
Spectral measurements and use of a scrambler

Eric Deliot

HP Laboratories Bristol, U.K.

e-mail: ed@hplb.hpl.hp.com

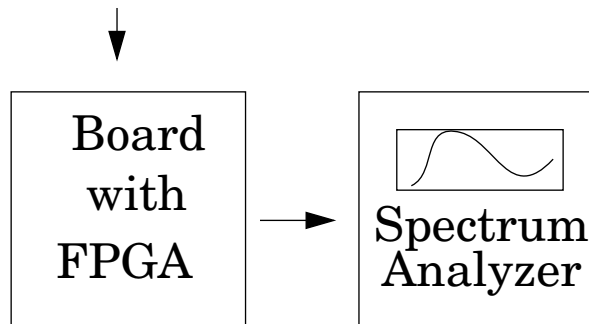
IEEE 1394b, June 1997

Outline

Objective: To illustrate with a few examples how a scrambler can ease the process of satisfying FCC class B limits.

Measurement set up:

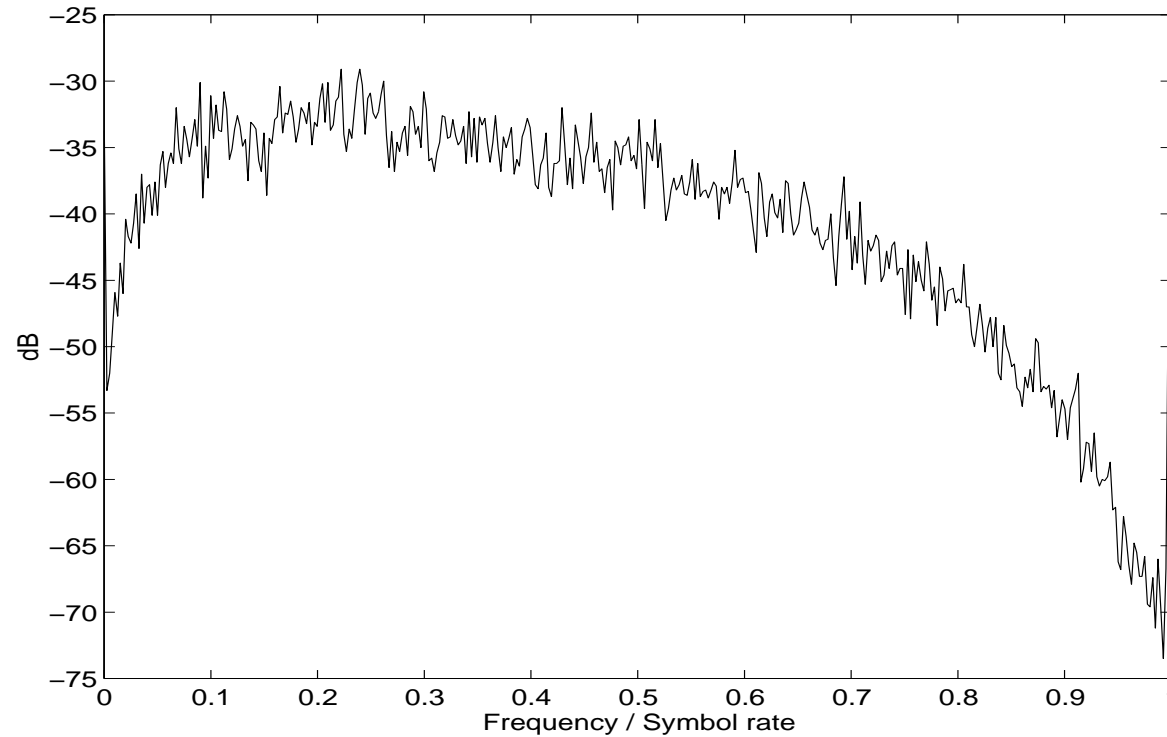
Verilog Programs



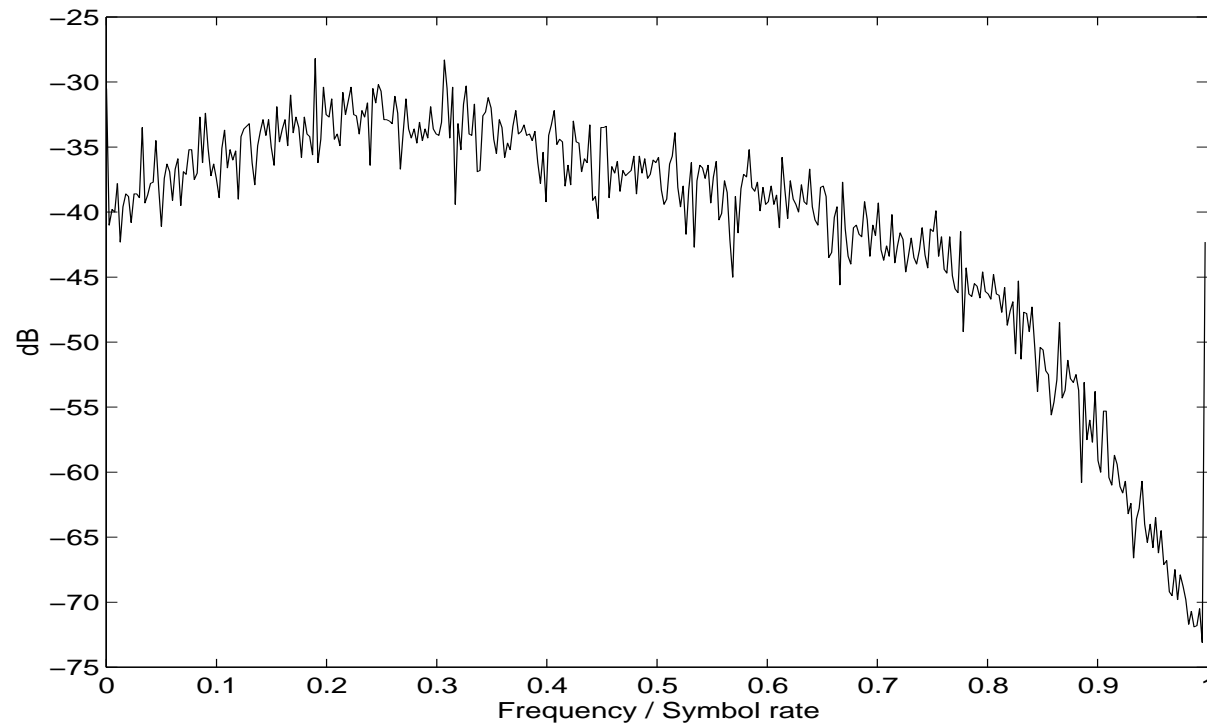
Experimental clock: 50 MHz

All results scaled to S800 / 1 GBd

IBM 8b10b data spectrum



FDDI data spectrum

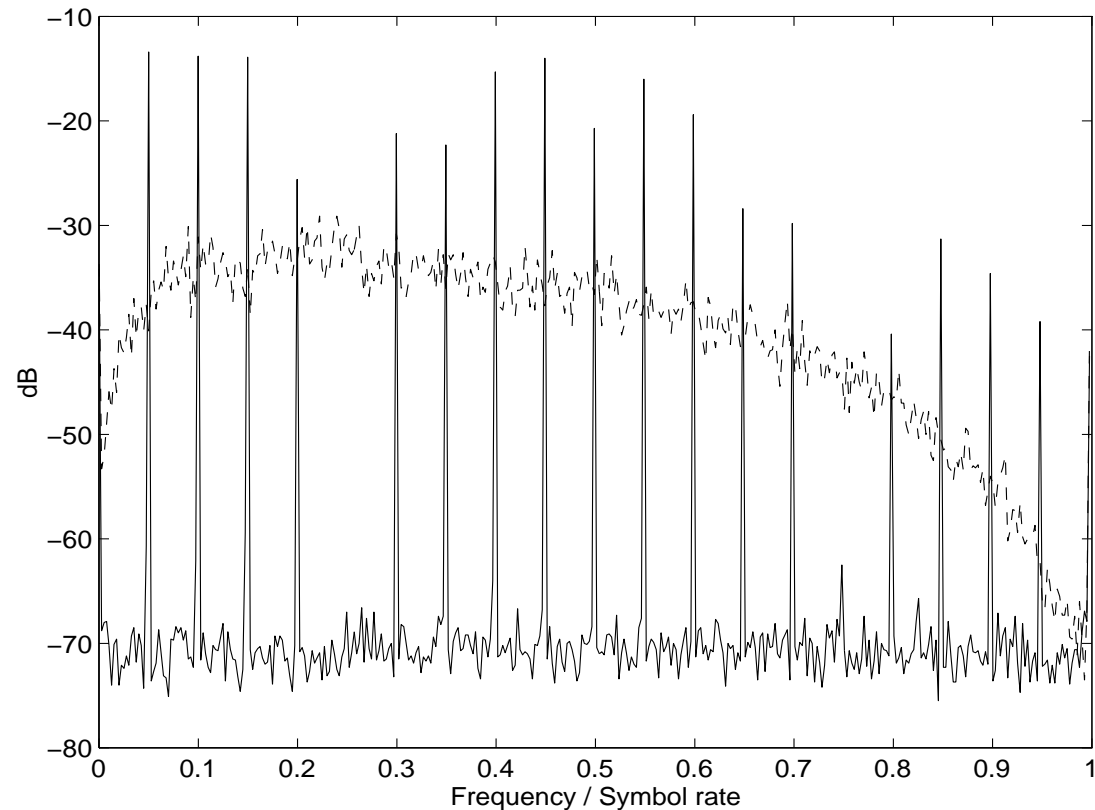


— Sending Idle - IBM 8b10b

Idle stream is the repetition of:

K28.5-D5.0

dashed line:
ibm8b10b data



— Sending Idle - Sony's control mapping

Idle is defined as:

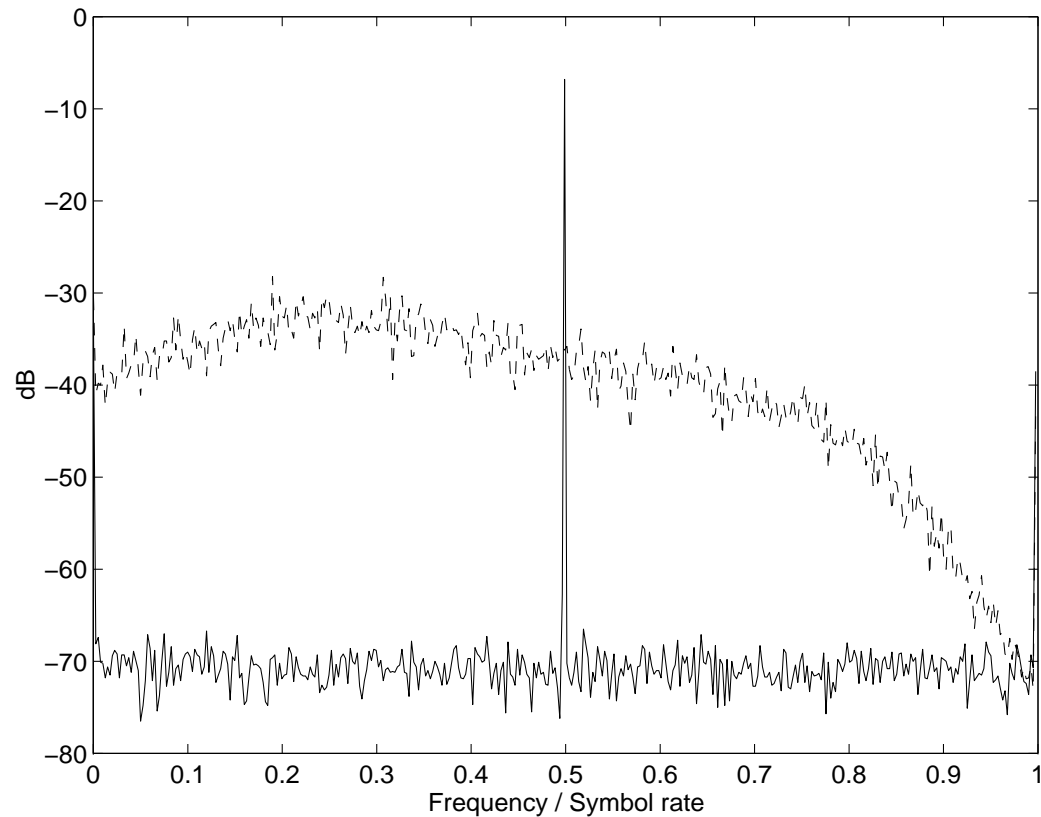
11111

followed by NRZI gives:

101010101010101010...

dashed line:

fddi 4b5b data



Byte padding - IBM 8b10b

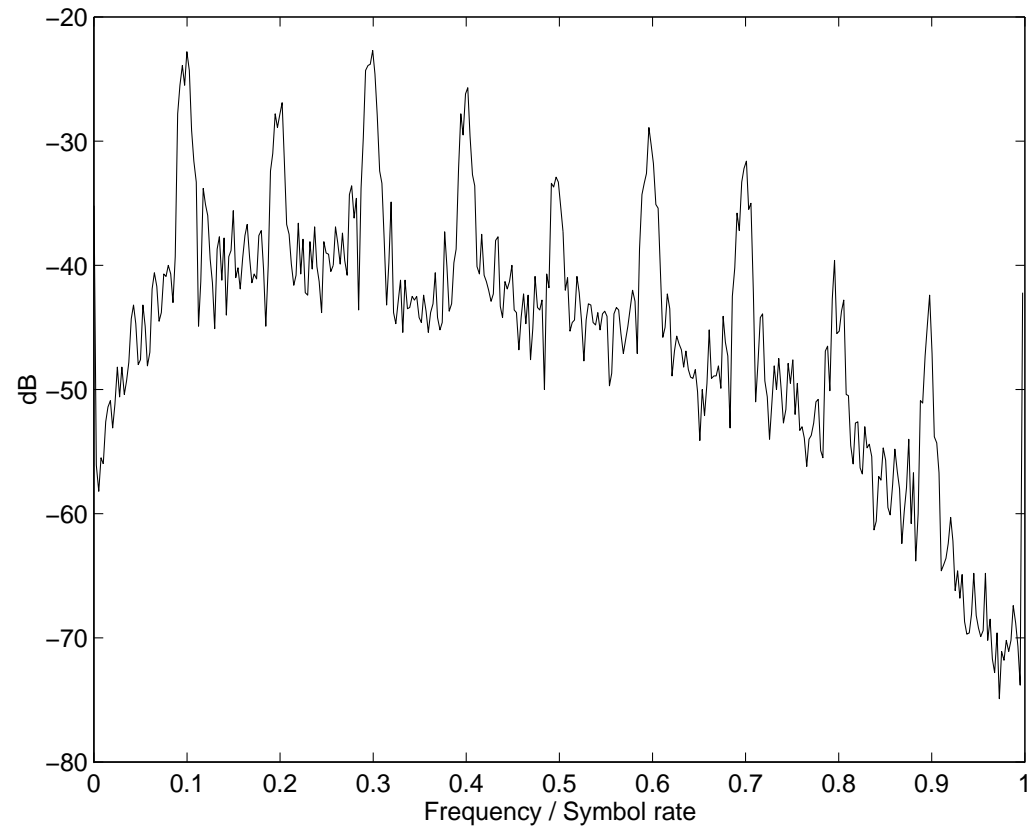
S100 data sent over a S800 link.

S100 byte stream:

B₁B₂B₃B₄...
 └─ 8 data bits

S800 stream:

B₁0000000B₂0000000B₃...
 └─ 8 zero bits



Nibble padding - FDDI 4b5b

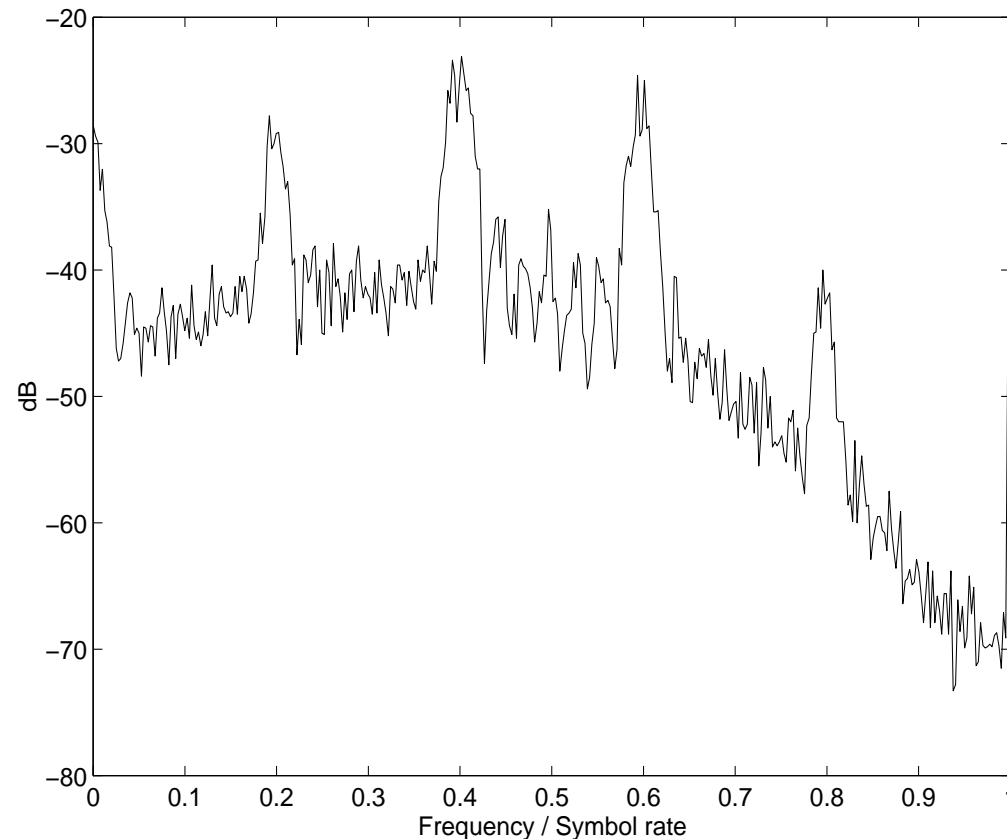
S100 data sent over a S800 link.

S100 nibble stream:

$N_1 N_2 N_3 N_4 \dots$
 └─▶ 4 data bits

S800 stream:

$N_1 \overset{\text{4 zero bits}}{\text{00000000}} N_2 \overset{\text{4 zero bits}}{\text{00000000}} N_3 \dots$



LSBs padding - IBM 8b10b

S100 data sent over a S800

link.

S100 byte stream:
ABCD...

└─► b₁b₂b₃b₄b₅b₆b₇b₈

S800 *bit* stream:

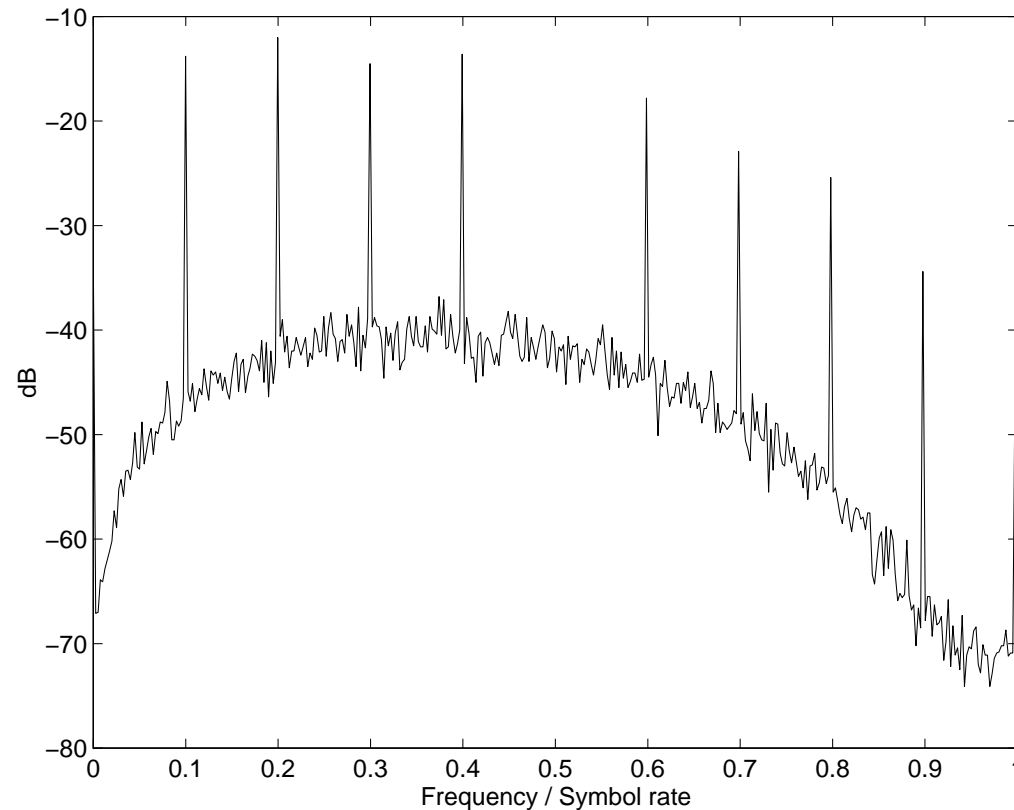
a₁0000000a₂0000000

a₃0000000a₄0000000

a₅0000000a₆0000000

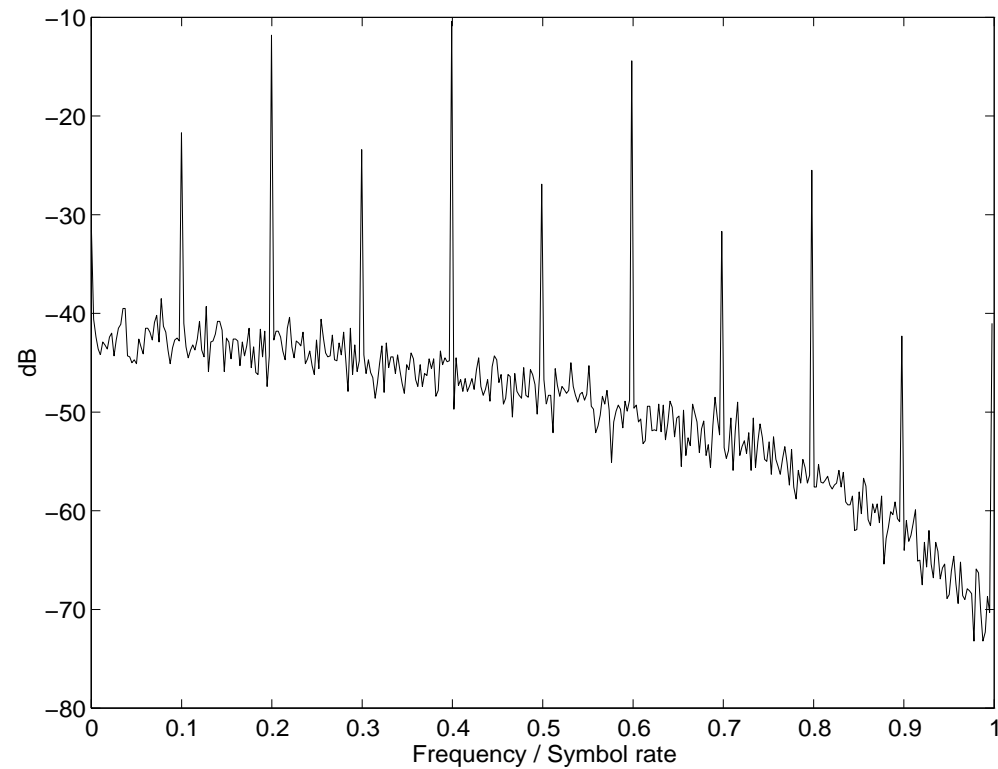
a₇0000000a₈0000000

b₁0000000b₂0000000...



LSBs padding - FDDI 4b5b

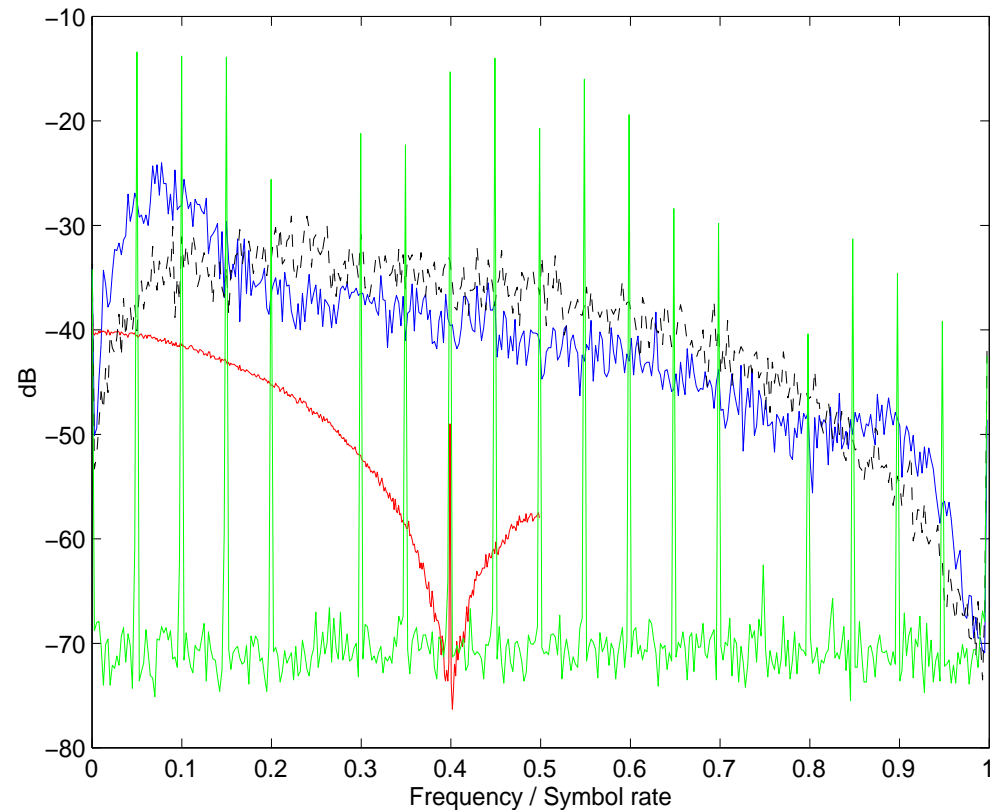
Same system as
previously (IBM 8b10b
case).



Modified IBM 8b10b - Control stream

black: IBM8b10b data
blue: new control words
green: IBM8b10b idle words
red: NRZ at S400

Note: S800 uses 1 V p-p
S400 uses 250 mV p-p



Summary

- Repetitive signals cause spectral lines and concentration of energy at a few frequency points. Examples shown include:
 - Sony 4b5b Idle signalling (10101010....)
 - IBM 8b10b Idle signalling (repeated K28.5-D5.0)
 - Transmission of S100 packet over S800 link with zero padding
- This makes life harder to be sure that systems pass FCC class B - further testing should be done with emission measurements.
- Using a scrambler gives smooth spectrum and makes life easier at almost no cost.