EMI Hardened Op Amps Reduce Errors In Infusion Pumps

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

Before the birth of electromagnetic interference (EMI) hardened amplifiers, board and system level engineers scratched their head to come up with the best possible filtering schemes without compromising the performance of the signal chain, 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 can be a headache; passive low pass filters (RC) particularly. 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 For You

The easiest way to deal with rejecting unwanted RF signals and electromagnetic interference is to select active components with integrated filters. Every op amp (designed in the last 7 years) from Texas Instruments provides such filters.

To determine whether the EMI rejection will be sufficient for the application, a plot like CMRR and PSRR called 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 a single, dual and quad options.

To better appreciate the benefits of EMI filters in the amplifier let us a consider an example:

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

EMI errors can have serious consequences on the system. Suppose a 100mV is injected into an amplifier with gain of 100. Let’s say you’re using an op amp with no EMI filters but which still provides 30dB of rejection (1GHz).

You will see 316mV at the output of the op amp [(100mV/31.6)*100]. Let’s now assume the output is fed to a 12 bit ADC with a 5V FSR.

We can compute the loss of counts caused the injected signal (EMI) as follows:

\[ \frac{5V}{2^{12}} = 1.22mV \]

now dividing the output of the op amp by 1.22mV (316mV/1.22mV), we determine a loss of nearly 260 counts.

Using an op amp like the OPA192 reduces the count loss to roughly 8. A majestic improvement!

So, the next time you’re looking to make your design more immune to EMI without compromising the performance of your circuit, look up TI’s precision amplifiers portfolio. You’ll be glad you did.

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

Put the Op Amp to Work for You

The easiest way to deal with rejecting unwanted RF signals and electromagnetic interference is to select active components with integrated filters. Every op amp (designed in the last 7 years) from Texas Instruments provides such filters.

To determine whether the EMI rejection will be sufficient for the application, a plot like CMRR and PSRR called 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 a single, dual and quad options.

To better appreciate the benefits of EMI filters in the amplifier let us a consider an example:

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

EMI errors can have serious consequences on the system. Suppose a 100mV is injected into an amplifier with gain of 100. Let’s say you’re using an op amp with no EMI filters but which still provides 30dB of rejection (1GHz).

You will see 316mV at the output of the op amp [(100mV/31.6)*100]. Let’s now assume the output is fed to a 12 bit ADC with a 5V FSR.

We can compute the loss of counts caused the injected signal (EMI) as follows:

\[ \frac{5V}{2^{12}} = 1.22mV \]

now dividing the output of the op amp by 1.22mV (316mV/1.22mV), we determine a loss of nearly 260 counts.

Using an op amp like the OPA192 reduces the count loss to roughly 8. A majestic improvement!

So, the next time you’re looking to make your design more immune to EMI without compromising the performance of your circuit, look up TI’s precision amplifiers portfolio. You’ll be glad you did.

Check out this clip in our video library for some additional interesting information on How to avoid electromagnetic interference (EMI).
Table 1. Alternative Device Recommendations

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>UNITY GAIN BANDWIDTH</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPA189</td>
<td>14 MHz</td>
<td>14MHz, MUX-Friendly, Low-noise, Zero-Drift, RRO, CMOS Precision Operational Amplifier</td>
</tr>
<tr>
<td>OPA188</td>
<td>2 MHz</td>
<td>Precision, Low-Noise, Rail-to-Rail Output, 36V Zero-Drift Operational Amplifier</td>
</tr>
<tr>
<td>OPA388</td>
<td>10 MHz</td>
<td>10MHz, CMOS, Zero-Drift, Zero-Crossover, True RRIO Precision Operational Amplifier</td>
</tr>
<tr>
<td>OPA333</td>
<td>350kHz</td>
<td>1.8V, 17µA, microPower, Precision, Zero-Drift CMOS Op Amp</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated