SENSOTERIC

smart SENSOR analog fronT-end powered by Emerging Reconfigurable devICes

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Deliverable D8.2
Data Management Plan

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Document Abstract

This document describes the **data management plan (DMP)** of the project SENSOTERIC and our commitment to the FAIR data principles, ensuring that our datasets are: Findable, Accessible, Interoperable, and Reusable. At M6 of the project, **four individual datasets** related to the four main objectives of the project have been identified. The DMP is intended as a description of these identified datasets, as well as others to be generated along the duration of the project, and it provides guidance for handling the organization of data storage in that time frame, and a structured scheme for accessing those data once the project is over.

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1. Data Management Strategy

The technical, professional and scientific publications that will be produced by **SENSOTERIC** will be **open access**, in order to be compliant with the general principle of the Horizon Europe funding program. In order to conserve our results and to foster scientific exchange, it is planned to distribute publication related digital data in a research **data repository** and make them available free of charge. Our **Data Management Plan** (DMP), in line with the **FAIR** (findable, accessible, interoperable, reusable) criteria, gives an overview of the data selection and distribution process, as outlined below. The DMP will describe how the project will collect, process, share and protect the data produced by the project partners. We identified zenodo.org as the most suitable repository, hosted in the EU, able to provide digital object identifiers (DOI) to data and metadata. Datasets shared on Zenodo will be used to disseminate and conserve data related to publications in scientific journals. The consortium expects experimental data, measurement data, layout & design data, and simulation code with an overall size of 2 GB will make the largest share of data produced in this project. At the beginning of the project we anticipate **four different datasets** related to the **four specific objectives** (OJB) of SENSOTERIC (ref. to D7.2 Plan for Dissemination and Communication Actions). A detailed description of the identified datasets will be established using the argos.openaire.eu platform. The DMP will be updated during the project runtime to contain all necessary information for a **long-term reusability** of the data. For each dataset a dedicated **lead scientist** is affirmed as **'owner'** in order to ensure maintenance and conservation of data even after the end of the project. The DMP will be consistent with the intellectual property right (IPR) policy (i.e., IP, confidentiality and publication provisions) defined in the Consortium Agreement (at the beginning of the project) and updated as any changes occur in the consortium policies. If applicable, a distribution under a creative common license model (e.g. CC-BY) will be considered.

2. F.A.I.R. Criteria

Our data management plan is intended to be in line with and respect the **F.A.I.R**. (findable, accessible, interoperable, and reusable) **criteria**, introduced in 2016 to address the increasing need to create an infrastructure able to **support the circulation of scholar data** [1]. Those principles are referred to three entities: data, metadata, and infrastructure.

- **Findable** data: the use and reuse of data relies on the capability of finding it, both from the perspective of a human user and from a machine in view of a well needed automatization of such process. Data and metadata originating in a project like SENSOTERIC, whose use will be relevant to others in the years to come, must be stored with univocally assigned persistent identifiers. Data should also be described largely by metadata, clearly relatable to the data they describe. Moreover, data and metadata should be indexed in a searchable resource.

- **Accessible** data: once the data is found, users need to know how to access it, considering authentication and authorization concerns. Standardized communication protocols should be used to retrieve data and metadata. Those protocols should be open, free, and universally implementable. Authentication and authorization are exactly included in the protocol, if there is the need. Metadata should always be accessible even after the data they refer to is not up-to-date anymore.

- **Interoperable** data: data integrated with other data need to interoperate with applications for analysis, storage, and processing. Both data and metadata should use a formal, accessible, shared, and applicable language for representing the knowledge. Data and metadata should use vocabularies that respect the FAIR principles, and include qualified references to other data and metadata.

- **Reusable** data: the ultimate goal of the FAIR principles is to make data reusable. The main requirement for this to happen is that data and metadata should be described well enough so that they can be replicated in different settings. Data and metadata should then be described with a large set of accurate and relevant attributes. Data and metadata should also be released with a clear and accessible data usage license, as well as be associated with a detailed provenance. Moreover, they should meet domain-relevant community standards.

3. Identified Datasets

Initially we identified **four datasets** (DS1, …, DS4) to organise the data generated during the project SENSOTERIC. Each of these datasets is **directly related to one of the four specific objectives** of the project (OBJ1, …, OBJ4). We are reporting a description of the datasets with respect to their relationship to the objectives and considering the kind of data that we expect to be generated from them and stored in the datasets hereafter. Each dataset will be managed by a named lead scientist (dataset owner). Expected contributors to all four identified datasets are listed.

1. *DS1: Data of "Reconfigurable Transistors as Add-On for CMOS Technology"*

This first dataset (**DS1**) is related to the first main objective of the project (**OBJ1**) and will collect all the data generated in the investigation of RFETs as an add-on technology for CMOS. RFETs are a potential key-enabling technology that can be directly co-integrated into the front-end-of-line (FEOL) of a standard CMOS process, with only a minor number of changes to the overall process flow. OBJ1 aims to leverage the co-integrability between CMOS and RFETs to enable a "More than Moore" style of increasing the system functionality for analog front-end applications, and beyond. Analog circuit design requires accurate and scalable compact models, as well as proper prediction of the distinctly different transport physics and its performance boundaries for the emerging technologies. Thus, the development of circuit-environment ready compact models for RFETs is also part of OBJ1.

In the light of this description of this first main objective, we expect the data generated in this context and to be stored in this dataset to be mainly composed of **electrical measurement** raw data, plotted **transistor characteristics**, and all kind of **support data** needed to accompany those results (e.g. description of the designs, of the taped-out structures, measurement routines, etc.). Moreover, model files or code generated within the **modelling** activities will be stored in this dataset. IP rights of partners as well as third parties have to be respected in view of this dataset, e.g. layout files of the CMOS baseline technology cannot be made open access.

Owner: Jens TROMMER (ORCID: 0000-0003-2972-438X)
Contributors: Giulio GALDERISI, Oskar BAUMGARTNER, Chhandak MUKHERJEE

2. *DS2: Data of "Exploiting Negative Differential Resistance at Room Temperature"*

The second dataset (**DS2**) is directly connected to the second global objective of the project (**OBJ2**) and will collect all the data generated from the investigation of the features of negative differential resistance at room temperature. The negative differential resistance (NDR) effect observed on lab scale Ge and SiGe geometrically confined Schottky devices shall be leveraged to a) determine its technological adjustment parameters and scaling properties towards performance enhancement, b) bridge modelling and technology

towards analog circuit design enablement, and c) exploit its inherent electronic transport features for the realization of tuneable oscillator circuits and bio-functionalized reconfigurable sensor transducers (RST) for colorectal cancer detection.

The data generated in the context of this global objective and stored in this dataset will mainly be composed of **electrical measurement** raw data of **material properties** and **device characteristics**, as well as **plotted and derived data**. **Device Layouts** and **physical analysis data** can be also envisioned to be part of this dataset. A certain set of **metadata** describing the main data is also foreseen. Since a large modelling activity is also expected related to this objective, files generated within the **modelling** of these phenomena and of devices exploiting them will be stored in this dataset, when not sensitive.

Owner: Walter M. WEBER (ORCID: 0000-0001-9504-5671)
Contributors: Masiar SISTANI, Oskar BAUMGARTNER

3. *DS3: Data of "Design of a Generic Highly Adaptable Reconfigurable Sensor Front-End"*

The third dataset (**DS3**) is directly connected to the third global objective of the project (**OBJ3**) and will collect all the data generated from the design activities related to the development of a generic and highly adaptable reconfigurable sensor front-end. Device level features, like NDR and reconfigurable polarity, provide new functionalities for circuit design. In this project, these functionalities are exploited to create a generic analog front-end (AFE) which adapts to various sensor application environments. OBJ3 is to provide an AFE, that a) can adapt to various sensor application needs, by adjusting input parameters, gain, range and bandwidth, and b) dynamically tune those parameters on user request or through a feedback from environmental influences. The higher functionality will be embedded by the inherent features of RFETs and NDR devices. Energy efficiency will be ensured by utilizing FDSOI baseline technology.

The data generated in the context of this global objective and stored in this dataset will mainly be composed of **circuit topologies** and their resulting **characterization data**. IP rights of partners as well as third parties have to be respected in view of this dataset, e.g. data related to the **tape-out** of analog circuits based on RFET and FDOSI technologies cannot be made openly accessible.

Owner: Eugenio CANTATORE (ORCID: 0000-0002-9646-7232)
Contributors: Klaus HOFMANN

4. *DS4: Data of "Low Noise Sensor System based on Doping-Free Technology"*

The fourth and last dataset (**DS4**) is directly connected to the fourth global objective of the project (**OBJ4**) and will collect all the data generated from the design of a low noise sensor system based on doping-free technology. RFETs feature a doping-free channel and a transport behavior which is more oriented towards the bulk, than at the surface, as opposed to a classical inversion type MOSFETs. This property can lead to a beneficial 1/f noise behavior for the AFE, as well as for the RST. Low-frequency noise is of fundamental importance in AFEs, and its reduction through additional overhead circuitry always results in increased circuit complexity and power consumption. Thus, the use of RFETs in AFEs holds the promise for a breakthrough in power efficiency, enabling energy autonomous and/or very high sensor count applications. The altered transport properties of RFETs with NDR also promise an increased detection range of RST elements with the same base technology. As part of OBJ4, this will be demonstrated by bio-functionalized transducers and photo detectors with extended measurement range.

Considering the description of this first main objective, we expect the data generated in this context and to be stored in this dataset to be diverse and mainly composed of **electrical characterisation** data of the low-noise performances of RFET devices, as well as of the sensor transducer. It will also incorporate data on the employed **cancer marker and bio-functionalisation procedures.**

Owner: Sandro CARRARA (ORCID: 0000-0003-4374-6104)
Contributors: Sonia PRADA LOPEZ

4. Conclusion

This deliverable summarizes our **data management strategy**. Four anticipated datasets at the beginning of the project runtime are described and analysed regarding the expected open data to be generated. A clear **owner** is defined for each dataset to ensure maintenance and conservation of the data beyond the project runtime. The DMP will be **updated regularly** during the project runtime. This update will provide a comprehensive review of our achievements and the tangible outcomes of our strategic plan, reaffirming our dedication to realizing the project's goals.

5. References

[1] Wilkinson MD, Dumontier M, Aalbersberg IJ, Appleton G, Axton M, Baak A, Blomberg N, Boiten JW, da Silva Santos LB, Bourne PE, Bouwman J, Brookes AJ, Clark T, Crosas M, Dillo I, Dumon O, Edmunds S, Evelo CT, Finkers R, Gonzalez-Beltran A, Gray AJ, Groth P, Goble C, Grethe JS, Heringa J, 't Hoen PA, Hooft R, Kuhn T, Kok R, Kok J, Lusher SJ, Martone ME, Mons A, Packer AL, Persson B, Rocca-Serra P, Roos M, van Schaik R, Sansone SA, Schultes E, Sengstag T, Slater T, Strawn G, Swertz MA, Thompson M, van der Lei J, van Mulligen E, Velterop J, Waagmeester A, Wittenburg P, Wolstencroft K, Zhao J, Mons B. **The FAIR Guiding Principles for scientific data management and stewardship**. Sci Data. 2016 Mar 15;3:160018. doi: 10.1038/sdata.2016.18. Erratum in: Sci Data. 2019 Mar 19;6(1):6. doi: 10.1038/s41597-019-0009-6. PMID: 26978244; PMCID: PMC4792175.

6. Glossary

AFE: Analog-Front-End
DS: Dataset
DMP: Data Management Plan
FEOL: front-end-of-line
NDR: Negative Differential Resistance
OBJ: Objective
RFET: Reconfigurable Field Effect Transistors
RST: Reconfigurable Sensor Transducer