

---

## **AN-2145 Power Considerations for SDI Products**

---

### **ABSTRACT**

This application report discusses the issues and trade-offs that  $V_{CC}$  ripple has on the performance of SDI components.

---

### **Contents**

1	Overview .....	2
2	Cable Equalizers .....	3
3	Reclocker and Ser/Des .....	4
4	Cable Drivers .....	5
5	Conclusion .....	6

### **List of Figures**

1	Sample SDI Block Diagram.....	2
2	$V_{CC}$ Ripple Requirements for SDI Equalizers.....	3
3	$V_{CC}$ Ripple Requirements for SDI Reclockers and Ser/Des .....	4
4	LMH0302 Cable Driver .....	5
5	Allowable $V_{CC}$ Ripple for a SDI Cable Driver .....	5

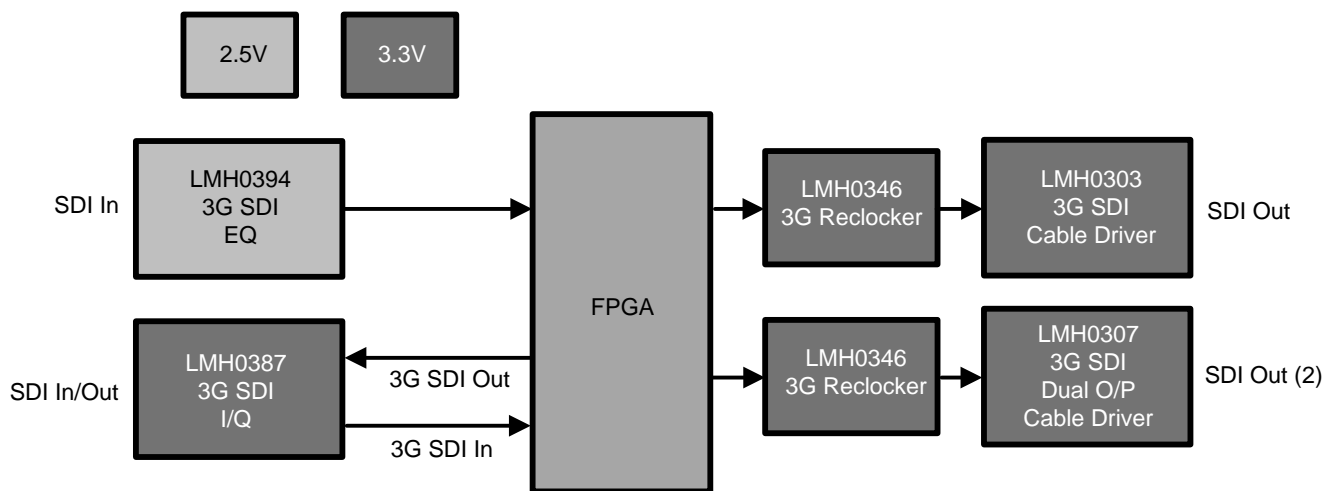
## 1 Overview

Broadcast video products continue to push the boundaries of performance, many beyond the published industry standards. There are a broad range of components required to design a product that meets the numerous industry requirements like jitter, eye timing and signal rise/fall, to mention a few. Each component in the video signal path can have an impact on the product's performance. The analog and mixed-signal serial digital interface (SDI) components – such as cable equalizers, cable drivers, reclockers, serializers and deserializers (Ser/Des) – form a critical portion of the video signal path.

They have power requirements, specifically for  $V_{CC}$  voltage ripple, that are often understated or misunderstood with regards to their impact on SDI video quality. Focus on this design parameter can make the difference between a product whose performance is acceptable and exceptional.

The  $V_{CC}$  ripple specification for SDI components like those shown in [Figure 1](#) is typically not found in the device's product datasheet because the ripple limitations depend on a particular product's specific performance needs. For example, what video data rates will be supported? What cable length (cable reach) is required at the product input? Meeting the product design specification requires managing the imposed jitter at each stage of the SDI signal path.

The  $V_{CC}$  ripple on an SDI component can have a direct impact on the jitter and therefore, the resulting product performance. Designers of SDI components make every attempt to make their devices tolerant to power supply ripple and noise. However, understanding the  $V_{CC}$  ripple requirements for these devices and the associated performance trade-offs is still an important consideration. This is especially true for 3G data rates and newer components which enable long cable reaches.

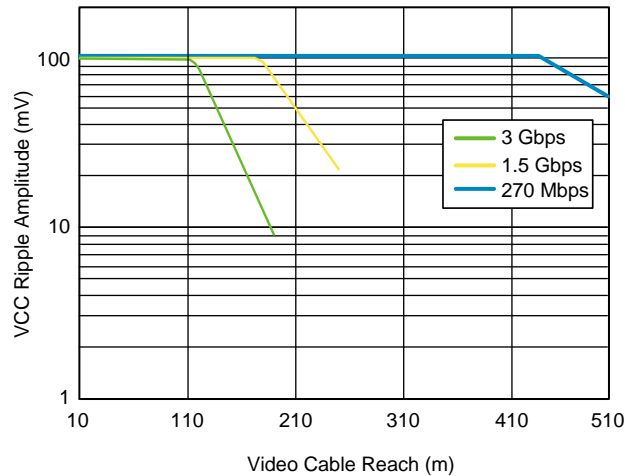


**Figure 1. Sample SDI Block Diagram**

## 2 Cable Equalizers

The cable equalizer (EQ) is the receive component in the SDI signal path and provides both amplification for and restoration of the incoming video signal. A 3G video signal can be attenuated by as much as 50dB on a 180m length of cable (Belden 1694A). That means a signal with 800mV of amplitude, at the cable driver, would be reduced to about 3mV after 180m of cable at the input of the EQ. The signal-to-noise ratio (SNR) plays a key role in powering a 3G EQ like the LMH0394 and LMH0395 (dual output), which can restore a signal after 180-200m of cable loss.

The graph in [Figure 2](#) shows the maximum power supply ripple on  $V_{CC}$  based on the data rate of the video signal and the desired video cable reach. The vertical axis is plotted on a log scale, making it easier to resolve the allowable ripple voltage for a longer cable reach. In order to achieve maximum cable reach, the ripple voltage limits for standard-definition (SD) and high-definition (HD) data rates are about 58mV and 22mV respectively, while for 3G at 190m is about 9mV. The ripple amplitude should be  $\leq 100$ mV regardless of the SDI data rate or cable reach, in order to ensure the full functionality of the equalizer.



**Figure 2.  $V_{CC}$  Ripple Requirements for SDI Equalizers**

### 3 Reclocker and Ser/Des

SDI devices like reclockers and Ser/Des have integrated phase lock loops (PLLs) which drive an obvious need for clean power. The video data rate determines the PLL loop bandwidth and therefore, the power supply rejection ratio (PSRR) which rolls off with frequency. As shown in Figure 3, the video data rate and also the switching frequency ( $F_{SW}$ ) of the power supply have an impact on the maximum  $V_{CC}$  ripple. Designing the power supply for a lower  $F_{SW}$  will allow more ripple on the  $V_{CC}$  of the device; it will also result in a higher efficiency power solution.

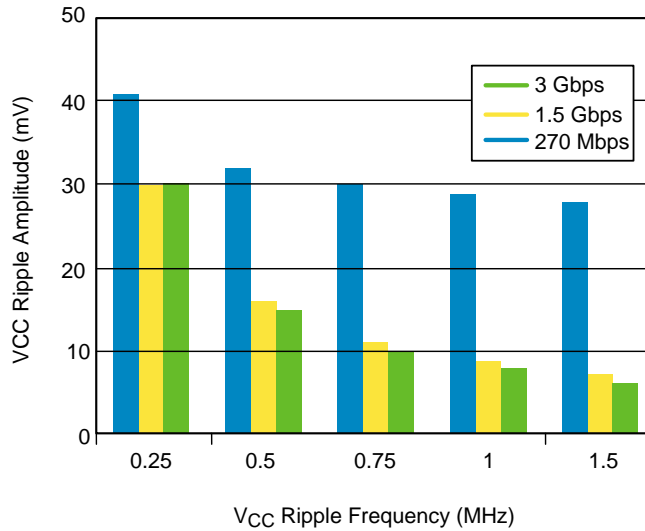


Figure 3.  $V_{CC}$  Ripple Requirements for SDI Reclockers and Ser/Des

## 4 Cable Drivers

SDI cable drivers like Texas Instruments LMH0302 and LMH0307 (dual output) have their outputs terminated directly to  $V_{CC}$ , as shown in Figure 4. Given that, any power supply noise or ripple on  $V_{CC}$  is transmitted directly on the outgoing video signal and will show up at the input of the receiving product as additive jitter. Like the cable EQ the cable driver's  $V_{CC}$  ripple limitation is data rate dependent. Slower data rates have a larger unit interval (UI) from a time based perspective, therefore, with a larger UI, more allowable jitter and correspondingly more  $V_{CC}$  ripple are acceptable.

The graph in Figure 5 shows the maximum ripple voltage based on a given video data rate and the cable driver's corresponding contribution to the total output jitter. As with other devices in the SDI signal path, the  $V_{CC}$  ripple, or lack thereof, is a contributor to the SNR and resulting jitter on the video signal. In summary, the  $V_{CC}$  ripple at the cable driver will directly contribute to the video signal's additive SNR resulting in more jitter at the EQ of the receiving product.

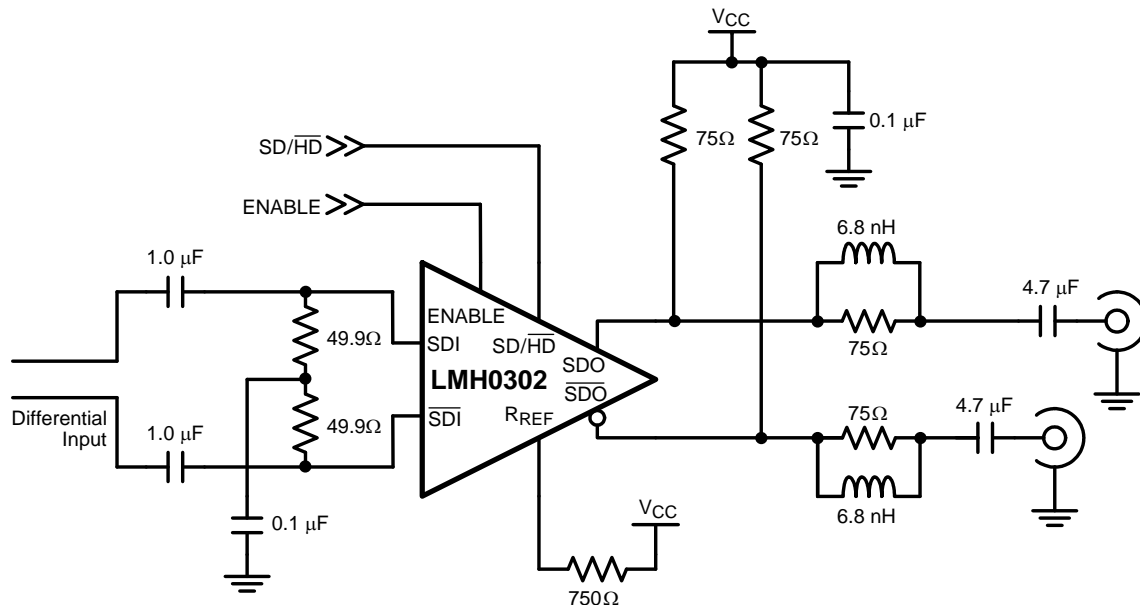


Figure 4. LMH0302 Cable Driver

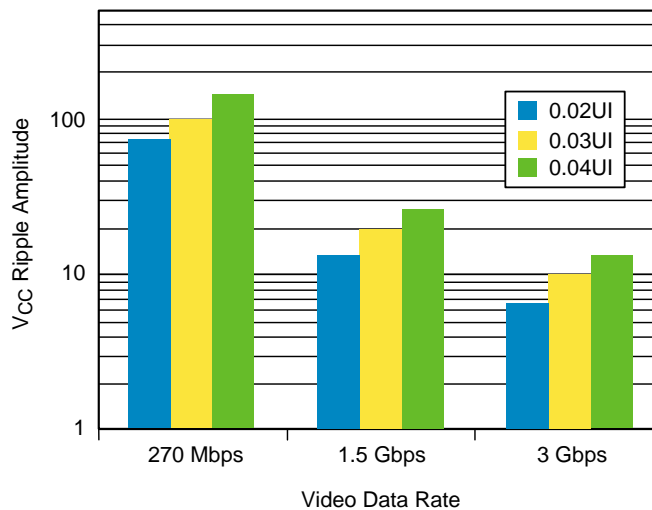


Figure 5. Allowable  $V_{CC}$  Ripple for a SDI Cable Driver

## 5 Conclusion

In conclusion, focusing on the  $V_{CC}$  ripple and noise level of a power design for SDI components can make the difference between a product whose performance is acceptable and one that's excellent. Conversely, if a product's jitter level or cable reach is less than optimal it may be worth examining the  $V_{CC}$  ripple on individual SDI components to see what improvements are possible. Designing switch mode power supplies (SMPS) with voltage ripple and noise that is  $<10\text{mV}$  takes some level of care. In most cases, the ripple on the output of a voltage regulator will exceed  $10\text{mV}$ .

Power modules like Texas Instruments award-winning SIMPLE SWITCHER® Power Modules are a notable exception. Modules like the LMZ10503/4/5 (3A, 4A, and 5A) and LMZ22008 and LMZ22010 (8A and 10A) are fully integrated, highly efficient buck regulators that boast low output ripple, excellent thermal performance and are compliant with EN55022 (CISPR 22) for electromagnetic interference (EMI). Linear drop-out regulators (LDO) can clean-up a voltage rail, but selecting the correct part is very important. The PSRR of LDOs decreases with frequency and is often insufficient to clean up the ripple of a SMPS operating at  $F_{SW} >100\text{KHz}$ .

LDOs like Texas Instruments LP5900 and LP3878 do an excellent job of attenuating power supply ripple and noise from switch mode supplies with  $F_{SW} >100\text{KHz}$ . Filtering power rails for sensitive designs like these is also an option worth consideration. Implementing post SMPS filters for  $V_{CC}$  ripple  $<10\text{mV}$  is not a trivial task and will involve care in both part selection and design.

For further discussion on power designs for SDI components and options for meeting the power supply ripple requirements mentioned here, please see *AN-2146 Power Design for SDI and other Noise Sensitive Devices Application Report* ([SNOA561](#)).

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions of TI 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)