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Alarm IC General Applications Overview

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INTRODUCTION

The MC14600, an IC designed for alarm applications, is a versatile part that can easily be configured with a minimum number of external components to serve a wide range of alarm applications and circuit configurations. For example, the MC14600 can be used in systems that detect pressure and temperature change, liquid levels, motion or intrusion. This application note presents considerations in interfacing external components to the MC14600 and an approach for configuring it with a latch.

The MC14600 Alarm IC can be simply described as a comparator that determines whether an alarm condition exists and in response drives a piezo horn. As illustrated in Figure 1 the MC14600 is more than a comparator and a horn driver. It drives an LED to indicate the device is working and has internal low battery detection circuitry. In the event of a low battery the MC14600 provides the signal to chirp the piezo horn. It also has a logical output that can be used to drive other outputs such as an LED. The MC14600 alarm threshold and oscillator speed are set externally providing system design flexibility. Figure 2 is a detailed block diagram of the MC14600 that includes the pin numbers referenced in this document.

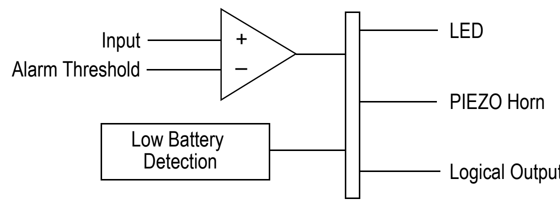

Figure 1. Alarm IC Concept

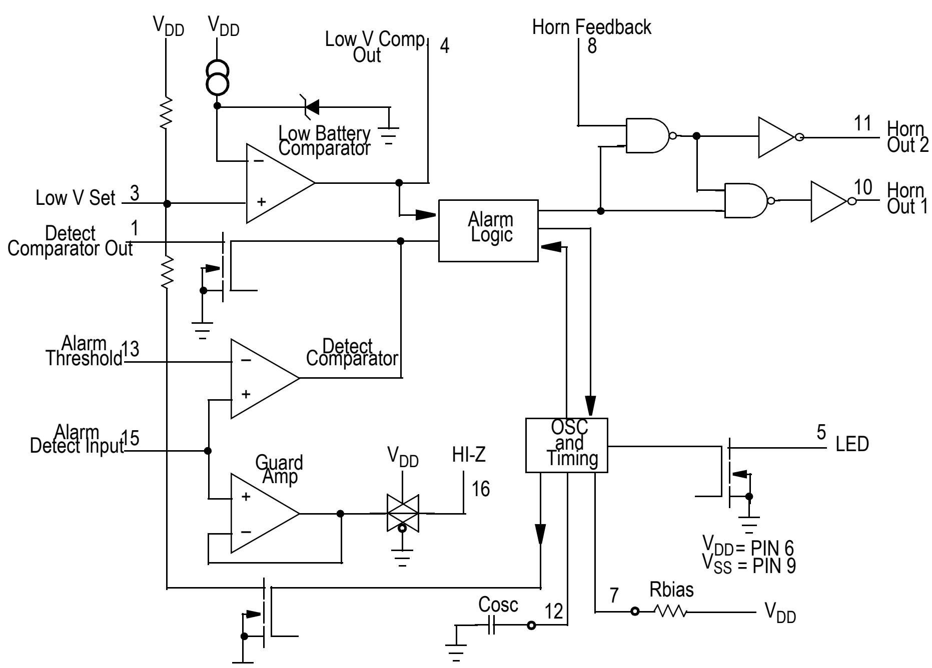

Figure 2. MC14600 Block Diagram

ALARM THRESHOLD ADJUSTMENTS

The alarm trigger point (alarm threshold) is set externally to any voltage level with a simple voltage divider connected to pin 13. For instance, to connect the Alarm IC to a sensor that has an output of 1.0 V during a no alarm condition and 4.0 V during an alarm condition, the alarm threshold voltage could be set to 3.0 V using a 2 MΩ and a 1 MΩ resistor connected between V_{DD} and ground (See Figure 3). Pin 13 connects internally to the negative input of the Detect Comparator. Based on the input impedance of the Detect Comparator the maximum suggested total resistance for the threshold voltage divider is 10 MΩ.

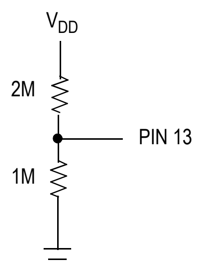

Figure 3. Alarm Threshold Voltage Divider

OSCILLATOR

The master clock frequency for the MC14600 is determined by the external components Rbias (pin 7) and Cosc (pin 12). This RC network provides the timing for the various functions conducted by the IC. The oscillator timing affects the period between LED pulses, alarm signal sampling, and the horn output pulses and power consumption. A standard RC network for the MC14600 oscillator uses an 8.2 M resistor (Rbias) connected from V_{DD} to pin 7 and a 0.1 µF capacitor (Cosc) connected from pin 12 to ground. This configuration will provide a period of approximately 1.65 sec in standby and 41.67 msec in alarm. A change in oscillator speed is accomplished by changing the resistor and capacitor values previously stated. Changing the oscillator timing will not change the horn pattern but it will change the speed at which it's delivered. The table below lists examples of RC values and measured sampling periods achieved with those values (deviation from theoretical values are due to tolerance in components).

Table 1. Oscillator Period vs. R_{bias} and C_{osc} Value

R_{bias}	C_{osc}	Period (no Alarm)	Period (Alarm)
5.6 MΩ	0.01 µF	93 ms	2.3 ms
8.2 MΩ	0.01 µF	142 ms	3.4 ms
10 MΩ	0.01 µF	172 ms	3.9 ms
5.6 MΩ	0.1 µF	1.4 s	32 ms
8.2 MΩ	0.1 µF	2.2 s	50 ms
10 MΩ	0.1 µF	2.7 s	60 ms
8.2 MΩ	1.0 µF	20.1 s	456 ms

PIEZO HORN INTERFACE

The MC14600 contains on-board horn driver circuitry to drive three leaded piezo horns. A three leaded horn is considered self-driven, having a feedback pin that is connected to a closed loop oscillation circuit. The MC14600 uses pin 8 (Horn Feedback), pin 10 (Horn Out 1) and pin 11 (Horn Out 2) to interface to a piezo horn and achieve the drive circuit. Pin 10 and pin 11 alternate their output providing the oscillation for the horn. Three external components are required to interface a piezo horn to the Alarm IC: R1, C1 and R2 (Figure 4). R1 is usually around 1.5 MΩ and is the least critical component as it only biases the horn. R2 and C1 are critical to achieve maximum horn output. The two components must be set so that the value of 1/(R2*C1) is close to the resonant frequency of the horn being used. Table 2 lists a common horn frequency and potential external components that can be used for R2 and C1.

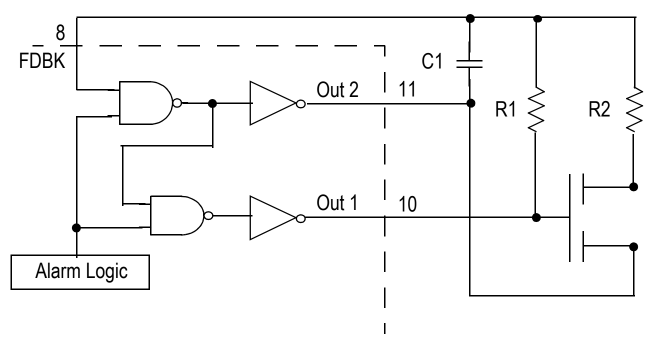

Figure 4. Piezo Horn Interface to MC14600

Table 2. External Components for a 3.4 kHz Three Leaded Piezo Horn

Horn OSC Frequency	R1	R2	C1	1/(R2*C1)
3.4 ± 0.4 kHz	1.5 MΩ 820 kΩ 1.5 MΩ 1.5 MΩ	200 kΩ 200 kΩ 120 kΩ 100 kΩ	1.5 nF 1.5 nF 2.2 nF 2.2 nF	3.33 kHz 3.33 kHz 3.79 kHz 4.55 kHz

LOW BATTERY THRESHOLD ADJUSTMENTS

The Alarm IC has a typical internal low battery reference voltage of 6 V. An internal resistor divider string provides a voltage of 80% of V_{DD} which is compared to the 6 V reference voltage (See Figure 5). This results in a low battery condition and horn chirp if the V_{DD} level is decreased to approximately 7.5 V. The percentage of V_{DD} that is compared can be changed by adding a resistor to pin 3. A resistor from pin 3 to V_{DD} will lower the percentage while a resistor from pin 3 to GND will increase the percentage. The low battery comparator information will be latched only during the LED pulse. Testing of the voltage at pin 3 should be done during the LED pulse for confirmation. It should also be measured through a high impedance buffer to avoid altering the voltage level.

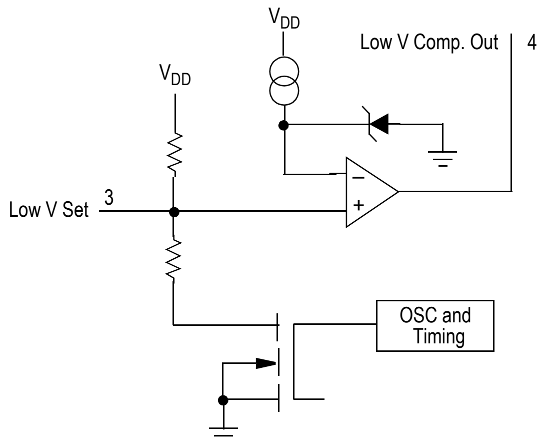

Figure 5. Low Battery Detection Circuitry

ALARM LATCHING APPROACHES

There are detection applications where the event that triggers the alarm can be instantaneous, such as shock or motion. In this case the Alarm IC would alarm for the brief moment that the event occurred and then stop. This is not always desirable, in particular during events where safety is of concern.

A latch can be implemented using the concept of **hysteresis** to alter the alarm threshold level and therefore remain in an alarm condition. It is very simple as it requires only one resistor, R3, connected to pin 1 (Detect Comp. Out.) and added in series to the alarm threshold voltage divider, R1 and R2, on pin 13 (See Figure 6). During a no alarm condition pin 1 is high which makes the alarm threshold voltage divider look like it would without R3 connected, keeping the alarm threshold at the initial desired point. When an alarm condition occurs pin 1 goes low, which in turn dramatically lowers the threshold voltage into the alarm comparator. When the alarm signal ends and the input voltage into pin 15 decreases, the alarm condition does not end because the alarm threshold has been lowered to below a standby voltage level. The MC14600 will continue in an alarm condition until the unit is RESET or pin 15 receives a signal below this alarming threshold. A RESET is implemented by connecting a switch to pin 1 that will toggle to V_{DD} through a resistor. This solution has the possibility that it will not latch on to the alarm condition indefinitely. As described above it is essentially just lowering the alarm threshold voltage so if the output from the sensor during a no alarm condition is below this threshold the latch will not work.

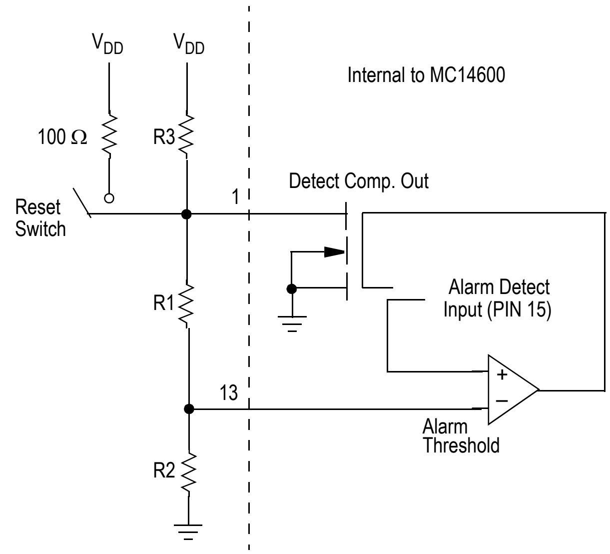

Figure 6. Latch Using Resistor in Series with Threshold Divider

SAMPLE DETECTION INPUTS

The MC14600 is a versatile device because its high impedance input pin allows it to be connected to a variety of systems and input signals. All that is required for an input is a device or circuit that will produce a change in voltage that corresponds to an environmental change. For example, a simple circuit around a thermistor could cause the MC14600 to alarm when the temperature gets too high. A photo transistor could be connected to cause an alarm for either the absence or existence of light.

Freescale also has sensors, specifically accelerometers and pressure sensors, that could be used as the input to the MC14600. An accelerometer, such as the MMA1201P, could be used to sense a shock or vibration. A possible solution is shown in Figure 7. The MC7805 is a voltage regulator that provides the 5 V supply required by the MMA1201P. Since the output of the MMA1201P resulting from a shock or vibration is very short some simple peak detection circuitry is required to keep the signal high long enough for the MC14600 to latch onto the alarm condition.

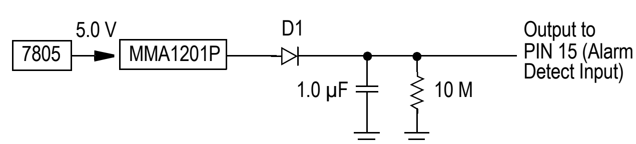

Figure 7. Shock and Vibration Detection Circuit

Freescale's pressure sensors can also provide the input to the MC14600. The MPX5000 series includes a wide variety of compensated and integrated pressure sensors with different pressure ranges, packaging and measurement options. One possible sensor is the MPXV5010. The output of the MPXV5010 can be fed directly into the input of the MC14600 (pin 15). If the latch described above is used with a pressure sensor resistors may be required at the output of the MPXV5010 to scale the output voltage (See Figure 8). This is because the output voltage for pressure sensors in the MPX5000 series under no pressure is 0.2 V, which may be below the lowered alarm threshold. (See previous section.)

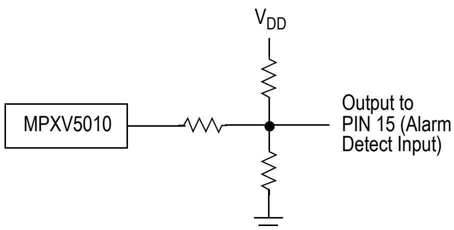

Figure 8. Pressure Detection Circuit

CONCLUSION

The MC14600 offers a simple solution for use in a wide variety of alarm applications. With a high impedance input pin it can be connected to many types of sensor devices. For sensor inputs that require a latched alarm condition there are several simple ways to add this option to the MC14600. It has the feature of not having a predetermined alarm threshold which gives it the flexibility of being set to any level as required by the application. The MC14600 has an internal horn driver that can drive a three leaded piezo horn with the addition of two resistors and one capacitor. The MC14600 integrates the features desired in alarm devices into a small and simple package that is still flexible enough for all types of alarm applications.

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