Weltrend AC DC Total Solution

Weltrend Semiconductor Inc.

05/28, 2018

NB PD-Adaptor Design-1/3

Facing Challenge by Designer

- **單一變壓器同時支援4倍/7倍輸出電壓**
  - PD2.0/3.0→ 5V~20V (4倍壓)
  - PD3.0 with PPS→ 3.3V to 21V (7倍壓)
- **PWM IC Vcc 寬工作電壓**
  - PWM IC Vcc 耐壓不足/輕載效率
- **系統穩定度**
  - 傳統IC單一補償參數，目前需要兼顧3.3V~21V不同輸出電壓
- **過功率保護功能**
  - 3.3V~21V考量LPS規範
- **線路精簡/PCB小型化**
- **規格不斷更新**
  - PD2.0→3.0→+PPS ; QC2.0→QC3.0→QC4.0/4.0+

NB PD-Adaptor Design-2/3

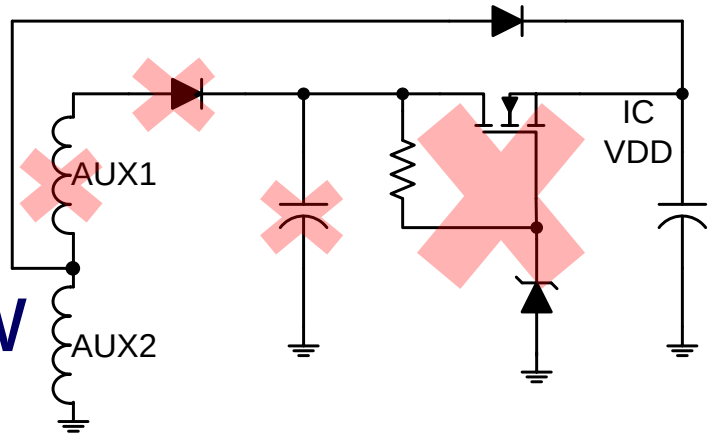
Weltrend WT7160 Advantage Solution

- **單一變壓器Vcc繞組可實現四倍壓、七倍壓輸出**
  - 無須外部LDO相關零組件與額外Vcc繞組
  - 僅需修改PD Code
- **兼容PD2.0/3.0+PPS/QC4.0/QC4.0+**
- **符合未來PD3.0+PPS (3.3V~21V)需求**
  - 變壓器設計單一化、有效降低成本
    - PCB共用性大幅提高→降低(備料)成本
    - 工序簡化，繞製成本降低
  - 安規不需要重新申請(兼容性)
  - 縮短產品開發時間並降低研發成本

NB PD-Adaptor Design-3/3

Weltrend WT7160 Advantage Solution

- CCM/QR Multi-Mode Control
  - Improve efficiency
- 符合DOE Level 6、CoC 5 Tier-2
- 無載No load power loss <50mW
- Start-up啟動時間< 0.5sec
- 有效減少周邊零組件、降低PCB設計成本
  - Single auxiliary winding (25~26V, VDD OVP:31V)
  - Eliminate External VDD’ s LDO
  - OCP/OTP/OVP/UVP/OPP…..Full Protection Function



Cost/Spec Competitive Advantang-3/3

Weltrend 偉詮電子

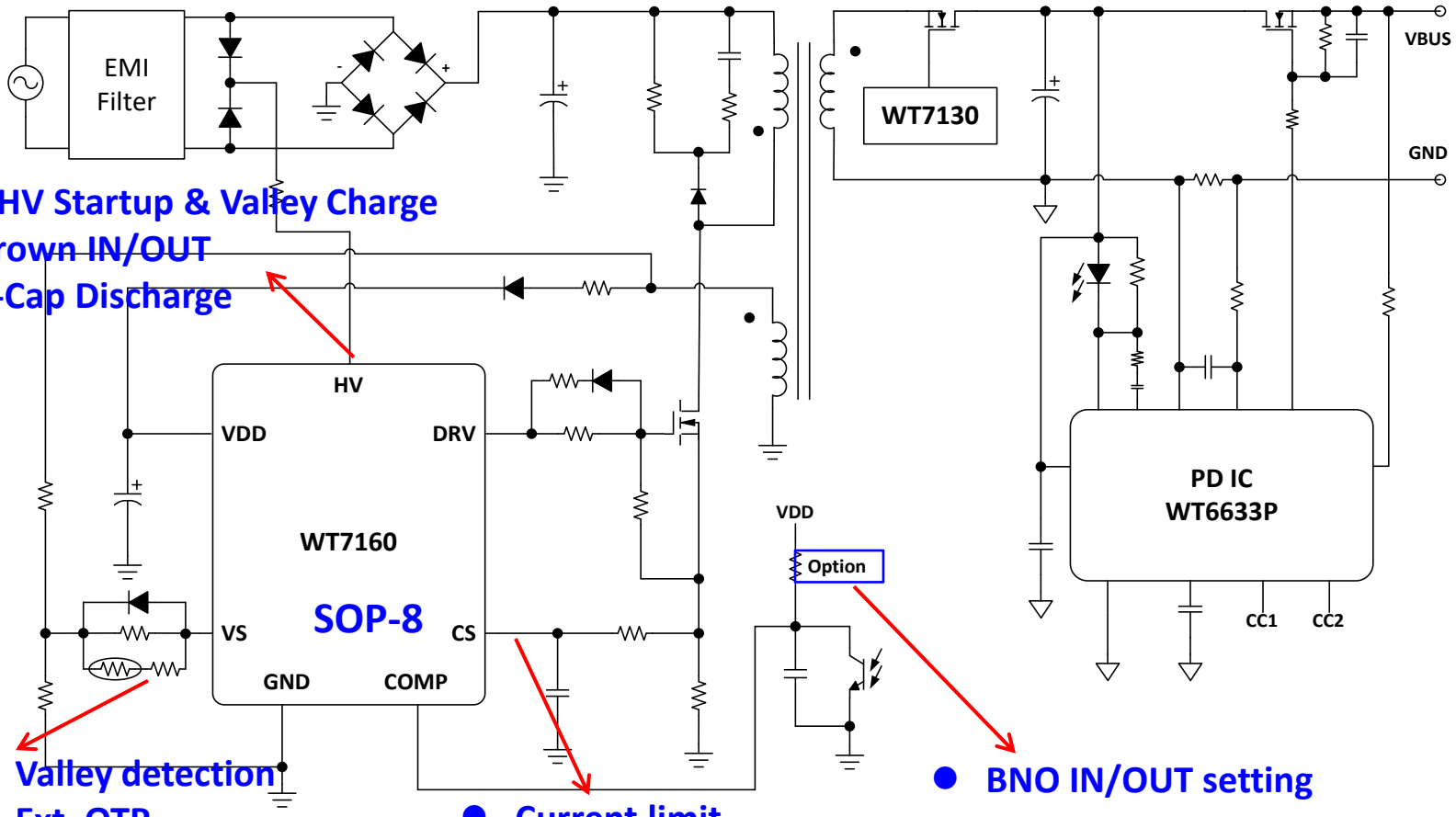
PD3.0+PPS(3.3V~21V) 7倍壓輸出設計需求

	Weltrend	R	L	R
	WT7160	Rxxx86	Lxxx63	Rxxx91
uHV-Pin 耐壓	600V	600V	650V	Lo-V
PD3.0+PPS (七倍壓應用)	單一變壓器	重新設計及安規申請	重新設計及安規申請	重新設計及安規申請
VDD	31V	40V	70V	70V/50V
外部 LDO	NA	Yes	Yes	Yes
輸出電壓	Support 四/七倍壓	Only 四倍壓	Only 四倍壓	Only 四倍壓

Introduction of WT7160

- UHV Pin 600V startup and BNO/X-Cap discharge(IEC62368)
- **UHV Valley Charge mode for USB PD with PPS (3.3V~21V) Application ,**
  Eliminate External LDO & 2nd Aux. winding design for USB PD application
- **Optimized for (PD&QC)Wide Output Voltage**
  - ✓ **Adaptive OCP Compensation** with Adjustable Line Compensation
  - ✓ **Adaptive Green Mode Control** CCM/QR Multi-mode operation
  - ✓ Meet DOE Level 6 and CoC 5 Tier 2
  - ✓ No load power loss<75mW
- External Over Temperature Protection on VS Pin
- VS UVP & CS Short Protection

Application circuit of WT7160



- UHV Startup & Valley Charge
- Brown IN/OUT
- X-Cap Discharge

- Valley detection
- Ext. OTP
- OVP/UVP
- Vin Detection

- Current limit
- OCP Compensation

- BNO IN/OUT setting

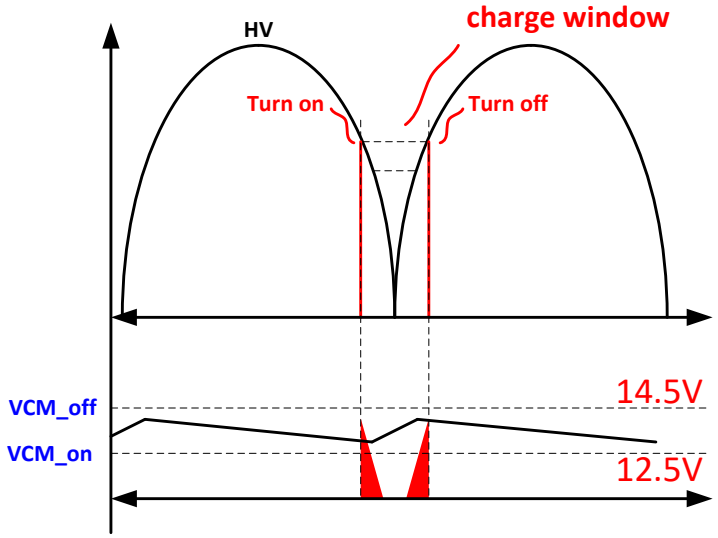
UHV Valley Charge Mode

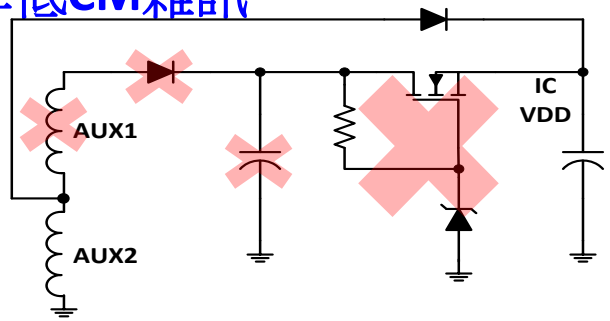
AC Input Valley Tracking Charge mode to supply IC VDD

PATENT

WT7160 HV pin優勢

- 簡化VDD 線路，減少零件數量節省PCB 面積。並且降低成本
- 減少變壓器繞組，降低變壓器製造成本，降低CM雜訊





- **VDD CAP ≧22uF**
- 5V Vout Hold up Time depend on VDD CAP Value
- VDD OVP 31V
- **Vout:20V => IC VDD≒25~26V**

Brown IN/OUT Function @ HV Pin

BNO IN

1. The WT7160 has four brown in/out thresholds, which set by a resistor between VDD and COMP pin.
2. HV Pin Voltage > brown-in threshold over 128us & VDD > 13.5V => BNO IN

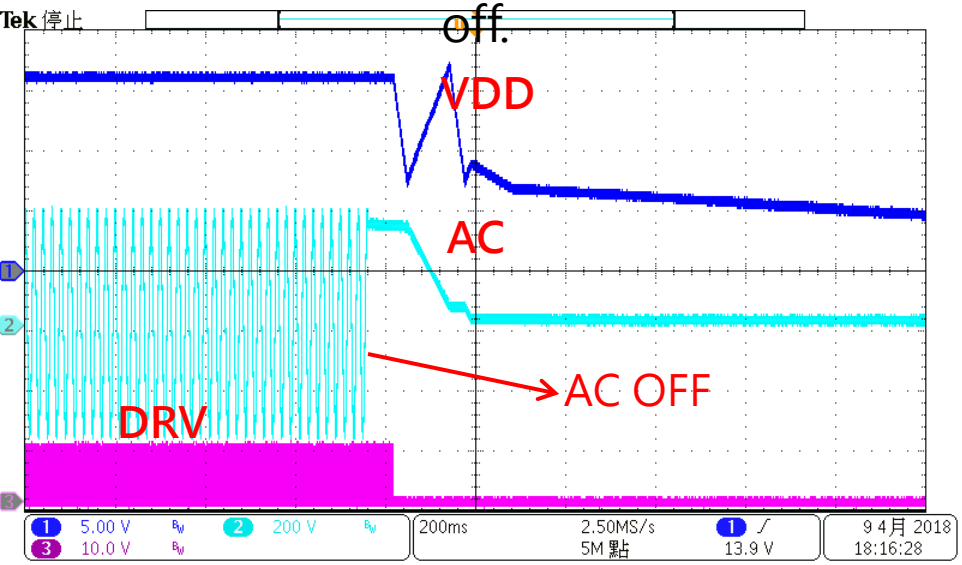
BNO OUT

1. HV Pin Voltage < brown-out threshold over 64ms => BNO Out
2. Auto Recovery Type

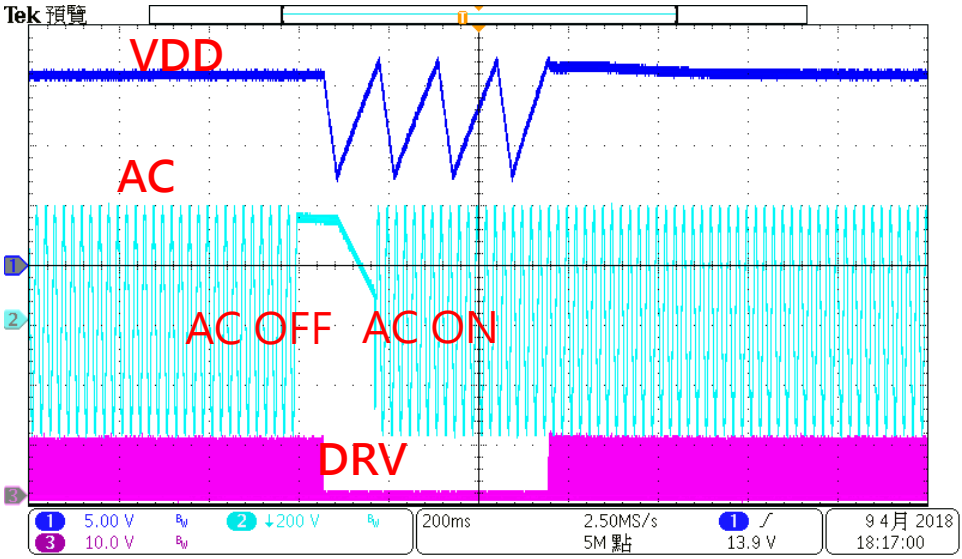
BNO IN/Out	VDD to COMP R(Ω)
160/144 V_{rms}	2MEG
140/126 V_{rms}	3.9MEG
70/63 V_{rms}	8MEG
80/72 V_{rms}	NC(default)

AC Off & X-Cap Discharge

The voltage of Xcap is discharged to zero during AC off.



IC will restart after four VDD hiccups when AC fast off to on.



Test Condition:

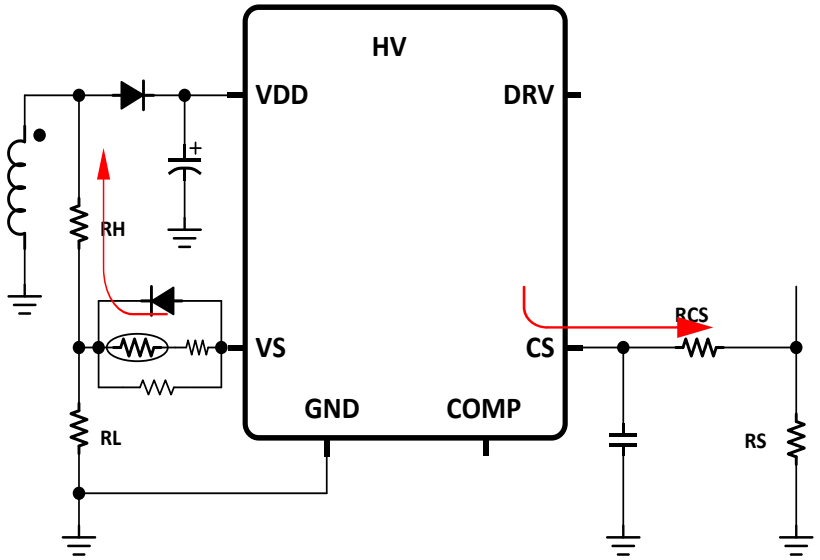
X-Cap:1uF

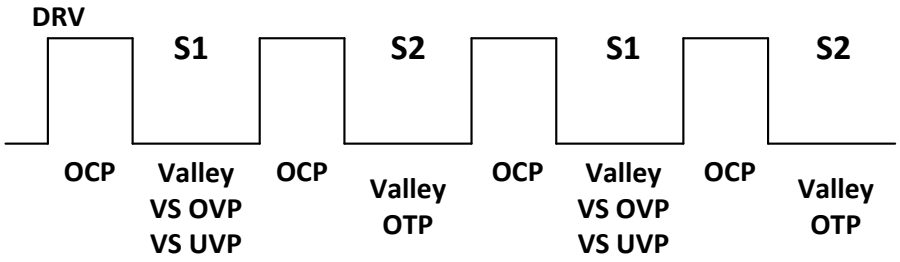
AC Input:264Vac

VDD CAP: 22uF

Multi-function @ VS pin

1. Valley Detection
2. VS OVP
3. VS UVP
4. Over Temperature Protection
5. Adaptive Green Mode Control
6. OCP High/Low Line Compensation
7. Adaptive Over Current Compensation

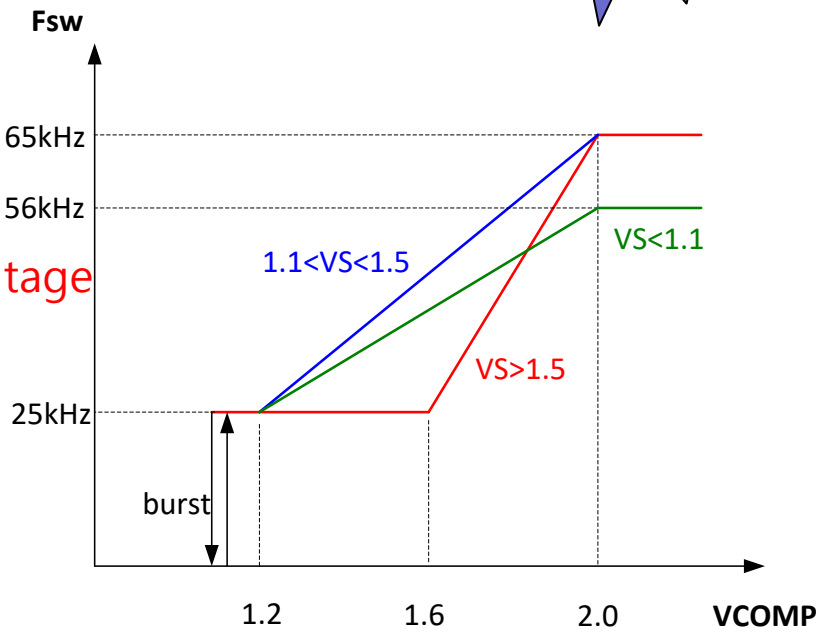




Adaptive Green Mode Control

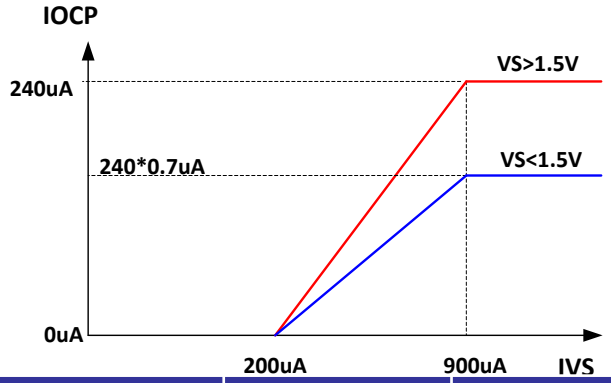
- Improve light load efficiency
  => Reduce switching loss
- Switching frequency proportion to VCOMP
- Burst mode operation for deep light load
- Fixed switching frequency in heavy load
- Adaptive green mode control by VS level
  => Improve system stability for lower output voltage

PATENT

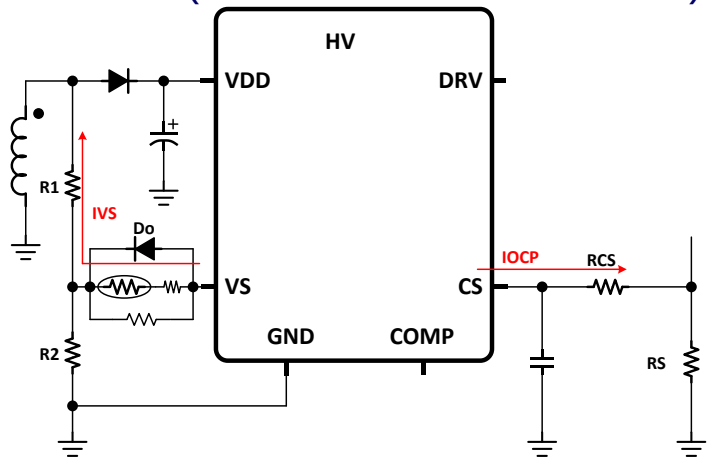


Adaptive Over Current Compensation

- IOCP Compensation current →for different input voltage
- IOCP depends on the clamping current of VS pin when the MOSFET is turned on.
- Output voltage:5/9/12…/20
  - Current limit threshold changed while output varied
- Eliminate discrete extra components to meet LPS (Limited Power Source)



VCS_OFF_12/20V	12-20V OCP	VS>1.5	0.66V
VCS_OFF_9V	9V OCP	VS>1.1	0.60V
VCS_OFF_5V	5V OCP	VS>0.7	0.50V
VCS_OFF_3V	3V OCP	VS<0.7	0.47V



$$IVS = \frac{V_{AUX} - VF_{Do}}{R1} - \frac{VF_{Do}}{R2} = \frac{Vin \times N_{AUX}/N_P - VF_{Do}}{R1} - \frac{VF_{Do}}{R2}$$

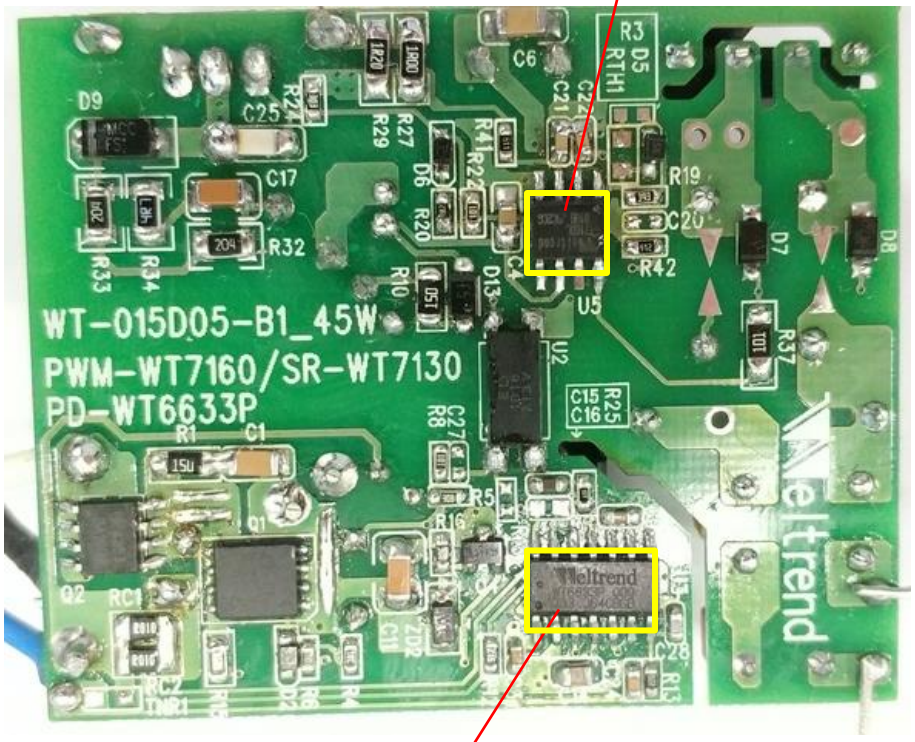
Demo Board Photos

PWM IC:WT7160, SR IC:WT7130, PD IC:WT6633P

57mm*41mm*22mm

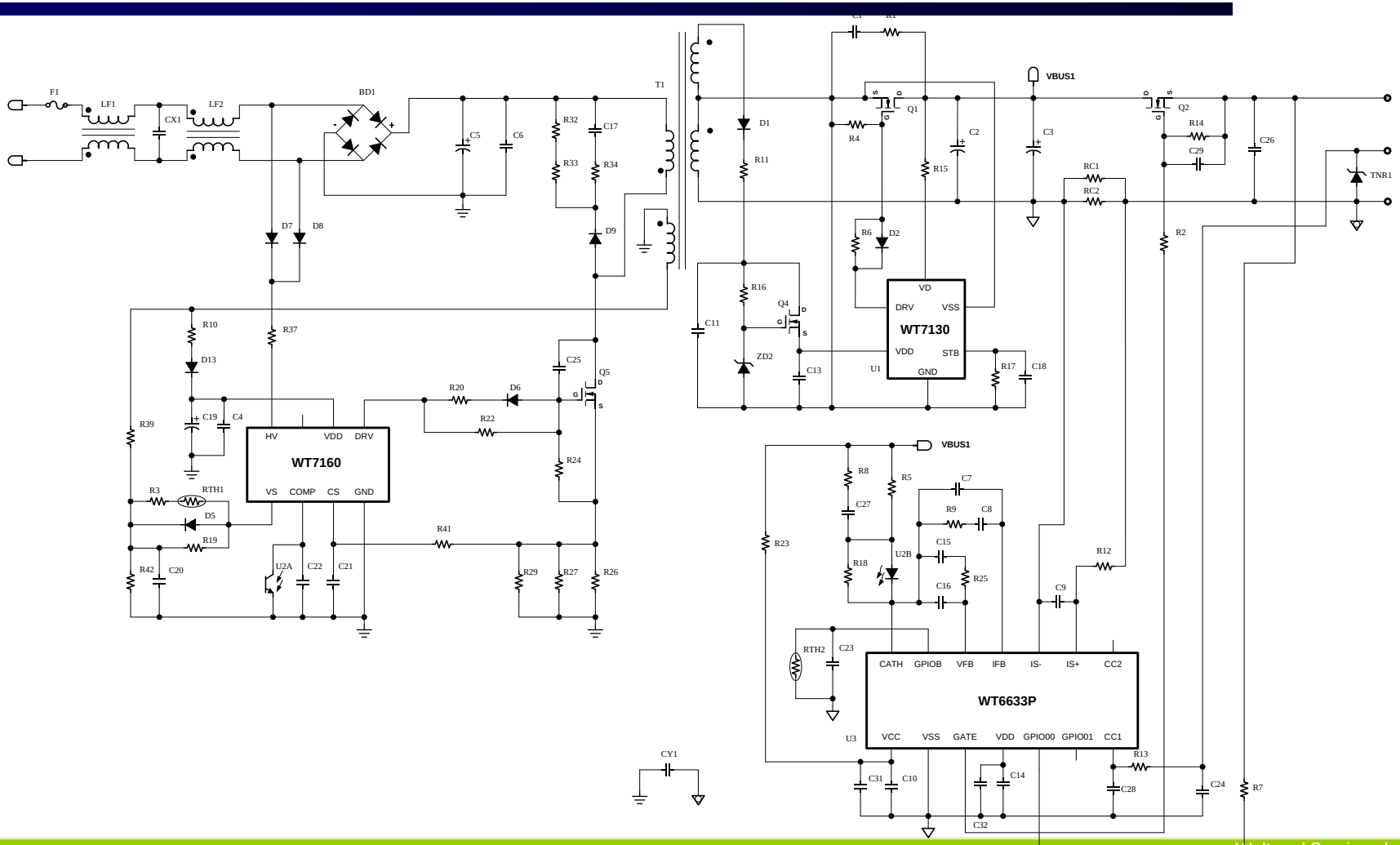
WT7130

WT7160



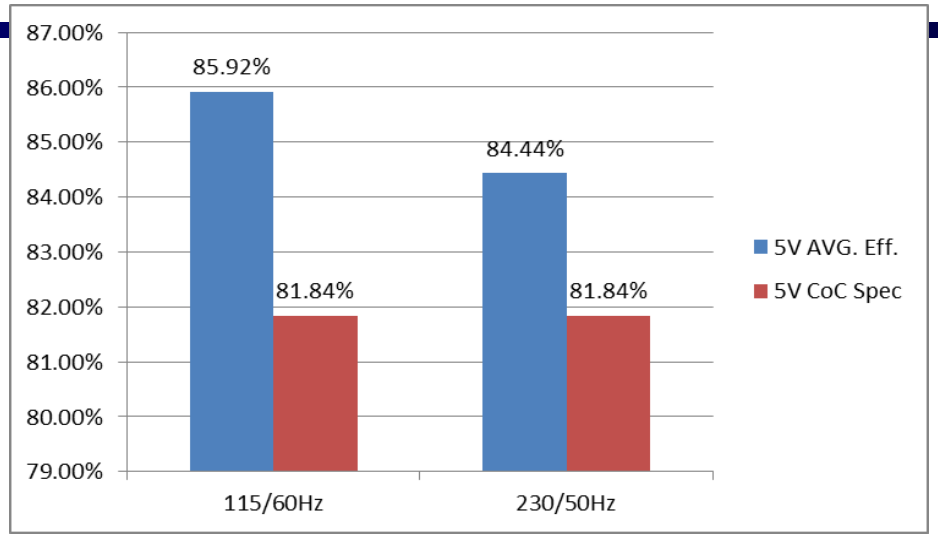
WT6633P

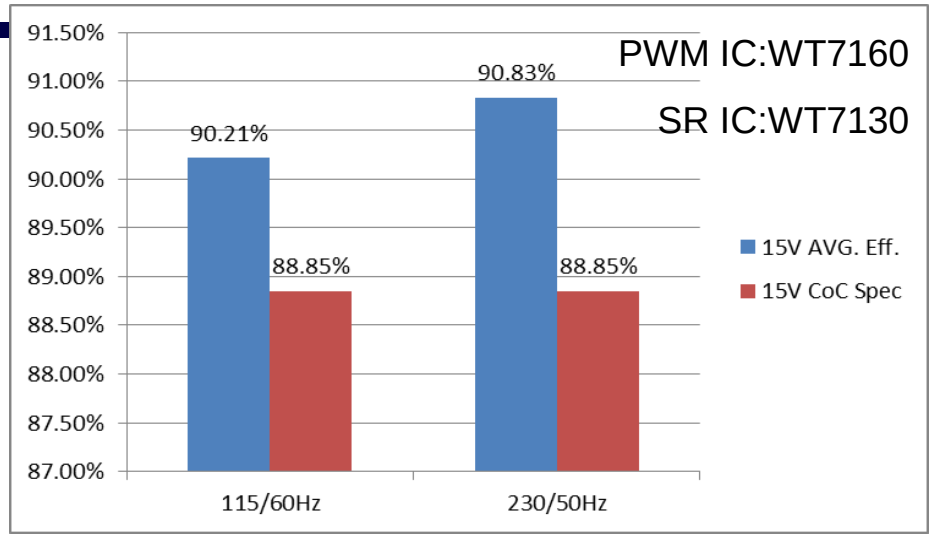
Schematic

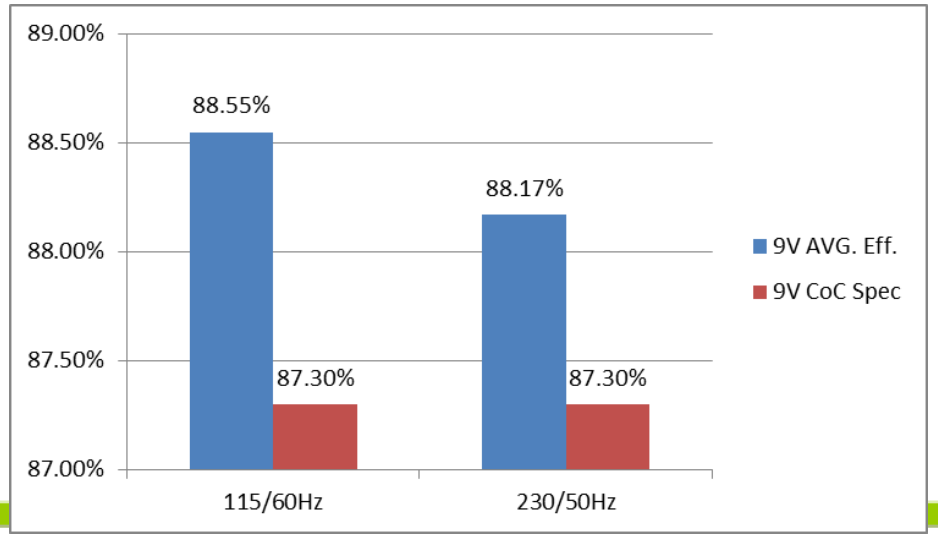


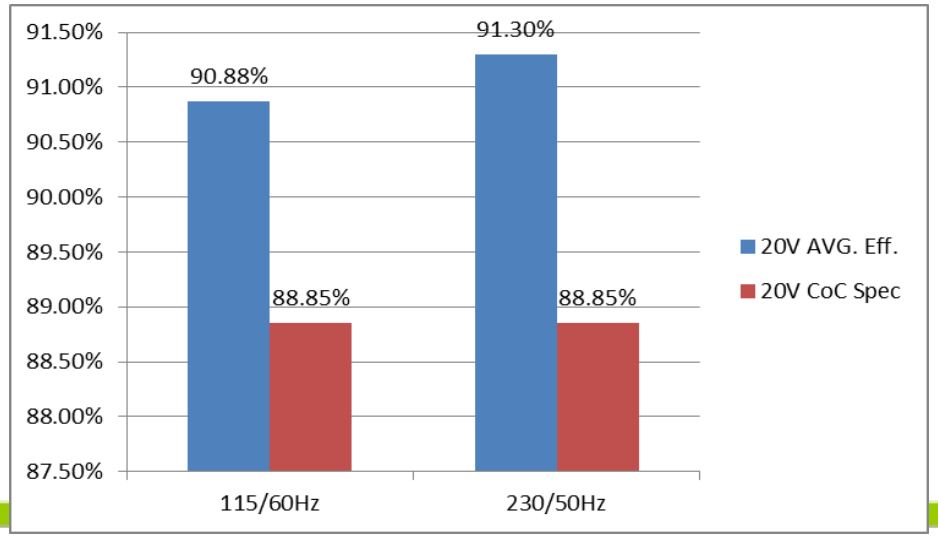
45W Test Board Average Efficiency

45W Test Board







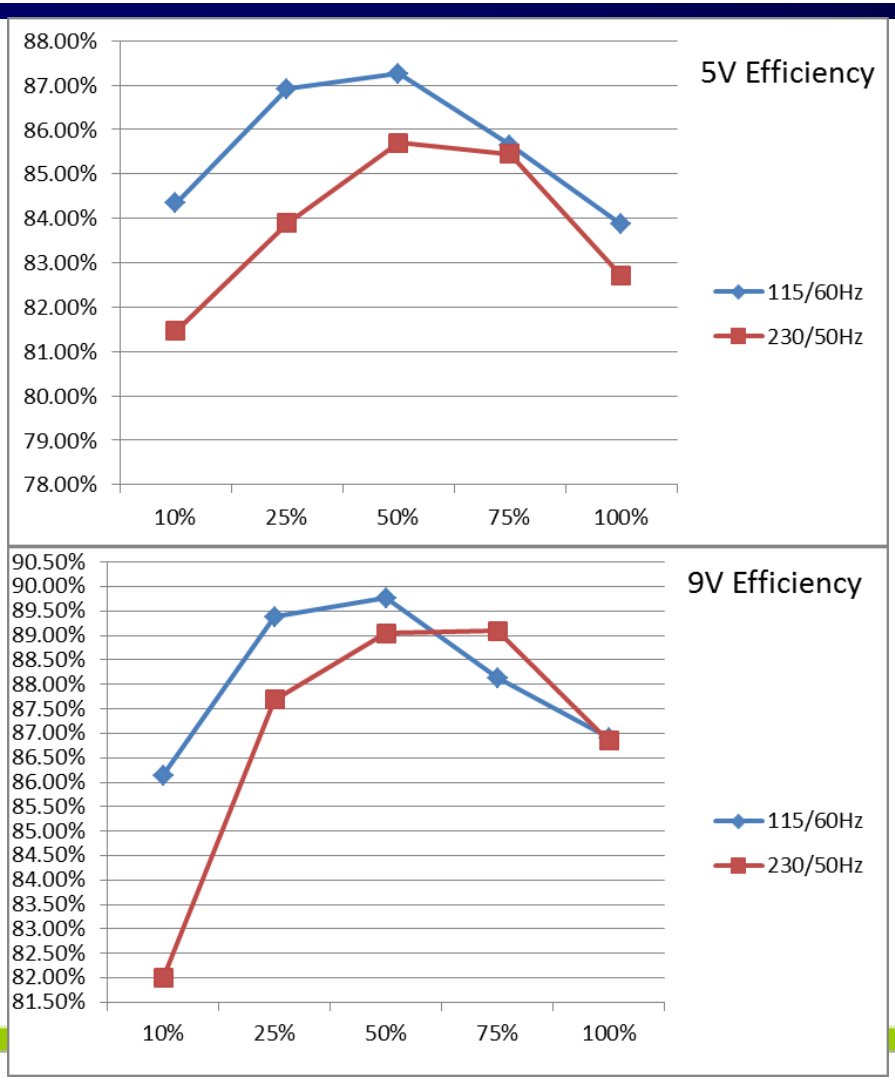


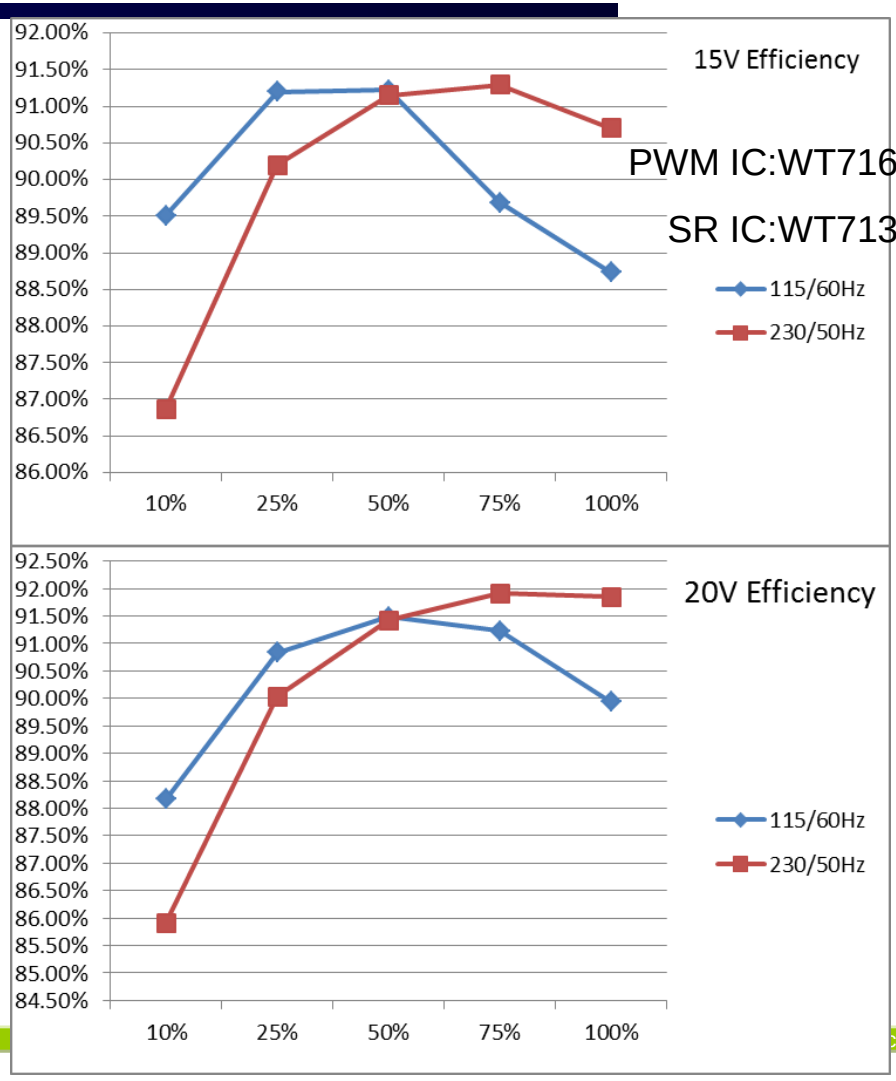
With 1.8m Cable

With 1.8m Cable

45W Test Board Efficiency

45W Test Board





PWM IC:WT7160

SR IC:WT7130

No Load Power Loss& 20V Light Load Efficiency

Weltrend 偉詮電子

45W Test Board

PWM IC:WT7160
SR IC:WT7130

No load power loss

90Vin/60Hz 35mW /pass

264Vin/50Hz 50mW/pass

Light load Efficiency

20Vout/ Po=0.25W

90Vin Pin=0.39W/pass (<0.5W)

264Vin Pin=0.42W/pass (<0.5W)

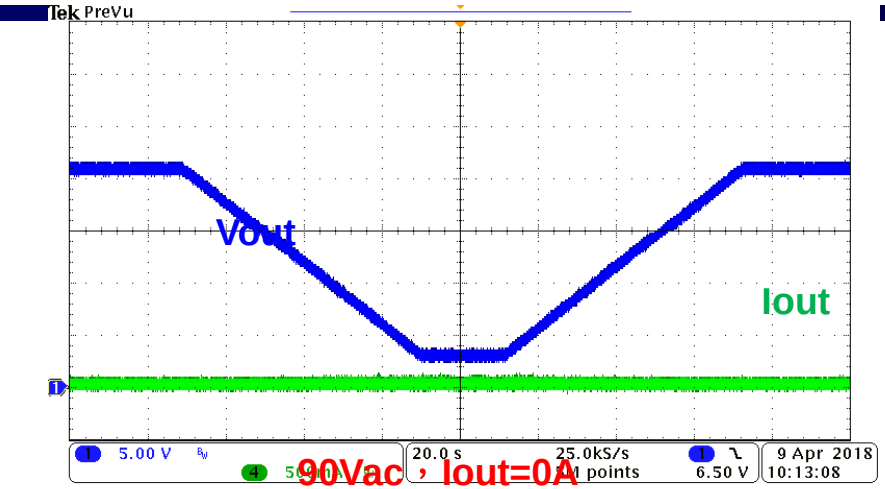
20Vout/Po= 0.5W

90Vin Pin=0.68W/pass (<1W)

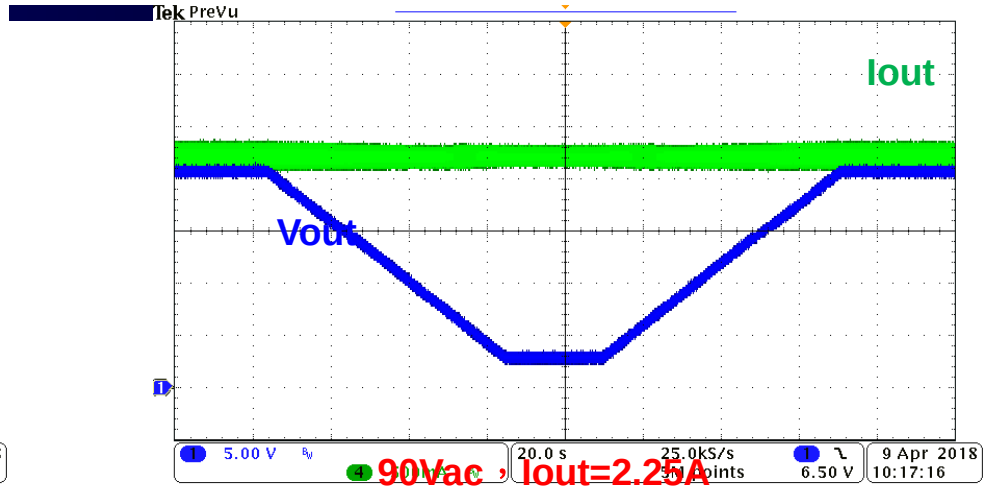
264Vin Pin=0.72W/pass (<1W)

Programmable Power Supply

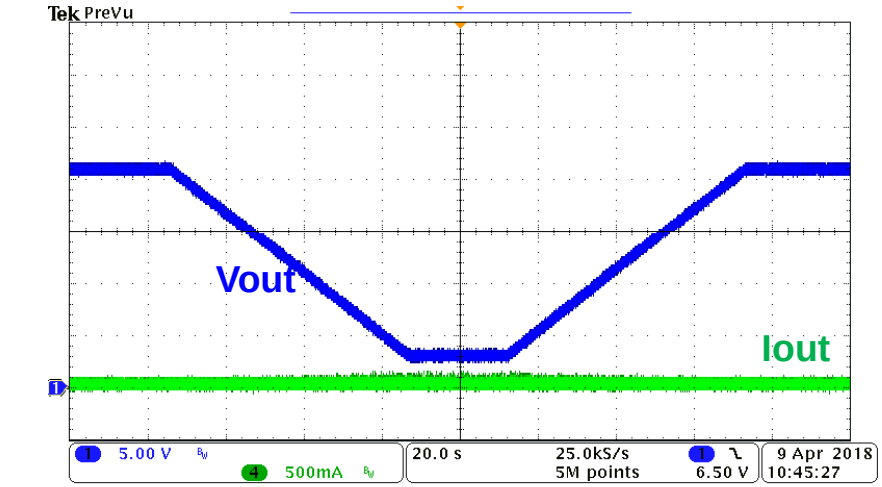
3V→21V



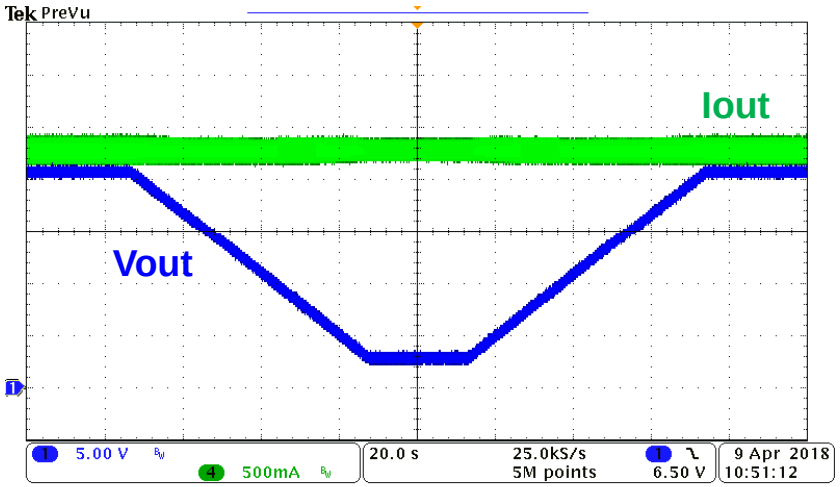
90Vac，Iout=0A



90Vac，Iout=2.25A



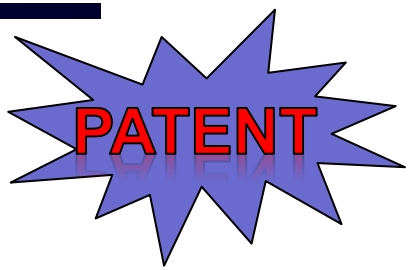
264Vac，Iout=0A



264Vac，Iout=2.25A

WT7130
Synchronous Rectification Controller

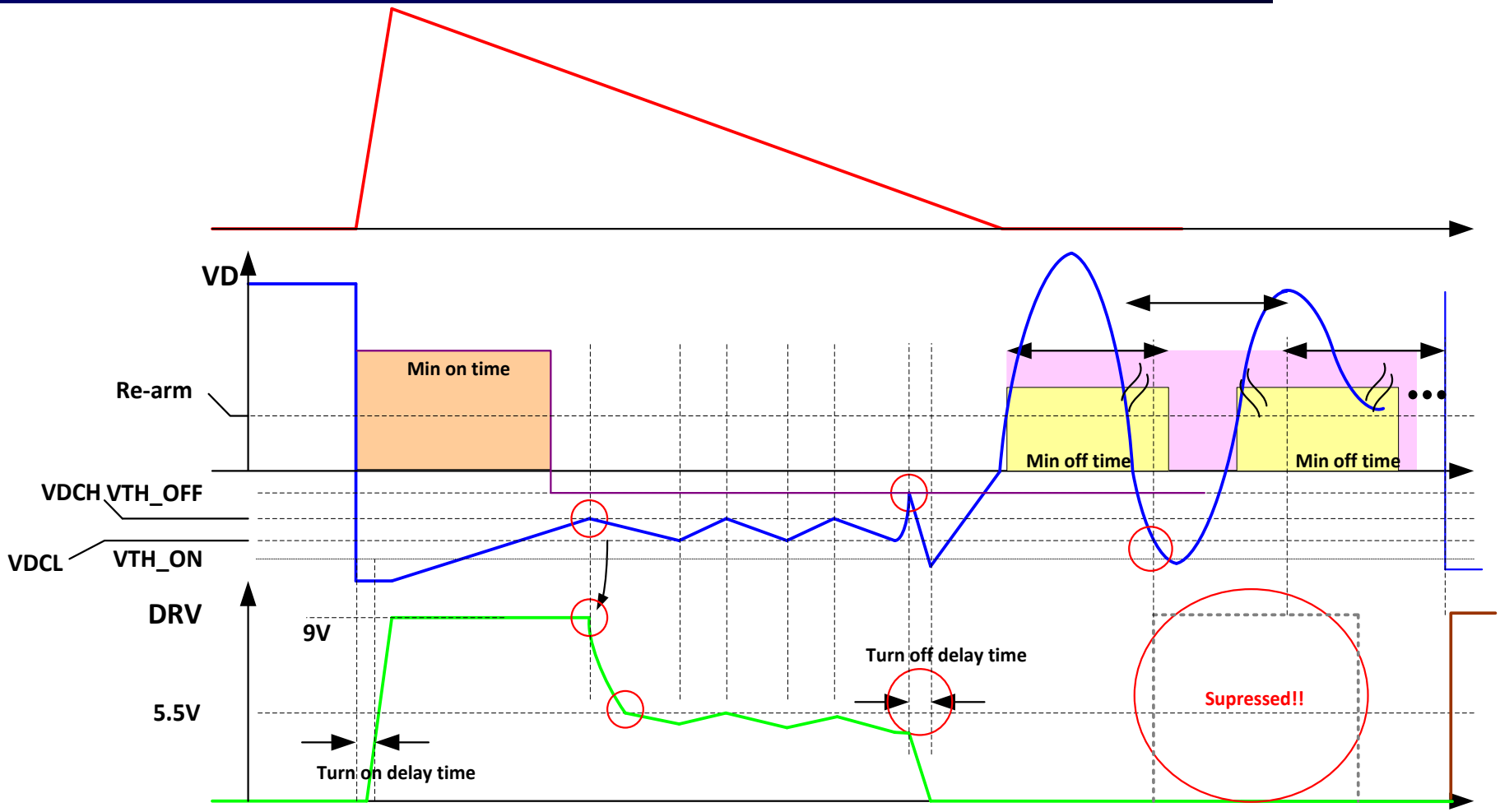
Introduction of WT7130



Product Features

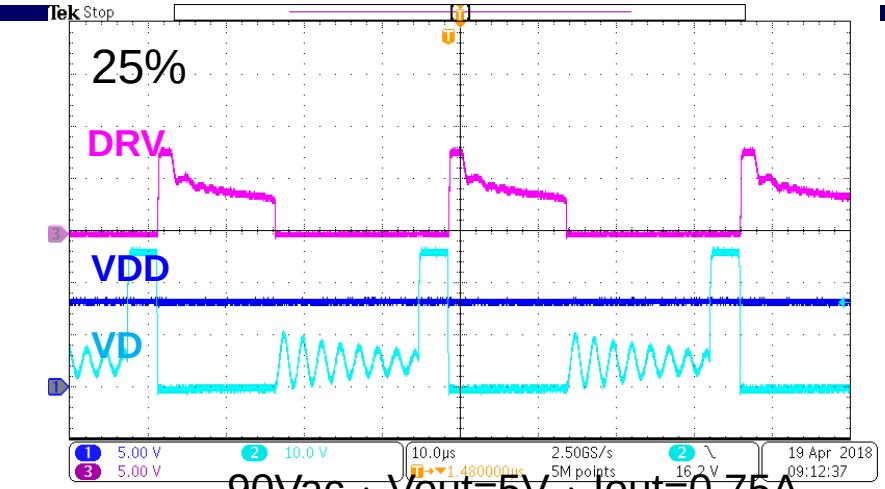
- **VDS Voltage Sensing with 35ns turn off delay**
- Wide VDD working voltage range (4.5V~28V)
- **V_{DS} MOSFET Direct-sensing(200V)**
- Adjustable standby level
- Internal over temperature protection
- **DRV pin suspended when VDD OVP & OTP**
- **Low operation current at standby mode(<1mW)**
- **Unique dynamic DRV Regulation technology(patent)**
- **Low turn off threshold -5mV**
- **SOT-26 package**

Blanking Time of WT7130

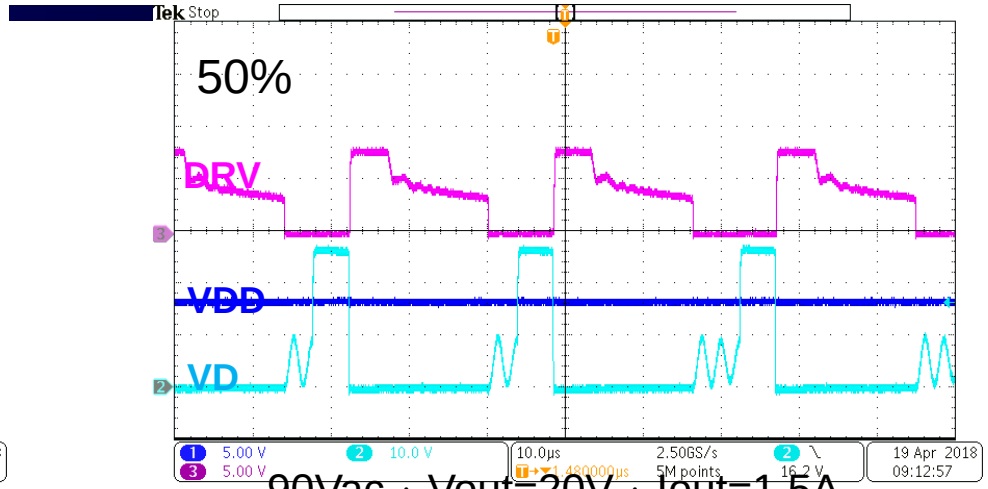


Secondary Waveform

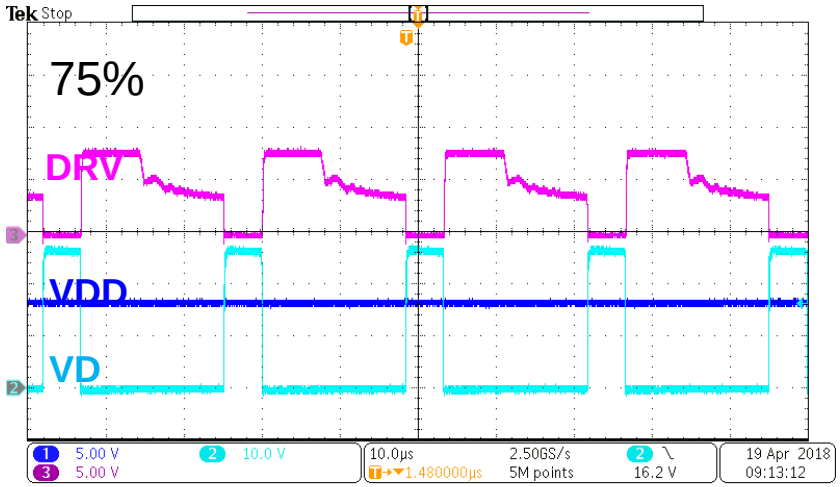
90Vin/Vout=5V



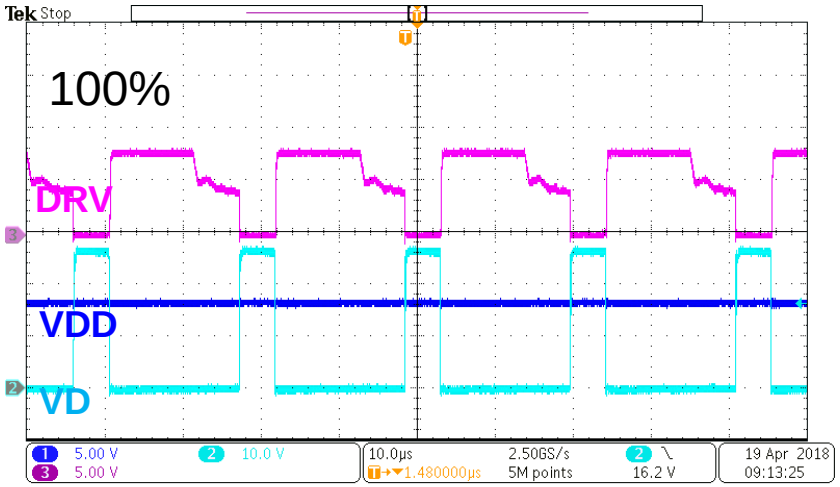
90Vac，Vout=5V，Iout=0.75A



90Vac，Vout=20V，Iout=1.5A



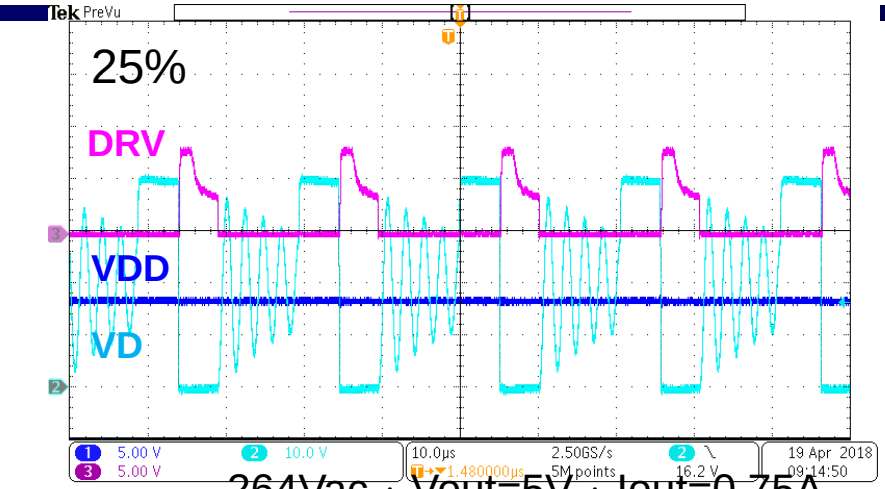
90Vac，Vout=5V，Iout=2.25A



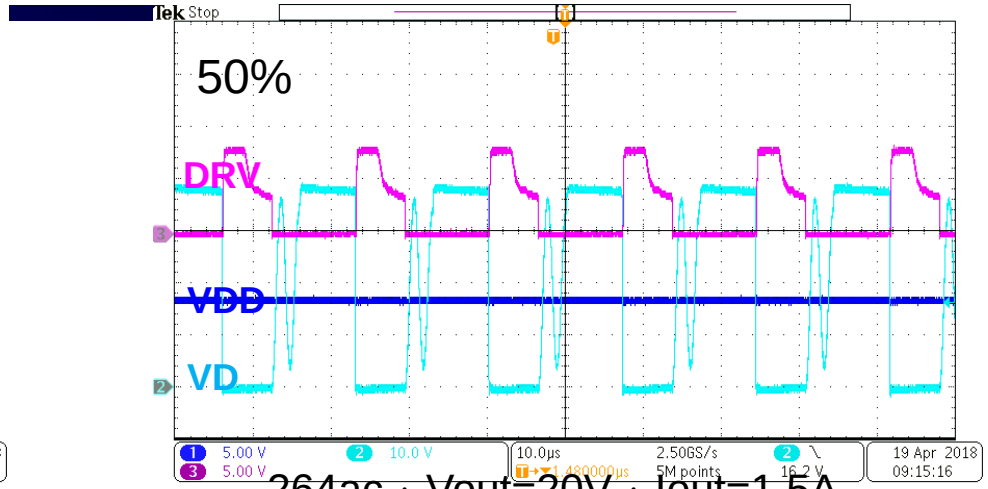
90Vac，Vout=5V，Iout=3A

Secondary Waveform

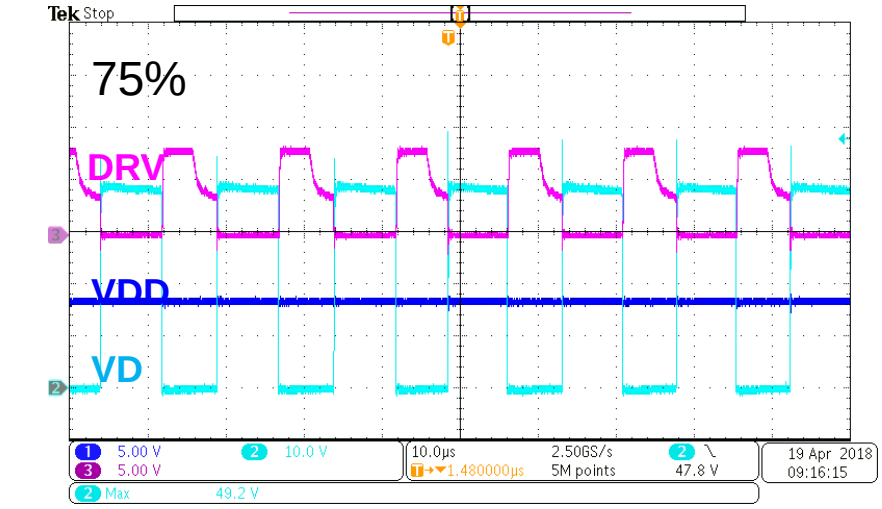
264Vin/Vout=5V



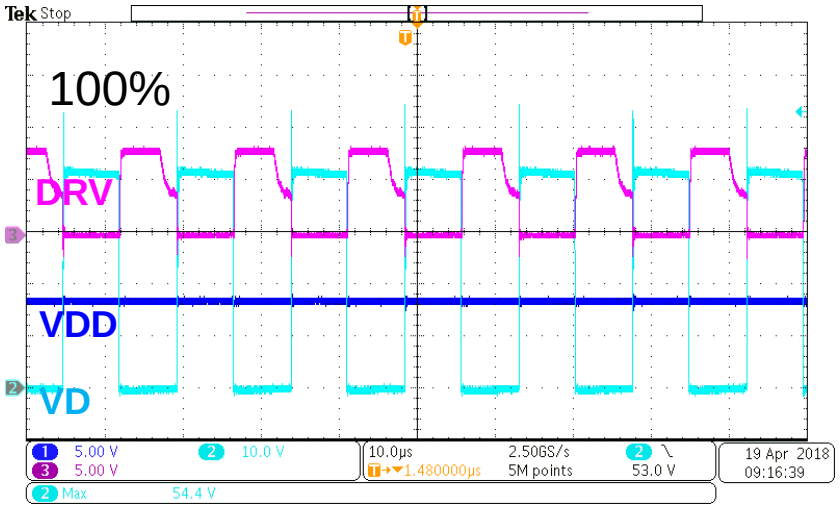
264Vac，Vout=5V，Iout=0.75A



264ac，Vout=20V，Iout=1.5A



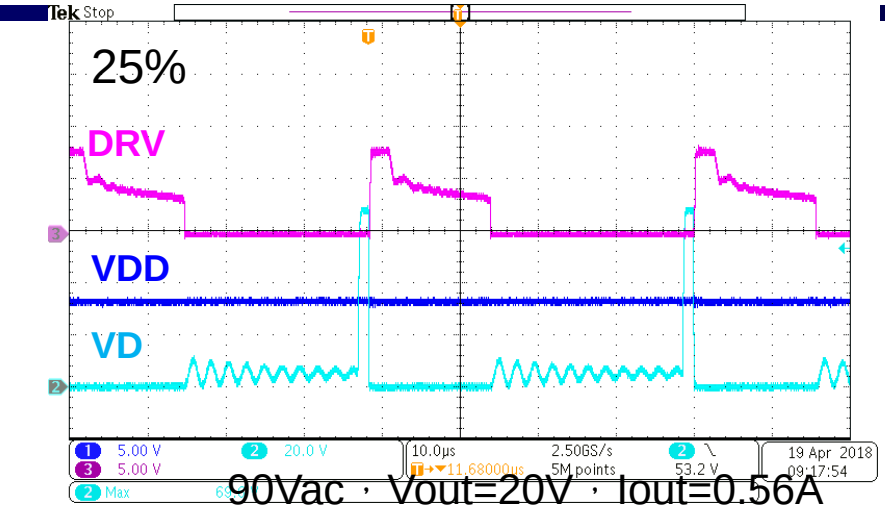
264Vac，Vout=5V，Iout=2.25A



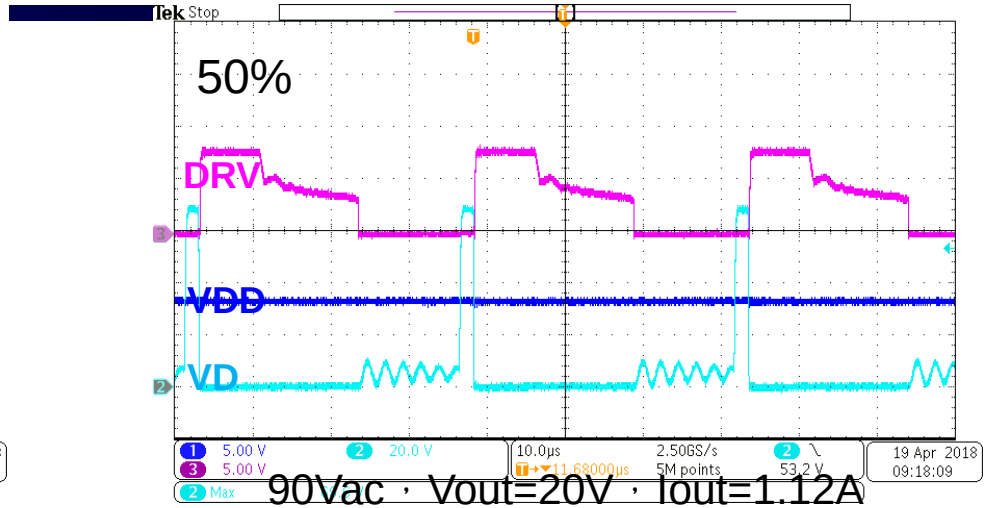
264ac，Vout=5V，Iout=3A

Secondary Waveform

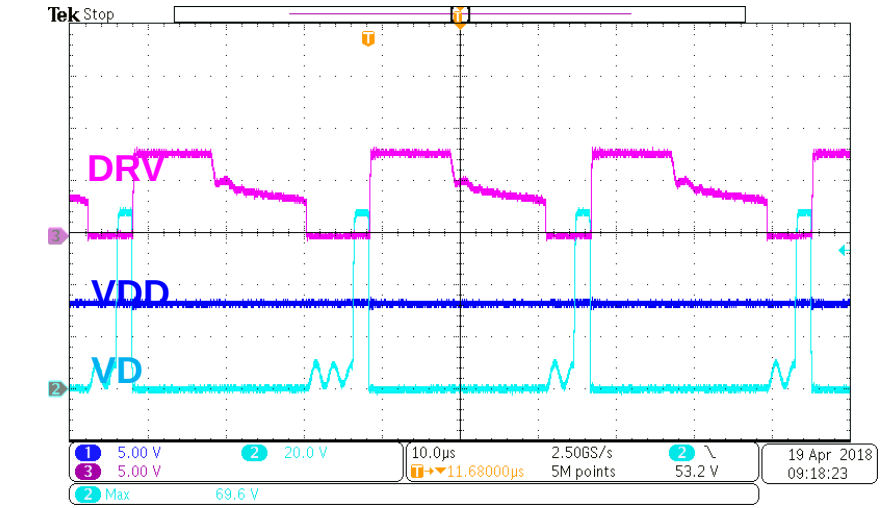
90Vin/Vout=20V



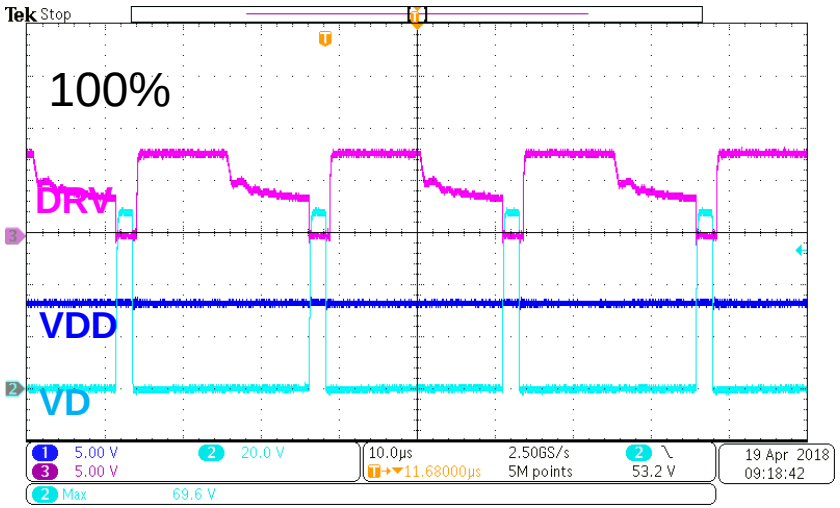
90Vac，Vout=20V，Iout=0.56A



90Vac，Vout=20V，Iout=1.12A



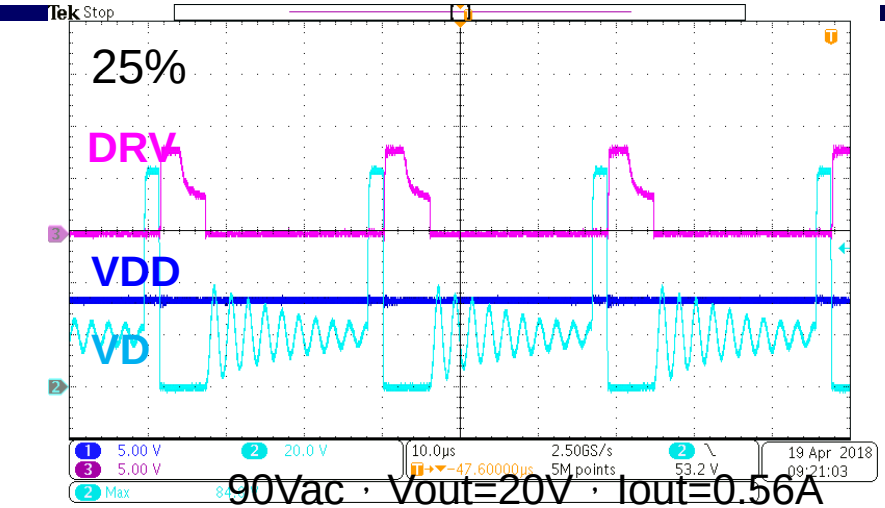
90Vac，Vout=5V，Iout=1.68A



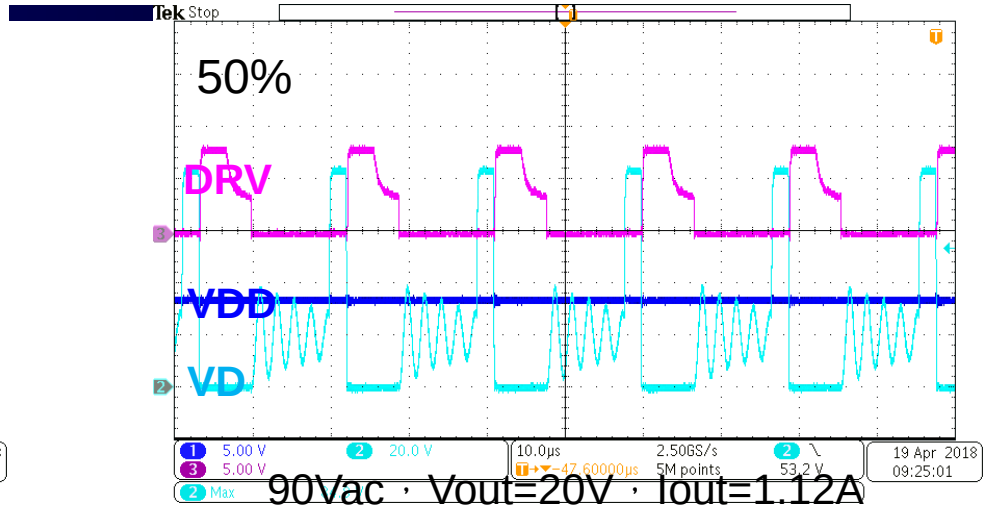
90Vac，Vout=20V，Iout=2.25A

Secondary Waveform

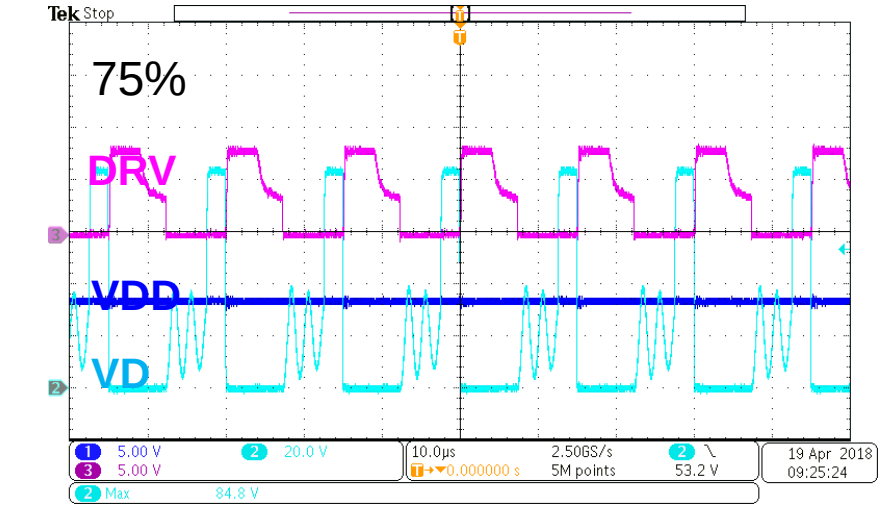
264Vin/Vout=20V



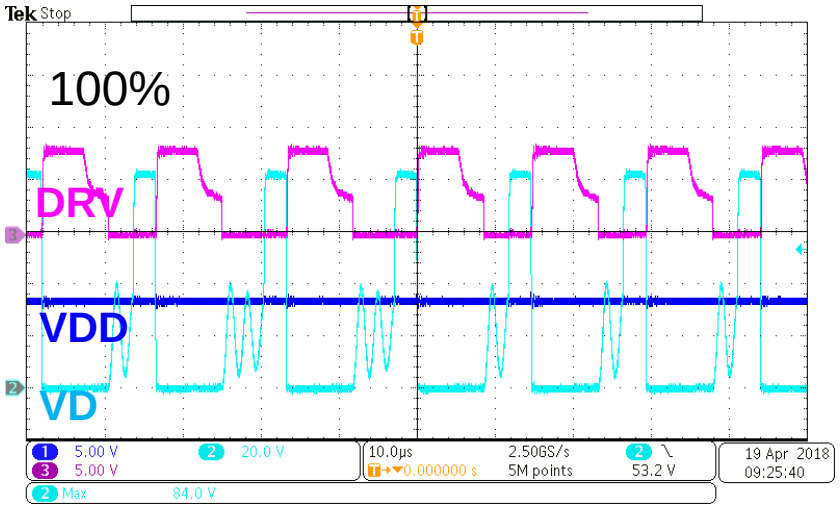
90Vac，Vout=20V，Iout=0.56A



90Vac，Vout=20V，Iout=1.12A



264Vac，Vout=20V，Iout=1.68A



264Vac，Vout=20V，Iout=2.25A

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THANK YOU!