11. *JTAG Interface Operation*

The JTAG interface is implemented according to the standard IEEE 1149.1 test access port protocol specifications.

The JTAG interface accesses the JTAG controller and instruction register as well as a boundary scan register. The JTAG operation does not require **DCOk** to be asserted or **SysClk** to be running; however, if **DCOk** is asserted the **SysClk** must run at the specified minimum frequency or the core logic may get damaged. (See page 189 of the Errata.)

11.1 Test Access Port (TAP)

The test access port (TAP) consists of four interface signals. These signals are used to control the serial loading and unloading of instructions and test data, as well as to execute tests.

The TAP consists of the following signals:

JTDI:	Serial data input	(Input signal)
JTDO:	Serial data output	(Output signal)
JTMS:	Mode select	(Input signal)
JTCK:	Clock	(Input signal)

The timing and the relationship of the TAP signals follows the IEEE 1149.1 standard protocol.

TAP Controller (Input)

The R10000 processor implements the 16-state TAP controller specified by the IEEE 1149.1 standard in the following manner:

- The **JTMS** signal operates the state machine synchronized by the **JTCK** signal.
- The TAP controller is reset by keeping the **JTMS** signal asserted through five consecutive edges of **JTCK.** This reset condition sets the reset state of the controller. The TAP controller is also reset by asserting **SysReset***. This pin must not be asserted while using the boundary scan register.

11.2 Instruction Register

The JTAG instruction register is four bits wide, permitting a total of 16 instructions to control the selection of the bypass register, the boundary scan register, and other data registers.

The encoding of the instruction register is given in Table 11-1:

Table 11-1 JTAG Instruction Register Encoding

MSB...LSB	Selected Data Register
0000 0001	Boundary Scan Register Sample - Preload
0010 to 1110	Data Register (not used)
1111	Bypass Register

The 0001 value is provided to represent sample-preload, but also selects the boundary scan register.

During a reset of the TAP controller, the value 1111 is loaded into the parallel output of the instruction register, thus selecting the bypass register as the default.

During the Shift-IR state of the TAP controller, data is shifted serially into the instruction register from **JTDI**, and the LSB of the instruction register is shifted out onto **JTDO**.

During the Update-IR state, the current state of the instruction register is shifted to its parallel output for decoding.

11.3 Bypass Register

The bypass register is 1 bit wide.

When the bypass register is selected and the TAP controller is in the Shift-DR state, data on **JTDI** is shifted into the bypass register and the output of the bypass register is shifted out onto **JTDO**.

11.4 Boundary Scan Register

The bypass register is 1 bit wide.

The boundary scan data register is selected by loading 0000 into the instruction register. The Shift-DR, Update-DR, and Capture-DR states of the TAP controller are used to operate the boundary scan register according to the IEEE 1149.1 standard specifications.

The boundary scan register provides serial access to each of the processor interface pins, as shown in Figure 11-1. Hence, the boundary scan register can be used to load and observe specific logic values on the processor pins.

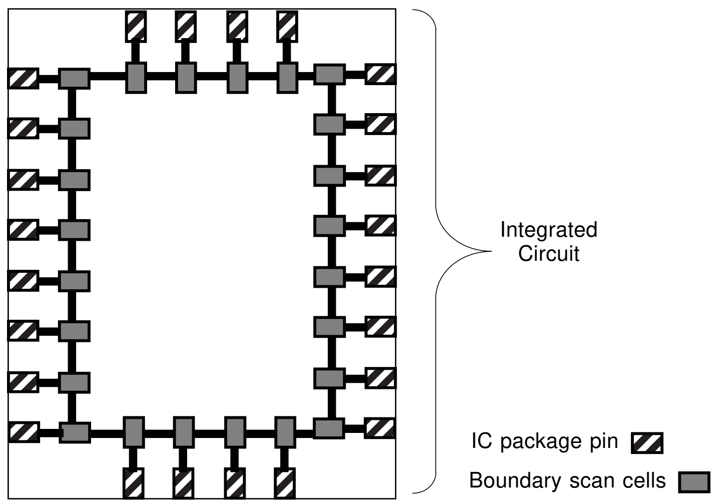

Figure 11-1 JTAG Boundary Scan Cells

The main application of the boundary scan register is board-level interconnect testing.

The use of the boundary scan register for applying data to and capturing data from the internal microprocessor circuitry is not supported.

The boundary scan register list for rev 1.2 of the fab is given in Table 11-2. The **TriState** signal will be eliminated from the BSR in rev 2.0 of the fab, and beyond.

An additional bit is provided in the boundary scan register to control the direction of bidirectional pins. As it is loaded through JTDI, this bit is the first bit in the boundary scan chain. The logic value of this bit is latched during the Update-DR state, and sets the direction of all bidirectional pins as follows:

Value	Direction
0	Input
1	Output

The value is set to 0 during reset, setting all bidirectional pins to *input* prior to any boundary scan operations.

Table 11-2 Boundary Scan Register Pinlist, rev 1.2

Signal	Signal	Signal	Signal	Signal	Signal
1. SCDataChk[1]	2. SCData[63]	3. SCData[62]	4. SCData[61]	5. SCData[60]	6. SCData[59]
7. SCData[58]	8. SCData[57]	9. SCData[56]	10. SCData[55]	11. SCData[54]	12. SCData[53]
13. SCData[52]	14. SCData[51]	15. SCData[50]	16. SCData[49]	17. SCData[48]	18. SCData[47]
19. SCData[46]	20. SCData[45]	21. SCData[44]	22. SCData[43]	23. SCData[42]	24. SCData[41]
25. SCData[40]	26. SCData[39]	27. SCData[38]	28. SCData[37]	29. SCData[36]	30. SCData[35]
31. SCData[34]	32. SCData[33]	33. SCData[32]	34. SysAD[0]	35. SysAD[1]	36. SysAD[2]
37. SysAD[3]	38. SysAD[4]	39. SysAD[5]	40. SysAD[6]	41. SysAD[7]	42. SysAD[8]
43. SysAD[9]	44. SysAD[10]	45. SysAD[11]	46. SysAD[12]	47. SysAD[13]	48. SysAD[14]
49. SysAD[15]	50. SCData[0]	51. SCData[1]	52. SCData[2]	53. SCData[3]	54. SCData[4]
55. SCData[5]	56. SCData[6]	57. SCData[7]	58. SCData[8]	59. SCData[9]	60. SCData[10]
61. SCData[11]	62. SCData[12]	63. SCData[13]	64. SCData[14]	65. SCData[15]	66. SCData[16]
67. SCData[17]	68. SCData[18]	69. SCData[19]	70. SCData[20]	71. SCData[21]	72. SCData[22]
73. SCData[23]	74. SCData[24]	75. SCData[25]	76. SCData[26]	77. SCData[27]	78. SCData[28]
79. SCData[29]	80. SCData[30]	81. SCData[31]	82. SCDataChk[0]	83. SCAAddr[18]	84. SCAAddr[17]
85. SCAAddr[16]	86. SCAAddr[15]	87. SCAAddr[14]	88. SCAAddr[13]	89. SCAAddr[12]	90. SCAAddr[11]
91. SCAAddr[10]	92. SCAAddr[9]	93. SCDataChk[2]	94. SCDataChk[4]	95. SCData[64]	96. SCData[65]
97. SCData[66]	98. SCData[67]	99. SCData[68]	100. SCData[69]	101. SCData[70]	102. SCData[71]
103. SCDataChk[9]	104. SysCyc*	105. SysAD[32]	106. SysAD[33]	107. SysAD[34]	108. SysAD[35]
109. SysAD[36]	110. SysAD[37]	111. SysAD[38]	112. SysAD[39]	113. SysAD[40]	114. SysAD[41]
115. SysAD[42]	116. SysAD[43]	117. SysAD[44]	118. SysAD[45]	119. SysAD[46]	120. SysAD[47]
121. SCData[72]	122. SCData[73]	123. SCData[74]	124. SCData[75]	125. SCData[76]	126. SCData[77]
127. SCData[78]	128. SCData[79]	129. SCAAddr[0]	130. SCAAddr[1]	131. SCAAddr[2]	132. SCAAddr[3]
133. SCAAddr[4]	134. SCAAddr[5]	135. SCAAddr[6]	136. SCAAddr[7]	137. SCAAddr[8]	138. SCADWay
139. SCADCS*	140. SCADOE*	141. SCADWr*	142. SCData[80]	143. SCData[81]	144. SCData[82]
145. SCData[83]	146. SCData[84]	147. SCData[85]	148. SCData[86]	149. SCData[87]	150. SCData[88]
151. SCData[89]	152. SCData[90]	153. SCData[91]	154. SCData[92]	155. SCData[93]	156. SCData[94]
157. SCData[95]	158. SCDataChk[6]	159. SCDataChk[8]	160. Spare1	161. SCTCS*	162. SCTOE*
163. SCTWr*	164. SCTag[25]	165. SCTag[24]	166. SCTag[23]	167. SCTag[22]	168. SCTag[21]
169. SCTag[20]	170. SCTag[19]	171. SCTag[18]	172. SCTag[17]	173. SCTag[16]	174. SCTag[15]
175. SCTag[14]	176. SCTag[13]	177. SCTag[12]	178. SCTag[11]	179. SCTag[10]	180. SCTag[9]
181. SCTag[8]	182. SCTag[7]	183. SCTag[6]	184. SCTag[5]	185. SCTag[4]	186. SCTag[3]
187. SCTag[2]	188. SCTag[1]	189. SCTag[0]	190. SCTagLSBAddr	191. TriState†	192. SCTWay
193. SCTagChk[6]	194. SCTagChk[5]	195. SCTagChk[4]	196. SCTagChk[3]	197. SCTagChk[2]	198. SCTagChk[1]
199. SCTagChk[0]	200. SysCmd[0]	201. SysCmd[1]	202. SysCmd[2]	203. SysCmd[3]	204. SysCmd[4]
205. SysCmd[5]	206. SysCmd[6]	207. SysCmd[7]	208. SysCmd[8]	209. SysCmd[9]	210. SysCmd[10]
211. SysCmd[11]	212. SysCmdPar	213. SysVal*	214. SysReq*	215. SysRel*	216. SysGnt*
217. SysReset*	218. SysRespVal*	219. SysRespPar	220. SysResp[4]	221. SysResp[3]	222. SysResp[2]
223. SysResp[1]	224. SysResp[0]	225. SysGblPerf*	226. SysRdRdy*	227. SysWrRdy*	228. SysStateVal*
229. SysStatePar	230. SysState[2]	231. SysState[1]	232. SysState[0]	233. SysCorErr*	234. SysUncErr*
235. SysNMI*	236. SCDataChk[7]	237. SCDataChk[5]	238. SCData[127]	239. SCData[126]	240. SCData[125]
241. SCData[124]	242. SCData[123]	243. SCData[122]	244. SCData[121]	245. SCData[120]	246. SCData[119]
247. SCData[118]	248. SCData[117]	249. SCData[116]	250. SCData[115]	251. SCData[114]	252. SCData[113]

†. Will be eliminated after rev. 1.2.

Table 11-2 (cont.) Boundary Scan Register Pinlist, rev 1.2

Signal	Signal	Signal	Signal	Signal	Signal
253. SCData[112]	254. SCBDWr*	255. SCBDOE*	256. SCBDCS*	257. SCBDWay	258. SCBAddr[8]
259. SCBAddr[7]	260. SCBAddr[6]	261. SCBAddr[5]	262. SCBAddr[4]	263. SCBAddr[3]	264. SCBAddr[2]
265. SCBAddr[1]	266. SCBAddr[0]	267. SCData[111]	268. SCData[110]	269. SCData[109]	270. SCData[108]
271. SCTag[8]	272. SCTag[7]	273. SCTag[6]	274. SCTag[5]	275. SCTag[4]	276. SCTag[3]
277. SCTag[2]	278. SCTag[1]	279. SCTag[0]	280. SCTagLSBAddr	281. TriState†	282. SCTWay
283. SCTagChk[6]	284. SCTagChk[5]	285. SCTagChk[4]	286. SCTagChk[3]	287. SCTagChk[2]	288. SCTagChk[1]
289. SCTagChk[0]	290. SysCmd[0]	291. SysCmd[1]	292. SysCmd[2]	293. SysCmd[3]	294. SysCmd[4]
295. SysCmd[5]	296. SysCmd[6]	297. SysCmd[7]	298. SysCmd[8]	299. SysCmd[9]	300. SysCmd[10]
301. SysCmd[11]	302. SysCmdPar	303. SysVal*	304. SysReq*	305. SysRel*	306. SysGnt*
307. SysReset*	308. SysRespVal*	309. SysRespPar	310. SysResp[4]	311. SysResp[3]	312. SysResp[2]
313. SysResp[1]	314. SysResp[0]	315. SysGblPerf*	316. SysRdRdy*	317. SysWrRdy*	318. SysStateVal*
319. SysStatePar	320. SysState[2]	321. SysState[1]	322. SysState[0]	323. SysCorErr*	324. SysUncErr*
325. SysNMI*	326. SCDataChk[7]	327. SCDataChk[5]	328. SCData[127]	329. SCData[126]	330. SCData[125]
331. SCData[124]	332. SCData[123]	333. SCData[122]	334. SCData[121]	335. SCData[120]	336. SCData[119]
337. SCData[118]	338. SCData[117]	339. SCData[116]	340. SCData[115]	341. SCData[114]	342. SCData[113]
343. SCData[112]	344. SCBDWr*	345. SCBDOE*	346. SCBDCS*	347. SCBDWay	348. SCBAddr[8]
349. SCBAddr[7]	350. SCBAddr[6]	351. SCBAddr[5]	352. SCBAddr[4]	353. SCBAddr[3]	354. SCBAddr[2]
355. SCBAddr[1]	356. SCBAddr[0]	357. SCData[111]	358. SCData[110]	359. SCData[109]	360. SCData[108]
361. SCData[107]	362. SCData[106]	363. SCData[105]	364. SCData[104]	365. SysAD[63]	366. SysAD[62]
367. SysAD[61]	368. SysAD[60]	369. SysAD[59]	370. SysAD[58]	371. SysAD[57]	372. SysAD[56]
373. SysAD[55]	374. SysAD[54]	375. SysAD[53]	376. SysAD[52]	377. SysAD[51]	378. SysAD[50]
379. SysAD[49]	380. SysAD[48]	381. SysADChk[7]	382. SysADChk[6]	383. SysADChk[5]	384. SysADChk[4]
385. SysADChk[3]	386. SysADChk[2]	387. SysADChk[1]	388. SysADChk[0]	389. SysAD[31]	390. SysAD[30]
391. SysAD[29]	392. SysAD[28]	393. SysAD[27]	394. SysAD[26]	395. SysAD[25]	396. SysAD[24]
397. SysAD[23]	398. SysAD[22]	399. SysAD[21]	400. SysAD[20]	401. SysAD[19]	402. SysAD[18]
403. SysAD[17]	404. SysAD[16]	405. SCData[103]	406. SCData[102]	407. SCData[101]	408. SCData[100]
409. SCData[99]	410. SCData[98]	411. SCData[97]	412. SCData[96]	413. SCDataChk[3]	414. SCBAddr[9]
415. SCBAddr[10]	416. SCBAddr[11]	417. SCBAddr[12]	418. SCBAddr[13]	419. SCBAddr[14]	420. SCBAddr[15]
421. SCBAddr[16]	422. SCBAddr[17]	423. SCBAddr[18]			

†. Will be eliminated after rev. 1.2.