

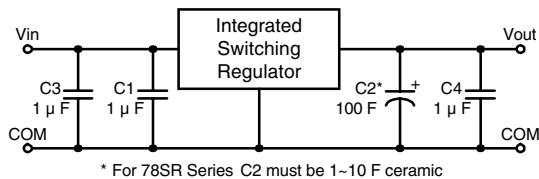
ISR Input/Output Filters

Power Trends includes internal input and output capacitors in all of their ISRs. However, some applications require much lower levels of either input or output ripple/noise. This application note describes various filters and design techniques found to be successful in reducing both input and output ripple/noise.

Input/Output Capacitors

The easiest way to reduce output ripple/noise is to add one or more $1\mu\text{F}$ ceramic capacitors, such as C4 shown in Figure 17. They should be placed as close as possible to the output pin of the ISR. A single $1\mu\text{F}$ capacitor will reduce the output ripple/noise by 30-50% for ISRs with $I_{\text{out}} < 3\text{A}$. (Note: C2 is required for loop stability and does not reduce output ripple/noise).

Figure 17



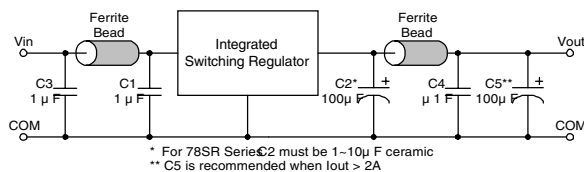
ISRs are switching regulators and as such draw current from the input line in pulses at their operating frequency. The amount of upstream (input) ripple/noise generated by an ISR is directly proportional to the equivalent source impedance of the power source including the impedance of any input lines. The addition of C3, a $1\mu\text{F}$ ceramic capacitor, near the input pins of the ISR, will reduce upstream conducted ripple/noise by 30-50%.

PI Filters

If you need further reduction in the ripple/noise level for your application, higher order filters must be used. A π (pi) filter employing a ferrite bead (Fair-Rite p/n 2673000701 or equivalent) in series with the input or output lines of the ISR (see Figures 18 and 20) reduces the ripple/noise by at least 20 db (See Figure 19).

These beads form an excellent filter because they are lossy

Figure 18



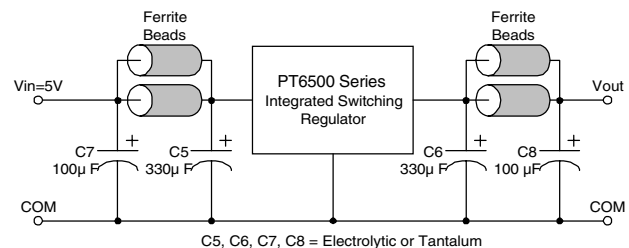
at the ISR's switching frequency (650kHz - 1MHz). The placement of this filter is critical. It must be located as close as possible to the input or output pins of the ISR. The ferrite bead is small (12.5mm long x 3mm diameter), easy to use, low cost, and has low DC resistance. Fair-Rite also manufactures an SMD bead (p/n 2773021447) rated to 5 Amps, but in this application, it is only effective to 2A.

C1, C3, and C4 are ceramic capacitors which have excellent high-frequency performance and low impedance. Capacitor C2 should be a $100\mu\text{F}$, low ESR type aluminum electrolytic or tantalum capacitor. All capacitors must have short leads and traces to be effective.

When using ISRs with output currents greater than 3A, such as the PT6500 Series, we recommend using two ferrite beads in parallel as shown in Figure 20.

Off The Shelf Filters

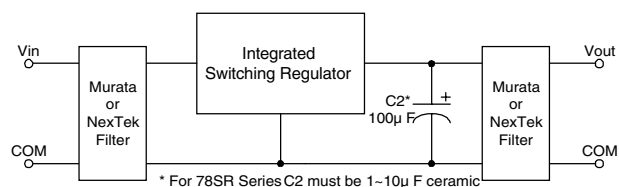
Figure 20



There are several manufacturers of completely self-contained filters with excellent rejection characteristics:

1. Murata Erie (BNX002A) - Ripple/noise reduction is greater than 20db and it filters both $V_{\text{in}}/V_{\text{out}}$ and ground return. Maximum current capacity is 10ADC.

Figure 21



IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2006, Texas Instruments Incorporated