Power Forest Company Profile

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Agenda

- Company Briefing
- Product Introduction
  - PWM Controller PF6151
  - SR Controller PF6602
- Reliability Data

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Company Briefing

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Power Forest Company Profile

Established:	Nov. 30 2009
HQ:	Zhubei city, Hsinchu County
Capital:	1.5E NTD
Product:	Power, Mixed signal & Analog IC
Chairman:	Ian Chan
President:	Song Yi Lin
Employee:	80+

3F. -3, No. 18, Taiyuan 1st St. 台元科技園區

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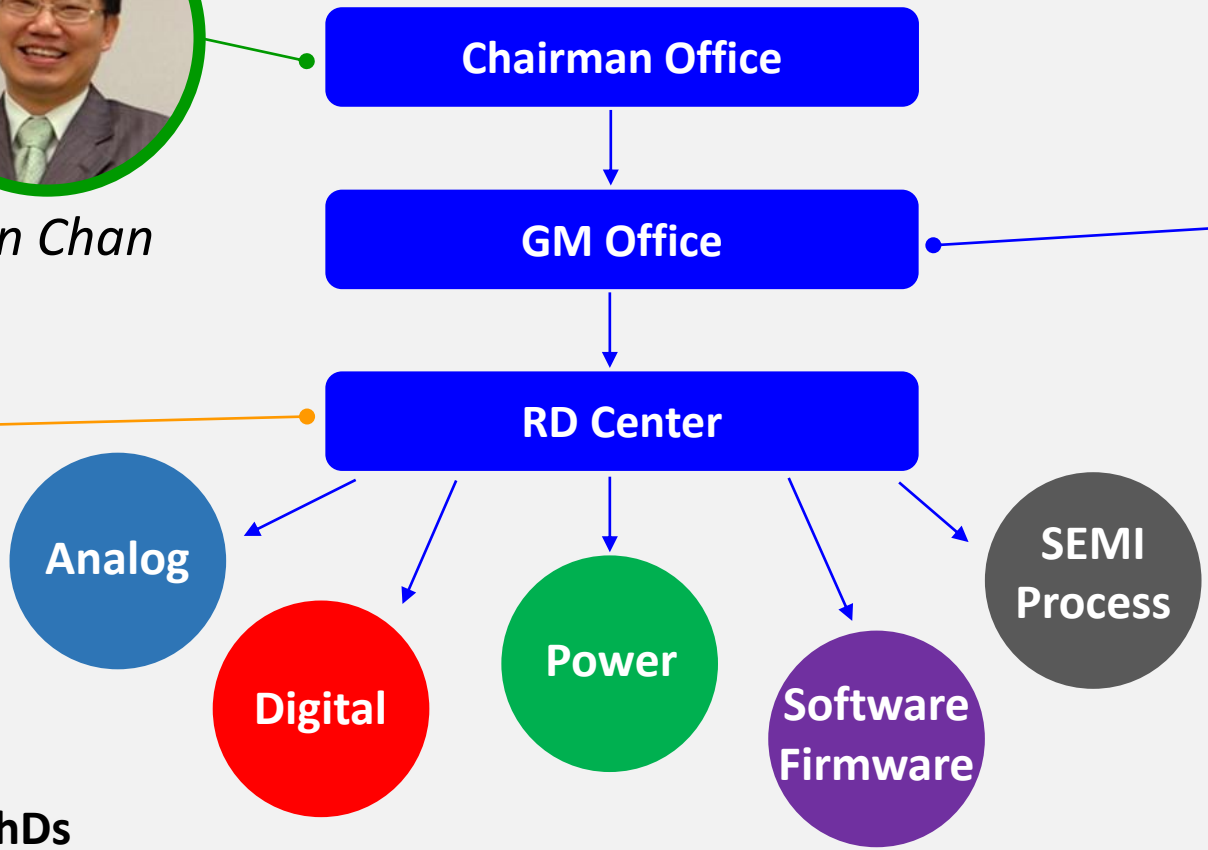
Management and RD Team

Dr. Ian Chan

Dr. GK Hong

Dr. Song Yi Lin



- **Over 60% of R&D**
- **With 35 Masters and 7 PhDs**
- **Members from tier1 companies**

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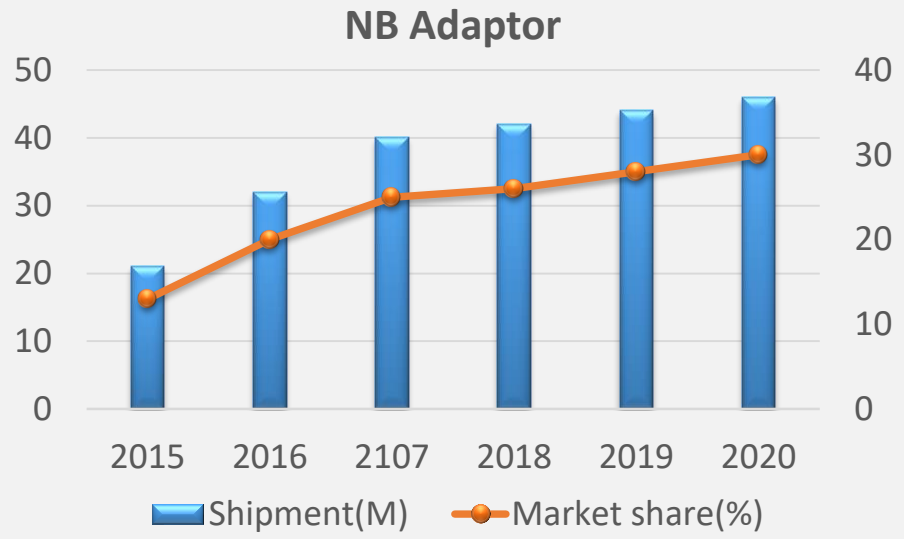
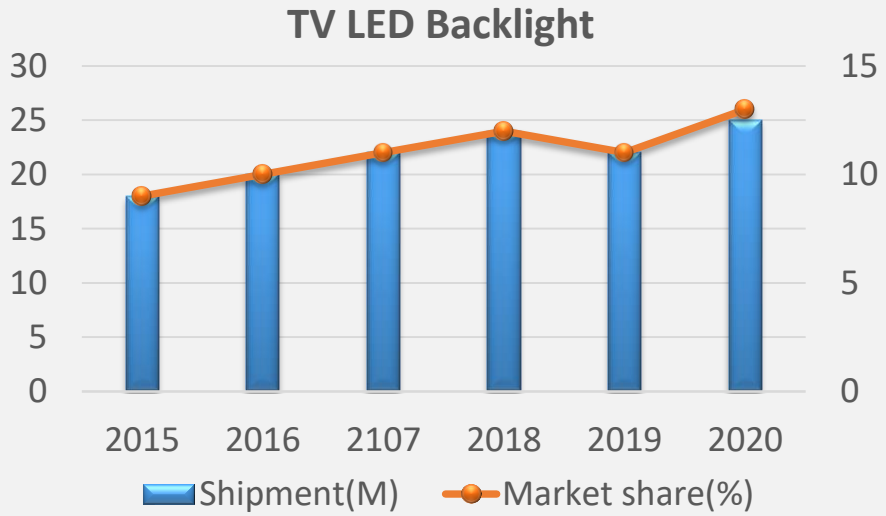
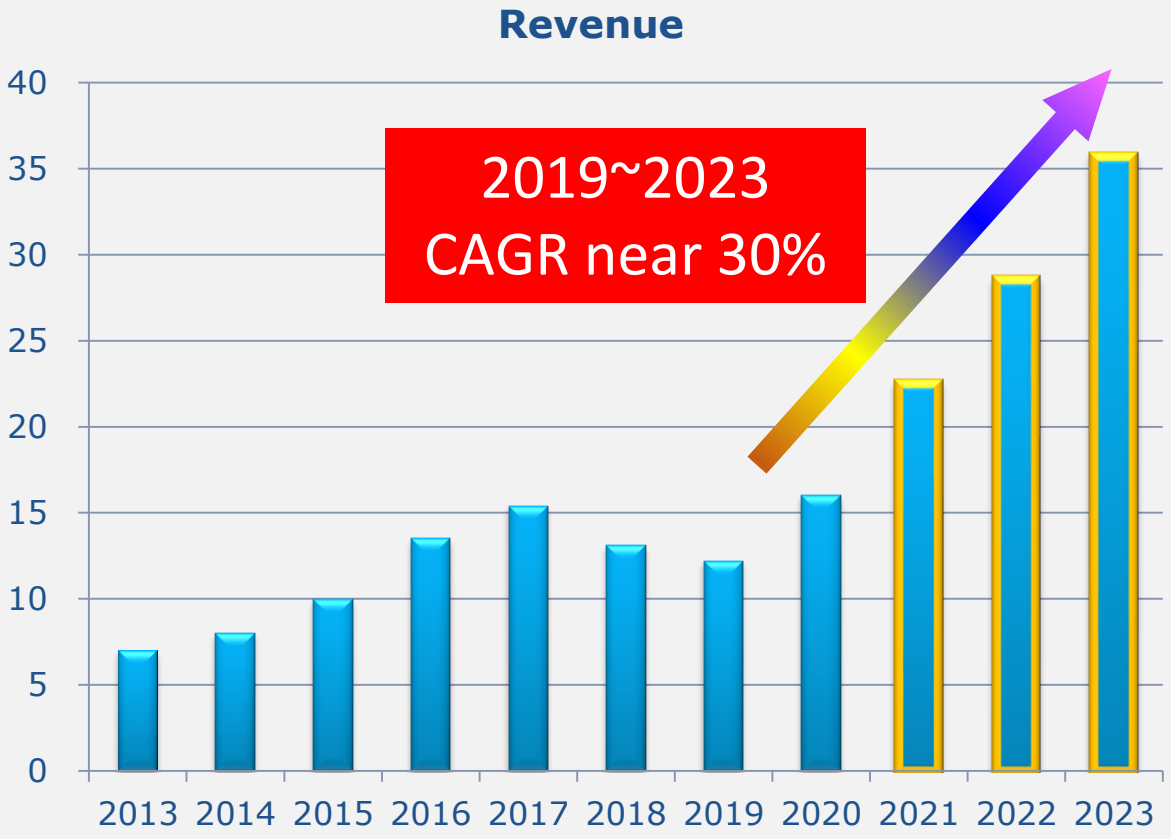
Company Revenue & Shipments





- Continue growth with strong momentum.



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Business Partners

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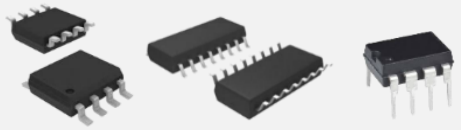


DELTA Chicony POWER TECHNOLOGY TPV

AcBel MW MEAN WELL FOXCONN 鴻海科技集團

PHIHONG Huntkey 航嘉 MOSO 茂硕电源

辰阳电子 CHENYANG ELECTRON

DELL hp invent ASUS lenovo

acer ZEBRA

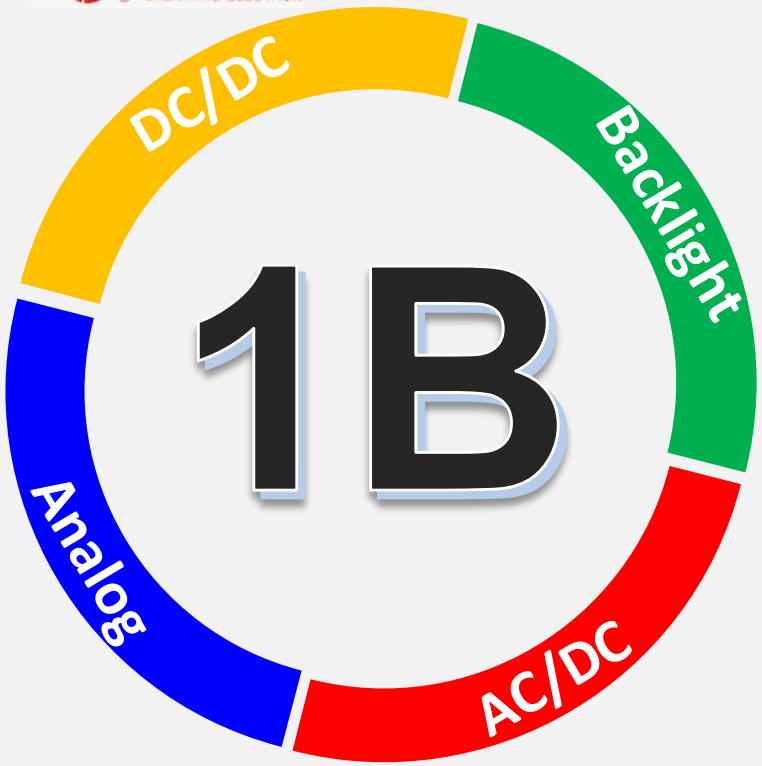
Nintendo Lexmark

ANKER NetBit

amazon facebook

vivo ARRIS Sony Interactive Entertainment

verizon



Over 1B shipments

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PWM and SR shipping record for PD models

Products	Application	Power Supply Customer	Accumulated Shipment
PF6151/2 series (gen.1 & gen.2)	NB Adapter Mobile Charger Gaming Adapter Multi-port Adapter Smart Speaker Adapter	Delta . CPT . Acbel . Phihong Hunkey . Mass Power . DVE Salcomp . MOSO . Stiger KTEC . Giant Sun . DBK	149Mpcs
PF6602 series (gen.1 & gen.2)			36Mpcs

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Product Introduction

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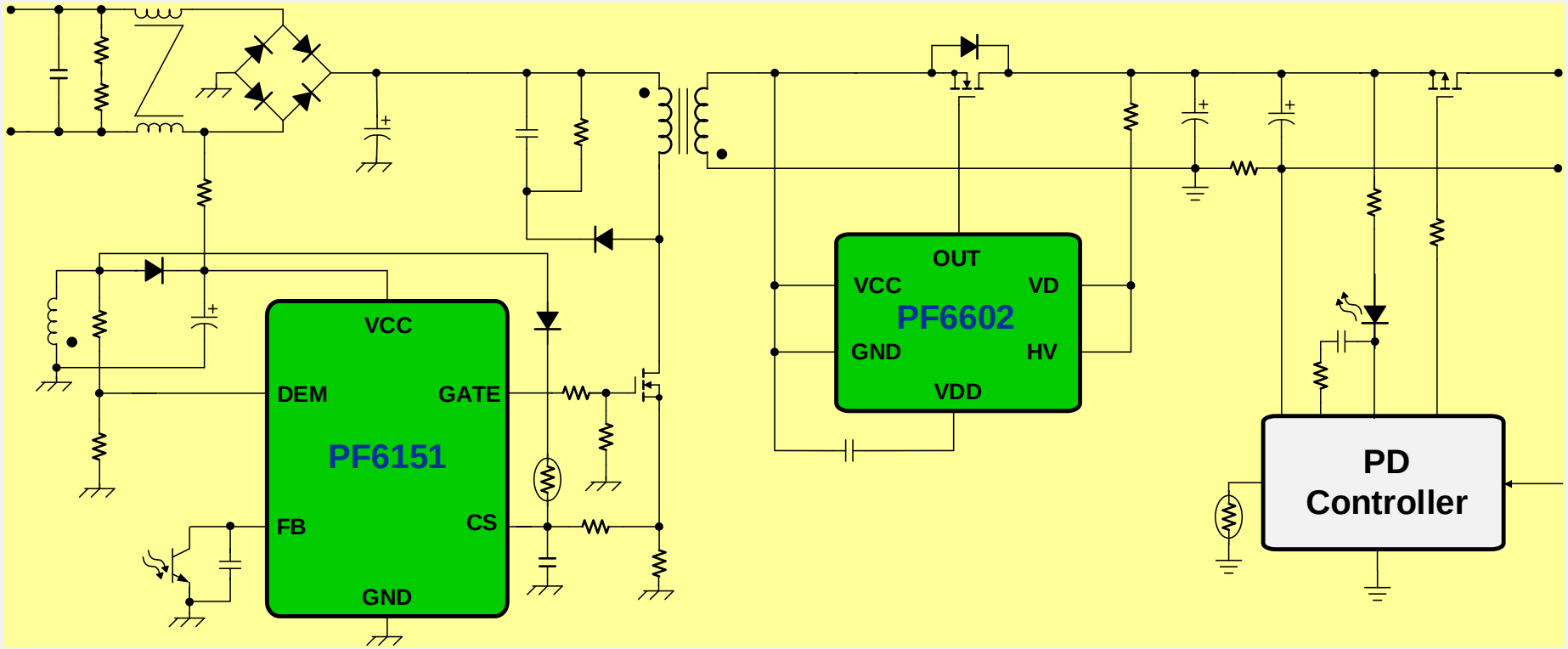
PWM & SR IC total Solution for PD application



AC/DC Controller

PF6151

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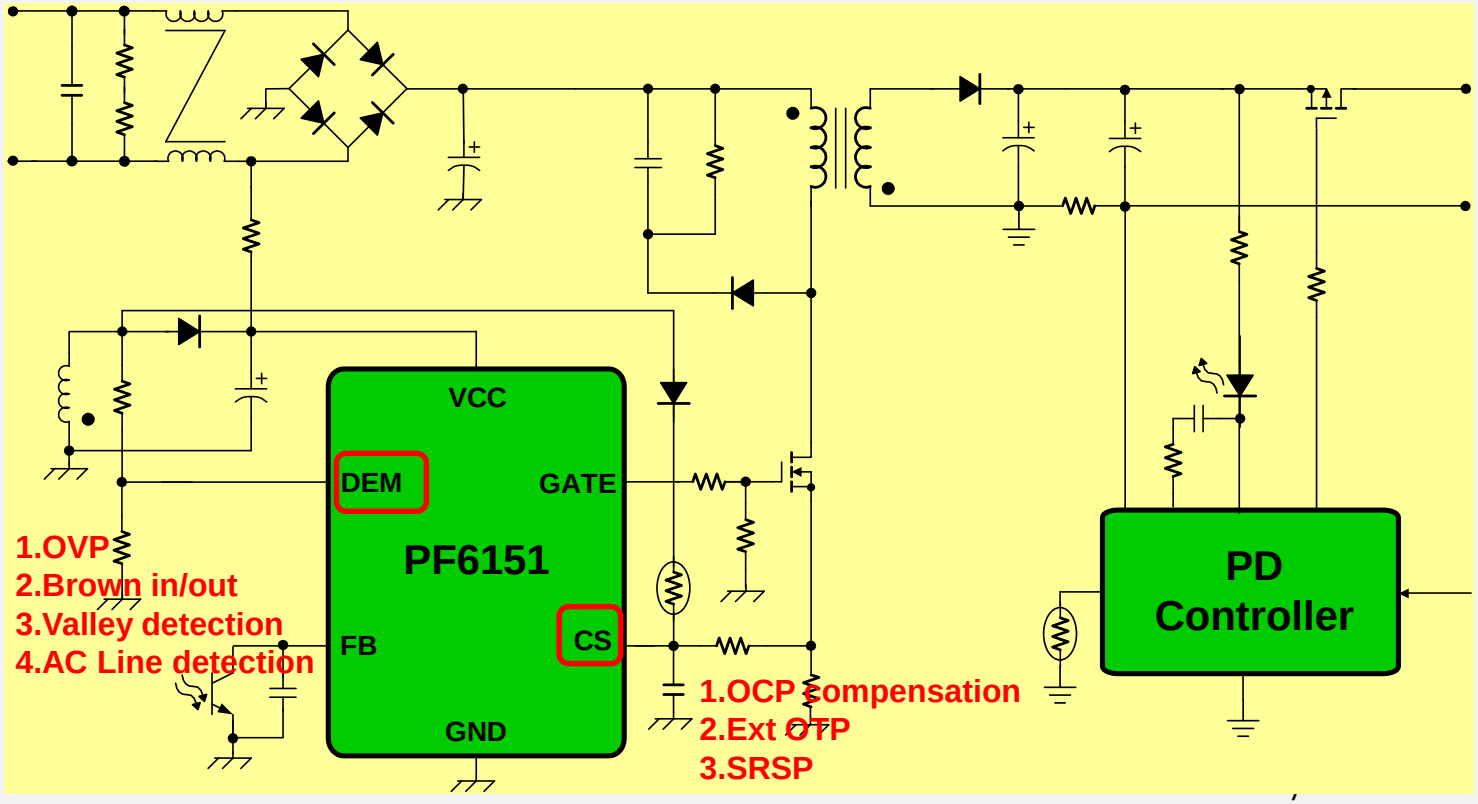
PF6151 Product Features

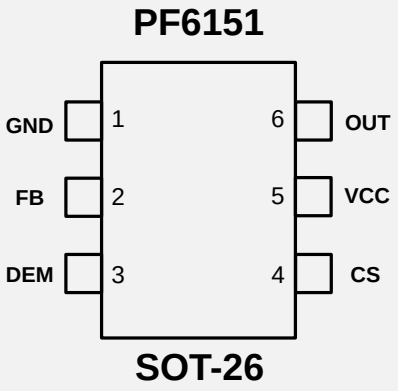
Key Features

- Wide Vcc operation range up to 80V
- Vo compensation OCP for PD application
- Vo compensated for Acoustic Noise Free
- Constant OTP for different Vo
- 130KHz Peak fsw for Peak Power Application
- CCM/Valley switching

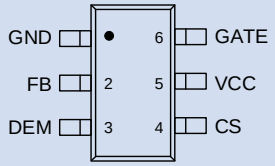
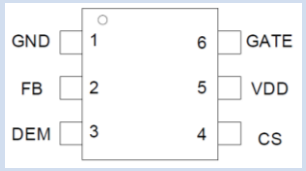
Common Features

- Adjustable Line Compensation for OCP
- Green Mode Operation
- Open Loop Protection
- Internal 4mS Soft Start
- AC brown in/out protection
- SRSP





Product Comparison

	PD PWM (Gen1)	PF6151 (Gen2)	Sx60	Benefit of PF6151
Pin Assignment				Low pin count & compatible with traditional LV parts
Vcc(ROC)	80V	80V	57V	PD PPS is possible w/o external regulator
Boost Frequency	Yes	Yes	Yes	Better peak load capability
Two Step CS Freeze	No	0.1V for 5Vo 0.15V for >=9Vo	No	Better audible noise performance
OCP detection	No	Linear	2 Step	Detection by CS pin for higher accuracy level OCP
Vout OTP compensation	No	Linear	2 Step	Compensation by different Vout
2-step current limit	Yes	Yes	No	Reduce CS limit at high line to improve high line voltage stress

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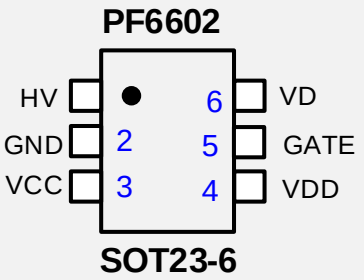
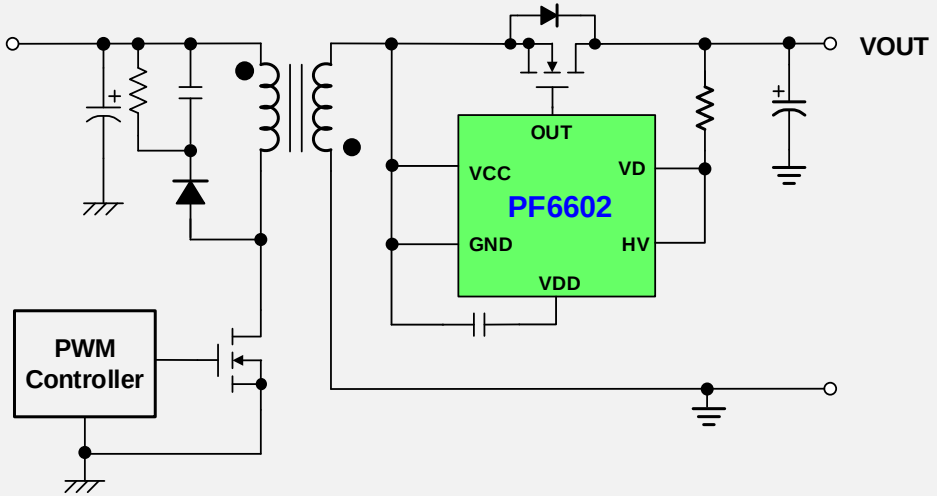
SR Controller
PF6602

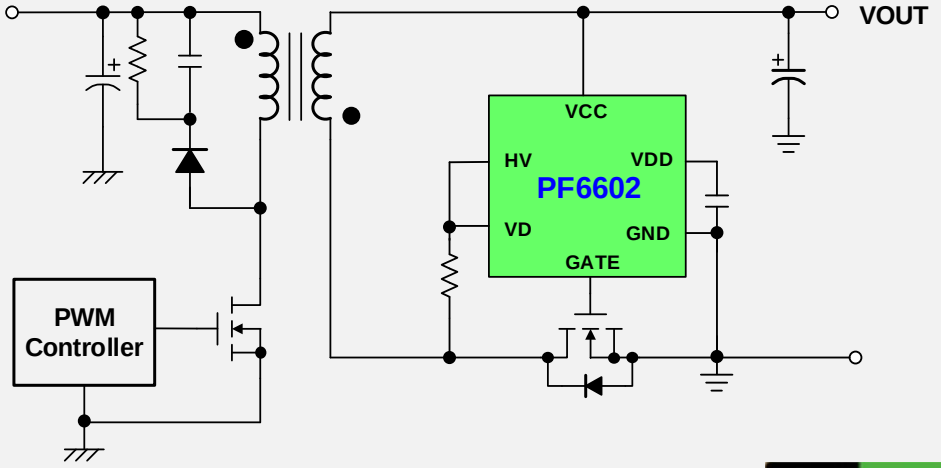
PF6602–Single Winding SR controller

Key Features

- Self-supplying for operation without an auxiliary winding
- Supports CCM, DCM and Quasi-Resonant Flyback converters
- Fast turn-off delay of 15ns
- Slew rate detection prevents false turn-on during DCM VDS ringing
- <100μA Quiescent Current at Standby Mode
- VD/HV pin support to 150V
- Use the minimum number of components
- External power pin reduces power consumption
- Gate pull down capability







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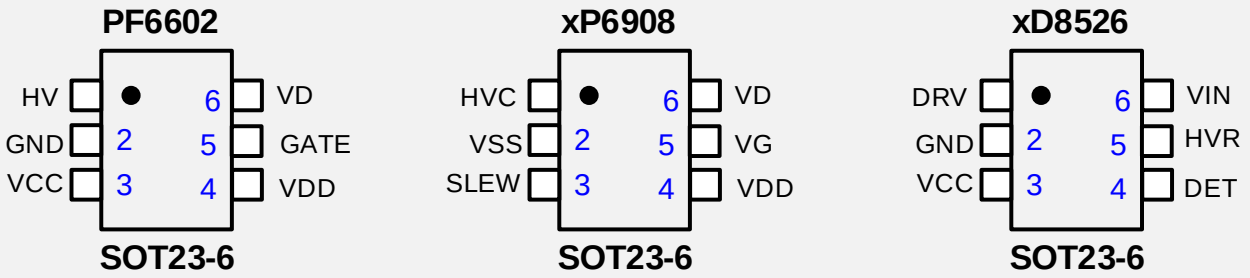
Product Comparison



Function	PF6602	xP6908	xD8526
On/Off detect	VD	VD	DET
HV LDO	HV	HVC	HVR
External Voltage Supply	VCC	HVC	VIN
Voltage Supply	VDD	VDD	VSS
Driving	Gate	VG	DRV
Ground	GND	VSS	GND
VD Slew Rate Controll	Internal Fix	Slew adj.	Internal Fix

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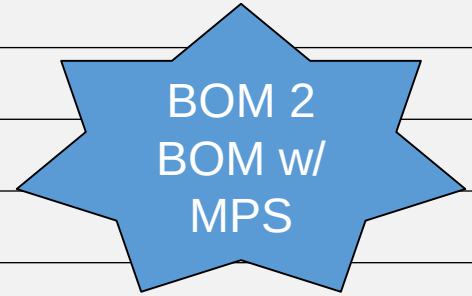
Product Comparison

	PF6602	xP6908	XD8526	Note
Applications	QR+CCM	QR+CCM	QR+CCM	
Package	SOT26	SOT26	SOT26	Directly drop in replacement xP6908
VDD operation range	3.6~6.5V	3.6~9V	3~6V	
UVLO ON/OFF	3.8/3.6V	3.8/3.6V	3/2.8V	
HV voltage	150V	180V	200V	
HV current	>80mA	>80mA	n.d	
External voltage supply	Y	Y	Y	
Output voltage	6.5V	9/5V	6V	Optimize efficiency and reduce IC power consumption
Gate pull down capability	<0.7V	2V	n.d	This function avoid abnormal turn on MOSFET before UVLO ON
Gate drop function	detection	detection	Depend on Ton	Current detection type has more precise control than predictive type, reducing the risk of shoot through
Regulation level	-60mV	-40mV	X	Optimize efficiency
Turn off total time (ns)	20	20	30	PF6602 MOSFET voltage stress is small
Minimum on time	1.2uS	1.1uS	1.5uS	This function avoid abnormal turn off or shoot through at high freq.
Slew rate	Fix 25ns	Adj.	70ns	PF6602 has better small detection tolerances
Standby mode	Y	N	Y	PF6602 Standby mode quiescent current (<100uA)



Reliability Data

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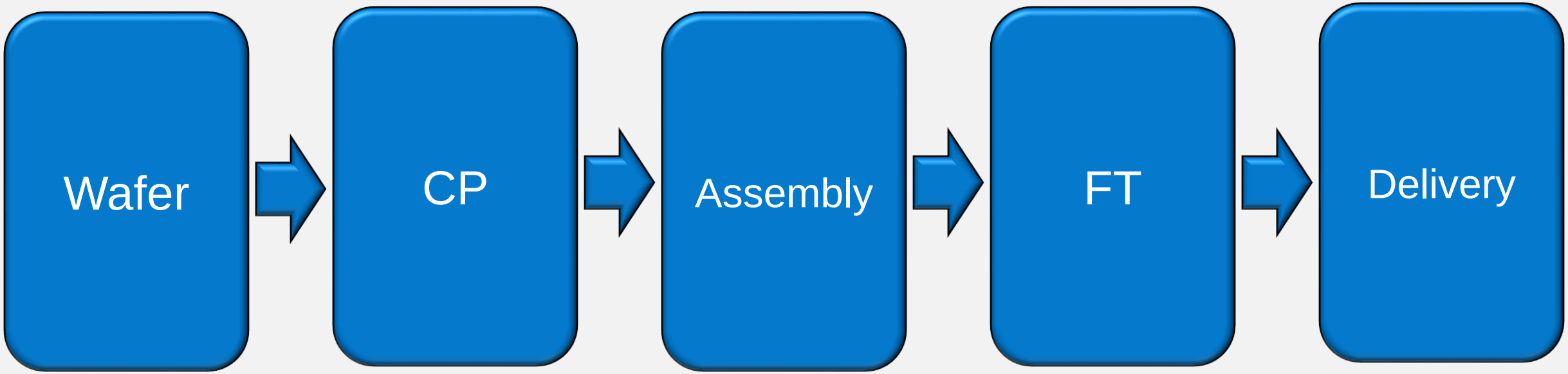
Production Flow



- Industrial standard > 95%

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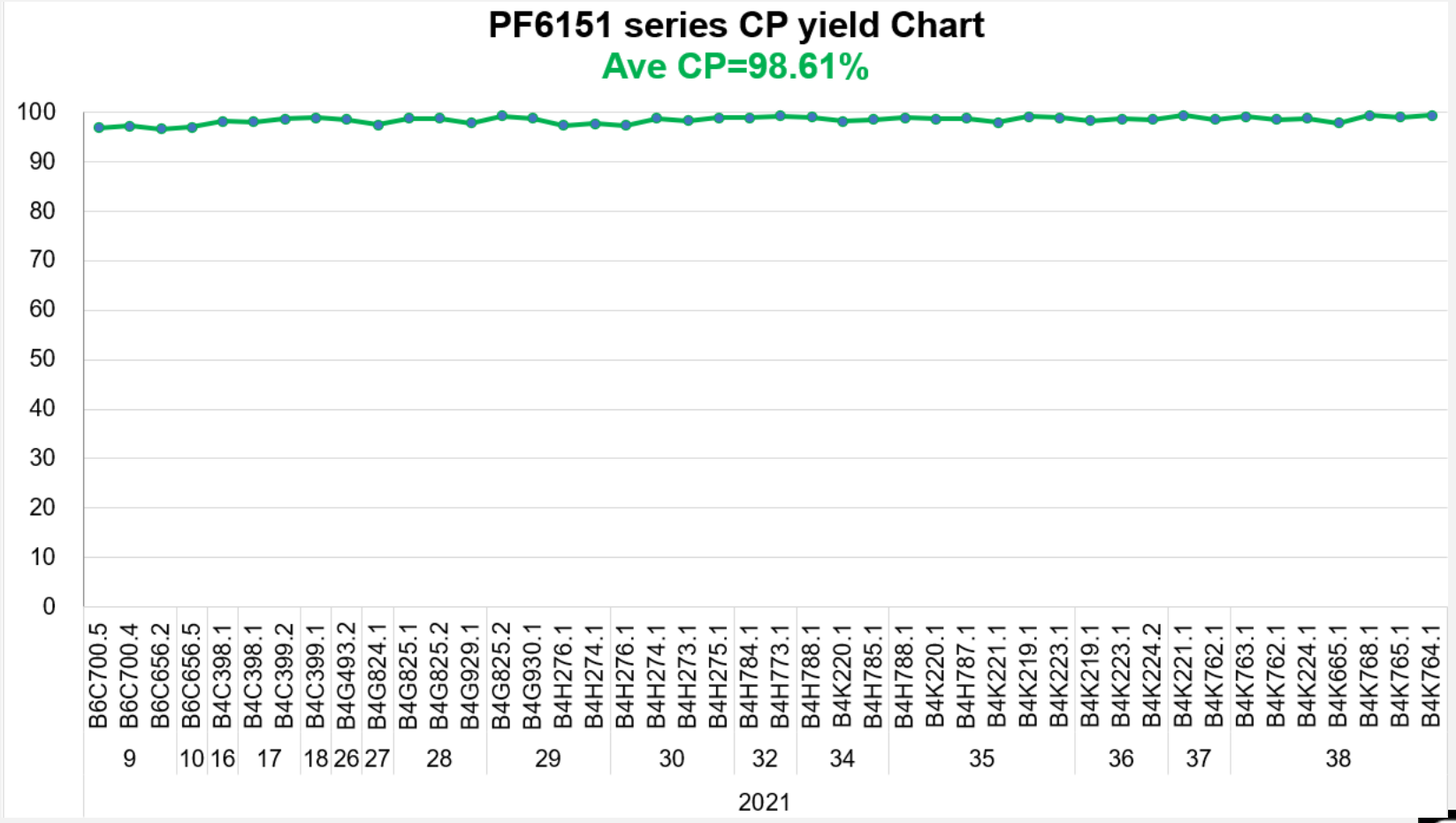
PF6151 Series CP Yield

- PF6151 series CP
  - Ave yield= 98.61% -> CP yield Stable



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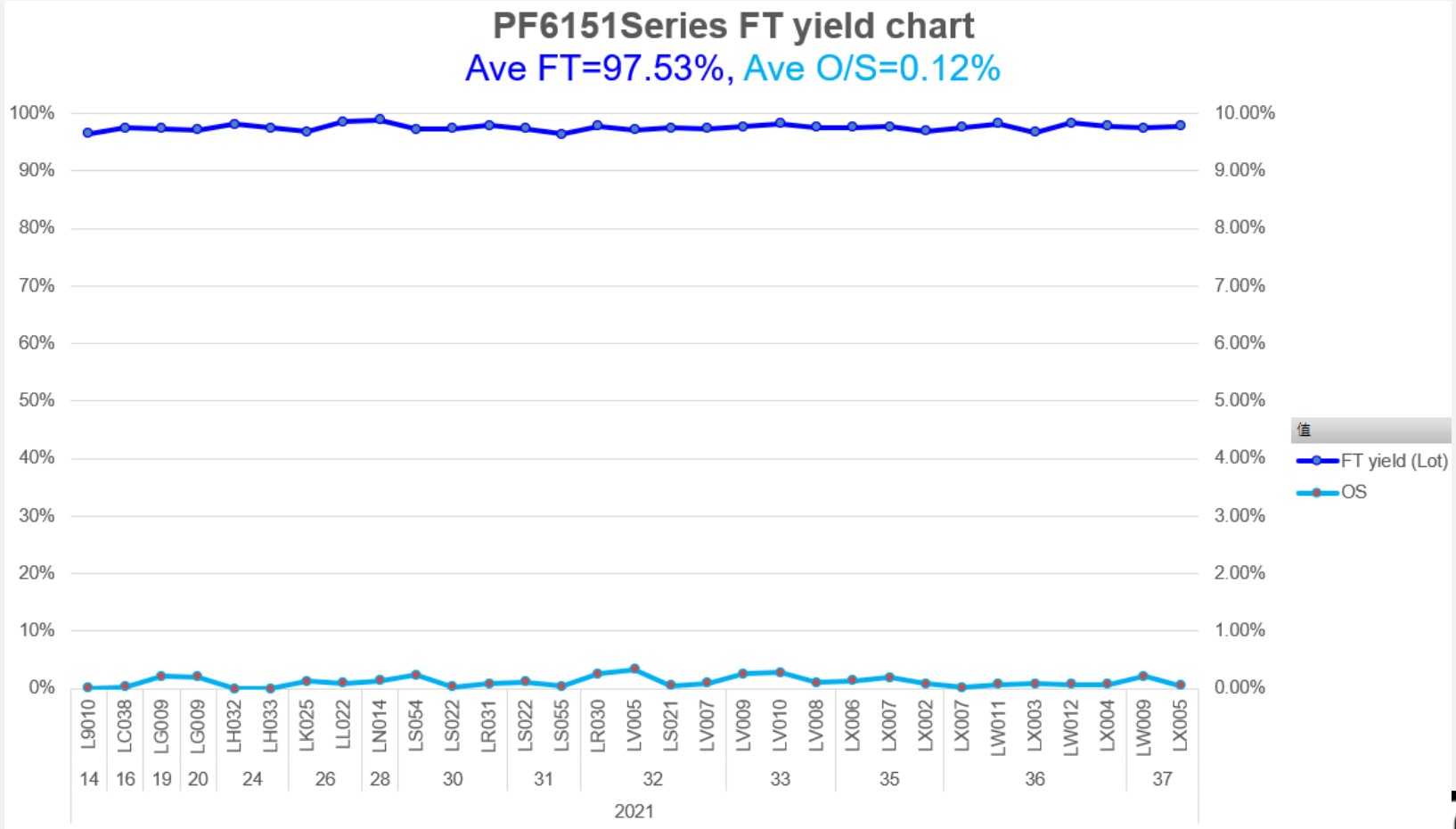
PF6151 Series FT Yield

- PF6151 series FT
  - Ave yield= 98.61% -> FT yield Stable
  - Ave O/S =0.12% -> Assembly yield Stable



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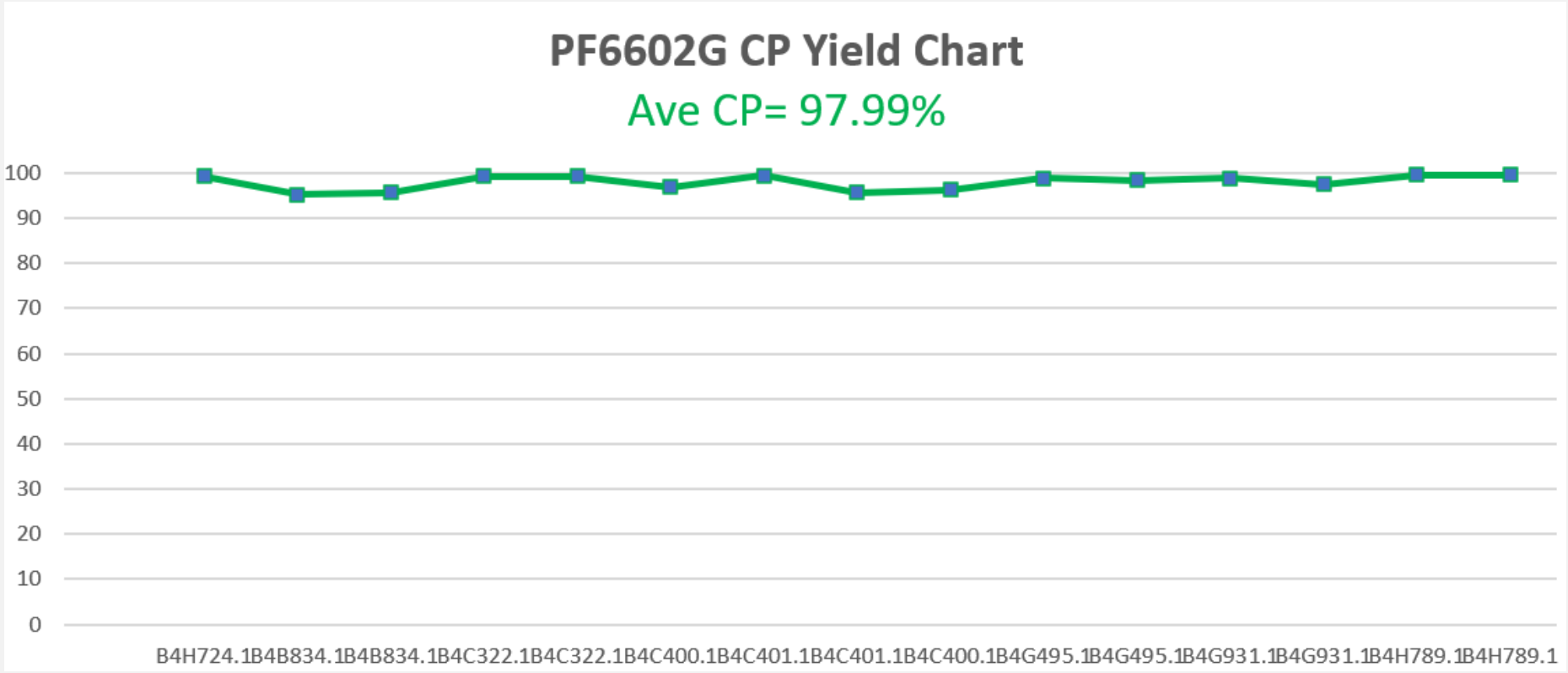
PF6602 Series CP Yield

- PF6602 series CP
  - Ave yield= 97.99% -> CP yield Stable



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PF6602 Series FT Yield

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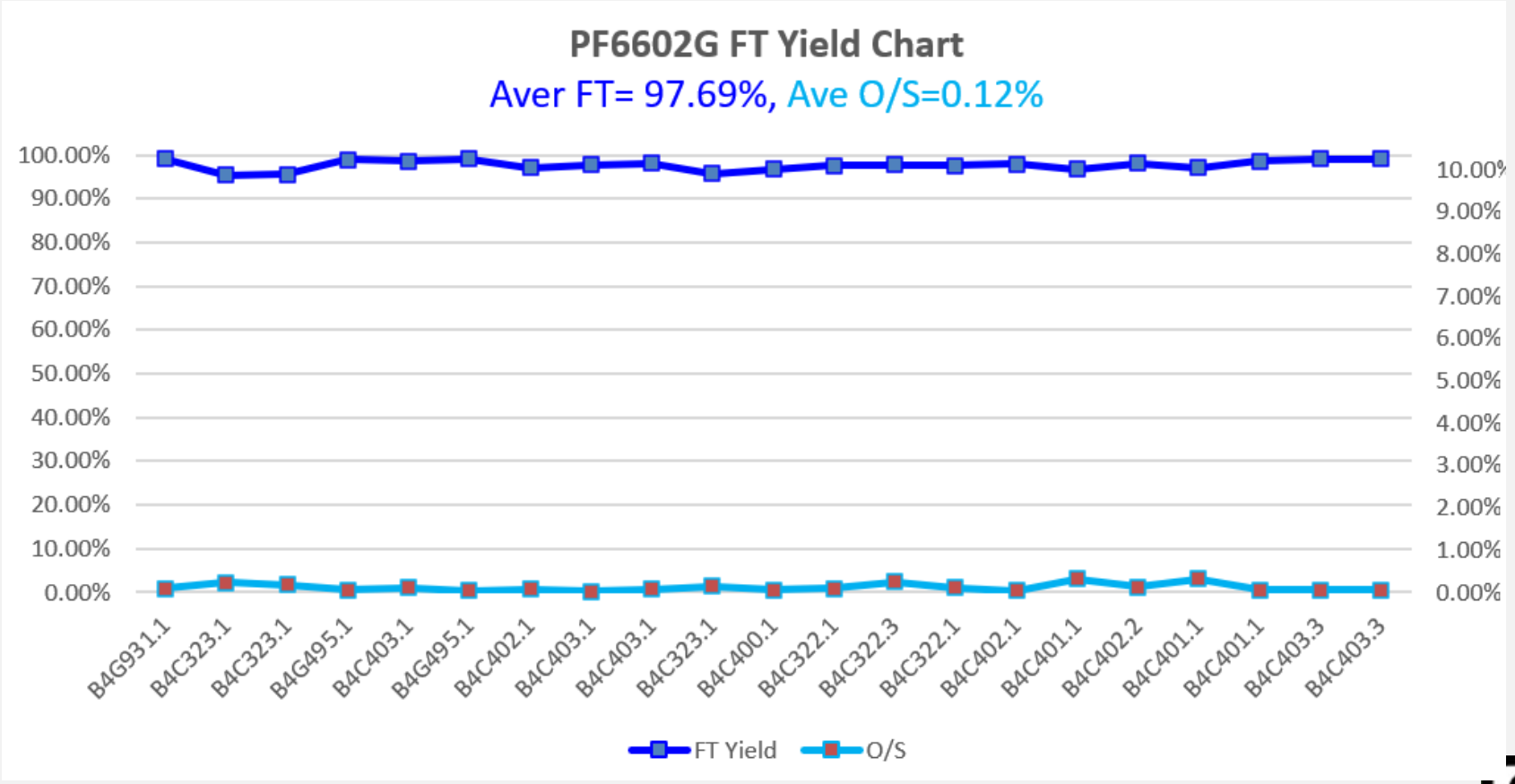

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Thank you

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Appendix

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PF6151 backup material

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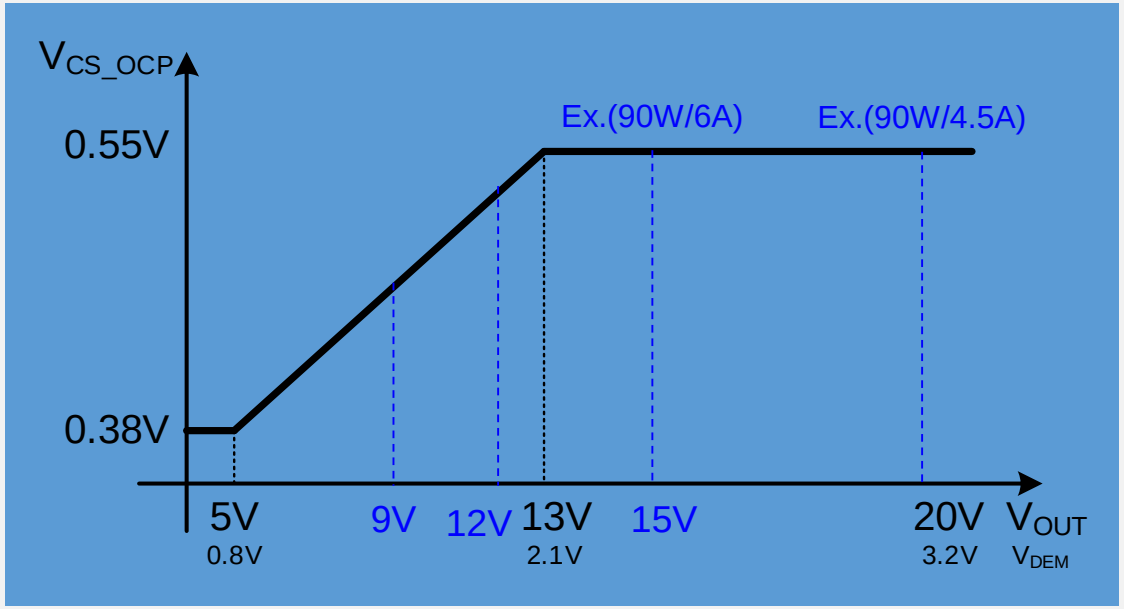
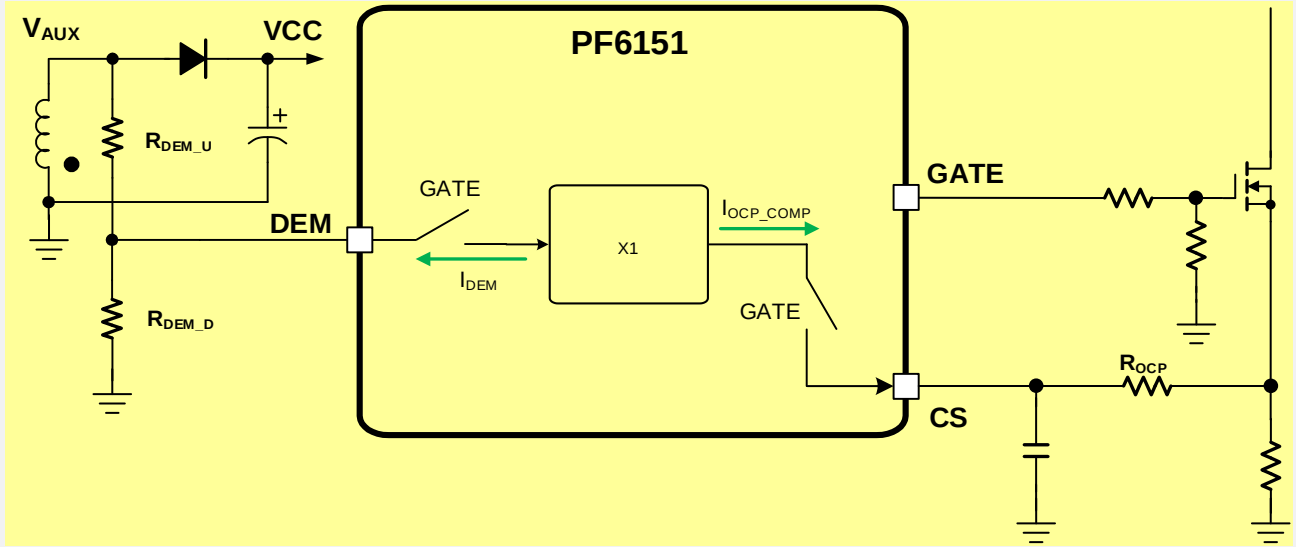
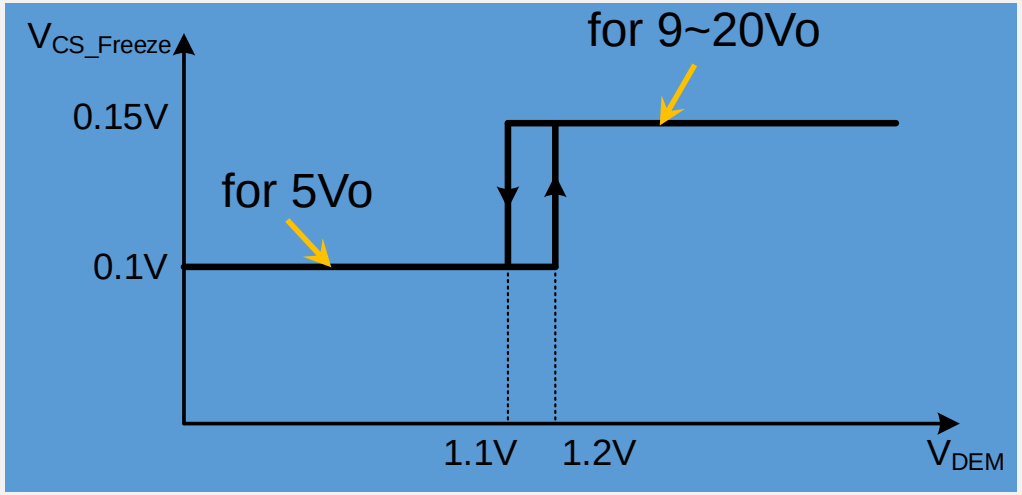
Over Current Protection & Line compensation



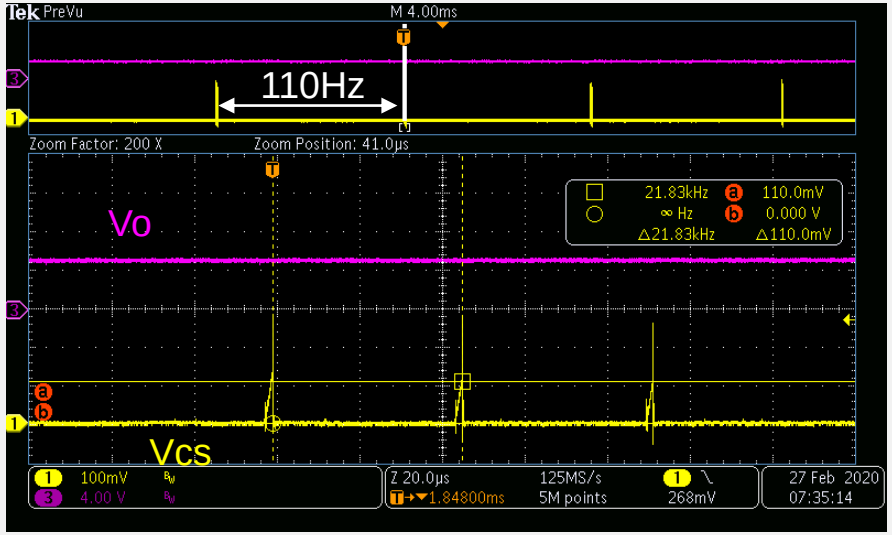
- CS signal is sensing and compared with DEM determined $V_{CS\_OCP\_REF}$ to determine OCP level



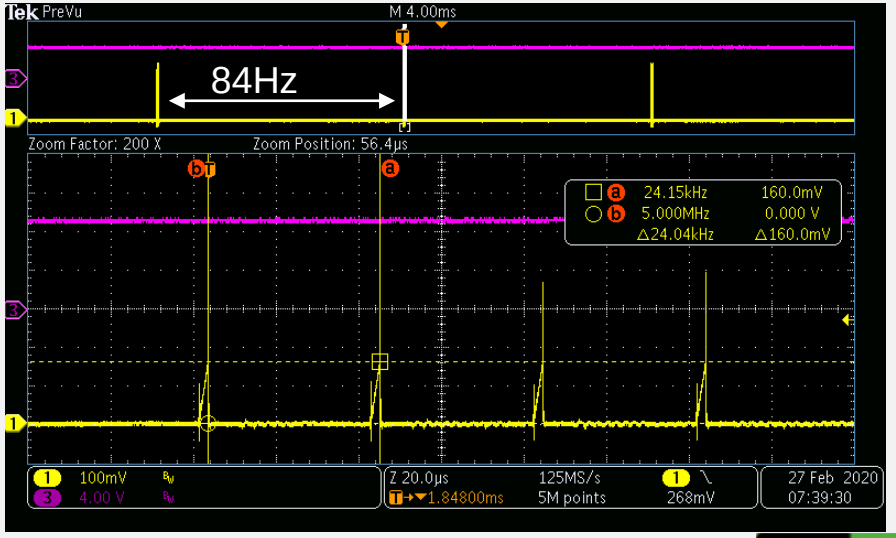
Modulated CS Freeze for Power Saving



5V/0A



9V/0A



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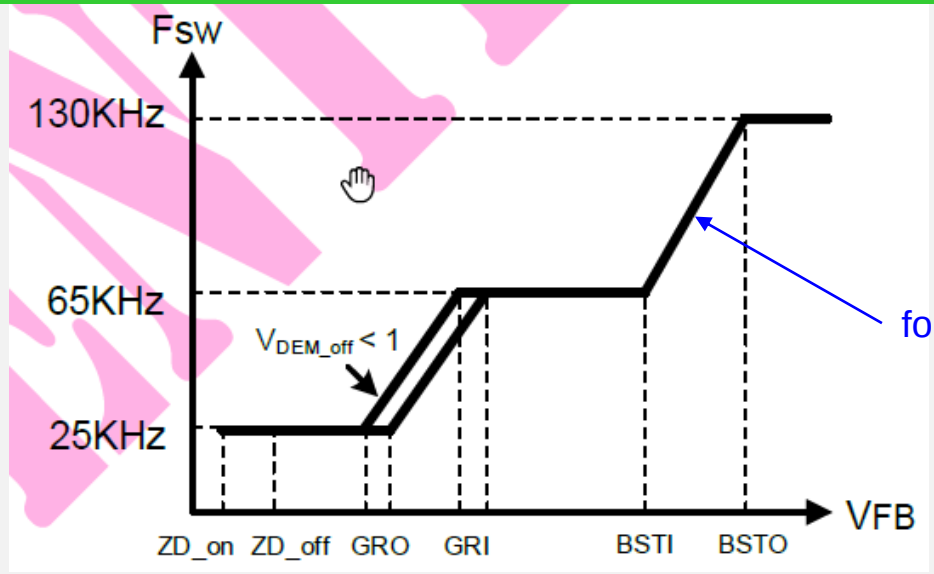
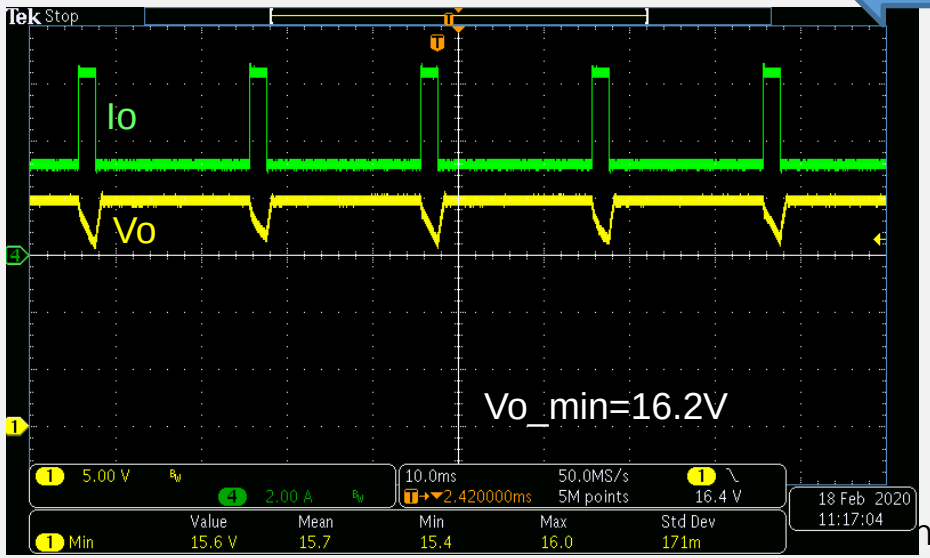
FB vs operation frequency curve

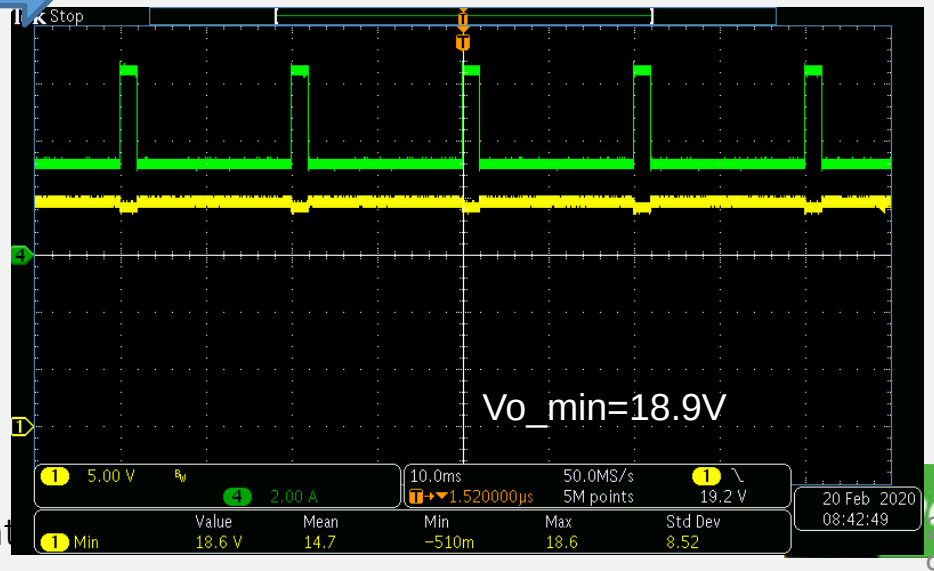


Peak load condition : 20V/3.25A(18ms)~6.5A(2ms) @ 100Vac/50Hz (Vo_min>17V)

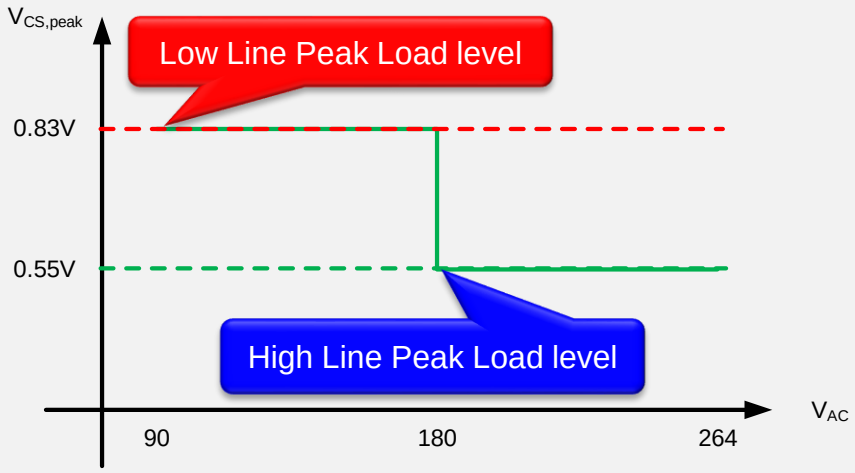
LX5763(No peak load function)



PF6151(with peak load function)

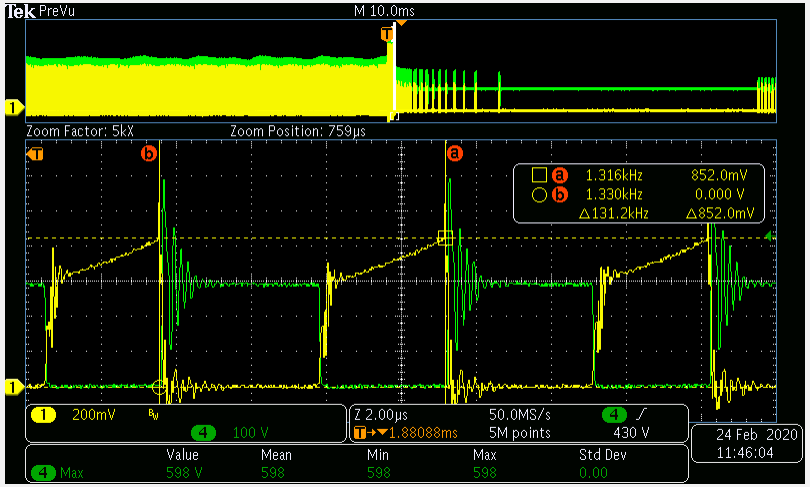


Two step peak load current limit level

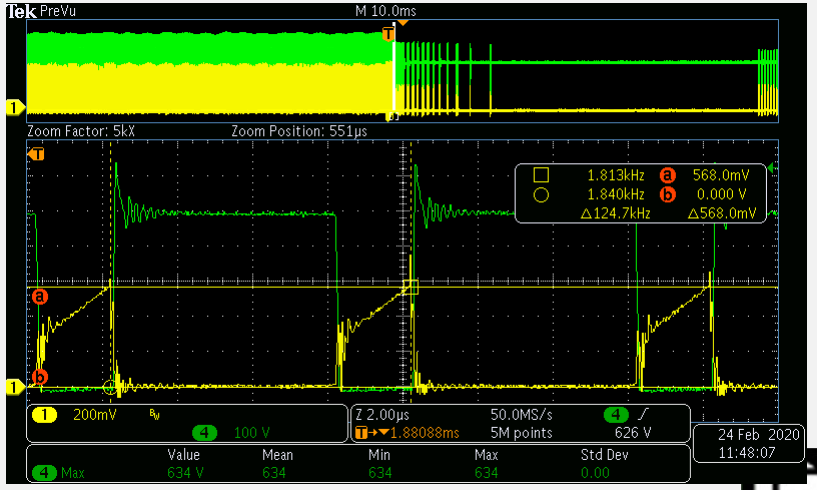


- Reduce CS limit at high line to improve high line voltage stress.

115Vac SCP



264Vac SCP



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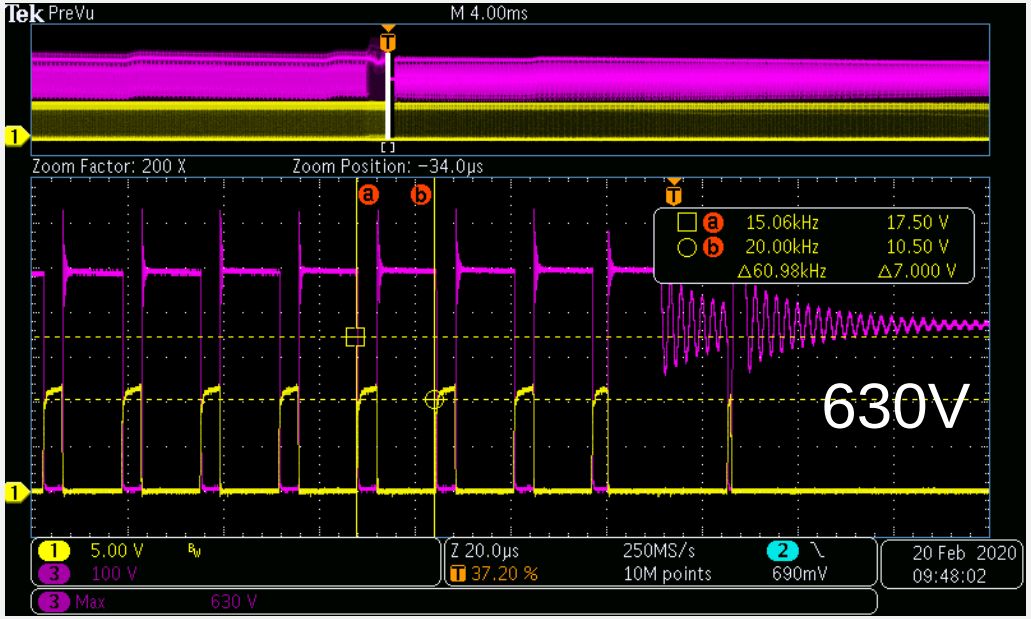
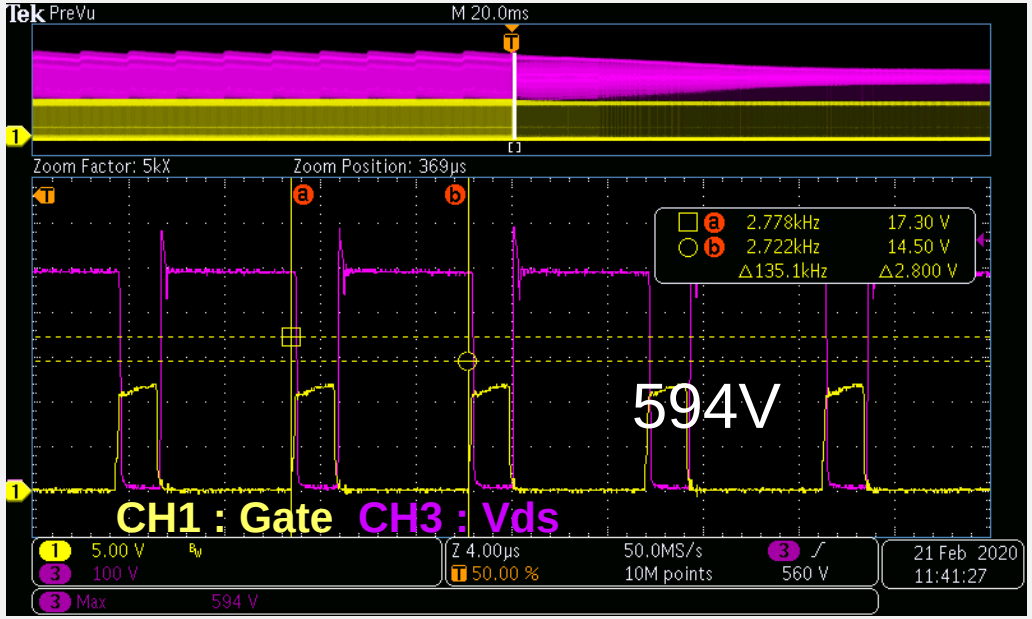
MOS Voltage Stress with SCP test

XD5763



PF6151



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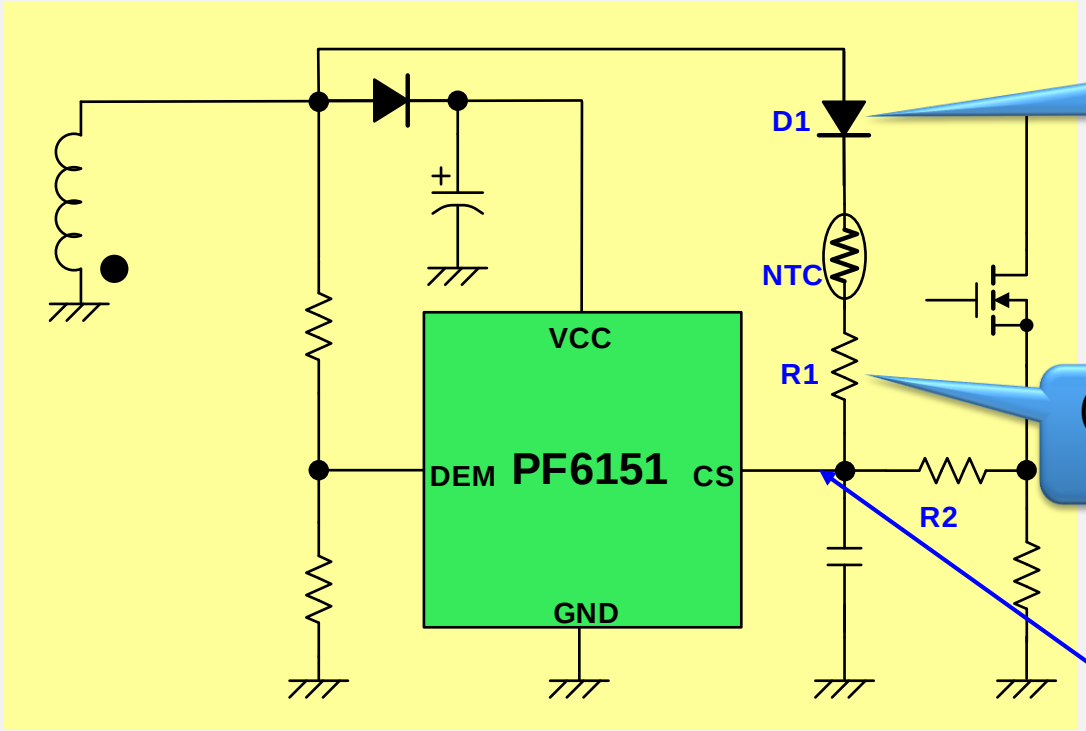
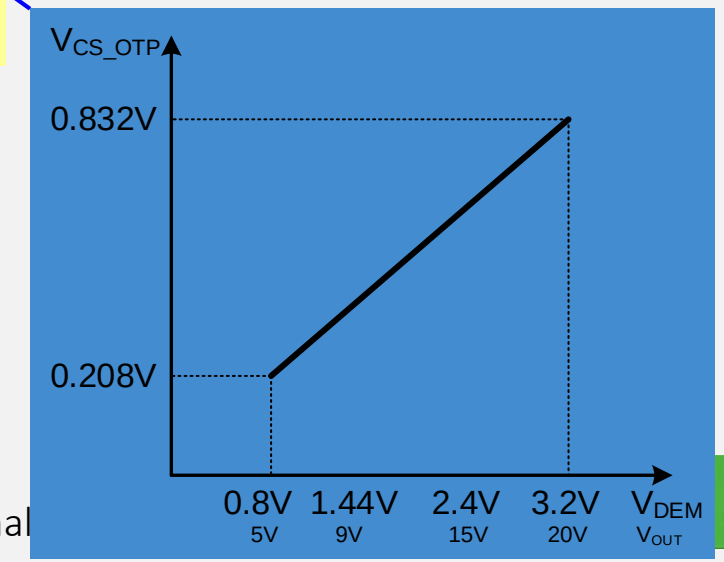
Constant OTP over Vo range



Ultra fast diode is suggestion

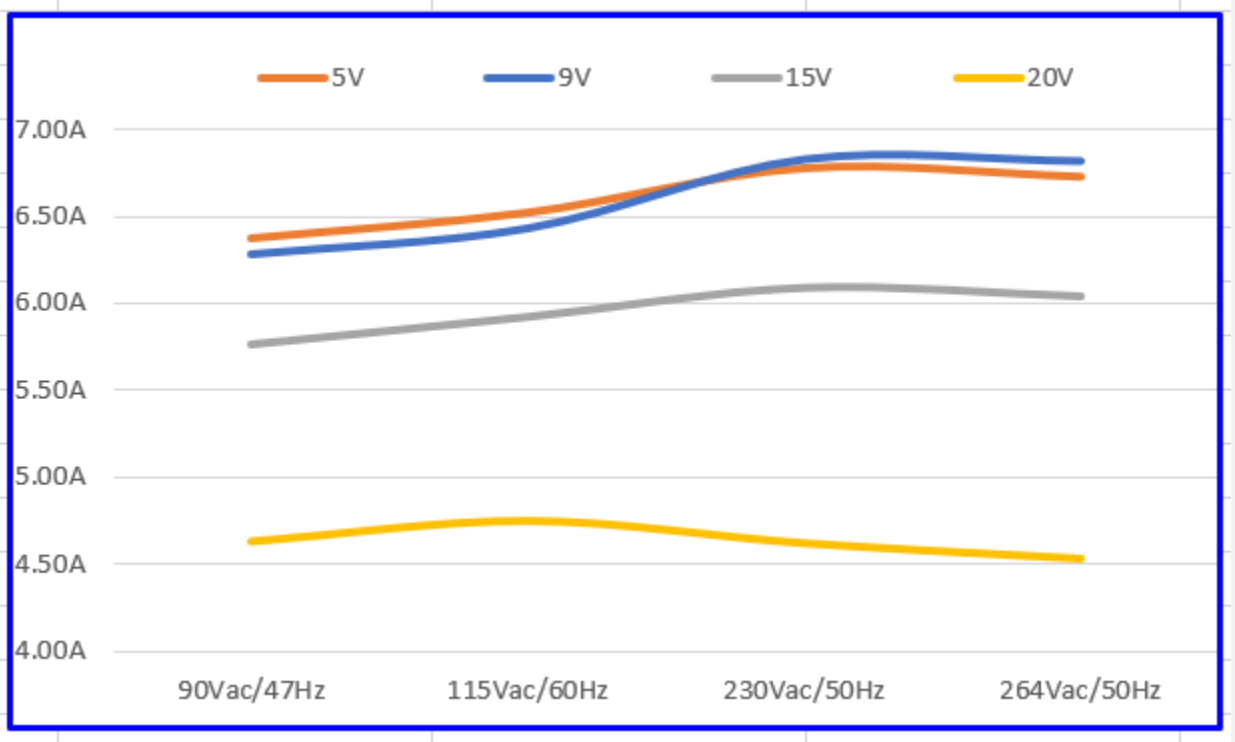
(Option)according to fine tune result

$$VCS\_OTP = (Vaux - VF\_D1) \times \frac{R2}{RNTC + R2 + R1}$$



OCP Performance

OCP				
Vin	20V	15V	9V	5V
90Vac/47Hz	4.63A	5.76A	6.28A	6.37A
115Vac/60Hz	4.75A	5.92A	6.43A	6.52A
230Vac/50Hz	4.62A	6.09A	6.83A	6.78A
264Vac/63Hz	4.53A	6.04A	6.82A	6.73A



Efficiency Performance

AC input	Vo_set	load	eff	eff_avg	eff_spec.	No load Power Consumption
115Vac/60Hz	5V/3A	10	84.34%	→	72.48%	26mW
		25	88.03%	86.55%	81.84%	
		50	87.37%			
		75	86.13%			
		100	84.66%			
	9V/3A	10	88.18%	→	77.30%	
		25	90.48%	89.40%	87.30%	
		50	89.84%			
		75	89.03%			
		100	88.23%			
	15V/3A	10	89.00%	→	78.85%	
		25	91.72%	91.12%	88.85%	
		50	91.48%			
		75	91.04%			
		100	90.23%			
	20V/3.25A	10	89.42%	→	79%	
		25	91.78%	91.19%	89%	
		50	91.71%			
		75	91.20%			
		100	90.08%			

	Vo_set	load	eff	eff_avg	eff_spec.	No load Power Consumption
230Vc/50Hz	5V/3A	10	76.98%	→	72.48%	61mW
		25	82.70%	83.71%	81.84%	
		50	84.67%			
		75	84.15%			
		100	83.33%			
	9V/3A	10	83.44%	→	77.30%	
		25	87.57%	88.22%	87.30%	
		50	88.89%			
		75	88.52%			
		100	87.91%			
	15V/3A	10	84.93%	→	78.85%	
		25	90.37%	90.80%	88.85%	
		50	91.10%			
		75	91.01%			
		100	90.73%			
	20V/3.25A	10	86.70%	→	79%	
		25	91.17%	91.44%	89%	
		50	91.67%			
		75	91.60%			
		100	91.30%			

PF6151 Reliability Data

- PF6151 Reliability Data
  - See attached file

PF6151_RA

4) Product Qualification：

4.1) Qualification Results：

Qualification item		Qualification Result		Sample Size	Class Level
HTOL		0/168/500/1000 hrs	All Pass	77 Units	NA
ESD	HBM	≥ 2.0V	All Pass	3 Units /Per Pin	Class 2
	MM	≥ 200V	All Pass	3 Units /Per Pin	Class B
	CDM	≥ 1000 V	All Pass	3 Units /Per Pin	Class C3
Latch up	I(+)	≥100mA	All Pass	3 Units /Per Pin	Class I
	I(-)	≥100mA	All Pass	3 Units /Per Pin	
	OV	≥1.1*VCC	All Pass	3 Units /Per Pin	

PF6602 backup material

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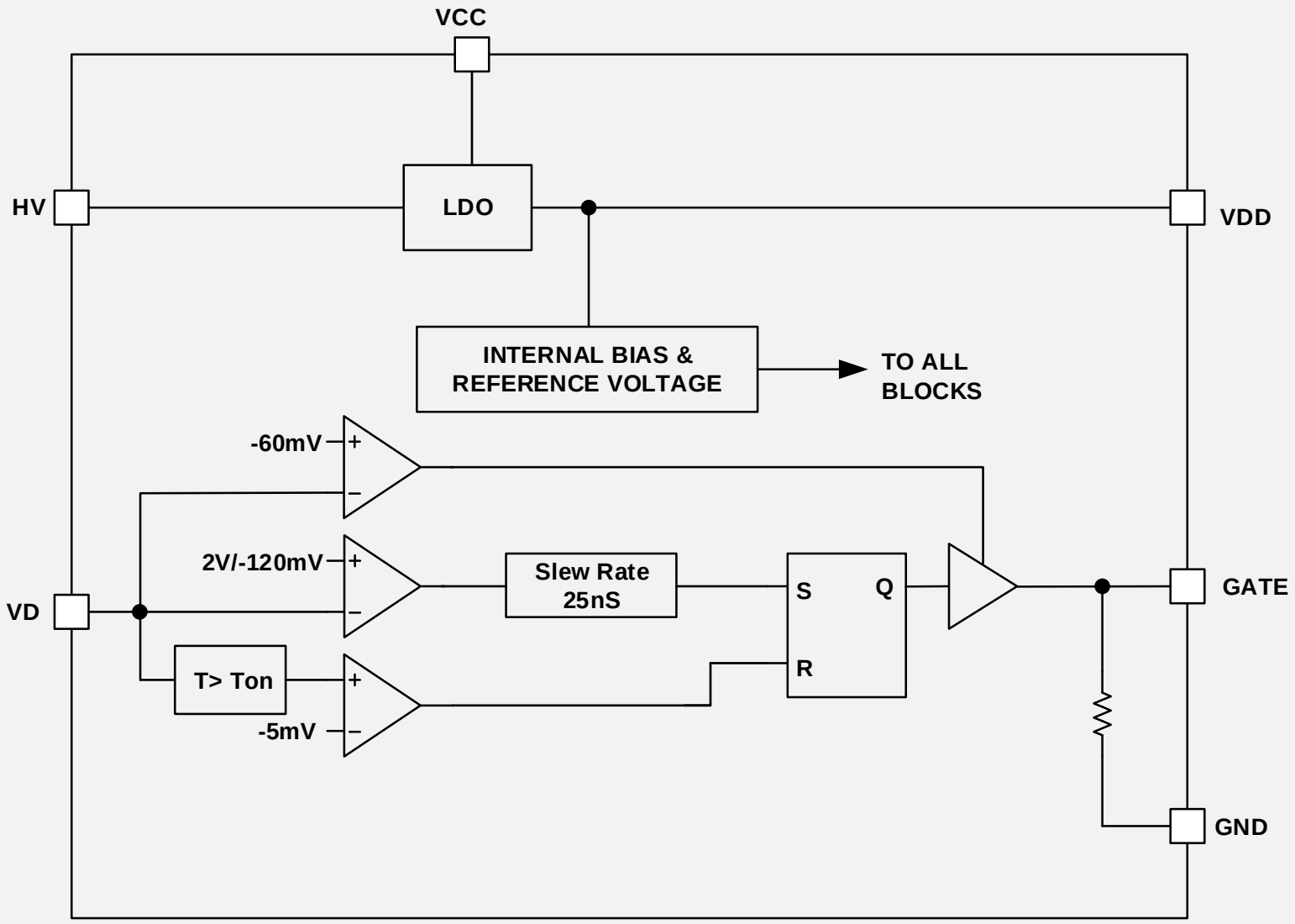
IC Internal Block Diagram



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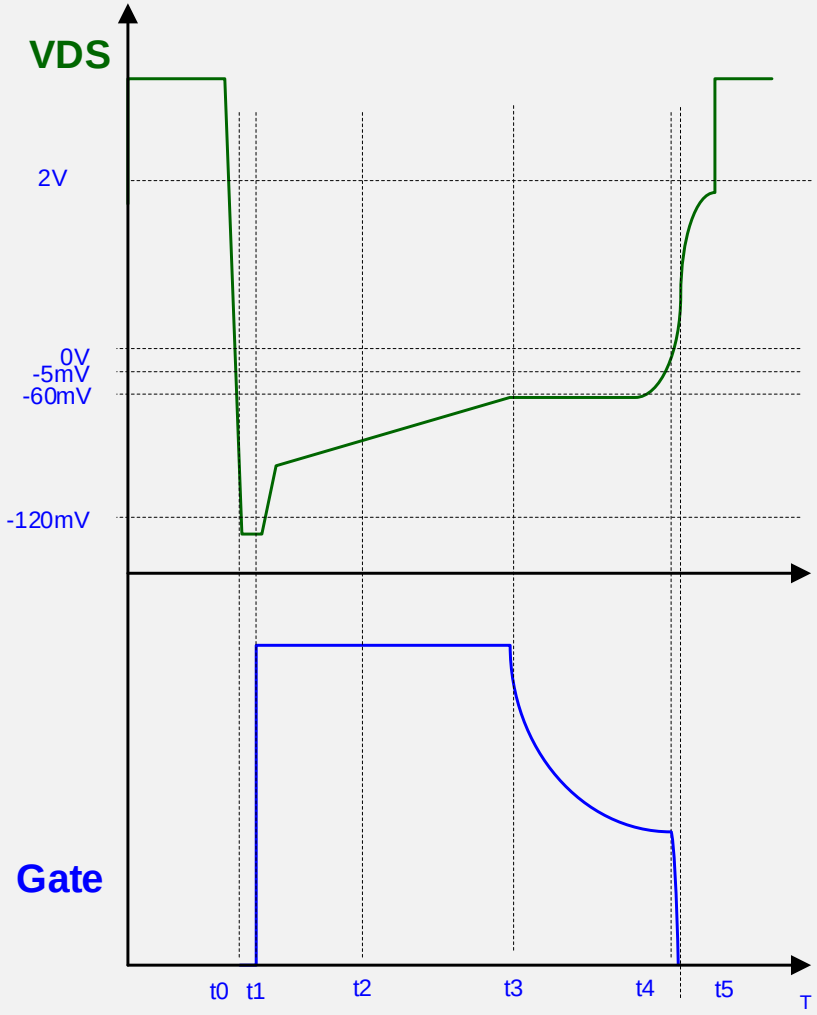
PF6602 operation timing



2V : Cycle on /off level

-5mV : turn off level with 20nS delay time at Ton>1.2uS

-60mV : VDS regulation level

-120mV : SR turn on level with 35nS delay time

T0~T1 : Turn on delay 35nS

T1~T2 : Mini on time 1.2uS

T3 : -60mV regulation level

T4 : -5mV turn off level

T4~T5 : Turn off delay 20nS

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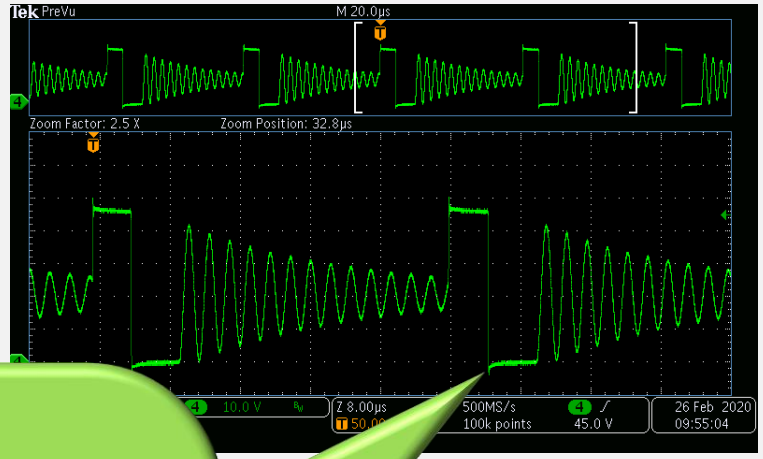
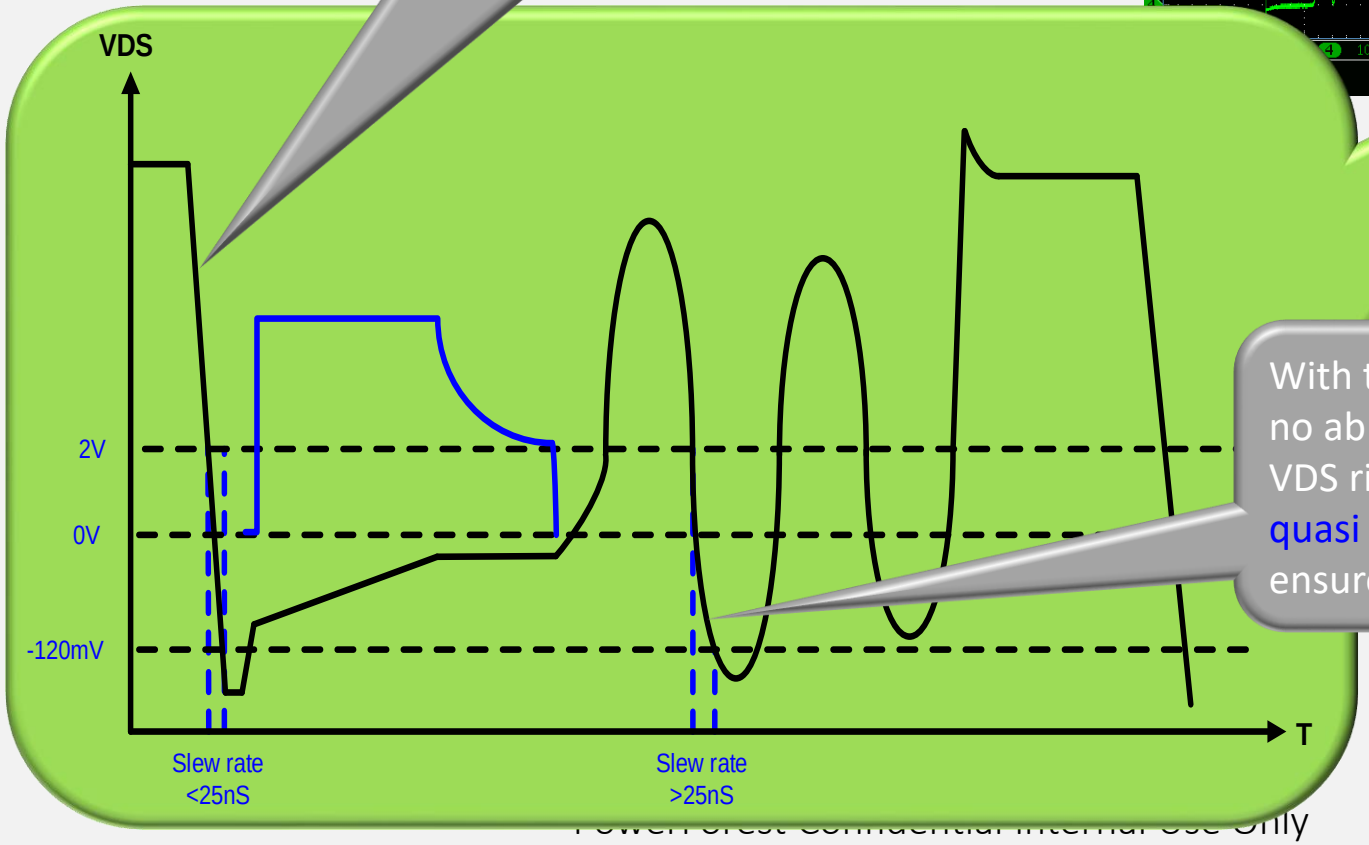
Turn On Slew rate

VDS falling slew rate from 2V to -120mV within 25ns can trigger the internal turn on mechanism for the SR.





With the detection mechanism, no abnormal false turn on by VDS ringing during DCM and quasi resonant operations is ensured.

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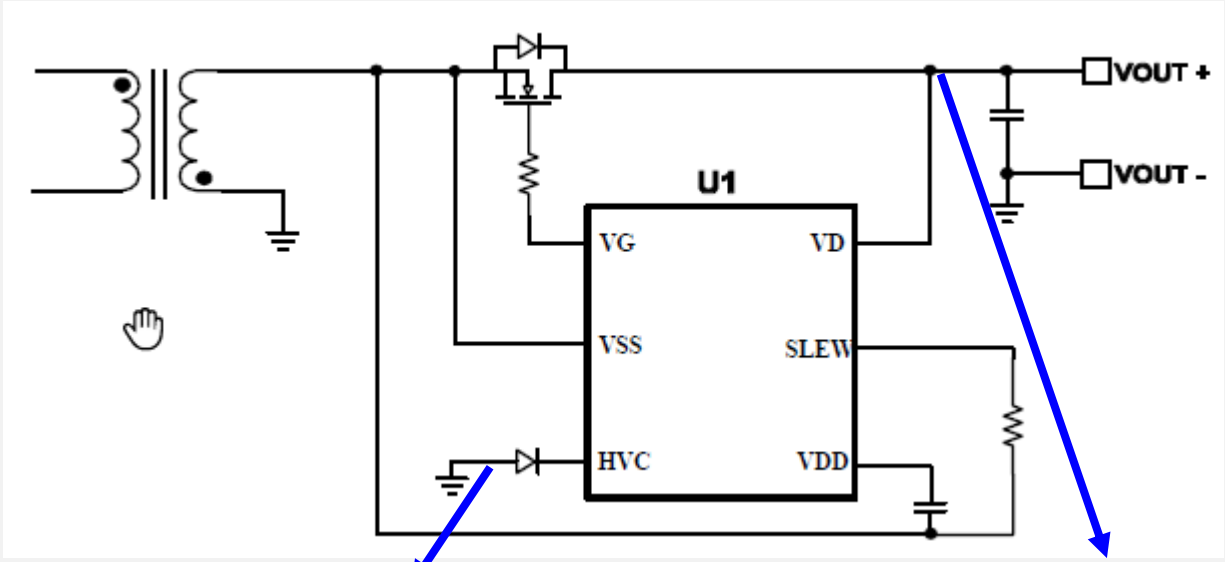
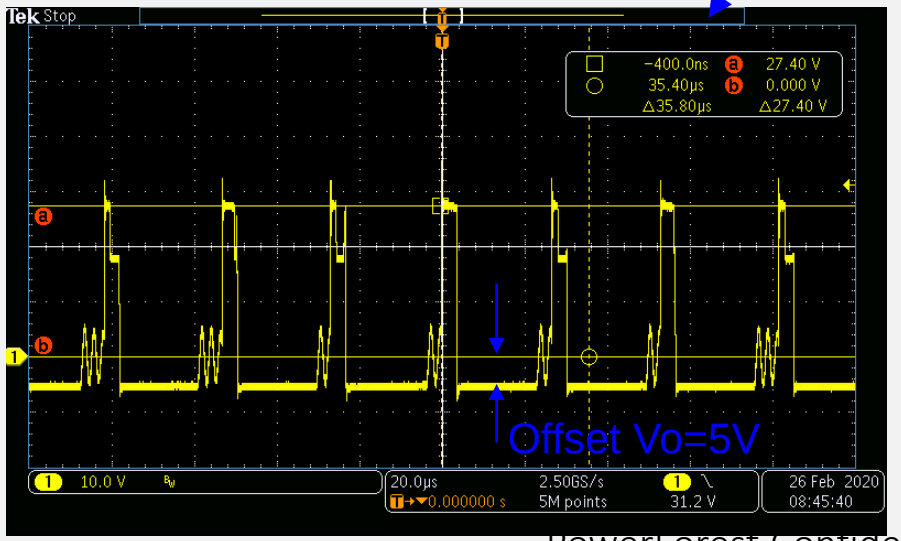
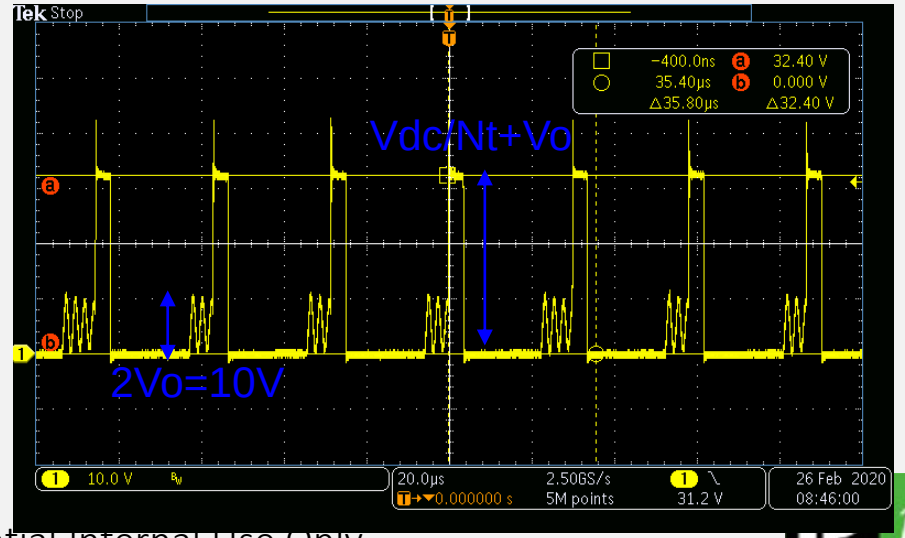
HV charge from Drain or GND
@ SR put on high side

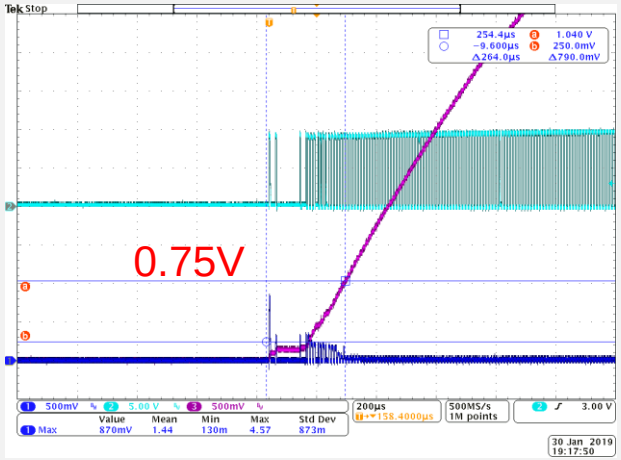






Gate pull down capability

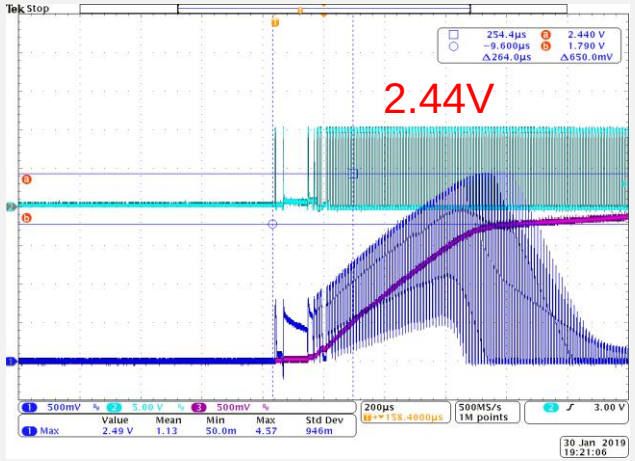
PF6602



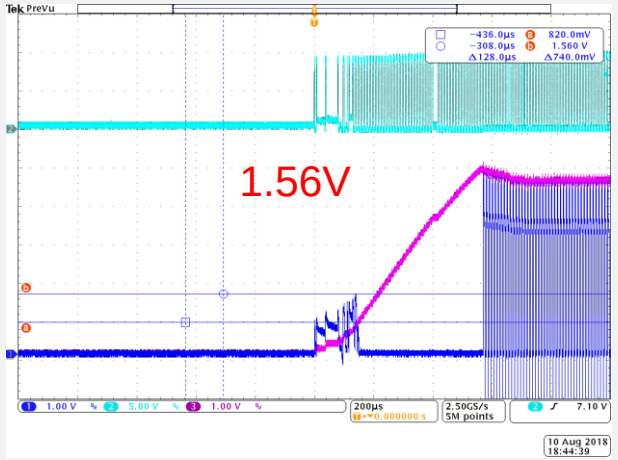
CH1:OUT CH2:VD CH3:VDD

- Fales trigger during star up will be caused primary and secondary side MOS short through.
- To prevent false trigger of SR MOS, gate signal will be pulled low during star up.

xP6908

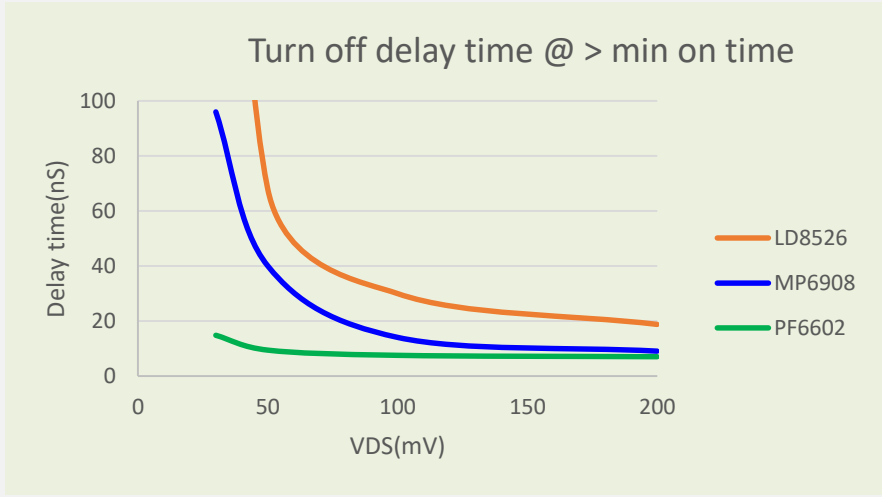


xD8526

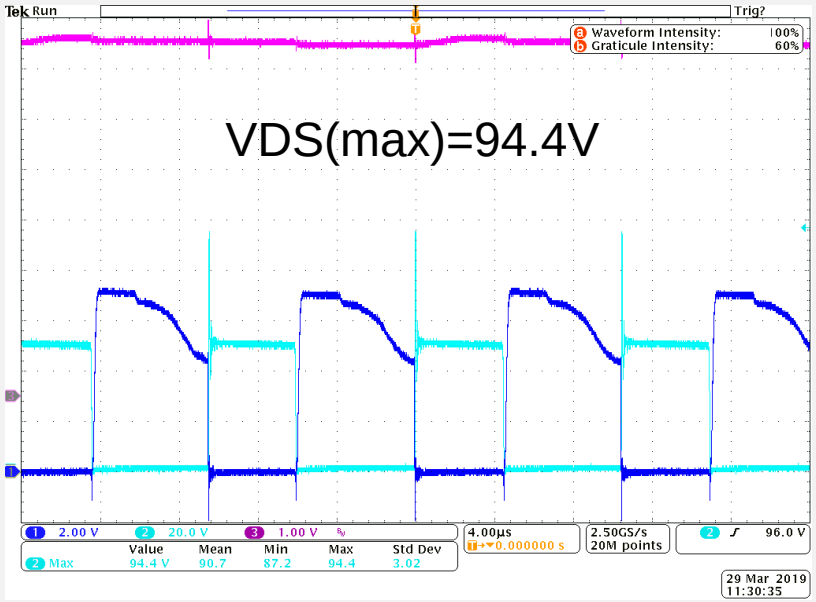


SR MOS stress comparison

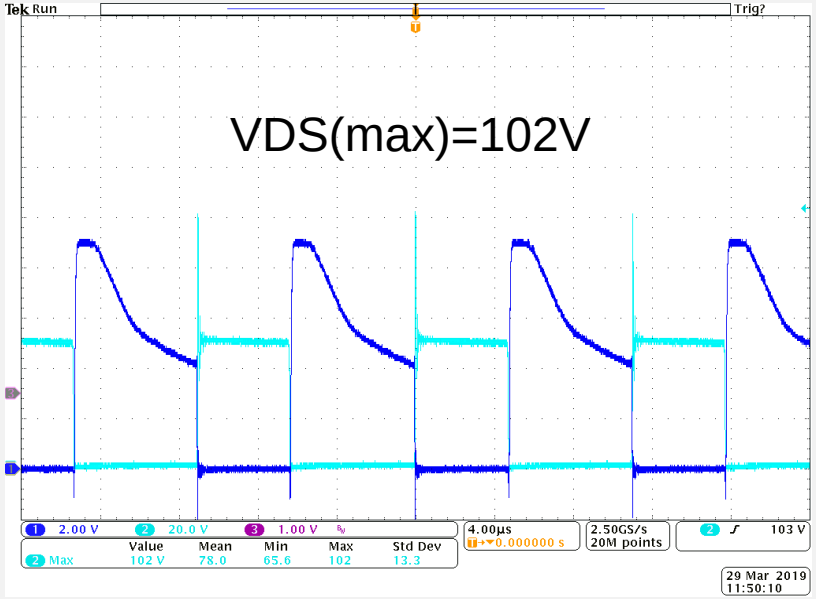
MOSFET	60W PD 20V/3A	PF6602 (V)	LX8526 (V)	XP6908 (V)
AP10TN004LCMT	115Vac 20V/3A	94.4	96	102
	115Vac 5V/3A	66.8	68.1	69.6
AP10TN008LCMT	115Vac 20V/3A	89.6	91.2	92
	115Vac 5V/3A	64	64.5	64.8
PDS0978	115Vac 20V/3A	80.8	91.5	92
	115Vac 5V/3A	55.2	58.1	61.6
AO4296	115Vac 20V/3A	72.2	74.5	77
	115Vac 5V/3A	51.4	52.5	54.6



PF6602



XP6908



MOSFET voltage stress is small with PF6602

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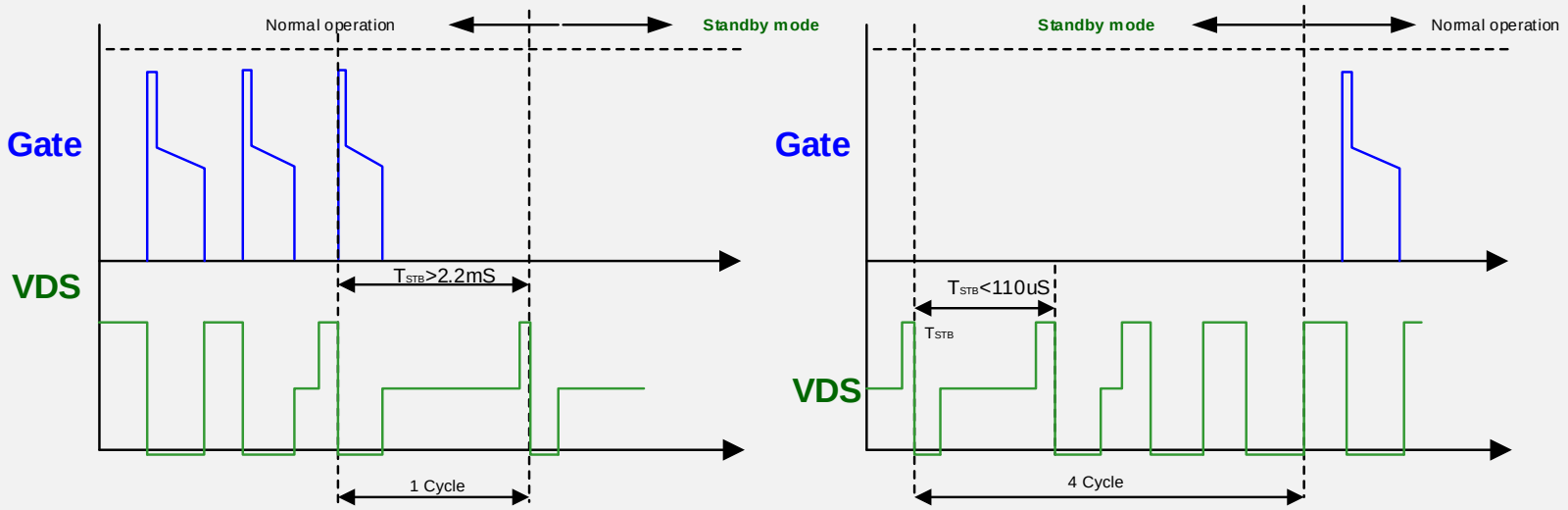
PF6602 Standby Mode Operation



Heavy Load → Light Load

Light Load → Heavy Load

Standby Current	VD=5V		100		uA

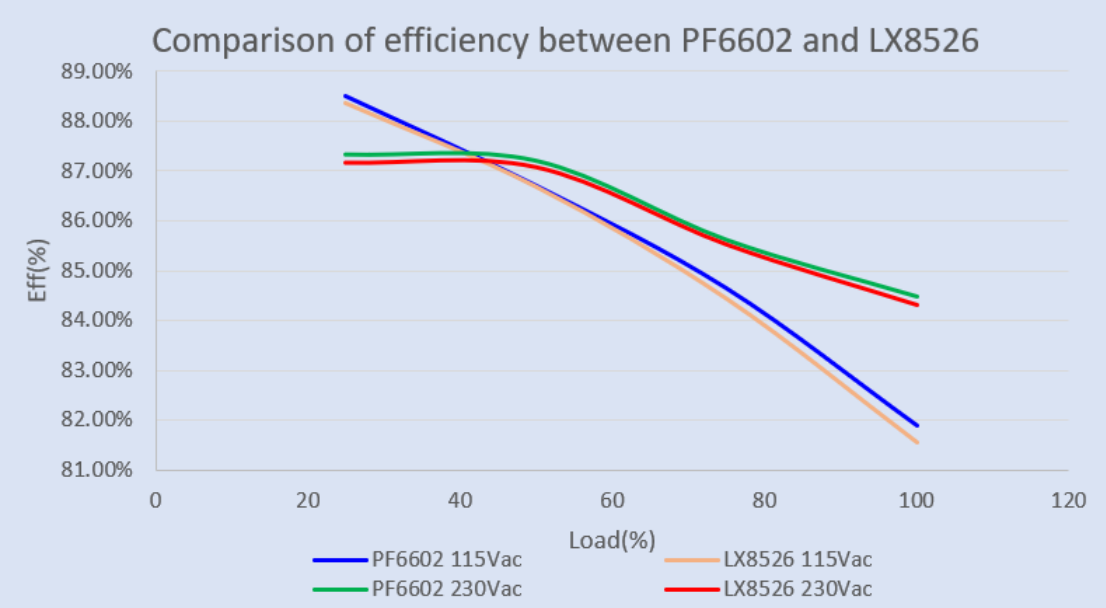
PF6602 vs XD8526
Power Saving & Efficiency for 5V/8A

PF6602	Pout 0.25W		
Vin	Pin(mW)	Pout(mW)	Spec(mW)
115Vac/60Hz	362	256	500
230Vac/50Hz	436	263	500

LX8526	Pout 0.25W		
Vin	Pin(mW)	Pout(mW)	Spec(mW)
115Vac/60Hz	366	256	500
230Vac/50Hz	448	256	500

PF6602	10% load		
Vin	Pin(W)	Pout(W)	Eff
115Vac/60Hz	4.554	4	0.88
230Vac/50Hz	4.64	4	0.86

LX8526	10% load		
Vin	Pin(W)	Pout(W)	Eff
115Vac/60Hz	4.579	4	0.87
230Vac/50Hz	5.12	4	0.78



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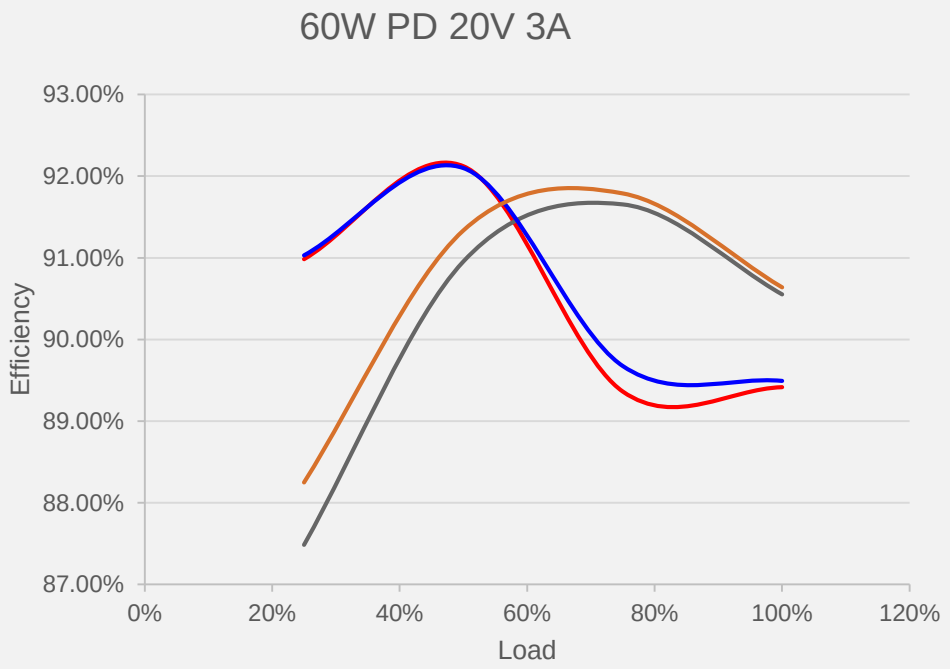
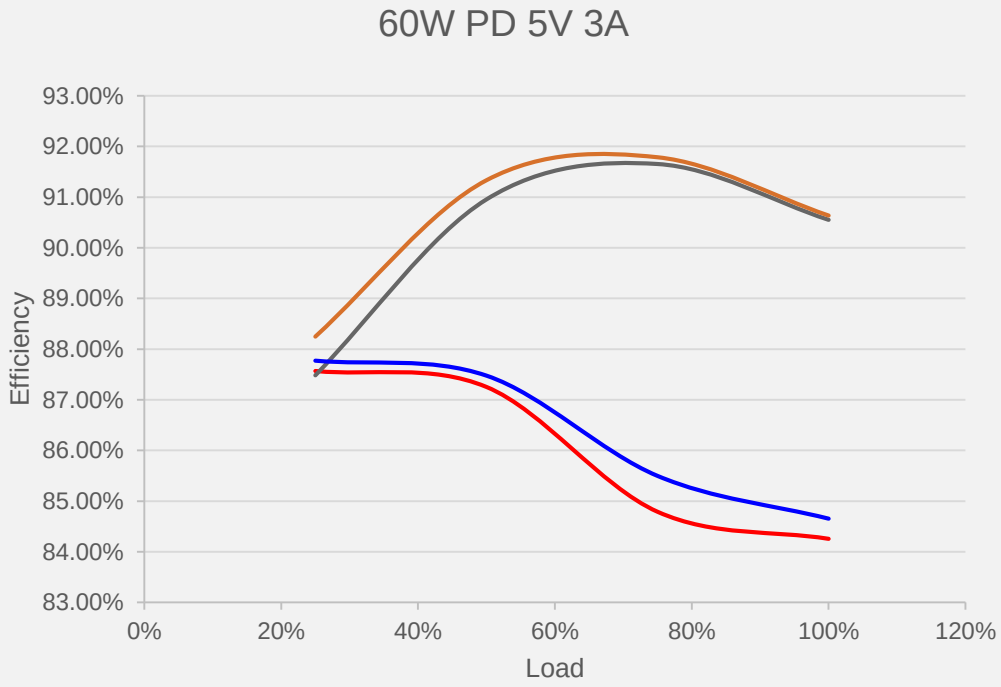
PF6602 vs XP6908 Efficiency





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PF6602 Reliability Data

- PF6602 Reliability Data
  - See attached file

PF6602_RA

4) Product Qualification：

4.1) Qualification Results：

Qualification item		Qualification Result		Sample Size	Class Level
HTOL		0/168/500/1000 hrs	All Pass	77 Units	NA
ESD	HBM	≥ 2.0V	All Pass	3 Units /Per Pin	Class 2
	MM	≥ 200V	All Pass	3 Units /Per Pin	Class B
	CDM	≥ 1000 V	All Pass	3 Units /Per Pin	Class C3
Latch up	I(+)	≥100mA	All Pass	3 Units /Per Pin	Class I
	I(-)	≥100mA	All Pass	3 Units /Per Pin	
	OV	≥1.1*VCC	All Pass	3 Units /Per Pin	