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APPLICATION NOTE 4230

Expanding the Functionality of the MAX9930 for CATV Applications

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Abstract: The MAX9930–MAX9933 family of RF controllers and detector can be used in a wide variety of applications. An ideal application is cable television (CATV) over fiber, where either a RF controller or a RF detector controls the gain of a transimpedance amplifier (TIA). This application note shows how the MAX9930 (RF controller) can be used as either the RF controller or detector.

PON Technology

Fiber applications have grown substantially, driven by the demands of high-speed Internet access and cable television systems (CATV). Key components of this growth are the advent of a new low-cost hardware system called PON (passive optical network) and the new standards for GPON (gigabit passive optical network) and EPON (Ethernet passive optical network).

PON technology features a central office called OLT (optical line termination) and multiple users called ONTs (optical network termination). Up to 32 ONTs can connect to the same OLT. Multiple signals such as Internet data, voice, and TV can be sent over the same fiber by using different wavelengths of light on multimode fibers. Optical transceivers in the ONTs recover the voice, data, and video information.

Basic RF Controller and Detector Operation for CATV

The optical transceivers in a PON system are also called triplexers. They provide three outputs, one of which is the RF port for the CATV to connect to a set-top-box. The optical transceivers typically have a transimpedance amplifier (TIA) that converts the current signal from a photodiode into a voltage output. The TIA gain needs automatic control in order to provide a constant RF output power to the set-top-box, regardless of the signal strength received from the fiber. This gain control is typically achieved by using either a RF controller in a purely analog feedback loop (**Figure 1**), or a RF detector in digital feedback loops that involve a microcontroller (**Figure 2**).

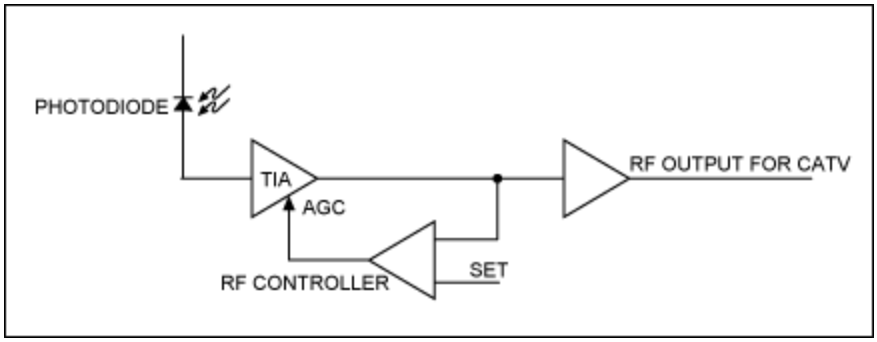

Figure 1. In a typical CATV application, the TIA gain is adjusted with an analog feedback loop by using a RF controller.

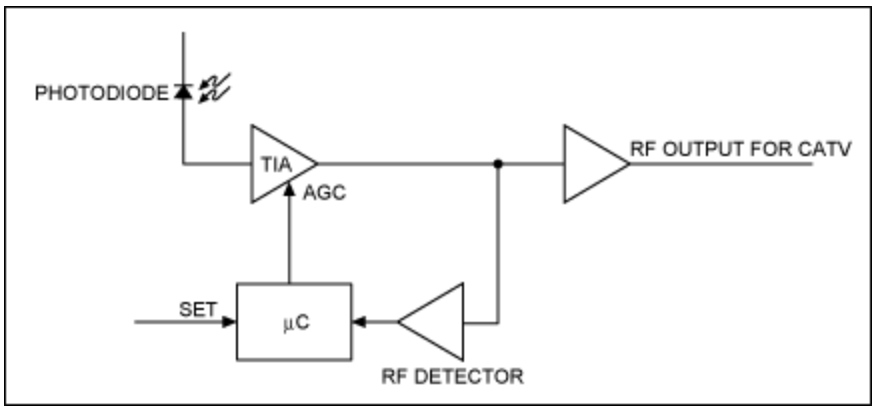

Figure 2. The TIA gain is adjusted with a digital feedback loop that involves a RF detector and a microcontroller.

For CATV applications the bandwidth of the TIA, as well as the bandwidth of the RF controller/detector that provides the gain adjustment, range from 47MHz to 870MHz. The MAX9930–MAX9933 family of RF controllers and detector are designed to meet these specifications.

The MAX9930 is a RF controller that operates in a 2MHz to 1600MHz frequency range and features a -45dBm to 0dBm input-power range. The MAX9933 is a RF detector that operates in the same frequency and input power ranges as the MAX9930. **Figure 3** shows the block diagram of both parts.

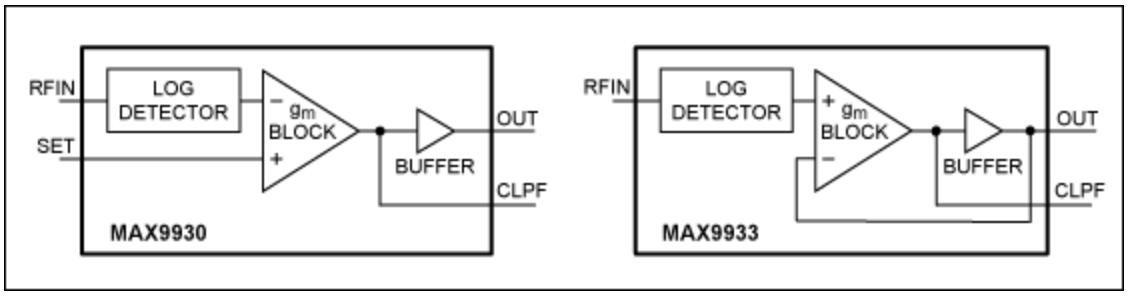

Figure 3. Block diagram of the MX9930 (RF controller) and MAX9933 (RF detector).

Typical Application for the RF Controller

The application of Figure 1 uses the MAX9930 and an operational amplifier (here the MAX4412) to

invert the MAX9930's output and maintain the negative feedback loop with the TIA. (See **Figure 4**.) When the TIA (the MAX3654 in this example) is used, a voltage increase at the gain-control input, VAGC, reduces the transimpedance gain. Consequently, the output of the MAX9930 must be inverted.

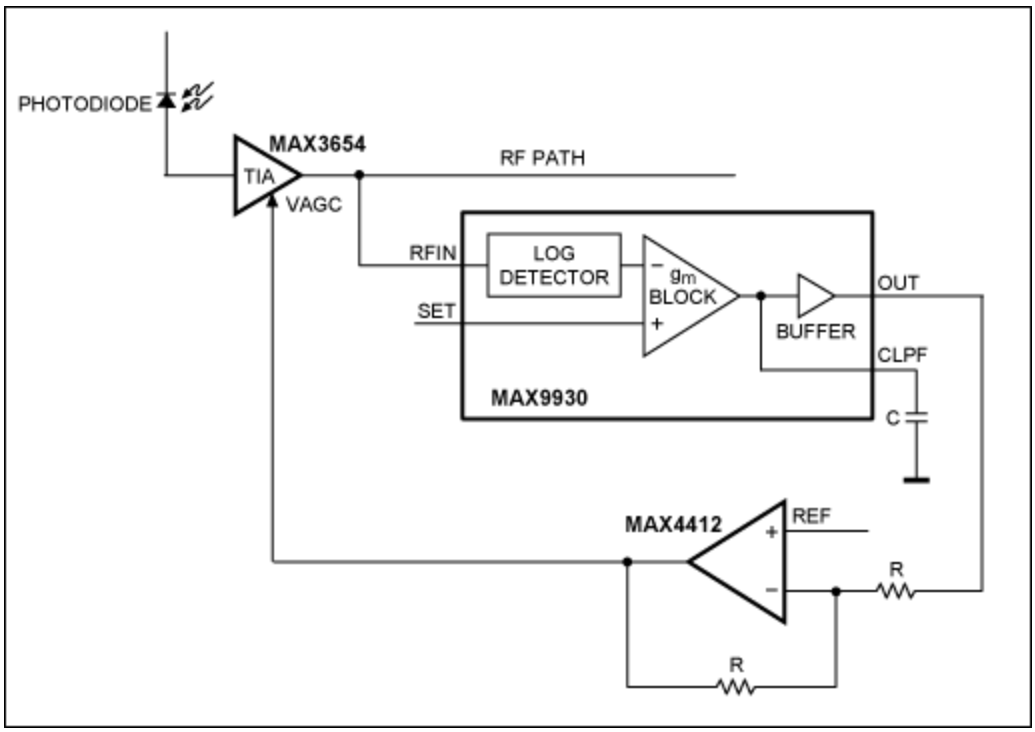

Figure 4. The MAX9930 is used in its typical application as a RF controller.

Using the Controller as a RF Detector

The application of Figure 2 has a digital feedback loop that uses a microcontroller and requires a RF detector. The MAX9933 RF detector could perform this operation. There is, however, an alternative design. Figure 3 shows that the MAX9930 RF controller can also operate as a RF detector when the loop between the output pin, OUT, and the input pin, SET, is closed externally with a polarity inversion. The polarity inversion provides the negative feedback loop, and is achieved by using an operational amplifier like the MAX4412 in the inverting configuration. **Figure 5** shows the circuit in which the MAX9930 RF controller operates like a RF detector.

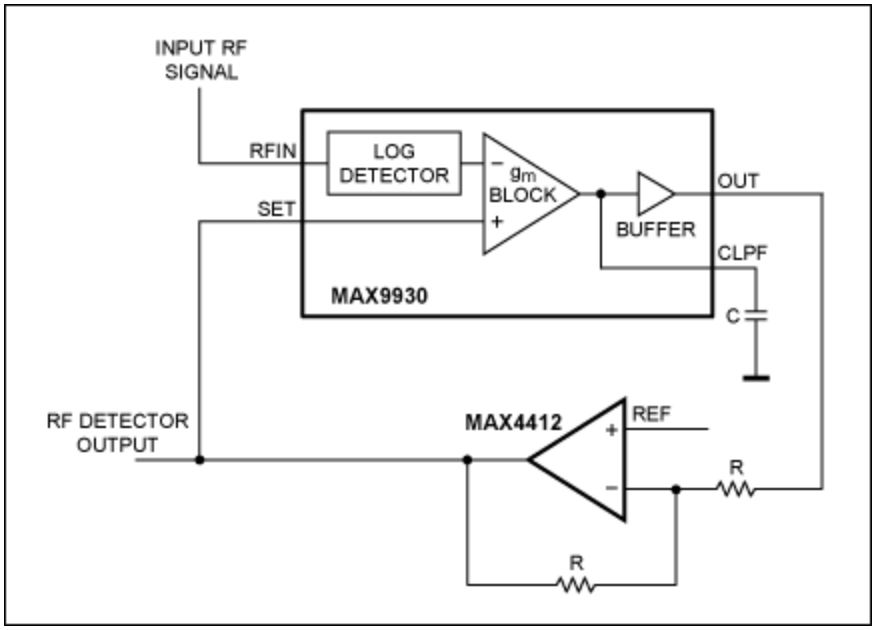

Figure 5. Used with the inverter MAX4412, the MAX9930 RF controller operates as a RF detector.

The circuit of Figure 5 has been tested with V_{CC} = 5V, R = 10kΩ, C = 2200pF, and V_{REF} = 2V. The MAX9930 RFIN is fed by a RF generator at 50MHz and with the power level varying from -45dBm to ±0dBm (into 50Ω termination).

The logarithm relationship between the SET voltage, which is the output of the RF detector circuit of Figure 5, and the RFIN power is shown in **Figure 6**.

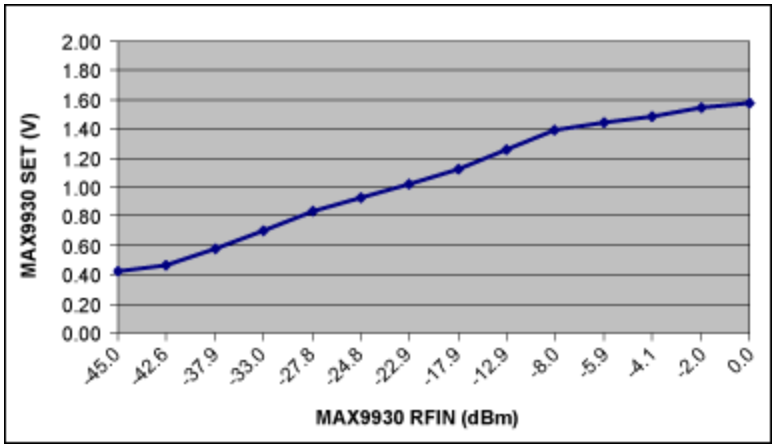

Figure 6. The relationship between SET vs. RFIN on the MAX9930 when it is used as a RF detector in the circuit of Figure 5.

Conclusion

In CATV applications over fiber, RF controllers and detectors can be used to control the gain of a TIA. A specific CATV application was presented that modified the MAX9930 RF controller's operation with an operational amplifier so the controller functioned as a RF detector.

Related Parts		
MAX9930	2MHz to 1.6GHz 45dB RF-Detecting Controllers and RF Detector	Free Samples
MAX9931	2MHz to 1.6GHz 45dB RF-Detecting Controllers and RF Detector	Free Samples
MAX9932	2MHz to 1.6GHz 45dB RF-Detecting Controllers and RF Detector	Free Samples
MAX9933	2MHz to 1.6GHz 45dB RF-Detecting Controllers and RF Detector	Free Samples

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