

JPCA Standard

**Generic rules for
Optoelectronic Modules**

JPCA-PE04S-2004

**Generic Specification for
OE-Module Substrates**

JPCA-PE04-01-01S-2004

**Generic Specification for
Packaging Interface of OE-Modules**

JPCA-PE04-02-01S-2004

Japan Printed Circuit Association

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Generic rules for Optoelectronic Modules

JPCA-PE04S

1. Scope This standard describes the architecture of standards for optoelectronic modules realizing desired performance of a module that is composed of electronic and optoelectronic components assembled on a board. This standard also specified the numbering system of the standards in the area of optoelectronic modules.

2. Normative References

IPC-0040: Optoelectronics Assembly and Packaging Technology

JPCA-PE04-01-01 S: Generic Standard for OE modules

3. Terms and Definition Terms not specified in this section shall be as specified in IPC-1050 or IEC 60194, IPC-0040, IEC-60793, and JPCA-PE04-01-01S.

(Note: Terms and definitions will be integrated in the 6th edition of IEC 60194 that will be published in 2007.)

- 1) **OE module** An module in which optical and electronic elements are mounted on a (small) substrate to made an opto-electronic integrated circuit, usually used as mounted on printed wiring board or opto-electronic wiring board. OE package and OE-MCM are some of the synonyms of the OE module.
- 2) **Optical pig-tail** An optical fibre extruding from an OE module or an optical element. The optical pig-tail optically connects optical signal to and from an out-side optical element or another OE module.
- 3) **Optical wiring board** Generic name of a wiring board incorporating optical fiber(s) enabling fast signal transmission
- 4) **Optical wiring** A solid medium that can transmit light through it. It includes but not limited to optical fibre, optical waveguide, optical transmission, and light transmitting plastics.

4. Standard hierarchy The standard hierarchy for OE modules is given in Annex 1. The standards are classified into specifications of substrates for OE modules and the specifications to provide necessary requirements for the assembly interfaces.

5. Numbering of Optoelectronic Module Standards The construction of a document number is shown below.

	Optoelectronic Assembly	Optoelectronic module	Substrate/ Interface Standard	Standard Classification	Document number	Type of Standard	Publication year
See section:	5.1	5.2	— 5.3	— 5.4	— 5.5	5.6	— 5.7
Example:	PE	04	— 01	— 02	— 03	S	— 2003

5.1 Symbol for the Optoelectronic Assembly Standard: PE

5.2 Number for Optoelectronic Module: 04

5.3 Number for Optoelectronic module substrate/interface: Substrate – 01, Interface – 02

5.4 Classification of standards: Classified into Specification, test method, or design guideline

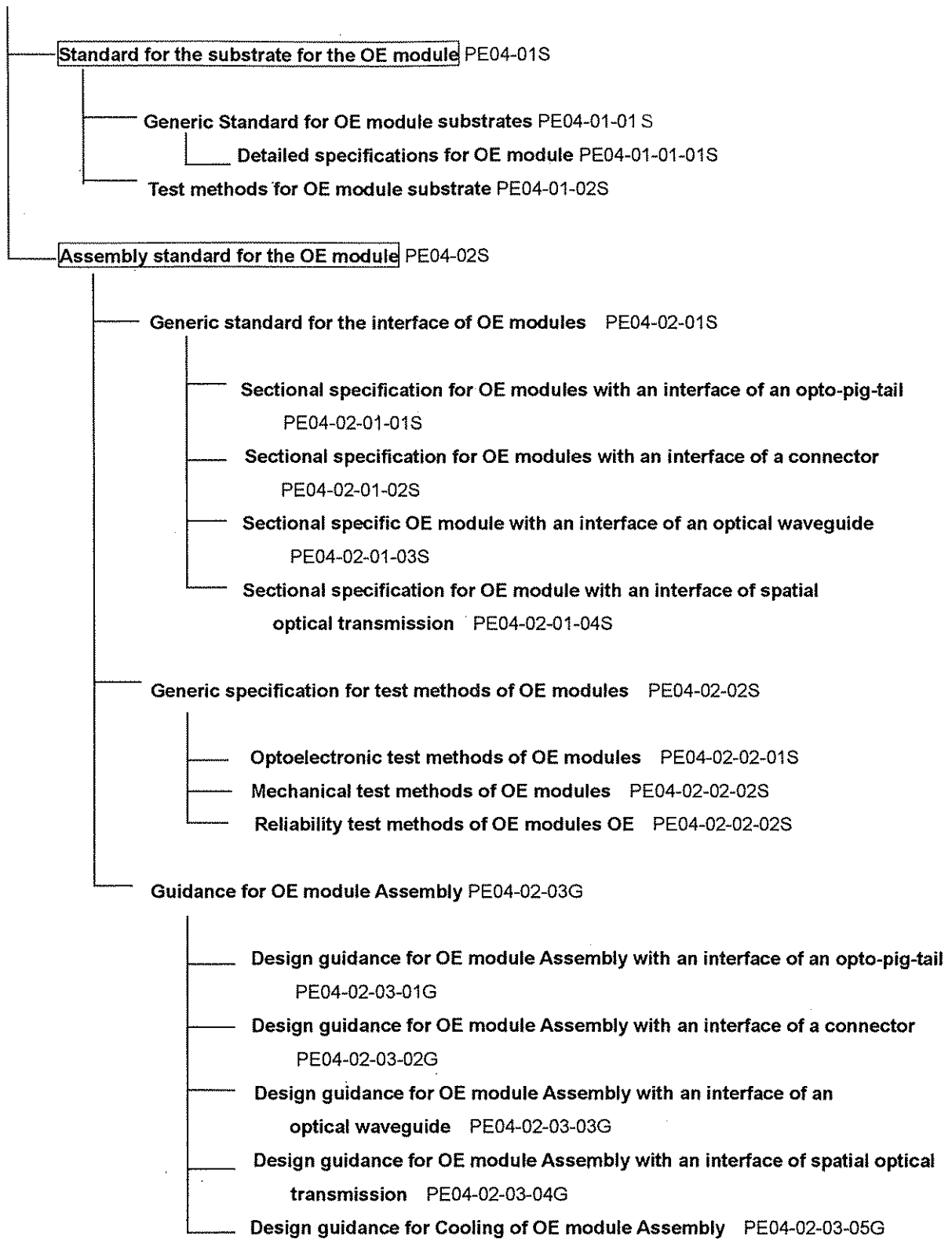
5.5 Individual Standard: A number is given for each standard classification

5.6 Symbols for types of standards: Standard – S, Guidance – G

5.7 Publication year: The year of publication of the document

Annex 1 Standard hierarchy of OE modules

Generic rules for Optoelectronic Modules (PE-04S)



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JPCA Standard

Generic Specification for OE-Module Substrates

JPCA-PE04-01-01S

1. Scope This specification gives general requirements to the substrates for OE (OptoElectric) modules.

2. Normative references

IPC-004 Optoelectronics Assembly and Packaging Technology

JPCA-PE04-02-01S General Specification for Packaging Interface of OE-Module

JIS C 5012 Measuring methods for printed wiring boards

JIS C 6521 Test Methods for pre-pregs for multi-layer printed wiring boards

UL94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances

3. Terms and definitions Terms not specified in this section shall be as specified in IPC-1050 or IEC 60194, IPC-0040, IEC-60793, JPCA-PE02S, and JPCA-PE02-04-04S.

(Note: Terms and definitions will be integrated in the 6th edition of IEC 60194 that will be published in 2007.)

- 1) **Optoelectronic (OE) module substrate** This is the substrate used to mount small sized optoelectronic integrated circuits (they may also be called as OE modules), the substrate is to be mounted on a board level substrate. The module substrate may be mounted with devices that may include transducer(s) of opto to electronic signals, devices/elements to drive the transducer, logic LSIs, and opto and electronic interconnections. The module may also have an optical and/or electric connector(s). The material of the substrate may be organic, inorganic, or an integrated material of organic and inorganic materials.
- 2) **Optoelectronic (OE) module** This is an optoelectronic integrated circuit made by mounting both opto- and electronic components on the same substrate, and to be used by mounted on a board level substrate. OE package and OEMEM are some of synonyms of the optoelectronic module.

4. Classification

4.1 Classification by the materials used The OE module substrate can be classified by the material used into: organic substrate, inorganic substrate, and compound substrate.

4.2 Classification by the mounting The OE module can be classified from the requirements in assembly processing into the following two types.

Type 1: A substrate in which electric and optical wirings do exist from the beginning.

Type 2: A substrate in which only electric wiring exists. After mounting opto and electronic components, fibres, and waveguides are mounted on the substrate to made direct interconnections of the electronic components to optical components.

For the classification of optical connection, see JPCA-PE04-02-01S.1

5. Requirements

5.1 Dimensions The requirements of dimensions specify the following dimensions.

5.1.1 Outer dimension The requirements to outer dimension specifies the outer dimension and its accuracy.

5.1.2 Pattern accuracy The pattern accuracy requirement specifies the position accuracy of electric and optical wiring patterns.

5.1.3 Coplanarity of the surface The coplanarity of the surface of a substrate specified bend and twist of the substrate.

5.2 Resistivity to process parameters The requirements of dimensions specify the following dimensions.

5.2.1 Resistance to soldering heat It specifies the resistivity to soldering heat of a substrate in processing. The test method is specified in JIS C 5012.

5.2.2 Resistance to chemicals It specifies the resistivity to chemicals of a substrate used in processing. The test method is specified in JIS C 5012.

5.3 Transmission characteristics

5.3.1 Electric characteristics The electric characteristics specify the insulation resistance, dielectric constant, and dielectric loss of the substrate.

5.3.2 Optical characteristics The optical characteristics specify the core size of the waveguide, numeric aperture, matching mode and transmission loss of the type 1 substrate.

5.4 Environmental requirements The requirements specified the test conditions and criteria for the following items.

- 1) High temperature and high humidity environment
- 2) High temperature environment
- 3) Temperature cycle environment
- 4) Thermal shock environment

5.5 Others

5.5.1 Thermal expansion It specified the thermal expansion coefficients of the materials used in substrate and in the waveguide for type 1 substrate, and the thermal expansion coefficient of the substrate for type 2 substrate.

5.5.2 Flammability It specifies the flammability of the substrate. The test method shall be in accordance with UL94. The flammability test is not required to substrates made of inorganic materials.

JPCA Standard

Generic Specification for Packaging Interface of OE-Modules

JPCA-PE04-02-01S

1. Scope This specification defines the requirements to the packaging interface of optoelectronic (OE) modules that is optoelectrically connected to other circuits in a board. This specification describes the items to be specified for the OE modules for optical connection of OE modules optically within a board in classes of 1) with an optical pig tail, 2) with an optical connector, 3) with connection to a waveguide, and 4) with spatial optical signal transmission. The purpose of setting this specification is to clarify the requirements in realizing packaging of OE modules that is composed of both optical and electronic circuits onto a board. This document, however, does not specify the functional interface nor conditions of protocol conditions.

2. Normative references

IPC-0040: Optoelectronics Assembly and Packaging Technology

JPCA-PE04-01-01S: Generic Specification for OE-Module Substrate

IEC60825-1: Safety of laser Products –Part1: Equipment classification requirements and users guide

3. Terms and Definition Terms not specified in this section shall be as specified in IPC-1050 or IEC 60194, IPC-0040, IEC-60793, JPCA-PE02S, and JPCA-PE02-04-04S.

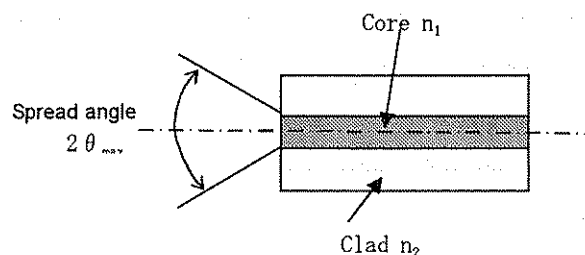
(Note: Terms and definitions will be integrated in the 6th edition of IEC 60194 that will be published in 2007.)

- 1) **Optoelectronic module (OE)** An module in which optical and electronic elements are mounted on a (small) substrate to made an opto-electronic integrated circuit, usually used as mounted on printed wiring board or opto-electronic wiring board. OE package and OE-MCM are some of the synonyms of the OE module.
- 2) **Optical pig tail** Optical pig-tail: An optical fibre extruding from an OE module or an optical element. The optical pig-tail optically connects optical signal to and from an out-side optical element or another OE module.
- 3) **Near filed diameter (NFD)** NFD is the diameter of the light flux irradiating from the light exit of a LED, an optical waveguide or an optical fibre. The diameter is defined to the diameter with the optical output power of $1/e^2$ of the maximum optical power at the center of the light flux (for an elliptic beam, the diameter is defined by the long and short diameters).
- 4) **Numerical aperture (NA)** NA is a quantity to specify the spread angle of incident and emitting light beams at the exits. The NA is defined by the following equation by the refractive indexes of the core and the clad making the waveguide and optical fibre.

$$NA = \sin \theta_{\max} = \sqrt{2 \Delta} n_1 \quad \text{where } \Delta = (n_1 - n_2) / n_1$$

n_1 : Refractive index of the core

n_2 : Refractive index of the clad



5) **Optical Signal Transmittable Range** The optical signal transmittable range is the range of frequency of the optical signal emitted from an OE module. The transmittable range is defined in terms of the optical power and the optical signal frequency in the case the optical output power depends on the speed of optical signal.

6) **Optical Signal Receivable Range** The optical signal receivable range is the range of frequency of the incident optical signal to an OE module. The receivable range is defined in terms of the optical power and the optical signal frequency in the case the optical input power depends on the speed of optical signal.

4. **Classification** OE modules are classified into following four classes depending on their packaging levels and the way of optical interconnection.

1) **OE module with a pig tail as the interface**

2) **OE module with a connector as the interface**

3) **OE module with an optical waveguide as the interface**

4) **OE module with spatial optical signal transmission as the interface**

5. Requirements

5.1 **Dimensions** The requirements of dimensions specify the following dimensions.

5.1.1 **Outer dimension** The requirements to outer dimension specifies the outer dimension of an OE module and its accuracy.

5.1.2 **Dimension of mounting area** This requirement specifies the area necessary to mount an OE module on a board.

It shall be stated if an additional area is required for the use of any other tools around the module in mounting.

5.2 **Characteristics of incident and emitting light** The following items shall be specified for an OE module as required.

Emitting light: Mode of the mode of emitting light, wavelength, power, flare angle of light, NFD, and optical signal transmission range.

Incident light: The matching mode of the incident light, wavelength, radius of incident light, and optical signal receiving range.

5.3 **Dimensional requirements to the structure of an optical connection** It specified the requirements to the structure to connect an OE module to a board.

1) **OE module with a pig tail as the interface** The types and the length of optical fibre of flexible optical waveguide.

2) **OE module with a connector as the interface:** The type of the connector.

3) **OE module with an optical waveguide as the interface:** The shape and size of a matching optical waveguide, and the accuracy required to the position adjustment in three directions (XYZ) of the optical waveguide together with the insertion loss of the waveguide.

4) **OE module with spatial optical signal transmission as the interface:** Relative position of the OE module that is used for spatial transmission of optical signal.

5.4 Electrical in- and output characteristics The requirements to the power supply (voltage, current, power) are specified. Specified are also the requirements of in- and output signals for the range of signal speed, circuitry and the signal format.

5.5 Connection and assembly requirement for electrical signal Specified are the requirements for the interconnection necessary to electric signal (soldering, connector and others) and the shapes and dimensions of necessary terminals.

5.6 Mechanical requirements

5.6.1 Resistance to vibration It specified the resistance to vibration of an OE module in short and long terms while in operation. The test method and criteria for the resistance are specified.

5.6.2 Resistance to shock The resistance to shock is tested by a drop test of a module in a package or without package. The test method and criteria for the resistance are specified.

5.7 Conditions for mounting of an OE module on a board The soldering method to mount an OE module on a board is specified when required.

5.8 Cooling condition The type of cooling method, air cooling or forced air cooling, is specified for an OE module as a condition in use. It shall be stated if a special type of cooling is required such as heat pipe, radiation fins, fan with fin, Peltier cooling, and others. The required specification for cooling shall also be clearly stated.

- 1) Natural air cooling
- 2) Forced air cooling (state also the required wind speed)

5.9 Service environment

5.9.1 Temperature and humidity requirements for guaranteed reliability of operation The upper and lower limits of the temperature and humidity requirements to guarantee a long time operation of an OE module are specified. The lower limit of humidity may not be specified if not required.

5.9.2 Temperature range for a short term operation with guaranteed reliability The temperature range (upper and lower limits) to guarantee operation of no more than 1 h is specified if necessary.

5.10 Flammability The flammability of the material having the least flammability among the major materials used in an OE module (cover, substrate or optical waveguide) is specified.

5.11 Environmental conditions The environmental conditions shall be specified for either the ranges of environmental condition guaranteeing satisfactory operation of an OE module, or the environmental condition for the most vulnerable component used in the module. Test conditions and criteria for judging the functional operation of an OE module are specified in the following items.

- 1) High temperature and high humidity

2) **High temperature**

3) **Temperature cycle**

4) **Thermal shock**

5.12 Transportation and storage

5.12.1 Transportation and packing The requirements for packing are specified to avoid damage or degradation of characteristics of an OE module, if required.

5.12.2 Temperature and humidity in storage The requirements for the temperature and humidity in storage, and the limited duration of storage are specified for an OE module, if required.

5.13 Marking

5.13.1 Marking for the safety of laser products Marking shall be made on an OE module on a place easily recognizable in accordance to IEC 60825-1.

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