

# Infineon Solution for LED TV SMPS

Willion Chen

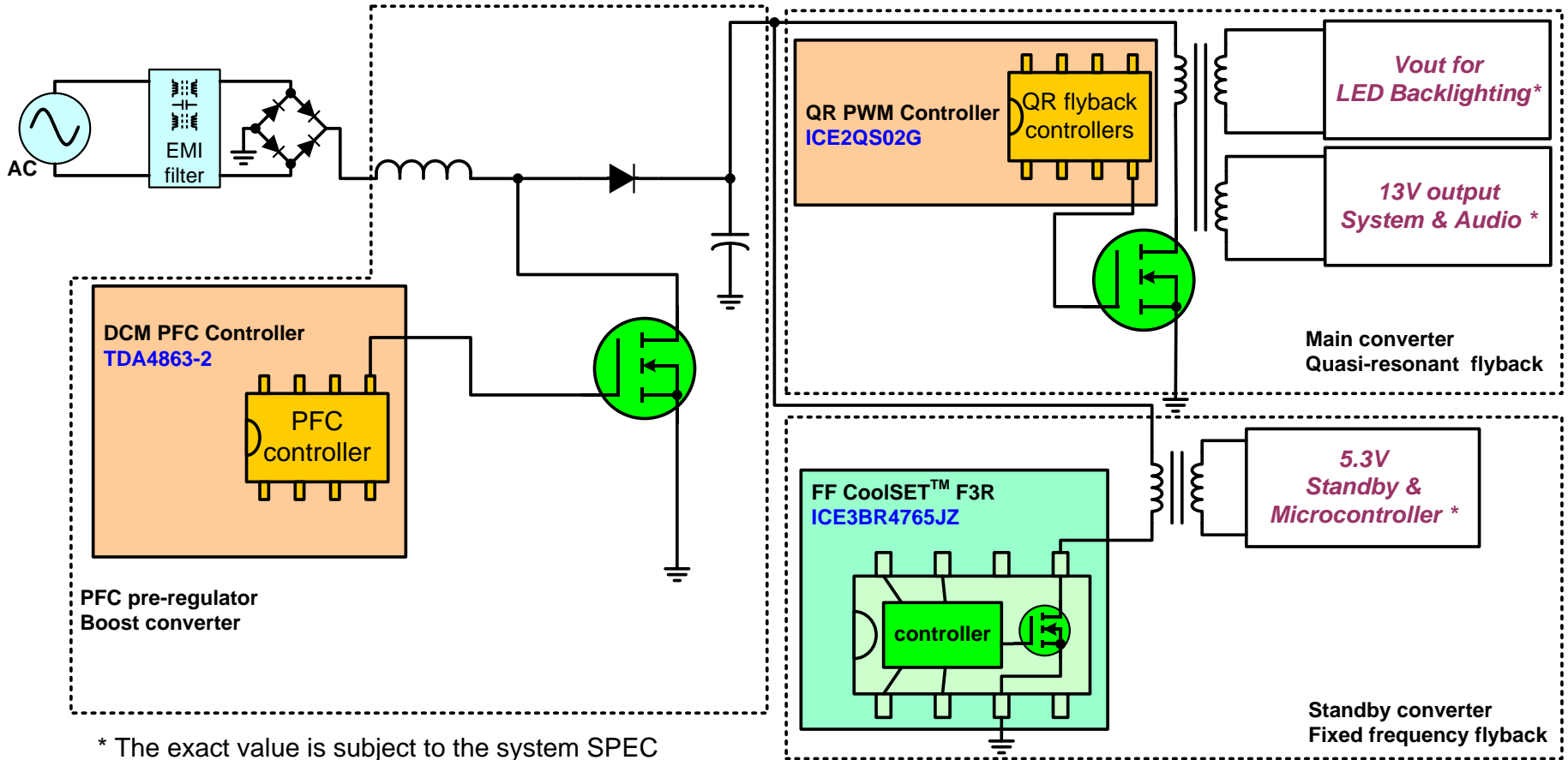
System Application Engineer

ASIC & Power IC



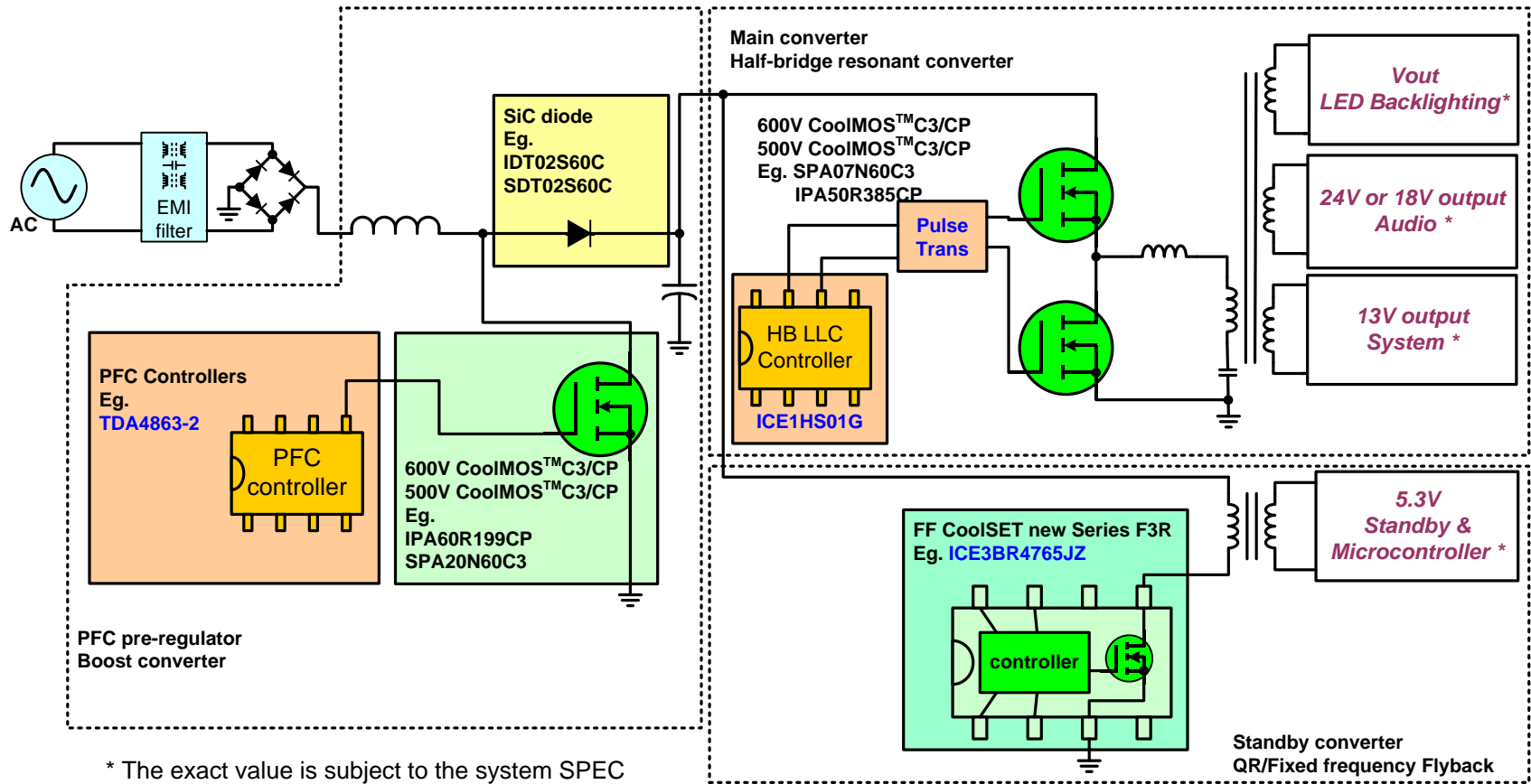
- Various Solution by power stages
- PFC controllers introduction
- LLC controllers introduction
- Auxiliary Power solution

# LED TV SMPS: <100W solution



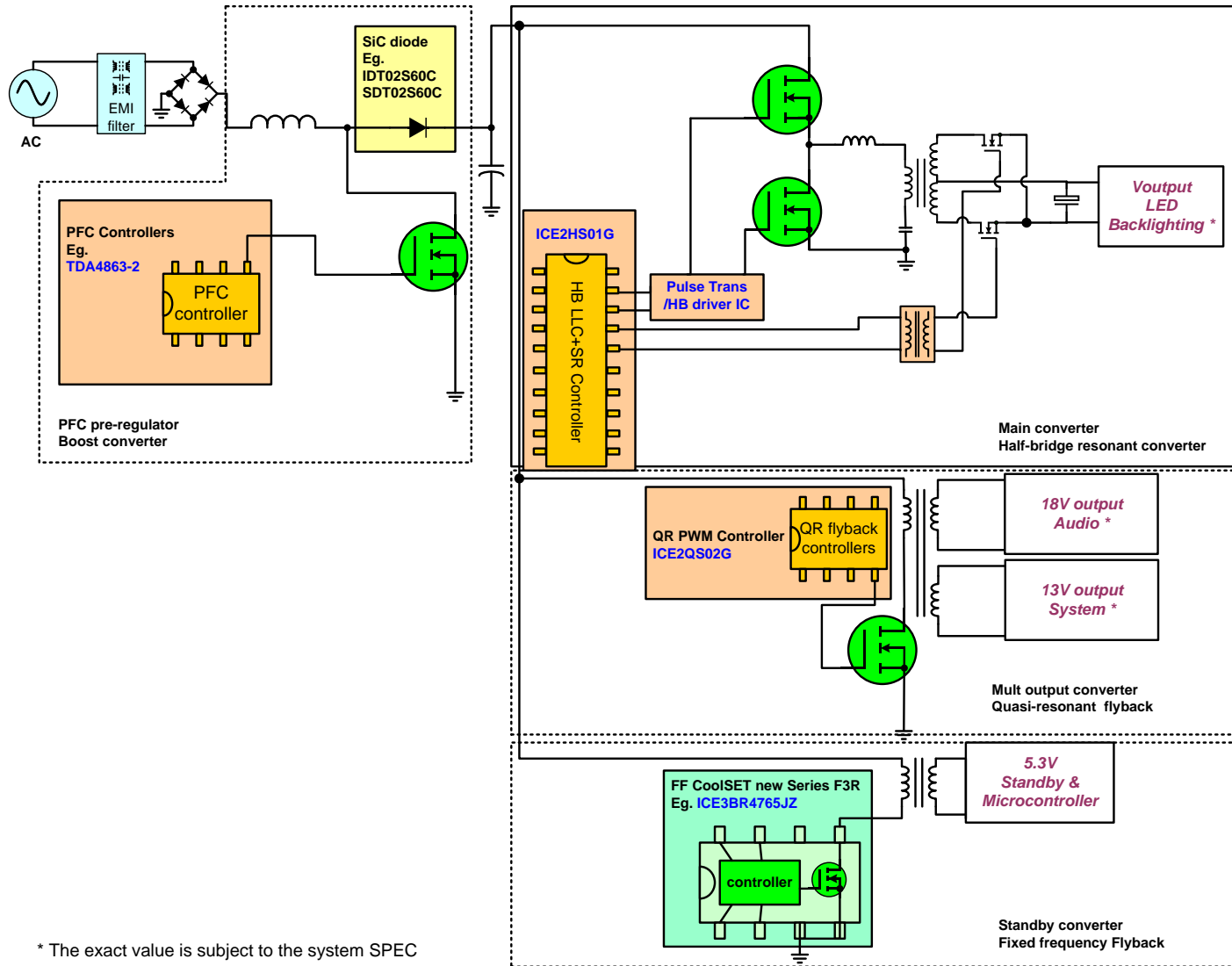
- ❑ **TDA4863-2:** Few external component , easy design, nearly 1 power factor can be achieved.
- ❑ **ICE2QS02G:** Mosfet Valley switching and Frequency reduction ensure high average efficiency >87%.
- ❑ **ICE3BR4765JZ:** Active burst mode ensures extremely low standby power consumption <0.1W.

# LED TV Power: 100~200W solution



- ❑ **TDA4863-2:** Few external component , easy design, nearly 1 power factor can be achieved.
- ❑ **ICE1HS01G:** LLC resonant converter ensures high efficiency >95% and low EMI radiation.
- ❑ **ICE3BR4765JZ:** Active burst mode ensures extremely low standby power consumption <0.1W.

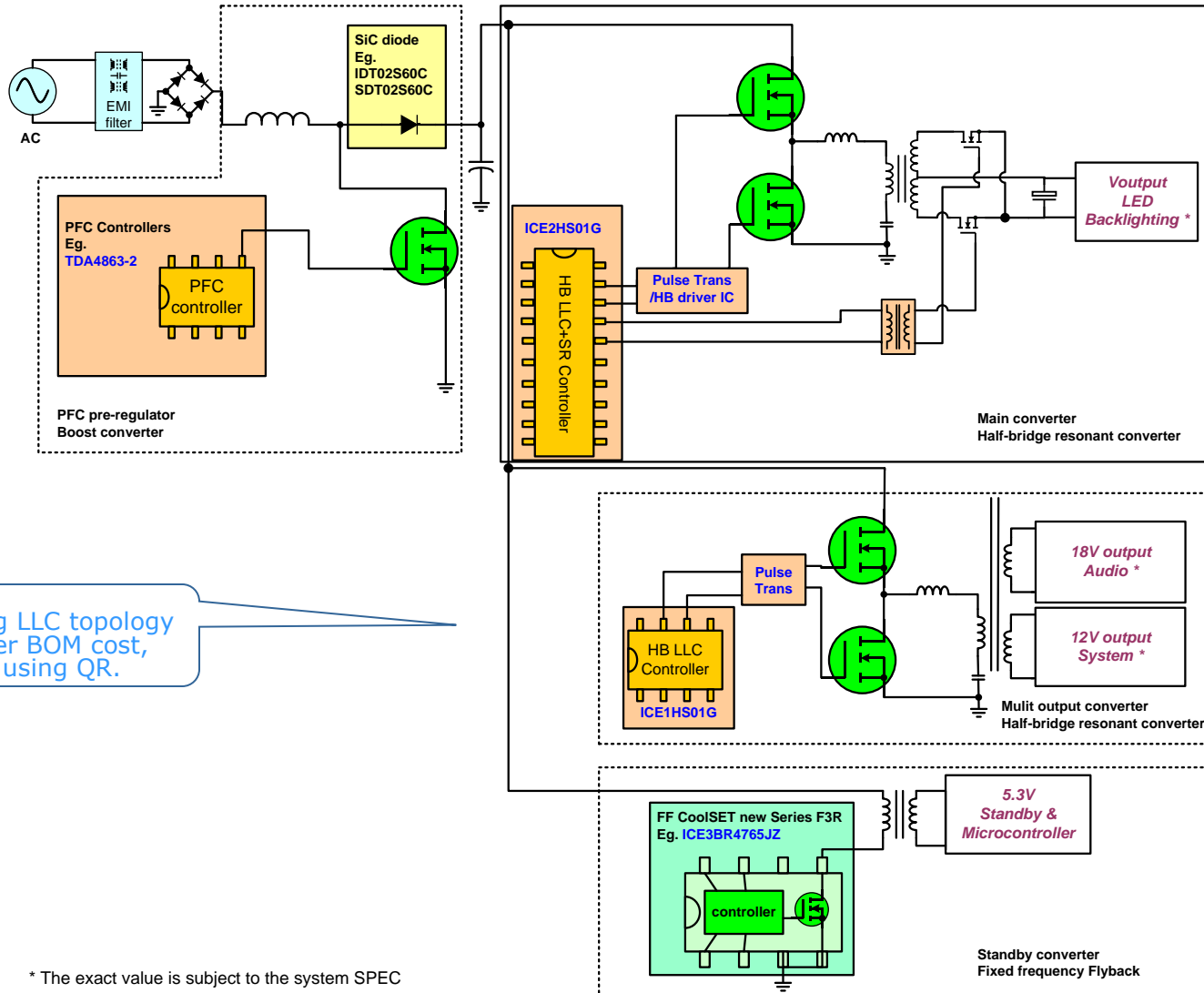
# LED TV Power: High Efficiency 200W solution\_ option 1



\* The exact value is subject to the system SPEC

□ **ICE2HS01G: LLC+SR controller further increases the LLC efficiency to a much higher level.**

# LED TV Power: High Efficiency 200W solution\_ option 2

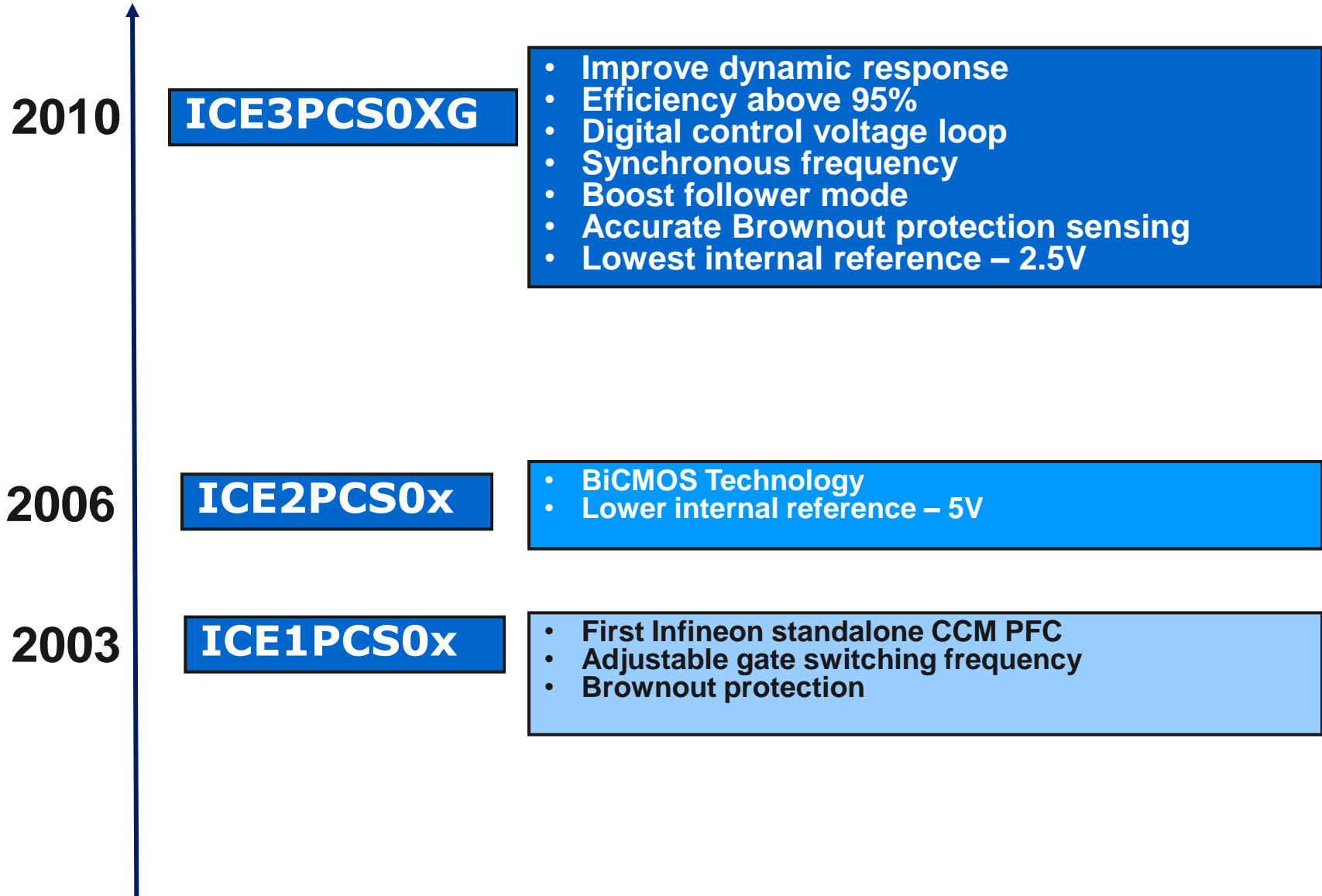


Multi output using LLC topology may cause lower BOM cost, compared to using QR.

\* The exact value is subject to the system SPEC

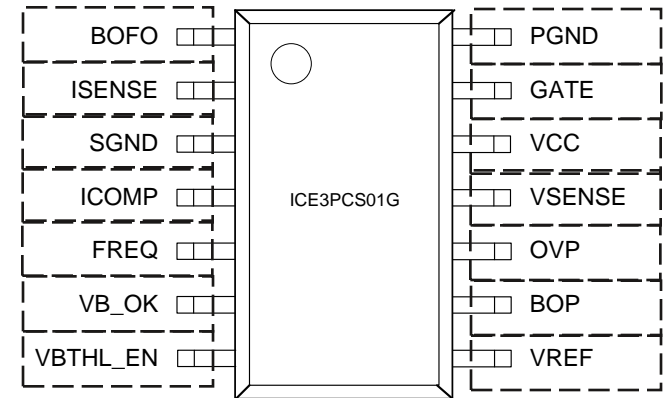
□ **ICE2HS01G: LLC+SR controller further increases the LLC efficiency to a much higher level.**

# Infineon CCM PFC controller History



# Pin Layout ICE3PCS01G

- Pin1** =Boost Follower Setting (BOFO)
- Pin2** =Current Sense Input (ISENSE)
- Pin3** =Signal Ground (SGND)
- Pin4** =Current Loop Compensation (ICOMP)
- Pin5** =Switching Frequency Setting (FREQ)
- Pin6** =Bulk Voltage OK Signal
- Pin7** =PFC Enable Function (VBTHL\_EN)
- Pin8** =Voltage reference (VREF)
- Pin9** =Brownout Protection (BOP)
- Pin10** =Over Voltage Protection (OVP)
- Pin11** =Bulk Voltage Sense (VSENSE)
- Pin12** =IC Supply Voltage (VCC)
- Pin13** =Gate Drive (GATE)
- Pin14** =Power Ground (PGND)

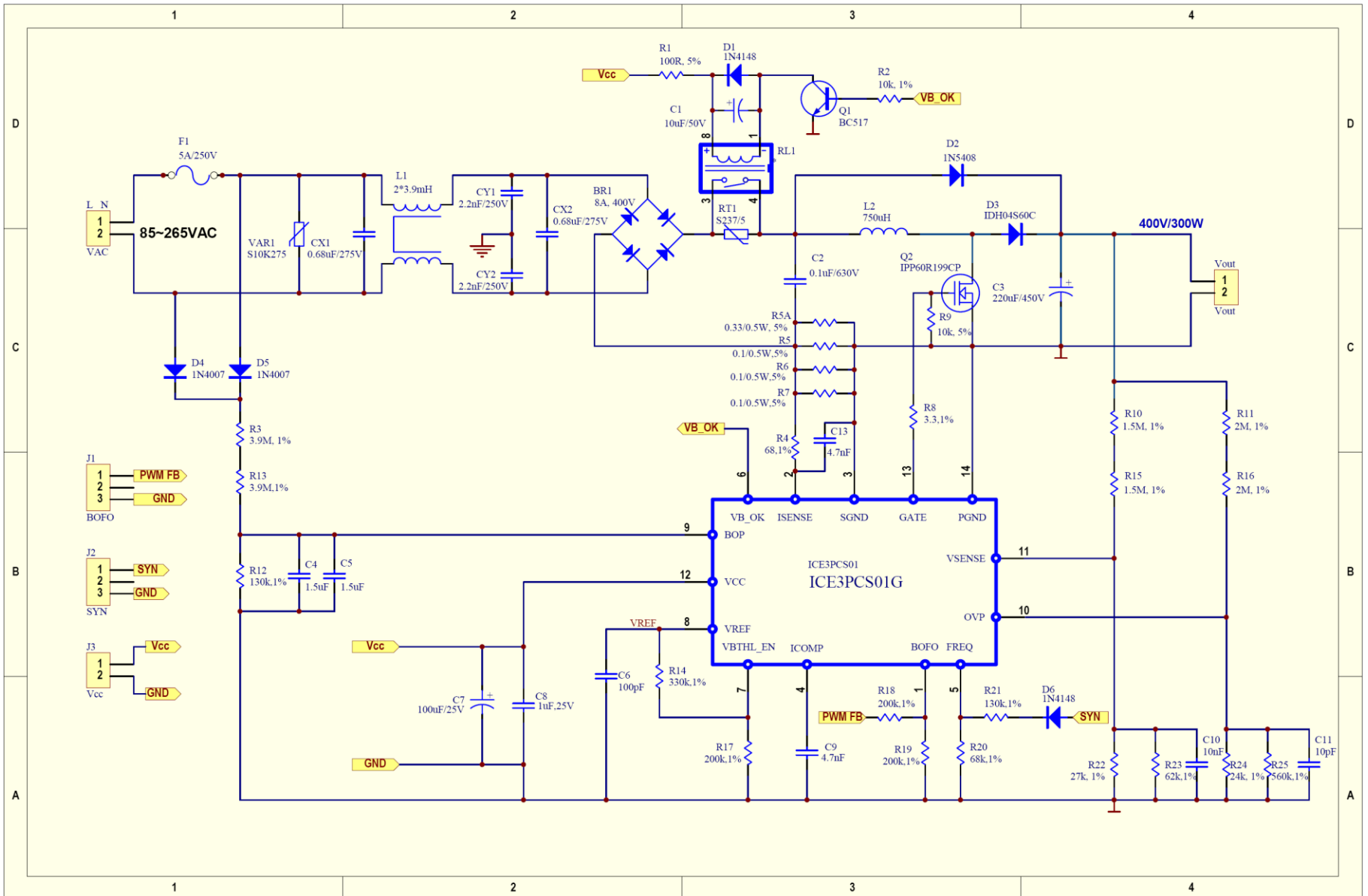






- Low Peak Current Limit (0.2V)
- Average current control without direct sinewave reference signal sensing
- Adjustable operating frequency (20kHz - 250kHz)
- Synchronous frequency (50kHz - 150kHz)
- Boost Follower Mode with adjustable bulk voltage at low step
- Accurate Brown Out protection
- Second Over Voltage protection (OVP2)
- PFC enable function
- Enhanced dynamic response without current distortion
- Digital Control Voltage Loop
- Simple and easy design with very few external components reduces system and assembling cost.
- Supports the trends: High efficiency, High power factor, High Power Density and Low System Cost
- Target Applications: PC, Server, TV, gaming console, Adapter

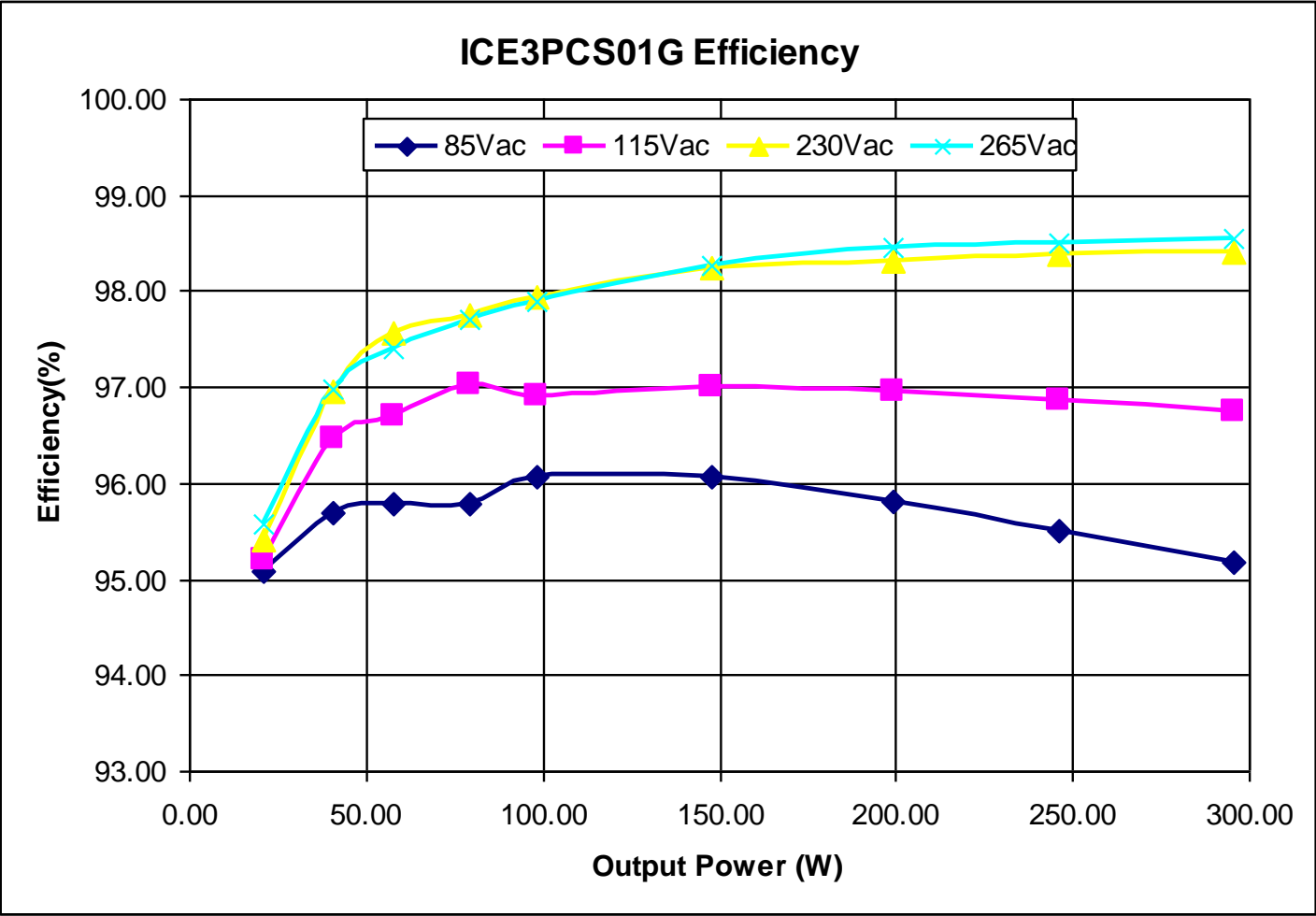
# Schematic of ICE3PCS01G Demoboard



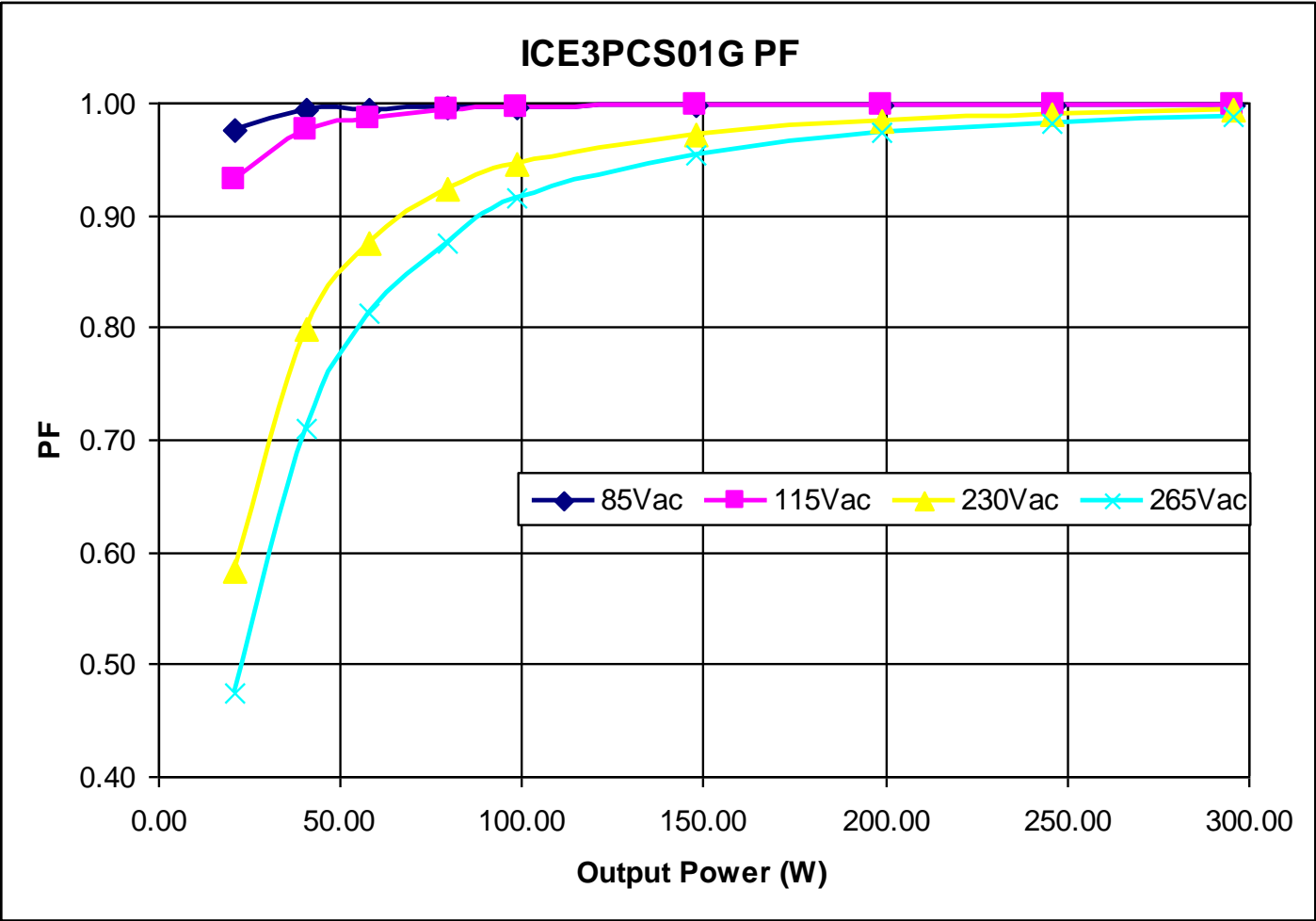
# ICE3PCS01G's 300W Demoboard



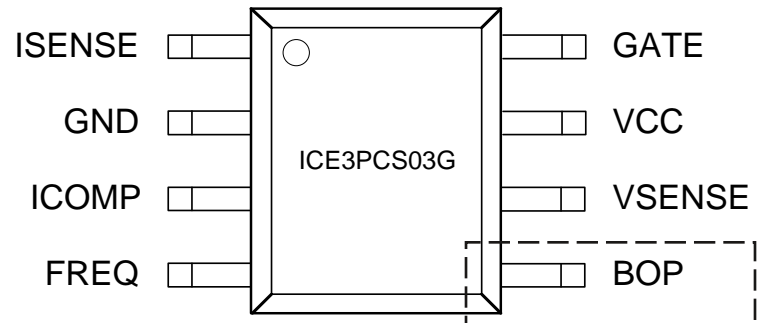
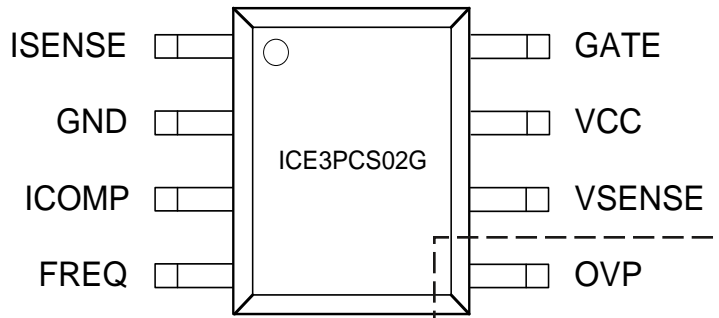
# Performance of Evaluation Board Efficiency Vs Output Power



# Performance of Evaluation Board Power Factor Vs. Output Power



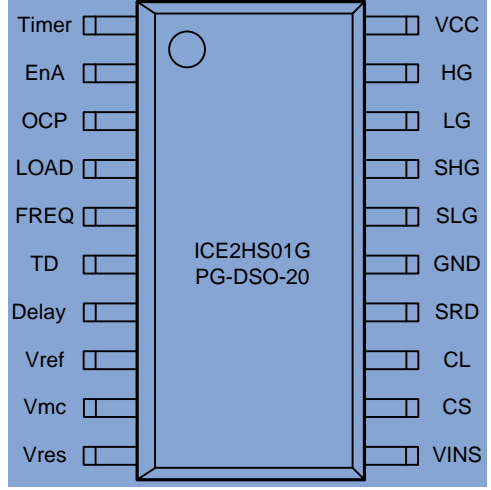
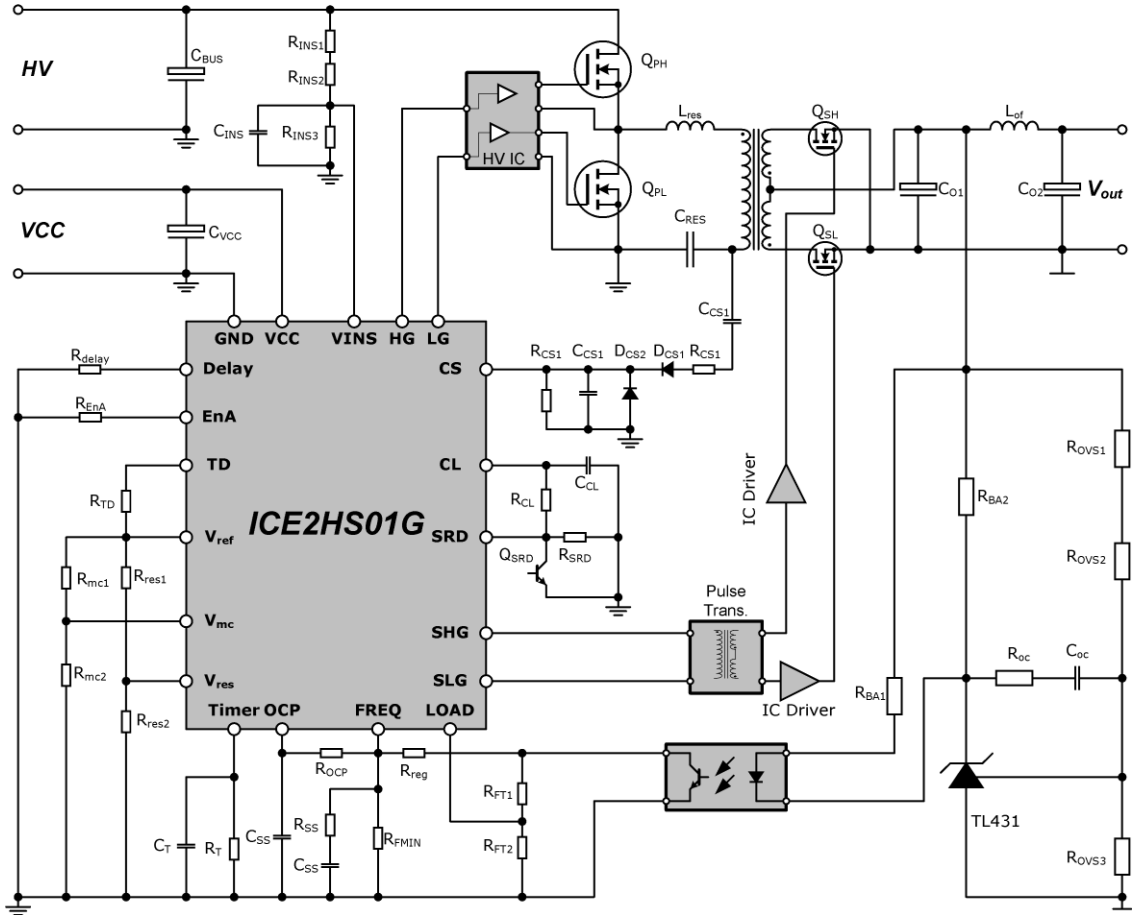
## Other ICE3PCS0XG family



- The difference between ICE3PCS02G and ICE3PCS03G is at pin 5

# LLC stage → ICE2HS01G

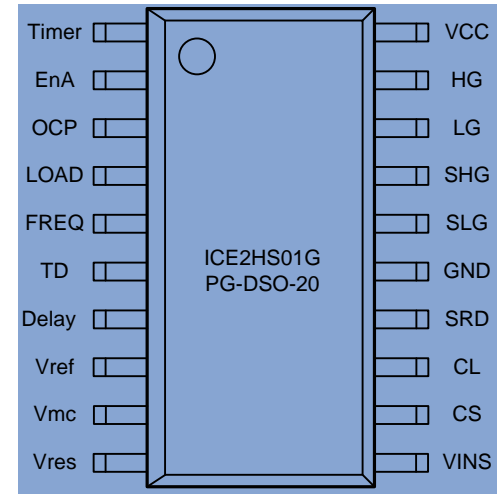
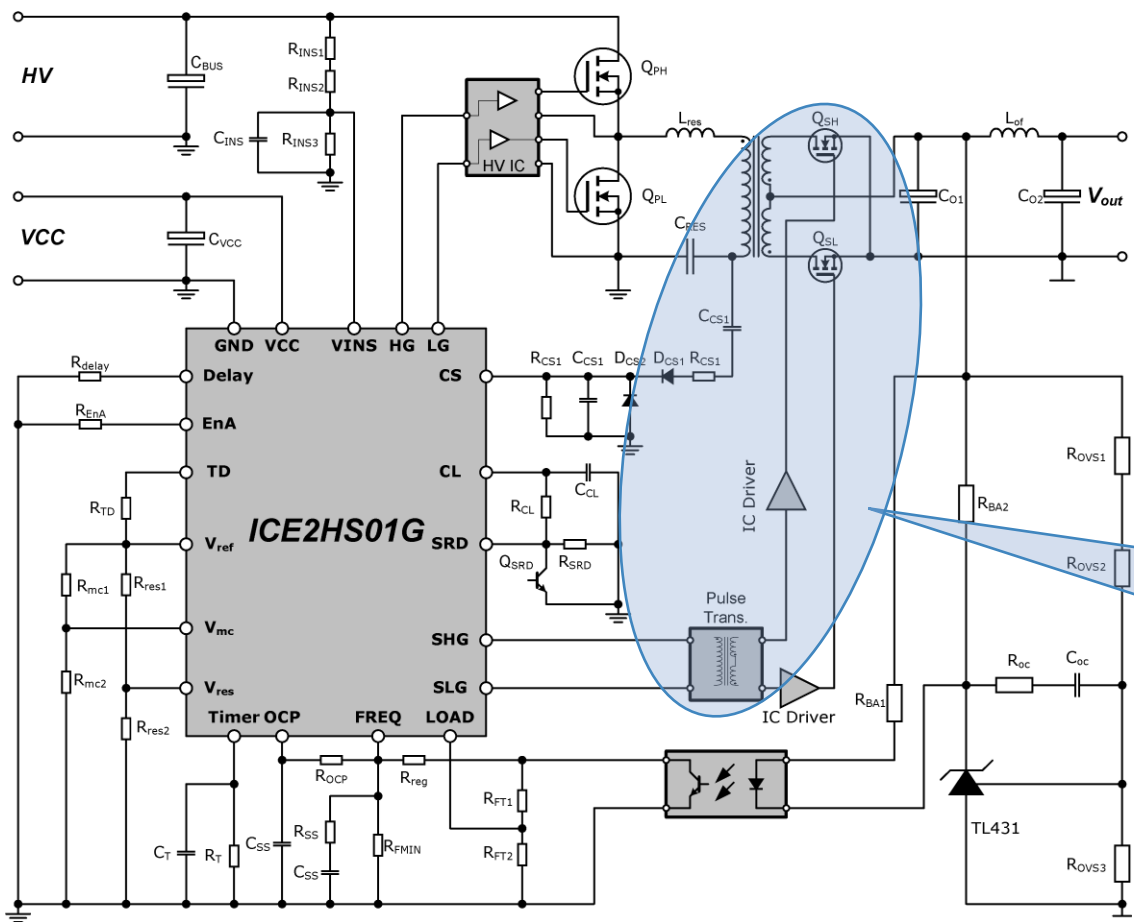
Load	20%	50%	100%
Efficiency	95.5%	97%	96.5%





# LLC stage → ICE2HS01G

Load	20%	50%	100%
Efficiency	95.5%	97%	96.5%

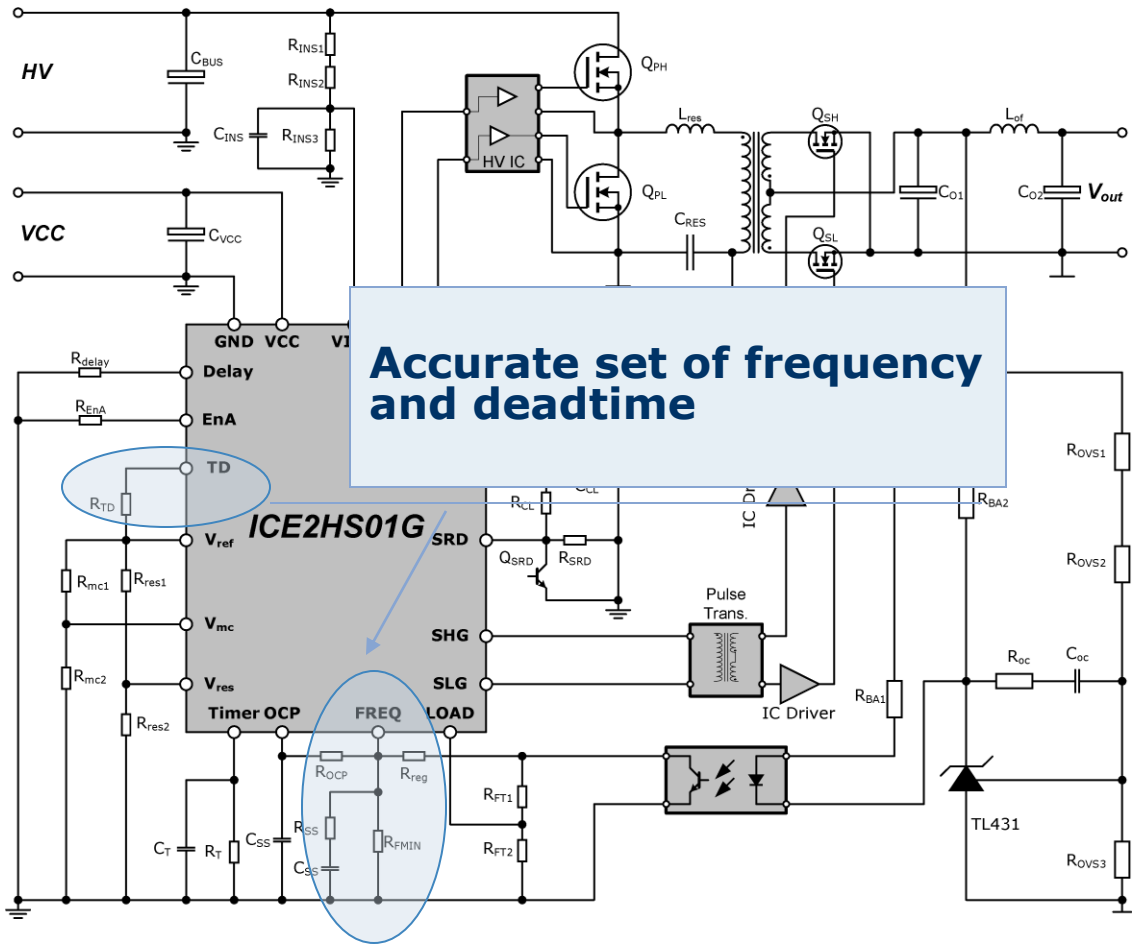


**•SR control from primary side for both CCM and DCM**  
**•No need SR IC/Current sense at secondary side**

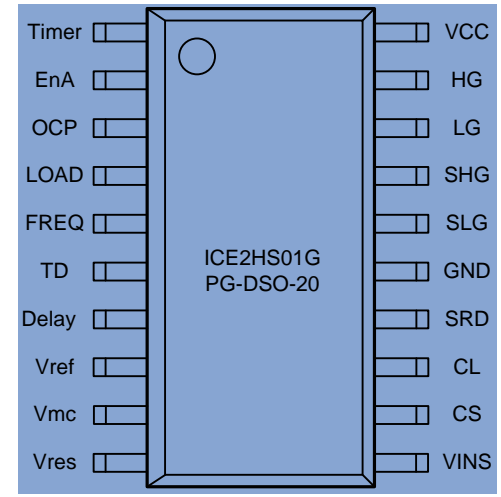
# Infineon System Solution for LED TV LLC stage → ICE2HS01G



Load	20%	50%	100%
Efficiency	95.5%	97%	96.5%



**Accurate set of frequency and deadtime**

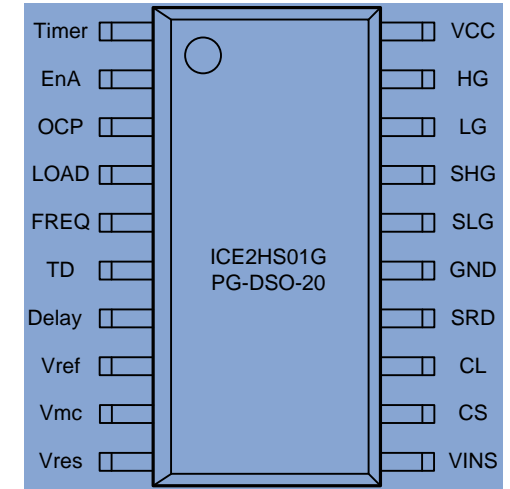
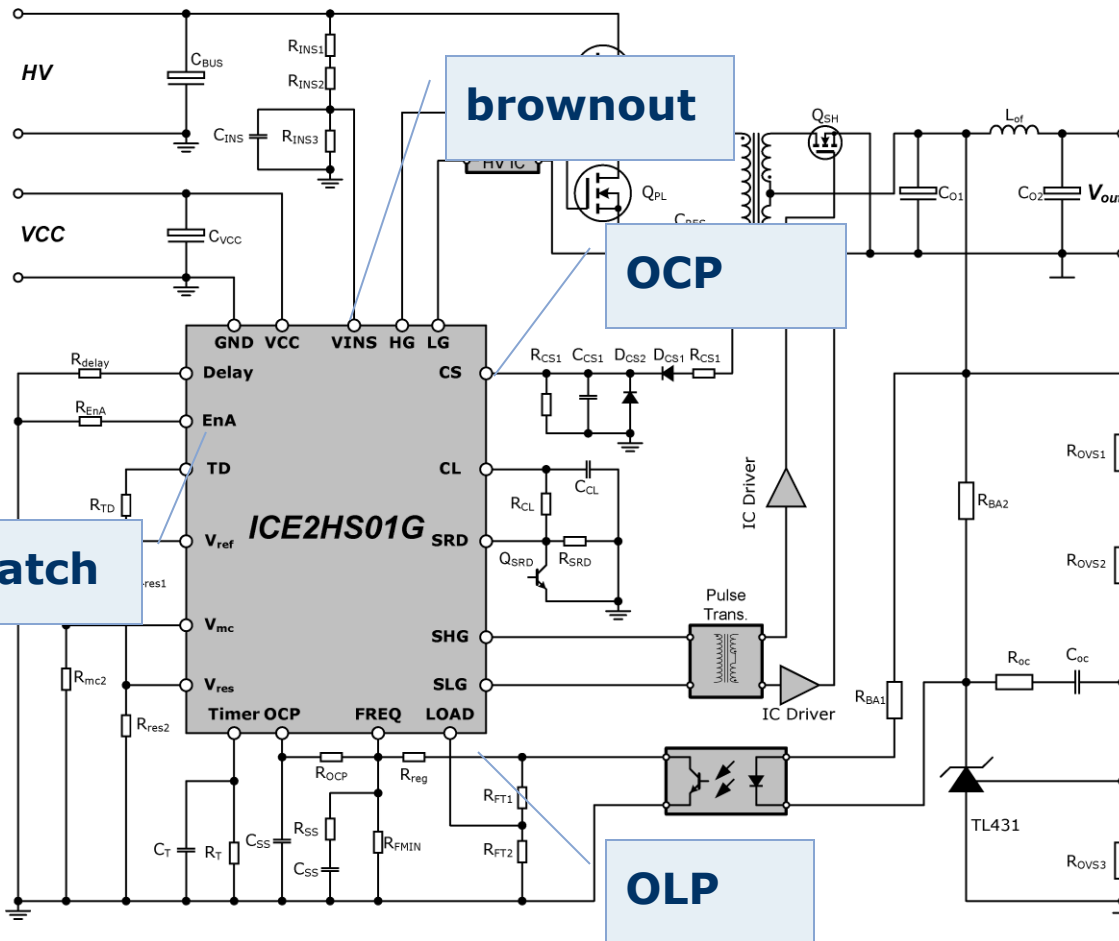


# Infinion System Solution for LED TV

## LLC stage → ICE2HS01G



Load	20%	50%	100%
Efficiency	95.5%	97%	96.5%



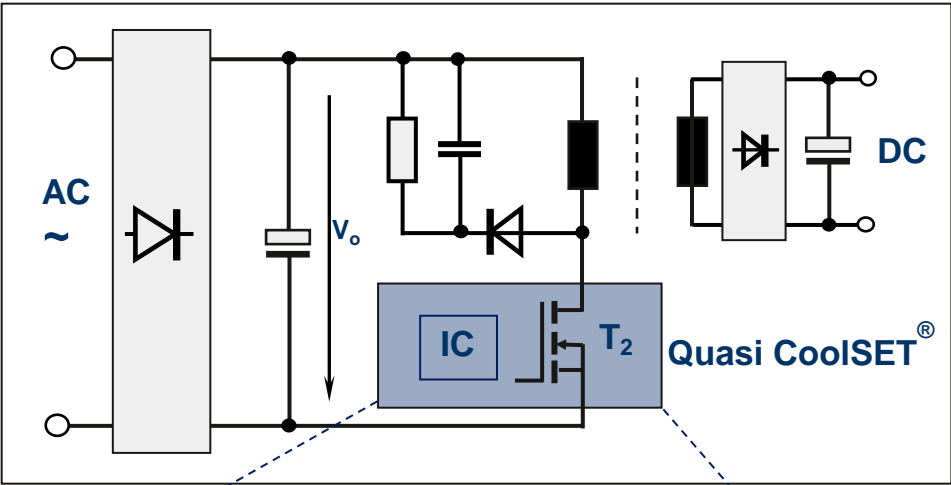
# Infineon system solution for LED TV

## ICE2HS01G Key Features



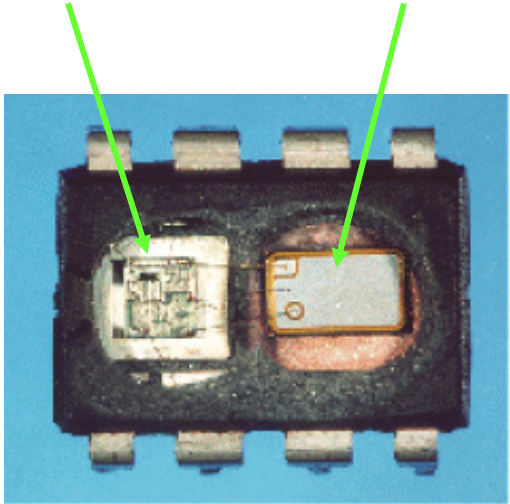
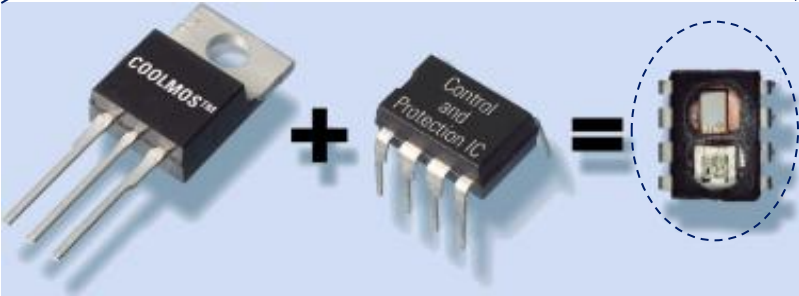
- Flexible LLC operation
  - Adjustable frequency for Min, Max, OCP and SS → **Easy design**
  - Maximum switching frequency up to 1MHz → **High power density**
  - Adjustable and adaptive dead time control → **Easy design**
- Novel SR operation mode with various protections (***patent pending***)
  - Can be operated at boost region with SR → **Highest achievable efficiency**
  - Variable protections for SR operation → **Easy and Reliable design**
  - Control SR from primary controller → **No need of SR IC, low system cost**
  - Tight tolerance control → **Feasibility for mass production**
- Accurate setting of switching frequency and dead time
  - **Simple system design**
  - **optimized system efficiency**
- Various protections
  - OTP, OLP, OCP, Latch-off Enable → **Easy system design**

# Infineon Integrated Power IC – F3 & Quasi. CoolSET®

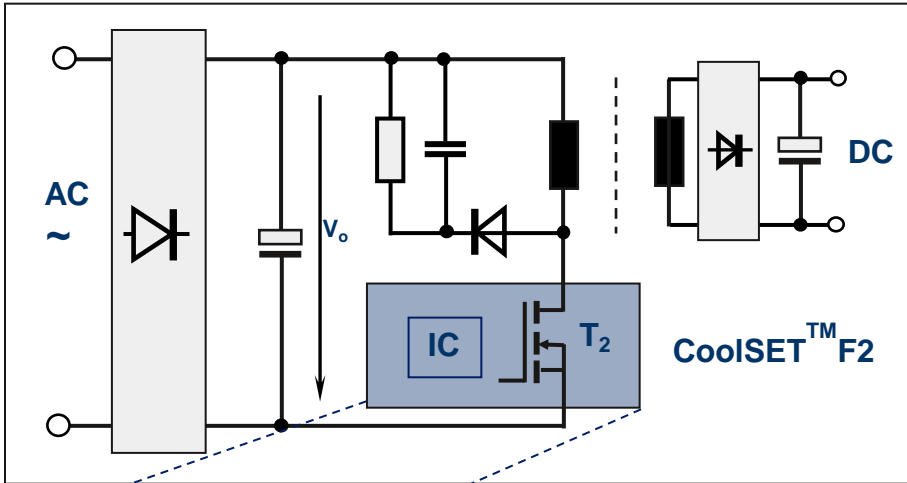


Quasi. PWM IC

CoolMOS



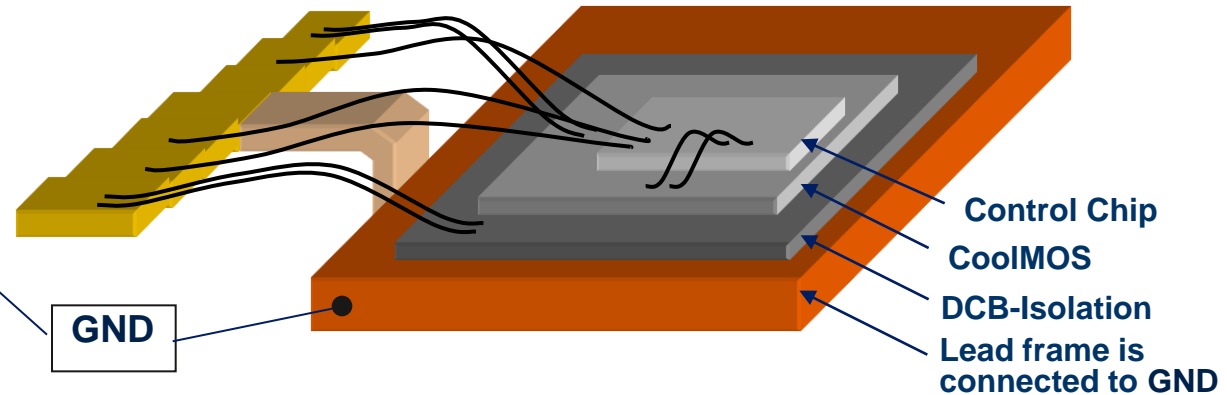
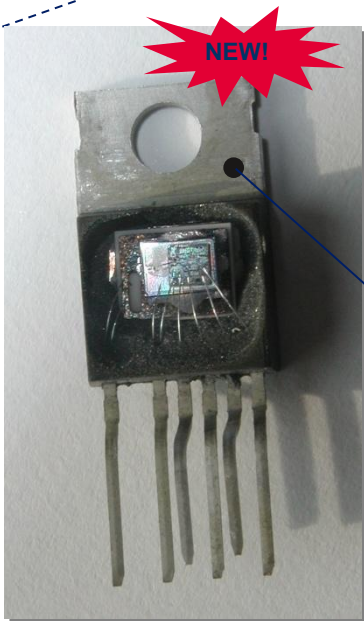
## Application - Isolated TO220-6 & Fullpak Package



Typical SMPS topology for AC/DC conversion with CoolSET

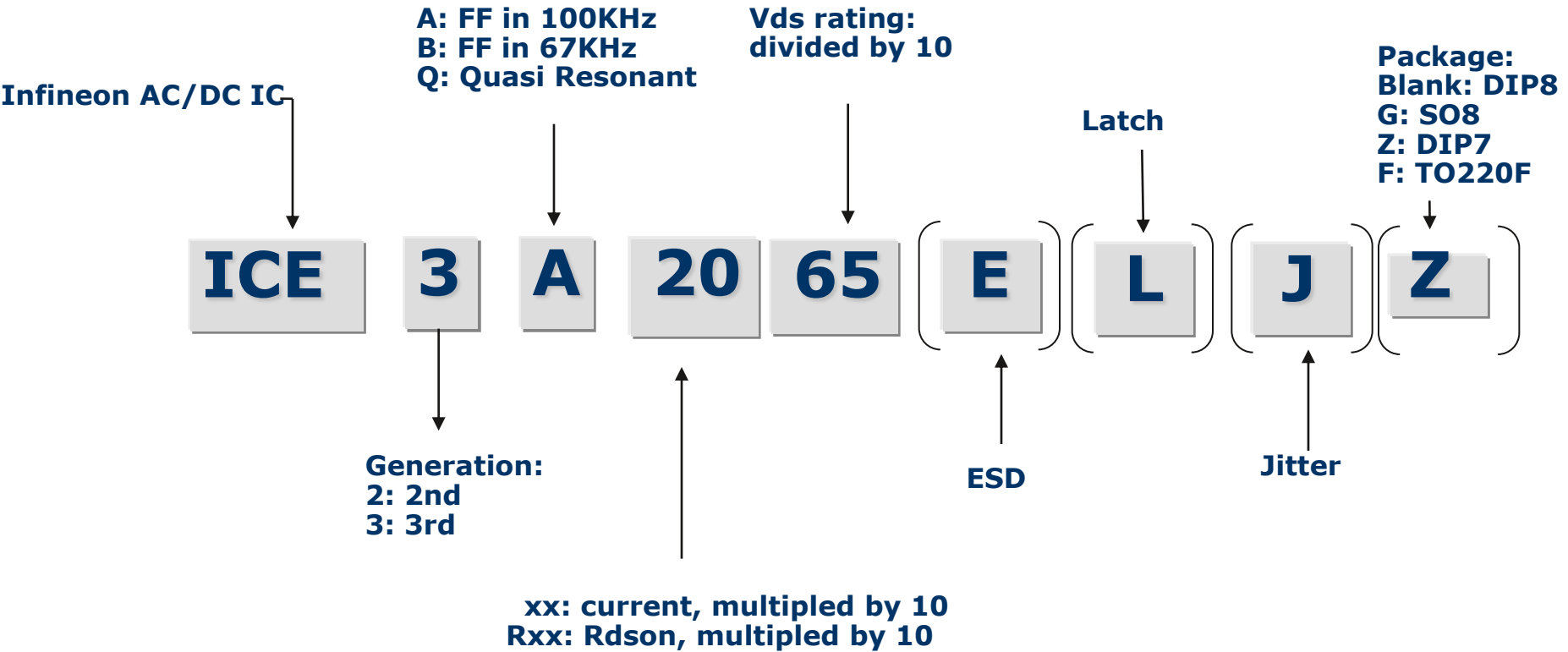


Photo and schematic of CoolSET in TO-220-6 ISODRAIN package



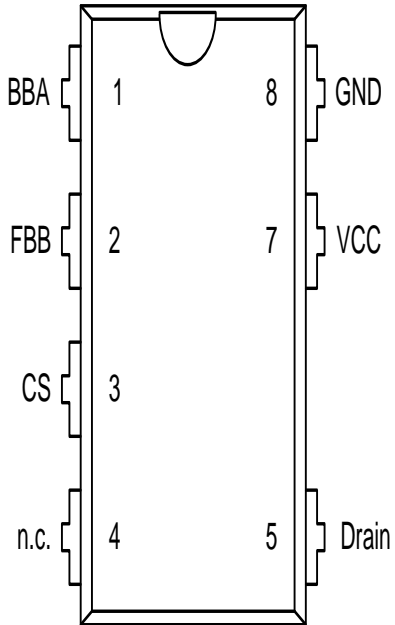
**TO-220-6 ISOdrain  
ISOLATED Package w. LOW Thermal Resistance**

# CoolSET Naming System



# Fixed Switching CoolSET and Pin Assignment

- Package : DIP-7 / DIP-8
- Pin assignment :

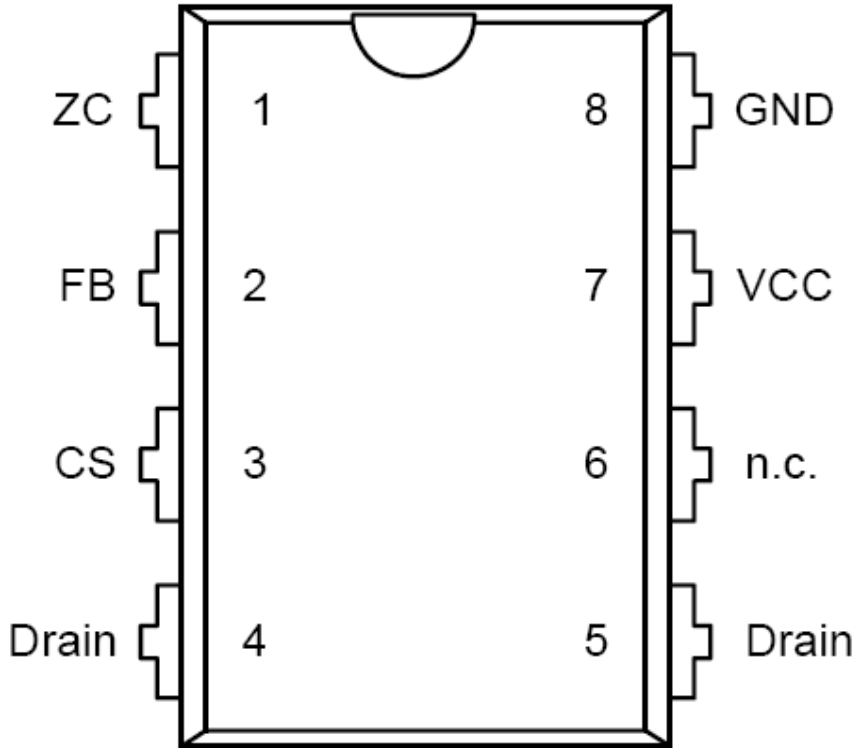


Pin	Name	Function
1	<b>BBA</b>	Brownout, extended Blanking time and external Auto-restart enable
2	<b>FBB</b>	FeedBack and Burst entry control
3	<b>CS</b>	Current Sense
4	<b>N.C.</b>	No Connection
5	<b>Drain</b>	Drain
6	<b>No pin</b>	No pin
7	<b>Vcc</b>	Vcc
8	<b>GND</b>	Ground



# Quasi. CoolSET and Pin Assignment

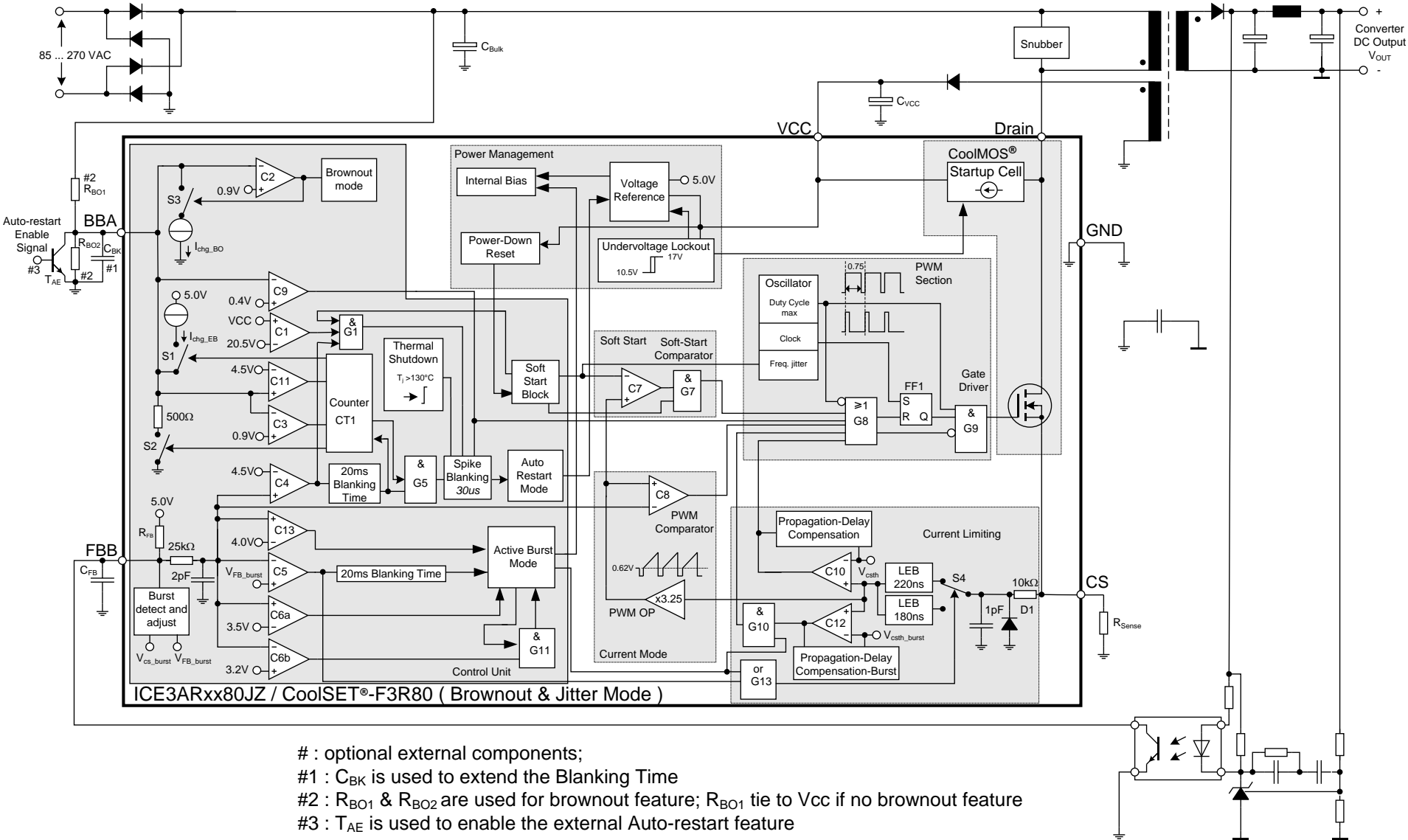
## Package PG\_DIP-8



Pin	Symbol	Function
1	ZC	Zero Crossing
2	FB	Feedback
3	CS	Current Sense/ 650V <sup>1)</sup> Depl. CoolMOS <sup>®</sup> Source
4, 5	Drain	650V <sup>1)</sup> Depl. CoolMOS <sup>®</sup> Drain
6	n.c.	Not connected
7	VCC	Controller Supply Voltage
8	GND	Controller Ground

<sup>1)</sup> at  $T_j = 110^\circ\text{C}$

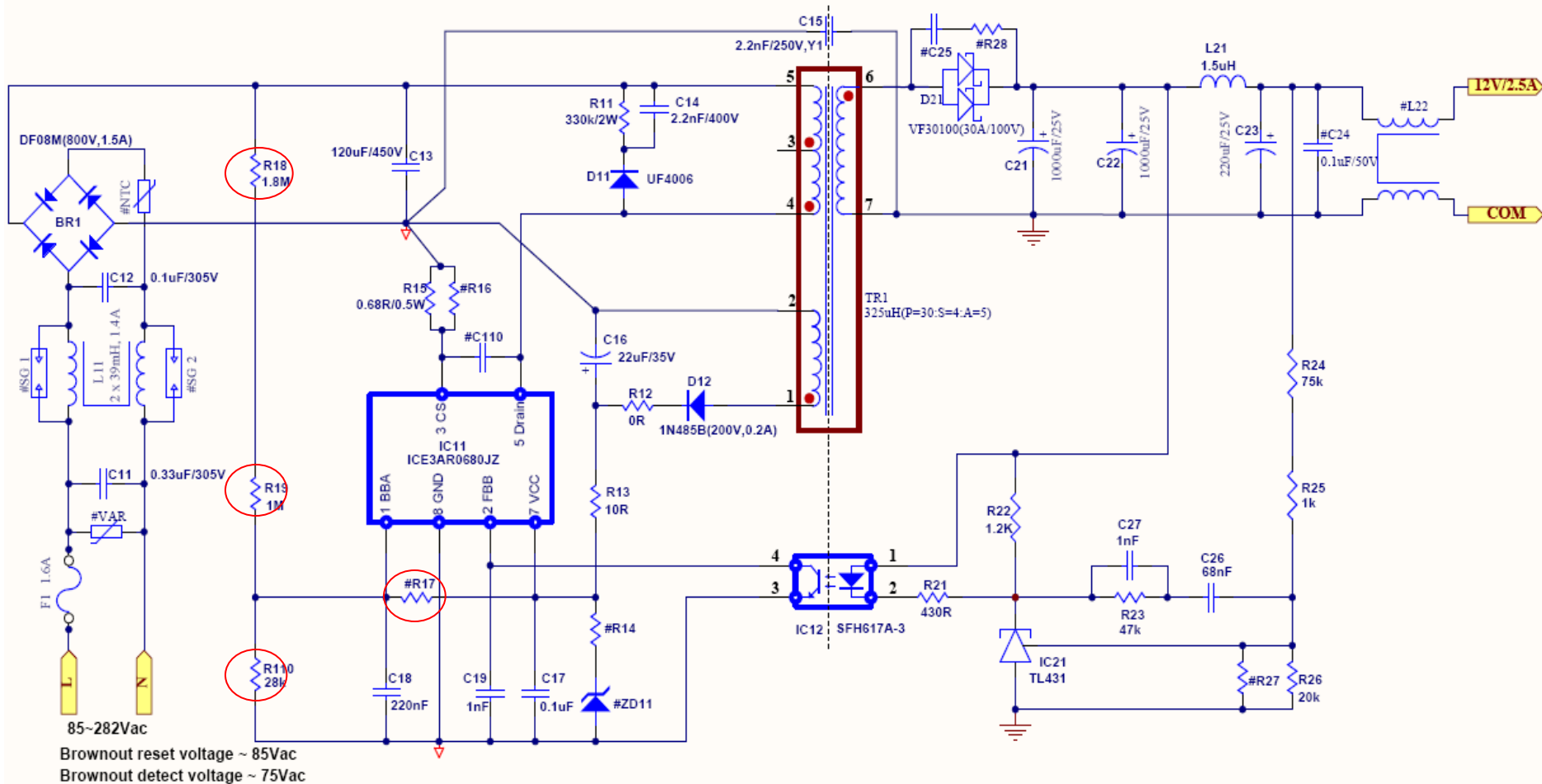
# Block diagram of ICE3A/BRXXXJ Fixed Switching Frequency CoolSET



- CoolSET® F3 (ICE3xxx65(L)(Z)(G)(P))
  - 1<sup>st</sup> F3 CoolSET® products, **Bipolar** technologies
  - Full power range series with DIP-8, DIP-7, DSO-16/12 and TO-220 isodrain.
- CoolSET® F3J (ICE3Bxx65J(G))
  - Cost reduction F3 CoolSET® (C1), **BiCMOS** technologies
  - For low power application and with **frequency jitter**
  - Only DIP-8 and DSO-16/12 packages
- CoolSET® F3LJ (ICE3A1065LJ)
  - **Latch version** of F3J with extra features (latch enable and extendable blanking time for over load)
  - Only DIP-8 package
- CoolSET® F3R (ICE3BR4765J)
  - **Non-latch version / Only Auto restart**
  - Replace the F3 CoolSET® series
  - Change **naming nomenclature** to specify  $R_{dson}$  instead of  $I_d$  current
  - DIP-8 package

# Evaluation Board Circuit Diagram 12V 30W ( $V_{in} = 85V_{ac} \sim 282V_{ac}$ ) using ICE3AR0680JZ

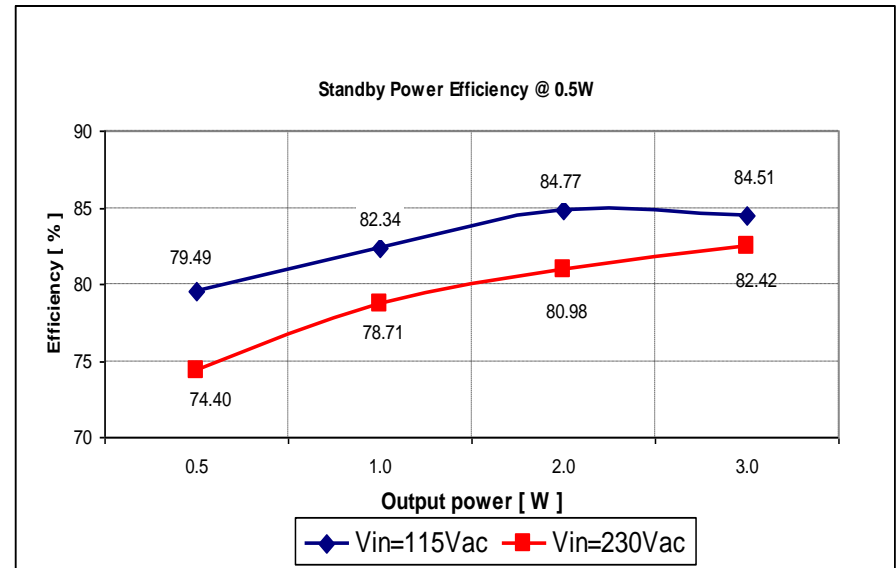
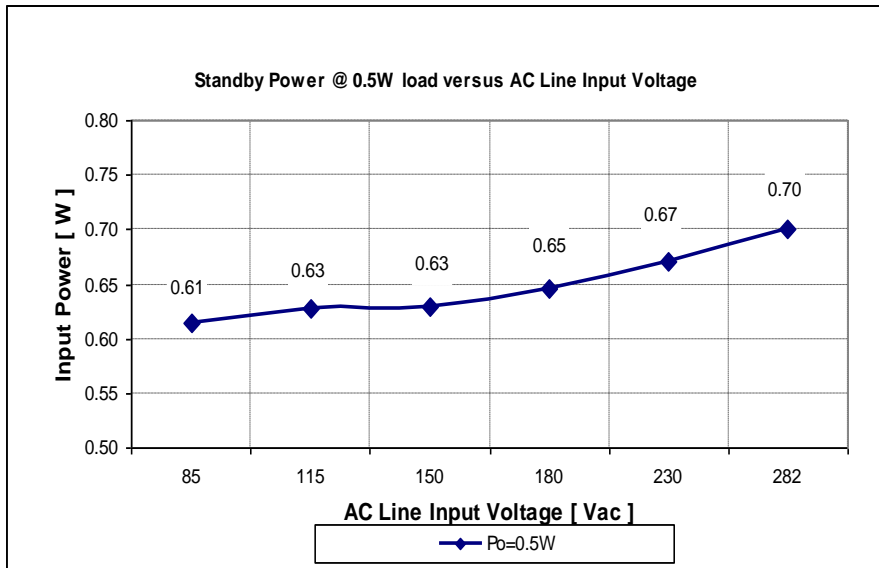
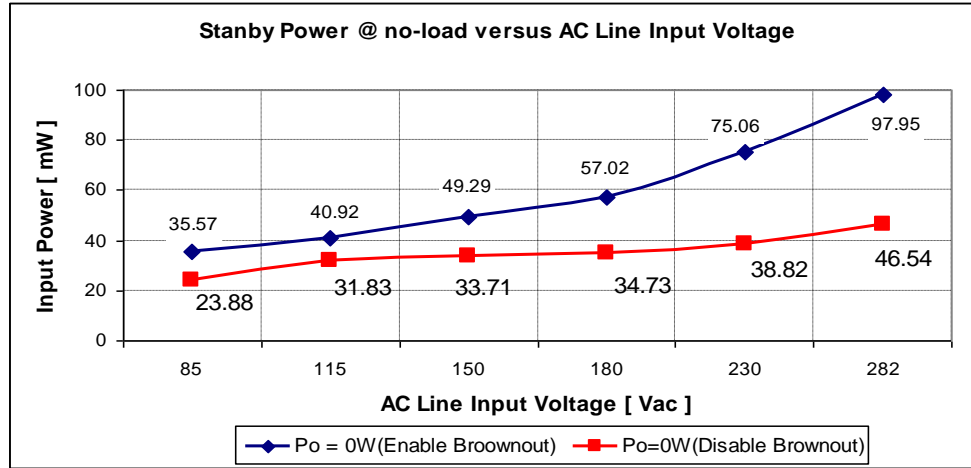
Enable BrownOut, EBO : Add R18, R19, R1100 and delete R17;  
 Disable BrownOut, DBO : Add R17 and delete R18, R19 and R100;  
 EBO and DBO would not happen at the same time.



## 30W 12V SMPS Demoboard with ICEAR0680JZ(V0.7)

Kyaw Zin Min, Eric Kok/ 31 Mar 2010

## Measurement based on demo board 30W 12V using ICE3AR0680JZ



# Standby power at different $C_{FB}$ for no load and 0.5W load



## Measurement based on demo board 30W 12V using ICE3AR0680JZ

### ■ Input standby power at no load with different $C_{FB}$

	Pin (mW) Enable Brownout						Pin (mW) Disable Brownout					
	85Vac	115Vac	150Vac	180Vac	230Vac	282Vac	85Vac	115Vac	150Vac	180Vac	230Vac	282Vac
$C_{FB}=6.8\text{nF}$	37.34	42.48	49.79	59.34	78.94	99.96	32.94	34.21	36.19	38.99	44.89	56.26
$C_{FB}=1\text{nF}$	36.55	41.29	50.83	56.23	76.35	96.54	32.56	33.48	36.42	38.86	43.83	55.79
$C_{FB}=330\text{pF}$	36.46	41.95	49.02	57.73	76.53	98.93	33.19	34.63	36.19	38.73	44.58	55.42
$C_{FB}=100\text{pF}$	108.57	104.48	105.77	114.59	128.02	149.37	97.52	80.17	87.36	88.81	92.49	100.84

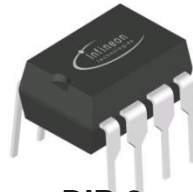
### ■ Input standby power at 0.5W load with different $C_{FB}$

	Pin (W) Enable Brownout						Pin (W) Disable Brownout					
	85Vac	115Vac	150Vac	180Vac	230Vac	282Vac	85Vac	115Vac	150Vac	180Vac	230Vac	282Vac
$C_{FB}=6.8\text{nF}$	0.584	0.595	0.610	0.625	0.638	0.664	0.581	0.596	0.605	0.606	0.612	0.628
$C_{FB}=1\text{nF}$	0.611	0.625	0.630	0.633	0.650	0.679	0.585	0.601	0.606	0.619	0.629	0.647
$C_{FB}=330\text{pF}$	0.606	0.614	0.637	0.642	0.668	0.682	0.589	0.602	0.614	0.620	0.630	0.652
$C_{FB}=100\text{pF}$	0.857	0.812	0.796	0.804	0.826	0.869	0.840	0.782	0.772	0.76	0.77	0.79

# CoolSET™ F3 Product Overview

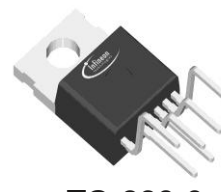


SO-16



DIP-8

- A version:  
f = 100kHz
- B version:  
f = 67 kHz



TO-220-6



I²-Pak

- ISODrain**
- Isolated
  - low  $R_{th}$

$R_{DSon}$
6.5Ω
4,7Ω
3,0Ω
2,1Ω
1,7Ω
1,5Ω
0,95Ω
0,8Ω
0,65Ω

ICE3B0365JG
ICE3B0565JG

ICE3A0365
ICE3B0365J
ICE3A0565
ICE3B0565J
ICE3A1065
ICE3B1065
ICE3B1565J
ICE3A1565
ICE3B1565
ICE3A2065
ICE3B2065
ICE3A2565
ICE3B2565

POUTmax
9W/17W
12W/21W
15W /25W
20W/32W
27W/41W
31W /46W

ICE3A2065P
ICE3B2065P
ICE3A3065P
ICE3B3065P
ICE3A3565P
ICE3B3565P
ICE3A5065P
ICE3B5065P
ICE3A5565P
ICE3B5565P

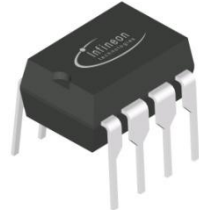
ICE3A2065I
ICE3B2065I
ICE3A3065I
ICE3B3065I
ICE3A3565I
ICE3B3565I
ICE3A5065I
ICE3B5065I
ICE3A5565I
ICE3B5565I

POUTmax
55W/90W
68W/125W
80W/144W
100W/180W
110W/200W

# CoolSET™ F3R & 2QR Product Overview



SO-16



DIP-7/8

- A version:  
f = 100kHz
- B version:  
f = 67 kHz
- Quasiresonant



TO-220-6

- Fullpak**
- Isolated
  - low  $R_{th}$

$R_{DSon}$
10.0Ω
4,7Ω
2,2Ω
1,7Ω
0,65Ω

ICE3B4765JG
ICE2QR0665G

ICE3BR4765J ICE2QR4765 <b>ICE3AR4780JZ ICE2QR4780Z</b>
<b>ICE3AR2280JZ ICE3BR2280JZ ICE2QR2280Z</b>
ICE3BR1765J ICE2QR1765
ICE3BR0665J ICE2QR0665 <b>ICE3AR0680JZ ICE3BR0680JZ ICE2QR0680Z</b>

$P_{OUTmax}$
9W/17W
12W/21W
15W/28W
20W/32W
31W /46W

$R_{DSon}$
2,5Ω
1,5Ω
1,0Ω
0,65Ω

ICE3BR2565JF
ICE3BR1565JF
ICE3BR1065JF
ICE3BR0665JF

$P_{OUTmax}$
55W/90W
68W/125W
80W/144W
110W/200W



# SMPS IC's at a glance

## Focus Product Portfolio



<b>FF CoolSET</b>	ICE3BR4765J	ICE3BR1765J	ICE3BR0665J			
	ICE3BR4765JZ	ICE3BR1765JZ	ICE3BR0665JZ			
	ICE3BR4765JG					
	ICE3BR2565JF	ICE3BR1565JF	ICE3BR1065JF	ICE3BR0665JF		
	ICE3A1065ELJ	ICE3A2065ELJ				
	ICE3AR4780JZ	ICE3AR2280JZ	ICE3AR0680JZ			
<b>FF PWM IC</b>	ICE3BS03LJG	ICE3AS03LJG				
<b>QR CoolSET</b>	ICE2QR4765	ICE2QR1765	ICE2QR0665			
<b>QR PWM IC</b>	ICE2QS01	ICE2QS02G	ICE2QS03	ICE2QS03G		
<b>Res LLC HB</b>	ICE1HS01G	ICE2HS01G				
<b>CCM PFC IC</b>	ICE2PCS01	ICE2PCS02	ICE2PCS03	ICE2PCS04	ICE2PCS05	ICE2PCS06
	ICE2PCS01G	ICE2PCS02G	ICE2PCS03G	ICE2PCS04G	ICE2PCS05G	ICE2PCS06G
	ICE3PCS01G	ICE3PCS02G	ICE3PCS03G			
<b>PFC+TTF</b>	ICE1CS02	ICE1CS02G				



# ENERGY EFFICIENCY MOBILITY SECURITY

Innovative semiconductor solutions for energy efficiency, mobility and security.

