A Unique, Ultra-low Power Analog IC Enables RF Wakeup Applications

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A wake detector is simply a circuit which wakes up a microcontroller from its low current sleep state, saving power while anticipating an event which must be processed. In the case of an RF wakeup scheme, substantial power can be saved by allowing the microcontroller to sleep while waiting for a transmitted RF signal, especially if the transmitted signal occurs infrequently. The RF wakeup circuit only interrupts the microcontroller from its sleep state when RF power at the appropriate frequency is detected, indicating a potentially valid signal from a remote transmitter. Generally, the microcontroller, once awakened, further processes the signal to ensure it is valid by examining its coding, and then places the device in a receiver mode to accept data in a coded transmission. An example of a system using such a scheme might be a remote industrial sensor which might be polled periodically or, perhaps, a wireless doorbell.

The TS12011 is a unique, extremely low power combination of an op amp, comparator, and a 0.58V reference, in a $4mm^2$ package. These basic circuit blocks are perfect for providing some gain, threshold detection, and a logic level signal for a very low power RF wake detector. Operating down to 0.8V, this “nanopower” IC draws around 1.1uA, ensuring these functions contribute negligibly to the currents required by the wake detector. Pairing the TS12011 with appropriately low power RF circuitry yields a very low power solution.

For the RF circuitry, there are many types of RF detectors, from simple diode circuits to fully heterodyned receivers. In general, the simpler circuits require the lowest supply currents, while suffering poorer sensitivity (range) and selectivity (rejection of interferers), while the more complex require more current but providing better sensitivity and interference immunity.

A simple diode detector offers the lowest power RF detector. In their most simple form, there are no active, powered elements in these circuits- just diodes connected to a capacitor and a tuned antenna circuit. Unfortunately, these circuits have poor sensitivity, limiting them to short range usage scenarios, where, for example, an RF illuminator (transmitter) is placed in proximity to the detector. Selectivity, as well, is based on the Q of passive components alone, without the benefit of active feedback; false alarms may be frequent with this type of RF wake detector, though this is somewhat mitigated by the poor range.

A more sensitive circuit can be built with a super-regenerative receiver architecture. The most efficient design of such a receiver requires just one transistor. These circuits can often be found in consumer electronics devices. While not as selective as a traditional receiver with more substantial filtering, sensitivity can be reasonably good. Super-regenerative receiver designs are described thoroughly in a variety of sources.

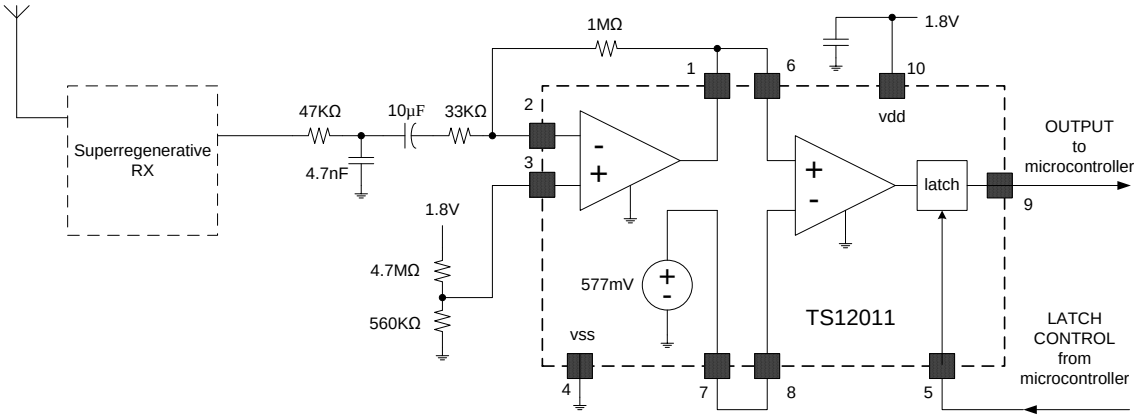

Figure 1. A super-regenerative RF receiver-based wakeup circuit.

Figure 1 shows a circuit for connecting a super-regenerative RF detector to the TS12011. Here, a single-transistor super-regenerative OOK (on-off-keyed) receiver, tuned for 315MHz, is found in a wireless doorbell product. The receiver produces a small drop in DC voltage across its output stage when RF is detected from the remote doorbell pushbutton transmitter. A TS12011 was wired into the circuit to take this signal, gain it up using an inverting gain configuration for the op amp, provide threshold detection using the comparator and reference, and ultimately deliver a logic signal to the microcontroller to indicate RF has been detected. Typically in a system like this, the microcontroller will be asleep in a very low power state until its sleep state is interrupted by this logic signal.

A nice feature of the TS12011 is its “latch enable” pin - a high level on this pin latches and holds the comparator’s output high, giving the microcontroller a clean indication that RF has been detected. The microcontroller can clear this state by momentarily pulsing the TS12011’s LHDET\ pin low.

Once woken up, the microcontroller can examine the ON-OFF keyed code and determine if it is a valid signal from the doorbell transmitter.

For additional information, please follow the links to the corresponding product pages:

- TS12011 Product Information
- TS12012 Product Information

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