APPENDIX A: USB MESSAGE SEQUENCE CHARTS

Chart 1: Test 1 without USB channel control messages

Time (ms)	Message direction MSFR	DP	Size (B)	Type	Ta.ID	Contents
				INIT		
176	←		65536	**BULK**	13	0s, except for `f0 ac 89` at every f70-address.
177	←		64	**BULK**	14	Msg X
315		→	64	**BULK**	14	Msg Y
315	←		64	**BULK**	31	Msg X'
577		→	65536	**BULK**	13	Start of empty **scan** in raw format
582	←		45888	**BULK**	35	0s, except for `f0 ac 89` at every f70-address.
631		→	45504	**BULK**	35	Part 2 of empty **scan** in raw format
643	←		65536	**BULK**	36	Memory dump in ASCII format, range: `00008c40 – 0000ce40`.
2211		→	64	**BULK**	31	Msg Z'
2211	←		64	**BULK**	39	Msg Y
				Known fingerprint		
30610		→	64	**BULK**	39	Msg Z
30610	←		64	**BULK**	41	Msg Z'
30709		→	65536	**BULK**	36	Start of **fp scan** in raw
30716	←		45888	**BULK**	43	Memory dump in ASCII format, range: `0000ce50 – 0000fc80`
30768		→	45504	**BULK**	43	Part 2 of **fp scan** in raw format
30778	←		65536	**BULK**	45	0s, except for `20 c4 81` at every f70-address.
30951		→	34624	**BULK**	45	"Checksum" of **fp scan** in raw format
30961	←		65536	**BULK**	47	Memory dump in ASCII format, range: `000018a0 – 00005aa0`.
31394		→	64	**BULK**	41	Msg Z'
31394	←		64	**BULK**	50	Msg Z
31954		→	0	**BULK**	47	Abort pipe

Chart 2: Test 2 without USB channel control messages

Time (ms) start=30610	Message direction MSFR	DP	Size (B)	Type	Ta.ID	Contents
				INIT		
156	←		0x10000	**BULK**	13	Contents of previous(?) scan, part 1
156	←		0x40	**BULK**	14	Msg X''
276		→	0x40	**BULK**	14	Msg Y
276	←		0x40	**BULK**	31	Msg Q
533		→	0x10000	**BULK**	13	Empty scan, part 1
538	←		0xB340	**BULK**	35	Contents of previous(?) scan, part 2
587		→	0xB1C0	**BULK**	35	Empty scan, part 2
595	←		0x10000	**BULK**	36	Mem dump in ASCII
2068		→	0x40	**BULK**	31	Msg Z'

2068	←		0x40	**BULK**	39	Msg Y
			Known finger			
10940		→	0x40	**BULK**	39	Msg Z
10940	←		0x40	**BULK**	41	Msg Z'
11044		→	0x10000	**BULK**	36	FP scan, part 1
11050	←		0xB340	**BULK**	43	Mem dump in ASCII
11100		→	0xB1C0	**BULK**	43	FP scan, part 2
11110	←		0x10000	**BULK**	45	Mem dump in ASCII
11287		→	0x8740	**BULK**	45	FP checksum
11297	←		0x10000	**BULK**	47	Mem dump in ASCII
11620		→	0x40	**BULK**	41	Msg Z'
11620	←		0x40	**BULK**	50	Msg Z
			Unknown finger			
23148		→	0x40	**BULK**	50	Msg Z
23148	←		0x40	**BULK**	53	Msg Z'
23245		→	0x10000	**BULK**	47	FP scan, part 1
23251	←		0xB340	**BULK**	55	Mem dump in ASCII
23300		→	0xB1C0	**BULK**	55	FP scan, part 2
23310	←		0x10000	**BULK**	57	Part of contents of empty scan
23488		→	0x8740	**BULK**	57	FP checksum
23498	←		0x10000	**BULK**	59	Part 1 of contents of known fp scan
23876		→	0x40	**BULK**	53	Msg Z'
23876	←		0x40	**BULK**	62	Msg Z
			Text, trial 1			
56931		→	0x40	**BULK**	62	Msg Z
56931	←		0x40	**BULK**	65	Msg Z'
57036		→	0x10000	**BULK**	59	"FP" scan, part 1
57042	←		0xB340	**BULK**	67	Part 2 of contents of known fp scan
57090		→	0xB1C0	**BULK**	67	"FP" scan, part 2
57100	←		0x10000	**BULK**	68	Part of contents of known fp checksum
			Text, trial 2			
57225		→	0x10000	**BULK**	68	"FP" scan, part 1
57230	←		0xB340	**BULK**	69	Mem dump in ASCII
57279		→	0xB1C0	**BULK**	69	"FP" scan, part 2
57290	←		0x10000	**BULK**	71	Part 1 of contents of unknown fp scan
57467		→	0x8740	**BULK**	71	"FP" checksum
57477	←		0x10000	**BULK**	73	aborted
58131		→	0x40	**BULK**	65	Msg Z'
58131	←		0x40	**BULK**	77	Msg Z
			Printed image			
141194		→	0x40	**BULK**	77	Msg Z
141204	←		0x10000	**BULK**	80	Part of contents of text checksum
141205	←		0x40	**BULK**	82	Msg Z'
141250		→	0x40	**BULK**	82	Msg Z
141250	←		0x40	**BULK**	84	Msg Z
141353		→	0x10000	**BULK**	80	"FP" scan, part 1
141359	←		0xB340	**BULK**	86	Part 2 of contents of unknown fp scan
141408		→	0xB1C0	**BULK**	86	"FP" scan, part 2
141418	←		0x10000	**BULK**	88	Mem dump in ASCII
141596		→	0x8740	**BULK**	88	"FP" checksum
141606	←		0x10000	**BULK**	90	Mem dump in ASCII

Time (ms)			0x40	**BULK**	84	Msg Z'
142258		→	0x40	**BULK**	84	Msg Z'
142258	←		0x40	**BULK**	94	Msg Z

Chart 3: Test 1, INIT-phase with USB control messages and channels

Time (ms) start=0	Message direction		Size (B)	Type	Pipe	Contents
	MSFR	DP				
33	←		9	Get_Descr	-	
37		→	9	CTRL	B	
37	←		32	Get_Descr	-	
41		→	32	CTRL	B	
76	←		18	Get_Descr	-	
80		→	18	CTRL	B	"Microsoft" (in UNICODE)
80	←		4	Get_Descr	-	
84		→	4	CTRL	B	
84	←		4	Get_Descr	-	
88		→	4	CTRL	B	
88	←		20	Get_Descr	-	
92		→	20	CTRL	B	
92	←		4	Get_Descr	-	
96		→	4	CTRL	B	
96	←		60	Get_Descr	-	
100		→	60	CTRL	B	"Microsoft Fingerprint Reader" (in UNIC)
100	←		4	Get_Descr	-	
104		→	4	CTRL	B	
104	←		78	Get_Descr	-	
109		→	78	CTRL	B	A class-ID in UNICODE {B0D8FE03-E826-0B42-982F-C987BD99E467}
162	←		1	VNDR	-	
166	←		10	CTRL	B	
176	←		65536	**BULK**	C	0s, except for f0 ac 89 at every f70-address. -> request for 577
177	←		64	**BULK**	A	Msg X -> request for 315.1
180	←		18	Get_Descr	-	
184		→	18	CTRL	B	Msg1
184	←		18	Get_Descr	-	
188		→	18	CTRL	B	Msg1
188	←		18	Get_Descr	-	
192		→	18	CTRL	B	Msg1
221		→	16	VNDR	-	
225		→	16	CTRL	B	
227		→	16	VNDR	-	
231		→	16	CTRL	B	
231		→	1	VNDR	-	
235		→	1	CTRL	B	
235	←		1	VNDR	-	
239	←		1	CTRL	B	
239	←		256	VNDR	-	Unencrypted data, part 1
246	←		256	CTRL	B	
246	←		256	VNDR	-	Unencrypted data, part 2
253	←		256	CTRL	B	
253	←		256	VNDR	-	Unencrypted data, part 3

Time	MSFR	DP	Size	Type	Pipe	Contents
260	←		256	CTRL	B	
260	←		256	VNDR	-	Unencrypted data, part 4
267	←		256	CTRL	B	
267	←		256	VNDR	-	Unencrypted data, part 5
274	←		256	CTRL	B	
274	←		256	VNDR	-	Unencrypted data, part 6
281	←		256	CTRL	B	
281	←		256	VNDR	-	Unencrypted data, part 7
288	←		256	CTRL	B	
296	←		112	VNDR	-	Unencrypted data, part 8
301	←		112	CTRL	B	
301	←		1	VNDR	-	
305	←		1	CTRL	B	
315		→	64	**BULK**	A	Msg Y reply to 177
315	←		64	**BULK**	A	Msg X' request for 2211.1
315		→	16	VNDR	-	
319		→	16	CTRL	B	
319	←		1	VNDR	-	
323	←		1	CTRL	B	
323	←		1	VNDR	-	
327	←		1	CTRL	B	
577		→	65536	**BULK**	C	Start of empty **scan** in raw format (reply to 176)
582	←		45888	**BULK**	C	0s, except for `f0 ac 89` at every `f70`-address. (request for 631)
631		→	45504	**BULK**	C	Part 2 of empty **scan** in raw format (reply to 582)
643	←		65536	**BULK**	C	Memory dump in ASCII format, range: `00008c40 – 0000ce40`. (request for ID.99)
652	←		1	VNDR	-	
657	←		1	CTRL	B	
2211		→	64	**BULK**	A	Msg Z' reply to 315.2
2211	←		1	VNDR	-	
2211	←		64	**BULK**	A	Msg Y request for ID.0.1
2215	←		1	CTRL	B	

Chart 4: Test 1, known fingerprint scan with USB control messages and channels shown

Time (ms) start=30610	Message direction MSFR	DP	Size (B)	Type	Pipe	Contents
0		→	64	**BULK**	A	Msg Z reply to INIT.2211.3
0	←		1	VNDR	-	
0	←		64	**BULK**	A	Msg Z' request for 784.1
0	←		1	VNDR	-	
4	←		1	CTRL	B	
8	←		1	CTRL	B	
99		→	65536	**BULK**	C	Start of **fp scan** in raw format (reply to INIT.643)
106	←		45888	**BULK**	C	Memory dump in ASCII format, range: `0000ce50 – 0000fc80`. (request for 158)
158		→	45504	**BULK**	C	Part 2 of **fp scan** in raw format (reply to 106)

158	←		1	VNDR	-	
168	←		65536	**BULK**	C	0s, except for `20 c4 81` at every `f70`-address. (request for 341.1)
168	←		1	CTRL	B	
341		→	34624	**BULK**	C	"Checksum" of **fp scan** in raw format (reply to 168.1)
341	←		1	VNDR	-	
351	←		65536	**BULK**	C	Memory dump in ASCII format, range: `000018a0 – 00005aa0.` (request for 1344)
351	←		1	CTRL	B	
388	←		1	VNDR	-	
392	←		1	CTRL	B	
784		→	64	**BULK**	A	Msg Z' reply to 0.3
784	←		1	VNDR	-	
784	←		64	**BULK**	A	Msg Z request for (reply not arrived)
788	←		1	CTRL	B	
986	←		1	VNDR	-	
989	←		1	CTRL	B	
1344		→	0	**BULK**	C	reply to 351.1

APPENDIX B: MSFR EVENT MESSAGES

Msg X:

```
00000000: 00 00 00 00 5f 53 54 41 a0 65 5c f7 a0 65 5c f7
00000010: 38 fd b7 89 84 67 bd 89 52 c8 5a f7 88 07 bb 89
00000020: c8 07 bb 89 cc 07 bb 89 00 00 00 00 00 00 00 00
00000030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Msg X':

```
00000000: 00 00 00 00 5f 53 54 41 a0 65 5c f7 a0 65 5c f7
00000010: 08 f0 b7 89 74 66 bd 89 52 c8 5a f7 88 07 bb 89
00000020: c8 07 bb 89 cc 07 bb 89 00 00 00 00 00 00 00 00
00000030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Msg Y ("scanner ready"):

```
00000000: 56 aa 03 91 0e fe 0c 54 02 01 00 10 0d ee 0c 40
00000010: 14 02 0c 44 16 04 02 70 0c 11 0c 40 14 02 0c 44
00000020: 0f 11 16 0b 02 c0 0c 40 0d e0 00 10 0f 10 0c 44
00000030: 14 02 0c 40 0e f1 00 4c 0e fe 0c 44 14 02 0c 40
```

Msg Z ("`finger placed`"):

```
00000000: 01 01 02 00 08 00 10 00 20 00 80 00 56 aa 03 91
00000010: 0e fe 0c 54 02 01 00 10 0d ee 0c 40 14 02 0c 44
00000020: 16 04 02 70 0c 11 0c 40 14 02 0c 44 0f 11 16 0b
00000030: 02 c0 0c 40 0d e0 00 10 0f 10 0c 44 14 02 0c 40
```

Msg Z' ("`finger lifted`"):

```
00000000: 02 00 08 00 10 00 20 00 80 00 56 aa 03 91 0e fe
00000010: 0c 54 02 01 00 10 0d ee 0c 40 14 02 0c 44 16 04
00000020: 02 70 0c 11 0c 40 14 02 0c 44 0f 11 16 0b 02 c0
00000030: 0c 40 0d e0 00 10 0f 10 0c 44 14 02 0c 40 0e f1
```