Application Report
SNLA127B–May 2010–Revised April 2013

# AN-2059 Replacing the CLC001 Cable Driver With the LMH0001

**ABSTRACT**

This application report discusses the process of replacing the CLC001 cable driver with the LMH0001 cable driver.

**Contents**



**List of Figures**



**List of Tables**

# 1 Introduction

The LMH0001 SD-SDI cable driver can replace the CLC001 cable driver in many applications. The LMH0001 and CLC001 are both cable drivers designed to drive 75Ω coaxial cable, primarily for the SMPTE 259M interface. The supported data rates are similar between the two devices. Both cable drivers are powered from a 3.3V supply and rated for industrial temperature range operation (-40°C to +85°C).

The LMH0001, the newer generation SDI cable driver, has improved performance and is pin compatible with the LMH0002 HD/SD-SDI cable driver and the LMH0302 3G/HD/SD-SDI cable driver. This allows a forward migration path from SD to HD to 3G. The LMH0001 provides improved output return loss along with a 46% power savings over the CLC001, with typical power of 125 mW in comparison with 231 mW for the CLC001.

Table 1 shows the key differences between the CLC001 and LMH0001.

**Table 1. CLC001 and LMH0001 Key Differences**

| | CLC001 | LMH0001 |
|---|---|---|
| **Supply Current ($I_{CC}$) (Typical)** | 70 mA | 38 mA |
| **Package** | 8-pin SOIC | 16-pin LLP |
| **Data Rates** | DC to 622 Mbps | DC to 540 Mbps |
| **Output Rise/Fall Time (Typical)** | 400 ps | 560 ps |
| **ESD Rating** | ≥±7 kV HBM | ≥±5 kV HBM |
| **Input Interface** | 0.05V to 3.25V common mode | 1.6V + $V_{SDI}$/2 to $V_{CC}$ - $V_{SDI}$/2 common mode (self biased) |
| **Output Interface** | Requires external 75Ω resistor to GND | Requires external 75Ω resistor to $V_{CC}$ |
| **$R_{REF}$ Resistor (800 $mV_{P-P}$ Output)** | 1.91 kΩ to ground | 750Ω to $V_{CC}$ |
| **Output Return Loss** | Compliant to SMPTE spec | Meets SMPTE spec with margin using recommended network |

# 2 How To Replace the CLC001 With the LMH0001

Replacing the CLC001 with the LMH0001 requires a few simple steps. The device packages and pinouts are different so this change requires a new PCB layout. To replace the CLC001 with the LMH0001, follow these steps:

1. Check the output common mode voltage of the driving device to determine if it is compatible with the LMH0001 input common mode range—if so, it is preferred to DC couple the inputs, and if not, add AC coupling capacitors in series with the inputs, prior to the input termination. When AC coupling, remove any bias applied to the inputs as this is not required for the LMH0001 since the inputs are self-biased.
2. Replace the 75Ω resistors to ground on the output with 75Ω resistors to $V_{CC}$. These pullup resistors should be placed as close as possible to the LMH0001 output pins.
3. Add a return loss network in series with the LMH0001 outputs in order to meet the SMPTE return loss specification. This network typically consists of a 5.6 nH inductor in parallel with a 75Ω resistor, immediately following the 75Ω pullup. If only one output is used, the return loss network is not necessary on the unused output.
4. Change the output coupling capacitor from 1 µF to 4.7 µF for SMPTE applications. Using this larger AC coupling capacitor value is good practice when dealing with the large DC shifts associated with the SMPTE pathological signals.
5. For 800 $mV_{P-P}$ output, change the $R_{REF}$ resistor from 1.91 kΩ connected to ground to 750Ω connected to $V_{CC}$. For 1.0 $V_{P-P}$ output, change the $R_{REF}$ resistor from 1.5 kΩ connected to ground to 590Ω connected to $V_{CC}$.

Figure 1 shows the typical application for the CLC001, and Figure 2 shows the typical application for the LMH0001.

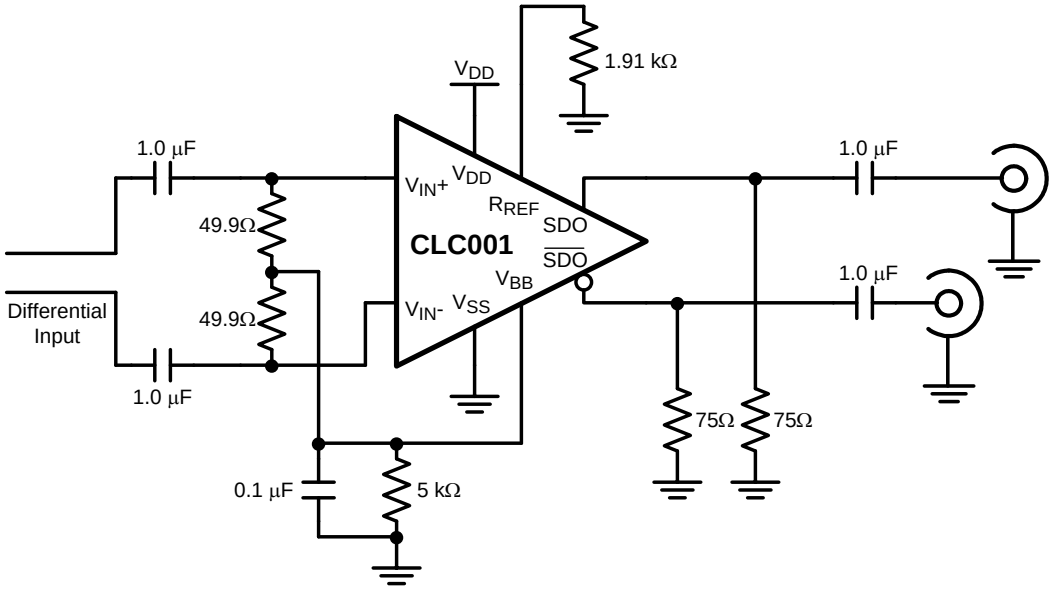


**Figure 1. CLC001 Typical Application**

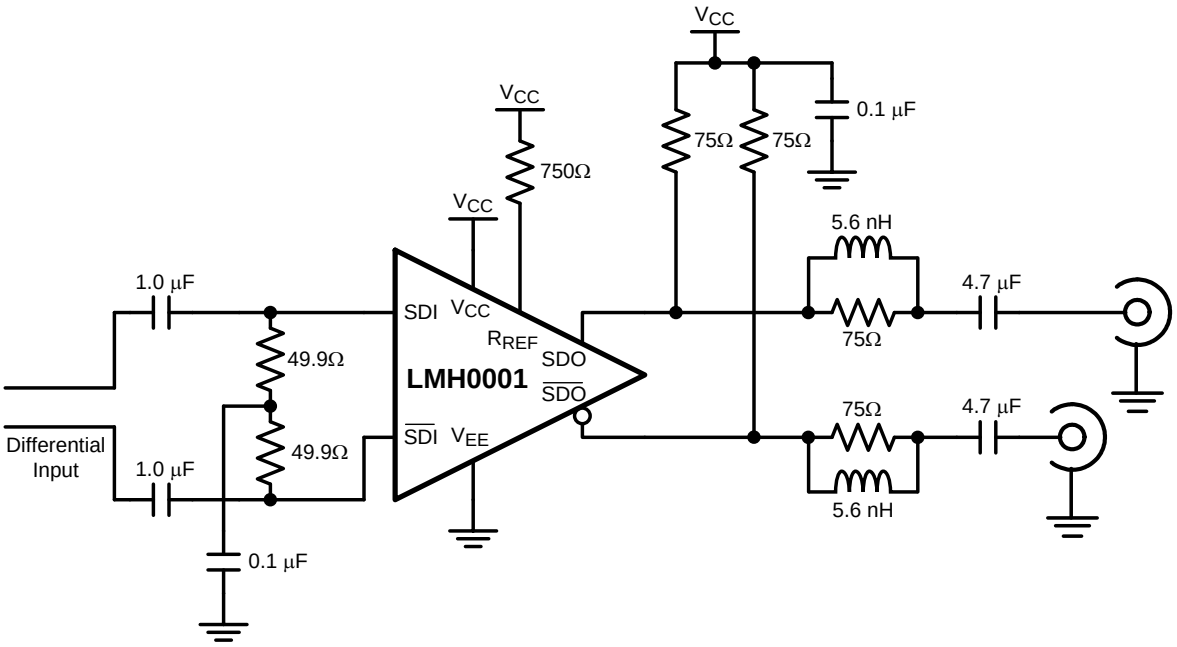


**Figure 2. LMH0001 Typical Application**

### 2.1 Input Interface

The input common mode voltage range of the CLC001 is between 0.05V and 3.25V, and the minimum differential input amplitude is 100 mV. The CLC001 inputs require a DC bias voltage to be applied when the inputs are AC coupled, and the $V_{BB}$ pin may be used for this. When driven differentially, the CLC001 inputs are typically terminated with a 100Ω resistor placed across the input pins, or two 50Ω resistors with a center tap capacitor to ground.

The LMH0001 input interface is similar to that of the CLC001, but it does not support rail-to-rail inputs like the CLC001. The input common mode voltage range of the LMH0001 is from 1.6V + $V_{SDI}$/2 to $V_{CC}$ - $V_{SDI}$/2, with the same minimum differential input amplitude as the CLC001. The LMH0001 inputs are self-biased, so no DC bias voltage is necessary when the inputs are AC coupled. When driven differentially, the LMH0001 inputs are typically terminated with a 100Ω resistor or two 50Ω resistor like the CLC001.

### 2.2 Output Interface

The CLC001 outputs are designed to drive 75Ω AC-coupled coaxial cable. They are current mode and ground referenced, requiring 75Ω resistors to ground to generate the output voltage. The output level is controlled by the $R_{REF}$ resistor.

The LMH0001 outputs are also current mode and designed to drive 75Ω AC-coupled coaxial cable. But the LMH0001 outputs are positive supply referenced and require 75Ω pullups to $V_{CC}$ to generate the output voltage. Like the CLC001, the LMH0001 output level is controlled by the $R_{REF}$ resistor.

### 2.3 Output Level Control ($R_{REF}$ Resistor)

The $R_{REF}$ resistor controls the output driver amplitude. The output amplitude for both the CLC001 and LMH0001 is adjustable from below 800 $mV_{P-P}$ to above 1.0 $V_{P-P}$. For the CLC001, the $R_{REF}$ resistor is connected to ground, and for the LMH0001, the $R_{REF}$ resistor is connected to $V_{CC}$. The output amplitude is inversely proportional to the value of $R_{REF}$ and approximately linear. For the CLC001, $R_{REF}$ is 1.91 kΩ for 800 $mV_{P-P}$ output and 1.5 kΩ for 1.0 $V_{P-P}$ output. For the LMH0001, $R_{REF}$ is 750Ω for 800 $mV_{P-P}$ output and 590Ω for 1.0 $V_{P-P}$ output.

### 2.4 Output Return Loss

The LMH0001 output structure provides improved return loss over the output structure used for the CLC001. This allows the LMH0001 to exceed the SMPTE return loss specification on the SD001SQ evaluation board with the recommended return loss network consisting of a 5.6 nH inductor in parallel with a 75Ω resistor. Return loss is dependent on board design so this return loss network may need to be optimized depending on the specific PCB design and BNC connector used.

## 3 LMH0001 Enhancements Over the CLC001

The LMH0001 is a solid upgrade and good replacement for the CLC001. It is designed in a newer, more advanced process. The LMH0001 offers much lower power and better output return loss. The LMH0001's smaller, space-saving package allows for more compact designs. In addition, the LMH0001's pin compatibility with HD-SDI and 3G-SDI cable drivers offers an easy upgrade path and allows future-proof designs.

## 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** | | **Applications** | |
|---|---|---|---|
| Audio | www.ti.com/audio | Automotive and Transportation | www.ti.com/automotive |
| Amplifiers | amplifier.ti.com | Communications and Telecom | www.ti.com/communications |
| Data Converters | dataconverter.ti.com | Computers and Peripherals | www.ti.com/computers |
| DLP® Products | www.dlp.com | Consumer Electronics | www.ti.com/consumer-apps |
| DSP | dsp.ti.com | Energy and Lighting | www.ti.com/energy |
| Clocks and Timers | www.ti.com/clocks | Industrial | www.ti.com/industrial |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
| Logic | logic.ti.com | Security | www.ti.com/security |
| Power Mgmt | power.ti.com | Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Microcontrollers | microcontroller.ti.com | Video and Imaging | www.ti.com/video |
| RFID | www.ti-rfid.com | | |
| OMAP Applications Processors | www.ti.com/omap | **TI E2E Community** | e2e.ti.com |
| Wireless Connectivity | www.ti.com/wirelessconnectivity | | |

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