User's Guide
SNLA299–August 2018

LMH12xx MADI Compatibility Application Note

This document gives the MADI (Multichannel Audio Digital Interface) specification requirements and necessary changes to enable LMH12xx device family to achieve compatibility with this specifications.

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1 MADI Specification Requirements

The MADI Specification standard describes the 125-Mbps NRZI, 4/5-bit coded serial data frame format and electrical characteristics for a multichannel audio digital interface. This specification governs requirements for serial digital transmission over coax or fiber-optic lines of 28, 56, or 64 channels represented at a common sampling frequency of 32 KHz to 96 KHz with a resolution of up to 24-bits per channel. Only a single-point interface from one transmitter to a receiver is supported. This document describes electrical parameters and changes necessary to make the LMH12xx device family compatible with these requirements.

1.1 MADI Transmitter Electrical Requirements

Same as SDI (Serial Digital Interface), the transmission media can either be over a 75-Ω coax cable or a fiber-optic cable. The following sections list the MADI specification electrical parameter requirements:

1.1.1 Line Driver Impedance

Output impedance should be 75-Ω ±2 Ω.

1.1.2 Mean Output Voltage

MADI data pattern is DC-balanced and thus the average voltage of the terminated output should be 0 V ±0.1 V

1.1.3 Maximum Output Voltage

After a 75-Ω termination, the output voltage should be within 0.3 to 0.6 V.

1.1.4 Terminated Signal Rise and Fall Time

After a 75-Ω termination, the 20/80% rise/fall time should be within 1 nS and 3 nS

1.2 MADI Receiver Electrical Requirements

MADI specification—unlike SDI—calls for minimum eye opening of 6 ns or 0.75 UI. Also, minimum vertical eye opening is 150 mV. Figure 1 through Figure 3 show a 6-ns horizontal eye opening. a variety of 75-Ω cables.

NOTE: For these eye diagrams, a MADI cable driver with 1-nS rise/fall time and 600-mV output swing was used. Thus, the cable lengths noted below are the maximum reach for each cable model or cable type with a 6-ns minimum vertical eye opening. For other cable types, it is proportional to the insertion loss at Nyquist frequency.

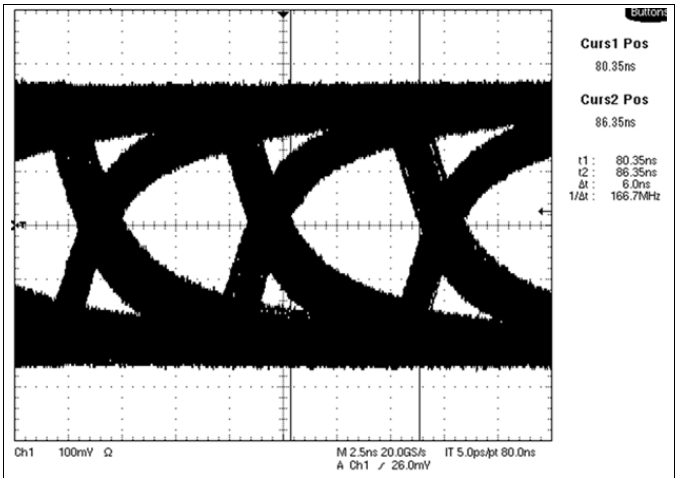

Figure 1. 100-m B1694A 6-ns Minimum Eye Opening

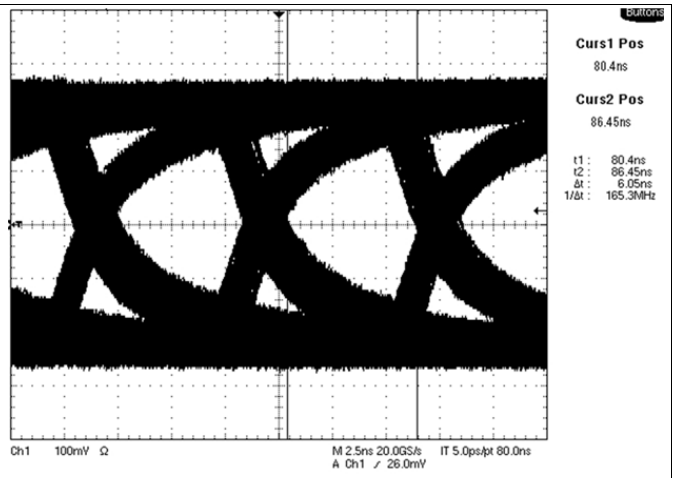

Figure 2. 150-m 5.5CUHD 6-ns Minimum Eye Opening

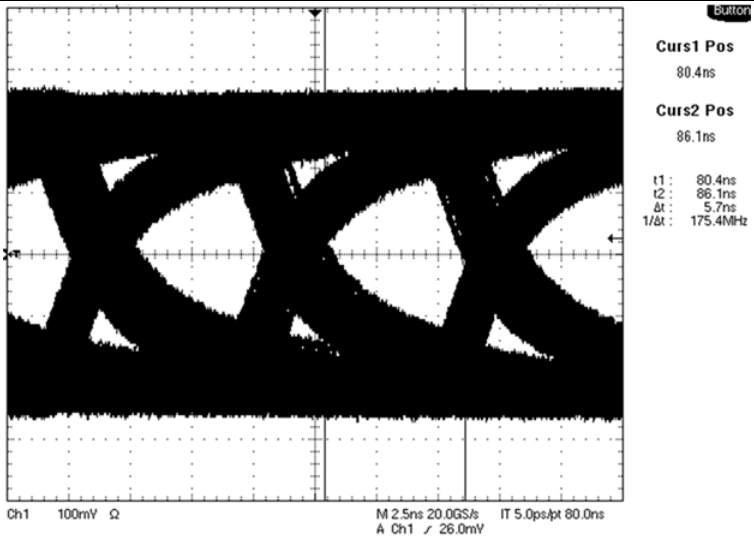

Figure 3. 120-m 5.5CFB 6-ns Minimum Eye Opening

2 LMH12xx Device Family

The LMH12xx device family consists of the following devices: the LMH1297 device family (the LMH1297, LMH1228, LMH1208, and LMH0397), the LMH1219 device family (the LMH1219 and LMH0324), and the LMH1218 device family (the LMH1218 and LMH0318). TI expects that the user is familiar with these devices. For more information on these devices, go to ti.com.

NOTE: At 125-MBps MADI data rate, these devices operate in bypass or raw mode—no retiming or reclocking.

2.1 LMH12xx Device Family

The LMH1297 and LMH0397 device families are 75-Ω bidirectional IOs, which means the devices can be configured either as adaptive cable equalizers or as dual cable drivers. When the user configures one of the devices as an adaptive cable equalizer, there is an additional loop-through port that can be used as an SDI or MADI cable driver, if needed. The LMH1297 device family can be controlled either through a register or pin. Through register control, the cable driver output amplitude can be controlled in 5-mV resolution or per step. Figure 4 shows these configurations.

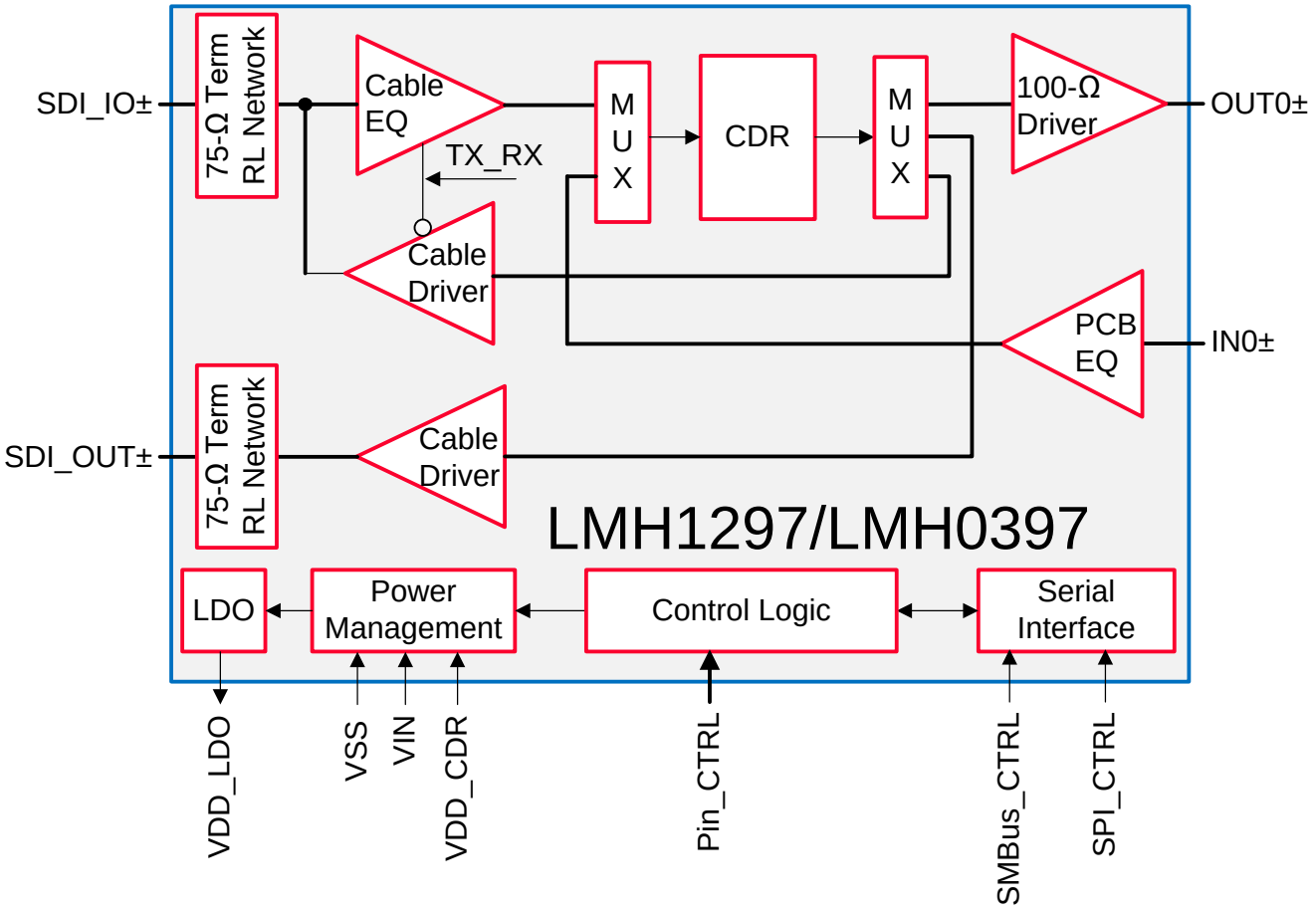

Figure 4. LMH1297/LMH0397 Block Diagram

2.1.1 LMH1297 MADI Modes of Operation

The LMH1297 device family provides four potential different modes of operation.

2.1.1.1 Dual MADI Cable Driver

The SDI_IO and SDI_OUT can operate in cable driver mode and provide two MADI cable drivers.

2.1.1.2 SDI Bidirectional IO and MADI Cable Driver

In this mode, the SDI_IO is used as a regular SDI bidirectional IO, and the SDI_OUT as a MADI output (when enabled). The LMH0397 is used for 3G-SDI while the pin/register-compatible LMH1297 is used for 12G SDI_IO.

2.1.1.3 Bidirectional MADI Port and SDI MADI Cable Driver

The SDI_IO is used either as a MADI cable driver or a MADI equalizer, and the SDI_OUT is used as a MADI driver.

2.1.1.4 Bidirectional MADI Port and SDI Cable Driver

The SDI_IO is used either as a MADI cable driver or a MADI equalizer, and the SDI_OUT is used as a regular SDI driver.

These four configurations provide flexibility to configure the ports, as needed.

2.1.2 LMH1297 Device Family Register Changes for MADI Compatibility

After a 75-Ω termination, output voltage should be within 0.3 V to 0.6 V. In default mode, LMH1297 device family supports SDI amplitude dynamic range. To support MADI output voltage range through SMBus or SPI interface, the following register settings are necessary:

RAW	FF	05	07	//enable config_io register set
RAW	61	80	80	//sdi_io vod ov enable
RAW	61	32	7F	//sdi_io vod equal to 0x32
RAW	68	80	80	//sdi_out vod override enable
RAW	68	32	7F	//sdi_out vod equal to 0x32
RAW	60	20	20	//force sdi_io slew rate
RAW	60	00	18	//select sd slew rate for sdi_io
RAW	68	20	20	//force sdi_out slew rate
RAW	68	00	18	//select sd slew rate for sdi_out
RAW	FF	04	07	//retimer register set enable
RAW	3F	08	08	//override out_ctrl pin
RAW	09	00	20	//disable independent control
RAW	1C	0C	0C	//raw sdi_out and out0

2.1.3 LMH1297 Device Family Hardware Changes for MADI Compatibility

The LMH1297 device family meets SMPTE SDI slew rates. MADI requires 80%/20% rise/fall time to be within 1 nS to 3 nS. To meet this requirement, a 10-pF capacitor was added across SDI_OUT± or SDI_IO± as shown in Figure 5.

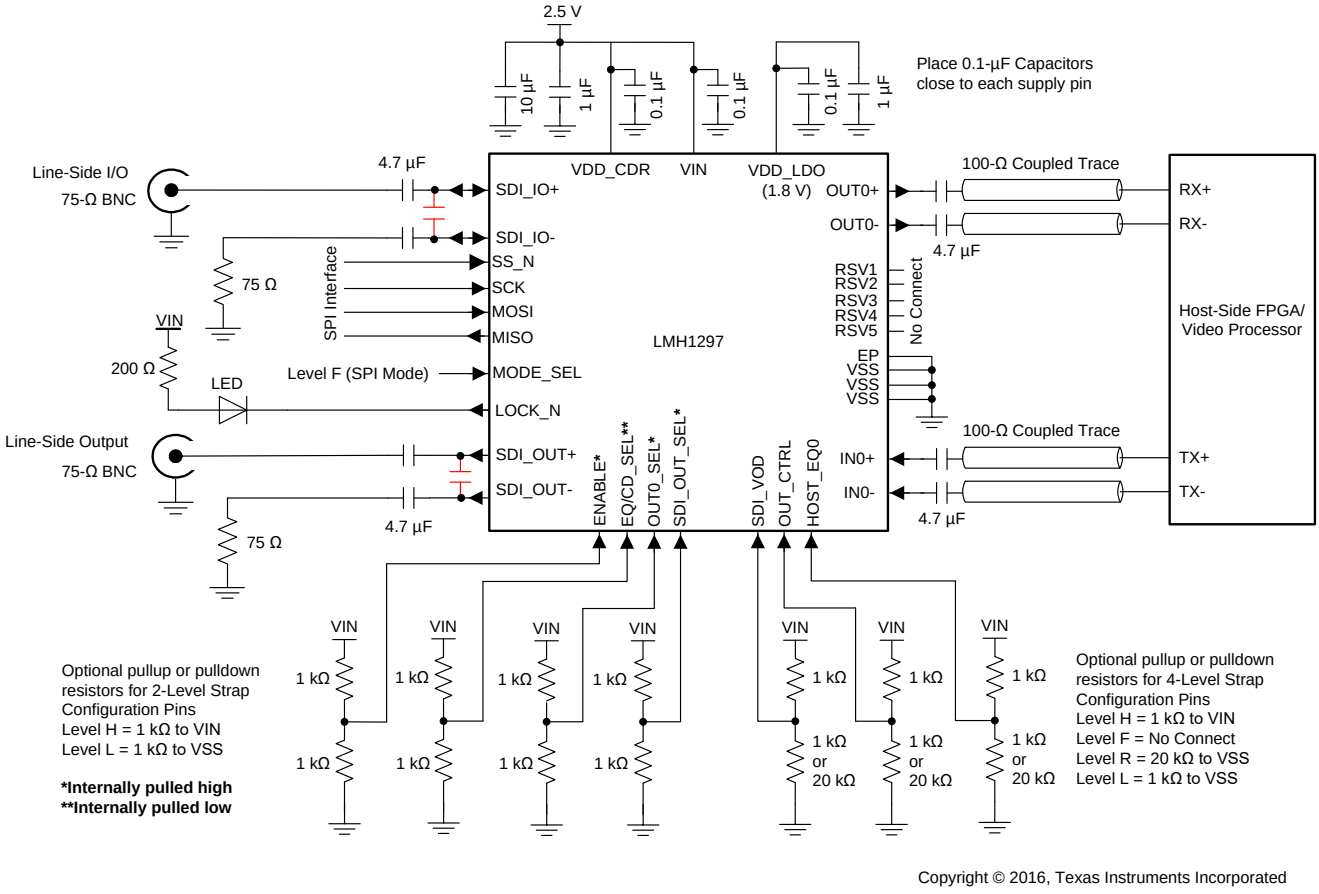

Figure 5. LMH1297 Family Application Schematic

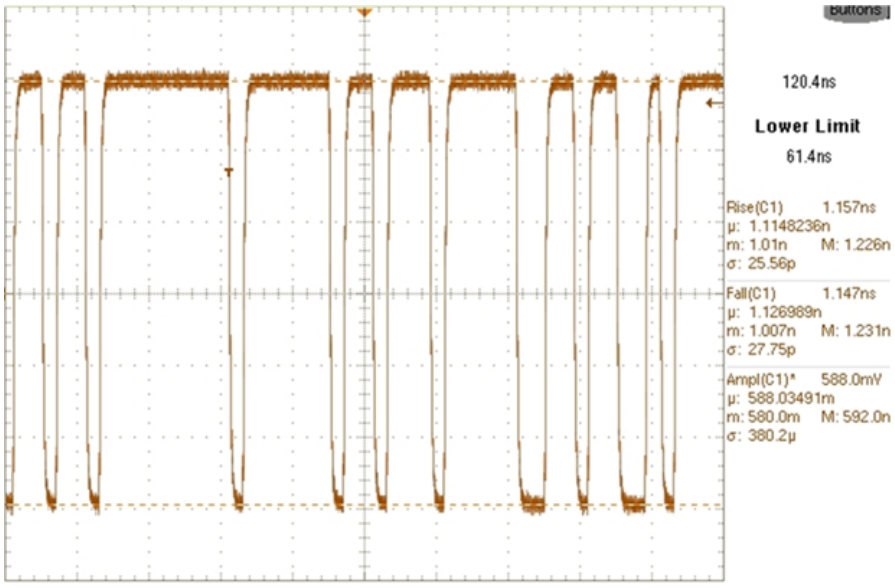

Figure 6. LMH1297/LMH0397 MADI-Compatible Transmit Waveform

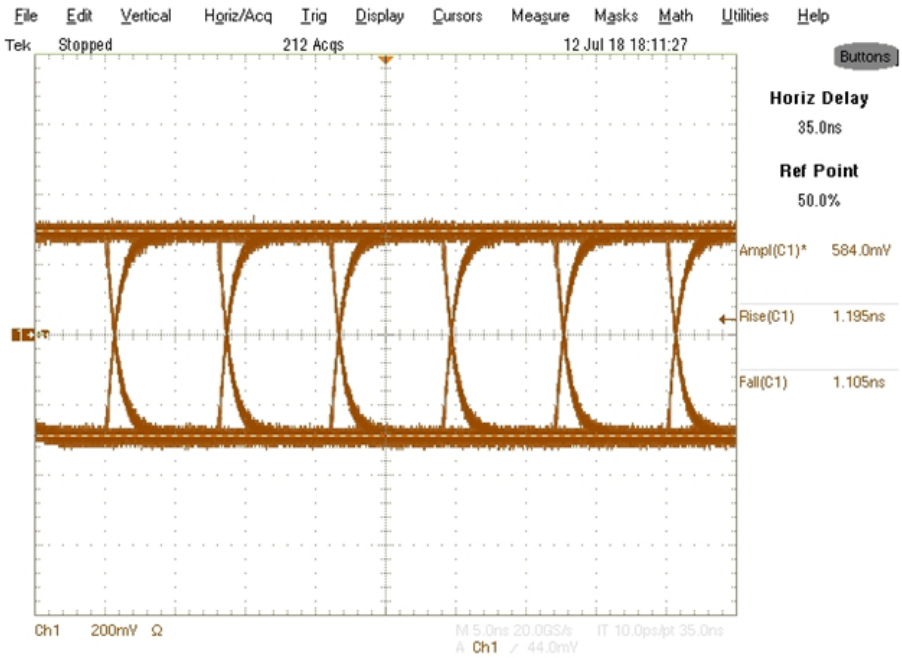

Figure 7. LMH1297/LMH0397 MADI-Compatible Output Eye Diagram

2.2 LMH1218 Device Family Hardware Changes to Support MADI Compatibility

The LMH1218 and LMH0318 devices were first-generation, 12G-SDI cable drivers designed to meet SDI SMPTE requirements. Thus amplitude was designed to be within 800 mV ±10%. Therefore to meet the MADI 300-mV to 600-mV output amplitude, a 6-dB passive attenuator block can be used. If the user wanted to slow down the slew rate in a similar way to the LMH1297 device changes shown in Section 2.1.3, a 10-pF capacitor can be added across OUT0± (see Figure 8).

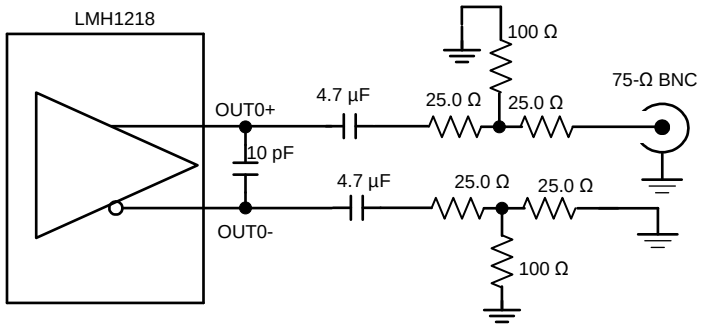

Figure 8. LMH1218 Block Diagram

The following register settings forces raw or CDR bypass for the LMH1218 device:

RAW	FF	04	07	//enable retimer registers
RAW	09	00	20	//enable override
RAW	1C	0C	0C	//out0 and out1 raw data

2.3 LMH1219 Device Family Recommended Register Settings

When operating as a MADI receiver, the LMH1219 and LMH0324 use the same register settings. The following register settings were used to bypass retimer because the LMH1219 does not lock to 125-Mbps MADI rate.

RAW	FF	05	07	//enable eq core
RAW	31	20	30	//enable override
RAW	33	20	30	//out1 powered up
RAW	FF	04	07	//enable retimer register table
RAW	3F	04	04	//Override reference rate
RAW	2F	00	C0	//Enable CDR lock to SMPTE rate

RAW	3F	10	10	//Override IN_OUT_SEL pin
RAW	31	00	03	//Select IN0 to OUT0 and OUT1
RAW	3F	08	08	///Override OUT_CTRL
RAW	09	00	20	//Disable independent output control
RAW	1C	0C	0C	//0x0C = forced raw data 0x08 = retimed data
RAW	0A	0C	0C	//Reset CDR
RAW	0A	00	0C	//Release CDR Reset

3 Summary

the LMH1297 device family provides different options to meet MADI requirements. These options are:

- Dual MADI Cable Drivers
- SDI_IO bidirectional SDI plus MADI cable driver
- SDI_IO bidirectional MADI with MADI cable driver
- SDI_IO bidirectional IO MADI with SDI cable driver

To meet these requirements, new register settings and a 10-pF capacitor must be added across SDI positive and negative pins.

The LMH1219 and LMH0324 require register settings to bypass retimer and thus reducing power consumption, and the LMH1218 MADI compatibility requires hardware changes and register settings to bypass retime function.

4 References

For more information on MADI specifications, see the following:

AES10-2008 AES Recommended Practice for Digital Audio Engineering - Serial Multichannel Audio Digital Interface (MADI), Audio Engineering Society

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