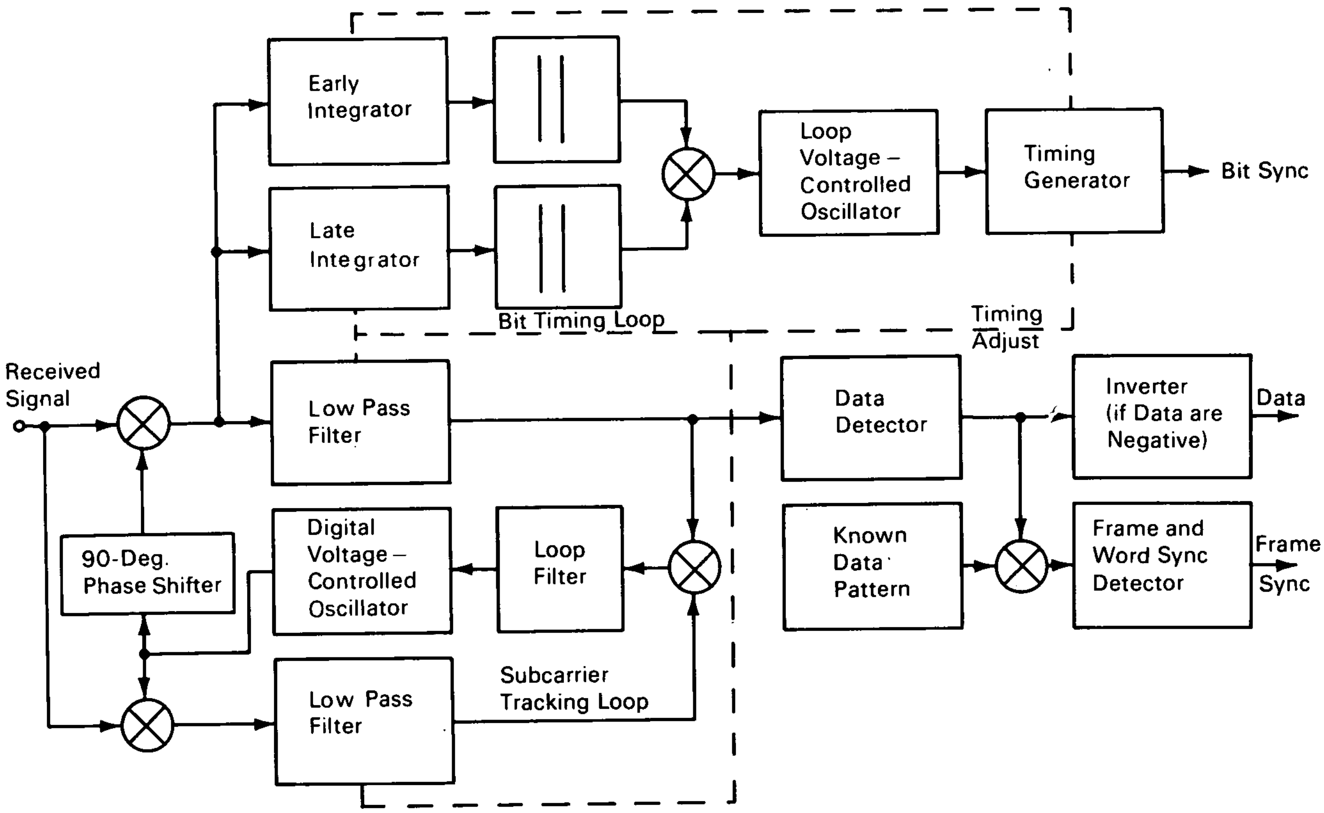
NASA TECH BRIEF

Digital Demodulation with Data Subcarrier Tracking



The concept of digital telemetry demodulation depends upon a computer algorithm to accomplish bit synchronization by testing the incoming data stream over intervals that are one-third of a bit time early and one-third of a bit time late with respect to the estimated data transition time. Correct bit synchronization results when the estimated timing intervals have been adjusted properly. This early-late timing scheme coupled with a Costas data tracking loop is the basis for the digital demodulator with data subcarrier tracking.

This system has been proven successful in the enhancement of weak signals (poor signal-to-noise ratios) from space where atmospheric and other interference media cause the bit error rate to reach an excessive level. A system such as this will prove useful in earth telemetry applications such as ship-to-shore, aircraft-to-ground station, and point-to-point com-

(continued overleaf)

mercial communications whenever low signal levels exist in the presence of noise.

The figure shows the digital demodulator in block diagram form. The lower section (subcarrier tracking loop) is a Costas loop. The phase of the data subcarrier is extracted from the suppressed carrier signal-plus-noise by multiplying the input voltage of the two low pass filters by that produced from the square-wave output of the digital voltage-controlled oscillator, and by a 90° phase shift of that voltage. The filter outputs are then multiplied, and this signal is used to control the phase and frequency of the loop voltage-controlled oscillator. When this control voltage is averaged over the probability of the noise and transitions, (1) the probability of a transition = the probability of no transition = 1/2; (2) the two noise functions are mutually independent; and (3) the signal and noise are mutually independent.

In the bit timing loop, the occurrence of a data polarity transition and the bit duration are determined. The digital demodulator accomplishes bit timing by integrating the input signal-plus-noise over a bit duration which begins one-third of a bit time before the local estimate of the bit transition marker. Independently, it is also integrated one-third of a bit time after the bit time estimate. When the absolute value of the difference or error signal derived from the two filter outputs is obtained, it will be zero if there is no error in the local estimate. If the error signal is not zero, the local estimate of the bit transition time is incremented and the integration start and dump time in the bit timing loop and subcarrier tracking loop are adjusted to produce a new error signal. Since the error signal is a function of the phase error and the bit timing error, and, assuming that these errors are slowly varying, it is then a probabilistic function only of the data transition and the noise.

Note:

The following documentation may be obtained from:

Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.65)

Reference:
NASA-CR-73514 (N69-15408), Digital Demodulation with Data Subcarrier Tracking

Patent status:

No patent action is contemplated by NASA.

Source: D. K. Sanger of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-10858)