

# STARRY NITE Multi-Project Wafer Program

## Request for Design Application (RFDA)

NTSXL Project Order N00164-22-9-W011

The Office of the Undersecretary of Defense, Research & Engineering (OUSDR&E) Trusted & Assured Microelectronics (T&AM) program is sponsoring the State-of-the-Art Radio Frequency Gallium Nitride (STARRY NITE) project with the intent of establishing RF GaN foundries, which offer open access to millimeter wave (mmW) foundry nodes as well as product transition paths via the DoD advanced packaging ecosystem. A critical piece of this effort is the selection of potential participants and collaborators (Collaborators) for Multi-Project Wafer runs at participating STARRY NITE foundry facilities at no charge to the selected Collaborator. This Request for Design Application (RFDA) provides background on the STARRY NITE program, the Collaborator selection process, the requirements for a Design Application to be submitted by potential Collaborators, details on the MPW runs, and the repository for STARRY NITE designs.

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### STARRY NITE Export Control Clause

*NSWC Crane is requesting that all applicants for STARRY NITE MPW Runs disclose the individuals in their company or institution who will have access to foundry PDKs for STARRY NITE design submission purposes. Please submit the names of all such individuals, and indicate if any such individual is not a U.S. person (as defined under U.S. export control laws).*

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### Background

1. STARRY NITE foundries– HRL, Northrop Grumman Space Systems, and Qorvo–were provided awards via NSTXL Project Order N00164-22-9-W011. These awards include the opportunity for public and private entities to collaborate with each STARRY NITE foundry in conformance with their respective goals and deliverables associated with the Project Order.
2. This Request for Design Application (RFDA) specifies the requirements for a potential collaborator (Collaborator) to participate in STARRY NITE Multi-Project Wafer (MPW) foundry runs under the provisions of a Collaboration Agreement to be negotiated by the Parties following selection of the Collaborator by the corresponding foundry and the Government.
3. This RFDA shall include certain required elements from the proposed Collaborator, including a Whitepaper as described below.

## Design Process Flow

The general flow of the STARRY NITE process flow for a design applicant is outlined in this section. Color coding is used to highlight alignment with key dates on the MPW Program Calendar posted at [www.info.nstxl.org/starry-nite-mpw-program](http://www.info.nstxl.org/starry-nite-mpw-program).

- Attend Industry Day (Optional)
- Visit STARRY NITE Webpage (to be released NLT Mar 29)
  - Review MPW Schedule (calendar will be on website)
  - Download [Application Form](#) (e.g., 2–3-page whitepaper)
  - Download Industry Day Brief (Distro A – Public Release)
  - Review Design [Submission Requirements](#) (if awarded)
  - Work NDA with foundry (optional)
- Apply
  - Submit completed [Application Form](#) and submit to respective foundry
  - Work NDA with foundry (optional)
  - PDK Training (optional, if available)
  - [Foundries and government will provide award notices](#)
- Circuit Design (if awarded)
  - Complete NDA (if not done already)
  - Complete Collaboration Agreement with foundry
  - Complete PDK training (if not done already)
  - Complete design by [Design Submission date](#) (i.e., DRC)
    - Design submission must be DRC-clean
    - Design submission must include all required foundry submission items
    - late designs NOT accepted, no exceptions
  - [Submit Design Package](#) to be retained in IP Vault; we have not decided, but here are things we might request from a govt-paid designer. Obviously, much of this will be optional if the designer is self-funded.
    - Design layout (GDSII file)
    - Schematics (may be encrypted)
    - PPT documenting targeted application, frequency range, simulation results
- Circuit Fab
  - Foundries assemble and tape out masks
  - Foundries complete fabrication and [deliver die to designers](#)
- Circuit Package & Test (optional)
  - Devices are packaged and tested
  - At least three packaged devices are provided to govt for IV&V
- Final Report, out brief, etc. (optional)
  - Final report delivered to govt with brief (verify PDK, feedback on foundry maturity, etc.)
  - If selected, performer will participate in DIB demo day – sales pitch to potential transition partners (PEOs, primes, etc.)

## Design Application Package (Whitepaper & Quad) Submission

1. The Design Application Package includes a whitepaper and a quad chart. The package will describe how the Collaborator’s proposed design will take advantage of a specific Government-funded MPW run offered by a STARRY NITE foundry. Carefully mark the package in accordance with your company’s proprietary data.
2. Complete the attached quad using the Whitepaper instructions below as guidance. To download, [click here](#).

<p><u>Innovative Claims</u></p> <ul style="list-style-type: none"> <li>• Problem</li> <li>• Existing Solutions &amp; Limitations</li> <li>• State-of-the-Art Design Proposed</li> </ul>	<p><u>Technical Area &amp; Impact</u></p> <ul style="list-style-type: none"> <li>• Focus Area</li> <li>• Performance Metrics</li> <li>• Impact</li> <li>• Transition Strategy</li> <li>• Transition Partners</li> <li>• Provide PoC email(s) if available</li> </ul>
<p><u>Technical Rationale &amp; Approach</u></p> <ul style="list-style-type: none"> <li>• Goal</li> <li>• Plan</li> <li>• Risks</li> </ul>	<p><u>Program Management</u></p> <ul style="list-style-type: none"> <li>• Team</li> <li>• Funding – call out cost-shared activities</li> <li>• Post Design Deliverables – see Table 1 in RFDA</li> <li>• Clarify – package, test data, eval board?</li> <li>• Schedule Image w/ Key Milestones</li> </ul>

3. Whitepaper must be submitted by published schedule date for each MPW run via the instructions provided at the STARRY NITE webpage (see [www.info.nstxl.org/starry-nite-mpw-program](http://www.info.nstxl.org/starry-nite-mpw-program))
4. Whitepaper will be limited to no more than 3 pages (single-spaced) and to include the following:
  - a. Proposed Design Goals and Objective
    - i. What are you trying to do/demonstrate?
    - ii. How will design be used in targeted application? What are the key metrics for your application? Examples are as follows:
      1. Bandwidth
      2. Power Efficiency
      3. Linearity
      4. Noise Figure
      5. Frequency
      6. Other
  - b. What is the impact of the Proposed Design Objectives?
    1. Why is the Design important to USG?
    2. Are there dual use applications for the proposed design?

- c. Innovativeness of the Design
  - i. Technical Challenges and Approach
  - ii. How will proposed design help advance technology beyond current State of the Art (SOTA)? Please quantify how SOTA is measured (provide references or benchmarks).
  - iii. How will proposed design capture the advantage presented by the SOTA processes and demonstrate novel performance of the transistor technology?
  - iv. How does your design compare with published results?
- d. Design, Packaging & Test
  - i. STARRY NITE does not provide funding for design, packaging, or test. What is the Collaborator's source/level of funding for design, packaging, and test, respectively? Does the Collaborator have interested DoD sponsors requiring a contract vehicle?
  - ii. Is the Collaborator intending to package and test the proposed design? If so, please describe the approach and packaging facility.
  - iii. How will performance be validated through measurement?
  - iv. What are the Collaborator's qualifications for performing design, packaging, and test?
- e. Technology Transition Plan
  - i. What is the Collaborator's technology transition plan?
  - ii. If selected, would the Collaborator be willing to prepare an outbrief to DoD program offices and the Defense Industrial Base (DIB) at the STARRY NITE Annual DIB Demo Day?
- f. Collaborator's Proposal for Government's IP Rights to Collaborator's Design. IP rights will be a strong selection criteria in awarding space. GPR is preferred but other types will be considered. Please select one of the following:
  - i. Government Purpose Rights (GPR)
    - 1. Government can disclose technical data within the Government or outside the Government to a third party solely for a Government Purpose
    - 2. Submission data is archived in the IP Repository
  - ii. Limited Purpose (LP) Rights
    - 1. Government cannot disclose technical data outside the Government, except for narrow exceptions
    - 2. Submission data is archived in the IP Repository
    - 3. Please provide justification
  - iii. None
    - 1. Submission data is NOT archived in the IP Repository
    - 2. Please provide justification
  - iv. Further Discussion Requested

Note: for further information, please refer to [DFAR 252.227.7013 "Rights in Technical Data-Noncommercial Items"](#)

- 5. No Government funds will be provided via STARRY NITE for performing Design, packaging, or testing.

6. Collaborator Selection Criteria – the Whitepaper will be reviewed and evaluated by the respective STARRY NITE Foundry and the Government. Collaborators will be selected based on the following criteria:
  - a. Timeliness of submission
  - b. Adequacy of the Design Application in describing the Collaborator’s design approach, including the expected performance and the relative novelty of the design.
  - c. Responsiveness of the Collaborator in addressing the elements of this RFDA and willingness to agree to the terms of Collaboration Agreement, including the granting of IP rights to the Government for the Collaborator’s submitted design

## Design IP Repository & Submission Requirements

1. Collaborators' submitted designs will become part of the STARRY NITE Intellectual Property (IP) Repository, subject to the Terms of Use set forth by the respective STARRY NITE Foundry and the Government.
2. The design details provided by the Collaborator along with submitted design will form the basis for the materials and data to be included in the IP repository. Required items for each submission are enumerated in Table 1 (see next page).
3. The STARRY NITE IP Repository will be implemented in a secure government-approved repository.
4. Access to the repository will be available to US Government only. The intent of the repository is to organize IP and support technology transition towards programs of record.

	Govt Purpose Rights	Govt Limited Purpose Rights	No Govt Rights
<b>Design Submission Package</b> <ul style="list-style-type: none"> <li>• Circuit layouts in GDS-II</li> <li>• Schematics</li> <li>• Simulation Plots</li> <li>• Information on PDK Version</li> <li>• EDA tools used and version</li> <li>• Any other simulation tools used and version</li> </ul>	Required. Captured as GPR in IP Vault.	Required. Captured as LP in IP Vault	Schematics & Circuit Layouts in GDS-II only. Not in IP Vault.
<b>Post-Design Submission Package</b> <ul style="list-style-type: none"> <li>• Packaged MMICs for IV&amp;V by USG</li> <li>• Raw and summarized test data</li> <li>• Virtual outbrief (see Final Report)</li> </ul>		Optional	
<b>Final Report</b> <ul style="list-style-type: none"> <li>• Design &amp; Application</li> <li>• Measured Results vs Simulation</li> <li>• Analysis of PDK &amp; Device Model</li> <li>• Lessons learned for future efforts</li> <li>• Feedback on foundry process</li> </ul>		Optional	
<b>DIB Demo Day Pitch</b> <ul style="list-style-type: none"> <li>• Brief on full design of package and evaluation board</li> <li>• Evaluation Board and test code</li> </ul>		Optional upon request	

Table 1. Summary table of deliverables for GPR, LP, and no USG rights for the STARRY NITE MPW Program.

## HRL MPW Run Details

1. Process Technologies Available
  - a. The process technology available for each MPW run is HRL's T3 GaN, which is a 40nm GaN node on 2mil (50um) wafer thickness. HRL has been offering T3 GaN MPW runs since 2019 and is continuing to mature its production process through the STARRY NITE initiative.
  - b. The current plan is to offer the following:
    - i. Year 1, 2, 3 (2022, 2023, 2024): T3 GaN
    - ii. Year 4 (2025): T3 GaN, T3 GaN w/ Advanced Interconnect (AIC)
2. Design Space

The design space allotted for each Participant will be at 3.0 mm x 5.00 mm (x direction by y direction, where "x" is parallel to gate width direction), inclusive of dicing streets.
3. Timeline
  - a. HRL is currently on a 4 runs per year MPW schedule. That approximately corresponds to a quarterly lot start schedule in 2022-2024. In 2025, the 4 MPW runs will be split between 2 standard runs and 2 runs with AIC.
  - b. For an updated schedule of upcoming MPW runs, please check HRL's GaN foundry website (<https://www.hrl.com/products-services/foundry>) or contact a HRL foundry representative.
4. MPW Run Procedure
  - a. Potential Collaborators are encouraged to sign NDA with HRL, which along with a signed End-User-Agreement will grant the Collaborator access to HRL's T3 GaN PDK for evaluation.
  - b. After the Collaborator submits the RFDA, the Collaborator will be notified if selected as STARRY NITE rider for a given MPW run. It is the Collaborator's to adhere to the selected design submission and mask tapeout schedules.
  - c. Each selected Collaborator will have a predetermined period of time to complete their design using the T3 GaN PDK and model. Each Collaborator will be required to submit their designs to the HRL foundry during the design submission period and to achieve DRC-clean status for their designs at the conclusion of the submission period, in preparation for mask tapeout and inclusion in the targeted MPW run.
  - d. After mask tapeout and assembly, HRL will fabricate wafers using assembled masks. HRL's Process Control Monitor (PCM) structures will be monitored throughout the fab process flow to ensure wafer health.
  - e. IP Repository: The Collaborator will be required to submit their design and documentation for archiving in the STARRY NITE IP Repository. It is encouraged for the Collaborator to present MMIC characterization report after parts delivery for archiving in the IP Repository.

5. Die Delivery

- a. HRL will deliver die from visually inspected tiles for each tile reservation (no sub-cuts or tile testing included). Die count will be released post NDA.
- b. DRC verification reports are provided by HRL for each tile design submission.
- c. Process Control Monitor report for “wafer health” are included in the delivery, comparing the performance of each MPW wafer lot against the model.

6. Point of Contact

All foundry related questions can be addressed to [ganmpw@hrl.com](mailto:ganmpw@hrl.com).



## Northrop Grumman Space Systems MPW Run Details

### 1. Process Technologies available

- a. The process technologies available for each MPW run are listed below. All are on 2mil (50um) wafer thickness. At the time when the MPW runs are offered, the GaN technologies may be unreleased and still being matured as a production process. The current plan is to offer the following:
  - i. Year 1, 2, 3 (2022, 2023, 2024): GaN09
  - ii. Year 4 (2025): GaN09 w/ AIC

GaN09 = 90nm GaN node

AIC = Advanced interconnect features

- b. Disclaimer: As the purpose of these MPW runs are provide early access to GaN technologies still in development, Northrop Grumman will provide preliminary models available at design period start. Models and PDKs are subject to change as technology matures. Northrop Grumman plans to meet delivery schedule according to plan, however, the actual completion date could vary based on design completions schedule, tape out completion schedule, and fab cycle time. Layout modifications to finalize the mask for each design may need to be performed by Northrop Grumman layout engineers.

### 2. Design Space

- a. The design space allotted for each Participant will be 5.0 mm x 5.0 mm (x direction by y direction, where “x” is parallel to gate width direction).
- b. Sub-dicing

### 3. Timeline

For the most updated schedule of upcoming MPW runs, please see the schedule at: [www.info.nstxl.org/starry-nite-mpw-program](http://www.info.nstxl.org/starry-nite-mpw-program) or contact Northrop Grumman.

### 4. MPW Run Procedure

- a. After Collaborators are selected, and the Collaborators sign NDA and Collaboration Agreement with Northrop Grumman, Collaborators will have a predetermined period of time (“Design Period”) to make their design using models and PDKs provided by Northrop Grumman. Upon conclusion of the Design Period, Collaborators will be required to submit their designs to the Foundry for mask tapeout by the provided deadline in order to have their design included in the fab run. Collaborators will also be required to submit their design and documentation for archiving in the STARRY NITE IP Repository. Once the mask is taped out, Northrop Grumman will fabricate wafers with the mask. Please note Northrop Grumman will not perform DC or RF testing of circuits; Process Control Monitor (PCM) structures on the mask will be measured throughout the fab process.
- b. Collaborators agrees to published design submission and mask tape out schedules.
- c. Note that the US government has the final decision authority on which designs are included in each reticle.

5. Die Delivery

- a. Die will be delivered by Northrop Grumman to Collaborators upon completion and dicing of fabricated wafers in conformance with the terms of the Collaboration Agreement. Die count will be released post NDA.
- b. Sub-dicing is not included in the STARRY NITE multi-project wafer run, but for an additional cost can be arranged through Northrop Grumman's Microelectronics Products & Services organization. Contact Northrop Grumman for additional details.

6. Points of Contact

- a. For questions, please contact Mike Barsky ([mike.barsky@ngc.com](mailto:mike.barsky@ngc.com)) or Farman Mesdaghi ([farman.mesdaghi@ngc.com](mailto:farman.mesdaghi@ngc.com)).

## Qorvo MPW Run Details

### 1. Process Technologies available

- a. The process technologies available for each MPW run are listed below. All are on 2mil (50um) wafer thickness. At the time when the MPW runs are offered, the GaN technologies may be unreleased and still being matured as a production process.

The current plan is to offer the following:

- i. Year 1, 2 (2022, 2023): GaN15 and GaN09
- ii. Year 3, 4 (2024, 2025): GaN15 w/ AIC, GaN09
- iii. Year 5 (2026): GaN15 w/ AIC, GaN09 w/ AIC

GaN09 = 90nm GaN node

GaN15 = 150nm GaN node

AIC = Advanced interconnect features

- b. Disclaimer: As the purpose of these MPW runs are provide early access to GaN technologies still in development, Qorvo will provide preliminary models available at design period start. Models and PDKs are subject to change as technology matures. Qorvo plans to meet delivery schedule according to plan, however, the actual completion date could vary based on design completions schedule, tape out completion schedule, and fab cycle time. Layout modifications to finalize the mask for each design(s) may need to be performed by Qorvo layout engineers. Qorvo will not perform sub-dicing services within each die for delivery. Any sub-dicing shall be done by the design contributors.

### 2. Design Space

- a. The design space allotted for each Participant will be at minimum 4.0 mm x 2.00 mm (x direction by y direction, where “x” is parallel to gate width direction); exact design space will be determined at a later date.

### 3. Timeline

For the most updated schedule of upcoming MPW runs, please see the schedule at: [www.info.nstxl.org/starry-nite-mpw-program](http://www.info.nstxl.org/starry-nite-mpw-program) or contact Qorvo representative.

### 4. MPW Run Procedure

- a. After Collaborators are selected, and the Collaborators sign NDA and Collaboration Agreement with Qorvo, Collaborators will have a predetermined period of time (“Design Period”) to make their design using models and PDKs provided by Qorvo. Upon conclusion of the Design Period, Collaborators will be required to submit their designs to the Foundry for mask tapeout by the provided deadline in order to have their design included in the fab run. Collaborators will also be required to submit their design and documentation for archiving in the STARRY NITE IP Repository. IP Repository submissions will be collected via the existing Foundry portal. Once the mask is taped out, Qorvo will fabricate wafers with the mask. Please note Qorvo will not perform DC or RF

testing of ckts; Process Control Monitor (PCM) structures on the mask will be measured throughout the fab process.

- b. Collaborators agrees to published design submission and mask tape out schedules.
  - c. Note that the US government has the final decision authority on which designs are included in each reticle.
5. Die Delivery
- a. Die will be delivered by Qorvo to Collaborators upon completion and dicing of fabricated wafers in conformance with the terms of the Collaboration Agreement. Die count will be released post NDA.
  - b. Qorvo will not perform sub-dicing on die.
6. Point of Contact
- a. For questions, please contact Anita Pacheco at [anita.pacheco@qorvo.com](mailto:anita.pacheco@qorvo.com)