INSTRUMENT TYPE	MANUFACTURER	MODEL NUMBER	MAXIMUM BANDWIDTH	SENSITIVITY/GAIN	AVAILABILITY	COMMENTS
Differential Amplifier	Tektronix	1A7/1A7A	500kHz/1MHz	10μV/DIV	Secondary Market	Requires 500 Series Mainframe, Settable Bandstops
Differential Amplifier	Tektronix	7A22	1MHz	10μV/DIV	Secondary Market	Requires 7000 Series Mainframe, Settable Bandstops
Differential Amplifier	Tektronix	5A22	1MHz	10μV/DIV	Secondary Market	Requires 5000 Series Mainframe, Settable Bandstops
Differential Amplifier	Tektronix	ADA-400A	1MHz	10μV/DIV	Current Production	Standalone with Optional Power Supply, Settable Bandstops
Differential Amplifier	Tektronix	AM-502	1MHz	100,000	Secondary Market	Standalone with Optional Power Supply, Settable Bandstops
Differential Amplifier	Preamble	1822	10MHz	Gain = 1000	Current Production	Standalone, Settable Bandstops
Differential Amplifier	Stanford Research Systems	SR-560	1MHz	Gain = 50000	Current Production	Standalone, Settable Bandstops, Battery or Line Operation

Figure H4. Some Applicable High Sensitivity, Low Noise Amplifiers. Trade-Offs Include Compatibility, Sensitivity and Availability

APPENDIX I

VOLTAGE REFERENCES

Figure I1 lists some voltage reference options for use with the DAC. The self-contained types are convenient and easily applied. The LM199A and the LTZ1000A require external circuitry but offer higher performance. All choices must be trimmed to establish absolute DAC accuracy. The LTZ1000A offers the highest stability and is discussed below.

Figure I2 shows the LTZ1000A and its support circuitry. A1 senses LTZ1000A die temperature and accordingly controls the IC heater via the 2N3904. A2 controls reference current. The Zener reference is sensed via Kelvin connections, minimizing voltage drop effects. A single point ground eliminates return current mixing and the attendant errors that would be produced.

Figure I3 offers choices for reference buffering. All employ a chopper stabilized amplifier augmented with a buffer output stage. Buffer error is extremely low, as noted in Appendix C's discussion. I3a, a simple unity-gain stage, transmits the input to the output with low error and minimal reference loading. I3b takes moderate gain, allowing a 7V reference input to produce (in this case) 10V at the output. I3c offers two ways to get 5V from the nominal 7V input. A precision divider lightly loads the reference in one case; the 5V output is taken at the LT1010. Reference loading is avoided by placing the divider at the output (optional case shown) and driving the A-to-D reference input from the divider output, which is permissible.

TYPE	VOLTAGE	INITIAL ACCURACY	TEMPERATURE DRIFT	LONG-TERM STABILITY	COMMENTS
LTZ1000A	7.2V	Minimum 7V Maximum 7.5V	0.05ppm/°C	4ppm/Yr Typical	Highest Stability Zener Available. Requires External Heater Control and Reference Buffer Circuitry
LM199A	6.95V	2%	0.5ppm/°C	10ppm/Yr Typical	Self-Contained, Including Heater Control Circuitry. Zener Output Is Unbuffered
LT1021	5V, 7V, 10V	0.05V (7V)	2ppm/°C (7V)	20ppm/kHr Noncumulative	Fully Self-Contained. Trimmable
LT1027	5V	0.02%	2ppm/°C	20ppm/kHr Noncumulative	Fully Self-Contained. Trimmable
LT1236	5V, 10V	0.05%	5ppm/°C	20ppm/kHr Noncumulative	Fully Self-Contained. Trimmable

Figure I1. Reference Choices Compared for Output Voltage, Accuracy and Stability. Highest Stability Types Require External Circuitry

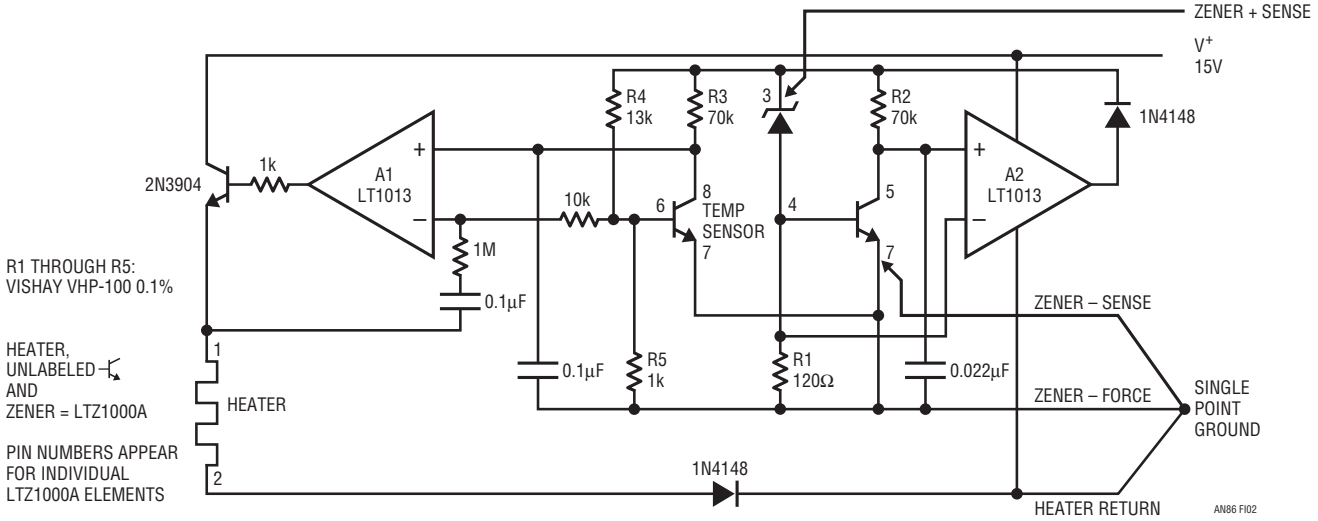

Figure I2. 7V Reference Includes A1 Heater Control Amplifier, A2 Zener Current Regulator and LTZ1000A Zener. Note Zener Kelvin Connections and Single Point Ground

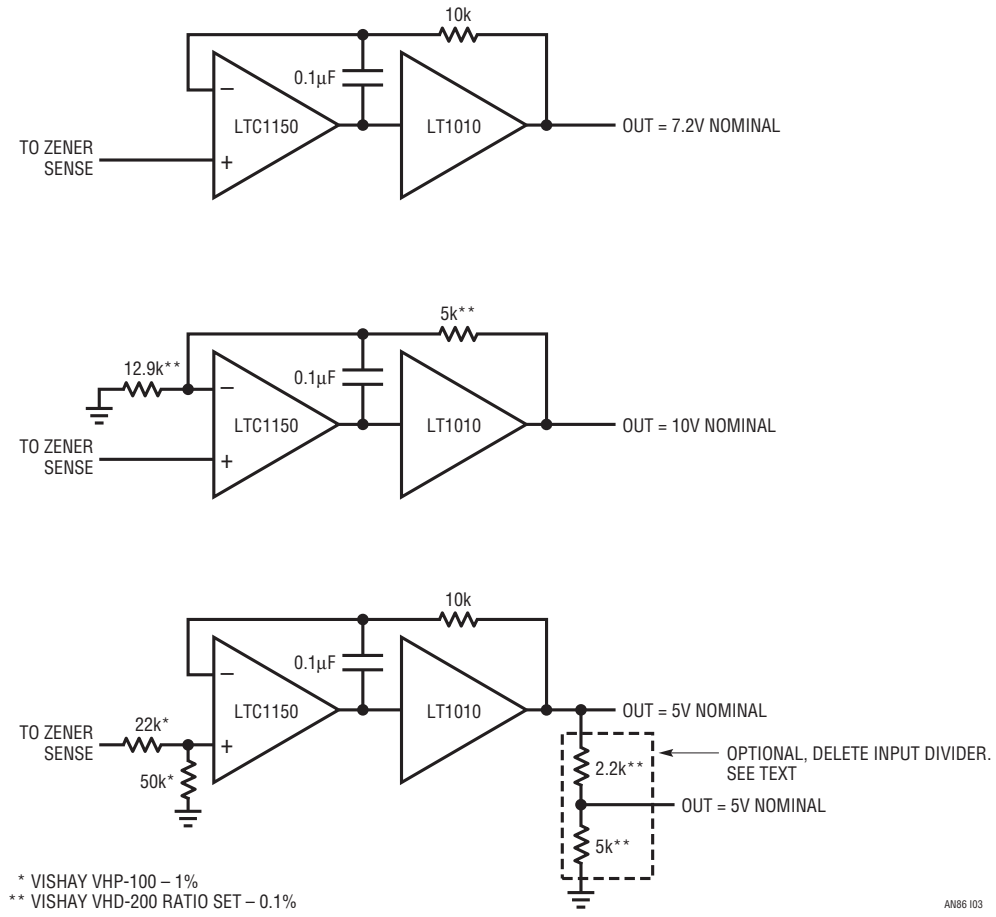

Figure I3. Chopper Stabilized Reference Buffer Options Include Unity Gain (a), 10V (b) and 5V (c) Output. Trimming Is Required for Absolute Accuracy