

MAIN CONTROLLER AAAA0079 INSPECTION

Date: 25th June 2020
Revision: 1.0
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Product: Electric Skateboard
Company: Globe Brand

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2 OVERVIEW

Customer return. Charger failure.

2.1 REGISTRAR NOTES

2020-06-05 - Battery current sensor fault (water ingress?). Battery charger failed.

2.2 LOG FILES

 AAAA0079_20200327_150035.log	2020-03-27 3:00 PM
 AAAA0079_20200605_110437.log	2020-06-05 11:03 AM
 AAAA0079_20200605_110655.log	2020-06-05 11:05 AM

366.3km

3 VISUAL INSPECTION

Not surprising to find the modules dirty given 366km traveled.





Charge port cover missing. Very dirty charging connector. Contact is pitted and surface damaged. It is not known if the contact damage is for dirt or water contamination while charging.



4 LOG DATA

4.1 LAST CUSTOMER LOG

```
!!Executing Connection Query!!
Application - dot-hub Firmware Tool : 03.000.D002 - dot_Skateboard_Remote_RC100_0044.fw
OS - Windows 7 SP 1 (6.1)
CPU - x86_64
Kernel Version - winnt :: 6.1.7601
```

dot Skateboard

```
Model : MC100
Hardware Version : 35
Software Version : 83
Bootloader Version : 4
Serial Number : AAAA0079
Paired Remote Serial : DDDD00AF
Batch Number : 12
Custom Change Index : 0
Production Date : 5-3-2020
Factory Tested : Yes
```

Battery Position: 0

```
Model : BM100
Hardware Version : 22
Software Version : 19
Serial Number : BBBB0213
Batch Number : 10
Production Date : 17-2-2020
Factory Tested : Yes
```

Battery Metrics

```
- State of Charge : 0.7%
- Current Capacity : 0.52Wh > FAIL <
- Full Capacity : 72.00Wh --
- #Charge Cycles x32 : 917 --
- Cell Resistance 25C : 236mohm --
```

Temperature Sensors

```
- PCB : 22.1'C --
- Cells 0-4 : 19.2'C --
- Cells 5-9 : 19.1'C --
```

Measurements

```
- V_Bus : 34807mV --
- Battery : 34802mV --
- V_Switch : 34797mV --
- V_Switch_Off : 48mV --
- VCC : 3314mV --
- V_Offset : 3000mV --
- V_Current_Sense : 1495mV --
```

```

- I_Current_Sense      : 10mA      --

Cell Voltages
- Cell 0               : 3446mV    --
- Cell 1               : 3460mV    --
- Cell 2               : 3466mV    --
- Cell 3               : 3469mV    --
- Cell 4               : 3475mV    --
- Cell 5               : 3486mV    --
- Cell 6               : 3474mV    --
- Cell 7               : 3489mV    --
- Cell 8               : 3499mV    --
- Cell 9               : 3507mV    --

Settings
-Wheel Diameter (mm)x10 : 830
- Options               : 0009
- Auto Power Off Period : 60000
- Power Down Timer     : 60000

Measurements
- V_Bus                 : 34710mV   --
- V_Aux                 : 6447mV    --
- V_Sys                 : 4542mV   > FAIL <  USB Power Interfering
- V_USB                 : 5019mV   --
- VCC                   : 3300mV   --

Battery Charger
- V_Charger_Input      : 158mV   > FAIL <
- V_Charger_Output    : 1597mV
- Temperature          : 24.9'C    --
- Connector Temperature : 25.6'C    --
- Power Limit          : 168W
- Power Consumption    : 0W      --

Inertial_Module
- Module                : Present   --
- Angular XYZ           : 125    -107   -494
- Linear XYZ            : -156   -652   16450

LIN Bus
- Bus State             : Active   --
- Discovered Devices   : 1        --

Communications
- Wireless RF           : Present   --
- Packet Count Tx/Rx   : 0/0     > FAIL <
- Paired Remote Serial : DDDD00AF
- Paired Status        : Unsynced > FAIL <

Motor Temperature Sensors
- Left Motor Temp      : 16.7'C   --
- Right Motor Temp     : 16.0'C   --

Metrics
- Trip Odo Left        : 0 m
- Trip Odo Right       : 0 m
- Trip Time            : 0.0 mins
- Number of trips      : 131
- Average Trip Distance : 2.7 km
- Total Ride Time      : 21.8 hrs
- Odometer              : 366.3 km

```

Trip Data	Dist_km	mins	Avg_kph	Max_kph	Max_Bat_LHS/RHS	Min_Bat_LHS/RHS
TempMax_Bat_LHS/RHS	Motor_Temp_High_mins	Features	Used			
Trip #0	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #1	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #2	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #3	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #4	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #5	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #6	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1
Trip #7	: 0.00	6	0.0	24.0	32.0	17.2/16.6
32 61/64	0/0		1 Expert			-7.2 -5.8/-5.1

Fault Report

Log #0	: 36	25292	2450	45419	181	3566	0	0
Log #1	: 35	1	0	1437	2877	0	768	6447
Log #2	: 34	1	0	1441	2884	0	256	6447
Log #3	: 33	3	2819	48044	14357	3395	0	4095
Log #4	: 42	5	1	49157	48	36425	1	35557
Log #5	: 1	94	4097	49297	26	36130	47831	18268
Log #6	: 13	84	32769	2998	40	38039	0	1446

4.2 LOG AT INSPECTION

dot Skateboard

Model	: MC100
Hardware Version	: 35
Software Version	: 83
Bootloader Version	: 4
Serial Number	: AAAA0079
Paired Remote Serial	: DDDD00AF
Batch Number	: 12
Custom Change Index	: 0
Production Date	: 5-3-2020
Factory Tested	: Yes

Battery Position: 0

Model	: BM100
Hardware Version	: 22
Software Version	: 19
Serial Number	: BBBB021E
Batch Number	: 10
Production Date	: 17-2-2020


```

Factory Tested           : Yes

Battery Metrics
- State of Charge       : 16.7%
- Current Capacity     : 12.05Wh    --
- Full Capacity        : 72.00Wh    --
- #Charge Cycles x32   : 878      --
- Cell Resistance 25C  : 212mohm  --

```

```

Temperature Sensors
- PCB                   : 24.5'C    --
- Cells 0-4             : 23.6'C    --
- Cells 5-9             : 23.7'C    --

```

```

Measurements
- V_Bus                 : 35622mV   --
- Battery               : 35613mV   --
- V_Switch              : 35622mV   --
- V_Switch_Off          : 58mV     --
- VCC                   : 3298mV   --
- V_Offset              : 3007mV   --
- V_Current_Sense      : 1534mV   --
- I_Current_Sense      : 40mA     --

```

```

Cell Voltages
- Cell 0                : 3529mV   --
- Cell 1                : 3549mV   --
- Cell 2                : 3553mV   --
- Cell 3                : 3548mV   --
- Cell 4                : 3562mV   --
- Cell 5                : 3574mV   --
- Cell 6                : 3560mV   --
- Cell 7                : 3580mV   --
- Cell 8                : 3572mV   --
- Cell 9                : 3567mV   --

```

```

Battery Position: 1
Model                : BM100
Hardware Version     : 22
Software Version     : 19
Serial Number        : BBBB0213
Batch Number         : 10
Production Date      : 17-2-2020
Factory Tested       : Yes

```

```

Battery Metrics
- State of Charge     : 1.9%
- Current Capacity    : 1.40Wh    > FAIL <
- Full Capacity       : 72.00Wh    --
- #Charge Cycles x32 : 917      --
- Cell Resistance 25C : 236mohm  --

```

```

Temperature Sensors
- PCB                   : 24.5'C    --
- Cells 0-4             : 23.9'C    --
- Cells 5-9             : 23.9'C    --

```

```

Measurements
- V_Bus                 : 35656mV   --
- Battery               : 34768mV   --
- V_Switch              : 61mV     > FAIL <
- V_Switch_Off          : 61mV     --
- VCC                   : 3314mV   --
- V_Offset              : 3000mV   --

```

```

- V_Current_Sense      : 1494mV      --
- I_Current_Sense     : 0mA         --

Cell Voltages
- Cell 0               : 3457mV      --
- Cell 1               : 3460mV      --
- Cell 2               : 3473mV      --
- Cell 3               : 3469mV      --
- Cell 4               : 3474mV      --
- Cell 5               : 3474mV      --
- Cell 6               : 3476mV      --
- Cell 7               : 3486mV      --
- Cell 8               : 3481mV      --
- Cell 9               : 3499mV      --

Settings
-Wheel Diameter (mm)x10 : 830
- Options               : 0009
- Auto Power Off Period : 60000
- Power Down Timer      : 60000

Measurements
- V_Bus                 : 35557mV     --
- V_Aux                 : 6448mV      --
- V_Sys                 : 4276mV     > FAIL <  USB Power Interfering
- V_USB                 : 4752mV     --
- VCC                   : 3300mV     --

Battery Charger
- V_Charger_Input      : 134mV     > FAIL <
- V_Charger_Output     : 1570mV
- Temperature          : 24.4'C      --
- Connector Temperature : 24.9'C      --
- Power Limit          : 168W
- Power Consumption    : 0W         --

Inertial_Module
- Module               : Present     --
- Angular XYZ          : 105      -37      -432
- Linear XYZ           : 414      58       16480

LIN Bus
- Bus State            : Active     --
- Discovered Devices   : 2         --

Communications
- Wireless RF          : Present     --
- Packet Count Tx/Rx   : 0/0        > FAIL <
- Paired Remote Serial : DDDD00AF
- Paired Status        : Unsynced   > FAIL <

Motor Temperature Sensors
- Left Motor Temp      : 392.8'C    > FAIL <
- Right Motor Temp     : 392.8'C    > FAIL <

Metrics
- Trip Odo Left        : 0 m
- Trip Odo Right       : 0 m
- Trip Time            : 0.0 mins
- Number of trips      : 131
- Average Trip Distance : 2.7 km
- Total Ride Time      : 21.8 hrs
- Odometer              : 366.3 km

```

Trip Data	Dist_km	mins	Avg_kph	Max_kph	Max_Bat_LHS/RHS	Min_Bat_LHS/RHS		
TempMax_Bat_LHS/RHS	Motor_Temp_High_mins	Features	Used					
Trip #0	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #1	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #2	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #3	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #4	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #5	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #6	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					
Trip #7	: 0.00	6	0.0	24.0	32.0	17.2/16.6	-7.2	-5.8/-5.1
32 61/64	0/0		1 Expert					

Fault Report

Log #0	: 36	34817	1302	158	2100	3381	0	0
Log #1	: 33	4	2833	48098	14357	3416	0	4095
Log #2	: 35	1	0	1437	2877	0	768	6447
Log #3	: 34	1	0	1441	2884	0	256	6447
Log #4	: 42	5	1	49157	48	36425	1	35557
Log #5	: 1	94	4097	49297	26	36130	47831	18268
Log #6	: 13	84	32769	2998	40	38039	0	1446

4.3 LOG COMMENTS

Originally operated with battery BBBB0213.

Supplied with batteries BBBB021E, BBBB0213.

1. BBBB021E, Charge Cycles = 27.44, 16.7%.
2. BBBB0213, Charge Cycles = 28.66, 1.9%.

BBBB021E isn't registered with any other board.

Batteries have different charge levels.

Charger over temperature faults.

The first battery has registered 94 zero calibration faults and 84 current sensor faults. The log does not have the data to log which serial number battery was in this position at the time. Possibly BBBB0213, however it has a front connector cover fitted.

5 FUNCTIONAL TEST

FUNCTIONAL TEST

dot Skateboard

Model : MC100
Hardware Version : 35
Software Version : 83
Bootloader Version : 4
Serial Number : AAAA0067
Paired Remote Serial : FFFF000
Batch Number : 9
Custom Change Index : 0
Production Date : 19-11-2019
Factory Tested : Yes

Pre-Conditions

- 48V Charger Connection : 47967mV --
- Battery Module : Present --
- Battery : 35766mV --

Settings

-Wheel Diameter (mm)x10 : 830
- Options : 0009
- Auto Power Off Period : 60000
- Power Down Timer : 60000

Measurements

- V_Bus : 35784mV --
- V_Aux : 6512mV --
- V_Sys : 4420mV > FAIL
- V_USB : 4858mV --
- VCC : 3303mV --

Inertial_Module

- Module : Present --
- Angular XYZ : 190 -708 -299
- Linear XYZ : -306 1011 16532

LIN Bus

- Bus State : Active --
- Discovered Devices : 1 --

Communications

- Wireless RF : Present --
- Packet Count Tx/Rx : 359/393 --
- Paired Remote Serial : FFFF000
- Paired Status : Synced --

Battery Charger

- V_Charger_Input : 47944mV --
- V_Charger_Output : 40mV --
- Temperature : 30.0'C --
- Connector Temperature : 27.3'C --
- Power Limit : 168W --
- Power Consumption : 0W --

FT Output Fault : > FAIL
- Target : 25000mV
- Measured : 40mV

VESC Left

- Module : Present --

- Battery Online : 36442mV --
- Firmware : V3.54 --
- Fault Code : None --
- Input Voltage : 36700mV --
- AD_Phase_B_Avg : 1591 --
- RPM x10 : 16774 > FAIL
- Current : 170mA --
- Duty Cycle : 949 --
- Temperature : 26.1'C --
- Left Motor Temp : 19.3'C --

VESC Right

- Module : Present --
- Battery Online : 36456mV --
- Firmware : V3.54 --
- Fault Code : None --
- Input Voltage : 36600mV --
- AD_Phase_B_Avg : 1598 --
- RPM x10 : 16637 > FAIL
- Current : 260mA --
- Duty Cycle : 950 --
- Temperature : 23.8'C --
- Right Motor Temp : 19.2'C --

Fault Codes

- Not Implemented

TEST SUMMARY

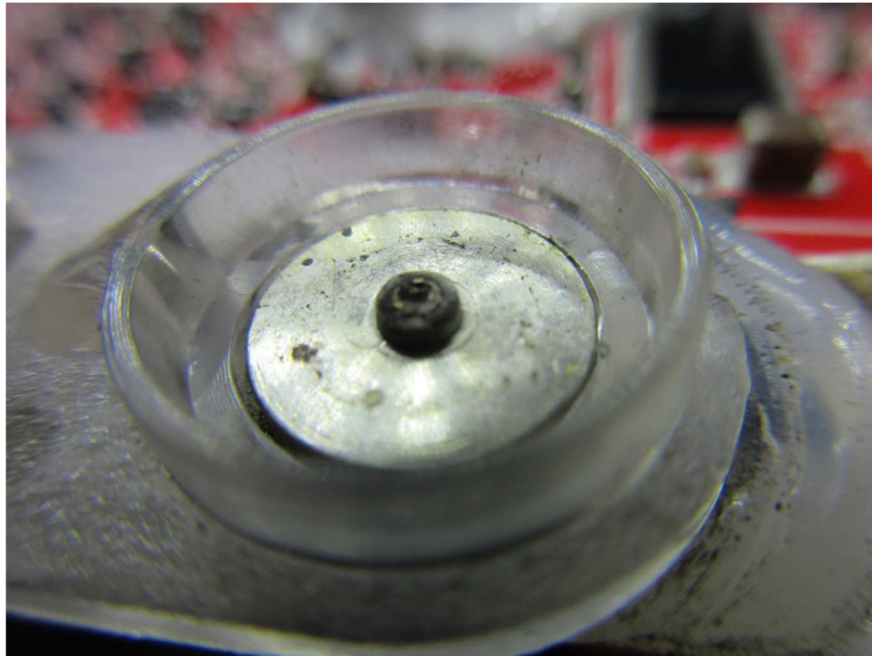
- Factory Test History : > FAIL
- Current Testing : > FAIL

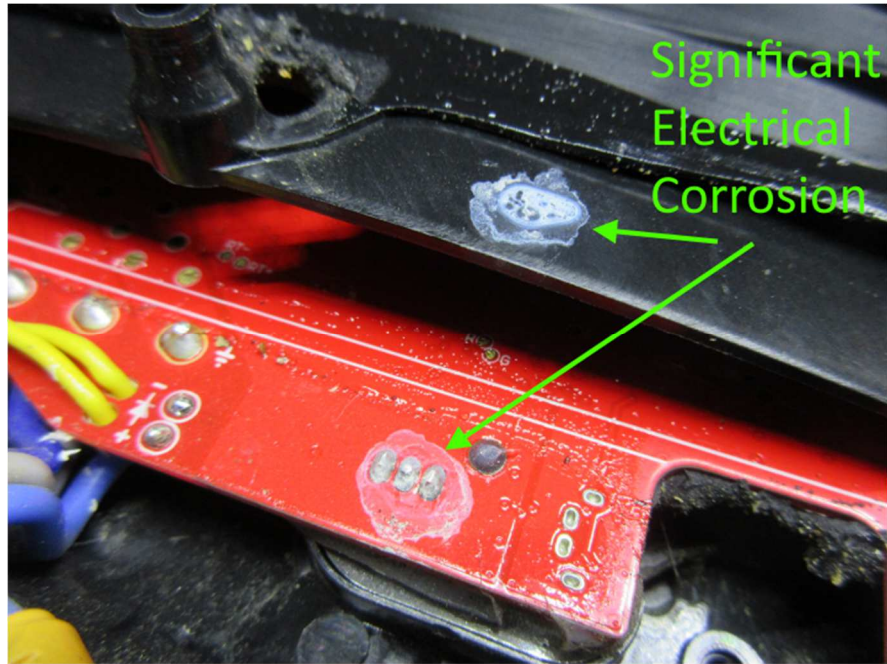
6 MAIN CONTROLLER INVESTIGATION

No signs of water ingress inside of the main controller.

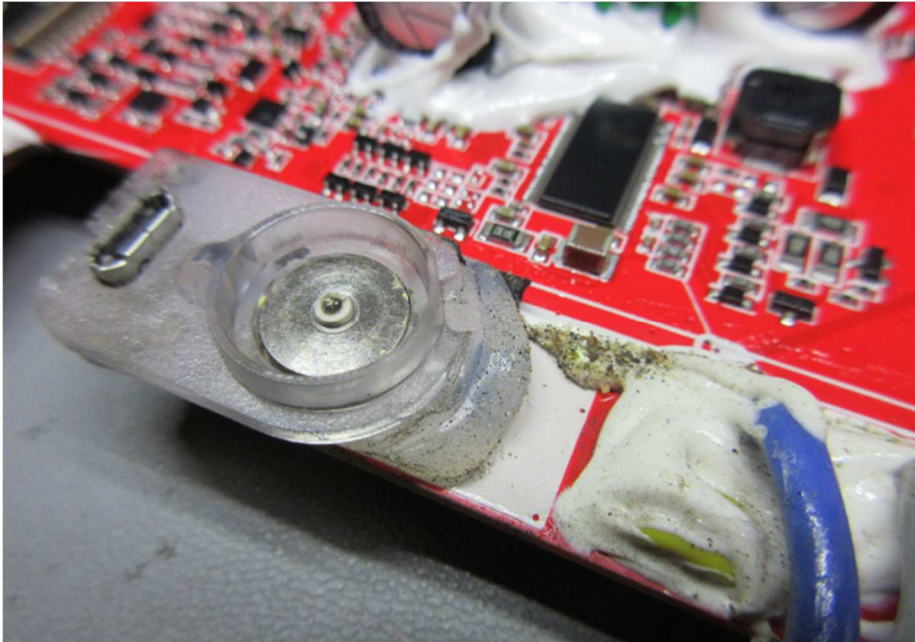
6.1 CHARGER PORT

The image below is of the charging connector AFTER being cleaned. The center pin has quite significant arcing damage. The negative contact has some arcing damage. This is likely a result of dirt preventing sufficient electrical contact.



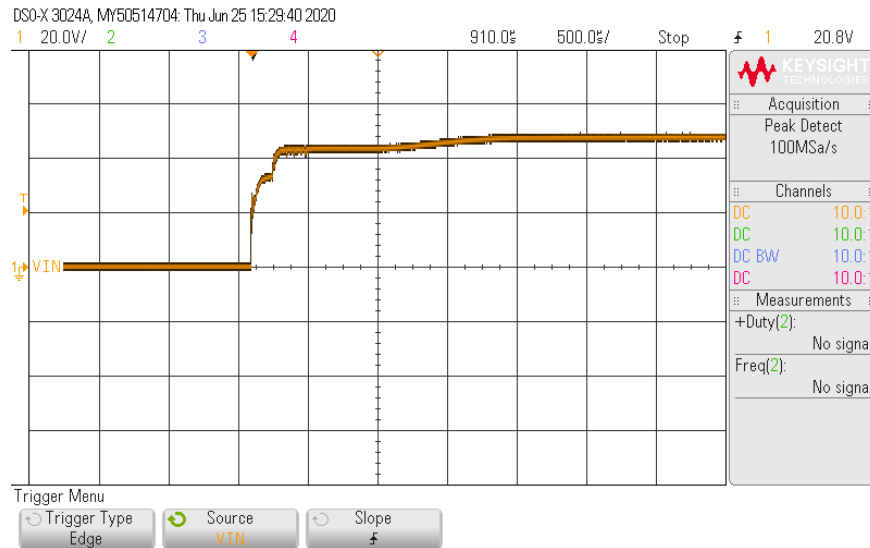


Noticeable dirt stuck to external glued surfaces. No signs of water ingress within the main PCB cavity.

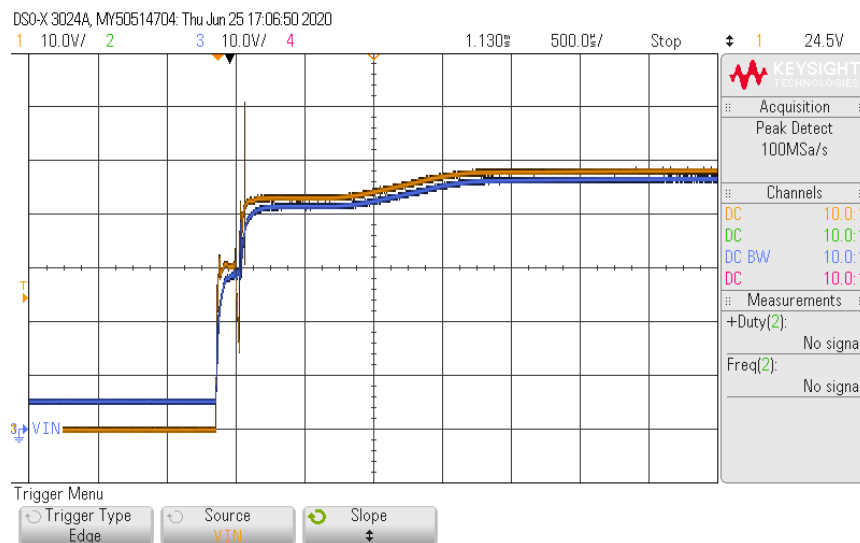


6.2 CHARGER CONNECTION

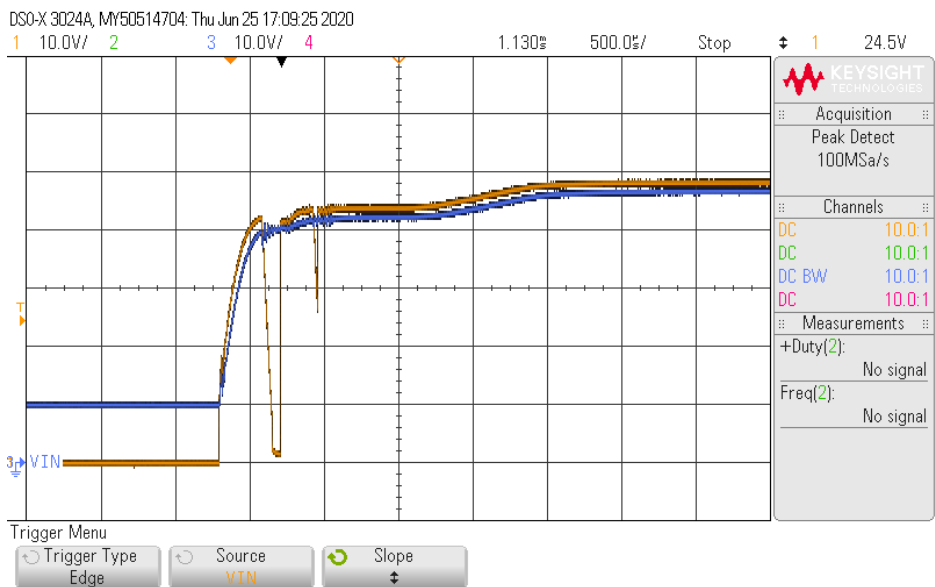
6.2.1 CONNECTION TO BOARD



60V transient captured with one connection. Blue trace taken after FET switch, but prior to PI filter. Snubber performance was excellent in filtering harmful spike.

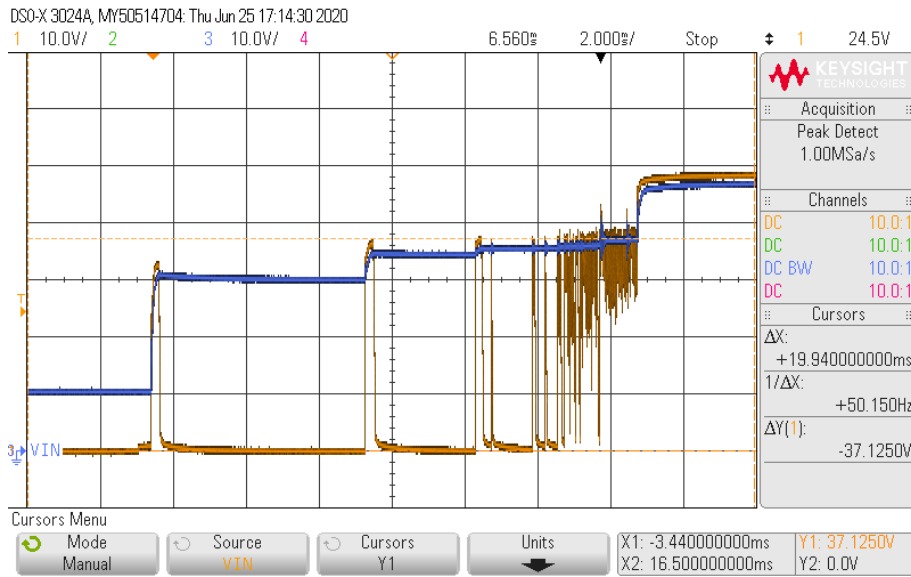


Input circuitry (blue) successfully filters connection disturbance (yellow).



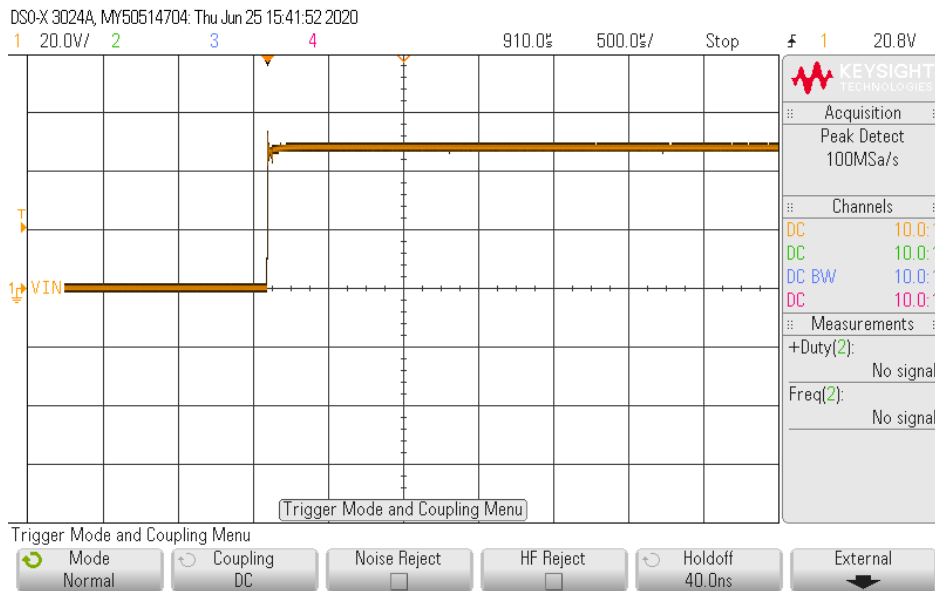
Worst case examples. Connector fitted on an angle with some restraint.





6.2.2 CONNECTION TO A GOOD BOARD

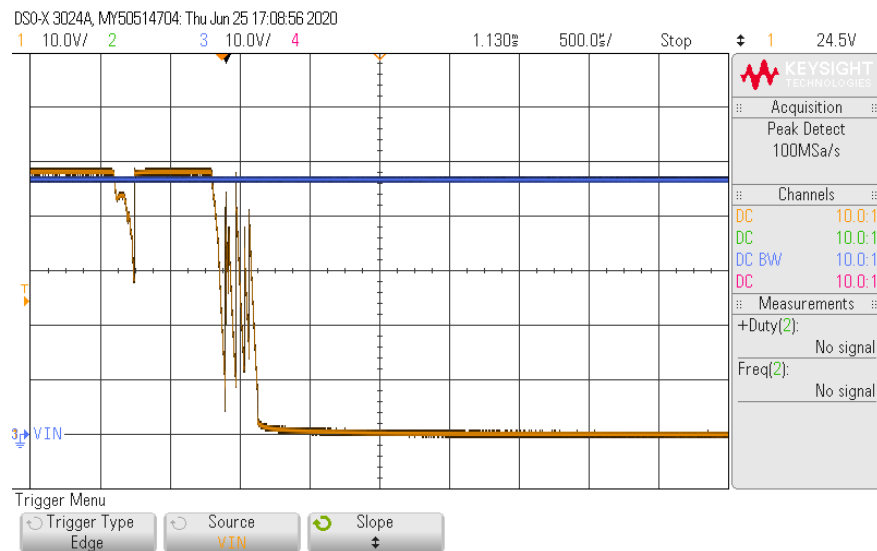
Example below shows the connection to a well-used development board, which has a socket in good condition. The same charger and charging cable was used.



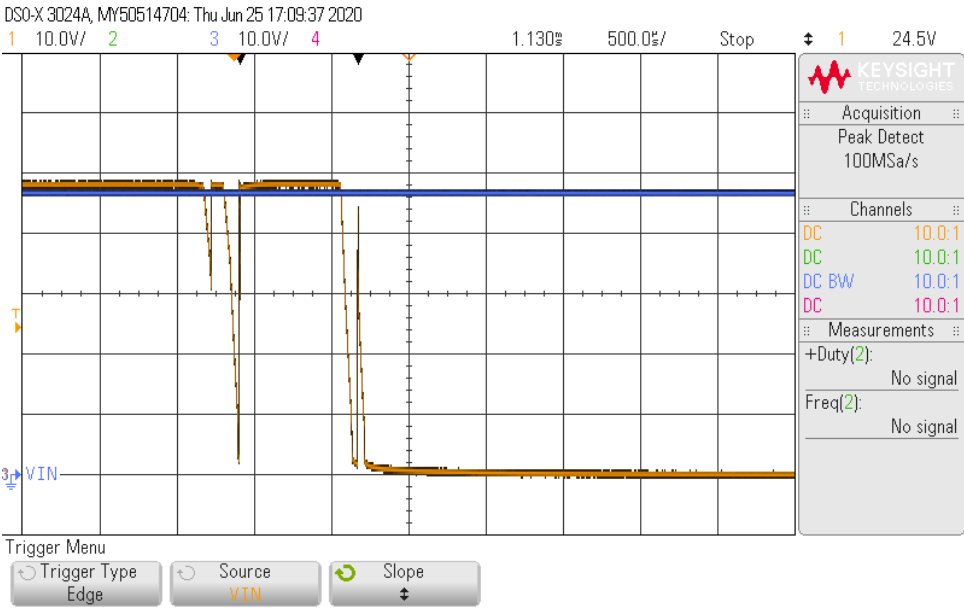
6.3 CHARGER DISCONNECTION

6.3.1 DISCONNECTION FROM THE BOARD

Terrible disconnection transitions....



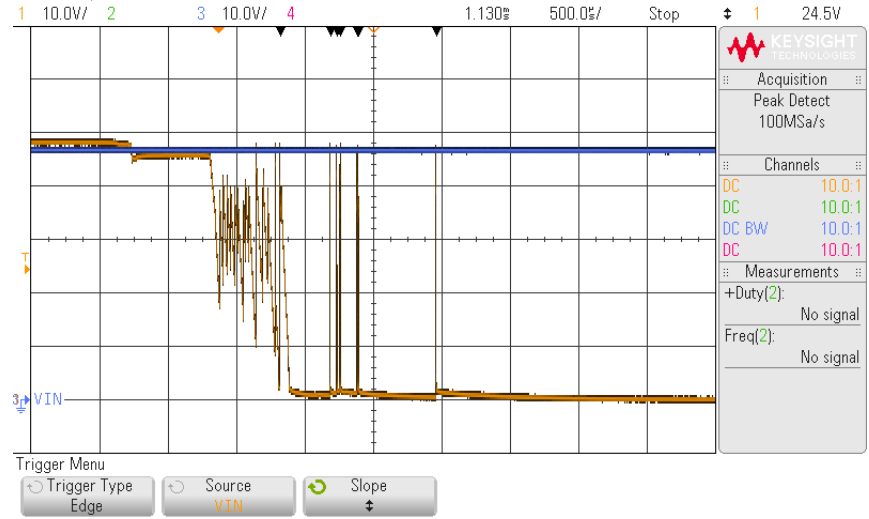
The input connection system (blue) electronically disconnects from the input (yellow) with a seamless transition. The system holds the voltage stable with input capacitance, preventing the disturbance from causing a negative offset across the battery charger.



DSO-X 3024A, MY50514704: Thu Jun 25 17:10:19 2020



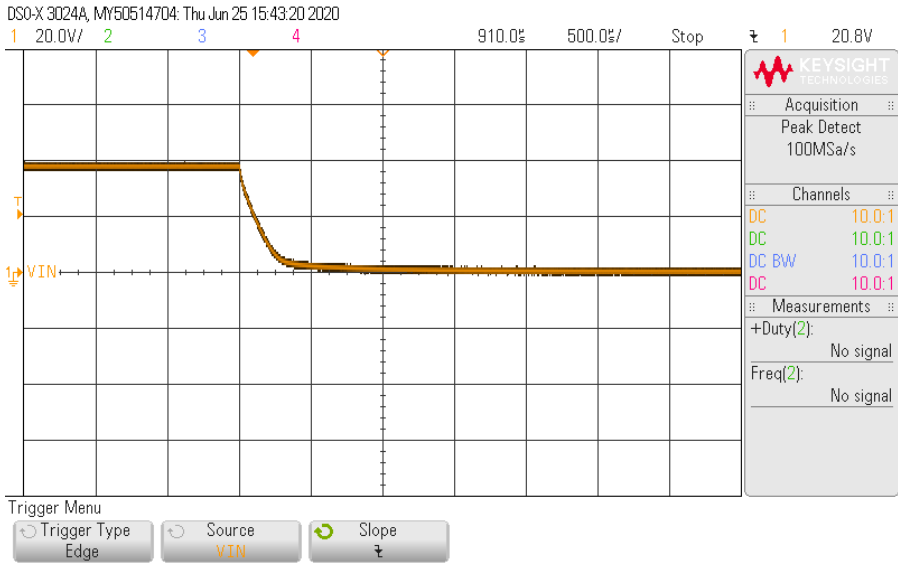
DSO-X 3024A, MY50514704: Thu Jun 25 17:10:40 2020



6.3.2 DISCONNECTION FROM A GOOD BOARD

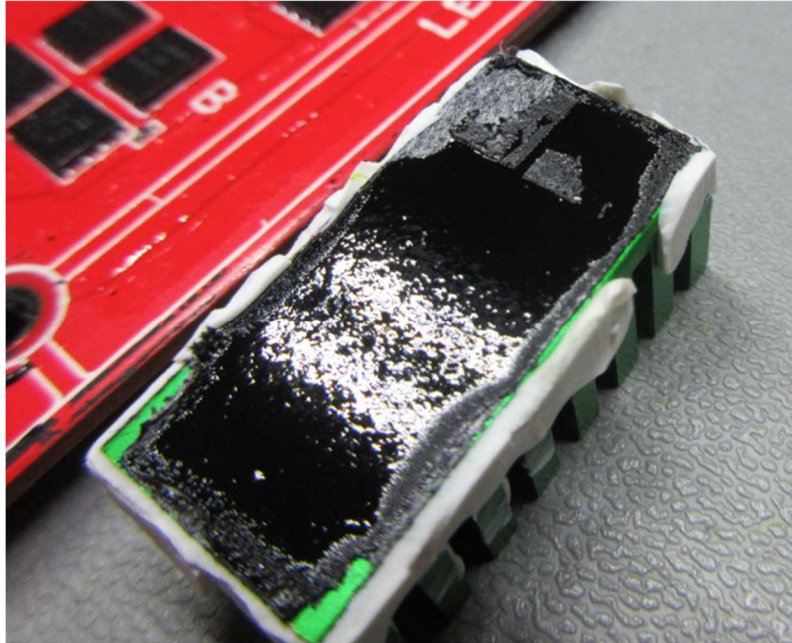
Example below shows the dis-connection from a well-used development board, which has a socket in good condition. The same charger and charging cable was used.

Very clean disconnection. Quite the contrast to the damaged receptacle.



6.4 BATTERY CHARGER

Heatsink had insufficient contact with MOSFETs. No contact with battery charger IC.



MOSFETs pass diode test; not shorted.

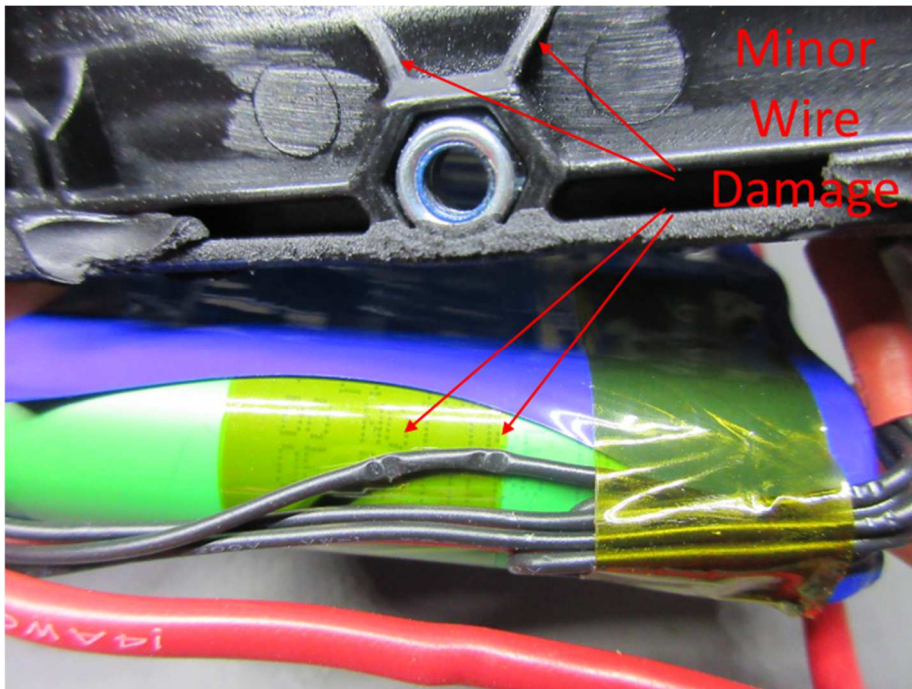
Battery charging failure likely the regulator chipset. Not replaced to check.

7 BATTERY MODULE INVESTIGATION

The system had registered 94 zero calibration faults and 84 current sensor faults.

7.1 BATTERY MODULE 3149595155 / BBBB0213

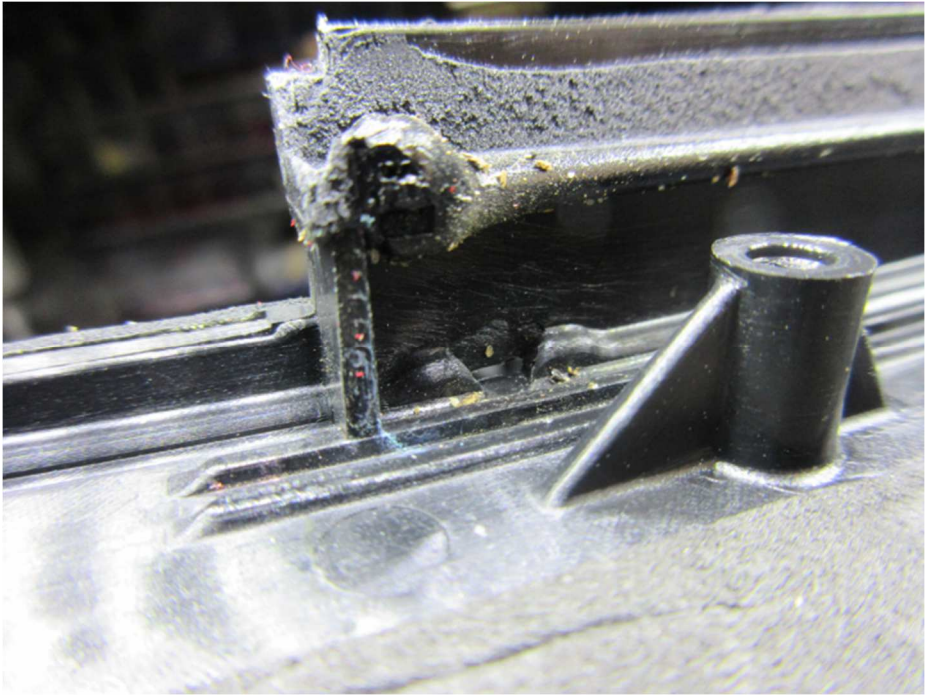
Minor wiring damage noticed on the battery balancing wires. This has not caused any issue.



Water corrosion damage is most evident on the circuitry. Specifically the susceptible high voltage circuit connections. Conformal coating decayed.

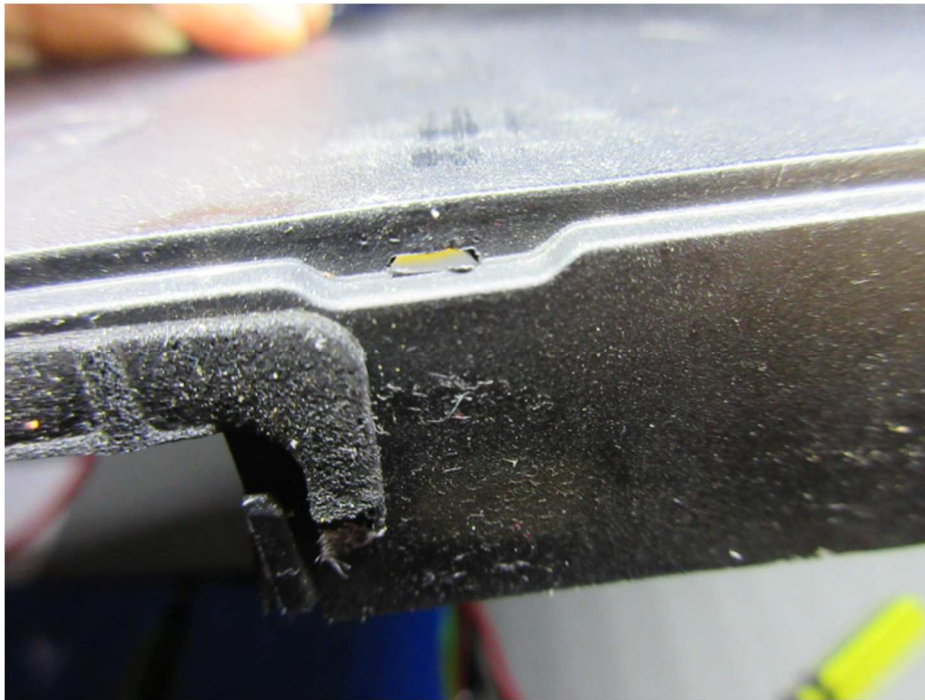


The water ingress appears to have occurred at the drain hole. The noticeable debris is isolated to this location. Water spray from this location direct faces the effected area on the circuit board.



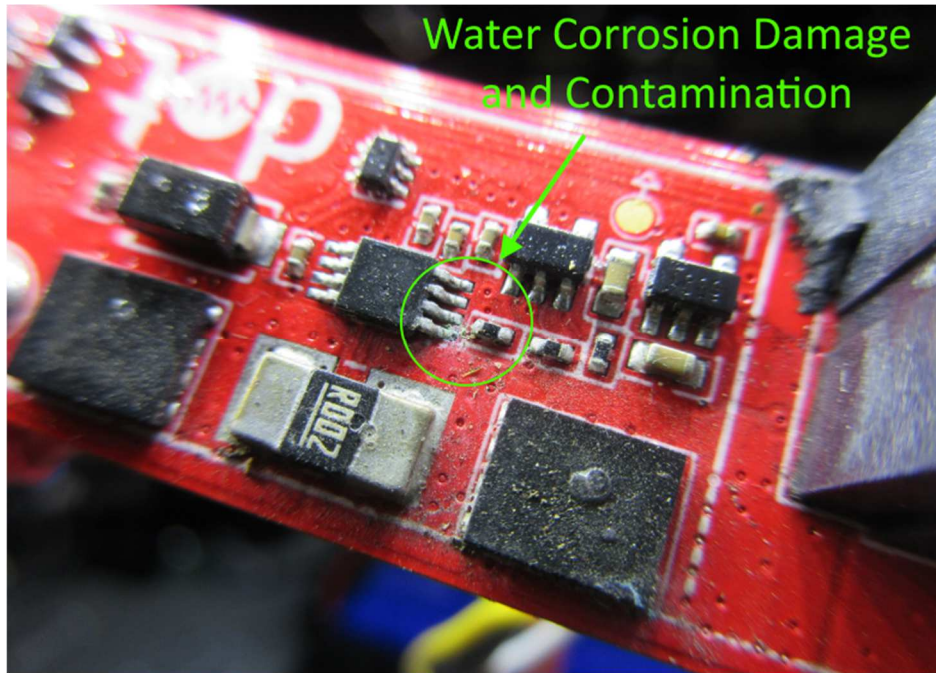
Pictured below is the external view of the drain hole.

Note, the torn gasket was from disassembly.

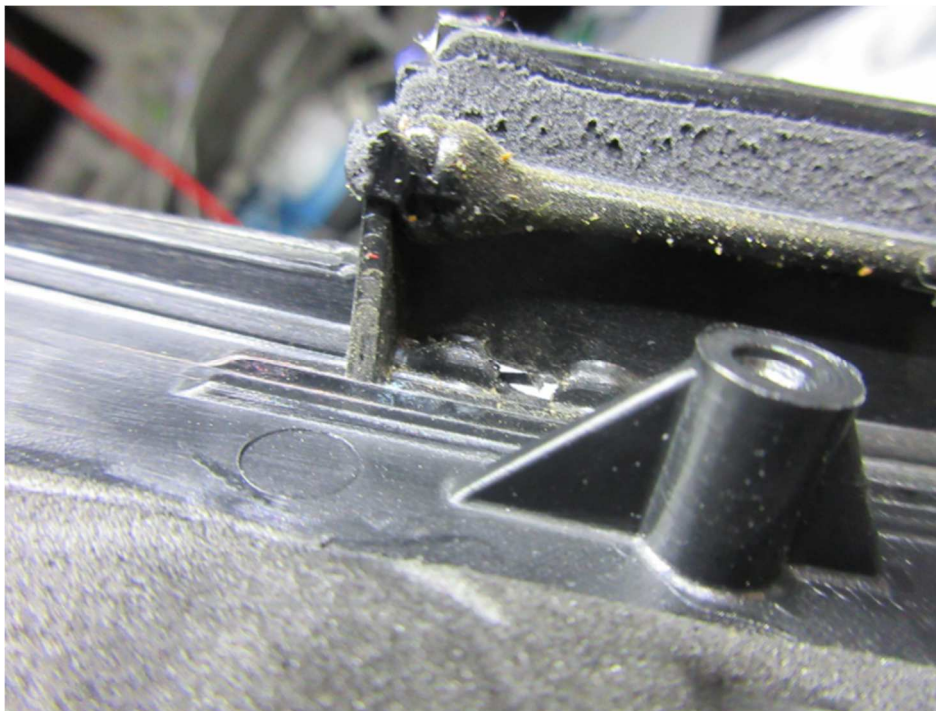


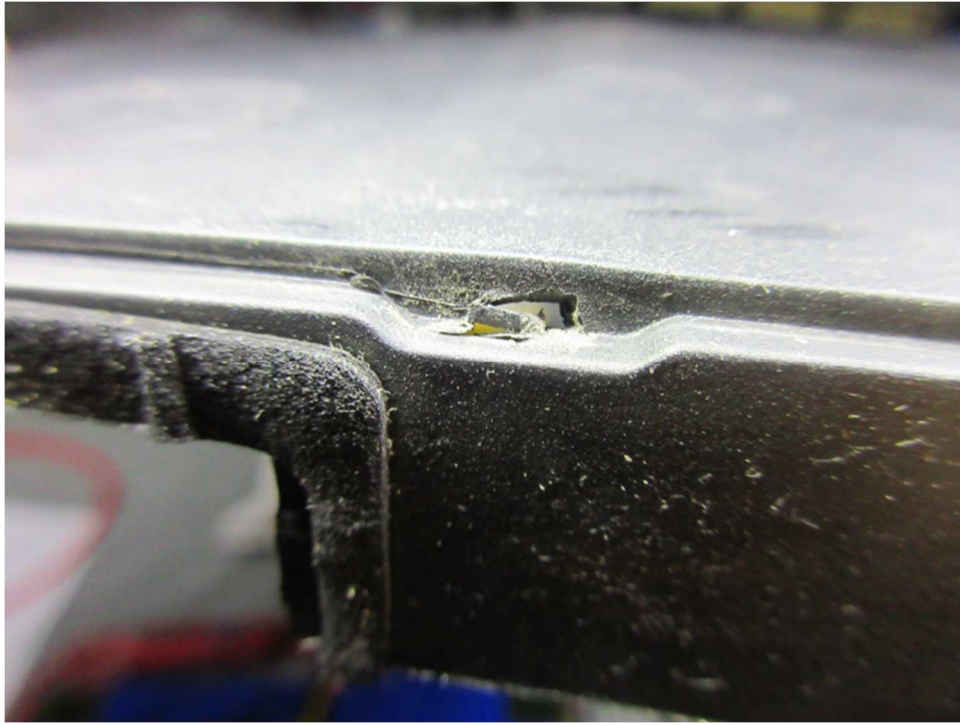
No other contamination was found. Except for the effected area, the interior and circuit board was quite clean.

This battery module has identical circuit corrosion damage. There is more residual dirt contamination to this area than the other battery module.



The water ingress again occurred at the drain hole. The residual dirt contamination is isolated to this area in the battery cover. The rest of the enclosure, PCB and battery pack are otherwise quite clean.





8 COMMENTS

8.1 CHARGING PORT

The battery charge port cover was missing. The charging connector was contaminated with an excess level of dirt. Arcing damage is evident. Significant electrical corrosion damage is evident on the PCB soldering of the magnetic connector. This occurred from charging while water was present on the circuit board. Water may have contributed to the connector damage.

Both magnetic receptacle and charging cable would need to be replaced. Replace charge port cover required.

8.2 CHARGER DAMAGE

The damage to the charging connector causes excessive connection and disconnection noise. This was inspected closely to determine if this could cause the battery charger to fail. The magnetic input switch circuitry, filtering and noise snubber were all performing as intended. These collectively prevent this connection/dis-connection noise from propagating through to the battery charger regulator.

The battery regulator chipset has failed. Cause cannot directly be determined. The charging chipset needs to be replaced.

8.3 BATTERY MODULE DAMAGE

The battery modules both exhibited water corrosion damage, congruent with the faults logged. Water ingress appears localized to the drain hole.

<end of report>