

AN-1906 LMH6518 Evaluation Board

1 Package Includes

- LMH6518 evaluation board (tested board that takes a 5 V and ground power supply connection and outputs main and auxiliary differential outputs).
- USB Interface board (Figure 1) with 10 pin interconnect cable (to mate with J6 on LMH6518 evaluation board). This board interfaces to a PC USB port to “Write” the SPI interface signals to the LMH6518 and can also display the LMH6518 state through “Read” back.
- USB Cable

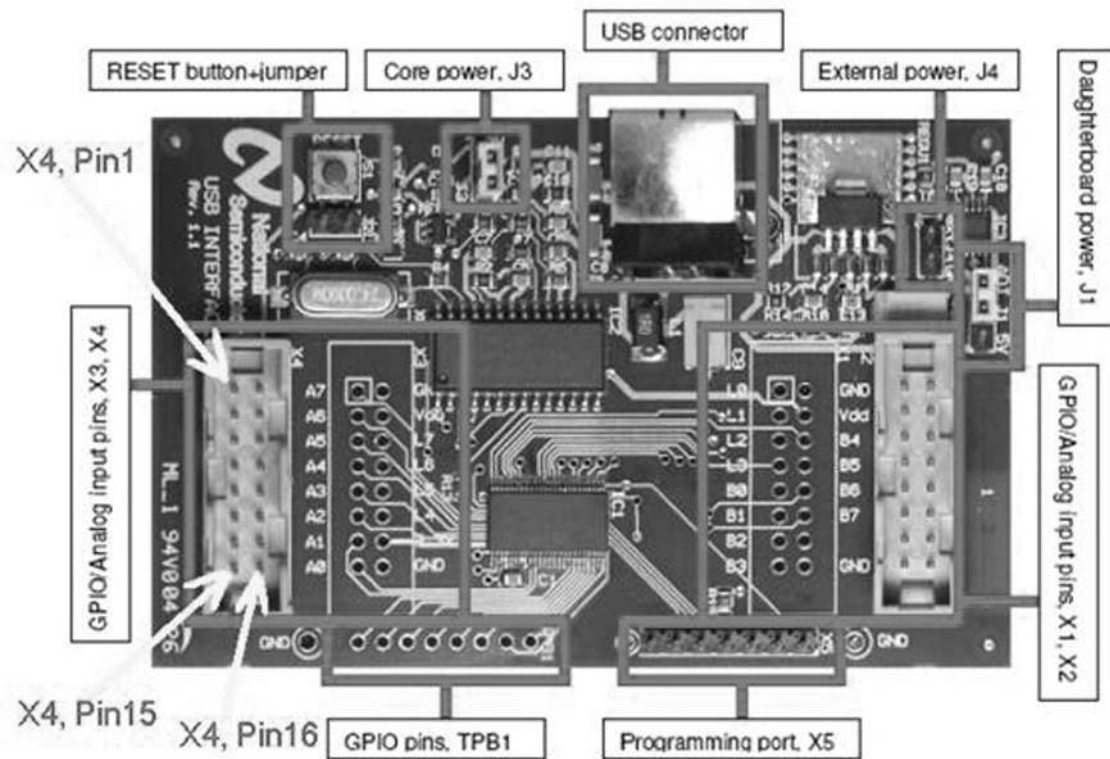


Figure 1. USB Interface Board

2 Additional Items Needed

- PC (Windows) with web connection
- A single ended input signal for testing the LMH6518. The input signal should be of the speed, purity, and fidelity needed to test LMH6518 functionality and to not limit measured performance. The LMH6518 has differential input; however, this evaluation board is configured for single ended drive (into the positive input, “+IN” (J3) SMA connector) and the undriven input is biased to $V_{CC}/2$ (= 2.5 V) on board. This input should be offset to 2.5 V DC ($< \pm 1$ mV of the undriven input voltage at R_{19} or LMH6518 pin 7). Here are possible input sources:
 - Lab generator (or other signal source) capable of 2.5 V offset in the presence of milli-volt level input signal.
 - Using a ground referenced (AC coupled or no offset adjust needed) generator with a “Bias-Tee” module that allows DC value to be set to 2.5 V using a fine tuned voltage lab DC power supply.

NOTE: If necessary, decouple the lab power supply with an effective low-pass filter (series R, shunt C) next to the “Bias-Tee” DC input to ensure little interference coupling to the signal path.

- A Hi-Z buffer that outputs the required mill-volt level AC signal centered at 2.5 V from a ground referenced input signal. In oscilloscope applications, this Hi-Z buffer is what interfaces the high-impedance oscilloscope probe to the LMH6518. The *LMH6518 900 MHz, Digitally Controlled, Variable Gain Amplifier Data Sheet* ([SNOSB21](#)) details a circuit that performs this function.

3 Setup and Operation

3.1 Preliminary Setup

1. Install Microsoft .NET Framework version 2.0 prior to installing the LMH6518 evaluation software (that is available for download from www.ti.com - evaluation board page). Point your browser to the following location:
 - (a) <http://www.microsoft.com> and search for “.NET Framework”.
 - (b) Continue to the page link where “Download” is located. The .NET Framework installation file, “dotnetfx.exe”, can be downloaded by clicking on the “Download” button.
2. Download “dotnetfx.exe” and save to any folder on the PC. Continue to Run and install this program.
3. Follow the LMH6518 Product Folder ([SNOA535](#)), “Eval. Boards”, “Buy Now” and click on the “Software Setup Files”.
4. Go to that folder and run setup.exe. Continue with the installation.
5. When the LMH6518 software installation completes, there would be a shortcut to the LMH6518 evaluation software on the PC desktop. Double click to run the software.
6. Apply 5 V (± 20 mV) DC and ground to the LMH6518 evaluation board. The power supply should be capable of at least 300 mA of current. Ensure the power connection to the evaluation board is properly made or damage may occur.

- Plug the 10 pin female end of the ribbon cable from the USB Interface board into J6 on the LMH6518 evaluation board. The ribbon cable pin 1 should connect to J6 pin 1 (J6 pin 1 has square pad on the board bottom, and a "1" silk-screened on the top side of the board, for easy identification). [Table 1](#) shows the connections to the USB interface board (for reference only).

Table 1. USB Interface Board/ LMH6518 Evaluation Board Interconnect Detail

Name	Function	LMH6518 Evaluation Board Pin (J6)	USB Interface Board (X4)
Ground	Ground	1	"GND", pin 2
\overline{CS}	Chip Select	3	A7, pin 1
DO ⁽¹⁾	Data out (LMH6518 SDIO pin)	4	A0, pin 15
SCLK	Clock	5	A6, pin 3
DI ⁽¹⁾	Data In (LMH6518 SDIO pin)	7	L7, pin 6

⁽¹⁾ DI and DO are tied together on the LMH6518 evaluation board, and connected to LMH6518 SDIO pin for bidirectional data read or write.

- Plug the USB Interface board to a free USB port, with the other end mating with the USB port on the USB Interface board, and launch the LMH6518 software, if not already. If a pop-up window appears, click "yes to upload the correct setup to the USB Interface board and you are now ready to control the LMH6518. When the application is running, you should see "USB Connected All ACK" in the Status Bar at the bottom-left of the LMH6518 software window shown in [Figure 3](#). If the status bar message does not appear, un-plug the USB cable and reapply to reinitiate the USB Interface board and until the proper message appears.

3.2 LMH6518 Evaluation Board Setup

Refer to the board schematic and layout documents.

- Jumper Placement:** The LMH6518 evaluation board generates the 3.3 V logic supply on board (Jumper JP3, pins 1-2 shorted powers the LMH6518 off the on-board 3.3 V source.

NOTE: JP3, pin 1 has a "1" silk-screened next to it on the top side of the board). The output common mode voltage (Main and Auxiliary outputs both) are set to about 1.2V using an onboard voltage divider (R_1 , and R_2) from V_{CC} (+5 V). R_{21} and R_{22} (0 Ω resistors) tie this 1.2 V level to both main and auxiliary common mode inputs (" V_{CM} " and " V_{CM_AUX} " that are pins 13 and 16, respectively).

- Outputs:** The main outputs of the LMH6518 appear at J1 and J2 (SMA connectors). These connectors can be tied directly to a Texas Instruments Gsample/second ADC (ADC081500), or equivalent, for DC coupled data acquisition. Done this way, pin 9 of J6 (V_{CMO}) can be tied to the common mode output control of the ADC to allow the ADC to control the LMH6518 output common mode voltage. Note that $R_3 = 10K$ and $C_1 = 1$ nF would need to be installed on the evaluation board for this kind of testing. In addition, move R_{21} and R_{22} (0 Ω resistors) to R_{23} and R_{24} in order to disconnect the onboard 1.2 V reference and instead allow the ADC to control the main and auxiliary common mode voltages.

The auxiliary outputs, that can be terminated in 100 Ω on board by installing R_4 (100 Ω), appear at J8 and J7. Note that the auxiliary outputs (used for trigger function in oscilloscope applications) are very similar to the main outputs, with the exception of slightly higher distortion levels. The auxiliary outputs are available at J8 and J7 SMA connectors.

J1, and J2 (and also J7, and J8) differential impedance should be close to 100 Ω with minimal parasitic effects when being measured. As these outputs are all at approximately 1.2 V common mode level, they cannot be terminated in DC coupled 50 Ω (similar to an oscilloscope input) directly. AC coupled 50 Ω terminated instrumentation (such as S parameter analyzers) can be connected to these SMA outputs directly for observation. With single ended Hi-Z input instrument observation, the LMH6518 outputs should be terminated in 100 Ω differential, as shown in [Figure 2](#) (beware of the loading effect of such an observation on the LMH6518 outputs).

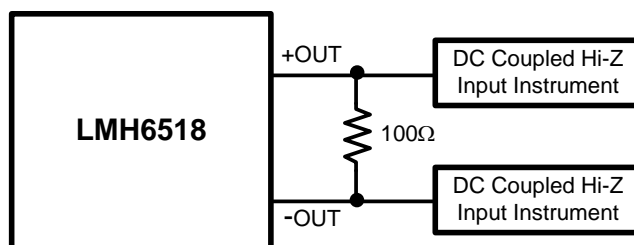


Figure 2. LMH6518 Output Observation With Hi-Z Instrumentation

- Input(s):** Ensure that the LMH6518 inputs (LMH6518 pins 6 and 7) are both close to $V_{CC}/2$ ($= 2.5\text{ V}$) and there is less than 1 mV of difference in voltage between them. On the board, use a DC voltmeter to measure LMH6518 pin 6 and 7 voltages (or C_{14} and R_{19} , right hand side pads). LMH6518 pin 6 potential (driven input) can be controlled by varying the incoming signal offset (2.5 V nominal) at J3 (SMA connector). If the two LMH6518 inputs are not offset close to each other, as stated, measured results could be affected. Some of the side-effects of input offset are: output clipping, excess distortion, loss of bandwidth, or step response anomalies.

Potentiometer R_{25} (board bottom side) is provided to null any remnant output offset, especially useful when the LMH6518 operating conditions change. For an effective method of input offset adjustment, especially when the LMH6518 is set for high gain (HG/ 0 dB), monitor J1 and J2 (outputs) SMA center pins (1.2 V nominal) with a DVM set to read DC voltage and adjust R_{25} to minimize the voltage difference between these two outputs to less than 50 mV. This will reduce any input offset so that the output can be observed.

4 Miscellaneous

- Overlapping gain state:** As shown in Table 2, one of the possible gain states (18.8 dB) is covered by either preamp HG, or preamp LG. This gain is possible with preamp set to high gain and 20 dB ladder attenuation, or, with preamp set to low gain and 0 dB ladder attenuation. Choose preamp high gain (with 20 dB ladder attenuation) for best noise performance or preamp low gain (with 0 dB ladder attenuation) for best distortion performance

Table 2. LMH6518 Gain Map

Preamp Gain	Attenuation (dB)										
	0	2	4	6	8	10	12	14	16	18	20
Lo	18.8	16.8	14.8	12.8	10.8	8.8	6.8	4.8	2.8	0.8	-1.16
Hi	38.8	36.8	34.8	32.8	30.8	28.8	26.8	24.8	22.8	20.8	18.8

- LMH6518 Evaluation Software Look:**

 - Ladder Attenuator:** 0 dB to 20 dB. 10 steps. Each step is 2 dB
 - Total Gain:** This displays the total device gain (read only, assuming 100 Ω differential load across J2 and J1 SMA or J8 and J7 outputs) based on the preamp gain and the ladder attenuation selected
 - Filters:** Full (no filter), 20 MHz, 100 MHz, 200 MHz, 350 MHz, 650 MHz, and 750 MHz.
 - Power Mode:** Full power and Aux Hi-Z (with Aux Hi-Z, the auxiliary output is turned off with approximately 60 mA reduction in 5 V supply current)
 - Preamp Gain:** Hi gain and low gain (with 20 dB difference between the two)
 - Write:** To write the current setup on the GUI screen into the LMH6518 registers. To change any of the LMH6518 operating registers, the adjustments should be made first, followed by a single click on the "Write" button.
 - Read:** To read back all LMH6518 registers for confirmation and verification. If the register Read back is different from the last Write state, the software displays an alert window.
 - Exit:** To close the application

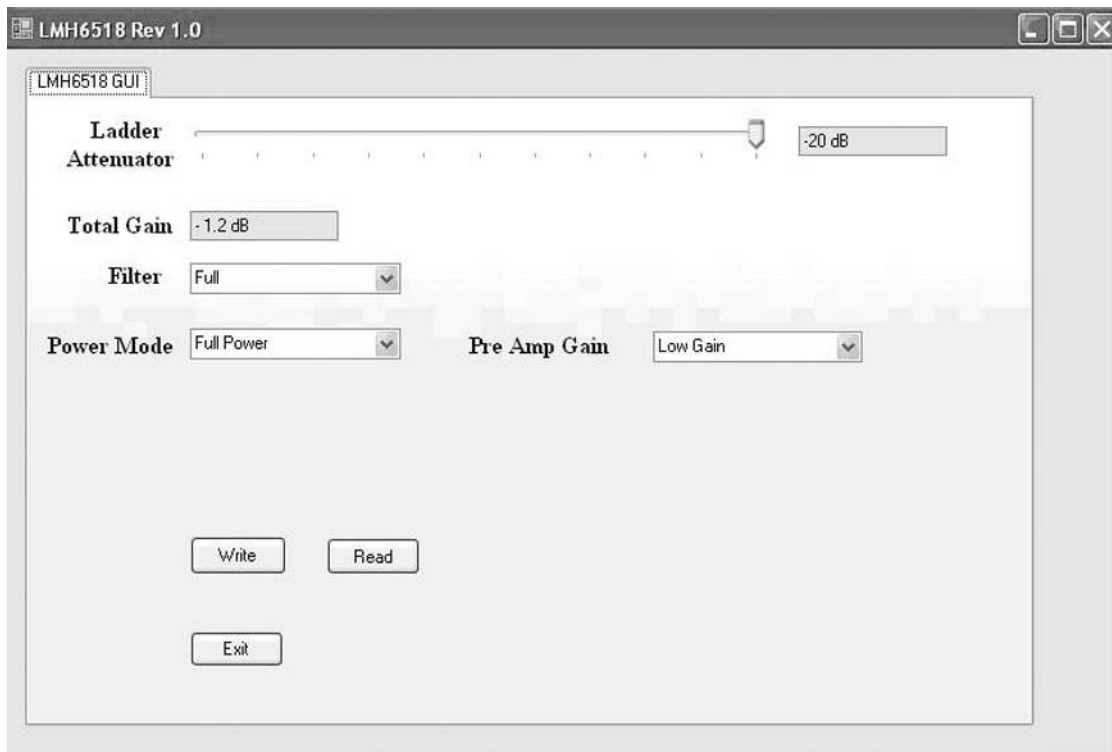


Figure 3. Evaluation Software Screen Shot

3. Default device turn-on state: Preamp low gain, 20 dB ladder attenuation, full-power mode, filter full. With the USB interface board connected, the LMH6518 evaluation board will remain powered on through the interconnect to the USB interface board, even if the 5 V supply to the board is disconnected. Therefore, the device states will not reset to default power-on even if the power is turned off.
4. When the power mode is switched, the change in +5 V supply current (~60 mA) through the power supply wiring/trace is enough to cause a noticeable difference in the voltage at “-IN” (voltage-divided from 5 V supply). This could cause enough input offset difference to shift or rail the output, especially at high gains (preamp HG and little or no ladder attenuation). If this occurs, readjust R_{25} (bottom side of the board) as described in [Section 3.2](#) to null the output offset that is caused by the way the undriven input is biased. This is merely a consequence of how the undriven input is biased.

In an oscilloscope application, the driven input's offset needs to be servo'd to the undriven input potential, similar to the JFET LNA shown in *LMH6518 900 MHz, Digitally Controlled, Variable Gain Amplifier Data Sheet* ([SNOSB21](#)); thus, the cause is eliminated.

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