Kunal Gandhi Jul 31, 2015

In parts 1 and 2 of this series, my colleague Matthew Sauceda described how to successfully bias radio frequency (RF) power amplifiers (PAs). A monitoring and control) solution is required to overcome the temperature-dependent nonlinearity of a RF PA. Automated monitoring and control (AMC) solutions overcome the nonlinearity by dynamically controlling the PA's gate voltage to maintain a desired drain current (I_{DSQ}).

The current and temperature sensing solutions presented in parts 1 and 2 of this series included several components: analog-to-digital converters (ADCs), digital-to-analog converters (DACs), precision references, current-sense amplifiers and temperature sensors. Many applications, such as wireless base stations, microwave backhaul can benefit from a simpler solution using an integrated device that requires less board space.

Let's take a look at an implementation of an AMC solution for an RF base station, using an integrated device.

The AMC7834 incorporates a multichannel ADC and several DAC outputs that enable parallel PA operation. Additional integrated components include high-side current-sense amplifiers and selectable DAC bipolar ranges. The bipolar range enables parallel operation of various types of PA technologies, such as biasing a laterally diffused metal-oxide semiconductor (LDMOS) PA with one DAC while using the other to bias a gallium nitride (GaN) PA. Using these blocks, you can create current- or temperature-sensing solutions, as shown in Figure 1.

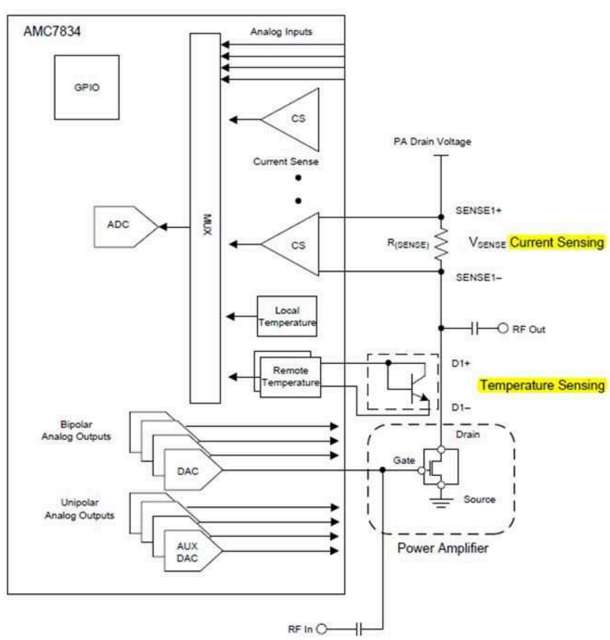

Figure 1: Current and temperature sensing with the AMC7834

Current sensing with the AMC7834

When the AMC7834 device is set in this configuration (Figure 1), the differential voltage across R_{SENSE} is input into the sense pins of the internal high-side current-sense amplifier. This differential voltage is internally translated to a current value. If the AMC is set for closed-loop operation, the DAC output is continuously updated, which adjusts the DAC output for a pre-programmed I_{DSQ} value. This is illustrated in Figure 2.

Alternatively, with the AMC7834 set for open-loop operation, you can interface a microcontroller with the device to obtain the I_{DSQ} value seen through the sense resistor. Another option is to use this information for tracking or calibration purposes, or use it in a defined algorithm when adjusting DAC outputs.

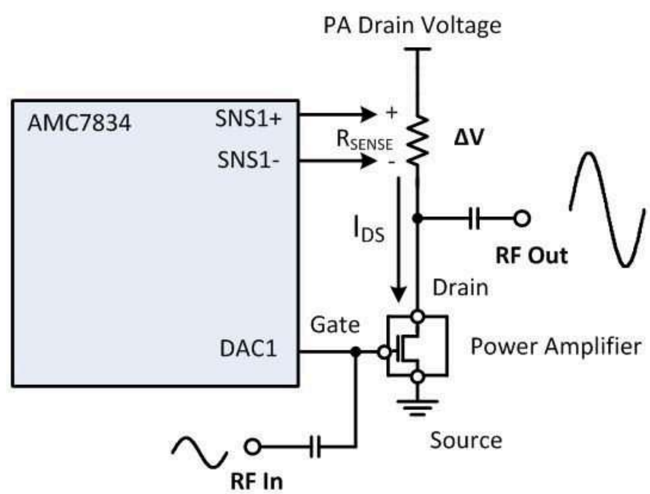

Figure 2: Current sensing with the AMC7834

Temperature sensing with the AMC7834

As described in part 2 of this series, the temperature sensing requires a gate voltage versus temperature-characterization curve from the PA. The lookup table (LUT) or curve contains temperature versus gate voltage (V_{GS}) data for a given I_{DSQ}.

In this configuration, a temperature sensor (in the form of a diode-connected transistor) is placed near the PA. The AMC7834 records the temperature as it changes across the PA and communicates this information to an external microcontroller. The microcontroller updates the DAC to a specific voltage value based on the data from the LUT, as show in Figure 3.

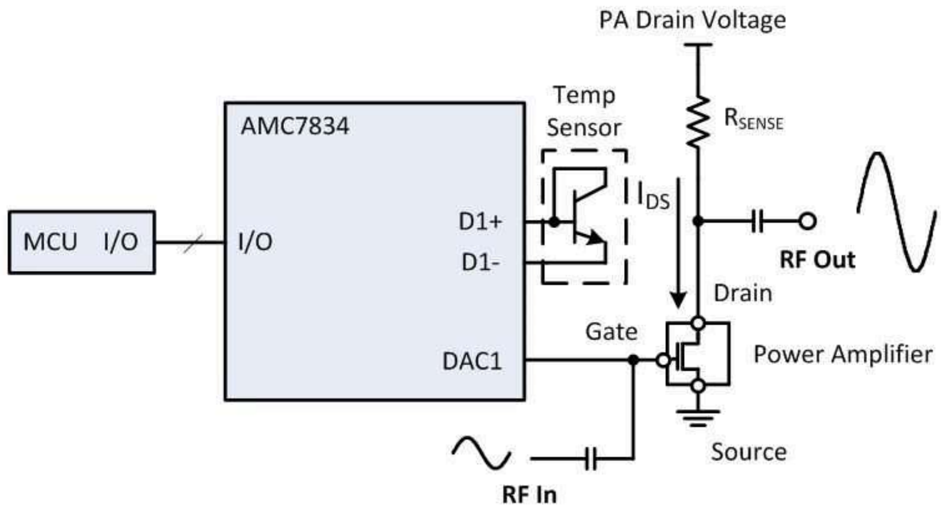

Figure 3: Temperature sensing with the AMC7834

The AMC7834, along with other devices in its family, is designed for PA control in wireless infrastructures – but these devices are also useful in data-acquisition applications that include temperature, current and voltage sensing. I encourage you to check out the other devices, as they have a variety of features that you may find helpful in your next AMC-related application.

- Read the rest of the blogs in our RF base station series.
- Learn more about the AMC7812 integrated multichannel ADC and DAC.
- Check out the AMC7836 bipolar DAC.
- Learn about TI's portfolio of precision DACs and find related technical resources for your design.

If you plan to use one of these devices in an unusual application or if there is anything you'd like to hear more about, please comment below.