HPMX-2007
Demonstration Circuit Board

ver AP052296A

Applications Bulletin

Introduction

The HPMX-2007 demonstration kit consists of a test board, this application note and a computer diskette.

The test board can be set up to test the modulator alone, the modulator + mixer combination or the mixer alone. It allows testing the IC at different frequencies including 900 MHz and 1500 -2500 MHz.

HP's testing is usually done at a fixed modulator LO frequency of 149.67 MHz. Your application may require a different frequency plan so we have developed a Microsoft Excel spreadsheet that calculates values of frequency dependent components. That file (LANDC.XLS) is on the diskette.

Assembly Notes

Tables 3 and 4 list the parts you will need to assemble the circuit board for the different operating frequency bands. Figures 7 and 8 show the parts placement.

1) **Always** use bypass capacitors on the Vcc lines. Vcc can be set anywhere from 2.7 to 5.5 Volts. **It is strongly recommended that you do not exceed the maximum IC voltage ratings shown on the IC data sheet.**

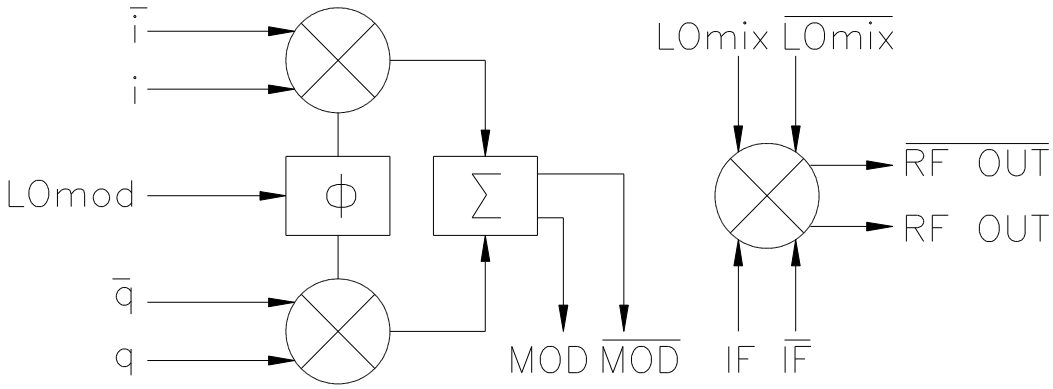
2) The board has been laid out to allow the use of E.F. Johnson SMA connectors (part no. 142-0701-631 or 142-0701-621), available from DigiKey and other suppliers.

3) Most of the components used on the board are the 0402 variety of chip component (40 mils x 20 mils). You will ned a magnifier or microscope for assembly.

Using the Board

The board can be set up for different input, output, and operational configurations. Figures 3 - 5 show various options for testing different sections of the IC. Tables 3 and 4 list component values for different operating frequency bands assuming a fixed modulator LO of 149.67 MHz.

The board has been designed to allow voltage dividers to be used at the i and q inputs. The voltage dividers allow an easy, low noise interface to test instruments.



The dividers shown on the schematic diagrams figures 3, 4 and 6 divide the input i,q signals by 9. Four 1 kΩ resistors are used in parallel to assure accurate match between the i and q circuits. Substituting a single resistor for the four parallel resistors is not recommended. The voltage dividers may be eliminated by substituting 0 Ω jumpers for resistors R12, R13, R14, R17, and omitting the parallel connected resistors.

The board includes coupling capacitors at the LO and IF inputs and at the RF output.

Testing the IC

The HPMX-2007 is designed so that the mixer can be turned completely off. It is not possible to turn the mixer on without also turning on the modulator. Therefore, there are two main operating modes: Modulator-Only and Modulator + Mixer. Modifying the board will allow Mixer-Only testing.

Modulator-Only testing

Fig.ure 3 shows a schematic diagram of the test board assembled for a typical modulator-only application. Only the components shown are required for this mode of operation. We have used resistors at the output of the modulator to simplify the board. You may want to use an LC network in your application.

Modulator + Mixer testing

Figure 4 shows the schematic diagram of the test board assembled for this mode. This is the schematic that was used for most of the data sheet characterization testing. Only the components shown are required. You have some options with regard to the modulator output bias/matching network. The LC network shown allows maximum output from the modulator, and acts as a band-pass filter at the same time. In a real application you may want to simplify the circuit by using resistors at the modulator output as shown in figure 2.

Mixer - Only testing

Even though there is no IC operating mode that allows the mixer to be turned on while the modulator is off, some users may want to run performance tests on the mixer only. You can use the test board to test the mixer alone by building up the board per the schematic diagram shown in figure 5.

You will have to cut the metal on the board that connects the modulator output to the mixer input. The easiest place to cut is on the top side of the board where pins 13 and 14 connect to vias under the IC.

We have included a balun at the IF input, but you can also operate the IF input in an unbalanced mode. Just AC ground one input through a capacitor and apply your signal to the other input. The high impedance at the IF port may require that you terminate the source with a resistor that matches the source impedance.

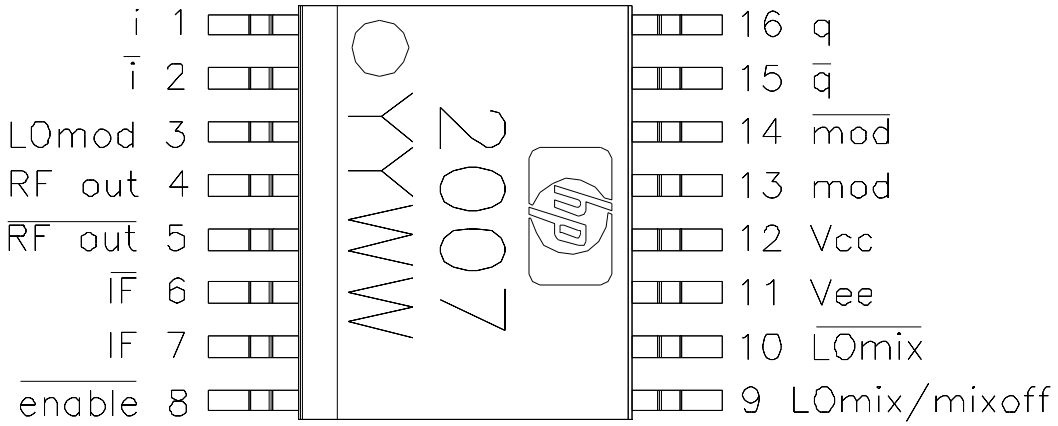


Figure 1. Pinout of the HPMX-2007 IC.

Table 1. HPMX-2007 IC pinout and typical signals. Note: the i, q the signal levels of the IC listed below are different from the levels listed for the test board in table 2. The test board has a divide by 9 circuit at the i and q input and requires higher drive levels than the IC itself.

Pin No.	Pin Function Name	Description	Typical Signal
1	i	differential i input	600 mV pk-pk differential
2	ibar		
3	LOmod	modulator LO input	149.67 MHz, -10 dBm
4	rf	differential mixer RF output	open collector output,
5	rfbar		+/- 3 mA, each pin
6	ifbar	differential mixer IF input	600 mV p-p differential with
7	if		average value of Vcc/2
8	enablebar	chip enable	
9	LOmix	differential mixer LO input	1750.33MHz, -10 dBm
10	LOmixbar		unbalanced
11	Vee	ground	0V
12	Vcc	positive supply input	3V, 25 mA
13	mod	differential modulator RF	open collector output,
14	modbar	output	+/- 0.5 mA, each pin
15	qbar	differential q input	600 mV pk-pk differential with
16	q		average value of Vcc/2

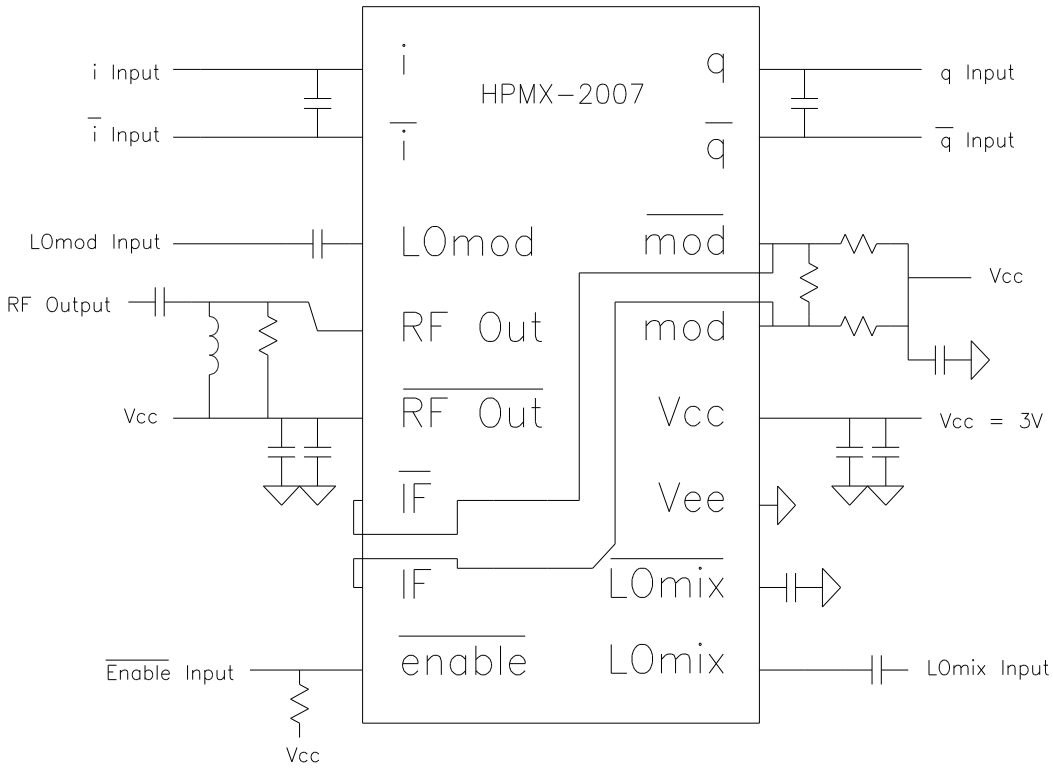


Figure 2. Typical real-world application circuit for the HPMX-2007 modulator IC. Component values match those of test board- refer to tables 3 and 4.

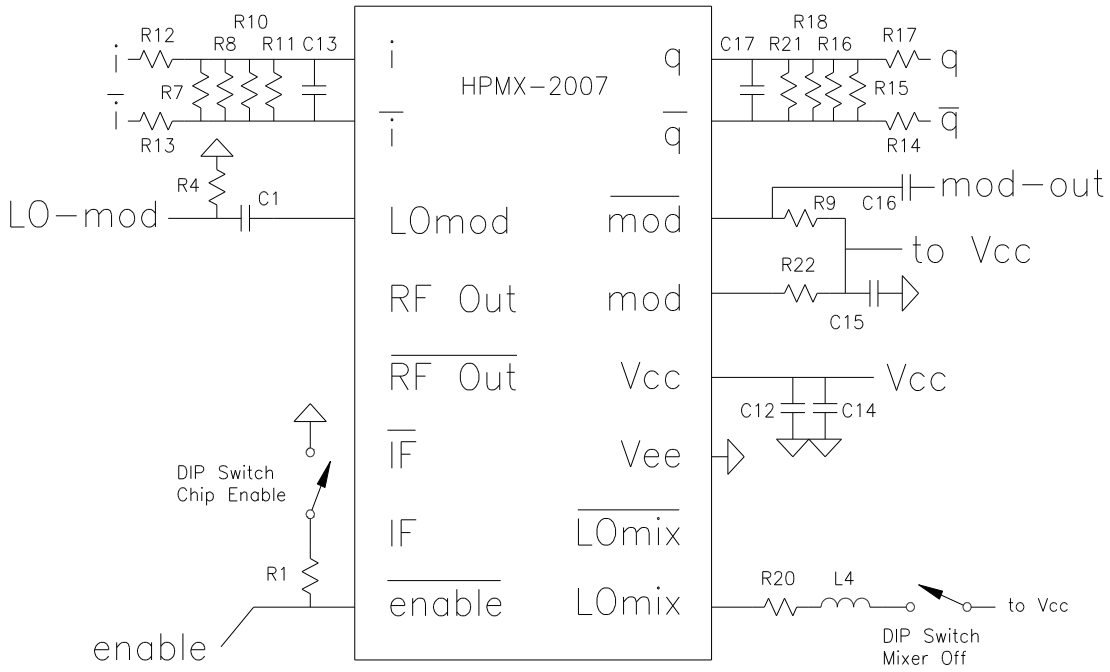


Figure 3. Demo board schematic showing components required for Modulator-Only mode testing. Component values are shown in table 3. Note: R22 is a 0 Ω jumper in this configuration. The Mixer Off switch should be closed (connecting LOmix to Vcc) in this test mode. This will disable the mixer and reduce current drain to that of the modulator alone (≈10 mA).

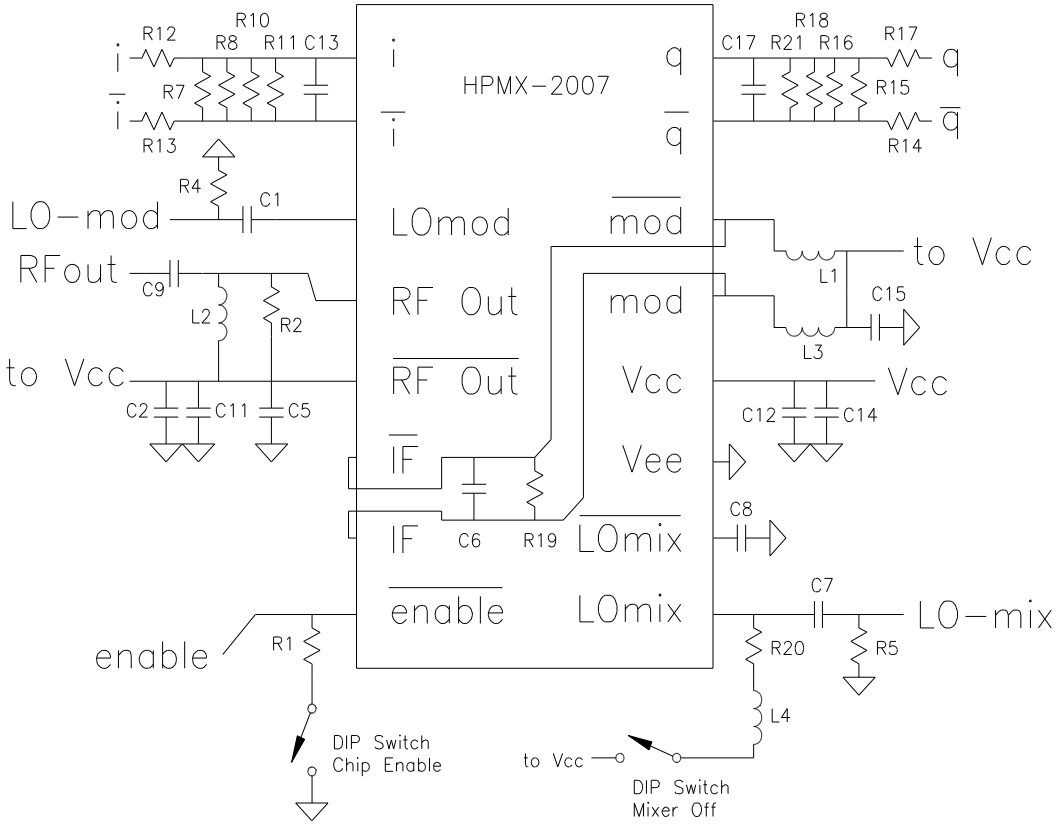


Figure 4. Schematic diagram of typical Modulator + Mixer demo board use. Output is at 1890 MHz. Component values are shown in tables 3 and 4. The IC is disabled when the enable switch is open (or off). The mixer is disabled when the mixer on/off switch is closed.

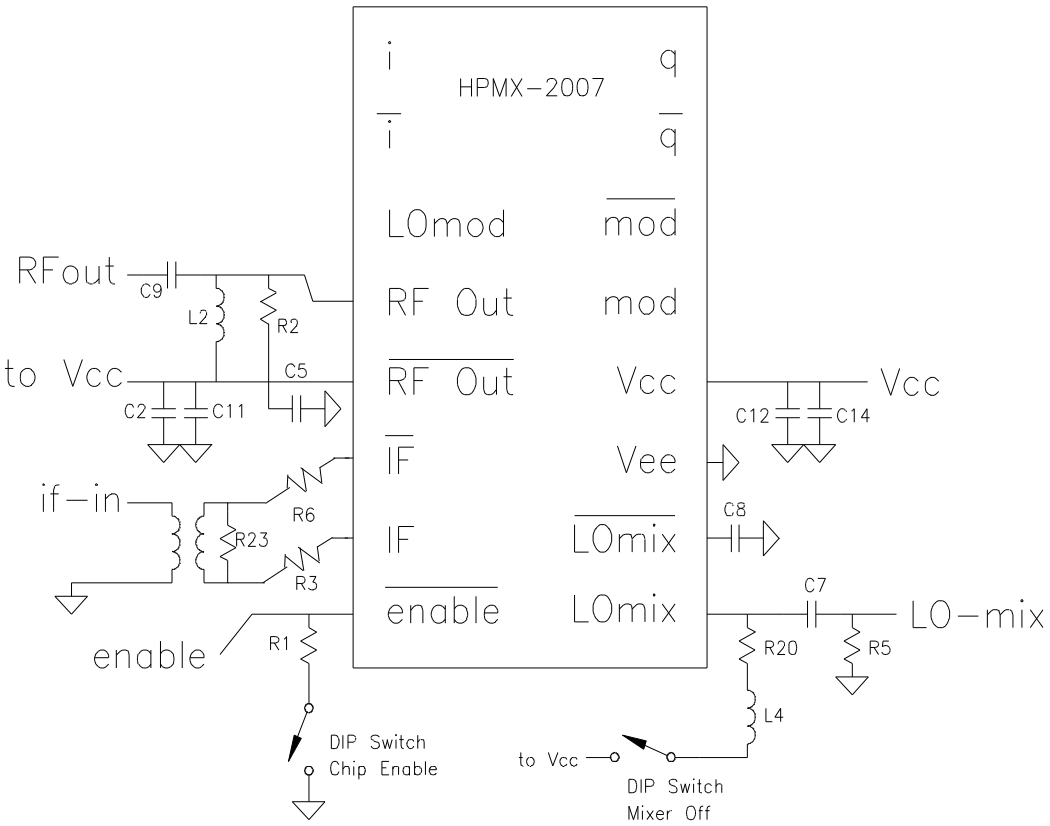


Figure 5. Demonstration board schematic showing Mixer-Only mode components. Component values are listed in table 3. Note: it is not possible to turn off the modulator when running in the Mixer-Only mode. DC current drain will be a total of ≈25 mA.

Table 2. Demonstration board I/O definitions and typical signal levels for operation at 1900 MHz. Note- I/O levels are for amplifier and mixer tested separately.

Board Designation	Signal Connection	Typical Level
enable pin or DIP switch	EnableBar	0V→ chip on; 3V/open → chip off dip switch: chip is enabled when switch is in the "on" position
i	i input	Vcc / 2 + 1.35 * SIN(10 kHz) (relative to gnd.)
GND	Gnd.	0V
i-bar	iBar input	Vcc / 2 - 1.35 * SIN(10 kHz) (relative to gnd.)
Vcc pin	Vcc	3.0V (Icc ≈ 25 mA, modulator + mixer)
q-bar	qBar input	Vcc / 2 + 1.35 * COS(10 kHz) (relative to gnd.)
q	q input	Vcc / 2 - 1.35 * COS(10 kHz) (relative to gnd.)
mixer on/off switch	mixoff	open→ mixer on; 3V→ mixer off
LO-mod	LOmod Input	-10 dBm, see table 4
LO-mix	LOmix Input	-10 dBm, see table 4
mod-out	mod	not connected
RFout	RF Output	see table 4

Table 3. Demonstration board component values. Figures 7 and 8 show parts placement for all the components listed.

Component	Value	Mod. Only	Mixer Only	Mod. + Mixer	Function
C1	.01 µF	√		√	LO-mod coupling capacitor
C2	.01 µF		√	√	Vcc bypass capacitor
C5	1000 pF			√	Vcc bypass capacitor
C6	table 4			√	modulator output tuning capacitor
C7	1000 pF		√	√	LOmix coupling capacitor
C8	1000 pF		√	√	LOmixbar grounding capacitor
C9	table 4		√	√	RFout coupling/tuning capacitor
C11	100 pF		√	√	Vcc bypass capacitor
C12	100 pF	√	√	√	Vcc bypass capacitor
C13	2200 pF	√		√	i input LPF capacitor
C14	.01 µF	√	√	√	Vcc bypass capacitor
C15	.01 µF	√		√	Vcc bypass capacitor
C16	10 nF	√			mod-out coupling capacitor
C17	2200 pF	√		√	q input LPF capacitor
R1	220 kΩ	√	√	√	enablebar pull-up resistor
R2	table 4		√	√	RFout collector bias resistor
R3	0 Ω		√		jumper to connect balun to mixer IF input
R4	100 Ω	√		√	LOmod transmission line termination resistor
R5	100 Ω		√	√	LOmix transmission line termination resistor
R6	0 Ω		√		jumper to connect balun to mixer IF input
R7	1 kΩ	√		√	i input voltage divider resistor
R8	1 kΩ	√		√	i input voltage divider resistor
R9	table 4	√			modbar output collector bias resistor
R10	1 kΩ	√		√	i input voltage divider resistor
R11	1 kΩ	√		√	i input voltage divider resistor
R12	1 kΩ	√		√	i input voltage divider resistor
R13	1 kΩ	√		√	i input voltage divider resistor
R14	1 kΩ	√		√	q input voltage divider resistor
R15	1 kΩ	√		√	q input voltage divider resistor
R16	1 kΩ	√		√	q input voltage divider resistor
R17	1 kΩ	√		√	q input voltage divider resistor
R18	1 kΩ	√		√	q input voltage divider resistor
R19	table 4			√	modulator output load resistor
R20	500 Ω	√		√	mixeroff bias resistor
R21	1 kΩ	√		√	q input voltage divider resistor
R22	table 4	short			mod output collector bias resistor
R23	120 Ω		√		balun termination resistor
L1	100nH			√	modbar tuning inductor- bottom side of board, 0805
L2	table 4		√	√	RFout tuning inductor- 1.6 x 0.8 mm type
L3	100 nH	short		√	mod tuning inductor- bottom side of board, 0805
L4	100 nH	√		√	mixeroff choke inductor, 0805
balun			√		Toko part number 616DB-1049
DIP Switch		√	√	√	Used to enable/disable the IC and mixer
SMA connector		2	3	3	EF Johnson 142-0701-631

Table 4. Component values that change with operating frequency. Refer to Figure 6. LOmix and LOmod are applied at -10 dBm each, at all frequencies listed.

$f_{LOmix}+f_{LOmod}$ MHz	f_{LOmix} MHz	f_{LOmod} MHz	R9 & R22 Ω	L1 nH	L3 nH	R19 Ω	C6 pF	R2 Ω	L2 nH	C9 pF
900	750.33	149.67	-	100	100	430	3.9	200	12	3.3
1500	1350.33	149.67	-	100	100	300	3.9	120	5.6	1.8
1900	1750.33	149.67	-	100	100	430	3.9	120	3.3	1.2
2500	2350.33	149.67	-	100	100	430	3.9	75	-	-
mod. only	-	149.67	300	-	0	-	-	-	-	-

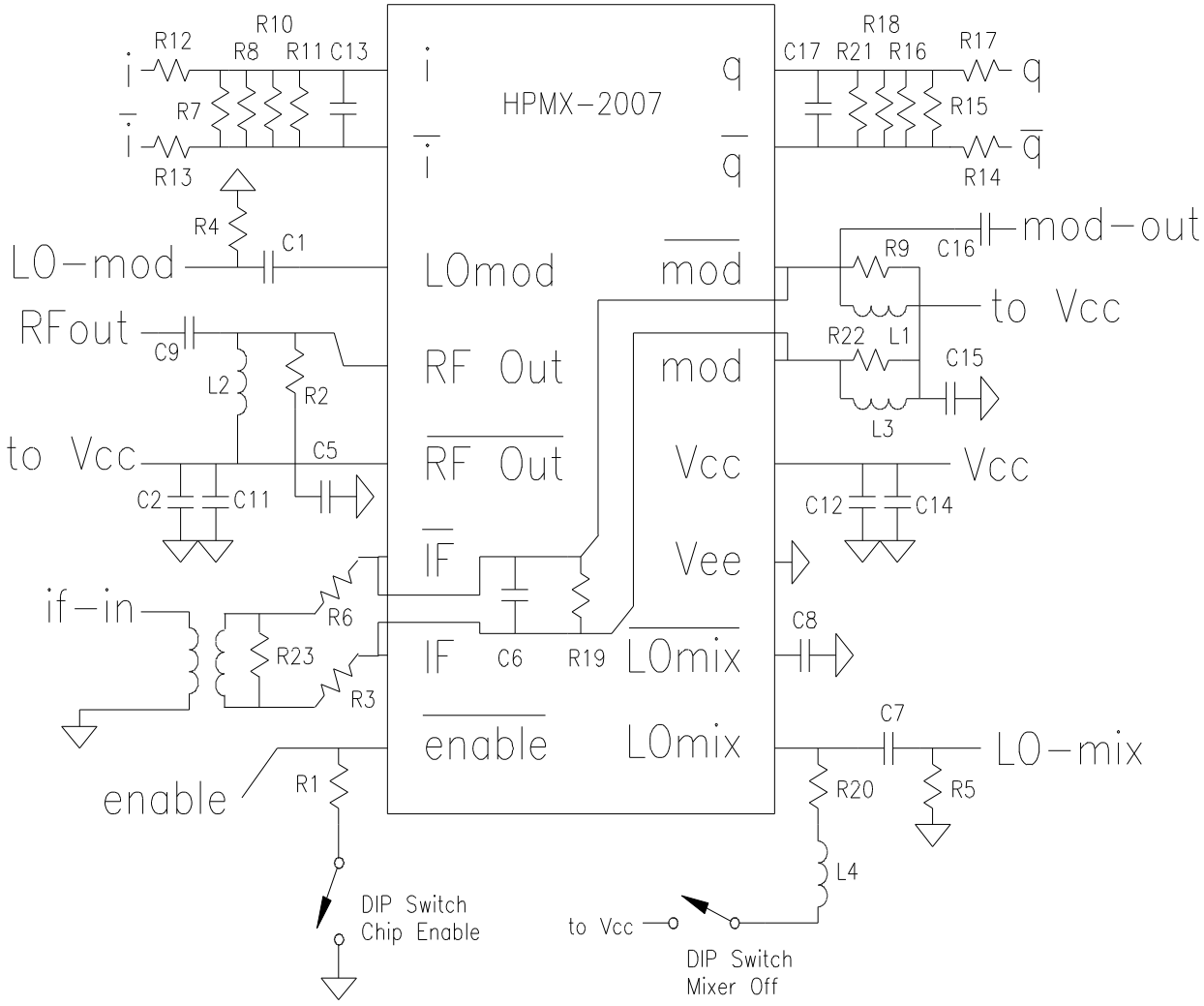


Figure 6. HPMX-2007 demonstration board schematic diagram showing all optional components. Component values are listed in Tables 3 and 4. Labels match those silk-screened onto the circuit board. See figures 7 and 8 for component placement on the board.

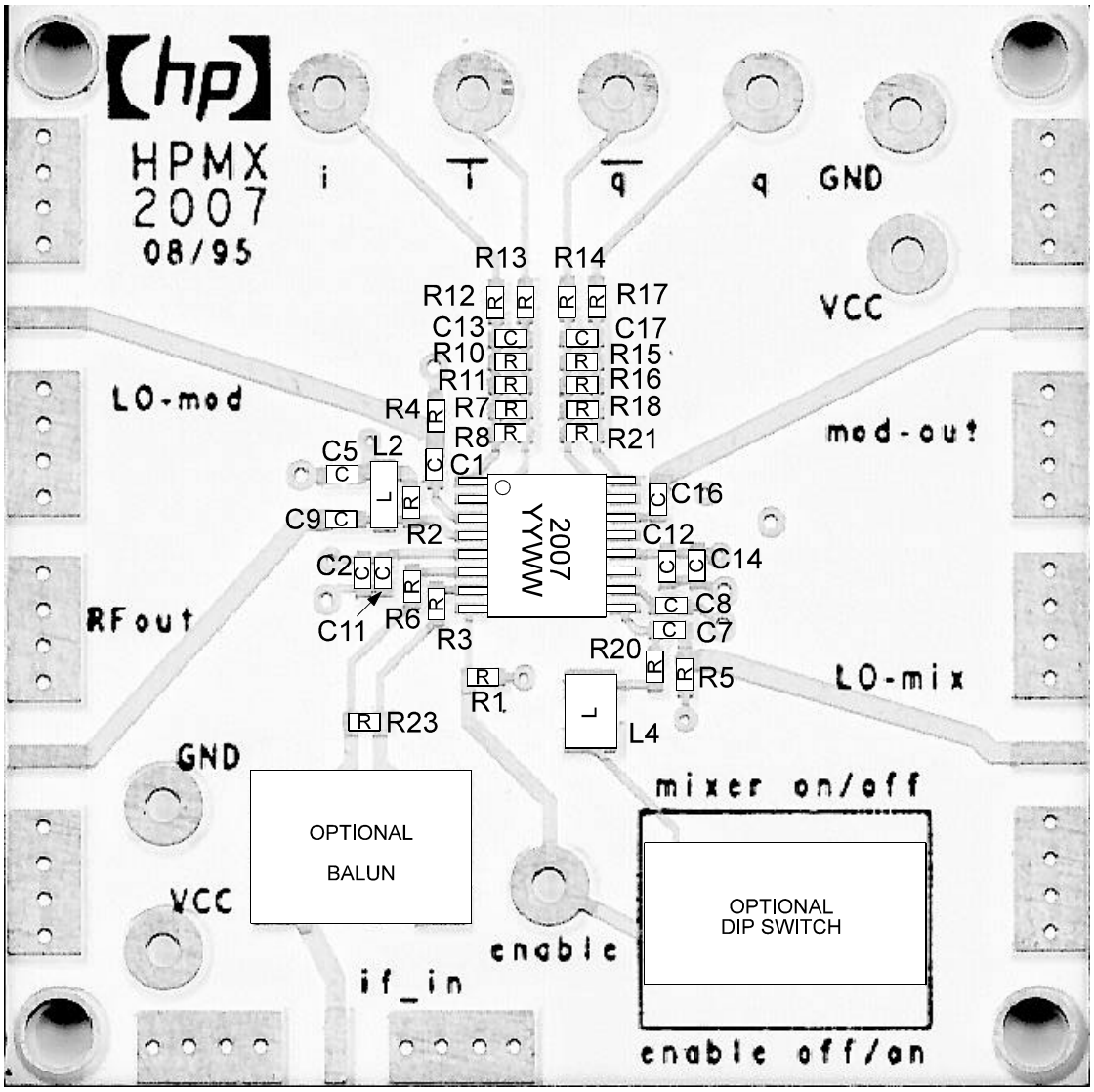


Figure 7. Component placement on the top side of the demonstration circuit board. The SMA connectors are not shown. Bottom side component placement is shown in figure 8. Component values are listed in tables 3 and 4, board schematic in figure 6. If the DIP switch is not installed, it will be necessary to jumper the enable off/on contacts so the IC will function. The mixer can be disabled by jumpering the mixer on/off contacts.

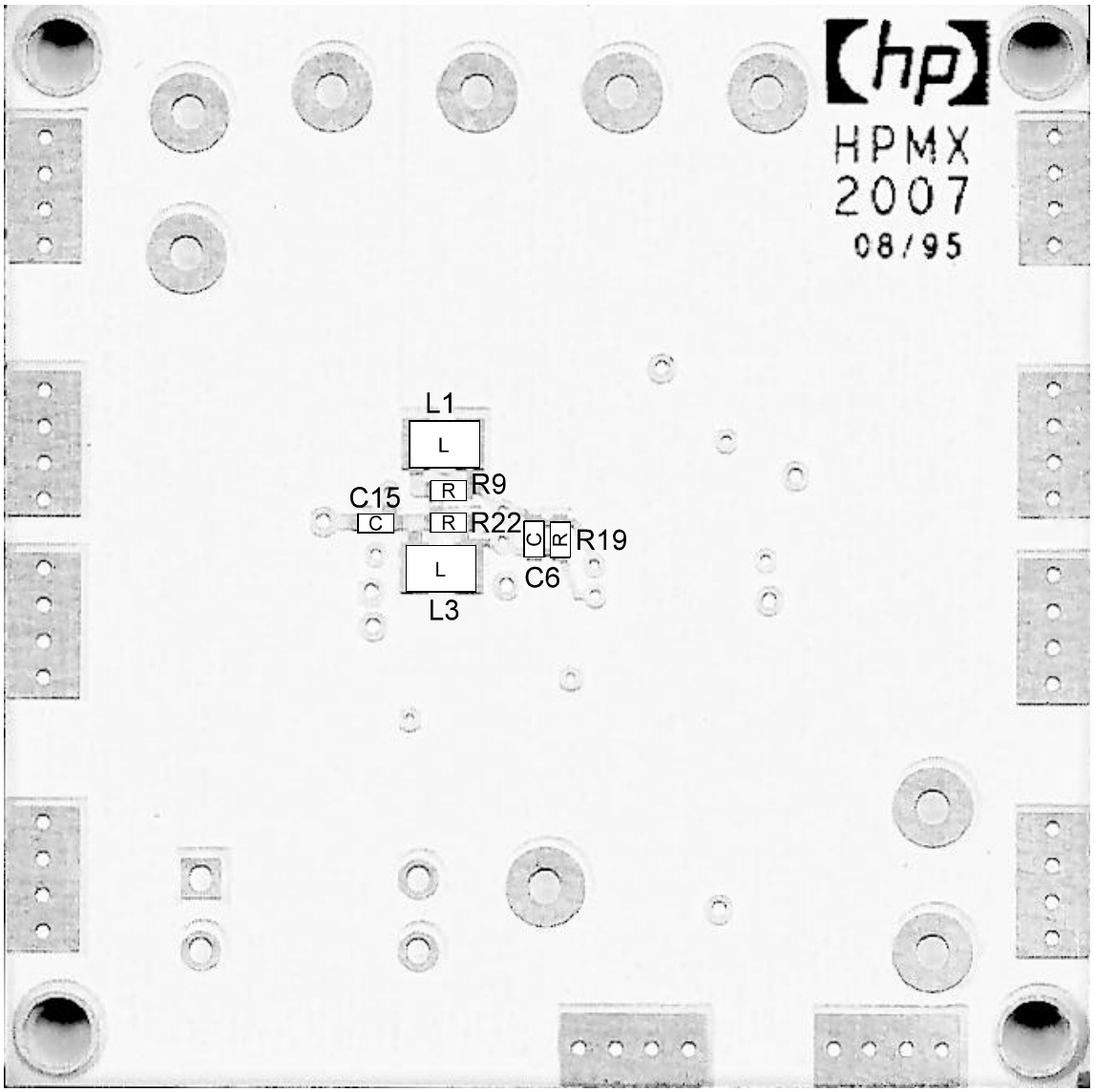


Figure 8. Component placement on the bottom of the demonstration circuit board. The SMA connectors are not shown. Top side component placement is shown in figure 7. Component values are listed in tables 3 and 4, board schematic in figure 6.

Note: this is a preliminary printing of this applications note. Any error reports, omissions, deletions, etc., or comments should be directed to Albert Pham, CMCD Applications Engineer, 510-505-5548.

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