SystemView Times

LEAD STORY

ELANIX Extends SystemView Platform to Third Party Developers

-- New User Code option Provides Open Environment for Application Specific Library Development

In an expanded new release of it's SystemView User Code option, ELANIX has introduced a powerful mechanism for the implementation of third-party optional libraries. The SystemView User Code option version 1.8-6 for the first time allows users and developers to create multiple libraries of custom functions that integrate seamlessly into the SystemView environment. In addition, the User Code has been improved to allow any token contained inside a custom library to incorporate any or all of the characteristics of a standard SystemView token.

The SystemView User Code option was designed from the start to:

1. Allow users to quickly and easily create custom tokens for their own use.
2. Allow users to create multiple custom token libraries for their own use.
3. Allow third party developers to create and market application specific libraries for use with SystemView.

The User Code library allows users and developers to build custom, application-specific token libraries for use with SystemView. All User Code functions are members of one or more Windows 3.1x, Windows 95 or Windows NT dynamically linked library (DLL). The functions are written in C or C++ and compiled with standard compilers including Borland

USER NEWS

SystemView32 Now Available

ELANIX has just introduced a powerful new 32-bit version of it's PC based dynamic system simulator; SystemView by ELANIX. The new release, SystemView32, offers performance 2x to 10x greater than the 16-bit version of the tool. SystemView32 also incorporates a powerful new tool for real-time dynamic signal analysis; the Dynamic System Probe™.

SystemView 32 Sets New Performance Records

Users can expect improvements ranging from two to ten times greater than the 16-bit version of the tool in simulation and waveform display speeds, depending on the platform and its configuration. SystemView32 fully exploits the direct 32-bit addressing capability provided by Windows 95 and Windows NT. This means that all CPU cycles associated with indirect addressing are eliminated, and that the SystemView user experiences faster system simulations. The multi-thread execution mode also provides reduced execution times. The SystemView32 executable file and all dynamically linked libraries (DLLs) are written in fully optimized 32-bit code.

Dynamic System Probe Provides "Real-Time" Signal Analysis

The Dynamic System Probe is SystemView32's powerful new utility for dynamic signal analysis. This new tool provides "real-time" signal analysis in the time and/or frequency domain. Using the
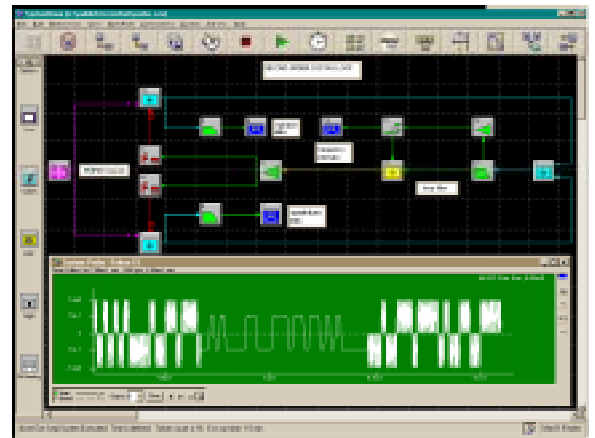
SystemView32 features performance two to ten times greater than the 16-bit version. This release is also equipped with the Dynamic System Probe™ for "real-time" signal analysis during system execution.

Dynamic System Probe, the user may view the output waveform produced by any functional block in real time.

"The Dynamic System Probe enables designers to perform debug and design optimization more rapidly than ever before," said Geoff Chatfield, Director of Marketing at ELANIX. "In previous

Inside This Issue:

RF Mixer Behavioral Model

By Stephen H. Kratzet, ELANIX, Inc.

T he SystemView mixer MetaSystem described below is based on the measurements taken from a hardware I/Q Down-converter (Figure 1) module developed and manufactured by ELANIX, Inc, the IQ-200. The model is based on measurements of the Mini-Circuits™ SRA1-1.
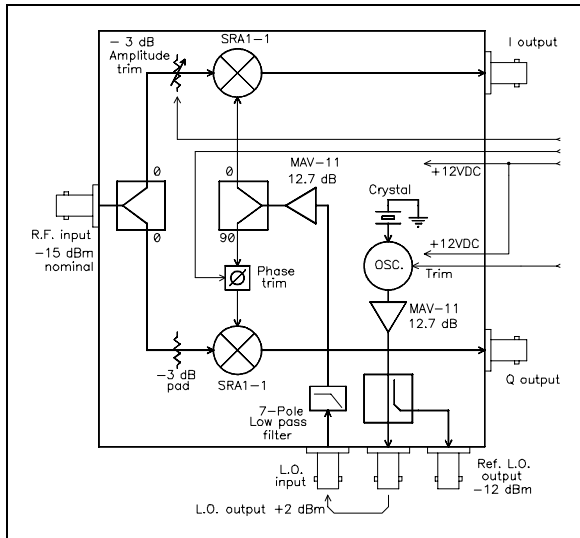

Figure 1. Block Diagram of the ELANIX IQ-200-RF-10.7 MHz down-converter module.

This MetaSystem approximates the operation of an RF mixer over a reasonable range of input amplitudes. A controlled amount of noise, RF and LO port leakage is also present at the output. The MetaSystem in Figure 2 works as follows:

Each of the inputs to the mixer is passed through a Function Limiter. The limiter parameters Min Input and Max Output are set equal to each other to cause the token to operate as a clipping function. A signal with an amplitude less than the limit value will pass through unchanged while amplitudes larger than the limits are clipped.

Each of the two clipping tokens are followed by a Polynomial token that gives an offset voltage to the signals, simulating less than perfectly matched diodes. These offset values determine the amount of LO and RF leakage present at the IF output. The amplitude of the RF signal is reduced by 0.5 dB before going into the multiplier token to simulate the transformer losses.

The amplitude of the clipped LO signal is increased before going into the multiplier token. To be consistent with a hardware mixer that has a negative output when both inputs are the same phase, the multiplier output is inverted. A base value for the noise may be set, and this base value may be set up or down by entering a dB parameter in the gain token.

The model has no provision to limit the mixer's frequency response. Another limitation of the model is that the mixer performs mixing no matter how weak the LO becomes.
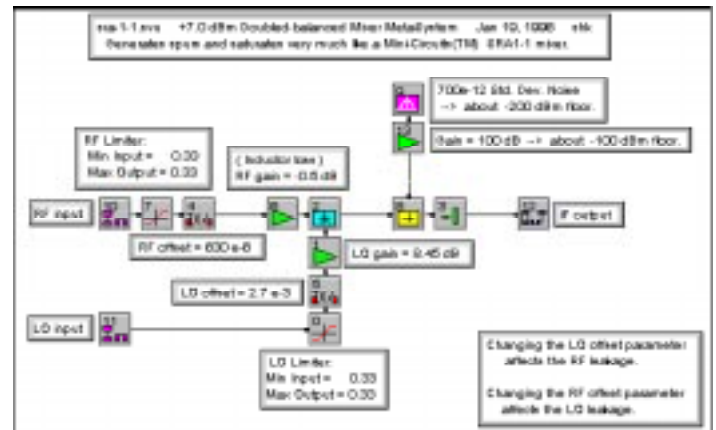

Figure 2. Mixer MetaSystem (sra1-1.mta).

When using the mixer, the SystemView sample rate is set to about 10 times the input frequency. This is necessary because the mixer harmonics mix with the sampling rate frequency causing aliasing spurs down at the lower frequencies. Since the higher order spurs are lower amplitude, their aliasing effect is less visible. The use of power-of-two numbers avoids the bin-splitting effects when the FFT is performed and gives a cleaner display for this particular test. Setting the Freq. Res. parameter to an integer value is helpful here when specifying the SystemView time values.

A future update of the SystemView RF/Analog Library will contain this behavioral model as an explicit token complementing the current mathematical model. Application Note AN101 contains a detailed discussion of RF mixer behavioral modeling, including examples that show:

- A simple procedure to adapt the model to other mixers,
- Mixer systems with normal and overdriven inputs and the output plots,
- A typical output spectrum,
- An I/Q demodulator with normal and overdriven inputs.

To receive Application Note AN101 and/or the MetaSystem described in this article (*sra1-1.mta*), contact ELANIX customer support at 818.597.1414 or download from the Internet at *www.elanix.com*.

The IQ-200 has been in production since 1993 and is available in several configurations. Contact ELANIX sales at 818.597.1414 for technical specifications and pricing information. ◆

Mr. Kratzet can be reached at:
818.597.1414, support@elanix.com

Microwave Receiver Design

The March 1996 issue of Penton's *Microwaves & RF* Magazine (p. 145) features a technical article on microwave receiver design by Special Projects Editor Alan Conrad. In the article, SystemView is used to simulate a mixed-signal system with a digitally sampled RF front end. To receive a copy, contact ELANIX marketing at 818.597.1414. ◆

When is 0 dBm = -2.5 dBm?

By Maurice Schiff, Ph.D., ELANIX, Inc.

*H*ave you ever used the Moving Average (found under the Operator tab in the Sink Calculator) or clicked the Statistics button on the toolbar to estimate the average dBm level in one of your spectral displays? Were the results not what you expected? This article explains why averaging dBm (or dB) can be dangerous-- and not just in SystemView!

Try this simple experiment in SystemView. Take a source token, define it as noise, select the spectral density option and enter .001 W/Hz (0 dBm/Hz). Now connect the source to a sink and run the system. Go over to the analysis window and in the sink calculator choose the Spectrum tab, and choose PSD (dBm/Hz) in 1 ohm. Click on the statistics button and read the mean as something like -2.5 dBm. But the input was chosen to be 0 dBm. Why the difference?

The answer is that the PSD is a random variable x, and for any function f(x) it does not necessarily follow that,

$$E[f(x)] = f(E[x])$$

In this case, $f(x) = 10\log_{10}(x)$.

The FFT algorithm computes a complex number for each bin $(I_m + jQ_m)$, where;

$$I_m = \sum_{k=0}^{k=N-1} x_k \cos[2\pi km / N]$$

$$Q_m = \sum_{k=0}^{k=N-1} x_k \sin[2\pi km / N]$$

where N is the number of points in the FFT. For the input noise samples, $\{X_k\}$ is a Gaussian random variable (G.R.V.), $[0, \sigma^2]$.

To obtain W/Hz in 1 ohm for the m-th FFT bin, the algorithm

$$z_m = (2 / Nf_s)[I_m^2 + Q_m^2]$$

is used, where f_s is the system sample rate. The statistics sink calculates the mean $\hat{z}$ as;

$$\hat{z} = \frac{1}{N}\sum_{m=0}^{N-1} z_m$$

In addition, a mathematically equivalent method for computing $\hat{z}$ is to calculate the expected value of the random variable Z_m. By the symmetry of the problem, the answer is independent of the FFT bin m, so we drop the subscript from here on. The variables I and Q are independent G.R.V. $[0, N\sigma^2/2]$. Thus the calculation for $\hat{z}$ can be written as;

$$\hat{z} = E[z] = \frac{[2 / Nf_s]}{[\pi N\sigma^2]} \iint [I^2 + Q^2] \exp[-(I^2 + Q^2) / (N\sigma^2)] dIdQ$$

$$= [2 / Nf_s]2(N\sigma^2 / 2) = 2\sigma^2 / f_s \equiv N_0$$

where N_0 is the desired noise power density (W/Hz). Note the answer is independent of N and f_s.

The mean of the log(z) can be written in the same way as;

$$E(10\log_{10}z) = \frac{10}{\pi N\sigma^2} \iint \log_{10}\{\frac{2y}{Nf_s}\} \exp[-y / N\sigma^2] dIdQ$$

where $y = I^2 + Q^2$

This integral is not as fearsome as it looks. The trick is to change variables of integration from rectangular to polar coordinates $[I = r\cos(\theta), Q = r\sin(\theta)]$. The integrand is a function of r only, and the angle variable, θ can be integrated out in a trivial manner. The resulting r integral is;

$$E\{10\log_{10}z\} = \frac{10}{(N\sigma^2 / 2)} \int_0^\infty \log_{10}\{2r^2 / Nf_s\} \exp[-r^2 / N\sigma^2] rdr$$

now we write

$$10\log_{10}[2r^2 / Nf_s] = 10\log_{10}[2 / Nf_s] + 10\log_{10}[r^2]$$

and change variables to $u = r^2$. The resulting expression becomes;

$$E(10\log_{10}z_m) = 10\log_{10}(2 / Nf_s) + \frac{1}{(N\sigma^2)} \int_0^\infty 10\log_{10}\{u\} \exp[-u / N\sigma^2] du$$

$$= 10\log_{10}(2 / Nf_s) + \frac{10\log_{10}e}{N\sigma^2} \int_0^\infty \ln\{u\} \exp[-u / N\sigma^2] du$$

This last integral (believe it or not!) can be found in a Table of Integrals as;

$$\int_0^\infty \ln(u) \exp[-\alpha u] du = -\frac{1}{\alpha}[C + \ln(\alpha)]$$

$$C = Eulers's\ constant = .577215.....$$

Making this substitution and combining terms gives;

$$E(10\log_{10}z_m) = 10\log_{10}(N_0) - 10C\log_{10}e$$

$$= 10\log_{10}(N_0) - 2.5068$$

Theoretically, the expected value of the log of the PSD will read 2.5068 dB lower than the log of the expected value. This agrees with our SystemView experiment. ◆

Dr. Schiff can be reached at:
818.597.1414
support@elanix.com

Quadrature Oscillators and Filter Token Modifications

An easy way to generate a voltage-controlled quadrature oscillator in SystemView is to use two FM tokens, set 90 degrees apart in phase. Some of the example systems in your *Systemvu* subdirectory use this technique. The Costas loop in Figure 1 is one of these examples. Here, the I channel has a +90 degree offset, while the Q channel has a zero degree offset.
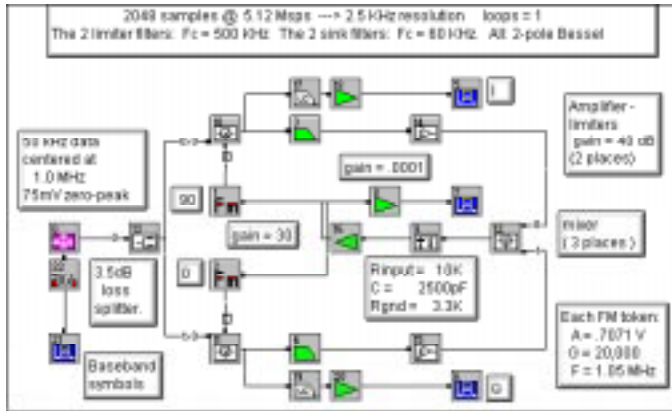

Figure 1. Costas-r.svu
(From the c:\systemvu\examples\rflib directory).

Another way of generating the quadrature outputs is to use only one FM token and follow it with a R-C highpass and a R-C lowpass filter (Figure 2). The RC Deriv token is used for the highpass filter to produce a +45 degree phase shift. The PLL RC1 token is used for the lowpass filter to produce a -45 degree phase shift. To obtain the original 90/0 degree phase shift, the FM token is set to +45 degrees. Also, because each of the filters have a 3 dB loss at their operating frequency, the FM token's output amplitude is set 1.414 times higher than the original value.
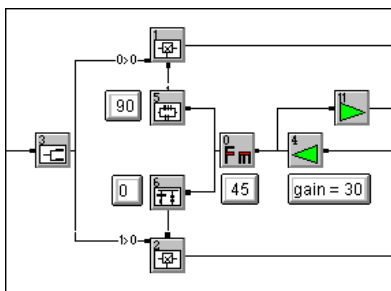

Figure 2. The one FM token quadrature oscillator.

Figures 3, 4, 5, and 6 show the design windows and Bode plots for the two filters. Notice that all of the components in this type of token do not have to be used. Since only a simple RC filter was needed, the unused components were set to zero or a very large value.
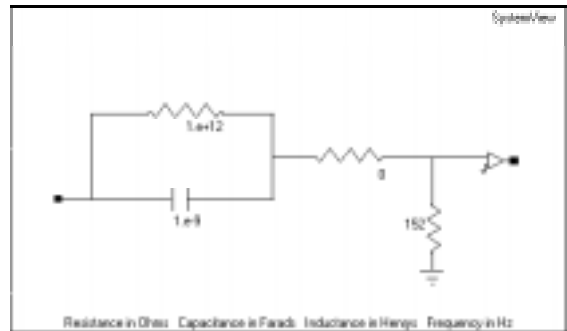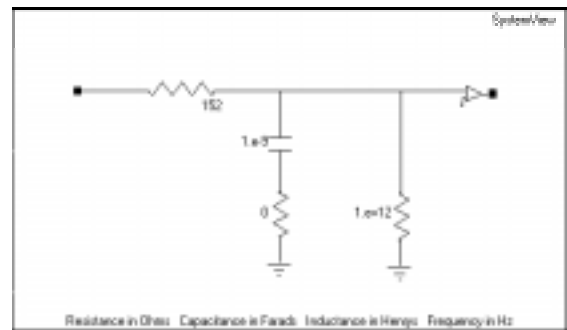

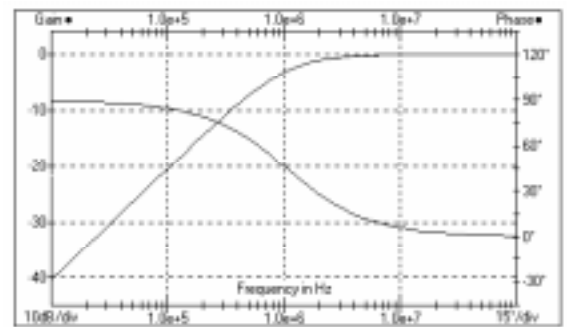Figure 3. RC Deriv design window.

Figure 4. PLL RC1 design window.

Figure 5. RC Deriv Bode plot.
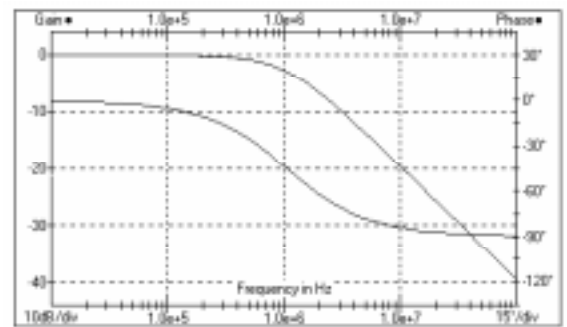
Figure 6. PLL RC1 Bode plot.

Quadrature Oscillators

(continued from page 4)

The parts values were calculated as follows: First, for this example of a 1.05 MHz FM token, the capacitor value was selected to be 0.001 µF (1.e-9). Then, the resistor Xc was computed.

$$Xc = 1 / (2 \text{ PI f C})$$
$$= 1 / (2 \times \text{PI} \times 1.05e6 \times 0.001e{-}6)$$
$$= 152 \text{ ohms}$$

When the Costas loop in Figure 1 is modified by using the +/- 45 degree filters, its loop response remains unchanged, except for the initial startup. There is a small delay before the two filters stabilize.

Your first reaction on seeing the R-C filters may be; "This will only work for a fixed frequency LO or only over a very narrow band LO". Let's look at another example. One of today's ISM bands (Industrial, Scientific, Medical) allows frequency hopping or direct sequence systems over the following range: 902 - 928 MHz   Selecting a capacitor value of 3.3 pF and 915 MHz as the center frequency:

$$Xc = 1 / (2 \text{ PI f C})$$
$$= 1 / (2 \times \text{PI} \times 915e6 \times 3.3e{-}12)$$
$$= 52.7 \text{ ohms}$$

Calculating Xc for the band edges:

902 MHz --> 53.5 ohms +1.5%
928 MHz --> 52.0 ohms -1.3%

The capacitor value deviation of less than 2% indicates that this is an acceptable range of operation for the LO.

A refinement of this technique is to include limiter amplifier after the filters. (Ref. 1).

References:
1. RF MICRO DEVICES, Inc., 1995 Designer's Handbook, Technical Article, *"A Direct Quadrature Modulator IC for 0.9 to 2.5 GHz Wireless Systems"*. ◆

User Code Option

(continued from page 1)

C++, Metaware High C/C++, Microsoft Visual C++, Symantec C++, Watcom C/C++.

Qualified developers may be granted the use of the SystemView by ELANIX logo and other trademarks after review and approval by ELANIX. Additionally, ELANIX may explore joint marketing activities with developers.

For further information on the ELANIX third party developer program, please contact ELANIX marketing at 818.597.1414. ◆

Frequency/Phase Response and Bode Plots in SystemView

A common question that occurs in a system design is: "What is the frequency response of this portion of the circuit?"   or "What does the Bode plot of the circuit look like?" Three areas in SystemView that are relevant to these questions will be described. A filter example will be used, but the comments apply to all linear systems. For clearer viewing most of the plots have been zoomed-in using Ctrl-right-mouse-click-and drag.

1. The simple system in Figure 1 contains two linear system tokens, a highpass filter and a lowpass filter. When a filter is being specified as a LinearSys token located in the Operator library, the Bode plot button at the bottom of the design window may be used to produce a plot similar to the one in Figure 2. This plot is calculated from a Laplace function and is the ideal transfer function of the filter, ignoring the system sample rate.
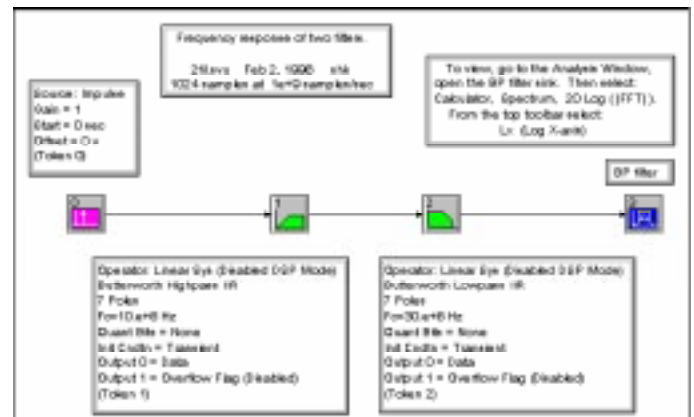

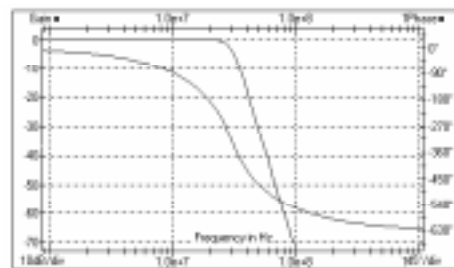Figure 1. A system with multiple (two) Linear System tokens.
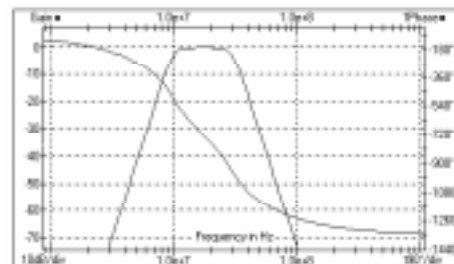

Figure 2. Filter design window.

Figure 3. System window Bode plot.

Bode Plots

(continued from page 5)

2. The Bode plot of both filters in series may also be viewed. In Figure 1 both filters have been specified, and connected in series, with a source and a sink. Any source may be applied to the system, including a zero amplitude signal. Just select the Bode plot toolbar button (3rd from the right, top).

The menu presents 3 choices in way the Bode plot is calculated:

S-Domain (Continuous)	Ignores the system sample rate.
Z-Domain (Time Discrete)	Uses the system sample rate.
Z-Domain (with Enforced Delay)	Uses the system sample rate.

The Enforced Delay mode is useful only if there is a feedback path in the system. The S-Domain (Continuous) Bode plot of Figure 1 was used to produce Figure 3.

3. A third way to view the frequency response of a system is to set the source to be an Impulse gain = 1 token, Run the system simulation and go into the Analysis Window. Open the BP filter sink (Figure 4.) and observe the system's impulse response. The frequency response in Figure 5 is obtained by the following procedure: Select Calculator, Spectrum, 20 Log (|FFT|), OK. From the top toolbar select Lx (Log X-axis).

To get the phase plot in Figure 6, make the impulse response (Figure 4.) the active window and select: Calculator, Spectrum, Phase Unwrapped, OK. From the top toolbar select Lx (Log X-axis).
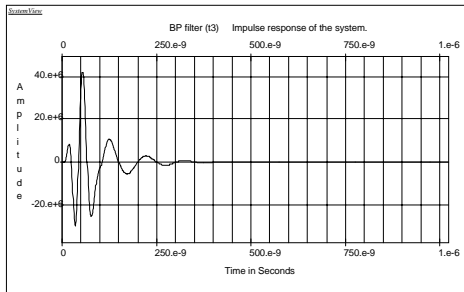
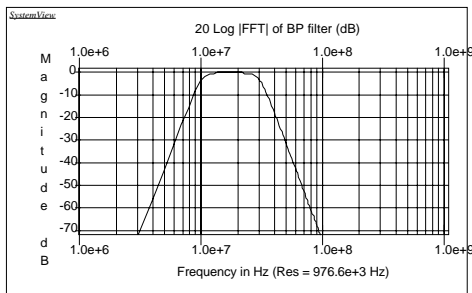Figure 4. Analysis window impulse response.

Figure 5. Analysis window frequency response.

If a plot of the time delay of the system is desired (Figure 7) take the derivative of the phase plot. To do this make the phase plot the active window (click on it) then select: Calculator, Operators, Differentiate, OK. Then select: Calculator, Scale, Scale Axis, Multiply X-axis by 1, Multiply Y-axis by -pi. (Either -pi or -3.14159... may be entered.)
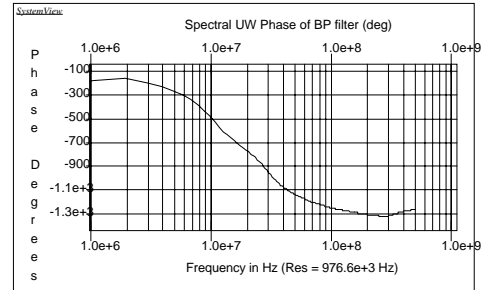
Figure 6. Analysis window phase plot.
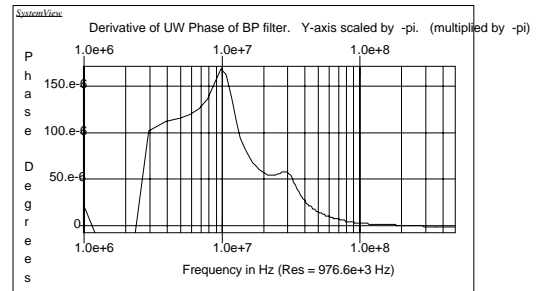
Figure 7. Analysis window delay plot.

GENERAL NOTES: It is best to Compile a system before setting the parameters in a linear system token. That will allow each of the tokens to know what the incoming sample rate is. This is especially important when there is a sampler or a decimator in the system. To compile a system, select System...Compile System Now from the menu bar in the System window. (Select Run System Simulation to both compile and run the system automatically.) ◆

Brain Teaser

Each issue of the SystemView Times will contain a "brain teaser" of the type shown below. The answer will appear in the succeeding issue.

A student writes home with the following message:

```
  SEND
+MORE
 MONEY
```

How much does he want? HINT: There is a unique assignment of letters to numbers. ◆

New Communications Models Available

SystemView version 1.8-5 was released in February, 1996. Version 1.8-5 includes a number of new models for wireless communications systems such as digital cellular and digital cordless phones, wireless WANs, and LANs, and PCS.

The latest additions to the System-View Communications library include a Phase Shift Keying (PSK) Demodulator, a Bit Interleaver, a Bit Synchronizer, a Gray Encoder/Decoder, and a Constant Modulus Algorithm (CMA) Equalizer. Other new tokens include a Gaussian Filter, a Pulse token, a Multiplexer token, and a Variable Sampler token. Combined with the existing models in the Communications library, these complex blocks simplify the implementation of applications such as Pi/4 Differential Quadrature Phase Keying (DQPSK), a modulation technique used heavily in digital cellular applications. The Gaussian Filter is a key element of both Gaussian Minimum Shift Keying (GMSK), and Gaussian Frequency Shift Keying (GFSK) modulation techniques for wireless WANs and LANs.

To receive example files related to these applications, Contact ELANIX customer service at 818.597.1414, or download from the Internet at www.elanix.com. ◆

Free SystemView32 Upgrade for Maintenance Customers

Current users with maintenance purchased prior to May 1, 1996 may upgrade to SystemView32 for free. To receive your upgrade, contact ELANIX customer service at 818.597.1414.

An evaluation version of System-View32 is available from ELANIX at 818.597.1414. You may also download the evaluation software over the Internet at *www.elanix.com*. ◆

$100 Author's Award!

Elanix actively promotes and sponsors the exchange of techniques and useful technical information throughout the SystemView user community.

We offer a $100 author's award for articles contributed by SystemView users and published in the SystemView Times.

Articles can discuss any topic of interest to the SystemView user community. Call 818.597.1414 for details or fax your ideas to: Editor, SystemView Times, 818.597.1427. ◆

SystemView32
(continued from page 1)

releases of SystemView by ELANIX, we enhanced it's analysis capabilities with a complete range of block processing operations for post-processing of simulation data. The addition of real-time signal analysis now dramatically simplifies what is typically the most time consuming portion of the design cycle."

After activating the probe, the designer clicks the execute button to begin the simulation run. As the simulation is executed, the designer simply points and clicks on any block in his system to instantly view the signal waveform at the output of the selected block. The signal may be viewed in time or frequency via a toggle button, and other controls give the Dynamic System Probe many of the analysis capabilities of a standard laboratory oscilloscope.

These controls include a persistence button for the creation of eye diagrams useful in communications applications, and internal and external trigger controls allowing synchronization between signals located in different subsystems, a reset button to restart the simulation, and pause and resume buttons that allow the user to observe and process interim results in the SystemView Analysis window.

The Dynamic System Probe also gives users the ability to dynamically modify system parameters (such as filter bandwidths, feedback loop gain, etc.) while the system is running.

In future maintenance releases, both 16-bit and 32-bit versions of the software will be upgraded. For each quarterly release, both tools will have identical new version numbers.

NOTE: Some new features, including the Dynamic System Probe, will be implemented only in the 32-bit version.

SystemView users with current maintenance purchased prior to May 1, 1996 may receive a free upgrade to System-View32. Contact ELANIX Customer Service for details.

An evaluation version of System-View32 is available from ELANIX at 818.597.1414. You may also download the evaluation software over the Internet at www.elanix.com. ◆

SystemView v. 1.8-6 To Feature RF/Analog Enhancements

SystemView v. 1.8-6 will be released in April 1996. As usual, the developers at ELANIX have been working feverishly to provide you with new and enhanced simulation capabilities.

Several modifications have been made to improve RF/Analog system modeling, including;

1. A new Global Noise Temperature parameter has been added allowing you to specify the operating temperature (T °K) associated with the noise in the RF library tokens.

2. The calculated noise in the RF/Analog tokens has been changed to model a 50Ω system. This eliminates the need for scaling required in previous versions of SystemView that modeled a 1Ω system.

3. The Gaussian noise source token has been modified to allow the user to choose W/Hz in a 1 ohm or a 50 ohm system.

4. The Amplifier token in the RF/Analog library has been improved to accurately model two tone IM products.

5. A Unit Conversion calculator has been added to SystemView. This calculator is available by selecting View...Units Converter from the System window menu, or by clicking on the equals (=) sign in the lower right corner of all Token Parameter Definition windows. ◆

SystemView Sales Information

If you're interested in further information about any of our products or would like to obtain an evaluation version of System-View, please contact:

ELANIX, Inc.
5655 Lindero Canyon Road,
Suite 721
Westlake Village, CA 91362
Phone: 818.597.1414
Fax: 818.597.1427
BBS: 818.597.0306
e-mail: elanix@elanix.com

International Distributors:

Europe
EnTegra Limited
2 Waltham Road, Maidenhead,
Berkshire SL6 3NH, U.K.
Phone: 44.01.628.829.061
Fax: 44.01.628.824.790
e-mail: tim@entegra.co.uk

Japan
Nepco, Incorporated
US Office
23552 Commerce Center Drive, Suite L
Laguna Hills, CA 92653
Phone: 714.837.3328
Fax: 714.837.3119
Tokyo Office
3-26-6-609 Aoto, Katsushika-ku
Tokyo, Japan 125
Phone: 03.3690.7424

Korea
Echo Microsystems
Suite 105, Kangbyeon Hanshin Core
Officitel, 350
Mapo-Dong, Mapo-Ku, Seoul, Korea
Phone: 82.2.704.5378
Fax: 82.2.704.5379
e-mail: echowon@nuri.net

Africa
Mission Electronic Systems
P.O. Box 3187
Benoni, 1500
South Africa
Phone/Fax: 27.157.59944
or 27.157.59721
e-mail: 100076.1014@ compuserve.com

Reader Service Card

Please help us keep our mailing list up to date by providing modifications or additions to your address and phone number in the space below. You can fax this form to us at 818.597.1427 or mail it to the address listed above.

Name: _____

Title: _____

Company: _____

Address: _____

_____

City, State:_____

Zip Code, Country: _____

Phone: _____

Fax: _____

E-mail: _____

❏ Please register me for a free subscription to the SystemView Times.

❏ Please have an applications engineer call me.

❏ Please remove me from your mailing list.

Please send me information on:

❏ SystemView Professional Edition

❏ SystemView Communications Library

❏ SystemView DSP Library

❏ SystemView Logic Library

❏ SystemView RF/Analog Library

❏ SystemView User Code Option (Create your own custom tokens!)

❏ SystemView Auto-Code Option