

Infineon Solution for LED TV SMPS

Willion Chen

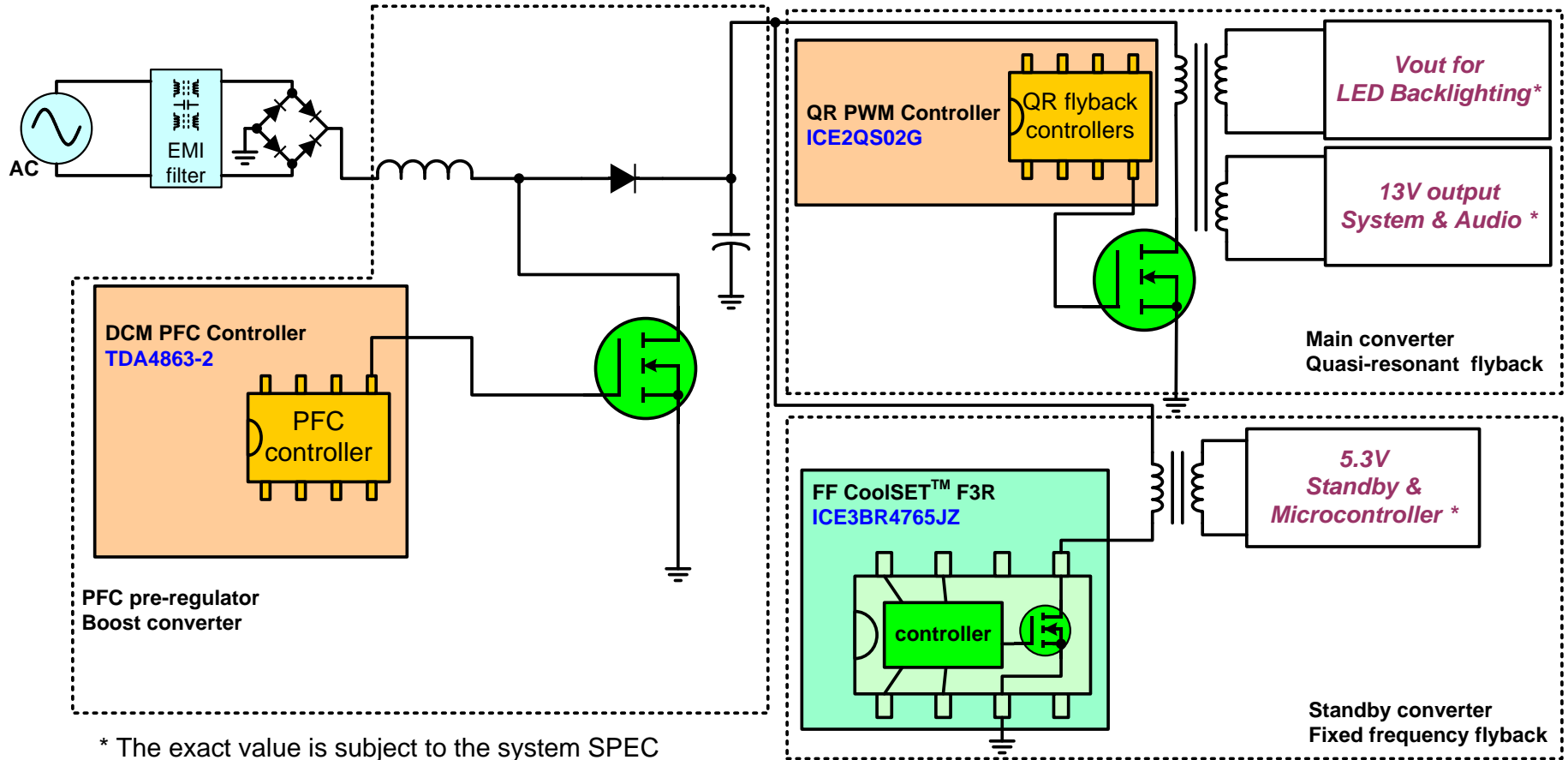
System Application Engineer

ASIC & Power IC



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

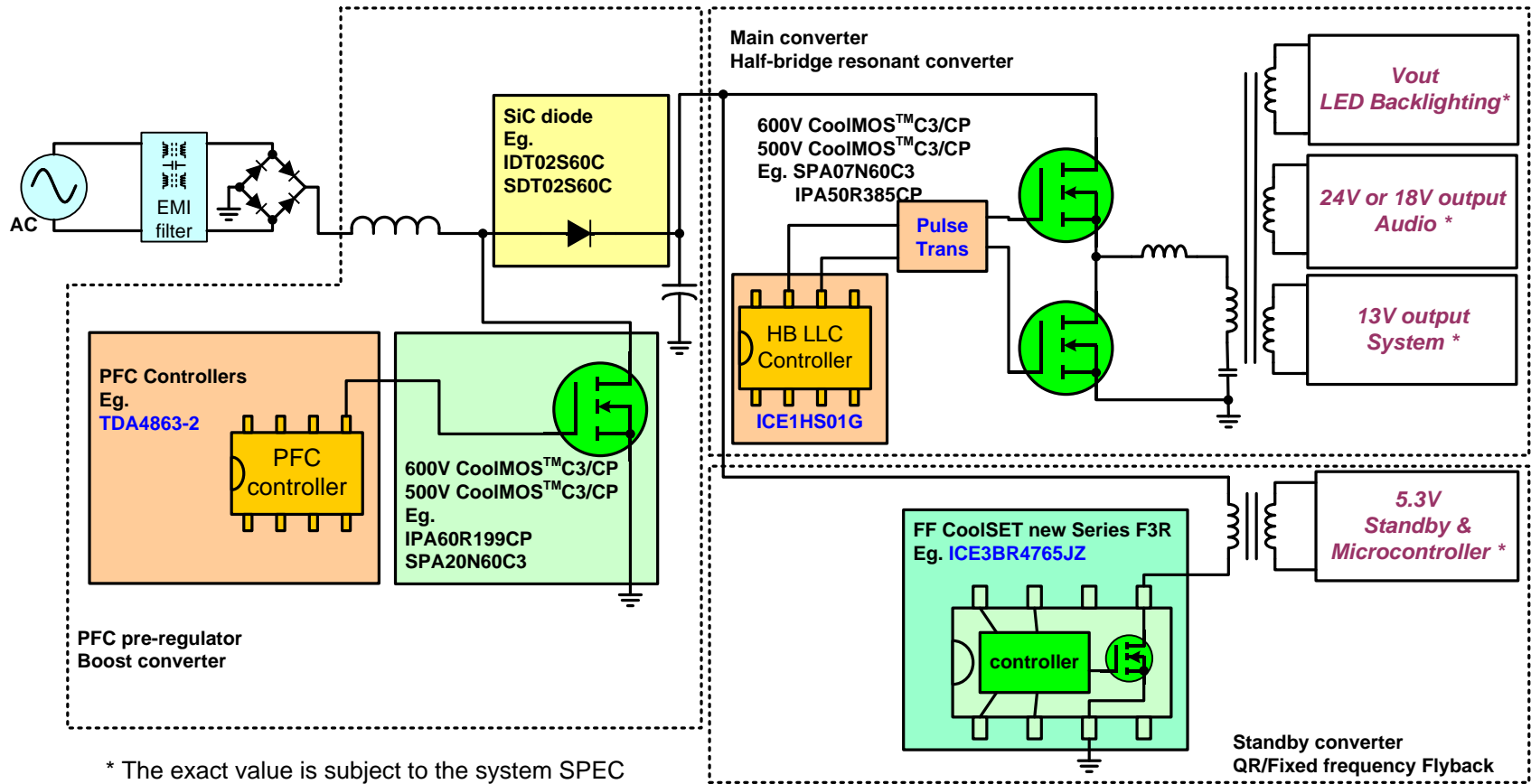
LED TV SMPS: <100W solution



* The exact value is subject to the system SPEC

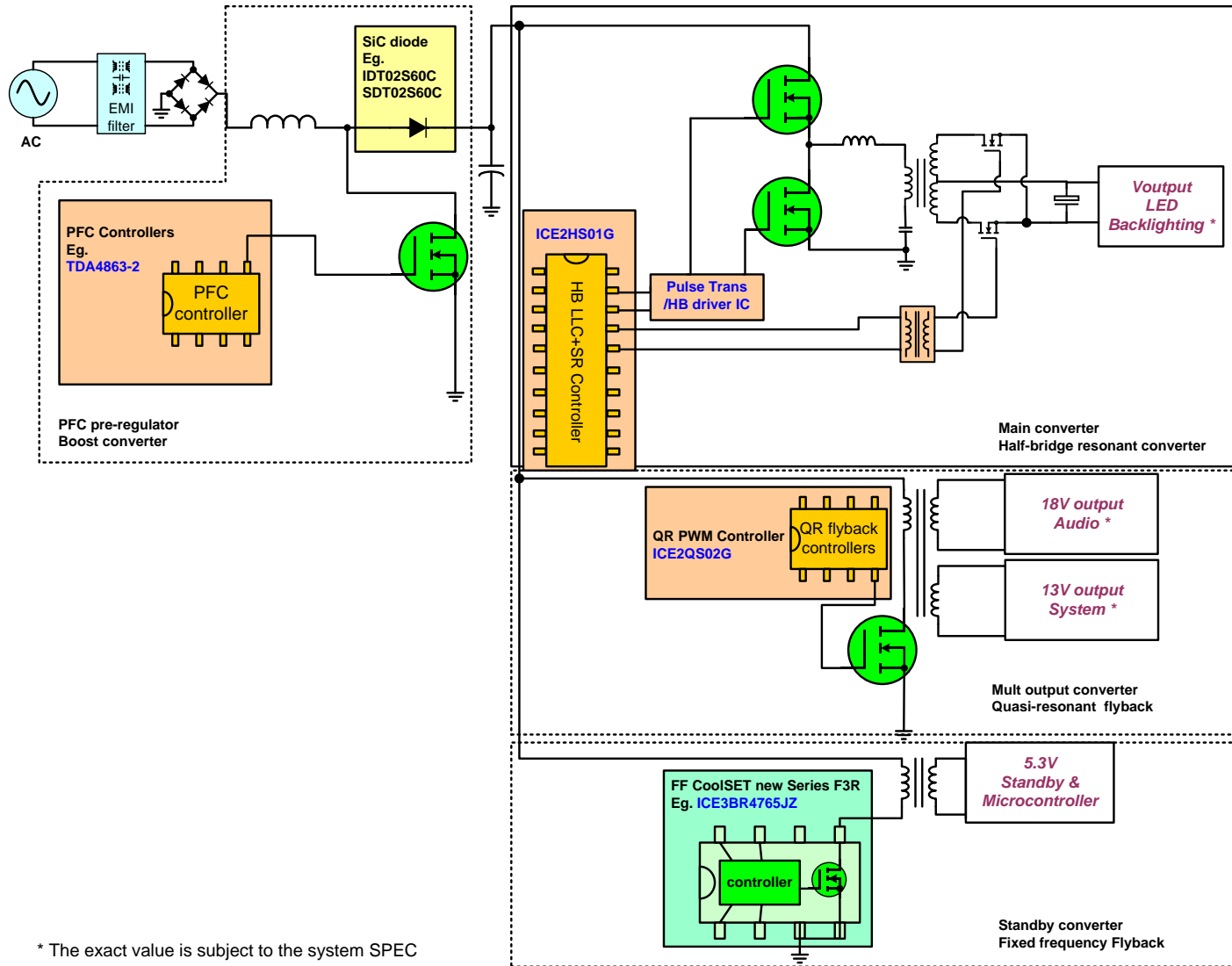
- ❑ **TDA4863-2:** Few external component , easy design, nearly 1 power factor can be achieved.
- ❑ **ICE2QS02G:** Mosfet Valley switching and Frequency reduction ensure high average efficiency >87%.
- ❑ **ICE3BR4765JZ:** Active burst mode ensures extremely low standby power consumption <0.1W.

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.

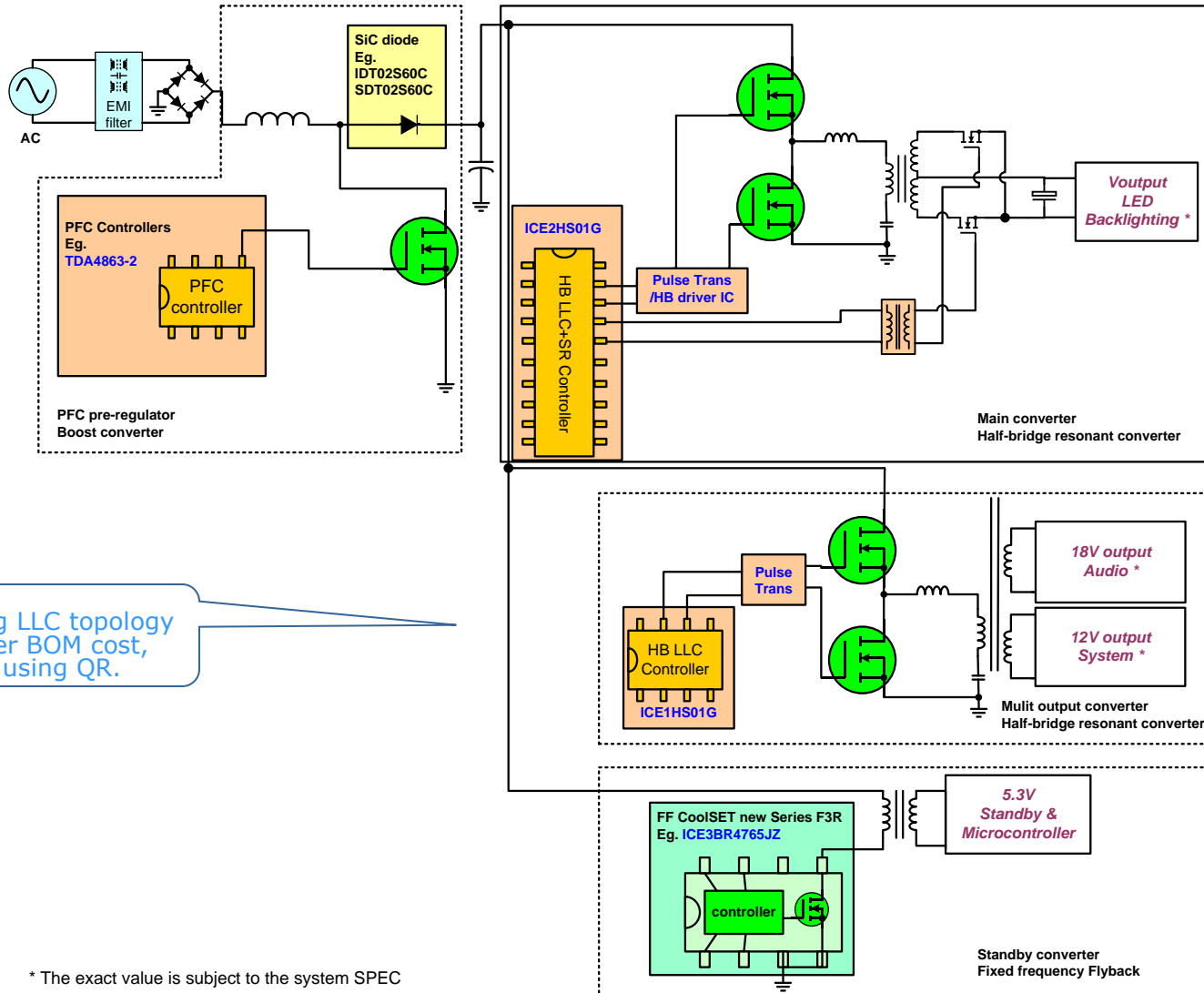
LED TV Power: High Efficiency 200W solution_ option 1



* 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

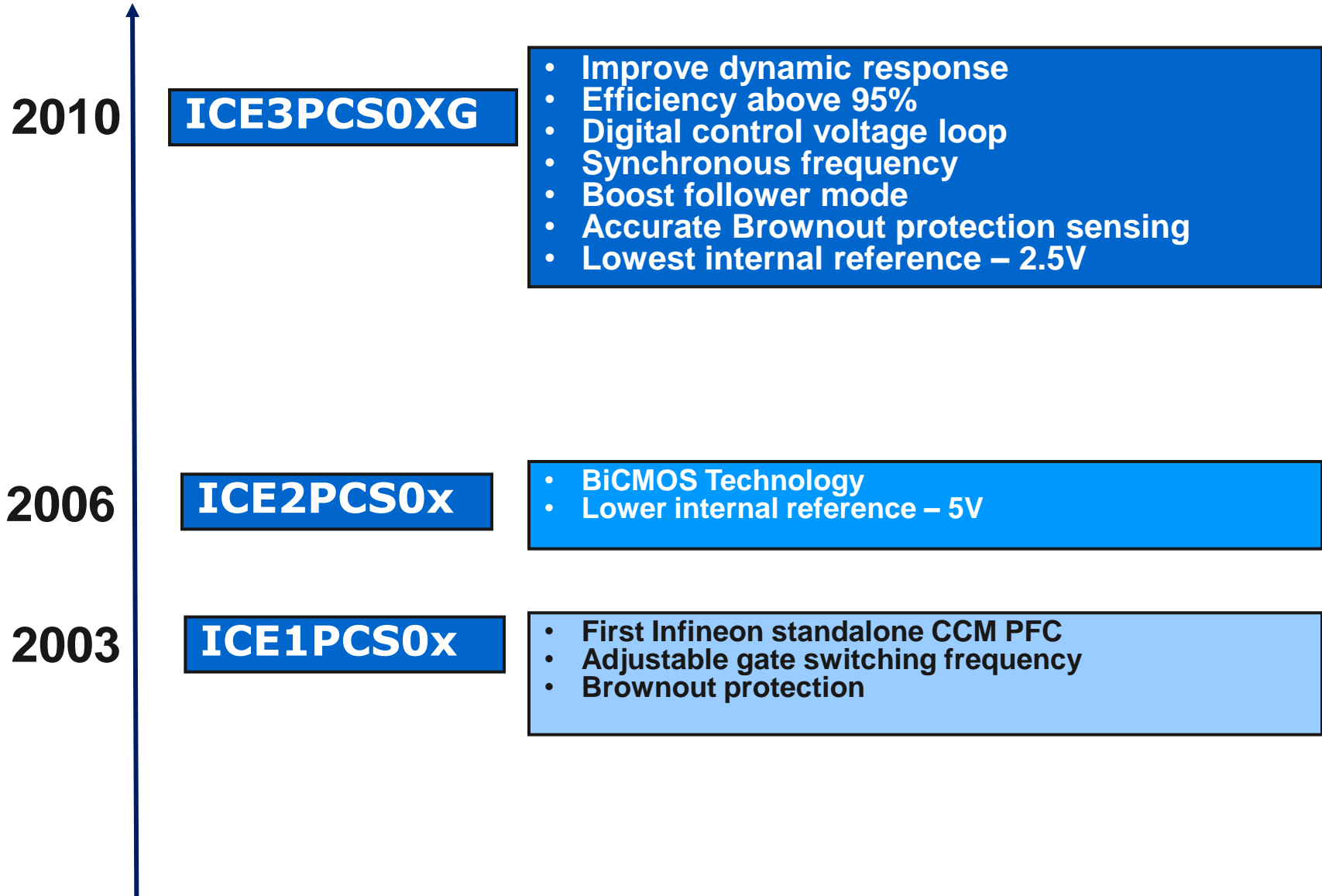


Multi output using LLC topology may cause lower BOM cost, compared to using QR.

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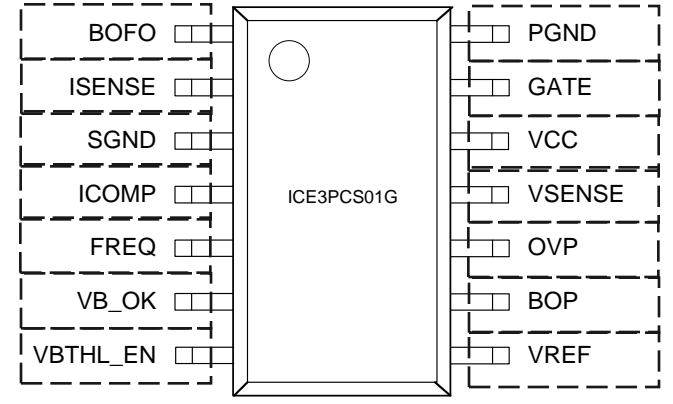
ICE2HS01G: LLC+SR controller further increases the LLC efficiency to a much higher level.

Infineon CCM PFC controller History

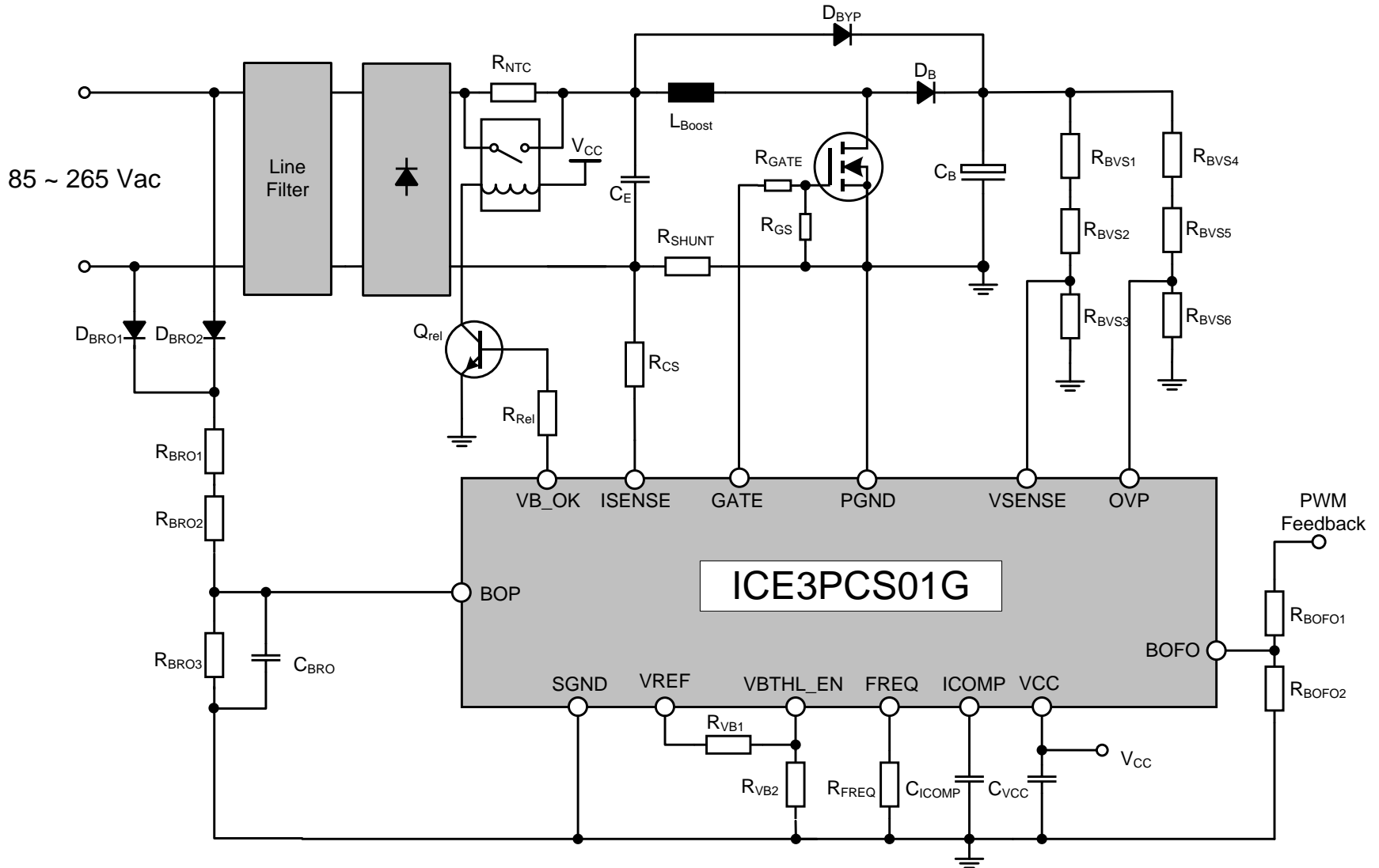


Pin Layout ICE3PCS01G

- 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 (VB_OK)
- 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)

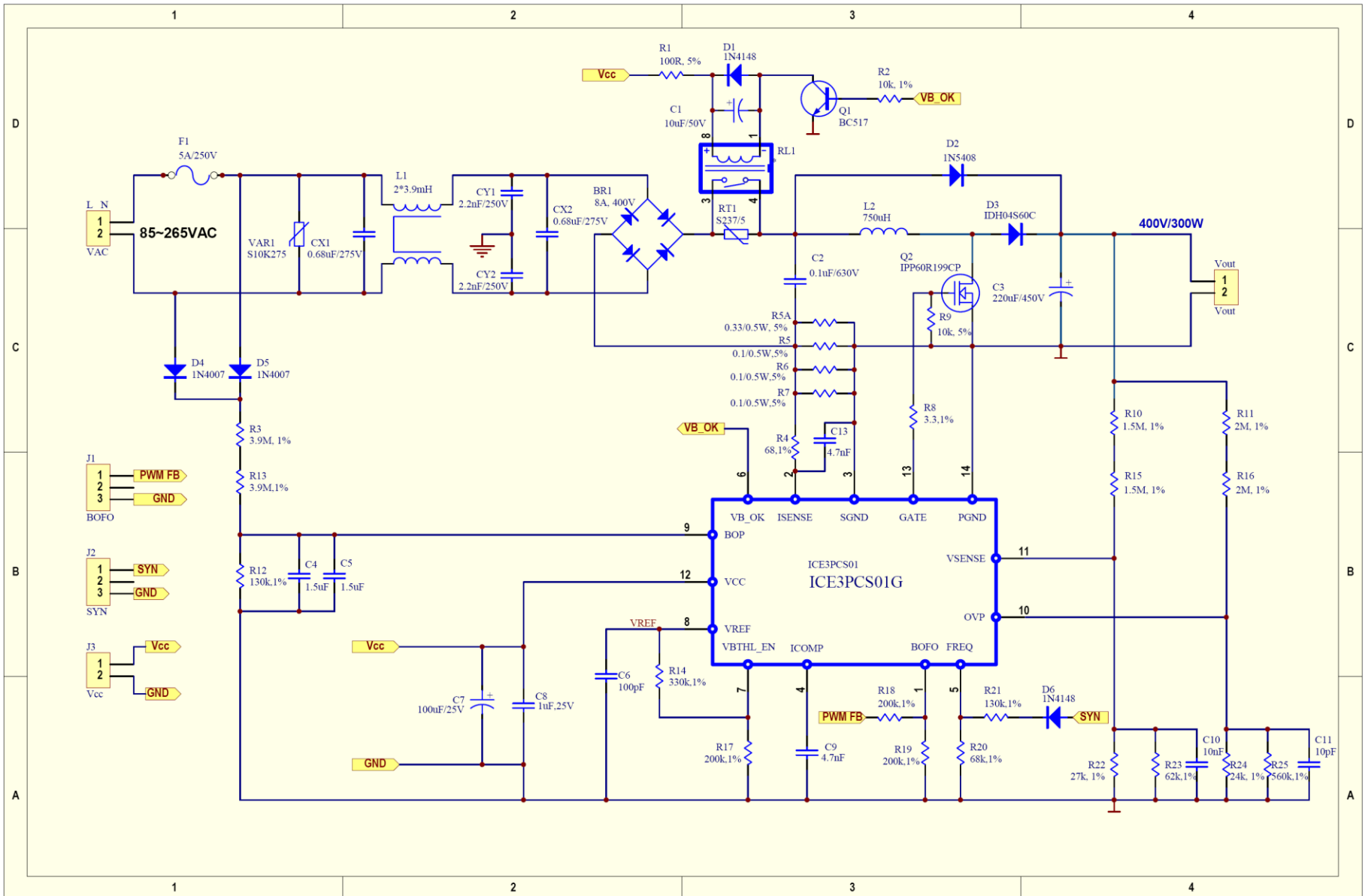


Typical Application Circuit



- 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

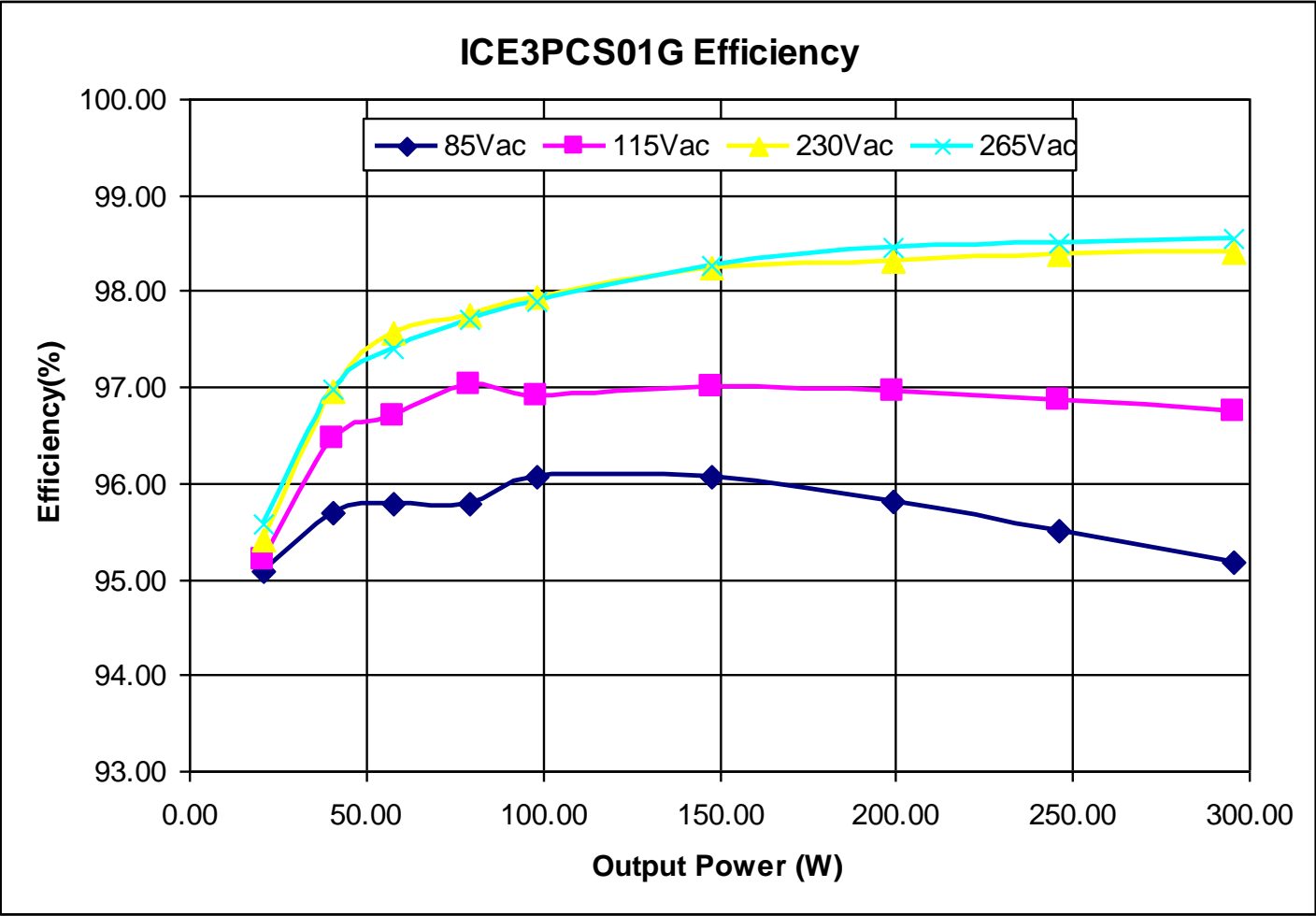
Schematic of ICE3PCS01G Demoboard



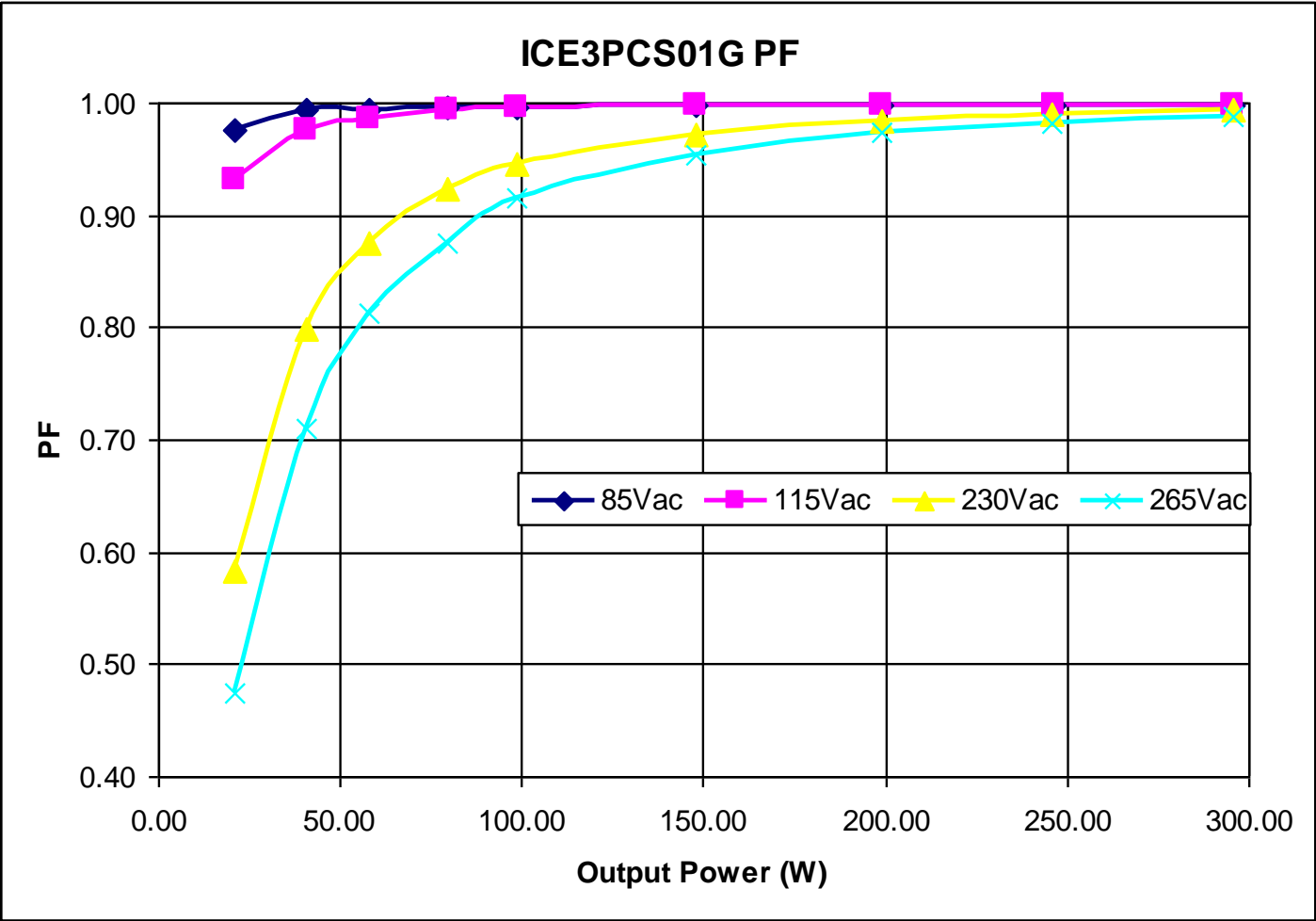
ICE3PCS01G's 300W Demoboard



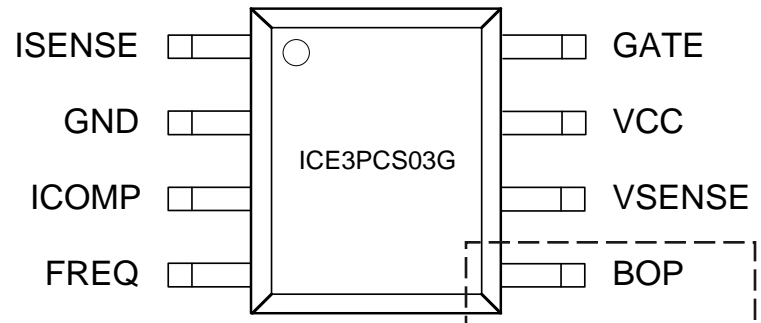
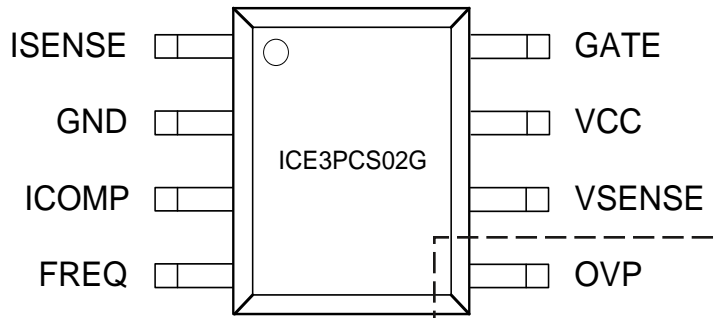
Performance of Evaluation Board Efficiency Vs Output Power



Performance of Evaluation Board Power Factor Vs. Output Power



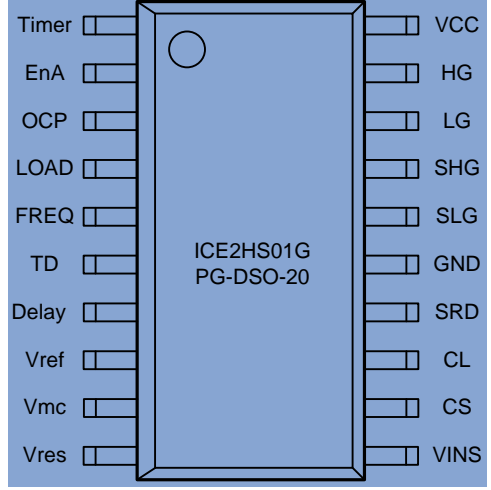
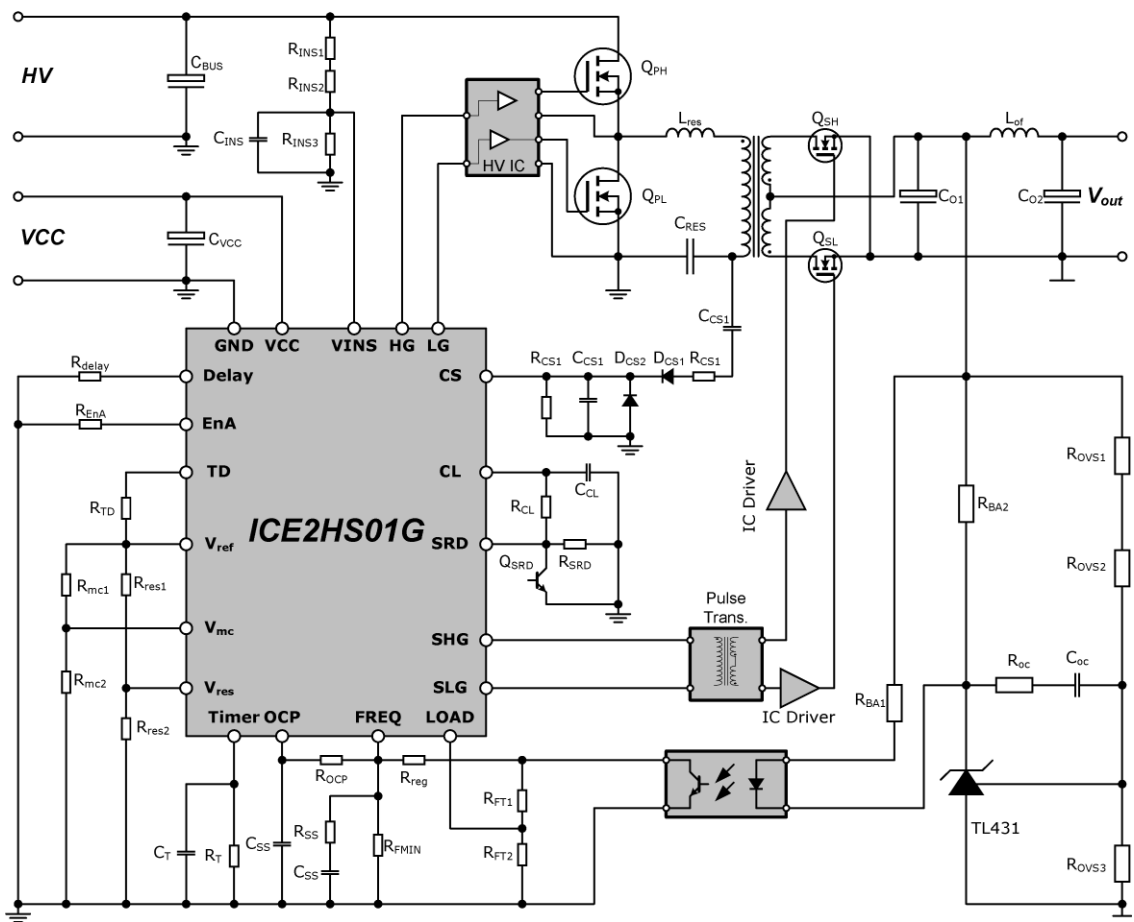
Other ICE3PCS0XG family



- The difference between ICE3PCS02G and ICE3PCS03G is at pin 5

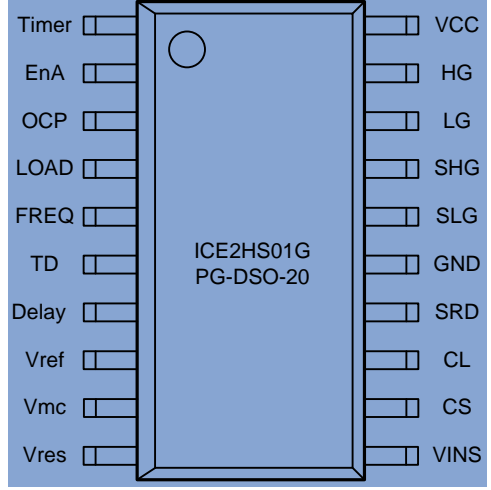
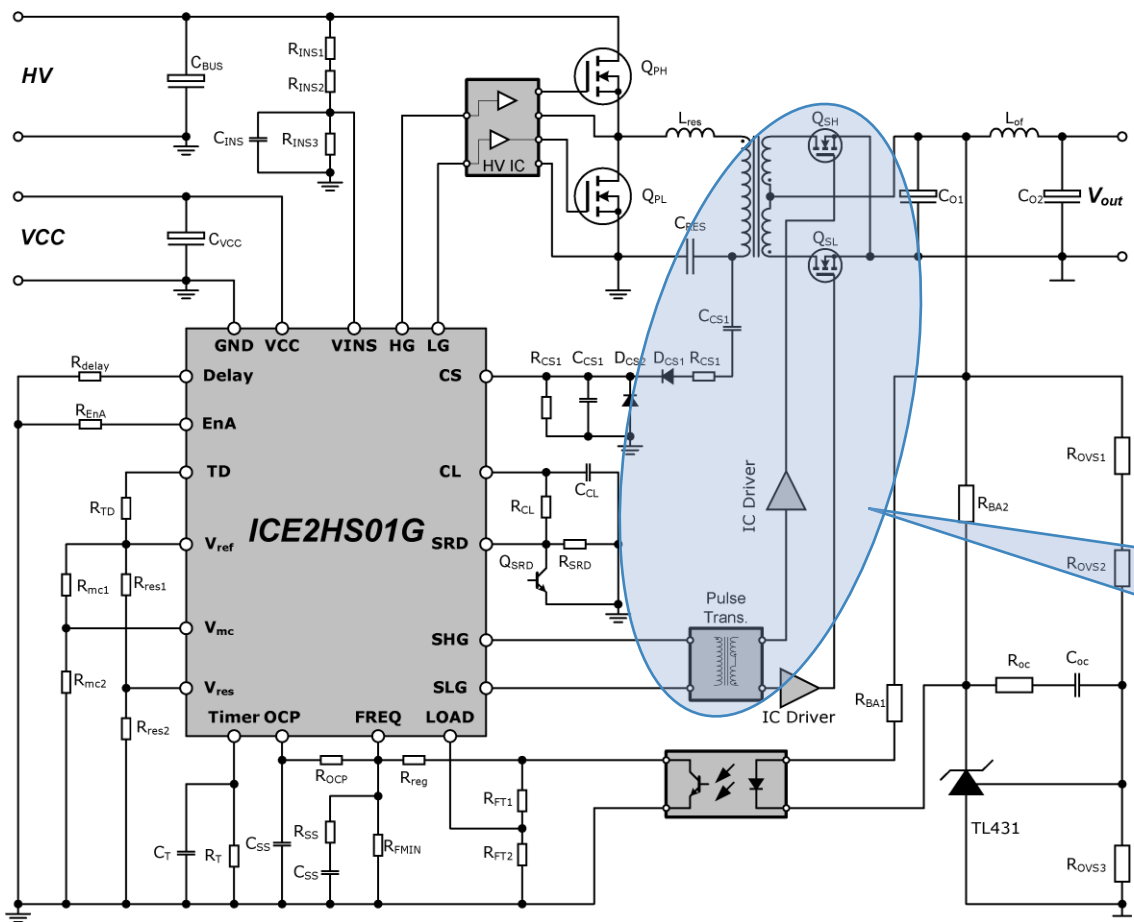
LLC stage → ICE2HS01G

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



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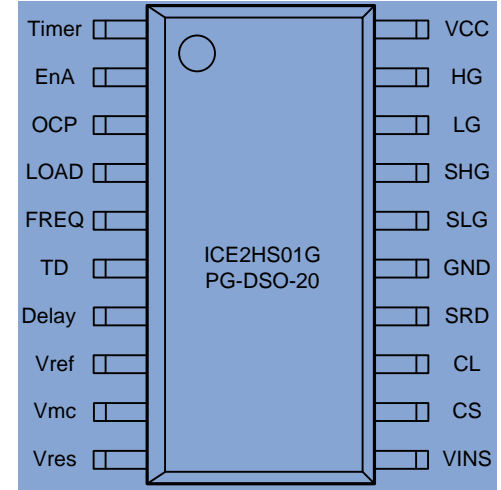
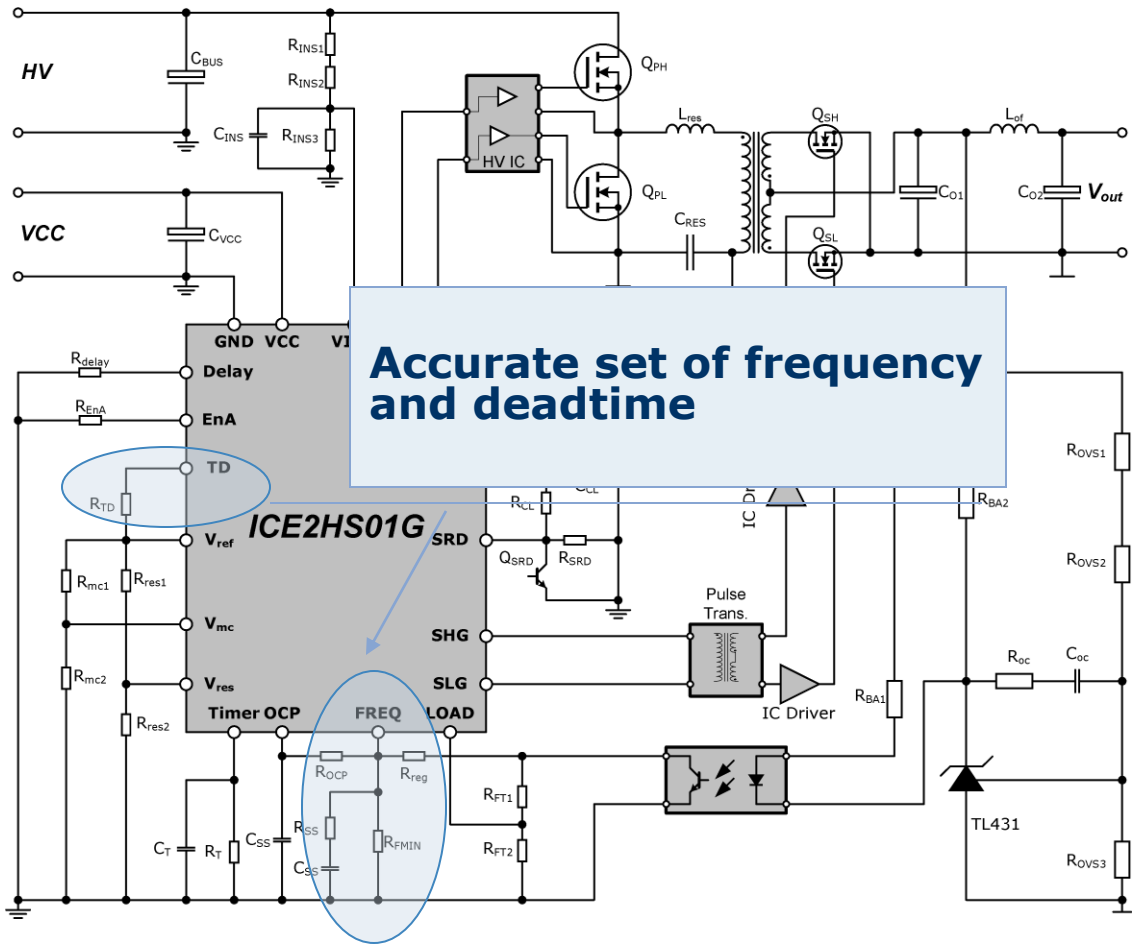


•SR control from primary side for both CCM and DCM
•No need SR IC/Current sense at secondary side

Infineon System Solution for LED TV LLC stage → ICE2HS01G



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

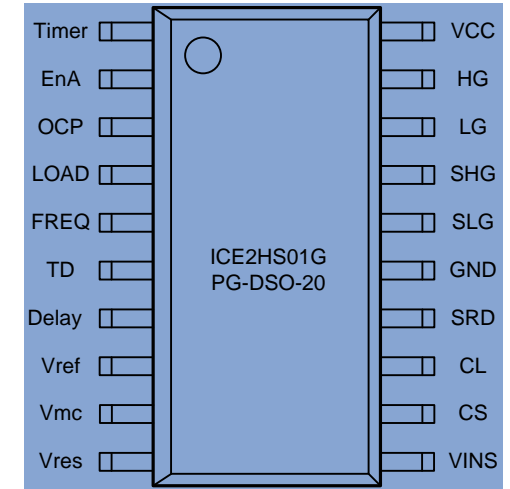
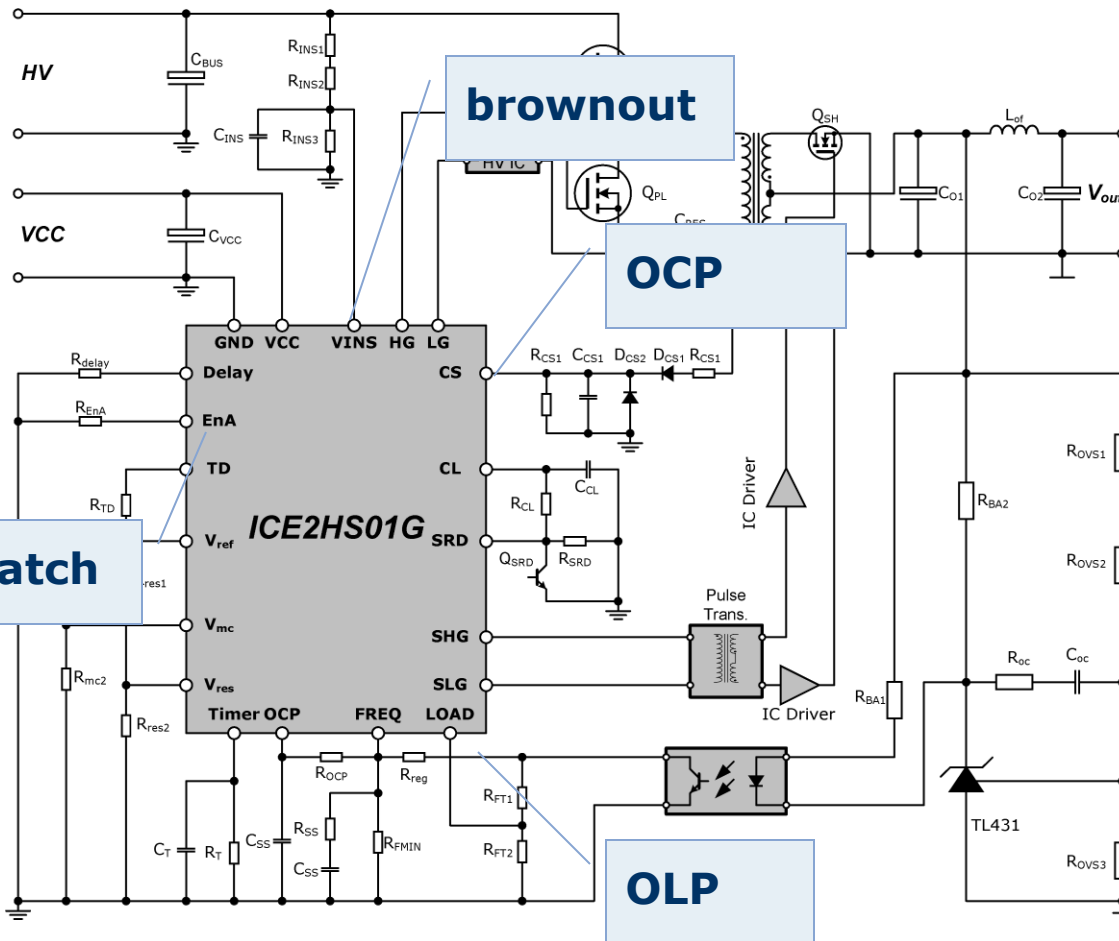


Infinion System Solution for LED TV

LLC stage → ICE2HS01G



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Efficiency	95.5%	97%	96.5%



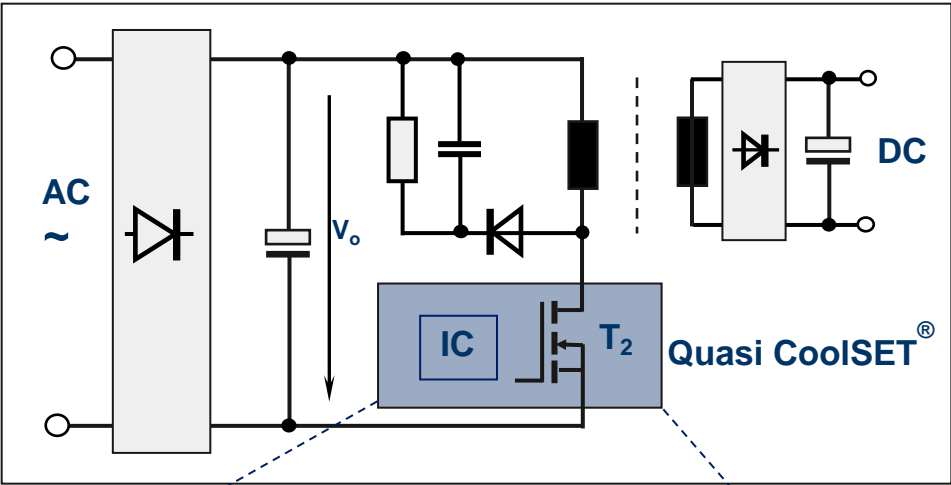
Infineon system solution for LED TV

ICE2HS01G Key Features



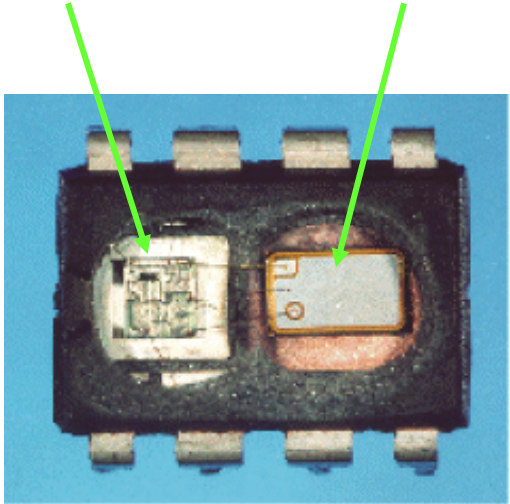
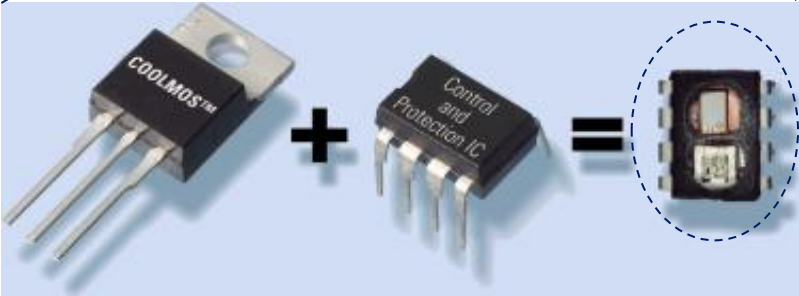
- Flexible LLC operation
 - Adjustable frequency for Min, Max, OCP and SS → **Easy design**
 - Maximum switching frequency up to 1MHz → **High power density**
 - Adjustable and adaptive dead time control → **Easy design**
- Novel SR operation mode with various protections (***patent pending***)
 - Can 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®

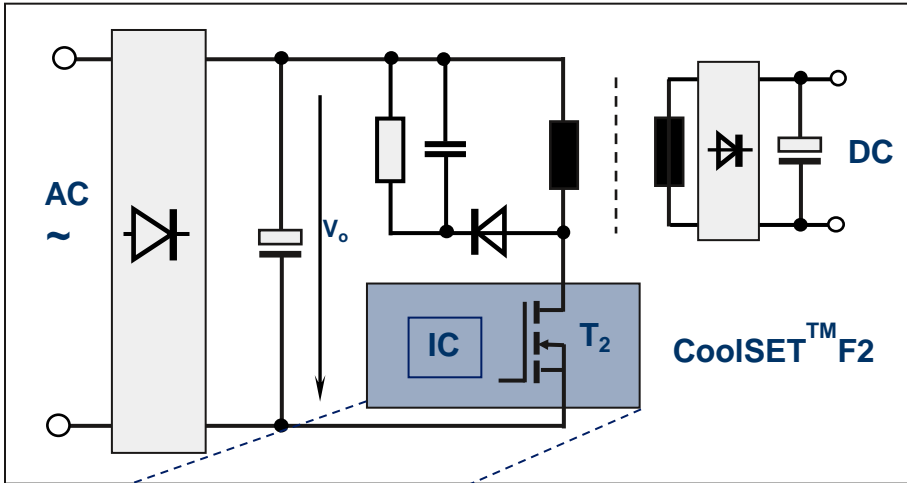


Quasi. PWM IC

CoolMOS



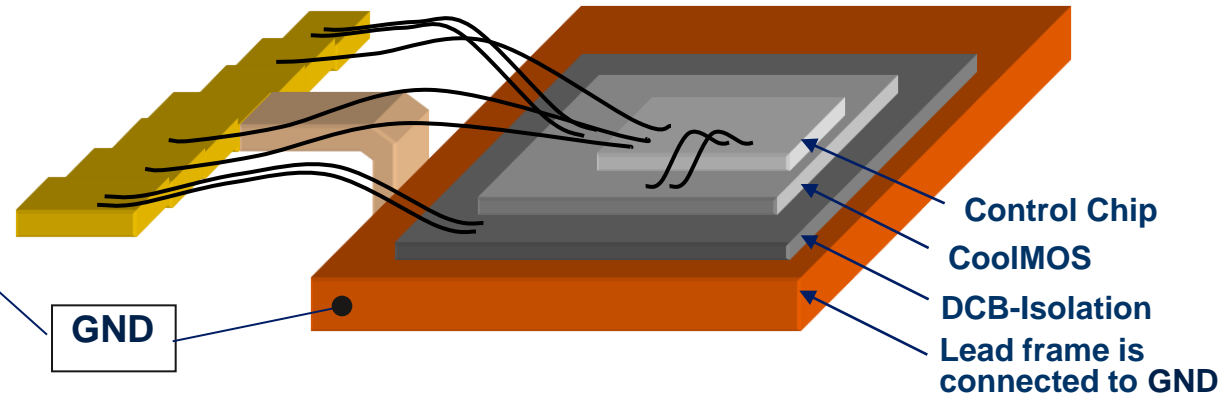
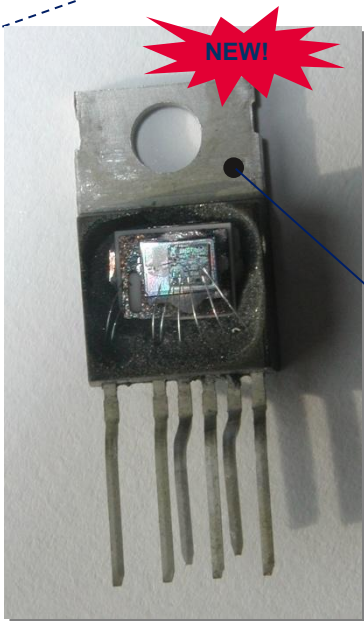
Application - Isolated TO220-6 & Fullpak Package



Typical SMPS topology for AC/DC conversion with CoolSET

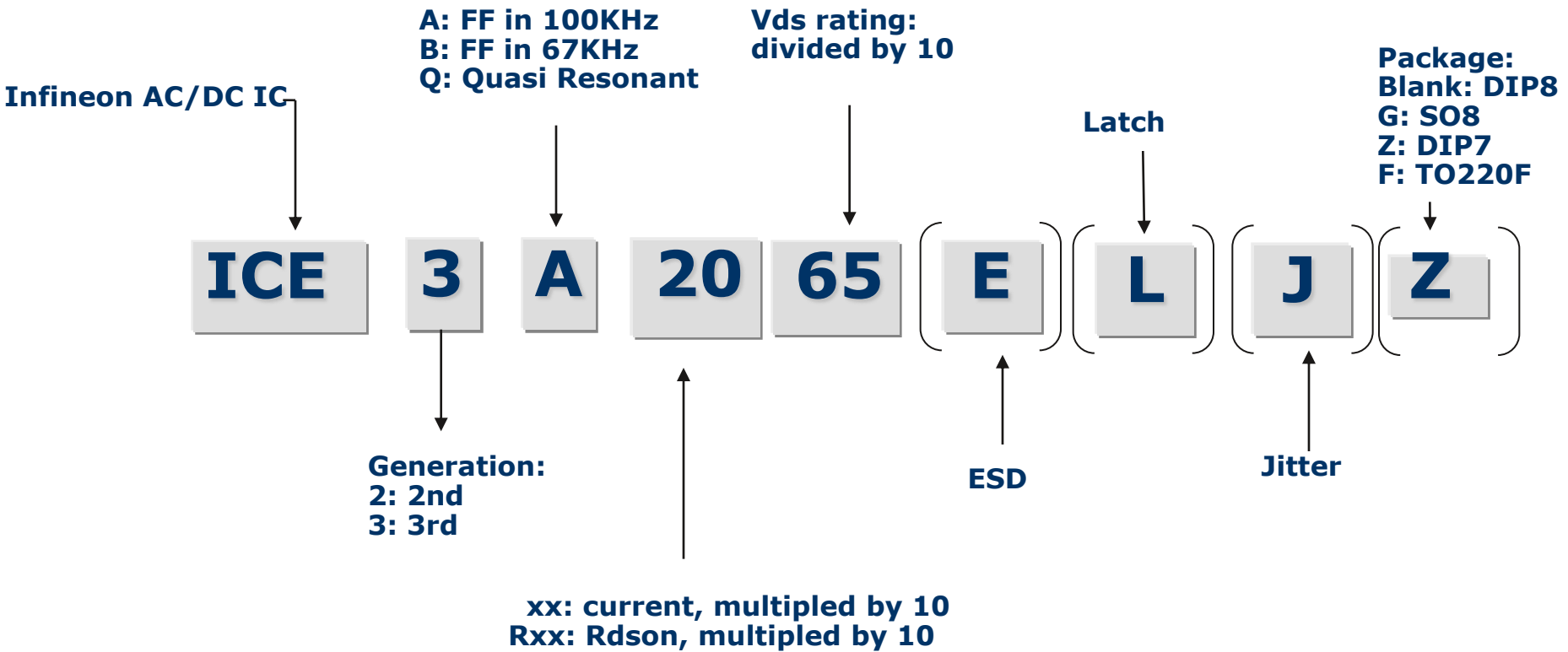


Photo and schematic of CoolSET in TO-220-6 ISODRAIN package



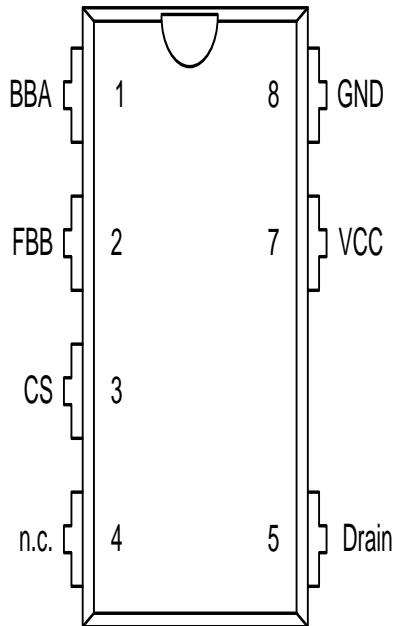
TO-220-6 ISODRAIN ISOLATED Package w. LOW Thermal Resistance

CoolSET Naming System



Fixed Switching CoolSET and Pin Assignment

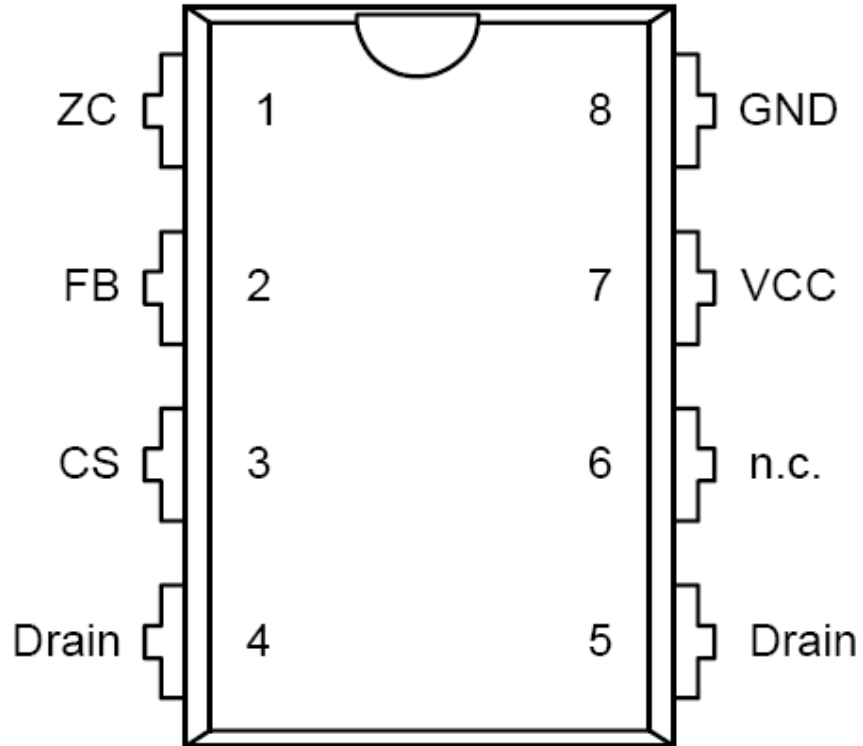
- Package : DIP-7 / DIP-8
- Pin assignment :



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

Quasi. CoolSET and Pin Assignment

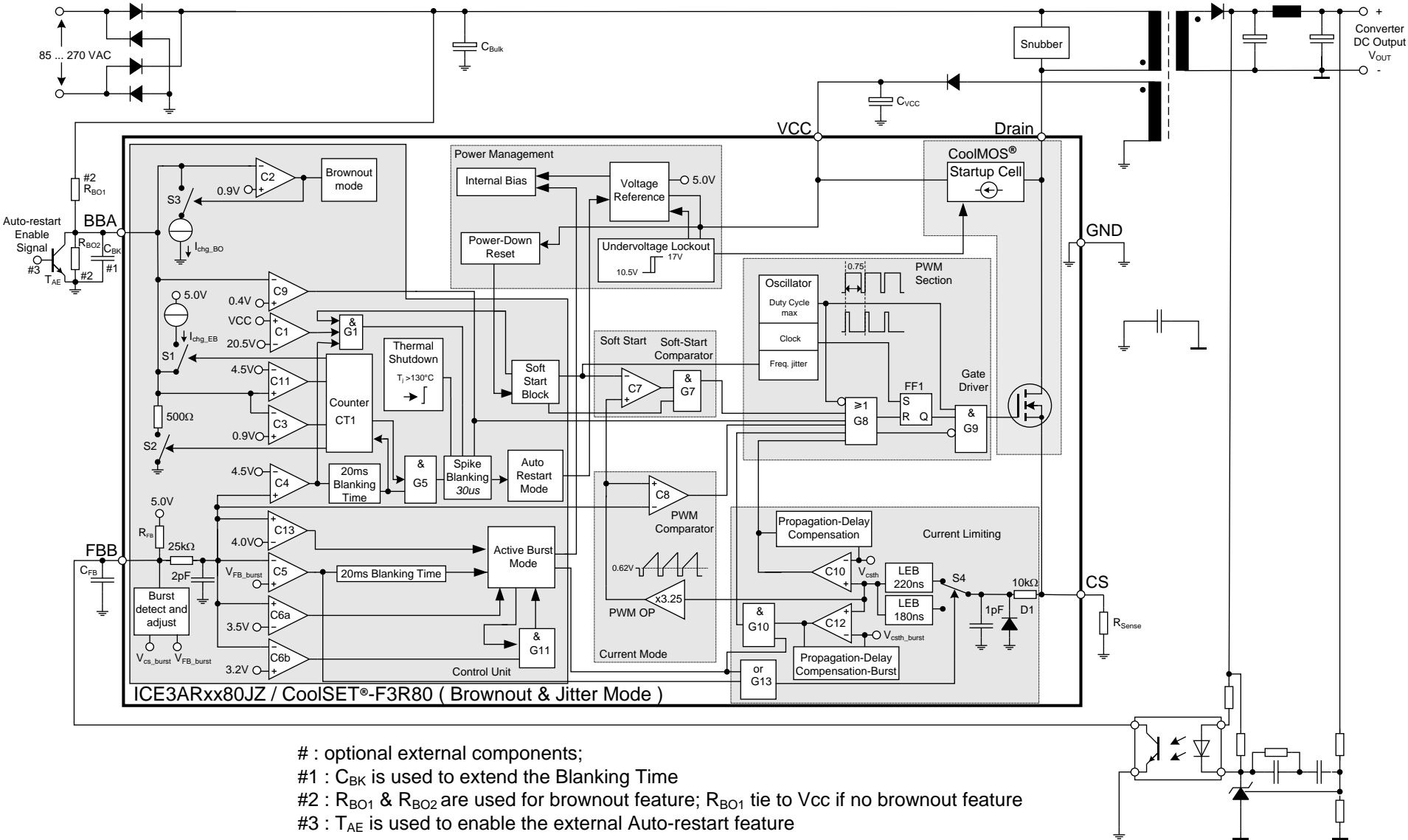
Package PG_DIP-8



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

¹⁾ at $T_j = 110^\circ\text{C}$

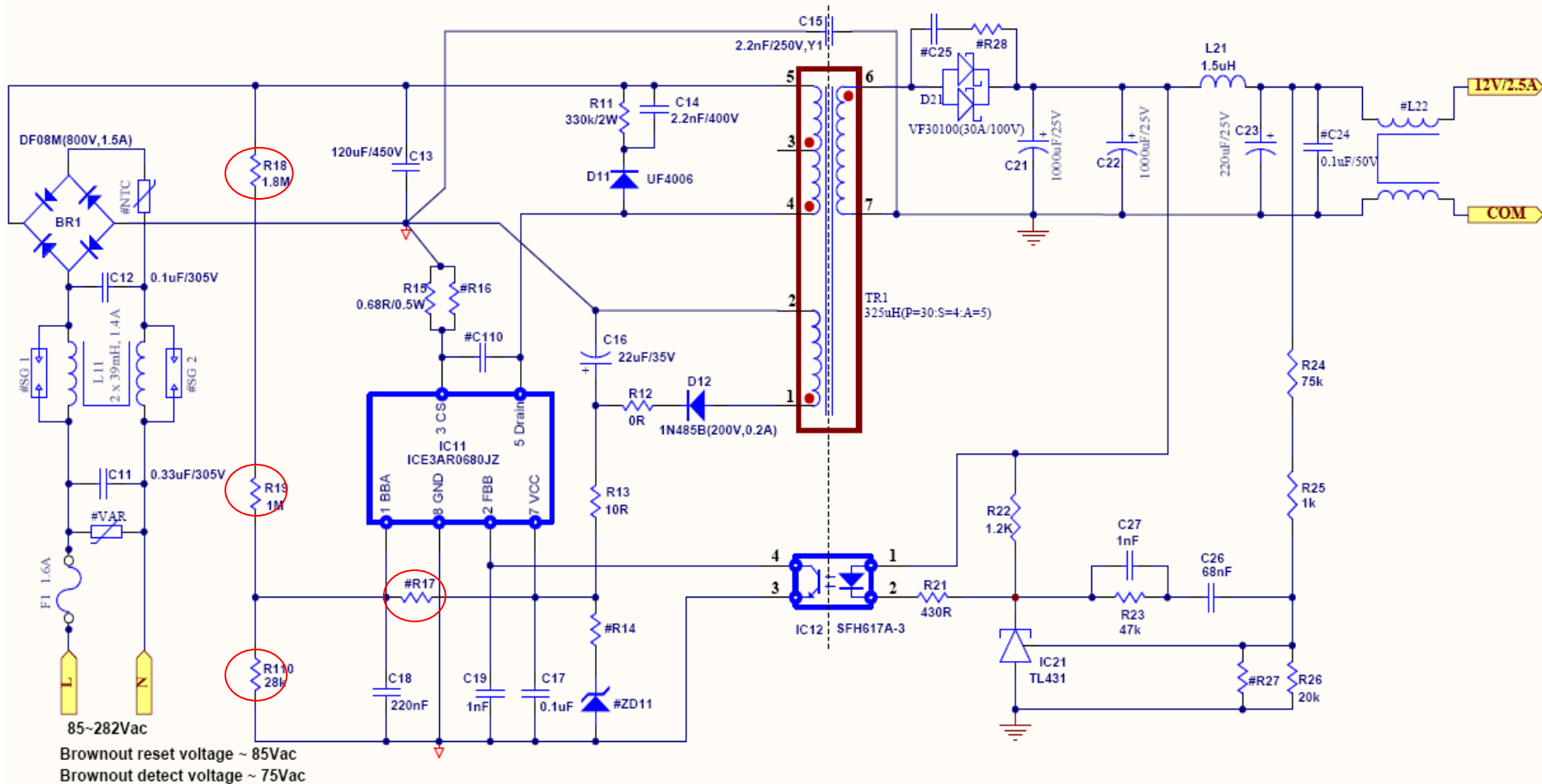
Block diagram of ICE3A/BRXXXJ Fixed Switching Frequency CoolSET



- CoolSET® F3 (ICE3xxx65(L)(Z)(G)(P))
 - 1st 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

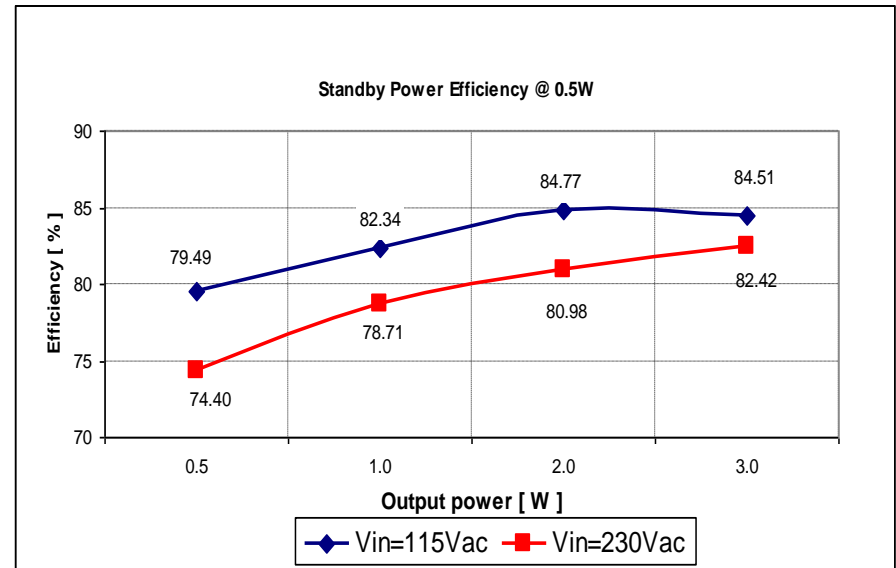
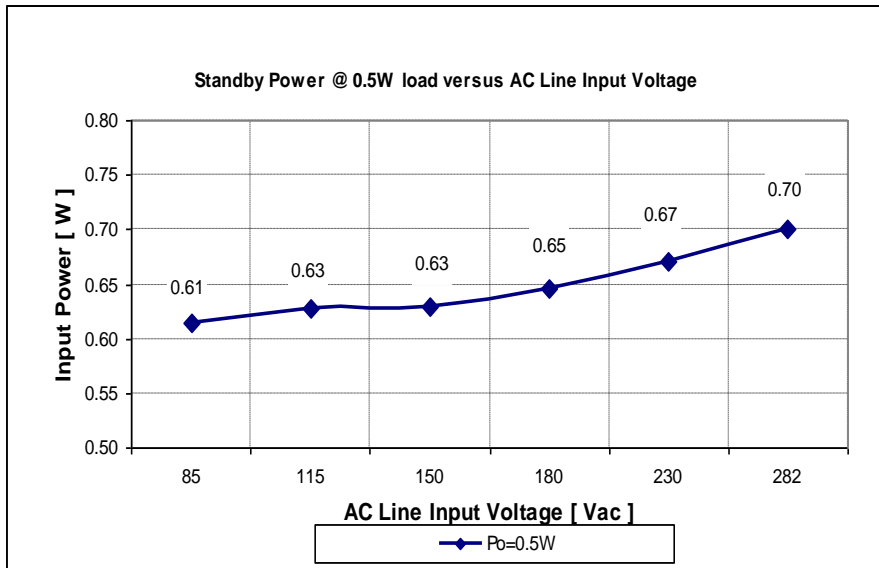
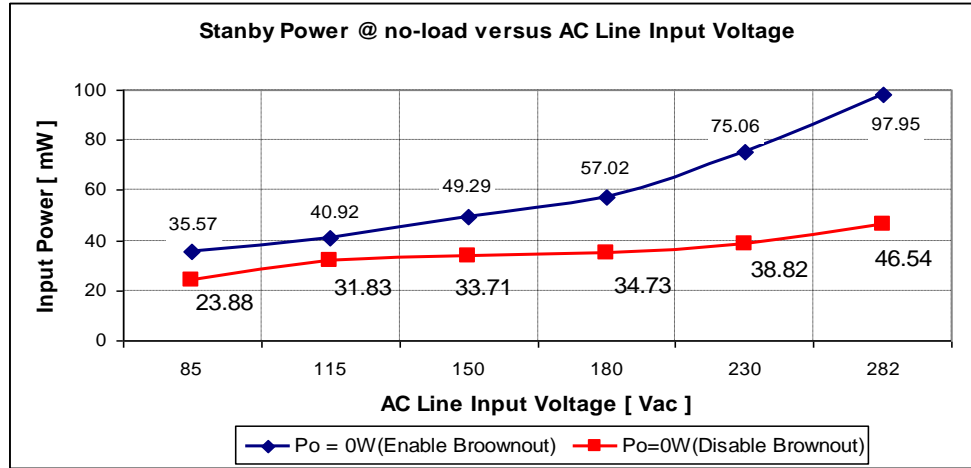
Enable BrownOut, EBO : Add R18, R19, R1100 and delete R17;
 Disable BrownOut, DBO : Add R17 and delete R18, R19 and R100;
 EBO and DBO would not happen at the same time.



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
$C_{FB}=6.8nF$	37.34	42.48	49.79	59.34	78.94	99.96	32.94	34.21	36.19	38.99	44.89	56.26
$C_{FB}=1nF$	36.55	41.29	50.83	56.23	76.35	96.54	32.56	33.48	36.42	38.86	43.83	55.79
$C_{FB}=330pF$	36.46	41.95	49.02	57.73	76.53	98.93	33.19	34.63	36.19	38.73	44.58	55.42
$C_{FB}=100pF$	108.57	104.48	105.77	114.59	128.02	149.37	97.52	80.17	87.36	88.81	92.49	100.84

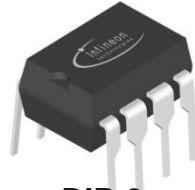
■ Input standby power at 0.5W load with different C_{FB}

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

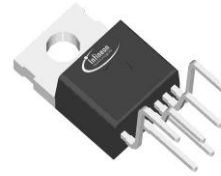


SO-16



DIP-8

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



TO-220-6



I²-Pak

ISODrain

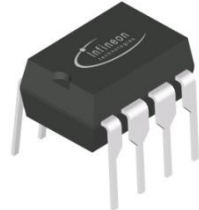
- Isolated
- low R_{th}

R _{DSon}	SO-16	DIP-8	POUTmax	TO-220-6	I²-Pak	POUTmax
6.5Ω	ICE3B0365JG	ICE3A0365	9W/17W			
4,7Ω	ICE3B0565JG	ICE3B0365J ICE3A0565 ICE3B0565J ICE3A1065 ICE3B1065	12W/21W	ICE3A2065P ICE3B2065P ICE3A3065P ICE3B3065P	ICE3A2065I ICE3B2065I ICE3A3065I ICE3B3065I	55W/90W
3,0Ω		ICE3B1565J ICE3A1565 ICE3B1565	15W /25W			68W/125W
2,1Ω		ICE3A2065 ICE3B2065	20W/32W	ICE3A3565P ICE3B3565P ICE3A5065P ICE3B5065P ICE3A5565P ICE3B5565P	ICE3A3565I ICE3B3565I ICE3A5065I ICE3B5065I ICE3A5565I ICE3B5565I	80W/144W
1,7Ω		ICE3A2565 ICE3B2565	27W/41W			100W/180W
1,5Ω			31W /46W			110W/200W
0,95Ω						
0,8Ω						
0,65Ω						

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}	SO-16	DIP-7/8	P_{OUTmax}	R_{DSon}	TO-220-6	P_{OUTmax}
10.0Ω	ICE3B4765JG	ICE3BR4765J ICE2QR4765 ICE3AR4780JZ ICE2QR4780Z	9W/17W	2,5Ω	ICE3BR2565JF	55W/90W
4,7Ω			12W/21W			
2,2Ω		ICE3AR2280JZ ICE3BR2280JZ ICE2QR2280Z	15W/28W	1,5Ω	ICE3BR1565JF	68W/125W
1,7Ω	ICE2QR0665G	ICE3BR1765J ICE2QR1765	20W/32W	1,0Ω	ICE3BR1065JF	80W/144W
0,65Ω		ICE3BR0665J ICE2QR0665 ICE3AR0680JZ ICE3BR0680JZ ICE2QR0680Z	31W /46W	0,65Ω	ICE3BR0665JF	110W/200W

SMPS IC's at a glance

Focus Product Portfolio



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



ENERGY EFFICIENCY MOBILITY SECURITY

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