
Magnet-less Microwave Isolation: a Scalable and Broadband Approach

A Data Management Plan created using DMPonline.be

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Project abstract:

Superconducting quantum technology recently demonstrated a paradigm shift of “quantum supremacy” and has validated many prototypical quantum algorithms. Nevertheless, the number of qubits on a chip still needs to scale up by several orders of magnitude to transcend such algorithmic demonstrations and enable useful quantum computation. A major hurdle to this scale-up is the use of ferrite-based isolators to protect the superconducting quantum systems from their noisy electromagnetic environment. Indeed, due to the bulky magnets required to bias the ferrite, only a limited number of such isolators can fit inside the dilution fridge that hosts the superconducting quantum system.

To tackle this issue, we propose a novel approach to microwave magnet-less isolation based on parametric mode conversion in dispersion-engineered coupled transmission lines. Specifically, we use composite right-left-handed (CRLH) transmission lines to engineer parallel dispersion curves for the even and odd modes of the coupled structures, and hence achieve broadband phase matching. We anticipate that this approach, implemented with foundry compatible process, will overcome the current trade-off between isolation, bandwidth, and device compactness, opening the path to large-scale integration of superconducting quantum processors.

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FWO DMP (Flemish Standard DMP)

1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • Generate new data • Reuse existing data 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • Digital • Physical 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • .por, .xml, .tab, .csv, .pdf, .txt, .rtf, .dwg, .gml, ... • NA 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA 	
Simulations	Simulation of analytical models, circuit designs, mask layout, etc.	Generate new data	Digital	Simulation data	.txt	<100 GB	N.A.
Prototypes	Produced chips, prototypes and other samples	Generate new data	Physical	N.A.	N.A.	N.A.	< 10 samples
Measurements	Data from characterization of the samples	Generate new data	Digital	Experimental	.csv, .txt, .jpg, .png	<100 GB	N.A.

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

N.A.

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, ...)? If so, please comment per dataset or data type where appropriate.

- Yes

Some data produced by simulation and prototyping could be part of a patentable invention(s). Depending on the patenting strategy, access to simulation data and prototypes might be restricted.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- Yes

This research is conducted at IMEC and some data will be restricted to IMEC/KU Leuven only.

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

The generated data will be stored on IMEC's servers and shared through Microsoft SharePoint.

Simulation data will be commented and accompanied by .pptx presentations summarizing the simulation set-up and results.

Prototypes and other samples will be stored in a dedicated shelf in IMEC's lab.

Measurement data will be gathered in shared repository, along with a README file and accompanied by .pptx presentations summarizing the experimental set-up and the main results.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- No

3. Data storage & back-up during the research project

Where will the data be stored?

All the generated data will be stored on IMEC's servers and accessed using Microsoft SharePoint and other repositories shared by the group.

The documentation and meta-data will also be stored on a personal OneDrive account.

All generated samples will be stored in a dedicated shelf in IMEC's cleanroom.

How will the data be backed up?

All measurement and simulation data will be backed up on IMEC's servers.

Additionally, documentation and meta-data are back-up on a personal OneDrive account.

**Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.**

- Yes

Storage and back-up capacity provided by IMEC are designed to support volumes of data (>1TB) much higher than the estimated volume of data produced by this research (<200GB).

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

IMEC servers are strongly secured (multifactor authentication, etc.).

Additionally, researchers have full control of the access to the data stored on their personal OneDrive account.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

These costs are covered by IMEC, granting free access for their staff to the various servers and repositories used to store data, including access to SharePoint and OneDrive.

4. Data preservation after the end of the research project

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

All digital data mentioned above will be stored and retained on IMEC's servers for at least five years after the end of the project. Physical data, will be stored in a dedicated shelf in IMEC's labs.

Where will these data be archived (stored and curated for the long-term)?

Besides its servers, IMEC also offers long term data archiving through Microsoft's Azure Data Lake Storage.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

These costs are covered by IMEC, granting free access for their staff to the various servers and repositories used to store digital data.

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in a restricted access repository (after approval, institutional access only, ...)

All data will be available for members of the research team at IMEC to re-use.

If access is restricted, please specify who will be able to access the data and under what conditions.

The research team at IMEC will have full access to the data.

On request, data may be made available to external parties after approval by the research team at IMEC.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- Yes, Intellectual Property Rights

Due to Intellectual Property Rights, all the data produced might be subject to restriction preventing the sharing with other parties outside of IMEC and KU Leuven.

Where will the data be made available? If already known, please provide a repository per dataset or data type.

No specific repository has been selected at this stage, but the KU Leuven RDR repository is a possibility considered.

When will the data be made available?

Upon publication of research results

Which data usage licenses are you going to provide? If none, please explain why.

Data usage licences will be discussed with IMEC/KU Leuven depending on the disclosure agreements and the sensitivity of the data considered.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- No

What are the expected costs for data sharing? How will these costs be covered?

KU Leuven RDR is free of charges.

6. Responsibilities

Who will manage data documentation and metadata during the research project?

The PhD researcher

Who will manage data storage and backup during the research project?

The PhD researcher

Who will manage data preservation and sharing?

The PhD researcher under the control of his supervisors

Who will update and implement this DMP?

The PhD researcher