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News Briefs

MAXIM REPORTS RECORD REVENUES FOR THE THIRD QUARTER 1993

SUNNYVALE, CA May 4, 1993 – Maxim Integrated Products, Inc. reported record net revenues of $28,384,000 for the third quarter of fiscal 1993, compared to $22,124,000 for the same period a year ago. This represents a 28.3% gain in net sales from the same quarter a year ago. Net income of $4,363,000 (or $0.29 per share) for the quarter marked the 28th consecutive increasingly profitable quarter for Maxim compared to net income of $3,546,000 (or $0.24 per share) for the same quarter in fiscal 1992.

Jack Gifford, Chairman, President and Chief Executive Officer, stated, "Maxim announced 25 new products during the quarter. This makes 64 new products introduced in fiscal 1993 to date, compared to 55 products introduced at this time last fiscal year. Our new product development capacity has clearly increased. Maxim's total product portfolio of 573 products continues to be the most products introduced by any analog company over the past nine years. Acceptance of new products in major markets continues to provide for our future growth."

RUGGED PLASTIC OFFERS HIGH-REL QUALITY FOR 50% LESS

In response to customer requests for high-reliability products at a lower cost, Maxim now has a new Hi-Rel screening flow for plastic devices. This screening includes many of the requirements common to /883 devices, such as burn-in at +125°C and electrical screening at -55°C to +125°C. Rugged plastic DIPs and small-outline packages offer a 50% cost reduction and use less board space compared to other existing /883 CERDIP or LCC Military packages.

New amplifiers simplify wideband techniques

Limited performance in transconductance amplifiers has hampered their acceptance for years, with exception of the few applications tailored to their capabilities. But two new products from Maxim promise to widen the scope of such amplifiers. The Maxim parts offer better specs for established circuits, and their unique architectures offer the prospect of entirely new applications.

MAX435/MAX436 amplifiers are open-loop devices that provide accurate gain without feedback. V_{OUT}/V_{IN} gain is the product of an internal current gain (4 ±2.5% in the MAX435; 8 ±2.5% in the MAX436), and the ratio of an output impedance Z_L to the user-connected "transconductance network" Z_t (**Figure 1**). Z_t is a 2-terminal network connected across the amplifier's Z+ and Z- terminals. The MAX435 has differential outputs, and the MAX436 has a single-ended output.

Because Z_L or Z_t (or both) can be frequency-shaping networks, the Z_L/Z_t ratio can implement some interesting transfer functions. A resistor ratio (times the internal current gain) simply sets a desired voltage gain. Replacing Z_L with a parallel-RC network produces a lowpass response, and replacing Z_t with a series-RC network produces a highpass response. Combining the parallel-RC Z_L and series-RC Z_t produces a bandpass filter. Or, by replacing Z_t with a crystal or series-LC network you can create a high-Q tuned amplifier.

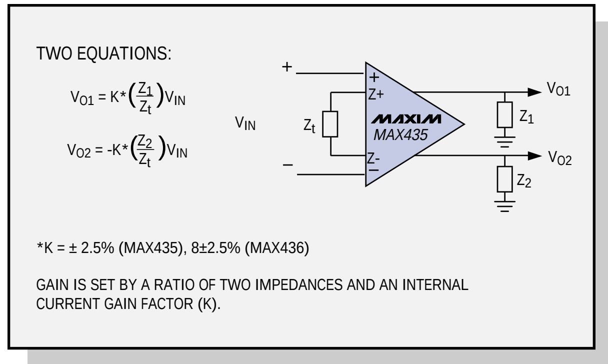

Figure 1. *Simple equations and freedom from instability ease the application of transconductance amplifiers.*

Each of these configurations is elevated to new levels of performance by the amplifiers' high speed: the MAX435 has a 275MHz bandwidth with 800V/µs slew rate, and the MAX436 has a 200MHz bandwidth with 850V/µs slew rate. Both offer 18ns settling times (±1%) for 0.5V step inputs, and both feature exceptional CMRRs of 53dB at 10MHz. Both have fully differential, symmetrical, high-impedance inputs. Input offset voltages (300µV typical) are much lower than those of most high-speed op amps.

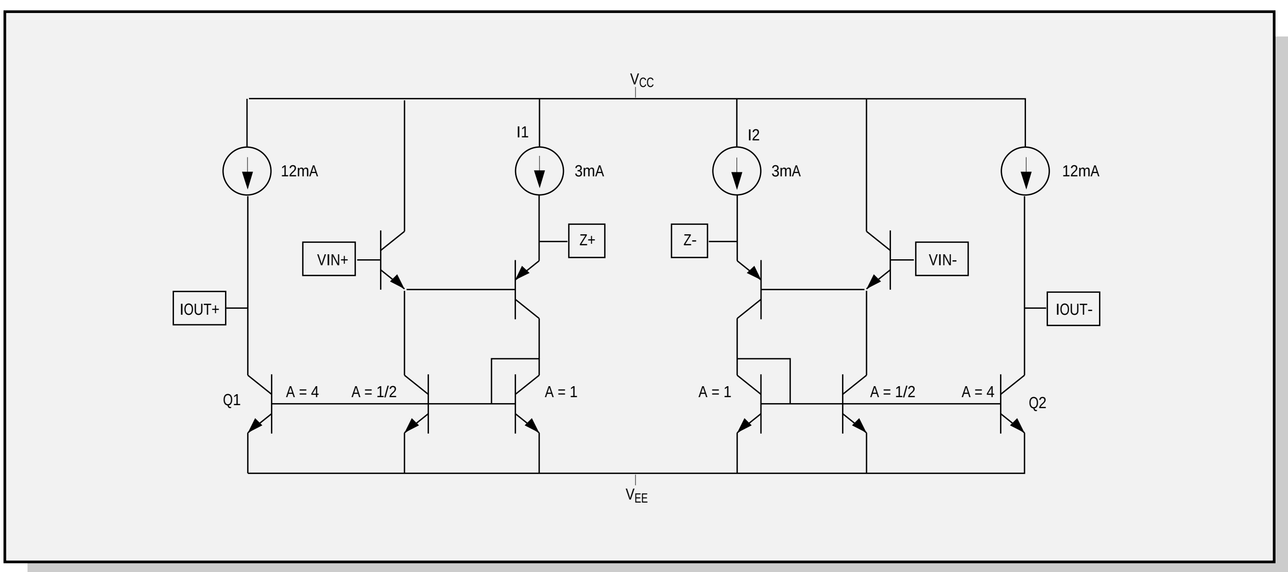

Figure 2. *This simplified schematic shows basic circuitry in the MAX435 differential-output transconductance amplifier. An external resistor (R_{SET}) controls the four current sources, and its nominal value of 5.9kΩ produces the current levels shown.*

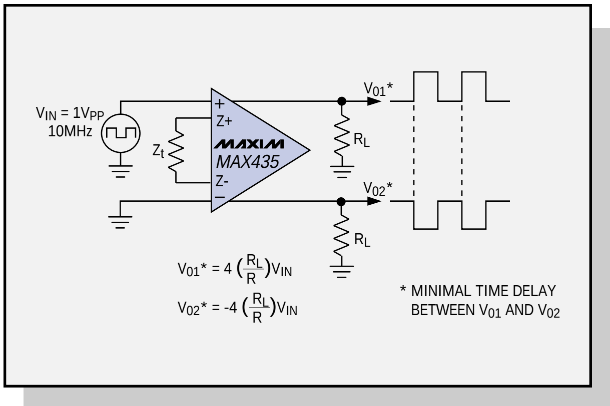

***Figure 3**. Differential outputs make the MAX435 a convenient single-package phase splitter.*

The secret of high speed lies in the MAX435/MAX436 architecture. Consider the MAX435 (**Figure 2**). With zero volts across VIN+ and VIN-, the currents from I1 and I2 are mirrored and multiplied, producing 12mA in Q1 and Q2. These currents each match 12mA from a current source in the output stage, producing a zero differential output at IOUT+ and IOUT-.

Connecting a positive differential voltage across VIN+ and VIN- diverts some of the I1/I2 current through Z_t (connected between Z+ and Z-), causing an imbalance in the Q1/Q2 currents. The result is a net differential output current at IOUT+ and IOUT-. Time delays are very short because the signals propagate as steered currents (rather than voltages), and because all stages in the signal path receive substantial bias currents. The following applications are made possible by these and other special capabilities in the MAX435/MAX436 amplifiers.

Because MAX435 and MAX436 outputs are high-impedance current sources, you can create a summing amplifier simply by tying two or more outputs together. No additional components are required except a load resistor to develop the output voltage. Another intrinsic function is that of phase splitter—the MAX435 differential outputs provide inverted and non-inverted (0° and 180°) versions of the input signal.

As phase splitter, the MAX435 offers a convenient, single-IC differential drive for balanced transmission lines **(Figure 3)**. The IC's excellent common-mode rejection (90dB at dc; -53dB at 10MHz) assures reliable transmissions.

The amplifiers' high-impedance inputs and outputs allow them to operate as monolithic impedance transformers (**Figure 4**). The high-impedance, true-differential inputs (800kΩ typical) let you connect any reasonable value of input termination resistance. Similarly, the current-source outputs have a relatively high source resistance (3.2kΩ typical) that lets you connect any reasonable value of load resistance.

The main advantage of these circuits over magnetic transformers is in their low-end frequency response, which extends to dc. Baseband video, for example, has frequency components ranging from 4.5MHz to below 60Hz. A line transformer with flat frequency response over that range would be very bulky and expensive! Flexibility is another advantage for the IC approach; by changing one or two resistors you can match the transmitter and receiver to a variety of cables in the same system.

As another illustration of the need for impedance matching, coaxial cables for high-speed signals must be carefully terminated in their characteristic impedance to ensure maximum power transfer and minimum distortion. To obtain optimum performance from 50Ω cable, therefore, you must terminate each end of the cable with 50Ω.

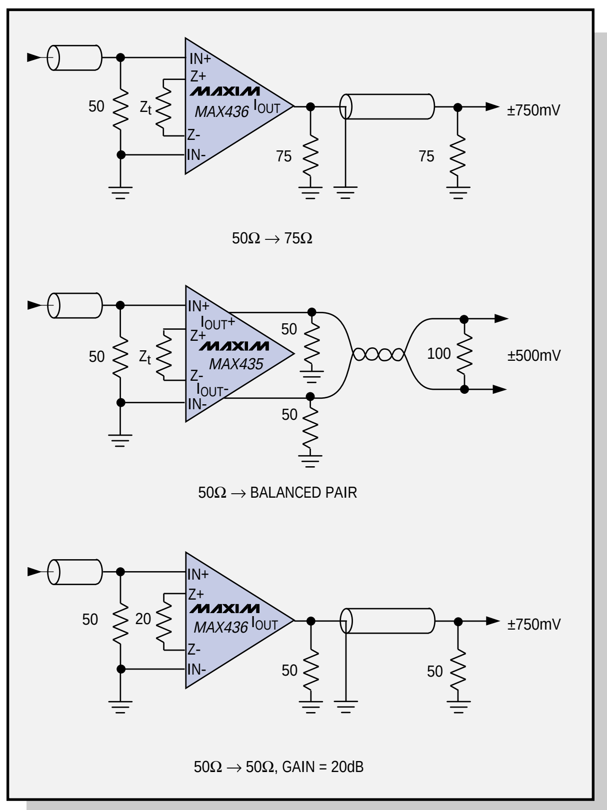

***Figure 4.** Independent settings for output current and load resistance enable MAX435/MAX436 amplifiers to act as impedance transformers. Supply voltages are ±5V, and the R_{SET} resistors (between the amplifiers' I_{SET} terminals and ground) are 5.9kΩ.*

Further description

Voltage-mode amplifiers have low output impedance, so they require a series-resistor interface to coaxial cable. But MAX435/ MAX436 amplifiers have high-resistance current-source outputs that require a parallel connection of the termination resistor (i.e., in shunt with the cable). Note that back-terminating the cable this way reduces the circuit voltage gain by half (**Figure 5**).

MAX435/MAX436 amplifiers offer the user several “control handles.” For top performance in this application and others, you should be aware of the amplifiers’ shutdown capability, their adjustable load-current limits, and the factors that affect their dc accuracy.

First, the internal current sources are controlled by an external resistor (R_{SET}) connected between the I_{SET} terminal and the V- supply voltage (Figure 2). Both amplifiers operate on ±5V. The standard R_{SET} value for which all specifications are guaranteed is 5.9kΩ, and this value sets the limit for maximum I_{OUT}: ±20mA for the MAX436, and ±10mA per output for the MAX435. By connecting a larger-valued R_{SET}, you can reduce the amplifiers’ supply current and power dissipation (along with the maximum I_{OUT}).

You can also increase the output current by decreasing R_{SET}, but be careful to ensure that the higher current does not combine with a particular operating condition to exceed the package power-dissipation rating. Removing R_{SET} altogether provides a partial shutdown of the amplifier. Without R_{SET}, the room-temperature supply currents (normally 35mA) drop to 450µA ±25% for the MAX435 and 850µA ±25% for the MAX436.

DC accuracy in the MAX435 and MAX436 is affected by the input offset voltage (V_{OS}), the output offset current (I_{OS}), and tolerance on the internal current gain K, as well as tolerance on the external impedances Z_t and Z_L. V_{OS} is caused by a V_{BE} mismatch at the input stage (like the V_{OS} in bipolar voltage amplifiers), and is measured between the Z+ and Z- terminals—with Z_t removed and the inputs (IN+ and IN-) grounded. V_{OS} produces a small error current in Z_t during normal operation. Multiplied by K, it produces an output error current, even with no differential input voltage applied.

I_{OS} is a separate and independent output error that is caused by imperfectly matched devices in the output current mirrors. Though measured under the same conditions as the V_{OS} measurement, I_{OS} does not vary with input voltage. Combining the I_{OS} and V_{OS} effects yields a net error in output voltage. The MAX435’s differential output error V_{ERR}(DIFF), for instance, is the sum of each output error:

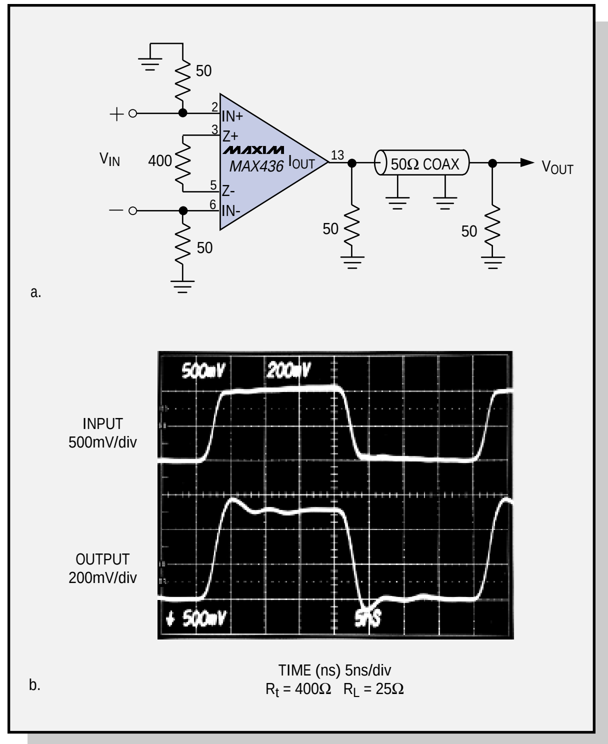

***Figure 5.** As a coaxial-cable driver (a), the MAX436 transconductance amplifier handles fast pulses with minimal overshoot and ringing (b).*

V_{ERR}(DIFF) = (V_{ERR}+) - (V_{ERR}-), where

$V_{ERR}+ = (R_L+)[(I_{OS}+) + K(V_{OS}/R_t)]$, and $V_{ERR}- = (R_L-)[(I_{OS}-) - K(V_{OS}/R_t)]$. I_{OS} is -20µA typical (±100µA max), and V_{OS} is 0.3mV typical (3.0mV max).

Similarly for the MAX436,

$V_{ERR} = (R_L)[I_{OS} + K(V_{OS}/R_t)]$, where I_{OS} is 6µA typical (±100µA max), and V_{OS} is 0.3mA typical (3mA max).

Twisted-pair video

The MAX435 and MAX436 amplifiers provide a differential-out/differential-in combination that is well suited for one-way transmission of video signals over a twisted-pair cable (**Figure 6**). As a bonus, the MAX436 Z_t network provides a means for line equalization and gain adjustment.

Replacing coaxial cable with twisted-pair cable saves cost in many applications that don’t require the higher bandwidth of coax. These applications have initially included LANs and LONs (local area networks and local operational networks). But twisted-pair cable is more compact than coaxial cable, and the miles of unused twisted-pair cabling that already reside in the phone systems of existing buildings may inspire additional applications. Baseband (composite) video can be transmitted over these cables as far as 5000 feet, with surprising quality.

Twisted-pair video transmission works best with a single channel of baseband video. Many applications require such transmissions within a building; an obvious example is the separate video channels routed from individual surveillance cameras back to a security office. Other closed-circuit TV (CCTV) systems are found in retail stores, supermarkets, airports, and schools.

Twisted pairs resist differential noise pickup; because a pair is twisted, any differential current induced by an interfering EM field in one loop gets cancelled in the following loop. Common-mode noise, on the other hand, must be rejected by a balanced (differential) circuit at the receiver. Twisted-pair cables must also be terminated in their characteristic impedance to minimize the reflections caused by line discontinuities.

For twisted pairs exceeding 200 feet (approximately), bandwidth falls short of the typical baseband-video bandwidths (4MHz to 5MHz). But these cables are satisfactory for baseband video if you equalize your receiver, provide an NTSC monitor with automatic gain compensation, and choose quality (wideband) cable.

Stranded and unstranded wires exhibit similar bandwidths, but the highest-bandwidth cables are unshielded, and have insulation of low dielectric constant between the conductors. Polyethylene or polypropylene insulation is recommended for new installations. For twisted-pair video transmissions under 1000 feet, use common 24AWG telephone wire. For longer distances, you can improve the video fidelity by using larger wire.

The differential-output MAX435 of Figure 6 eliminates the need for a balun (balanced-to-unbalanced) transformer or the two-driver alternative—one single-ended inverting driver and one single-ended non-inverting driver. The MAX435 drives the balanced twisted-pair cable from a ground-referred input signal (in this case, from a VCR's VIDEO OUT baseband signal).

At the driver end of the cable, each conductor is terminated with a 50Ω resistor to ground. The resulting 100Ω between conductors is an appropriate match for the cable's characteristic impedance. A mismatch can degrade the video, but it cannot affect amplifier stability because the MAX435 has no feedback. Output amplifiers are ±0.5V.

At the receiver end, a MAX436 amplifier converts the balanced input channel to a single-ended output. Again, the proper line termination is 100Ω between cable conductors at the IN+, IN- inputs. The Z_t impedance network across Z+ and Z- adds adjustable gain (approximately 6dB) to compensate for a 6dB loss

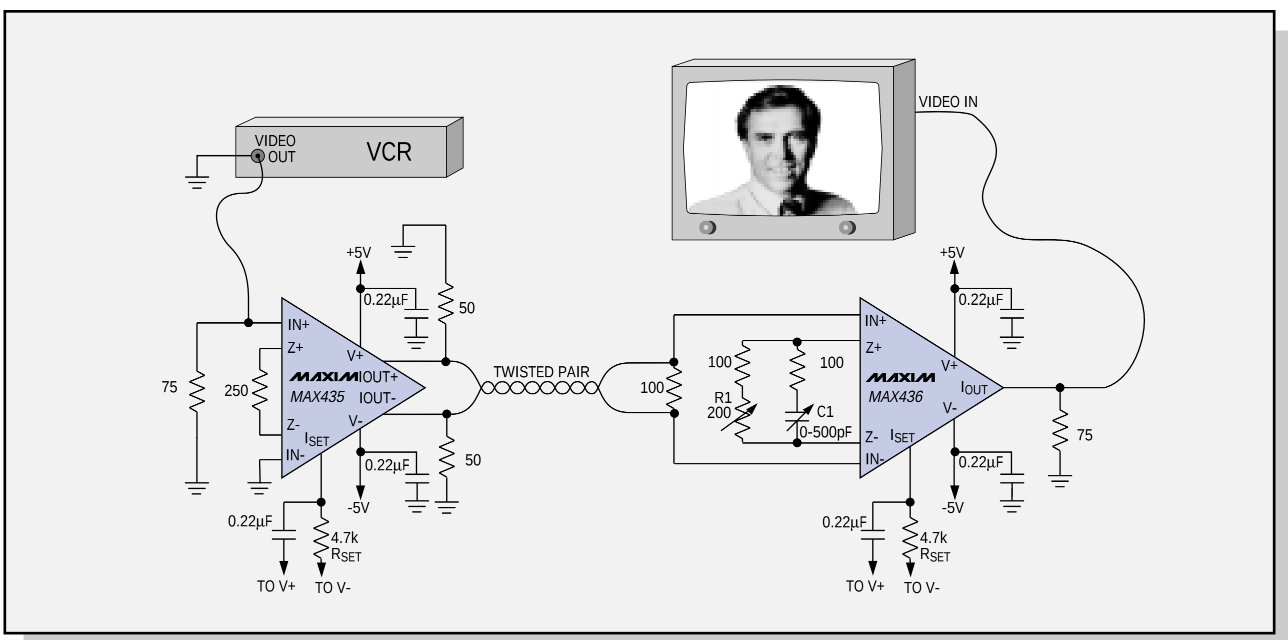

Figure 6. *Two transconductance amplifiers and a twisted-pair cable transmit baseband video for 5000 feet or more.*

introduced by the termination resistors. The network's adjustable capacitor also provides line equalization (frequency compensation) if required. Load resistance is 50Ω, consisting of the 75Ω resistor in parallel with 150Ω at the monitor's input port.

Test results

Operating with 500 feet of inexpensive, 22-gauge, twisted-pair burglar-alarm cable (approximately 4¢ per foot), the Figure 6 circuit attenuates the baseband video's 3.58MHz colorburst frequency about 6dB (F**igure 7**). Despite the distortion, no degradation of color saturation was observed at the NTSC monitor used in this test. No degradation was expected, however; this monitor compensates for signal attenuation by calibrating automatically against test patterns in the vertical interval test signal (VITS).

The monitor's automatic loss equalization is robust; it compensates for colorburst attenuation as high as 10dB, displaying an excellent picture with no noticeable color fading or loss of horizontal resolution. Further attenuation, however, produces poor chroma and a horizontal fuzziness that makes it difficult to read displayed text.

Under that condition you can still achieve compensation via adjustments at the MAX436 Z_t network: R1 adjusts brightness by boosting the overall gain to compensate for ohmic losses, and C1 introduces a pole/zero pair in the receiver circuit, which adjusts for color by extending the channel bandwidth. Because compensation is introduced at the receiver, you can simply view the display and adjust for the best picture. Before-and-after waveforms show the result of this equalization (**Figure 8**).

Next, consider the Figure 6 circuit operating with 1000 feet of twisted-pair telephone cable. The test setup included a length of unused twisted pair in a trunk cable between two Maxim buildings, two jumper connections in the phone-patch room, and additional twisted-pair cable that was routed through hallways to complete the transmission path.

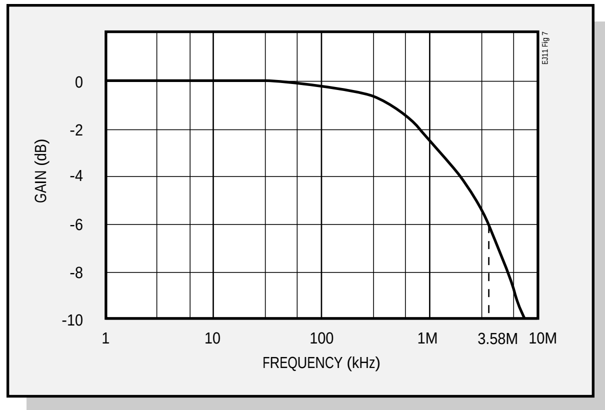

Figure 7. *Inexpensive burglar-alarm cable (twisted pair, 500 feet, 22AWG) attenuates the 3.58MHz colorburst frequency of baseband video by 6dB.*

This system easily transmitted baseband video from a VCR, producing an excellent picture with R1 and C1 at their nominal settings (no equalization required). High noise immunity was illustrated by coupling 60Hz common-mode noise to the line (**Figure 9**). The MAX436 CMRR (60dB at 60Hz) removed this noise with no evidence of beating in the display. On the other hand, driving the cable in an unbalanced mode produced poor results as expected.

Although tests on the Figure 6 circuit involved only NTSC video signals, the circuit should provide comparable performance for PAL signals, which have a chroma carrier of 4.43MHz (vs. 3.58MHz).

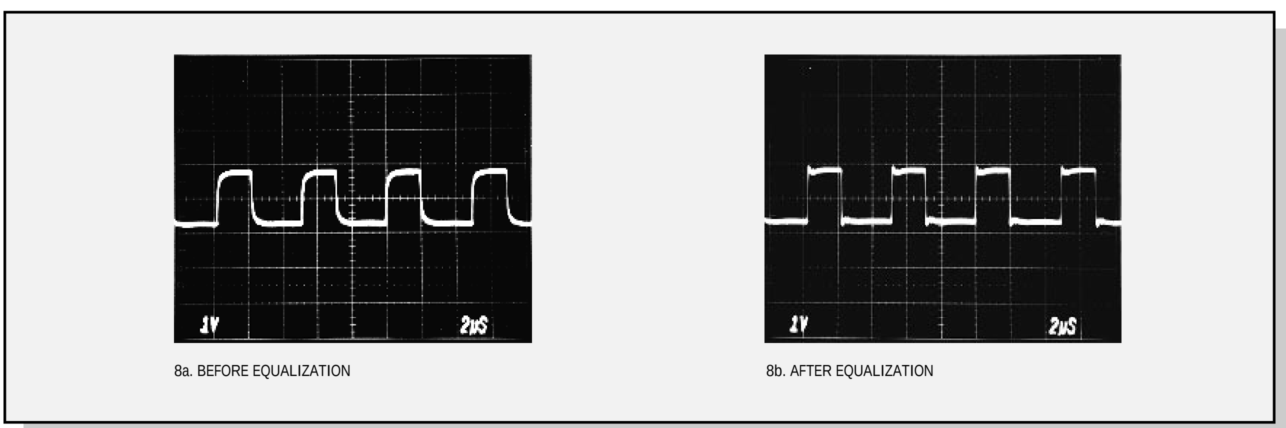

Figure 8. *These before-and-after waveforms show the effect of adjusting for optimum brightness and color via R1 and C1 (Figure 6), while observing the monitor display.*

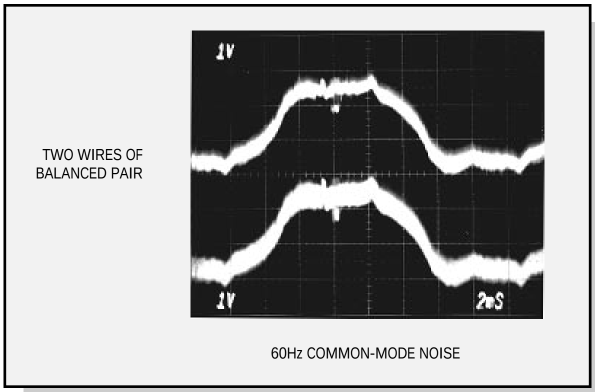

Figure 9. *Thanks to 60dB CMRR in the MAX436, the display in Figure 6 is unaffected when these 60Hz common-mode signals are deliberately added to each wire of the balanced cable.*

Settling time measurements

Quick response and avoidable output saturation favor the MAX436 for use in measuring the settling time of slower amplifiers (**Figure 10**). In the test circuit, you configure the device under test (DUT) as a voltage follower and drive its inputs with a square wave. The MAX436 observes DUT settling time by comparing its input and output signals.

The applied square wave appears quickly at the MAX436's non-inverting input, but is delayed by propagation time through the DUT before reaching the inverting input. The result is a brief but high-amplitude signal (clamped by D2 and D3) that appears between the MAX436 inputs before the DUT can settle. If the MAX436 were a voltage-mode amplifier, this large differential input would cause the output transistors to saturate, thereby corrupting the settling-time measurement with overload-recovery time.

With properly chosen gain elements, however, the MAX436 can accommodate input signals that span its entire input common-mode range without saturation in the output stage. This characteristic suits the amplifier for settling-time measurements of D/A converters as well as high-speed op amps. (Following a 0.5V common-mode step, the MAX436 itself settles to ±0.1% in about 17ns.) Note that this common-mode response is faster than the response to a differential signal, in which the output response time is limited by the slew rate.

Figure 11 illustrates the response of a MAX442 (2-channel, 140MHz video multiplexer and amplifier) operating as a DUT in the circuit of Figure 6. The input step is 2V in this case. Note that the initial output level (40mV) should ideally be zero. It represents the difference in forward voltages for the Schottky clamp diodes D2 and D3, multiplied by voltage gain from the MAX436 to the scope (which is 8*50/390, i.e., near unity). This initial voltage has no effect on the settling measurement.

You can define settling time either from the beginning of the input's downward transition (which includes the DUT's propagation delay), or from the first output transition (a useful parameter in video applications). Because the MAX442's propagation delay is small, its ±0.1% settling time measures about 42ns either way. The mid-screen graticule line is 0V, the first cursor line is the final-settling level, and the next cursor line marks the boundary for ±0.1% settling.

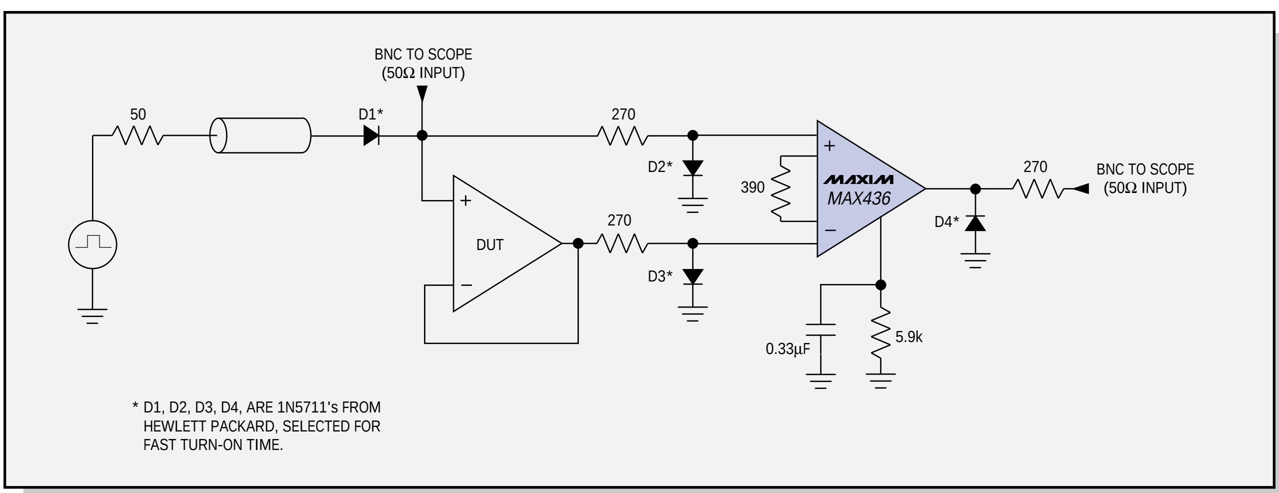

Figure 10. *Wideband differential inputs and an absence of output saturation suit the MAX436 for use in settling-time fixtures.*

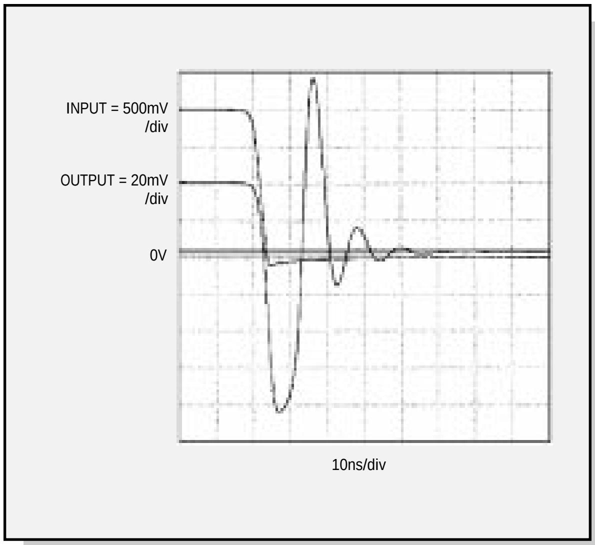

Figure 11. *Settling time for a MAX442 video amplifier in the Figure 10 circuit is 42ns.*

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Carol Cable Catalog, Carol Cable Company, Inc., Highland Heights, KY, 1989.

Reference Data for Radio Engineers, 4th edition, International Telephone and Telegraph Corporation, Sept. 1989.

Transmission Systems for Communications, Revised 4th edition, Members of the Technical Staff, Bell Telephone Laboratories, Dec. 1971.

Vargha, Douglas, conversations at Maxim Integrated Products, Feb. 1993.

(Circle 1)

3rd-order highpass filter has synthetic inductor

Inductors have a bad reputation as filter components—they not only transmit EMI, they act as antennas for receiving EMI as well. To avoid these problems, you can simulate the impedance of an inductor with the combination of two operational transconductance amplifiers (OTAs) and a capacitor **(Figure 1)**. The circuit acts as a synthetic inductor (LSYN) with one end connected to ground.

By forcing a current at LSYN and measuring the resulting voltage, you can determine the equivalent impedance Z_{EQ}:

$$Z_{EQ} = \frac{sC}{gm1*gm2}, \text{ where gm} \equiv \text{transconductance.}$$

The equivalent inductance, therefore, is:

$$L_{EQ} = \frac{C}{gm1*gm2}.$$

This single-port network clearly offers the frequency-proportional impedance of an inductor, along with an advantage and a limitation: the inductance value can be large if gm1*gm2 << 1, but one end of the network must always connect to ground. Highpass, all-pole ladder filters make good applications because all their inductors connect to ground. Two OTAs and a capacitor must be substituted for each one, so you should choose a configuration with the minimum number of inductors.

To be cost-effective, your design should feature a series capacitor at each end of the filter, with the simulated inductor acting as a shunt between them **(Figure 2)**. The input capacitor blocks any dc applied to the filter, and the output capacitor blocks any dc offset introduced by the synthetic inductor. Even though the filter is constructed with active components, it retains some of the advantages of a passive filter.

In an actual circuit **(Figure 3)**, C2 and C3 are bypass capacitors and C2 is part of the simulated inductor. The transconductance for each OTA is set by an external resistor (R1 or R3) according to the relationship gm = 8/R. Because the simulated inductance depends on the product of these transconductances, it may appear that you have a range of choices for each. But the optimum circuit for a given application restricts gm values by allowing the full range of output swing for each OTA.

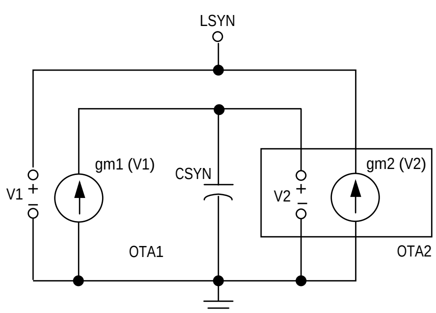


Figure 1. *This single-port network simulates an inductor with two operational transconductance amplifiers and a capacitor.*

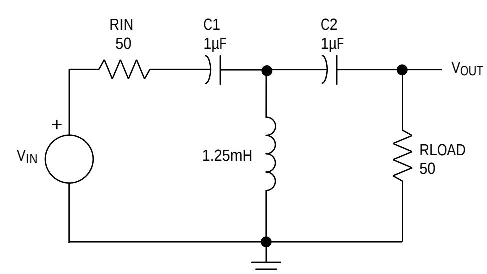


Figure 2. *This simple ladder filter is a good application for the simulated inductor, which must have one end connected to ground.*

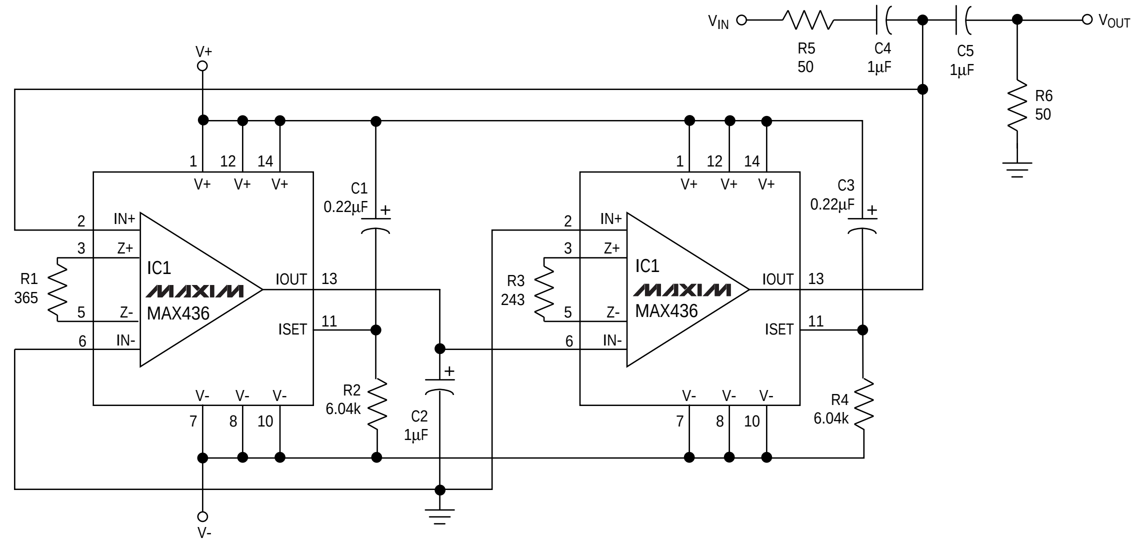


Figure 3. *A 3rd-order Butterworth highpass filter is constructed by substituting the simulated inductor of Figure 1 in the ladder filter of Figure 2. The filter has a 3.2kHz corner frequency and a -6dB loss due to the source and load impedances.*

To determine these optimal gm values, start with equal transconductances and simulate the filter in Spice using "g" elements for the amplifiers. While sweeping the frequency at least one decade above and below the filter's corner frequency, observe each OTA output for its peak voltage magnitude (the two peaks may occur at different frequencies).

At the synthetic inductor's port (pin 13 of IC2) the peak value is demanded by the filter and cannot be changed; a real inductor would produce the same peak. Therefore adjust the other peak to match. Let K equal the ratio of gm2 to gm1. Gain is proportional to transconductance, so divide gm1 by K and multiply gm2 by K. Finally, rerun the Spice simulation with these new gm values to verify that the peaks are equal and the filter shape has not changed.

The filter exhibits a maximum attenuation of 58.6dB/decade **(Figure 4)**. The slope decreases at lower frequency because the synthetic inductor's Q is affected by its series resistance. (Comparable 1.25mH inductors also have an appreciable resistance of 53Ω or so.) At 10Hz, for instance, the attenuation for an ideal filter is -90dB. For this circuit the attenuation is -80dB.

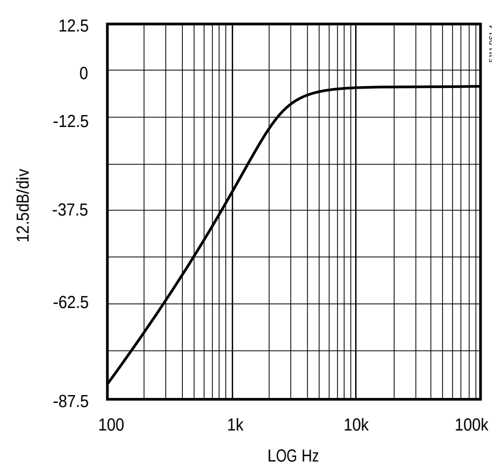


Figure 4. *The Figure 3 filter has a maximum attenuation of 58.6dB per decade.*

(Circle 2)

DESIGN SHOWCASE

Comparator and charge pump convert 3V to 5V

Charge-pump ICs can either invert or double an input voltage (3V to -3V or 6V, for example). The charge pump operates without inductors, but it doesn't regulate the output and it doesn't easily boost 3V to intermediate levels such as 5V. By adding a comparator and reference (IC2 in **Figure 1**) you can generate arbitrary outputs (such as 5V) and regulate them as well.

The charge pump (IC1) has an internal oscillator whose 45kHz operation transfers charge from C1 to C2, causing the regulated output to rise. When the feedback voltage (pin 3 of IC2) exceeds 1.18V, the IC2 comparator output goes high and turns off the oscillator via Q1.

Comparator hysteresis—easily added at IC2—is set to zero because the control loop requires no hysteresis. The oscillator generates only two cycles after turn-on, which is always enough to drive V_{OUT} slightly above the desired level before feedback turns the oscillator off again. The resulting output ripple depends mainly on the input voltage and the output load current (**Figure 2**).

You can reduce output ripple at the expense of circuit efficiency by adding a small resistor of about 1Ω (not shown) in series with C1. Ripple also depends on the value and ESR associated with C1; smaller values of C1 transfer less charge to C2, producing smaller jumps in V_{OUT}.

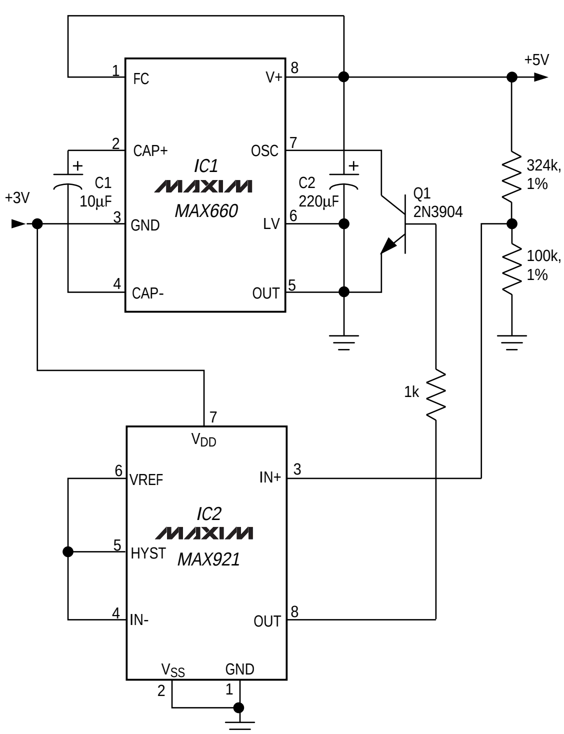


Figure 1. By configuring a comparator and transistor to control the oscillator in a charge pump, you enable the pump to generate a regulated output of any reasonable value.

LOAD RESISTANCE (Ω)	OUTPUT VOLTAGE (V)	OUTPUT RIPPLE (mV_{p-p})
∞	5.00	30
10k	5.00	35
1k	5.00	100
100	4.96	100
50	4.59	150

a. SUPPLY = +3.0V

LOAD RESISTANCE (Ω)	OUTPUT VOLTAGE (V)	OUTPUT RIPPLE (mV_{p-p})
∞	5.01	55
10k	5.01	55
1k	5.01	55
100	4.98	170
50	4.90	170

b. SUPPLY = +3.3V

LOAD RESISTANCE (Ω)	OUTPUT VOLTAGE (V)	OUTPUT RIPPLE (mV_{p-p})
∞	4.98	10
10k	4.98	25
1k	4.98	25
100	4.64	70
50	4.29	90

c. SUPPLY = +2.7V

Figure 2. Output ripple in the Figure 1 circuit depends on the input voltage and load current.

(Circle 3)

DESIGN SHOWCASE

5-comparator IC provides 3V-to-5V regulator and µP reset

Three-volt systems are becoming common, but they often include at least a few 5V components. A single five-comparator IC can produce the required 5V (from 3V) while generating power-on reset signals for the system microprocessor as well (**Figure 1**).

Comparator IC1A is configured as an oscillator whose square-wave output (with approximate 60% duty cycle) drives the base of Q1. Q1 drives a conventional dc-dc converter consisting of inductor L1, catch diode D2, and C2. When V_{OUT} exceeds 5V, comparator IC1B pulls the oscillator signal low (IC1's open-drain outputs may be tied together without harm). The net effect is regulation at 5V.

IC1's minimum operating voltage is 2.7V, and when the circuit is operated at that voltage it can supply 2.8mA at 5V with 60% efficiency. L1 is an inexpensive 1mH inductor with a series resistance of about 25Ω. For higher current and better efficiency, you must lower this resistance by providing a more expensive inductor. Output ripple, which is almost entirely due to the hysteresis built into comparator IC1B, is about 50mV.

Comparator IC1C provides an active-high "5V ready" signal when the boost regulator's output reaches 4.5V—the level at which most 5V logic is operable.

Comparators IC1D and IC1E provide a reset for the microprocessor when the 3V supply is too low (below 2.83V). $\overline{\text{RESET}}$ goes low when the supply voltage falls below this threshold, and remains low for 200ms after it rises above the threshold. For the positive-going supply voltage, hysteresis raises the threshold to approximately 2.87V. The 200ms interval assures time for a full reset of the microprocessor after power is restored, and it allows time for recharging any capacitors associated with the circuit.

A related application for the five comparators of IC1 is to translate the logic signals generated by 3V devices to the levels appropriate for 5V devices.

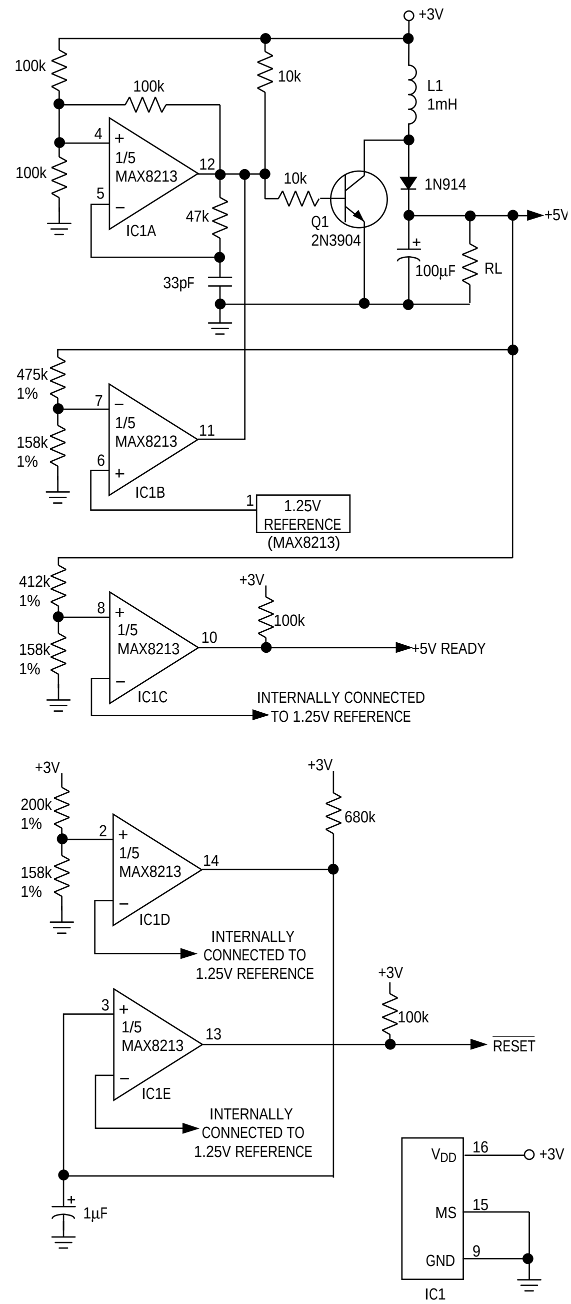


Figure 1. This IC and related components boost the 3V supply to 5V, issue "5V ready" signals, and issue µP-reset signals.

(Circle 4)

DESIGN SHOWCASE

Simple circuit measures battery drain

Measuring battery life for a portable system is a time-consuming task, and the methods that accelerate battery discharge don't provide reliable results. In the usual approach you simply measure elapsed time while operating the product to the point of battery discharge. Running several such systems in parallel obviously gives more data, if you can afford to tie up the lab equipment.

You can try to derive battery life from data-sheet specifications associated with the circuit components, but a calculated value is usually far short of the actual operating time. Current-drain specs tend to be conservative for low-power ICs, because they are tested with high-speed equipment that cannot easily measure low supply currents. Unlike many electrical parameters, battery life (in most cases) is better specified as a realistic typical than as a guaranteed minimum.

The movie "Chinatown" has inspired a simple alternative to the expensive data-acquisition systems and chart recorders normally required in these efforts. (Jack Nicholson placed a cheap watch under the tire of a parked car so he could return at his convenience to check the time of departure.) A similar trick marries a cheap (but low-power) clock to a low-power comparator/reference circuit (**Figure 1**).

The clock can be a "Spartus quartz alarm" at $9.95, or any other drug-store style, non-digital, battery-powered analog clock. IC1 is a CMOS comparator/reference circuit that gates power to the clock. The IC's low current drain (4µA) lets it steal power directly from the circuit under test. Why not power the clock from the input terminals? Because it doesn't run properly that way—the clock has a stepper motor that draws its current in brief surges, with amplitudes as high as 100mA. For the circuit shown, a large filter capacitor at the clock's input terminal did not solve the problem.

When the test circuit's battery voltage (or output voltage, if desired) falls below a selected threshold, the comparator output swings low and turns off Q1, removing power to the clock. The inactive clock then reads the running time, provided you set it to 12:00 before the test.

To set the operating threshold voltage, connect a power supply to the input terminals and adjust it to the minimum voltage for which the circuit will just operate. Adjust R1 so the clock just stops running. Then remove the power supply, set the clock to 12:00, connect the test circuit, and go home.

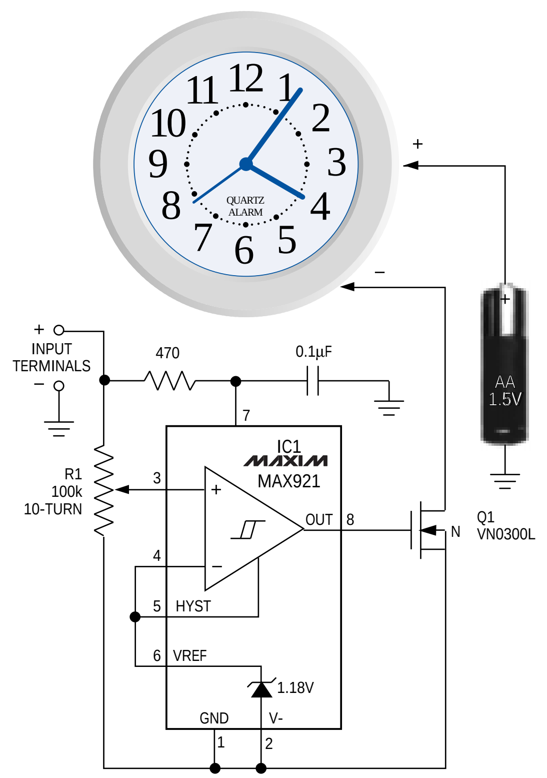


Figure 1. *This inexpensive clock tracks the operating time for a battery-powered portable system. When the battery voltage (or a selected output) drops below the discharge threshold set by R1, the stopped clock retains the elapsed operating time.*

(Circle 5)

DESIGN SHOWCASE

Simple circuit stretches pulses

Short pulses are not easily resolved by digital circuits. D-type flip-flops are often used as pulse stretchers, but they cannot respond to pulses shorter than about 40ns. Electronically sensed laser pulses of 15ns to 25ns, for instance, will go unrecognized by the D flip-flop.

By self-latching a fast comparator you can capture pulses as short as 15ns (**Figure 1**). The input pulses can be short in amplitude as well. Unlike a flip-flop, the comparator circuit responds to amplitudes down to 100mV and below.

The response to positive input pulses is almost immediate: the output goes low and the capacitor (C) pulls the TTL-compatible latch input low, latching the output. As the 15ns pulse subsides (light travels less than 2.4m during this interval), C discharges through R until the latch input voltage crosses its 1.4V threshold, releasing the latch. Values shown for R and C yield an output pulse of about 100ns (**Figure 2**).

To assure stable operation, the latch-input waveform (bottom trace of Figure 2) should include a substantial portion of the timing capacitor's discharge curve—as indicated by the waveform's extension down to 0V. Adjust R1 (or R2) as required for this purpose. V1 (between R1 and R2) will then be about 2V. By choosing an R value of 270Ω to 1kΩ and a C value of 10pF to 100pF, you can produce output pulse widths from 50ns to 500ns.

The low-power, TTL-compatible comparator exhibits rise/fall times shorter than 2ns, and accepts input voltages down to 0V. It also accepts split ±5V supplies to accomodate bipolar inputs. Either way, to allow resolution of low-level signals the analog supply should be isolated from the noisy digital supply. As for all high-speed circuits, the layout should include short connections and a ground plane. Solder the IC package directly to the board and locate all other components close to it.

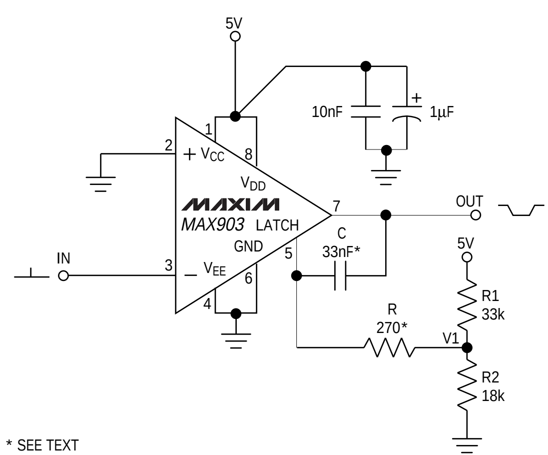


Figure 1. This circuit accepts input pulses as narrow as 15ns, and stretches them to a width determined by R and C (the values shown result in 100ns output pulses).

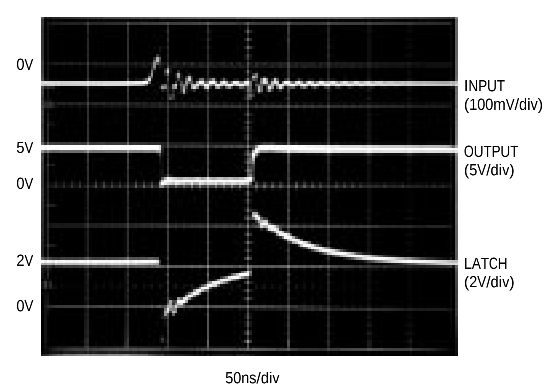


Figure 2. A 15ns, 100mV input pulse (top trace) produces a 100ns output pulse (middle trace). The output pulse is extended until the latch-input waveform, releasing gradually, reaches its switching threshold (bottom trace).

(Circle 6)

NEW PRODUCTS

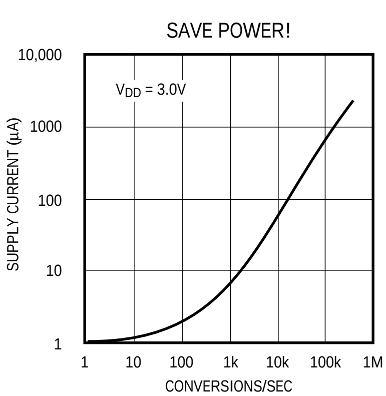
8-bit, 400ksps ADC offers 3V operations and 1µA power-down

The MAX152 is a micropower A/D converter that provides full 8-bit performance with a 3V supply: total unadjusted error is ±1LSB maximum over temperature. Its half-flash conversion circuitry produces as many as 400k samples per second, and a power-down feature extends battery life at reduced sampling rates by cutting supply current to microamp levels. And for space-sensitive applications, the 20-pin SSOP package occupies 30% less area than an 8-pin DIP.

To minimize battery drain during burst-mode conversions, the converter powers down quickly and then powers up within one conversion period. Supply current drops from 1.5mA (3mA max) to 1µA following a power-down command. The device powers up in less than one microsecond maximum, including 450ns for signal acquisition by the internal track/hold circuit.

The MAX152's dynamic specifications include 45dB minimum SINAD and -50dB maximum total harmonic distortion. Its µP interface requires no external logic, and appears to the processor as a memory location or I/O port. VIN and VREF terminals allow ratiometric operation.

The MAX152 comes in 20-pin DIP, wide SO, and SSOP packages, screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices start at $4.25 (1000 up, FOB USA).



(Circle 7)

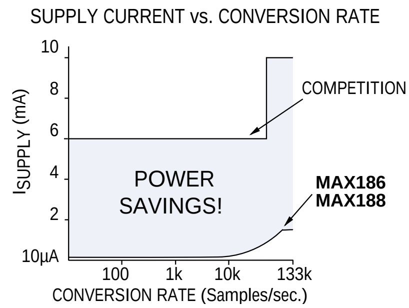
Micropower, 8-channel, 12-bit ADCs draw only 10µA

- ***Serial-data interface***
- ***Operates from single 5V supply***
- ***SSOP package saves space***

The MAX186/MAX188 micropower A/D converters feature ultra-low power consumption and conversion rates to 133k samples per second. The MAX186 has a 4.096V reference; the MAX188 operates with an external reference. Both operate on a single 5V supply or dual ±5V supplies. And for space-sensitive applications, the converters' 20-pin SSOP package occupies 30% less board area than an 8-pin DIP!

A power-down function lowers the supply current to less than 10µA at reduced sampling rates, and to 2µA during shutdown. At maximum sampling rates, the supply current (including reference current) is only 1.5mA. Both converters guarantee ±1LSB offset and ±1/2LSB integral nonlinearity over temperature.

The 10MHz serial interface not only simplifies the addition of opto-isolation; it connects directly to SPI, QSPI, and Microwire ports without external logic. In addition, the serial-strobe output enables a direct interface to TMS320 digital signal processors. Software configures the



MAX186/MAX188 inputs as eight single-ended channels or four differential channels, and for unipolar or bipolar input signals.

The MAX186EVKIT-DIP ($55)—an optimized and fully assembled circuit with proven pc layout—aids evaluation either as a stand-alone MAX186/MAX188 test board or by direct substitution in the target system. The MAX186EVSYS-DIP ($150), on the other hand, lets you perform quick and easy evaluations with a personal computer. It includes the MAX186EVKIT-DIP, plus custom software, RAM and ROM, an RS-232 port, and an 80C32 microcontroller.

Available in 20-pin DIP, wide SO, and SSOP packages, the MAX186 and MAX188 A/D converters are screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices start at $7.97 for the MAX188 and $9.24 for the MAX186 (1000 up, FOB USA).

(Circle 8)

MX390: first-ever upgrade for AD390

- ***Improved quad 12-bit D/A converter saves 600mW***

The MX390 is an improved, lower-power, plug-in upgrade for the AD390 quad 12-bit D/A converter. Operating on ±15V supplies, the Maxim device consumes just 0.96W typical (1.35W max), vs. 1.6W for the original device. Combining four double-buffered 12-bit DACs, four voltage-output amplifiers, and a 10V reference with buffer amplifier, the MX390 comes in a 28-pin package that saves board space, lowers the component count, and improves system reliability.

The MX390's voltage-output DACs are laser-trimmed to ±0.05% absolute accuracy and ±1/2LSB max integral nonlinearity over temperature (KD and TD versions). The package also includes a 10V buried-zener reference, which exhibits accuracy to ±5mV and a low temperature drift of 20ppm/°C max. The reference buffer's high input impedance (>1000MΩ) lets you drive multiple MX390s from a single internal or external reference voltage.

One or more of the MX390's double-buffered inputs may be loaded independently, and all outputs can be updated simultaneously. All outputs settle to ±1/2LSB in 8µs. Applications include test equipment, control systems, and military products.

The MX390 comes in a 28-pin ceramic side-braised DIP, screened for the commercial (0°C to +70°C) or military (-55°C to +125°C) temperature range. Prices start at $156.90 (25 up, FOB USA). Contact the factory for MIL-STD-883 versions.

(Circle 9)

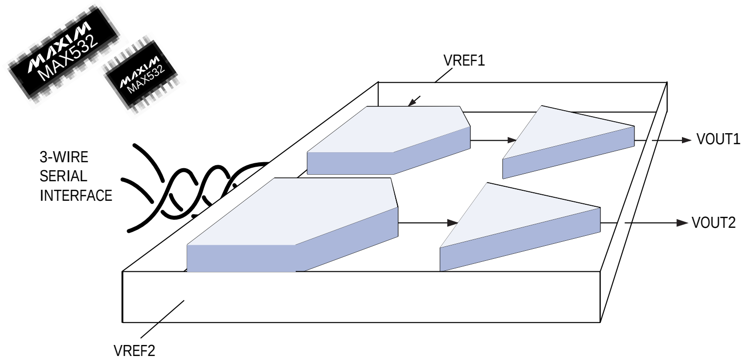
NEW PRODUCTS

Dual 12-bit DAC has serial input and voltage outputs

- ***Two voltage-output D/A converters for only $8.45!***
- ***Output buffers deliver more than 10mA, for outputs to ±12V***
- ***16-pin DIP/SO packages save space***

The MAX532 is a dual 12-bit, 4-quadrant multiplying D/A converter with a 6MHz, 3-wire serial interface. The device achieves 12-bit performance (±1/2LSB max integral nonlinearity) over temperature and without external adjustment. Its serial interface and 16-pin DIP/SOIC packages provide compact circuit layouts.

The digital output terminal (DOUT) enables simultaneous loading of any number of MAX532s, by cascading DOUT of one to DIN of the next. To simplify programmable-gain applications, the package includes external access to the feedback resistor for each output buffer. The buffers settle to ±1/2LSB in 2.5µs, and are capable of developing ±12V across a 1kΩ load.



MAX532 applications include digital offset/gain adjustment, ATE, machine control, and waveform reconstruction. The device comes in 16-pin DIP and wide SO packages, screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices start at $8.45 (1000 up, FOB USA).

(Circle 10)

Single-supply, 700µA comparators offer 40ns propagation delays

The MAX907/MAX908/MAX909 (dual/quad/single) high-speed, low-power comparators are designed for single-supply (5V) operation, with an input-voltage range that extends from below ground to within 1.5V of the positive rail. The comparators draw 700µA typical and consume only 3.5mW each. In addition to 5V operation, the MAX909 offers ±5V operation with an input range that includes -5V.

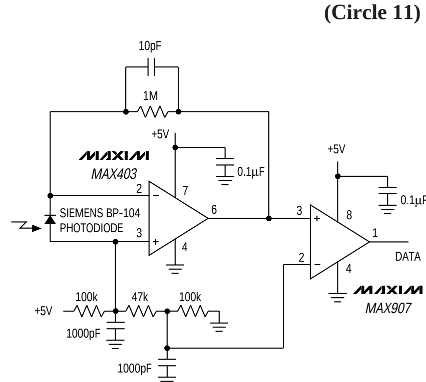
The MAX907 and MAX908 are the first high-speed comparators designed specifically for single-supply, low-power applications. And for the 30-to-100ns range of progagation delays, MAX907/MAX908/MAX909 comparators have the lowest power dissipation available. With 5mV overdrive, the propagation delay is 40ns for all three comparators.

MAX907/MAX908/MAX909 outputs are TTL compatible and require no external pull-up circuitry. All inputs and outputs can be shorted indefinitely to either supply rail without damage, and the comparators' internal hysteresis insures clean and reliable switching even with slow-moving input signals.

The single-comparator MAX909 has a V- pin for extending the input range to -5V. It also provides a latch-control input and a complementary output pin. Applications include battery-powered systems, high-speed A/D and V/F converters, line receivers, sampling circuits, and zero-crossing detectors.

The MAX907 and MAX909 come in 8-pin DIP and SO packages, and the MAX908 comes in 14-pin DIP and SO packages. All are screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices (1000 up, FOB USA) start at $1.70 for the MAX907 (dual), $2.95 for the MAX908 (quad), and $1.50 for the MAX909 (single).

(Circle 11)



12-bit voltage-output DACs settle to ±1/2LSB in 3.0µs

The MX667 and MX767 monolithic D/A converters include an output amplifier, input latches, and a high-stability reference that provides an overall gain error of less than ±15ppm/°C max. Each operates on ±12V or ±15V and dissipates only 144mW.

The MX667's double-buffered latches, compatible with 4-, 8-, 12-, and 16-bit buses, respond to strobe pulses as short as 100ns. The MX767's single latch, which is simpler, faster, and compatible with 12- and 16-bit buses, responds to strobe pulses as short as 40ns. Both amplifiers have 40mA short-circuit current limiting and deliver ±5mA to 2kΩ/500pF loads. Following an output transition of 10V, they settle to ±1/2LSB in 3.0µs.

A µP-write command to either converter can latch the applied input data only 40ns (50ns max) after it becomes valid. Both devices spec ±1/2LSB max integral nonlinearity (INL) over temperature. At +25°C, the max INL specs are ±1/4LSB for the MX667 and ±1/2LSB for the MX767.

The MX667 comes in 28-pin DIP, SO, LCC, and PLCC packages; the MX767 comes in 24-pin DIP and SO as well as 28-pin PLCC packages. Both are screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices (1000 up, FOB USA) start at $9.42 for the MX667 and $8.22 for the MX767. Please contact the factory for price and delivery on MIL-STD-883 versions.

(Circle 12)

NEW PRODUCTS

Quad SPDT analog switch replaces two DG-303s at lower cost

The MAX333 is the first monolithic IC to include four single-pole, double-throw (SPDT) switches for less than 80¢ per channel (1000 up). Designed for multiple-SPDT switching applications, the MAX333 saves board space by lowering the component count in telecommunications systems, modems, and environmental controls.

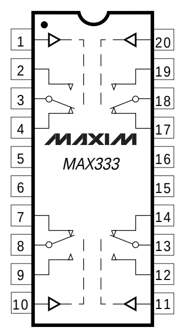
A MAX333 can operate with a single supply of 10V to 30V or dual supplies of ±5V to ±18V. Specifications are guaranteed for both +12V and ±15V operation. The device is TTL/CMOS compatible and requires no separate logic supply whether operating with single or dual supplies. The input signal range includes the supply rails.

The MAX333 requires little power; it draws only 130µA and -10µA from ±15V supplies. On resistance is 140Ω, on leakage is 0.2nA, and off leakage is a mere 0.02nA, yet the turn-off time is a fast 50ns. Make-before-break switching is guaranteed.

MAX333s come in 20-pin DIP and SO packages, screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices start at $3.19 (1000 up, FOB USA).

(Circle 13)

TOP VIEW



SWITCHES ARE SHOWN WITH LOGICAL 0 INPUT

Low-power, precision analog switches have 35Ω max on resistance

- ***Plug-in replacement for industry standard***

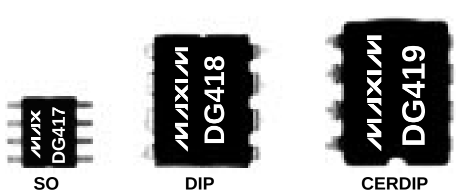
The DG417, DG418, and DG419 precision CMOS analog switches offer low leakage (250pA max at +25°C), fast switching (175ns max turn-on time, 145ns max turn-off time), and low on resistance (35Ω max).

The DG417 is a single-pole/single-throw (SPST) normally open (NO) switch. The MAX418 is a SPST normally closed (NC) switch, and the DG419 is a single-pole/double-throw (SPDT) NO/NC switch.

Each IC is fabricated with an improved silicon-gate process whose maximum breakdown voltage (44V) enables the switches to withstand applied voltages equal to the supply rails.

DG417/DG418/DG419 switches operate on ±15V and draw only 1µA supply currents at +25°C. They are well suited for use in battery-powered systems, sample/hold circuits, guidance and control systems, test equipment, and military radios.

Available in 8-pin DIP, narrow SO, and CERDIP packages, DG417/DG418/DG419 switches are screened for the extended-industrial (-40°C to +85°C) and military (-55°C to +125°C) temperature ranges. Prices (1000 up, FOB USA) start at $1.19 for the DG417/DG418, and $1.63 for the DG419.



Save Space with 8-Pin Packages

(Circle 14)

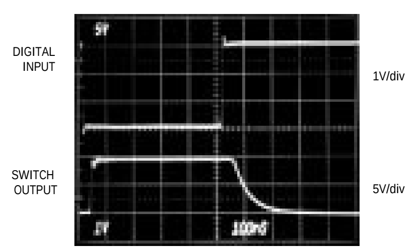
Analog switch has 30ns t_{ON}/t_{OFF}

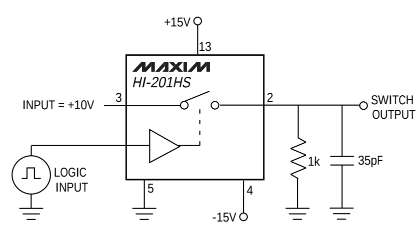
The HI-201HS—a high-speed, monolithic, single-pole/single-throw (SPST), quad CMOS analog switch—is pin-compatible with the industry-standard DG201A.

Maxim's HI-201HS offers fast switching (50ns max for turn-on and turn-off) and low on resistance (50Ω max; 30Ω typical). An improved silicon-gate process enables performance not possible with the original devices: by increasing the absolute-maximum supply voltage rating to 44V, it allows continuous operation at supply voltages to ±20V. The analog input range includes the supply rails: ±4.5V to ±20V, or single supply 12V to 30V. Logic inputs are TTL/CMOS compatible.

Power to the HI-201HS may be disconnected while analog inputs are present, without fear of latchup, provided the continuous input current rating (30mA) is not exceeded. The HI-201HS comes in 16-pin DIP, 16-pin narrow SO, and 20-pin LCC packages, screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices start at $2.64 (1000 up, FOB USA).

(Circle 15)





NEW PRODUCTS

High-performance analog multiplexers offer 100Ω max on resistance

- ***Plug-in replacement for industry standard***

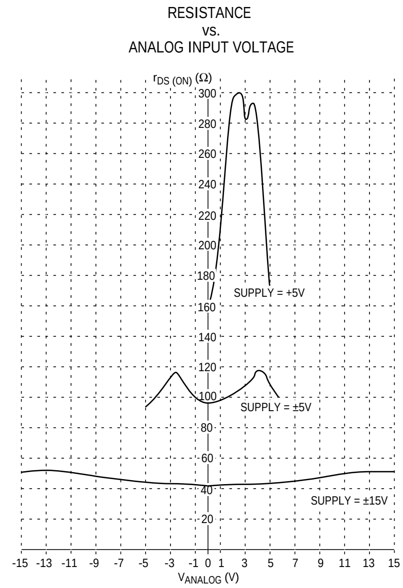
Maxim's DG406 (a 16-channel single-ended multiplexer) and DG407 (an 8-channel differential analog multiplexer) have +25°C on resistances of 50Ω typical and 100Ω max.

Maxim's DG406 and DG407 are fabricated with an improved silicon-gate process whose maximum breakdown voltage (44V) enables them to withstand applied voltages equal to the supply rails. Low on resistance over temperature (125Ω max) improves system accuracy by reducing the voltage error.

Fast switching (t_{TRANS} = 250ns max) suits the DG406 and DG407 for high-speed applications such as signal routing and sample/hold circuits. Typical charge injection is only 20pC. The DG406/DG407 can operate with a single positive supply of 5V to 30V, or with dual supplies of ±4.5V to ±20V. The CMOS logic inputs are CMOS/TTL compatible, and their low input leakage (10µA max over temperature) reduces input loading.

The DG406 and DG407 come in 28-pin DIPs and PLCCs, screened for the extended-industrial (-40°C to +85°C) and military (-55°C to +125°C) temperature ranges. Prices start at $6.72 (1000 up, FOB USA). Contact the factory for MIL-STD-883 products.

(Circle 16)



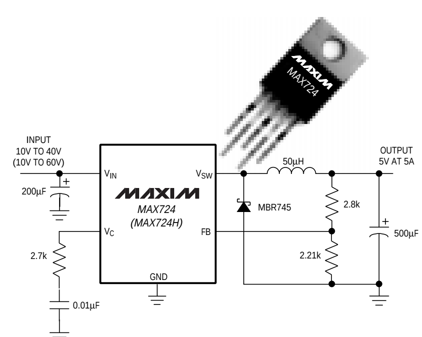
5A step-down dc-dc converter has 60V input range

- ***Easy-to-use switch-mode dc-dc converter needs few external components***

The MAX724 is a high-power, pulse-width-modulated dc-dc converter optimized for step-down applications. It has an internal 5A switch, and operates with input voltages from 8V to 40V (to 60V for the MAX724H high-voltage version). Few external components are required for standard operation because the power switch, oscillator, and control circuitry are all on-chip.

Two external resistors set the output voltage anywhere between 2.5V and V_{IN}, and the reference voltage tolerance is ±2.5% max over line, load, and temperature. Quiescent supply current is 8.5mA; typical efficiency is 80%. To minimize external component size, the internal oscillator is preset to 100kHz.

MAX724 and MAX724H converters come in 5-pin TO-220 packages, screened for the commercial (0°C to +70°C) and extended-industrial (-40°C to +85°C) temperature ranges. MAX724 prices start at $4.69 (1000 up, FOB USA).



5A STEP-DOWN CONVERTER

(Circle 17)

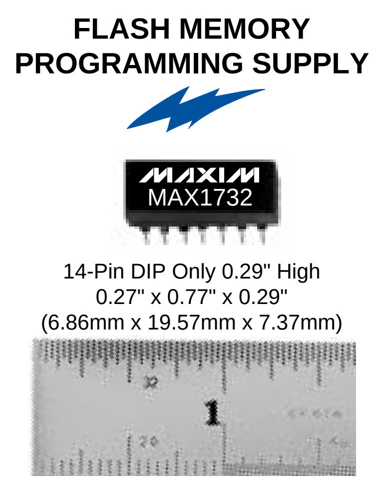
Flash-memory programming module generates 120mA at 12V

The MAX1732 is a 14-pin multichip module (DIP) that contains a complete flash-memory programming supply. Occupying only 0.25in.^{2} (1.6cm^2)of board area, the device guarantees 12V at 120mA with ±4% load regulation over temperature. Power density is 24W/in.^{3} (1.45W/cm^3). The device accepts input voltages in the range 4.5V to 6V, and exhibits a typical conversion efficiency of 85%.

To save power in portable applications, the MAX1732 provides a digitally actuated shutdown that reduces the nominal 1.7mA quiescent current to only 70µA. Output regulation is maintained via current-mode feedback and pulse-width modulation of the internal power MOSFET—a control scheme that delivers precise output regulation along with excellent transient response, low subharmonic noise, and low fixed-frequency output ripple at 170kHz.

The MAX1732 module is screened for the commercial temperature range (0°C to +70°C). It is 0.300in. high and has a standard 14-pin DIP footprint. Prices start at $21.70 (100 up, FOB USA).

(Circle 18)



NEW PRODUCTS

2.5W step-down regulator module generates 500mA at 5V

The MAX1738 dc-dc converter is a complete 5V/500mA power supply, housed in a 14-pin multichip module (DIP) that occupies only 0.2in.^{2} (1.3cm^2) of board area. Operating with input voltages in the range 6V to 16V, the MAX1738 produces 5V ±5% with typical efficiencies exceeding 86%. Because it requires no external components or design work, the MAX1738 is ideal for use in portable instruments, general-purpose 5V power, distributed power, and power supplies for computer peripherals.

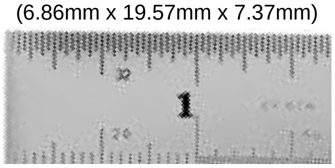
No-load quiescent current is 1.7mA. During shutdown this current drops to 60µA, and the output voltage drops to zero. Internal current-mode, pulse-width modulation control provides precise output regulation and low subharmonic noise. Power density is 41W/in.^{3} (2.5W/cm^3).

Undervoltage lockout shuts down the MAX1738 when the input voltage drops below 5.7V. The soft-start mode limits current surges when coming out of shutdown, during an overcurrent fault, and during undervoltage lockout.

The MAX1738 comes in a 14-pin DIP module of 0.77 x 0.27 x 0.29 inches (19.56 x 6.86 x 7.60mm), screened for the commercial (0°C to +70°C) temperature range. Prices start at $20.51 (100 up, FOB USA).

STEPDOWN TO +5V

14-Pin DIP Only 0.29" High
0.27" x 0.77" x 0.29"
(6.86mm x 19.57mm x 7.37mm)



(Circle 19)

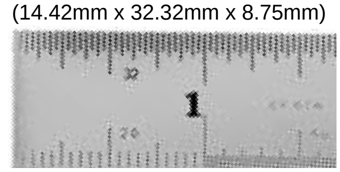
Multichip power-supply module converts 5V to ±12V or ±15V

The MAX1743 is a complete dc-dc converter module that derives either ±12V or ±15V from 5V, according to pin-strap connections made by the user. The device is a complete power supply that requires no design effort or external components.

Output-current capability is 125mA at ±12V, or 100mA at ±15V. The MAX1743 guarantees ±4% regulation for the positive and negative outputs simultaneously, over all specified conditions of line voltage, load current, and temperature. Typical peak-to-peak ripple is only 0.3% of full scale. Protective features include cycle-by-cycle current sensing, undervoltage lockout, and an externally controlled soft-start that prevents current surges during start-up.

DUAL ±12V OR ±15V OUTPUTS

24-Pin Wide DIP Only 0.345" High
0.57" x 1.27" x 0.345"
(14.42mm x 32.32mm x 8.75mm)



The MAX1743 comes in a 24-pin DIP module, 0.600in. wide by 0.345in. high by 1.27in. long, screened for the commercial (0°C to +70°C) temperature range. The price is $26.92 (100 up, FOB USA). **(Circle 20)**

Complete RS-232 serial port monitors ring indicator while in shutdown

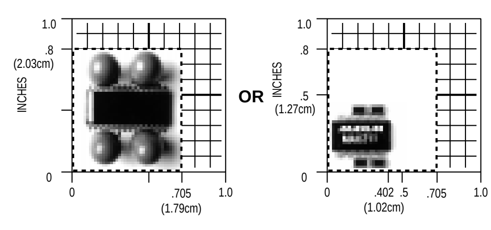
- ***Transceiver operates with 0.1µF external capacitors***

The MAX213 is an RS-232 transceiver containing four drivers and five receivers. Designed for notebook computers and other battery-operated equipment, the MAX213 transceiver meets all EIA/TIA-232E and CCITT V.28 specifications at 20kbits/sec. When loaded in accordance with EIA/TIA-232E, it meets the output levels of that specification for data rates in excess of 120kbits/sec. The MAX213 operates with 0.1µF (instead of 1µF) external capacitors.

During shutdown the device draws only 15µA with two of its five receivers active. When connected to a modem, for example, either receiver can monitor the ring indicator signal from the modem. Internal charge-pump converters boost and invert the applied 5V, producing internal voltages sufficient for generating output levels in full compliance with EIA/TIA-232E for all specified conditions.

The MAX213 comes in 28-pin wide SO packages as well as 28-pin SSOP types, which are 60% smaller than equivalent SO packages. The four external 0.1µF charge-pump capacitors save additional space (vs. the 1µF and 10µF values required with conventional transceivers). The MAX213 comes screened for the commercial (0°C to +70°C) or extended-industrial (-40°C to +85°C) temperature range, with prices starting at $3.29 (1000 up, FOB USA).

SSOP PACKAGE WITH 0.1µF CAPACITORS REDUCES BOARD SPACE BY >60%!



28-pin Wide SOIC **28-pin SSOP**

(Circle 21)

NEW PRODUCTS

RS-485 transceiver reduces EMI 100 times

MAX481, MAX483, and MAX485 transceivers meet the requirements of RS-485 and RS-422 applications. MAX483 drivers feature a reduced slew rate that dramatically lowers radiated EMI while minimizing the reflections caused by mismatched cable terminations. Its low quiescent current (350µA) makes it the lowest-power IC available for RS-485 applications.

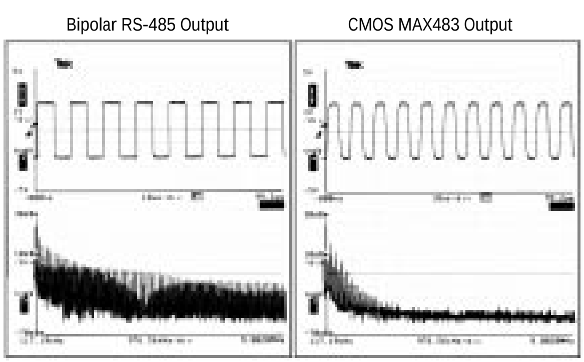
The MAX483 meets all RS-485 specifications while operating at data rates to 150kbits/sec. Higher slew rates in the MAX481 and MAX485 transceivers enable data rates as high as 2.5Mbits/sec. The MAX481 and MAX485 draw quiescent currents of 500µA; the MAX483 has the lowest quiescent current, at 350µA max. The MAX485 is a direct replacement for the LTC485. MAX481 and MAX483 transceivers offer shutdown currents of 0.1µA (10µA max).

Current limiting protects the driver outputs against external short circuits. Thermal-shutdown circuitry offers further protection, placing the driver outputs in a high-impedance state when necessary to guard against excessive power dissipation. All driver and receiver outputs have three-state enable controls, and the receivers' fail-safe protection guarantees a logic-high output when the input is open circuited.

The MAX481/MAX483/MAX485 transceivers come in 8-pin DIP and SO packages, screened for the commercial (0°C to +70°C), extended-industrial (-40°C to +85°C), and military (-55°C to +125°C) temperature ranges. Prices start at $1.25 (1000 up, FOB USA).

(Circle 22)

REDUCE EMI BY 100X!



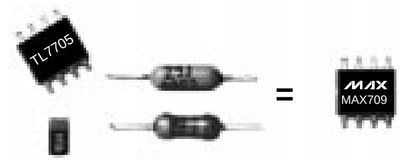
Simple, inexpensive reset monitor requires no external parts

The MAX709 is an inexpensive µP-supervisory IC that issues system resets during power-up, power-down, and brownout conditions. The MAX709 comes in a small 8-pin SO package, and (unlike the TL7705) requires no external parts.

Five trip thresholds (identified by suffix) enable variants of the MAX709 to flag low V_{CC} voltages in 3V, 3.3V, and 5V systems: 4.6V ("L" suffix), 4.4V ("M"), 2.63V ("R"), 2.93V ("S"), and 3.08V ("T"). The outputs are guaranteed valid for V_{CC} as low as 1V. They go low when V_{CC} drops below the threshold, and remain low for 200ms after V_{CC} rises above the threshold.

MAX709s come in 8-pin DIP and SO packages, screened for the commercial (0°C to +70°C) and extended-industrial (-40°C to +85°C) temperature ranges.

The MAX709 REPLACES 1TL7705, 1 RESISTOR, AND 2 CAPACITORS

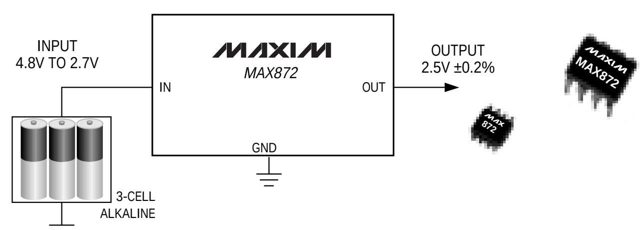


(Circle 23)

2.5V, 40ppm/°C reference draws less than 10µA

- ***Only 3-terminal reference guaranteed to regulate from supply voltages as low as 2.7V***
- ***±0.2% initial accuracy***
- ***Ideal for 3V battery applications***

The MAX872—the only 3-terminal precision reference that guarantees 2.5V ±0.2% outputs for inputs as low as 2.7V—is ideal for 3V battery-powered systems. Drawing less than 10µA regardless of input voltage, it offers the lowest power consumption available in a 3-terminal precision voltage reference. For 12-bit applications requiring a micropower 4.096V reference, the MAX874 also draws less than 10µA, and operates from supply voltages as low as 4.3V.



For applications that require a temperature-dependent output, the MAX872 and MAX874 generate voltages (at their TEMP terminals) that vary 2.3mV/°C. The references' line regulation is about 80µV/V for the V_{IN} range 2.7V to 5.5V, improving to 4µV/V for the range 4.5V to 20V.

The MAX872 and MAX874 come in 8-pin DIP and SO packages, screened for the commercial (0°C to +70°C) and extended-industrial (-40°C to +85°C) temperature ranges. Prices start at $2.12 (1000 up, FOB USA).

(Circle 24)

MAXIM’S MILITARY PROGRAM

Maxim's MIL-STD-883 (/883) program tests the devices per Method 5004 and performs Quality Conformance Inspection per Method 5005, Groups A,B,C, and D. As a result, Maxim's /883 products comply fully with paragraph 1.2.1 of MIL-STD-883.

For complete electrical specifications on the available /883-compliant products, Maxim's *Military Products Data Book* is scheduled for release in June 1993.

Parts currently /883 compliant:

MAX1232	MX7541A-7543
MAX154/158	MX7545
MAX160	MX7547
MAX232	MX7572/7574
MAX331-333	MX7628
MAX358/359	MX7820
MAX368/369	MX7824/7828
MAX378/379	DG200A-202
MAX543	DG300A-309
MAX626-628	DG381A/384A/387A
MAX631**	DG390A
MAX638**	DG401/403/405
MAX663/664/666	DG411-413
MAX674/675	DG441/442
MAX690-697	DG506A-509A
MAX8211/8212	DG528/529
MX536A	HI-201
MX574A	HI-508/509
MX580/581/584	IH5048-5051
MX7224-7226	IH5140-5145
MX7520/7521	IH5341/5352
MX7524/7528	ICL7667
MX7533	REF01/02
MX7537	TSC426-428

DESC approved devices to Standard Military Drawings (SMDs) currently available:

MAXIM P/N	SMD NUMBER	MAXIM P/N	SMD NUMBER
MAX232	5962-89877	DG201	77053
MAX543**	5962-92345	DG411-413	5962-90731
MAX631-633	5962-92141	DG528	5962-87689
MAX638	5962-92127	HI-201	77053
MAX663/664/666	5962-92126	ICL7667	5962-87660
MAX680**	5962-93120	IH5040-5047	81006
MAX690/692/694	5962-90712	IH5140-5151	81006
MAX691/693/695	5962-90711	REF01	5962-89581
MAX8211/8212	5962-90811	REF02	85514
MX580	5962-86861	TSC426-428	5962-88503
MX584	5962-38128		
MX7226	5962-87802		
MX7524	5962-87700		
MX7528	5962-87701		
MX7537	5962-87763		
MX7541	5962-89481		
MX7545**	5962-87702		
MX7547	5962-89657		
MX7572	5962-87591		
MX7574	5962-89616		
MX7820	5962-88650		
MX7824/7828	5962-88764		

Parts in /883 qualification*:

MAX174/176/178	MAX738
MAX180/182	MAX7645
MAX231/232A	MX390
MAX238	MX674A
MAX274/275	MX7245/7248
MAX280	MX7549
MAX326-329	MX7578
MAX4420	MX7582
MAX4425-4429	MX7821
MAX630	MX7845
MAX634-637	DG406/407
MAX667	DG408/409
MAX680	OP07
MAX690A-693A	OP27/37
MAX732/733	

SMDs currently in progress:

MAXIM P/N	SMD NUMBER	MAXIM P/N	SMD NUMBER
MAX232A	5962-89877	MX674	5962-91610
MAX358	77052	DG403	5962-89763
MAX359	5962-85131	DG405	5962-89961
MAX4420/4429	No Number Assigned	DG506-509	5962-85131
MAX4426-4428	No Number Assigned	DG508	77052
MAX634	5962-92124		
MAX635/636/637	5962-92125		
MAX738	5962-93021		
MAX574	5962-85127		

* Contact factory for availability.
** New Addition