EMI-Hardened Op Amps Reduce Errors In Pulse Oximeters

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Medical devices such as infusion pumps, EKGs and pulse oximeters are designed with great care for electromagnetic compatibility (EMC). In other words, they must be compatible with their environment, and not cause any interference.

Before the creation of electromagnetic interference (EMI)-hardened amplifiers, board and system-level engineers struggled to come up with the best possible filtering schemes without compromising signal chain performance, especially that of the analog front end. Operational amplifiers needed special care and attention due to common mishaps, such as placing a capacitor across the inputs of the amplifier.

While the goal was to eliminate undesirable voltage spikes at the output of the amplifier, it usually resulted in unstable circuits.

Similarly, filters on the output, passive, low-pass filters (RC) particularly, can be a headache. Lowering the cutoff frequency often implies using a large capacitor, which not every op amp can drive. Conversely, increasing the resistor value causes gain errors.

Put The Op Amp To Work

The easiest way to deal with rejecting unwanted RF signals and electromagnetic interference is selecting active components with integrated filters. Every TI op amp designed in the last seven years provides such filters.

To determine whether the EMI rejection is sufficient for the application, a plot like the CMRR and PSRR, called the EMIRR (EMI rejection ratio), is provided in the datasheet.

The choice of amplifiers ranges from the INA828 high-voltage instrumentation amplifier to the ubiquitous OPA192, which comes in single, dual, and quad options.

To better appreciate the benefits of EMI filters in the amplifier, consider an example:

A first-order filter at 10 MHz rejects 40 dB at 1 GHz. However, a 10 MHz device with a cut-off at 100MHz has a rejection of only 20 dB at 1 GHz.

EMI errors can have serious consequences on the system. Suppose 100 mV is injected into an amplifier with gain of 100. This example uses an op amp with no EMI filters, but still provides 30 dB of rejection (1 GHz). 316 mV is present at the output of the op amp [(100 mV / 31.6) × 100]. Now assume the output is fed to a 12-bit ADC with a 5-V FSR.

The loss of counts caused the injected signal (EMI) can be computed as follows:

5 V / (2^{12}) = 1.22 mV. Divide the output of the op amp by 1.22 mV (316 mV / 1.22 mV) to determine a loss of nearly 260 counts.

Using an op amp like the OPA192 reduces the count loss to roughly eight.

When making a design more immune to EMI without compromising the circuit performance, look up TI's precision amplifiers portfolio.

See this clip for additional information on avoiding electromagnetic interference (EMI).

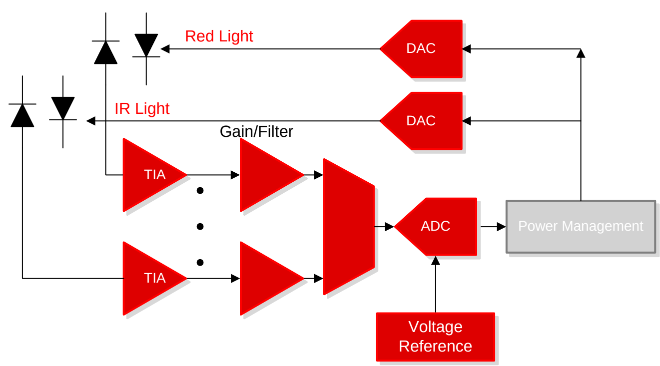

Figure 1. Typical Block Diagram for EKG

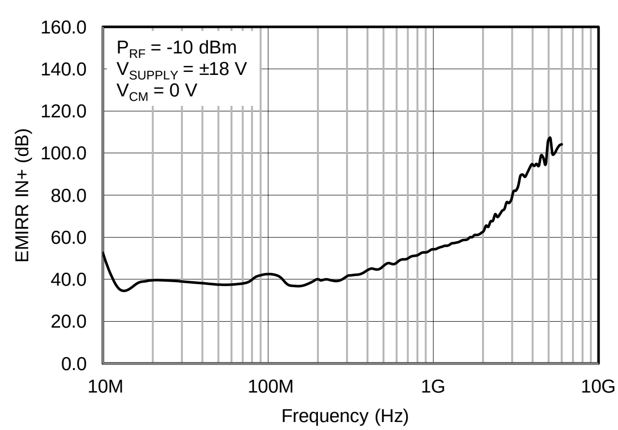

Figure 2. OPA192 EMI Rejection Ratio Plot Versus Frequency

Table 1. Alternative Device Recommendations

DEVICE	UNITY GAIN BANDWIDTH	DESCRIPTION
OPA320	20 MHz	Precision, Zero-Crossover, 20 MHz, 0.9 pA Ib, RRIO, CMOS Operational Amplifier
OPA2156	25 MHz	Ultra-Low Noise, FET-Input, Precision RRIO Op-Amp
OPA1671	12 MHz	5 V, RRIO Low-Noise Audio Op-Amp
OPA325	10 MHz	Precision, 10 MHz, Low-Noise, Low-Power, RRIO, CMOS Zero-Crossover Operational Amplifier
OPA187	550 kHz	Zero Drift, Low-Power, Rail-to-Rail Output Amplifier

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