

COMPLETE TEMPERATURE DATA ACQUISITION SYSTEM FROM A SINGLE +5V SUPPLY

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The CMOS ADS574 and ADS774 are drop-in replacements for industry standard ADC574 analog-to-digital converters, offering lower power and the capability to operate from a single +5V supply. The switched capacitor array architecture (CDAC), with the input resistor divider network to provide ADC574 input ranges, also allow the new parts to handle additional input ranges, including a 0V to 5V range. This can be used to build a complete temperature data acquisition system using a single +5V supply.

Figure 1 shows the input resistor divider network on the ADS574, and how it can be configured for a 0V to 5V input range. Pin 12 is normally the bipolar offset pin on standard ADC574s, and serves the same function for $\pm 5V$ and $\pm 10V$ input ranges on the ADS574. However, when connected as shown, pin 12 on the ADS574 can also be used as an analog input. In this mode, the ADS574 can also be used as an analog input. In this mode, the ADS574 maintains its differential linearity of 12-bit "No-Missing-Codes", and integral linearity is typically better than 0.1%, or 10-bits. The slight change in linearity is due to internal circuitry designed to maximize compatibility of the ADS574 used in existing ADC574 sockets.

Figure 2 shows the circuit for a complete high accuracy temperature measurement system using the 0V to 5V input range on the ADS574. The RTD sensor shown has a resis-

tance of 100Ω at $0^\circ C$, and is rated for use from $-200^\circ C$ to $660^\circ C$. Over this range, the resistance of the RTD will vary from about 18Ω to about 333Ω .

Amplifiers A_1 and A_2 (the two op amps inside a single OPA1013) are used to generate a stable 1mA current source to excite the RTD. The 2.5V reference output of the ADS574 is used to derive this current source, so that the entire system will be ratiometric. As the reference in the ADS574 changes over temperature or time, it will affect both the gain of the A/D and the current source.

RTDs in industrial process controls are often far removed from the electronics. One thousand feet of 22-gauge copper has 16Ω of resistance (shown as R_w in Figure 2), and this varies with temperature. The circuit around A_3 (half of a second OPA1013) uses a third wire from the remote RTD to remove most of the effect of the two R_w drops in series with the RTD. The $100k\Omega$ resistors are much larger than R_w , minimizing inaccuracies due to currents flowing through them.

Amplifier A_4 is used in a gain of 12.207V/V, so that a 0.1 Ω change in the value of the RTD (changing the positive input to A_4 by $100\mu V$) corresponds to one LSB change in the output of the ADS574. 0V and 5V full scale inputs to the ADS574 would result from 0 Ω and 409.6 Ω RTD values (and hence 0mV and 409.6mV at A_4 's input.) Choosing this range not only sets one LSB equal to a 0.1 Ω change, but also keeps A_3 and A_4 from ever operating near their 0V and 5V rails. The RTD never gets below about 18Ω or above about 330Ω , which gives 18mV to 330mV at the input to A_4 (and somewhat more at the input to A_3 , due to the two R_w drops.)

As used in Figure 2, the ADS574 will switch to the hold mode and start a conversion immediately when a convert command is received (a falling edge on pin 5.) Pin 28 will output a HIGH during conversion, and a falling edge output on pin 28 can be used to read the data from the conversion. Since digital processing will normally be done to linearize the output of the RTD for maximum accuracy, the same process can also be used to calibrate out gain and offset errors in the circuit, and any effects from the approximations used in the feedback around A_3 .

This linearization will also restore the integral linearity of the ADS574 mentioned above, since the differential linearity remains at the 12-bit level.

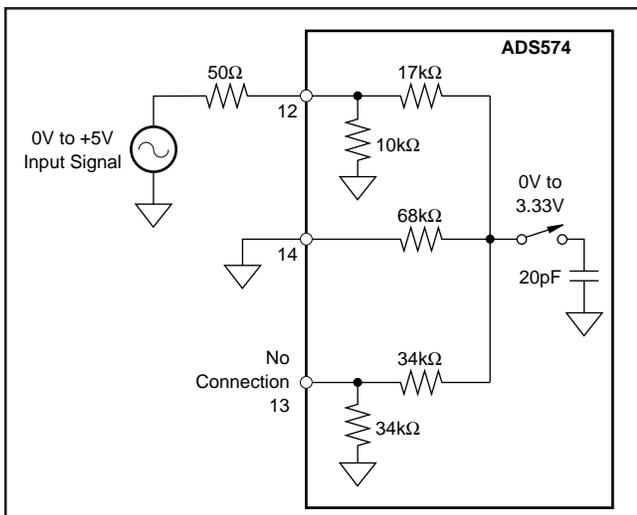


FIGURE 1. ADS574 Connections for 0V to +5V Input Range.

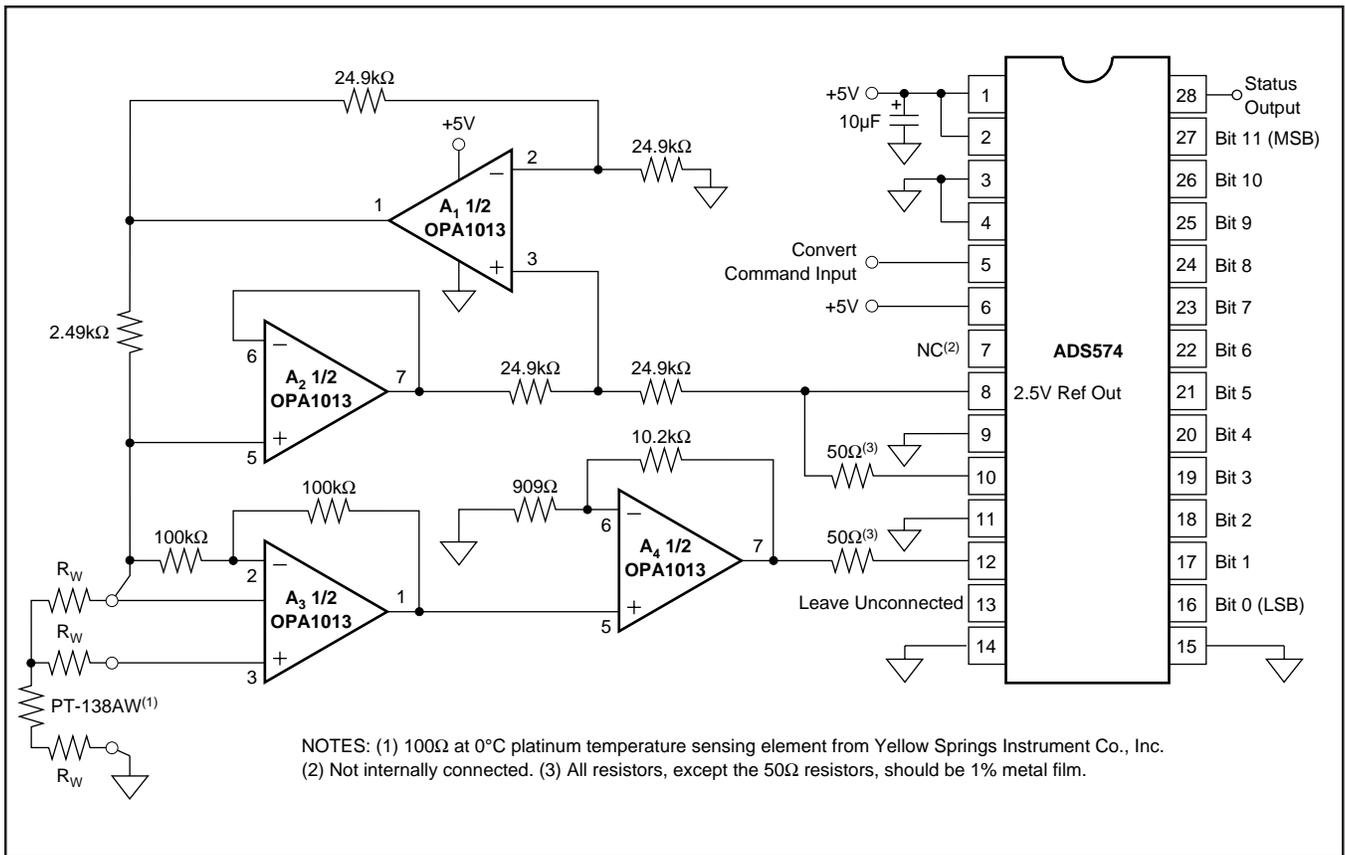


FIGURE 2. Complete Single-Supply Temperature Measurement System. Using 3-Wire RTD Connection.

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