

**Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)**

**Submission Title:** [CSK constellation in all color band combinations]

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**Re:** []

**Abstract:** [CSK constellation all color band combinations]

**Purpose:** [Contribution to IEEE 802.15.7 TG-VLC]

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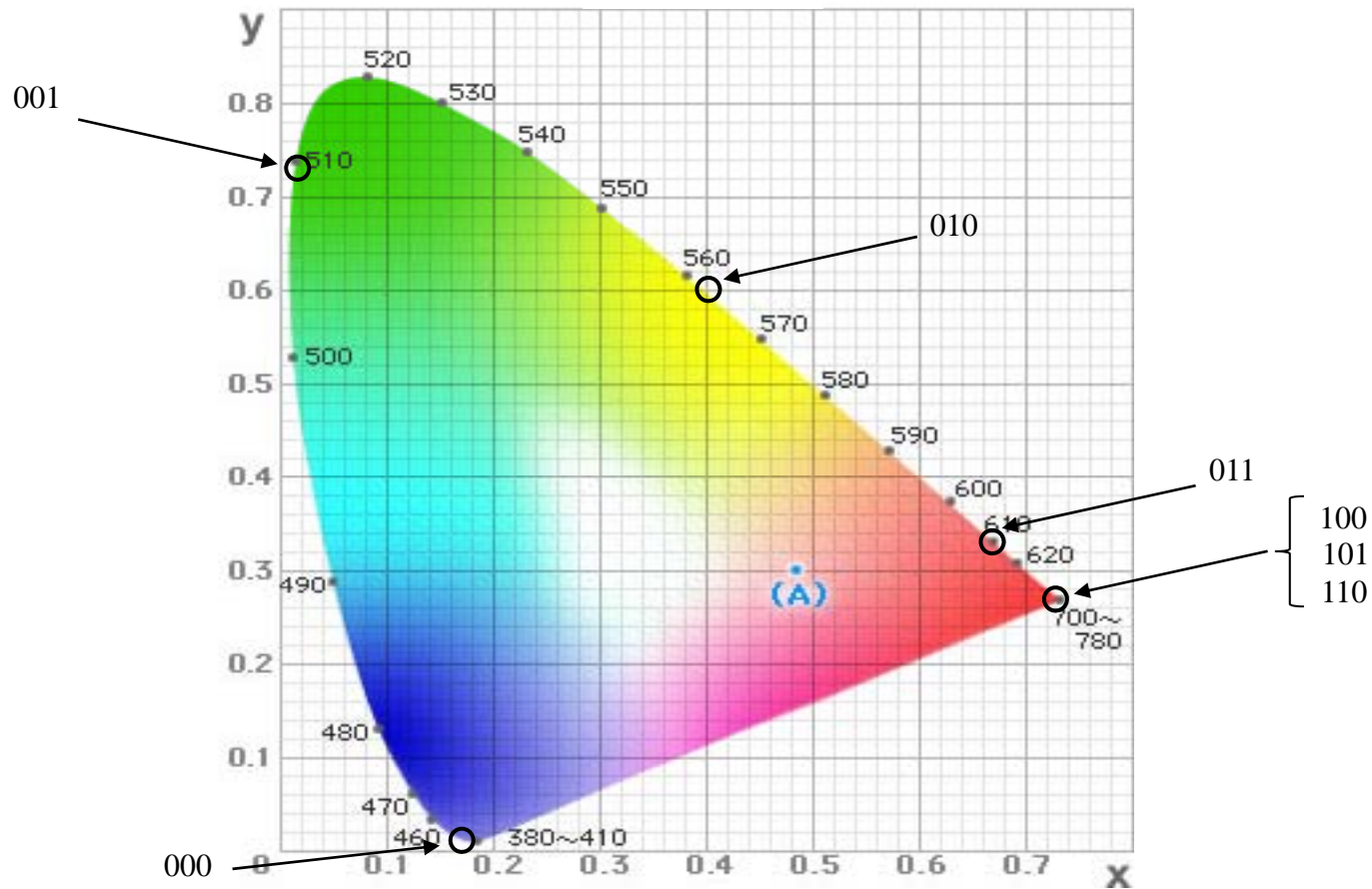
Table 105 - xy color coordinates

Band (nm)	Color Code	Center (nm)	(x , y)
380-478	000	429	(0.169, 0.007)
478-540	001	509	(0.011, 0.733)
540-588	010	564	(0.402, 0.597)
588-633	011	611	(0.669, 0.331)
633-679	100	656	(0.729, 0.271)
679-726	101	703	(0.734, 0.265)
726-780	110	753	(0.734, 0.265)

Table 106 – Valid color band combinations for CSK

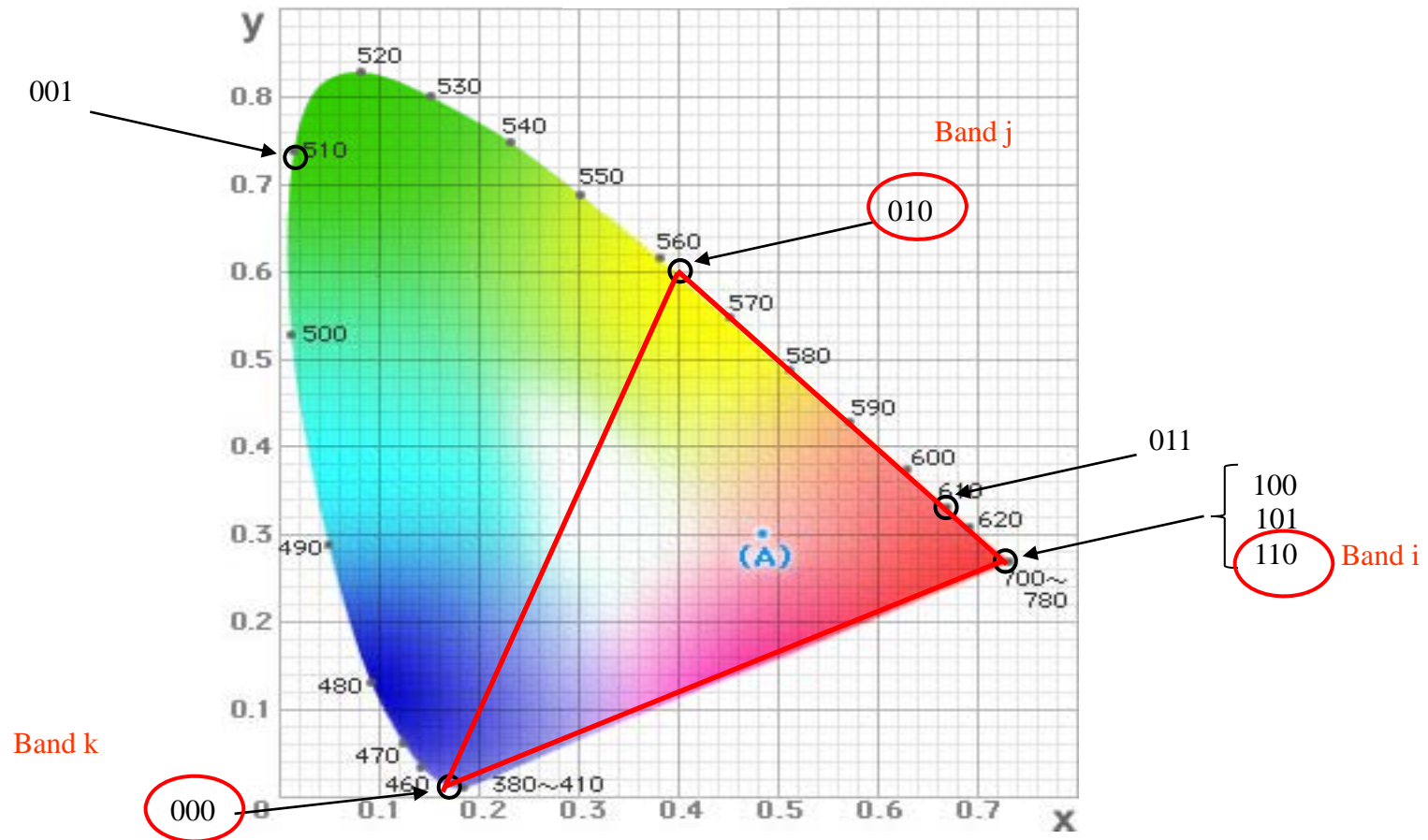
	Band i	Band j	Band k
1	110	010	000
2	110	001	000
3	101	010	000
4	101	001	000
5	100	010	000
6	100	001	000
7	011	010	000
8	011	001	000
9	010	001	000

Figure 135—Center of color bands on xy color coordinates



Code 100, 101 and 110 have a almost same position on xy color coordinates for the new color bands.

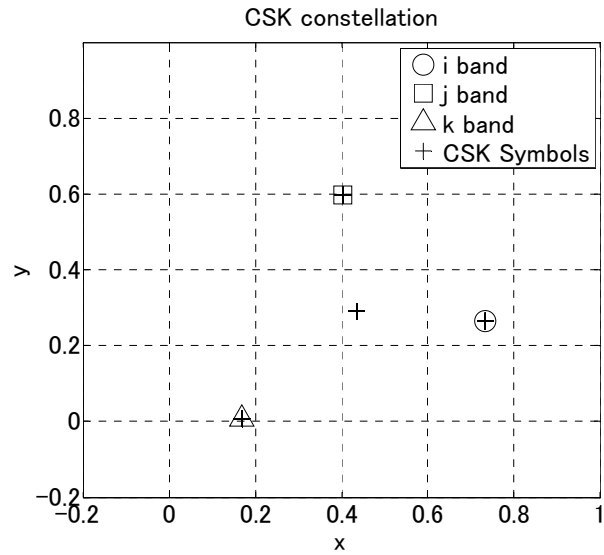
# Valid CSK constellation example for codes (110, 010, 000)



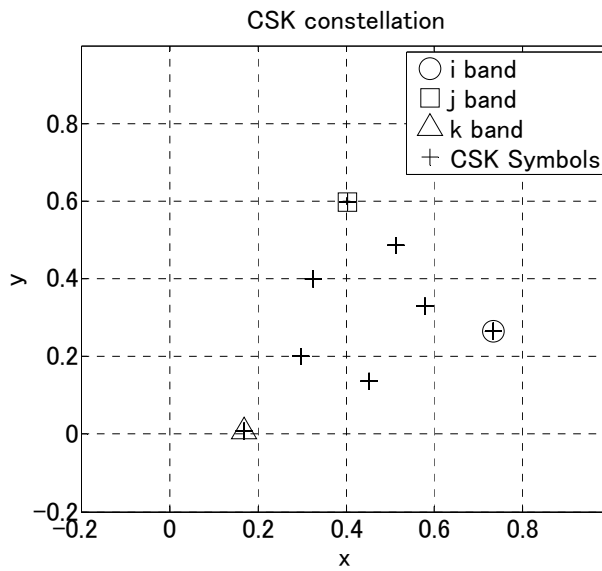
## Color band combination example for (110, 010, 000)

Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.734 0.265)	[0 0] --> (0.402 0.597)	[0 0 0] --> (0.324 0.400)	[0 0 0 0] --> (0.402 0.597)
(0.402 0.597)	[0 1] --> (0.435 0.290)	[0 0 1] --> (0.297 0.200)	[0 0 0 1] --> (0.413 0.495)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.579 0.329)	[0 0 1 0] --> (0.335 0.298)
	[1 1] --> (0.734 0.265)	[0 1 1] --> (0.452 0.136)	[0 0 1 1] --> (0.324 0.400)
		[1 0 0] --> (0.402 0.597)	[0 1 0 0] --> (0.623 0.376)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.513 0.486)
		[1 1 0] --> (0.513 0.486)	[0 1 1 0] --> (0.435 0.290)
		[1 1 1] --> (0.734 0.265)	[0 1 1 1] --> (0.524 0.384)
			[1 0 0 0] --> (0.734 0.265)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.247 0.204)
			[1 0 1 1] --> (0.258 0.101)
			[1 1 0 0] --> (0.546 0.179)
			[1 1 0 1] --> (0.634 0.273)
			[1 1 1 0] --> (0.546 0.179)
			[1 1 1 1] --> (0.357 0.093)

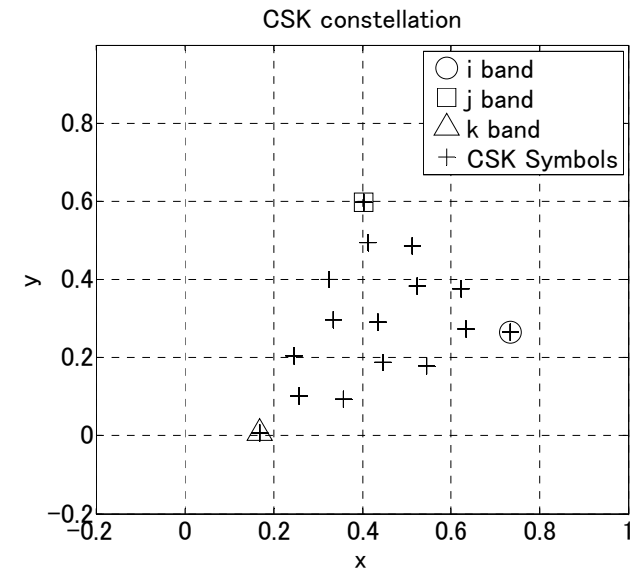
# CSK constellation made by color band combinations (110, 010, 000)



**4 CSK**

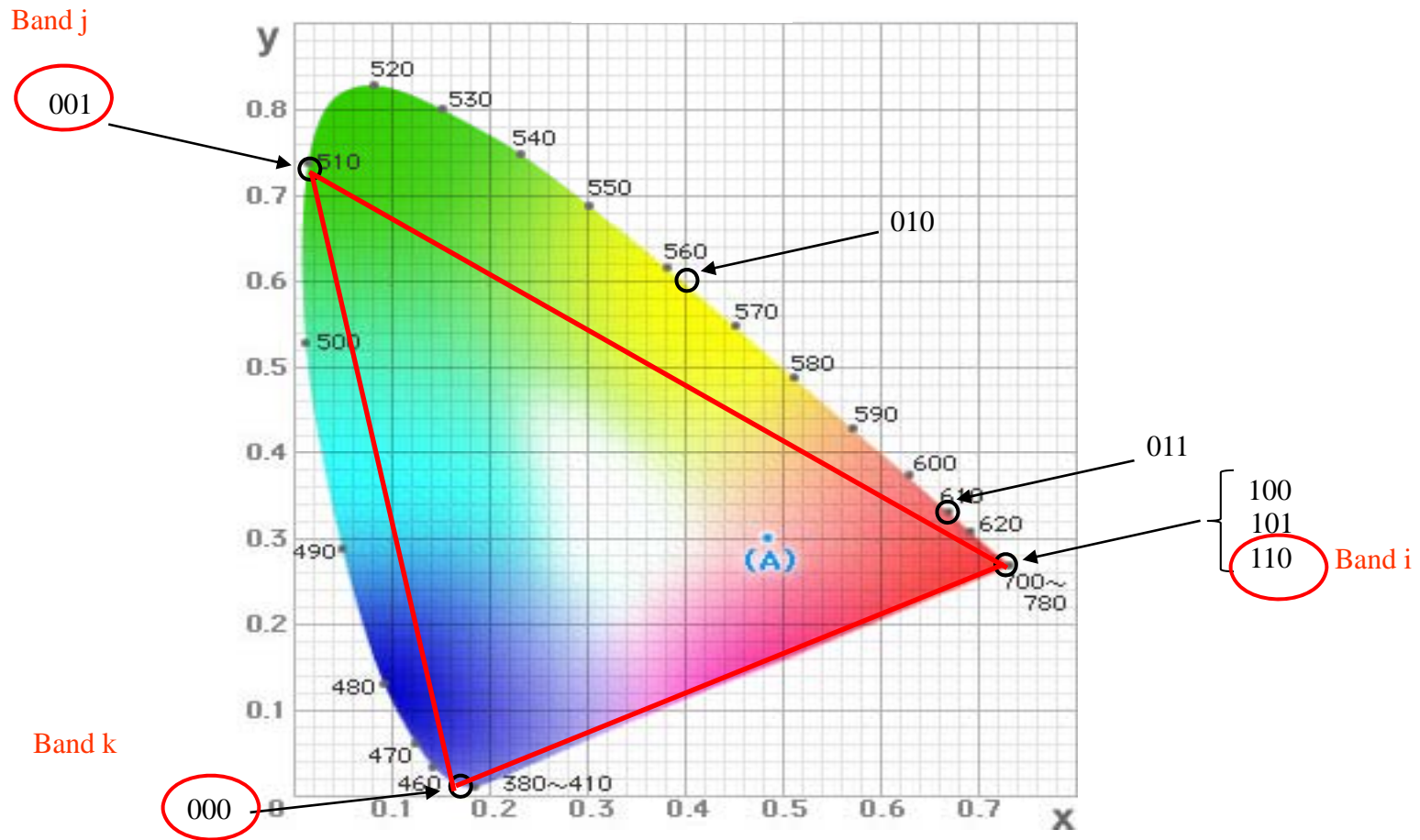


**8 CSK**



**16 CSK**

# Valid CSK constellation example for codes (110, 001, 000)

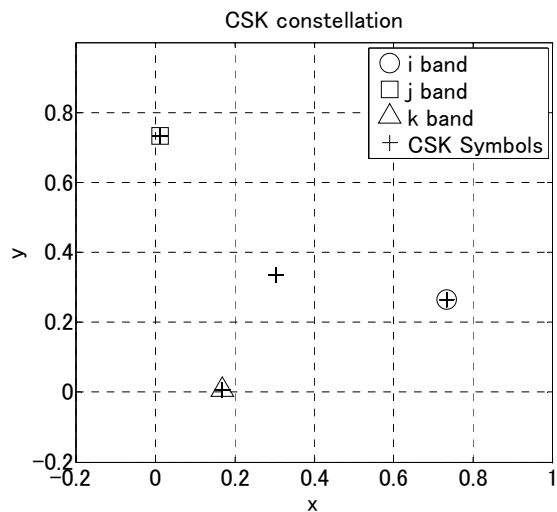




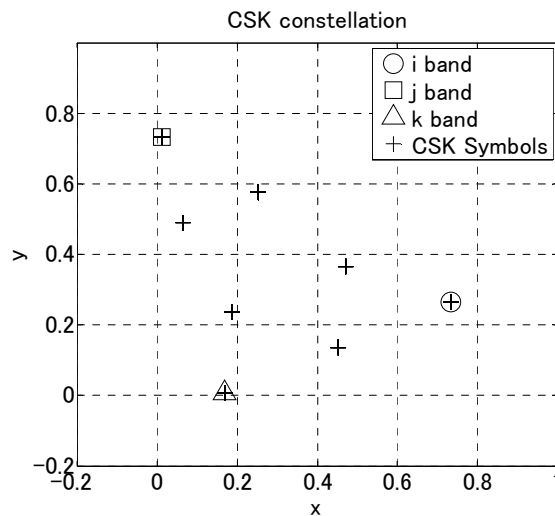
## Color band combination example for (110, 001, 000)

Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.734 0.265)	[0 0] --> (0.011 0.733)	[0 0 0] --> (0.064 0.491)	[0 0 0 0] --> (0.011 0.733)
(0.011 0.733)	[0 1] --> (0.305 0.335)	[0 0 1] --> (0.188 0.237)	[0 0 0 1] --> (0.109 0.600)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.470 0.366)	[0 0 1 0] --> (0.162 0.358)
	[1 1] --> (0.734 0.265)	[0 1 1] --> (0.452 0.136)	[0 0 1 1] --> (0.064 0.491)
		[1 0 0] --> (0.011 0.733)	[0 1 0 0] --> (0.493 0.421)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.252 0.577)
		[1 1 0] --> (0.252 0.577)	[0 1 1 0] --> (0.305 0.335)
		[1 1 1] --> (0.734 0.265)	[0 1 1 1] --> (0.350 0.444)
			[1 0 0 0] --> (0.734 0.265)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.116 0.249)
			[1 0 1 1] --> (0.214 0.116)
			[1 1 0 0] --> (0.546 0.179)
			[1 1 0 1] --> (0.591 0.288)
			[1 1 1 0] --> (0.546 0.179)
			[1 1 1 1] --> (0.357 0.093)

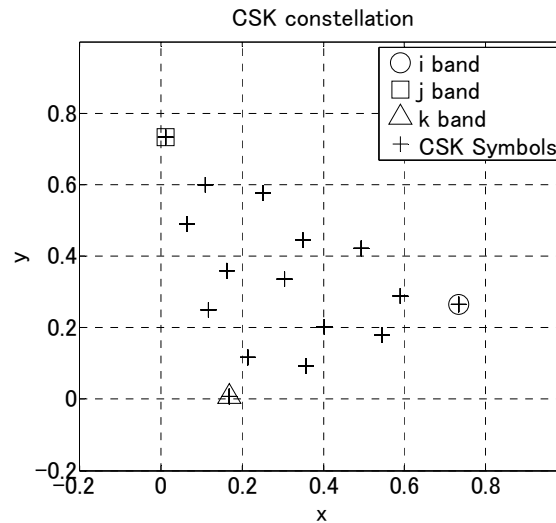
# CSK constellation made by color band combinations (110, 001, 000)



**4 CSK**

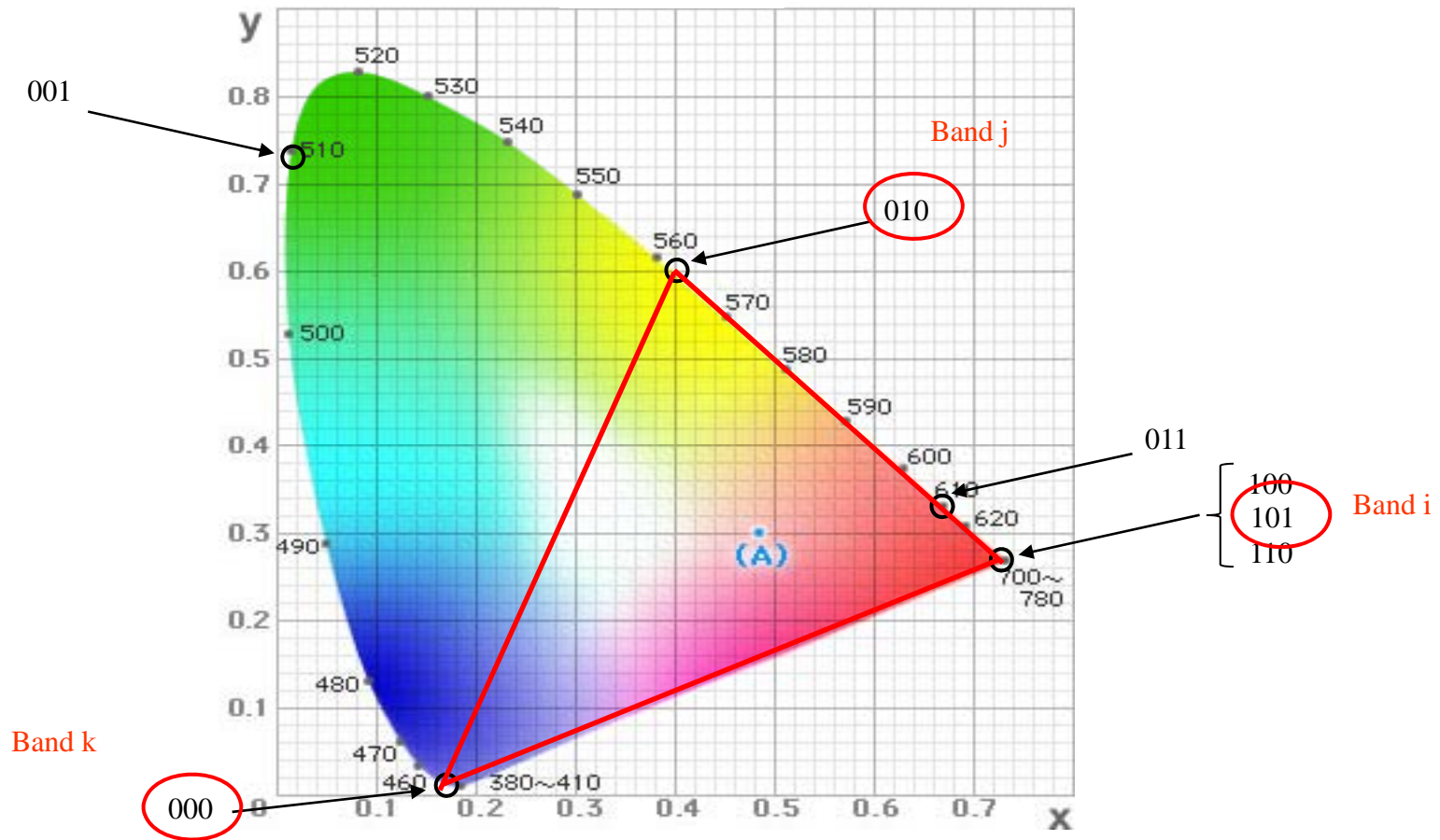


**8 CSK**



**16 CSK**

# Valid CSK constellation example for codes (101, 010, 000)

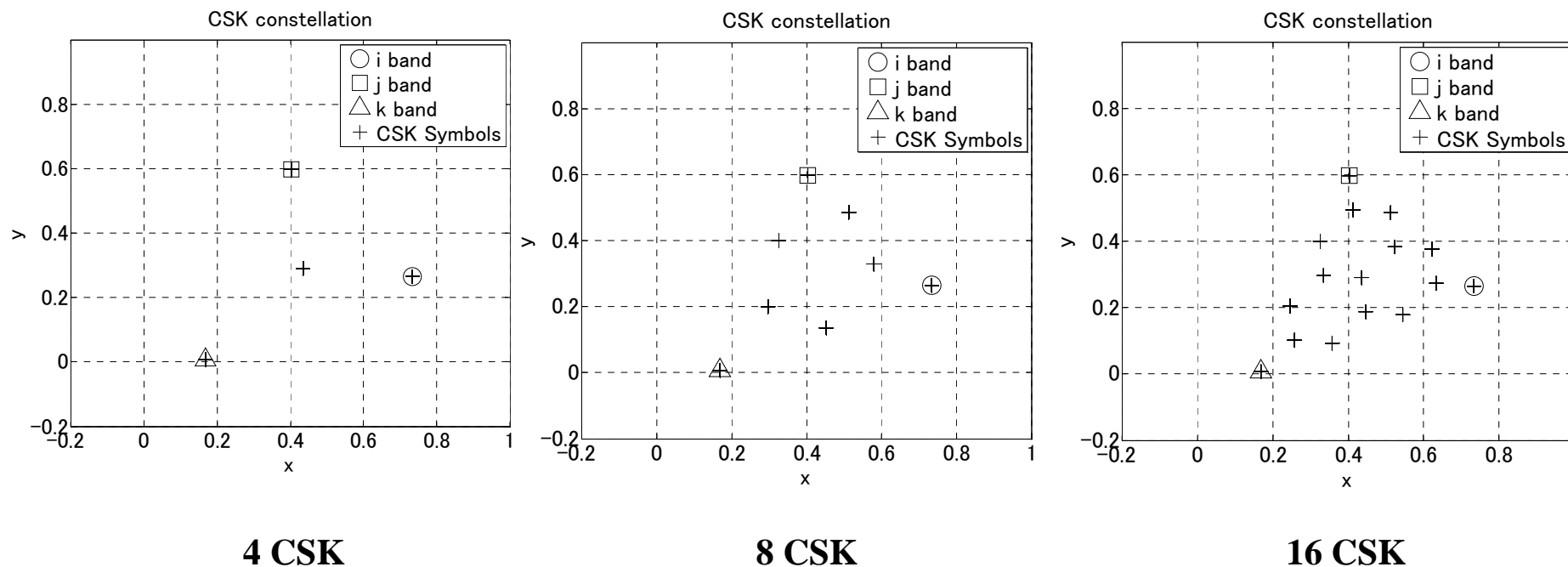


This is same as the color bands combination (110, 010, 000).

## Color band combination example for (101, 010, 000)

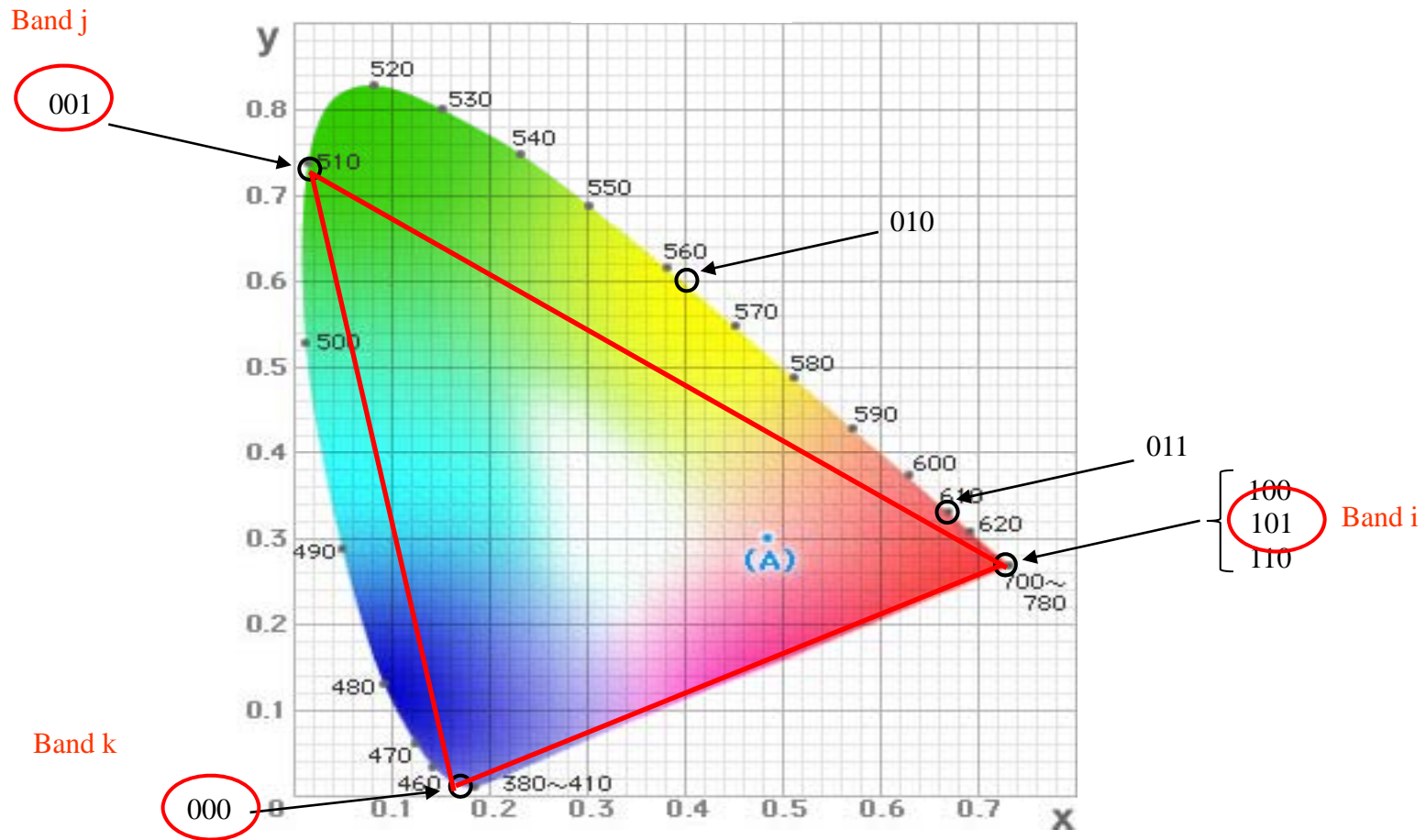
Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.734 0.265)	[0 0] --> (0.402 0.597)	[0 0 0] --> (0.324 0.400)	[0 0 0 0] --> (0.402 0.597)
(0.402 0.597)	[0 1] --> (0.435 0.290)	[0 0 1] --> (0.297 0.200)	[0 0 0 1] --> (0.413 0.495)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.579 0.329)	[0 0 1 0] --> (0.335 0.298)
	[1 1] --> (0.734 0.265)	[0 1 1] --> (0.452 0.136)	[0 0 1 1] --> (0.324 0.400)
		[1 0 0] --> (0.402 0.597)	[0 1 0 0] --> (0.623 0.376)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.513 0.486)
		[1 1 0] --> (0.513 0.486)	[0 1 1 0] --> (0.435 0.290)
		[1 1 1] --> (0.734 0.265)	[0 1 1 1] --> (0.524 0.384)
			[1 0 0 0] --> (0.734 0.265)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.247 0.204)
			[1 0 1 1] --> (0.258 0.101)
			[1 1 0 0] --> (0.546 0.179)
			[1 1 0 1] --> (0.634 0.273)
			[1 1 1 0] --> (0.546 0.179)
			[1 1 1 1] --> (0.357 0.093)

# CSK constellation made by color band combinations (101, 010, 000)



This is same as the color bands combination (110, 010, 000).

# Valid CSK constellation example for codes (101, 001, 000)

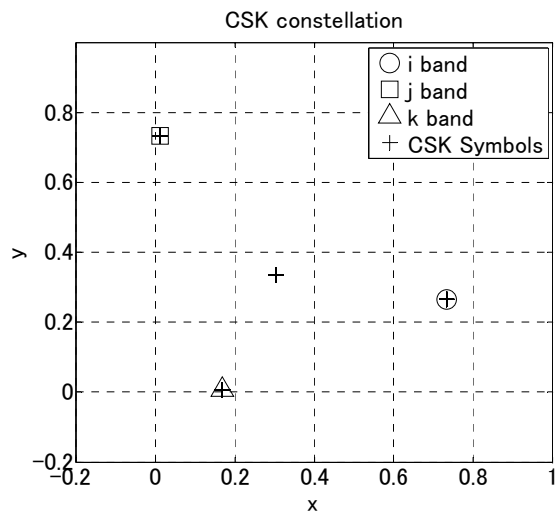


This is same as the color bands combination (110, 001, 000).

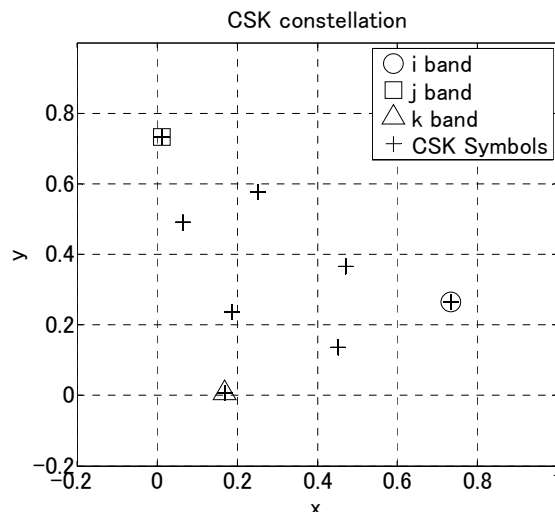
## Color band combination example for (101, 001, 000)

Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.734 0.265)	[0 0] --> (0.011 0.733)	[0 0 0] --> (0.064 0.491)	[0 0 0 0] --> (0.011 0.733)
(0.011 0.733)	[0 1] --> (0.305 0.335)	[0 0 1] --> (0.188 0.237)	[0 0 0 1] --> (0.109 0.600)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.470 0.366)	[0 0 1 0] --> (0.162 0.358)
	[1 1] --> (0.734 0.265)	[0 1 1] --> (0.452 0.136)	[0 0 1 1] --> (0.064 0.491)
		[1 0 0] --> (0.011 0.733)	[0 1 0 0] --> (0.493 0.421)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.252 0.577)
		[1 1 0] --> (0.252 0.577)	[0 1 1 0] --> (0.305 0.335)
		[1 1 1] --> (0.734 0.265)	[0 1 1 1] --> (0.350 0.444)
			[1 0 0 0] --> (0.734 0.265)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.116 0.249)
			[1 0 1 1] --> (0.214 0.116)
			[1 1 0 0] --> (0.546 0.179)
			[1 1 0 1] --> (0.591 0.288)
			[1 1 1 0] --> (0.546 0.179)
			[1 1 1 1] --> (0.357 0.093)

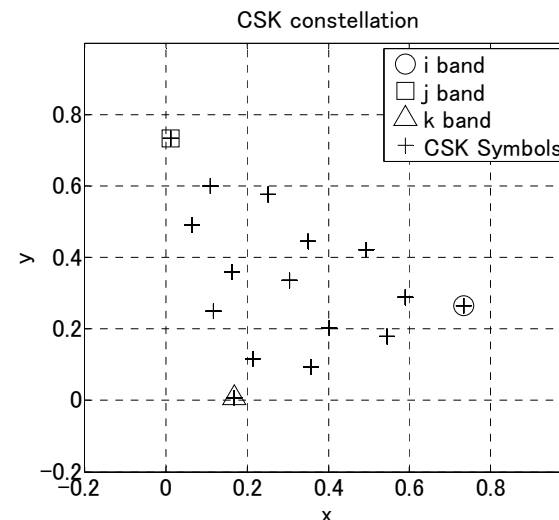
# CSK constellation made by color band combinations (101, 001, 000)



**4 CSK**



**8 CSK**

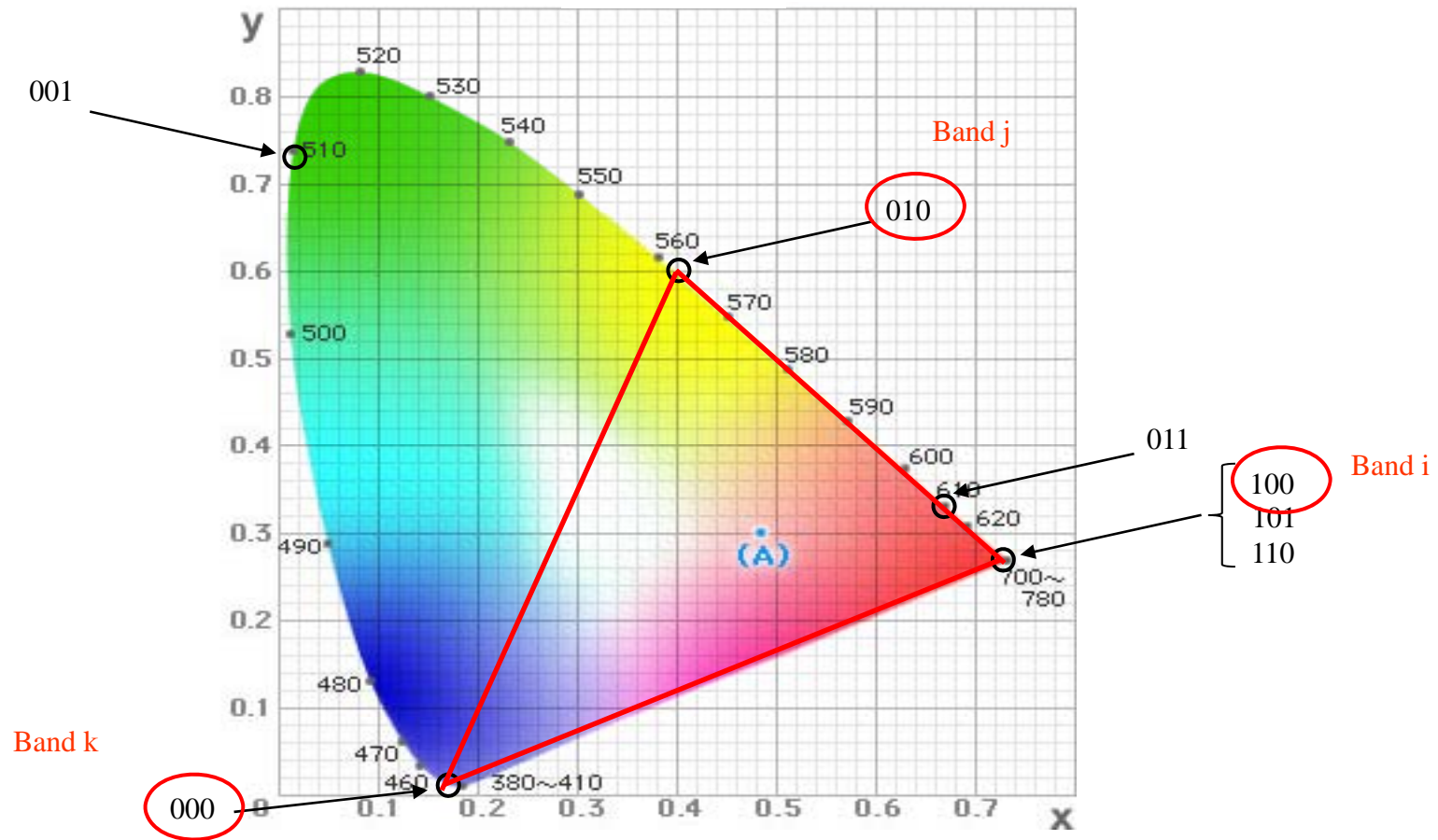


**16 CSK**

This is same as the color bands combination (110, 001, 000).



# Valid CSK constellation example for codes (100, 010, 000)

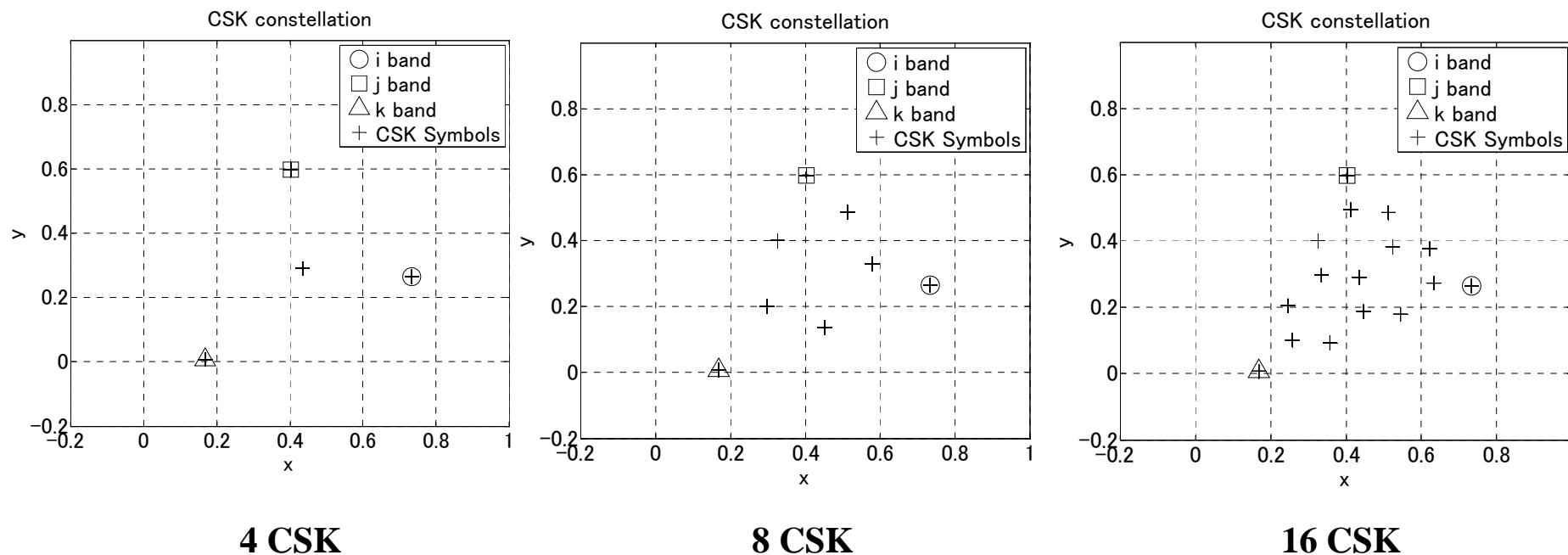


This is almost same as the color bands combination (110, 010, 000).

## Color band combination example for (100, 010, 000)

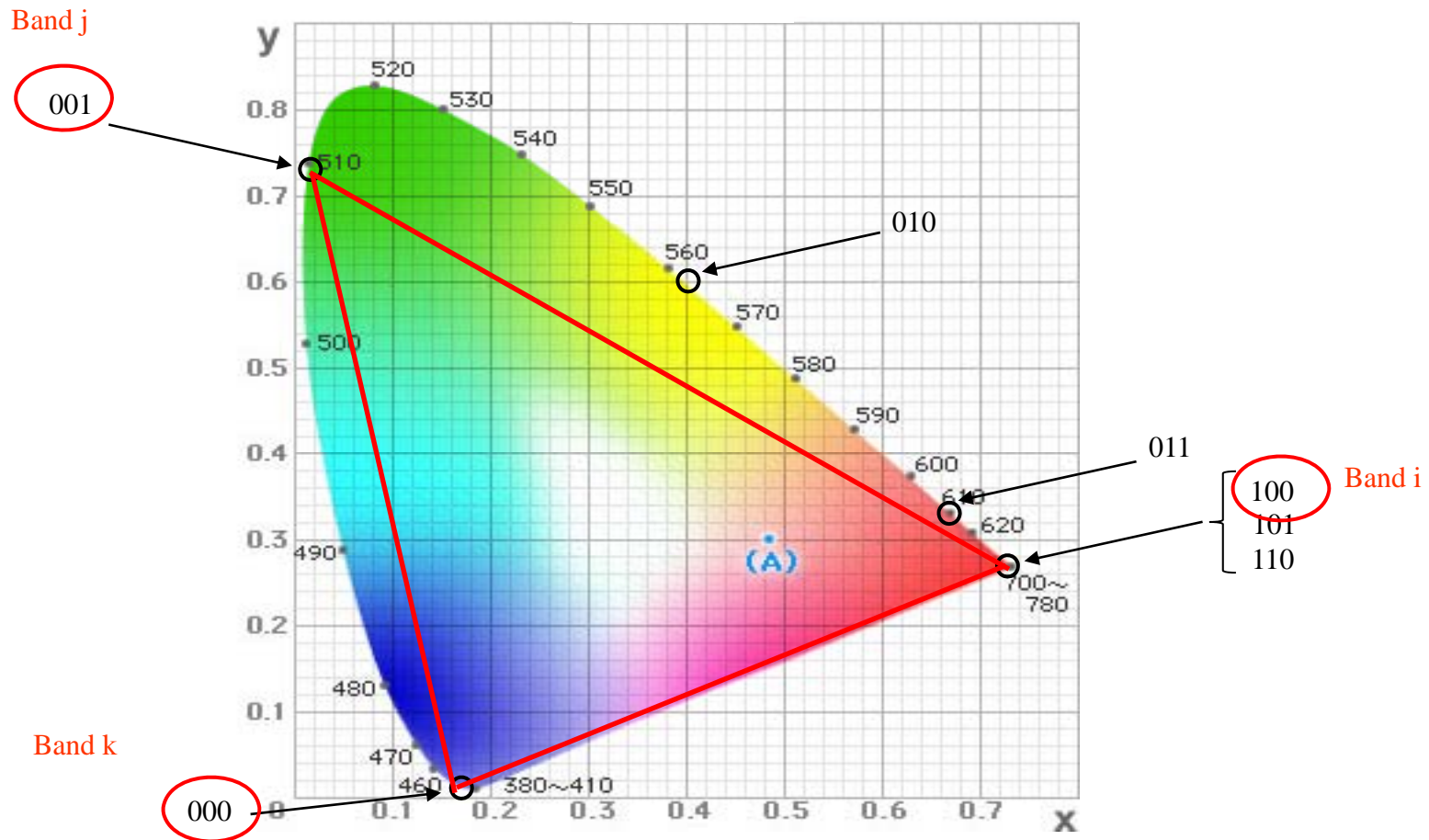
Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.729 0.271)	[0 0] --> (0.402 0.597)	[0 0 0] --> (0.324 0.400)	[0 0 0 0] --> (0.402 0.597)
(0.402 0.597)	[0 1] --> (0.433 0.292)	[0 0 1] --> (0.296 0.200)	[0 0 0 1] --> (0.412 0.495)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.576 0.332)	[0 0 1 0] --> (0.335 0.299)
	[1 1] --> (0.729 0.271)	[0 1 1] --> (0.449 0.139)	[0 0 1 1] --> (0.324 0.400)
		[1 0 0] --> (0.402 0.597)	[0 1 0 0] --> (0.620 0.380)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.511 0.488)
		[1 1 0] --> (0.511 0.488)	[0 1 1 0] --> (0.433 0.292)
		[1 1 1] --> (0.729 0.271)	[0 1 1 1] --> (0.521 0.387)
			[1 0 0 0] --> (0.729 0.271)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.247 0.204)
			[1 0 1 1] --> (0.257 0.102)
			[1 1 0 0] --> (0.542 0.183)
			[1 1 0 1] --> (0.630 0.278)
			[1 1 1 0] --> (0.542 0.183)
			[1 1 1 1] --> (0.356 0.095)

# CSK constellation made by color band combinations (100, 010, 000)



This is almost same as the color bands combination (110, 010, 000).

# Valid CSK constellation example for codes (100, 001, 000)

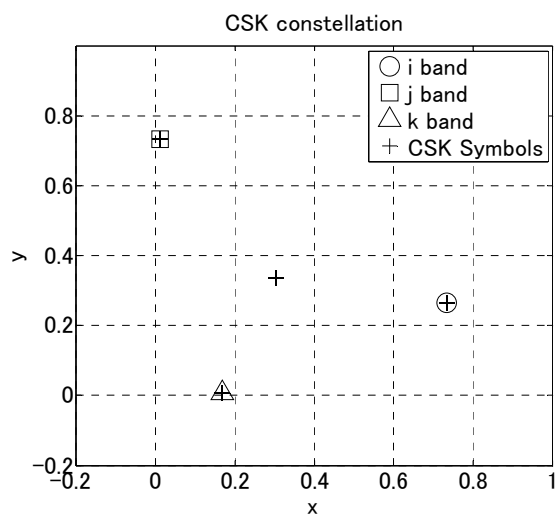


This is almost same as the color bands combination (110, 001, 000).

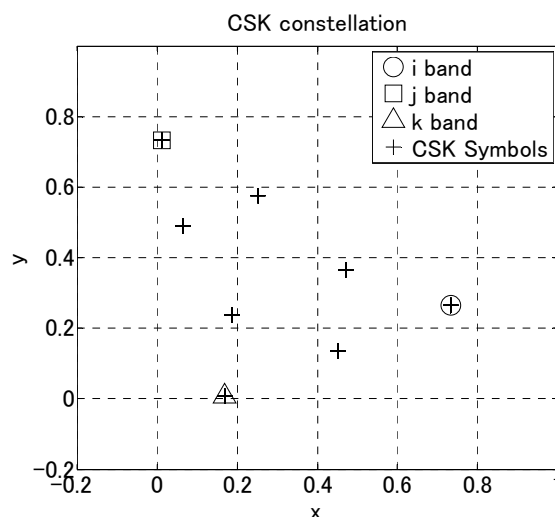
## Color band combination example for (100, 001, 000)

Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.729 0.271)	[0 0] --> (0.011 0.733)	[0 0 0] --> (0.064 0.491)	[0 0 0 0] --> (0.011 0.733)
(0.011 0.733)	[0 1] --> (0.303 0.337)	[0 0 1] --> (0.187 0.238)	[0 0 0 1] --> (0.108 0.601)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.467 0.370)	[0 0 1 0] --> (0.161 0.359)
	[1 1] --> (0.729 0.271)	[0 1 1] --> (0.449 0.139)	[0 0 1 1] --> (0.064 0.491)
		[1 0 0] --> (0.011 0.733)	[0 1 0 0] --> (0.490 0.425)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.250 0.579)
		[1 1 0] --> (0.250 0.579)	[0 1 1 0] --> (0.303 0.337)
		[1 1 1] --> (0.729 0.271)	[0 1 1 1] --> (0.348 0.447)
			[1 0 0 0] --> (0.729 0.271)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.116 0.249)
			[1 0 1 1] --> (0.214 0.117)
			[1 1 0 0] --> (0.542 0.183)
			[1 1 0 1] --> (0.587 0.293)
			[1 1 1 0] --> (0.542 0.183)
			[1 1 1 1] --> (0.356 0.095)

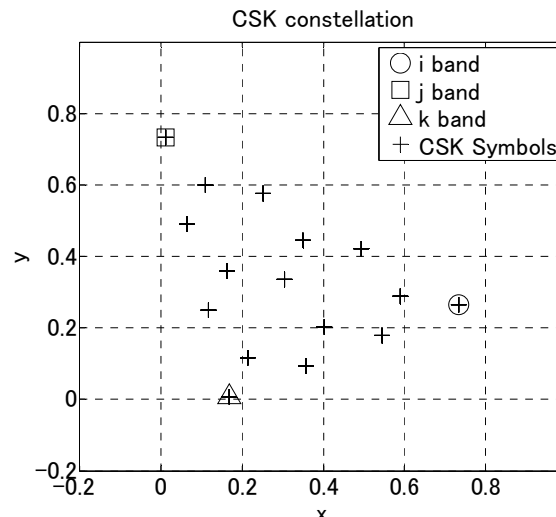
# CSK constellation made by color band combinations (100, 001, 000)



**4 CSK**



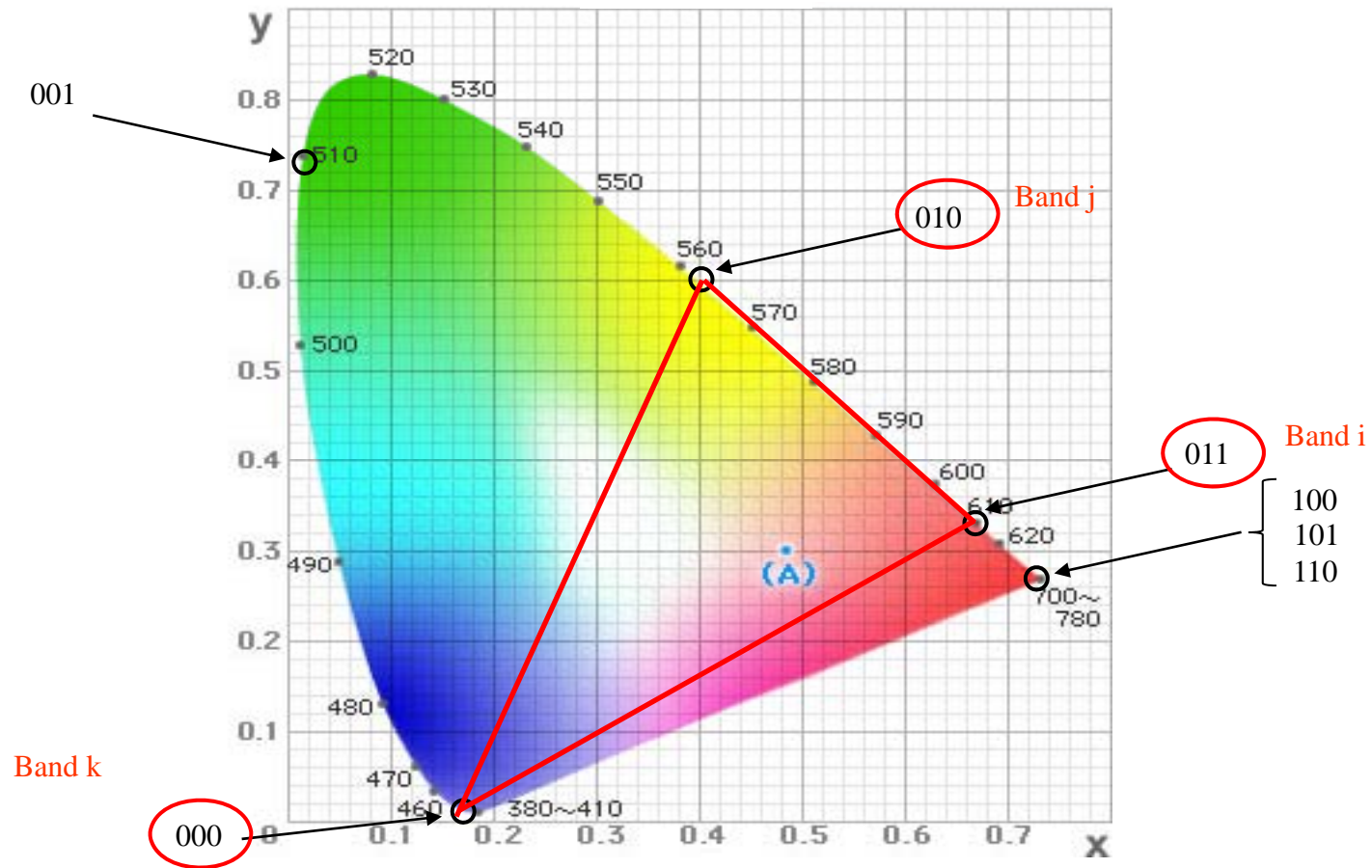
**8 CSK**



**16 CSK**

This is almost same as the color bands combination (110, 001, 000).

# Valid CSK constellation example for codes (011, 010, 000)

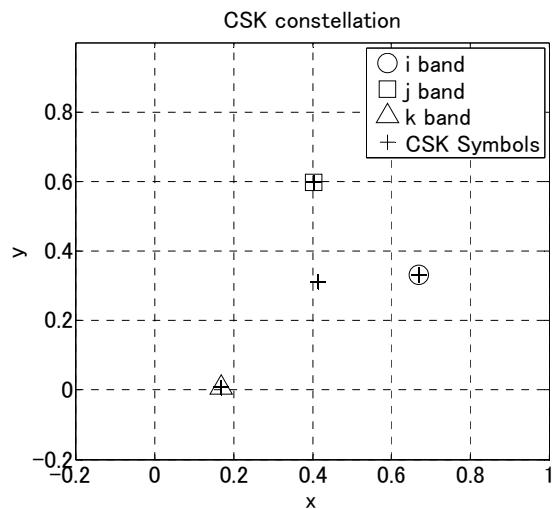


## Color band combination example for (011, 010, 000)

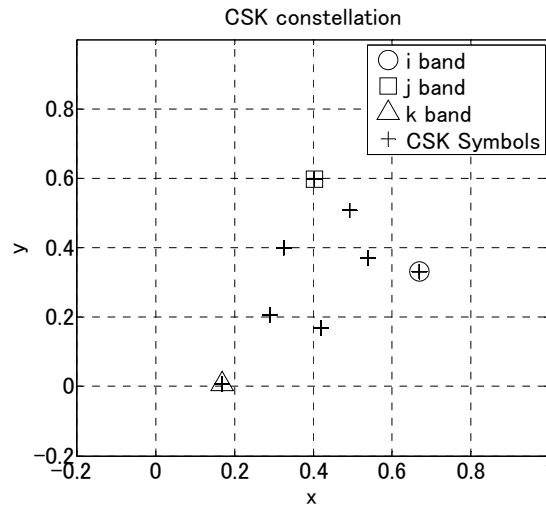
Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.669 0.331)	[0 0] --> (0.402 0.597)	[0 0 0] --> (0.324 0.400)	[0 0 0 0] --> (0.402 0.597)
(0.402 0.597)	[0 1] --> (0.413 0.312)	[0 0 1] --> (0.289 0.207)	[0 0 0 1] --> (0.406 0.502)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.539 0.369)	[0 0 1 0] --> (0.328 0.305)
	[1 1] --> (0.669 0.331)	[0 1 1] --> (0.419 0.169)	[0 0 1 1] --> (0.324 0.400)
		[1 0 0] --> (0.402 0.597)	[0 1 0 0] --> (0.580 0.420)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.491 0.508)
		[1 1 0] --> (0.491 0.508)	[0 1 1 0] --> (0.413 0.312)
		[1 1 1] --> (0.669 0.331)	[0 1 1 1] --> (0.495 0.413)
			[1 0 0 0] --> (0.669 0.331)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.247 0.204)
			[1 0 1 1] --> (0.250 0.109)
			[1 1 0 0] --> (0.502 0.223)
			[1 1 0 1] --> (0.584 0.325)
			[1 1 1 0] --> (0.502 0.223)
			[1 1 1 1] --> (0.336 0.115)



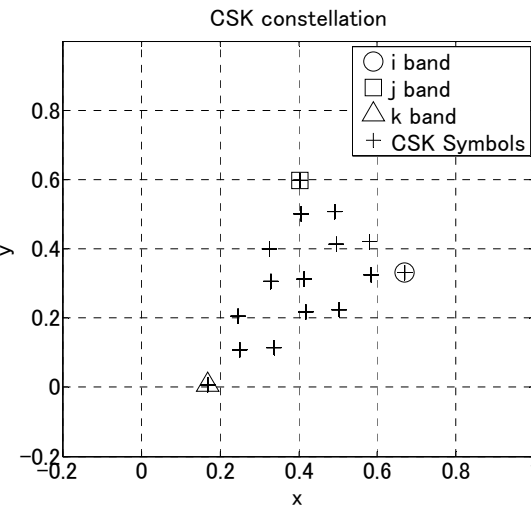
# CSK constellation made by color band combinations (011, 010, 000)



**4 CSK**

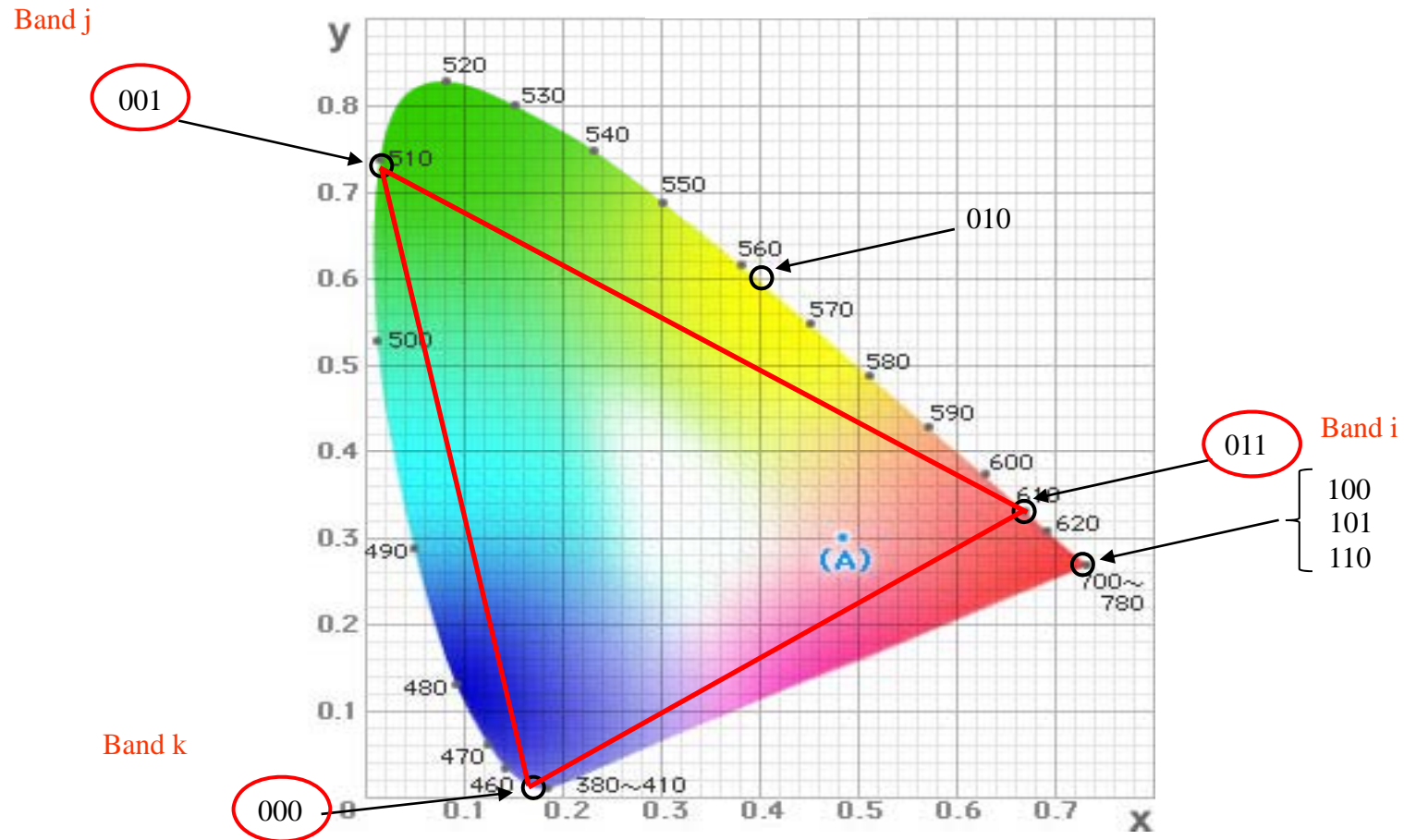


**8 CSK**



**16 CSK**

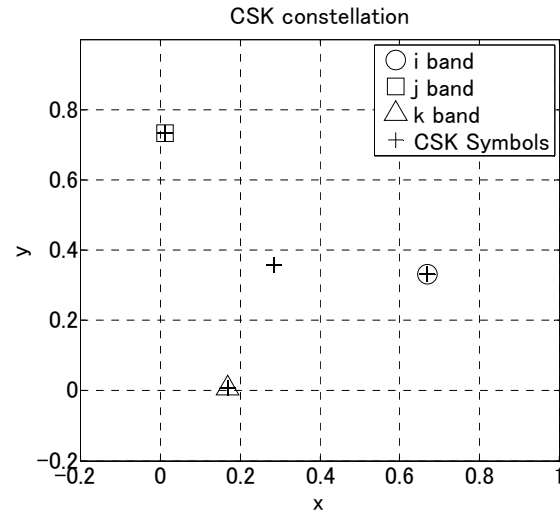
# Valid CSK constellation example for codes (011, 001, 000)



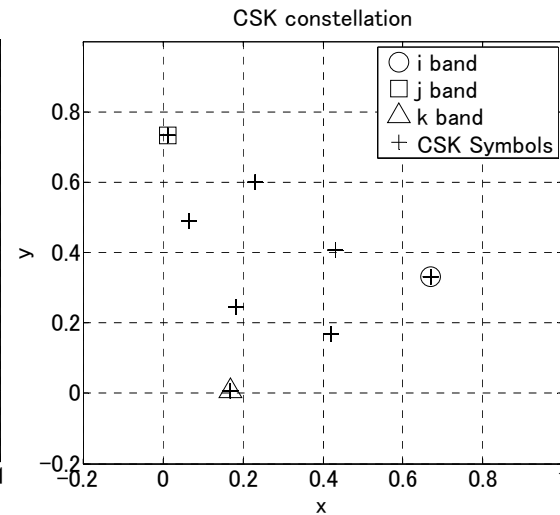
## Color band combination example for (011, 001, 000)

Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.669 0.331)	[0 0] --> (0.011 0.733)	[0 0 0] --> (0.064 0.491)	[0 0 0 0] --> (0.011 0.733)
(0.011 0.733)	[0 1] --> (0.283 0.357)	[0 0 1] --> (0.181 0.245)	[0 0 0 1] --> (0.102 0.608)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.431 0.407)	[0 0 1 0] --> (0.154 0.366)
	[1 1] --> (0.669 0.331)	[0 1 1] --> (0.419 0.169)	[0 0 1 1] --> (0.064 0.491)
		[1 0 0] --> (0.011 0.733)	[0 1 0 0] --> (0.450 0.465)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.230 0.599)
		[1 1 0] --> (0.230 0.599)	[0 1 1 0] --> (0.283 0.357)
		[1 1 1] --> (0.669 0.331)	[0 1 1 1] --> (0.321 0.474)
			[1 0 0 0] --> (0.669 0.331)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.116 0.249)
			[1 0 1 1] --> (0.207 0.124)
			[1 1 0 0] --> (0.502 0.223)
			[1 1 0 1] --> (0.540 0.340)
			[1 1 1 0] --> (0.502 0.223)
			[1 1 1 1] --> (0.336 0.115)

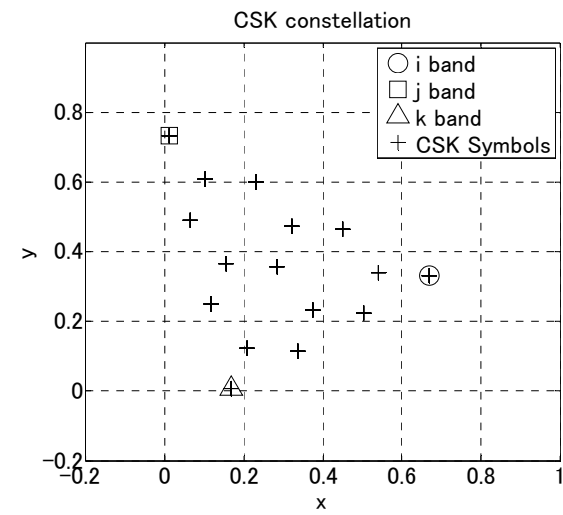
# CSK constellation made by color band combinations (011, 001, 000)



**4 CSK**

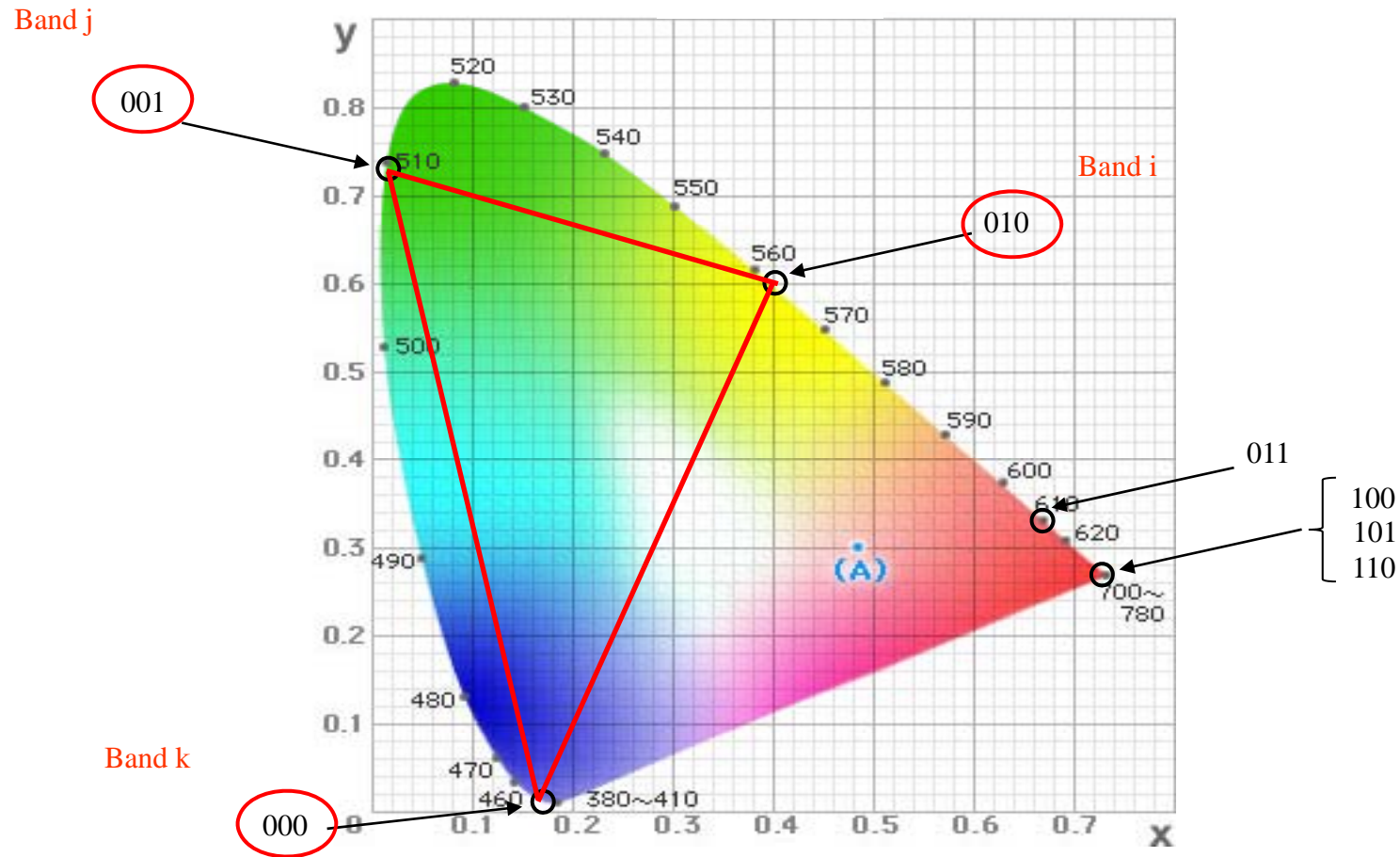


**8 CSK**



**16 CSK**

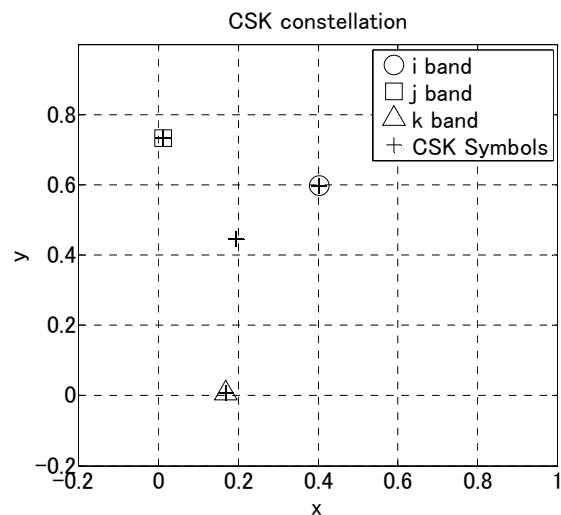
# Valid CSK constellation example for codes (010, 001, 000)



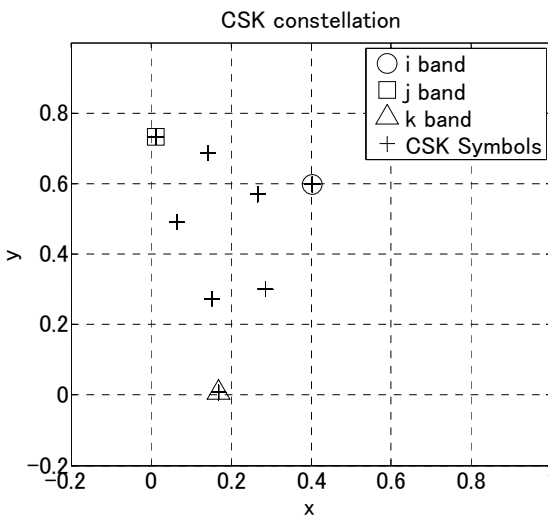
## Color band combination example for (010, 001, 000)

Center of band (x,y)	xy coordinates values of symbols		
	4CSK [data] – (xp,yp)	8CSK [data] – (xp,yp)	16CSK [data] – (xp,yp)
(0.402 0.597)	[0 0] --> (0.011 0.733)	[0 0 0] --> (0.064 0.491)	[0 0 0 0] --> (0.011 0.733)
(0.011 0.733)	[0 1] --> (0.194 0.446)	[0 0 1] --> (0.151 0.274)	[0 0 0 1] --> (0.072 0.637)
(0.169 0.007)	[1 0] --> (0.169 0.007)	[0 1 0] --> (0.268 0.569)	[0 0 1 0] --> (0.125 0.395)
	[1 1] --> (0.402 0.597)	[0 1 1] --> (0.286 0.302)	[0 0 1 1] --> (0.064 0.491)
		[1 0 0] --> (0.011 0.733)	[0 1 0 0] --> (0.272 0.642)
		[1 0 1] --> (0.169 0.007)	[0 1 0 1] --> (0.141 0.688)
		[1 1 0] --> (0.141 0.688)	[0 1 1 0] --> (0.194 0.446)
		[1 1 1] --> (0.402 0.597)	[0 1 1 1] --> (0.202 0.592)
			[1 0 0 0] --> (0.402 0.597)
			[1 0 0 1] --> (0.169 0.007)
			[1 0 1 0] --> (0.116 0.249)
			[1 0 1 1] --> (0.177 0.153)
			[1 1 0 0] --> (0.324 0.400)
			[1 1 0 1] --> (0.333 0.547)
			[1 1 1 0] --> (0.324 0.400)
			[1 1 1 1] --> (0.247 0.204)

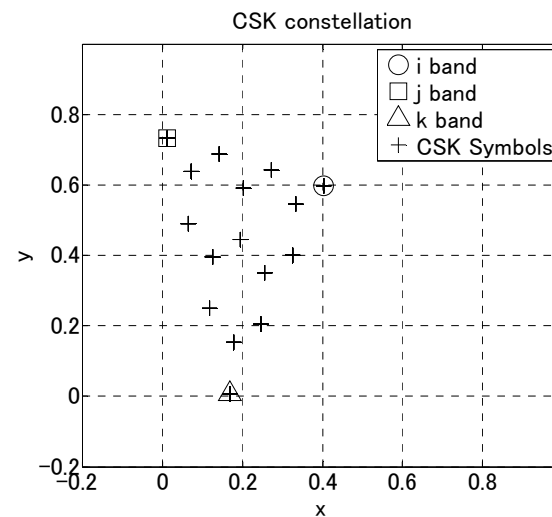
# CSK constellation made by color band combinations (010, 001, 000)



**4 CSK**



**8 CSK**



**16 CSK**