FRDM-KW38 Load-Pull

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BL Micro

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Test Purpose

The purpose of the measurements is to monitor the supply current, the transmit power and the harmonics level while the complex load seen by the FRDM-KW38 is tuned in amplitude and phase.

The automated impedance tuner MT982BL from MAURY MICROWAVE is used to make vary the FRDM-KW36 load.

The following slide describes the test set-up.

Test limitations : the harmonics rate depends on the FRDM-KW38 load value not only at the fundamental frequency but also at the harmonics frequencies. For the described measurements we control the load at the fundamental frequency but the return loss of the impedance tuner at the harmonics frequencies is not known.

Test set-up

1 - The FRDM-KW38 is plugged on the SMA connector

2 – The PC controls the KW38 and sets it in TX mode @ +3.5 dBm – Connectivity Software GenFSK used

3 – The USB port is used to supply the FRDM-KW38 at VDD = 3.0V (LDO).

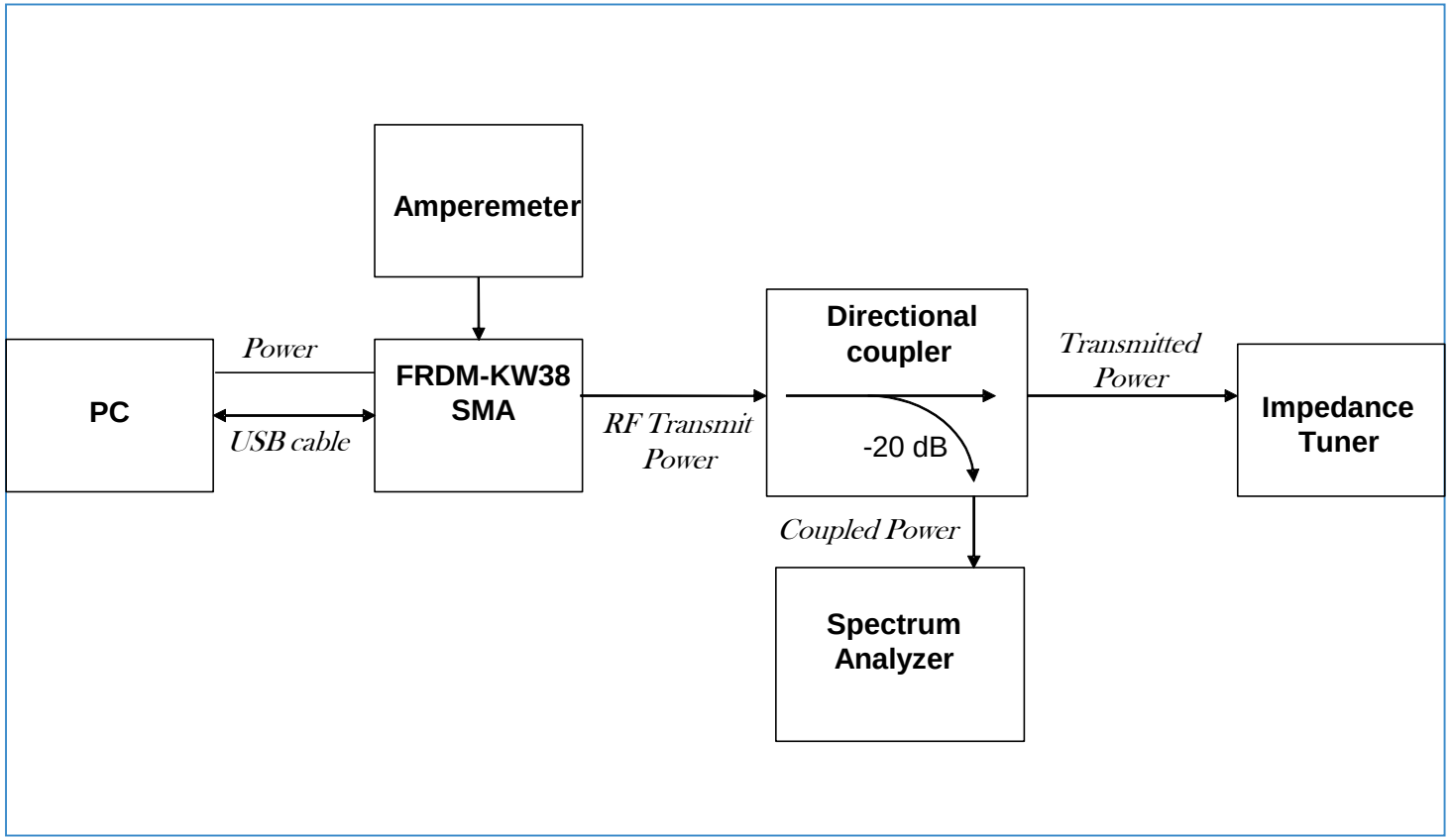
4 – The amperemeter is used to measure the KW38 supply current.

5 – The directional coupler :

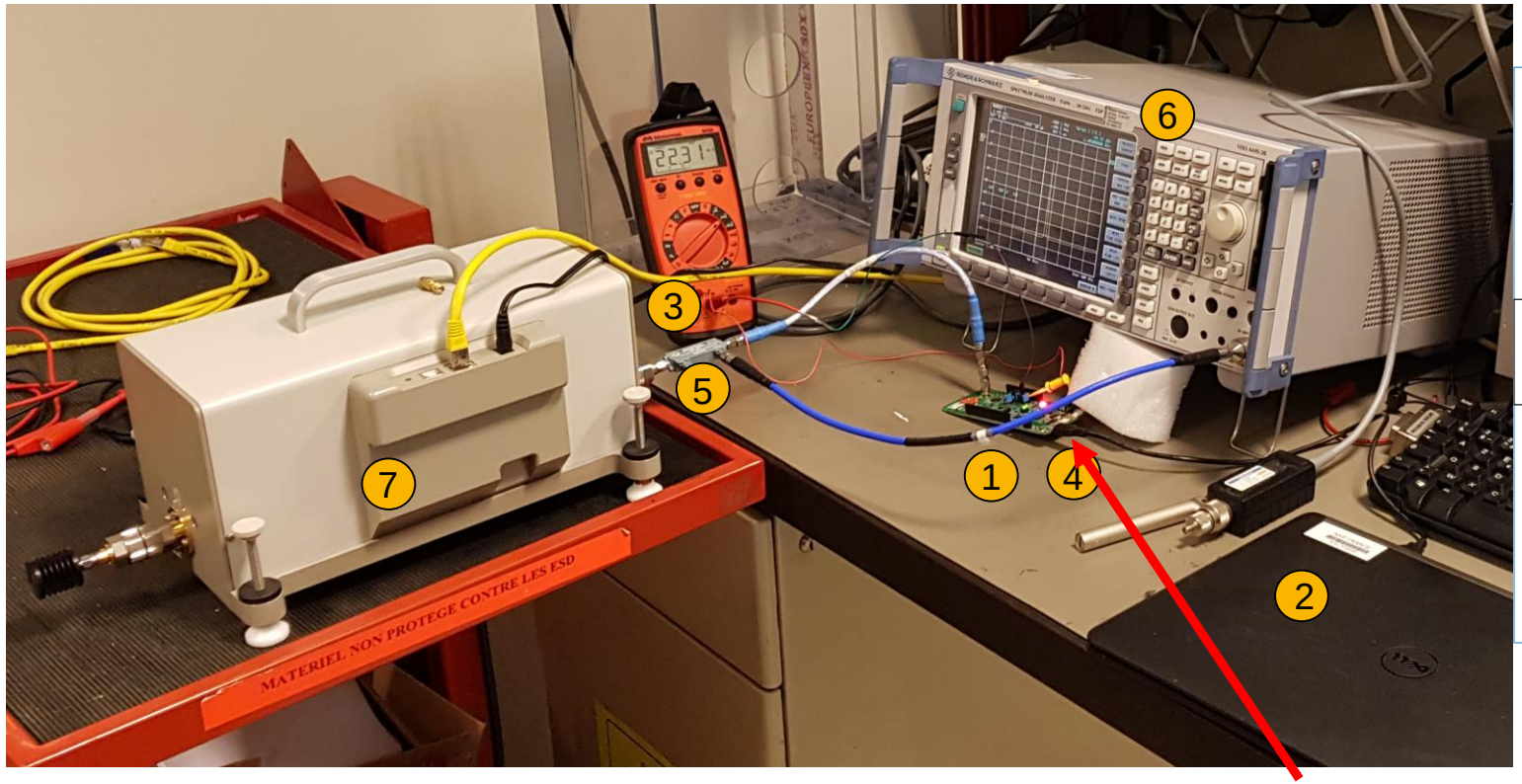
- connects the impedance tuner to the FRDM-KW38 RF output port through the direct path
- Allows to monitor the RF output power and harmonics with a spectrum analyser on the coupled path (attenuated by 20 dB)

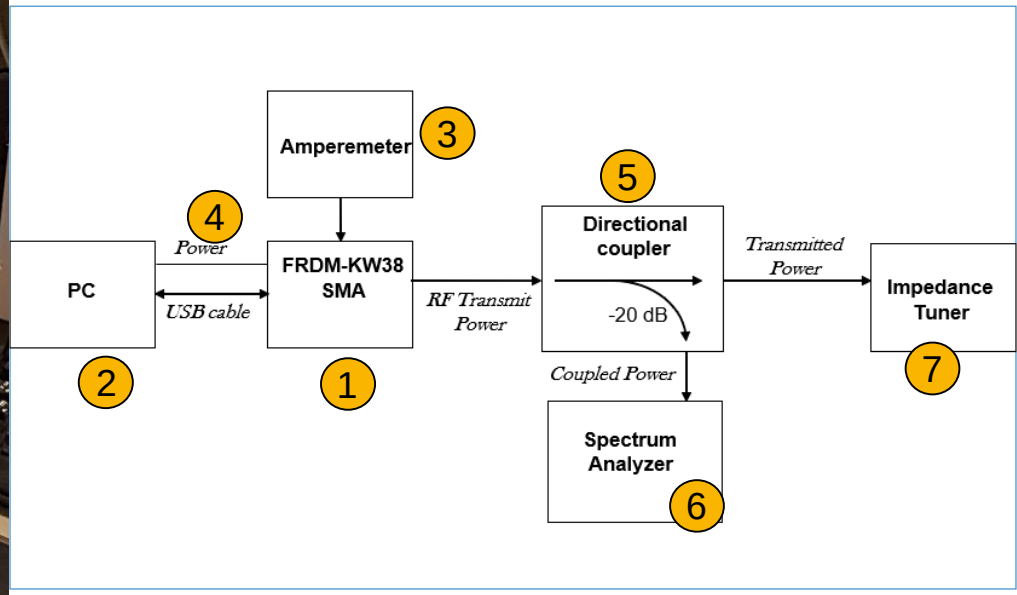
6 – The spectrum analyzer is used to measure the fundamental and harmonics.

7 – The impedance tuner is used to make vary the load of the FRDM-KW38



Test Set-up picture





USB cable to PC

Tests conditions

Measurements have been done under the following conditions :

- Channel 19 (2440MHz) , continuous CW, Power level +3.5dBm, Buck mode, MCU run, Flash enabled
- USB power supply (5.0V) , Temperature = room temperature

- 3 values of VSWR have been tested :
  - 1.004:1 (return loss = 54 dB) : very good return loss
  - 2:1 (return loss = 9.5 dB) : corresponds to a ceramic antenna without matching
  - 3.1:1 (return loss = 5.8 dB) : poor return loss

    For each value of VSWR the phase is varied from 0° to 315° by 45 ° steps

- Spectrum analyzer settings for harmonics measurements
  - Reference amplitude : -20 dBm , RBW : 10KHz, VBW : 30KHz, Span 1MHz, RF attenuation = 0 dB

- TX fundamental:
  - Center freq 2.44GHz / RBW 100KHz / VBW 300KHz / Span 10MHz / Ref level 20dBm /Trace average mode

Power and supply current Results

VSWR = 1.004:1 :

- The TX power and supply current are almost constant versus the phase at 19.5mA.

	VSWR=1.004 => RL=54dB							
	Phase 0	Phase 45	Phase 90	Phase 135	Phase 180	Phase 225	Phase 270	Phase 315
impedance (Ohms)	50.1+j0.1	50.2+j0.2	50.1+j0.3	49.9+j0.2	49.8+j0.1	49.9+j0.2	50+j0.3	53.4+j3.7
TX power (dBm)	3.43	3.42	3.42	3.41	3.4	3.4	3.4	3.42
Vdd Current (mA)	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5

VSWR = 2:1

- The power varies from +2.34 dBm to +3.31 dBm depending on the phase (variation = 0.97 dB)
- The current consumption is stable whatever the phase at 19.5mA.

	VSWR=2.0 => RL=9.5dB							
	Phase 0	Phase 45	Phase 90	Phase 135	Phase 180	Phase 225	Phase 270	Phase 315
impedance	100+j0.1	69.5+j36.9	40.1+j30	28.1+j14.9	25.1+j0.1	28.1+j5	40.1+j10	69.5+j36.8
TX power (dBm)	3.31	3.05	2.93	2.61	2.34	2.55	2.76	2.96
Vdd Current (mA)	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5

VSWR = 3:1

- The power varies from 1.56 dBm to +3.03 dBm depending on the phase (variation = 1.47 dB)
- The current consumption is stable whatever the phase at 19.5mA.

	VSWR=3.0 => RL=6.2dB							
	Phase 0	Phase 45	Phase 90	Phase 135	Phase 180	Phase 225	Phase 270	Phase 315
impedance	150+j0.1	69.1+j65.3	30+j40.1	19.2+j18.1	16.7+j0.1	19.2+j18.1	30+j40.1	69.1+j65.4
TX power (dBm)	3.03	2.67	2.23	2.06	1.56	1.79	2.26	2.63
Vdd Current (mA)	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5

Harmonics results at VSWR = 3.0:1

Power level +3.5dBm

	VSWR=3.0=> RL=6.2dB							
	Phase 0	Phase 45	Phase 90	Phase 135	Phase 180	Phase 225	Phase 270	Phase 315
impedance	150.04+j0.210	69.07+j65.22	29.2+j40.6	19.13+j18.06	16.64+j0.01	19.13-j18.08	29.95-j40.05	69.01-j65.35
H2	-38.96	-41.16	-44.63	-46.56	-47.06	-50.22	-52.56	-48.81
H3	-45.86	-47.36	-47.66	-48.1	-48.11	-47.72	-46.93	-45.86
H4	Noise Floor @-92dBm							
H5	Noise Floor @-92dBm							

These harmonic results take into account the coupler + cable losses

H2 level is more than 8dB worst case margin (vs ETSI)
H3 level is more than 15dB worst case margin (vs ETSI)

Conclusion

TX power level : up to 1.5dB variation with a poor quality antenna

Supply current : No significant extra consumption with a poor quality antenna

Harmonics :

- H4, H5 seems to be not sensitive to load variation
- H2, H3 are more sensitive but within an acceptable range