Precision peak-reading circuit

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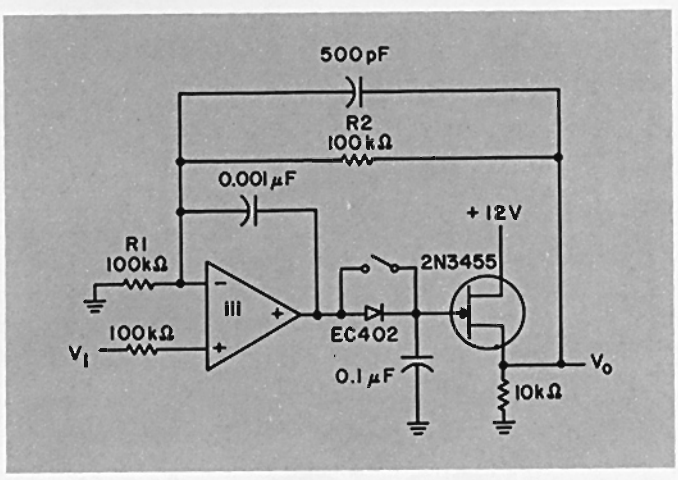
Sir, — A recent laboratory requirement involved the capture of the peak value of a positive pulse of varying duration. The standard method of doing this is by charging a capacitor *via* a diode and sensing the voltage across the capacitor with a high-input-impedance device, such as a valve. Disadvantages of such a system are primarily due to the diode. On applying a pulse, this has initially a low forward resistance but as the voltage across the storage capacitor rises the diode forward resistance increases. In a test the following results were obtained from an SGS Fairchild EC402 diode:

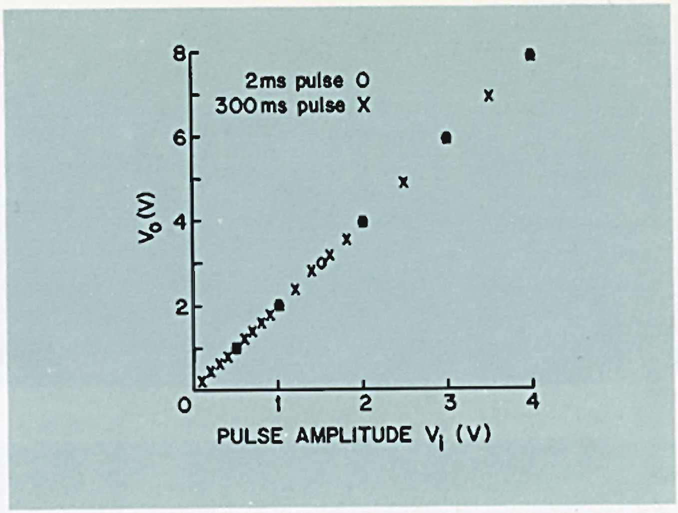
Forward current, mA,	Forward voltage, V	Forward resistance, Ω
1·0	0·65	650
0·52	0·62	1200
0·25	0·59	2360
0·10	0·55	5500
0·05	0·53	10600
0·025	0·51	20400
0·0125	0·485	38800
0·006	0·46	76700
0·003	0·435	145000
0·0015	0·41	274000
0·0005	0·365	730000
0·00025	0·345	1380000

The diode forward characteristic causes the peak-reading circuit to be sensitive to pulse duration, a short pulse giving a lower reading than a long pulse of the same amplitude. The diode characteristic also necessitates a meter with a nonlinear scale, particularly at the low end.



The illustrated circuit overcomes the above disadvantages, giving, for pulses of 2 to 300ms, an output that is not a function of pulselength and providing a linear V_o/V_i relationship. Performance was not investigated beyond these limits or for V_i greater than 4V. The graph shows the linearity and independence of pulselength that was achieved.

The gain of the circuit is given by $(R_1+R_2)/R_1$. The 500pF feedback capacitor brings results from 2ms pulses into line with those from 300ms pulses. The operational amplifier is an



Analog 111, the diode is a low-reverse-leakage type and the field-effect transistor is by Amelco. The circuit will hold the peak value of an applied pulse for an hour or more if due attention is paid to insulation. Closing the switch resets the system to zero. A 20000Ω/V meter was used to record V_o, but in the final application an emitter follower is connected to the field-effect transistor and the feedback loop taken from the emitter-follower output.

Signal is sampled and held for 1 minute

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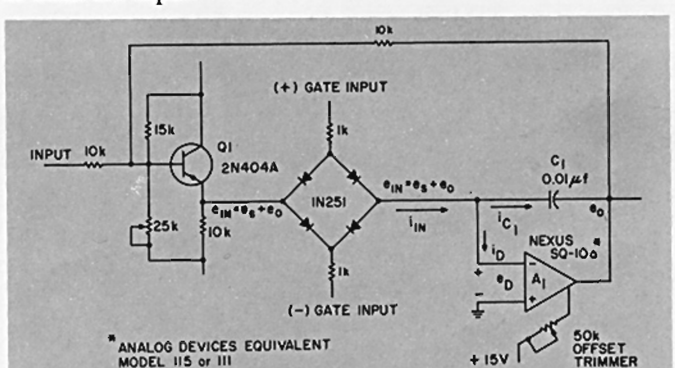
A low-cost operational amplifier and a single transistor combine to form a $20 track and hold circuit for use with low sampling rates. This application requires sampling of a 30-hertz sinewave once per cycle with a 0.4 millisecond sample width; therefore, an off-the-shelf, low performance operational amplifier was used. By substituting more expensive operational amplifiers in the integrator, performance can be upgraded.

Input signal e_s and the feedback signal e_o are fed to the base of emitter follower Q_1. When gate voltages of +1.5 and −1.5 volts are applied to the +gate and −gate terminals respectively, the diode bridge conducts and capacitor C_1 charges through the low output impedance of Q_1. In this mode the feedback path through the 10-kilohm resistor causes the output to track the input.



Input signals e_s and e_o are tracked by charging C_1 when the diode bridge is conducting.

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When the voltages at the gate inputs of the diode bridge are reversed, the forward path of the diode bridge is opened and the circuit behaves as a conventional integrator in the hold mode. Thus the capacitor remains charged to the value of the output voltage immediately prior to switching. The 50-kilohm offset trimmer balances out the offset current of the operational amplifier to prevent rundown of the output voltage e_o during the hold mode.

Operation of the circuit is possible with sample widths down to 0.4 milliseconds or track widths of several times this value. In this application the network functions as a sample and hold circuit because with this gate width it is just possible to charge the capacitor between the most negative and positive output values. With larger gate widths the output will track the input after the initial charging time. The data can be held for periods of up to one minute. The minimum sample width is determined by the charging time constant of the capacitor. Although the time constant may be reduced with a smaller capacitor, this makes the offset adjustment more critical. The circuit becomes more sensitive to the time and temperature variations of the offset current of operational amplifier A_1. Usually, C_1 is chosen as the largest value of capacitance that provides satisfactory operation with the desired sample and track width.

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