APPLICATION NOTE

AN1441
Applications for the NE5514

1988 Dec

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NE5514 DESCRIPTION

The SE/NE5514 family of Quad Operational Amplifiers sets new standards in Bipolar Quad Amplifier Performance. The amplifiers feature low input bias current and low offset voltages. Pinout is identical to LM324/LM348, which facilitates direct product substitution for improved system performance. Output characteristics are similar to a µA741 with improved slew and drive capability.

FOUR-QUADRANT PHOTO-CONDUCTIVE DETECTOR AMPLIFIER

When operating a photo diode in the photo-conductive mode (reverse-biased) very small currents in the microampere range must be sensed in the photo active operating region. Dark currents in the nanoamperes are common. Generally, for this reason, JFET input preamps are used to prevent interaction and accuracy degradation due to input bias currents.

The 5514 has sufficiently low input bias current (6nA) to allow its use under these circuit constraints as shown in a possible design used to sense four-quadrant motion of a light source. By proper summing of the signals from the X and Y axes, four-quadrant output may be fed to an X-Y plotter, oscilloscope or computer for simulation (see Figure 1).

The wide input common-mode voltage range of the device allows a +10V supply to be used to drive the signal bridge giving high sensitivity and improved signal-to-noise. Obviously, input balancing is critical to achieving

common-mode signal rejection in addition to adequate shielding of the sensor leads. The sensor head itself must be shielded and the shield grounded to signal common to avoid unwanted noise pick-up from power line and other local noise sources. Amplifier response may be shaped to aid in noise reduction by more complex filter configurations. If possible the 5514 should be located in close proximity to the sensor head.

System balance may be done under dark field conditions if adequate photo detector tracking results. However, for high accuracy systems, a bipolar balance adjust added to the non-inverting output stage is more desirable. With this latter method, the signal bridge is balanced for a null output under uniform light field conditions using the bridge balance pot as shown. DC offset is then

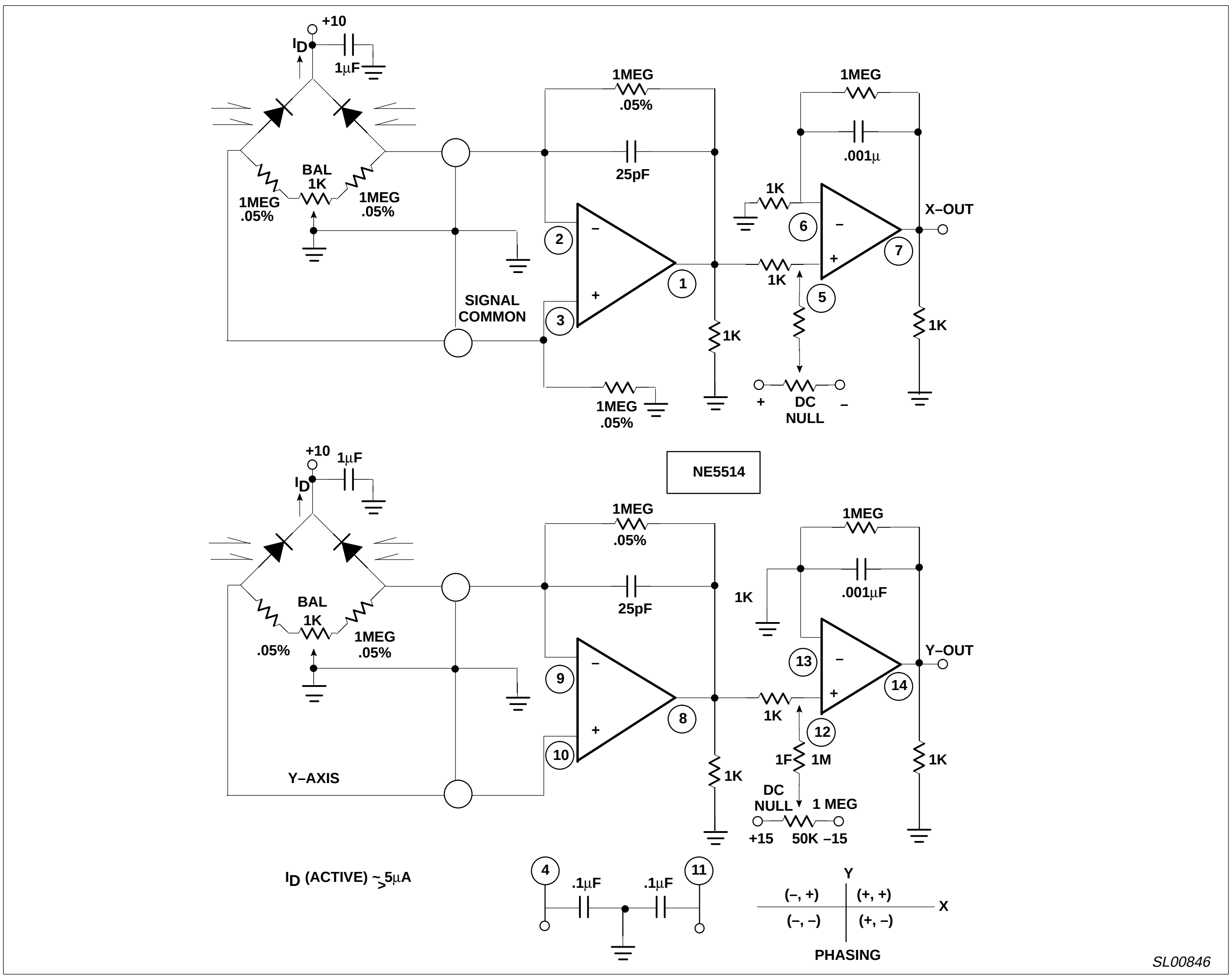

Figure 1. Four-Quadrant Photo Detector

adjusted using the balance pot on the output amplifier under dark field conditions.

MULTI-TONE BANDPASS FILTER FOR PLL TONE DECODER

In the design of a multiple tone signaling system, particularly where signals are transmitted over long lines, noise and adjacent channel interference may be a significant barrier to reliable communications.

By the use of narrow-band active pre-filters to attain selectivity and gain, the effective signal to noise ratio is greatly improved. The NE/SE5514 is easily adapted to such filter configurations due to its inherent stability. In addition, its very high input impedance drastically reduces loading to the passive networks and allows for increased "Q" and large value resistors.

The circuit in Figure 2 demonstrates multiple feedback filters operating at four of the standard signaling frequencies. More channels may be added to increase the capacity of the system.

Test results obtained from the filter configuration were as follows:

Wide-band signal-to-noise	63dB
Gain (Mid band)	30dB
Q (effective)	≈ 30
Output	0dBm ($0.775V_{RMS}$)

Note that the amplifiers are operated from a single +12V supply and are biased to half V_{CC} by a simple resistive divider at point B which connects to all non-inverting inputs.

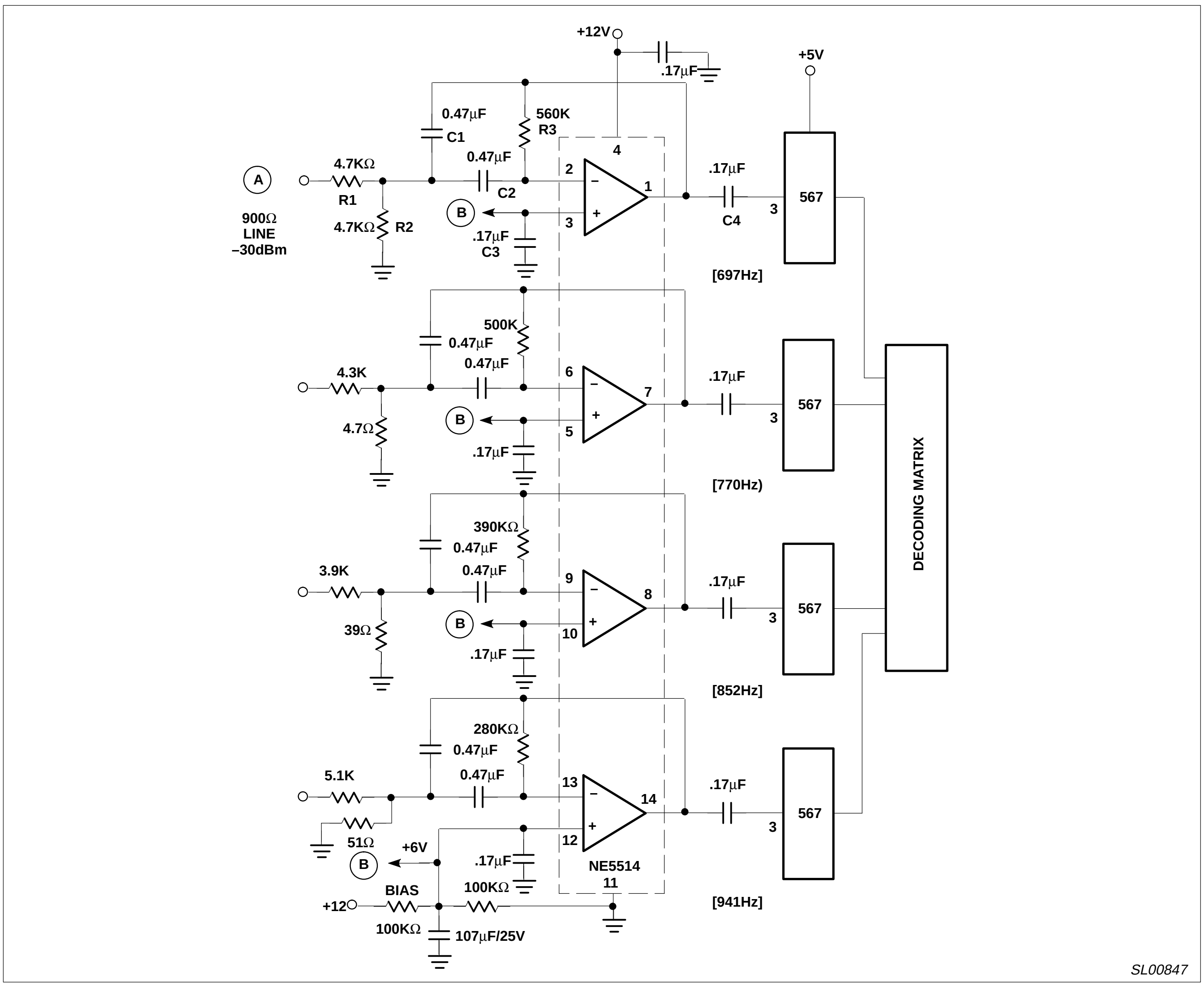

Figure 2. NE5514 MFB Bandpass Filter for Multi-Channel Tone Decoder

4-STATION 0-50° TEMPERATURE SENSOR

By using an NPN transistor as a temperature sensing element, the NE5514 forms the basis for a multi-station temperature sensor as shown in Figure 3. The principle used is fundamental to the current voltage relationship of a forward-biased junction. The current flow across the base-emitter junction is determined by absolute temperature in the following way:

$$I_E = -(I_C + I_B)$$

and $I_E \propto I_S \exp(V_{BE}/V_T)$; $V_T = kt/q$

therefore, $V_{BE} \propto V_T \ln I_E/I_S$

Where I_E is the forward current and I_S is the saturation current inherent in the junction, I_E must be high enough such that the I_S variation with temperature is small relative to I_E ($I_E >> I_S$). I_S is typically 0.05pA, therefore, setting I_E to 1 or 2μA gives the desired condition.

Diode D_1 serves to substantially reduce error due to power supply variation by giving a fixed voltage reference. To calibrate the sensor adjust R_4 for "0" volts output from the NE5514 at 0°C. Adjust R_6 tracking resistor for a scale factor of 100mV/°C output.

Only the transistor need be placed in the temperature-controlled environment. Figure 4 shows the addition of an A/D converter and display to give a digital thermometer.

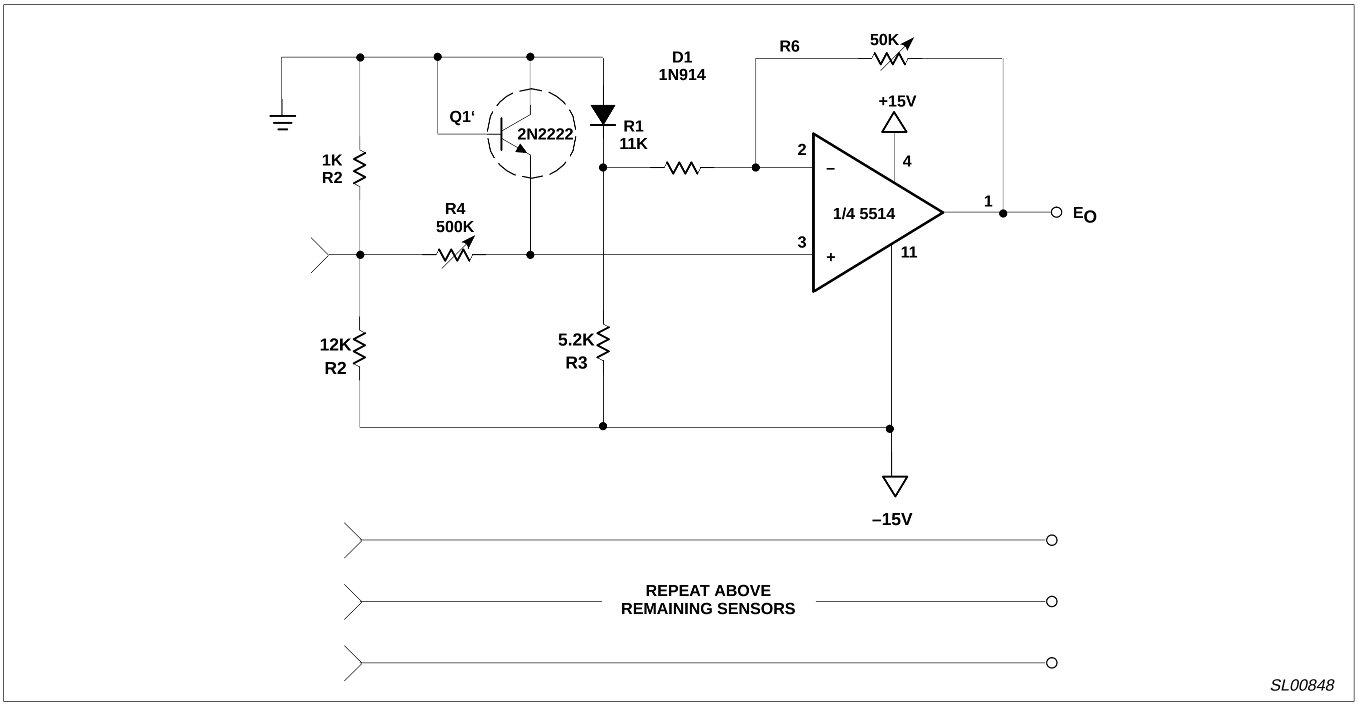

Figure 3. 4-Channel Temperature Sensor (0-50°C)

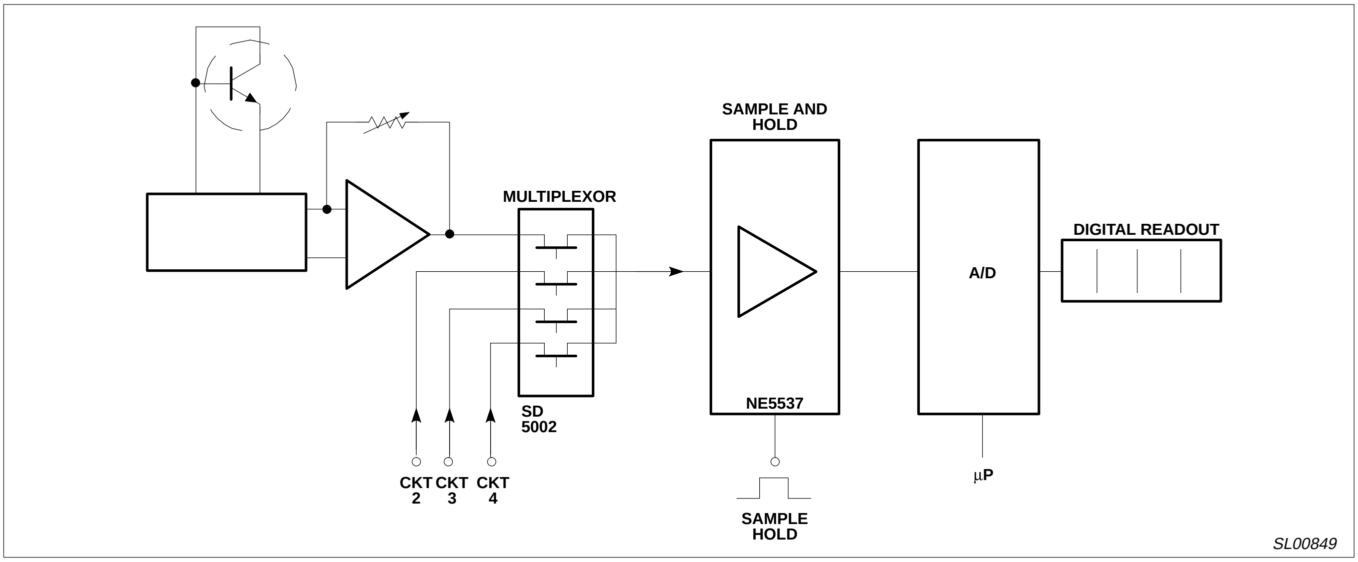

Figure 4. Microprocessor-Controlled Digital Thermometer