Application Report

SNLA255–March 2016

LMH1980 Sync Separator Design Considerations in Cable Hot-Plug Applications

ABSTRACT

In a video receiver, a sync separator's function is to recover the sync timing embedded in an analog video signal and output the sync pulses to the timing subsystem. This allows the timing subsystem to lock or synchronize its local timebase to the recovered sync pulses so it can reliably capture, process, display, and/or re-transmit the incoming video data. The LMH1980 is a sync separator device intended for consumer, automotive, security, or other applications where the video input signal is applied continually upon power-up. The LMH1980 was **not** designed for applications where the video input may be subjected to plug-unplug cycles during operation, also known as "hot-plugging", which may be encountered in genlock subsystems used in broadcast or professional video equipment. When the LMH1980 is subjected to repeated hot-plug events, it is possible under certain conditions for its input stage to enter a lock-up state that induces improper input operation which could remain indefinitely until the next power cycle or unless an application circuit countermeasure is employed.

This application note will discuss the operation of the LMH1980 in normal and lock-up states, conditions under which the lock-up state can occur, application/board-level countermeasures known to prevent or exit the lock-up state to mitigate risk of using this device in cable hot-plug applications.

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1 LMH1980 in Normal Operation

In the typical application circuit in Figure 1, the video input signal is AC-coupled through the capacitor C_{IN} to Pin 4 (VIN) of the LMH1980, which internally has a dynamic input clamping stage to DC-restore the negative sync-tip level to 0.7 V (typical) for the next sync processing stage. If a low-pass filter is needed to attenuate the chroma subcarrier component of an NTSC/PAL input, then the series resistor (Rs) may be a small value to form a RC low-pass filter with a parallel capacitor to ground (Cp). This filter is optional to attenuate the chroma amplitude and only needed to avoid false sync slicing when the negative peak of the chroma peak extends below the LMH1980's sync slicing level (+70 mV above the sync tip). Since most video standard signals do not have excessively large chroma levels to actually trigger a false sync slice, Rs can be 0 Ω and Cp can left unpopulated.

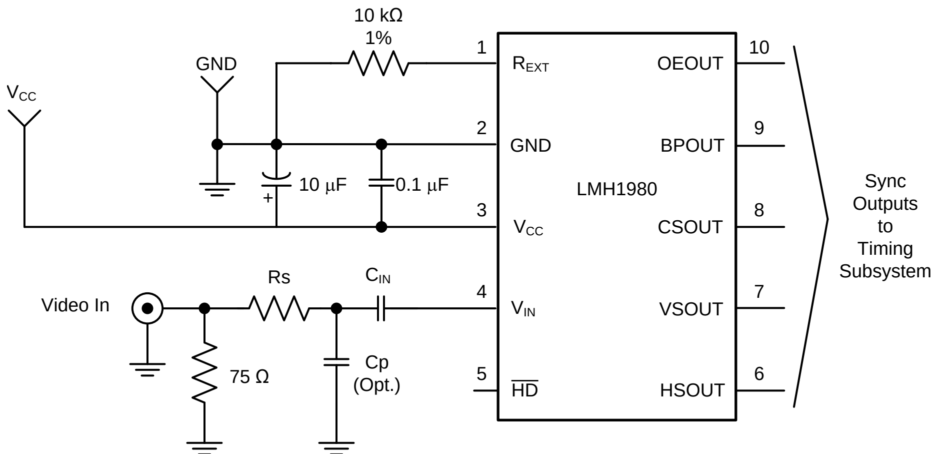
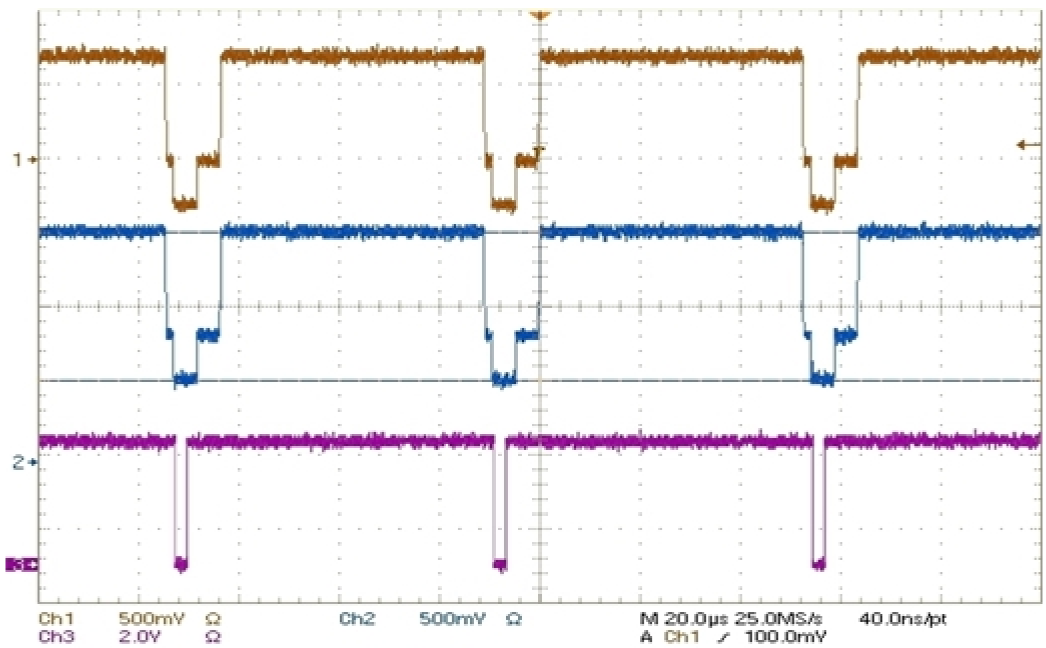


Figure 1. Typical Application Circuit

When the LMH1980 is operating normally with a 480i signal applied to the “Video In” port, the following input and output sync waveforms in Figure 2 were observed on an oscilloscope. Ch1 and Ch2 show identical input waveforms, except Ch2 is observed after Rs and C_{IN} (at VIN pin 4) with the video sync tip DC-restored to 0.7V by the input clamp stage. Ch3 shows the expected output Hsync pulse extracted from the input’s negative sync pulse.



Ch1: 480i input at “Video In” BNC cable port (before Rs = 100 Ω)

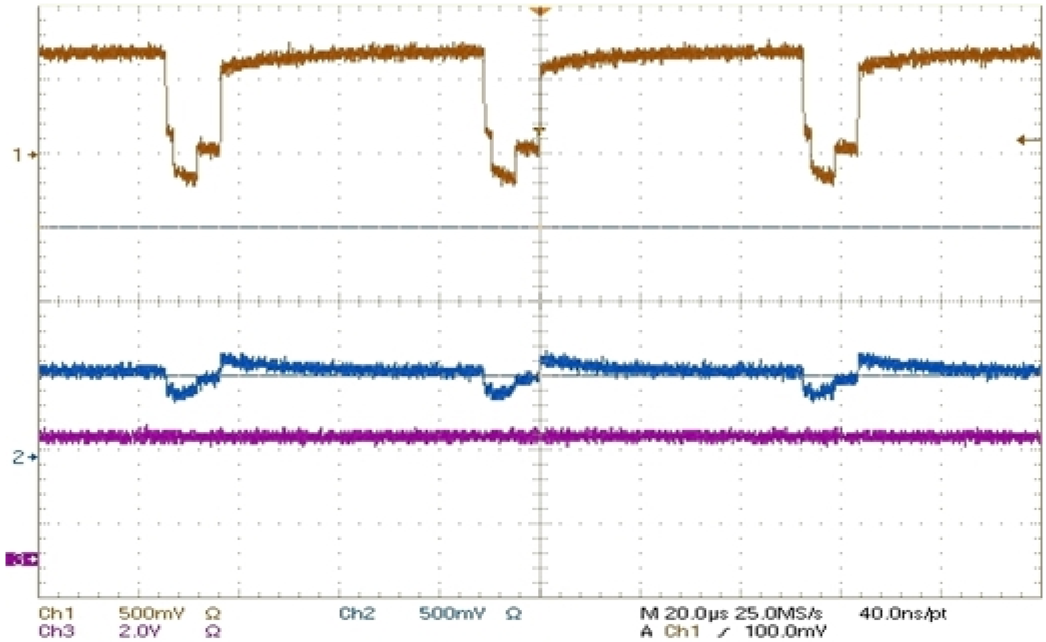
Ch2: 480i input at VIN pin 4 of LMH1980 (after Rs and C_{IN})

Ch3: Hsync output pulses at HSOUT pin of LMH1980

Figure 2. Video Input and Hsync Output Waveforms in Normal Operation

2 LMH1980 in Lock-up State

When a live video cable is plugged into the “Video In” port while the LMH1980 is powered-on, it is possible for this cable hot-plug event to induce a charge on the VIN pin that triggers a lock-up state on the input clamp circuit. In the lock-up state, internal parasitic structure is turned-on and introduces a low-resistance path on the VIN pin. Because this parasitic path is overriding the normal input operation on VIN, the video signal after C_{IN} will be effectively clamped when the video source is driven through a non-zero series resistance (like 100 Ω). In Figure 3, Ch1 and Ch2 show the input waveforms distorted due to the low-resistance parasitic path. Under the lock-up state, no syncs can be processed from the input signal and thus no outputs pulses can be observed on Ch3.



Ch1: 480i input at “Video In” BNC cable port (before Rs = 100 Ω)

Ch2: 480i input at VIN pin 4 of LMH1980 (after Rs & C_{IN}), distorted due to low-resistance parasitic path

Ch3: Missing Hsync output pulses at HSOUT pin of LMH1980

Figure 3. Video Input and Hsync Output Waveforms in Lock-Up State

The lock-up state can occur on any LMH1980 device when subjected to hot-plug events under the test conditions listed in Table 1. Under these conditions, it can take many repeated hot-plug events (tens to hundreds of plug-unplug cycles) before the lock-up state is triggered.

Table 1. Test Conditions to Induce LMH1980 Lock-Up State due to Hot-Plugging

Parameter	Test Conditions
Supply Voltage	3.3V to 5 V
Ambient Temperature	50°C or higher
Rs	Non-zero value
C_{IN}	1 nF or higher

Once lock-up state is triggered, normal device operation may not be restored until either: a) the VIN pin is briefly driven by above the 0.9 V threshold to disable the internal parasitic structure, or b) the device is power-cycled. Either of these 2 options can be leveraged as a countermeasure to exit the lock-up state and permit use of LMH1980 in cable hot-plug applications.

3 Application/Board-Level Countermeasures Against Lock-Up Due to Cable Hot-Plug

3.1 Method #1:

Referring to the application circuit in Figure 1, Use Rs = 0 Ω and C_{IN} = 220 pF to minimize the input circuit impedance between the video source and VIN pin of the LMH1980. By having the lowest impedance on the input path, the video input signal swing can strongly drive the sync pulse amplitude of 0.3 Vpp (typical) on top of the internal clamp level of 0.7 V, which should be sufficient to drive VIN above the 0.9 V threshold to disable the internal parasitic structure if triggered by the hot-plug event. With this method, the video input impedance is low enough for the normal video swing to “overdrive” the VIN pin above the 0.9 V threshold, such that it is not possible to observe the lock-up state with this input configuration.

3.2 Method #2:

Implement a NMOS switch to momentarily pull-up VIN each time the video cable is connected Figure 4. After the cable is connected, the gate input of NMOS can be pulsed to turn on the NMOS switch to momentarily pull-up VIN above the 0.9 V threshold, which turns off the internal parasitic path if triggered by the hot-plug event. This method requires video buffers to split the input signal to both LMH1980 and the cable detection circuit “black box” (BB) input paths. The black box detects the video cable presence and produces a one-shot pulse to turn-on the NMOS switch and exit the lock-up state. Normal device operation will resume once the internal parasitic path is disabled and the NMOS switch is turned off.

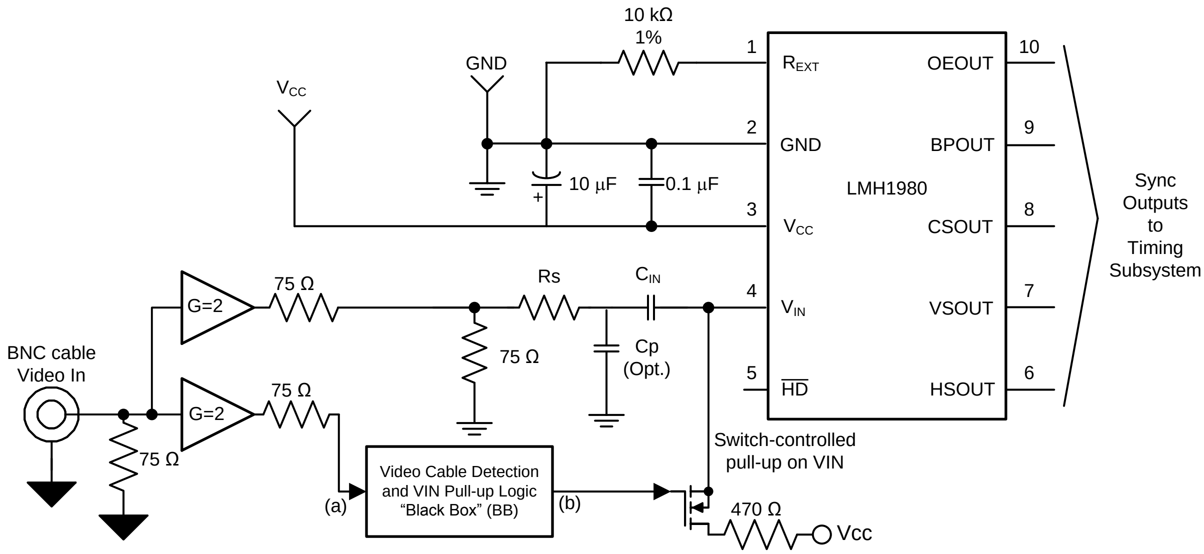


Figure 4. LMH1980 Application Circuit with Lock-up Countermeasure Method #2 (Switch-Controlled Pull-up on VIN)

Figure 5 shows an example timing diagram for the signals that define the behavior of the black box circuit.

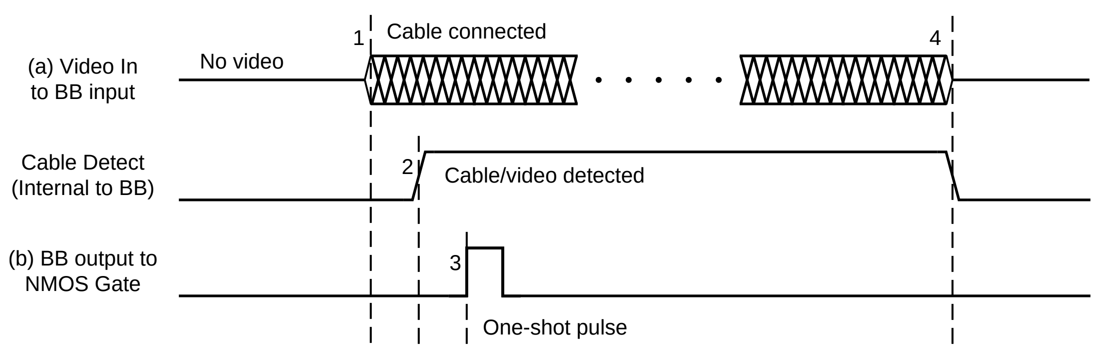


Figure 5. Example Timing Diagram to Pulse NMOS Switch to Pull-up VIN (Countermeasure Method #2)

The key events annotated in the timing diagram are described as follows:

1. Cable is connected and buffered video signals are present at the inputs of the LMH1980 and the BB circuit. The cable hot-plug event could have induced the lock-up state in LMH1980.
2. Once a valid video signal is detected at the BB input, the “Cable Detect” logic signal transitions high and stays high while video is present.
3. After “Cable Detect” has transitioned high, the BB output is a one-shot pulse (a few ms duration) to the NMOS gate. This pulse turns-on the NMOS switch, which forces LMH1980 to exit the lock-up state if triggered by the hot-plug event (#1) so normal operation can resume.
4. 4. Video cable is unplugged and Cable Detect signal goes low immediately. The black box circuit will repeat sequence on the next cable hot-plug event.

3.3 Method #3:

Power-cycle the LMH1980 after the hot-plug event, such that the device restarts in normal operation.

4 Summary

In summary, when using LMH1980 in cable hot-plug applications, it is important to be aware of risk of the lock-up state, the conditions under which this can occur, and apply the application/board-level countermeasure(s) to prevent or exit the lock-up state to mitigate the risk in the system application.