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APPLICATION BULLETIN
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SWITCH GAINS ACCURATELY WITH THE INA120

Integrated circuit instrumentation amplifiers are used in a wide variety of applications such as medical instruments, data acquisition systems and thermocouple signal conditioners. Many such applications require the gain to be switched to accommodate a variety of input signals and/or wide-ranging signal levels. The INA120 instrumentation amplifier meets this requirement as well as making it simple to switch the gains.

An analog multiplexer can be used to switch gains of an instrumentation amplifier. This allows gains to be digitally selected. Unfortunately, this scheme has poor gain accuracy because the channel on-resistance of the multiplexer, R_{ON}, is in series with the gain-setting resistors which determine the gain. Multiplexers have R_{ON} values ranging from 50 to 5000Ω. Even with R_{ON} as low as 50Ω gain accuracy is severely degraded.

The INA120 precision instrumentation amplifier is ideal for accurate signal acquisition. Gain-sense connections on the INA120 maintain gain accuracy when using multiplexer or gain-switching circuitry. Figure 1 shows that the internal gain-set and feedback resistors are always connected in series. No error-causing parasitic resistance is inserted into

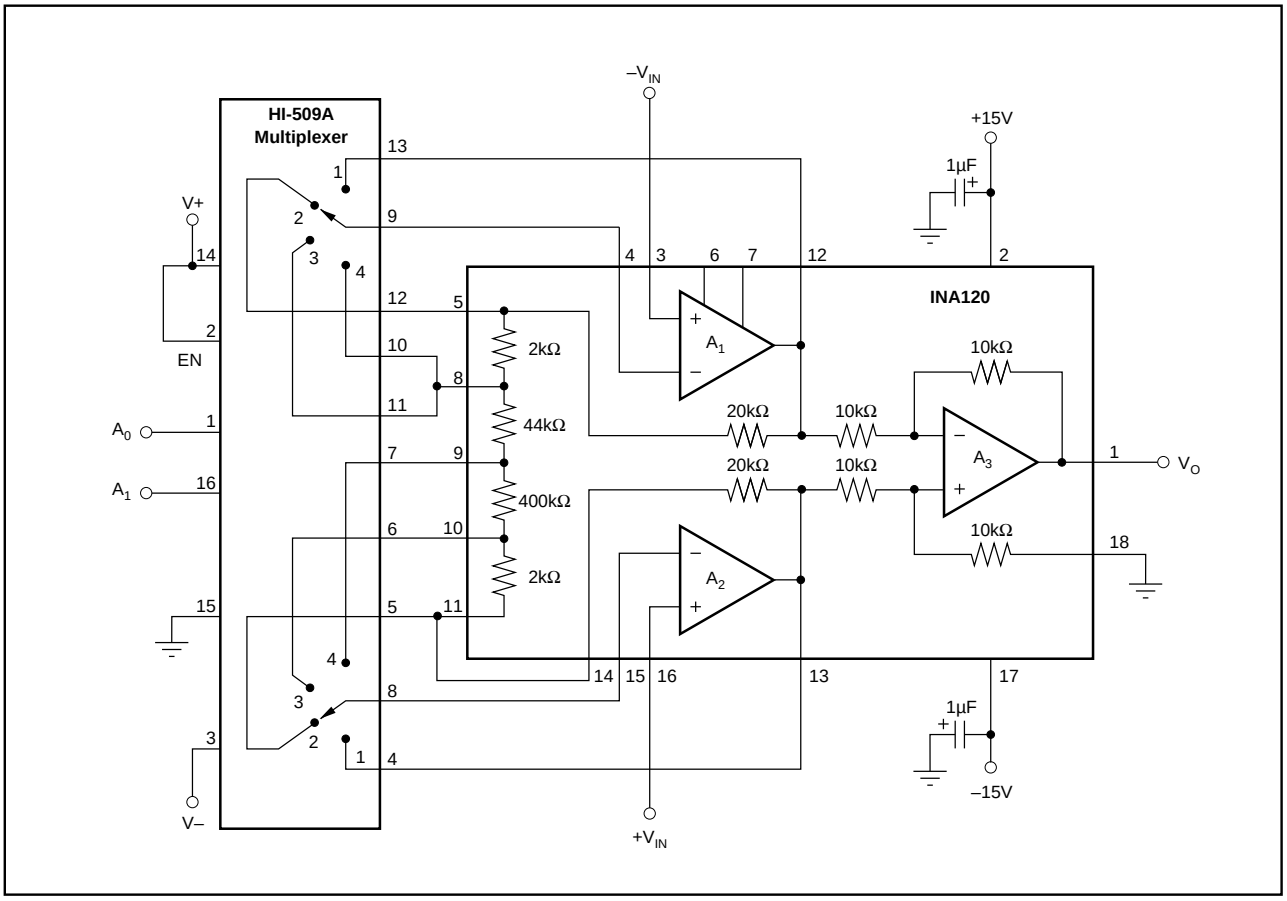

FIGURE 1. The INA120 and a Dual 4-to-1 Analog Multiplexer Form a Programmable Gain Amplifier.

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the loop. Multiplexer resistance, R_{ON}, is in series with the INA120's high impedance inputs at pins 4 and 15 where gain is not affected. Table I lists the available gains, the digital selection codes, and the observed gain errors. For all four gains, gain accuracy is maintained to better than 1% over the full operating temperature range, due to the low gain drift of the INA120's internal resistor network.

GAIN	SELECT CODE A1	SELECT CODE A0	MEASURED GAIN ERROR (%)
1	0	0	0.05
10	0	1	0.08
100	1	0	0.10
1000	1	1	0.30

TABLE 1. The INA120 and a Dual 4-to-1 Analog Multiplexer. Gain errors are small because parasitic channel resistances are placed in series with the amplifier inputs.