We had been evaluating the operation with PFC + LLC (EVM remodeled product) until recently, but there was an unstable region in the primary SW current waveform against LLC static load fluctuation, so confirm input / output characteristics again with LLC alone.

This state seems to worsen further if the input voltage of DC 380 V changes up and down from the center. The data at the load factor at which the current waveform becomes unstable is shown below. Please tell me the cause of instability at light load.

＜Pri.SW current observation result of UCC 256302＞

1. Input condition：DC380V (DC dedicated variable power supply)
2. Output condition：Two outputs（5V10A，24V2A）, both are CC mode setting by electronic load.
3. Test conditions：(LLC_EVM (Modified Transformer),
   Output setting：Depends on each load factor of measurement data.

3-1.Modified Trans. 1) Turns ratio P1／P2(bias)／S1(5)／S2(24)＝36／3／1／4.5

2) Pri. inductance：803μH (100kHz No load measurement)

3) Leakage inductance：35μH (Measured with short circuit only for 5V windings)

：28μH (Measured with short circuit only for 24V windings)

：17μH (Both 5 V and 24 V windings are shorted and measured)

3-2. C/R changed value around LLC IC（and it's reason）

① C10 only：0.015μF→0.01μF（Correct waveform disturbance）

② R14：732k→847kΩ（parts lost and then changed to approximate constant.）

③ R23：6.04k→,1.5kΩ（For 5V output change）

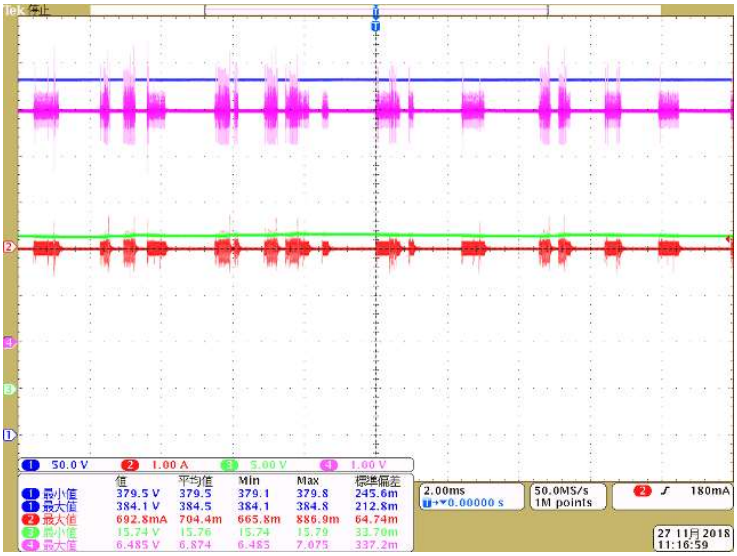
④ R25：147k→50.96kΩ（For 5V output change）

⑤ R26：16.9k→16.5kΩ（For 5V output change）

⑥ D6,D7：Diode→FET（For synchronous rectification to improve efficiency）

4. Waveform observation result

4-1. 5V0A，24V0A（Total no load）Is it in the burst state but there is no problem?



① Blue: LLC_Vin [50V/div]

② Red：LLC_Isw [1A/div]

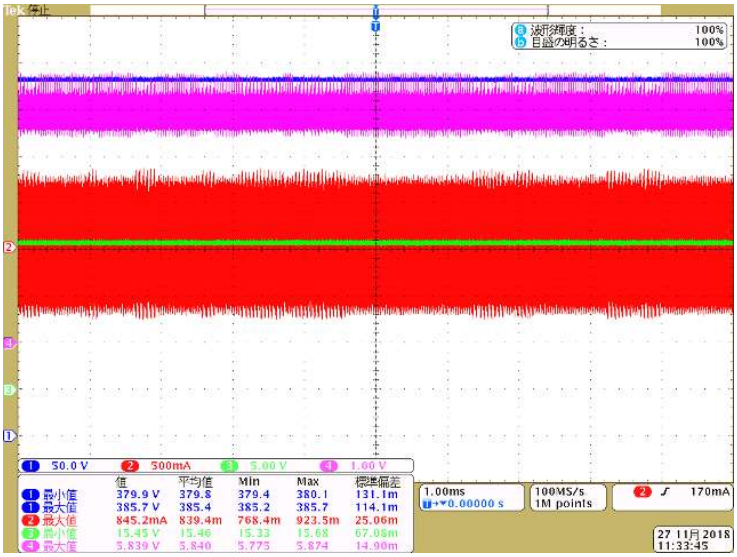
③ Green: Vcc(LLC) [5V/div]

④ Pink: 5V_out [1V/div]

H:[2mS/div]

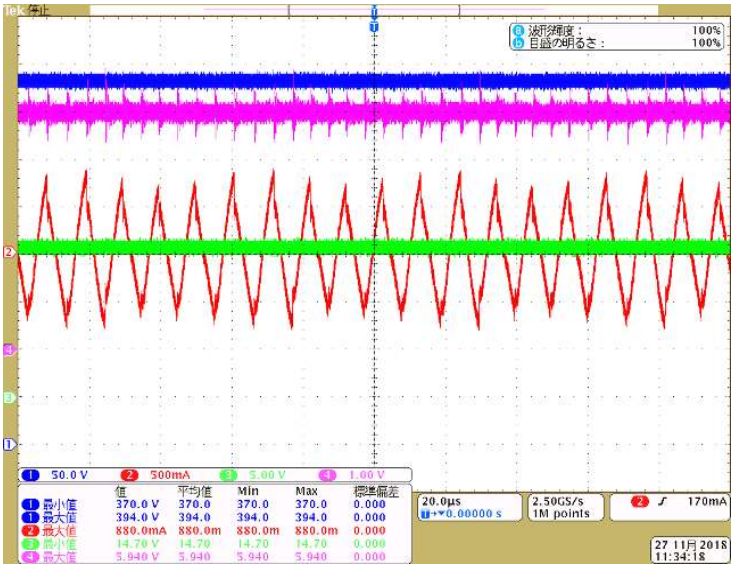
4-2. 5V3.1A, 24V0A

4-2.1 [2mS/div] Runaway is observed at the peak of the current waveform.



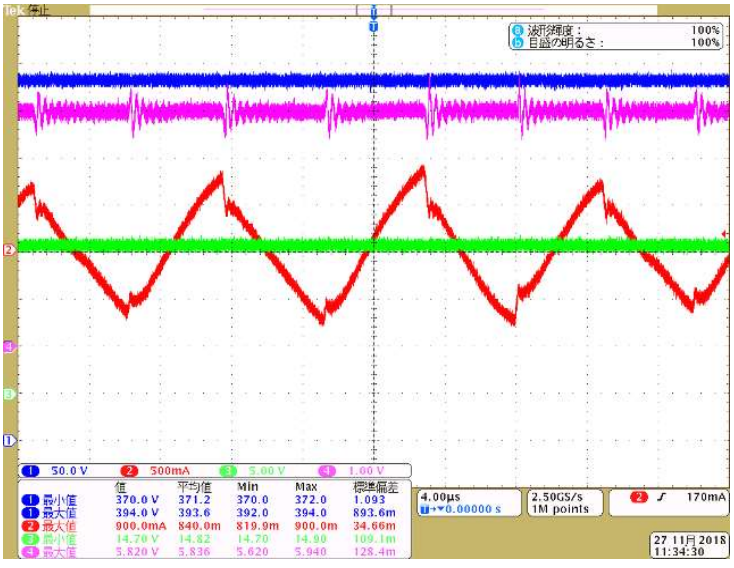
① Blue : LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[1mS/div]

4-2.2 [20μS/div] Fluctuation in the current waveform is remarkable and unstable.



① Blue : LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[20μS/div]

4-2.3 [4μS/div]



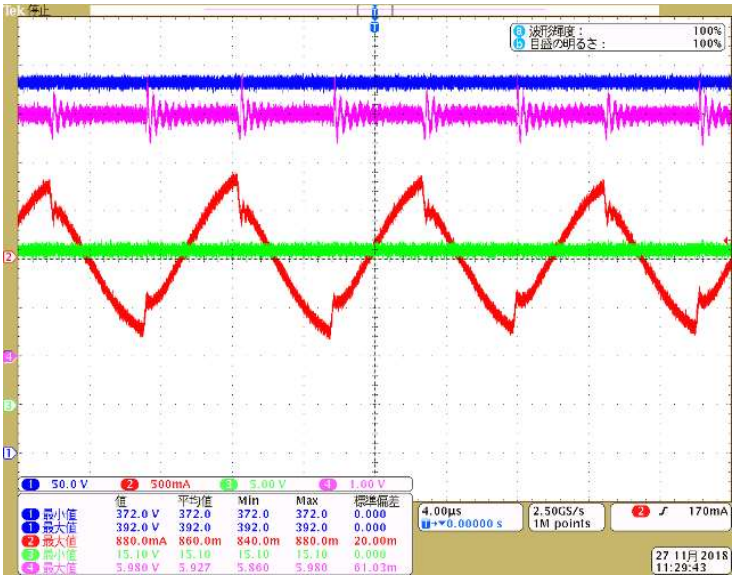
① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink : 5V_out [1V/div]
H:[4μS/div]

4-3. 5V5A, 24V0A

4-3.1 [80µS/div] There is fluctuation in a part of the current waveform peak.

① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [1A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[80µS/div]

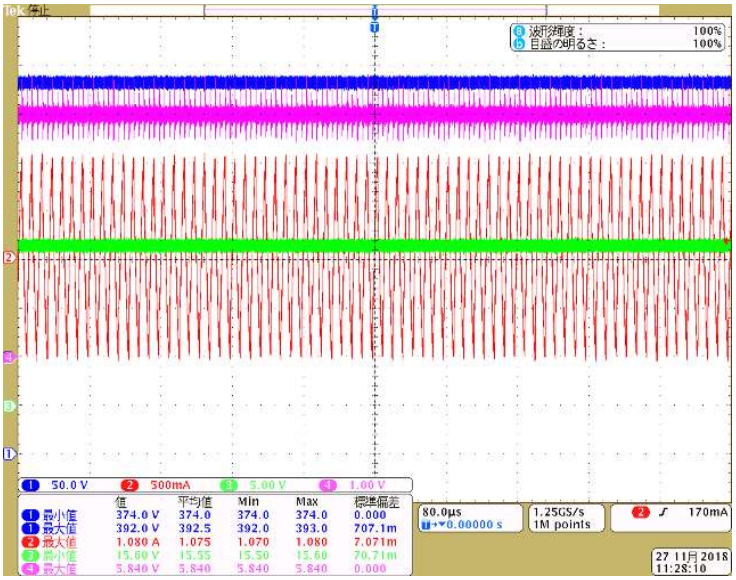
4-3.2 [4µS/div]



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[4µS/div]

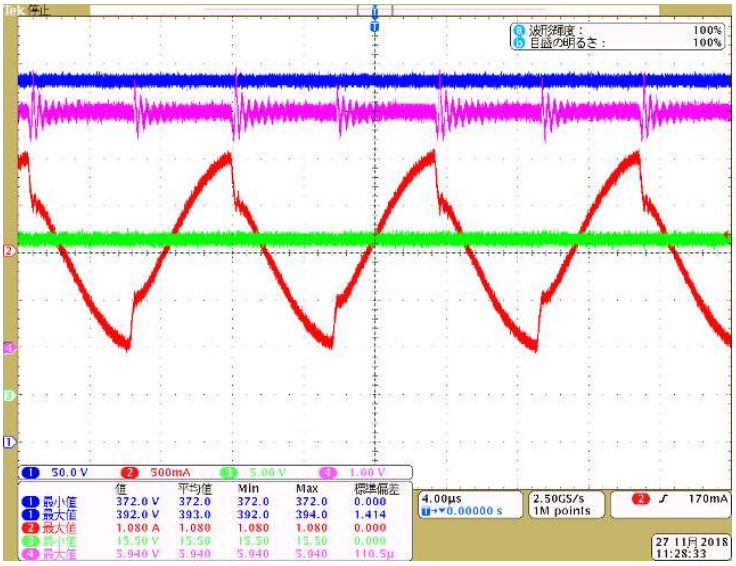
4-4. 5V10A, 24V0A

4-4.1 [80µS/div] Almost no current fluctuation , acceptable?



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[80µS/div]

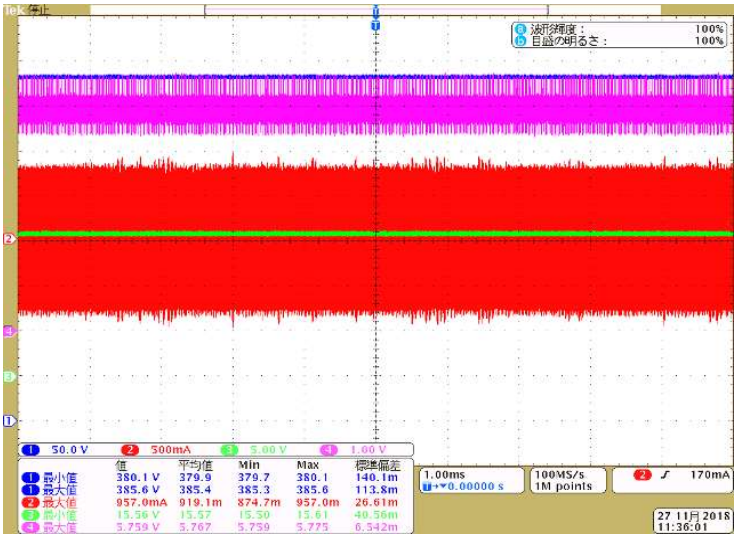
4-4-2. [4μS/div]



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[4μS/div]

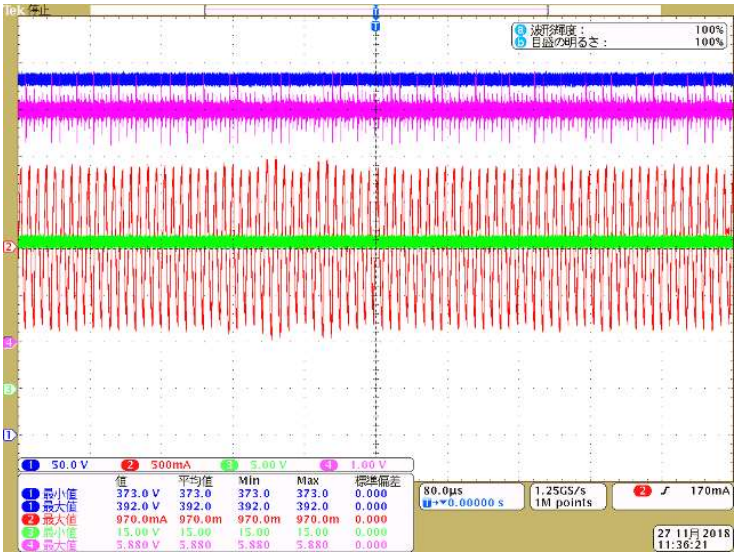
4-5. 5V2.9A, 24V2A

4-5.1 [1mS/div] Rampage is observed in the current waveform peak.



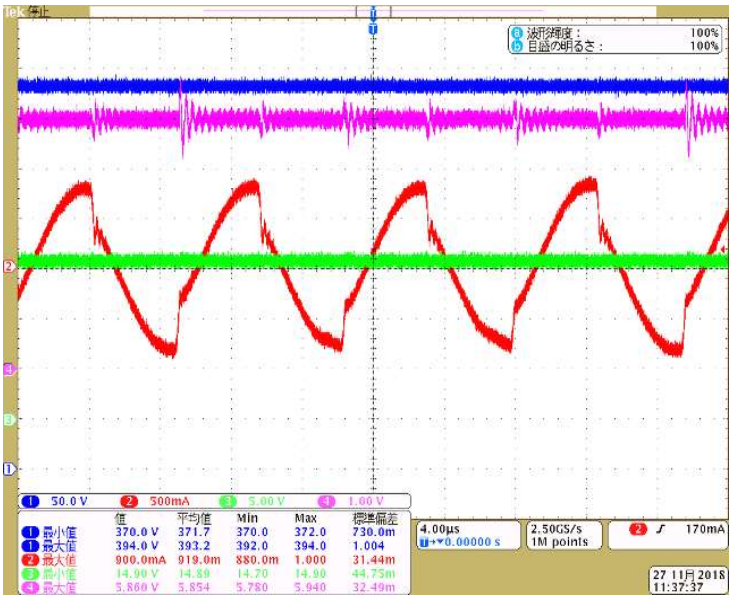
① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[1mS/div]

4-5.2 [80μS/div] There is fluctuation in a part of the current waveform peak.



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[80μS/div]

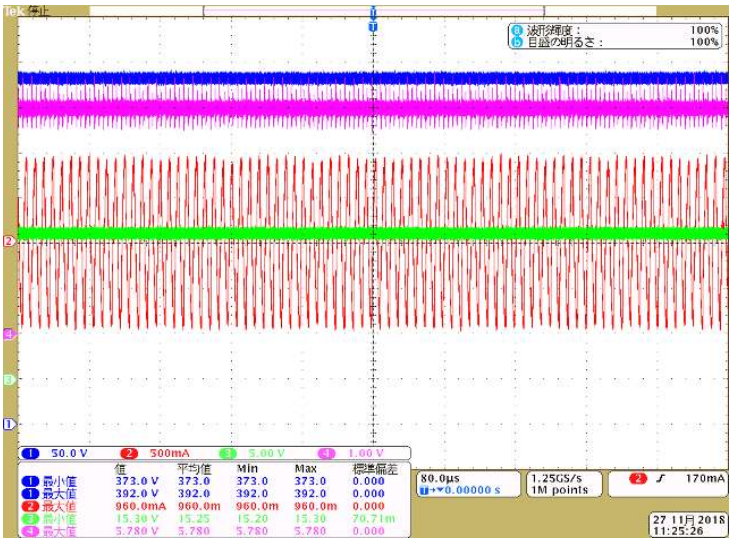
4-5.3 [4μS/div]



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[4μS/div]

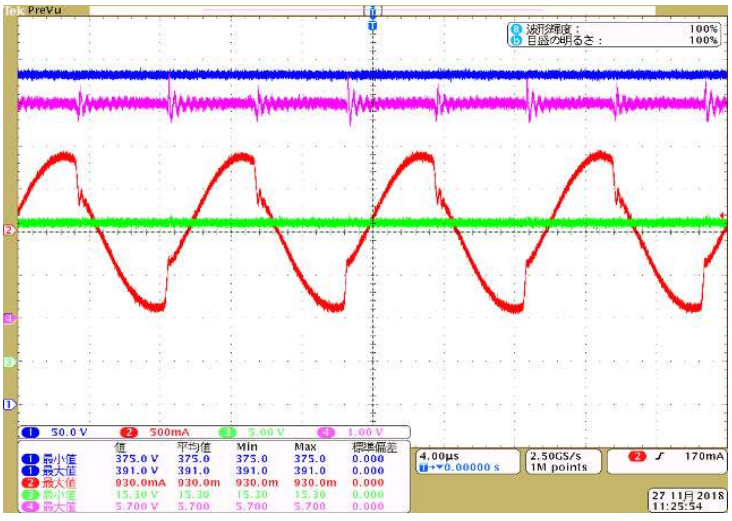
4-6. 5V5A, 24V2A

4-6.1 [80μS/div] There is fluctuation in a part of the current waveform peak.



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[80μS/div]

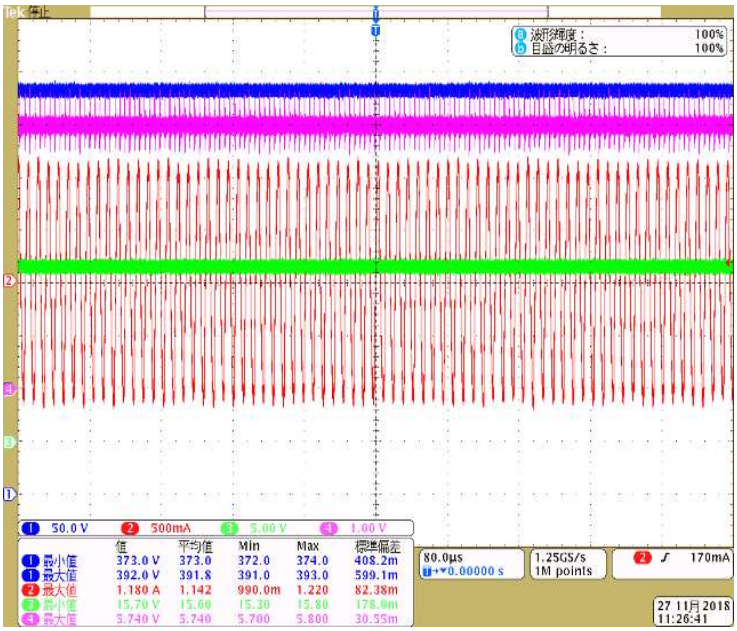
4-6.2 [4μS/div]



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[4μS/div]

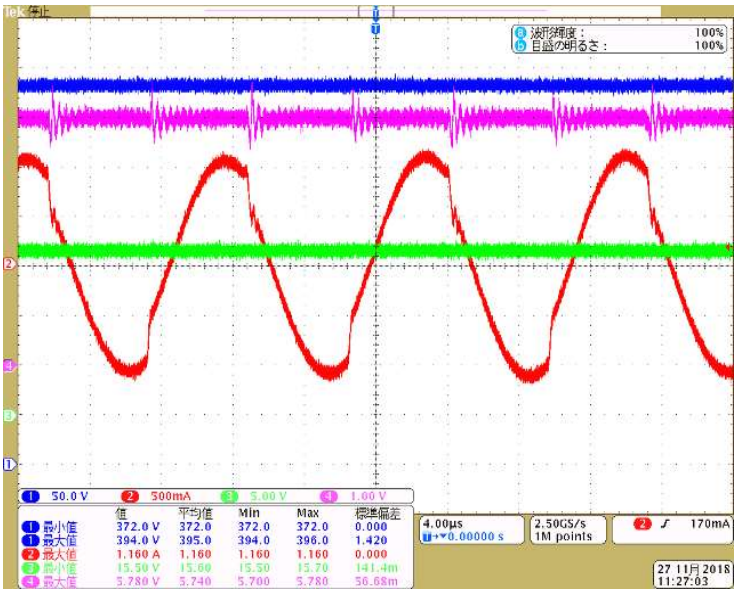
4-7. 5V10A, 24V2A（All rated load）

4-7.1 [80μS/div] There is almost no fluctuation in the current waveform and it is within the allowable range?



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[80μS/div]

4-7.2 [4μS/div]



① Blue: LLC_Vin [50V/div]
② Red: LLC_Isw [0.5A/div]
③ Green: Vcc(LLC) [5V/div]
④ Pink: 5V_out [1V/div]
H:[4μS/div]