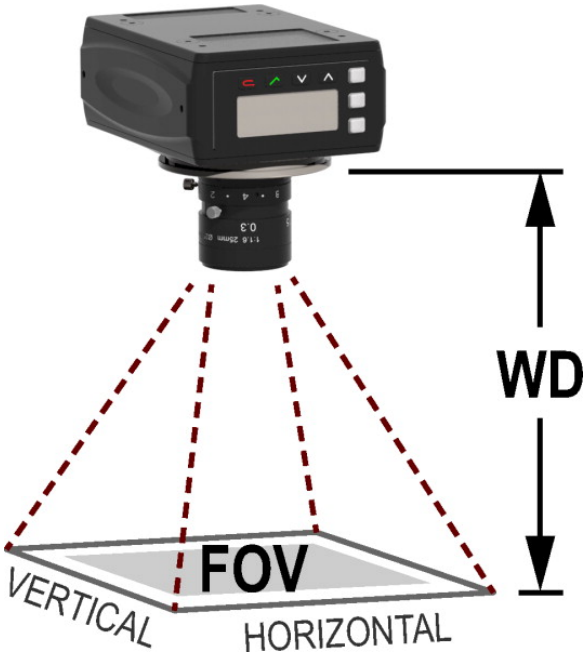
5MP Lens Charts

This paper offers information useful for selecting a C-mount lens for the VE Series 5MP vision sensor.

Working Distance and Field of View

The two main variables involved when discussing a camera's lens choice are the **Working Distance** and the **Field of View** size. The Working Distance, or WD, is the distance from the camera to the target object. In the case of this collection of lens charts, the Working Distance is measured from the front surface of the threaded lens cover mount. The distance is not measured from the end of the lens because different lenses from different manufacturers, even with the same focal length, can vary in length.



The Field of View, or FOV, is the real world size of the picture the camera takes. This can also be broken down into a horizontal FOV size and a vertical FOV size. Note that the picture taken by a VE Series vision sensor is not square. The imager used in the 5MP VE sensor is 2592 x 2048 pixels, making a rectangular image where the vertical FOV is 4/5 the size of the horizontal FOV.

The Working Distance and Field of View sizes are related by linear equations determined by the focal length of the lens. Choosing the correct lens for a given application might be a matter of selecting the desired size of the FOV, then seeing which of the options for focal length result in a good fit for camera Working Distance. The situation might also be reversed, where the desired mounting location of the camera is known (and thus the Working Distance is fixed) and the various focal length lenses give a range of FOV sizes to choose from. In all cases, only one of these two variables may be freely selected. The second variable then becomes a function of the first. This is the reason why we offer a broad range of lens focal lengths—to provide as many options as possible to suit different WD/FOV size requirements.

Multiple Manufacturers and Format Size

Banner does not manufacture any C-mount lenses used by our vision sensors. Any C-mount lens will technically work in a VE Series vision sensor, but some lenses are better suited than others. Banner recommends using at least 1-inch format lenses for the 5 MP VE camera. A lens of at least this format size ensures that the entire VE Series imager chip is used when taking pictures. These lenses are also better at resolving small features in the picture, allowing an inspection to make better use of the camera's resolution.

ПРОМЭЛЕКТРОНИКА/ sales@prom-elec.com

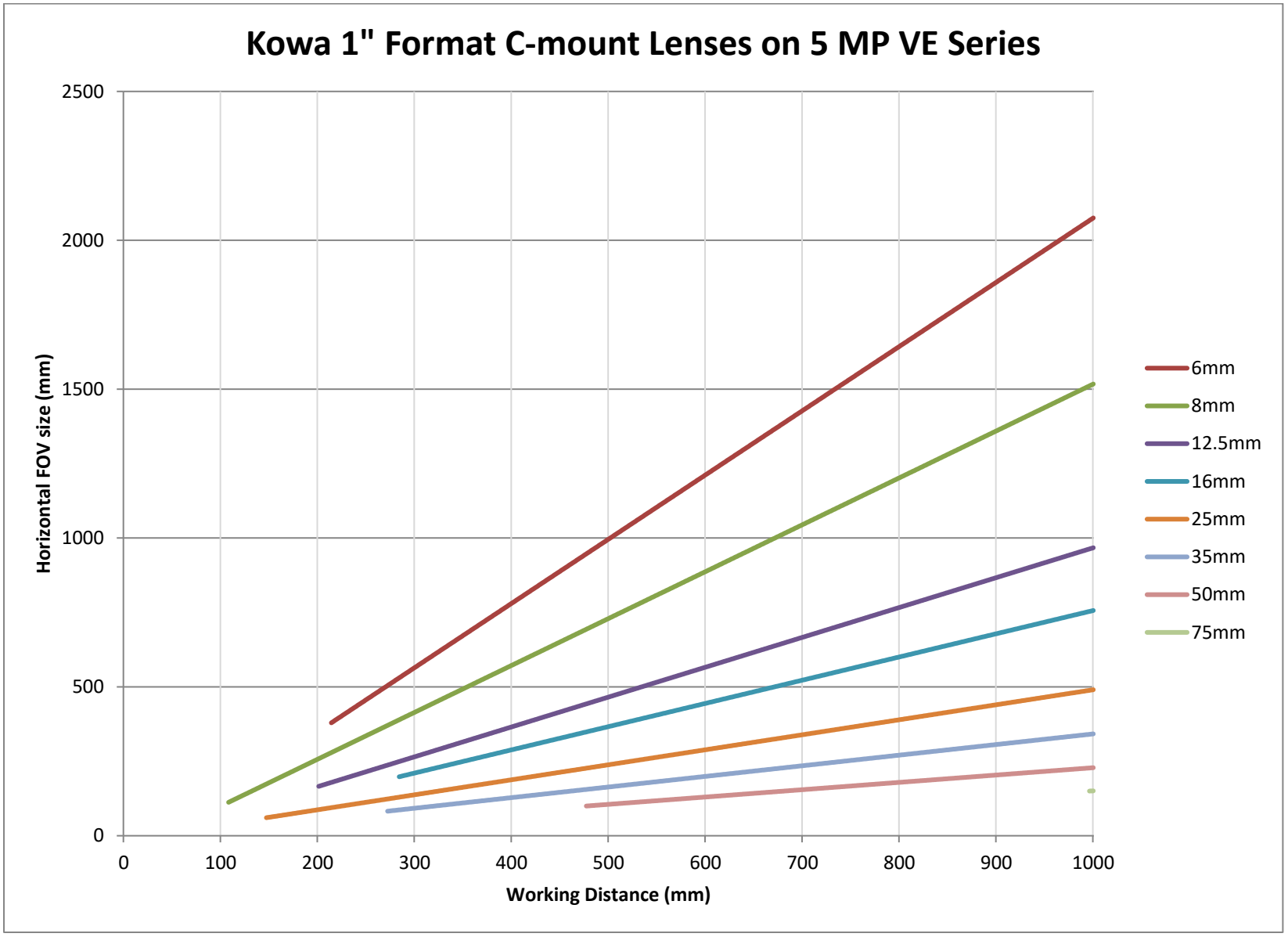
Imager Resolution: 2592 px (H) × 2048 px (V)
Pixel Size: 4.8 µm × 4.8 µm
Image Size: 12.4 mm (H) × 9.8 mm (V), 15.9 mm (diagonal)

Off the Charts

In the pages that follow, graphical views of the Working Distance versus Horizontal FOV relationships are shown, out to a maximum working distance of 1 meter. These graphs offer a quick and easy way to estimate the FOV size for a given Working Distance and lens focal length. Also provided are two tables with entries out to 1.5 meters. The first shows FOV size as a function of Working Distance and the second shows Working Distance as a function of FOV size. The mathematical equations that describe the relationship between these two variables are also provided, allowing for calculations beyond what the chart and tables offer.

Each lens has a natural minimum Working Distance. If a camera using this lens were to move closer to the target than this minimum distance, the image would be out of focus and the lens alone would not be able to fix it. This is where extension tubes and shims are used. Extension tubes allow a lens to come into focus at a Working Distance closer than the minimum. The relationship between Working Distance and FOV size remains in effect as extension tubes are added, and so extension tubes are usually used to generate very small FOVs. A microscope is basically a high focal length lens with a large amount of extension tubes applied.

Kowa 1-inch Format C-mount Lenses on 5 MP VE Series



Kowa 1-inch Format C-mount Lenses on 5 MP VE Series

	FOV (mm)							
WD (mm)	6mm	8mm	12.5mm	16mm	25mm	35mm	50mm	75mm
Minimum	*380 x 300 @ 214mm*	*109 x 86 @ 108mm*	*165 x 130 @ 201mm*	*196 x 155 @ 284mm*	*59 x 47 @ 147mm*	*82 x 65 @ 272mm*	*100 x 79 @ 477mm*	*151 x 119 @ 996mm*
20								
40								
60								
80								
100								
120		131 x 104						
140		163 x 129						
160		194 x 153			67 x 53			
180		226 x 178			77 x 61			
200		257 x 203			87 x 69			
220	392 x 310	289 x 228	185 x 146		97 x 77			
240	435 x 344	320 x 253	205 x 162		107 x 85			
260	479 x 378	352 x 278	225 x 178		117 x 93			
280	522 x 412	383 x 303	245 x 194		128 x 101	86 x 68		
300	565 x 446	415 x 328	265 x 210	211 x 166	138 x 109	93 x 74		
320	608 x 480	446 x 352	285 x 225	226 x 179	148 x 117	100 x 79		
340	651 x 514	478 x 377	305 x 241	242 x 191	158 x 125	107 x 85		
360	694 x 548	509 x 402	325 x 257	257 x 203	168 x 133	115 x 90		
380	737 x 583	541 x 427	346 x 273	273 x 216	178 x 141	122 x 96		
400	781 x 617	572 x 452	366 x 289	289 x 228	188 x 149	129 x 102		
420	824 x 651	604 x 477	386 x 305	304 x 240	198 x 157	136 x 107		
440	867 x 685	635 x 502	406 x 320	320 x 253	208 x 164	143 x 113		
460	910 x 719	667 x 527	426 x 336	335 x 265	218 x 172	150 x 119		
480	953 x 753	698 x 552	446 x 352	351 x 277	228 x 180	157 x 124	101 x 79	
500	996 x 787	730 x 576	466 x 368	367 x 290	238 x 188	164 x 130	105 x 83	
520	1039 x 821	761 x 601	486 x 384	382 x 302	249 x 196	172 x 136	110 x 87	
540	1083 x 855	793 x 626	506 x 400	398 x 314	259 x 204	179 x 141	115 x 91	
560	1126 x 889	824 x 651	526 x 416	413 x 327	269 x 212	186 x 147	120 x 95	
580	1169 x 923	856 x 676	546 x 431	429 x 339	279 x 220	193 x 152	125 x 99	
600	1212 x 958	887 x 701	566 x 447	445 x 351	289 x 228	200 x 158	130 x 103	
620	1255 x 992	919 x 726	586 x 463	460 x 364	299 x 236	207 x 164	135 x 107	
640	1298 x 1026	950 x 751	606 x 479	476 x 376	309 x 244	214 x 169	140 x 111	
660	1342 x 1060	982 x 776	626 x 495	491 x 388	319 x 252	222 x 175	145 x 114	
680	1385 x 1094	1013 x 800	646 x 511	507 x 401	329 x 260	229 x 181	150 x 118	
700	1428 x 1128	1045 x 825	666 x 526	523 x 413	339 x 268	236 x 186	155 x 122	
720	1471 x 1162	1076 x 850	687 x 542	538 x 425	349 x 276	243 x 192	160 x 126	
740	1514 x 1196	1108 x 875	707 x 558	554 x 437	359 x 284	250 x 198	165 x 130	
760	1557 x 1230	1139 x 900	727 x 574	569 x 450	369 x 292	257 x 203	169 x 134	
780	1600 x 1264	1171 x 925	747 x 590	585 x 462	380 x 300	264 x 209	174 x 138	
800	1644 x 1298	1202 x 950	767 x 606	601 x 474	390 x 308	271 x 214	179 x 142	
820	1687 x 1333	1234 x 975	787 x 622	616 x 487	400 x 316	279 x 220	184 x 146	
840	1730 x 1367	1265 x 1000	807 x 637	632 x 499	410 x 324	286 x 226	189 x 149	
860	1773 x 1401	1297 x 1024	827 x 653	647 x 511	420 x 332	293 x 231	194 x 153	
880	1816 x 1435	1328 x 1049	847 x 669	663 x 524	430 x 340	300 x 237	199 x 157	
900	1859 x 1469	1360 x 1074	867 x 685	679 x 536	440 x 348	307 x 243	204 x 161	
920	1902 x 1503	1391 x 1099	887 x 701	694 x 548	450 x 356	314 x 248	209 x 165	
940	1946 x 1537	1423 x 1124	907 x 717	710 x 561	460 x 364	321 x 254	214 x 169	
960	1989 x 1571	1454 x 1149	927 x 732	725 x 573	470 x 372	329 x 260	219 x 173	
980	2032 x 1605	1486 x 1174	947 x 748	741 x 585	480 x 379	336 x 265	224 x 177	
1000	2075 x 1639	1517 x 1199	967 x 764	757 x 598	490 x 387	343 x 271	229 x 181	151 x 119
1020	2118 x 1673	1549 x 1224	987 x 780	772 x 610	501 x 395	350 x 276	233 x 184	154 x 122
1040	2161 x 1707	1580 x 1248	1007 x 796	788 x 622	511 x 403	357 x 282	238 x 188	157 x 124
1060	2205 x 1742	1612 x 1273	1027 x 812	803 x 635	521 x 411	364 x 288	243 x 192	161 x 127
1080	2248 x 1776	1643 x 1298	1048 x 828	819 x 647	531 x 419	371 x 293	248 x 196	164 x 129
1100	2291 x 1810	1675 x 1323	1068 x 843	835 x 659	541 x 427	378 x 299	253 x 200	167 x 132
1120	2334 x 1844	1706 x 1348	1088 x 859	850 x 672	551 x 435	386 x 305	258 x 204	171 x 135
1140	2377 x 1878	1738 x 1373	1108 x 875	866 x 684	561 x 443	393 x 310	263 x 208	174 x 137
1160	2420 x 1912	1769 x 1398	1128 x 891	881 x 696	571 x 451	400 x 316	268 x 212	177 x 140
1180	2463 x 1946	1801 x 1423	1148 x 907	897 x 709	581 x 459	407 x 322	273 x 216	180 x 143
1200	2507 x 1980	1832 x 1448	1168 x 923	913 x 721	591 x 467	414 x 327	278 x 219	184 x 145
1220	2550 x 2014	1864 x 1472	1188 x 938	928 x 733	601 x 475	421 x 333	283 x 223	187 x 148
1240	2593 x 2048	1895 x 1497	1208 x 954	944 x 746	611 x 483	428 x 338	288 x 227	190 x 150
1260	2636 x 2082	1927 x 1522	1228 x 970	959 x 758	621 x 491	435 x 344	293 x 231	194 x 153
1280	2679 x 2117	1958 x 1547	1248 x 986	975 x 770	632 x 499	443 x 350	297 x 235	197 x 156
1300	2722 x 2151	1990 x 1572	1268 x 1002	991 x 783	642 x 507	450 x 355	302 x 239	200 x 158
1320	2765 x 2185	2021 x 1597	1288 x 1018	1006 x 795	652 x 515	457 x 361	307 x 243	204 x 161
1340	2809 x 2219	2053 x 1622	1308 x 1034	1022 x 807	662 x 523	464 x 367	312 x 247	207 x 163
1360	2852 x 2253	2084 x 1647	1328 x 1049	1037 x 819	672 x 531	471 x 372	317 x 251	210 x 166
1380	2895 x 2287	2116 x 1671	1348 x 1065	1053 x 832	682 x 539	478 x 378	322 x 254	213 x 169
1400	2938 x 2321	2147 x 1696	1368 x 1081	1069 x 844	692 x 547	485 x 383	327 x 258	217 x 171
1420	2981 x 2355	2179 x 1721	1389 x 1097	1084 x 856	702 x 555	493 x 389	332 x 262	220 x 174
1440	3024 x 2389	2210 x 1746	1409 x 1113	1100 x 869	712 x 563	500 x 395	337 x 266	223 x 176
1460	3068 x 2423	2242 x 1771	1429 x 1129	1115 x 881	722 x 571	507 x 400	342 x 270	227 x 179
1480	3111 x 2457	2273 x 1796	1449 x 1144	1131 x 893	732 x 579	514 x 406	347 x 274	230 x 182
1500	3154 x 2492	2305 x 1821	1469 x 1160	1147 x 906	742 x 587	521 x 412	352 x 278	233 x 184

Kowa 1-inch Format C-mount Lenses on 5 MP VE Series

FOV (mm)			WD (mm)																			
			6mm			8mm			12.5mm			16mm			25mm			35mm			50mm			75mm		
		Minimum	380	x	300	109	x	86	165	x	130	196	x	155	59	x	47	82	x	65	100	x	79	151	x	119
			@ 214mm			@ 108mm			@ 201mm			@ 284mm			@ 147mm			@ 272mm			@ 477mm			@ 996mm		
20	x	16																							
40	x	32																							
60	x	47													146										
80	x	63													186										
100	x	79													225			319			478				
120	x	95				113									265			375			559				
140	x	111				126									305			431			640				
160	x	126				138									344			487			722			1056	
180	x	142				151			215						384			544			803			1178	
200	x	158				164			235			286			424			600			884			1299	
220	x	174				176			255			312			463			656			965			1420	
240	x	190				189			275			338			503			712			1047			1541	
260	x	205				202			295			363			543			768			1128			1662	
280	x	221				214			315			389			582			824			1209			1784	
300	x	237				227			335			415			622			880			1290			1905	
320	x	253				240			355			440			662			936			1372			2026	
340	x	269				253			374			466			702			992			1453			2147	
360	x	284				265			394			492			741			1048			1534			2268	
380	x	300	214			278			414			517			781			1104			1615			2390	
400	x	316	224			291			434			543			821			1160			1697			2511	
420	x	332	233			303			454			568			860			1217			1778			2632	
440	x	348	242			316			474			594			900			1273			1859			2753	
460	x	363	251			329			494			620			940			1329			1941			2875	
480	x	379	261			341			514			645			979			1385			2022			2996	
500	x	395	270			354			534			671			1019			1441			2103			3117	
520	x	411	279			367			554			697			1059			1497			2184			3238	
540	x	427	288			380			574			722			1098			1553			2266			3359	
560	x	442	298			392			594			748			1138			1609			2347			3481	
580	x	458	307			405			614			774			1178			1665			2428			3602	
600	x	474	316			418			634			799			1217			1721			2509			3723	
620	x	490	326			430			654			825			1257			1777			2591			3844	
640	x	506	335			443			674			851			1297			1833			2672			3965	
660	x	521	344			456			694			876			1336			1890			2753			4087	
680	x	537	353			468			714			902			1376			1946			2834			4208	
700	x	553	363			481			733			927			1416			2002			2916			4329	
720	x	569	372			494			753			953			1455			2058			2997			4450	
740	x	585	381			507			773			979			1495			2114			3078			4572	
760	x	600	390			519			793			1004			1535			2170			3160			4693	
780	x	616	400			532			813			1030			1575			2226			3241			4814	
800	x	632	409			545			833			1056			1614			2282			3322			4935	
820	x	648	418			557			853			1081			1654			2338			3403			5056	
840	x	664	428			570			873			1107			1694			2394			3485			5178	
860	x	679	437			583			893			1133			1733			2450			3566			5299	
880	x	695	446			595			913			1158			1773			2507			3647			5420	
900	x	711	455			608			933			1184			1813			2563			3728			5541	
920	x	727	465			621			953			1210			1852			2619			3810			5662	
940	x	743	474			634			973			1235			1892			2675			3891			5784	
960	x	758	483			646			993			1261			1932			2731			3972			5905	
980	x	774	492			659			1013			1287			1971			2787			4054			6026	
1000	x	790	502			672			1033			1312			2011			2843			4135			6147	
1020	x	806	511			684			1053			1338			2051			2899			4216			6268	
1040	x	822	520			697			1072			1363			2090			2955			4297			6390	
1060	x	837	530			710			1092			1389			2130			3011			4379			6511	
1080	x	853	539			722			1112			1415			2170			3067			4460			6632	
1100	x	869	548			735			1132			1440			2209			3123			4541			6753	
1120	x	885	557			748			1152			1466			2249			3180			4622			6875	
1140	x	901	567			760			1172			1492			2289			3236			4704			6996	
1160	x	916	576			773			1192			1517			2329			3292			4785			7117	
1180	x	932	585			786			1212			1543			2368			3348			4866			7238	
1200	x	948	594			799			1232			1569			2408			3404			4947			7359	
1220	x	964	604			811			1252			1594			2448			3460			5029			7481	
1240	x	980	613			824			1272			1620			2487			3516			5110			7602	
1260	x	995	622			837			1292			1646			2527			3572			5191			7723	
1280	x	1011	631			849			1312			1671			2567			3628			5273			7844	
1300	x	1027	641			862			1332			1697			2606			3684			5354			7965	
1320	x	1043	650			875			1352			1722			2646			3740			5435			8087	
1340	x	1059	659			887			1372			1748			2686			3796			5516			8208	
1360	x	1074	669			900			1392			1774			2725			3853			5598			8329	
1380	x	1090	678			913			1411			1799			2765			3909			5679			8450	
1400	x	1106	687			926			1431			1825			2805			3965			5760			8572	
1420	x	1122	696			938			1451			1851			2844			4021			5841			8693	
1440	x	1138	706			951			1471			1876			2884			4077			5923			8814	
1460	x	1153	715			964			1491			1902			2924			4133			6004			8935	
1480	x	1169	724			976			1511			1928			2963			4189			6085			9056	
1500	x	1185	733			989			1531			1953			3003			4245			6166			9178	

Kowa 1-inch Format Lens equations for 5 MP VE Series

H = horizontal FOV size, W = working distance



6 mm 1-inch format lens

Banner model: LCF06LK1F (p/n 803861)

Kowa model: LM6HC

1-inch format, no compatible filter, minimum f/1.8, does not fit with a sealed lens cover

H(W), mm

H = 2.1575 × W – 82.43 (minimum W ~ 214 mm)

W(H), mm

W = (H + 82.43)/2.1575 (minimum H ~ 380 mm)



8 mm 1-inch format lens

Banner model: LCF08LK1F (p/n 803862)

Kowa model: LM8HC

1-inch format, 55 mm filter, minimum f/1.4, does not fit with a sealed lens cover

H(W), mm

H = 1.5751 × W – 57.831 (minimum W ~ 108 mm)

W(H), mm

W = (H + 57.831)/1.5751 (minimum H ~ 109 mm)



12.5 mm 1-inch format lens

Banner model: LCF12LK1F (p/n 803863)

Kowa model: LM12HC

1-inch format, 35.5 mm filter, minimum f/1.4, fits with VELC85 lens cover, requires LHWK-1 set screws

H(W), mm

H = 1.0029 × W – 35.58 (minimum W ~ 201 mm)

W(H), mm

W = (H + 35.58)/1.0029 (minimum H ~ 165 mm)



16 mm 1-inch format lens

Banner model: LCF16LK1F (p/n 803864)

Kowa model: LM16HC

1-inch format, 35.5 mm filter, minimum f/1.4, fits with VELC85 lens cover, requires LHWK-1 set screws

H(W), mm

H = 0.7799 × W – 23.347 (minimum W ~ 284 mm)

W(H), mm

W = (H + 23.347)/0.7799 (minimum H ~ 196 mm)



25 mm 1-inch format lens

Banner model: LCF25LK1F (p/n 803865)
Kowa model: LM25HC (1-inch format)
1-inch format, 35.5 mm filter, minimum f/1.4, requires LHWK-1 set screws
H(W), mm
H = 0.504 × W – 13.571 (minimum W ~ 147 mm)
W(H), mm
W = (H + 13.571)/0.504 (minimum H ~ 59 mm)



35 mm 1-inch format lens

Banner model: LCF35LK1F (p/n 803866)
Kowa model: LM35HC (1-inch format)
1-inch format, 35.5 mm filter, minimum f/1.4, requires LHWK-1 set screws
H(W), mm
H = 0.3566 × W – 13.823 (minimum W ~ 272 mm)
W(H), mm
W = (H + 13.823)/0.3566 (minimum H ~ 82 mm)



50 mm 1-inch format lens

Banner model: LCF50LK1F (p/n 803867)
Kowa model: LM50HC (1-inch format)
1-inch format, 40.5 mm filter, minimum f/1.4, does not fit with a sealed lens cover
H(W), mm
H = 0.2461 × W – 17.569 (minimum W ~ 477 mm)
W(H), mm
W = (H + 17.569)/0.2461 (minimum H ~ 100 mm)



75 mm 1-inch format lens

Banner model: LCF75LK1F (p/n 803868)
Kowa model: LM75HC (1-inch format)
1-inch format, 46 mm filter, minimum f/1.8, does not fit with a sealed lens cover
H(W), mm
H = 0.165 × W – 14.299 (minimum W ~ 996 mm)
W(H), mm
W = (H + 14.299)/0.165 (minimum H ~ 151 mm)