

LAMBDA 10-3 OPTICAL FILTER CHANGER SYSTEM

EXTERNAL CONTROL QUICK REFERENCE

REV. 1.02 (20190605)

Table 1. Commands.

Command Byte Value			Keyboard Entry			Description			
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command
						W h e e l	S p e e d	F i l t e r	
0	00	00000000	Alt-0000	^@	(NUL)	A or C	0	0	
1	01	00000001	Alt-0001	^A	(SOH)			1	
2	02	00000010	Alt-0002	^B	(STX)			2	
3	03	00000011	Alt-0003	^C	(ETX)			3	
4	04	00000100	Alt-0004	^D	(EOT)			4	
5	05	00000101	Alt-0005	^E	(ENQ)			5	
6	06	00000110	Alt-0006	^F	(ACK)			6	
7	07	00000111	Alt-0007	^G	(BEL)			7	
8	08	00001000	Alt-0008	^H	(BS)			8	
9	09	00001001	Alt-0009	^I	(HT)			9	
10	0A	00001010	Alt-0010	^J	(LF)				
-	-	-	-	-	-				
15	0F	00001111	Alt-0015	^O	(SI)				
16	10	00010000	Alt-0016	^P	(DLE)	A or C	1	0	
17	11	00010001	Alt-0017	^Q	(DC1)			1	
18	12	00010010	Alt-0018	^R	(DC2)			2	
19	13	00010011	Alt-0019	^S	(DC3)			3	
20	14	00010100	Alt-0020	^T	(DC4)			4	
21	15	00010101	Alt-0021	^U	(NAK)			5	
22	16	00010110	Alt-0022	^V	(SYN)			6	
23	17	00010111	Alt-0023	^W	(ETB)			7	
24	18	00011000	Alt-0024	^X	(CAN)			8	
25	19	00011001	Alt-0025	^Y	(EM)			9	
26	1A	00011010	Alt-0026	^Z	(SUB)				
-	-	-	-	-	-				
31	1F	00011111	Alt-0031	^_	(US)				
32	20	00100000	Alt-0032		(space)	A or C	2	0	
33	21	00100001	Alt-0033		!			1	
34	22	00100010	Alt-0034		“			2	
35	23	00100011	Alt-0035		#			3	
36	24	00100100	Alt-0036		\$			4	
37	25	00100101	Alt-0037		%			5	
38	26	00100110	Alt-0038		&			6	
39	27	00100111	Alt-0039		‘			7	
40	28	00101000	Alt-0040		(			8	
41	29	00101001	Alt-0041		)			9	
42	2A	00101010	Alt-0042		*				
-	-	-	-	-	-				
47	2F	00101111	Alt-0047		/				
48	30	00110000	Alt-0048		0	A or C	3	0	
49	31	00110001	Alt-0049		1			1	
50	32	00110010	Alt-0050		2			2	

Command Byte Value			Keyboard Entry			Description						
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command			
						W h e e l	S p e e d	F i l t e r				
51	33	00110011	Alt-0051		3			3				
52	34	00110100	Alt-0052		4			4				
53	35	00110101	Alt-0053		5			5				
54	36	00110110	Alt-0054		6			6				
55	37	00110111	Alt-0055		7			7				
56	38	00111000	Alt-0056		8			8				
57	39	00111001	Alt-0057		9			9				
58	3A	00111010	Alt-0058		:							
-	-	-	-		-							
63	3F	00111111	Alt-0063		?							
64	40	01000000	Alt-0064		@	A or C	4	0				
65	41	01000001	Alt-0065		A			1				
66	42	01000010	Alt-0066		B			2				
67	43	01000011	Alt-0067		C			3				
68	44	01000100	Alt-0068		D			4				
69	45	01000101	Alt-0069		E			5				
70	46	01000110	Alt-0070		F			6				
71	47	01000111	Alt-0071		G			7				
72	48	01001000	Alt-0072		H			8				
73	49	01001001	Alt-0073		I			9				
74	4A	01001010	Alt-0074		J							
-	-	-	-		-							
79	4F	01001111	Alt-0079		O							
80	50	01000000	Alt-0080		P	A or C	5	0				
81	51	01000001	Alt-0081		Q			1				
82	52	01000010	Alt-0082		R			2				
83	53	01000011	Alt-0083		S			3				
84	54	01000100	Alt-0084		T			4				
85	55	01000101	Alt-0085		U			5				
86	56	01000110	Alt-0086		V			6				
87	57	01000111	Alt-0087		W			7				
88	58	01001000	Alt-0088		X			8				
89	59	01001001	Alt-0089		Y			9				
90	5A	01001010	Alt-0090		Z							
-	-	-	-		-							
95	5F	01011111	Alt-0095		`							
96	60	01010000	Alt-0096		`	A or C	6	0				
97	61	01010001	Alt-0097		a			1				
98	62	01010010	Alt-0098		b			2				
99	63	01010011	Alt-0099		c			3				
100	64	01010100	Alt-0100		d			4				
101	65	01010101	Alt-0101		e			5				
102	66	01010110	Alt-0102		f			6				
103	67	01010111	Alt-0103		g			7				
104	68	01011000	Alt-0104		h			8				
105	69	01011001	Alt-0105		i			9				
106	6A	01011010	Alt-0106		j							
-	-	-	-		-							
111	6F	01011111	Alt-0111		o							
112	70	01110000	Alt-0112		p	A or	7	0				
113	71	01110001	Alt-0113		q			1				

Command Byte Value			Keyboard Entry			Description				
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command	
						W h e e l	S p e e d	F i l t e r		
114	72	01110010	Alt-0114		r	C		2		
115	73	01110011	Alt-0115		s			3		
116	74	01110100	Alt-0116		t			4		
117	75	01110101	Alt-0117		u			5		
118	76	01110110	Alt-0118		v			6		
119	77	01110111	Alt-0119		w			7		
120	78	01111000	Alt-0120		x			8		
121	79	01111001	Alt-0121		y			9		
122	7A	01111010	Alt-0122		z					
-	-	-	-		-					
127	7F	01111111	Alt-0127		(DEL)					
128	80	10000000	Alt-0128			B	0	0		
129	81	10000001	Alt-0129					1		
130	82	10000010	Alt-0130					2		
131	83	10000011	Alt-0131					3		
132	84	10000100	Alt-0132					4		
133	85	10000101	Alt-0133					5		
134	86	10000110	Alt-0134					6		
135	87	10000111	Alt-0135					7		
136	88	10001000	Alt-0136					8		
137	89	10001001	Alt-0137					9		
138	8A	10001010	Alt-0138							
-	-	-	-		-					
143	8F	10001111	Alt-0143							
144	90	10010000	Alt-0144			B	1	0		
145	91	10010001	Alt-0145					1		
146	92	10010010	Alt-0146					2		
147	93	10010011	Alt-0147					3		
148	94	10010100	Alt-0148					4		
149	95	10010101	Alt-0149					5		
150	96	10010110	Alt-0150					6		
151	97	10010111	Alt-0151					7		
152	98	10011000	Alt-0152					8		
153	99	10011001	Alt-0153					9		
154	9A	10011010	Alt-0154							
-	-	-	-		-					
159	9F	10011111	Alt-0159							
160	A0	10100000	Alt-0160			B	2	0		
161	A1	10100001	Alt-0161					1		
162	A2	10100010	Alt-0162					2		
163	A3	10100011	Alt-0163					3		
164	A4	10100100	Alt-0164					4		
165	A5	10100101	Alt-0165					5		
166	A6	10100110	Alt-0166					6		
167	A7	10100111	Alt-0167					7		
168	A8	10101000	Alt-0168					8		
169	A9	10101001	Alt-0169					9		
170	AA	10101010	Alt-0170							Open Shutter A
171	AB	10101011	Alt-0171							Open Shutter A conditionally
172	AC	10101100	Alt-0172							Close Shutter A

Command Byte Value			Keyboard Entry			Description						
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command			
						W h e e l	S p e e d	F i l t e r				
185	AD	10101101	Alt-0185									
-	-	-	-									
175	AF	10101111	Alt-0175									
176	B0	10110000	Alt-0176					0				
177	B1	10110001	Alt-0177					1				
178	B2	10110010	Alt-0178					2				
179	B3	10110011	Alt-0179					3				
180	B4	10110100	Alt-0180					4				
181	B5	10110101	Alt-0181					5				
182	B6	10110110	Alt-0182					6				
183	B7	10110111	Alt-0183					7				
184	B8	10111000	Alt-0184					8				
185	B9	10111001	Alt-0185					9				
186	BA	10111010	Alt-0186						Open Shutter B			
187	BB	10111011	Alt-0187						Open Shutter B conditionally			
188	BC	10111100	Alt-0188						Close Shutter B			
189	BD	10111101	Alt-0189						Batch Start (next 1 to 6 bytes are filter wheel and shutter movement commands)			
190	BE	10111110	Alt-0190						Batch End (ends Batch Start and 1 to 6 movement command sequence)			
191	BF	10111111	Alt-0191									
192	C0	11000000	Alt-0192					0				
193	C1	11000001	Alt-0193					1				
194	C2	11000010	Alt-0194					2				
195	C3	11000011	Alt-0195					3				
196	C4	11000100	Alt-0196					4				
197	C5	11000101	Alt-0197					5				
198	C6	11000110	Alt-0198					6				
199	C7	11000111	Alt-0199					7				
200	C8	11001000	Alt-0200					8				
201	C9	11001001	Alt-0201					9				
202	CA	11001010	Alt-0202									
-	-	-	-									
203	CB	11001011	Alt-0203									
204	CC	11001100	Alt-0204						Status			
205	CD	11001101	Alt-0205									
206	CE	11001110	Alt-0206						All motors power on			
207	CF	11001111	Alt-0207						All motors power off			
208	D0	11000000	Alt-0208					0				
209	D1	11000001	Alt-0209					1				
210	D2	11000010	Alt-0210					2				
211	D3	11000011	Alt-0211					3				
212	D4	11000100	Alt-0212					4				
213	D5	11000101	Alt-0213					5				
214	D6	11000110	Alt-0214					6				
215	D7	11000111	Alt-0215					7				
216	D8	11001000	Alt-0216					8				
217	D9	11001001	Alt-0217					9				
218	DA	11001010	Alt-0218									
-	-	-	-									
219	DB	11001011	Alt-0219									

Command Byte Value			Keyboard Entry			Description						
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./char.	Filter Wheel Command			Shutter or Special Command			
						W	S	F				
						h	p	i				
						e	e	l				
						e	d	t				
						l		e				
								r				
220	DC	11001100	Alt-0220						Fast mode. Followed by 1 byte for shutter indicator.			
221	DD	11001101	Alt-0221						Soft mode. Followed by 1 byte for shutter indicator.			
222	DE	11001110	Alt-0222						Neutral density mode. Followed by 1 byte for shutter indicator, and a third byte containing a value of 1 – 144.			
223	DF	11011111	Alt-0223						Batch Transfer of next 4 bytes (2 shutter and 2 filter wheel commands)			
224	E0	11100000	Alt-0224			B	6	0				
225	E1	11100001	Alt-0225					1				
226	E2	11100010	Alt-0226					2				
227	E3	11100011	Alt-0227					3				
228	E4	11100100	Alt-0228					4				
229	E5	11100101	Alt-0229					5				
230	E6	11100110	Alt-0230					6				
231	E7	11100111	Alt-0231					7				
232	E8	11101000	Alt-0232					8				
233	E9	11101001	Alt-0233					9				
234	EA	11101010	Alt-0234						Enable error reporting			
235	EB	11101011	Alt-0235						Open Shutter C			
236	EC	11101100	Alt-0236						Open Shutter C conditionally			
237	ED	11101101	Alt-0237						Close Shutter C			
238	EE	11101110	Alt-0238						On Line			
239	EF	11101111	Alt-0239						Local			
240	F0	11110000	Alt-0240			B	7	0				
241	F1	11110001	Alt-0241					1				
242	F2	11110010	Alt-0242					2				
243	F3	11110011	Alt-0243					3				
244	F4	11110100	Alt-0244					4				
245	F5	11110101	Alt-0245					5				
246	F6	11110110	Alt-0246					6				
247	F7	11110111	Alt-0247					7				
248	F8	11111000	Alt-0248					8				
249	F9	11111001	Alt-0249					9				
250	FA	11111010	Alt-0250									
251	FB	11111011	Alt-0251						Reset			
252	FC	11111100	Alt-0252						Wheel C first byte			
253	FD	11111101	Alt-0253						Get controller type & configuration			
254	FE	11111110	Alt-0254									
255	FF	11111111	Alt-0255									

NOTE 1: Bit 7 is used to select either Wheel A, B, or C. The bit is set to 0 for Wheel A or C, and is set to 1 for Wheel B. When selecting Wheel C, the entire encoded filter wheel command byte must be preceded by a byte containing the value of 252 decimal (FC hexadecimal, 11111011 binary).

NOTE 2: The “ASCII def./char.” column for codes 128 through 255 (80 through FF hex) is left blank, since there are no ASCII character definitions for the codes in this range. However, many computers and operating systems do support characters within this range, although there is no single standard across all platforms. Furthermore, many operating systems, such as Microsoft Windows and Apple Mac OS X, have several “code pages” (character sets), many of which are country/language specific, from which the user can select. Therefore, this part of the table is left blank – if you wish, you may write in the characters defined in the character set you use on a regular basis.

NOTE 3: Shutter C commands and parameters are active only in Lambda 10-3 Generation 4, and only if Shutter C is enabled instead of Wheel C. Also, “Open Shutter C Conditionally”, although defined, is not functional because Shutter C and Wheel C cannot be both made functional at the same time.

Table 2. Filter command structure.

Byte Bit Positional #	7	6	5	4	3	2	1	0
Functional Bit Groups	Wheel	Speed			Filter Position			
Group Bit #	0	2	1	0	3	2	1	0
Decimal Group Values	0-1	0-7			0-9			
Binary Group Values	0-1	000-111			0000-1001			
Parallel Port Pin #	9	8	7	6	5	4	3	2

Encoding filter wheel commands into a single byte:

$$\text{Command byte} = (\text{wheel} * 128) + (\text{speed} * 16) + \text{position}$$

Where *wheel* = 0 (Wheel A or C) or 1 (Wheel B),

speed = 0 through 7, and

position = 0 through 9.

NOTE: Wheel C is differentiated from Wheel A by having its command byte preceded by the “Wheel C First Byte” command (252 decimal (FC hexadecimal)).

Table 3. Status command return codes and data.

Order	Num. of bytes	Category	Sub Category	Value (Decimal, hexadecimal, & binary)	Description
1	1	Command echo		204 CC 11001100	The Status command byte code echoed back.
2	1	Filter Wheel A status	Wheel, Speed and Position	Encoded command byte: 0 – 121 00 – 79 00000000 – 01111001 *	Filter Wheel (Bit 7): 0 Speed (Bits 6, 5, & 4): 0 – 7. Position (Bits 3, 2, 1, & 0): 0 – 9
3	1	Filter Wheel B status	Wheel, Speed and Position	Encoded command byte: 128 – 249 80 – F9 10000000 – 11111001 *	Filter Wheel (Bit 7): 1 Speed (Bits 6, 5, & 4): 0 – 7. Position (Bits 3, 2, 1, & 0): 0 – 9
4	2	Filter Wheel C status	Wheel, Speed and Position	1 st byte = Wheel C indicator byte: 252 FC 11111100 2 nd byte = encoded filter wheel status byte: 0 – 121 00 – 79 00000000 – 01111001 *	Filter Wheel (Bit 7): 0 NOTE: Preceding byte containing 252 decimal (FC hexadecimal), indicates Wheel C. Speed (Bits 6, 5, & 4): 0 – 7. Position (Bits 3, 2, 1, & 0): 0 – 9
5	1	Shutter A open/-closed state	Open	170 AA 10101010	Shutter A is in the open state.

Order	Num. of bytes	Category	Sub Category	Value (Decimal, hexadecimal, & binary)	Description
			Open state is conditional	171 AB 10101011	The open state of Shutter A is conditional upon the movement of the Filter Wheel A.
			Closed	172 AC 10101100	Shutter A is in the closed state.
6	1	Shutter B open/-closed state	Open	186 BA 10111010	Shutter B is in the open state.
			Open state is conditional	187 BB 10111011	The open state of Shutter B is conditional upon the movement of the Filter Wheel B.
			Closed	188 BC 10111100	Shutter B is in the closed state.
7	2 or 3	Shutter A mode (<i>SMART-SHUTTER</i> only)	<i>SMART-SHUTTER</i> not connected	219 + 1 DB + 01 11011011 + 00000001	Indicates that no SmartShutter is connected to Port A. Either no shutter is connected or a Vincent shutter is connected.
			Fast	220 + 1 DC + 01 11011100 + 00000001	Indicates that SmartShutter A is in the fast mode.
			Soft	221 + 1 DD + 01 10111011 + 00000001	Indicates that SmartShutter A is in the soft mode.
			Neutral Density (1 byte) plus number of microsteps (1 byte)	222 + 1 + 1 – 144 DE + 01 + 01 – 90 10111100 + 00000001 + 00000001 - 10010000	Indicates that SmartShutter A is in the neutral-density mode. A third byte contains the number of microsteps (1 – 144).
8	2 or 3	Shutter B mode (<i>SMART-SHUTTER</i> only)	<i>SMART-SHUTTER</i> not connected	219 + 2 DB + 02 11011011 + 00000010	Indicates that no SmartShutter is connected to Port B. Either no shutter is connected or a Vincent shutter is connected.
			Fast	220 + 2 DC + 02 11011100 + 00000010	Indicates that SmartShutter B is in the fast mode.
			Soft	221 + 2 DD + 02 10111011 + 00000010	Indicates that SmartShutter B is in the soft mode.

Order	Num. of bytes	Category	Sub Category	Value (Decimal, hexadecimal, & binary)	Description
			Neutral Density (1 byte) plus number of microsteps (1 byte)	222 + 2 + 1 – 144 DE + 02 + 01 – 90 10111100 + 00000010 + 00000001 - 10010000	Indicates that SmartShutter B is in the neutral-density mode. A third byte contains the number of microsteps (1 – 144).

Table 4. Get Controller Type and Configuration command return data.

Total num. bytes	Description			
	Category	Num · Byte s	Possible values	
			ASCII string	Meaning
29	Controller Type	4	10-3	Lambda 10-3
	Filter Wheel A Type	5	WA-25	25mm
			WA-32	32mm
			WA-HS	High Speed
			WA-BD	Belt Driver
			WA-NC	Not Connected
			WA-ER	Error
	Filter Wheel B Type	5	WB-25	25mm
			WB-32	32mm
			WB-HS	High Speed
			WB-BD	Belt Driver
			WB-NC	Not Connected
			WB-ER	Error
	Filter Wheel C Type	5	WB-25	25mm
			WB-32	32mm
			WB-HS	High Speed
			WB-BD	Belt Driver
			WB-NC	Not Connected
			WB-ER	Error
	Shutter A Type	5	SA-IQ	SmartShutter
			SA-VS	Vincent Shutter
	Shutter B Type	5	SB-IQ	SmartShutter
			SA-VS	Vincent Shutter