

In a signal processing system it is frequently necessary to calculate the modulus and argument of Complex numbers. This operation is particularly common after Fast Fourier Transforms or in coherent receiver systems. The evaluation of  $(x^2 + y^2)$  and  $\arctan(y/x)$  are far from easy, so approximations are often used. A common technique for estimating the magnitude of  $x + jy$  is to take the larger value of  $x$  or  $y$  and add to it half the smaller value. The PDSP16330 Pythagoras Processor is a dedicated DSP engine capable of accurate calculation of both magnitude (modulus) and phase (argument) of Complex data at a rate of 100ns per sample.

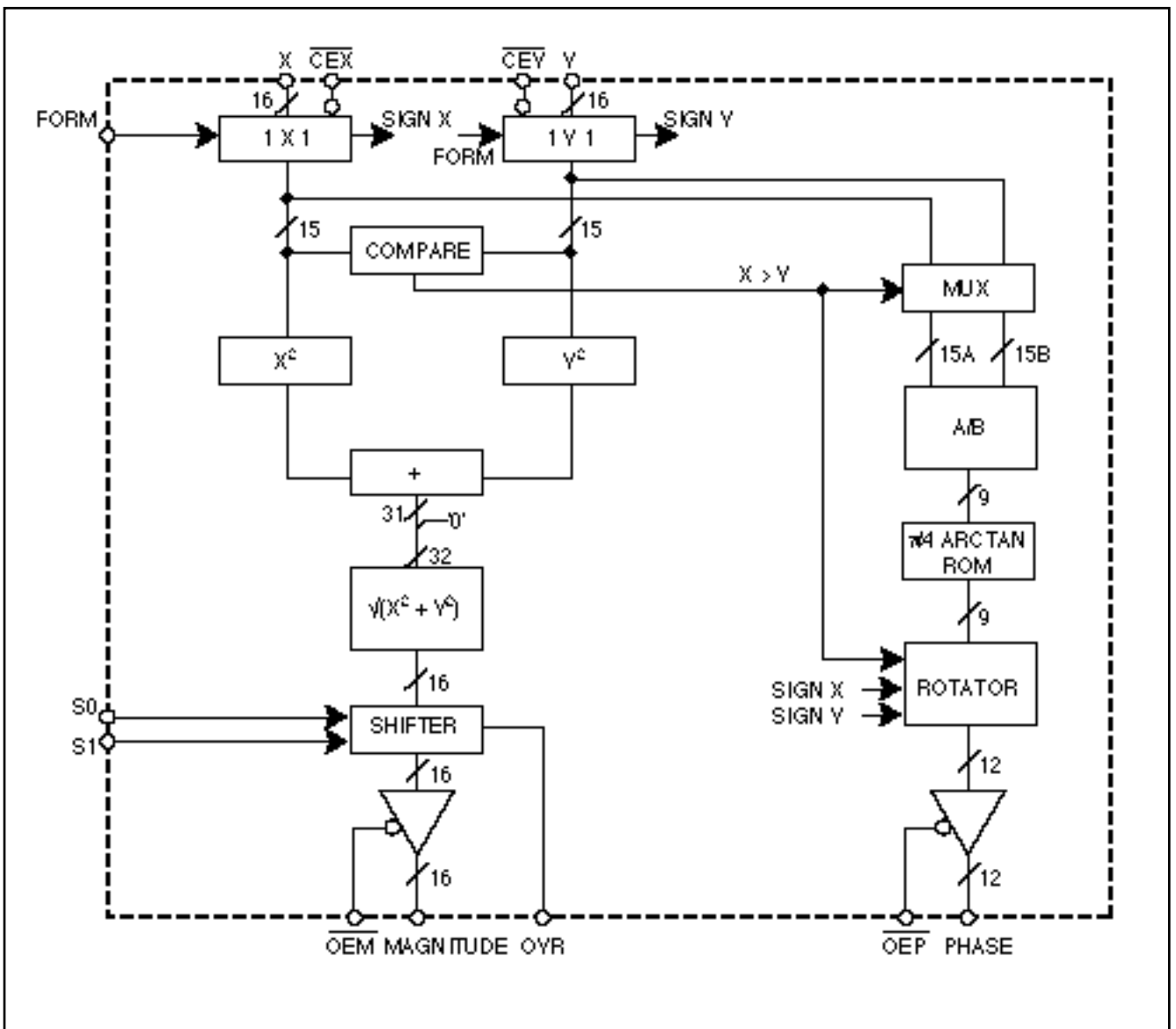


Fig.1 PDSP16330 Block diagram

## AB04

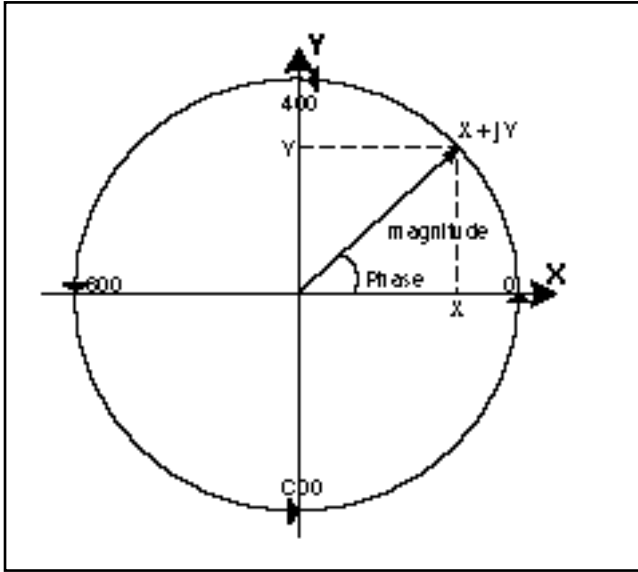


Fig.2

Fig.1 is the block diagram of the device, showing the separate paths for the root sum of squares and arctan ( $y/x$ ). Fig.2 shows the relationship between the complex input  $x + jy$  and the magnitude and phase outputs. Input data can be either 2's complement or sign/magnitude format, depending on the state of the FORM control line.

The magnitude output has a range from 0 to FFFF, four degrees of magnitude output scaling are available via the shift control lines S0 and S1. If the MSB is shifted out of the 0 to FFFF range the OVR flag becomes active, indicating an invalid output. The range of the phase output is 0 to FFF representing a full  $2\pi$  radians.

## APPLICATIONS

### FFT

After an FFT has been carried out the resulting data is complex. This complex data contains information on the magnitude and phase of individual spectral components, but a Cartesian to Polar co-ordinate transformation is required to extract the desired information.

### DEMODULATION

In coherent receiver systems the output from the IF stage will have two orthogonal components, I and Q. The carrier may be amplitude or phase modulated, or both. The Pythagoras Processor is used to extract the modulations from the I/Q data.

### ROBOTICS

There are many requirements in robotics, position control and position monitoring where conversion from Cartesian space (X, Y, co-ordinates) to polar space (range and angular position) is needed. The Pythagoras Processor is capable of these transformations at very high speeds making it suitable for use even in fast moving machines.



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