虹冠電子

Champion Microelectronic Corp.

http://www.champion micro.com.tw

$Dr.Flyback^{TM}$

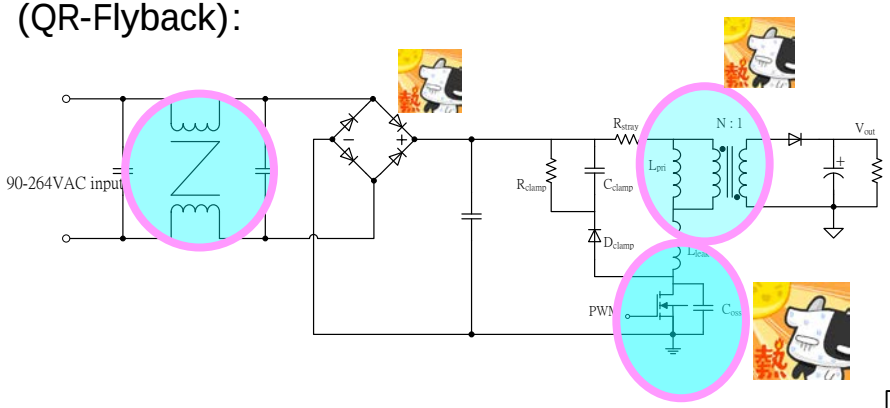
The Best Flyback = Dr. Flyback™

CUDrFB (Dr. Flyback™) from Champion

- ✓ Build-in High Side 800V Power Mosfet (800V High Side Driver Inside)
- ✓ Always ZVS for both Power Mosfets, High Side and Low Side
- ✓ Always ZVS for EMI Filterless
- ✓ 280Khz for Smaller Transformer/Inductor
- ✓ 280Khz, Laser Trimming Options for fast turn around
- ✓ Optimized efficiency for 25% 50% load
- ✓ Proprietary Kick Mode for optimal efficiency, acoustic noise, and output ripple
- ✓ All necessary protections with either Latched or Auto-Restart
- ✓ 800V 30V 5V UHV VIS process
- ✓ TSSOP18-Power Package
- ✓ Precision: with Precision Laser Trimming

Slim type/High efficiency/High Power density new topology

(QR-Flyback):



Slim type:
Bridge
Primany side
Mosfet
Secondary side

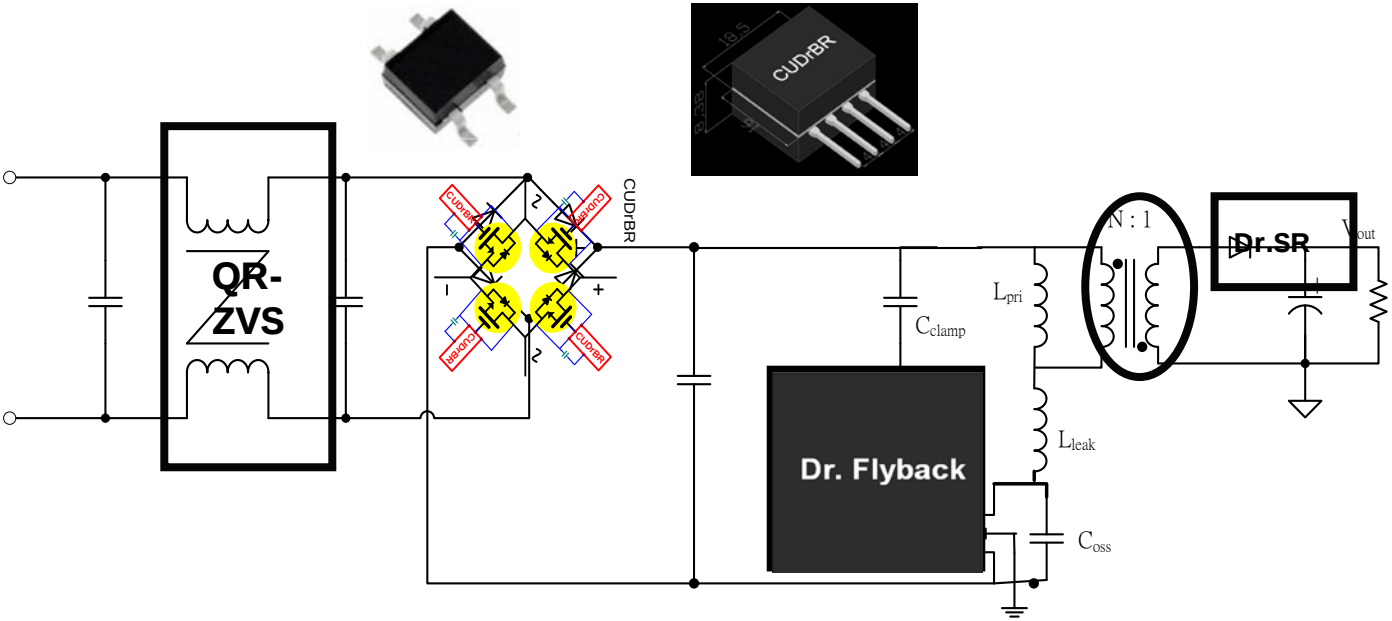
SMD type

Thermal issue

High efficiency → **QR is not Z.V.S**

High power density → **QR FB can not operated high frequency**

Efficiency:95 plus Dr.FB/Dr.SR/Dr.Bridge



DR.FB QR resonant topology
Improve Efficiency 3% UP

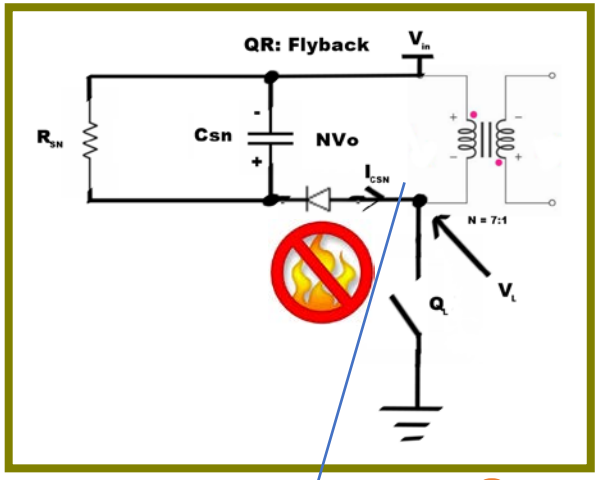
DR.SR:
Improve Efficiency 2% UP

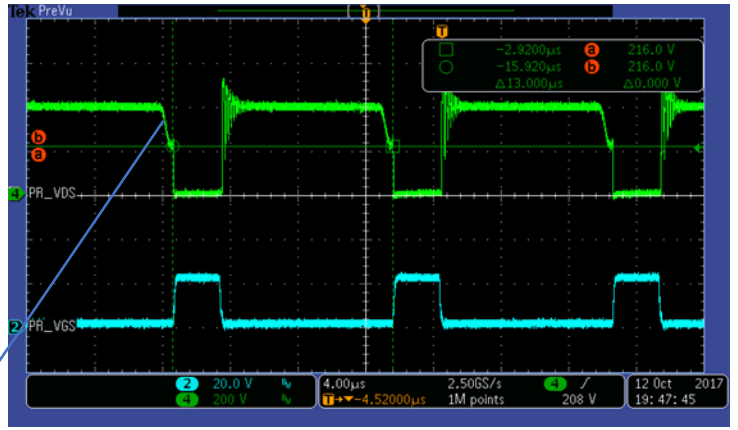
DR. Bridge
Improve Efficiency 1% UP

Resontant Flyback ZVS
EMI easy

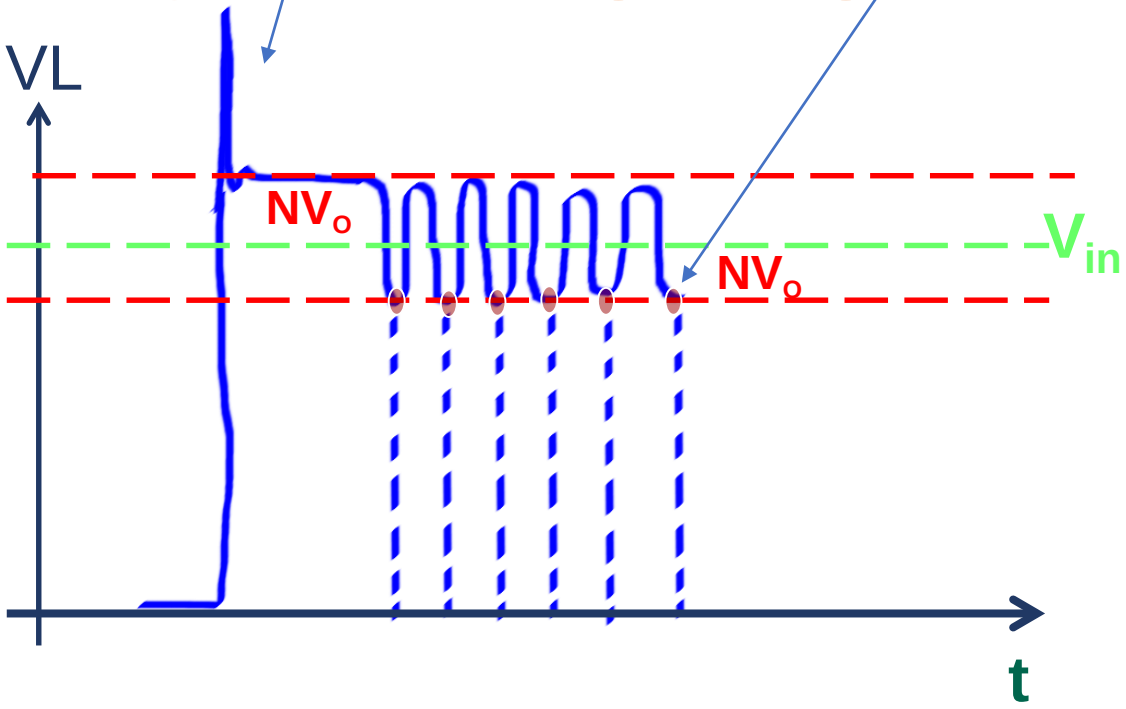
High frequency
Transformer size reduce

QR Flyback(variable frequency)





Operating High frequency X



E = 0.5 x C x V(230Vac) x V(230Vac)

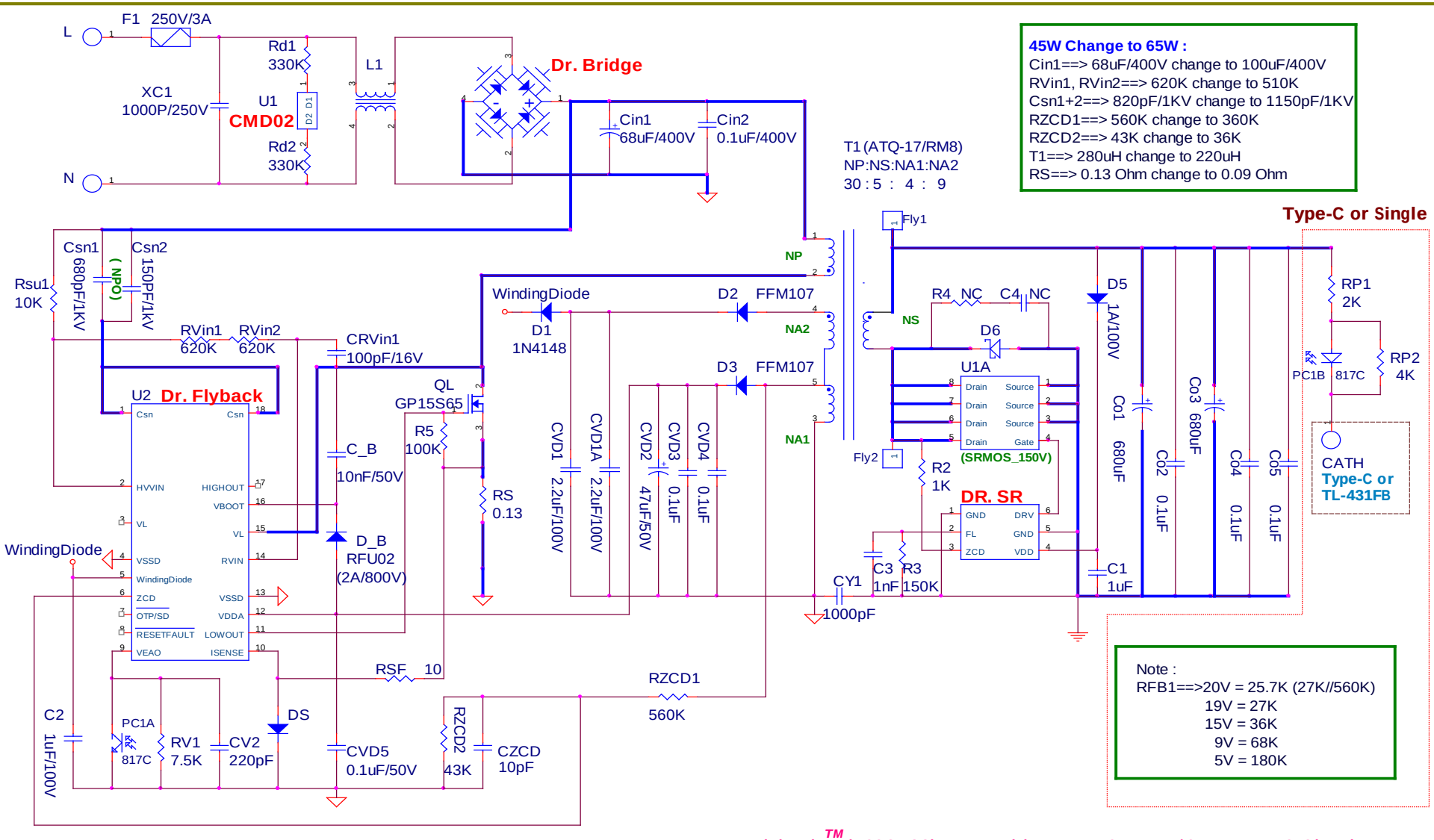
= 0.5 x C(V_L) x 325V x 325V

Pd = E x fsw

E x 280Khz Vs. E x 100Khz

Mosfet Thermal Issue
at High Frequency operating

DR.FB Application Circuit

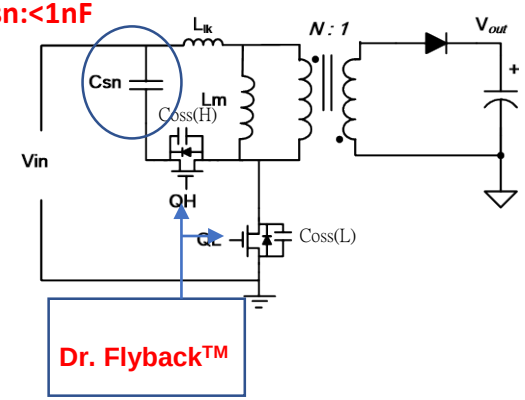


Dr. Flyback™ (TSSOP23)+ Dr. Bridge + Dr. SR 45W/65W Type-C Circuit

Dr. Flyback™ VS A.C.F Compare

Dr. Flyback™

Csn:<1nF

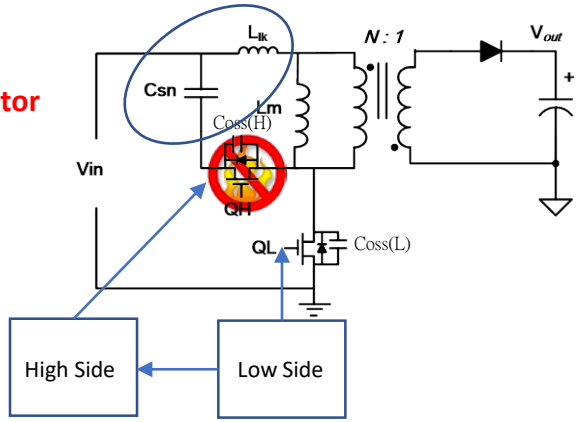


Dr. Flyback™

Adaptive Control High Side and Low Side
- Csn<3nF~1nF
- High side 4A/650V SJ Mosfet

A.C.F

Csn>100nF~400nF
Or +external inductor



Complementary control
- **Csn>10nF~100nF or need external inductor**
- **High side MosFSET Gan 20A**

Dr. Flyback
Close Loop:

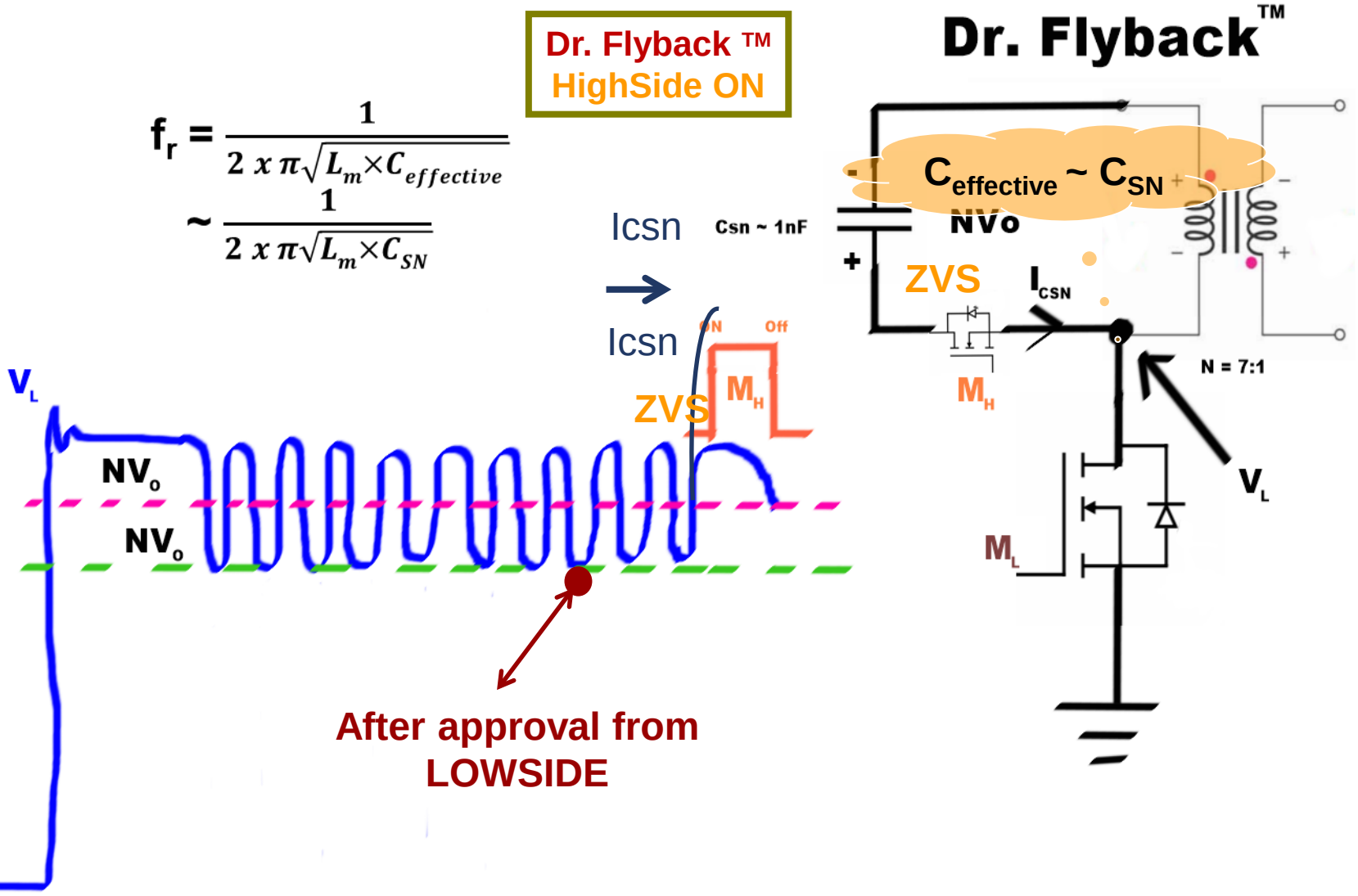
1. **HighSide ON = (SelfDetermination after Permission from LowSide)**
2. **Not Complimentary Duty Cycle; HighSide only ONs when it is needed**
3. **It has its own Brain**
4. **HighSide ZVS(On) ● ZVS(Off) and LowSide ZVS(On)**

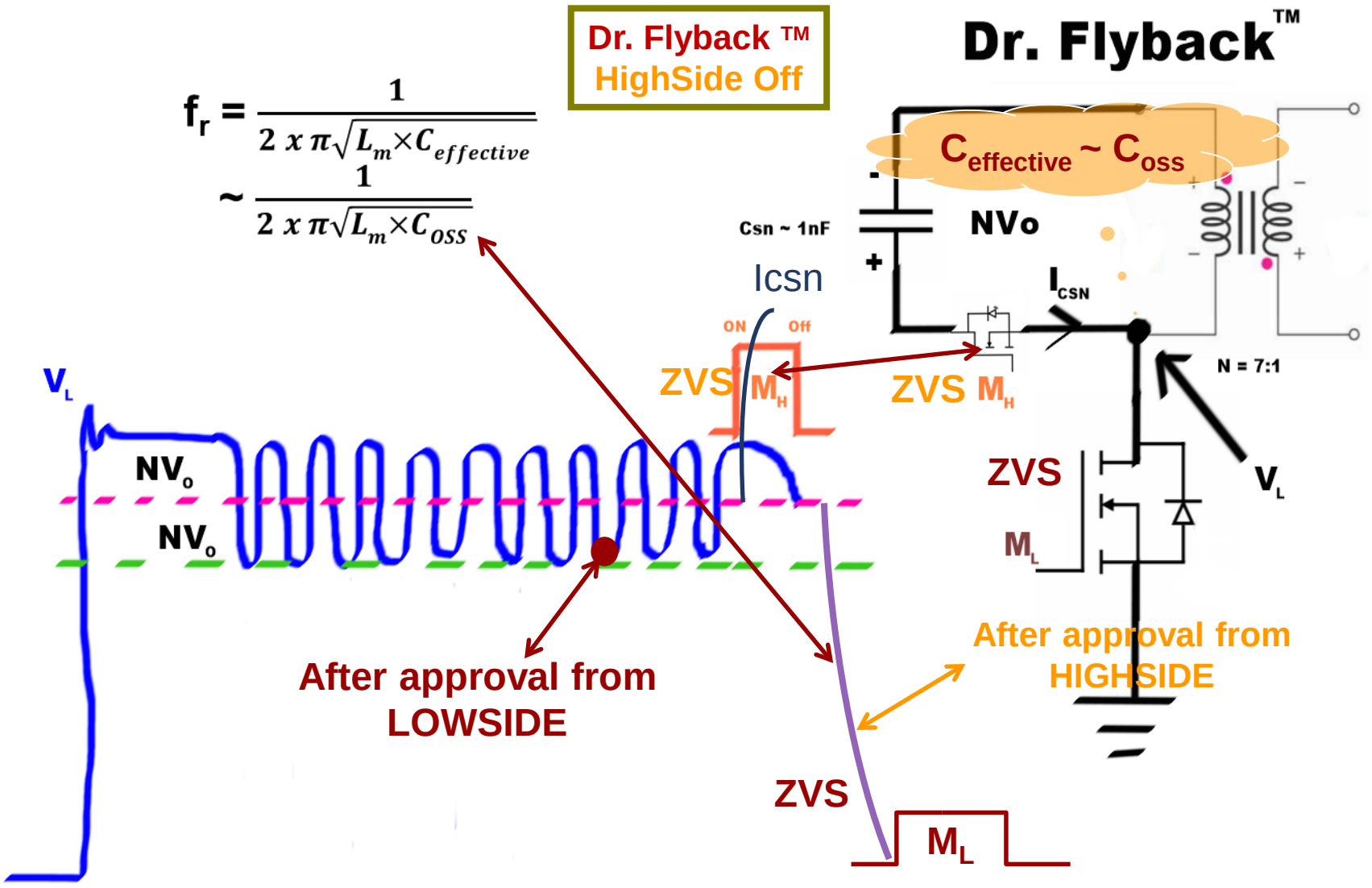
ACF
Open Loop:

1. **Complementary Duty Cycle**
2. **Dead Time Control**
3. **Sensitive to Tpd (So use GaN Driver IC) Need GaN HighSide Driver**
4. **Csn ~> 400nF (400 X Bigger)**
5. **Must Use GaN**
6. **Cannot go to DCM at LightLoad due to Not ZVS and …**
7. **Audible Noise**
8. **Need Rsn~> More Components and More Loss**
9. **HighSide SW is not ZVS**
10. **….**

Dr. Flyback ™
HighSide ON

$$f_r = \frac{1}{2\,x\,\pi\sqrt{L_m \times C_{effective}}} \sim \frac{1}{2\,x\,\pi\sqrt{L_m \times C_{SN}}}$$



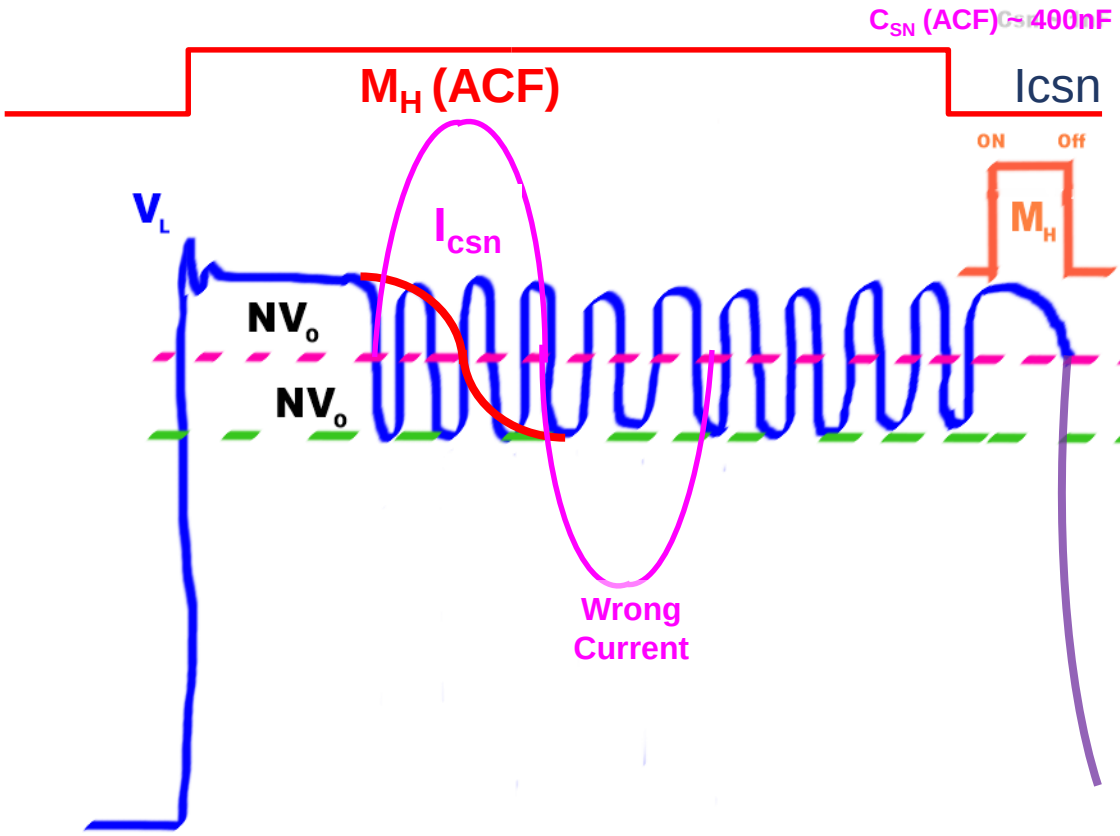

Dr. Flyback ™
HighSide Off
$f_r = \frac{1}{2\ x\ \pi\sqrt{L_m \times C_{effective}}} \sim \frac{1}{2\ x\ \pi\sqrt{L_m \times C_{OSS}}}$
Dr. Flyback™
$C_{effective} \sim C_{oss}$
Csn ~ 1nF
NVo
Icsn
I_{CSN}
ON
Off
ZVS M_H
ZVS M_H
N = 7:1
V_L
NV_o
NV_o
ZVS
M_L
V_L
After approval from LOWSIDE
After approval from HIGHSIDE
ZVS
M_L

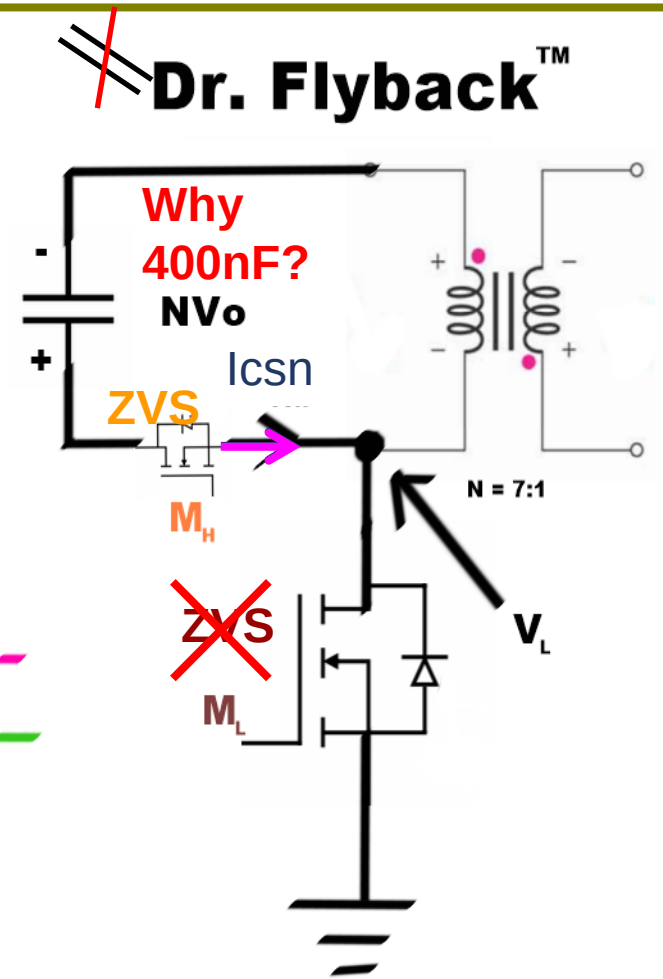
A.C.F: Active Clamp Flyback Issues

ACF:

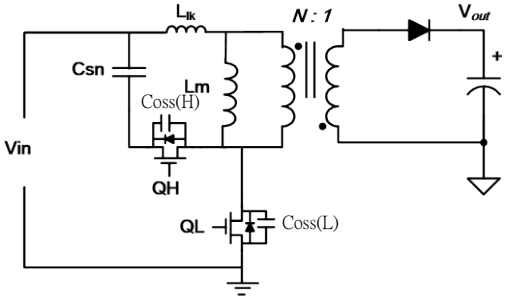
OPEN LOOP Control, Dead time control:

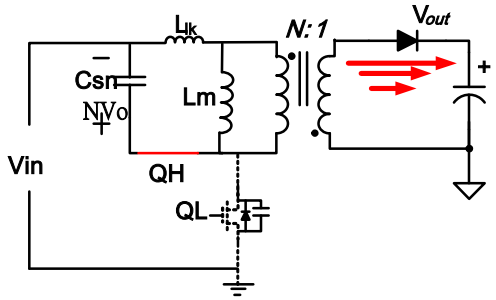
- C_{SN} (ACF) ~ 400 x C_{SN} (Dr. Flyback™) ~ 400nF
- Must Use GaN Fets and GaN Driver IC



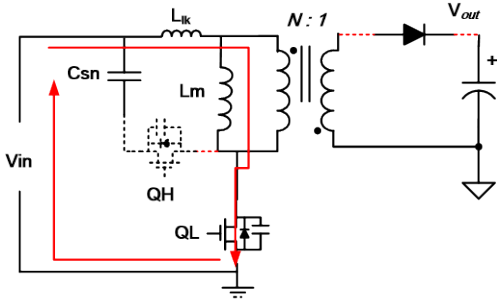


Dr Flyback™

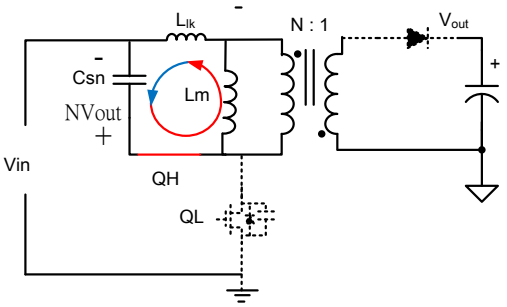




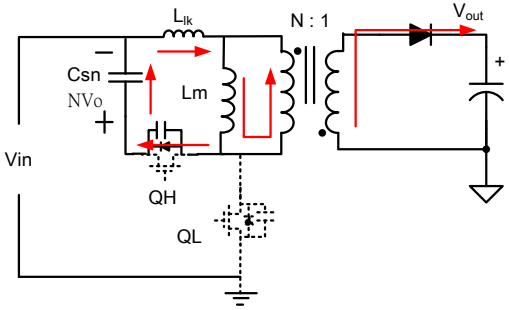
t3-t4



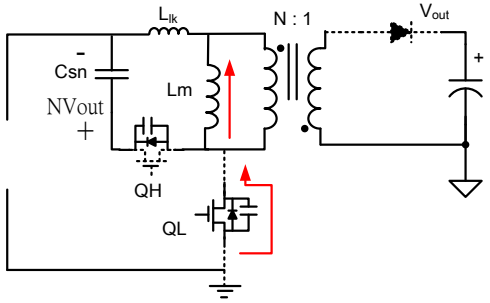
t0-t1



t4-t5

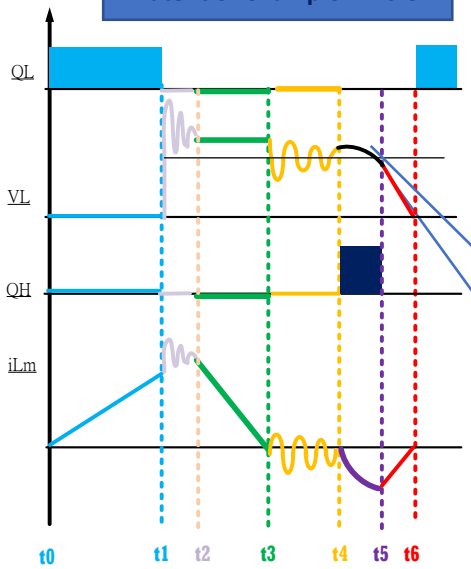


t1-t2



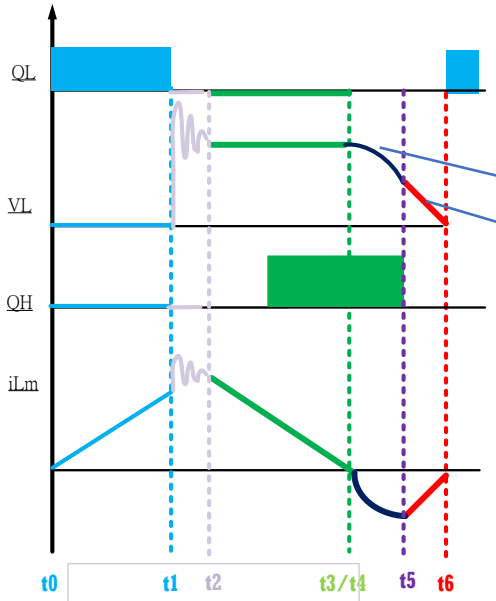
t5-t6

Patent of Championmicro



Lm&Csn resonant

Lm&Coss(QL) resonant



Lm&Csn resonant

Lm&Coss(QL) resonant

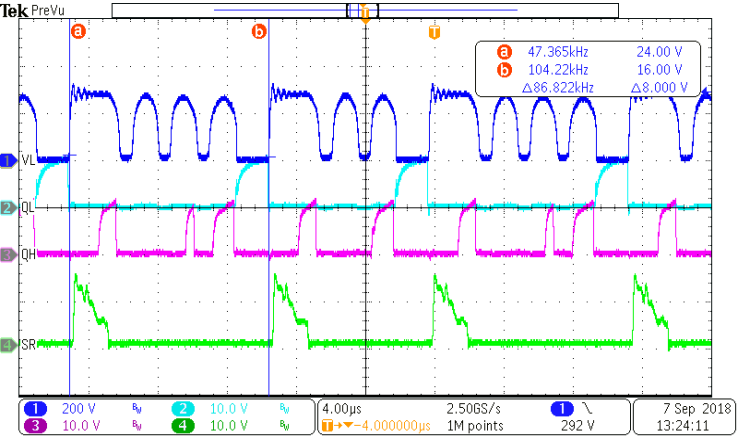
ZVS condition control by Lm current

Qusai Flyback/**Dr. Flyback™**/Active clamp Flyabck compare table

QR FB VS Dr.FB VS ACF			
Control Method	Qusai-Resonant	Dr Flyback	ACF
Operating frequency	Variable frequency	Variable frequency	Variable frequency
Operating Mode	DCM/CRM	DCM/CRM	CRM/CCM
High side driver	X	O	O
High Side Mosfet	X	Small	Big
High Side Mosfet	X	ZVS	Diffcult all condiction control ZVS
Low side Mosfet	Valley switch	ZVS	Diffcult all condiction control ZVS
Z.V.S condition	X	Lm	Llk
Z.V.S condition	X	Csn small easy achive	External inductor or big Csn
EMI	Bad	Good	Middle
SR control	Easy	Easy	Diffcult
High frequency operating	limit	Easy	Easy
Efficiency	Middle	Excellent	Good

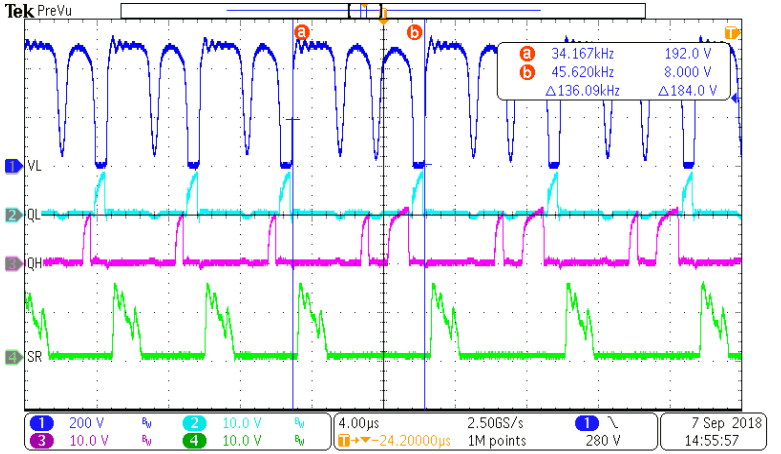
Dr. Flyback™ Operating Waveform

115VAC Light Load

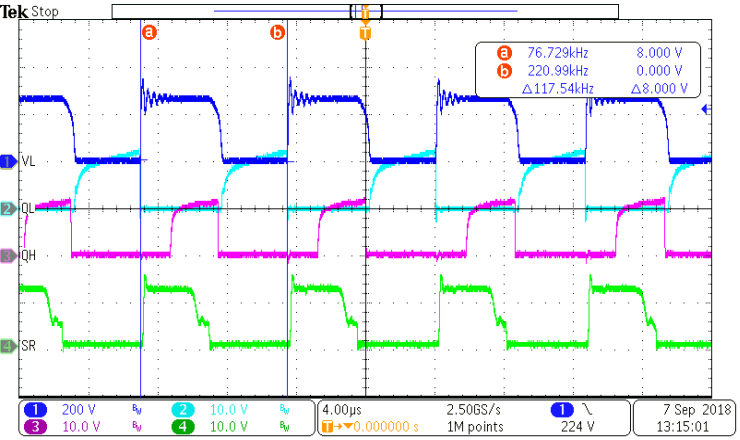


115VAC Mosfet switch at VDS~0V

230VAC light Load

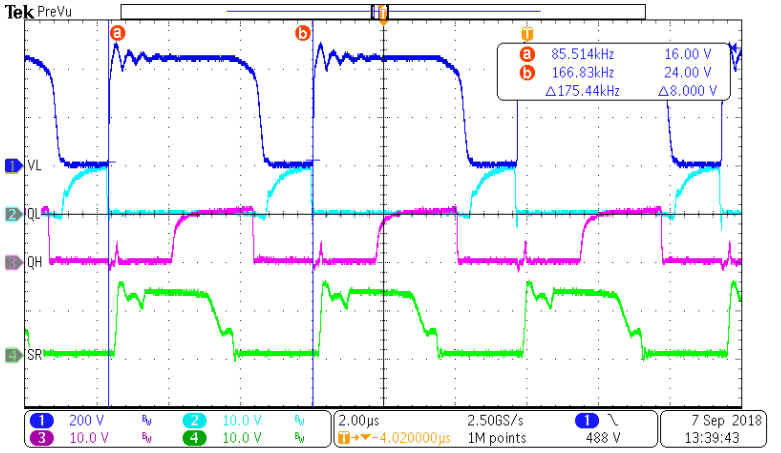


115VAC 100% load



230VAC Mosfet switch at VDS~30V

230VAC 100% load



Dr. Flyback™ 45W & 65W Efficiency

45W_115VAC & 230VAC Efficiency

115VAC @ 20V @60Hz							
1.RM8(30:5:4:9) 2.Lm=280uH 3.Csn=830pF 4.Bulk Cap=68uF 5. Lowside MOS:GP15S65 6.Highside MOS:GP04S65 7.SR MOS:BSC093N15							
Mode	Load	Vout	Iout	Pout	Pin	EFF	Fsw(KHz)
KICK	10%	20.04	0.225	4.51	4.95	91.09%	
DCM	25%	20.04	0.563	11.27	12.46	90.47%	125、93
CRM	50%	20.04	1.125	22.55	24.36	92.55%	170-181
CRM	75%	20.04	1.688	33.82	36.22	93.37%	130-147
CRM	100%	20.05	2.250	45.11	48.25	93.50%	100-123

230VAC @ 20V @50Hz							
1.RM8(30:5:4:9) 2.Lm=280uH 3.Csn=830pF 4.Bulk Cap=68uF 5. Lowside MOS:GP15S65 6.Highside MOS:GP04S65 7.SR MOS:BSC093N15							
Mode	Load	Vout	Iout	Pout	Pin	EFF	Fsw(KHz)
KICK	10%	20.04	0.225	4.51	4.96	90.91%	
KICK	25%	20.04	0.563	11.27	12.3	91.65%	
DCM	50%	20.04	1.125	22.55	24.44	92.25%	137
CRM	75%	20.04	1.688	33.82	36.26	93.26%	200-205
CRM	100%	20.05	2.250	45.11	48.18	93.63%	171-177

65W_115VAC & 230VAC Efficiency

115VAC @ 20V @60Hz							
1.RM8(30:5:9:4) 2.Lm=220uH 3.Csn=1150pF 4.Bulk Cap=100uF 5. Lowside MOS:GP15S65 6.Highside MOS:GP04S65 7.SR MOS:BSC093N15							
Mode	Load	Vout	Iout	Pout	Pin	EFF	Fsw(KHz)
KICK	10%	20.04	0.325	6.51	7.232	90.06%	
DCM	25%	20.04	0.813	16.28	17.78	91.58%	123
CRM	50%	20.04	1.625	32.57	35.02	92.99%	163-177
CRM	75%	20.04	2.438	48.85	52.34	93.33%	122-135
CRM	100%	20.04	3.250	65.13	69.86	93.23%	93-117

230VAC @ 20V @50Hz							
1.RM8(30:5:9:4) 2.Lm=220uH 3.Csn=1150pF 4.Bulk Cap=100uF 5. Lowside MOS:GP15S65 6.Highside MOS:GP04S65 7.SR MOS:BSC093N15							
Mode	Load	Vout	Iout	Pout	Pin	EFF	Fsw(KHz)
KICK	10%	20.03	0.325	6.51	7.2	90.41%	
KICK	25%	20.04	0.813	16.28	18.03	90.31%	
CRM	50%	20.04	1.625	32.57	34.99	93.07%	230
CRM	75%	20.04	2.438	48.85	52.01	93.92%	186-191
CRM	100%	20.05	3.250	65.16	69.2	94.17%	157-165