Annual Technical Report 2016

Year Ended March 31, 2017

OITDA
Optoelectronics Industry and Technology Development Association

Message from OITDA

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Development Association (OITDA)

It is my pleasure to present to you an Annual Technical Report 2016, which outlines the result of our surveys, research and development activities in FY 2016.

According to the Optoelectronics Industry Trends Survey conducted every year by our association (OITDA), the total shipments of the optoelectronics industry decreased by 13.7% in FY 2016 to 14,517 billion yen, following a decrease of 5.1% in FY 2015. Domestic production also decreased by 11.9% to 7,837.3 billion yen in FY 2016, following a decrease of 2.3% in FY 2015. The decrease is mainly attributable to the significant drop in the photovoltaic energy field (-22.9% in total shipments, -25.5% in domestic production). Total shipments in other fields of the optoelectronics industry also decreased: -14.8% for optical communication equipment/systems, -9.5% for optical storage, -15.8% for display equipment, and -18.7% for input/output equipment. Various negative conditions occurred at the same time in FY 2016 although the causes of the decrease varied in each field.

Meanwhile, fields such as laser/optical processing equipment (+13.5% in total shipments), LED lighting equipment (+8.0%), optical communication components (+7.1%), optical sensing and measuring equipment (+2.8%), and image sensors (+2.5%) remained brisk. The good performance in these fields is mainly attributable to the investment in Japan's automotive industry and data centers outside Japan. Typical products of the former includes fiber lasers for processing and image sensors essential for automated driving systems, while the latter includes components such as light emitting and receiving devices, optical fibers, and optical sensors. Optical sensors such as image sensors will contribute significantly to the development of AI, IoT, robots, and medical equipment technologies which have been strongly promoted by the government. It becomes more important than ever for optoelectronics industry to formulate technology development strategy, commercialization strategy, and standardization strategy for these new emerging markets in addition to the existing market.

OITDA has been engaged in the following priority issues in order to select optoelectronics technologies with the potential to be developed into industry and to turn the potential into realty: (1) survey and research on the optoelectronics technology and industry; (2) promotion of technology development; (3) promotion of standardization; (4) creation of new business and development of human resources. In FY 2016, we directed our efforts to these issues as in previous years and, based on the results of such efforts, also conducted dissemination and education, international exchange and cooperation and provision of information on the optoelectronics technology and industry.

Details of the activities and the outcomes of individual issues are presented in the report. Here, I would like to introduce noteworthy events in FY 2016. First, we created a road map for the "automotive photonics"(optoelectronics technologies for an automobile), which has been drawing attention as a new field of the optoelectronics industry as mentioned above, in the hope that it will be utilized as guidelines which contribute to the development of the optoelectronics industry. We presented the road map at the Symposium on the Optoelectronic Industry and Technology held on February 9, 2017. The road map is expected to be reflected in R&D activities in industry, academia and government. In terms of standardization, we hosted the ISO/TC 172/SC 9 meeting on laser measurement in Kurashiki, Japan to promote international contribution. Further in the project of the Ministry of Economy, Trade and Industry, we created and proposed draft standards for in-vehicle high-speed optical Ethernet, connector parameters of physically contacting optical fiber, and new laser safety guard material and test method at IEC, ISO, and IEEE meetings.

In order to support the growth of optoelectronics technology and industry, OITDA will strengthen and enhance our activities in accordance with needs, under the guidance of the Ministry of Economy, Trade and Industry and other governmental organizations, with the understanding and cooperation of our supporting members and many other people from the business world and the academic community who are our important partners. We look forward to your continued guidance, support and cooperation.

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Optoelectronics Industry Trends

1. Introduction

Since its foundation in 1980, thanks to great support and cooperation of the affiliated members and enterprises, OITDA has conducted its annual "Survey of Trends in the Optoelectronics Industry." The data accumulated continuously over more than 30 years are regarded highly as basic information on optoelectronics industry trends.

The purpose of this survey is to suggest the future direction of the optoelectronics industry through an analysis of its current status. In this fiscal year, as in the previous year, seven field-specific committees: optical communications, optical storage, input/output equipment, display and solid-state lighting, photovoltaic energy, laser/optical processing, and sensing and measuring were established under the Optoelectronics Industry Trend Research Committee (parent committee) to survey and analyze the trends in each field and the optoelectronics industry as a whole.

2. Total Shipments and Domestic Production for the Optoelectronics Industry

2.1 Survey of Total Shipments and Domestic Production for the Optoelectronics Industry

A survey of total shipments and domestic production for the optoelectronics industry was conducted as described below.

In order to determine the industry trends of domestic enterprises which manufacture optoelectronics-related products (optoelectronics equipment/systems and optical components), questionnaire survey was carried out by sending questionnaires about actual results of FY2015, estimated values of FY2016 and qualitative projections for FY2017 concerning all shipments including overseas production and domestic production to 271 enterprises in October 2016 and collected them from December 2016 to February 2017.

In addition to the questionnaire survey, we also referred to the data of Japan Photovoltaic Energy Association (JPEA), Japan Lighting Manufacturers Association (JLMA), Camera & Imaging Products Association (CIPA) and Fuji Chimera Research Institute, Inc. for photovoltaic energy field, solid-state lighting field, display field and input/output equipment field, respectively.

Based on the results of the questionnaire and the references, total shipments, domestic production and industry trend in each product field were analyzed by the field-specific research committees established under the Optoelectronics Industry Trend Research Committee. The validity of the data and analysis results was reviewed by the Optoelectronics Industry Trend Research Committee, and the research results were compiled as a report on Optoelectronics Industry Trend in Japan.

In this survey, the Optoelectronics industry is categorized into the following seven product fields and "Others", while each product field is further categorized into equipment/systems and components.

1. Optical Communication: Optical transmission equipment/system, optical fiber fusion splicing, light emitting device, photo detection device, optical passive component, optical fiber, optical connector, etc.

2. Optical Storage: Optical disc equipment (read-only, recording and playing types), optical disc media, laser diodes, etc.

3. Input/Output: Optical printers, multifunction printers (MFP: optical and ink-jet), digital cameras (interchangeable lenses: single-lens reflex, mirrorless type (only the body without lens for both) and compact type), digital video cameras (including business use), camera mobile phones, tablet computers, etc.

4. Display and Solid-state Lighting: Flat panel display devices and equipment, projector, solid-state lighting devices and equipment, LED (for lighting and displays), etc.

5. Photovoltaic Energy: Photovoltaic power generation systems, photovoltaic cells and modules

6. Laser/Optical Processing: Laser/Optical processing equipment, lamp/LD lithography, additive manufacturing (3D printer), laser oscillator, etc.

7. Sensing and Measuring: Optical measuring instruments, optical sensing equipment

8. Others: Hybrid optical device, etc.

(Notes)

Dotted underline:	Items added to optoelectronics products since FY 2009 research.
Single underline:	Items added to the optoelectronics products since FY 2010 research.
Dashed line:	Items added to optoelectronics products since FY 2013 research.
Wavy line:	Items added to optoelectronics products since FY 2014 research
Double underline:	Items added to optoelectronics products since FY 2015 research.

2.2 Overview of Survey Results of Total Shipment

Table 1 shows actual total shipments for FY 2015, estimated total shipments for FY 2016 and a qualitative projection of total shipments for FY 2017.

The blue shaded sections in Table 1 represent optoelectronics equipment/systems, and the yellow sections represent optical components.

● FY 2015 (results): 16,825.9 billion yen, growth rate: −5.1%

In FY 2015, the total shipment value (results) for the optoelectronics industry was 16,825.9 billion yen (growth rate: −5.1%):11,851 billion yen for optoelectronics equipment/systems (growth rate: −5.9%, component ratio: 70.4%) and 4,974.9 billion yen for optical components (growth rate: −2.9%, component ratio: 29.6%).

The shipment value by field was:

531.4 billion yen for the optical communication field (growth rate: +2.1%, component ratio: 3.2%),

1,054 billion yen for the optical storage field (growth rate: −6.7%, component ratio: 6.3%),

4,068.9 billion yen for the input/output equipment field (growth rate: −7.2%, component ratio: 24.2%),

6,544.9 billion yen for the display and solid-state lighting field (growth rate: +5.3%, component ratio: 38.9%),

3,733.4 billion yen for the photovoltaic energy field (growth rate: −19.6%, component ratio: 22.2%),

558.6 billion yen for the laser/optical processing field (growth rate: +9.2%, component ratio: 3.3%), and

249.7 billion yen for the sensing and measuring field (growth rate: +4.6%, component ratio: 1.5%).

● FY 2016 (estimation): 14,517 billion yen, growth rate: −13.7%

The total shipment value for the optoelectronics industry in FY 2016 is estimated to decrease significantly to 14,517 billion yen (growth rate: −13.7%): 10,053.9 billion yen for optoelectronics equipment/systems (growth rate: −15.2%, component ratio: 69.3%) and 4,463.1 billion yen for optical components (growth rate: −10.3%, component ratio: 30.7%).

The shipment value by field is estimated to be:

528.5 billion yen for the optical communication field (growth rate:

−0.5%, component ratio: 3.6%),
954.3 billion yen for the optical storage field (growth rate: −9.5%, component ratio: 6.6%),
3,429.4 billion yen for the input/output equipment field (growth rate: −15.7%, component ratio: 23.6%),
5,746.9 billion yen for the display and solid-state lighting field (growth rate: −12.2%, component ratio: 39.6%),
2,876.7 billion yen for the photovoltaic energy field (growth rate: −22.9%, component ratio: 19.8%),
634.1 billion yen for the laser/optical processing field (growth rate: +13.5%, component ratio: 4.4%), and
256.8 billion yen for the sensing and measuring field (growth rate: +2.8%, component ratio: 1.8%).

● A slight decrease is likely in FY 2017 (projections)

The total shipment value for the optoelectronics industry in FY 2017 is projected to decrease slightly. A slight decrease is projected for both optoelectronics equipment/systems and optical components. By field, the optical communication field will remain steady, and the optical storage field will slightly decrease. The input/output equipment field will remain steady, and the display and solid-state lighting field will slightly increase. The photovoltaic energy field will decrease, while the laser/optical processing field and the sensing and measuring field will slightly increase.

2.3 Overview of Survey Results of Domestic Production

Table 2 shows the actual domestic production for FY 2015, estimated domestic production for FY 2016 and a qualitative projection of the domestic production for FY 2017.

● FY 2015 (results): 8,896.2 billion yen, growth rate: −2.3%

The domestic production value (results) for the optoelectronics industry in FY 2015 almost remained steady at 8,896.2 billion yen (growth rate: −2.3%): 5,236.1 billion yen for optoelectronics equipment/systems (growth rate: −5.0%, component ratio: 58.9%) and 3,660 billion yen for optical components (growth rate: +1.7%, component ratio: 41.1%).

The production value by field was:
450.8 billion yen for the optical communication field (growth rate: +2.7%, component ratio: 5.1%),
234.7 billion yen for the optical storage field (growth rate: +1.0%, component ratio: 2.6%),
1,084.4 billion yen for the input/output equipment field (growth rate: +1.7%, component ratio: 12.2%),
3,309.9 billion yen for the display and solid-state lighting field (growth rate: +5.4%, component ratio: 37.2%),
3,030 billion yen for the photovoltaic energy field (growth rate: −13.2%, component ratio: 34.1%),
544.5 billion yen for the laser/optical processing field (growth rate: +9.2%, component ratio: 6.1%), and
166.8 billion yen for the sensing and measuring field (growth rate: +0.2%, component ratio: 1.9%).

● FY 2016 (estimation): 7,837.3 billion yen, growth rate: −11.9%

The domestic production value of the optoelectronics industry in FY 2016 is estimated to decrease significantly to 7,837.3 billion yen (growth rate: −11.9%): 4,560.9 billion yen for optoelectronics equipment/systems (growth rate: −12.9%, component ratio: 58.2%) and 3,276.4 billion yen for optical components (growth rate: −10.5%, component ratio: 41.8%).

The production value by field was:
441.8 billion yen for the optical communication field (growth rate: −2.0%, component ratio: 5.6%),
205.9 billion yen for the optical storage field (growth rate: −12.3%, component ratio: 2.6%),
1,008.1 billion yen for the input/output equipment field (growth rate: −7.0%, component ratio: 12.9%),
3,053.9 billion yen for the display and solid-state lighting field (growth rate: −7.7%, component ratio: 39.0%),
2,258.8 billion yen for the photovoltaic energy field (growth rate: −25.5%, component ratio: 28.8%),
618.1 billion yen for the laser/optical processing field (growth rate: +13.5%, component ratio: 7.9%), and
171.5 billion yen for the sensing and measuring field (growth rate: +2.9%, component ratio: 2.2%).

● A slight decrease is likely in FY 2017 (projections)

Domestic production for the optoelectronics industry in FY 2017 is projected to decrease slightly. A slight decrease is projected for both optoelectronics equipment/systems and optical components. By field, the optical communication field will remain steady, and the optical storage field will decrease slightly. The input/output equipment field will remain steady, and the display and solid-state lighting field will slightly increase. The photovoltaic energy field will decrease, while the laser/optical processing field and the sensing and measuring field will increase slightly.

2.4 Trends in the Total Shipment for the Optoelectronics Industry

(1) Changes in the Total Shipment for the Optoelectronics Industry

Figure 1 shows the changes in the total shipment value and the rate of growth from the previous fiscal year for the six years from FY 2009 to FY 2016. The nominal GDP (1/10 of the actual value) and the domestic and overseas output of the Japanese electronics industry have been added as a reference for a comparison between the total shipment value for the optoelectronics industry and domestic production for the Japanese economy and other industries.

In FY 2014, the overall output of the optoelectronics industry remained steady (+2.0%) due to the significant increase in the previous fiscal year. In FY 2015, the output decreased for the first time in three years (−5.1%). In FY 2016, the output is estimated to decrease significantly (−13.7%) due to considerable decrease in the photovoltaic energy field, etc.

Figure 2 shows the changes by field. In FY 2015, the total shipment of the display and solid-state lighting field increased slightly due to the increase in display devices (attributed to the expansion of the smartphone and tablet device market) and LED lighting devices (attributed to the growing awareness to save energy). The laser/optical processing field grew steadily due to the increase in capital investment mainly in the automotive industry. The sensing and measuring field, in which sales of security devices and in-vehicle cameras, etc. were strong, also showed a slight increase. In the input/output equipment field, image sensors remained strong, but could not compensate for the decrease in digital cameras, etc., resulting in a decrease in the total shipment. In the optical communication field, light emitting devices and other components compensated for the decrease in optical transmission equipment for trunk lines and metro lines. The shipment almost remained steady. The optical storage field decreased slightly due to the continuous price decline and decrease in demand. The photovoltaic energy field attained positive growth until the previous fiscal year. It decreased significantly in FY 2015 due to changes in the Feed-in Tariff (FIT) system and the falling purchase price.

In FY 2016, the laser/optical processing field and the sensing and measuring field are estimated to increase moderately due to the increase in capital investment (mainly in the automotive industry) and strong sales of security devices and in-vehicle cameras, etc., respectively. In the optical communication field, optical transmission equipment for

Table 1　Shipment Value of the Optoelectronics Industry (Summary)

	Product Items	FY 2014 Shipment Actual			FY 2015 Shipment Actual			FY 2016 Shipment Estimate			FY 2017 Shipment Projection
		(in million yen)		Growth Rate(%)	(in million yen)		Growth Rate(%)	(in million yen)		Growth Rate(%)	
	Optical Communications Field	520,328		-8.5	531,358		2.1	528,494		-0.5	Stable
Optical Equipment	Optical Communications Field	202,542		-23.4	169,728		-16.2	144,684		-14.8	Stable
	Truck Line and Metro Line		104,323	-36.8		93,916	-10.0		75,650	-19.4	Stable
	Subscriber Line		49,825	-10.3		38,339	-23.1		31,879	-16.8	Stable
	Router and Switch		31,211	12.1		25,407	-18.6		25,709	1.2	Positive growth
	Video Transmission (CATV, etc)		3,180	-16.0		2,985	-6.1		3,029	1.5	Positive growth
	Optical Fiber Amplifier		14,003	13.6		9,081	-35.1		8,417	-7.3	Stable
Optical Component	Optical Transmission Components	296,471		3.6	338,242		14.1	362,104		7.1	Positive growth
	Optical Transmission Link		66,166	0.9		77,874	17.7		78,964	1.4	Growth
	Light Emitting Device		42,003	13.5		55,405	31.9		67,810	22.4	Stable
	Photo Detectors		13,964	18.2		17,076	22.3		26,011	52.3	Positive growth
	Optical Passive Component		23,671	-6.1		27,849	17.7		28,799	3.4	Stable
	Optical Circuit Component		23,951	23.9		25,967	8.4		27,919	7.5	Growth
	Optical Fiber		97,058	-1.6		105,685	8.9		102,882	-2.7	Positive growth
	Optical Connector		25,952	0.6		24,402	-6.0		24,089	-1.3	Stable
	Others (Semiconductor Amplifying Element, Composite Optical Device)		3,706	32.1		3,984	7.5		5,630	41.3	Stable
	Optical Fiber Fusion Splicer	21,315		16.3	23,388		9.7	21,706		-7.2	Stable
	Optical Storage Field	1,129,820		-5.0	1,053,952		-6.7	954,283		-9.5	Little negative
Optical Equipment	Optical Disk	1,103,106		-5.0	1,031,739		-6.5	934,353		-9.4	Nagative
	Equipment		1,007,038	-4.6		939,653	-6.7		847,423	-9.8	Nagative
	Read-only (CD, CD-ROM UNIT, DVD, BD)		668,848	2.5		632,965	-5.4		600,579	-5.1	Nagative
	Recordable		338,190	-16.0		306,688	-9.3		246,844	-19.5	Little negative
	Media		34,823	-16.3		35,871	3.0		36,233	1.0	Stable
	Others (Optical Head)		61,245	-3.8		56,215	-8.2		50,697	-9.8	Little negative
	Laser Diode	26,714		-5.8	22,213		-16.8	19,930		-10.3	Stable
	Input/Output Field	4,383,145		0.5	4,068,914		-7.2	3,429,401		-15.7	Stable
Optical Equipment	Optical I/O Equipment	3,855,762		-0.9	3,491,820		-9.4	2,837,630		-18.7	Stable
	Optical Printer・MFP		777,115	8.4		769,431	-1.0		726,009	-5.6	Stable
	Digital Camera・Digital Video Camera [Note]		1,216,101	–		1,092,906	-10.1		890,018	-18.6	Stable
	Camera Mobile Phone		1,725,098	-0.1		1,508,440	-12.6		1,120,089	-25.7	Little negative
	Others (Bar Code Readers, Image Sensor, Tablet Computer, etc)		137,448	-8.4		121,043	-11.9		101,514	-16.1	Positive growth
	Image Sensor	527,383		11.4	577,094		9.4	591,771		2.5	Positive growth
	Display and Solid-state Lighting Field	6,215,342		-0.9	6,544,918		5.3	5,746,879		-12.2	Positive growth
Optical Equipment	Display Equipment	3,108,255		-11.0	3,153,734		1.5	2,653,975		-15.8	Stable
	Flat Panel Display		2,769,525	-13.7		2,826,130	2.0		2,368,043	-16.2	Stable
	Projector		272,170	17.0		280,299	3.0		244,621	-12.7	Growth
	Large-scale LED Display, etc		66,560	25.3		47,305	-28.9		41,311	-12.7	Stable
	Display Device	2,150,864		15.5	2,372,480		10.3	2,023,711		-14.7	Growth
	LED	377,278		-6.4	357,659		-5.2	372,681		4.2	Stable
	Solid-state Lighting	578,945		13.7	661,045		14.2	696,512		5.4	Positive growth
	LED Device		474,828	15.5		553,891	16.7		598,158	8.0	Positive growth
	LED Lamp		104,117	6.4		107,154	2.9		98,354	-8.2	Stable
	Photovoltaic Energy Field	4,641,830		9.8	3,733,350		-19.6	2,876,685		-22.9	Nagative
	Photovoltaic Power System	3,151,081		17.0	2,691,860		-14.6	2,036,719		-24.3	Nagative
	Photovoltaic Cell/Module	1,490,749		-2.9	1,041,490		-30.1	839,966		-19.3	Nagative
	Laser/Optical Processing Field	511,530		14.1	558,589		9.2	634,149		13.5	Positive growth
Optical Equipment	Laser and Optical Processing Equipment	442,515		13.4	485,094		9.6	569,918		17.5	Positive growth
	CO_2 Laser		70,544	10.3		64,460	-8.6		45,847	-28.9	Nagative
	Solid State Laser		33,338	5.1		37,000	11.0		37,334	0.9	Stable
	Excimer Lasers		114,819	-8.4		124,133	8.1		148,778	19.9	Positive growth
	Fiber Lasers		35,103	137.5		41,656	18.7		54,223	30.2	Growth
	Semiconductor Laser Direct Processing Equipment		2,625	8.2		2,487	-5.3		4,706	89.2	Growth
	Lamp/LD Exposure Machine		183,376	21.2		211,210	15.2		276,280	30.8	Positive growth
	Additive Manufacturing (3D Printer)		2,710	377.1		4,148	53.1		2,750	-33.7	Growth
	Oscillators	69,015		18.3	73,495		6.5	64,231		-12.6	Stable
	Optical Sensing and Measuring Field	238,857		3.8	249,735		4.6	256,783		2.8	Positive growth
	Optical Measuring Instrument	14,715		4.6	16,518		12.3	16,304		-1.3	Positive growth
	Optical Sensing Equipment	224,142		3.8	233,217		4.0	240,479		3.1	Positive growth
	Others Field	81,517		14.5	85,066		4.4	90,318		6.2	Positive growth

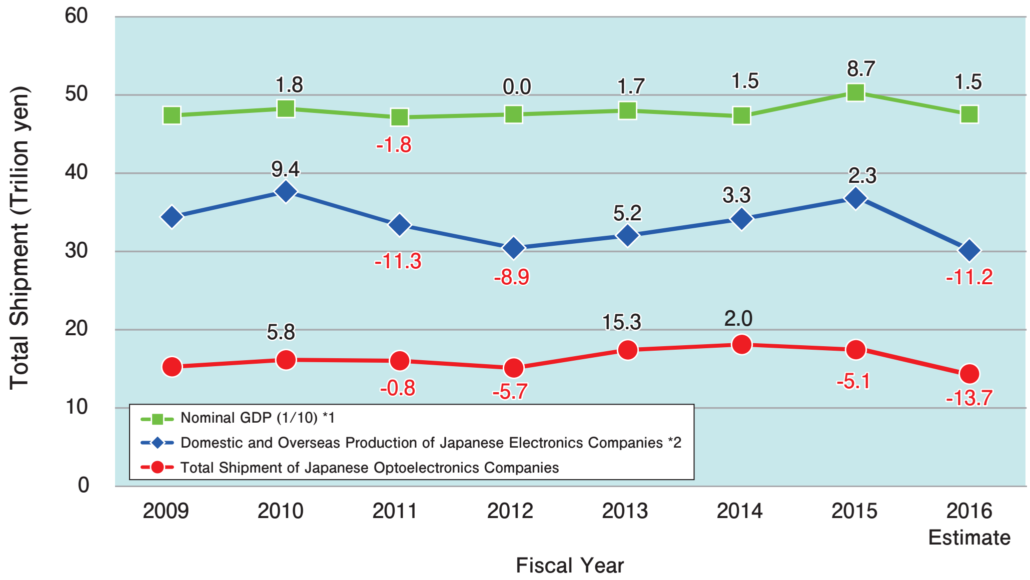
Product Items	FY 2014 Shipment Actual			FY 2015 Shipment Actual			FY 2016 Shipment Estimate			FY 2017 Shipment Projection
	(in million yen)		Growth Rate(%)	(in million yen)		Growth Rate(%)	(in million yen)		Growth Rate(%)	
Sub Total for Optoelectronics Equipment	12,598,261		0.4	11,850,989		-5.9	10,053,926		-15.2	Little negative
Sub Total for Optoelectronics Components	5,124,108		6.4	4,974,893		-2.9	4,463,066		-10.3	Little negative
Total for Optoelectronics Products	17,722,369		2.0	16,825,882		-5.1	14,516,992		-13.7	Little negative

[Note] Digital Video Camera includes cameras for Business use from FY 2014.

Table 2　Domestic Production of the Optoelectronic Industry (Summary)

	Product Items	FY 2014 Production Actual (in million yen)		Growth Rate(%)	FY 2015 Production Actual (in million yen)		Growth Rate(%)	FY 2016 Production Estimate (in million yen)		Growth Rate(%)	FY 2017 Production Projection
	Optical Communications Field	439,151		-14.4	450,827		**2.7**	441,837		-2.0	Stable
Optical Equipment	Optical Communications Field	182,514		-28.2	157,828		-13.5	132,815		-15.8	Little negative
	Truck Line and Metro Line		102,046	-37.9		92,370	-9.5		74,463	-19.4	Little negative
	Subscriber Line		47,679	-9.0		37,302	-21.8		31,299	-16.1	Stable
	Router and Switch		18,949	-24.0		17,951	-5.3		17,547	-2.3	Positive growth
	Video Transmission (CATV, etc)		2,905	-15.4		2,900	-0.2		2,928	**1.0**	Positive growth
	Optical Fiber Amplifier		10,935	17.4		7,305	-33.2		6,578	-10.0	Stable
Optical Component	Optical Transmission Components	235,322		-2.1	269,611		**14.6**	287,316		**6.6**	Positive growth
	Optical Transmission Link		39,591	-21.7		49,345	**24.6**		49,187	-0.3	Growth
	Light Emitting Device		30,401	-4.9		36,894	**21.4**		46,235	**25.3**	Stable
	Photo Detectors		8,353	-6.4		11,042	**32.2**		17,024	**54.2**	Positive growth
	Optical Passive Component		21,024	-5.9		24,863	**18.3**		26,184	**5.3**	Positive growth
	Optical Circuit Component		22,692	24.1		24,237	**6.8**		25,981	**7.2**	Growth
	Optical Fiber		90,552	3.3		99,989	**10.4**		97,618	-2.4	Positive growth
	Optical Connector		20,354	1.3		20,299	-0.3		20,252	-0.2	Positive growth
	Others (Semiconductor Amplifying Element, Composite Optical Device)		2,355	345.2		2,942	**24.9**		4,835	**64.3**	Positive growth
Optical Equipment	Optical Fiber Fusion Splicer	21,315		16.3	23,388		**9.7**	21,706		-7.2	Stable
	Optical Storage Field	232,269		-9.8	234,700		**1.0**	205,857		-12.3	Little negative
Optical Equipment	Optical Disk	232,269		-9.8	234,700		**1.0**	205,857		-12.3	Little negative
	Equipment		214,639	-10.8		217,647	**1.4**		194,030	-10.9	Little negative
	Read-only (CD, CD-ROM UNIT, DVD, BD)		180,936	-10.8		184,927	**2.2**		179,616	-2.9	Positive growth
	Recordable		33,703	-10.8		32,720	-2.9		14,414	-55.9	Nagative
	Media		17,630	4.4		17,053	-3.3		11,827	-30.6	Little negative
	Input/Output Field	1,065,828		-3.5	1,084,399		**1.7**	1,008,146		-7.0	Stable
Optical Equipment	Optical I/O Equipment	678,898		-10.5	659,051		-2.9	571,842		-13.2	Stable
	Optical Printer・MFP		104,592	-4.4		117,405	**12.3**		111,276	-5.2	Little negative
	Digital Camera・Digital Video Camera [Note]		320,665	–		298,152	-7.0		271,663	-8.9	Little negative
	Camera Mobile Phone		190,035	-32.5		187,826	-1.2		139,640	-25.7	Little negative
	Others (Bar Code Readers, Image Sensor, Tablet Computer, etc)		63,606	45.3		55,668	-12.5		49,263	-11.5	Positive growth
	Image Sensor	386,930		11.7	425,348		**9.9**	436,304		**2.6**	Positive growth
	Display and Solid-state Lighting Field	3,140,705		9.4	3,309,878		**5.4**	3,053,852		-7.7	Positive growth
Optical Equipment	Display Equipment	500,270		-12.6	508,463		**1.6**	514,977		**1.3**	Positive growth
	Flat Panel Display		471,857	-12.5		481,781	**2.1**		491,851	**2.1**	Positive growth
	Projector		25,054	-13.8		23,466	-6.3		19,629	-16.4	Nagative
	Large-scale LED Display, etc		3,359	-16.4		3,216	-4.3		3,497	**8.7**	Positive growth
	Display Device	1,980,084		20.6	2,075,463		**4.8**	1,760,257		-15.2	Growth
	LED	330,306		-9.0	327,664		-0.8	349,945		**6.8**	Positive growth
	Solid-state Lighting	330,045		12.4	398,288		**20.7**	428,673		**7.6**	Positive growth
	LED Device		318,203	15.2		387,739	**21.9**		418,714	**8.0**	Positive growth
	LED Lamp		11,842	-31.2		10,549	-10.9		9,959	-5.6	Little negative
	Photovoltaic Energy Field	3,488,824		4.4	3,030,032		-13.2	2,258,811		-25.5	Nagative
	Photovoltaic Power System	2,980,648		11.5	2,626,198		-11.9	1,968,700		-25.0	Nagative
	Photovoltaic Cell/Module	508,176		-24.0	403,834		-20.5	290,111		-28.2	Nagative
	Laser/Optical Processing Field	498,723		16.6	544,474		**9.2**	618,142		**13.5**	Positive growth
Optical Equipment	Laser and Optical Processing Equipment	430,486		16.5	472,004		**9.6**	554,750		**17.5**	Positive growth
	CO_2 Laser		68,599	8.3		62,696	-8.6		43,930	-29.9	Nagative
	Solid State Laser		29,404	13.3		32,820	**11.6**		33,203	**1.2**	Stable
	Excimer Lasers		111,096	-1.5		120,776	**8.7**		144,531	**19.7**	Positive growth
	Fiber Lasers		32,753	146.4		38,830	**18.6**		49,948	**28.6**	Growth
	Semiconductor Laser Direct Processing Equipment		2,548	5.8		2,213	-13.1		4,601	**107.9**	Growth
	Lamp/LD Exposure Machine		183,376	21.2		211,210	**15.2**		276,280	**30.8**	Positive growth
	Additive Manufacturing (3D Printer)		2,710	383.1		3,459	**27.6**		2,257	-34.7	Growth
	Oscillators	68,237		17.6	72,470		**6.2**	63,392		-12.5	Stable
	Optical Sensing and Measuring Field	166,407		3.6	166,763		**0.2**	171,527		**2.9**	Positive growth
	Optical Measuring Instrument	13,476		3.5	14,403		**6.9**	14,455		**0.4**	Positive growth
	Optical Sensing Equipment	152,931		3.6	152,360		-0.4	157,072		**3.1**	Positive growth
	Others Field	77,049		11.2	75,091		-2.5	79,155		**5.4**	Positive growth
	Product Items	FY 2014 Production Actual (in million yen)		Growth Rate(%)	FY 2015 Production Actual (in million yen)		Growth Rate(%)	FY 2016 Production Estimate (in million yen)		Growth Rate(%)	FY 2017 Production Projection
	Sub Total for Optoelectronics Equipment	5,511,010		3.2	5,236,134		-5.0	4,560,888		-12.9	Little negative
	Sub Total for Optoelectronics Components	3,597,946		5.7	3,660,030		1.7	3,276,439		-10.5	Little negative
	Total for Optoelectronics Products	9,108,956		4.1	8,896,164		-2.3	7,837,327		-11.9	Little negative

[Note] Digital Video Camera includes cameras for Business use from FY 2014.



*1 FY2016 GDP data/FY2017 Econominal Outlook (Dec.2016) [Cabinet Decision]
*2 Production Forecasts for the Global Electronics and Infomation Technology Industries, JEITA, Dec. 21, 2016

Figure 1 Changes in Total Shipment Value of Optoelectronics, Nominal GDP and Electronics Production

trunk lines, metro lines, and subscriber lines is estimated to decrease significantly. Meanwhile, optical transmission components such as light emitting/photo detection devices, etc. are estimated to remain steady. In the display and solid-state lighting field, the solid-state lighting field is estimated to remain strong due to the growing awareness to save energy. The display field including display devices is projected to decrease significantly due to the slower growth of 4K TV sets, declining prices due to the globally intense competition, and decrease in demand for iPhones in the global market. The input/output equipment field is estimated to decrease as a whole due to a significant decrease in sales related to digital cameras. The optical storage field is estimated to decrease due to the shrinking market. The photovoltaic energy field is estimated to continue to decrease significantly due to changes in the FIT and the falling purchase price.

(2) Changes in the Proportions and Contribution Ratios for the Total Shipment by Field in the Optoelectronics Industry

Figure 3 shows the changes in the proportion of the total shipment value of optoelectronics products by field over the five years from FY 2012 (actual results) until FY 2016 (estimate), while Figure 4 shows the changes in the contribution ratio for changes in the increase/decrease in total shipment of optoelectronics products for each field.

From the proportions by field (Figure 3), we can see that the photovoltaic energy field grew in FY 2013, whereas the display and solid-state lighting field declined.

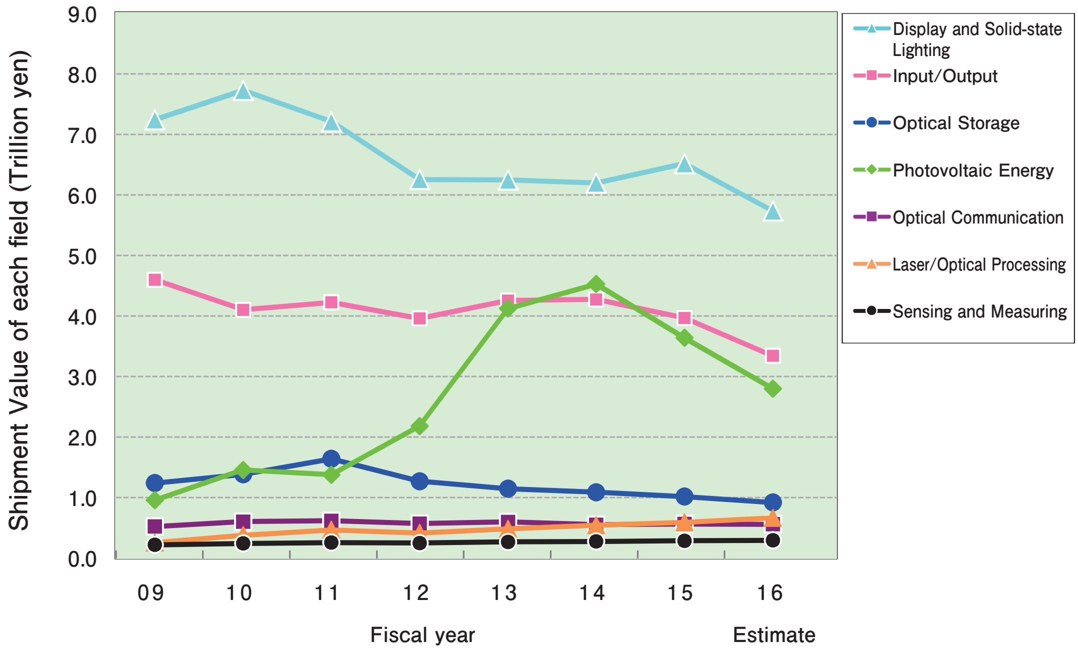


Figure 2 Changes in Total Shipment Value by Each Field

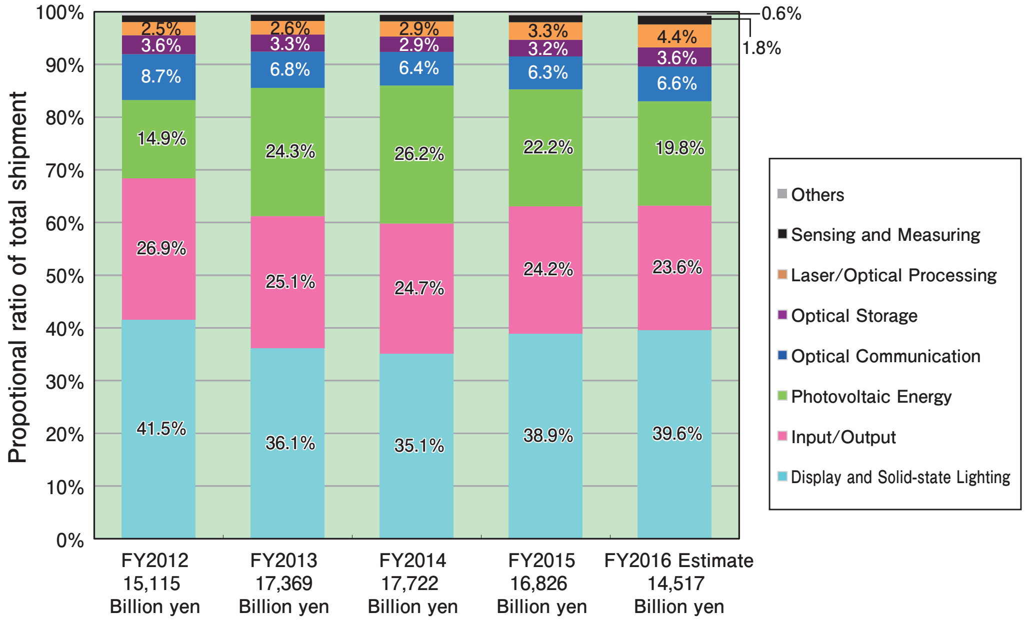


Figure 3　Changes in Proportion of Total Shipment Value by Each Field

In FY 2014, the photovoltaic energy field switched places with the input/output equipment field in shares and leapt into second position. However, the input/output equipment field returned to second place due to the decline in the share of the photovoltaic energy field in FY 2015. The share of the photovoltaic energy field is estimated to further decrease in FY 2016.

The contribution ratio by field (Figure 4) shows that the photovoltaic energy field recorded large positive growth, and the display and solid-state lighting, optical communication, laser/optical processing, and sensing and measuring fields inverted to positive in FY 2013. The other two fields were negative.

In FY 2014, the display and solid-state lighting, photovoltaic energy, laser/optical processing, and sensing and measuring fields maintained positive growth but the other three fields turned negative. In particular, growth was substantially inhibited in the photovoltaic energy field.

In FY 2015, the display and solid-state lighting, laser/optical processing and sensing and measuring fields maintained positive growth but the growth rate decreased significantly. The optical communication, optical storage and input/output equipment fields remained negative. In FY 2016, only the laser/optical processing and sensing and measuring fields are estimated to achieve positive growth, and the display and solid-state lighting and photovoltaic energy fields are estimated to be significantly negative.

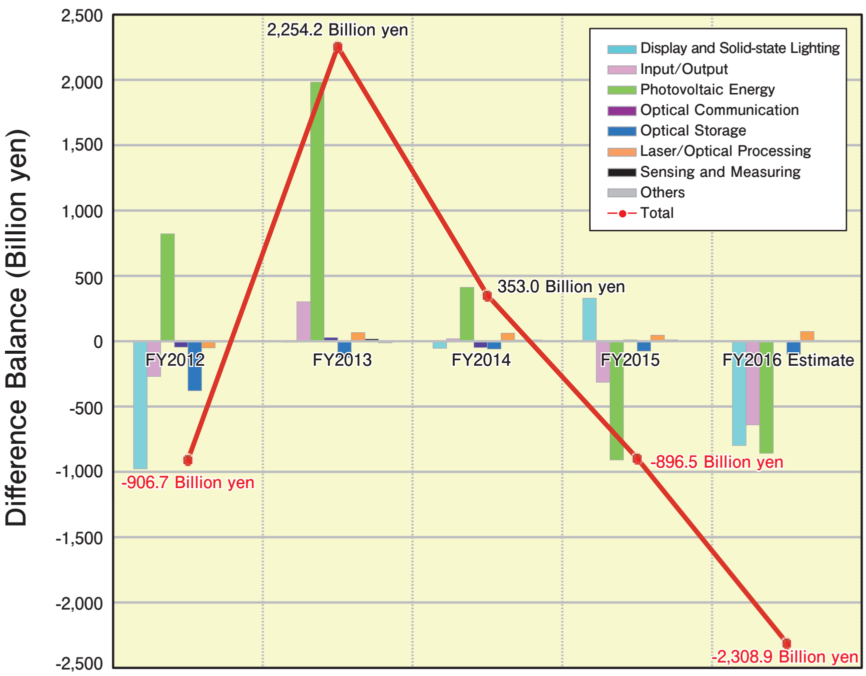
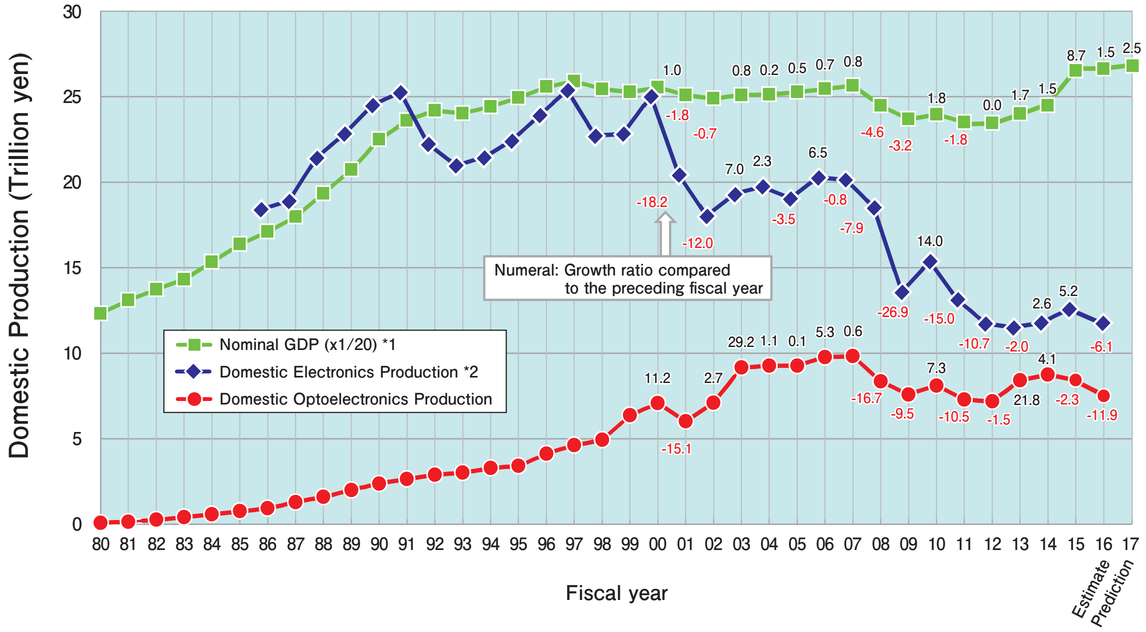


Figure 4　Changes in Contribution Ratio of Total Shipment Fluctuations in Optoelectronics Products for Each Field



*1 FY2016 GDP data/FY2017 Economical Outlook (Dec.2016) [Cabinet Decision]
*2 Production Forecasts for the Global Electronics and Infomation Technology Industries, JEITA, Dec. 21, 2016

Figure 5　Changes in Domestic Optoelectronics, Electronics Production, and Nominal GDP

2.5 Trends in Domestic Production for the Optoelectronics Industry

(1) Changes in Domestic Production for the Optoelectronics Industry

Figure 5 shows the changes in domestic production from FY 1980 to FY 2016 with the nominal GDP (1/20 of the actual value) and the domestic output of the electronics industry.

Output for the optoelectronics industry was around 80 billion yen in FY 1980 when our survey on domestic production value started, and grew in the 80s along with Japan's economy. In 1991, it accounted for one-tenth of the domestic production value for the electronics industry, and consistently maintained positive growth, exceeding the 7 trillion yen level in FY 2000. Affected by the IT recession, the optoelectronics industry recorded negative growth in FY 2001 for the first time since the survey started. After a rapid recovery, it approached the 10 trillion yen level in FY 2003, and from there on has been greatly affected by the macro economy, showing changes linked to GDP and the electronics industry. Until FY 2007 it grew slowly, but affected by the global financial recession from FY 2008 to FY 2009, it experienced two consecutive years of negative growth. The partial recovery trend seen in FY 2010 lost steam, and again has been negative in FY 2011 to FY

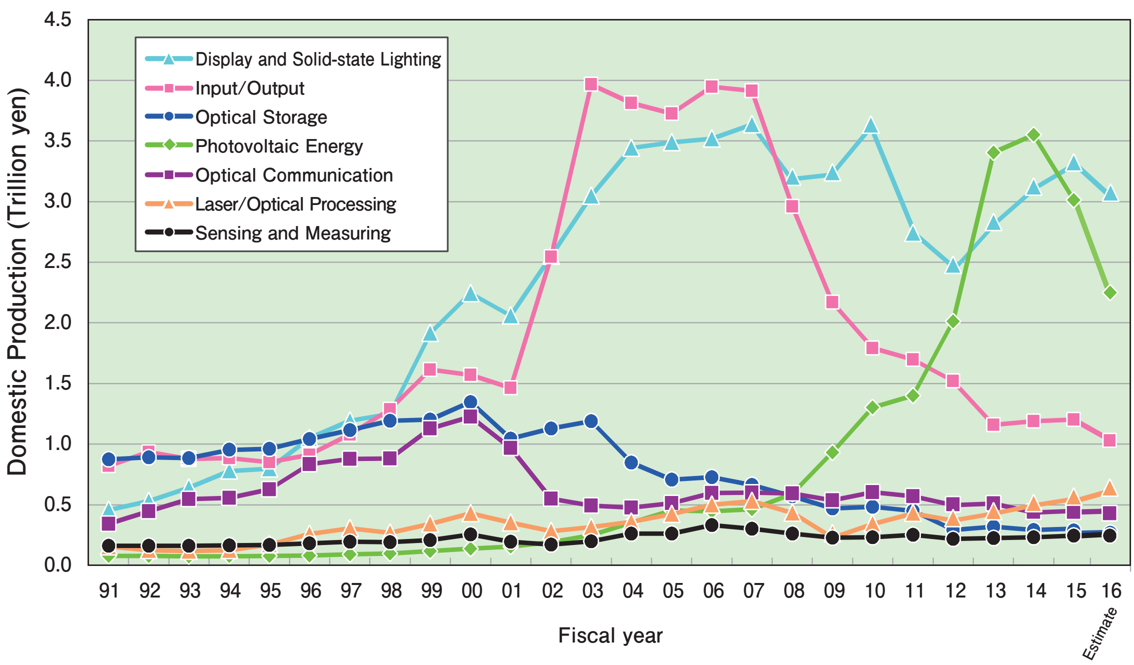


Figure 6　Changes in Domestic Optoelectronics Production by Each Field

2012. However, in FY 2013, the economy recovered due to the effects of Abenomics, as indicated by the 1.7% nominal GDP growth and the increase in capital investment and general consumption, and the domestic production value for the entire optoelectronics industry grew substantially (21.8%) for the first time in years. In FY 2014, the production also increased by 4.1% compared to FY 2013.

In FY 2015, production decreased by 2.3% for the first time in three years due to the significant decrease in the photovoltaic energy field. In FY 2016, five fields including photovoltaic energy are estimated to be negative with a significant decrease by 11.9%.

Figure 6 shows the changes in domestic production of optoelectronics products for each field over the 22 years from FY 1995 (actual results) until FY 2016 (estimate) (seven fields, excluding "Other").

During the 1990s, there was favorable growth in displays, input/output equipment, optical communications, and optical storage fields, with domestic production for each increasing to over 1 trillion yen in the year 2000. In the laser/optical processing, sensing and measuring, and photovoltaic energy fields, they also had performed favorably in the 1990s although the production value was less than 500 billion yen. However, developments in each field showed significantly different after the IT bubble burst in 2001.

There was not much decline in the input/output equipment field in FY 2001, and it also remained steady from FY 2002 onwards, but it started showing negative growth from FY 2008 onwards. In FY 2011, although it finally started showing signs of bottoming out, by FY 2012 and even in FY 2013 it followed a path of negative growth. In FY 2014, however, the trend stayed almost flat. The display and solid-state lighting field continued to grow favorably despite some fluctuations, peaked in FY 2010, and then nosedived. In particular, the domestic production value for flat display devices in the two years from FY 2011 decreased by almost 80%. On the other hand, the solid-state lighting field, which stands out in this field, attained three-digit growth in FY 2011 and double-digit growth in FY 2012. For FY 2013, although the values are not comparable with values from the previous year because of the changes in the aggregation method, production itself seems to be steadily increasing until FY 2016. However, the overall production is estimated to decrease significantly due to the decrease in the demand for TV sets and falling price, etc.

Recently, the photovoltaic energy field has been leading growth in the optoelectronics field, and has been rising rapidly since FY 2008. In particular, since the introduction of Feed in Tariff (FIT) in July 2012, production for the power industry grew substantially, and this field showed the highest proportion of the domestic production value in FY 2013. (Customarily, the display and solid-state lighting field has been the highest.) However, the growth rate dropped sharply in FY 2014, resulting in a significant decrease in FY 2015. Production is estimated to continue to decrease significantly in FY 2016.

The optical storage field is continuing its prolonged decline. It fell below 250 billion yen in FY 2012 (−40.4%) but rebounded to significantly increase by 17.1% in FY 2013. However, it reversed to a decline of −9.8% in FY 2014, and remained steady with an increase of 1.0% in FY 2015. In FY 2016, it is estimated to decrease significantly again by 12.3%.

Optical communications, laser/optical processing, and sensing and measuring, which are mainly related to the domestic market, are easily influenced by domestic economic conditions and capital investments, are reflecting the trends in the economic conditions, and grew substantially in FY 2013. In FY 2014, the laser/optical processing field grew significantly by 16.6%, and the sensing and measuring field grew slightly by 3.6%. These two fields showed a similar trend in FY 2015 and later.

Optical communications had a negative growth of −14.4% in FY 2014 due to underperformance in trunk and metro lines, etc. In FY 2015, optical transmission equipment/system was negative, but components were strong, resulting in an overall increase of 2.7%. It is estimated to remain almost flat in FY 2016.

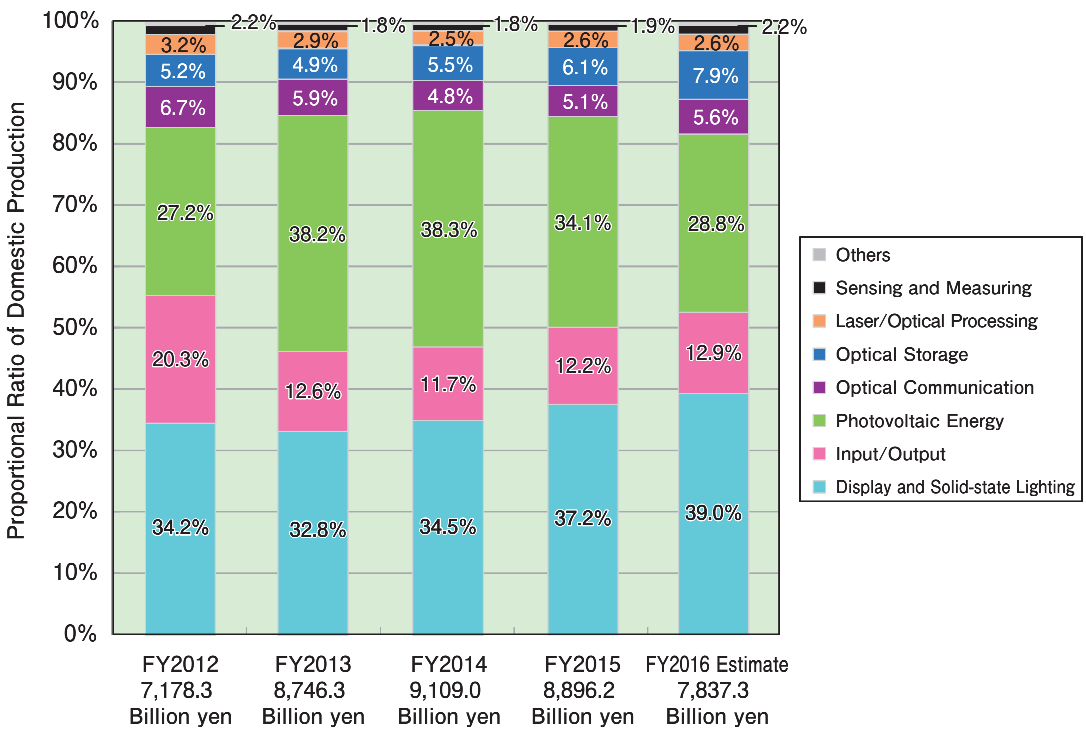


Figure 7 Changes in the Proprtion of Domestic Optoelectronics Production by Each Field

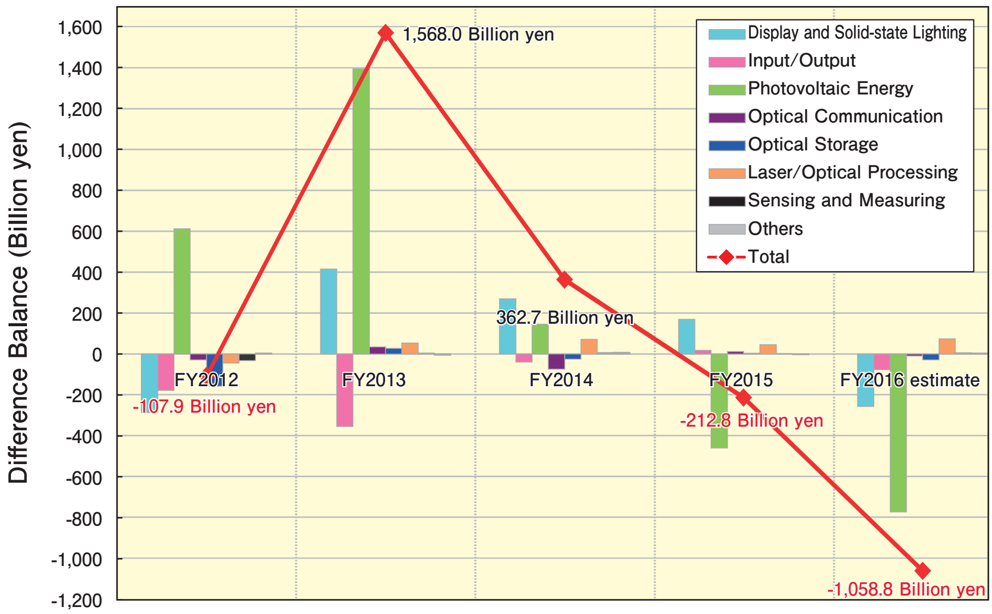


Figure 8　Changes in Contribution Ratio of Domestic Optoelectronics Production Fluctuations for Each Field

(2) Changes in the Proportions and Contribution Ratios for the Domestic Production by Field in the Optoelectronics Industry

Figure 7 shows the changes in the proportion of products for the fields comprising the domestic production value for the optoelectronics products over the five years from FY 2012 (actual results) until FY 2016 (estimate), while Figure 8 shows the changes in the contribution ratio for changes in the domestic production of Optoelectronics products for each field.

Looking at Figure 7 showing the proportion by field, three fields (display and solid state lighting, input/output equipment, and photovoltaic energy) account for approximately 80% of the whole, but due to the difference between the extents of recovery after the FY 2009 global recession, the proportions have been changing drastically. The photovoltaic energy field has continued to rise very rapidly due to FIT and the excess power purchase system, subsidies, etc.; it leapt to the top in FY 2013. In the display and solid-state lighting field, due to the response to the vigorous demand before the complete transition to digital terrestrial broadcasting (DTB) in 2011, the stronger yen, as well as the shift towards overseas production due to continuously declining prices, the domestic production of flat display devices fell nearly 80% in two years. On the other hand, solid-state lighting has continued to grow rapidly due to the growing awareness of energy conservation, but this did not fully compensate for the decline in the display field, and as a result, its component ratio fell by 1.4% from FY 2012 to FY 2013. In FY 2015, its component ratio returned to the top position due to the decrease in the photovoltaic energy field. In FY 2016, it decreased significantly, but the photovoltaic energy field also decreased significantly. Thus, its component ratio is estimated to continue to be at the top.

The input/output equipment field is estimated to decline by 7.4% from FY 2012 to FY 2016, due to the slump in the market for devices such as digital cameras and camera phones.

Regarding the contribution ratio for each field (Figure 8), the photovoltaic energy field showed a strong positive contribution in FY 2013. Only the input/output equipment field was negative. By field, the display and solid-state lighting field inverted to positive in FY 2013, but is estimated to be significantly negative in FY 2016.

The input/output equipment field finally showed signs of recovery in FY 2014. It turned slightly positive in FY 2015, but is projected to be negative again in FY 2016.

The optical communication and optical storage fields turned positive slightly in FY 2013, but inverted to negative in FY 2014 again. They showed slight positive growth in FY 2015, but are estimated to be negative again in FY 2016. Although the amount is small, the laser/optical processing and sensing and measuring fields are estimated to increase steadily in FY 2016.

Technological Strategy Development

1. Introduction

Since 1996, OITDA has undertaken "Optoelectronics Technology Roadmap Development" activities, with the aim of ascertaining the future growth of the optoelectronics industry, and seeking a direction for optoelectronics technology R&D. These activities have become one of the platforms for launching many national projects in the fields of optical communication, optical storage, displays, light energy and laser processing, and have contributed extensively to the development of the Optoelectronics industry and technology. In the roadmap development, we took an approach to take social needs as a starting point, that is, we first envisioned the future of society in order to anticipate social needs and issues, and then identified the technologies required to solve the issues.

In FY 2016, "Automotive Photonics" was selected as a theme of the roadmap, focusing on automated driving which has witnessed significant technology innovation and has attracted much public attention with growing expectations in recent years. The Automotive Photonics Technology Roadmap Committee was established, consisting of eight experts in this field from industry and academia. The committee investigated the current status and future outlook of optoelectronics technology for advancing automated driving technologies, and formulated the "Automotive Photonics" technology roadmap.

2. "Automotive Photonics" Technology Roadmap

An overview of the "Automotive Photonics" technology roadmap is shown in Figure 9 and Figure 10.

Automated driving can be classified into five levels (including the level at which no driver assistance is available) based on the system automation level and the extent of responsibility transferred to the system. In the roadmap, needs are indicated by the level of automated driving. As commercial vehicles are equipped with Level 2 systems as of 2016, we identify the required technologies from Level 3 at which the system performs all the operations (acceleration, steering, and control) and the driver takes action when requested by the system.

Note that, for the same automated driving level, the technology level required for expressways is significantly lower than that for general roads. On expressways, the types of targets to be recognized are limited because only vehicles should be handled as dynamic targets in principle, thus requiring a small sensing angle. The time required for emergency avoidance can be also longer than that on general roads if an appropriate distance is kept from the preceding vehicle, although long-distance sensing is required.

On general roads, on the other hand, there are many types of targets to be recognized, such as vehicles, pedestrians, and animals. The moving pattern and speed are different depending on the target, requiring wide-angle sensing. Given the possibility of pedestrians rushing suddenly into the road, etc., the time for emergency avoidance should be short although the sensing distance can be short.

In general, the technology level required for automated driving on general roads is higher, and so the deployment of automated driving on general roads is anticipated to take longer than on expressways. Thus, we presumed that the Level 3 automated driving on expressways would be deployed by 2025, Level 3 automated driving on general roads by 2030, and Level 4 fully automated driving in 2031 or later.

In Figure 9, system technologies required for each automated driving level are summarised. It is noteworthy that after the deployment of fully automated driving, vehicles are expected to be used in unconventional ways, and new businesses that utilize the network of automated driving systems and the cabin space during travel are expected to emerge because the fully automated driving does not need driver's intervention.

In Figure 10, optoelectronics technologies and specifications necessary for achieving respective system technologies are mapped into three categories with the timing of deployment: sensor technologies for detecting the situation outside the vehicle, human machine interface (HMI) technologies for providing external information to the driver or enabling the vehicle to monitor the driver's cognitive performance, and communication technologies outside or inside the vehicle.

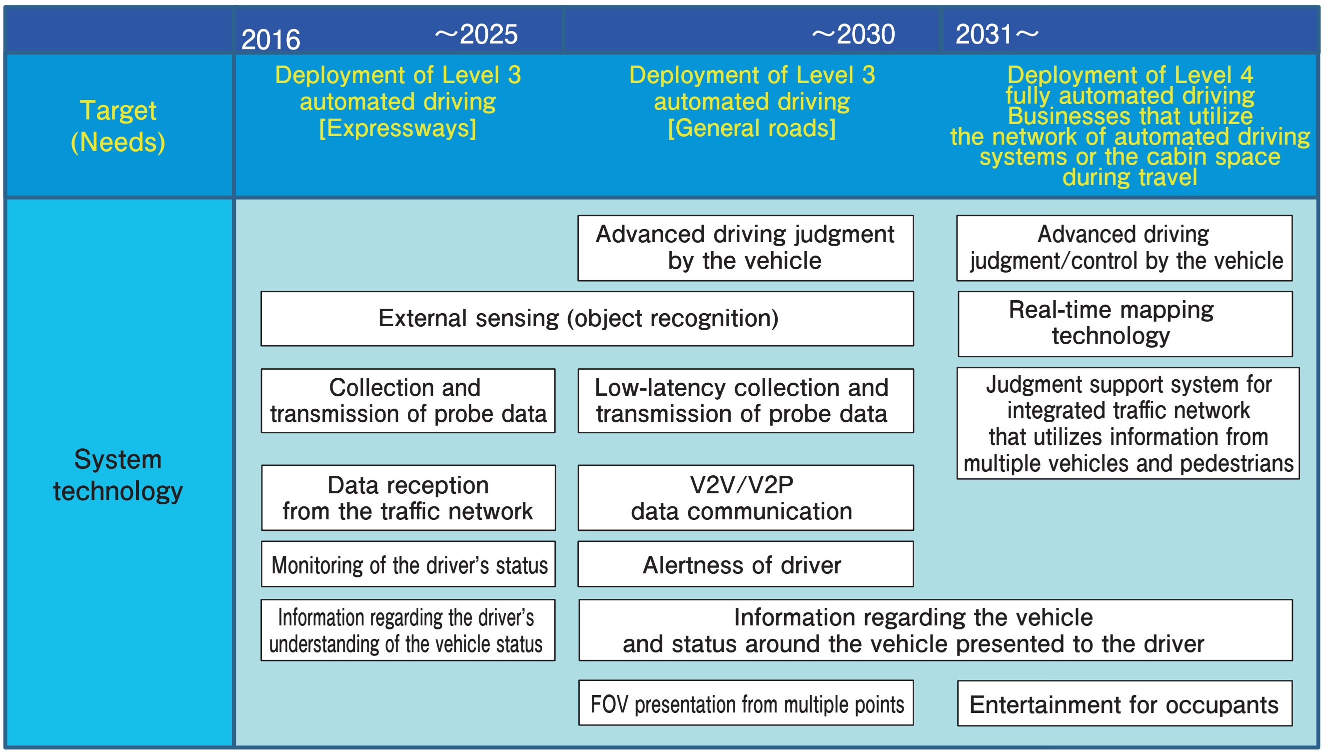


Figure 9　Automotive photonics technology roadmap (system technology)

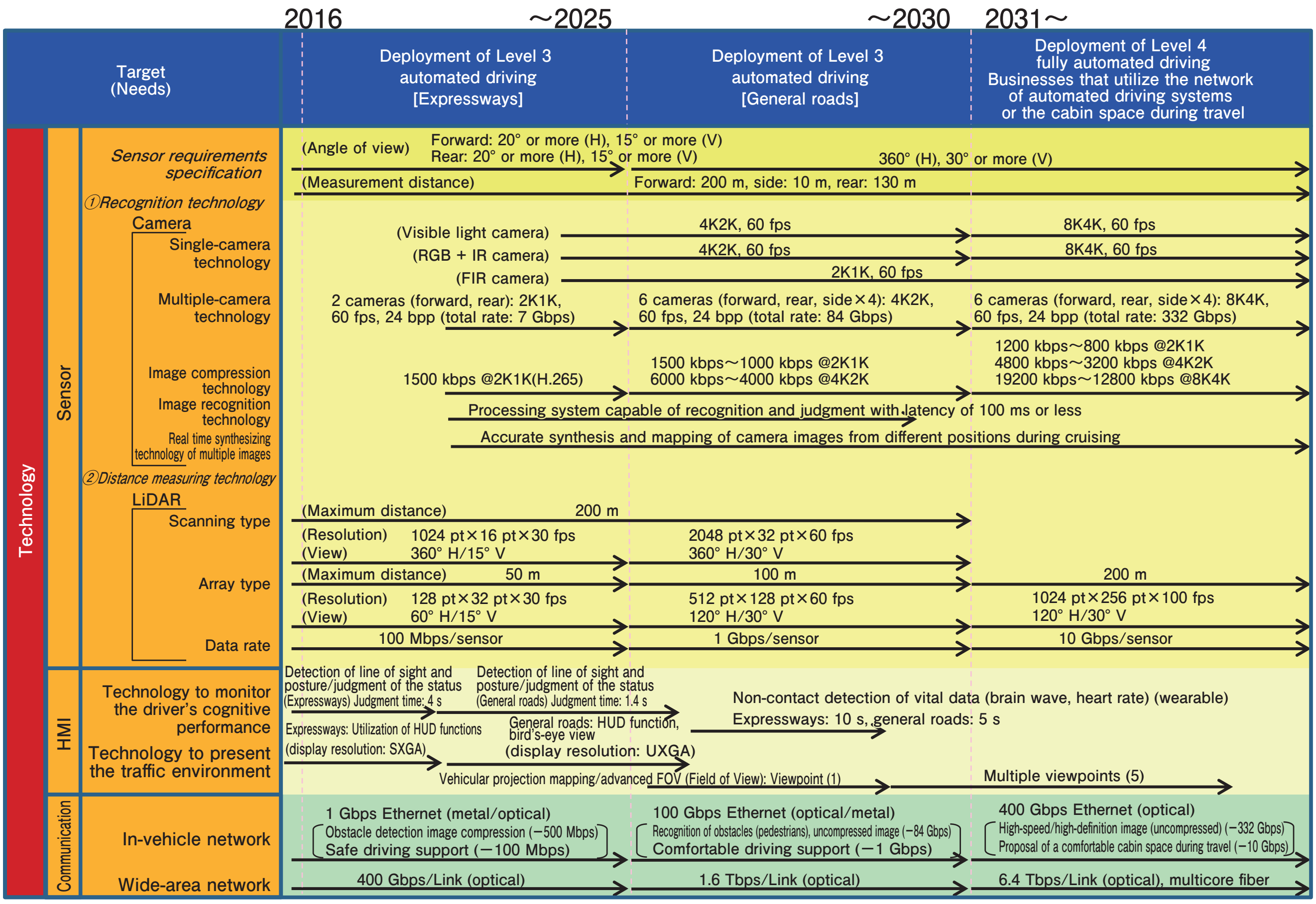


Figure 10　Automotive photonics technology roadmap (optoelectronics technology)

Standardization

1. Introduction

Standardization has been one of OITDA's major activities since its establishment, and has been promoted broadly across the optoelectronics industry. OITDA standardization efforts are mainly focused on the optical transmission field, but they also include several fiber optics application fields and lasers. Besides working for domestic standardization(JIS, OITDA standards and Technical papers), OITDA is also working on international standardization such as IEC and ISO through field specific meetings in order to respond quickly to the fast changing industrial structure.

Discussed below are the results of OITDA's international standardization activities at IEC, ISO, and IEEE and trends in FY 2016, as well as OITDA's activities in three international standardization projects contracted by the Ministry of Economy, Trade and Industry, etc.: "international standardization/dissemination of large-diameter multimode optical fiber connectors and their communications performance," "international standardization of fiber optic connector optical interfaces for fiber PC connectors," and "international standardization of test procedures for highly laser-resistant laser guards."

Table 3　Activities at the IECmeetings in FY2016 (TC 86/SC 86C/WG 2)

Date	Place	Documents
May 30 2016	Limerick (Ireland)	IEC 61757-1 Ed.3：Fibre optic sensors-Part1: Generic specification IEC 61757-2-1 Ed.1: Temperature sensors based on fibre Bragg gratings Distributed fibre strain sensors Distributed fibre acoustic sensors Current measurement – Polarimetric current Measurement
Oct 1 2016	Frankfurt (Germany)	IEC 61757 Ed.1：Fibre optic sensors-Part1: Generic specification IEC 61757-2-1 Ed.1：Temperature sensors based on fibre Bragg gratings Strain measurement – Distributed strain measurement Acoustic sensing – Distributed acoustic sensing PNW IEC 61757-4-3 Current measurement–Polarimetric current Measurement

2. IEC

2.1 Fiber Optics Standardization

2.1.1 Dynamic Module (IEC TC 86/SC 86C/WG 5)

Six IEC deliberation documents were reviewed: IEC 62343 Ed.2 (Dynamic modules – General and guidance), IEC 62343-3-4 (Dynamic modules - Part 3-4: Performance specification templates - Multicast optical switches), IEC 62343-5-2 (Dynamic modules - Part 5-2: Test methods - 1xN fixed-grid WSS - Dynamic crosstalk measurement), IEC TR 62343-6-4 (Dynamic modules - Part 6-4: Design guides - Reconfigurable optical add/drop multiplexer), IEC TR 62343-6-6 (Dynamic modules - Part 6-6: Design guide - Failure mode effect analysis for optical units of dynamic modules), and IEC TR 62343-6-10 (Dynamic modules - Part 6-10: Design guide - Intermediate controller for multiple dynamic module systems).

These six documents were reviewed at the Frankfurt meeting in October 2016. Based on the questionnaire results reported from Japan, it was agreed to prepare a template for reliability test items and a technical report on the MCOS control interface.

2.1.2 Optical Fiber Sensors (IEC TC 86/SC 86C/ WG 2)

The review of IEC 61757-1-1 (Fibre optic sensors - Part 1-1: Strain measurement - Strain sensors based on fibre Bragg gratings) and IEC 61757-2-2 (Fibre optic sensors - Part 2-2: Temperature measurement - Distributed sensing) started two years ago. These two documents were published in February and May 2016, respectively. The review of IEC 61757-1 (Fibre optic sensors - Part 1: Generic specification) also started because the numbers assigned to the standards were reorganized in the course of reviewing these two documents.

Meanwhile, Japan proposed IEC standardization for the optical fiber current sensors which have been introduced in the electricity market in Japan, in order to promote application of these sensors in other markets. New proposals were made by other countries regarding IEC 61757-2-1 (Fibre optic sensors - Part 2-1: Temperature measurement - Temperature sensors based on fibre Bragg gratings), IEC 61757-1-2 (Fibre optic sensors - Part 1-2: Strain measurement - Distributed sensing), IEC 61757-3-2 (Fibre optic sensors - Part 3-2: Distributed acoustic sensing), etc. The submeeting and IEC/TC 86/SC 86C/WG 2 are expected to become increasingly active (Table 3).

The document for optical fiber current sensors was subject to NP voting in February 2017, and approval was given to develop the standard. Japan was approved to serve as the project leader in WG 2. IEC 61757-4-3 Ed.1 (Fibre optic sensors - Part 4-3: Optical current sensors based on the polarimetric method) will be officially reviewed at the IEC meeting.

2.2 Optical Fibers

2.2.1 Optical Fibers (IEC TC 86/SC 86A/WG 1)

At the IEC SC 86A/WG 1 Frankfurt meeting in October 2016, active discussions were held regarding the change of names of optical fibers (IEC 60793-2-10, IEC 60793-2-50). A policy was established to change the indication of A1 multimode optical fibers to A1-OMx and the indication of B single-mode optical fibers to B.65x.

Regarding the existing documents, discussions were held to add the specifications of wideband multimode fiber (WBMMF) (wavelength range used: 850–950 nm) to IEC 60793-2-10 (Optical fibres - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres). Regarding IEC 60793-2-50 (Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single-mode fibres), progress was made in handling of the capability to remove the coating of 200 μm coated optical fibers. It was agreed that in-depth discussions will be continuously held in the Correspondence Group (CG).

Regarding the polarization-maintaining optical fibers, continuous efforts were made to achieve IEC standardization of the enacted JIS. Specifically, it was agreed to use IEC 60793-2-70, IEC 60793-1-60, and IEC 60793-1-61 (i.e., IEC drafts corresponding to JIS C 6873 [Polarization-maintaining optical fiber], JIS C 6840 [Polarization crosstalk measurement of optical fiber], and JIS C 6872 [Beat length measurement of polarization-maintaining optical fibers]) as a Committee Draft for Vote (CDV) at the Arlington meeting in May 2016. The documents were approved by voting based on the CDV in December, and the International Standard (IS) was published in February 2017.

2.2.2 Optical Fiber Cables (IEC TC 86/SC 86A/WG 3)

At the IEC SC 86A/WG 3 Frankfurt meeting in October 2016, progress was made in developing IEC 60794-1-31 (Optical fibre cables Part 1-31: Sectional specification for cable element - Optical fibre ribbons) under Japan's initiative and it was agreed to circulate the 2nd CD. Discussions were also held regarding the optical cable standard for outdoor/indoor shared fiber cables which had been agreed to be standardized at the previous meeting.

Regarding the revision of existing documents, the optical cable test methods and specifications for optical cable family were reviewed. It was agreed to make efforts to publish an amendment for the optical cable mechanical test methods (including the test method for the friction coefficient between cables as proposed by Japan) at an early stage.

China made a new proposal regarding the family specifications for the aerial optical cables along power transmission lines. These Optical Phase Power Conductor (OPPC) cables can be used at high voltages far exceeding that of the Optical Ground Wire (OPGW), and are characterized by high reliability and low cost. It was decided to hold discussions in the CG by the next meeting.

2.3 Fiber Optic Connectors and Optical Passive Components (IEC TC 86/SC 86B)

2.3.1 Fiber Optic Connectors (IEC TC 86/SC 86B/WG 6)

At the Locarno meeting in April 2016, NC comments were resolved for the Japan-related documents. Progress was made such as approval of the draft documents for the next stage, etc.

Regarding the mechanical interface standard for the two-row MPO connectors, it was agreed to change the spring force in the rejected FDIS draft to 20 N for CDV.

Regarding the general and guidance for the fiber optic interconnecting devices and the passive components performance standard (IEC 61753-1), comments were resolved, and it was agreed to revise the 2nd CD and circulate the 3rd CD.

At the Frankfurt meeting in October 2016, Japan-NC comments for one Japan-related document (optical compatibility) were resolved, and it was agreed to develop an IS. Explanations were given about two draft CDs (mechanical interface standards), and it was agreed to circulate the CDs.

In the process of resolving comments for IEC 61753-1, the tolerance of loss variation during testing was discussed. It was agreed to reflect Japan's proposals for CDV.

Corning proposed that a grade without core alignment be added to the IEC 61755-3 series. It was decided to hold discussions among stakeholders. Votes will be cast to decide whether the CD should be circulated at the next meeting.

Regarding the rigorousness of the connector endface standard, a proposal was made to set the same conditions of Zone B for the grades of respective sales companies. Japan maintained that the contamination condition differs depending on the reflection amount. It was decided to conduct a review again.

2.3.2 Optical Passive Components (IEC TC 86/SC 86B/WG 7)

WG 7 (optical passive components) reviews the generic specifications, performance standards, reliability documents, technical specifications, and technical reports. This year, the generic specifications for optical isolators were published. The performance standards for pigtailed-style fixed optical attenuators (Categories U and C) and cyclic-frequency AWG (Categories C and O) were also published.

Regarding the technical specifications, IEC TS 62627-09 (in which common terminology proposed by Japan was defined) was published in October 2016. As of February 2017, the working group reviewed three circulation documents including maintenance documents (one document each on general specifications, performance standards, and reliability).

2.3.3 Standard Tests and Measurement Methods for Fiber Optic Connectors and Optical Passive Components (IEC TC 86/SC 86B/WG 4)

Test and measurement procedures standardized under the IEC 61300 series have been established for fiber optic interconnecting devices and optical passive components including optical connectors and closures. In that series, IEC 61300-2 series describes test procedures, and IEC 61300-3 series describes measurement procedures.

At the Locarno meeting in April 2016, nine documents were reviewed and five presentations were given. The meeting proceeded smoothly, reflecting Japan's standards and opinions. It was agreed that the testing of the strength of mounted adaptors proposed by Japan should proceed to CDV. Japan's commitment was well accepted.

At the Frankfurt meeting in October 2016, nine documents were reviewed and five presentations were given. The meeting proceeded smoothly, reflecting Japan's standards and opinions. It was agreed that the testing of the strength of mounted adaptors proposed by Japan should proceed to FDIS. Regarding the measurement of the angular misalignment between bore and axes of cylindrical ferrules, clarification of the measurement uncertainty was required before CDV. Action will be taken in cooperation with the U.S.

2.4 Optical Amplifier (IEC TC 86/SC 86C/WG 3)

Japan submitted a new IEC draft document based on OITDA's new standard published in the last fiscal year regarding the test methods for gain transient parameters – single channel optical amplifiers in gain control.

Regarding the IEC technical report (IEC/TR 61292-3) on the classification, characteristics, and applications of optical amplifiers, it was decided to revise the TR, including a significant change in the document organization and additional descriptions on array amplifiers, space-division multiplexing amplifiers, and remote optically pumped optical amplifier, etc. Japan proposed a draft of contents for this revision at the IEC meeting.

2.5 Optical Amplifier and Optical Active Device (IEC TC 86/SC 86C/WG 3-WG 4)

Regarding the gain ripple measurement method for semiconductor optical amplifiers (SOAs) which had been jointly reviewed from the last fiscal year by the Optical Amplifier Standardization Meeting, Optical Active Device Standardization Meeting, and IEC/SC 86C/WG 3 and WG 4 domestic committee, Japan proposed a plan to add the SOA gain ripple evaluation items to IEC 61290-1-1 (Optical amplifiers - Test methods - Part 1-1: Power and gain parameters - Optical spectrum analyzer method) at the IEC/SC 86C/WG 3-WG 4 Frankfurt joint meeting in October 2016, and the plan was approved. The proposal documents are being prepared and will be submitted early in the next fiscal year.

2.6 Optical Subsystem (IEC TC 86/SC 86C/WG 1)

At the IEC/TC 86/SC 86C/WG 1 Frankfurt meeting in October 2016, Japan proposed a revision of IEC 61281-1 (Fibre optic communication subsystems - Part 1: Generic specification) (e.g., addition of terminology and transmission characteristics parameters). Japan serves as the project leader of the revision process.

CDV circulation of IEC 61280-4-4 (Fibre optic communication subsystem test procedures - Part 4-4: Cable plants and links - Polarization mode dispersion measurement for installed links), which reflected changes based on Japan's findings regarding the omission of a diagram, etc., was closed before the Frankfurt meeting. It was confirmed that an agreement was reached without any comments.

2.7 Optical Measuring Instrument (IEC TC 86/WG 4)

Toward the standardization of the IEC 62129-3 Ed.1.0 (Calibration of wavelength/optical frequency measurement instruments - Part 3: Optical frequency meters using optical frequency combs) on which an agreement was reached at the Gwangju meeting in 2015 based on Japan's proposal, Japan prepared the 1st CD as the project leader and comments were received from respective countries. The document and comments were reviewed at the Frankfurt meeting in October 2016. It was agreed to prepare the 2nd CD following the modification of the 1st CD and to continue the discussion in 2017 and beyond.

Regarding the revision of other existing documents, discussions were held on the revision of IEC 61315 Ed.3.0 (Calibration of fibre-optic power meters) and IEC 61745 Ed.2.0 (End-face image analysis procedure for the calibration of optical fibre geometry test sets).

Regarding calibration of fiber optic power meters, it was decided to continue the discussion in 2017 and beyond.

Regarding the end-face image analysis procedure for the calibration of optical fiber geometry test sets, it was decided to prepare a CDV to be subject to voting by countries in 2017.

Regarding IEC 61315:2005 Ed.2.0 (an international standard whose revision was approved at IEC TC 86/WG 4 in 2015), the CD for IEC 61315 Ed.3.0 was circulated. Japan submitted technical comments, etc. through the national committee.

2.8 Laser Safety (IEC TC 76)

Regarding the IEC/TC 76 meeting, the annual meeting was held in Beijing in October in this fiscal year. The interim meetings of WG 1 and WG 8 were held in Atlanta in March. Regarding the JWG, the documents are being reviewed by relevant TCs other than TC 76.

The status of review of standard documents by respective WGs is outlined below, focusing mainly on the meetings in Beijing and Atlanta.

2.8.1 Optical radiation safety (IEC TC 76/WG 1)

Regarding IEC 60825-1 Ed.3 (Laser Equipment classification and requirements) published in 2014, a policy was adopted to apply the Interpretation Sheet (I-SH) after publication of Ed.3 without reflecting technical comments in the CDV stage. Thus, two separate documents are being reviewed: I-SH1 (some complex extended sources of irregular temporal emmission: related to Subclause 4.3) and I-SH2 (laser radiation designed to function as a conventional lamps: related to Subclause 4.4).

In this fiscal year, a review for DC circulation was made at the Beijing meeting. Subsequently, the draft for FDIS circulation was fixed at the Atlanta meeting.

Discussions have started for the next edition (Ed.4) of IEC 60825-1.

A project group was established so that a draft can be submitted at the IEC/TC 76 Milan meeting in November in the next fiscal year regarding the handling of the virtual enclosure (sensors detect the human body interrupting the beam and reduce the risk of exposure) and moving platform (the position of the aperture stop for measurement around a moving object including the laser equipment changes depending on the speed).

Meanwhile, discussions have started with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) to relax the ICNIRP guidelines on ultraviolet radiation (wavelength: 270 nm or less) and infrared radiation (wavelength: 1 400 nm or more).

2.8.2 Laser radiation measurement (IEC TC 76/WG 3)

Discussions have been held on an ongoing basis about action items to revise IEC/TR 60825-13 Ed.2 (Safety of laser products - Part 13: Measurements for classification of laser products) in 2018. The new item is the guidelines for the ultra-short pulse duration measurement method. The definition of the ultra-short pulse was changed from less than 100 fs to less than 100 ps. Efforts have been made to circulate the CD in May in the next fiscal year.

2.8.3 Safety of medical laser equipment (IEC TC 76/WG 4)

In the Ed.4 project to add the Class 1C requirements to IEC 60601-2-22 (Medical electrical equipment - Part 2-22: Particular requirements for basic safety and essential performance of surgical, cosmetic, therapeutic and diagnostic laser equipment), discussions were held about the comments for the 2nd CD circulation. A revised draft will be circulated for CDV.

Regarding the revision of IEC/TR 60825-8 Ed.3 (Safety of laser products - Part 8: Guidelines for the safe use of laser beams on humans), efforts have been made to circulate the CD so that discussions can be held about comments at the Milan meeting in the next fiscal year. It was agreed that IEC/TR 62471-3 (Photobiological safety of lamps and lamp systems - Part 3: Guidelines for the safe use of intense pulsed light source equipment on humans) (including high-brightness LEDs) will be integrated to IEC/TR 60825-8 in the near future.

Regarding the risks of ophthalmopathy in the treatment of the upper part of the eyelid using a laser or Intense Pulsed Light (IPL), two standards were developed in ISO/TC 94/SC 6/JWG 1 with cooperation from IEC/TC 76/JWG 12. The opinions of WG 4 about this project (ISO/TR 22463 and ISO 12609-1) were compiled and proposed to the JWG above.

2.8.4 Safety of fiber optics communications systems (IEC TC 76/WG 5)

Japan was elected as the new project leader for the next editions of IEC 60825-2 and IEC 60825-12 (which were delayed). The revision project has been accelerated.

The policy for handling comments for the CDV circulation was compiled for IEC 60825-12 Ed.2 (“Safety of free space optical communication systems used for transmission of information), and the draft for FDIS circulation was sent to the TC 76 secretary.

Toward IEC 60825-2 Ed.4 (Safety of laser products - Part 2: Safety of optical fiber communication systems (OFCS)), a policy was established to (1) take into account both C_7 (whose wavelength dependence is exponential) and MPE (of the skin) and (2) to set the measurement condition 2 (magnifying lens observation condition) to the measurement distance of 14 mm and aperture stop diameter of 3.5 mm in the full spectrum. The draft for CD circulation was sent to the TC 76 secretary. Regarding the current edition of IEC 60825-2 (Ed.3.2), it was decided to publish an I-SH to confirm that the upper limit of C_7 is eight.

Regarding extraction of the requirements from IEC/TR 60825-17 (Safety of laser products - Part 17: Safety aspects for use of optical passive components and optical cables in high power optical fibre communication systems) and transition to IEC 60825-2, it was decided to take action in Ed.5 or later. This will inevitably require cooperation with IEC/TC 86. The correspondence between TC 86 and TC 76 is being reorganized.

2.8.5 High power lasers (IEC TC 76/WG 7)

The CDV of IEC 60825-4 Ed.3 (Safety of laser products - Part 4: Laser guards) was circulated. The NP of IEC 60825-18 (Guided beam delivery systems) (which extracts the provisions of Annex G of IEC 60825-4) was also circulated. Annex G of IEC 60825-4 will be deleted when IEC 60825-18 is published.

At the plenary session of the Beijing meeting, Japan proposed that the new evaluation method, which can evaluate the performance of highly laser-resistant laser guards (capable of protection against high output laser beams of 5 kW or more), be added to the Annex to IEC 60825-4 (refer to Section 7). This proposal will be reviewed as amendment or Ed.4 after publication of IEC 60825-4 Ed.3.

2.8.6 Development and maintenance of basic standards (IEC TC 76/WG 8)

The details of I-SH for IEC 60825-1 Ed.3 have been almost fixed. Thus, a project will be fully launched to prepare a CD of IEC/TR 60825-

14 Ed.2 (Safety of laser products - Part 14: A user's guide) (including relevant information for an I-SH). Regarding the project to revise IEC/TR 60825-3 Ed.3 (Safety of laser products - Part 3: Guidance for laser displays and shows), additional information will be collected after the Atlanta meeting, and an RR will be circulated subsequently.

The 2nd CD for IEC/TR 60825-5 Ed.3 (Safety of laser products - Part 5: Manufacturer's checklist for IEC 60825-1) was circulated, and comments were reviewed. There were requests to distribute IEC/TR 60825-5 as an editable file. An editable checklist would be useful for users, and an inquiry has been made to the IEC Central Office to see whether IEC/TR can offer such a checklist.

Regarding the Commission Decision of 5 February 2014 on the safety requirements to be met by European standards for consumer laser products pursuant to Directive 2001/95/EC of the European Parliament and of the Council on general product safety, the European Committee for Electrotechnical Standardization (CENELEC) will have to publish the safety standards for consumer laser products by December 2017. At present, the European standards do not apply as IEC standards.

Under the provisions of the European standards, consumer laser products for general purposes (including toys) should be Class 1. Class 1M, Class 2M, and Class 3R (visible pulse) apply to consumer laser products for special purposes that require risk analysis. Class 2 and Class 3R (visible CW) apply to consumer laser products for general purposes that do not require risk analysis.

2.8.7 Non-coherent sources (IEC TC 76/WG 9)

IEC 62471-1 will be discussed in 2.8.8. This section explains other standards of the IEC 62471 series. The 2nd CD of IEC/TR 62471-4 Ed.1 (Photobiological Safety of Lamps and Lamp Systems: Measuring Methods) was circulated, but the comments about the 1st CD were not fully discussed. The discussions about the parent standard (IEC 62471-1) have not been completed yet. Thus, the policy to circulate a CD again was confirmed.

IEC 62471-6 (Photobiological safety of ultraviolet lamp products), which was once rejected due to a shortage of experts, was subject to NP again, and is expected to be approved as a project.

2.8.8 IEC 62471-1 Special Joint TC (JTC 5)

The project to revise CIE S009/IEC 62471 (Photobiological Safety of Lamps and Lamp Systems) as CIE S009/IEC 62471-1 has been underway since April 2013 by Div. 2 and Div. 6 of CIE and TC 34 and TC 76 of IEC as Joint TC (JTC 5). The circulation of CD has been delayed. In this fiscal year, neither an interim meeting nor a web meeting was held. The policy for the CD was reviewed again at the Beijing meeting.

The draft that was distributed immediately before the Beijing meeting proposed that the organization of the annexes be changed. It was decided in Annexes A–K (which were significantly reorganized) that provisions regarding measurement (which were reviewed by Div. 2 of CIE) be reflected in Annexes G–J.

It was decided to review the possibility of transitioning part of IEC/TR 62471-2 in Section 9 (requirements for manufacturers). Regarding the evaluation conditions, the basic policy to specify the default conditions in IEC 62471-1 (i.e., horizontal standard) and set the product conditions in the vertical standards was reconfirmed.

The conversion of distance conditions based on the inverse-square law (about which Japan and the U.K. expressed concern) remains included. It will be required to demonstrate based on actual data that the scope in which the inverse-square law is effective is limited. The revised draft based on the discussions will be circulated as CD.

The JTC 5 meeting will be the CIE interim meeting (Jeju) or IEC/TC 76 Milan meeting. It was decided to hold a web meeting to review comments for the circulated CD.

2.8.9 Safety of lasers and laser equipment in an industrial materials processing environment (IEC TC 76/JWG 10)

Activities are underway as the JWG with ISO/TC 172/SC 9/JWG 3 to review the ISO/IEC 11553 series. Regarding the revision of ISO/IEC 11553-1 (Safety of machinery - Laser processing machines - Part 1: General safety requirements) and ISO/IEC 11553-2 (Safety of machinery - Laser processing machines - Part 2: Safety requirements for hand-held laser processing devices), comments for the 2nd CD circulation were checked at the Beijing meeting, and the CDV was circulated concurrently with ISO. The FDIS will be circulated at the next meeting.

2.8.10 Eye and face protection against laser radiation (IEC TC 76/JWG 12)

Activities are underway as the JWG with ISO/TC 94/SC 6/JWG 1. A review is being conducted at the ISO meeting, and web meetings are held as appropriate. The documents in the WD stage are circulated based on the ISO numbers.

Regarding ISO/IEC 19818 Ed.1 (Eye and face protection - Protection against laser radiation - requirements and test methods), the comment (N44) for the WD (N 36) was discussed at the Beijing meeting.

In terms of the combination table for optical density (OD) and laser resistance class (RC), discussions were held about the RC's division into steps (whether to make 1 step 10 times or 100 times). It was decided to continue the review. Respective countries showed understanding about the change in threshold for mode lock lasers and femtosecond lasers as proposed by Japan.

Meanwhile, it was decided to conduct investigations by the ad hoc group and complete the table due to insufficient data on material damage for femtosecond lasers. A CD which reflects other review matters will be circulated.

Comments for the WD of ISO/TR 22463 (Patient/client eye protectors for protection against laser/intense light source (ILS) equipment used on humans for cosmetic and medical applications - Guidance for selection and use) were discussed at the Beijing meeting to fix the details and circulate a CD.

3. ISO

3.1 Electro-Optical Systems (ISO/TC 172/SC 9)

This meeting compiles domestic opinions and reflects Japan's proposals on the international standards, etc. proposed by ISO/TC 172/SC 9 (composed of WG 1: Terminology and test methods for lasers, WG 4: Laser systems for medical applications, WG 7: Electro-optical systems other than lasers, and JWG 3: Joint ISO/TC 172/SC 9-IEC/TC 76 WG: Machines safety), which is in charge of preparing international standards on lasers.

In this fiscal year, a domestic meeting was held in September 2016 to deliberate on international meeting strategy. In February 2017, a report was submitted at the international meeting, and the strategy for the next international meeting, etc. was reviewed.

In this fiscal year, Japan served as the host country, and the international meeting was held in Kojima, Kurashiki City, Okayama Prefecture for three days from November 30 to December 2, 2016. Thirty individuals participated from seven countries in total: four from China, one from France, seven from Germany, one from South Korea, one from the U.K., three from the U.S., and 13 from Japan.

The main points reviewed in the international meeting are reported below.

3.1.1 Plenary

The term of the chairperson (U.S.) ended, and a new chairperson (Germany) took office. The secretary (Germany) also changed. The next meeting will be held in Boulder (U.S.) in 2017.

3.1.2 Terminology and test methods for lasers (ISO/TC 172/ SC 9 WG 1)

Regarding ISO/DIS 11554 (Optics and optical instruments - Laser and laser-related equipment - Test methods for laser beam power, energy and temporal characteristics) (in which Japan serves as the project leader), it was decided to skip the Final Draft International Standard (FDIS) and publish the standard.

Regarding ISO/DTR 20811 (Qualification of laser optics for space applications), comments made by Japan were approved, and the abbreviation "LIC" (Laser Induced Contamination) was changed to "LIMC" (Laser Induced Molecular Contamination). It was decided to publish ISO/DTR 20811 as a Technical Report (TR).

At first, ISO/TS 17915: 2013 (Optics and photonics - Measurement method of semiconductor lasers for sensing) was published as a Technical Specification (TS) based on Japan's proposal. It was decided to publish ISO/TS 17915: 2013 as an IS.

3.1.3 Laser systems for medical applications (ISO/TC 172/ SC 9 WG 4)

ISO/DIS 11990 (Lasers and laser-related equipment - Determination of laser resistance of tracheal tube and tracheal cuffs) has been developed jointly with ISO/TC 121/SC 2 (a liaison). It was decided to submit a Draft International Standard (DIS) by December 20, 2016.

3.1.4 Electro-optical systems other than lasers (ISO/TC 172/SC 9 WG 7)

Regarding ISO 11807-1, -2 (Integrated optics - Vocabulary - Part 1: Basic terms and symbols, - Part 2: Terms used in classification), and ISO 14881 (Integrated optics - Interfaces - Parameters relevant to coupling properties), it was decided that Japan will serve as the project leader to revise these three standards for the first time in 15 years.

Regarding ISO 14880-1 (Optics and photonics - Microlens arrays - Part 1: Vocabulary and general properties), a revised edition was published in April 2016 with Japan and the U.K. serving as the project leaders. The Central Secretariat (CS) revised the Final Draft International Standard (FDIS) without confirmation and published it. A misprint was found, and it was decided to revise the standard to publish it again. It was also decided to submit a DIS in June 2017.

4. IEEE

4.1 Intra-Building Optical Wiring System (IEEE 802.3)

At IEEE, Japan and other countries proposed standardization in March 2014. The draft standard for the physical/link layer of Gigabit Ethernet over a large-diameter SI-type Plastic Optical Fiber (POF) (port name: 1000BASE-RH) has been prepared by the Task Force under the project name of P802.3bv. At the bimonthly meeting, a draft was prepared, comments were resolved, and a revision was conducted.

For home network applications with the maximum interconnection length of 50 m, provisions were added for plugless connections in terms of printing on POF cables and transceivers, cable tearing length and retention force, etc. At the meeting in July 2016, votes were cast at the 802.3 Working Group (WG), and the transition from the WG voting phase to the sponsor voting phase was approved.

The draft standard was circulated, subjected to voting, and revised repeatedly. Based on the voting at the 802.3 WG in November 2016, revision of the draft standard and an application for the next step (i.e., review by the Standards Review Committee) were approved. The sponsor circulation phase was completed in January 2017. The work moved on to the peer review phase by the final review committee. The amendment of the standard will be published in spring of 2017.

5. International Standardization and Dissemination Committee for High-speed Communication Network Performance over Large Core Multimode Optical Fiber

5.1 Objective

This project builds the foundations for international standardization and dissemination of communication networks mainly using short-distance optical fibers with the aim of generalizing in-vehicle optical components and reducing their costs.

Specifically, targeting high-speed in-vehicle LANs using large core multimode optical fibers, which will become the mainstream, international standards on test and measurement methods for optical signals are developed in IEC, and international standards on optical components such as connectors and cables for in-vehicle LANs are developed in ISO.

In addition to the development of international standards, the project ensures consistency between IEEE standards and IEC/ISO standards on in-vehicle LANs using large core multimode optical fibers through activities on in-vehicle Ethernet in the IEEE as part of the efforts for dissemination. The project also reviews the generalization to relevant housing and industrial machinery fields.

Moreover, the project indicates the effectiveness of the international standards and IEEE standards, develops demonstration systems including devices and their evaluation tools, and promotes dissemination of the next generation vehicles. Use of optical fibers in in-vehicle LANs can reduce carbon dioxide emissions and improve fuel consumption due to the reduced weight and power saving, so that it contributes to saving energy in automobiles.

5.2 Status of activities

The ultimate goal of the project, the goal and results for this fiscal year, and future tasks are summarized in Table 4.

The IEC and IEEE documents, which had been prepared respectively from the first fiscal year (FY 2014), were published by the end of the fiscal year. Regarding the two ISO documents which were proposed to be newly developed in FY 2015, Japan played a key role as a convenor and project leader, respectively. Discussions are underway to publish the documents by the end of FY 2018.

Notably, Japan could make proposals ahead of international trends in ISO. The structure of the standard was upgraded as "In-vehicle Ethernet" (in-vehicle backbone standard for automated driving) by incorporating electrical Ethernet.

Meanwhile, the preparations to propose the standard on Ethernet exceeding 1 Gbit/s (which was planned to be proposed to IEEE by the end of FY 2016) were delayed.

6. Committee for International Standardization of Fiber Optic Connector Optical Interfaces for Fiber PC Connectors

6.1 Objective

Fiber PC (Physical Contact) connectors are suitable for multi-fiber optical interconnection within a board/between boards in various types of information processing equipment and optical communications equipment. The mechanical interface standard for SF connectors was published as IEC 61754-26 Ed.1: 2012 (Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 26: Type SF connector family).

Thus far, fiber optic connector optical interfaces standards have been developed for various connector configuration (e.g., cylindrical or rectangular ferrules), but no optical compatibility standard has been developed for fiber PC connectors.

To encourage the widespread use of fiber PC connectors for ultra high-speed, ultra high-density optical interconnection, the mechanical interface standard needs to be developed, and the fiber optic connector

Table 4 Summary of progress of international standardization

International standard	IEC	ISO	IEEE
Place of proposal	TC 86/SC 86B/WG 4	TC 22/SC 31/WG 3 TC 22/SC 32/WG 10	P802.3bv
Domestic Committee	Institute of Electronics, Information and Communication Engineers 86B Optical Component Subcommittee	Society of Automotive Engineers of Japan Optical Communications Subcommittee	JasPar/Next Generation High-Speed LAN WG OPEN Alliance SIG /TC 7
Ultimate Goal (–2018)	(1) EAF measurement method (2014) (2) Specification of an EAF template for loss measurement (2016)	(3) Common for in-vehicle communication systems (2018) (4) Physical layer of in-vehicle optical gigabit communication (2018) (5) In-vehicle optical gigabit communication parts (2018)	(6) In-vehicle Ethernet (1 Gbit/s) (2016) (7) In-vehicle Ethernet (10 Gbit/s) (2020–)
Goal for this fiscal year (2016)	(1) None (The IS for IEC 61300-3-53 was published in FY 2014.) (2) Efforts will be made to publish an IS by the end of this fiscal year.	(3)–(5) Efforts will be made to prepare a WD by May, start discussions in the WG, and submit a CD in December 2016. Regarding (5), the possibility of handling each chapter as an independent standard document will be reviewed.	(6) Efforts will be made to publish 1000BASE-RH by the end of this fiscal year. (7) The goal is to make a new proposal regarding speeds exceeding 1 Gbit/s by the end of this fiscal year by ascertaining the market situation. ・Efforts will be made to spread the in-vehicle optical LAN by presenting the results of the project at scientific meetings, exhibitions, etc.
Results for this fiscal year (2016)	(1) The method to reduce the dispersion of the EAF curve based on the measurement method of the published standard was reviewed. (2) The EAF template for loss measurement (which was derived from experiments and round robin tests under this project) was added to IEC 61300-1 and published. An application was made for early maintenance to reflect the results of the round robin tests in Japan and the U.K. and was approved.	(3)–(5) During preparation of draft documents for ISO 21111-1 (related to (3) and (4) adopted as a NWIP by January 2016) and ISO 21111-3 (related to (5)), a request from Europe and the U.S. to include the electrical Ethernet standard in the ISO 21111 family was accepted. ISO 21111-1 was split into (3) ISO 21111-2 and (4) ISO 21111-3 ((3) is common for electrical and optical Ethernet), and ISO 21111-3 transitioned to (5) ISO 21111-4. Based on these discussions, submission of the WG draft was postponed until July 2017.	(6) In IEEE P802.3bv, Japan worked with Spain and Germany to promote standardization of short-distance 1 Gbit/s Ethernet communication (for automobiles, housing, and industrial machinery) using multimode optical fibers. Response to all the comments was completed by January 2017. The document was published in March. (7) A Study Group on the physical layer of in-vehicle Ethernet with speeds exceeding 1 Gbit/s was established in IEEE 802.3 to start discussions on the specifications. Preparations for a presentation have been made with the target of 10 Gbit/s for optical Ethernet. ・A demonstration was held to promote standardization activities in the IEEE international meeting (Paris) and exhibition (Tokyo) to solicit needs and feedback from users.

optical interfaces will need to be standardized.

This committee covers international standardization of fiber optic connector optical interfaces for fiber PC connectors, and prepares a draft standardization document.

6.2 Status of activities

In response to the negative comments at the IEC TC 86/SC 86B Gwangju meeting in October 2015, Monte-Carlo simulation and verification by experiment were conducted taking into account the bore diameter, bore length, core connectivity error, and chamfer angle at the end of the optical fiber, in order to increase the data accuracy and repropose the CDV document. The results showed that the optical performance may be Grade D when B1 fiber is used. Thus, the CDV document was revised.

Japan gave explanations again based on the revised CDV document at WG 6 of the SC 86B Locarno meeting in April 2016. Detailed explanations were given to resolve all the questions of respective countries. It was agreed to circulate the CDV based on the revised edition. The CDV was circulated in July 2016.

The RVC document was reviewed at WG 6 of the SC 86B Frankfurt meeting in October 2016. No against votes were cast, and only editorial comments were made. The establishment of the IS was approved without the FDIS. The IS draft was submitted in November 2016. As a result, IEC 61755-3-10 Ed.1 (Fibre optic interconnecting devices and passive components - Fibre optic connector optical interface - Part 3-10: Connector parameters of non-dispersion shifted single mode physically contacting fibres - non-angled, ferrule-less, bore alignment connectors) was published in December 2016.

In the published IEC 61755-3-10 optical interfaces standard, the optical performance is Grade D because only the established optical fiber standard (B1 fiber) can be used as the basis. However, the results of a simulation conducted in this fiscal year showed that Grade C or Grade B may be attained by using commercially available fibers. The results are considered to benefit users. Consultations with IEC members will commence so that the document for commercially available fibers can be published as a Technical Report (TR).

7. Committee for International Standardization of Highly Laser-resistant Laser Guards

7.1 Objective

Laser guards are a means of protection (shield plates or equipment) that shield against laser beams. In general, they are constructed of metals such as aluminum alloys. However, with the development of high power laser technology, even safer protective measures are demanded.

There is an international standard for laser guards: IEC 60825-4. One problem is that guard materials that are sufficiently durable against high power laser beams and their evaluation method have not been proposed.

The purpose of this project is to build prototype laser guards using the superior qualities of Carbon Fiber Reinforced Plastics (CFRPs), conduct evaluation tests to verify their high protection performance against laser beams, establish a method to properly evaluate the performance characteristics as laser guards, and propose a new international standard.

7.2 Status of activities

This fiscal year, which is the last fiscal year of the three-year plan, laser radiation tests were conducted using CFRPs and conventional laser guard materials (e.g., aluminum) as comparison samples based on the survey results.

As a result, a quantitative evaluation method appropriate for CFRP laser guards was developed, and it was demonstrated to achieve protection against high power laser beams (5 kW or more). Conventional laser guards constructed of metals could not provide protection.

The results of the project were presented at a laser-related international scientific meeting (ICALEO 2017) and IEC/TC 76 Beijing meeting. Japan proposed to IEC to revise the annex to IEC 60825-4 and add the performance evaluation method for CFRP laser guards.

Educational and Public Relations Activities

1. FY 2016 Symposium on the Optoelectronics Industry and Technology

The FY 2016 Symposium on the Optoelectronics Industry and Technology was held at the Rihga Royal Hotel Tokyo on Thursday, February 9, 2017, jointly sponsored by OITDA and the Photonics Electronics Technology Research Association (PETRA) with the support of the Ministry of Economy, Trade and Industry.

While there has been rapid progress in utilization of AI, IoT and big data in recent years, the development of optoelectronics technology is expected to create innovation which leads automobile (e.g., automated driving), robot, and industrial equipment industries as well as to serve as the fundamental technology which supports Japan's industry and society.

In the symposium, with more than 290 participants, experts from various fields gave presentations on automated driving and security, LiDAR (Light Detection and Ranging) technologies, robot evolution, medical imaging, technology roadmaps for automotive photonics, and development of integrated photonics-electronics convergence system technology under the theme of "Photonics that Underpins the Future of Automobiles, Robots, and Industrial Equipment", and the future vision of Japan's optoelectronics industry and technology was actively discussed (Table 5).

2. InterOpto 2016

InterOpto 2016, an international exhibition of cutting-edge optoelectronics technology, was held at Pacifico Yokohama for three days from Wednesday, September 14 to Friday, September 16 with the support and cooperation of "the Ministry of Economy, Trade and Industry" and many other organizations.

The exhibition covered a wide range of fields such as; lasers/light sources, optical elements/parts, materials, optical equipment/devices, optical industry related services/software and 103 exhibitors including optoelectronics manufacturers, trading companies, etc. (93 the last year) participated in the exhibition with 146 booths (148 the last year).

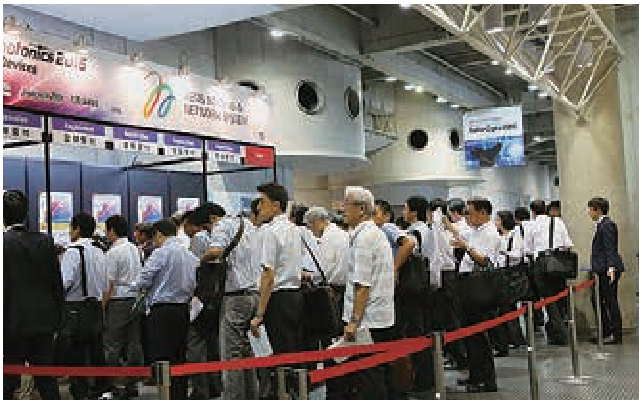


Table 5　FY 2016 Symposium on the Optoelectronics Industry and Technology

10:00 ～ 10:05	Opening Remarks	Mr. Yasuhisa Odani President, OITDA
10:05 ～ 10:15	Guest Greeting	Mr. Takatoshi Miura Director, Information and Communication Electronics Division, Commerce and Information Policy Bureau, METI
10:15 ～ 11:15	Keynote Speech: Automated Driving and Security in Control System	Dr. Seiichi Shin Professor, Graduate School of Information and Engineering, The University of Electro-Communications
11:15 ～ 12:00	Amazon Picking Challenge and Evolution of Robot	Mr. Taizan Yonetsuji Engineer, Preferred Networks
13:00 ～ 13:45	LiDAR Technologies for Automated Driving	Mr. Eiji Muramatsu Director, Autonomous Driving Systems Business Development Division, Pioneer Corporation
13:45 ～ 14:30	Optoelectronics Technology Roadmap －Automotive Photonics－	Dr. Nobuhiko Nishiyama Associate Professor, School of Engineering, Tokyo Institute of Technology
14:45 ～ 15:30	8K Television Technology and its Application for Endoscopic surgery	Dr. Kenkichi Tanioka Vice Chairman, Medical Imaging Consortium
15:30 ～ 16:15	Integrated Photonics-Electronics Convergence System Technology －Performance and system evaluation of Optical I/O core－	Mr. Junichi Tsuchida Photonics Electronics Technology Research Association (PETRA)
16:20 ～ 17:00	The Award Ceremony of 32nd Kenjiro Sakurai Memorial Prize	
17:00 ～ 19:00	Get-together	

As well as Japanese companies and institutes, foreign companies from North America, Europe, Asia, etc. joined the exhibition to share optical technologies and information and give an overview of cutting edge optical products and their development status from a global viewpoint.

This year, MEMS Sensing & Network System 2016 was also held simultaneously at the same venue in addition to the three exhibitions of optical-related technologies (LED JAPAN 2016, BioOpto Japan 2016, and LaserTech 2016) which have been held with InterOpto in past years. There were totally 7,718 registered visitors (including visitors to the simultaneously held exhibitions above) over the three days.

A "Notable Optoelectronics Technology and Special Exhibit Zone" was set up in the Exhibition Hall. In this zone, eight companies recommended by each working group of OITDA's Optoelectronics Technology Trend Committee exhibited their recommended technologies and products. A Notable Optoelectronics Technology Seminar was also held for two days from September 15 to 16 at the seminar site in the Exhibition Hall.

Further, in Seminar Room of the Annex Hall, a special lecture entitled "Optical Submarine Cabled Observation System and Its Applications" was presented by Dr. Katsuyoshi Kawaguchi, Deputy Director of R&D Center for Earthquake and Tsunami, Japan Agency for Marine-Earth Science and Technology, and seminars on technology trends in seven optoelectronics technology fields were held on September 15. And on September 16, Professor Hiroyuki Morikawa, Research Center for Advanced Science and Technology, the University of Tokyo gave a special lecture entitled "The way of Value Creation in the Fourth Industrial Revolution - Current Status and Future Outlook of IoT-" and seminars on the optoelectronics industry trends in seven product fields and overview trends were presented. These seminars attracted large audiences and stimulated exchanges of opinion among the audiences.

3. 32nd Kenjiro Sakurai Memorial Prize

The Kenjiro Sakurai Prize was established as a memorial to the late Dr. Kenjiro Sakurai, who was a Director of OITDA and played a major role in developing the optoelectronics industry, and for the purpose of promoting technological development of the optoelectronics industry. The prize has been awarded to 23 individuals and 36 groups, totaling 142 people, in the past 31 times.

This year, the Sakurai Memorial Prize was awarded to two applicants among 13 applicants for achievements in their pioneering roles in the optoelectronics industry and technology since 2006.

The prize for "Realizing development of a narrow line width wavelength variable light source for digital coherent communication" was awarded to Dr. Toshikazu Mukaihara, Mr. Toshio Kimura, Mr. Hiroyuki Koshi, Mr. Tatsuro Kurobe of Furukawa Electric Co., Ltd. and the prize for "Development of Photonics Integration Technologies based on VCSEL Photonics" was awarded to Dr. Fumio Koyama of Tokyo Institute of Technology.

Awardees of 32nd Kenjiro Sakurai Memorial Prize
(From left) Mr. Kurobe, Dr. Mukaihara, Mr. Kimura, Mr. Koshi
(Photo on the right) Dr. Koyama

Dr. Toshikazu Mukaihara and co-workers of Furukawa Electric Co., Ltd. have successfully realized a light source for a narrow line width wavelength tunable laser having the highest level power and stability in the world, by developing an optical compound semiconductor technology to monolithically integrate multi-wavelength arrays, which consist of many DFB lasers, and a plurality of optical functional elements on the same substrate, resin bonding technology to halve the package volume compared to the conventional packages, and high-performance electronic control circuit technology, through their commitment to developing a light source for digital coherent communication. The development and implementation of the light source for a narrow line width wavelength tunable laser is a great achievement that will contribute significantly to the development and dissemination of digital coherent communication as a new technology for increasing the traffic capacity and upgrading the network.

Dr. Fumio Koyama of Tokyo Institute of Technology received the prize for continuing research on improving the performance of Vertical Cavity Surface Emitting Laser (VCSEL) and creating new functions after achieving room-temperature continuous wave oscillation of VCSEL with Dr. Kenichi Iga, Professor Emeritus of Tokyo Institute of Technology (who received the prize in FY 1987) for the first time in the world in 1988, thereby opening up the possibility of VCSEL integrated photonics having new technologies such as wavelength control by MEMS mirror and slow light waveguide. R&D on VCSEL has stimulated the development of technologies such as optical interconnection at data centers and laser printers originated from Japan. This is a great accomplishment that will contribute significantly to new developments in the optoelectronics industry and technologies.

The commendation ceremony was held on February 9, 2017 following the FY 2016 Symposium on the Optoelectronics Industry and Technology. At the ceremony, Dr. Yasuhiko Arakawa (Professor at the University of Tokyo), chairperson of the Kenjiro Sakurai Memorial Prize Committee, reported on the selection process and results. After that, the certificates, medals and extra prizes were presented to the awardees.

Supporting Members

(As of March 31, 2017)

[Textile & Pulp]

Mitsubishi Rayon Co., Ltd.

[Chemistry]

Fujifilm Corporation

Nissan Chemical Industries, Ltd.

Shin-Etsu Chemical Co., Ltd.

Sumitomo Bakelite Co., Ltd.

Yamamoto Kogaku Co., Ltd.

[Glass & Ceramics]

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Technical Co., Ltd.

Toyo Seikan Group Holdings, Ltd.

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Nippon Steel & Sumikin Welding Co., Ltd.

[Electric Wire & Cable]

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Fujikura Dia Cable Ltd.

Furukawa Electric Co., Ltd.

Okano Electric Wire Co., Ltd.

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SWCC Showa Holdings Co., Ltd.

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Anritsu Corporation

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Hirose Electric Co., Ltd.

Hitachi, Ltd.

Honda Tsushin Kogyo Co., Ltd.

Huawei Technologies Japan K.K.

Japan Aviation Electronics Industry, Ltd.

Kyocera Corporation

Macom Japan Limited

Mitsubishi Electric Corporation

Murata Mfg. Co., Ltd.

NEC Corporation

NTT Electronics Corporation

Oclaro Japan, Inc.

Oki Electric Industry Co., Ltd.

Panasonic Corporation

Pioneer Corporation

Rohm Co., Ltd.

Santec Corporation

Sanwa Denki Kogyo Co., Ltd.

Sharp Corporation

Sony Corporation

Taiyo Yuden Co., Ltd.

Toshiba Corporation

Tyco Electronics Japan G.K.

Ushio Inc.

Yamaichi Electronics Co., Ltd.

Yamamura_Photonics Co., Ltd.

Yokogawa Electric Corporation

[Precision Instrument]

Canon Inc.

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Sigma Koki Co., Ltd.

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Hakuto Co., Ltd.

JTB Communication Design, Inc.

Marubun Corporation

The Optronics Co., Ltd.

[Electric Power]

Central Research Institute of Electric Power Industry

[Other Manufacturing]

Adamant Co., Ltd.

Dai Nippon Printing Co., Ltd.

Iwasaki Electric Co., Ltd.

Optoquest Co., Ltd.

[Others]

Granopt Ltd.

Institute for Laser Technology

Japan Optomechatronics Association

KDDI R&D Laboratories Inc.

Nippon Telegraph and Telephone Corporation

NTT Advanced Technology Corporation

Photonics Electronics Technology Research Association

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