

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Resolutions to MR-FSK Comments on Modulation Quality]

Date Submitted: [September 2010]

Source: [Steve Shearer, Cristina Seibert] Company [Silver Spring Networks]
[Hiroshi Harada, Fumihide Kojima] Company [NICT]
[Kazuyuki Yasukawa] Company [Fuji Electric]
[Roberto Aiello, John Buffington, Daniel Popa, Hartman Van Wyk] Company [Itron]
[Robert Mason, Kuor-Hsin Chang] Company [Elster Solutions]
[Khanh Tuan Le] Company [Texas Instruments]

Re: [MR-FSK Modulation Quality Proposal]

Abstract: [This document describes aspects of the MRFSK PHY related to Modulation Quality and proposes methods to specify the Modulation Quality]

Purpose: [802.15.4g Comment Resolution for LB51.]

Notice: This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release: The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.

Overview

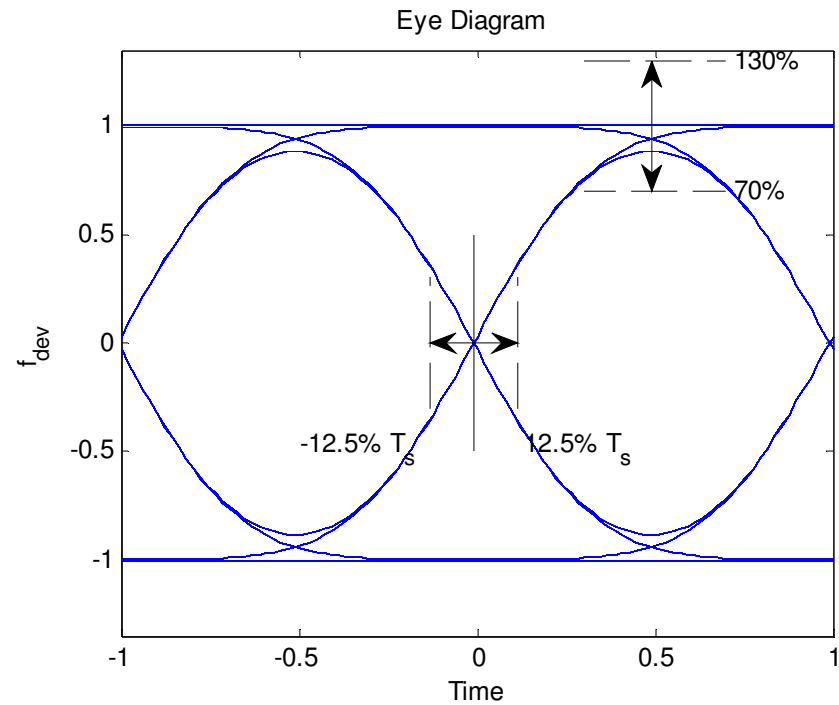
- Comments 1510, 1513, 1515, 1517, 1519, 1347, 1348, 1349, 1350
 - “Modulated signal quality has not been defined for MRFSK – measurement method is needed”
- The modulation quality of the MRFSK can be assessed by examining the eye diagram and determining appropriate limits to ensure reliable demodulation.

Modulation Quality Measurement

- Use a Pseudo random transmit sequence to exercise all transition possibilities
- Observe the demodulated eye diagram and examine
 - Frequency deviation - allow some frequency deviation error
 - Zero crossing - allow for some asymmetry in the mark-space ratio
- Symbol length
 - Addressed separately under “Symbol Rate Tolerance”

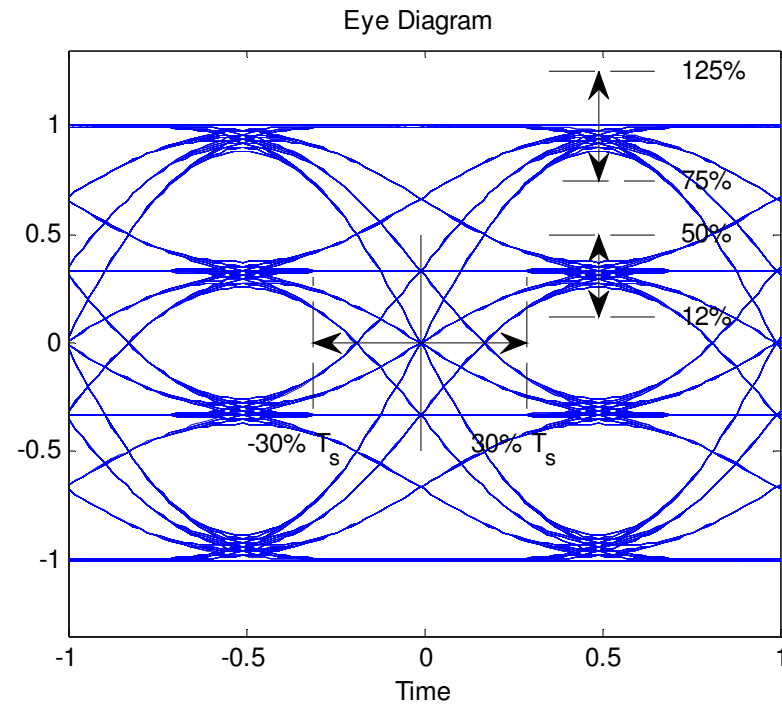
Limits – 2 Level FSK

- Eye diagram shown for 2 level GFSK, $bt=0.5$
- Zero crossing tolerance
 - $\pm 1/8$ 'th symbol
- Frequency deviation tolerance
 - Allow $\pm 30\%$
 - Then $70\% f_{dev} < |f| < 130\% f_{dev}$



Limits – 4 Level FSK

- Eye diagram shown for 4 level GFSK, bt=0.5
- Zero crossing tolerance
 - +/-30% symbol
- Frequency deviation tolerance
 - Then $12\% f_{dev} < |f| < 50\% f_{dev}$
 - And $75\% f_{dev} < |f| < 125\% f_{dev}$



Proposed Resolution

- Comments 1510, 1513, 1515, 1517, 1519, 1347, 1348, 1349, 1350
- Accept in principle
 - Place appropriate text and diagrams in the draft

Resolution text to place in the draft

6.12a.4.2 Modulation

The modulation for MR-FSK is either 2 or 4 level filtered FSK. Modulation quality shall be measured by observing the eye diagram caused by a pseudo random sequence.

Frequency Deviation Tolerance

The modulation index for the MR-FSK modes is defined in Table 1a. Modulation frequency tolerance is measured as a percentage of the maximum frequency deviation, f_{dev} , dictated by the modulation index.

In the case of 2 level the measured frequency deviation, f , at $T_s/2$ shall be constrained to the range $70\% f_{dev} < |f| < 130\% f_{dev}$ as shown in fig 1.

In the case of 4 level the measured frequency deviation, f , at $T_s/2$ shall be constrained to the range $12\% f_{dev} < |f| < 50\% f_{dev}$ for the inner levels, and $75\% f_{dev} < |f| < 125\% f_{dev}$ for the outer levels as shown in fig 2.

Zero Crossing Tolerance

In the case of 2 level the excursions for the zero crossings for all trajectories of the eye diagram shall be constrained to within $\pm 12.5\%$ of the symbol time T_s as shown in Fig 1.

In the case of 4 level the excursions for the zero crossings for all trajectories of the eye diagram shall be constrained to within $\pm 30\%$ of the symbol time T_s as shown in Fig 2.