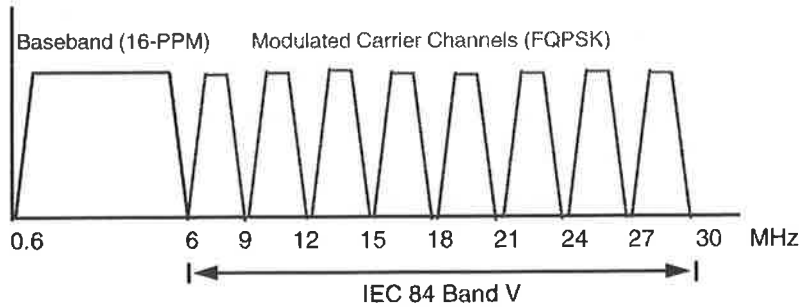
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### Proposed Spectral Template

P. Blomeyer IEEE P802.11-94/62



- 6 MHz baseband supports up to 1-Mb/s with 16-PPM
- Carrier band channels support 1- to 10-Mb/s (or higher) in a TBD bandwidth
- Constant envelope nonlinearly amplified IR system for power efficiency

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## Issues

- **Constraints**
  - Battery operation
  - Limited spectral bandwidth
  - Physical size (hand held devices)
- **Needs**
  - Low power carrier modulated solutions
  - High performance designs to achieved desired data rates
  - Compact solution
  - Fast time-to-market at a reasonable cost

Recommendation: Combine today's field programmable gate array technology with low power Analog and RF ASICs

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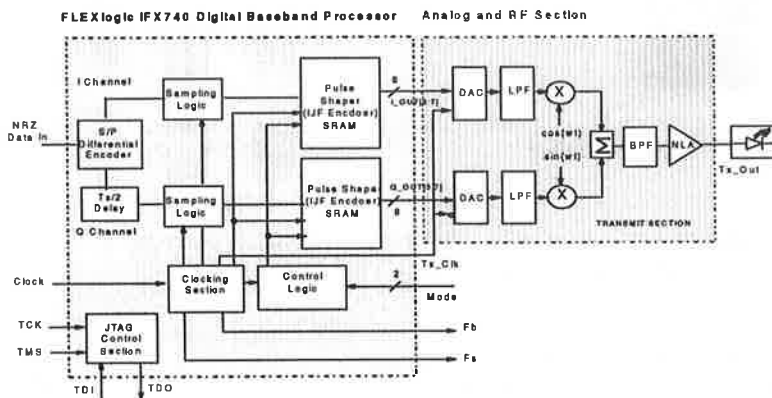
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## FQPSK Carrier Modulation



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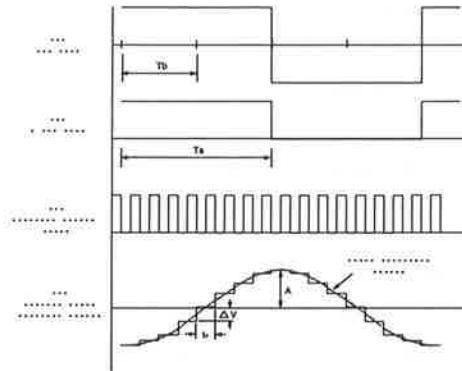
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## Baseband Processing

11001100... NRZ Data Stream



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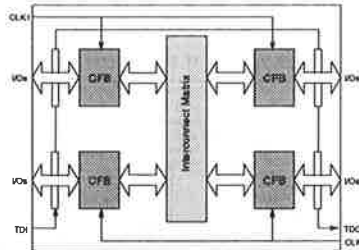
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## FPGA Technology



Small PLCC packaging



- SRAM/EPROM architecture on 0.8 micron CHMOS process
- Low power - typical  $\mu\text{A}$  standby with 1 mA/MHz active power
- Configurable Function Blocks (CFBs) configured as 24V10 logic or SRAM
- IEEE 1149.1 JTAG supports boundary scan testing and in-circuit reconfiguration and programming
- Low cost path to mask programmed version



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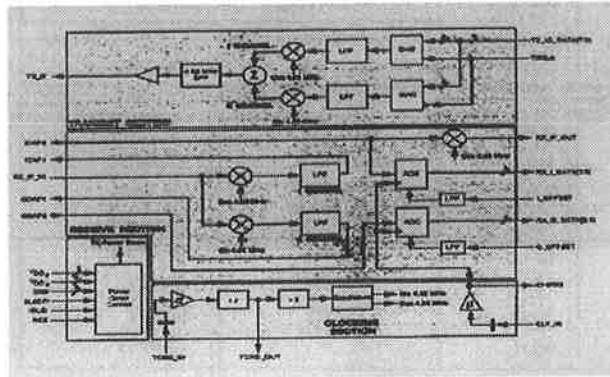
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## Low Power Analog ASIC Technology



- Qualcomm Baseband Analog and RF ASIC in 64 pin TQFP package
- Consumes 385 mW at 5V in full transmit and receive operation

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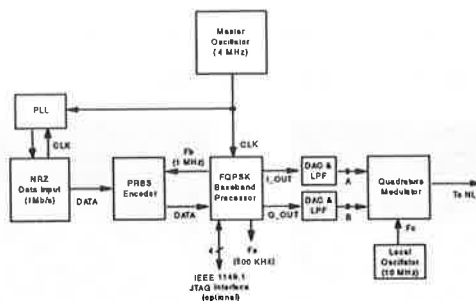
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## Test Setup



- Tested FQPSK and other quadrature modulation techniques
- Tested 1 Mb/s and 4 Mb/s (device supports up to 16 Mb/s)
- Power consumption, transmit and receive baseband, and power spectrum measurements taken

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### Test Results

Data Rate (Mb/s)	Master Oscillator (MHz)	Power Consumption	
		Lot # V3471001 Nov. '93	Lot # L4091644 Feb. '94
standby	0	35uW	145uW
0.1	0.4	4.0mW	12.0mW
0.25	1.0	9.0mW	17.5mW
0.5	2.0	17.5mW	19.5mW
1.0	4.0	34.0mW	24.0mW
2.0	8.0	60.0mW	29.5mW
4.0	16.0	132mW	46mW
5.0	20.0	176mW	57mW
10.0	40.0	n/a	103mW

(Vcc = 5.0V at room temperature, Measured Icc + Icco)

- February lots include new power screens in wafer test

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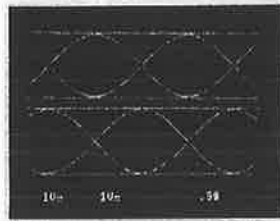
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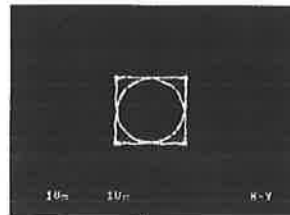
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### Test Results

- 1 Mb/s Baseband Signal and Constellation Diagram
- No ISI nor jitter in baseband signal



Baseband



Constellation

Measured at input of quadrature modulator (unfiltered)

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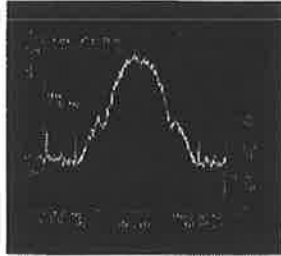
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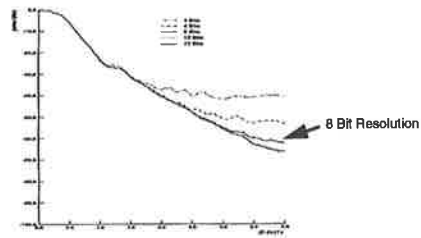
## Test Results

- 1 Mb/s FQPSK Out-of-Band Power Spectrum
- Carrier modulated at 10 MHz



Measured

(Fc = 10 MHz, Span=3 MHz, RBW=3KHz)



Simulated

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## Summary and Comments

- FPGA technology provides a low-power, flexible means to implement first generation carrier modulated EXIRLAN systems
- 8 Bit quantization achieved nearly equal power spectrum and equal BER as 12 bit resolution
- The iFX740 based FQPSK baseband processor consumed less than 35 mW at 1 Mb/s and typical standby power less than 150 uW and is able to support data rates up to 16 Mb/s
- FQPSK carrier modulated transmission in a NLA channel provided IJF signaling and spectral compactness

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