



SLOVENSKI STANDARD
oSIST prEN IEC 60747-16-9:2023
01-maj-2023

Polprevodniški elementi - 16-9. del: Mikrovalovna integrirana vezja - Fazni menjalniki

Semiconductor devices - Part 16-9: Microwave integrated circuits - Phase shifters

iTeh STANDARD PREVIEW
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Ta slovenski standard je istoveten z: **prEN IEC 60747-16-9:2023**

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31.200	Integrirana vezja, mikroelektronika	Integrated circuits. Microelectronics

oSIST prEN IEC 60747-16-9:2023 **en**



47E/803/CDV

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TITLE:

Semiconductor devices - Part 16-9: Microwave integrated circuits - Phase shifters

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

All Observations of Secretariat were agreed in the WG2 online meetings held on 2022-05-18 and 2022-10-27

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CONTENTS

1			
2	FOREWORD		5
3	1	Scope	7
4	2	Normative references	7
5	3	Terms and definitions	7
6	4	Essential ratings and characteristics	9
7	4.1	General requirements	9
8	4.1.1	Circuit identification and types	9
9	4.1.2	General function description	10
10	4.1.3	Manufacturing technology	10
11	4.1.4	Package identification	10
12	4.2	Application description	10
13	4.2.1	Conformance to system and/or interface information	10
14	4.2.2	Overall block diagram	10
15	4.2.3	Reference data	10
16	4.2.4	Electrical compatibility	10
17	4.2.5	Associated devices	10
18	4.3	Specification of the function	10
19	4.3.1	Detailed block diagram – Functional blocks	10
20	4.3.2	Identification and function of terminals	11
21	4.3.3	Function description	11
22	4.4	Limiting values (absolute maximum rating system)	12
23	4.4.1	Requirements	12
24	4.4.2	Electrical limiting values	12
25	4.4.3	Temperatures	13
26	4.5	Operating conditions (within the specified operating temperature range)	13
27	4.6	Electrical characteristics	14
28	4.7	Mechanical and environmental ratings, characteristics and data	14
29	4.8	Additional information	14
30	5	Measuring methods	15
31	5.1	General	15
32	5.1.1	General precautions	15
33	5.1.2	Characteristic impedance	15
34	5.1.3	Handling precautions	15
35	5.1.4	Types	15
36	5.2	Transmission loss (L_{trans}) and insertion loss (L_{ins})	15
37	5.2.1	Purpose	15
38	5.2.2	Measuring methods	15
39	5.3	Phase shift value (S_{ph})	18
40	5.3.1	Purpose	18
41	5.3.2	Circuit diagram	18
42	5.3.3	Principle of measurement	18
43	5.3.4	Circuit description and requirements	19
44	5.3.5	Precautions to be observed	19
45	5.3.6	Measurement procedure	19
46	5.3.7	Specified conditions	19
47	5.4	Phase shift range (R_{ph})	19
48	5.4.1	Purpose	19

49	5.4.2	Circuit diagram	19
50	5.4.3	Principle of measurement	19
51	5.4.4	Circuit description and requirements	20
52	5.4.5	Precautions to be observed	20
53	5.4.6	Measurement procedure	20
54	5.4.7	Specified conditions	20
55	5.5	Phase shift accuracy (S_{acc})	20
56	5.5.1	Purpose	20
57	5.5.2	Circuit diagram	20
58	5.5.3	Principle of measurement	20
59	5.5.4	Circuit description and requirements	20
60	5.5.5	Precautions to be observed	21
61	5.5.6	Measurement procedure	21
62	5.5.7	Specified conditions	21
63	5.6	Phase shift accuracy root mean square ($S_{acc(RMS)}$)	21
64	5.6.1	Purpose	21
65	5.6.2	Circuit diagram	21
66	5.6.3	Principle of measurement	21
67	5.6.4	Circuit description and requirements	21
68	5.6.5	Precautions to be observed	22
69	5.6.6	Measurement procedure	22
70	5.6.7	Specified conditions	22
71	5.7	Input return loss ($L_{ret(in)}$)	22
72	5.7.1	Purpose	22
73	5.7.2	Measuring methods	22
74	5.8	Output return loss ($L_{ret(out)}$)	25
75	5.8.1	Purpose	25
76	5.8.2	Measuring methods	25
77	5.9	Amplitude Flatness (F_{amp})	27
78	5.9.1	Purpose	27
79	5.9.2	Measuring methods	27
80	5.10	Transmission loss ripple (L_{rip})	28
81	5.10.1	Purpose	28
82	5.10.2	Measuring methods	28
83	5.11	Input power at 1 dB compression ($P_{i(1dB)}$)	30
84	5.11.1	Purpose	30
85	5.11.2	Circuit diagram	30
86	5.11.3	Principle of measurement	30
87	5.11.4	Circuit description and requirements	30
88	5.11.5	Precaution to be observed	30
89	5.11.6	Measurement procedure	30
90	5.11.7	Specified conditions	31
91	5.12	Intermodulation distortion (two-tone) (P_n/P_1)	31
92	5.12.1	Purpose	31
93	5.12.2	Circuit diagram	31
94	5.12.3	Principle of measurement	31
95	5.12.4	Circuit description and requirements	32
96	5.12.5	Precaution to be observed	32

97	5.12.6	Measurement procedure	32
98	5.12.7	Specified conditions	33
99	5.13	Power at the intercept point (for intermodulation products) ($P_{n(IP)}$)	33
100	5.13.1	Purpose	33
101	5.13.2	Circuit diagram	33
102	5.13.3	Principle of measurement	33
103	5.13.4	Circuit description and requirements	33
104	5.13.5	Precaution to be observed	33
105	5.13.6	Measurement procedure	33
106	5.13.7	Specified conditions	34
107	5.14	Turn on time(t_{ON}), turn off time(t_{OFF})	34
108	5.14.1	Purpose	34
109	5.14.2	Circuit diagram	34
110	5.14.3	Principle of measurement	34
111	5.14.4	Circuit description and requirements	35
112	5.14.5	Precaution to be observed	36
113	5.14.6	Measurement procedure	36
114	5.14.7	Specified conditions	36
115		Bibliography	37
116			
117		Figure 1 –Circuit diagram for the measurement of the transmission loss and insertion	
118		loss (method 1)	16
119		Figure 2 –Circuit diagram for the measurement of the scattering parameters	17
120		Figure 3 –Circuit diagram for the measurement of the return loss(method 1)	23
121		Figure 4 –Circuit diagram for the measurement of intermodulation distortion	32
122		Figure 5 –Circuit diagram for the measurement of switching times	34
123		Figure 6 –Input and output waveforms	35
124			
125		Table 1 – Function of terminals	12
126		Table 2 – Electrical limiting values	13
127		Table 3 – Electrical limiting values in detail specification	13
128		Table 4 –Temperatures	13
129		Table 5 – Electrical characteristics	14

130

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Part 16-9: Microwave integrated circuits –
Phase shifters

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FOREWORD

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142 all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international
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173 IEC 60747-16-9 has been prepared by subcommittee 47E: Discrete semiconductor devices, of
174 IEC technical committee 47: Semiconductor devices. It is an International Standard.

175 The text of this International Standard is based on the following documents:

Draft	Report on voting
47E/XX/FDIS	47E/XX/RVD

176

177 Full information on the voting for its approval can be found in the report on voting indicated in
178 the above table.

179 The language used for the development of this International Standard is English.

180 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
181 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
182 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
183 described in greater detail at www.iec.ch/publications.

184 A list of all parts in the IEC 60747 series, published under the general title *Semiconductor devices*, can

185 be found on the IEC website.

186 The committee has decided that the contents of this document will remain unchanged until the
187 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
188 specific document. At this date, the document will be

- 189 • reconfirmed,
- 190 • withdrawn,
- 191 • replaced by a revised edition, or
- 192 • amended.

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SEMICONDUCTOR DEVICES

Part 16-9: Microwave integrated circuits – Phase shifters

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198 **1 Scope**

199 This part of IEC 60747 specifies the terminology, essential ratings and characteristics, and
200 measuring methods of microwave integrated circuit phase shifters.

201 **2 Normative references**

202 The following documents are referred to in the text in such a way that some or all of their content
203 constitutes requirements of this document. For dated references, only the edition cited applies.
204 For undated references, the latest edition of the referenced document (including any
205 amendments) applies.

206 IEC 60747-1:2006, *Semiconductor devices – Part 1: General*
207 IEC 60747-1:2006/AMD 1:2010

208 IEC 60747-4, *Semiconductor devices – Discrete devices – Part 4: Microwave diodes and*
209 *transistors*

210 IEC 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic*
211 *phenomena – General requirements*

212 IEC TR 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic*
213 *phenomena – User guide*

214 **3 Terms and definitions**

215 For the purposes of this document, the following terms and definitions apply.

216 ISO and IEC maintain terminology databases for use in standardization at the following
217 addresses:

- 218 • IEC Electropedia: available at <https://www.electropedia.org/>
- 219 • ISO Online browsing platform: available at <https://www.iso.org/obp>

220 **3.1** 221 **reference state**

222 state where the phase difference between input and output of the phase shifter is a particular
223 value

224 Note 1 to entry: The condition for the reference state shall be specified.

225 Note 2 to entry: Though the phase difference at the reference state is usually maximum, median, or minimum value
226 of all available phase differences of the phase shifter, the other value can be acceptable.

227 **3.2** 228 **phase shift state** 229 state except for the reference state

230 **3.3** 231 **transmission loss**

232 L_{trans}

233 ratio of the input power to the output power, in the linear region of the power transfer curve
234 $P_o(\text{dBm})=f(P_i)$

235 Note 1 to entry: In this region, $\Delta P_o(\text{dBm})=\Delta P_i(\text{dBm})$.

236 Note 2 to entry: Usually the transmission loss is expressed in decibels.

- 237 **3.4**
 238 **insertion loss**
 239 L_{ins}
 240 ratio of the input power to the output power, in the linear region of the power transfer curve
 241 $P_o(\text{dBm})=f(P_i)$ in the reference state
- 242 Note 1 to entry: In this region, $\Delta P_o(\text{dBm})=\Delta P_i(\text{dBm})$.
 243 Note 2 to entry: Usually the insertion loss is expressed in decibels.
 244 [SOURCE: IEC 60747-16-4:2004/AMD 1:2009, 3.1, modified – “at the switched on port” has been deleted and “in the
 245 reference state” has been added.]
- 246 **3.5**
 247 **phase shift value**
 248 S_{ph}
 249 difference between the phase in the phase shift state and that in the reference state
- 250 **3.6**
 251 **phase shift range**
 252 R_{ph}
 253 difference between the maximum and minimum phase among all phase shift states and
 254 reference state
- 255 **3.7**
 256 **phase shift accuracy**
 257 S_{acc}
 258 difference between the measured and the nominal phase shift value
- 259 **3.8**
 260 **phase shift accuracy root mean square**
 261 $S_{acc(\text{RMS})}$
 262 root-mean-square value of the maximum differences between the measured and the nominal
 263 phase shift values
- 264 **3.9**
 265 **input return loss**
 266 $L_{ret(\text{in})}$
 267 ratio of the incident power at the input port to the reflected power at the input port
 268 [SOURCE: IEC 60747-16-6:2019, 3.4]
- 269 **3.10**
 270 **output return loss**
 271 $L_{ret(\text{out})}$
 272 ratio of the incident power at the output port to the reflected power at the output port
 273 [SOURCE: IEC 60747-16-6:2019, 3.5]
- 274 **3.11**
 275 **amplitude flatness**
 276 F_{amp}
 277 difference between the maximum and minimum insertion loss value in working frequency range
- 278 **3.12**
 279 **transmission loss ripple**
 280 L_{rip}
 281 difference between the maximum and minimum transmission loss value among all phase shift
 282 states

283 **3.13**284 **input power at 1 dB compression**285 $P_{i(1dB)}$ 286 input power where the transmission loss increases by 1 dB compared with transmission loss in
287 linear region

288 [SOURCE: IEC 60747-16-4:2004, 3.4]

289 **3.14**290 **intermodulation distortion**291 P_n/P_1 292 ratio of the n th order component of the output power to the fundamental component of the output
293 power294 Note 1 to entry: The abbreviation “ IMD_n ” is in common use for the n th order intermodulation distortion.

295 [SOURCE: IEC 60747-4:2007/AMD1:2017, 7.2.19]

296 **3.15**297 **power at the intercept point (for intermodulation products)**298 $P_{n(IP)}$ 299 output power at intersection between the extrapolated output powers of the fundamental
300 component and the n th order intermodulation components, when the extrapolation is carried
301 out in a diagram showing the output power of the components (in decibels) as a function of the
302 input power (in decibels)

303 [SOURCE: IEC 60747-16-1:2001, 3.8]

304 **3.16**305 **switching time**306 **3.16.1**307 **turn on time**308 t_{on} 309 interval between the lower reference point on the leading edge of the control voltage and the
310 upper reference point on the leading edge of the envelope of output voltage in the linear region
311 of the power transfer curve $P_o(\text{dBm})=f(P_i)$ when the state of phase shifter changes from the
312 reference state to the phase shift state313 Note 1 to entry: In this region, $\Delta P_o(\text{dBm})=\Delta P_i(\text{dBm})$.

314 Note 2 to entry: Usually the reference is 50% of the amplitude.

315 [SOURCE: IEC 60747-16-4:2004, 3.6, modified — Note 2 to entry has been added]

316 **3.16.2**317 **turn off time**318 t_{off} 319 interval between the upper reference point on the trailing edge of the control voltage and the
320 lower reference point on the trailing edge of the envelope of the output voltage in the linear
321 region of the power transfer curve $P_o(\text{dBm})=f(P_i)$ when the state of phase shifter changes from
322 the reference state to the phase shift state323 Note 1 to entry: In this region, $\Delta P_o(\text{dBm})=\Delta P_i(\text{dBm})$.

324 Note 2 to entry: Usually the reference is 50% of the amplitude.

325 [SOURCE: IEC 60747-16-4:2004, 3.7, modified — Note 2 to entry has been added]

326 **4 Essential ratings and characteristics**327 **4.1 General requirements**328 **4.1.1 Circuit identification and types**329 The identification of type (device name), the category of circuit and technology applied shall be
330 given.

331 Microwave phase shifters comprise two categories:

- 332 – Type A: Digital phase shifters ;
- 333 – Type B: Analog phase shifters.

334 **4.1.2 General function description**

335 A general description of the function performed by the microwave integrated circuit phase
336 shifters and the features for the application shall be made.

337 **4.1.3 Manufacturing technology**

338 The manufacturing technology, e.g. semiconductor monolithic integrated circuit, thin film
339 integrated circuit, micro-assembly, etc. shall be stated. This statement shall include details of
340 the semiconductor technologies such as PIN diode, heterostructure field effect transistor
341 (HFET), pseudomorphic high electronic mobility transistor(PHEMT), etc.

342 IEC 60747-4 shall be referred to for terminology and letter symbols, essential ratings and
343 characteristics and measuring methods of such microwave devices.

344 **4.1.4 Package identification**

345 The following statements shall be made:

- 346 a) chip or packaged form;
- 347 b) IEC and/or national reference number of the outline drawing, or drawing of non-standard
348 package including terminal numbering;
- 349 c) principal package material, for example, metal, ceramic, plastic.

350 **4.2 Application description**

351 **4.2.1 Conformance to system and/or interface information**

352 It should be stated whether the integrated circuit conforms to an application system and/or an
353 interface standard or a recommendation.

354 Detailed information concerning application systems, equipment and circuits such as radar
355 systems, communication systems, Wifi wireless network systems, etc. should also be given.

356 **4.2.2 Overall block diagram**

357 A block diagram of the applied systems should be given if necessary.

358 **4.2.3 Reference data**

359 The most important properties that permit comparison between derivative types should be given.

360 **4.2.4 Electrical compatibility**

361 It should be stated whether the integrated circuit is electrically compatible with other particular
362 integrated circuits, or families of integrated circuits, or whether special interfaces are required.

363 Details should be given concerning the type of input and output circuits, e.g. input/output
364 impedances, DC block, open-drain, etc. Interchangeability with other devices, if any, should
365 also be given.

366 **4.2.5 Associated devices**

367 If applicable, the following should be stated:

- 368 – devices necessary for correct operation (list with type number, name and function);
- 369 – peripheral devices with direct interfacing (list with type number, name and function).

370 **4.3 Specification of the function**

371 **4.3.1 Detailed block diagram – Functional blocks**

372 A detail block diagram or equivalent circuit information of the integrated circuit microwave
373 phase shifters shall be given. The block diagram shall be composed of the following: