SUTTER INSTRUMENT®

Lambda XL External Control Quick Reference

Rev. 1.00b (20190606)

Table 1. Complete Command Reference.

Byte Value			Keyboard Entry			Description			
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command
						Wheel	Speed	Filter	
0	00	0000 0000	Alt-0000	^@	(NUL)	A	0	0	
1	01	0000 0001	Alt-0001	^A	(SOH)			1	
2	02	0000 0010	Alt-0002	^B	(STX)			2	
3	03	0000 0011	Alt-0003	^C	(ETX)			3	
4	04	0000 0100	Alt-0004	^D	(EOT)			4	
5	05	0000 0101	Alt-0005	^E	(ENQ)			5	
6	06	0000 0110	Alt-0006	^F	(ACK)			6	
7	07	0000 0111	Alt-0007	^G	(BEL)			7	
8	08	0000 1000	Alt-0008	^H	(BS)			8	
9	09	0000 1001	Alt-0009	^I	(HT)			9	
10 - 15	0A - 0F	0000 1010 - 0000 1111	Alt-0010 - Alt-0015	^J - ^O	(LF) - (SI)				
16	10	0001 0000	Alt-0016	^P	(DLE)	A	1	0	
17	11	0001 0001	Alt-0017	^Q	(DC1)			1	
18	12	0001 0010	Alt-0018	^R	(DC2)			2	
19	13	0001 0011	Alt-0019	^S	(DC3)			3	
20	14	0001 0100	Alt-0020	^T	(DC4)			4	
21	15	0001 0101	Alt-0021	^U	(NAK)			5	
22	16	0001 0110	Alt-0022	^V	(SYN)			6	
23	17	0001 0111	Alt-0023	^W	(ETB)			7	
24	18	0001 1000	Alt-0024	^X	(CAN)			8	
25	19	0001 1001	Alt-0025	^Y	(EM)			9	
26 - 31	1A - 1F	0001 1010 - 0001 1111	Alt-0026 - Alt-0031	^Z - ^_	(SUB) - (US)				
32	20	0010 0000	Alt-0032		(space)	A	2	0	
33	21	0010 0001	Alt-0033		!			1	
34	22	0010 0010	Alt-0034		“			2	
35	23	0010 0011	Alt-0035		#			3	
36	24	0010 0100	Alt-0036		$			4	
37	25	0010 0101	Alt-0037		%			5	
38	26	0010 0110	Alt-0038		&			6	
39	27	0010 0111	Alt-0039		‘			7	
40	28	0010 1000	Alt-0040		(			8	
41	29	0010 1001	Alt-0041		)			9	
42 - 47	2A - 2F	0010 1010 - 0010 1111	Alt-0042 – Alt-0047		* – /				
46	30	0011 0000	Alt-0048		0	A	3	0	
49	31	0011 0001	Alt-0049		1			1	
50	32	0011 0010	Alt-0050		2			2	
51	33	0011 0011	Alt-0051		3			3	
52	34	0011 0100	Alt-0052		4			4	
53	35	0011 0101	Alt-0053		5			5	
54	36	0011 0110	Alt-0054		6			6	

Byte Value			Keyboard Entry			Description			
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command
						Wheel	Speed	Filter	
55	37	0011 0111	Alt-0055		7			7	
56	38	0011 1000	Alt-0056		8			8	
57	39	0011 1001	Alt-0057		9			9	
58 - 63	3A - 3F	0011 1010 - 0011 1111	Alt-0058 – Alt-0063		: – ?				
64	40	0100 0000	Alt-0064		@	A	4	0	
65	41	0100 0001	Alt-0065		A			1	
66	42	0100 0010	Alt-0066		B			2	
67	43	0100 0011	Alt-0067		C			3	
68	44	0100 0100	Alt-0068		D			4	
69	45	0100 0101	Alt-0069		E			5	
70	46	0100 0110	Alt-0070		F			6	
71	47	0100 0111	Alt-0071		G			7	
72	48	0100 1000	Alt-0072		H			8	
73	49	0100 1001	Alt-0073		I			9	
74 - 79	4A - 4F	0100 1010 - 0100 1111	Alt-0074 – Alt-0079		J – O				
80	50	0100 0000	Alt-0080		P	A	5	0	
81	51	0100 0001	Alt-0081		Q			1	
82	52	0100 0010	Alt-0082		R			2	
83	53	0100 0011	Alt-0083		S			3	
84	54	0100 0100	Alt-0084		T			4	
85	55	0100 0101	Alt-0085		U			5	
86	56	0100 0110	Alt-0086		V			6	
87	57	0100 0111	Alt-0087		W			7	
88	58	0100 1000	Alt-0088		X			8	
89	59	0100 1001	Alt-0089		Y			9	
90 - 95	5A - 5F	0100 1010 - 0101 1111	Alt-0090 – Alt-0095		Z – _				
96	60	0101 0000	Alt-0096		`	A	6	0	
97	61	0101 0001	Alt-0097		a			1	
98	62	0101 0010	Alt-0098		b			2	
99	63	0101 0011	Alt-0099		c			3	
100	64	0101 0100	Alt-0100		d			4	
101	65	0101 0101	Alt-0101		e			5	
102	66	0101 0110	Alt-0102		f			6	
103	67	0101 0111	Alt-0103		g			7	
104	68	0101 1000	Alt-0104		h			8	
105	69	0101 1001	Alt-0105		i			9	
106 - 111	6A - 6F	0101 1010 - 0101 1111	Alt-0106 – Alt-0111		j – o				
112	70	0111 0000	Alt-0112		p	A	7	0	
113	71	0111 0001	Alt-0113		q			1	
114	72	0111 0010	Alt-0114		r			2	
115	73	0111 0011	Alt-0115		s			3	
116	74	0111 0100	Alt-0116		t			4	
117	75	0111 0101	Alt-0117		u			5	
118	76	0111 0110	Alt-0118		v			6	

Byte Value			Keyboard Entry			Description			
Dec.	Hex.	Binary	Alt-keypad entry	Ctrl-char.	ASCII def./-char.	Filter Wheel Command			Shutter or Special Command
						Wheel	Speed	Filter	
119	77	0111 0111	Alt-0119		w			7	
120	78	0111 1000	Alt-0120		x			8	
121	79	0111 1001	Alt-0121		y			9	
122 - 127	7A - 7F	0111 1010 - 0111 1111	Alt-0122 – Alt-0127		z – ~				
128 - 169	80 - A9	1000 0000 - 1010 1001	Alt-0128 – Alt-0169						
170	AA	1010 1010	Alt-0170						Open Shutter A
171	AB	1010 1011	Alt-0171						Open Shutter A conditionally
172	AC	1010 1100	Alt-0172						Close Shutter A
173 - 185	AD - B9	1010 1101 - 1011 1001	Alt-0173 – Alt-0185						
186	BA	1011 1010	Alt-0186						Open Shutter B
187	BB	1011 1011	Alt-0187						
188	BC	1011 1100	Alt-0188						Close Shutter B
189 - 203	BD - CB	1011 1101 - 1100 1011	Alt-0189 - Alt-0203						
204	CC	1100 1100	Alt-0204						Status
205	CD	1100 1101	Alt-0205						
206	CE	1100 1110	Alt-0206						All motors power on
207	CF	1100 1111	Alt-0207						All motors power off
208 - 219	D0 - DD	1100 0000 - 1100 1011	Alt-0208 – Alt-0219						
220	DC	1100 1100	Alt-0220						Fast mode
221	DD	1100 1101	Alt-0221						Soft mode
222	DE	1100 1110	Alt-0222						Neutral density mode
223 - 237	DF - ED	1101 1111 - 1110 1101	Alt-0223 – Alt-0237						
238	EE	1110 1110	Alt-0238						On Line
239	EF	1110 1111	Alt-0239						Local
240 - 250	F0 - FA	1111 0000 - 1111 1010	Alt-0240 – Alt-0250						
251	FB	1111 1011	Alt-0251						Reset
252	FC	1111 1100	Alt-0252						
253	FD	1111 1101	Alt-0253						Get controller type & configuration
254	FE	1111 1110	Alt-0254						
255	FF	1111 1111	Alt-0255						

NOTE 1: The Lambda XL supports only one filter wheel (Wheel A). Therefore, Bit 7 should always be set to 0.

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.

Table 2. Filter command structure.

Functional Bit Groups								
Nibble	**Upper**				**Lower**			
Byte Bit #	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Parameter Bit Group	**Wheel**	**Speed**			**Filter Position**			
Group Bit #	**0**	**2**	**1**	**0**	**3**	**2**	**1**	**0**
Bit Group Value Range	0	0 – 7 (000 – 111 binary)			0 – 9 (0000 – 1001 binary)			
Group Bit Position Multiplier	128	16			0			

Encoding filter wheel commands into a single byte (all numbers are in decimal):

(*speed* * 16) + *position* = command byte

... where *speed* = 0 through 7 and *position* = 0 through 9. The Wheel Bit is not included in the formula because in the Lambda XL it is always set to 0 (Wheel A).

Table 3. Status Command Return Codes and Data in a "Wheel/Shutter" Configuration.

Order	**Num. of bytes**	**Category**	**Sub Catego-ry**	**Value** (Decimal, hexa-decimal, & bina-ry)	**Description**
1	1	**Command echo**		204 CC 11001100	The Status command byte code echoed back.
2	1	**Filter wheel state**	Wheel, Speed and Position	* 0 – 121 00 – 79 00000000 – 01111001	Filter Wheel (Bit 7): Always 0.
					Speed (Bits 6, 5, & 4): 0 – 7.
					Position (Bits 3, 2, 1, & 0): 0 – 9
			Error or no filter wheel installed	10 0A 00001010	Either no filter wheel is installed or there is an error on the 15-pin wheel port.
3	1	**Shutter open/closed state**	Open	170 AA 10101010	The shutter is in the open state.
			Open state is conditional	171 AB 10101011	The open state of the shutter is conditional upon the movement of the filter wheel.
			Closed	172 AC 10101100	The shutter is in the closed state.

Order	Num. of bytes	Category	Sub Category	Value (Decimal, hexadecimal, & binary)	Description
4	1 or 2	**Shutter mode (*SMART*-SHUTTER only)**	*SMART*-SHUTTER not connected	219 DB 11011011	Indicates that no *Smart*Shutter is connected. Either no shutter is connected or a Vincent shutter is connected.
			Fast mode	220 DC 11011100	Indicates that the *Smart*Shutter is in fast mode.
			Soft mode	221 DD 10111011	Indicates that the *Smart*Shutter is in soft mode.
			Neutral Density mode (1 byte) plus number of microsteps (1 byte)	222, 1 – 144 DE, 01 – 90 10111100, 00000001 - 10010000	Indicates that the *Smart*Shutter is in neutral-density mode. A second byte contains the number of microsteps (1 – 144).

*** NOTE:** Range shown for the filter wheel command/status byte is not 100% inclusive. Please refer to Table 5-4 for an explanation of how the byte is encoded, and to Table 5-3 for a list of valid byte values.

Table 4. “Get Controller Type and Configuration” Command Return Codes and Data.

Configuration	Total num. bytes	Description			
		Category	Num. Bytes	Possible Values	
				ASCII string	Meaning
Filter Wheel with or without shutter or Single Shutter (no filter wheel) (One standalone filter wheel only, one filter wheel with one integrated shutter, or one standalone filter wheel and one standalone shutter	14	**Command echo back**	1	**ý**	253 decimal; FD hexadecimal. *
		Controller Type	4	**LBXL**	Lambda XL **
				10-B	“Lambda 10-B” **
		Filter Wheel Type	4	**W-25**	25mm
				W-32	32mm
				W-HS	High Speed
				W-BD	Belt Driver
				W-NC	Not Connected
				W-ER	Error
		Shutter Type	4	**S-IQ**	SmartShutter
				S-VS	No shutter connected
		Command return data terminator	1		ASCII carriage return; 13 decimal, 0D hexadecimal.
Dual *Smart*Shutters™ (no filter wheel) (Two shutters (*Smart*Shutters™ only); no filter wheel))	16	**Command echo back**	1	**ý**	253 decimal; FD hexadecimal. *
		Controller Type	4	**LBXL**	Lambda XL **
				10-B	“Lambda 10-B” **
		Shutter A Type	5	**SA-IQ**	1st SmartShutter
		Shutter B Type	5	**SB-IQ**	2nd SmartShutter
		Command return data terminator	1		ASCII carriage return; 13 decimal, 0D hexadecimal.

*__NOTE:__ The character shown in the “ASCII string” column for the command echo is a typical visual representation of the byte value 253 decimal (FD hexadecimal) on both Windows and Linux platforms. However, other platforms may display a different character or nothing at all. For the command return data terminator (ASCII carriage return (13 decimal, 0D hexadecimal), generally no character will be displayed, although the carriage return is acted upon in most cases in text-based console programs.

** __NOTE:__ The text returned for “Controller Type” is “LBXL” by default. This text can be changed to “10-B” (for Lambda 10-B) in cases where the remote control software being used to control the Lambda XL issues the Get Controller Type and Configuration command to identify the product but does not recognize “LBXL” as a supported product. The Controller Type text is changed via the Lambda XL’s keypad and display menus in local mode, as described in Chapter 5 (OPERATIONS: EXTERNAL COMMAND CONTROL).

NOTES: