CONFIDENTIAL B

GM3.0 Customized Setup Flow V1.4

201707

Revision History

Revision	Data	Author	Note
V1.0	11/22/2016	Zhangshuai	1st release
V1.1	01/17/2017	JH Huang/ Weiching Lin	GMAT Tool User Guide Update(Step2/3) Add verify flow
V1.2	03/22/2017	Zhangshuai	Add SP_META TOOL
V1.3	05/03/2017	Bo Jia	Add GM3.0 Software Patch Check List @p2/p3 Add SW setting check for calibration @p25
V1.4	07/21/2017	Bo Jia	Add critical patch ID for P25/X30 @ P2/3

GM3.0 Software Patch Check List

- Please make sure below patches has been integrated.

If not , please submit patch request.

Patch ID for P25 alps-mp-n0.mp5	Patch ID for P25 alps-mp-n1.mp5	Description
ALPS03119317	No need	• Fix nvram calibration issue
ALPS03158638	No need	• Fix NAFG vbat measurement issue
ALPS03248687	ALPS03258450	• Add method to disable NAFG by NTC • Fix issue: soc stay 99% or 100% when discharging
ALPS03253502		• Fix issue: nvram car_tune_value will be formatted after download only or firmware update • Fix issue: kpoc can not load nvram car_tune_value • Fix issue: After long press PWRKEY reset, the UISOC increase 1%
ALPS03245474		• Fix 3.4V low battery interrupt bug • Fix NTC voltage compensation issue
ALPS03287248	ALPS03285277	• Fix the wrong operation of low tracking: UISOC drop from 100% to 0% in several minutes.
ALPS03411143	ALPS03407776	• **[Critical Patch]** Fix the low probability issue: UISOC drop fast due to coulomb counter error in suspend mode

GM3.0 Software Patch Check List

- Please make sure below patches has been integrated.

If not , please submit patch request.

Patch ID for X30 alps-mp-n0.mp8	Description
ALPS03252445	• Add method to disable NAFG by NTC • Fix issue: soc stay 99% or 100% when discharging • Fix issue: nvram car_tune_value will be formatted after download only or firmware update • Fix issue: kpoc can not load nvram car_tune_value • Fix issue: After long press PWRKEY reset, the UISOC increase 1%
ALPS03250083	• Fix 3.4V low battery interrupt bug • Fix NTC voltage compensation issue • Fix the wrong operation of low tracking: UISOC drop from 100% to 0% in several minutes.
ALPS03417071	• **[Critical Patch]** Fix the low probability issue: UISOC drop fast due to coulomb counter error in suspend mode

Steps

1. CAR_TUNE_VALUE calibration in lab
2. Modify parameter value with GMAT_Tool
   - Generate battery_prop_ext.dtsi
3. Import ZCV table with GMAT_Tool
   - Generate battery_table_ext.dtsi
4. Optional :Rfg auto calibration in factory with Multi ATE_Tool
   - Optional :NVRAM CAR_TUNE_VALUE modify in META Mode

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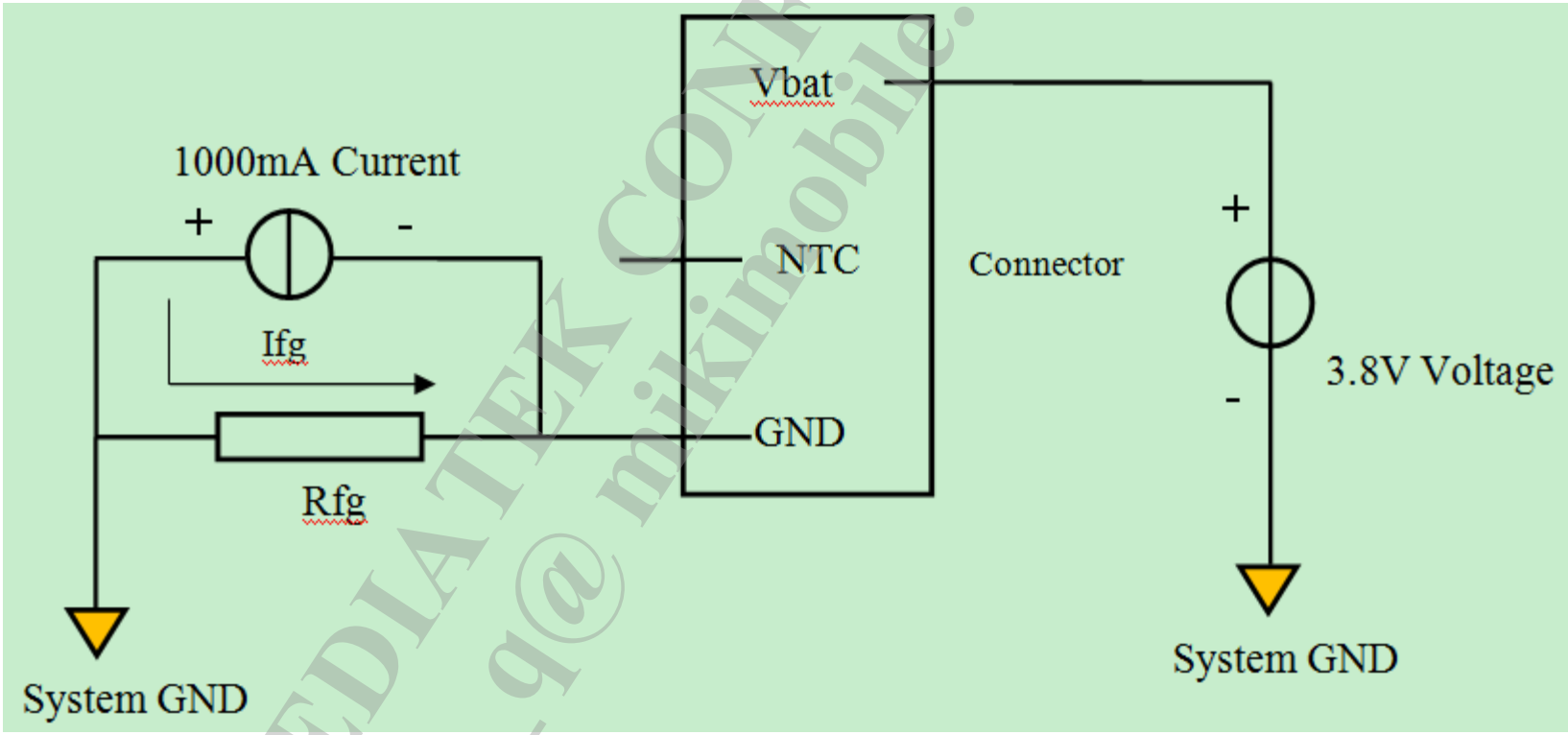
CAR_TUNE_VALUE calibration in Lab

CAR_TUNE_VALUE Calibration in Lab

- HW Fuel gauge must calibrate the Rfg accuracy-CAR_TUNE_VALUE calibration
- HW Fuel gauge design note：
  - Rfg 1% must place as close as Vbat connector;
  - CS_P/CS_N layout in Kelvin-sense way and differential pair;
  - Need NTC to sense Vbat temperature;
  - BATSNS must close to Vbat connector.

CAR_TUNE_VALUE Calibration in Lab

- Diagram without Battery(NTC needs)



CAR_TUNE_VALUE Calibration in Lab

- Step 1: #define CAR_TUNE_VALUE 100， build temp load for test ;
- Step 2: Provide V1 between VBAT and System GND for system boot up ;
- Step 3: Provide constant current I1 between System GND and negative of battery connector, don’t solder wire at both ends of Rfg ;
  - Please confirm the value of I1 with current meter

CAR_TUNE_VALUE Calibration in Lab

- Step 4: Set the value of I1 = 1000mA ,enter EngineerMode
  -> Hardware Testing -> Power -> Charge Battery -> FG_Battery , getting Ifg of FGADC (average value b),Using a formula：
  CAR_TUNE_VALUE = 1000/b*100;
- Step 5: Modify CAR_TUNE_VALUE in code and build temp load

❖ Suggested to increase the number of test samples for MP Project to ensure the consistency.

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Modify Parameter Value with GMAT_Tool Generate battery_prop_ext.dtsi

Modify Parameter Value with GMAT_Tool

- GMAT_Tool is used to customize GM3.0 algorithm to achieve the best performance and user experience. The details of parameter customization can refer to "GM3.0_Customization parameter design guide" document on DCC.
- Input file: CFG_GM30_dtsi_prop_ext.txt, this file can be got from the GMAT_Tool folder.
- dtsi_prop_ext.txt includes many customized parameters.
- If necessary, you can modify the export path of "battery_prop_ext.dtsi " in dtsi_prop_ext.txt.

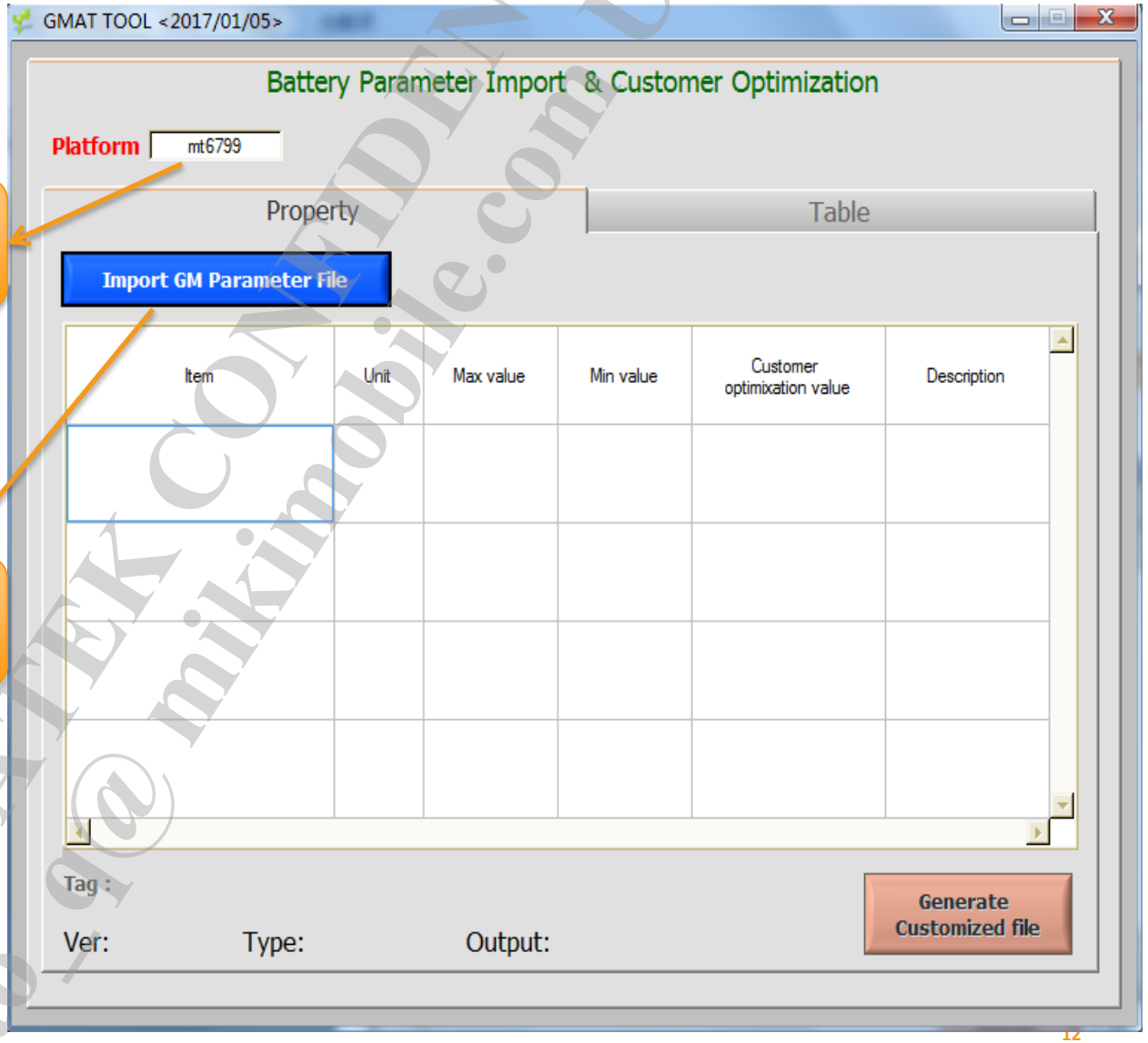
CFG_GM30_dtsi_prop_ext.txt

```
1  ==========================================
2  /* Init setting */
3  ==========================================
4  <Ver>
5  K99_v1.0;property;dtsi
6  </Ver>
7
8  <export_file>
9  C:\<platform>_battery_prop_ext.dtsi
10 </export_file>
11
```

Select Property Setting File

(1)Input platform name

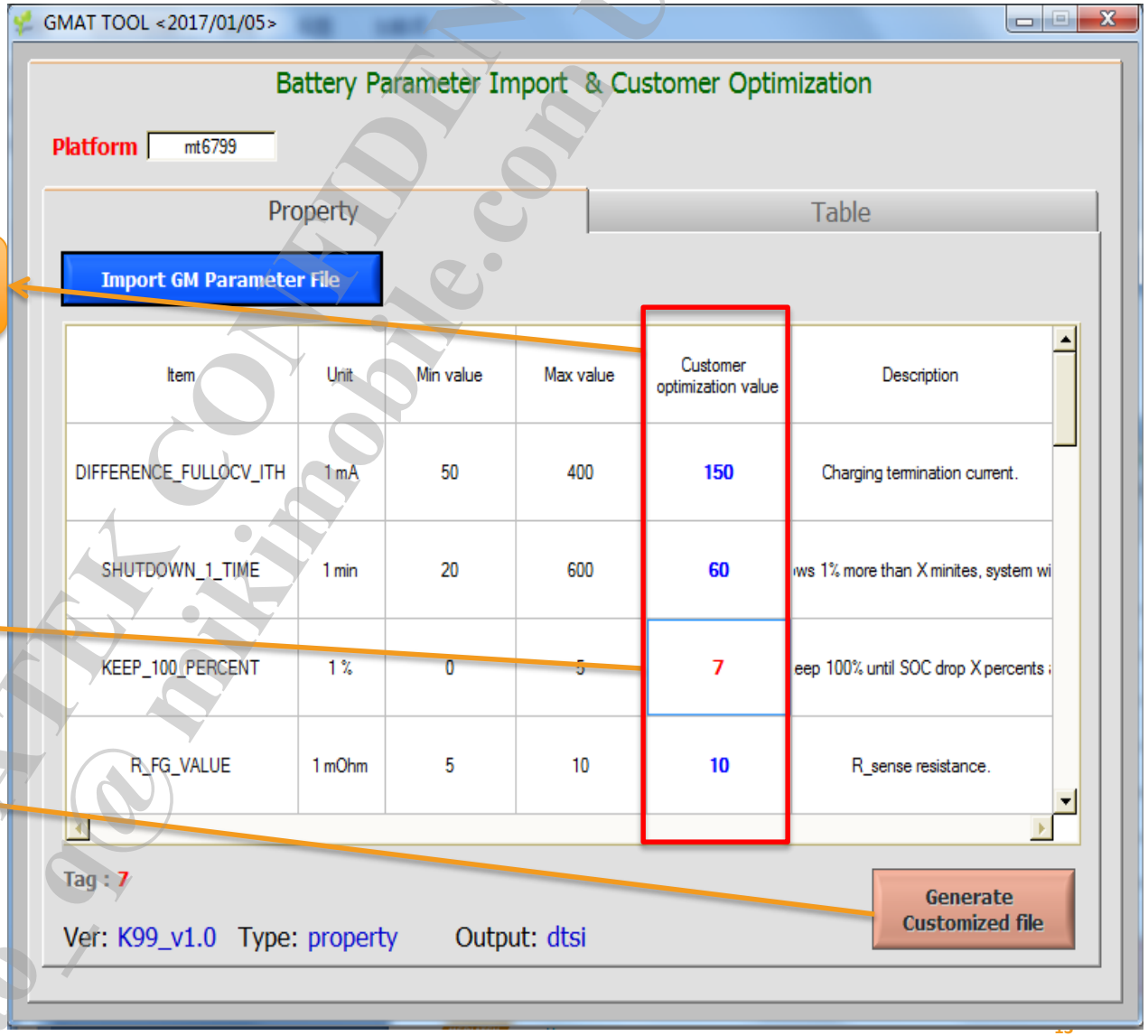
(2)Select CFG_GM30_dtsi_prop_ext.txt



Modify Parameter Value

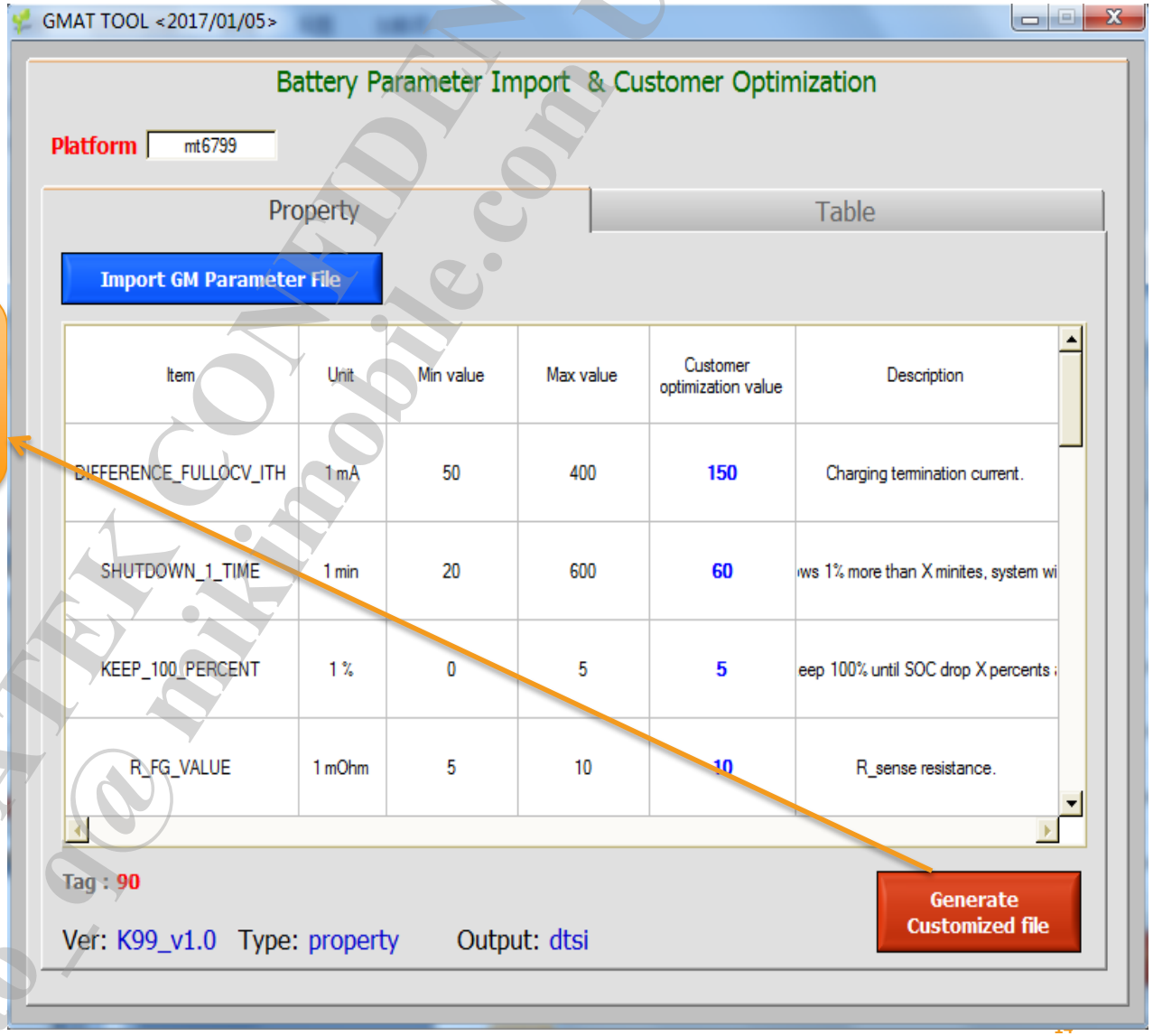
(3)Modify parameter here

a. The number will turn red if it's out of range.
b. The generation button will turn pink and cannot be pressed.

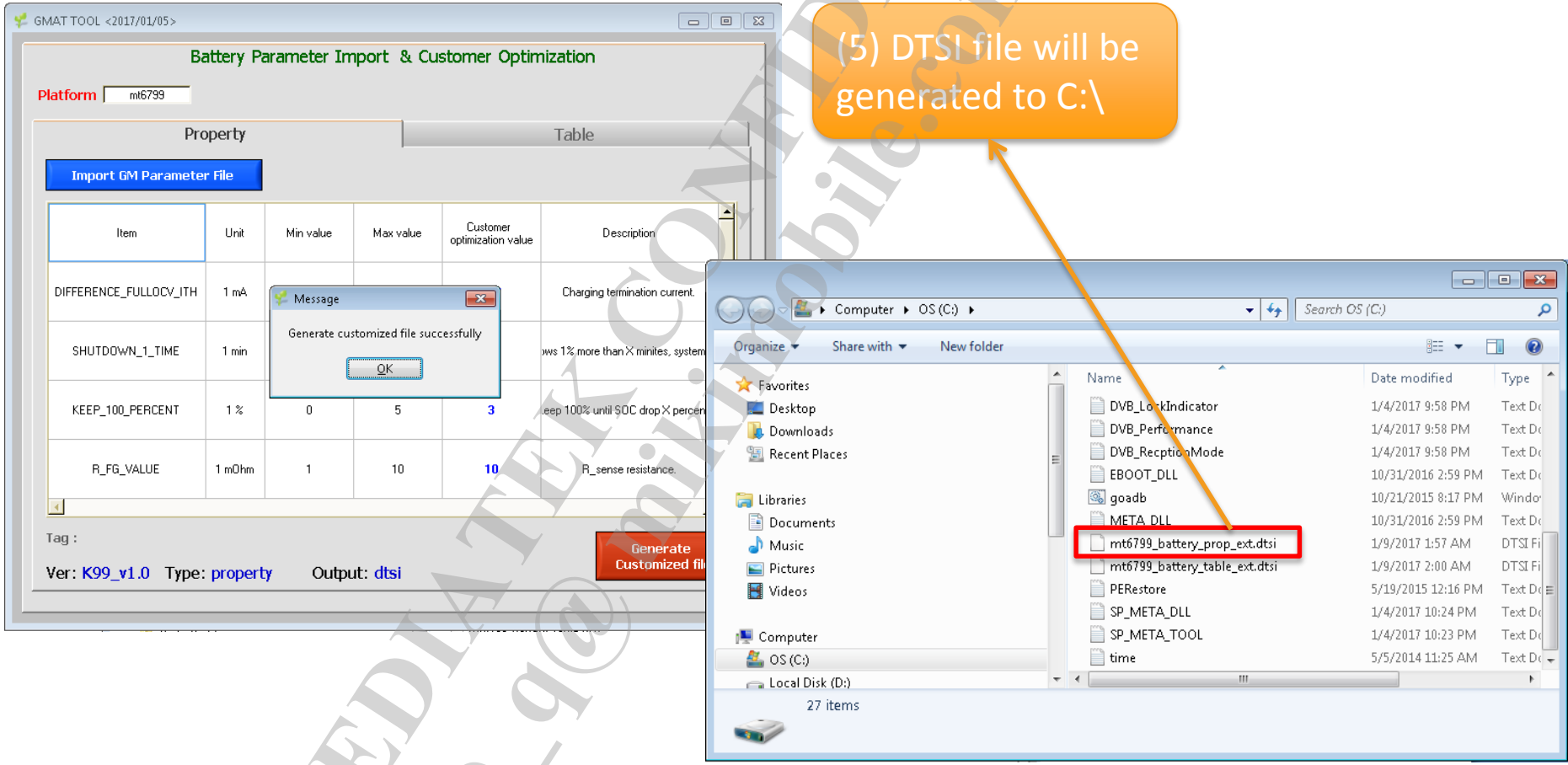


Generate battery_prop_ext.dtsi

(4) Press this button to generate battery_prop_ext.dtsi file.



Generate battery_prop_ext.dtsi



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Import ZCV Table with GMAT_Tool Generate battery_table_ext.dtsi

Import ZCV Table with GMAT_Tool

- Input file: CFG_GM30_dtsi_table_ext.txt and battery ZCV table.xlsx, CFG_GM30_dtsi_table_ext.txt can be got from the GMAT_Tool folder.
- If necessary, you can modify the export path of “battery_table_ext.dtsi ” in dtsi_table_ext.txt.
- Battery ZCV table is different from before, you can get the template from DCC.

CFG_GM30_dtsi_table_ext.txt

```
1  ==========================================
2  /* Init setting */
3  ==========================================
4  <Ver>
5  K99_v1.0;table;dtsi
6  </Ver>
7
8  <export_file>
9  C:\<platform>_battery_table_ext.dtsi
10 </export_file>
11
```

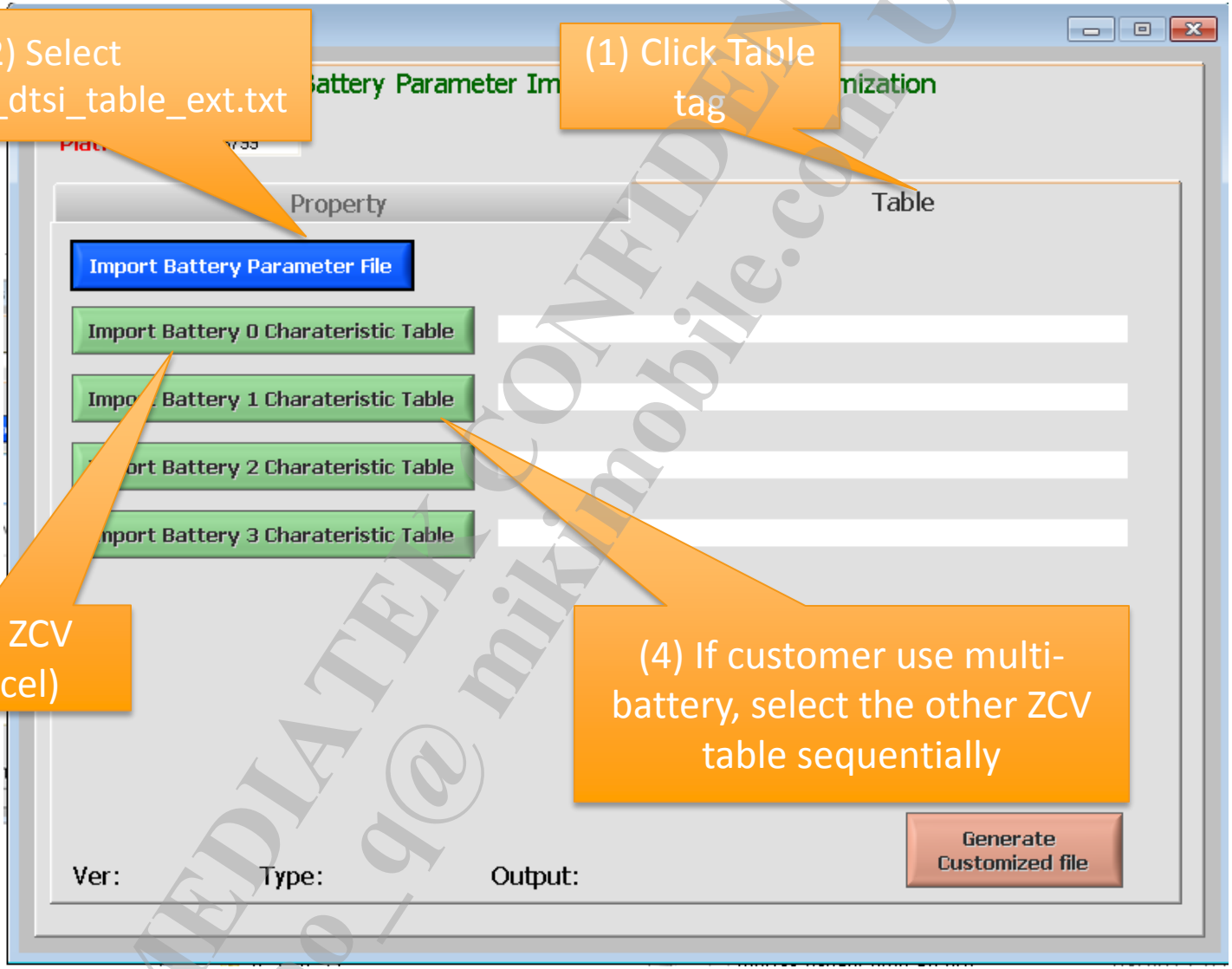
Import ZCV Table with GMAT_Tool

a. Battery ZCV table is different from before.
b. Each column ends with an “end”.
c. Temp ranged from high to low . Default Temp :50/25/10/0/-10℃

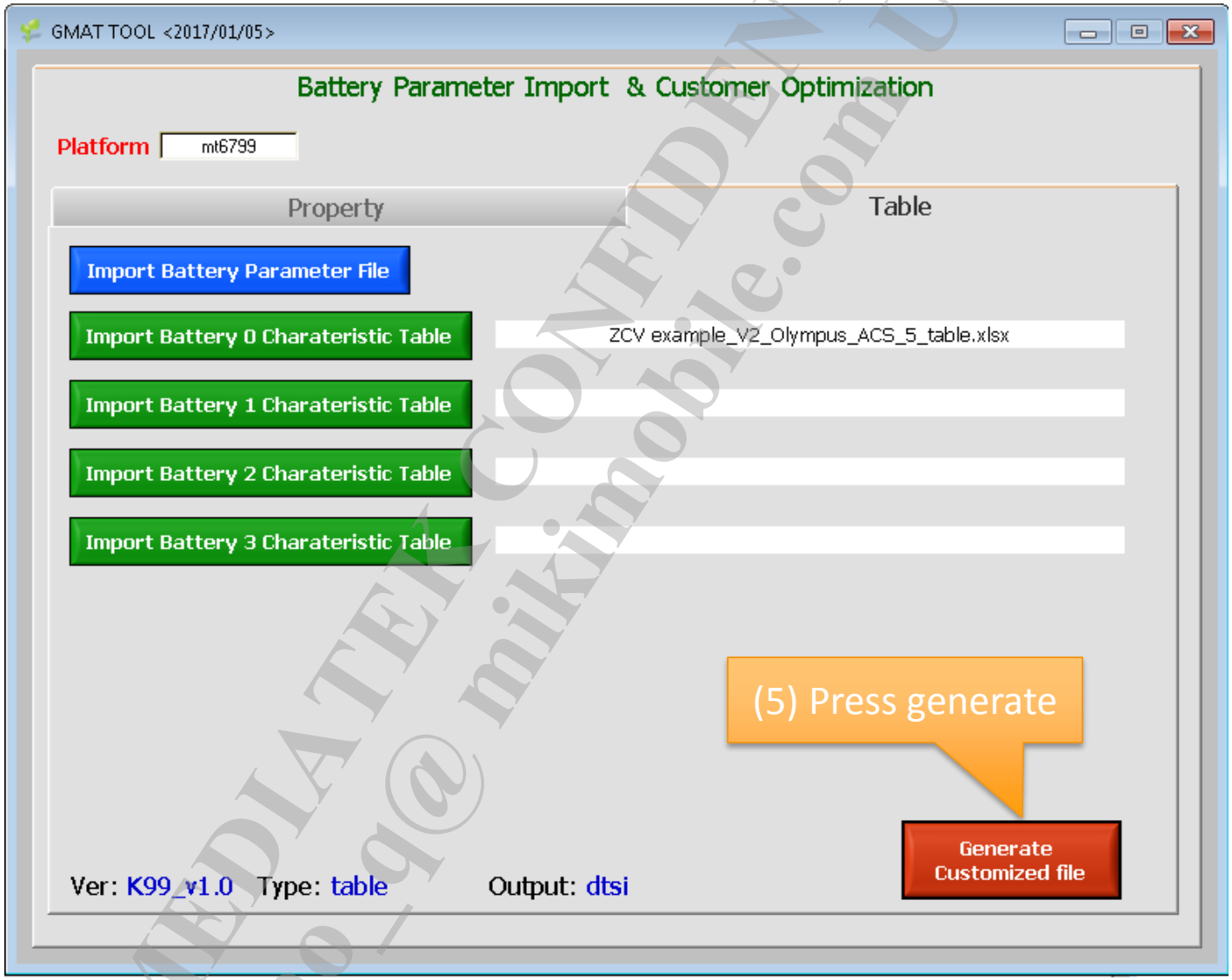
	Qmax	measure Current	OCV	VC	mAh	R	DOD
2	2970	400	4337		0	115	0
3		400	4308	4262	50	115	2
4		400	4287	4241	100	115	3
5		400	4266	4221	150	113	5
6		400	4248	4202	200	115	7
7		400	4229	4181	250	120	8
8		400	4210	4163	300	118	10
9		400	4192	4144	350	120	12
10		400	4174	4126	400	120	13
11		400	4157	4108	450	123	15
12		400	4139	4091	500	120	17
13		400	4122	4072	550	125	19
14		400	4106	4055	600	128	20
15		400	4089	4038	650	128	22
16		400	4074	4019	700	138	24
17		400	4059	4001	750	145	25
18		end	end	end	end	end	end
19							
20							
21							
22							
23							

Temp_50d | Temp_25d | Temp_10d | Temp_0d | Temp_n10d

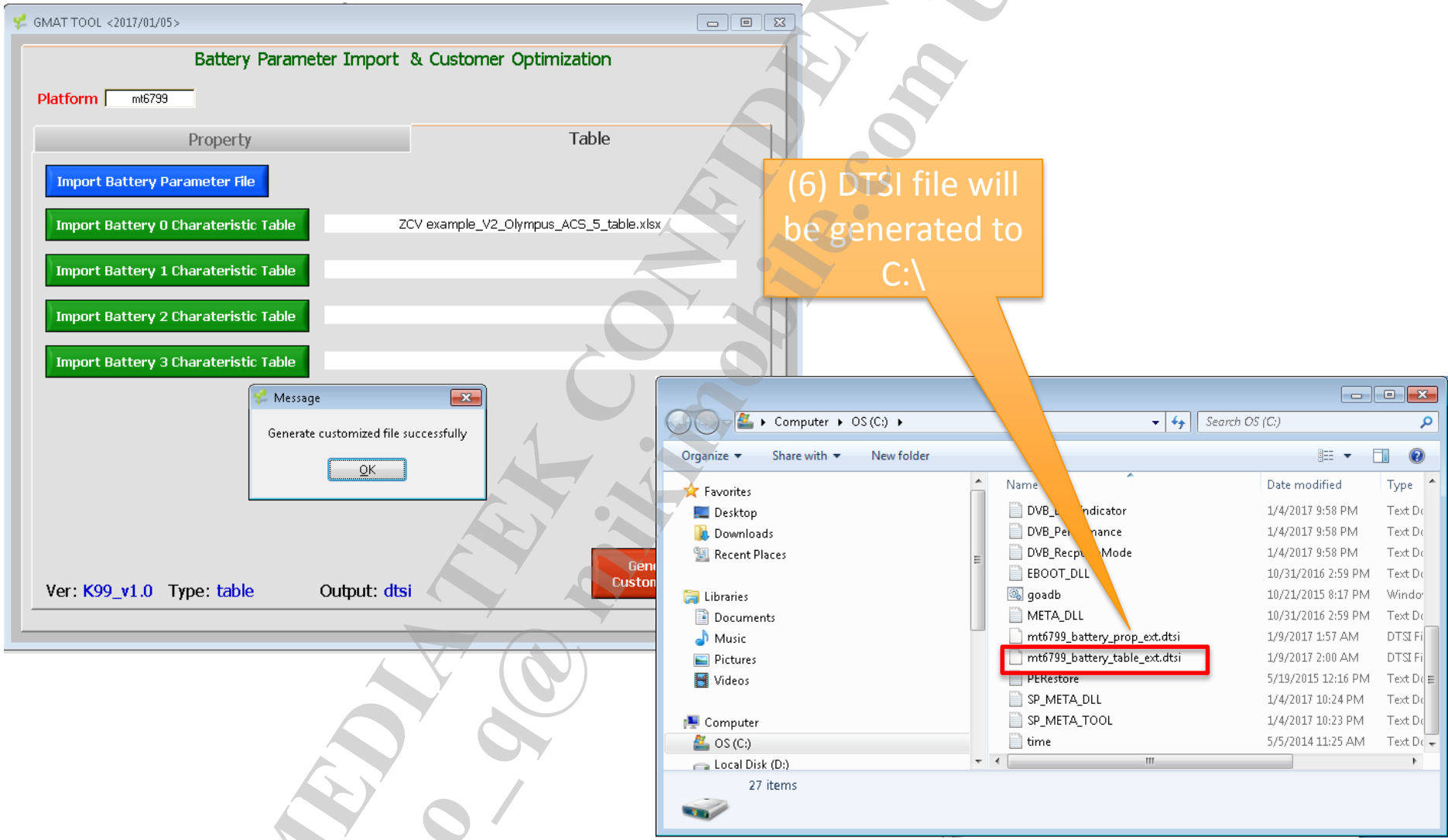
Import ZCV Table with GMAT_Tool



Generate battery_table_ext.dtsi

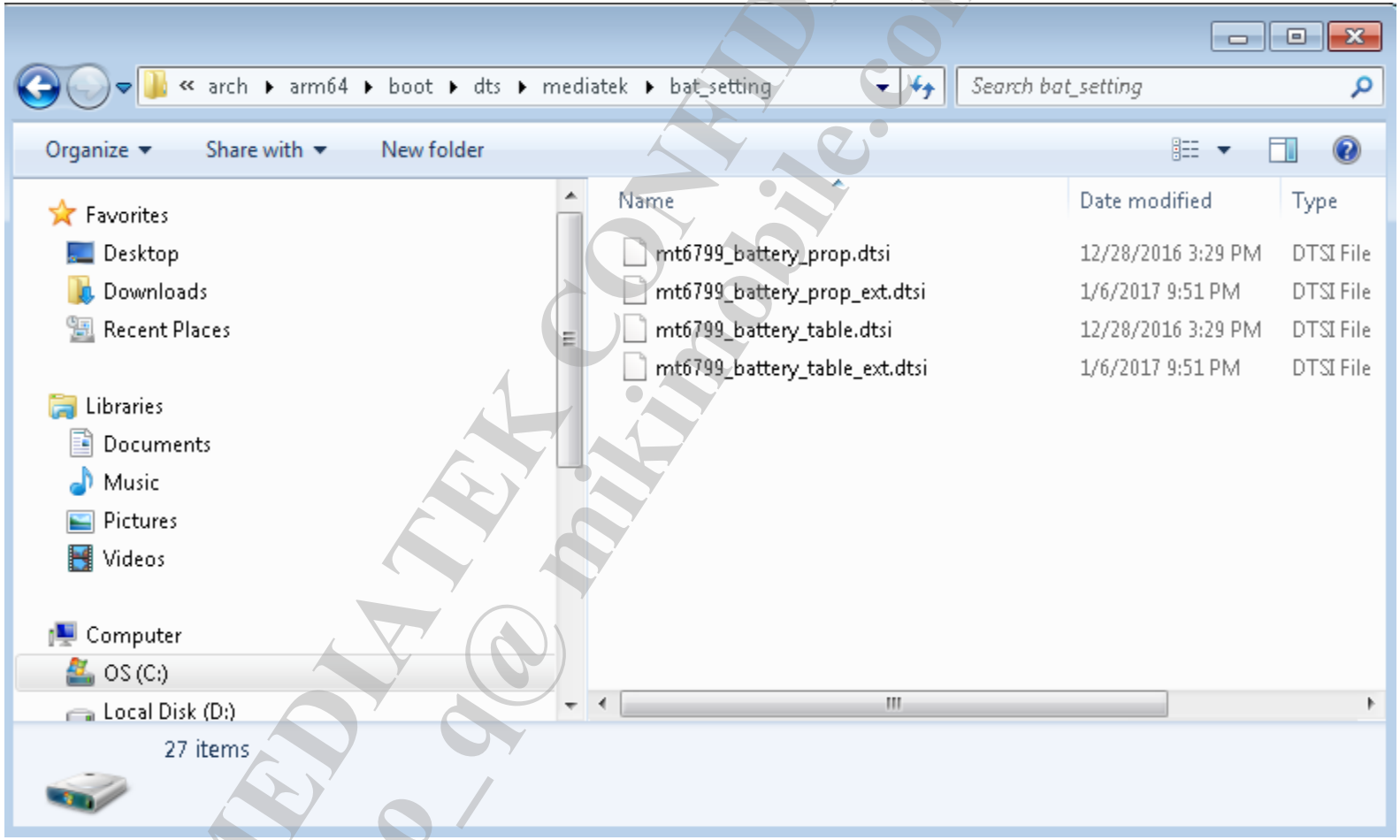


Generate battery_table_ext.dtsi



Replace the DTSI file

Path: kernel-4.4\arch\arm64\boot\dts\mediatek\bat_setting\



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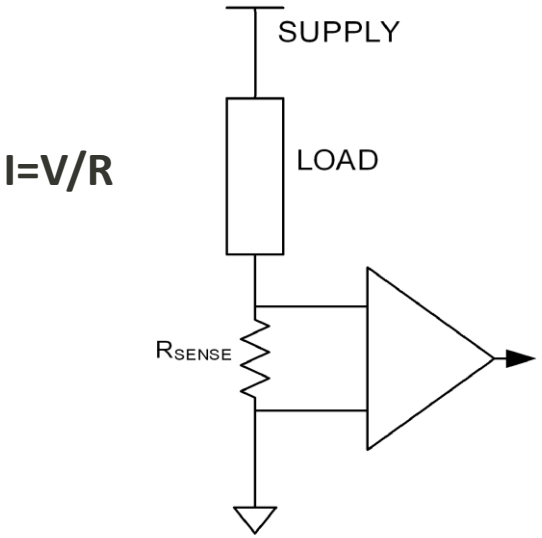
Optional :Rfg Auto Calibration in Factory with Multi ATE_Tool

Optional :NVRAM CAR_TUNE_VALUE Modify in META Mode

Rfg Auto Calibration in Factory with Multi ATE_Tool

- The Auto Calibration can achieve the accuracy of 1%, if no calibration accuracy will be 3%.
- Board Offset (variation of resistance from current sensing resistor and PCB) will introduce error into the measuring result directly.
- Calibrating every device is definitely beneficial to the accuracy of measurement.



Preparation for Calibration

- Equipment Request
  - Current source (Agilent E3631A is recommended)
  - Power source (to provide VBAT)
  - Current meter (Accuracy<0.1%, Keithley 2700 is recommended)
  - Test fixture (to inject current into PCBA)
  - Windows PC (to run the calibration tool)

- SW Setting Check
  - The macro "CALIBRATE_CAR_TUNE_VALUE_BY_META_TOOL" should be defined in "Kernel_4.4/drivers/misc/mediatek/include/mt-plat/mt6757/include/mach/mtk_battery_property.h" for calibration.
  - If no definition, please modify it as below:

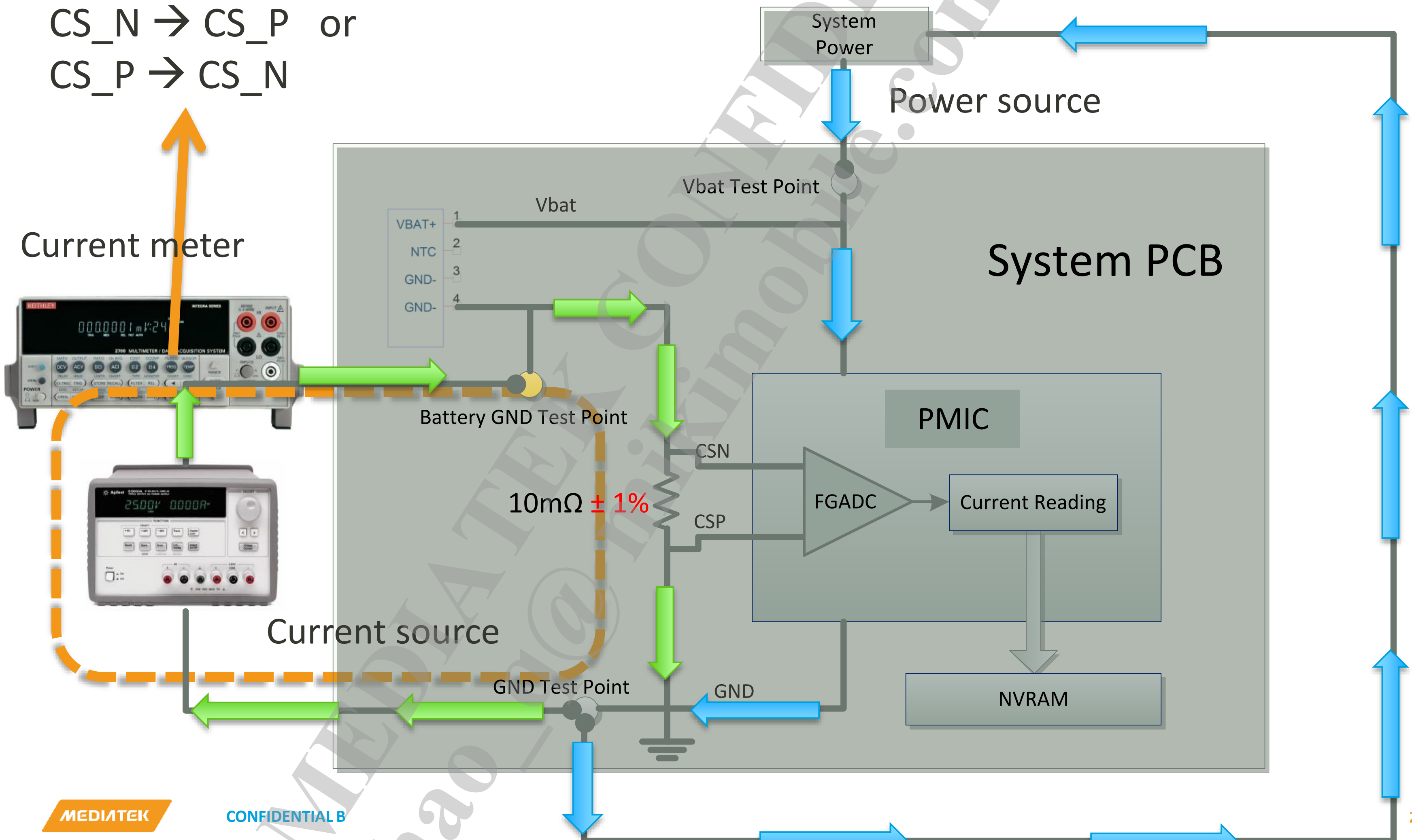
```
/* PCB setting */
#define CALIBRATE_CAR_TUNE_VALUE_BY_META_TOOL
#define CALI_CAR_TUNE_AVG_NUM   60
```

Rfg Auto Calibration in Factory with Multi ATE_Tool

Direction of current can be:

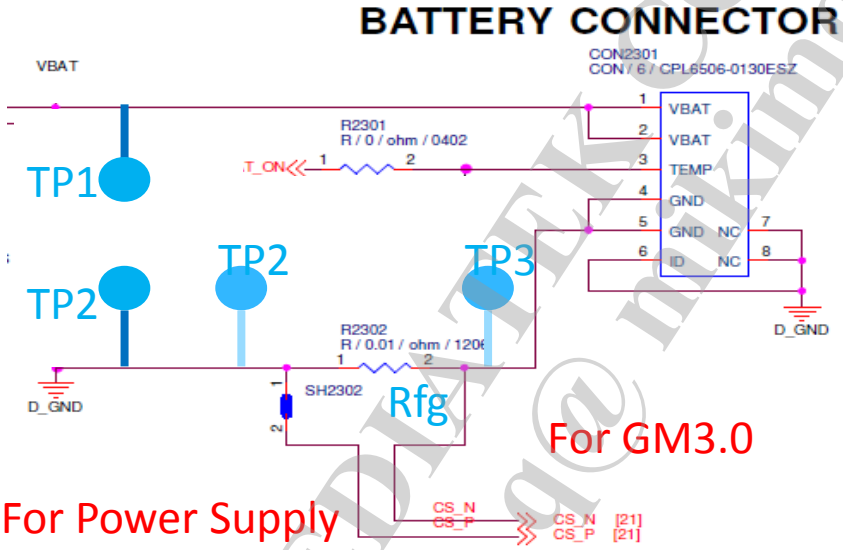
CS_N → CS_P or

CS_P → CS_N



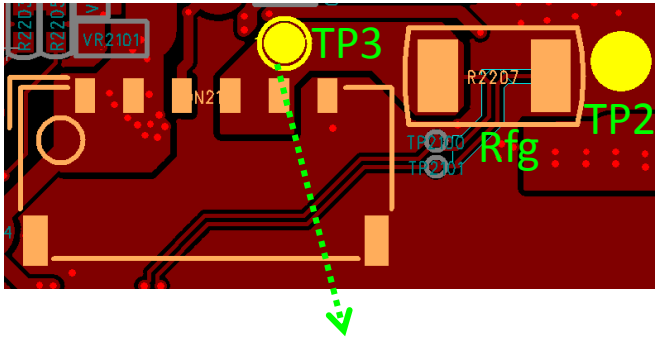
SCH & PCB Design Notice

- **TP1 & TP2** for system power supply
  - The test point should on the main trace, as it is used for power input point.
- **TP2 & TP3** for GM3.0 calibration
  - The test point should on the main trace， or the width of trace to test point should not less than 40 mil as the current would be 1000mA
  - The test point DO NOT draw from the trace of CS_N &CS_P



For Power Supply

For GM3.0



The TP3 is on the trace between CS_N Pad to Battery GND

Rfg Auto Calibration in Factory with Multi ATE_Tool

- Step 1: Place PCBA in the test fixture.
- Step 2: Connect the voltage source and current source to the test fixture
  - The voltage source is suggested to be 3.8V and current source 1000mA. (Double check the values by voltage and current meter)
- Step 3: Open the calibration tool Multi ATE_Tool and set up as below. (Tool version: MultiATE v6.1704.00 and later)
  - Install visa503full.exe before installing Multi ATE_Tool since your computer may lack a variety of .dll files.
  - The initial file ”tool.ini” must set as this

```
[GM Calibration]
Is GM Calibration = 1
GM Current Value = 1000
Max Value = 1500
Min Value = 500
```

Rfg Auto Calibration in Factory with Multi ATE_Tool

1.Open Multi ATE.exe

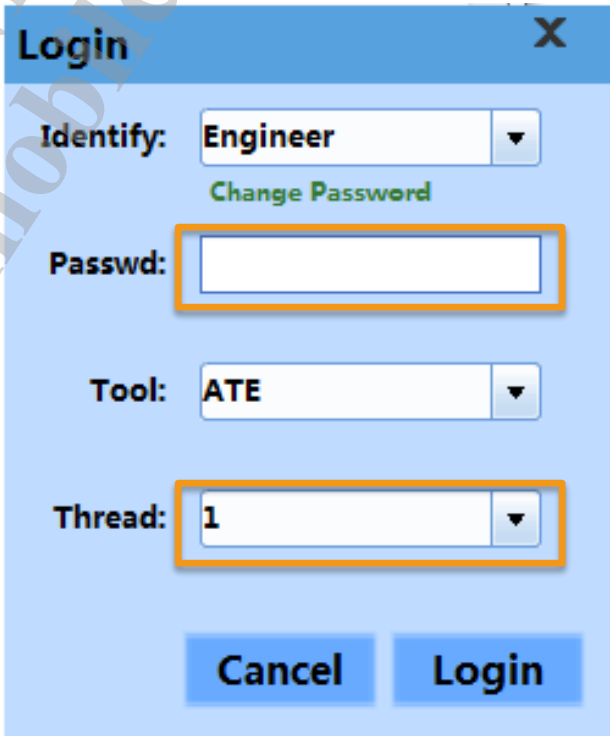
Identify : Engineer

Passwd:1234

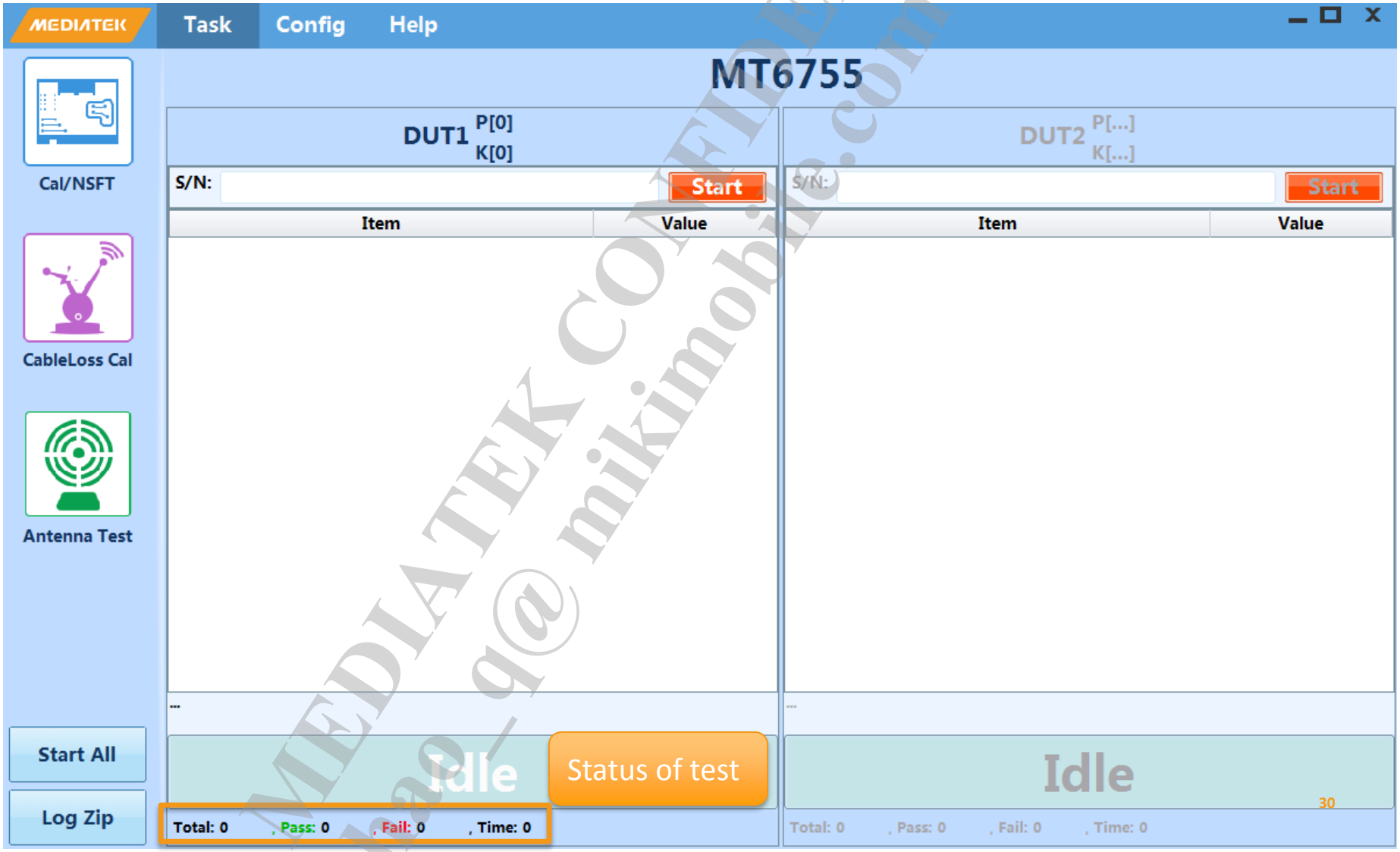
Tool :ATE

Thread: numbers of test

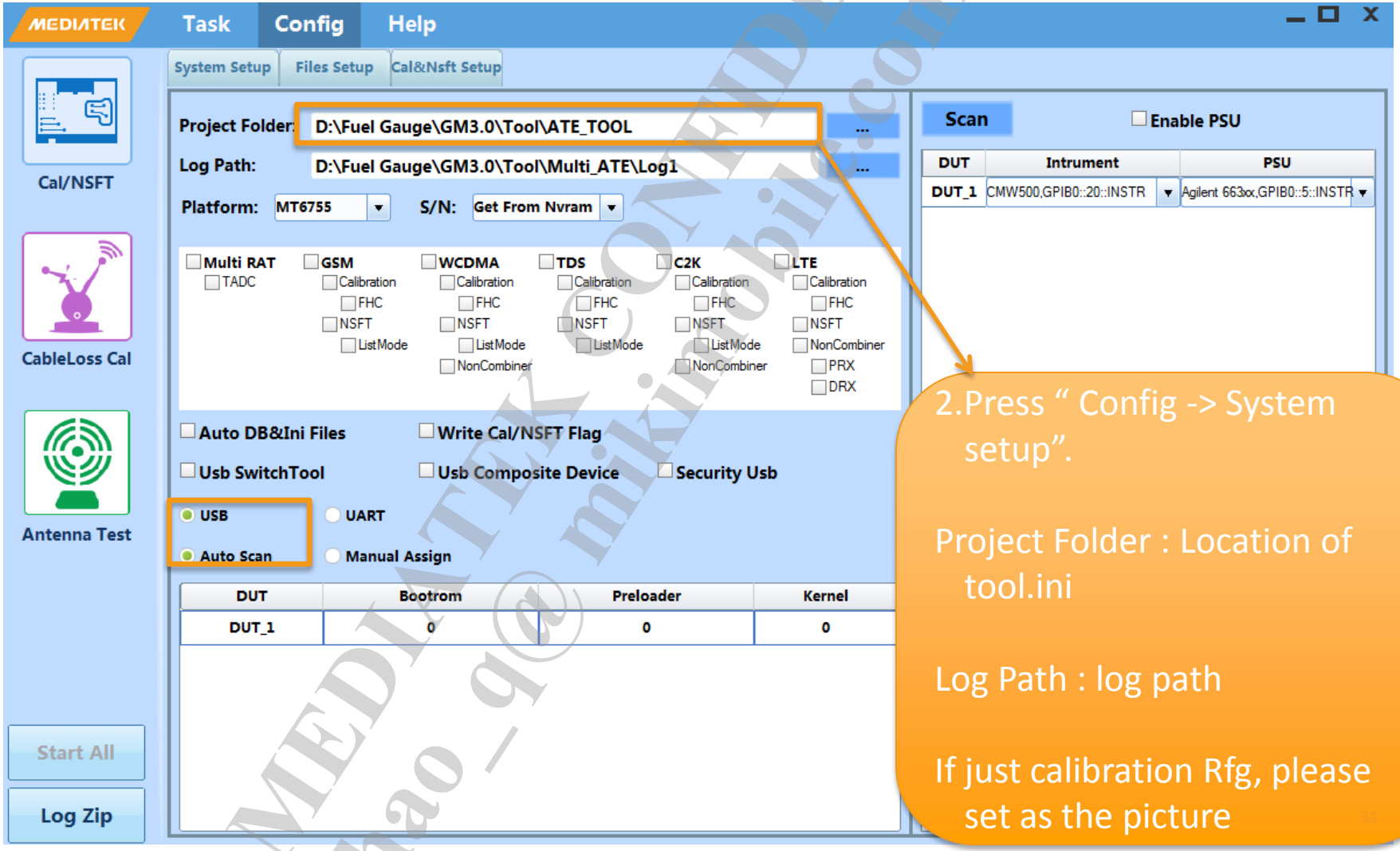
Then Login



Rfg Auto Calibration in Factory with Multi ATE_Tool



Rfg Auto Calibration in Factory with Multi ATE_Tool



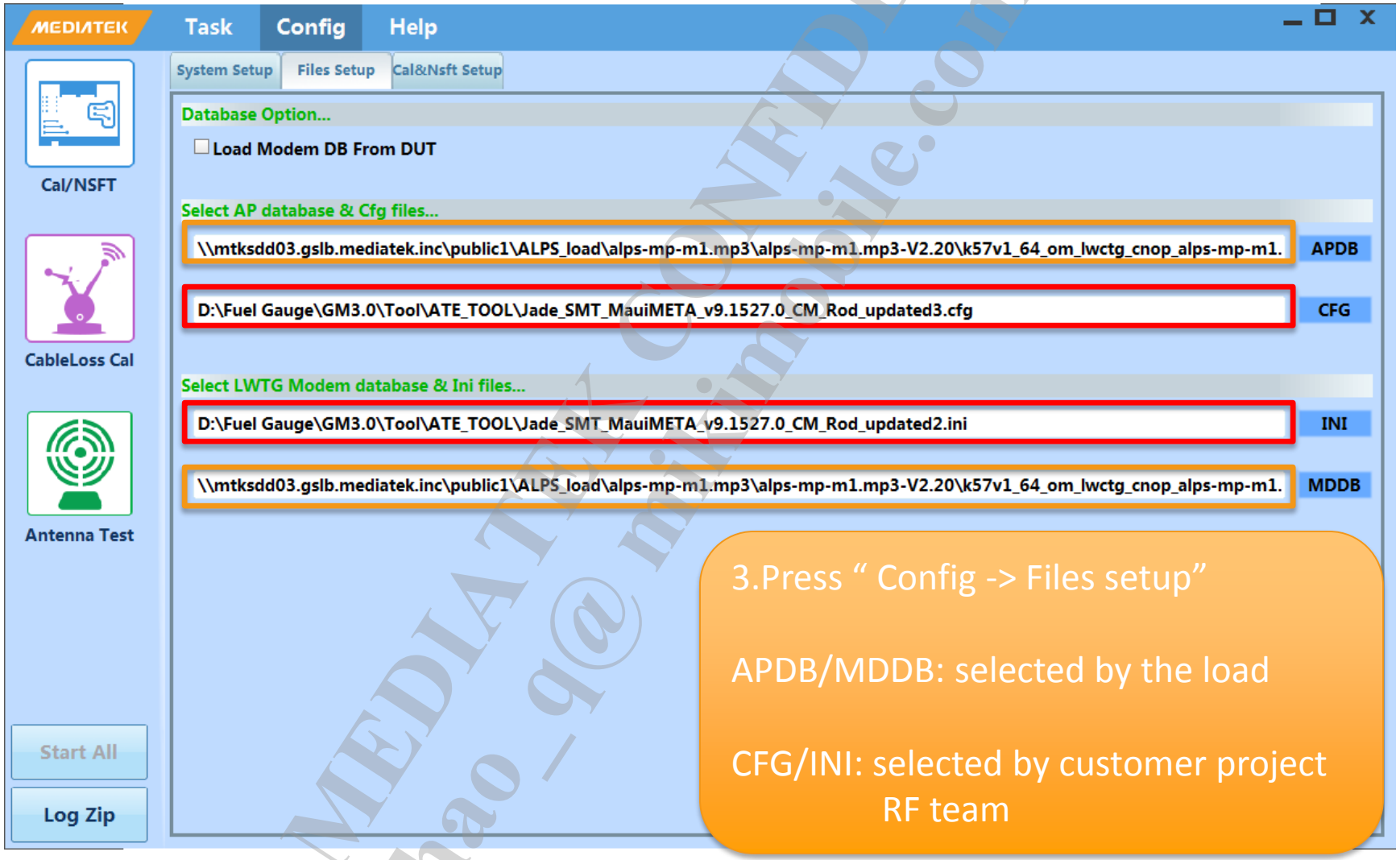
2.Press " Config -> System setup".

Project Folder : Location of tool.ini

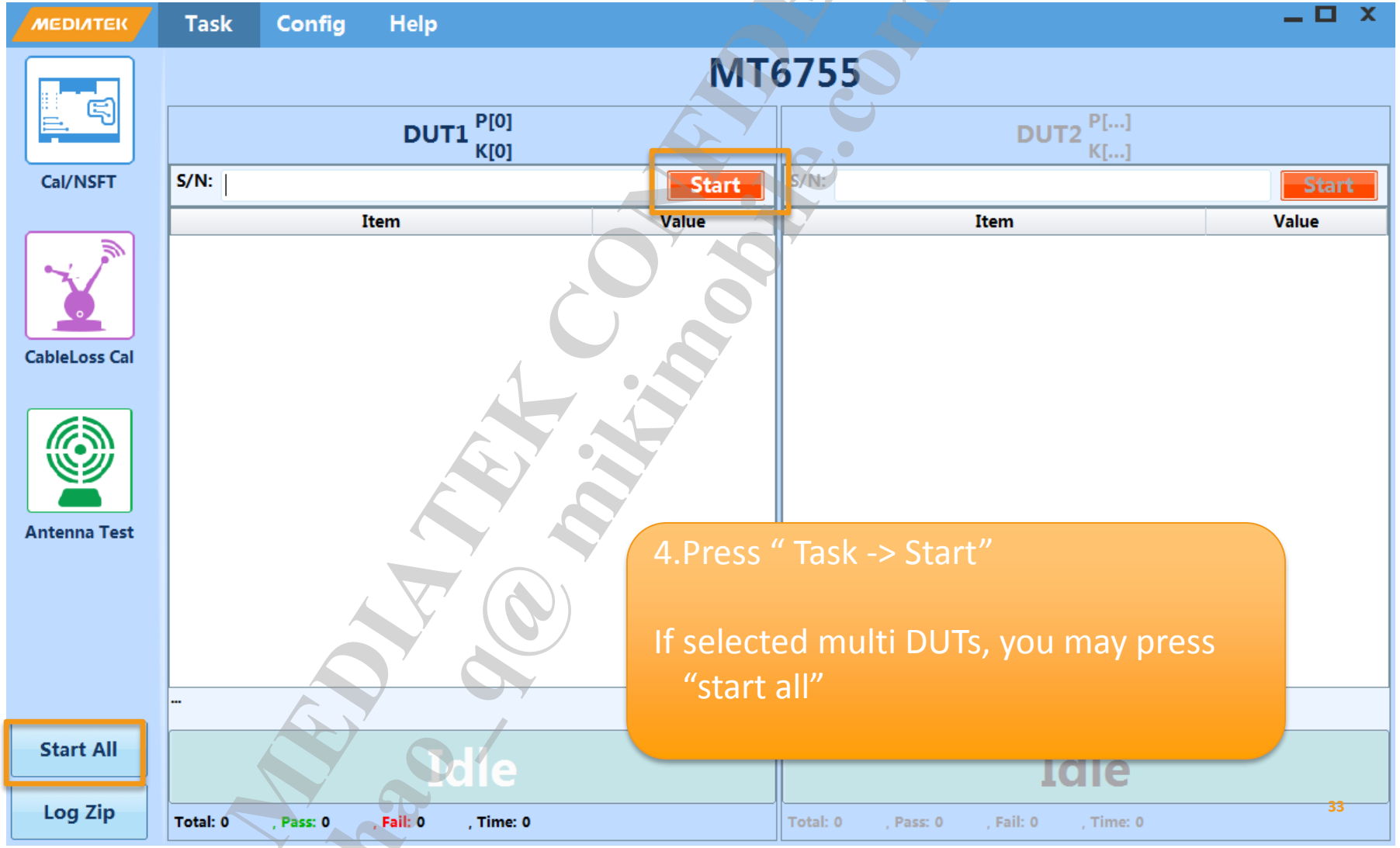
Log Path : log path

If just calibration Rfg, please set as the picture

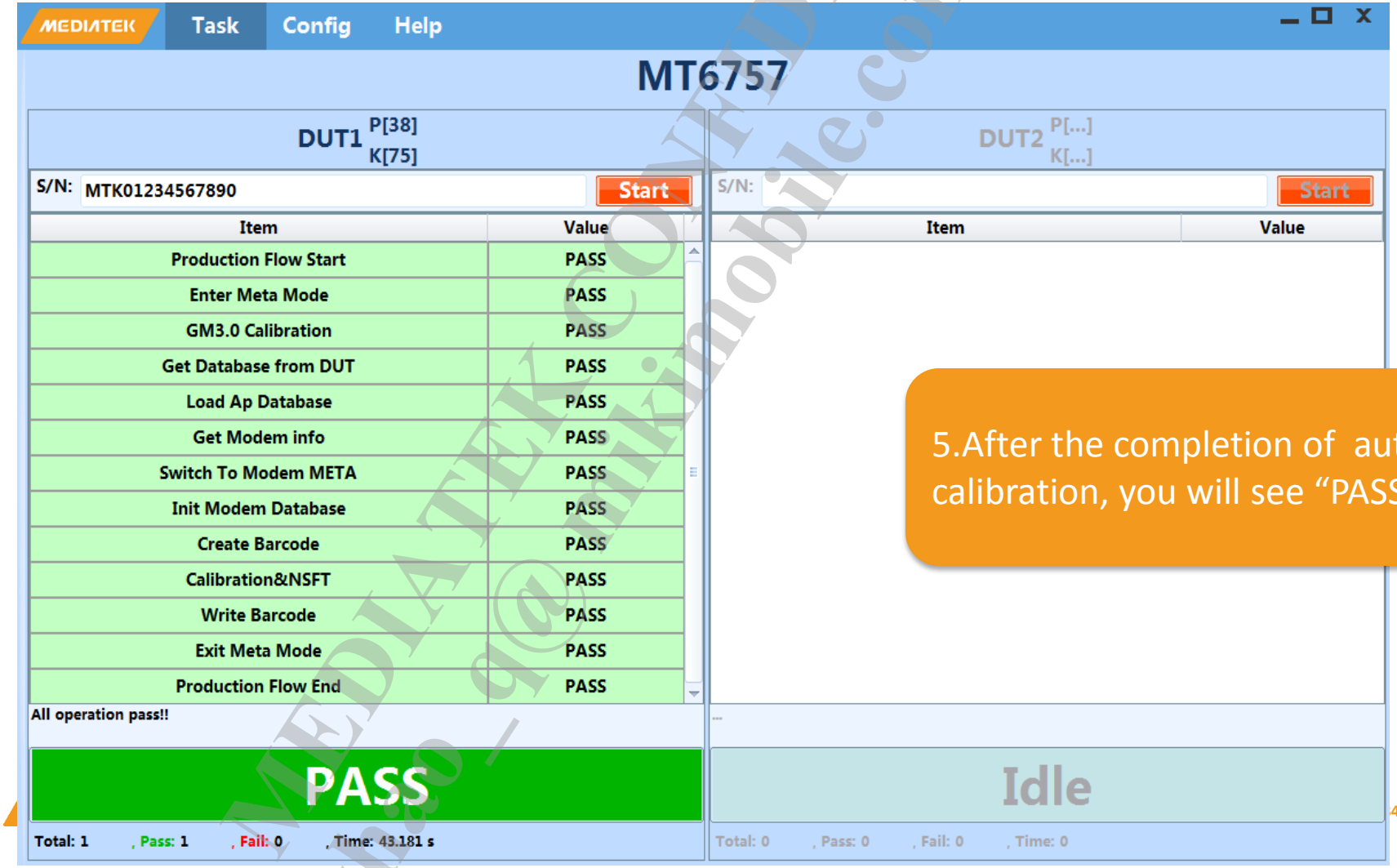
Rfg Auto Calibration in Factory with Multi ATE_Tool



Rfg Auto Calibration in Factory with Multi ATE_Tool



Rfg Auto Calibration in Factory with Multi ATE_Tool



5.After the completion of auto calibration, you will see “PASS”.

Rfg Auto Calibration in Factory with Multi ATE_Tool

- Step 4: After auto calibration, “Car_Tune_Value” will be kept in NVRAM.

Calibration log:

```
SetAdcCarTune() : Set ADC car tune value... (MtkSpMeta_Base.cpp:574)
SetAdcCarTune() : Set ADC car tune value successful. (MtkSpMeta_Base.cpp:582)
GetAdcCarTune() : Get ADC car tune value... (MtkSpMeta_Base.cpp:591)
GetAdcCarTune() : Get ADC car tune value successful and reportVaule = 1190 (MtkSpMet
```

Verify flow

- 1.使用meta tool 做calibration , 確認算出來的car tune value 合理,並寫入nvram
- [Tue Feb 07 21:34:45.156 2017] [4.241852] <8>.(8)[1:swapper/0][name:pmic_throttling_dlpt&]Get default car_tune_value= 1000
- [Tue Feb 07 21:35:03.186 2017] [22.277456] <8>.(8)[376:meta_tst][name:mtk_battery_hal&][777]dvalue 1002 fg_cust_data.r_fg_value 100 cali_car_tune 998
- [Tue Feb 07 21:35:03.186 2017] [22.278831] <8>.(8)[376:meta_tst][name:mtk_battery_hal&][fgauge_meta_cali_car_tune_value][998] meta:1000, adc:2628, UNI_FGCUR:381470, r_fg_value:100
- 紅字說明default car_tune_value = 1000
- 綠字說明meta 說灌1000 , 但gauge 量到1002 , 因此car_tune_value 算出來為998

Verify flow

- 2.打開fg log ,開機後放一陣子,會看到一開始開機為1000(下面紅字)等nvram ready 之後會從nvram load 出來998 , 如下面綠字

- [Thu Feb 09 14:28:27.498 2017] [4.245657] <9>.(9)[1:swapper/0][name:pmic_throttling_dlpt&]Get default car_tune_value= 1000
- [Thu Feb 09 14:28:41.188 2017] [17.941996] <8>.(4)[209:battery_thread][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-33 r_fg_value=100 car_tune_value=1000
- [Thu Feb 09 14:28:41.608 2017] [18.339519] <8>.(9)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-33 r_fg_value=100 car_tune_value=1000
- [Thu Feb 09 14:28:41.628 2017] [18.343307] <8>.(9)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-33 r_fg_value=100 car_tune_value=1000
- [Thu Feb 09 14:28:45.768 2017] [22.564262] <4>.(4)[389:fuelgauged_nvra]NVRAM: nvram_car_tune_value : 998
- [Thu Feb 09 14:29:01.157 2017] [37.876996] <9>.(9)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-85 r_fg_value=100 car_tune_value=1000
- [Thu Feb 09 14:29:01.297 2017] [37.909498] <8>.(4)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-84 r_fg_value=100 car_tune_value=998
- [Thu Feb 09 14:29:01.327 2017] [37.910501] <8>.(4)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-84 r_fg_value=100 car_tune_value=998
- [Thu Feb 09 14:29:15.797 2017] [52.432033] <8>.(1)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-114 r_fg_value=100 car_tune_value=998
- [Thu Feb 09 14:29:30.647 2017] [67.415032] <1>.(1)[388:fuelgauged][name:mtk_battery_hal&][fgauge_read_columb_internal] CAR=-142 r_fg_value=100 car_tune_value=998

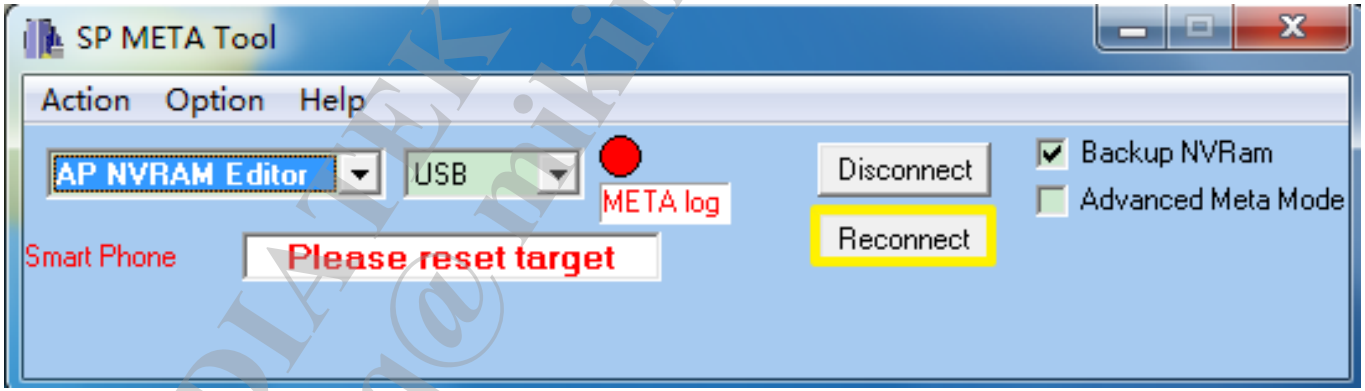
NVRAM CAR_TUNE_VALUE modify in META Mode

- CAR_TUNE_VALUE could be modified in meta mode by SP_META TOOL , So the tests don’t have to compile the special version load.

- SP_META TOOL.exe could be got from MOL

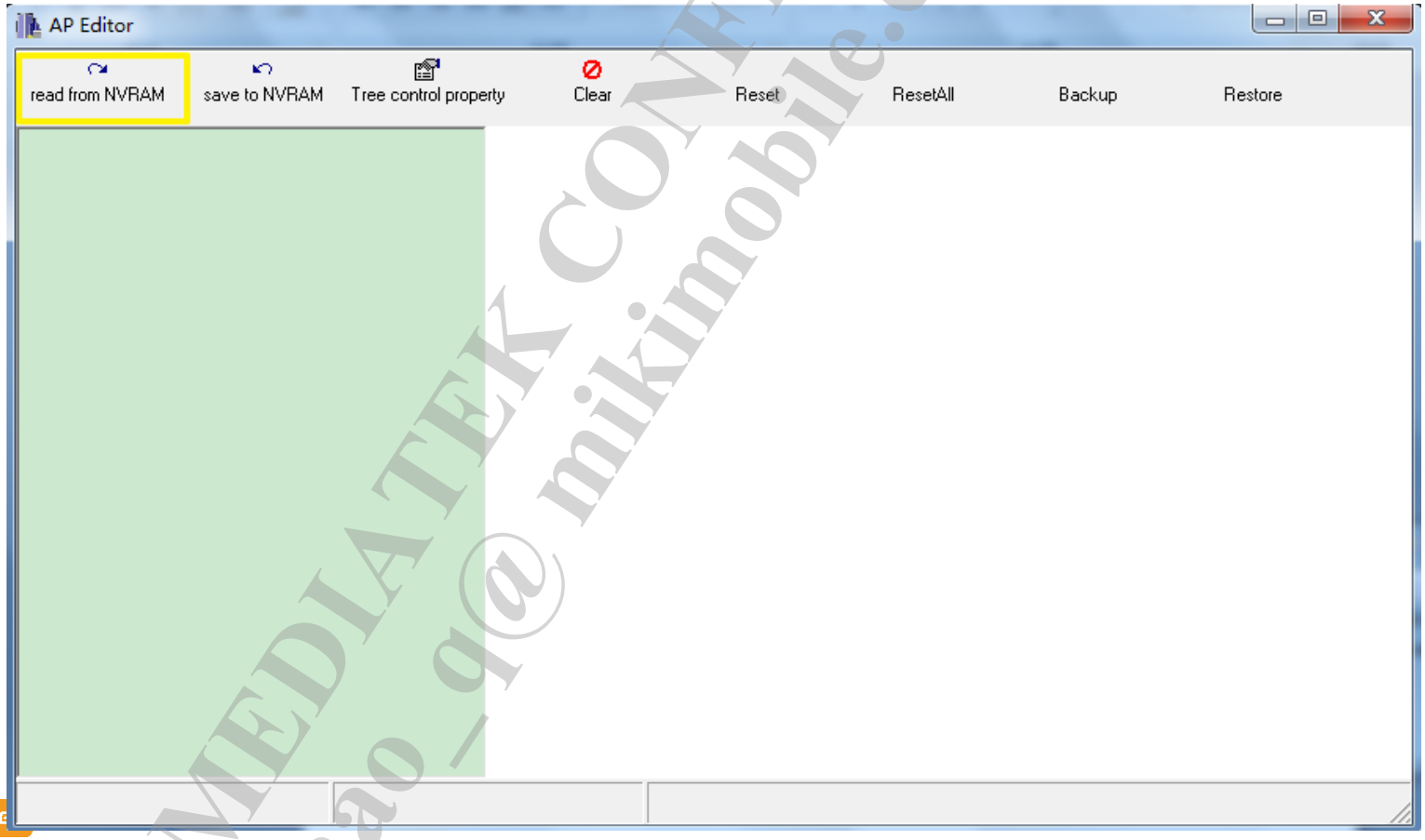
NVRAM CAR_TUNE_VALUE modify in META Mode

- Step 1: Power off the test phone.
- Step 2: Open the SP_META TOOL and connect the test phone to USB port with cable.
- Step 3: Press “Reconnect” button then the test phone will enter meta mode



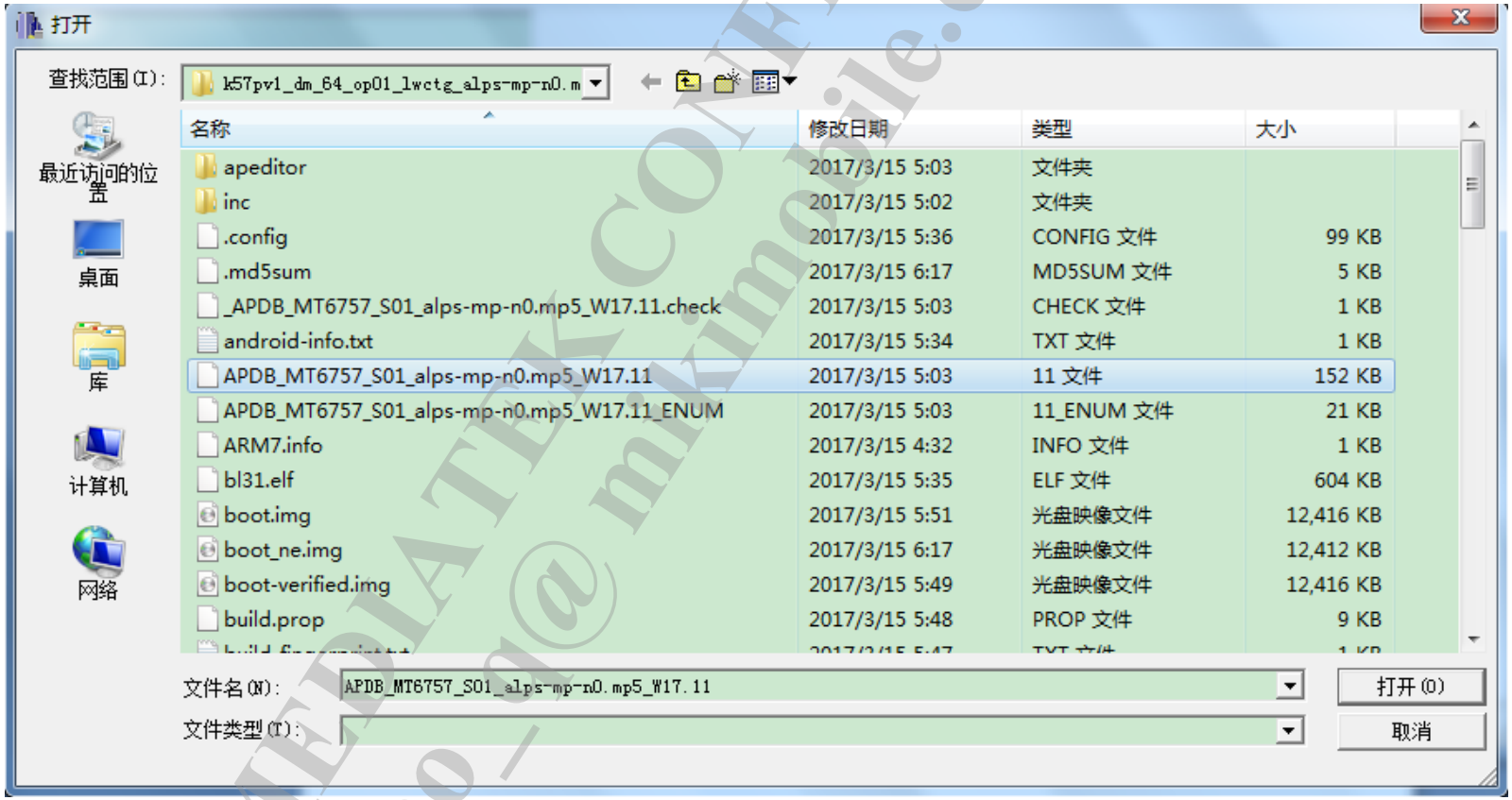
NVRAM CAR_TUNE_VALUE modify in META Mode

- Step 4: After enter meta mode , Press “read from NVRAM”



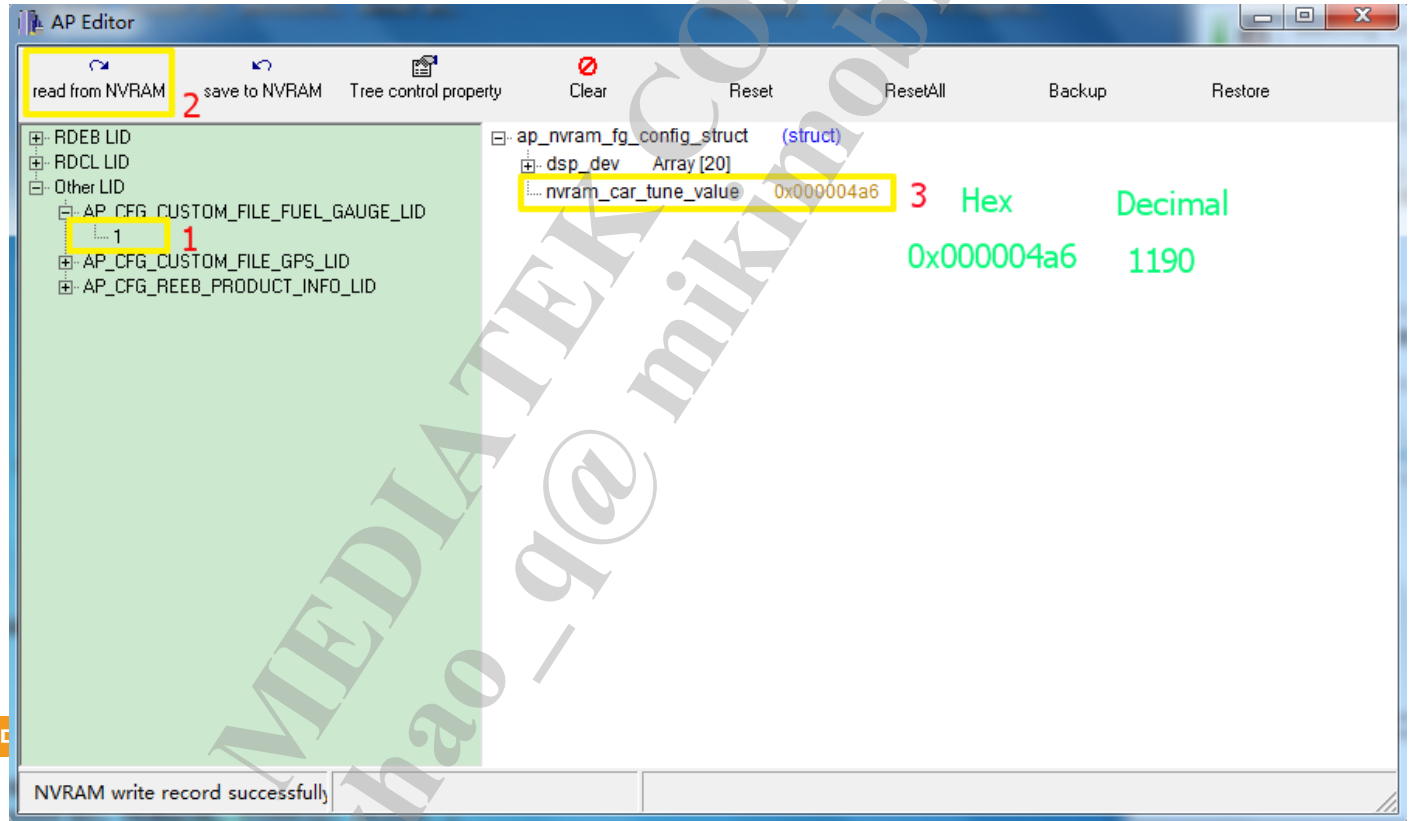
NVRAM CAR_TUNE_VALUE modify in META Mode

- Step 5: Select the right APDB file



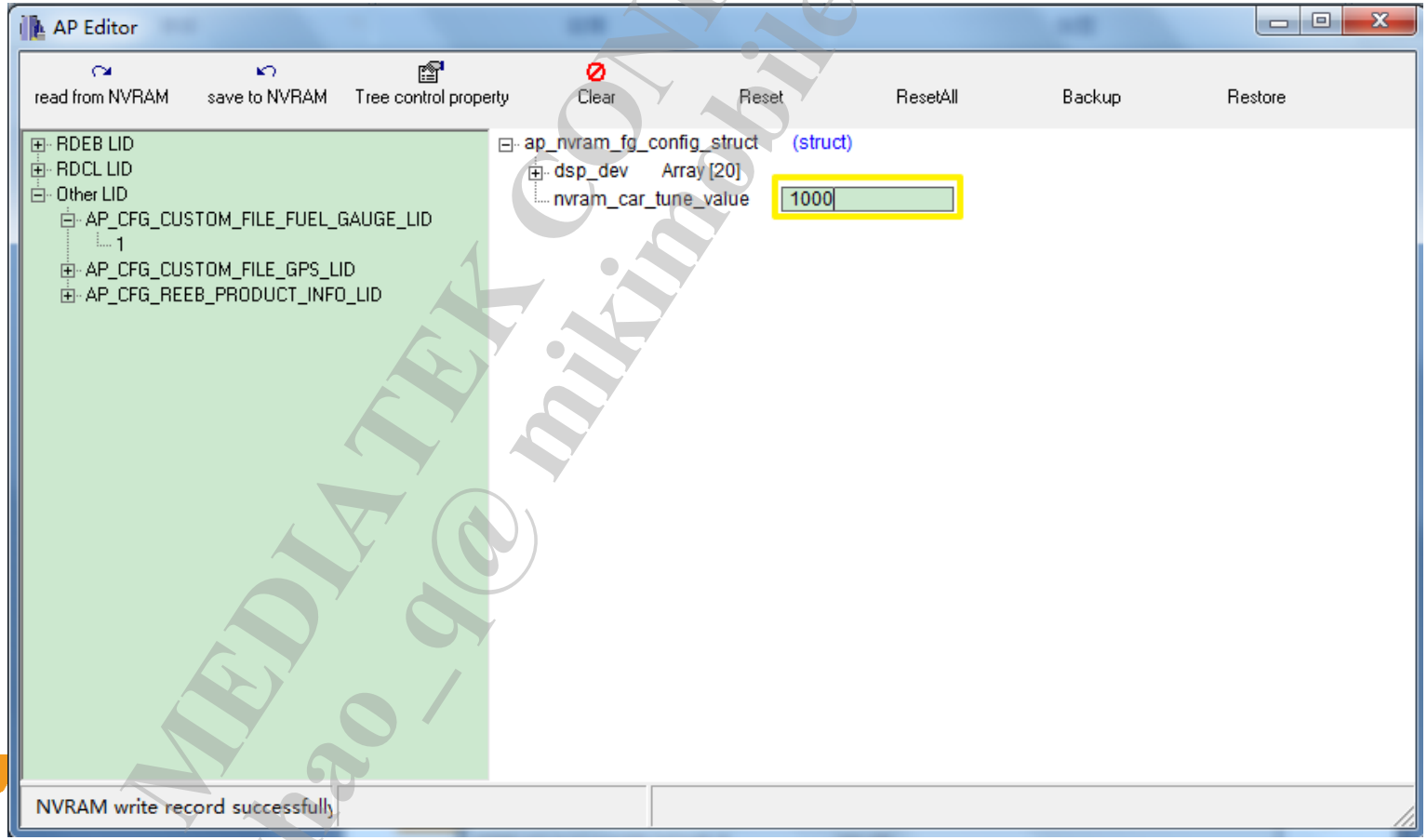
NVRAM CAR_TUNE_VALUE modify in META Mode

- Step 6: Select Other LID --> FUEL_GAUGE_LID --> 1,then read from NVRAM, car_tune_value 0x000004a6 is 1190.
  - Note： if without calibration, the default value is **119**.



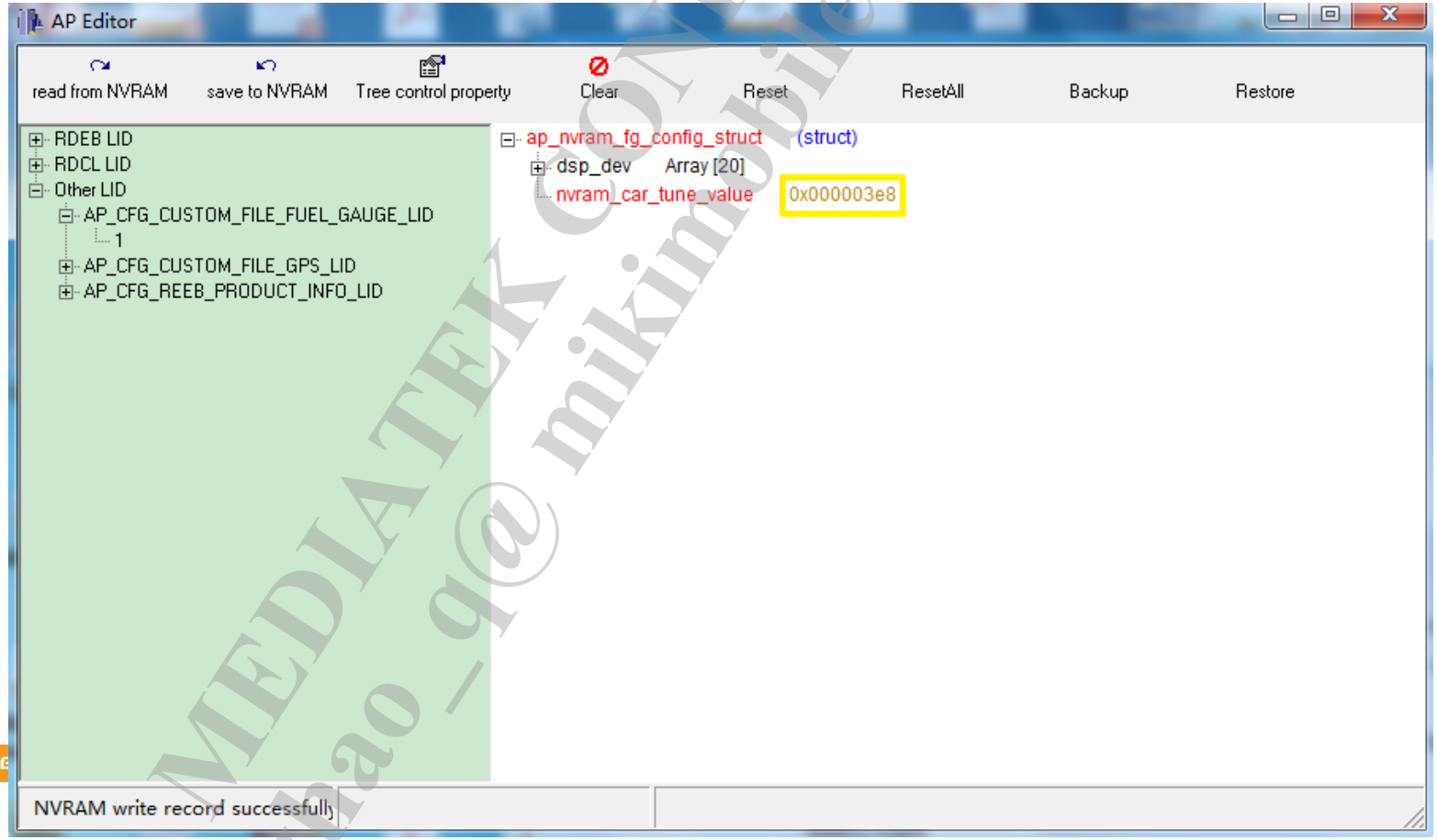
NVRAM CAR_TUNE_VALUE modify in META Mode

- Step 7.1: Modify car_tune_value to the right number(such as 1000)



NVRAM CAR_TUNE_VALUE modify in META Mode

- Step 7.2: It will show 0x000003e8 after press enter , then save to NVRAM and finish.



Q & A

Question	Ans
1. How long does the auto calibration take in factory?	If combined with RF calibration, it only takes 3 more seconds.
2. Why do we need to do both Lab calibration and factory calibration?	15s before the boot is used for Lab calibration parameters; after 15s is used for NVRAM parameters
3. The suggested current source is 1000mA? The direction must be CS_N → CS_P?	1000mA is recommend. The current direction can be CS_N → CS_P or CS_P → CS_N.
4. SP_META TOOL read NVRAM car_tune_value is 119 and much smaller than 1190	Because without Multi-ATE calibration it is the NVRAM default value, SW will replace it with .h's or .dtsi's value

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