

# PhD Thesis EPFL n° 5307 : ERRATA

Title : *Design of a Discrete-Component Impulse-Radio Ultra Wide-Band (IR-UWB) Testbed and Design of a very Low-Power IR-UWB Transmitter in CMOS Technology*

## Page v :

Replace the word *mani re* by *man re*.

## Pages 1 to 2 :

Replace the paragraph :

*Given the bandwidth from 3.1 to 4.8 GHz, there are several ways to design a UWB communication system. One method is to use the entire 1700 MHz of bandwidth and spread the transmitted information using spread spectrum or code-division multiple access (CDMA) techniques. The main advantage of building UWB communication systems based on spread-spectrum techniques are that these techniques are well understood and have been proven in other commercial technologies like for example wideband CDMA. However, building RF and analog circuits as well as high speed analog-to-digital converters (ADCs) to process this extremely wideband signal is a challenging problem as discussed in this work.*

By :

*According to [4], « [g]iven the bandwidth from 3.1 to 4.8 GHz, there are several ways to design a UWB communication system. One method is to use the entire 1700 MHz of bandwidth and spread the transmitted information using spread spectrum or code-division multiple access (CDMA) techniques. The main advantage of building UWB communication systems based on spread-spectrum techniques are that these techniques are well understood and have been proven in other commercial technologies like for example wideband CDMA. However, building RF and analog circuits as well as high speed analog-to-digital converters (ADCs) to process this extremely wideband signal is a challenging problem », as discussed in this work.*

## Page 3 :

Replace the sentence :

*UWB pulses can be sent sporadically at relatively low pulse rates to support time/position modulation, but can also be sent at rates up to the inverse of the UWB pulse bandwidth (see [2]).*

By :

*According to [2], « UWB pulses can be sent sporadically at relatively low pulse rates to support time or position modulation, but can also be sent at rates up to the inverse of the UWB pulse bandwidth. »*

## Page 6 :

Replace the sentence :

- *proven in commercial technology (ex. IEEE 802.11a/g).*

By :

- *proven in commercial technology (ex. IEEE 802.11a/g), see [4].*

Replace the paragraph :

*According to [4], the main advantages of OFDM are that it is easier to collect multi-path energy using a single RF chain, it is insensitive to group delay variations, and it is able to deal with narrowband interference at the receiver without having to sacrifice sub-bands or data rate. The only drawback of this type of system is that the transmitter is slightly more complex because it requires an IFFT (inverse Fast Fourier Transform) and the peak-to-average ratio may be slightly higher than that of the pulse-based multi-band approaches. Another drawback is the generation of multi-tones that requires a lot of power consumption. The distribution of tones in frequency sub-bands is shown in Figure 1.2.*

By :

*According to [4], « the main advantages [of OFDM] are that it is easier to collect multi-path energy using a single RF chain », it is insensitive « to group delay variations, and » it is able « to deal with narrowband interference at the receiver without having to sacrifice sub-bands or data rate. The only drawback of this type of system is that the transmitter is slightly more complex because it requires an IFFT [(inverse Fast Fourier Transform)] and the peak-to-average ratio may be slightly higher than that of the pulse-based multi-band approaches. » Another drawback is the generation of multi-tones that requires a lot of power consumption. The distribution of tones in frequency sub-bands is shown in Figure 1.2.*

## Pages 6 to 7 :

Replace the paragraph :

*According to [4], increasing the number of tones in an OFDM system decreases the overhead due to Cyclic Prefix, or CP (cyclic prefix is the time between two OFDM symbol). On the other hand, the complexity of the Fast Fourier transform/inverse Fast Fourier transform (FFT/IFFT) block increases and the spacing between adjacent tones decreases. To provide the best trade-off between the CP overhead and FFT complexity, the multiband OFDM system uses 128 tones. To be compliant with FCC regulations, the 10 dB bandwidth of an UWB signal has to be at least 500 MHz, as mentioned previously. This implies the use of at least 122 tones. Hence, the 128 tones are partitioned into 100 data tones, 22 pilot tones and 6 null tones. Among the 22 pilot tones, 12 are standard-defined pilot tones and 10 are user-defined pilot tones. The 12 standard-defined pilot tones are used to estimate/track phase variations due to carrier/timing frequency mismatch. To relax the specifications on the channel select filter, the tones that are at the edge of the spectrum are either null tones or user-defined pilot tones.*

By :

*According to [4], « [i]ncreasing the number of tones in an OFDM system decreases the overhead due to [Cyclic Prefix, or] CP [(cyclic prefix is the time between two OFDM symbol)]. On the other hand, the complexity of the Fast Fourier transform/inverse Fast Fourier transform (FFT/IFFT) block increases and the spacing between adjacent tones decreases. To provide the best tradeoff between the CP overhead and FFT complexity, the multiband OFDM system uses 128 tones. To be compliant with FCC regulation, the 10 dB bandwidth of an UWB signal ought to be at least 500 MHz, [as mentioned previously]. This implies the use of at least 122 tones. Hence, the 128 tones are partitioned into 100 data tones, 22 pilot tones and 6 null tones. Among the 22 pilot tones, 12 are standard-defined pilot tones and 10 would be user-defined pilot tones. The 12 standard-defined pilot tones are sufficient to estimate/track phase variations due to carrier/timing frequency mismatch. To relax the specifications on the channel select filter, the tones [that are] at the edge of the spectrum are either null tones or user-defined pilot tones. »*

## Page 7 :

Replace the sentence :

*The main characteristics of UWB FM are the following (see [5]):*

- *Transmitter implementation is straightforward;*
- *Spectral roll-off of the UWB FM signal is very steep;*
- *Robustness against narrow-band jamming;*
- *The system works with a variety of antennas;*
- *Receiver requires no local oscillator;*
- *No carrier synchronization (as in Impulse Radio, see thereafter);*
- *The solution can be fully integrated and does not rely on "exotic" components (like step-recovery diodes (SRD), see Chapter 2) that need individual "tweaking".*

By :

*According to [5], the main characteristics « of UWB FM are the following :*

- *Transmitter implementation is straightforward;*
- *Spectral roll-off of the UWB FM signal is very steep;*
- *Robustness against narrow-band jamming;*
- *The system works with a variety of antennas;*
- *Receiver requires no local oscillator;*
- *No carrier synchronization (as in Impulse Radio, [see thereafter]);*
- *The solution can be fully integrated and does not rely on "exotic" components (like step-recovery diodes [(SRD), see Chapter 2]) that need individual "tweaking". »*

## Page 9 :

Replace the sentence :

*This section summarizes the physical layer of our future experimental setup (see Chapter 2 and further) which, as described later, would comprise several transmitters and one receiver (we will use two transmitters in Chapter 10 for our experiments).*

By :

*The physical layer of our future experimental setup (see Chapter 2 and further) which, as described later, would comprise several transmitters and one receiver (we will use two transmitters in Chapter 10 for our experiments) is described in detail in [26] and [16]; for the sake of completeness, it is recalled in this section.*

**Page 17 :**

Add the following sentence to the beginning of the first paragraph of Introduction 2.1 :

*The specifications and expectations for the UWB testbed are described in detail in [26] and [16]; for the sake of completeness, it is recalled thereafter.*

**Page 48 :**

Add the following sentence to the end of the first paragraph of Chapter 3 :

*For UWB spectra calculations, the reader can also refer to [92].*

**Page 69 :**

Add the following sentence to the end of the first paragraph of 4.2 Overview of the U-Lite Testbed :

*The U-Lite hardware specifications and components' rationale are described in detail in [26] and [16]; for the sake of completeness, it is recalled in this section.*

**Page 75 :**

Replace the sentence :

*This oscillator was designed in 2008 by Ms Jasmine [sic] Akhertouz Moreno during her Master semester project under the supervision of the author.*

By :

*This PLL oscillator was designed in 2008 by Ms Yasmine Akhertouz Moreno during her Master semester project and MICS summer internship under the supervision of and with the collaboration from the author (see [93]); for the sake of completeness it is recalled with her permission in this chapter, in Appendix B, and in Sections C8 and F.1 with several modifications and improvements from the author.*

**Page 76 :**

Replace caption : *Figure 5.1: Phase-Locked Loop architecture*

By : *Figure 5.1: Phase-Locked Loop architecture (see [93]).*

**Page 79 :**

Replace caption : *Figure 5.2: Functional block diagram of an oscillator based on a PLL*

By : *Figure 5.2: Functional block diagram of an oscillator based on a PLL (see [93], based on drawings from the author).*

**Page 80 :**

Replace caption : *Figure 5.3: The schematic of the oscillator*

By : *Figure 5.3: The schematic of the oscillator (see [93]).*

**Page 83 :**

Replace caption : *Table 5.1: Summary of the passive elements*

By : *Table 5.1: Summary of the passive elements (see [93], based on drawings from the author).*

**Page 84 :**

Replace caption : *Figure 5.4: PCB layout of the oscillator*

By : *Figure 5.4: PCB layout of the oscillator (see [93]).*

**Page 86 :**

Replace caption : *Figure 5.5: Sine wave measured at the output of the oscillator circuit*

By : *Figure 5.5: Sine wave measured at the output of the oscillator circuit (see [93]).*

**Page 87 :**

Replace caption : *Figure 5.6: Spectrum with a bandwidth of 3MHz*  
By : *Figure 5.6: Spectrum with a bandwidth of 3 MHz (see [93]).*

**Page 88 :**

Replace caption : *Figure 5.7: Spectrum with a bandwidth of 20KHz*  
By : *Figure 5.7: Spectrum with a bandwidth of 20 kHz (see [93]).*

**Page 89 :**

Replace caption : *Figure 5.8: Phase noise at 20Hz*  
By : *Figure 5.8: Phase noise at 20 Hz (see [93]).*

Replace caption : *Figure 5.9: Suggested improvements*  
By : *Figure 5.9: Suggested improvements (see [93]).*

**Page 102 :**

Add the following sentence to the beginning of the first paragraph of 6.2 UWB Transmitter prototype n° 2 :  
*The UWB Transmitter, prototype n° 2, is presented and described in detail in the article [37]; for the sake of completeness, it is recalled thereafter.*

**Page 111 :**

Add the following sentence to the beginning of the first paragraph of LNA prototype n° 1 :  
*The LNA prototype n° 1 was designed and built by the author during his Diploma project in 2007 (see [98]); for the sake of completeness, it is recalled in this chapter.*

**Pages 152 to 153 :**

Replace the paragraph :

*Ordinarily, the two different materials used for a heterojunction must have the same lattice constant (spacing between the atoms). An analogy - imagine pushing together two plastic combs with a slightly different spacing- at regular intervals, you'll see two teeth clump together. In semiconductors, these discontinuities are a kind of "trap", and greatly reduce device performance. A HEMT where this rule is violated is called a pHEMT or pseudomorphic HEMT. This feat is achieved by using an extremely thin layer of one of the materials - so thin that it simply stretches to fit the other material. This technique allows the construction of transistors with bigger bandgap differences than otherwise possible. This gives them better performance.*

By :

*According to [55], « [i]deally, the two different materials used for a heterojunction would have the same lattice constant (spacing between the atoms). In practice, e.g. AlGaAs on GaAs, the lattice constants are typically slightly different, resulting in crystal defects. As an analogy, imagine pushing together two plastic combs with a slightly different spacing. At regular intervals, you'll see two teeth clump together. In semiconductors, these discontinuities form deep-level traps, and greatly reduce device performance. A HEMT where this rule is violated is called a pHEMT or pseudomorphic HEMT. This is achieved by using an extremely thin layer of one of the materials – so thin that the crystal lattice simply stretches to fit the other material. This technique allows the construction of transistors with larger bandgap differences than otherwise possible, giving them better performance ».*

**Page 153 :**

Replace caption : *Figure 7.34: Cross view of a pHEMT transistor*  
By : *Figure 7.34: Cross view of a pHEMT transistor (see [55]).*

Replace the paragraph :

*Another way to use materials of different lattice constants is to place a buffer layer between them. This is done in the mHEMT or metamorphic HEMT, an advancement of the PHEMT developed in recent years. In the buffer layer made of AlInAs, the indium concentration is graded, so that it can match the lattice constant of both the GaAs substrate and the*

*GaInAs channel. This brings the advantage that practically any Indium concentration in the channel can be realized, so the devices can be optimized for different applications (low indium concentration provides low noise, high indium concentration gives high gain).*

By :

*According to [55], « [a]nother way to use materials of different lattice constants is to place a buffer layer between them. This is done in the mHEMT or metamorphic HEMT, an advancement of the pHEMT. The buffer layer is made of AlInAs, with the indium concentration graded so that it can match the lattice constant of both the GaAs substrate and the GaInAs channel. This brings the advantage that practically any Indium concentration in the channel can be realized, so the devices can be optimized for different applications (low indium concentration provides low noise; high indium concentration gives high gain). »*

#### **Page 175 :**

Replace the sentence :

*The UWB LNA described here is a fundamental part of the U-Lite testbed and is described in an article [38].*

By :

*The UWB LNA described here is a fundamental part of the U-Lite testbed and is described in detail in the article [38]; for the sake of completeness, it is recalled thereafter.*

#### **Page 187 :**

Replace the sentence :

*This demodulator was designed by the author and built by Ms Angélique Umuhire in 2010 during her Master Diploma project under the supervision of the author.*

By :

*This I/Q demodulator was designed in 2009 by the author and built in 2010 by Ms Angélique Umuhire during her Master Diploma project under the supervision of and with the collaboration from the author (see [94]). The initial idea and rationale of the I/Q demodulator, and all the preliminary theoretic contributions used in [94] were made by the author and given to the student for training purposes; for the sake of completeness it is recalled with her permission in this chapter (Sections 9.2 until 9.5), in Appendix E, and in Section F.2 with several modifications and improvements from the author.*

#### **Page 188 :**

Add the following sentence to the beginning of the first paragraph of Section 9.1.2 The importance of I/Q demodulation in our testbed :

*The content of this section is already presented in detail in the article [39]; for the sake of completeness, it is recalled thereafter.*

#### **Page 189 :**

Replace caption : *Figure 9.2: The principle of an I/Q mixer (here the HMC620: I and Q are labelled IF1 and IF2).*

By : *Figure 9.2: The principle of an I/Q mixer (here the HMC620: I and Q are labelled IF1 and IF2) (see [96]).*

#### **Page 193 :**

Replace caption : *Table 9.1: Example: Estimated budget-link of the I/Q demodulator. (\*): level used in the real circuit.*

By : *Table 9.1: Example: Estimated budget-link of the I/Q demodulator. (\*): level used in the real circuit (see [94]).*

#### **Page 194 :**

Replace caption : *Figure 9.6: The architecture of the I/Q demodulator*

By : *Figure 9.6: The architecture of the I/Q demodulator (see [94], based on drawings from the author).*

#### **Page 196 :**

Replace caption sentence: *Figure 9.7: The complete schematic of the UWB I/Q receiver.*

By : *Figure 9.7: The complete schematic of the UWB I/Q receiver (see [39]).*

**Page 198 :**

Replace caption : *Table 9.2: Comparison between ideal and real scenarios of power splitter/combiner*  
By : *Table 9.2: Comparison between the ideal and real scenarios of power splitter/combiner (see [94]).*

**Page 199 :**

Replace caption : *Figure 9.8: Impedance seen by the amplifier MAR-8ASM+*  
By : *Figure 9.8: Impedance seen by the amplifier MAR-8ASM+ (see [94], based on drawings from the author).*

Replace caption : *Table 9.3: Input impedance comparisons*  
By : *Table 9.3: Comparisons between input impedance (see [94], based on drawings from the author).*

**Page 200 :**

Replace caption : *Figure 9.9: Impedance seen by the amplifier MAR-8ASM+ with  $R_4$*   
By : *Figure 9.9: Impedance seen by the amplifier MAR-8ASM+ with  $R_4$  (see [94], based on drawings from the author).*

Replace caption : *Table 9.4: Study of combined resistances with  $Z_0 = 50\Omega$  (all values are expressed in  $[\Omega]$ )*  
By : *Table 9.4: Study of combined resistances with  $Z_0 = 50\Omega$  (all values are expressed in  $[\Omega]$ ) (see [94], based on drawings from the author).*

**Page 201 :**

Replace caption : *Figure 9.10: Inductance behavior according to the frequency [13]*  
By : *Figure 9.10: Inductance's behavior according to the frequency (see [51]).*

**Page 202 :**

Replace caption : *Table 9.5: Function of passive elements*  
By : *Table 9.5: Function of passive elements (see [94], based on drawings from the author).*

**Page 203 :**

Replace caption : *Figure 9.11: Close view of the I/Q receiver.*  
By : *Figure 9.11: Closer view on the I/Q receiver (see [94]).*

**Page 204 :**

Replace caption : *Table 9.6: Estimated budget link by removing the attenuator*  
By : *Table 9.6: Estimated budget link when removing the attenuator (see [94], based on drawings from the author).*

**Page 205 :**

Replace caption : *Table 9.7: Comparison between the cascade of two amplifiers and one amplifier at the I/Q mixer output.*  
By : *Table 9.7: Comparison between 1) the cascade of two amplifiers and, 2) only one amplifier at the I/Q mixer output. (see [94], based on drawings from the author).*

Replace caption : *Figure 9.12: The FPGA board received signal, scale 0.1V*  
By : *Figure 9.12: The received signal at FPGA board, scale 0.1 V (see [94], made in collaboration with the author).*

**Page 206 :**

Replace caption : *Figure 9.13: The FPGA board received signal, scale 0.05V*  
By : *Figure 9.13: The received signal at FPGA board, scale 0.05 V (see [94], made in collaboration with the author).*

Replace caption : *Figure 9.14: The FPGA board received signal, scale 0.2V*  
By : *Figure 9.14: The received signal at FPGA board, scale 0.2 V (see [94], made in collaboration with the author).*

**Page 207 :**

Replace caption : *Figure 9.15: The FPGA board received signal, scale 0.5V*

By : *Figure 9.15: The received signal at FPGA board, scale 0.5 V (see [94], made in collaboration with the author).*

Replace caption : *Figure 9.16: The received UWB signal with the board without the I/Q mixer*

By : *Figure 9.16: The UWB signal received when using the board without the I/Q mixer (see [94], made in collaboration with the author and modified by the author).*

**Page 208 :**

Replace caption : *Figure 9.17: The FPGA board received signal, scale 0.05V*

By : *Figure 9.17: The received signal at FPGA board, scale 0.05 V (see [94], made in collaboration with the author).*

Replace caption : *Figure 9.18: The FPGA board received signal, scale 0.1V*

By : *Figure 9.18: The received signal at FPGA board, scale 0.1 V (see [94], made in collaboration with the author).*

**Page 209 :**

Replace caption : *Table 9.8: Estimation of the level at the input of I/Q mixer*

By : *Table 9.8: Estimation of the signal level at the input of I/Q mixer (see [94], based on drawings from the author).*

**Page 210 :**

Replace caption : *Table 9.9: Values of the passive elements*

By : *Table 9.9: Values of the passive elements (see [94], based on drawings from the author).*

Replace caption : *Table 9.10: Maximum RF input level of the I/Q mixer*

By : *Table 9.10: Highest RF input signal level of the I/Q mixer (see [94], based on drawings from the author).*

**Page 211 :**

Replace caption : *Figure 9.19: The FPGA board received signal, scale 0.5V*

By : *Figure 9.19: The received signal at FPGA board, scale 0.5 V (see [94], made in collaboration with the author).*

Replace caption : *Figure 9.20: The FPGA board received signal, scale 0.2V*

By : *Figure 9.20: The received signal at FPGA board, scale 0.2 V (see [94], made in collaboration with the author).*

**Page 212 :**

Replace caption : *Figure 9.21: Received signal, scale 1V*

By : *Figure 9.21: Received signal, scale 1 V (see [94], made in collaboration with the author).*

Replace caption : *Figure 9.22: Received signal, scale 2V*

By : *Figure 9.22: Received signal, scale 2 V (see [94], made in collaboration with the author).*

**Page 217 :**

Add the following sentence to the end of the first paragraph of Section 10.1 Experimental validation of PID synchronization algorithm :

*The content of this section is already presented in detail in the article [26]; for the sake of completeness, it is recalled thereafter.*

**Page 225 :**

Replace the sentence :

*Our colleague Hai Zhan works for his PhD thesis on algorithms for UWB ranging and positioning (see [10]); he uses our testbed for validating his algorithmic improvement and also for characterising the behaviour of the UWB channel concerning multi-user robustness, which has a strong influence on the quality of the ranging .*

By :

Our colleague Hai Zhan works for his PhD thesis on algorithms for UWB ranging and positioning (see [10]); this contribution was only possible with the help of the U-Lite testbed, which was used for validating his algorithmic improvement and also for characterizing the behavior of the UWB channel concerning multi-user robustness, which has a strong influence on the quality of the ranging. His contribution is presented in [10], which is briefly summarized in this Section with permission from his advisor (Prof. Jean-Yves Le Boudec) for the sake of completeness.

**Page 234 :**

Replace the sentence :

*In this section, we determine the voltage required to generate the UWB impulse that reaches the power calculated previously.*

By :

*In this section, we determine the voltage required to generate the UWB impulse in order to reach the power calculated previously [95].*

**Page 339 :**

Add the following sentence to the beginning of the first paragraph of Appendix B – The oscillator's firmware :

*This Appendix is based on [93] where the code was written by the student following the guidelines of the author and the code architecture and organization were made by the author; it is recalled thereafter for the sake of completeness.*

**Page 340 :**

Replace caption : *Figure B.1: Structure of the firmware's code*

By : *Figure B.1: Structure of the firmware's code (see [93], based on drawings from the author).*

**Page 341 :**

Replace caption : *Table B.1: Description of the microcontroller's registers*

By : *Table B.1: Description of the microcontroller's registers (see [93]).*

Replace the sentence :

*As described in [X8] , ...*

By :

*As described in [86] , ...*

Replace caption : *Table B.2: The 24-bit Shift register*

By : *Table B.2: The 24-bit Shift register (see [93], based on [86]).*

**Page 342 :**

Replace caption : *Table B.3: Truth table for C1 and C2*

By : *Table B.3: Truth table for C1 and C2 (see [93], based on [86]).*

Replace caption : *Table B.4: Content of the Initialisation Latch register*

By : *Table B.4: Content of the Initialisation Latch register (see [93], based on [86]).*

Replace caption : *Table B.5: Function description of Initialisation Latch register*

By : *Table B.5: Function description of Initialisation Latch register (see [93], based on [86]).*

**Page 343 :**

Replace caption : *Table B.6: Content of the R counter register*

By : *Table B.6: Content of the R counter register (see [93], based on [86]).*

Replace caption : *Table B.7: Function description of R counter register*

By : *Table B.7: Function description of R counter register (see [93], based on [86]).*

Replace caption : *Table B.8: Content of N counter register*

By : *Table B.8: Content of N counter register (see [93], based on [86]).*

**Page 344 :**

Replace caption : *Table B.9: Function description of N counter register*

By : *Table B.9: Function description of N counter register (see [93], based on [86]).*

**Page 347 :**

Replace caption : *Figure B.2: Reset flow chart*

By : *Figure B.2: Reset flow chart (see [93], based on drawings from the author).*

**Page 348 :**

Replace caption : *Figure B.3: Main flow chart*

By : *Figure B.3: Main flow chart (see [93], based on drawings from the author).*

**Page 349 :**

Replace caption : *Figure B.4: Load\_PLL flow chart*

By : *Figure B.4: Load\_PLL flow chart (see [93], based on drawings from the author).*

**Page 350 :**

Replace caption : *Figure B.5: Sendvalue flow chart*

By : *Figure B.5: Sendvalue flow chart (see [93], based on drawings from the author).*

**Page 352 :**

Replace caption : *Figure B.6: Send\_bits flow chart*

By : *Figure B.6: Send\_bits flow chart (see [93], based on drawings from the author).*

**Page 353 :**

Replace caption : *Figure B.7: Send\_one flow chart*

By : *Figure B.7: Send\_one flow chart (see [93], based on drawings from the author).*

**Page 354 :**

Replace caption : *Figure B.8: Send\_zero flow chart*

By : *Figure B.8: Send\_zero flow chart (see [93], based on drawings from the author).*

**Page 355 :**

Replace caption : *Figure B.9: Send\_LE flow chart*

By : *Figure B.9: Send\_LE flow chart (see [93], based on drawings from the author).*

**Page 361 :**

Replace the sentence :

*This appendix was written by MM. Karim Jaber, Anurag Mangla and Haisong Wang during their MICS summer internship in 2009; corrections and additions were made by the author.*

By :

*This appendix was written in 2009 by MM. Karim Jaber, Anurag Mangla and Haisong Wang during their MICS summer internship under the supervision of and with the collaboration from the author (see [99]); for the sake of completeness it is recalled with their permission in this chapter with modifications and improvements from the author.*

**Page 380 :**

Replace caption : *Figure C.29: Pinout of MGA-86576*

By : *Figure C.29: Pinout of MGA-86576 (see [97]).*

**Page 383 :**

Replace caption : *Figure C.31: Oscillator's Schematic*  
By : *Figure C.31: Oscillator's Schematic (based on [93]).*

**Page 385 :**

Add the following sentence to the beginning of the first paragraph of C.8 Oscillator construction :  
*The construction of the oscillator is presented in [93], which was made under the supervision of and with the collaboration from the author; for the sake of completeness it is recalled in this section.*

**Page 386 :**

Replace caption : *Figure C.34: Oscillator's PCB*  
By : *Figure C.34: Oscillator's PCB (see [93]).*

Replace caption : *Figure C.35: The soldering process of a SMA connector.*  
By : *Figure C.35: The soldering process of a SMA connector. (see [93]).*

**Page 387 :**

Replace caption : *Figure C.36: The milling process of the in line connector.*  
By : *Figure C.36: The milling process of the in line connector. (see [93]).*

**Page 388 :**

Replace caption : *Figure C.37: The dongle*  
By : *Figure C.37: The dongle (see [93]).*

Replace caption : *Figure C.38: The schematic of the dongle*  
By : *Figure C.38: The schematic of the dongle (see [93], original picture from [100]).*

**Page 389 :**

Replace caption : *Figure C.39: The serial cable used to program the microcontroller with the dongle.*  
By : *Figure C.39: The serial cable used to program the microcontroller with the dongle. (see [93]).*

Replace caption : *Figure C.40: The signals measured at the output of the microcontroller*  
By : *Figure C.40: The signals measured at the output of the microcontroller (see [93]).*

**Page 390 :**

Replace caption : *Figure C.41: The value of the data is already set when the clock is raised*  
By : *Figure C.41: The value of the data is already set when the clock is raised (see [93]).*

**Page 391 :**

Replace caption : *Figure C.42: Reference clock of 50MHz*  
By : *Figure C.42: Reference clock of 50 MHz (see [93]).*

**Page 392 :**

Replace caption : *Figure C.43: Oscillator view*  
By : *Figure C.43: A view on the Oscillator's circuit (see [93]).*

**Page 393 :**

Replace caption : *Figure C.44: Transmitter's schematic*  
By : *Figure C.44: The schematic of the whole UWB Transmitter (based on [93] and [37]).*

**Page 423 :**

Add the following sentence to the beginning of the first paragraph of Appendix E – Resistive Networks :  
*This Appendix is mainly based on several contributions and calculations made by the author and that were made available to the student for training purpose in work [94]; it is recalled thereafter for the sake of completeness.*

**Page 424 :**

Replace caption : *Figure E.1: Power splitter/combiner circuit*

By : *Figure E.1: Power splitter/combiner circuit (see [94], based on drawings from the author).*

Replace caption : *Figure E.2: Impedance seen by one port with definition of currents and voltages*

By : *Figure E.2: Impedance seen by one port with definition of currents and voltages (see [94], based on drawings from the author).*

**Page 426 :**

Replace caption : *Table E.1: Gain and attenuation of an N-ports*

By : *Table E.1: Gain and attenuation of an N-ports (see [94], based on drawings from the author).*

**Page 427 :**

Replace caption : *Figure E.4: Power splitter attenuator*

By : *Figure E.4: Power splitter attenuator (see [94], based on drawings from the author).*

**Page 428 :**

Replace caption : *Figure E.5: Power splitter with T-attenuator*

By : *Figure E.5: Power splitter with T-attenuator (see [94], based on drawings from the author).*

**Page 429 :**

Replace caption : *Figure E.6: Power splitter with attenuator at one of the output*

By : *Figure E.6: Power splitter with attenuator at one of the output (see [94], based on drawings from the author).*

**Page 430 :**

Replace caption : *Figure E.7: Impedance seen from the input of the attenuator*

By : *Figure E.7: Impedance seen from the input of the attenuator (see [94], based on drawings from the author).*

Replace caption : *Figure E.8: T- Attenuator pad*

By : *Figure E.8: T- Attenuator pad (see [94], based on drawings from the author).*

**Page 431 :**

Replace caption : *Figure E.9: The topology of the cross attenuator*

By : *Figure E.9: The topology of the cross attenuator (see [94], based on drawings from the author).*

**Page 432 :**

Replace caption : *Figure E.10: The equivalent resistance  $R'$*

By : *Figure E.10: The equivalent resistance  $R'$  (see [94], based on drawings from the author).*

Replace caption : *Figure E.11: The impedance matching condition*

By : *Figure E.11: The impedance matching condition (see [94], based on drawings from the author).*

**Page 433 :**

Replace caption : *Figure E.11: Figure E.12: The attenuating pad currents and voltages*

By : *Figure E.12: The attenuating pad currents and voltages (see [94], based on drawings from the author).*

**Page 436 :**

Replace caption : *Table E.2: Resistance values of the attenuator pad when  $R_1$  is a normalized-valued resistor and  $R_2$  is calculated accordingly. We assume  $Z_0 = 50\Omega$*

By : *Table E.2: Resistance values of the attenuator pad when  $R_1$  is a normalized-valued resistor and  $R_2$  is calculated accordingly. We assume  $Z_0 = 50\Omega$  (see [94], based on drawings from the author).*

**Page 437 :**

Replace caption : *Table E.3: Resistance values of the attenuator pad when  $R_2$  is a normalized-valued resistor and  $R_1$  is calculated accordingly. We assume  $Z_0 = 50\Omega$*

By : *Table E.3: Resistance values of the attenuator pad when  $R_2$  is a normalized-valued resistor and  $R_1$  is calculated accordingly. We assume  $Z_0 = 50\Omega$  (see [94], based on drawings from the author).*

**Page 439 :**

Replace the sentence :

*This appendix gives the details about the market exploration that was made for finding and choosing the components for the oscillator and the I/Q demodulator devices.*

By :

*This appendix, based on [93] for Section F.1 and on [94] for Section F.2 that are both recalled here for the sake of completeness, gives the details about the market exploration that was made for finding and choosing the components for the oscillator and the I/Q demodulator devices.*

**Page 440 :**

Replace caption : *Table F.1: Potential PLL synthesizers*

By : *Table F.1: Potential PLL synthesizers (see [93]).*

**Page 442 :**

Replace caption : *Table F.2: Potential VCO elements*

By : *Table F.2: Potential VCO elements (see [93]).*

**Page 443 :**

Replace caption : *Table F.3: Comparing ADI56 PLL synthesizer with potential VCO*

By : *Table F.3: Comparing ADI56 PLL synthesizer with potential VCO (see [93]).*

**Page 444 :**

Replace caption : *Table F.4: Comparing LMX2434 PLL synthesizer with potential VCOs*

By : *Table F.4: Comparing LMX2434 PLL synthesizer with potential VCOs (see [93]).*

**Page 445 :**

Replace caption : *Table F.5: Comparing LMX2486 PLL synthesizer with potential VCOs*

By : *Table F.5: Comparing LMX2486 PLL synthesizer with potential VCOs (see [93]).*

**Page 447 :**

Replace caption : *Figure F.1: Overview of the system for choices no 1 and 2. The input VCO amplifier is used only for choices no 1 and 2 but not for choice no 3*

By : *Figure F.1: Overview of the system for choices no 1 and 2. The input VCO amplifier is used only for choices no 1 and 2 but not for choice no 3 (see [93]).*

**Page 450 :**

Replace caption : *Table F.6: I/Q mixers*

By : *Table F.6: I/Q mixers (see [94]).*

**Page 451 :**

Replace caption : *Figure F.2: The LC4 package*  
By : *Figure F.2: The LC4 package (see [96]).*

**Page 456 :**

Replace caption : *Table F.7: Mixer devices (all from www.minicircuits.com)*  
By : *Table F.7: Mixer devices (all from www.minicircuits.com) (see [94]).*

**Page 463 :**

Replace caption : *Table F.8: Amplifier devices (in green: our choice)*  
By : *Table F.8: Amplifier devices (in green: our choice) (see [94]).*

**Page 465 :**

Replace caption : *Table F.9: Amplifiers group*  
By : *Table F.9: Amplifiers group (see [94]).*

**Page 517 :**

Replace the word *engineer* by *engineer*.

**Page 539 :**

Add the following references :

- [92] D. Marchaland, “Architectures et Circuits dédiés aux Émetteurs Ultra Large Bande Bas Débit ”, Ph.D. Dissertation, Université de Marne-La-Vallée , 2007. [Online]. Available: [http://www-common.esiee.fr/download/recherche/fic\\_publication/These\\_MARCHALAND.pdf](http://www-common.esiee.fr/download/recherche/fic_publication/These_MARCHALAND.pdf)
- [93] Y. Akhertouz Moreno, “Designing and Realizing a PLL Based Sine Wave Oscillator at 4.25 GHz”, Lausanne : EPFL Master semester project & MICS Summer internship EPFL, 2008. Supervision : James Colli-Vignarelli and Dr Catherine Dehollain, RFIC group
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- [95] From a private discussion with Dr Prakash Egambaram Thoppay
- [96] From Hittite Corporation : <https://www.hittite.com/>
- [97] From Avago Technologies : <http://www.avagotech.com/pages/home/>
- [98] J. Colli-Vignarelli, “Ultra-Wide Band Low-Noise Amplifier with Voltage Controlled Gain”, Lausanne : EPFL Diploma project, 2007. Supervision : Prakash Egambaram Thoppay, Dr Catherine Dehollain and Prof. Michel Declercq, Laboratoire d'Electronique Générale (LEG)
- [99] K. Jaber, A. Mangla, H. Wang, “Builder's Manual for Ultra Wideband Transmitter and Receiver System”, Lausanne : MICS Summer internship EPFL, 2009. Supervision : James Colli-Vignarelli and Dr Catherine Dehollain, RFIC group
- [100] From Olimex : <https://www.olimex.com> or <http://www.olimex.com/dev>