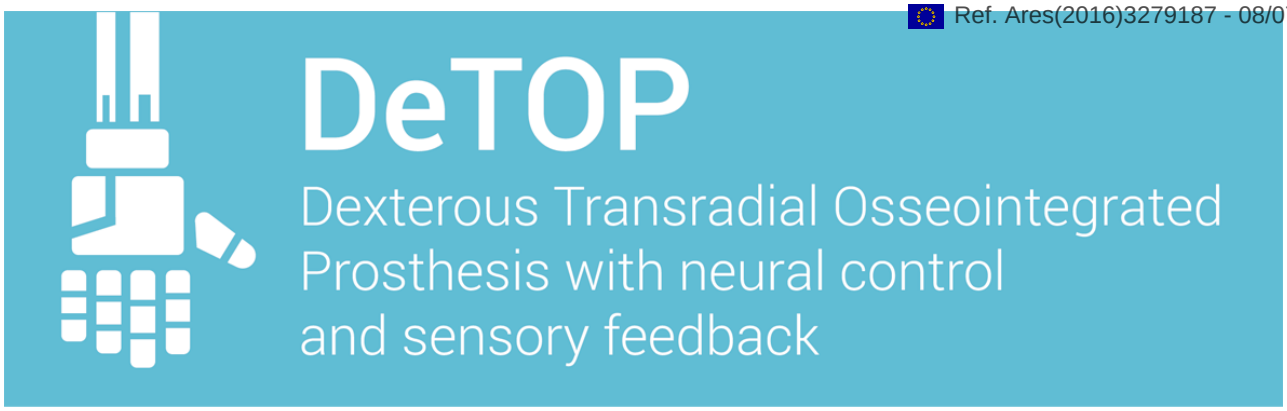

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D6.1

MINIATURE PROCESSING COMMUNICATION NODE AND NETWORK REQUIREMENTS

Leader partner: SSSA
Due date of deliverable: 30/05/2016
Actual submission date: 08/07/2016

TYPE OF DELIVERABLE		
R	Document, report (excluding the periodic and final reports)	**X**
DEM	Demonstrator, pilot, prototype, plan designs	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

DISSEMINATION LEVEL OF DELIVERABLE		
PU	Public, fully open, e.g. web	**X**
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

TABLE OF CONTENTS

1 INTRODUCTION

The functional requirements for the ASIC and for the RF protocol of the DeTOP system will be identified by the consortium and will serve CSEM to start the design of the system. In particular, based on the number of expected: EMG channels, artificial sensors and stimulation channels, the pre-processing possible on sensor nodes, the consortium will identify the bit-rate, the maximum acceptable delay, hand-shake policies, power consumption, etc.

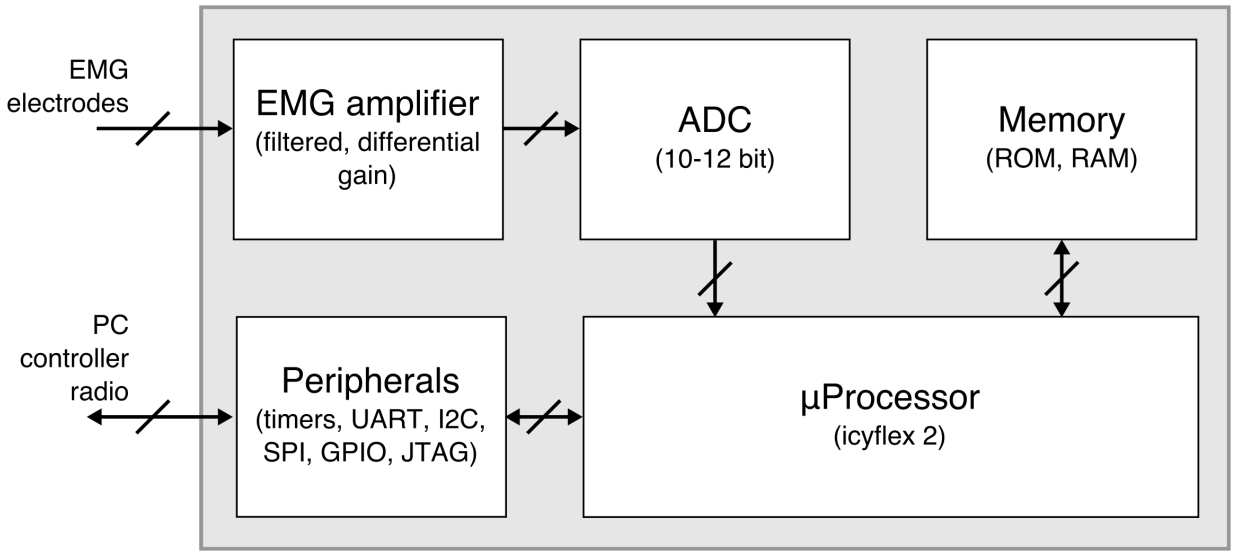

Figure 1 Schematic representation of the ASIC

2 DESIRED REQUIREMENTS

2.1 EMG RECORDING SYSTEM

The 20-channel EMG acquisition system consists of an array of low-noise amplifiers with built-in programmable anti-aliasing filter, a 20 to 1 analog multiplexer and an ultra-low energy 10 to 12-bit scalable successive-approximation ADC. Each amplifier has a pass band extending from a low-frequency cut-off f_L to a high-frequency cut-off f_H. The low pass cut-off frequency can be programmed through digital control bits. The analog outputs of the amplifiers are multiplied and fed to the ultra-low energy ADC.

2.1.1 EMG amplifier specifications

SYMBOL	PARAMETER	CONDITIONS	Target VALUE	UNIT	COMMENTS
V_{DD}	Power Supply		1.2	V	
A_D	Amplifier Differential Gain	$f_L < f < f_H$	50/100/150 34/40/43.5	V/V dB	Default: 50
V_{LSB}	Least Significant Bit	referred to amplifier input	5 20	uV uV	12bit 10bit
f_L			5	Hz	-20dB at the Nyquist frequency
f_H			2, 4, 6	kHz	-20dB at the Nyquist frequency
V_{AMP_AC}	Amplifier AC Input Voltage Range		±0.1 - ±10.0	mV	
V_{AMP_DC}	Amplifier AC Input Allowable DC Offset		±0.4	V	
V_{ni}	Amplifier Input-referred Noise		2.5	uV	RMS value
f_{MUX}	Maximum ADC MUX Switching Frequency		120	kHz	20 channels can be sampled to 6KS/s or 5 channels at 24 kS/s

2.1.2 ADC specifications

SYMBOL	PARAMETER	CONDITIONS	Target VALUE	UNIT	COMMENTS
V_{DD}	Power Supply		1.2	V	
	Full-Scale Range		1	V	
	Resolution		10 - 12	Bits	Power scalable
INL	Integral Linearity Error		±1.5	LSB	
DNL	Differential Nonlinearity		±1	LSB	
	Throughput Rate		1	MS/s	
	Clock Frequency		20	MHz	
SNR	Signal-to-Noise Ratio	V_{IN} = 1Vp-p @ 20kHz	63	dB	
THD	Total Harmonic Distortion	V_{IN} = 1Vp-p @ 20kHz	-66	dB	

2.2 PROCESSING CAPABILITIES

SYMBOL	PARAMETER	CONDITIONS	Target VALUE	UNIT	COMMENTS
f_{CK}	Clock Frequency	1.2V power supply	150	MHz	
	ROM		64	kB	
	RAM		128-256	kB	

2.3 PERIPHERALS

TYPE	QUANTITY	COMMENTS
UART	3	
Master/Slave I2C	2	
Master/Slave SPI	2	
Timer (32 bit)	8	
General purpose IO	16	multiplexed with other peripherals' IO
JTAG	1	to be used for on-chip debug

2.4 WIRELESS COMMUNICATION

Wireless communication (using an external module) is planned between implanted electrodes or artificial sensors and a control system. It must support continuous acquisition of data (EMG case) and/or event (e.g. touch) and data (e.g. pressure) from artificial sensors. Communications shall provide the followings:

- Given the sampling rates and data size, up to 960kb/s raw data uplink flow. Lossless compression is acceptable provided the maximum end-to-end latency is not exceeded.
    - This rate is obtained when all sensors are connected to a single node
    - Continuous operations at maximum flow rate is not advisable for long operations as it requires at least 20mW power.
- Up to 250 nodes with reduced data rate (approximately 4 Hz @ 250 nodes)
- Downlink traffic for configuration and mode change
- Adaptable data throughput (to adapt to varying usage)
- End-to-end latency below 100ms (both up and downlink)
- Error correction within the latency limits
- Indication of temporal data consistency (age and simultaneity)
- Safety mechanisms to detect link loss
- Low energy (in particular in absence of uplink traffic) for possible implanted solution (EMG case) or battery operation (artificial sensors)
- Single hop transmission from sensors to controller (star topology)
- Support for coexistence of different networks (more than a single amputee in same zone)
- Support for coexistence with WiFi and other ISM band technologies
- For security reason, nodes shall be paired before use (this is to guarantee that only allowed nodes can communicate information to the control system)
- Automatic node detection (provided the node has been previously paired) and network start.
- Security functions provide authentication and integrity (confidentiality can be added but not mandated)
- As an option, capacity to store locally the acquired data for differed transfer (when rate exceed real-time network capacity).

2.5 POWER CONSUMPTION CONSIDERATIONS

Ideally, the device has to be implantable, thus it does not have to heat up the surrounding tissue. Minor modifications of the specifications could be implemented in order to reduce power consumption.

2.6 FINAL DIMENSIONS OF ASIC (IN PACKAGE)

The target dimensions for the ASIC are 12 mm^2.