Jitter Considerations of MB810

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Abstract

We did simulations to measure the jitter performance of MB810, with the transfer function of fourth order Bessel Thompson filter defined in IEEE 802.3z.

MB810 shows good relative jitter performance over NRZ and 8B/10B, particularly for reduced channel bandwidth.

We also completed a MB810 codec FPGA and successfully confirmed MB810 encoding and decoding algorithms electronically.

CONTENTS

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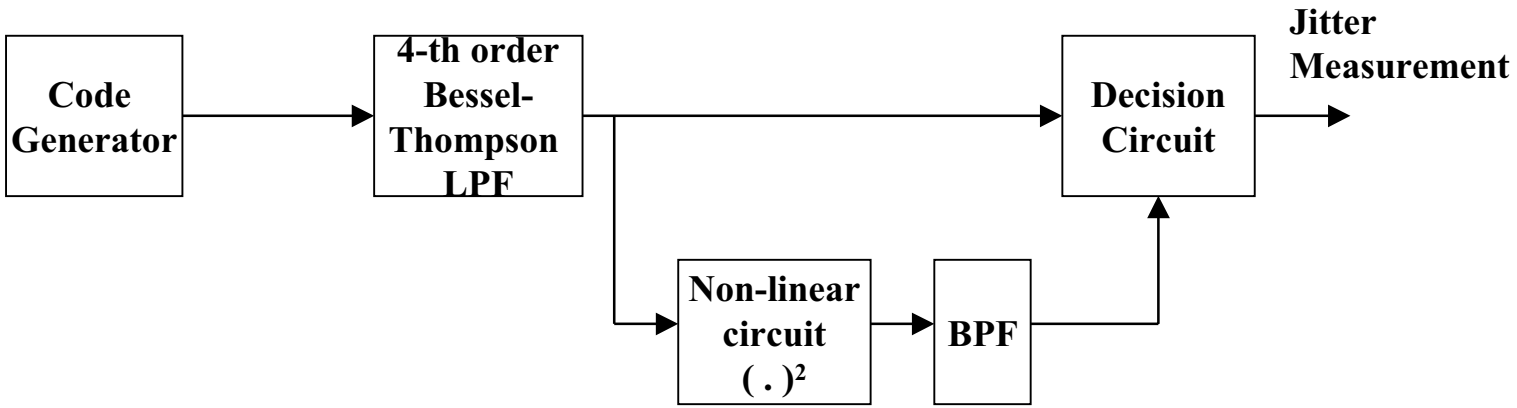
Jitter Simulation System Model



- We measured rms jitter(UI) using the recovered clock.

- The 4th order Bessel-Thompson filter is as described in IEEE 802.3z Clause 38.6, i.e., due to the GbE link model.

- Q of BPF is set arbitrarily to 100 for relative comparison between MB810 and others.

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Simulation Conditions

- **We assume the line rates of MB810 and 8B/10B are 1.25Gbps while that of NRZ is 1Gbps.**
- **Test data patterns are as follows:**
  - **8B/10B LF, MF, and HF data as defined in IEEE 802.3z Annex 36A(informative)**
  - **NRZ HF data is a stream of continuous '1010….'**
  - **NRZ MF data is PRBS with Pr{Mark}=0.5.**
  - **NRZ LF data is PRBS, but randomly inserted words of RDS=10 and Pr{word}=0.25.**
  - **MB810 LF, MF, and HF are designed according to the MB810 codebook. All codewords satisfy DC-free and MB conditions.**
- **Data length is n*4096 for NRZ and n*5120 for block codes.**

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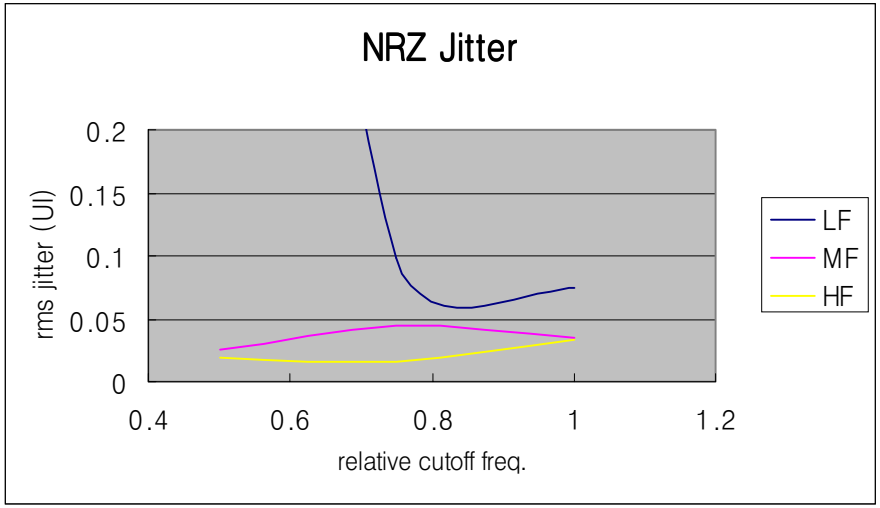
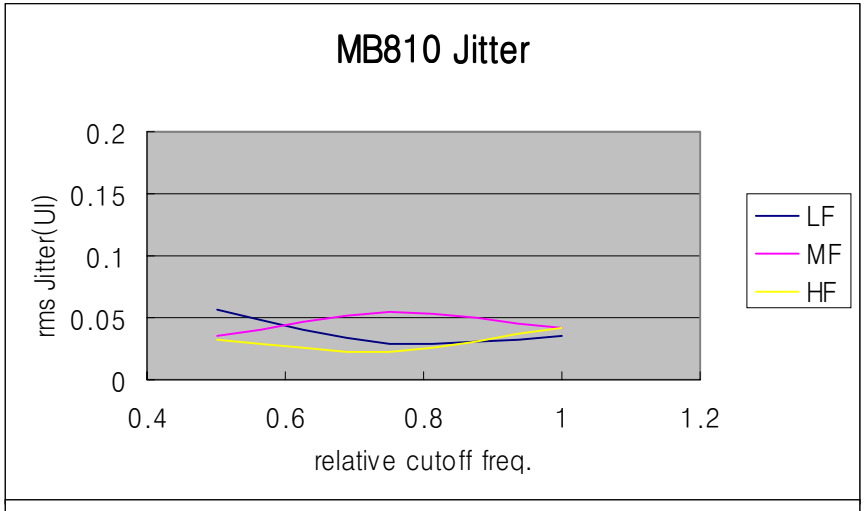
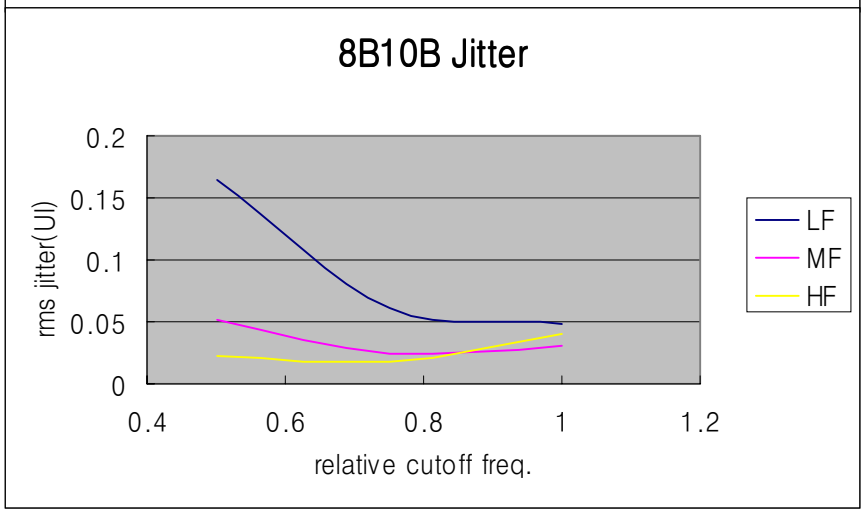
Jitter Simulation Results







- **The GbE link model is used.**
- **The rms jitter(UI) is measured as the cutoff frequency of the BT filter is decreased.**

LF: Low Frequency
MF: Mixed Frequency
HF: High Frequency

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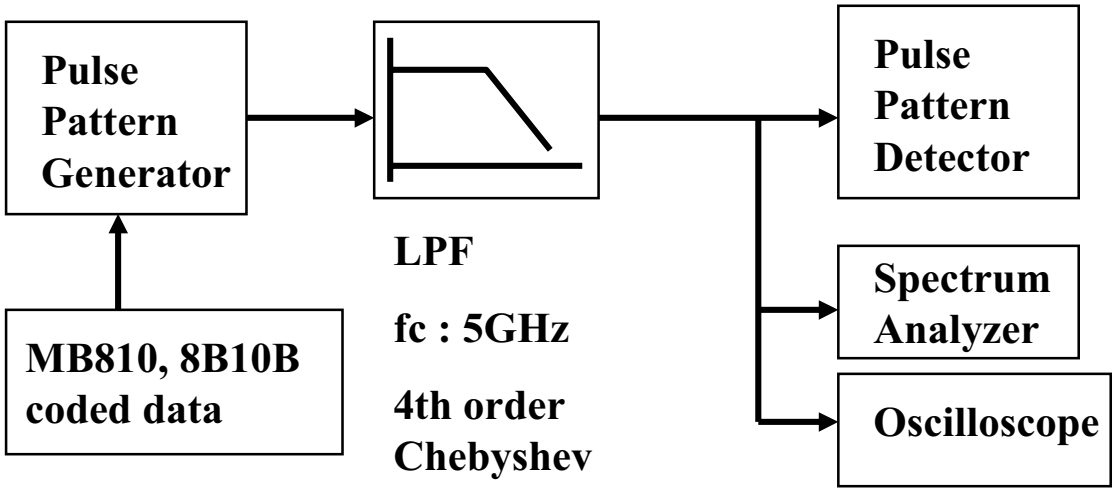
Measurement Set-up for MB810 and 8B10B



Conditions;
- Line rates used in this measurement are 10Gbps.
- MB810 and 8B/10B coded data is generated by program.
- Input random data has mark ratio of 0.5 and sequence period of 100K.

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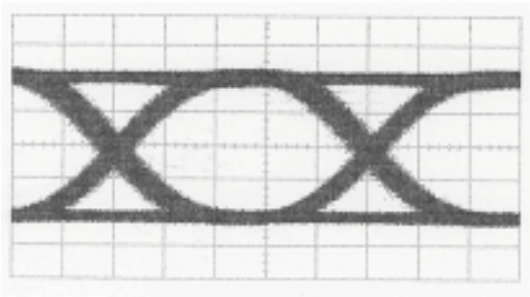
Measurement Results : MB810

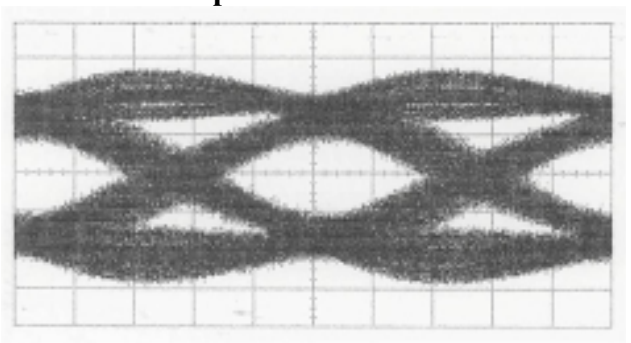
20 ps/Div



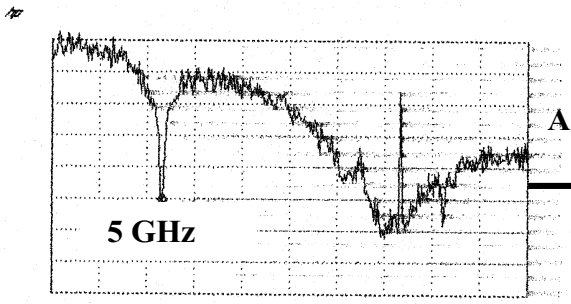
MB810 coded data of 10Gbps

After Filtered by 5GHz -LPF

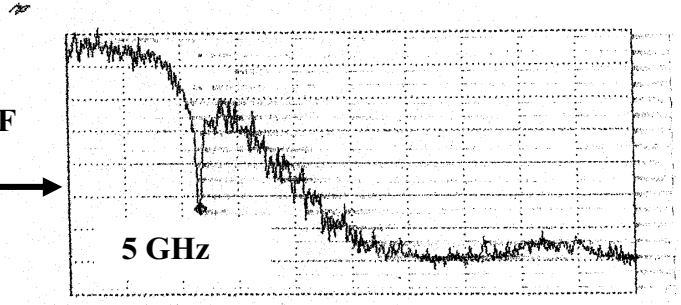
20ps/Div



MB810 coded data of 10Gbps



After Filtered by 5GHz -LPF



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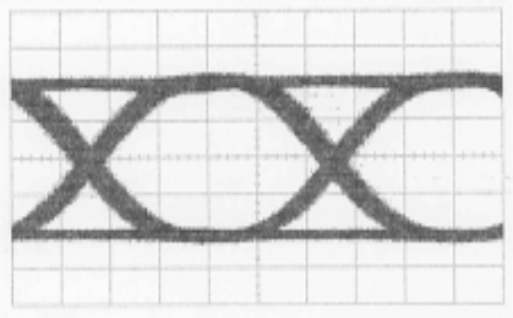
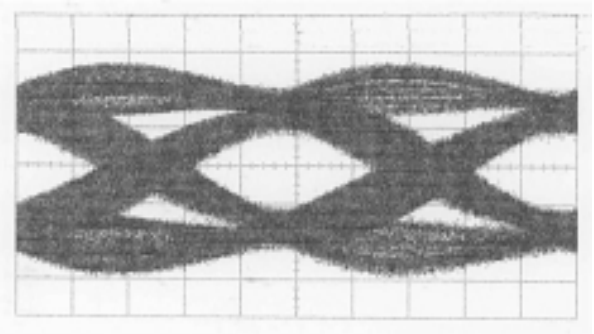
Measurement Results : 8B10B

20 ps/Div

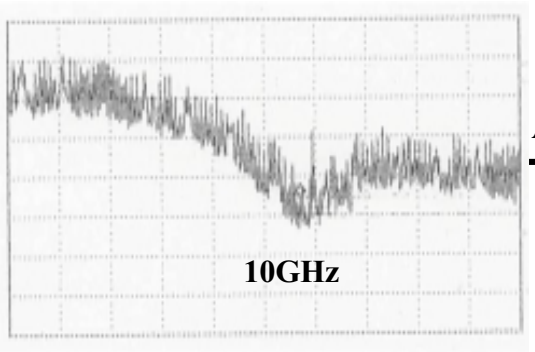


After Filtered by 5GHz -LPF

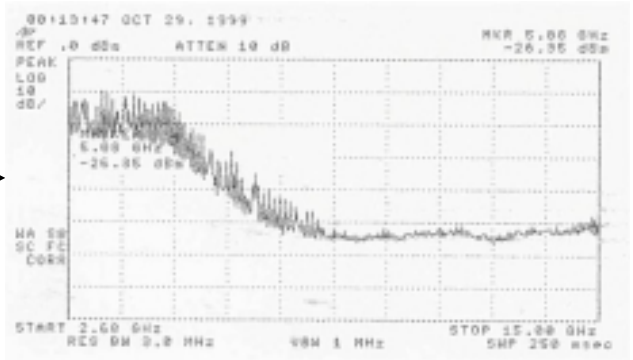
20 ps/Div



8B/10B coded data of 10Gbps



After Filtered by 5GHz -LPF



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Measurement Results

- Jitter performances of MB810, 8B/10B and NRZ are comparable down to a channel bandwidth equal to 80% of the data rate bandwidth, i.e., the NRZ bandwidth.
- As the channel bandwidth decreases further, the jitter of NRZ and 8B/10B explode whereas that of MB810 stays relatively constant.
- These simulation results demonstrate the relative robustness of MB810 in regard to jitter performance under stringent bandwidth constraint.
- A 10GbE link model would enable more accurate jitter performance comparisons.

A Sub-Rate Implementation of MB810 Codec

- Lacking in a 10GHz 10:1 MUX, we implemented the codec at GHz range to first confirm the whole codec operation.
- MB810 coded at 12.5 Mbps and fed to two-stage 10:1 MUXs.
- The final MB810 line rate is then 1.25 Gbps.

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A Sub-Rate MB810 Encoder Architecture

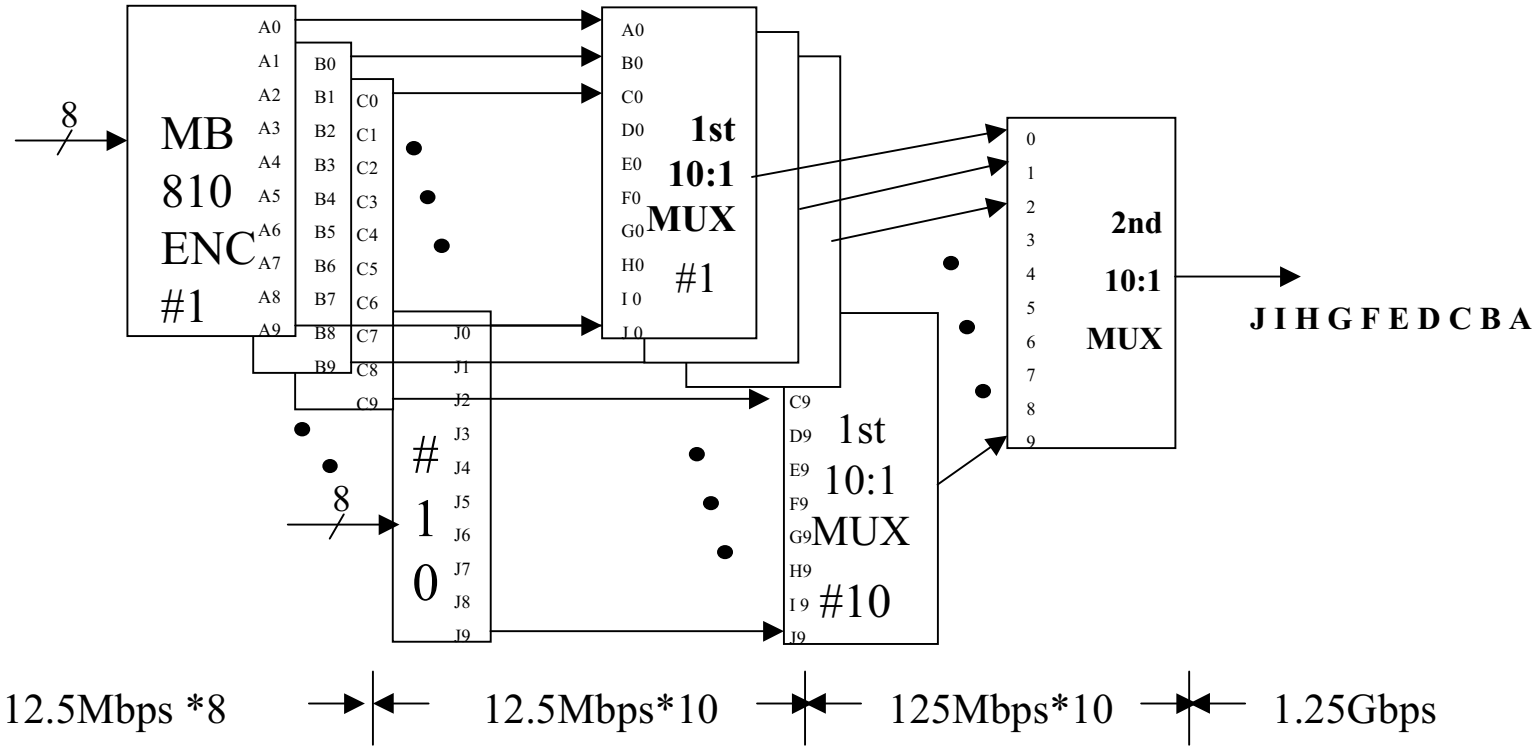

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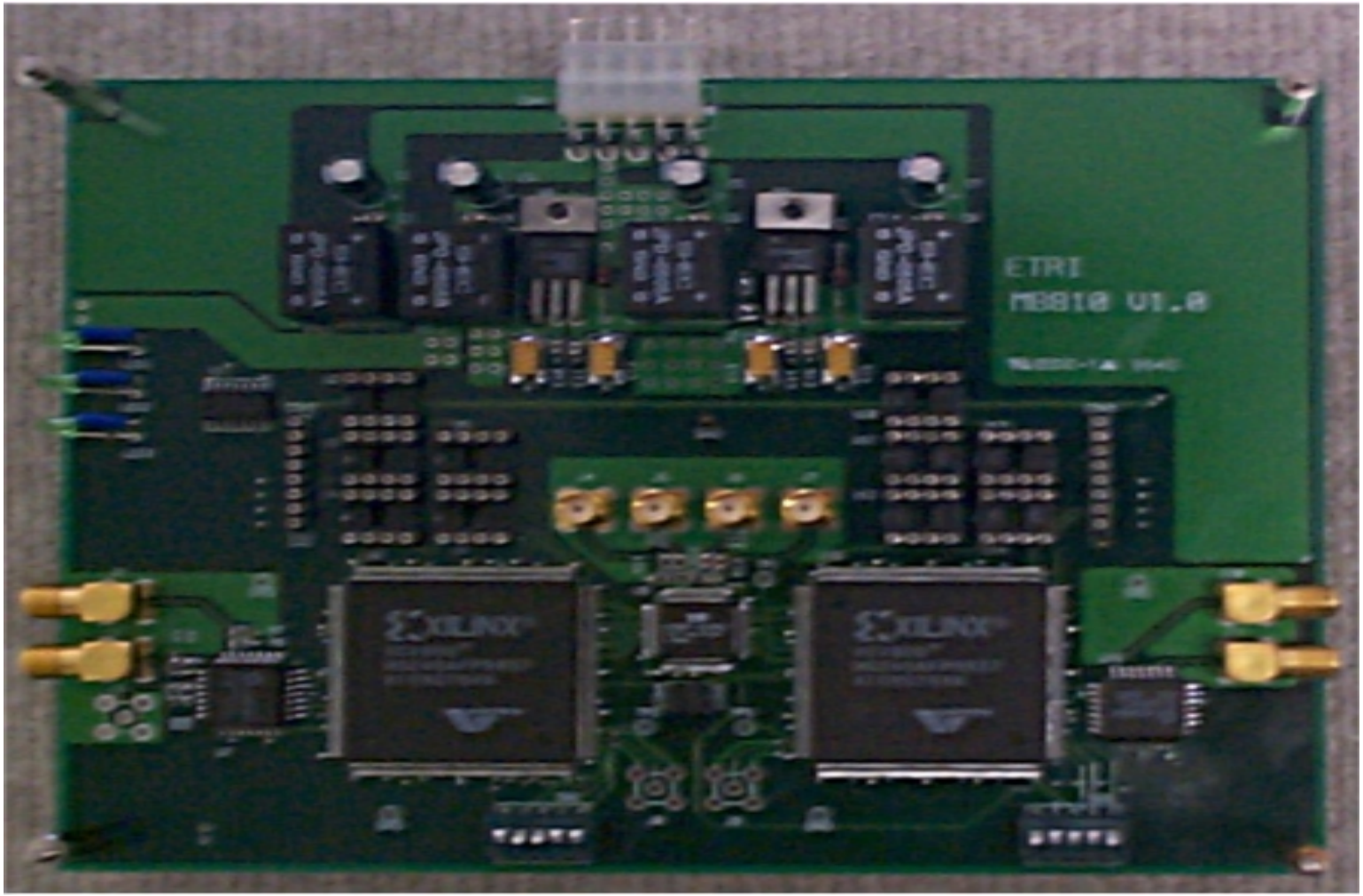
Photo Shot of MB810 Codec



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Conclusion

- MB810 has a good relative jitter performance over 8B/10B and NRZ.
- The rms jitter of MB810 stays confined within an acceptable limit even for a considerable reduction in the channel bandwidth while those of others diverge considerably.
- A MB810 codec was successfully implemented and proved with FPGA, suggesting feasibility of high-speed and low-cost custom chips.

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