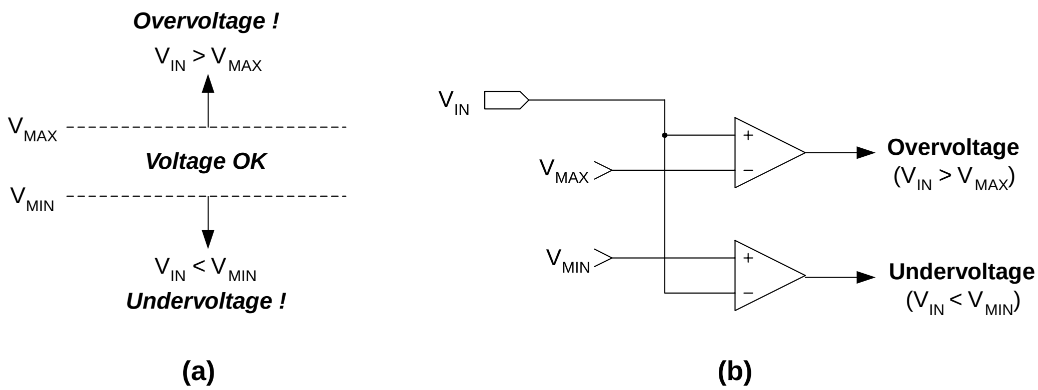
Lattice Semiconductor Corporation

Programmable High/Low Voltage Monitor Using ispPAC30

July 2001 **Circuit Solution CS1019**

Voltage monitoring circuits report when a voltage is beyond one or more pre-defined limits. These circuits are used for many purposes, ranging from determining when a power supply has achieved stable operation to determining when a sensed variable in a manufacturing process has drifted out of tolerance. Although it is possible to monitor a voltage with an analog-to-digital converter and make an in-bounds/out-of-bounds determination digitally with a microprocessor, a completely analog solution is often simpler to implement or offers performance advantages such as fast reaction time.

Figure 1. Alarm Conditions (a) and Functional Diagram (b) of Voltage Monitor



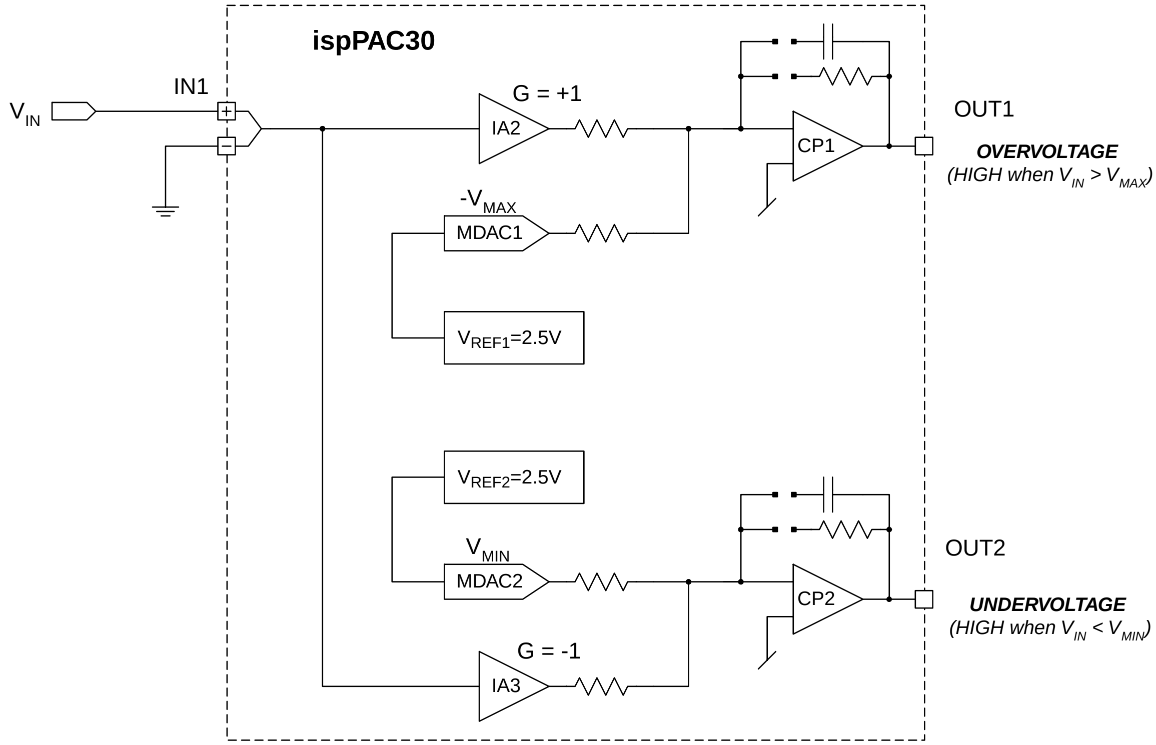
The monitoring function here is one that reports whether an input voltage (V_{IN}) has moved outside of a set on minimum (V_{MIN}) and maximum (V_{MAX}) bounds, as shown in Figure 1a. If the voltage is higher than V_{MAX}, an OVERVOLTAGE signal should be reported, and a voltage lower than V_{MIN} should result in an UNDERVOLTAGE signal. Traditionally, this function is implemented with a pair of comparators, referenced from separate V_{MIN} and V_{MAX} voltage references (Figure 1b). V_{MIN} and V_{MAX} can be developed several ways, such as with discrete voltage references, digital-to-analog converters, taps along a resistive divider, or with potentiometers. When a reasonable degree of accuracy is required of the V_{MIN} and V_{MAX} voltages, a significant amount of effort and expense can be spent in coming up with suitable circuitry to implement these functions.

The Lattice ispPAC®30 can be used to realize precision monitoring functions with a single integrated circuit. The internal configuration needed to do so is shown in Figure 2. In this circuit, both output amplifiers are configured as comparators with open feedback links. The ispPAC30's programmable interconnects also allow for other configurations.

Because the ispPAC30's comparator blocks are not traditional two-input comparators, but detect when a signal is greater or less than zero, the ispPAC30 configuration used to implement this function is somewhat different than that shown in Figure 1b. To develop the OVERVOLTAGE output signal, the negative of the V_{MAX} level is added to the V_{IN} input signal and then compared to zero. The condition $V_{IN} + (-V_{MAX}) > 0$ implies an overvoltage condition, and will result in OUT1 going HIGH. To obtain the UNDERVOLTAGE signal, the polarity of the input must be inverted and added to a V_{MIN}. In this case the condition $V_{MIN} - V_{IN} > 0$ implies an undervoltage condition and will cause OUT2 to go HIGH. In the case that $V_{MIN} < V_{IN} < V_{MAX}$, both outputs will be LOW. As an example, to build a voltage monitor that will report overvoltage conditions in excess of 1.8V (V_{MAX}) and undervoltage conditions of less than 1.4V (V_{MIN}), one would set MDAC1 for a -1.8V output, and MDAC2 for a 1.4V output.

Because all of the configuration information in an ispPAC30 is stored in non-volatile E^2 memory, V_{MIN} and V_{MAX} thresholds do not need to be set at design time, but can be adjusted during the manufacturing process or even out in the field. The ability to adjust these parameters on-chip, without the use of potentiometers, both increases reliability, and allows for increased automation on the manufacturing process.

Figure 2. Using the ispPAC30 as a High/Low Voltage Monitor



Alternatively, the V_{MIN} and V_{MAX} thresholds can even be adjusted through the ispPAC30's SPI interface. This feature allows a microcontroller to adjust alarm thresholds dynamically in response to environmental changes or other conditions.

Although the acceptable input voltages for the ispPAC30 are limited to a range spanning 0V to +2.8V, it is possible to adapt this circuit to monitoring voltages over much larger ranges through the use of a resistive divider or scaling network at the input. For more information on how to construct a suitable input scaling network, please refer to Circuit Solution CS1001: *Voltage Level Adapter Circuit*. Alternatively, by setting the gains of input amplifiers IA2 and IA3 to values greater than one, and/or setting the values of the programmable voltage references to smaller voltages (down to 64mV), it is possible to monitor very small input voltage signals.

Technical Support Assistance

Hotline: 1-800-LATTICE (Domestic)

1-408-826-6002 (International)

e-mail: ispPACs@latticesemi.com