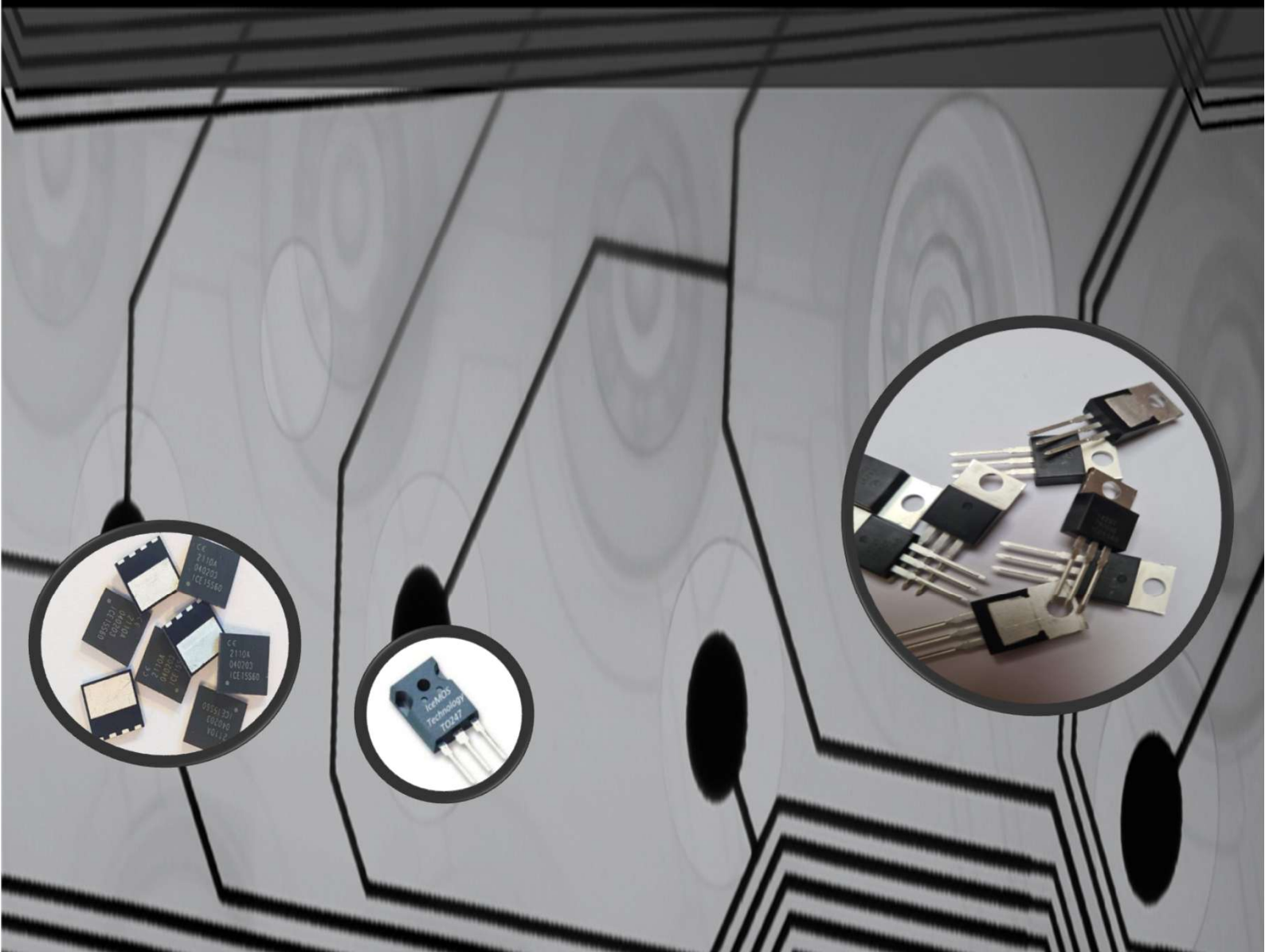
IceMOS Technology

Case Studies on the Use of High Voltage Super Junction MOSFET

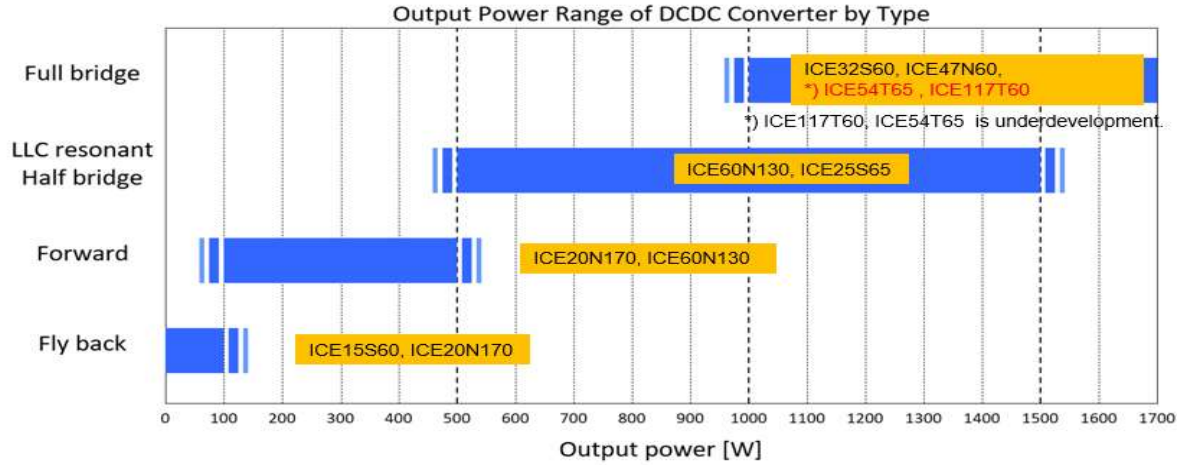
https://icemostech.com/



1.Application Matrix Table

★:Showing type frequently use of Circuit.

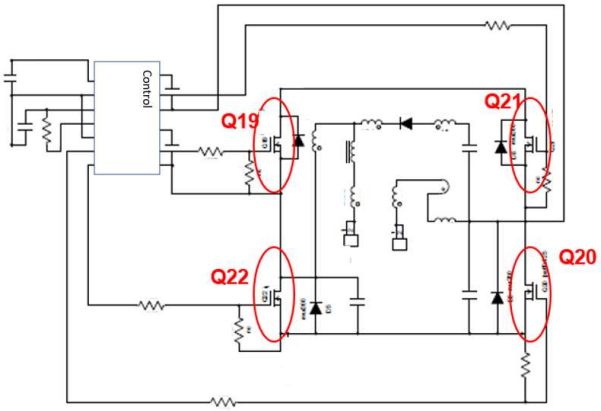
#	Application	Output Power (W)		Circuit								ICEMOS
				AC-DC			DC-DC				DC-AC	
		Min	Max	Half wave	Full Wave1	Full Wave2	Fly back	For ward	LLC Half Bridge	Full Bridge	Inverter	Product
1	SMPS Power Factor Correction	500							★	★		ICE25S65 ICE60N130
2	LLC Half Bridge	1000								★		ICE47N60 ICE32S60
3	Low power SMPS Quasi- Resonant Flyback		100				★					ICE8S65,ICE8N60, ICE10N60,ICE15S60
4	High Power SMPS LLC Half- Bridge	500	1500						★			ICE47N60 ICE32S60
5	ATXPower Supplies	200	1600	★	★	★	★	★	★			ICE47N60 ICE32S60
6	LED TV	5k-140inch				★				★		ICE32S60 ICE47N60
7	LED Lighting	20	500	★	★	★	★	★				ICE25S65 ICE60N130
8	Data center AC/DC(Severs and Telecom)	500k-1k node				★				★		ICE32S60 ICE47N60
9	Fast Chargers	3k	400k			★				★		ICE47N60
10	Chargers PC Adapters	36	90	★	★		★					ICE8S65,ICE8N60, ICE10N60,ICE15S60
11	TV Power application	24	410		★	★	★	★				ICE25S65 ICE60N130
12	UPS	500	10k			★			★	★	★	ICE32S60 ICE47N60
13	Solar inverters	300	6k					★	★	★	★	ICE32S60 ICE47N60
14	HID Street lights	22	500			★		★	★			ICE25S65 ICE60N130
15	Gaming consoles	100	200		★	★		★				ICE60N130 ICE20N170
16	LED signage	10	250	★	★			★				ICE60N130 ICE20N170
17	E bikes E-Mobility	600	40k			★			★	★		ICE32S60 ICE47N60
18	Printers	10	1500	★	★	★	★	★	★	★		ICE32S60 ICE47N60
19	White good Fridge	200	300			★			★	★	★	ICE60N130 ICE20N170
20	Washing machine	800	1500			★			★	★	★	ICE32S60 ICE47N60
21	Audio Amp	200 x n	5k x n			★			★	★		ICE32S60 ICE47N60
22	Projector	300	2k			★		★	★	★		ICE32S60 ICE47N60
23	Car audio	10 x n	100xn				★	★				ICE47N60 ICE32S60
24	Navigation	10	20				★					ICE8S65,ICE8N60, ICE10N60,ICE15S60
25	3D printer	180	1500	★	★	★	★	★	★	★		ICE32S60 ICE47N60
26	Smart phone adaptors	20	90	★	★		★					ICE15S60 ICE20N170
27	Factorized power	320	1300			★			★	★		ICE47N60
28	Tablet computers	200	1500	★	★		★					ICE15S60 ICE20N170
29	Micro Inverters	200	1500						★	★	★	ICE47N60

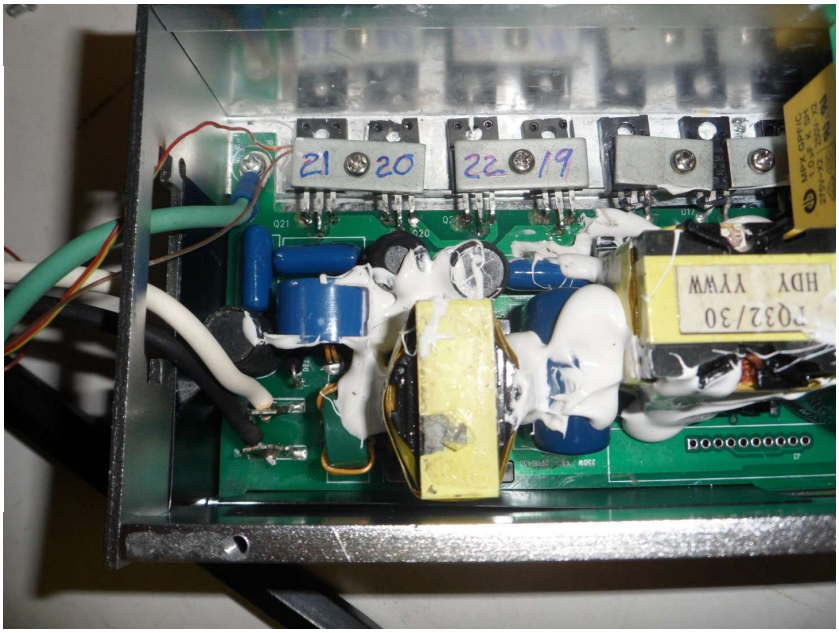


2.General Application

1)HID light ballast application ~500W

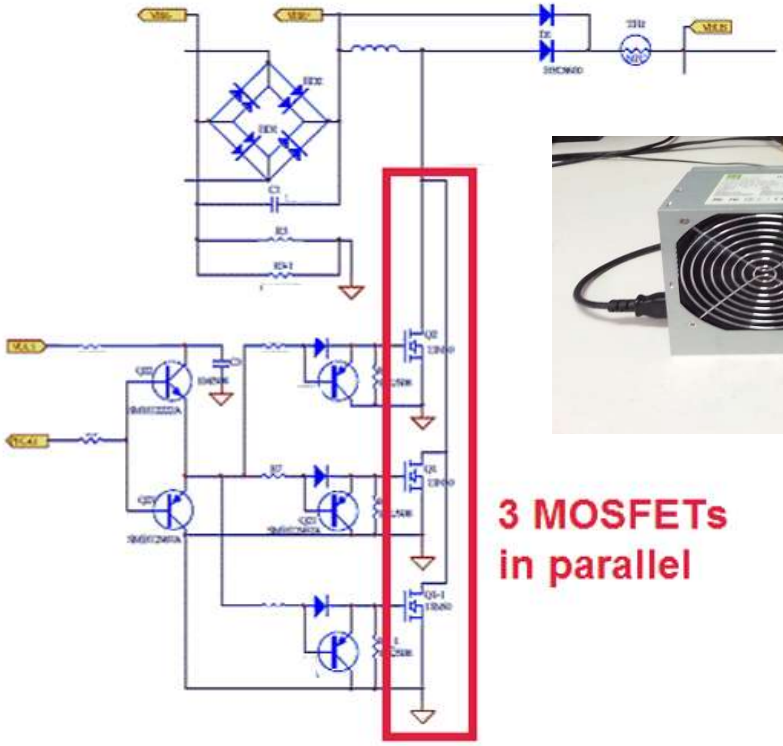
ICE15N60-15A/600V (4 MOSFETs are used for Bridge section)





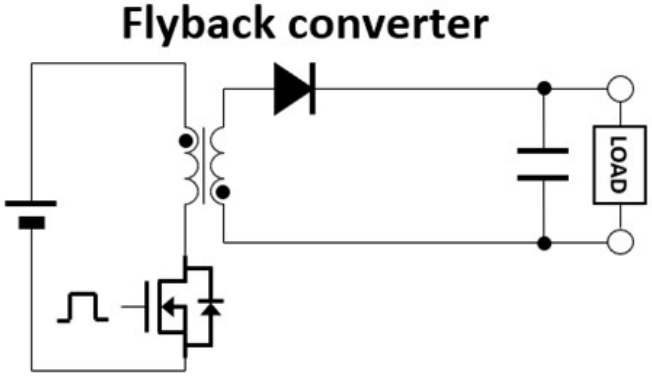
2)ATX 600W Model

ICE20N170 -20A/600V /TO220
(3つの MOSFET をPFC(boost Converter)に使用。
SPEC:AC 100/240V DC 0~400W, 12V output



3) Switched-Mode Power Supply for Multifunction Peripheral/Printer/Product_FC Stage

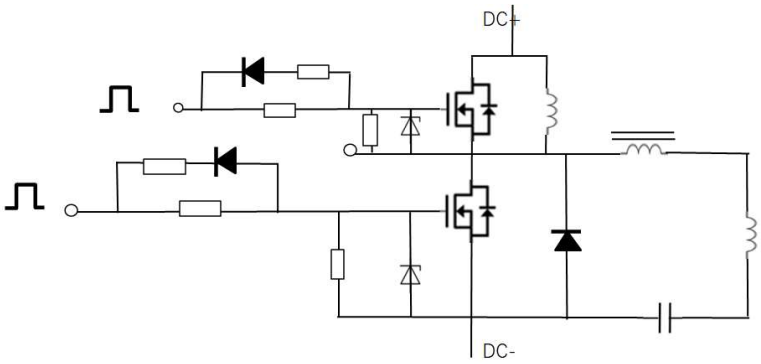
ICE10N60FP -10A600V
Alternative:
ICE15N60FP -15A600V
ICE20N170FP- 20A/ 600V



LED Driver
ICE20N170 20A/600V Robust UIS
ICE15S60 15A/600V Lower FOM

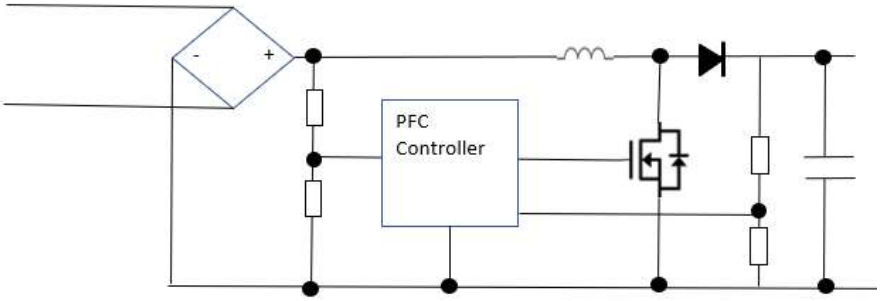
4) ATE 420W products

ICE60N130 25A/ 600V 2pcs
ICE15N60 15A/600V 2pcs



5) AC/DC 100kHz PFC Boost Converter

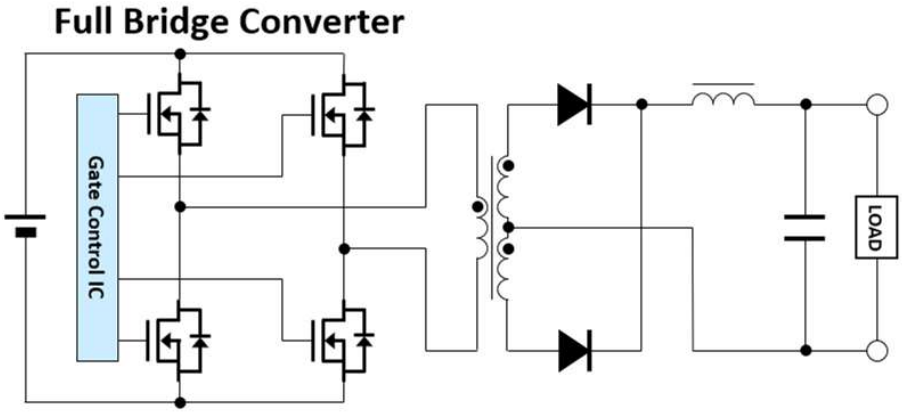
ICE8S65-8A/650V
ICE7N60 7A/ 600V
200V DC Input Output 385V DC



6) Full Bridge Converter

ICE47N60W -47A/600V

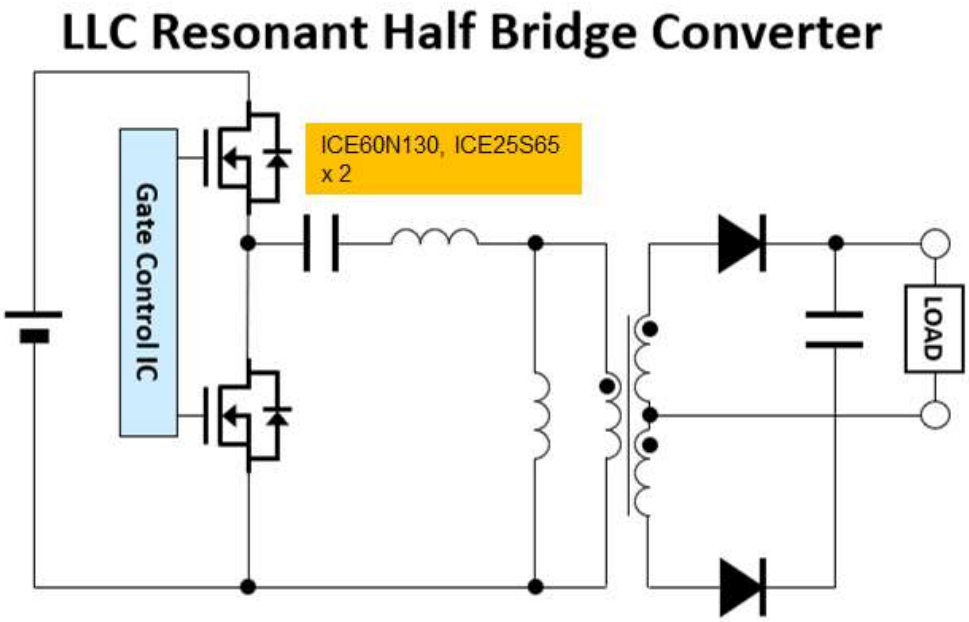
Audio Power



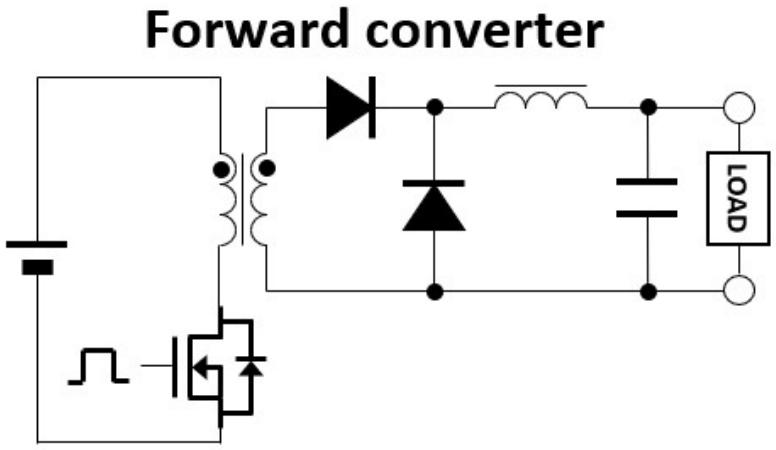
7) LLC Resonant Half Bridge Converter

Printer Power supply
ICE60N130 25A/600V -Robust UIS
ICE25S65 25A/650V – Lower FOM

Audio Power supply（声学电源）
22N60B 22A/600V/D2PAK



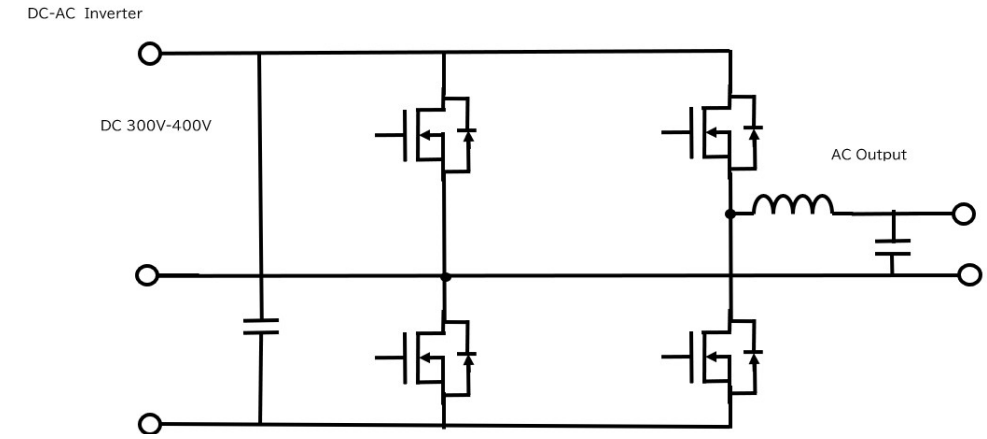
8) **Forward Converter** (Isolated) Low to High:PC, Industrial
ICE20N170 20A/600V Robust UIS
ICE60N130 25A/600V Lower FOM

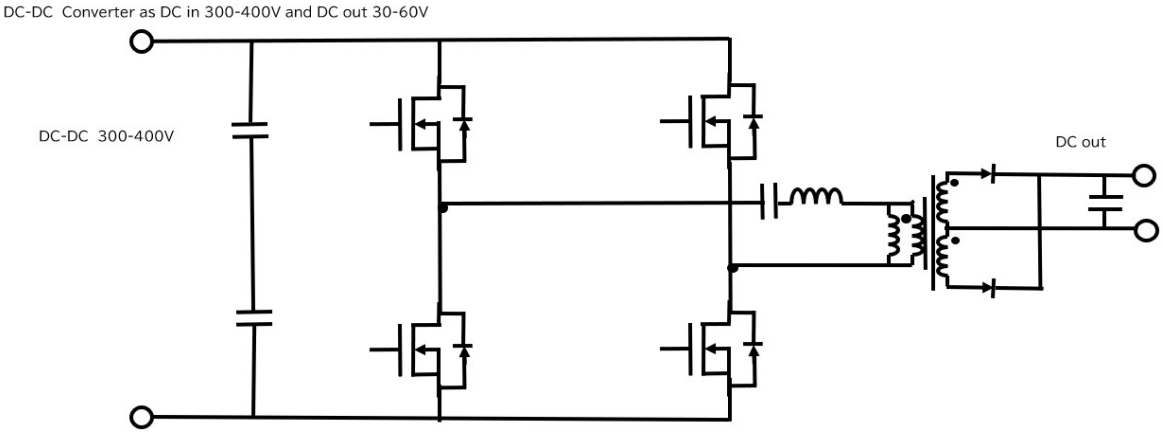


Example using an ICE20N170 and an ICE60N130. This system provides a wide range of outputs. The ripple voltage is lower compared to the flyback type, although the diode and choke coil must be included. The output voltage is determined by the turns ratio of the primary and secondary.

9) DC-AC Inverter /DC-DC Converter

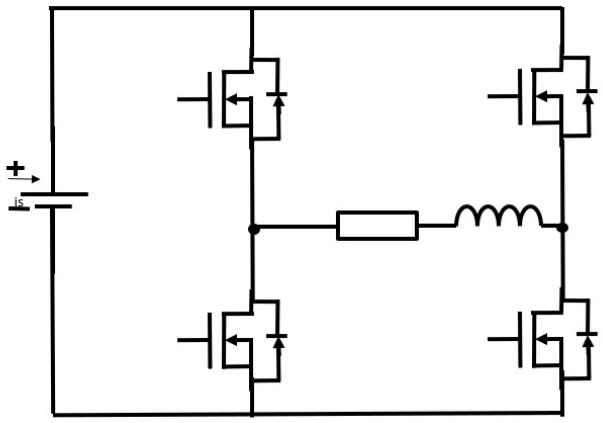
UPS 25A and 15A rated 600 and 650V
ICE60N130 25A/600V-Robust EAS
ICE25S65 25A/650V –Low FOM due to Low Qg
ICE15N60 15A/600V –Cost Effective
ICE15S60 15A/600V –Low FOM due to Low Qg





10) **Inverter**
Solar Inverter/ Micro Inverter

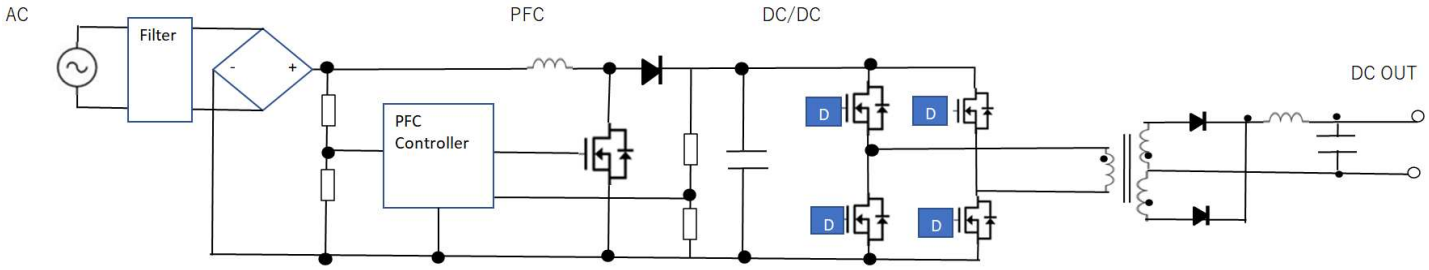
25A and 15A rated 600 and 650V
ICE25S65 25A/650V –Low FOM due to Low Qg
ICE15S60 15A/600V –Low FOM due to Low Qg

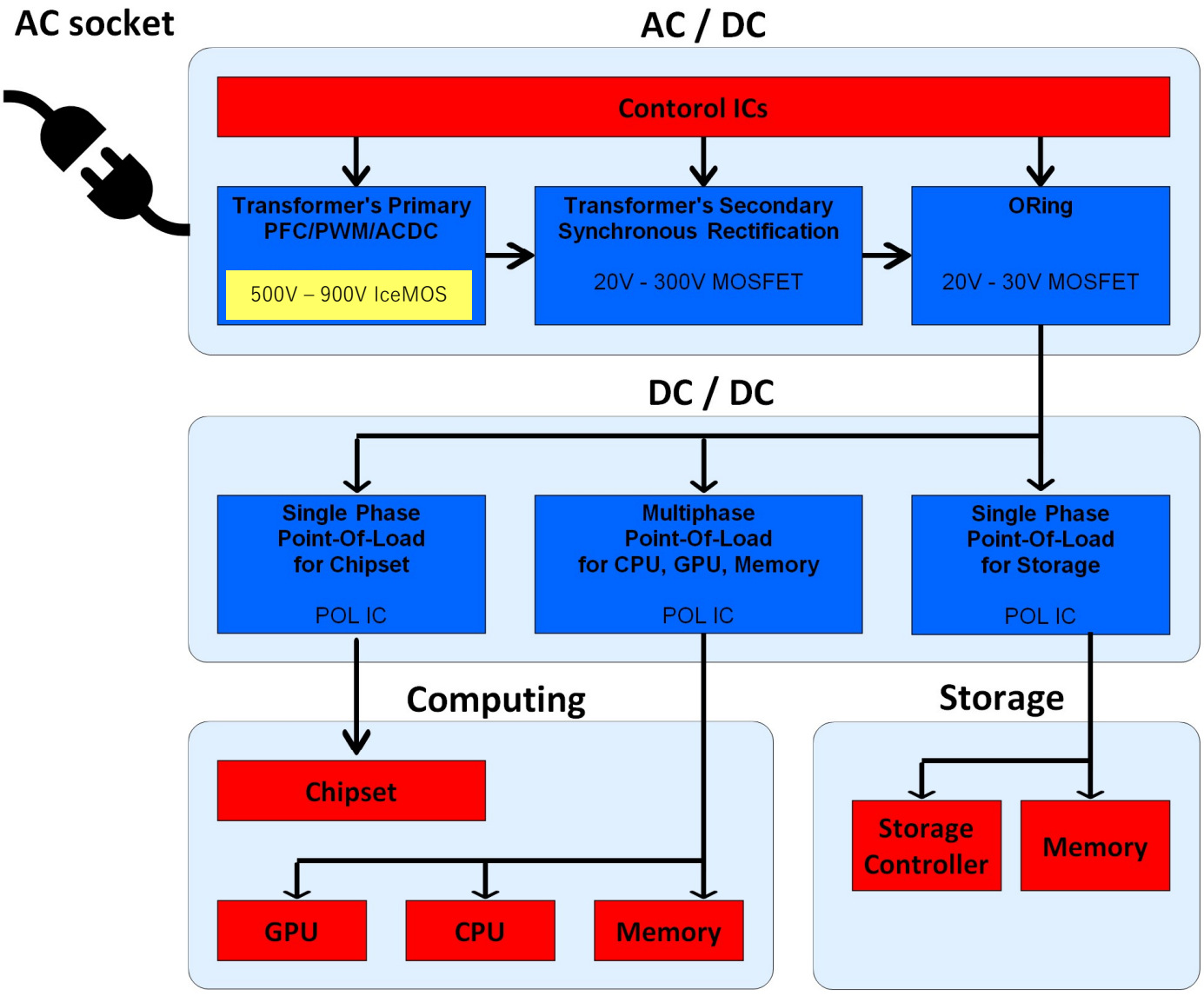


The case which needs high current in such Solar panel.

11) PFC/PWM/AC-DC
Data Center Power Supply
AC 90-265V
DC-DC 400V and Output 12V dc

ICE25S65 25A/650V –Low FOM due to Low Qg
ICE60N130 25A/600V-Robust UIS





MOSFETs with various current and voltage ranges are used according to the design and specifications.

IceMOS
Cooler than Cool

12)LTE Rooter Load 5V 4A 54V 0.55A Power Module
ICE8S65FP 8A/650V/TO220FP

LTE Wi-Fi Router Power Supply

Key Device Technology: ICE8S65FP (8A,650V, TO220FP) and ICE11N70FP (11A,700V,TO220FP)

Long Term Evolution (LTE) routers, also known as “4G routers”, are a specific type of network router that can provide mobile broadband internet connectivity to devices via a Wi-Fi, Ethernet, or USB connection. They are categorized by their use of fourth-generation long-term evolution (4G LTE) and LTE-Advanced wireless modems, modules, or PCI Mini Cards to drive high-speed data transfer over cellular networks. These routers are very popular for machine-to-machine (M2M) and the Internet of Things (IoT) communications environments because they offer full-duplex communications links using frequency-division duplexing (FDD) or time-division duplexing (TDD) depending on the frequency band used. LTE router mobility can support devices moving at speeds of up to 350 kilometers per hour, with coverage of 5 to 100 km, along with individual channel bandwidths between 1.4 and 20 MHz. Antenna diversity and spatial multiplexing with MIMO features enhance the performance and speed. Using MIMO increases downlink speeds of up to 300 Mbps with low latency (10 mS).

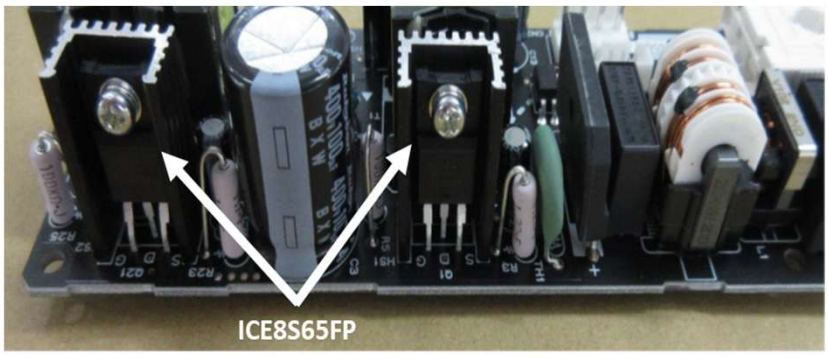
The designers of these routers are placing greater emphasis on more reliable efficient power MOSFET devices in their circuits. The ICE11N70FP (Gen1 technology) and the ICE8S65FP (Gen2 technology) are both idea for the LTE Wi-Fi Router application.

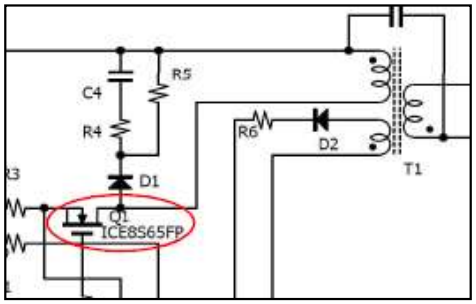
LTE Wi-Fi Router Case Study:

Customer “A” evaluated the ICE8S65FP as a replacement for the device from our competitor because of delivery problems. The table below shows the actual side-by-side comparison test results assessing the ICE8S65FP performance versus the device from “SUPPLIER-1”. The conclusion was that the ICE8S65FP had no issue for thermal characteristic and was a viable replace for the new Wi-Fi Router design in development. IceMOS got the design win!

			AC90V			AC100V			AC230V			AC264V		
CH. No.	REF.No.	SUPPLIER	Tc	ΔT	Tc (50°C)	Tc	ΔT	Tc (50°C)	Tc	ΔT	Tc (50°C)	Tc	ΔT	Tc (50°C)
7	Q1	SUPPLIER-1	68.55	38.70	88.70	65.50	36.15	86.15	65.20	36.80	86.80	66.80	38.50	88.50
	Q1	ICE8S65FP	64.30	34.95	84.95	62.60	33.50	83.50	60.70	32.80	82.80	63.10	34.55	84.55
		Δ	-	-	-3.75	-	-	-2.65	-	-	-4.00	-	-	-3.95
14	Q21	SUPPLIER-1	59.45	29.60	79.60	57.75	28.40	78.40	65.40	37.00	87.00	68.25	39.95	89.95
	Q21	ICE8S65FP	56.20	26.85	76.85	55.00	25.90	75.90	60.30	32.40	82.40	64.30	35.75	85.75
		Δ	-	-	-2.75	-	-	-2.50	-	-	-4.60	-	-	-4.20
Power Consumption (W)		SUPPLIER-1	59.6	-	-	58.5	-	-	57.6	-	-	57.8	-	-
		ICEMOS	59.1	-	-	58.4	-	-	57.5	-	-	57.7	-	-
		Δ	-0.50	-	-	-0.10	-	-	-0.10	-	-	-0.10	-	-

Power Module Load Conditions: 5V/4A and 54V/0.55A
Temperature Requirement: < 142° C @ 1.75W





- **Two MOSFETs used for LTE Router AC-DC**
- **AC in 90-100V**
- **Two lines DC out for DC 5V and 54V POE**

13) PMF Circuit

ICE22N60W Device 22A/600V TO247

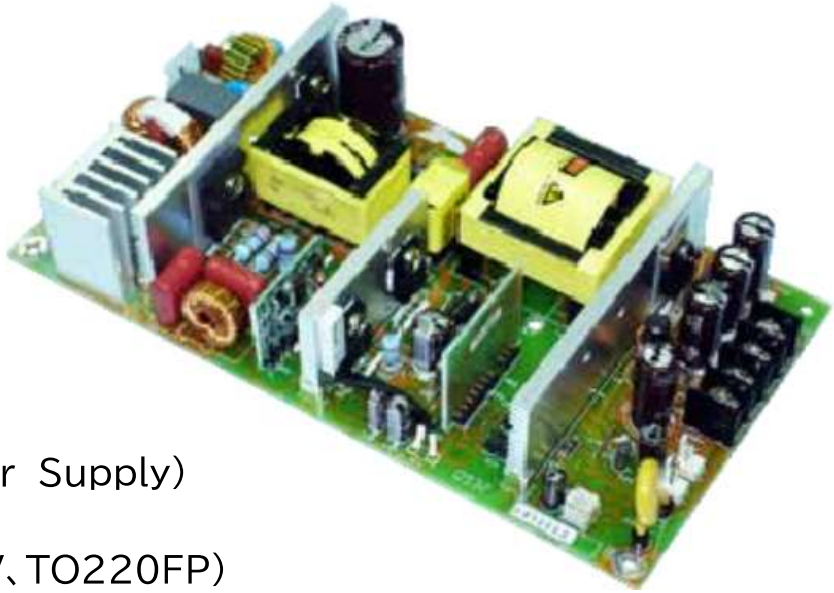
Design WIN CASE

Efficiency 86-88%

380W peak load

After evaluate with other 2competitor's samples, ICE22N60W win to adopt.

Reason of design win:Customer explained that other competitor's device did not functioned due to higher Vg. And Other competitor device sometime destroyed during function. Therefore Customer choose our ICE22N60W.



14) 100 V Power Module (Power Supply)

ICE20N60EFP (20A, 600V、TO220FP)

100W Power Supply

Input 90Vac to 264Vac47－63Hz

Input current 4A max 115Vac, 2A max /230Vac

Inrush current 40A maz 115Vac , 80A max 230Vac

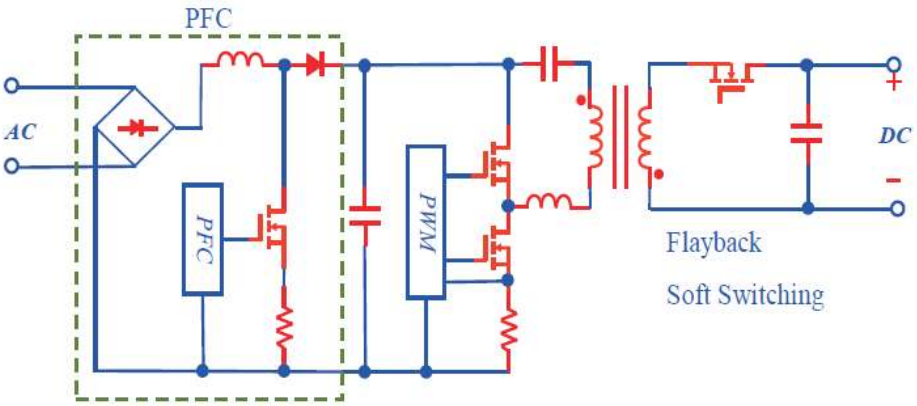
Output

Vo 24V, Peak load 8.4A

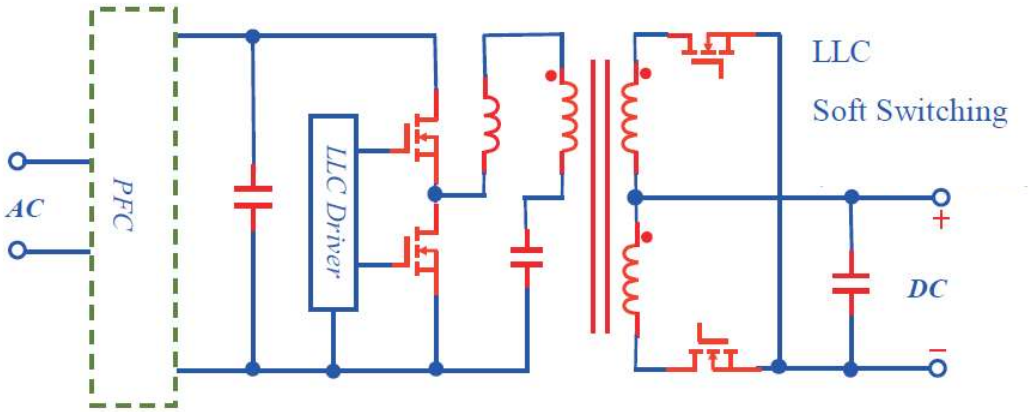
ICE20N60EFP

15) Asymmetrical ZVS Flyback
120W to 300W with PFC

ICE47N60W ,47A/600V TO247
2 MOSFETs
Design WIN CASE FOR EURO Maker
Two MOS with PFC,Single & Multiple output

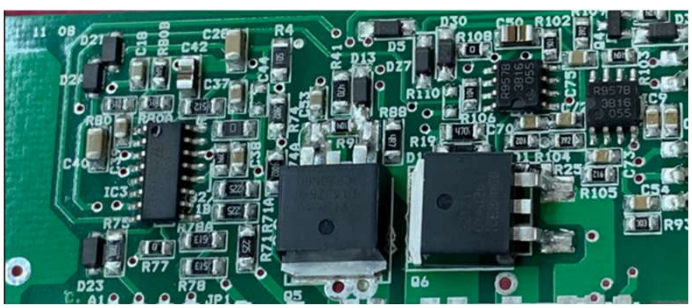


16)Half Bridge LLC Resonant Soft Switching ZVS 200W Single Output with PFC , Peak and Surge Load



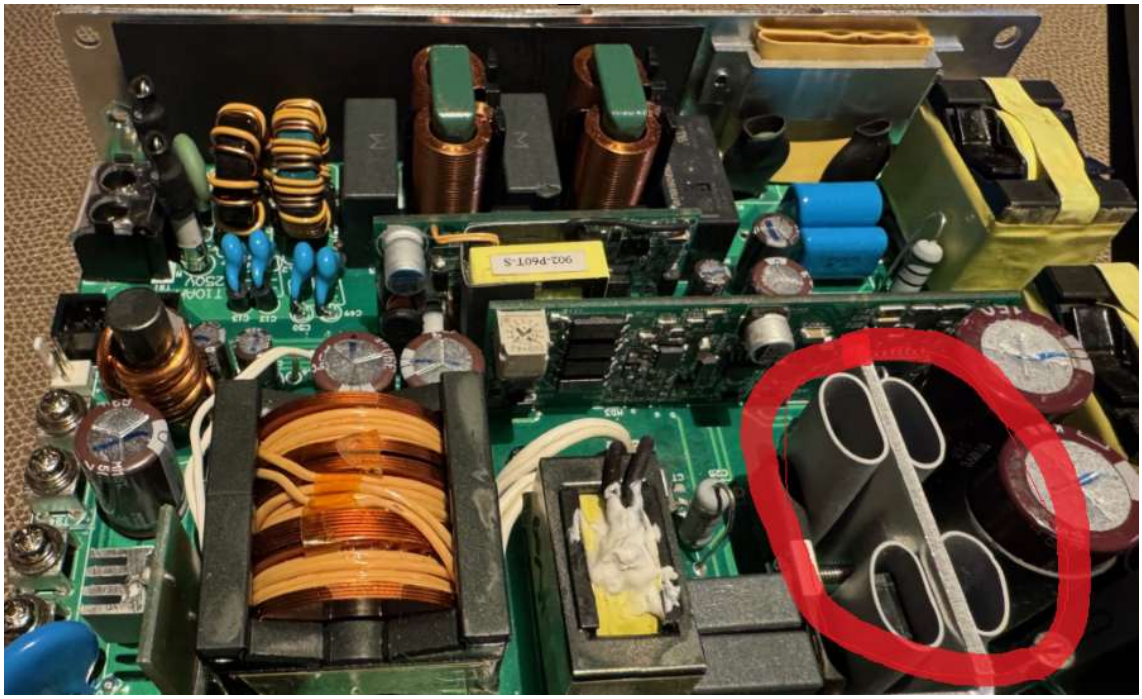
ICE22N60B 2 MOSFETs
22A,600V D2PAK

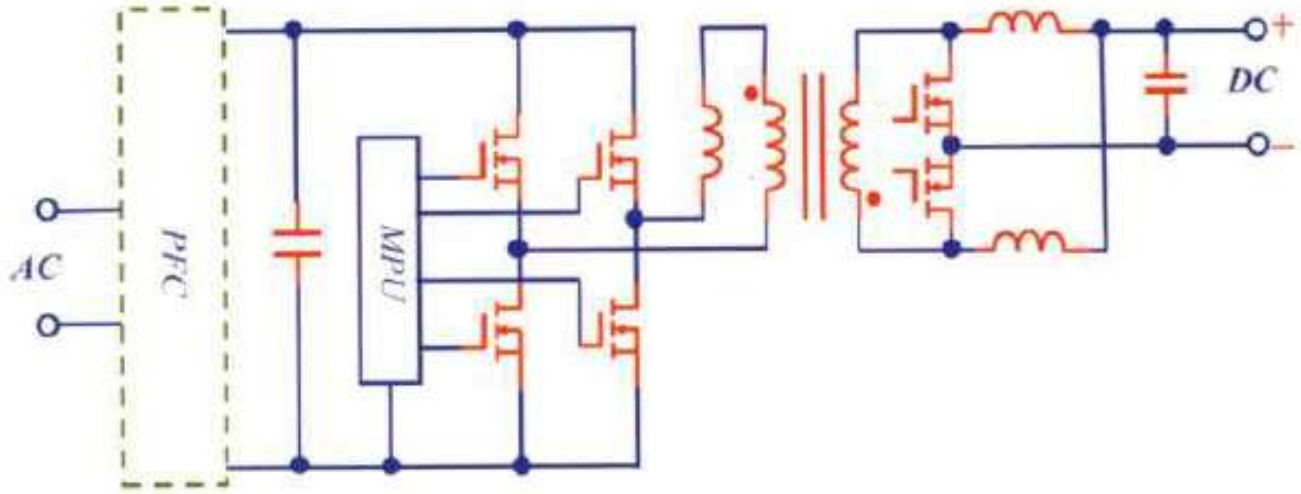
ICE20N60B 2 MOSFETs
20A,600V D2PAK



16) Phase shift full bridge ZVS topology

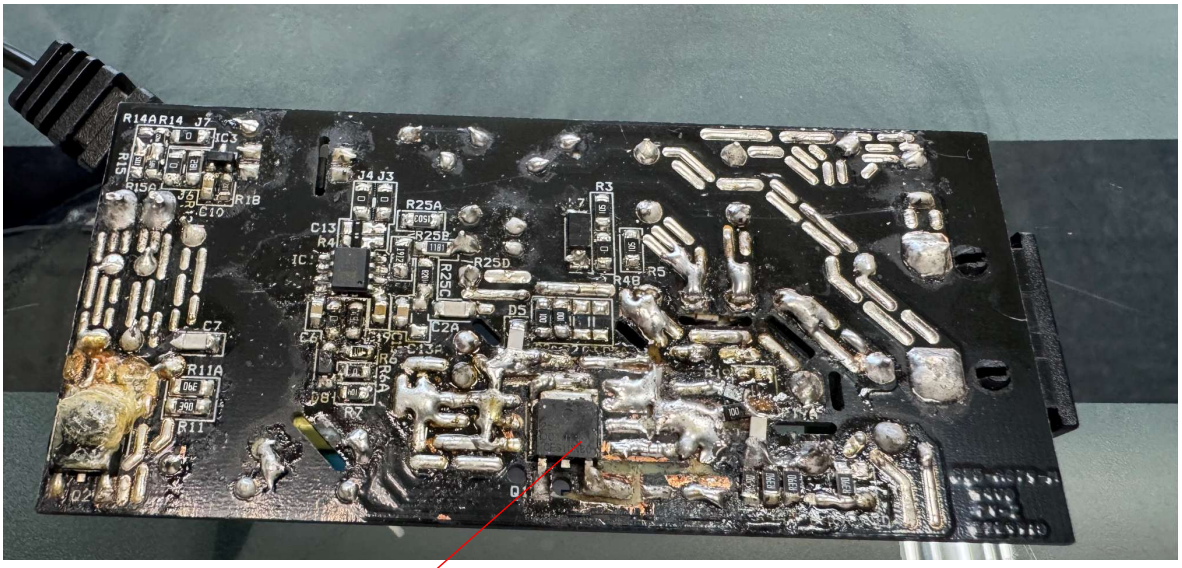
ICE20N60EFP 4 pcs used for Full bridge 600W
All power MOSFET operate in soft-switching mode.
For high –wattage applications, the full-bridge phase shift topology combined with a current doubler is an ideal match.

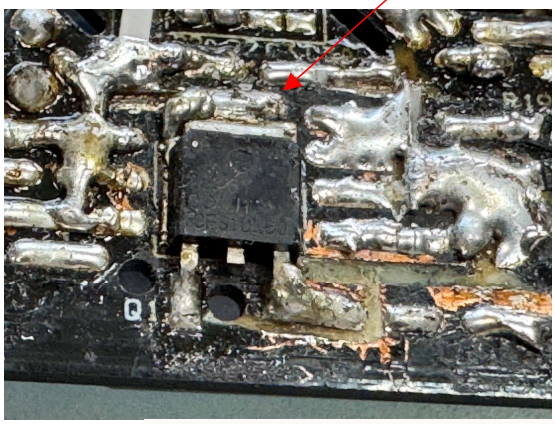




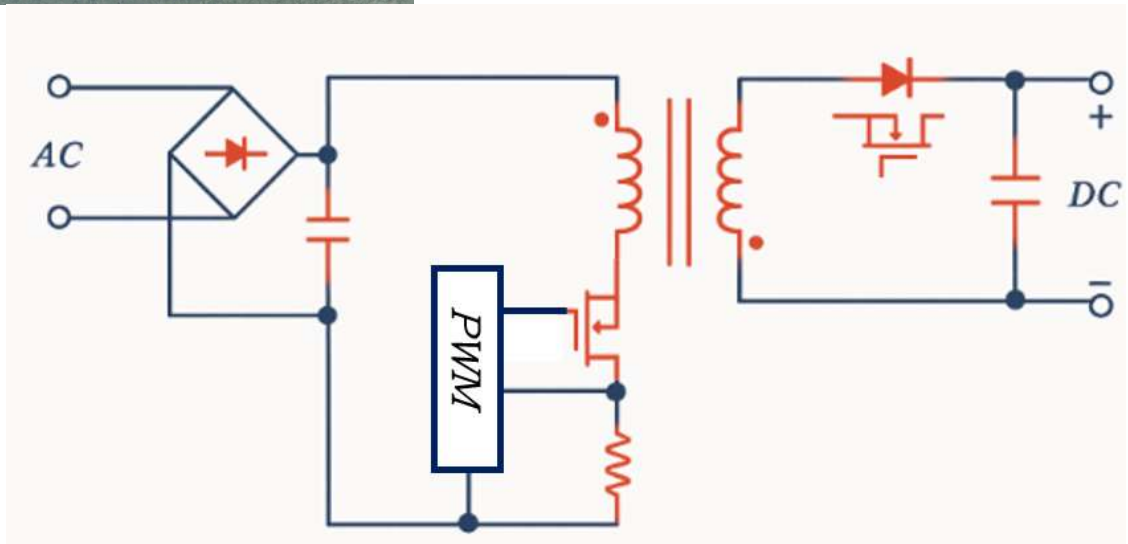
ICE20N60EFP 4pcs
600V, 20A, 190mohm

17) Flyback Topology Hard switching. 600V 10A ICES10N60D 1pcs is used in Adapter for European Medical Application.





ICES10N60D 1pcs
600V, 10A,360mohm



High Voltage Super Junction MOSFET Product table

Power MOSFETs								
Device Type	Product	BVDSS Min. (V)	ID Max. (A)	RDSON Max. (mΩ)	Qg Typ. (nC)	FOM (Ω· nC)	Trr/Qrr (ns)/(us)	Package
MEMS SJ GEN1 Robust UIS	ICE47N60	600	47	68	189	12.85	552/12	W,C
	ICE60N130	600	25	150	84	12.6	440/8	TO,FP,W,C
	ICE22N60	600	22	160	84	13.44	440/8	TO, B ,W
	ICE20N170	600	20	199	59	11.74	358/6.8	TO,FP,W,C,B
	ICE20N60	600	20	190	59	11.21	358/6.8	TO,FP,W,B,C
	ICE19N60	600	19	220	59	12.98	358/6.8	L8x8
	ICE15N73	730	15	350	75	26.25	383/7.0	TO,FP,W,T
	ICES15N60	600	15	240	52	12.48	318/5.3	TO,FP,L8X8,T
	ICE13N60	600	13	270	48	12.96	285/4.2	TO,FP,L8X8,T
	ICE11N70	700	11	250	84	21	408/7.5	TO,FP,W,B,C
	ICE10N60	600	10	330	43	14.19	303/4.21	TO,FP,W,B,L8x8
	ICES10N60	600	10	360	40	14.4	281/3.9	D
	ICE8N60	600	8	520	32	16.64	194/2.2	TO,FP,W,B,L8X8,T,D,LK
MEMS SJ GEN2 Good FOM	ICE32S60	600	32	78	47	3.67	400/6.8	TO,FP,W,C
	ICE25S65	650	25	133	34	4.52	326/5.6	TO,FP,W,C,B
	ICE24S65	650	24	141	34	4.79	326/5.6	L8x8
	ICE15S60	600	15	175	30	5.25	300/4	TO,FP,W,C,B
	ICE14S65	650	14	195	24	4.68	300/4	TO,FP,W,C,B
	ICE8S65	650	7.8	400	11.5	4.6	308/2	TO,FP,W,B,C,D,L5x6
Silicon SJ K series FAST Recovery	*ICEK55NF60	600	55.1	38	136	5.17	130/0.8	T, TO
	*ICEK49NF60	600	49.1	45	117	5.27	132/1.0	T,W,TO
	*ICEK42NF60	600	42	58	95	5.51	90/0.8	W, TO220,T
	*ICEK35NF60	600	35	68	83	5.64	111/0.6	TO , W
	*ICEK16NF60	600	16	180	32	5.76	83/1.0	D,FP
	*ICE26NF65	650	25.6	99	48	4.75	114/0.7	T,W
	*ICEK15NF65	650	15.1	190	32	6.08	66/0.6	TO,D,FP
	*ICEK11NF65	650	10.5	290	22	6.38	71.5/0.29	TO220 ,D,FP
	*ICEK9NF65	650	9.1	360	20	7.2	59/0.35	D , FP
	*ICEK6NF65	650	6	600	14	8.4	62/0.33	D