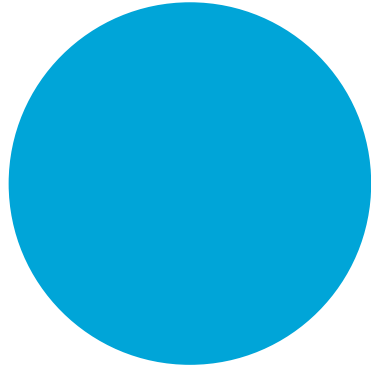


iXblue



Space grade Modulators Definitions

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Space grade Modulators definitions

iXblue can provide these categories of modulators

iXblue can provide these categories of Electro-Optical Modulators (EOM):

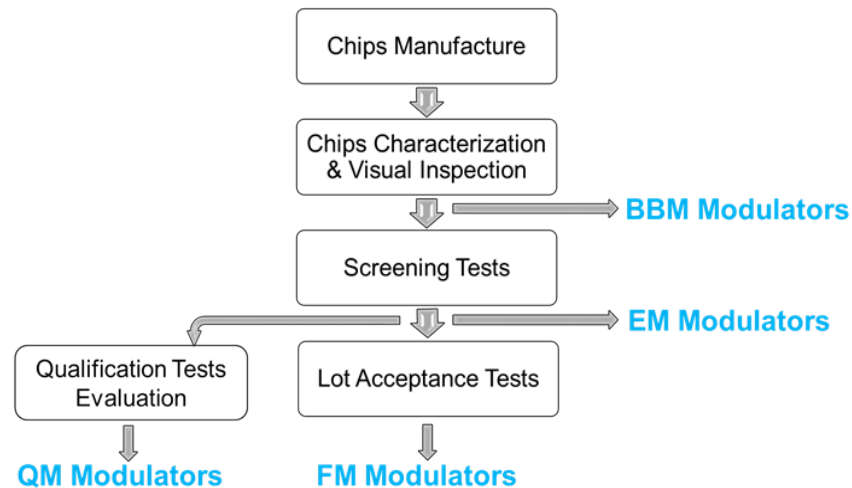
- Commercial Off-The-Shelf (COTS), products portfolio available from <https://photonics.ixblue.com/>
- Breadboard Model 1 (BBM1);
- Breadboard Model 2 (BBM2);
- Engineering Model (EM);
- Flight Model (FM).

Space grade Modulators definitions

iXblue can provide these categories of modulators

The following guidelines are intended to define the LiNbO_3 modulator models involved in the verification process and the selection of the associated model.

- The **Commercial-Off-The-Shelf (COTS)** is a commercial and standard LiNbO_3 modulator, iXblue portfolio amplitude and phase modulators are provided from <https://photonics.ixblue.com/products-list/intensity-modulators>, <https://photonics.ixblue.com/products-list/phase-modulators>.
- The **Breadboard Model (BBM)** we identify:
 - the **BBM1**: it can be seen as a COTS modulator model but with a custom LiNbO_3 chip (based on customer requirement such as an adapted EO-bandwidth, a lower $\sqrt{V\pi}$, a higher SER, a lower IL,...).
 - the **BBM2**: is identical modulators to flight hardware except for reliability and quality assurance. It is used for the confirmation of key performances (optical, electrical, electro-optical) and behavior, as well as interface and size (mechanical footprint, fibers,...).The **BBM1** & **BBM2** modulators are not intending to be submitted to tests, neither space operating condition.
- The **Qualified Model (QM) and Engineering Model (EM)** are modulators that are used for the confirmation of key performances and interface, including unit mounting scheme and thermal characteristics. These modulators are identical to flight hardware, it is sampled from flight model lot after screening test. The QMs are hardly tested following full level functional and environmental qualification tests (Qualification Tests Evaluation).
- The **Flight Model (FM)** are the modulators dedicated to fly; these are tested to acceptance-level testing (LAT Lot Acceptance Tests corresponding to a relaxed qualification tests program).



Space grade Modulators definitions

Differences between COTS, BBM1, BBM2, EM and FM

	-	COTS ⁽¹⁾	BBM1	BBM2 ⁽²⁾	EM, QM ⁽²⁾	FM ⁽²⁾
Raw material	Lithium Niobate Chip	Standard	Standard or customized ⁽³⁾	Standard or customized ⁽³⁾	Standard or customized ⁽³⁾	Standard or customized ⁽³⁾
	Metal Housing	Standard	Standard	Space-compatible	Space-compatible	Space-compatible
	Electrical & optical connectors (RF & FC)	Standard	Standard	Standard	Space-compatible	Space-compatible
	Fiber jackets	Standard	Standard	Space-compatible	Space-compatible	Space-compatible
	Fiber boots	Standard	Standard	Space-compatible	Space-compatible	Space-compatible
	Embedded elements	Standard	Standard	Space-compatible	Space-compatible	Space-compatible
	Assembly Process	-	Standard	Standard	Standard	Space-compatible
Selection	-	Standard	Standard	Standard	After screening	After screening and LAT

Standard for Space products: ESCC and/or MIL-STD if applicable.

⁽¹⁾ iXblue's standard modulator, see our portfolio on [photonics.ixblue.com](https://www.ixblue.com)

⁽²⁾ Raw material and final modulators coming from the same batch.

⁽³⁾ Custom LiNbO₃ Chip based on non-standard modulator specification.

Space grade Modulators definitions

Differences between COTS, BBM1, BBM2, EM and FM: the COTS & BBM1 package



Example of our COTS & BBM1 modulator
MXAN-LN-10

- Standard metal housing;
- Hytrel jacket;
- Standard fiber boots;
- Standard FC/APC PM;
- Standard RF connector, etc.

Space grade Modulators definitions

Differences between COTS, BBM1, BBM2, EM and FM: the space grade package



Example of Space-grade modulator (EM, QM, FM, BBM2)

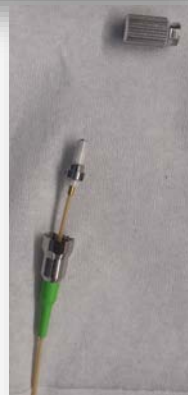
Space grade metal housing

Peek jacket;

Fiber boots space-grade;

FC/APC & Mini AVIM (only for EM, QM, FM);

RF connector space-grade (only for EM, QM, FM)



Space grade Modulators definitions

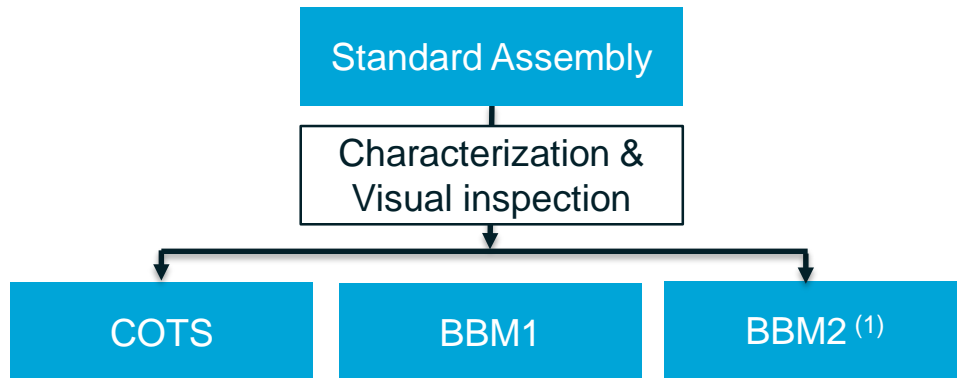
Standard and Space Assembly Process

Main differences	Assembly Process	
	Standard	Space
Pre-test on electrical bonding by using a control sample	No	Yes
Post-test on electrical bonding by using a control sample	No	Yes
Seal welding pre-test on a control sample	No	Yes
Seal welding post-test on a control sample	No	Yes
Visual Inspection (Internal elements and/or external)	Yes (~ 3 times)	Yes (~ 5 times)
Metal Housing semi-hermetic	No (Optical feedthrough screwed)	Yes
Number of manufacturing steps from Front End to EOM final test	~ 20	~ 27

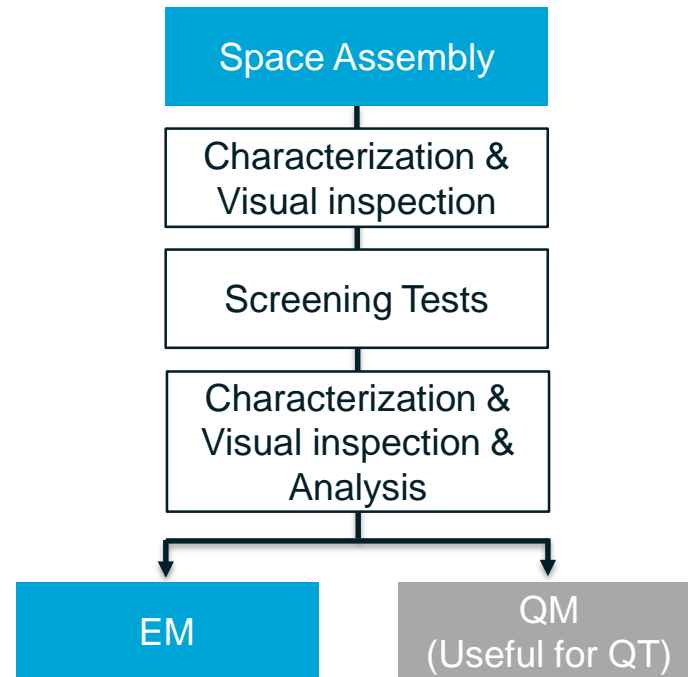
Applicable standard for Space products: ESCC and/or MIL-STD

Space grade Modulators definitions

General view of Manufacturing flow diagram



(1) Standard Assembly with [space-grade Metal housing](#)



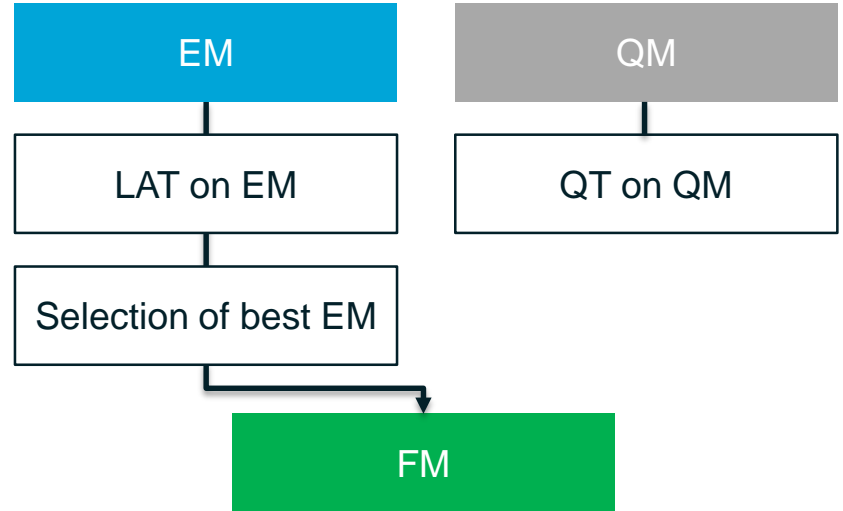
Space grade Modulators definitions

How to get Flight Model Modulators

How to get Flight Model (FM) modulators?

To get FM, in parallel we perform:

- Lot Acceptance Tests (LAT) on EM;
- The EM with the best performances during (and after) LAT become FM;
- Successful Qualification Tests (QT) on QM.



Space grade Modulators definitions

How to get Flight Model Modulators: example of Qualification Test (QT) and LAT

