

FUJI Power Semiconductors

Power Supply Control ICs Selection Guide

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AC/DC Power Supply Control ICs

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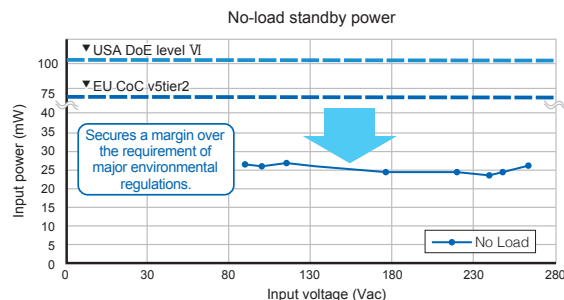
Green Mode PWM-ICs

FA8A60N/70N/80N/90N Series

The AC/DC PWM Control IC FA8A60N/70N/80N/90N Series offer the best system for flyback circuits. With a rich variety of functions integrated in the small-sized package of SOP8, it makes excellent cost performance via a compact power supply design that leads to good energy saving at light loads.

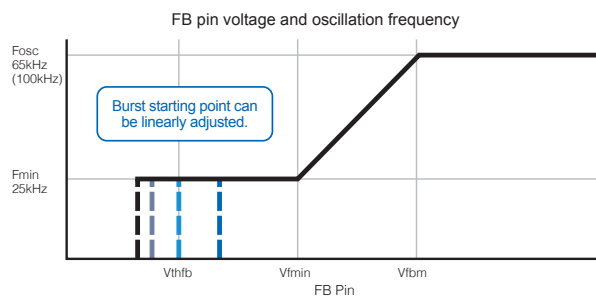
1. Low standby power (Burst operation function)

It achieves low standby power with its burst operation function. It is also capable of clearing the energy-saving standards for external power supplies such as DoE*1 and CoC*2 even securing some margin.



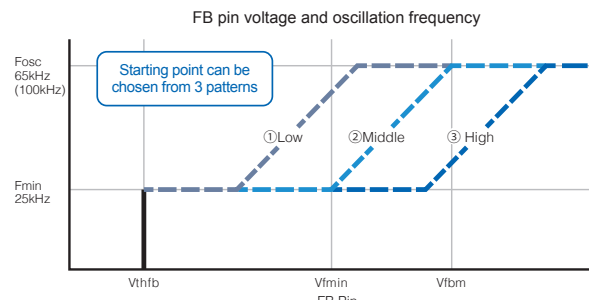
3. Burst starting point can be adjusted

The burst starting point can be continuously adjusted, which makes it easy to improve efficiency at light loads and implement measures for acoustic noise reduction.



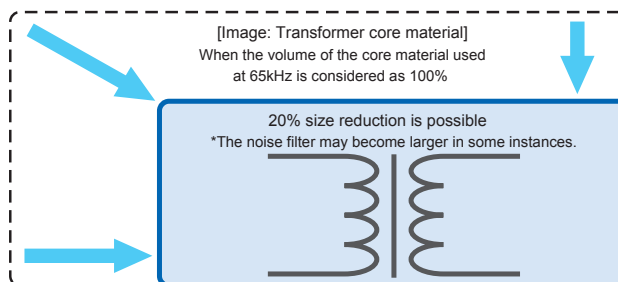
2. Switching frequency reduction adjustment is available

The frequency reduction starting point can be chosen from three patterns, which makes it possible to improve efficiency for each power supply.



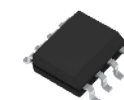
4. Reduced size of the power supply (100kHz type)

In addition to the 65kHz type, a 100kHz type is also available. The high frequency has made it possible to reduce the size of the power supply transformer.



Applications (for flyback circuits)

Office automation equipment, AC adapters, external power supplies, LCD TVs, etc.



Package: SOP-8

Product Line-up

Type	500V Starting circuit	65kHz	FA8A60N	FA8A61N	FA8A70N	FA8A71N
	100kHz		FA8A64N	FA8A65N	FA8A74N	FA8A75N
	650V Starting circuit	65kHz	FA8A80N	FA8A81N	FA8A90N	FA8A91N
	100kHz		FA8A84N	FA8A85N	FA8A94N	FA8A95N
Overload protection (OLP)		Auto-Recovery	Latch	Auto-Recovery	Latch	
Delay time		200ms	200ms	200ms	200ms	
Line compensation		Built-in	Built-in	Built-in	Built-in	
Detection level		1 Stage	1 Stage	1 Stage	1 Stage	
X-Cap discharge function		None	Built-in			
Frequency reduction function		Selectable (3 patterns)				
Burst operation point adjustment		Linearly adjustable				
Power-off mode		Built-in				
DSS (Dynamic self supply)		Built-in				
Overvoltage protection		25.5V (latch)				
Over temperature protection		140°C (latch)				

*1 DoE (United States Department of Energy): The energy-saving regulations in the United States that stand in for the Energy Star program promoted by the United States Department of Energy.

*2 CoC (Code of Conduct): Abbreviation for the EU Code of Conduct. Tier 2 became effective in January 2016 as a replacement of the EuP directive.

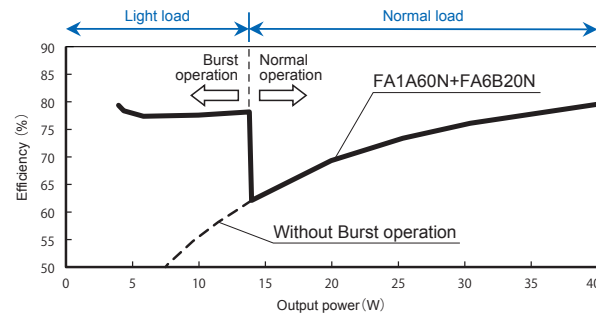
Critical mode PFC control IC and LLC current resonance control IC for high-efficiency power supplies

FA1A60N/FA6B20N

The critical mode PFC Control IC FA1A60N and LLC current resonance control IC FA6B20N provide an optimum system for LLC converters with an input of 75W or higher. The auto standby function enables the products to be applied not only to internal power supplies for LCD TVs, etc but also to adapters that do not have external standby signals.

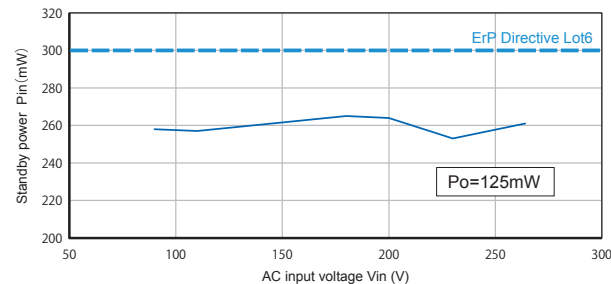
1. Improved efficiency at light load

Efficiency above 75% is achieved at 3% of rated power by providing burst control for both PFC control IC and LLC control IC at light load.



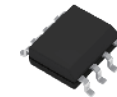
2. Low standby power

Standby power below 260mW is achieved without standby power supply when input is 230V AC and output power is 125mW. (ErP Directive Lot6*1: 0.3W or lower)

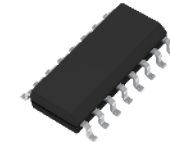


Application examples

LCD TVs, high power adapters, office automation (OA) equipment, communication power supplies and industrial power supplies



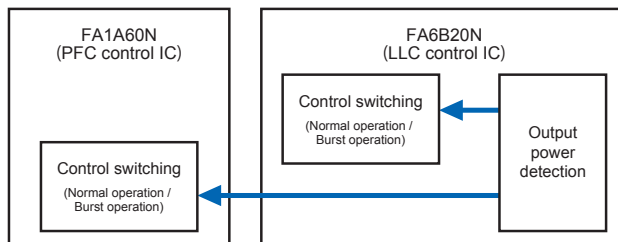
FA1A60N package
:SOP-8



FA6B20N package
:SOP-16 (N)

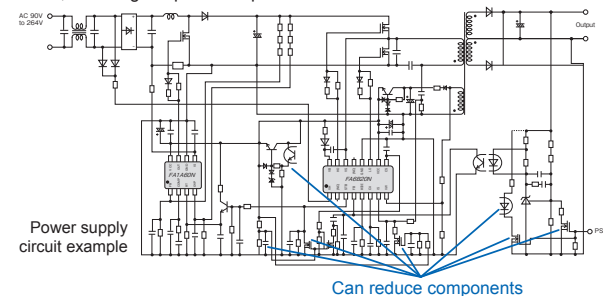
3. Auto standby function

Output power is detected by LLC control IC, and at light load condition, both PFC control IC and LLC control IC are switched from normal operation to burst operation.



4. Reduced power supply components

Because the auto standby function is integrated, an external standby signal is unnecessary. This makes it possible to reduce the number of components by seven, including the photo coupler.



*1 The ErP Directive is also called the Eco Design Directive, the EU regulation that obligates environmentally conscious design

Contents

No.	Title	Page	Applicable circuit					
			Flyback	Forward	Full-bridge	Half-bridge Current Resonant	Boost	Buck
1	Product map	4						
2	AC/DC Power Supply Control ICs	Green Mode PWM-ICs (Current Mode)	6	✓				
3		General PWM-ICs	8	✓	✓		(✓) *1	(✓) *1
4		Green Mode Quasi-resonant ICs (Current Mode)	10	✓				
5		Power Factor Correction ICs	12	✓			✓	
6		Current Resonant ICs	14			✓		
7	Driver ICs	15			✓	✓		✓
8	Application circuit examples	16						
9	Package outlines	18						

*1: Some products can be utilized depending on the applicable circuit

Type nomenclature

Example: FA8A00N

F		A		8		A	00	N	
Company symbol		Control system		Series		Generation	Number	Package code	
F	Fuji	A	Analog	1	CRM PFC*	A	Two-digit integer	N	SOP
				6	LLC	B			
				8	PWM	C			
					...				

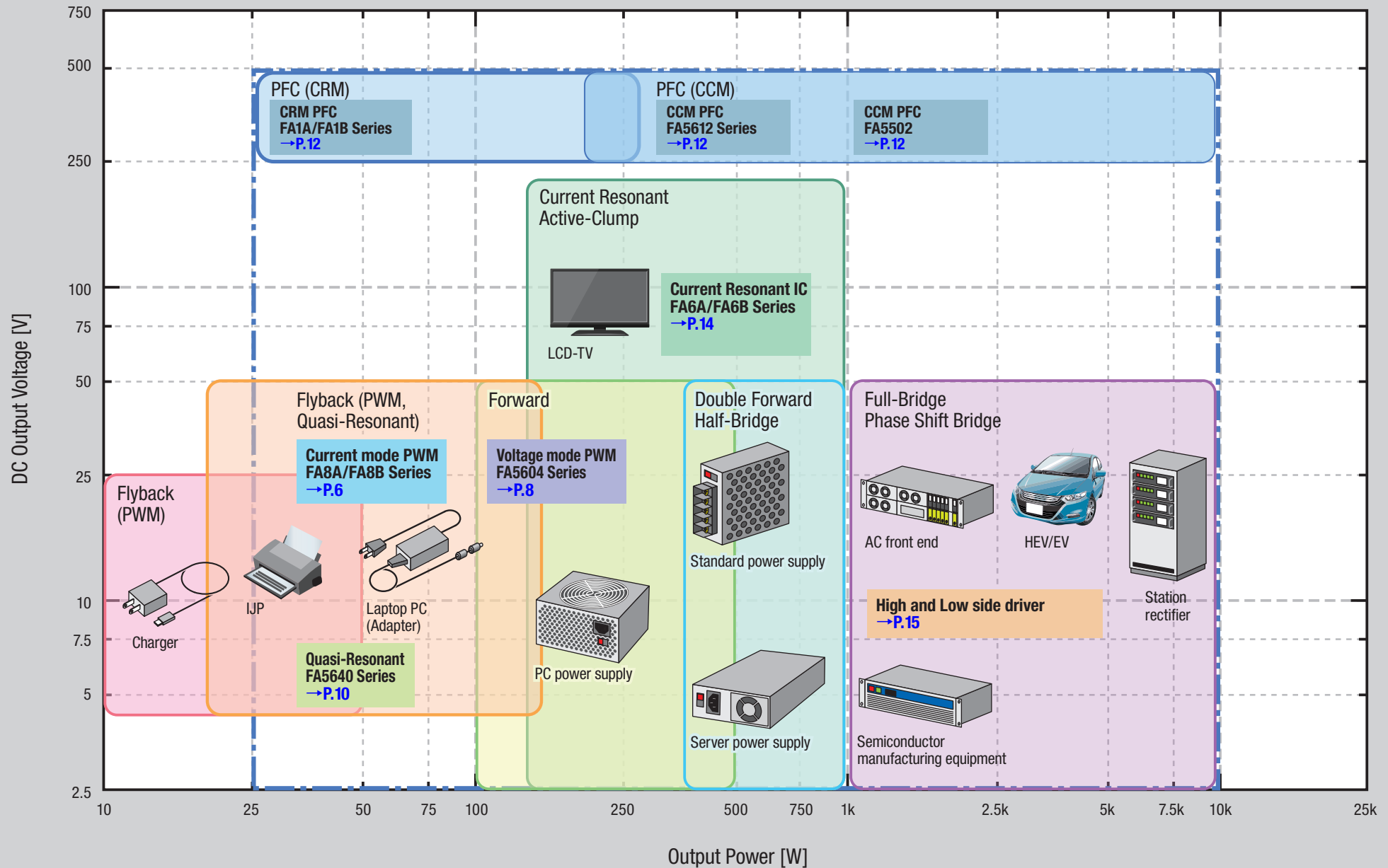
*CRM PFC: Critical Conduction Mode PFC

Example: FA5590N

F		A		55		90	N	
Company symbol		Control system		Series		Number	Package code	
F	Fuji	A	Analog	3X	AC/DC	Two-digit integer	M/N	SOP
				5X				
				13X				

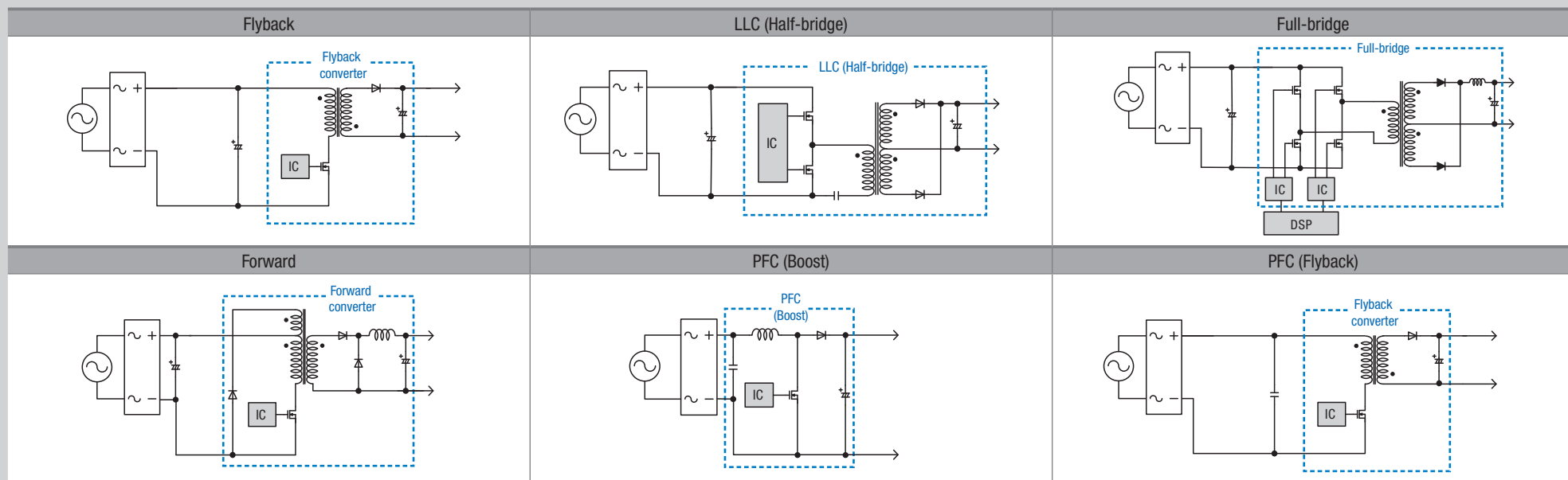
Product Map

Application specific output power/output voltage and applicable ICs



■ Circuit type (AC/DC)

Circuit type	Product category	Page	Output power 10W	50W	100W	150W	200W	300W	500W	1kW -
Flyback	Green Mode PWM-ICs (Current Mode)	6								
	General PWM-ICs	8								
	Green Mode Quasi-resonant ICs (Current Mode)	10								
Forward	General PWM-ICs	8								
LLC (Half-bridge)	Current Resonant ICs	14								
Full-bridge	Driver ICs	15								
PFC (Boost)	Power Factor Correction ICs (Critical Conduction Mode)	12								
	Power Factor Correction ICs (Continuous Conduction Mode)	12								
PFC (Flyback)	Power Factor Correction ICs (FA1B00N, FA1A21N)	12								



Green Mode PWM-ICs (Current Mode)

Generation	Series	Type name	Control mode	Applied circuit	Built-in start up circuit	X-Cap discharge function	Brown out function	Max Duty	Frequency fsw	Overcurrent detection	Protection mode			Light-load switching	Power supply voltage Vcc	Vcc threshold voltage		Package	Remarks
											Over load	Over power	Overvoltage			ON	OFF		
6th generation	FA8A00 Series (Basic functions version)	FA8A00N	Current mode	Flyback	✓ 500V	✓	✓ Fixed	83%	65kHz	+ detection	Auto-Recovery	2 Stage (OPP ratio 1:1.4)*	Latch Vcc detection	Linearly frequency reduction + Intermittent operation	12-24V	13V	6.5V	SOP-8	
		FA8A01N									Timer-latch Delay 70 ms								
		FA8A40N							Auto-Recovery										
		FA8A41N							Timer-latch Delay 70 ms										
		FA8A27N					Timer-latch Delay 860 ms		2 Stage (OPP ratio 1:1.8)*		10-28V								
		FA8A37N					Timer-latch Delay 1.6 s												
		FA8A39N					Timer-latch Delay 2.5 s												
		FA8A12N					Auto-Recovery					2 Stage (OPP ratio 1:1.4)*			12-24V				
	FA8A60 Series (Advanced functions version)	FA8A60N			✓ 500V	-	-	83%	65kHz	+ detection	Auto-Recovery	1 Stage	Latch Vcc detection	Linearly frequency reduction + Intermittent operation (Frequency reduction/burst point adjustable)	10-24V	12.5V	6.5V		
		FA8A61N									Timer-latch								
		FA8A64N							Auto-Recovery										
		FA8A65N							Timer-latch										
		FA8A70N							Auto-Recovery										
		FA8A71N							Timer-latch										
		FA8A74N							Auto-Recovery										
		FA8A75N							Timer-latch										
	FA8A80 Series (Advanced functions, VH high withstand-voltage version)	FA8A80N			✓ 650V	-	-	83%	65kHz	+ detection	Auto-Recovery	1 Stage	Latch Vcc detection	Linearly frequency reduction + Intermittent operation (Frequency reduction/burst point adjustable)	10-24V	12.5V	6.5V		
		FA8A81N									Timer-latch								
		FA8A83N				✓ Fixed	100kHz		Auto-Recovery		-								
		FA8A84N				Timer-latch													
		FA8A85N				Auto-Recovery			Latch Vcc detection										
		FA8A86N				✓ Fixed					Timer-latch								
		FA8A87N				✓	-				65kHz		Auto-Recovery						
		FA8A90N											Timer-latch						
		FA8A91N							Auto-Recovery										
		FA8A94N							Timer-latch										
		FA8A95N				100kHz	Auto-Recovery												
		FA8A95N				Timer-latch													
	FA8Bxx Series	FA8B16N			✓ 500V	✓	✓ Fixed	83%	65kHz	+ detection	Auto-Recovery	2 Stage (OPP ratio 1:1.5)*	Latch Vcc detection	Linearly frequency reduction + Intermittent operation	12-24V	12.5V	8V		
	5th generation	FA5680 Series			FA5680N	✓ 750V	-	-	85%	65kHz	- detection	Auto-Recovery	1 Stage	Latch Vcc detection	Linearly frequency reduction + Intermittent operation	11-24V	18V		8V
FA5681N			Timer-latch	OCP,OLP correction by external circuit															

*OPP ratio = Over Load Protection (OLP) : Over Current Protection (OCP)

Green Mode PWM-ICs (Current Mode)

Features

- With 500V/650V/750V withstand voltage start up circuit
- Green mode functions (Intermittent Switching/Linearly reduced switching frequency)
- Protect functions (Over voltage/Brown out/2 stage Over power,etc.)
- Low EMI noise

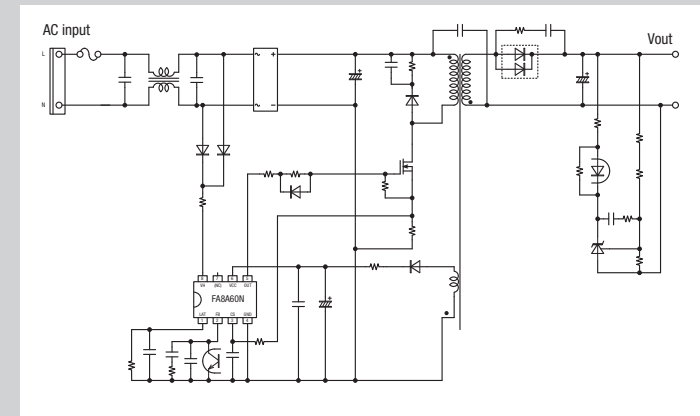
Green mode PWM-ICs with Brown Out function

Green Mode PWM IC									
Brown out function	With								
Current sense	Positive								
Over power protection	2 Stage OPP ratio 1:1.4		2 Stage OPP ratio 1:1.8			2 Stage OPP ratio 1:1.5		1 Stage	
Frequency (kHz)	65	100	65	65	65	65	65	100	
Overload protection	Auto-Recovery	Timer-latch	Auto-Recovery	Timer-latch	Timer-latch	Auto-Recovery	Timer-latch	Auto-Recovery	
OLP delay time (ms)	70	70	70	70	860	1600	2500	3560	200
X-Cap discharge function	With								Without
Start up circuit 500V	FA8A00N	FA8A01N	FA8A40N	FA8A41N	FA8A27N	FA8A37N	FA8A39N	FA8B16N	
Start up circuit 650V								FA8A83N	FA8A86N

Green mode PWM-ICs without Brown Out function

Green ModePWM IC									
Brown out function	Without								
Over power protection	1Stage				2Stage				
Current sense	Negative		Positive			Positive			
Overload protection	Auto-Recovery	Timer-latch	Auto-Recovery	Timer-latch	Timer-latch	Auto-Recovery	Auto-Recovery		
Frequency (kHz)	65	65	65	100	65	100	65	65	65
X-Cap discharge function			With	With	With	With	With	With	With
OCV OLP correction	With								
Start up circuit 500V			FA8A60N	FA8A70N	FA8A64N	FA8A74N	FA8A61N	FA8A71N	FA8A65N
Start up circuit 650V			FA8A80N	FA8A90N	FA8A84N	FA8A94N	FA8A81N	FA8A91N	FA8A85N
Start up circuit 750V	FA5680N	FA5681N							

Circuit example (Flyback) : FA8A60N



General PWM-ICs

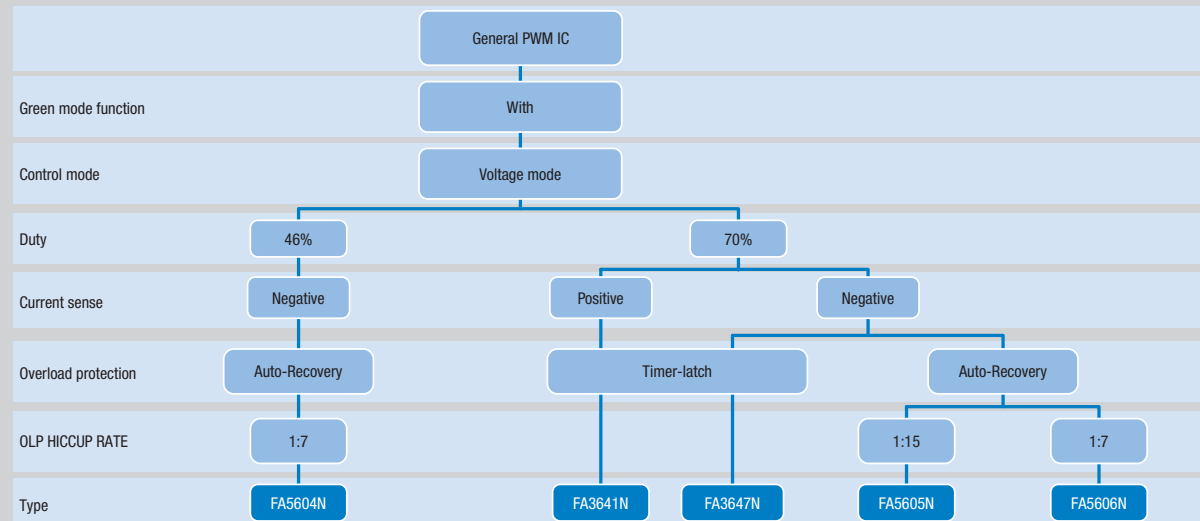
Series	Type name	Control mode	Applied circuit	Max Duty	Frequency fsw	Overcurrent detection	Protection mode		Light-load switch operation	Power supply voltage Vcc	Vcc threshold voltage		Package	Features
							Overload	Overvoltage			ON	OFF		
FA1384× Series	FA13842N	Current mode	Flyback	96%	External settings 10-500kHz	+ detection	—	—	—	10-25V	16.5V	9.0V	SOP-8	384 Series pin compatible, 5V reference voltage output, With error amplifier
	FA13843N										9.6V			
	FA13844N		Forward	48%	External settings 5-250kHz						16.5V			
	FA13845N										9.6V			
FA5504 Series	FA5504N	Voltage mode	Forward	46%	External settings 10-500kHz	+ detection	Timer-latch	CS latch Vcc voltage detection	—	10-28V	16.5V	9.0V		With error amplifier 5V reference voltage output
FA551× Series	FA5510N		Forward	46%	External settings 10-500kHz	+ detection	Timer-latch	CS latch Vcc voltage detection	—	10-28V	16.5V	9.0V		5V reference voltage output
	FA5511N		Flyback	70%		— detection								
	FA5515N		Flyback	70%										
FA364× Series	FA3641N		Flyback	70%	External settings 30-500kHz	+ detection	Timer-latch	CS latch Vcc voltage detection	Frequency reduction	10-28V	16.5V	9.0V		5V reference voltage output Frequency-reduction function added to FA5511/15
	FA3647N					— detection								
FA5604 Series	FA5604N		Forward	46%	External settings 100-300kHz	— detection	Auto-Recovery	CS latch (External detection)	Frequency reduction Start/stop FB voltage 1.8V/1.95V	10-30V	17.5V	9.7V	Overload current drooping Frequency reduction	
	FA5605N		Flyback	70%					Frequency reduction Start/stop FB voltage 1.55V/1.65V					
	FA5606N								—					
	FA5607N								—					

General PWM-ICs

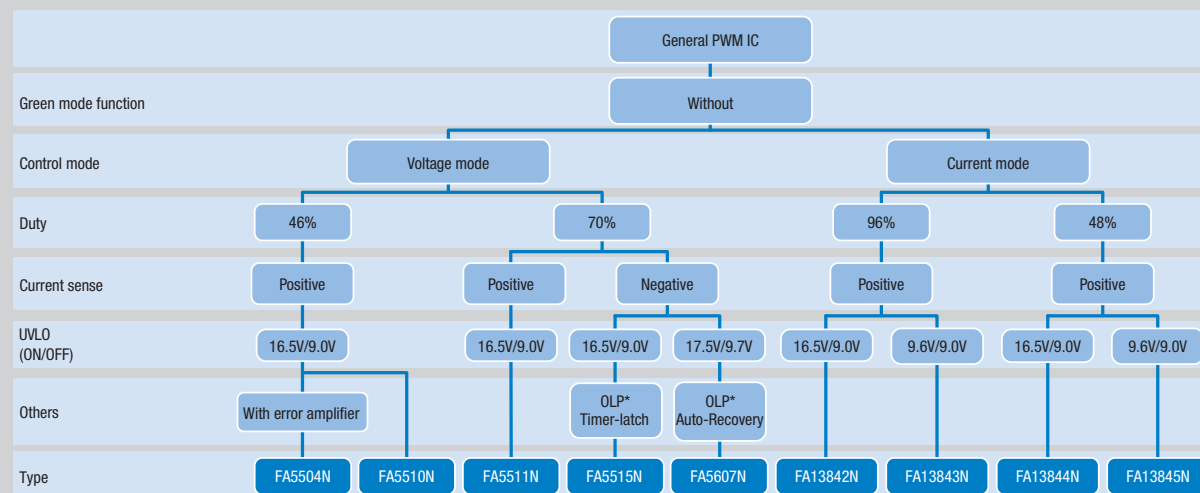
Features

- Voltage mode control
- Operating frequency can be set externally
- 5V reference voltage output

General PWM Control IC Series with Green Mode Function

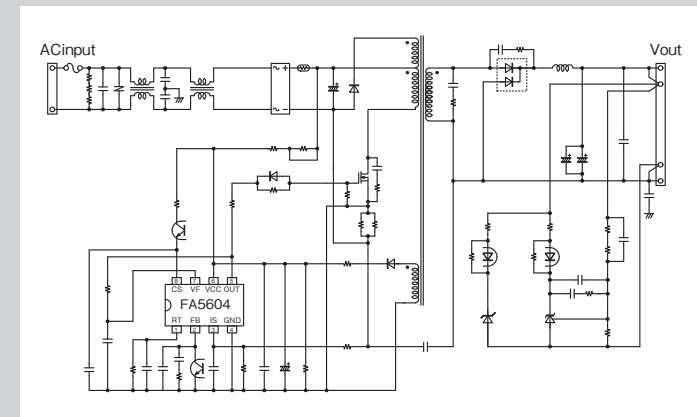


General PWM Control IC Series without Green Mode Function



* OLP : Over Load Protection

Circuit example (Forward) : FA5604N



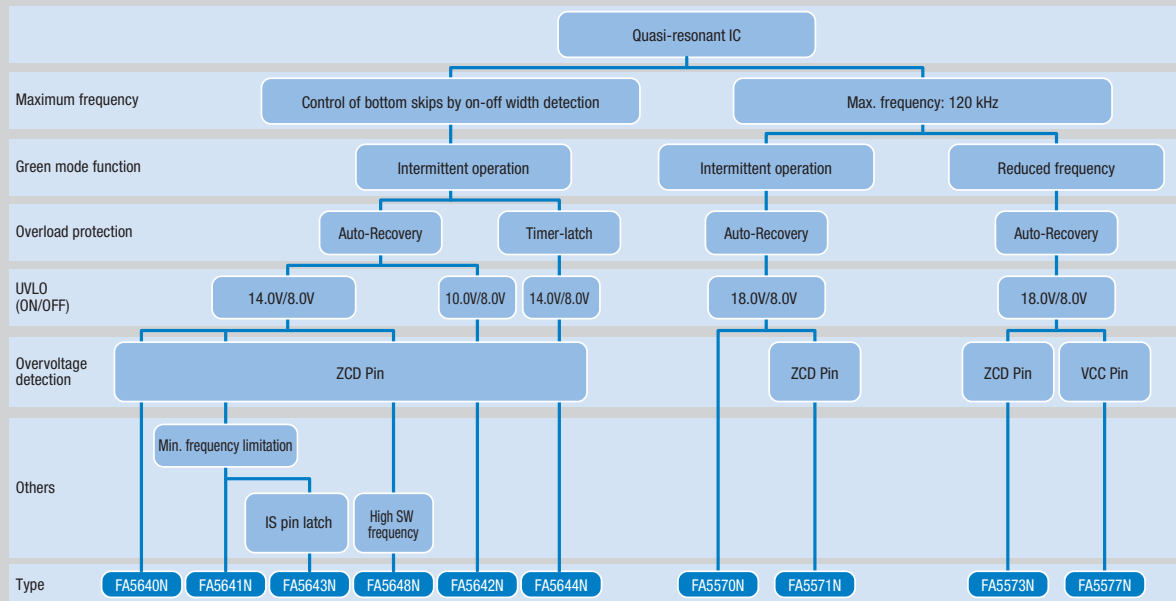
■ Green Mode Quasi-resonant ICs (Current Mode)

Generation	Series	Type name	Control mode	Applied circuit	Built-in start up circuit	Frequency fsw	Overcurrent detection	Protection mode		Light-load switch operation	Power supply voltage Vcc	Vcc threshold voltage		Package	Features		
								Overload	Overvoltage			ON	OFF				
4th generation	FA5640 Series	FA5640N	Current mode	Flyback	✓ 500V	Bottom skip count control via self-excited on-off width detection, estimated frequency switching from 1st to 2nd bottom 110kHz (FA5648 is 260 kHz)	+ detection +0.5V (AC100V) +0.45V (AC230V)	Auto-Recovery	Latch ZCD voltage detection	Intermittent operation	11-26V	14V	8V	SOP-8	—		
		FA5641N										10V			Minimum frequency (25kHz)		
		FA5642N										14V			Vcc on-voltage (10V)		
		FA5643N						IS pin latch stop									
		FA5644N						Overload latch stop									
		FA5648N						Auto-Recovery							For High SW frequency		
3rd generation	FA5571 Series	FA5570N			✓ 500V	Self-oscillation Maximum 120kHz	+ detection +1.0V	Auto-Recovery	—	Intermittent operation	10-28V	18V	8V			Without overvoltage protection	
		FA5571N							Latch ZCD voltage detection							Overvoltage ZCD detection	
		FA5573N					+ detection +0.5V		Latch Vcc voltage detection	Linearly frequency reduction							
		FA5577N															

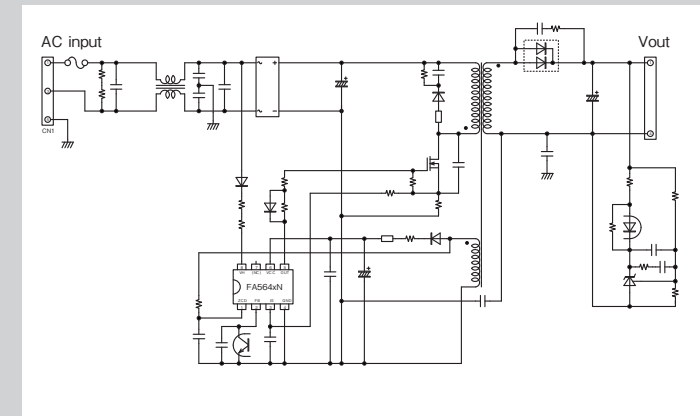
■ Green Mode Quasi-resonant ICs (Current Mode)

● Features

- Built-in 500V withstand voltage start up circuit
- Green mode functions (Intermittent Switching/Linearly reduced switching frequency)
- Protect functions (overvoltage/overload, etc.)



● Circuit example (Flyback) : FA5640N



Power Factor Correction ICs

Critical Conduction mode PFC Control IC

Series	Type name	Control mode	Applied circuit	OVP pin	Zero current detection	Overcurrent detection	Frequency fsw	Protection mode		FB open/ short circuit protection	Light-load switching	Power supply voltage Vcc	Vcc threshold voltage		Package	Features
								Overload	Overvoltage				ON	OFF		
FA1Axx Series	FA1A00N	Voltage mode	PFC (Boost)	✓	CS pin (Resistance)	– detection	Self-oscillation	Input current limitation (Auto-recovery)	Output current limitation (Auto-recovery)	✓	Frequency reduction	10-26V	9.6V	8.8V	SOP-8	Light-load bottom skip function Output overvoltage double protection
	FA1A01N			12.4V												
	FA1A10N			–									9.6V			Light-load bottom skip function
	FA1A11N												12.4V			
	FA1A50N		✓	9.6V	8.8V	Light-load bottom skip function FA1A00N enhanced version										
	FA1A60N			12.5V	7.5V	Light-load intermittent switching coordinated operation with FA6B19N/20N/22N										
	FA1A61N			12.5V	7.5V	Light-load intermittent operation coordinated operation with FA6B21N										
	FA1A21N			17.3V	9.6V	For LED lighting Soft start function Overload protection										
FA5590 Series	FA5590N	PFC (Boost)	–	IS pin (Resistance)	– detection	Self-oscillation	Input current limitation (Auto-recovery)	Output current limitation (Auto-recovery)	✓	Max. frequency limitation	10-26V	9.6V	9.0V	SOP-8	Max. frequency setting (100k~800kHz)	
	FA5591N		13.0V									Max. frequency setting Output overvoltage double protection				
	FA5696N		9.6V													
FA1Bxx Series	FA1B00N	PFC (Boost/ Flyback)	–	ZCD pin (Winding)	+ detection	Self-oscillation	Auto-Recovery	Output current limitation		Max. frequency limitation	10-24V	13.0V	9.0V		For LED lighting (PFC Flyback)	

Continuous Conduction Mode PFC Control IC

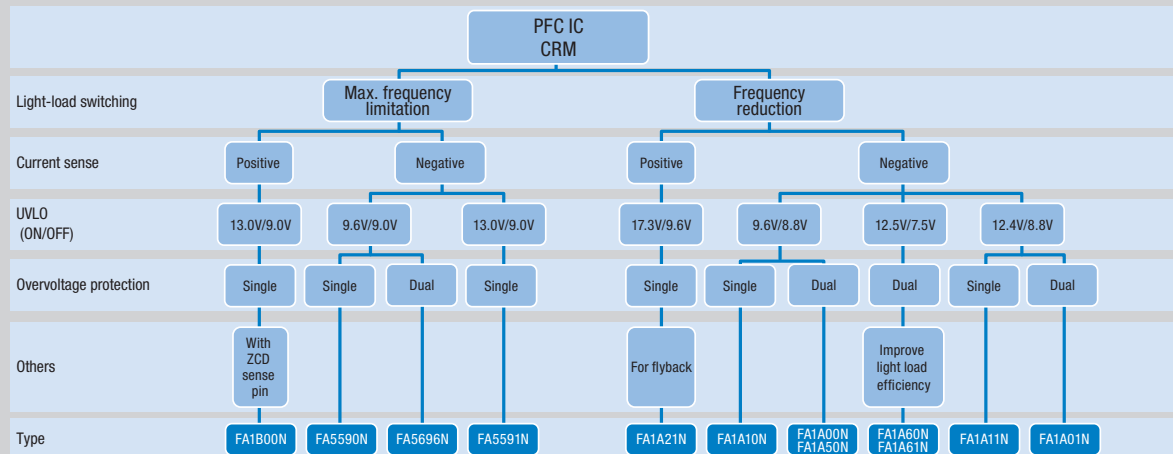
Series	Type name	Control mode	Applied circuit	OVP pin	Max Duty	Overcurrent detection	Frequency fsw	Protection mode		FB open/ short circuit protection	Light-load switching	Power supply voltage Vcc	Vcc threshold voltage		Package	Features
								Overload	Overvoltage				ON	OFF		
FA5612 Series	FA5612N	Average current	PFC (Boost)	–	94%	– detection -0.5V (AC100V) -0.4V (AC230V)	External selection (50-70 kHz scattered, 60 kHz, 65 kHz)	Input current limitation (Auto-recovery)	Output current limitation (Auto-recovery)	✓	–	10-26V	9.6V	9.0V	SOP-8	Overcurrent detection level switching Fixed frequency, jitter switching
	FA5613N										–		13.0V			
FA5502 Series	FA5502M	Voltage mode	PFC (Boost)	✓	94%	– detection	External settings 15-150kHz	Input current limitation (Auto-recovery)	Output current limitation (Auto-recovery)	–	–	10-28V	16.5V	8.9V	SOP-16 (M)	ON/OFF pin Synchronous pin

Power Factor Correction ICs

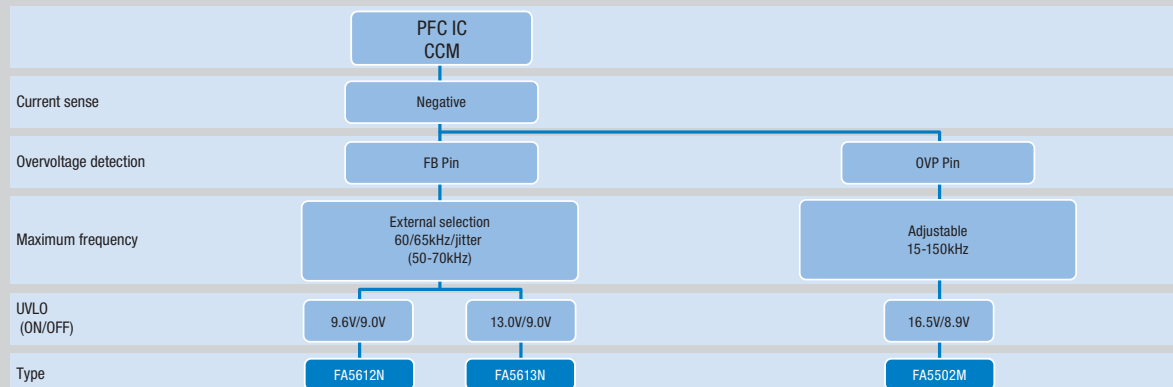
Features

- Wide electric power range (From 25W to 10kW)
- Power factor ≥ 0.99
- Protect functions (FB pin open short/Over voltage, etc.)

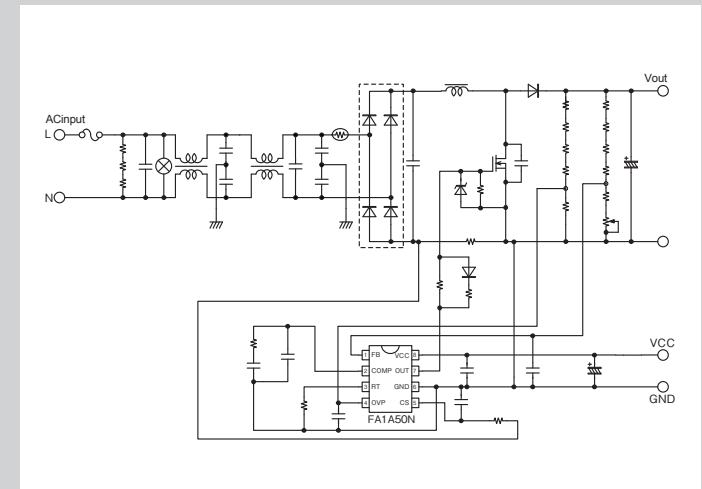
Critical Conduction mode PFC Control IC



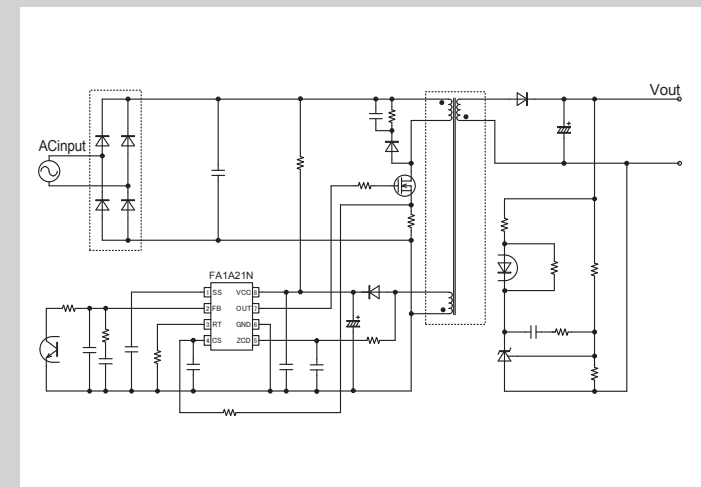
Continuous Conduction Mode PFC Control IC



Circuit example (PFC boost) : FA1A50N



Circuit example (PFC flyback) : FA1A21N

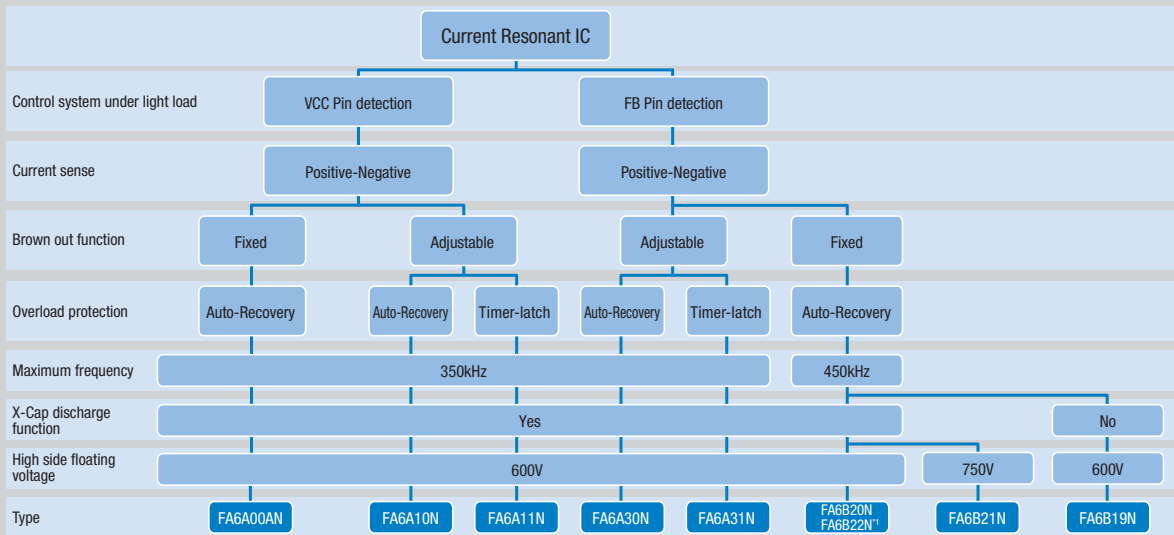


Current Resonant ICs

Generation	Series	Type name	Applied circuit	Built-in start up circuit	High side floating voltage	X-Cap discharge function	Brown out function	Low standby mode switching	Duty	Current sense	Frequency fsw	Protection mode			Light-load switching	Power supply voltage Vcc	Vcc threshold voltage		Package	Features																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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3rd generation	FA6Bxx Series	FA6B19N		✓ 600V	600V	—	✓ Fixed	CA Pin detection Auto switching/ external switching	50%	Positive-Negative	25-450kHz	Auto-recovery	Auto-Recovery	Auto-Recovery	Burst operation FB pin control	14-29V	14.0V	9.0V		Auto standby function State setting function																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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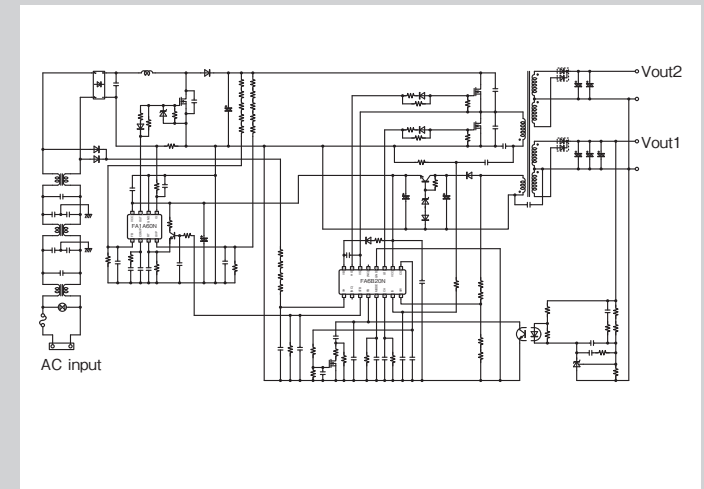
Features

- Realize 1 convertor circuit structure at world wide input power
- Built-in High side driver
- Preventing capacitive region operation
- Protect functions (Over current/Over voltage/Over load/Over heat/Brown out)
- Green mode function (Intermittent switching)



*1: BO detection delay time extension type

Circuit example (PFC + LLC) : FA1A60N, FA6B20N

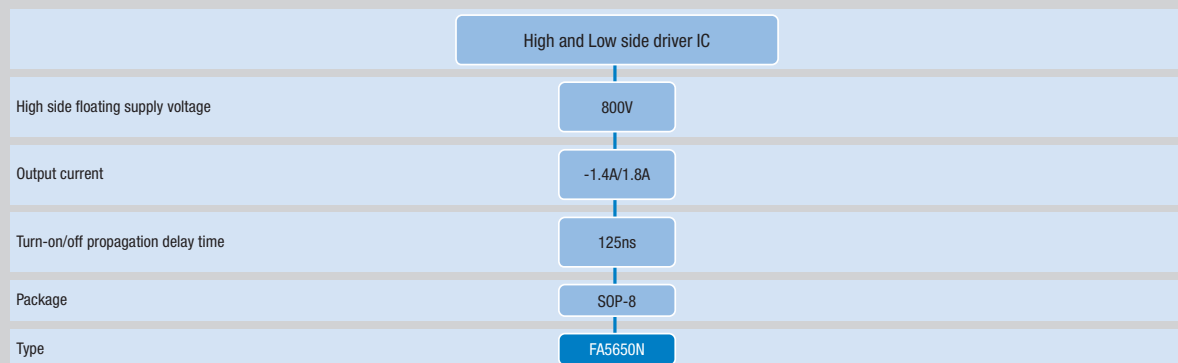


High and Low side driver ICs

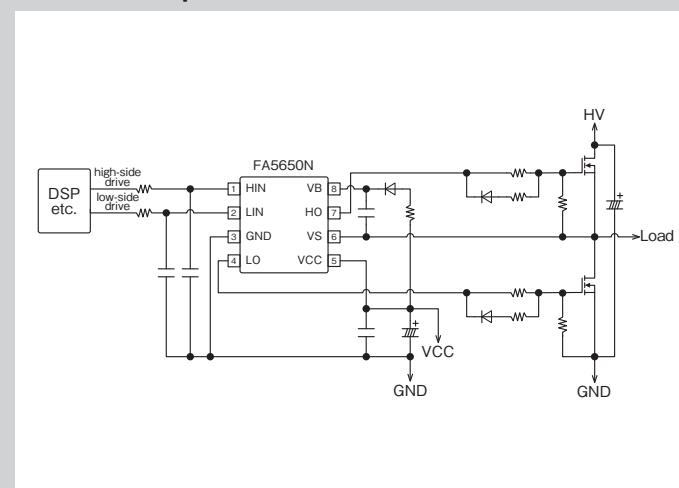
Series	Type name	Number of input/output pin	Absolute maximum ratings				Input threshold voltage	Turn-on/off propagation delay	Recommended power supply voltage VCC, VBS	VCC, VBS threshold voltage		Package	Features
			High side floating supply voltage	Output current	Power supply voltage	Maximum frequency				ON	OFF		
FA5650 Series	FA5650N	2	800V	-1.4/1.8A	30V	500kHz	Logic "1" 2.1V Logic "0" 1.1V	125ns	12-18V	8.9V	8.2V	SOP-8	High-side and low-side delay time difference 30ns (max), high-side dVs/dt withstand 50kV/μs, input 3.3V logic compatible

● Features

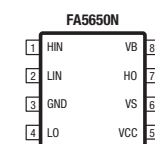
- High negative transient voltage on VS pin
- Wide range supply voltage up to 30V
- 3.3V logic compatible
- Built-in under voltage lockout
- Allowable high slew rate of VS pin: dV_S/dt up to 50kV/ μ s
- High speed response: Turn on/off delay time 125ns (Typ.)



- **Circuit example : FA5650N**

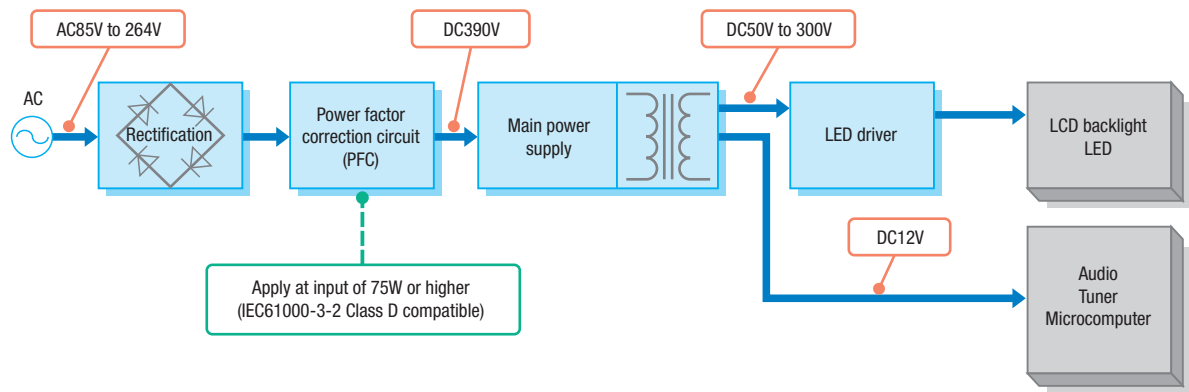


- **Pin Layout**



Application circuit examples

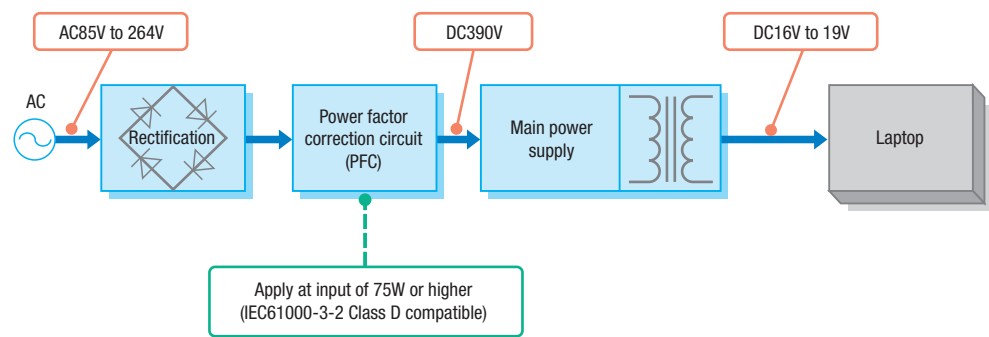
1. LCD TV power supply



Recommended IC

Circuit	Type	Recommended IC	Page
Power factor correction	PFC (75W-200W)	FA1Axx Series	12
	PFC (more than 200W)	FA561x Series	12
Main power supply	Quasi-resonant	FA564x Series	10
	PWM	FA8A6x Series	6
	LLC	FA6Axx Series	14
		FA6Bxx Series	14

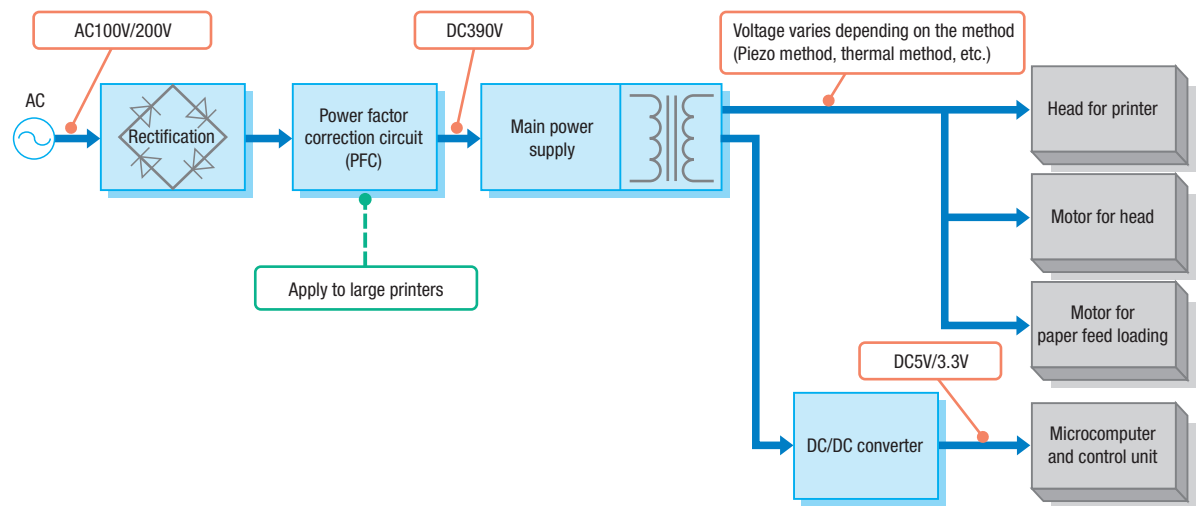
2. Laptop (AC Adapter) Power Supply



Recommended IC

Circuit	Type	Recommended IC	Page
Power factor correction	PFC (75W-200W)	FA1Axx Series	12
	PFC (more than 200W)	FA561x Series	12
Main power supply	Quasi-resonant	FA564x Series	10
	PWM	FA8A6x Series	6
	LLC	FA6Bxx Series	14

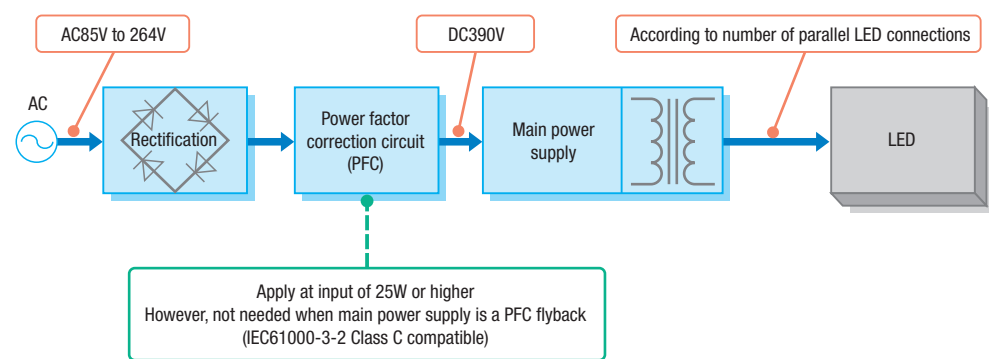
3. Printer (IJP) Power Supply



Recommended IC

Circuit	Type	Recommended IC	Page
Power factor correction	PFC (75W-200W)	FA1Axx Series	12
	PFC (more than 200W)	FA561x Series	12
Main power supply	Quasi-resonant	FA564x Series	10
	PWM	FA8A6x Series	6

4. LED lighting Power Supply

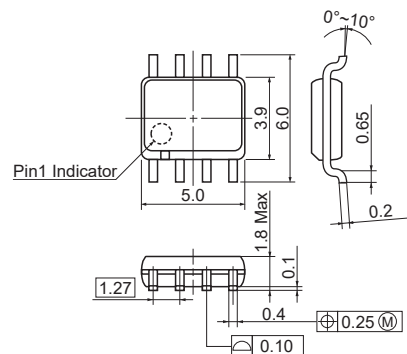


Recommended IC

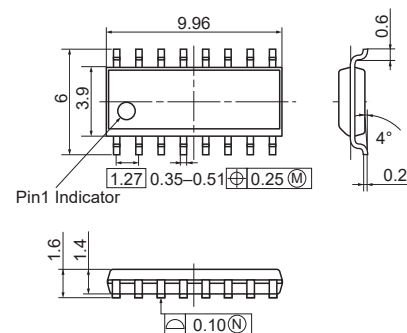
Circuit	Type	Recommended IC	Page
Power factor correction	PFC (25W-200W)	FA1Axx Series	12
		FA1B00N	12
	PFC (more than 200W)	FA561x Series	12
Main power supply	Quasi-resonant	FA564x Series	10
	PWM	FA8A6x Series	6
	LLC	FA6Bxx Series	14
	PFC Flyback	FA1A21N	12
		FA1B00N	12

Package Outlines, mm

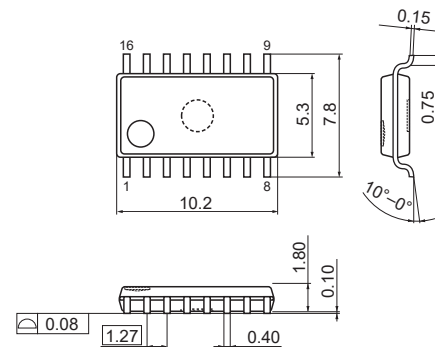
SOP-8 *1



SOP-16(N)



SOP-16(M)



*1) This is the package size for the representative device type (FA8AxxN). For other ICs, please refer to the separate application note (specifications).

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