Design and development of low voltage, low current, transient suppressed and ripple free power supply for critical systems

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Introduction

In high energy physics detector base system it is very important to have ripple-less glitch free low voltage power supply[1].Stable operation of data acquisition channels demands glitch free power supply. The significant loss of data due to transients and glitches hampers the authenticity of concerned experimental result. Fluctuations in front end electronics supply also disrupt the ideal working of various shaper and other sophisticated circuits. Moreover, line transients may burn front end electronics board.
Typical radiation detector chain shown in Fig.1 which demands ripple-less glitch free supply.

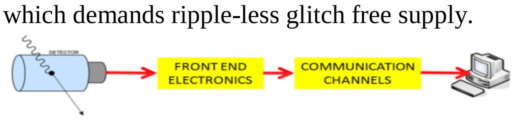

Fig.1 Typical radiation detector

This paper gives an insight view of detail implementation of moving average filter for improving the signal to noise ratio and transient suppression. Finally a low voltage (0-5V) low current (10mA), ripple free, inherently transient suppressed power supply has been developed for highly critical systems.

Moving Average Filter

Digital filter using moving average technique is basically a FIR filter without assigning any value of cut off frequency [2].Moving average technique can be used effectively to separate a repetitive signal from noise without distorting the base signal. If the noise is random with zero mean and is uncorrelated with the signal, averaging will improve the signal to noise ratio [3]. Since the averaging is done on a point-by-point basis, more the number of points better will be the final wave form. As shown in Fig.2 simple n point moving average filter operates by averaging n number of data points from the input

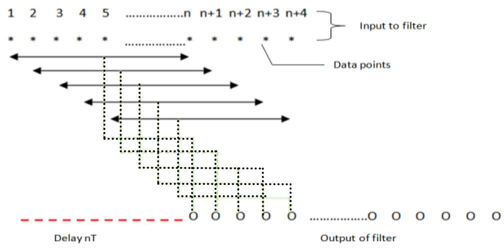

Fig.2 Moving average filter

signal to produce each point in the output signal. In equation form, this can be written as

$$Y(n) = \sum_{1}^{n} \frac{X(n)}{n}$$

Where X(n) and Y(n) are input output in discrete domain and n is order of filter. Output of moving average filter delayed by n times of sampling time. Transfer function of n point moving average filter in z domain

$$\frac{1 + z^{-1} + z^{-2} + z^{-3} \ldots\ldots z^{-n}}{n}$$

Test Set Up

Layout of purposed transient suppressed, ripple free power supply is shown in Fig.3. Supply chain draws power from 230V mains with heavy inductive load in parallel. The first component of the power supply chain is a voltage divider followed by the step down transformer (46:1).The output of the transformer rectified by full bridge rectifier. The dc output of rectifier fed to FPGA via ADC. Algorithm for simple moving average filter had been implemented in FPGA. Algorithms were written in such a way that they provide ripple free and transient suppression inherently. For testing of moving average algorithm, 580mv peak to peak sinusoidal supply (via signal generator with 100mv off-set) given to FPGA via ADC and output was taken from DAC as shown in Fig.4.

Finally this system has been modified to make detector power supply shown in Fig.3.

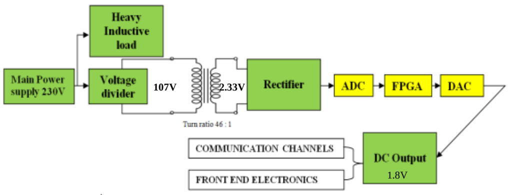

Fig.3 Layout of Detector power supply

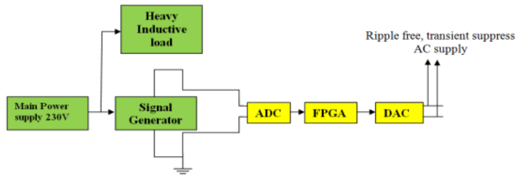

Fig .4 Testing set up

Transients were introduced by sudden switching (on) heavy inductive load connected in parallel to the system as shown in Fig.3 and Fig.4.Noise were introduce in the system by making loose connection in grounding connector purposely.

Results and conclusion

Results from testing set up are shown below in Fig5a, Fig 5b, Fig 5c, Fig 5d , Fig 6a and Fig 6b

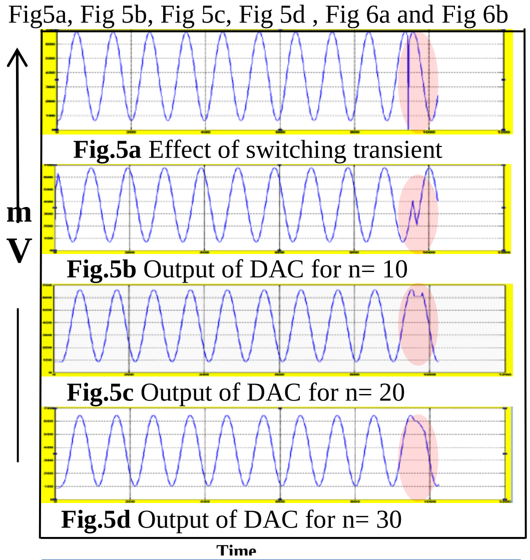

Fig.5a Effect of switching transient

Fig.5b Output of DAC for n= 10

Fig.5c Output of DAC for n= 20

Fig.5d Output of DAC for n= 30

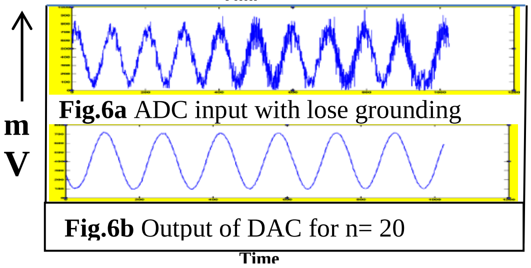

Fig.6a ADC input with lose grounding

Fig.6b Output of DAC for n= 20

Real time results of detector power supply are shown in Fig 7a ,Fig7b, Fig 7c and Fig7d

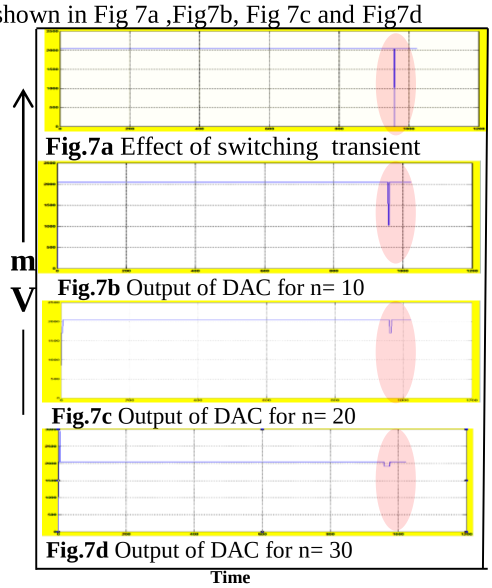

Fig.7a Effect of switching transient

Fig.7b Output of DAC for n= 10

Fig.7c Output of DAC for n= 20

Fig.7d Output of DAC for n= 30

It is observed that switching on heavy inductive load drops the main supply significantly which in turn introduced transient/glitches in other systems connected to mains. Results obtained in Fig.5(a,b,c,d), and Fig.7(a,b,c,d) clearly indicates that if order of moving average filter increased there is significant suppression of any glitch or switching transients . Moreover for higher orders, signal to noise ratio improves considerably as shown in Fig.6b.

Limitations

Output voltage and output current of purposed power supply scheme (shown in Fig.3) limited by ADC (0-5v) and DAC (0-5v, 10mA) voltage and current rating.

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References

[1] Knoll, Glenn F. (1989): “Radiation detection and measurement” 2nd ed., Wiley and Sons.
[2] Digital signal processing: Pearson new International edition by john G. Proakis and Dimities.
[3] Algorithm for statistical signal processing by Proakis.