

# **Specification for Dispersion Slope Compensating Module for SMF Transmission Fiber**

## **SMF-DK**

Version 1.45 – 2017-04-28

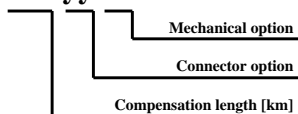


*A Furukawa Company*

## OFS SMF-DK Specification

### 0 Ordering information

Order code format: **SMFDK-S-xxx-yy-zz**



The following table lists the nominal dispersion for the various compensation lengths:

Compensated fiber length [km]	Nominal Dispersion 1550 nm [ps/nm]	Order Code
5	85	SMFDK-S-005-yy-zz
10	170	SMFDK-S-010-yy-zz
15	255	SMFDK-S-015-yy-zz
20	340	SMFDK-S-020-yy-zz
25	425	SMFDK-S-025-yy-zz
30	510	SMFDK-S-030-yy-zz
35	595	SMFDK-S-035-yy-zz
40	680	SMFDK-S-040-yy-zz
45	765	SMFDK-S-045-yy-zz
50	850	SMFDK-S-050-yy-zz
60	1020	SMFDK-S-060-yy-zz
70	1190	SMFDK-S-070-yy-zz
80	1360	SMFDK-S-080-yy-zz
90	1530	SMFDK-S-090-yy-zz
100	1700	SMFDK-S-100-yy-zz
110	1870	SMFDK-S-110-yy-zz
120	2040	SMFDK-S-120-yy-zz
130	2210	SMFDK-S-130-yy-zz
140	2380	SMFDK-S-140-yy-zz
150	2550	SMFDK-S-150-yy-zz
Custom compensation lengths available on request		

'yy' in order code reflects choice of connectors:

Connector code	Connector type
01	LC/PC connectors, 0.9 mm cable
02	SC/UPC connectors, 2.7 mm cable
03	FC/APC connectors (wide key), 3 mm cable
04	FMU/UPC connectors, 1.7 mm cable
05	SC/APC connectors, 3 mm cable
06	LC/APC connectors, 0.9 mm cable
07	SC/APC connectors, 0.9 mm cable
08	FC/APC connectors (narrow key), 0.9 mm cable
09	E2000 connectors 2.7 mm cable
10	FC/PC connectors, 3 mm cable
Other connector types available on request	

'zz' in order code reflects choice of mechanical solution (see section 0 for details and drawings)

Mechanical code	Mechanical package
01	Spool size 140 mm x 22 mm (up to 90 km)
02	Spool size 165 mm x 22 mm (up to 130 km)
03	Spool size 175 mm x 23 mm (up to 150 km)
10	Standard DSCM box
Other spool sizes and DSCM box types available on request.	

#### Example:

SMFDK-S-080-01-10: DSCM for compensation of 80 km SMF, with LC/PC connectors, standard box.

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### 0.1 Rack for mounting standard DSCM box:

The standard box can be rack mounted in a 19" or 21" rack with the following rack mounts:

Order code	Rack type
DSCM-Rack-19-1	19" rack mount
DSCM-Rack-21-1	21" rack mount

See section 0 for details and drawings.

## 1 Operating and Storage Conditions

### 1.1 Operating and Storage Temperature & Humidity

Item	Symbol	Min	Max	Unit
Environmental operating temperature	T <sub>OP</sub>	-5	+70	°C
Environmental operating (relative) humidity	X <sub>OP</sub>	5	85	%
Environmental storage temperature	T <sub>ST</sub>	-40	+70	°C
Environmental storage (relative) humidity	X <sub>ST</sub>	5	85	%

### 1.2 Operating Wavelength Range

The operating wavelength range of the SMF-DK DSCM modules is 1528 nm – 1565 nm

### 1.3 Absolute Maximum Ratings

Applicable for the full operating temperature range T<sub>OP</sub> without causing irreversible damage to the module.

Item	Symbol	Max	Unit	Remarks
Total optical input power	P <sub>TOT</sub>	23	dBm	Connector face is clean

## 2 Optical Properties

This section describes the optical properties of the SMF-DK DSCM. Unless otherwise stated, all parameters are valid EOL, over temperature and over the operating wavelength range.

### 2.1 Residual Dispersion

The residual dispersion RD is defined as

$$RD(\lambda) = D_{SMF}(\lambda) + D_{DSCM}(\lambda),$$

where

$$D_{SMF}(\lambda) = -72.9 + 0.058\lambda,$$

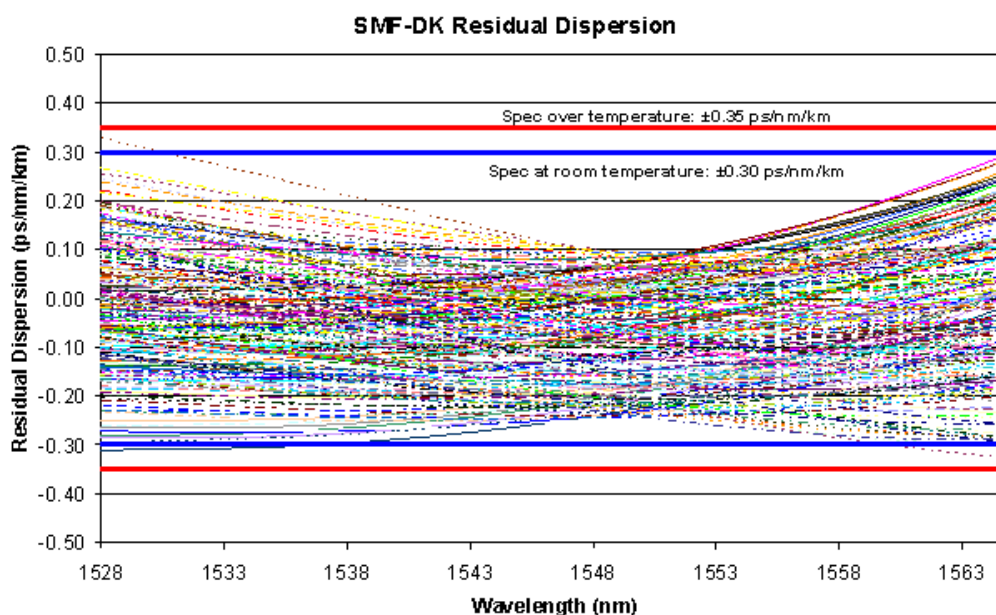
where  $\lambda$  is the wavelength in units of nm. This dispersion model leads to a dispersion of 17 ps/nm/km and a slope of 0.058 ps/nm<sup>2</sup>/km at a wavelength of 1550 nm.

The table below shows the residual dispersion spec of the SMF-DK DSCM:

Nominal Compensation Length [km]	Residual Dispersion BOL RT [ps/nm/km]	Residual Dispersion EOL over temperature [ps/nm/km]
All modules	±0.30*	±0.35*

\* ±0.40 ps/nm/km (BOL RT) and ±0.45 ps/nm/km (EOL over temperature ) for the 5 km version

The typical residual dispersion is shown in the figure below:



**Figure 1:** Typical residual dispersion for SMF-DK DSCMs

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### 2.2 Dispersion

The following table defines the dispersion characteristics of the SMF-DK DSCMs:

Nominal Compensation Length [km]	Dispersion BOL RT [ps/nm]								
	1528 nm			1550 nm			1565 nm		
	min	typical	max	min	typical	max	min	typical	max
5	-80.6	-79	-76.6	-87.0	-85	-83.0	-91.4	-90	-87.4
10	-160.2	-157	-154.2	-173.0	-171	-167.0	-181.7	-179	-175.7
15	-240.4	-236	-231.4	-259.5	-256	-250.5	-272.6	-269	-263.6
20	-320.5	-314	-308.5	-346.0	-341	-334.0	-363.4	-358	-351.4
25	-400.6	-393	-385.6	-432.5	-427	-417.5	-454.3	-448	-439.3
30	-480.7	-471	-462.7	-519.0	-512	-501.0	-545.1	-537	-527.1
35	-560.8	-550	-539.8	-605.5	-597	-584.5	-636.0	-627	-615.0
40	-641.0	-628	-617.0	-692.0	-683	-668.0	-726.8	-716	-702.8
45	-721.1	-707	-694.1	-778.5	-768	-751.5	-817.7	-806	-790.7
50	-801.2	-785	-771.2	-865.0	-853	-835.0	-908.5	-895	-878.5
60	-961.4	-943	-925.4	-1038.0	-1024	-1002.0	-1090.2	-1074	-1054.2
70	-1121.7	-1100	-1079.7	-1211.0	-1195	-1169.0	-1271.9	-1253	-1229.9
80	-1281.9	-1257	-1233.9	-1384.0	-1366	-1336.0	-1453.6	-1432	-1405.6
90	-1442.2	-1414	-1388.2	-1557.0	-1536	-1503.0	-1635.3	-1611	-1581.3
100	-1602.4	-1571	-1542.4	-1730.0	-1707	-1670.0	-1817.0	-1790	-1757.0
110	-1762.6	-1728	-1696.6	-1903.0	-1878	-1837.0	-1998.7	-1969	-1932.7
120	-1922.9	-1885	-1850.9	-2076.0	-2048	-2004.0	-2180.4	-2148	-2108.4
130	-2083.1	-2042	-2005.1	-2249.0	-2219	-2171.0	-2362.1	-2327	-2284.1
140	-2243.4	-2199	-2159.4	-2422.0	-2390	-2338.0	-2543.8	-2506	-2459.8
150	-2403.6	-2356	-2313.6	-2595.0	-2560	-2505.0	-2725.5	-2685	-2635.5

Nominal Compensation Length [km]	Dispersion EOL over temperature [ps/nm]					
	1528 nm		1550 nm		1565 nm	
	min	max	min	max	min	max
5	-80.9	-76.4	-87.3	-82.8	-91.6	-87.1
10	-160.7	-153.7	-173.5	-166.5	-182.2	-175.2
15	-241.1	-230.6	-260.3	-249.8	-273.3	-262.8
20	-321.5	-307.5	-347.0	-333.0	-364.4	-350.4
25	-401.9	-384.4	-433.8	-416.3	-455.5	-438.0
30	-482.2	-461.2	-520.5	-499.5	-546.6	-525.6
35	-562.6	-538.1	-607.3	-582.8	-637.7	-613.2
40	-643.0	-615.0	-694.0	-666.0	-728.8	-700.8
45	-723.3	-691.8	-780.8	-749.3	-819.9	-788.4
50	-803.7	-768.7	-867.5	-832.5	-911.0	-876.0
60	-964.4	-922.4	-1041.0	-999.0	-1093.2	-1051.2
70	-1125.2	-1076.2	-1214.5	-1165.5	-1275.4	-1226.4
80	-1285.9	-1229.9	-1388.0	-1332.0	-1457.6	-1401.6
90	-1446.7	-1383.7	-1561.5	-1498.5	-1639.8	-1576.8
100	-1607.4	-1537.4	-1735.0	-1665.0	-1822.0	-1752.0
110	-1768.1	-1691.1	-1908.5	-1831.5	-2004.2	-1927.2
120	-1928.9	-1844.9	-2082.0	-1998.0	-2186.4	-2102.4
130	-2089.6	-1998.6	-2255.5	-2164.5	-2368.6	-2277.6
140	-2250.4	-2152.4	-2429.0	-2331.0	-2550.8	-2452.8
150	-2411.1	-2306.1	-2602.5	-2497.5	-2733.0	-2628.0

## 2.3 Insertion loss

Nominal Compensation Length [km]	Insertion Loss BOL RT [dB]			Insertion Loss EOL over temperature [dB]	
	min	typical	max	min	max
5	0.30	0.70	1.40	0.30	1.70
10	0.60	1.00	1.60	0.60	1.90
15	0.80	1.30	1.90	0.80	2.20
20	1.10	1.60	2.20	1.10	2.50
25	1.30	1.90	2.50	1.30	2.80
30	1.60	2.20	2.90	1.60	3.20
35	1.80	2.50	3.20	1.80	3.50
40	2.00	2.80	3.50	2.00	3.80
45	2.30	3.10	3.90	2.30	4.20
50	2.50	3.40	4.20	2.50	4.50
60	3.00	4.00	4.90	3.00	5.20
70	3.50	4.60	5.60	3.50	5.90
80	4.00	5.20	6.20	4.00	6.50
90	4.50	5.80	6.90	4.50	7.20
100	5.00	6.40	7.60	5.00	7.90
110	5.50	7.00	8.20	5.50	8.50
120	5.90	7.60	8.90	5.90	9.20
130	6.40	8.20	9.60	6.40	9.90
140	6.90	8.80	10.30	6.90	10.60
150	7.40	9.40	10.90	7.40	11.20

## 2.4 Wavelength Dependent Loss

The wavelength dependent loss is defined as the difference between the maximum insertion loss and the minimum insertion loss within the C-band.

Nominal Compensation Length [km]	Max Wavelength Dependent Loss [dB]	
	BOL RT	EOL over temp.
5	0.40	0.50
10	0.40	0.50
15	0.40	0.50
20	0.40	0.50
25	0.40	0.50
30	0.40	0.50
35	0.40	0.50
40	0.40	0.50
45	0.45	0.55
50	0.45	0.55
60	0.55	0.65
70	0.60	0.70
80	0.65	0.75
90	0.75	0.85
100	0.80	0.90
110	0.85	0.95
120	0.95	1.05
130	1.00	1.10
140	1.05	1.15
150	1.15	1.25

## 2.5 Polarization Effects

Nominal Compensation Length [km]	PMD [ps]		PDL [dB]
	typical	max	max
5	0.08	0.20	0.1
10	0.10	0.25	
15	0.12	0.30	
20	0.14	0.30	
25	0.16	0.35	
30	0.17	0.40	
35	0.19	0.40	
40	0.20	0.45	
45	0.21	0.45	
50	0.22	0.50	
60	0.24	0.55	
70	0.26	0.60	
80	0.28	0.60	
90	0.30	0.65	
100	0.32	0.70	
110	0.33	0.70	
120	0.35	0.75	
130	0.36	0.80	
140	0.37	0.80	
150	0.39	0.85	

## 2.6 Length and Delay

Nominal Compensation Length [km]	Length [km]			Delay [ $\mu$ s]		
	min	typical	max	min	typical	max
5	0.4	0.5	0.6	2.0	2.5	3.1
10	0.8	1.0	1.2	4.1	5.0	6.1
15	1.2	1.5	1.9	6.1	7.5	9.2
20	1.7	2.0	2.5	8.2	10.0	12.3
25	2.1	2.5	3.1	10.2	12.5	15.4
30	2.5	3.0	3.7	12.2	15.0	18.4
35	2.9	3.6	4.4	14.3	17.5	21.5
40	3.3	4.1	5.0	16.3	20.0	24.6
45	3.7	4.6	5.6	18.3	22.5	27.7
50	4.1	5.1	6.2	20.4	25.0	30.7
60	5.0	6.1	7.5	24.5	30.1	36.9
70	5.8	7.1	8.7	28.5	35.1	43.0
80	6.6	8.1	10.0	32.6	40.1	49.2
90	7.4	9.1	11.2	36.7	45.1	55.3
100	8.3	10.2	12.5	40.8	50.1	61.5
110	9.1	11.2	13.7	44.8	55.1	67.6
120	9.9	12.2	15.0	48.9	60.1	73.7
130	10.8	13.2	16.2	53.0	65.1	79.9
140	11.6	14.2	17.5	57.1	70.1	86.0
150	12.4	15.2	18.7	61.2	75.1	92.2

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### 2.7 Nonlinearity

Nominal Compensation Length [km]	Typical Effective Area 1550 nm [ $\mu\text{m}^2$ ]	Typical Nonlinear Coefficient $\gamma$ 1550 nm [1/(W-km)]	Typical Fiber Attenuation 1550 nm [dB/km]	Typical Splice Loss (per end) 1550 nm [dB]
All modules	14	7.6	0.58	0.2

## 3 SMF-DK Mechanical Design

The standard SMF-DK DSCMs are available in two mechanical options

Option code	Description	Dimensions	Drawing no
01	Fiber spool (up to 90 km)	$\text{Ø}140 \text{ mm} \times 22 \text{ mm}$	rv_sys24_k02_spol09_01_d
02	Fiber spool (up to 130 km)	$\text{Ø}165 \text{ mm} \times 22 \text{ mm}$	
03	Fiber spool (up to 150 km)	$\text{Ø}175 \text{ mm} \times 23 \text{ mm}$	
10	Standard box	$212 \times 244.2 \times 41 \text{ mm}^3$	rv_sys04_k02_asm01_00_d

Furthermore, a rack mount that allows two modules to be mounted in a 19" rack is also available (ordered separately).

Order code	Rack type	Drawing no
DSCM-Rack-19-1	19" rack	rv_sys04_k02_asm01_00_d
DSCM-Rack-21-1	21" rack	

### 3.1 Reference Spool Drawing

