

CMC Compact Model Release Specification



Revision History

Revision	Date	Authors	Comments
1.0	04/14/06	R. Jones	Initial release
1.1	05/08/06	R. Jones	Model version control modified to <version>.<subversion>.<revision>

Review History

Revision	Date	Attendees

1 Introduction

This document specifies what is required by the General Electrical Industries Association (GEIA) Compact Model Council (CMC) to release a new or updated standard semiconductor device compact model for SPICE or SPICE-like circuit simulators. Such device compact models are, hereafter, referred to simply as standard models.

2 Model Release Process

The CMC standard model release procedure is shown in flow chart form in Figures 1 and 2. Figure 1 shows the procedure for new standard models while Figure 2 shows the procedure for bug fixes and/or enhancements to existing standard models.

2.1 Model Release Process for New Standard Models

Details of each step in the release procedure for new standard models (Figure 1) are provided as follows:

2.1.1 Step 1: Release plan

When a new model is chosen for CMC standardization, the CMC, in conjunction with the model development team, must assess if the model reviewed during the evaluation period is sufficient for release as a new standard model and, if not, what needs to be changed or added to the model for initial release as a CMC standard model. Once this assessment is complete, the model development team principal investigator(s), the CMC model development team liaison, and the CMC Model QA and Release subcommittee chairperson will issue a written release plan, including milestones, for the CMC to approve. The plan needs to specify the beta entry and exit dates, and a final formal release date as well as acceptance criteria. The plan also needs to provide a brief description of the approach and methodology, including formulations and code implementations, for how the project will be developed and tested in terms of accuracy, numerical stability, version control, backward compatibility, warning/error message output, simulation overhead, etc. The release plan timeline will be set on a case by case basis depending on the work required to prepare for the release.

2.1.2 Step 2: CMC to review and sign-off on release plan

CMC review of the release plan will be coordinated by the CMC Model QA and Release subcommittee chairperson and will typically involve the CMC model development team liaison, the CMC Model QA and Release subcommittee, and representatives of the CMC Executive committee. CMC feedback on the release plan should be completed within five business days. The model development team is responsible for making any refinements to the release plan as identified during the CMC review.

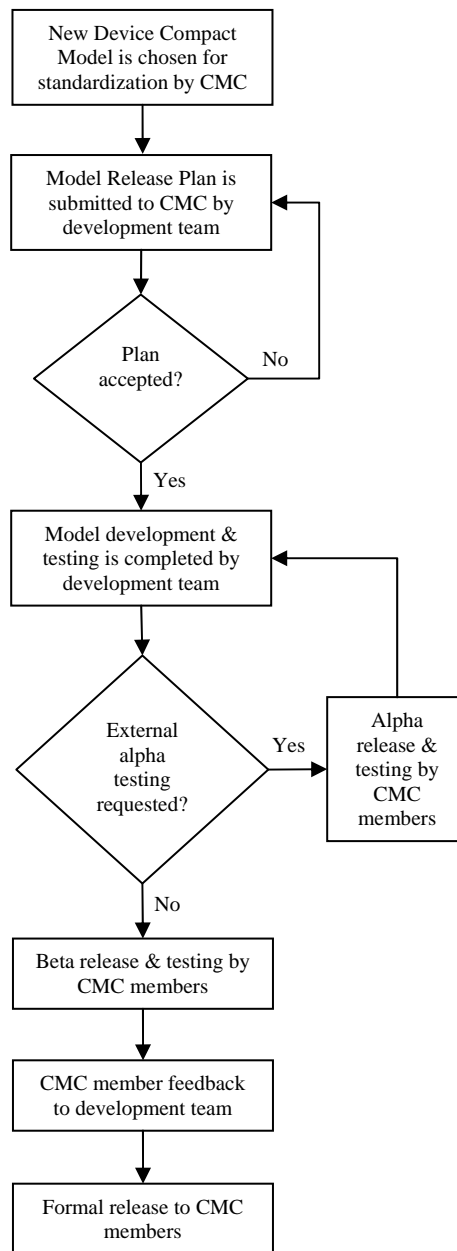


Figure 1 Flow chart of CMC standard device compact model release procedure for new standard models

2.1.3 Step 3: Development, implementation, and alpha testing

The model development team starts to develop and implement new model equations/code, or starts to make bug fixes based on what has been agreed to in the finalized release plan. The model development team is also responsible for model alpha testing. If the model development team requires assistance with alpha testing, notification must be sent to the CMC executive committee and the CMC Model QA and Release subcommittee chairperson so that all CMC member companies can be notified of the request and given equal access to

alpha code. The model development team is not required to provide code for alpha testing, and CMC members are not required to provide alpha testing feedback if alpha code is made available to all members.

2.1.4 Step 4: Beta release and testing

On the date specified in the release plan, the beta release should be made readily available to all CMC member companies. All CMC members are encouraged to participate in beta testing. Volunteer beta testers will be solicited for specific aspects of a model that are new or have undergone major revision since the model was evaluated for standardization. It is the obligation of volunteer beta testers to perform thorough evaluations of the items each tester has agreed to evaluate to see if the code has met the requirements set forth in the release plan.

2.1.5 Step 5: Beta exit

On the beta exit date, all beta testers need to provide evaluation feedback to the model development team as well as the CMC Model QA and Release subcommittee via the subcommittee chairperson. The model development team and the CMC Model QA and Release subcommittee will make sure all issues in the beta feedback reports will be addressed for the formal release.

2.1.6 Step 6: Status report to CMC

The model development team and the CMC Model QA and Release subcommittee will inform the CMC if the model has addressed any identified bug fixes and/or enhancements, if all known issues from beta testing have been fixed, and whether or not the model code, test cases, reference simulation results, and release documents are ready for a formal release.

2.1.7 Step 7: Formal release once CMC confirms readiness

2.2 Model Release Process for Bug Fixes and/or Enhancements to Existing Standard Models

The release procedure for bug fixes and/or enhancements to existing standard models (Figure 2) is similar to that for new standard models except that there is a potential entry point involving the simulator vendors. Bug fix requests made directly to a simulator vendor will be handled via the vendor's standard bug fix procedure and should be included in vendor activity reports made at quarterly CMC meetings. If it is determined that a bug is not specific to the simulator vendor's implementation of the model in their simulator, the request is forwarded to the CMC for further consideration.

Unlike a new model that has been chosen for standardization by the CMC, a bug fix and/or enhancement request will be assessed by the CMC to determine if the request

should be accepted, sent back to the requestor for additional clarification, or rejected. Once a bug fix and/or enhancement request has been accepted by the CMC, the remainder of the release procedure is identical to that for new standard models. Model developers are strongly encouraged to limit the number of model releases to two per year and, as such, multiple bug fixes and/or enhancements should be combined into a single release whenever possible. Exceptions will be made to this recommended practice for critical bug fixes as determined by the CMC in conjunction with a given model development team and the simulator vendors.

Details of each step in the release procedure for bug fixes and/or enhancements to existing standard models (Figure 2) are provided as follows:

2.2.1 Step 1a: Making a bug fix and/or enhancement request directly to the CMC

A bug fix and/or enhancement requestor informs the CMC via presentation and/or email that certain code fixes and/or model equation enhancements need to be made into a new release. The requestor can either be a representative of a CMC member company or a member of the model development team. The request itself can originate outside of the CMC and CMC member companies.

The requestor provides necessary data to support the request. The data package should include a document that justifies the request by describing the possible observations of the existing model codes such as core dump or convergence failures in extractions and simulations, excessive simulation overhead, unsatisfactory fitting accuracy due to model formulation problems or missing device physics effects, ease of use issues with the model, etc. When applicable, the data package should also include proposed fixes and/or model equations, measurement data, or improved modeling fitting or verified simulation results to aid the CMC in assessing the request and any potential model release to follow. In almost all cases, test cases and reference model parameter files as well as simulation results should be included in the data package.

2.2.2 Step 1b: Making a bug fix request to a simulator vendor

A bug fix requestor informs the simulator vendor via the particular vendor's standard support request mechanism. The simulator vendor performs an initial evaluation of the request based on the data provided by the requestor to determine if the bug is related to model implementation in the simulation tool or the model formulation itself. If the bug is tool related, the standard simulator vendor bug fix procedure should be followed. Otherwise, the bug fix requestor should resubmit the bug fix request to the CMC as outlined in step 1a.

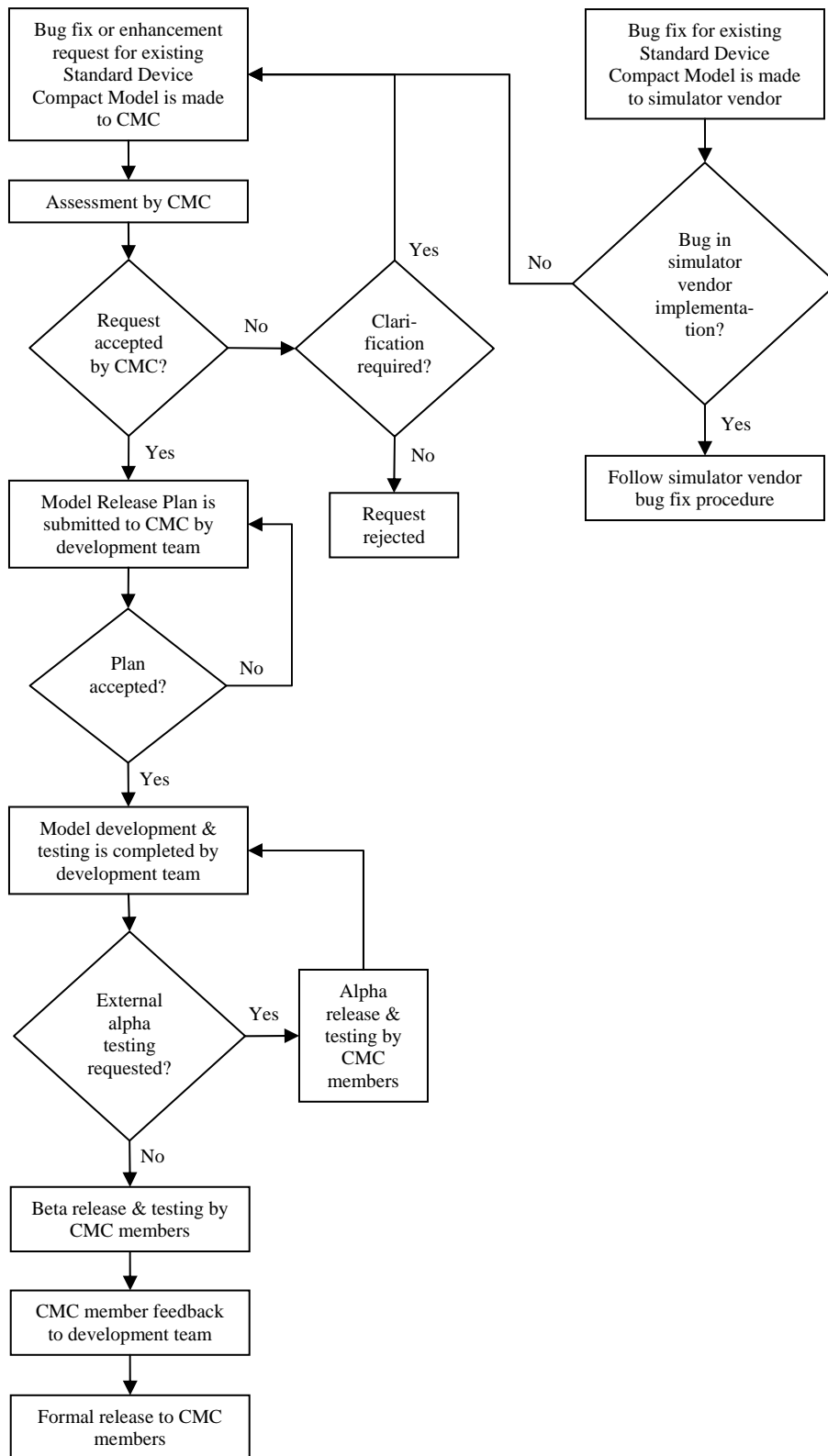


Figure 2 Flow chart of CMC standard device compact model release procedure for bug fixes and/or enhancements to existing standard models

2.2.3 Step 2: CMC assessment of request

Based upon the information provided by the requestor, the CMC Model QA and Release subcommittee will review the technical merits of a request and make a recommendation to the entire CMC at a face-to-face meeting, a phone meeting, or via email. CMC members may be asked to assist with the evaluation of a request based on expertise related to or interest in a particular request. Part of the assessment of a request will be to determine whether or not the data provided with the request is sufficient for the CMC to reach a conclusion and for the model development team to generate a successful release. If the data provided with the request is insufficient, the CMC needs to specify what additional information is required to enable further assessment by the CMC. Ultimately, the CMC will determine whether or not to accept the request and into which release the request should be included. At least one beta tester for each bug fix or enhancement feature item will be solicited at this time.

2.2.4 Step 3: Release plan

No later than ten business days after the CMC agrees to make a request into a new release, the model development team principal investigator(s), the CMC model development team liaison, and the CMC Model QA and Release subcommittee chairperson will issue a written release plan, including milestones, for the CMC to approve. The plan needs to specify the beta entry and exit dates, and a final formal release date as well as acceptance criteria. The plan also needs to include a brief description of the approach and methodology, including formulations and code implementations, for how the project will be developed and tested in terms of accuracy, numerical stability, version control, backward compatibility, warning/error message output, simulation overhead, etc. The release plan timeline will be set on a case by case basis depending on the work required to prepare for the release. The timing of the release should be consistent with the recommended practice of two model releases per year, unless it is determined that the request is urgent enough to warrant its own release.

2.2.5 Step 4: CMC to review and sign-off the release plan.

CMC review of the release plan will be coordinated by the CMC Model QA and Release subcommittee chairperson and will typically involve the CMC model development team liaison, the CMC Model QA and Release subcommittee, and representatives of the CMC Executive committee. CMC feedback on the release plan should be completed within five business days. The model development team is responsible for making any refinements to the release plan as identified during the CMC review.

2.2.6 Step 5: Development, implementation, and alpha testing

The model development team starts to develop and implement new model equations/code, or starts to make bug fixes based on what has been agreed to in the finalized release plan. The model development team is also responsible for model alpha testing. If the model development team requires assistance with alpha testing, notification must be sent to the CMC executive committee and the CMC Model QA and Release subcommittee chairperson so that all CMC member companies can be notified of the request and given equal access to alpha code. The model development team is not required to provide code for alpha testing, and CMC members are not required to provide alpha testing feedback if alpha code is made available to all members.

2.2.7 Step 6: Beta release and testing

On the date specified in the release plan, the beta release should be made readily available to all CMC member companies. All CMC members are encouraged to participate in beta testing. Volunteer beta testers will be solicited for specific aspects of a model that are new or have undergone major revision since the model was evaluated for standardization. It is the obligation of volunteer beta testers to perform thorough evaluations of the items each tester has agreed to evaluate to see if the code has met the requirements set forth in the release plan.

2.2.8 Step 7: Beta exit

On the beta exit date, all beta testers need to provide evaluation feedback to the model development team as well as the CMC Model QA and Release subcommittee via the subcommittee chairperson. The model development team and the CMC Model QA and Release subcommittee will make sure all issues in the beta feedback reports will be addressed for the formal release.

2.2.9 Step 8: Status report to CMC

The model development team and the CMC Model QA and Release subcommittee will inform the CMC if the model has addressed all requests (whether bug fixes, enhancements, or both), if all known issues from beta testing have been fixed, and whether or not the model code, test cases, reference simulation results, and release documents are ready for a formal release.

2.2.10 Step 9: Formal release once CMC confirms readiness

3 Model Release Documentation (Model Development Team):

The following documentation is required by the CMC for all releases of CMC-certified standard models by a model development team:

- General release notes providing high-level overview of model capabilities, enhancements, and/or bug fixes included in given release
- Bug fix report providing a detailed listing of bug fixes included in given release
- Manual providing detailed documentation on:
 - model features and formulation including model equations in human readable format
 - model parameter names, descriptions, units, default values, and recommended ranges
 - recommended model extraction procedures
- Model in Verilog-A or C-code format with a consistent and documented version control mechanism
- Model QA test specifications and reference test results per *CMC Compact Model QA Specification*

It is important to note that all documents associated with a release should contain the release version information. Furthermore, each file associated with model code as well as model QA test specifications and reference test results should contain, at the beginning of the file header, the release version information.

For new models, where a version control mechanism has not been established, it is recommended that the version control number take the following form:

<version#>.<subversion#>.<revision#>

where the numbers in angle brackets (< >) are integers.

The model version number is used to identify a major model formulation change which requires a new model parameter set (i.e. is not backward compatible with the previous release), and is increased when such a major model formulation change has been implemented. The model subversion number is used to identify a minor model formulation change which does not require a new model parameter set (i.e. is backward compatible with the previous release). The model subversion number is increased whenever minor model formulation changes are made which do not require new model parameter sets, and is reset whenever the model version number is changed (i.e. when a major model formulation change is made). It is important to note that a model change may necessitate the use of additional model parameters, but if the model formulation and default values for the additional model parameters are chosen carefully, model parameter sets from the previous release will yield results that match those of the previous release. In this case, only the model subversion number needs to be changed since backward compatibility with the previous release is maintained.

The model revision number is used to identify different implementations of the same set of model equations. The following are examples where different implementations may arise:

- Numerical measures to improve convergence
- Restructuring of source code to increase maintainability, readability, etc.
- Small changes in the model such as changing constants used in smoothing functions or changing clipping values of model parameters

- Bug fixes which do not change the model formulation

The model revision number is increased whenever such changes occur, and is reset when the model subversion number is changed.

Model developers are strongly encouraged to use conditionals (e.g. if (subversion == 2) then ..., or if (revision <= 4) then ...) in their source code to capture model implementation changes that require changes to the model revision number or the model subversion number. In this way, a single source code file or set of source code files can cover multiple model releases, making it easier for simulator vendors to implement a new model release in their simulator. It is not expected that changes to the model version number can be handled with source code conditionals.

4 Model Release Documentation (Simulator Vendor):

The following documentation is required by the CMC for all releases of CMC-certified standard models by a simulator vendor:

- Simulator-specific release notes providing high-level overview of model capabilities, enhancements, and/or bug fixes included in given release
- Bug fix report providing a detailed listing of bug fixes included in given release
- Manual providing detailed documentation on:
 - model parameter names, descriptions, units, default values, and recommended ranges
 - simulator-specific flags or switches required to use the model in the given simulator
- Model QA test results and report based on model QA test specifications and reference test results provided by model development team per *CMC Compact Model QA Specification*

Simulator vendors should include the documentation described above in a manner consistent with their standard documentation practices.