Eye Pattern Generator (EPG) Board for the Dragon Board

National Semiconductor
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INTRODUCTION

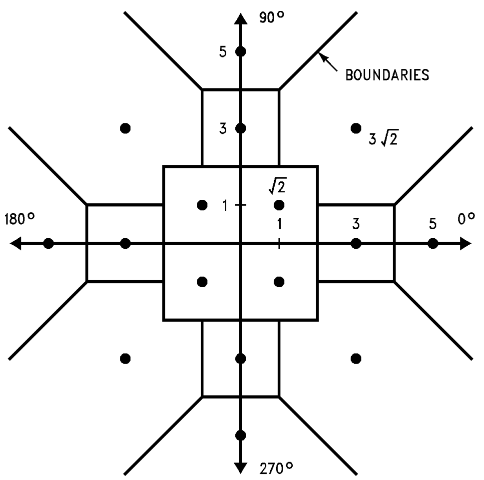
This application note describes an Eye-Pattern Generator (EPG) board that can be used to provide a variety of detailed diagnostic information for the modem design engineer while using the DRAGON board. This data is extremely useful in the evaluation of the modem performance and line conditions.

GENERAL

The Eye Pattern Generator board is connected to the I/O slot of the DRAGON. It converts digital data to an analog voltage that can be measured and displayed on a scope. The purpose of this board is to support debugging of the modem by displaying the complex numbers that have been received from the modem, in real time, showing the constellation points. The modem SW writes data to the EPG.

EYE PATTERN

A quadrature eye pattern is an extremely useful diagnostic tool. The visual display of an eye pattern can be monitored to identify common line disturbances, as well as defects in the modem process. The ideal eye patterns or signal constellations for the various encoding methods are illustrated in *Figure 1* to *Figure 6.* In the polar coordinates each point represents a magnitude and a differential phase shift. Eye pattern data is updated at the baud rate so the oscilloscope display appears as a continuous signal constellation.



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Q2	Q3	Q4	Phase Change	Absolute Phase	Q1	Relative Amplitude
0	0	1	0°	0°, 90°, 180°, 270°	0	3
0	0	0	45°C			
0	1	0	90°C		1	5
0	1	1	135°C			
1	1	1	180°C	45°, 135°, 225°, 315°	0	$\sqrt{2}$
1	1	0	225°			
1	0	0	270°		1	$3\sqrt{2}$
1	0	1	315°			

FIGURE 1. Ideal Eye Pattern—V.29/9600 bps

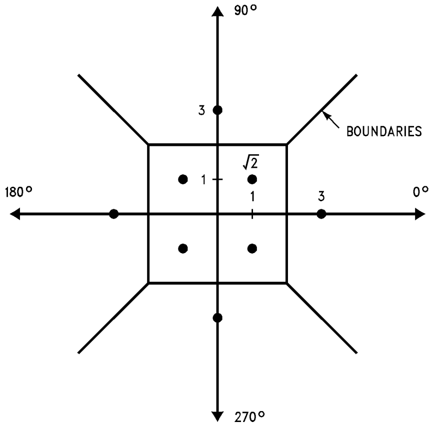

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FIGURE 2. Ideal Eye Pattern—V.29/7200 bps

Tribit Encoding: In V.29/7200 BPS Fallback mode, Data is encoded in Groups of 3 bits or tribits. The endcoding is as for V.29/9600 BPS above except that: The first data bit in time determines Q2 of the modulator quad-bit. The second and third bits in time determine Q3 and Q4, respectively. Q1 = 0 for all eight signal elements.

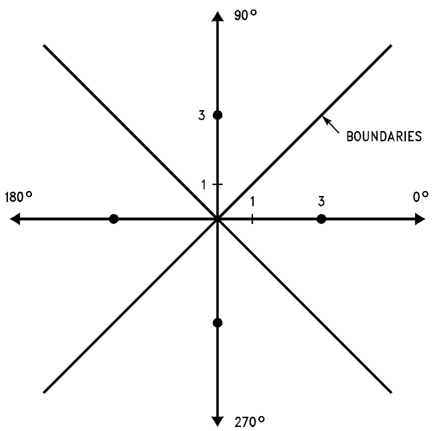

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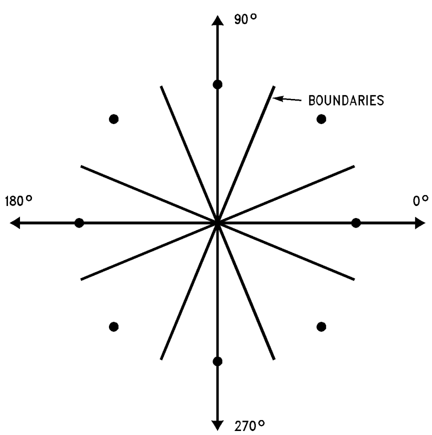
FIGURE 3. Ideal Eye Pattern—V.29/4800 bps and V.27/BIS/TER/2400 bps

Dibit Encoding

Data Bits	Phase Change	Relative Amplitude
00	0°	Constant
01	90°	
11	180°	
10	270°	

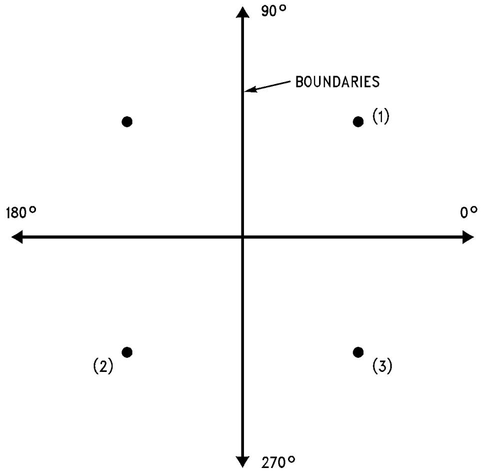


TL/EE/11183–4

FIGURE 4. V.27 BIS/TER/4800 bps

Tribit Encoding

Tribit Value	Phase Change	Relative Amplitude
0 0 1	0°	Constant
0 0 0	45°	
0 1 0	90°	
0 1 1	135°	
1 1 1	180°	
1 1 0	225°	
1 0 0	270°	
1 0 1	315°	



Dibit Values (1200)	Bit Values (600 bps)	Phase Change
00	0	+90°
01	—	0°
11	1	+270°
10	—	+180°

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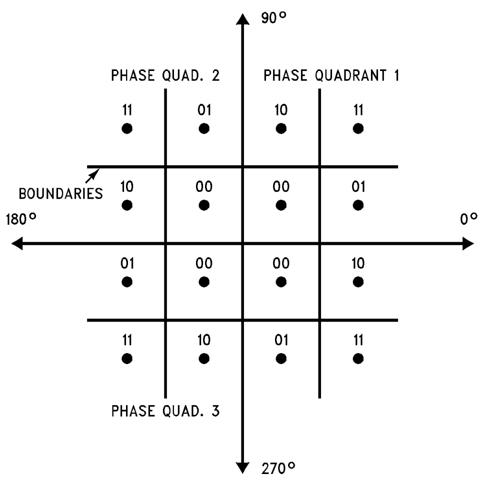
FIGURE 5. V.22 A/B 1200 bps/600 bps



Data is encoded in quadbits. The first two bits or dibit select one of four quadrants. The second dibit selects one of four points in that quadrant, as shown below.

First Two Bits in Quadbit [2400 Bit(s)] or Dibit Values [1200 Bit(s)]	Phase Quadrant Change	
00	1–2 2–3 3–4 4–1	90°
01	1–1 2–2 3–3 4–4	0°
11	1–4 2–1 3–2 4–3	270°
100	1–3 2–4 3–1 4–2	180°

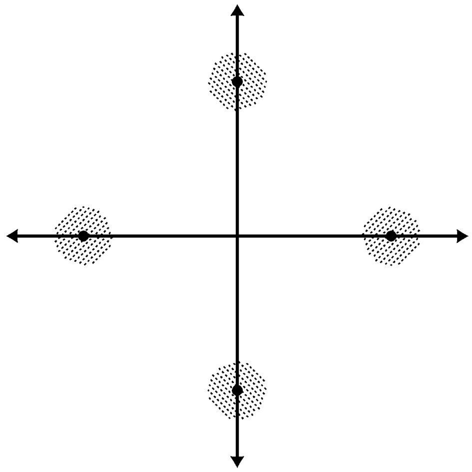
TL/EE/11183–6

FIGURE 6. V.22 BIS/4800 bps

LINE DISTURBANCES

The received signal is distorted by one or more types of line disturbances and distortions, such as white noise, phase and amplitude jitter, harmonic distortions, phase and amplitude hits and drop-outs (out of boundaries).

1. White noise produces a smearing of each signal constellation point around its ideal location (See *Figure 7a*).
2. Phase jitter produces periodic phase smearing with little or no amplitude effect (see *Figure 7b*).
3. Amplitude jitter produces an effect similar to harmonic distortion, but in this case the distortion is periodic.
4. Harmonic distortion produces a non-periodic amplitude smearing with little phase effect (see *Figure 7c*).
5. An amplitude or phase hit is associated with an instantaneous big error in the amplitude or the phase of the signal.
6. The degree of smearing in the eye pattern is proportional to the severity of the particular disturbance. Several disturbances may occur simultaneously producing a complex smearing of the eye pattern. A point falling within the signal space delimited by boundaries is decoded by the modem as if it were located at the ideal point within that space. When a line disturbance causes the signal point to cross a decision boundary, the received signal is incorrectly decoded.



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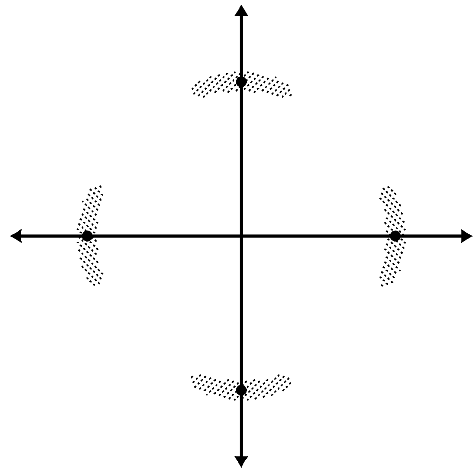
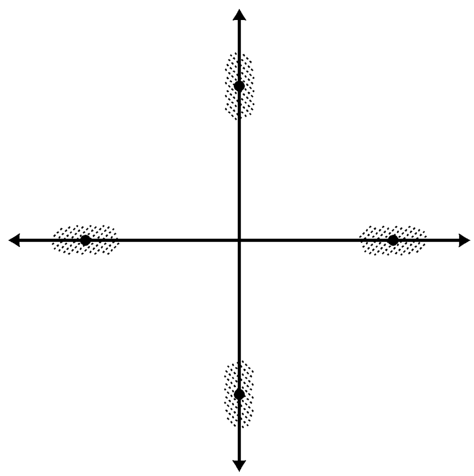
A. White Noise



TL/EE/11183–8

B. Phase Jitter



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C. Harmonic Distortion (Non-periodic) amplitude jitter (periodic)

FIGURE 7. Typical Line Disturbances

DATA FORMAT

There are two channels on the card. Each of them displays a single byte. The bytes should contain numbers, represented by a 2's complement format, and they must be transferred to the EPG by ''move byte'' operation.

DISPLAY

The bytes can be displayed using the X ⟷ Y function of the scope (for eye-pattern display, were the data is two complex numbers), or X and Y as a function of time. J1 (channel 1) displays the data that has been sent to address 0x0fffd60, and J2 (Channel 2) displays the data that has been sent to address 0x0fffd62.

CONFIGURATION

The EPG board is connected to the I/O slot of the DRAGON board. It has four connectors.

P1—Connected to the I/O slot of the DRAGON board.

P2—Connected to +12 VDC and −12 VDC.

J1, J2—Two BNC connectors.

USAGE

To display the channels on the scope you have to connect the scope using a BNC to BNC cable, to the BNC connectors (J1 and J2) of the EPG. If the bytes are samples of the data it is possible to display them using the X ⟷ Y mode of the scope, and in that way to get the eye pattern of the constellation points.

NS—MODEM

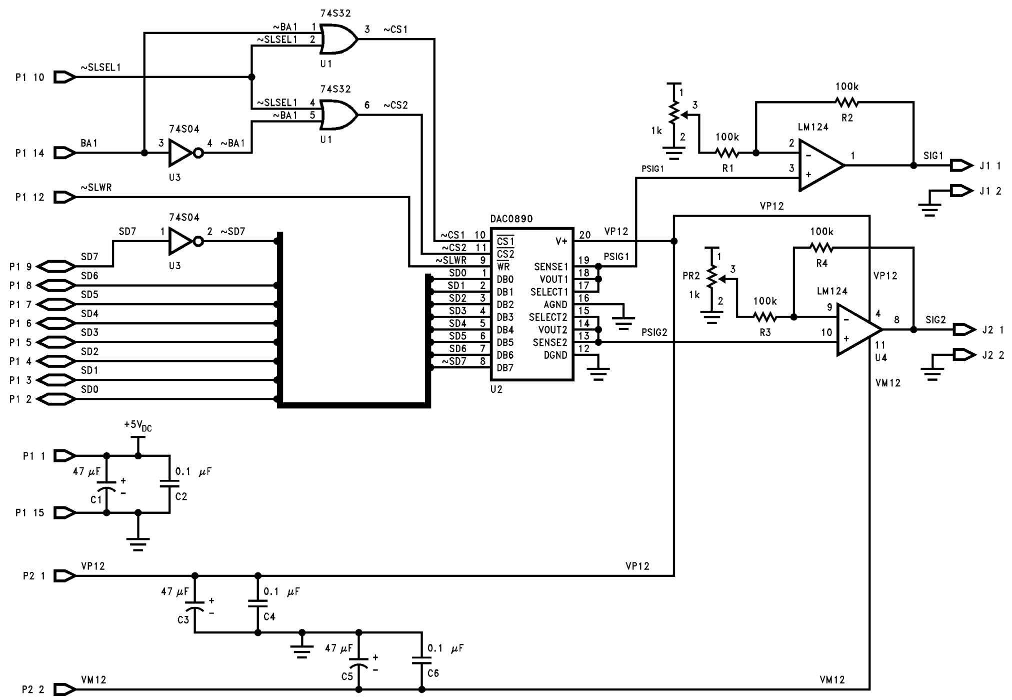
The NS MODEM uses the EPG for debug. It displays a complex-plane representation of the received/transmitted points (both real and imaginary components are used together).

ADDRESSES

The addresses that used for channel 1 (J1) are the even addresses from 0x0fffd40 to 0x0fffd7c that A1 is 0. The addresses that used for channel 2 (J2) are even addresses from 0x0fffd42 to 0x0fffd7e that A1 is 1. A0 is ignored. The data must be asserted as byte addresses instructions (movb).

CIRCUIT DESCRIPTION

The DRAGON's NSFAX ASIC asserts $\overline{\text{SLSEL1}}$ when addresses 0x0fffd40—0x0fffd7f are accessed. According to BA1, the appropriate $\overline{\text{CS}}$ is asserted to the DAC0890 ($\overline{\text{CS1}}$ when BA1 = 0 and $\overline{\text{CS2}}$ when BA1 = 1), and the DAC0890 latches the data from the data bus to the appropriate latches when $\overline{\text{SLWR}}$ is asserted. The MSB (D7) is inverted because the data is in 2's complement format. The analog signal output is biased around 0 VDC by operational amplifiers. The potentiometers (PR1 and PR2) are used to calibrate the board outputs (at J1 and J2) to 0 VDC while a value of zero is transferred to the DAC.



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Eye Pattern Generator for Dragon

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