Maximize weigh scale accuracy with emi-hardened amplifiers

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Precision Amplifiers

The accuracy of weigh scales is affected by several factors, including input offset voltage drift, vibration RFI, and EMI. EMI sources can emanate from light, long wires, relays, cell phones, and other electronic equipment in the vicinity. The accuracy of a weigh scale is affected by radiated and conducted undesirable signals as these signals can cause erroneous readings, thereby impacting the sensitivity of the apparatus.

To avoid such problems, precautionary measures must be taken. These include shielding, proper grounding, and filtering. Passive filters at the input and output of the amplifier are not a trivial task. A simple low-pass RC filter, whether at the input or output, is likely to affect the dynamic performance of the amplifier. The most effective way to reject RF and EMI signals is to select op amps with integrated filters.

Advantages of EMI-Hardened Op Amps

Texas Instruments precision amplifiers are designed with integrated filters that are closely matched on silicon. The additional filters reduce errors through the signal path feeding into the analog to digital converter. EMIRR plots are provided in the product data sheet and, much like PSRR or CMRR, these graphs show the rejection over a frequency band.

To better understand how EMI hardened amplifiers, reduce errors let us consider an example:

Suppose a non-EMI hardened op amp inherently provides 50 dB of rejection, is set up in a gain of 100, and interfaces with a 16-bit analog to digital converter with a full-scale voltage range of 5 V.

Next, assume we have an RF signal of –20 dBV (0.1 V) at the input of the amplifier. A quick computation yields 0.31 mV at the input or 0.1V/10^(50/20). Multiplying by a gain of 101 gives us 32 mV. With a 5-V full-scale voltage range and a 16-bit ADC we'll have 5 / (2^{16}) = 76 µV as one LSB.

Taking the initial 32 mV and dividing by 76 µV yields approximately 420, which represents the loss of digital counts. Selecting an amplifier like the zero-drift OPA187 provides 100 dB of EMIRR at 1 GHz. Let us determine how much improvement we can get by using the OPA187:

First, we'll compute the shift at the output as follows: 0.1V/10^5 *101 , which gives us 0.1 mV at the output of the amplifier. To find the loss of counts we simply take 0.1 mV and divide by 76 µV, which represents 1 LSB for 16 bits with a full-scale voltage range of 5 V. We express the equation as: (0.1E-3 / (5 / 65536)), which yields 1.3 counts! An extraordinary improvement without compromise.

Check out this clip in TI's video library for some additional interesting information on How to avoid electromagnetic interference (EMI).

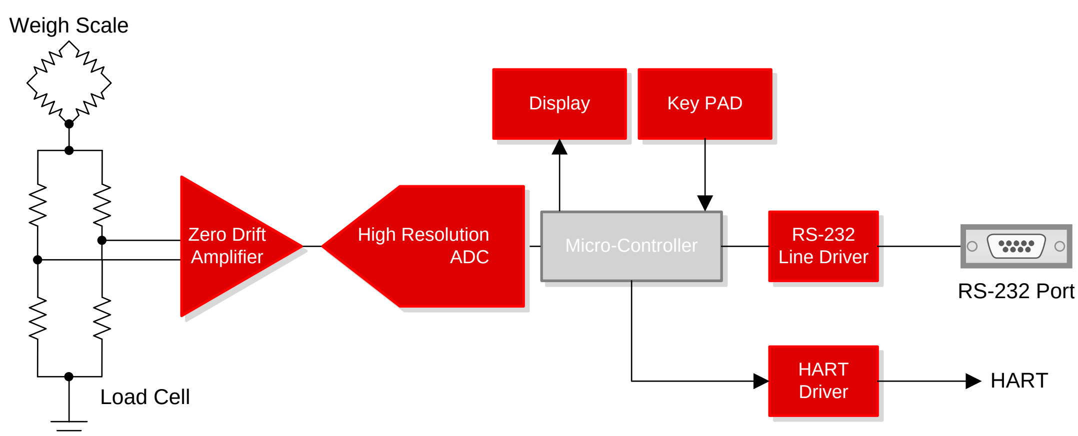

Figure 1. Typical Block of a Precision Weigh Scale

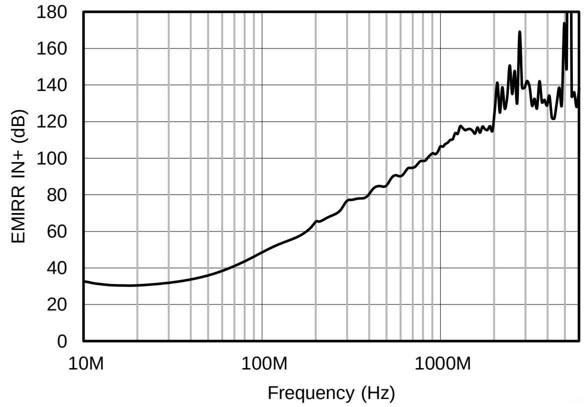

Figure 2. EMIRR IN+ vs Frequency

Table 1. Alternative Device Recommendations

Device	Unity Gain Bandwidth	Description
OPA189	14 MHz	14MHz, MUX-Friendly, Low-noise, Zero-Drift, RRO, CMOS Precision Operational Amplifier
OPA188	2 MHz	Precision, Low-Noise, Rail-to-Rail Output, 36V Zero-Drift Operational Amplifier
OPA388	10 MHz	10MHz, CMOS, Zero-Drift, Zero-Crossover, True RRIO Precision Operational Amplifier

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