

## LMH0074 SMPTE 259M / 344M Adaptive Cable Equalizer

Check for Samples: [LMH0074](#)

### FEATURES

- **SMPTE 259M and SMPTE 344M Compliant**
- **Supports DVB-ASI at 270 Mbps**
- **Data Rates: 125 Mbps to 540 Mbps**
- **Equalizes up to 400 Meters of Belden 1694A at 270 Mbps**
- **Manual Bypass and Output Mute with a Programmable Threshold**
- **Single-Ended or Differential Input**
- **50Ω Differential Outputs**
- **Single 3.3V Supply Operation**
- **Industrial Temperature Range: -40°C to +85°C**
- **208mW Typical Power Consumption with 3.3V Supply**
- **Footprint Compatible with the LMH0044 and the GS9074A**

### DESCRIPTION

The LMH0074 SMPTE 259M / 344M Adaptive Cable Equalizer is designed to equalize data transmitted over cable (or any media with similar dispersive loss characteristics). The equalizer operates over a wide range of data rates from 125 Mbps to 540 Mbps and supports SMPTE 259M and SMPTE 344M.

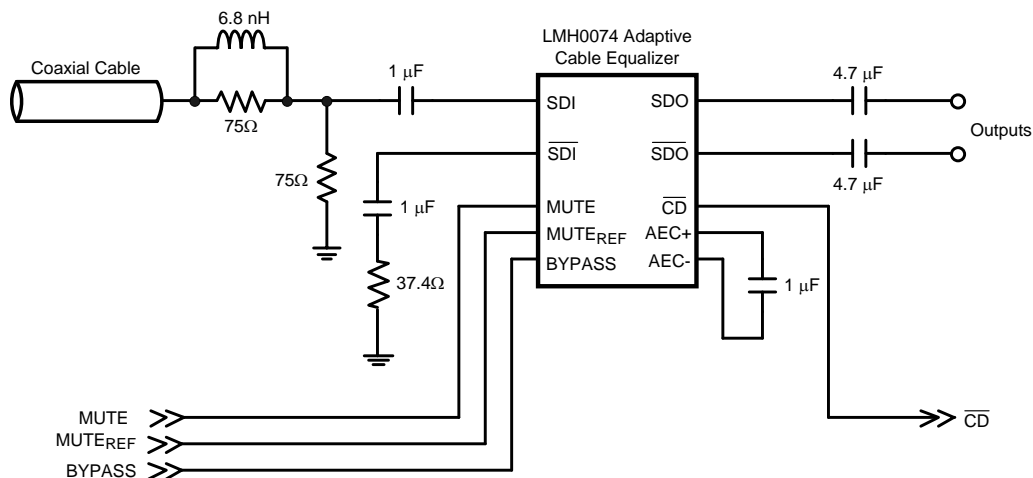
The LMH0074 implements DC restoration to correctly handle pathological data conditions. The equalizer may be driven in either a single ended or differential configuration.

Additional features include separate carrier detect and output mute pins which may be tied together to mute the output when no signal is present. A programmable mute reference is provided to mute the output at a selectable level of signal degradation.

### APPLICATIONS

- **SMPTE 259M and SMPTE 344M Serial Digital Interfaces**
- **Serial Digital Data Equalization and Reception**
- **Data Recovery Equalization**

### Typical Application



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Supply Voltage	-0.5V to 3.6V
Input Voltage (all inputs)	-0.3V to $V_{CC}+0.3V$
Storage Temperature Range	-65°C to +150°C
Junction Temperature	+150°C
Lead Temperature (Soldering 4 Sec)	+260°C
Package Thermal Resistance $\theta_{JA}$ 16-pin WQFN $\theta_{JC}$ 16-pin WQFN	+43°C/W +9°C/W
ESD Rating (HBM)	8kV
ESD Rating (MM)	250V

- (1) "Absolute Maximum Ratings" are those parameter values beyond which the life and operation of the device cannot be ensured. The stating herein of these maximums shall not be construed to imply that the device can or should be operated at or beyond these values. The table of "Electrical Characteristics" specifies acceptable device operating conditions.

## RECOMMENDED OPERATING CONDITIONS

Supply Voltage ( $V_{CC} - V_{EE}$ )	3.3V $\pm 5\%$
Input Coupling Capacitance	1.0 $\mu$ F
AEC Capacitor (Connected between AEC+ and AEC-)	1.0 $\mu$ F
Operating Free Air Temperature ( $T_A$ )	-40°C to +85°C

## DC ELECTRICAL CHARACTERISTICS

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified<sup>(1)(2)</sup>.

Parameter		Test Conditions	Reference	Min	Typ	Max	Units
$V_{CMIN}$	Input Common Mode Voltage		SDI, $\overline{SDI}$		1.9		V
$V_{SDI}$	Input Voltage Swing	At LMH0074 input <sup>(3)(4)</sup>		720	800	950	mV <sub>P-P</sub>
$V_{CMOUT}$	Output Common Mode Voltage		SDO, $\overline{SDO}$		$\frac{V_{CC} - V_{SDO}}{2}$		V
$V_{SDO}$	Output Voltage Swing	50 $\Omega$ load, differential			750		mV <sub>P-P</sub>
	MUTE <sub>REF</sub> DC Voltage (floating)		MUTE <sub>REF</sub>		1.3		V
	MUTE <sub>REF</sub> Range				0.7		V
	$\overline{CD}$ Output Voltage	Carrier not present	$\overline{CD}$	2.6			V
		Carrier present				0.4	V
	MUTE Input Voltage	Min to mute outputs	MUTE	3.0			V
		Max to force outputs active				0.8	V
$I_{CC}$	Supply Current	See <sup>(5)</sup>			63	77	mA

- (1) Current flow into device pins is defined as positive. Current flow out of device pins is defined as negative. All voltages are stated referenced to  $V_{EE} = 0$  Volts.  
(2) Typical values are stated for  $V_{CC} = +3.3V$  and  $T_A = +25^\circ C$ .  
(3) Specification is ensured by characterization.  
(4) The maximum input voltage swing assumes a nonstressing, DC-balance signal; specifically, the SMPTE-recommended color bar test signal. Pathological or other stressing signals may not be used. This specification is for 0m cable only.  
(5) Supply current depends on the amount of cable being equalized. The current is highest for short cable and decreases as the cable length is increased. Refer to [Figure 2](#).

## AC ELECTRICAL CHARACTERISTICS

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified<sup>(1)</sup>.

Parameter		Test Conditions	Reference	Min	Typ	Max	Units
BR <sub>MIN</sub>	Minimum Input Data Rate		SDI, $\overline{\text{SDI}}$		125		Mbps
BR <sub>MAX</sub>	Maximum Input Data Rate					540	Mbps
	Jitter for various Cable Lengths (with equalizer pathological)	270 Mbps, Belden 1694A, 400 meters <sup>(2)</sup>			0.2		UI
		270 Mbps, Belden 8281, 280 meters <sup>(2)</sup>			0.2		UI
t <sub>r</sub> , t <sub>f</sub>	Output Rise Time, Fall Time	20% – 80% <sup>(2)</sup>	SDO, $\overline{\text{SDO}}$		100	220	ps
	Mismatch in Rise/Fall Time	See <sup>(2)</sup>			2	15	ps
t <sub>OS</sub>	Output Overshoot	See <sup>(2)</sup>			1	5	%
R <sub>OUT</sub>	Output Resistance	Single-ended <sup>(3)</sup>			50		Ω
RL <sub>IN</sub>	Input Return Loss	See <sup>(4)</sup>	SDI, $\overline{\text{SDI}}$	15	18-20		dB
R <sub>IN</sub>	Input Resistance	Single-ended			1.3		kΩ
C <sub>IN</sub>	Input Capacitance	Single-ended <sup>(3)</sup>			1		pF

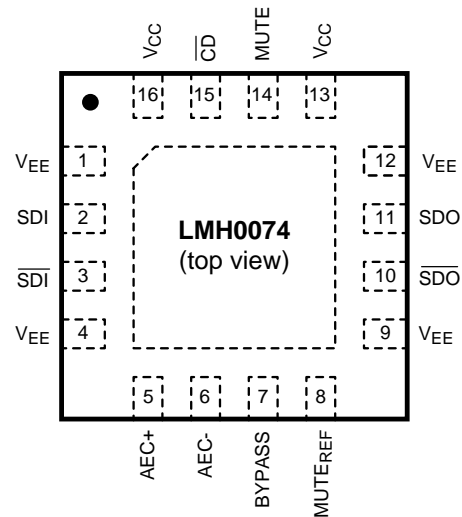
(1) Typical values are stated for V<sub>CC</sub> = +3.3V and T<sub>A</sub> = +25°C.

(2) Specification is ensured by characterization.

(3) Specification is ensured by design.

(4) Input return loss is dependent on board design. The LMH0074 meets this specification on the SD074 evaluation board from 5MHz to 1.5GHz.

## CONNECTION DIAGRAM

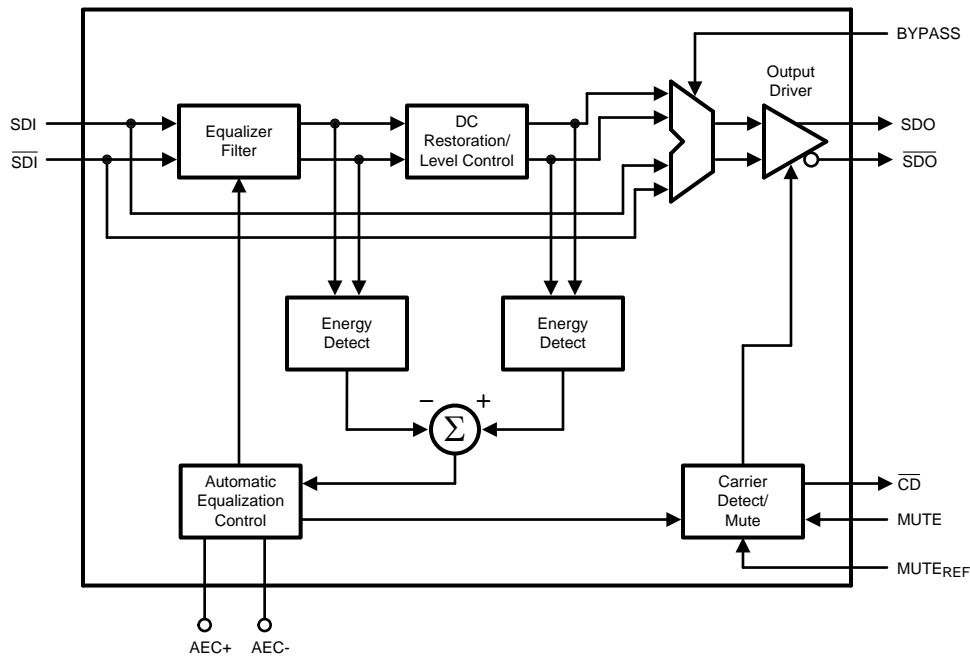


**Figure 1. 16-Pin WQFN Package**  
See Package Number RUM0016A

### Pin Descriptions

Pin	Name	Description
1	$V_{EE}$	Negative power supply (ground).
2	SDI	Serial data true input.
3	$\overline{SDI}$	Serial data complement input.
4	$V_{EE}$	Negative power supply (ground).
5	AEC+	AEC loop filter external capacitor (1 $\mu$ F) positive connection.
6	AEC-	AEC loop filter external capacitor (1 $\mu$ F) negative connection.
7	BYPASS	Bypasses equalization and DC restoration when high. No equalization occurs in this mode.
8	MUTE <sub>REF</sub>	Mute reference. Sets the threshold for $\overline{CD}$ and (with $\overline{CD}$ tied to MUTE) determines the maximum cable to be equalized before muting. MUTE <sub>REF</sub> may be unconnected for maximum equalization.
9	$V_{EE}$	Negative power supply (ground).
10	$\overline{SDO}$	Serial data complement output.
11	SDO	Serial data true output.
12	$V_{EE}$	Negative power supply (ground).
13	$V_{CC}$	Positive power supply (+3.3V).
14	MUTE	Output mute. To disable the mute function and enable the output, MUTE must be tied to GND or a low level signal. To force the outputs to a muted state, tie to $V_{CC}$ . $\overline{CD}$ may be tied to this pin to inhibit the output when no input signal is present. MUTE has no function in BYPASS mode.
15	$\overline{CD}$	Carrier detect. $\overline{CD}$ is high when no signal is present. $\overline{CD}$ has no function in BYPASS mode.
16	$V_{CC}$	Positive power supply (+3.3V).
DAP	$V_{EE}$	Connect exposed DAP to negative power supply.

## Block Diagram



## BLOCK DESCRIPTION

The **Equalizer Filter** block is a multi-stage adaptive filter. If Bypass is high, the equalizer filter is disabled.

The **DC Restoration / Level Control** block receives the differential signals from the equalizer filter block. This block incorporates a self-biasing DC restoration circuit to fully DC restore the signals. If Bypass is high, this function is disabled.

The signals before and after the DC Restoration / Level Control block are used to generate the **Automatic Equalization Control (AEC)** signal. This control signal sets the gain and bandwidth of the equalizer filter. The loop response in the AEC block is controlled by an external 1 $\mu$ F capacitor placed across the AEC+ and AEC- pins.

The **Carrier Detect / Mute** block generates the carrier detect signal and controls the mute function of the output. This block utilizes the  $\overline{\text{CD}}$  and **MUTE** signals along with **Mute Reference (MUTE<sub>REF</sub>)**.

The **Output Driver** produces SDO and  $\overline{\text{SDO}}$ .

### MUTE REFERENCE (MUTE<sub>REF</sub>)

The mute reference sets the threshold for  $\overline{\text{CD}}$  and (with  $\overline{\text{CD}}$  tied to MUTE) determines the amount of cable to equalize before automatically muting the outputs. This is set by applying a voltage inversely proportional to the length of cable to equalize. As the applied MUTE<sub>REF</sub> voltage is increased, the amount of cable that can be equalized before carrier detect is de-asserted and the outputs are muted is decreased. MUTE<sub>REF</sub> may be left unconnected for maximum equalization before muting.

### CARRIER DETECT ( $\overline{\text{CD}}$ ) AND MUTE

Carrier detect  $\overline{\text{CD}}$  indicates if a valid signal is present at the LMH0074 input. If MUTE<sub>REF</sub> is used, the carrier detect threshold will be altered accordingly.  $\overline{\text{CD}}$  provides a high voltage when no signal is present at the LMH0074 input.  $\overline{\text{CD}}$  is low when a valid input signal is detected.

MUTE can be used to manually mute or enable SDO and  $\overline{\text{SDO}}$ . Applying a high input to MUTE will mute the LMH0074 outputs. Applying a low input will force the outputs to be active.

$\overline{CD}$  and MUTE may be tied together to automatically mute the output when no input signal is present.

### INPUT INTERFACING

The LMH0074 accepts either differential or single-ended input. The input must be AC coupled. Transformer coupling is not supported.

The LMH0074 correctly handles equalizer pathological signals for standard definition serial digital video, as described in SMPTE RP 178.

### OUTPUT INTERFACING

The SDO and  $\overline{SDO}$  outputs are internally loaded with  $50\Omega$ . They produce a  $750\text{ mV}_{P-P}$  differential output, or a  $375\text{ mV}_{P-P}$  single-ended output.

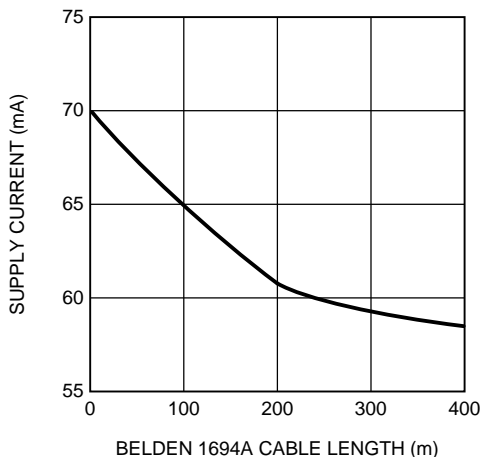
**APPLICATION INFORMATION**

**PCB LAYOUT RECOMMENDATIONS**

Refer to the following Application Note on TI's website: [AN-1372, "LMH0034 PCB Layout Techniques."](#) The PCB layout techniques in the application note apply to the LMH0074 as well.

**SUPPLY CURRENT VS. CABLE LENGTH**

The supply current ( $I_{CC}$ ) depends on the amount of cable being equalized. The current is highest for short cable and decreases as the cable length is increased. [Figure 2](#) shows supply current vs. Belden 1694A cable length for 270 Mbps data.



**Figure 2. Supply Current vs. Belden 1694A Cable Length, 270 Mbps**

## REVISION HISTORY

Changes from Revision C (April 2013) to Revision D	Page
• Changed layout of National Data Sheet to TI format .....	<a href="#">7</a>



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LMH0074SQ/NOPB	ACTIVE	WQFN	RUM	16	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	L074	<a href="#">Samples</a>
LMH0074SQE/NOPB	ACTIVE	WQFN	RUM	16	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	L074	<a href="#">Samples</a>
LMH0074SQX/NOPB	ACTIVE	WQFN	RUM	16	4500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	L074	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

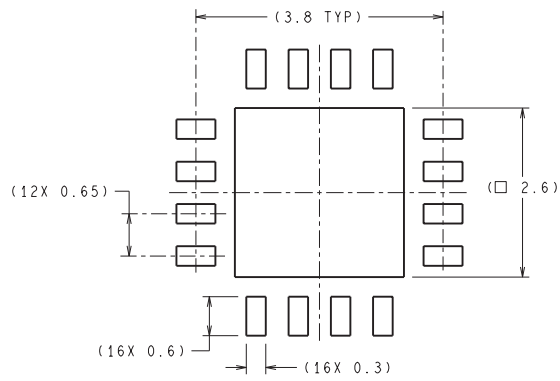
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LMH0074SQ/NOPB	WQFN	RUM	16	1000	178.0	12.4	4.3	4.3	1.3	8.0	12.0	Q1
LMH0074SQE/NOPB	WQFN	RUM	16	250	178.0	12.4	4.3	4.3	1.3	8.0	12.0	Q1
LMH0074SQX/NOPB	WQFN	RUM	16	4500	330.0	12.4	4.3	4.3	1.3	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

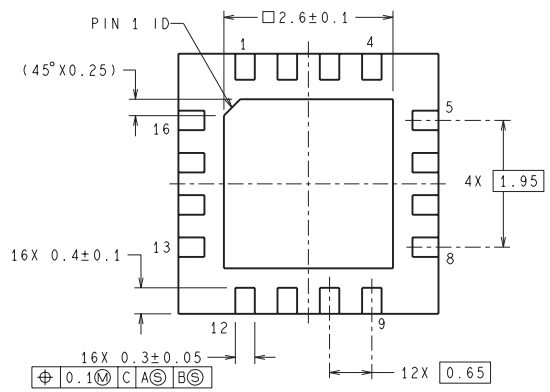
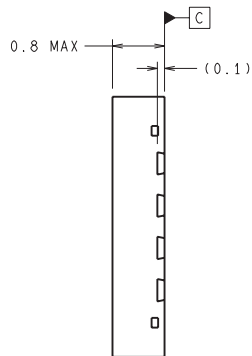
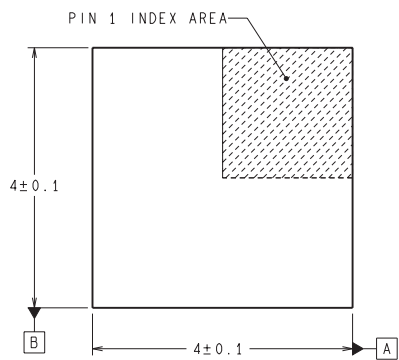
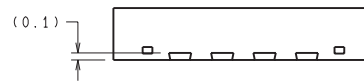
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMH0074SQ/NOPB	WQFN	RUM	16	1000	210.0	185.0	35.0
LMH0074SQE/NOPB	WQFN	RUM	16	250	210.0	185.0	35.0
LMH0074SQX/NOPB	WQFN	RUM	16	4500	367.0	367.0	35.0

RUM0016A



RECOMMENDED LAND PATTERN

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SQB16A (Rev A)

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