Charging A50 smartphone prb.

1 The goal our Project

We are using a smartphone A50 from Samsung to put inside a plastic box and connect to an intelligent electronic board that can manage to communicate with IR, RF, LED…

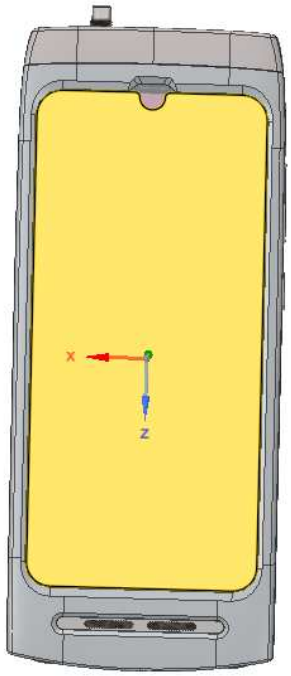
This means the A50 must power on the electronic board when it is in the customer's hands. We also need to charge the A50 by the electronic board.

To manage the power path of the différent use we decide to use a Power delivery USB-C component.

The A50 could in difference state when we want to charge it.

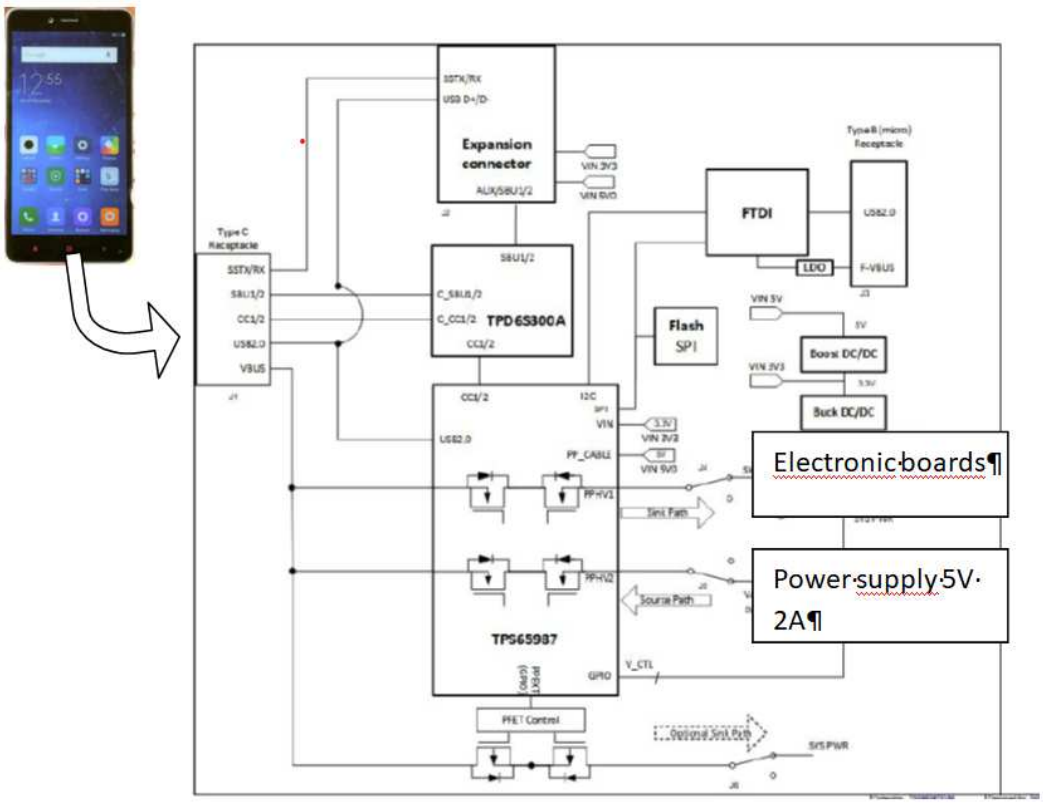
- **Running stage** the OS android and application are running.
- **Switch off** with some battery , it is possible to switch on the A50.
- **Switch off** without battery, it is not possible to switch on the A50.

In the case of the A50 is Off when we put in the charger it boots and we have on screen the percentage of the battery.



2 Our design

Below you will find the POC we do. We use the TPS65987EVM board.
And we use the mode DRP . The project is a DRP (the A50) to DRP (the TPS65987)



3 The problem

We made our prope prototype Board and everything was ok , we decided to do a first production. And when we start making some important tests on many products we get some product no charging when they are in the state **Switch off.** The percentage is 1 over 20!!!!. And it is not the same . To restart normally the charge of the A50 we need to take it out and to plug it to a USB charger .

We can’t accept that we need to take out the A50 from the plastic box to solve the problem.
We need to charge the A50 for any situation.

To find a solution we decide to redo the test on the TPS 65987 EVM board and to simplify we decided to use the evaluation board which has a charger in DFP mode.
All the test below are made with this function.

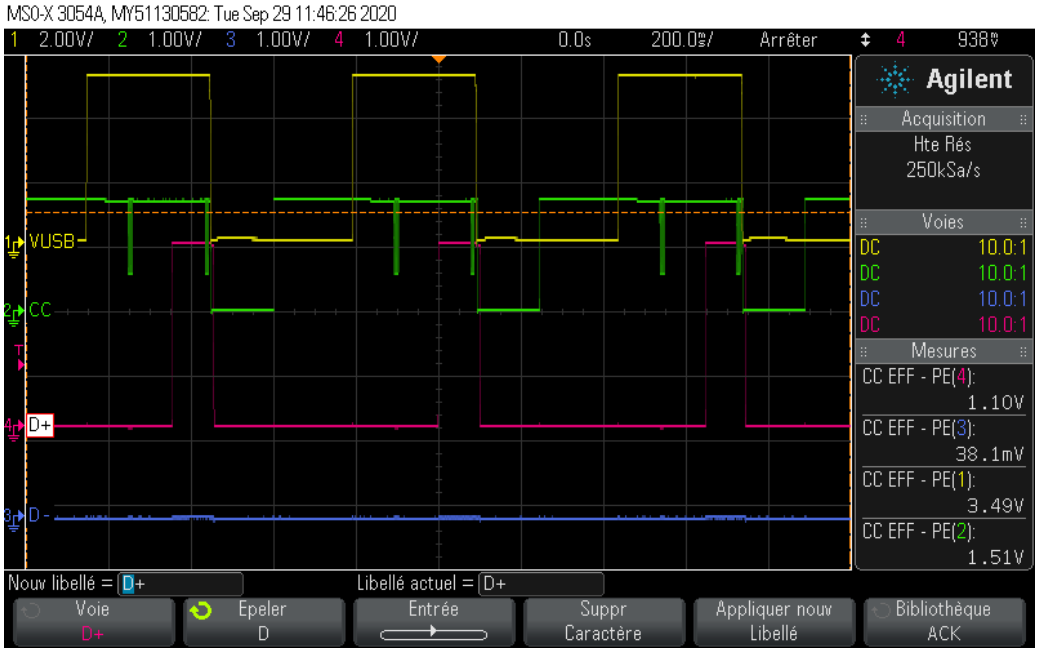
4 TEST

4.1 Result when we have the problem .

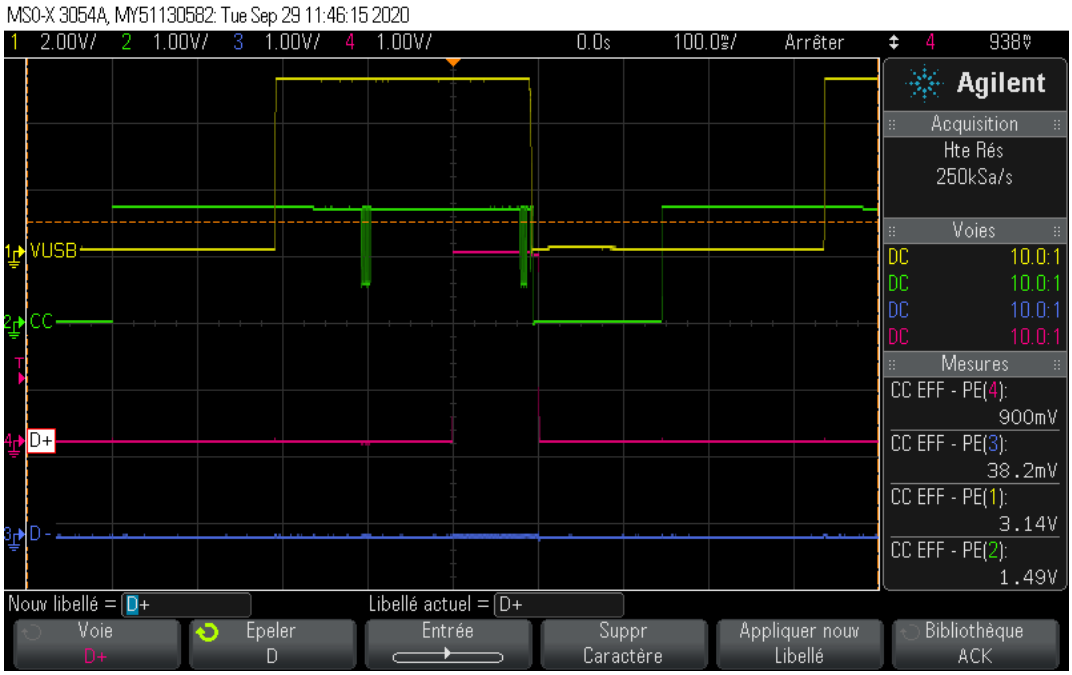
We are using a UCB-C analyser between the A50 and the Evaluation board
With the ticket I put the file project of PD .

The A50 is in switch off state with no battery.

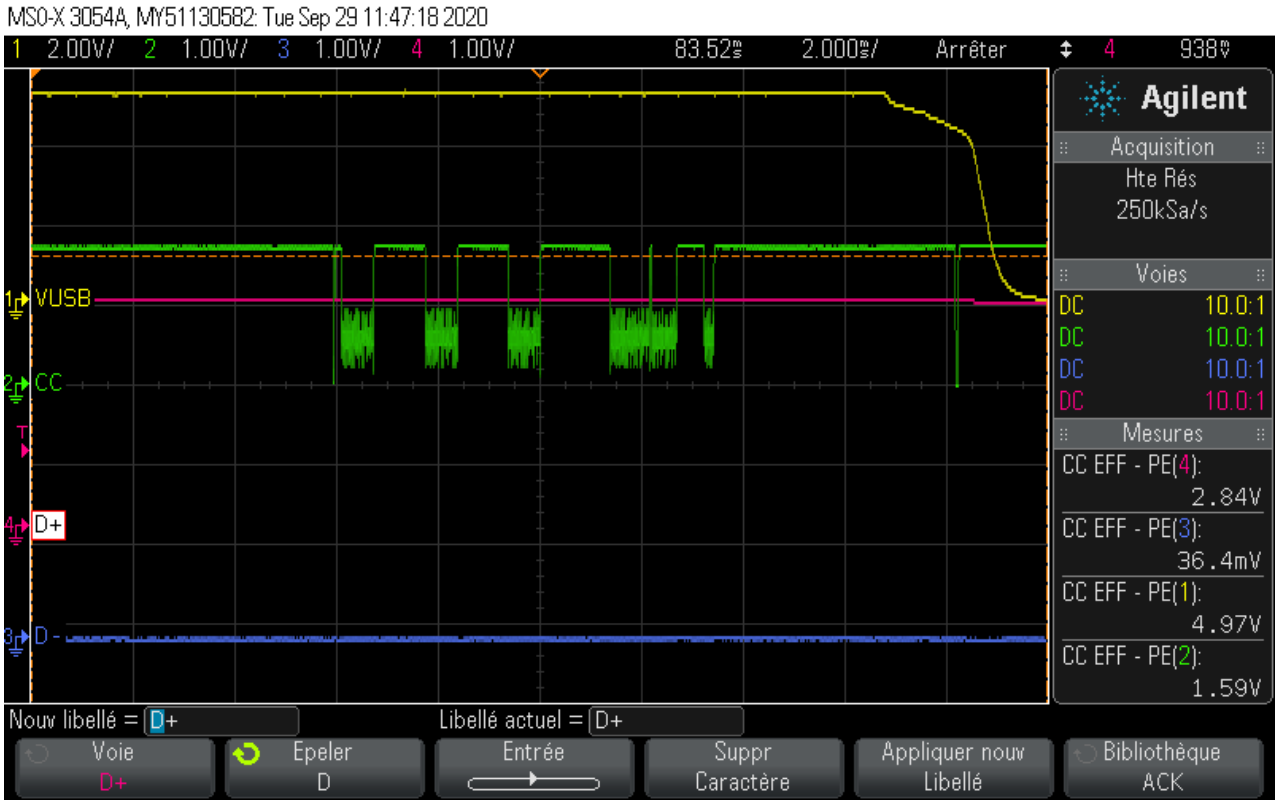
Below we see the VUSB switching between 5V to 0V



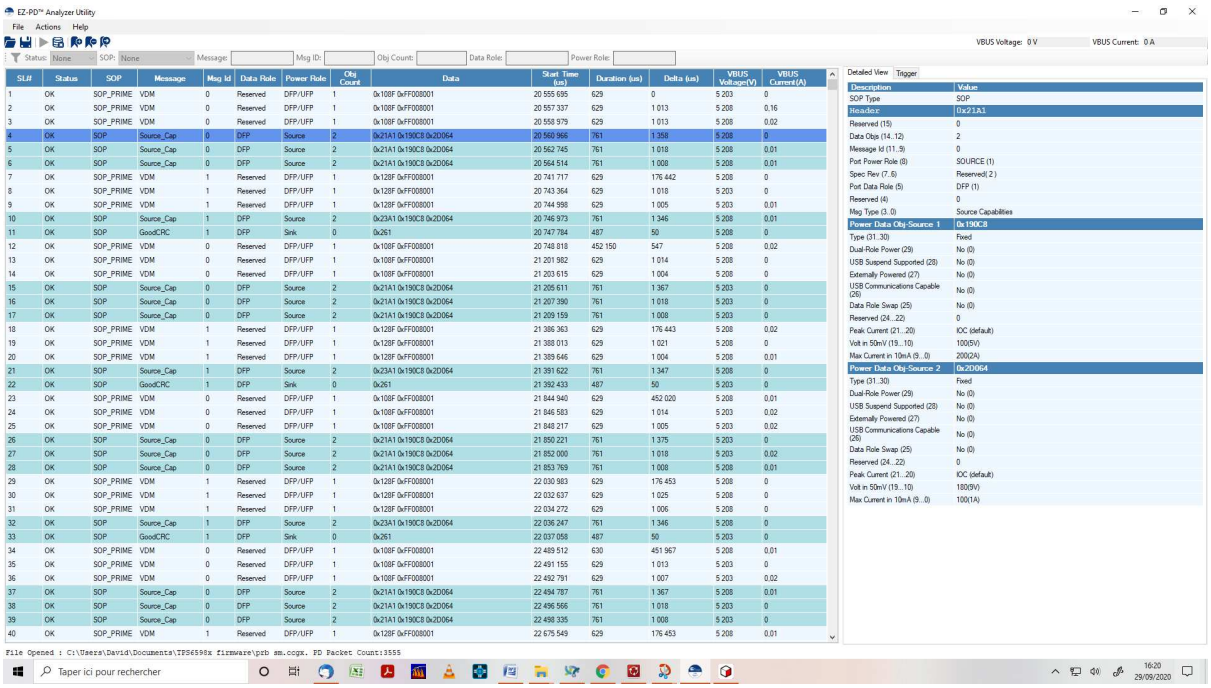
Zoom



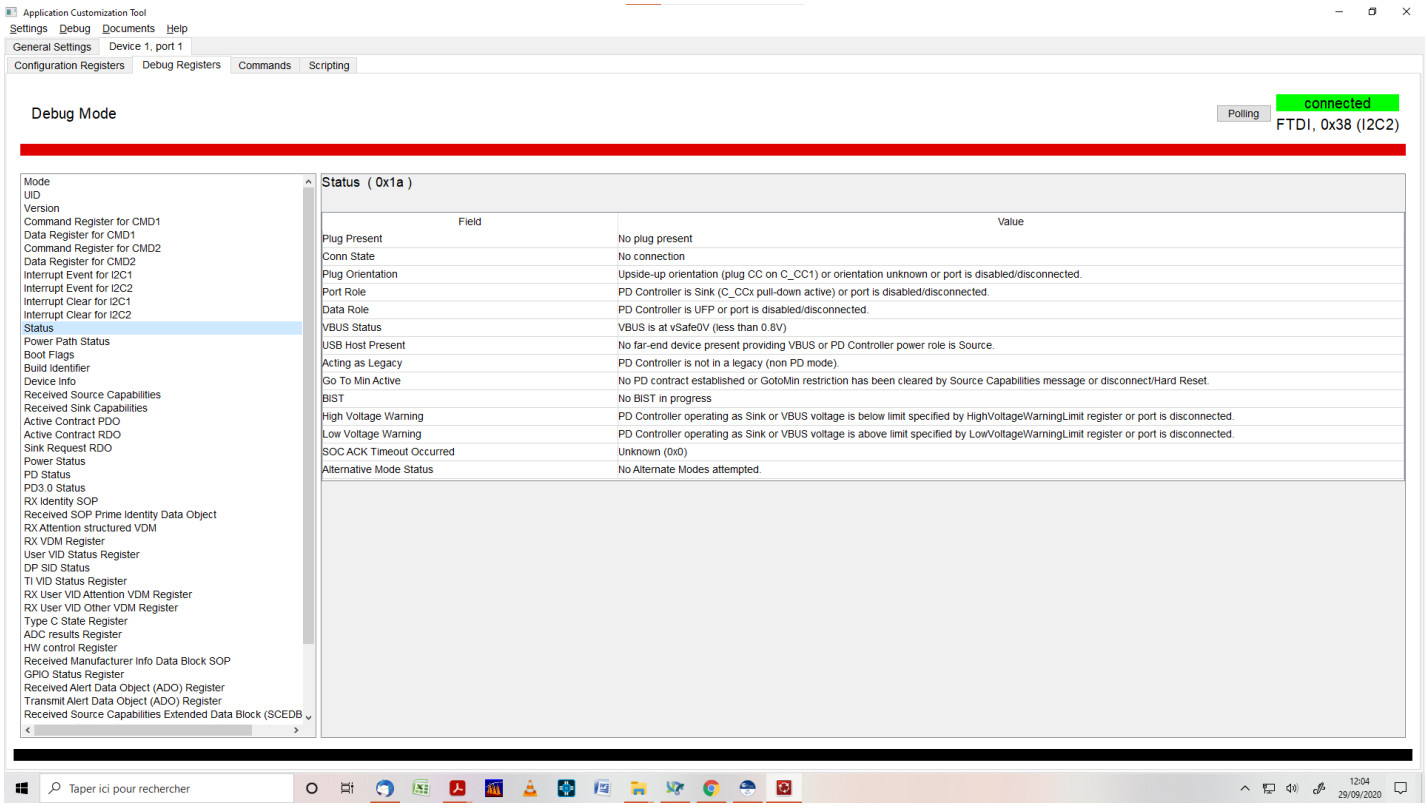
ZOOM on the CC line below

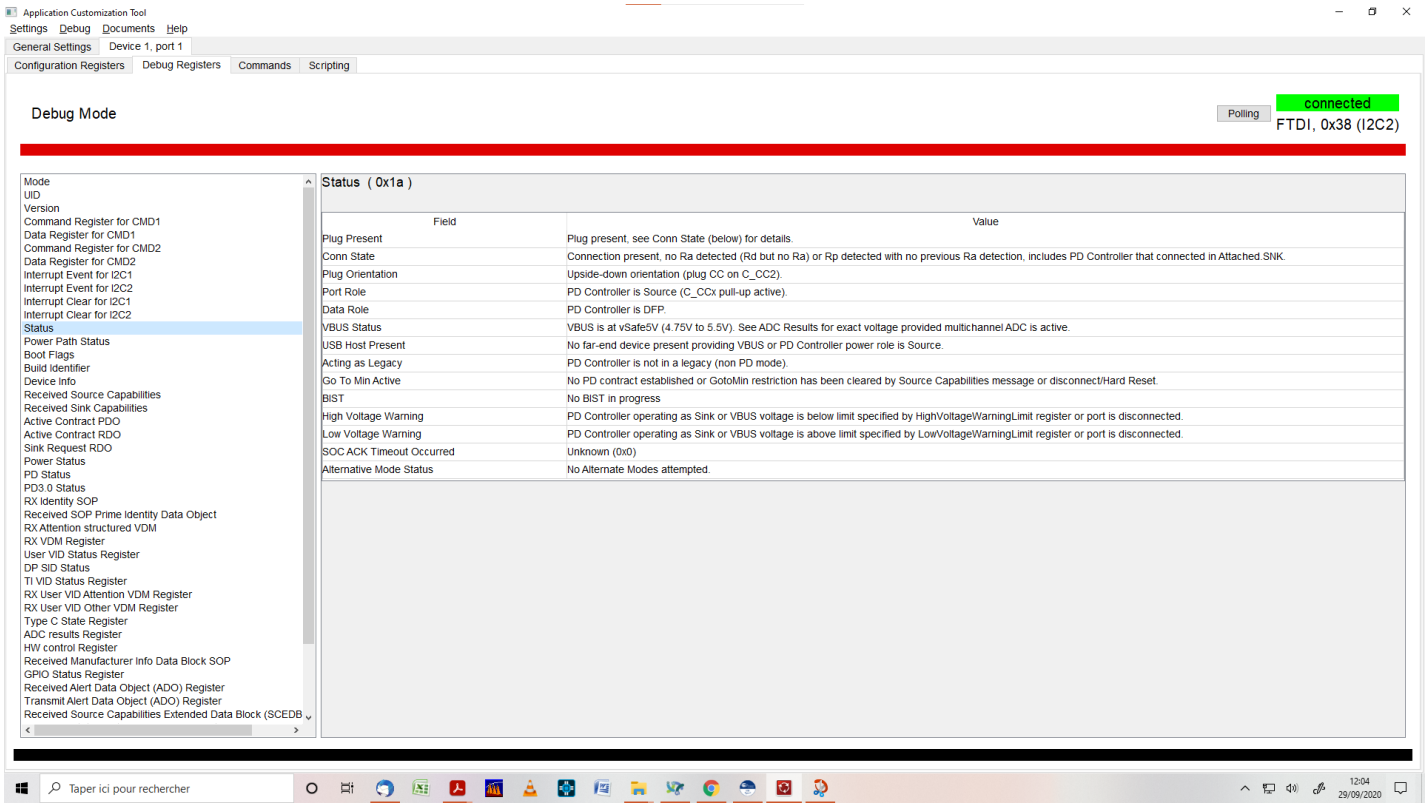


Below The USB-C protocol



Below the status changing between plug present and no plug present.





Below the PD state machine. We can see in red there is an error

Port 1	Module 31	0x1ff = UNKNOWN
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	PD	0x15 = PEState_Source_Discovery
Port 0	PD	0x96 = PESTATE_SRC2PLUG_VDM_Identity_Request
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	PD	0x98 = PESTATE_SRC2PLUG_VDM_Identity_NAKed
Port 0	PD	0x14 = PEState_Source_Startup_Continue
Port 0	PD	0x16 = PEState_Source_SendCapabilities
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	Protocol	0xc5 = PRState_RX_BUF_RDY
Port 0	PD	0xbf = PEState_ErrorRecovery
Port 0	PD	0x1 = PEState_CableTypeDetect
Port 0	INT	0x3 = PLUG_INSERT_OR_REMOVAL
Port 0	INT	0x19 = DATA_STATUS_UPDATE
Port 0	Type-C	0x5 = SRC_STATE_ERROR_RECOVERY
Port 0	VBUS	0xcc = VBUSState_MON_HILO
Port 0	VBUS	0x91 = VBUSState_MON_LO
Port 0	VBUS	0x90 = VBUSState_MON_HI
Port 0	Type-C	0x67 = COMMON_STATE_UNATTACHED_SRC
Port 0	Type-C	0x64 = COMMON_STATE_ATTACHWAIT_SRC
Port 0	Type-C	0x60 = COMMON_STATE_ATTACHED_SRC
Port 0	BC 1.2	0xd = CHARGER_DCP_ADVERTISEMENT_COMPLETE
Port 0	INT	0x19 = DATA_STATUS_UPDATE
Port 0	INT	0x3 = PLUG_INSERT_OR_REMOVAL
Port 0	PD	0x2 = PEState_LaunchPolicyEngine
Port 0	PD	0x2e = PEState_Enable_VCONN
Port 0	PD	0x2f = PEState_Enable_VBUS
Port 0	BC 1.2	0x4 = CHARGER_DETECTION_COMPLETE
Port 0	INT	0x19 = DATA_STATUS_UPDATE
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Port 0	**PD**	**0xbf = PEState_ErrorRecovery**
Port 0	PD	0x1 = PEState_CableTypeDetect
Port 0	INT	0x3 = PLUG_INSERT_OR_REMOVAL
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Port 0	Protocol	0xc8 = PRState_TXDONE
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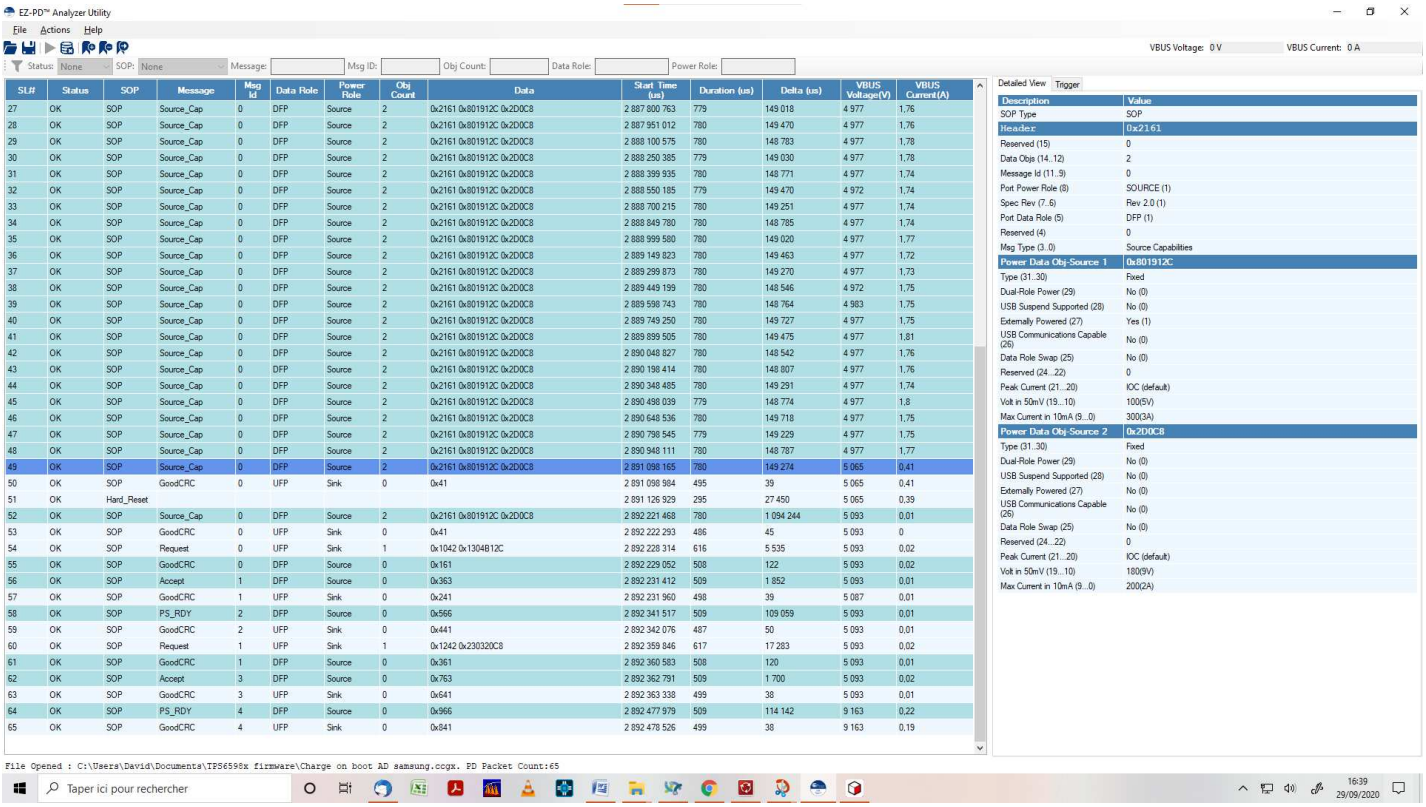
Port 0	Protocol	0xc8 = PRState_TXDONE
Port 0	PD	0x98 = PESTATE_SRC2PLUG_VDM_Identity_NAKed
Port 1	Module 31	0x114 = UNKNOWN

4.2 Test when we plug to USC-C adapter charger

We are using a UCB-C analyser between the A50 and the the adapter USB-C charger

The A50 is in switch off state with no battery.

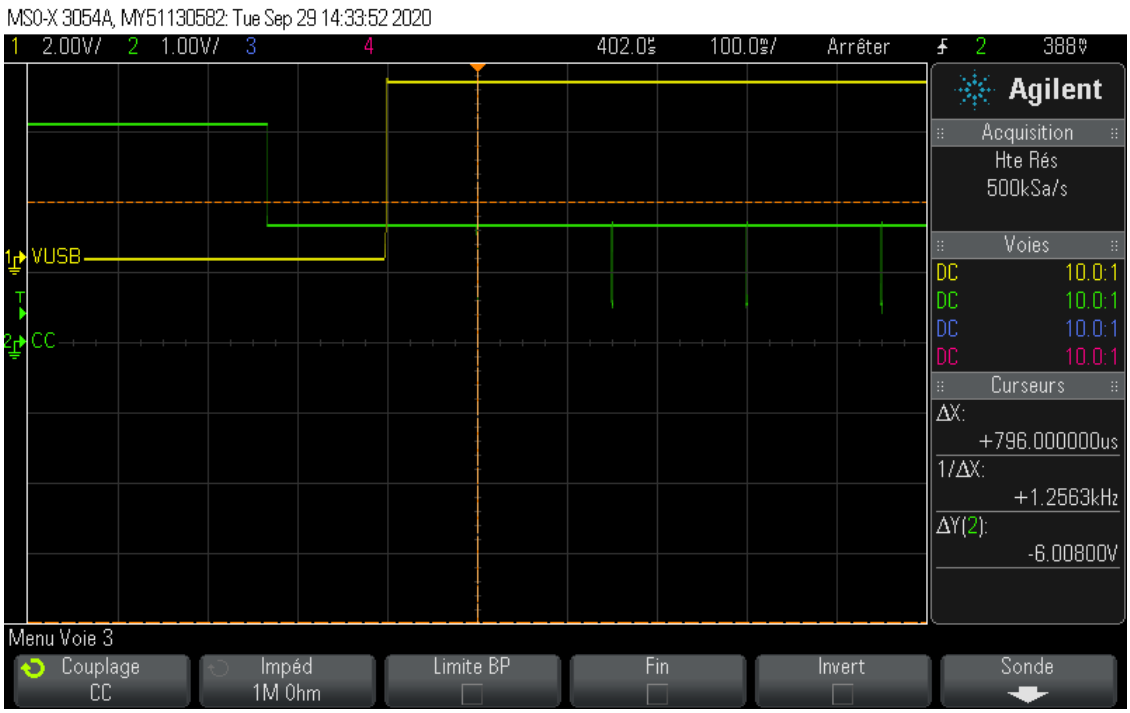
The UCB-C protocol



St.#	Status	SOP	Message	Msg Id	Data Role	Power Role	Obj Count	Data	Start Time (us)	Duration (us)	Delta (us)	VBUS Voltage(V)	VBUS Current(A)
27	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 887 800 763	779	149 018	4 977	1,76
28	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 887 951 012	780	149 470	4 977	1,76
29	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 100 575	780	148 783	4 977	1,78
30	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 250 385	779	149 030	4 977	1,78
31	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 399 935	780	148 771	4 977	1,74
32	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 550 185	779	149 470	4 972	1,74
33	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 700 215	780	149 251	4 977	1,74
34	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 849 780	780	148 785	4 977	1,74
35	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 888 999 580	780	149 020	4 977	1,77
36	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 889 149 823	780	149 463	4 977	1,72
37	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 889 299 873	780	149 270	4 977	1,73
38	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 889 449 199	780	148 546	4 972	1,75
39	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 889 598 743	780	148 764	4 983	1,75
40	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 889 749 250	780	149 727	4 977	1,75
41	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 889 899 505	780	149 475	4 977	1,81
42	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 048 827	780	148 542	4 977	1,76
43	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 198 414	780	148 807	4 977	1,76
44	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 348 485	780	149 291	4 977	1,74
45	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 498 039	779	148 774	4 977	1,8
46	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 648 536	780	149 718	4 977	1,75
47	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 798 545	779	149 229	4 977	1,75
48	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 890 948 111	780	148 787	4 977	1,77
49	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 891 098 165	780	149 274	5 065	0,41
50	OK	SOP	GoodCRC	0	UFP	Sink	0	0x41	2 891 098 984	495	39	5 065	0,41
51	OK	Hard_Reset							2 891 126 929	295	27 450	5 065	0,39
52	OK	SOP	Source_Cap	0	DFP	Source	2	0x2161 0x801912C 0x2D0C8	2 892 221 468	780	1 094 244	5 093	0,01
53	OK	SOP	GoodCRC	0	UFP	Sink	0	0x41	2 892 222 293	486	45	5 093	0
54	OK	SOP	Request	0	UFP	Sink	1	0x1042 0x1304B12C	2 892 228 314	616	5 535	5 093	0,02
55	OK	SOP	GoodCRC	0	DFP	Source	0	0x161	2 892 229 052	508	122	5 093	0,02
56	OK	SOP	Accept	1	DFP	Source	0	0x363	2 892 231 412	509	1 852	5 093	0,01
57	OK	SOP	GoodCRC	1	UFP	Sink	0	0x241	2 892 231 960	498	39	5 087	0,01
58	OK	SOP	PS_RDY	2	DFP	Source	0	0x566	2 892 341 517	509	109 059	5 093	0,01
59	OK	SOP	GoodCRC	2	UFP	Sink	0	0x441	2 892 342 076	487	50	5 093	0,01
60	OK	SOP	Request	1	UFP	Sink	1	0x1242 0x230320C8	2 892 359 846	617	17 283	5 093	0,02
61	OK	SOP	GoodCRC	1	DFP	Source	0	0x361	2 892 360 583	508	120	5 093	0,01
62	OK	SOP	Accept	3	DFP	Source	0	0x763	2 892 362 791	509	1 700	5 093	0,02
63	OK	SOP	GoodCRC	3	UFP	Sink	0	0x641	2 892 363 338	499	38	5 093	0,01
64	OK	SOP	PS_RDY	4	DFP	Source	0	0x966	2 892 477 979	509	114 142	9 163	0,22
65	OK	SOP	GoodCRC	4	UFP	Sink	0	0x841	2 892 478 526	499	38	9 163	0,19

Description	Value
SOP Type	SOP
Header	0x2161
Reserved (15)	0
Data Objs (14..12)	2
Message Id (11..9)	0
Port Power Role (8)	SOURCE (1)
Spec Rev (7..6)	Rev 2.0 (1)
Port Data Role (5)	DFP (1)
Reserved (4)	0
Msg Type (3..0)	Source Capabilities
Power Data Obj-Source 1	0x801912C
Type (31..30)	Fixed
Dual-Role Power (29)	No (0)
USB Suspend Supported (28)	No (0)
Externally Powered (27)	Yes (1)
USB Communications Capable (26)	No (0)
Data Role Swap (25)	No (0)
Reserved (24..22)	0
Peak Current (21..20)	IOC (default)
Volt in 50mV (19..10)	100(5V)
Max Current in 10mA (9..0)	300(3A)
Power Data Obj-Source 2	0x2D0C8
Type (31..30)	Fixed
Dual-Role Power (29)	No (0)
USB Suspend Supported (28)	No (0)
Externally Powered (27)	No (0)
USB Communications Capable (26)	No (0)
Data Role Swap (25)	No (0)
Reserved (24..22)	0
Peak Current (21..20)	IOC (default)
Volt in 50mV (19..10)	180(9V)
Max Current in 10mA (9..0)	200(2A)

The Scope



5 Conclusion

The goal to resolve this problem is to make the PD have the same behaviour of the charging adapter . I think it is possible to do this .

Below my question :

I would like to understand what is the line ?

SL#	Status	SOP	Message	Msg Id	Data Role	Power Role	Obj Count	Data	Start Time (us)	Duration (us)	Delta (us)	VBUS Voltage(V)	VBUS Current(A)
1	OK	SOP_PRIME	VDM	0	Reserved	DFP/UFP	1	0x108F 0xFF008001	2 563 955	629	0	5 203	0,02
2	OK	SOP_PRIME	VDM	0	Reserved	DFP/UFP	1	0x108F 0xFF008001	2 565 598	630	1 014	5 203	0,01
3	OK	SOP_PRIME	VDM	0	Reserved	DFP/UFP	1	0x108F 0xFF008001	2 567 233	629	1 005	5 203	0

In the configuration program I set up 0 transmit identity Data object (0x47)

Why is the PD switching off the source path off the USB ?