Adjustable discriminator cleans up signal noise

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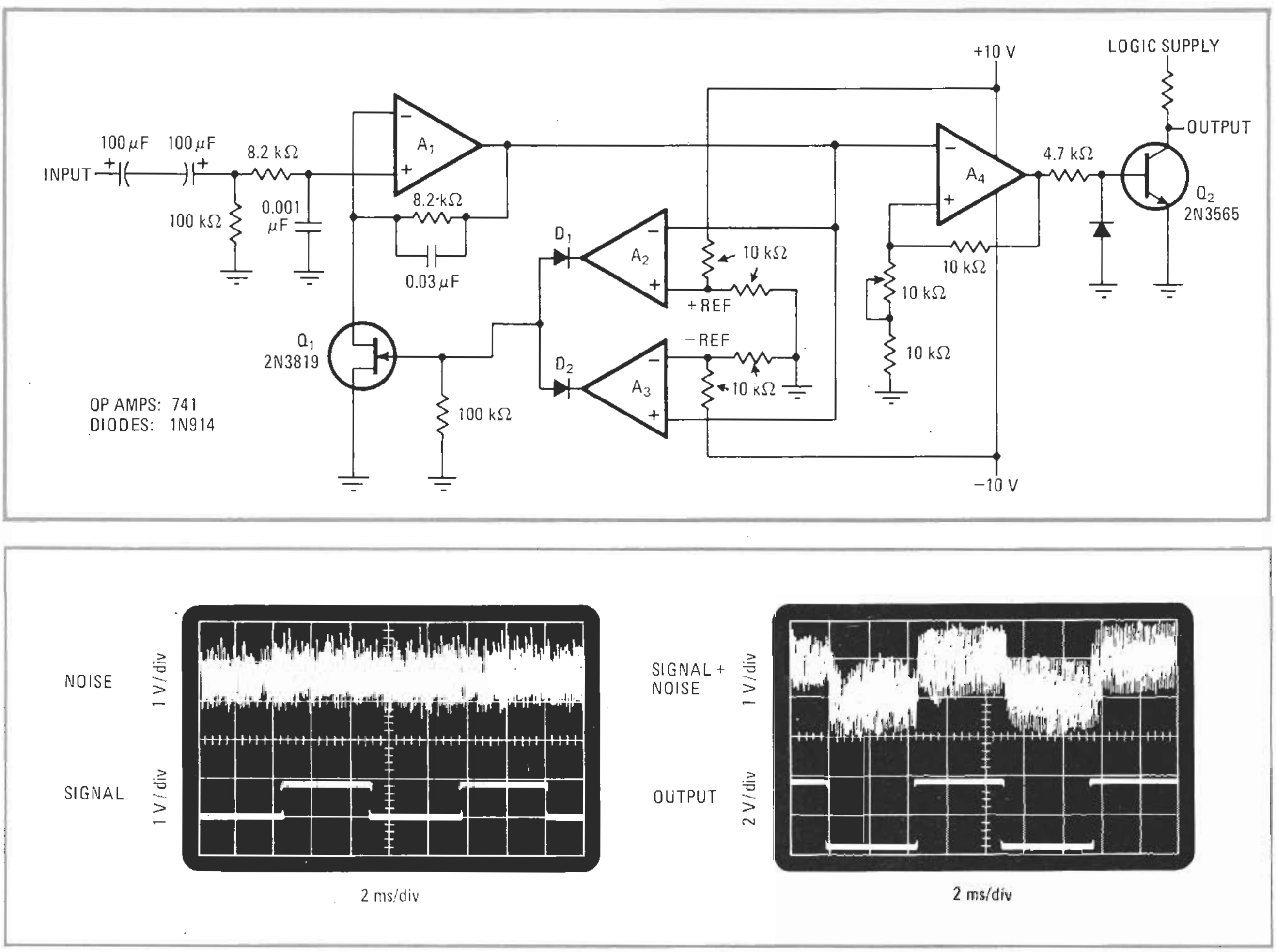
Telemetry signals or other logic signals often pick up a lot of extra noise during transmission. But they can easily be cleaned up at the receiving end by a discriminator circuit having adjustable hysteresis.

The voltage discriminator shown in the figure can clean up signals containing as much as 70% noise without the need to alter the signal amplitude or dc level. The input to the amplifier that serves as the voltage-discriminator (amplifier A_4) is kept constant at 5 volts peak-to-peak. But the signal to be conditioned, the one at the input to the circuit, does not have to be critically maintained or its level known precisely.

Amplifier A_1 is gain-controlled, with field-effect transistor Q_1 acting as the gain-control element. This FET, which functions as a voltage-variable resistor, is controlled by amplifiers A_2 and A_3. Amplifier A_4 is the voltage-discriminator stage that provides the adjustable hysteresis through its variable regenerative feedback.

Before the capacitively coupled input signal goes positive or negative, the output of amplifier A_1 may be treated as if it were at ground. The gain of amplifier A_1 is then at its maximum since the inputs to amplifiers A_2 and A_3 are below (in absolute magnitude) their respective reference voltages. The output of each amplifier is now positive, and diodes D_1 and D_2 are back-biased, which allows transistor Q_1 to turn fully on.

If the input signal goes positive, the output of A_1 will move towards the positive power-supply level. When it reaches the reference voltage of A_2, the output of A_2 quickly swings negative, turning transistor Q_1 partially off and thus lowering the gain of A_1. The output of A_1 is held at the positive reference voltage until this reference level is greater than the input voltage multiplied by the maximum gain of A_1. At this point, the input voltage is only a few millivolts above ground.



Pulling the data out of the noise. Adjustable-hysteresis voltage discriminator makes significant improvement in signal-to-noise ratios, as can be seen from the scope traces. The level of regenerative feedback of amplifier A_4, the voltage-discriminator stage, is adjusted to provide optimum noise immunity. The gain of amplifier A_1 is controlled by transistor Q_1, which is operated as a voltage-variable resistor.

response time of the comparator is less than 10 milliseconds and is free of jitter.

The circuit may be set up for any $V_{IN(MAX)}$ from 10 to 100 volts by adjusting resistor R_1 so that the maximum voltage at point X is 10 V. Since R_2 is 10 kilohms, the value of R_1 in kilohms is ($V_{IN(MAX)}$ − 10). The value of R_3 in the squarer circuit is made 10 $V_{IN(MAX)}{}^{1/2}$ kilohms.

Typical values are:

$V_{IN(MAX)}$ (volts)	R_1 (kΩ)	R_3 (kΩ)
10	0	31.6
50	40	71
100	90	100

Potentiometer P_1 is adjusted to make the voltage at point Y exactly equal to $V_{IN(MAX)}{}^{1/2}$. Finally, resistor R_6 is trimmed to provide the best square-root tracking, P_1 being readjusted as R_6 is varied.

To minimize offset error, resistor R_{15} should be equal to the resistance of the combination of R_3 in parallel with R_4 and P_1. Since (R_4 + P_1) is much smaller than R_3 on any range, however, R_{15} may be made 6.8 kΩ as a good compromise. Diode D_1 should be chosen to have a resistance of about 160 Ω for an applied voltage of 0.8 V. The type 741 op amps use a ±15-V power supply, decoupled with 0.1-microfarad ceramic capacitors at the voltage-input points. □