ON Semiconductor®

Adapters < 75 W

Agenda

- New ENERGY STAR® requirements
- Needed features to meet the new specification
- New controllers
- Practical examples
- Conclusion

EPA 2.0 (External Power Supplies)

EPA ENERGY STAR Version 2.0 EPS Voluntary Specification
(Effective November 1, 2008)

Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: Standard Models

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal)
0 to ≤ 1 watt	≥ 0.480 * P_{no} + 0.140
> 1 to ≤ 49 watts	≥ [0.0626 * Ln (P_{no})] + 0.622
> 49 watts	≥ 0.870

(was > 0.84 in previous version 1.1)

Energy Consumption Criteria for No-Load

Nameplate Output Power (P_{no})	Maximum Power in No-Load	
	AC-AC EPS	AC-DC EPS
0 to < 50 watts	≤ 0.5 watts	≤ 0.3 watts
≥ 50 to ≤ 250 watts	≤ 0.5 watts	≤ 0.5 watts

(< 0.5 W in 1.1)

(< 0.75 W in 1.1)

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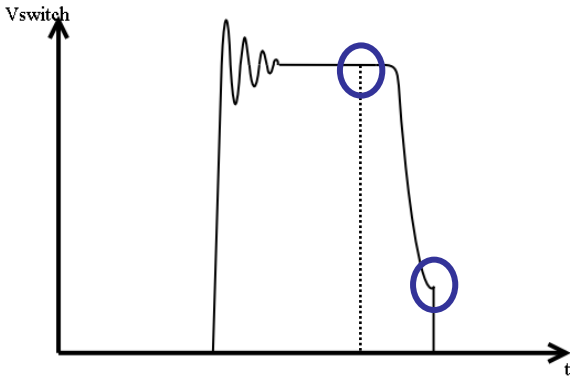
Improving Efficiency

- Sources of loss:
  - Switching losses:

$$P_{loss(switching)} = \frac{1}{2} \cdot C_{DRAIN} \cdot V_{DRAIN(turn-off)}^{2} \cdot F_{SW}$$

  - Gate charge losses:

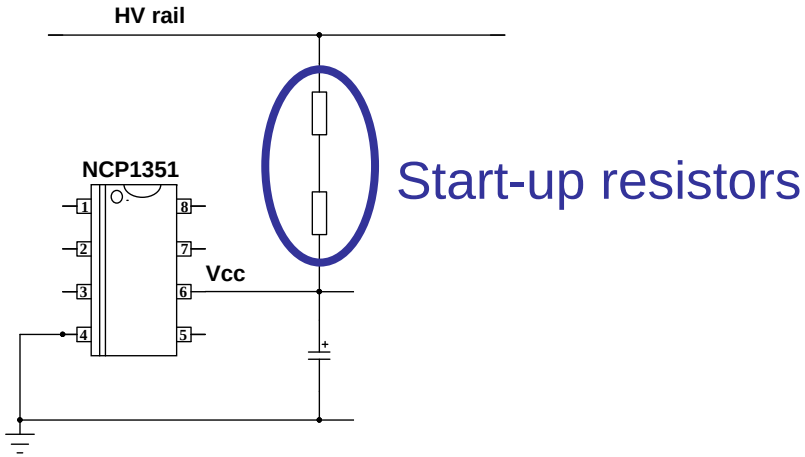
$$P_{loss(gate)} = V_{gate(high)} \cdot Q_{gate} \cdot F_{SW}$$



- Ways to improve efficiency:
  - Lower the switching frequency F_{SW} ➔ frequency foldback at light loads
  - Lower the Drain voltage at turn-off ➔ valley switching

Reducing No-load Input Power

- Static losses in the start-up circuit:
  - Start-up resistor permanently drawing current from the bulk capacitor
- Ways to lower the start-up circuit losses
  - With external start-up resistor ➔ Extremely low start-up current
  - Integrated start-up current source ➔ Extremely low leakage when off
  - Connect the start-up circuit to the half-wave rectified ac input



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The Right Controllers

- Two new families of controllers implement features to increase efficiency and lower no-load input power:
  - NCP1237/38/87/88:

    fixed-frequency controllers with integrated start-up current source, frequency foldback and skip mode

    → Increased efficiency at light load and standby
  - NCP1379/80

    valley switching controllers with extremely low start-up current and frequency foldback

    → Increased efficiency at all load levels

NCP1237/38/87/88

Value Proposition

The NCP12X7/X8 series represents the next generation of fixed frequency PWM controllers. It targets applications where cost-effectiveness, reliability, design flexibility and low standby power are compulsory.

Unique Features

- High-voltage current source with built-in Brown-out and mains OVP
- Freq. reduction in light load conditions and skip mode
- Adjustable Over Power Protection

Benefits

- Fewer components and rugged design
- Extremely low no-load standby power
- Simple option to alter the max. peak current set point at high line

Others Features

- Latch-off input for severe fault conditions, allowing direct connection of NTC
- Timer-based protection: auto-recovery or latched
- Dual OCP option available
- Built-in ramp compensation
- Frequency jittering for a softened EMI signature
- Vcc operation up to 30 V

Market & Applications

- AC-DC adapters for notebooks, LCD monitor, game console, printers
- CE applications (DVD, STB)

Application Data



	DSS	Dual OCP	Latch	Auto Recovery
NCP1237A	Yes	Yes	Yes	
NCP1237B	Yes	Yes		Yes
NCP1238A	Yes	No	Yes	
NCP1238B	Yes	No		Yes
NCP1287A	HV only	Yes	Yes	
NCP1287B	HV only	Yes		Yes
NCP1288A	HV only	No	Yes	
NCP1288B	HV only	No		Yes

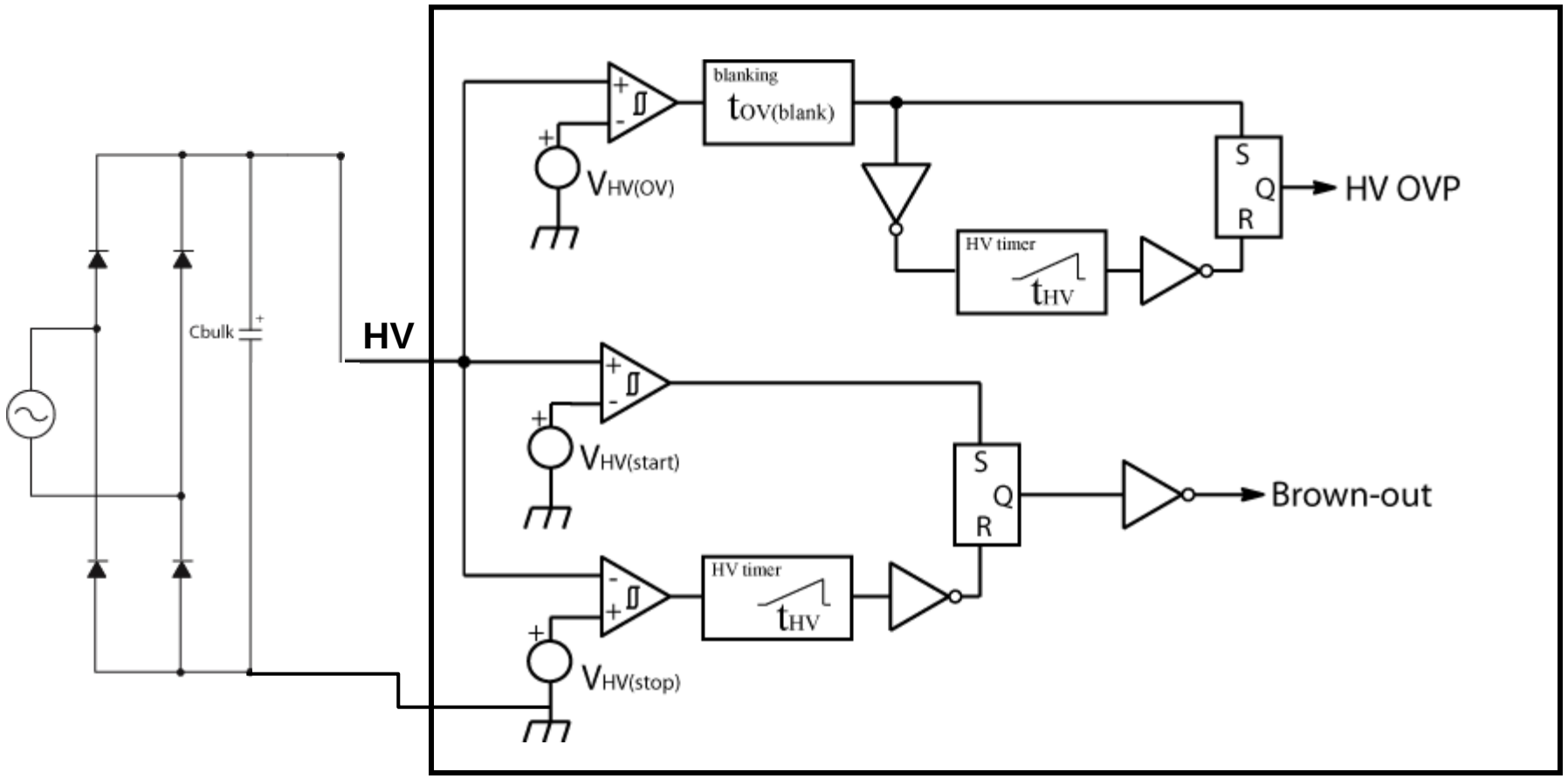
Various options available depending upon end applications needs

Ordering & Package Information

- NCP1237/38xDR2G - NCP1287/88xDR2G
- SOIC-7 2500p per reel

Pb O, DW

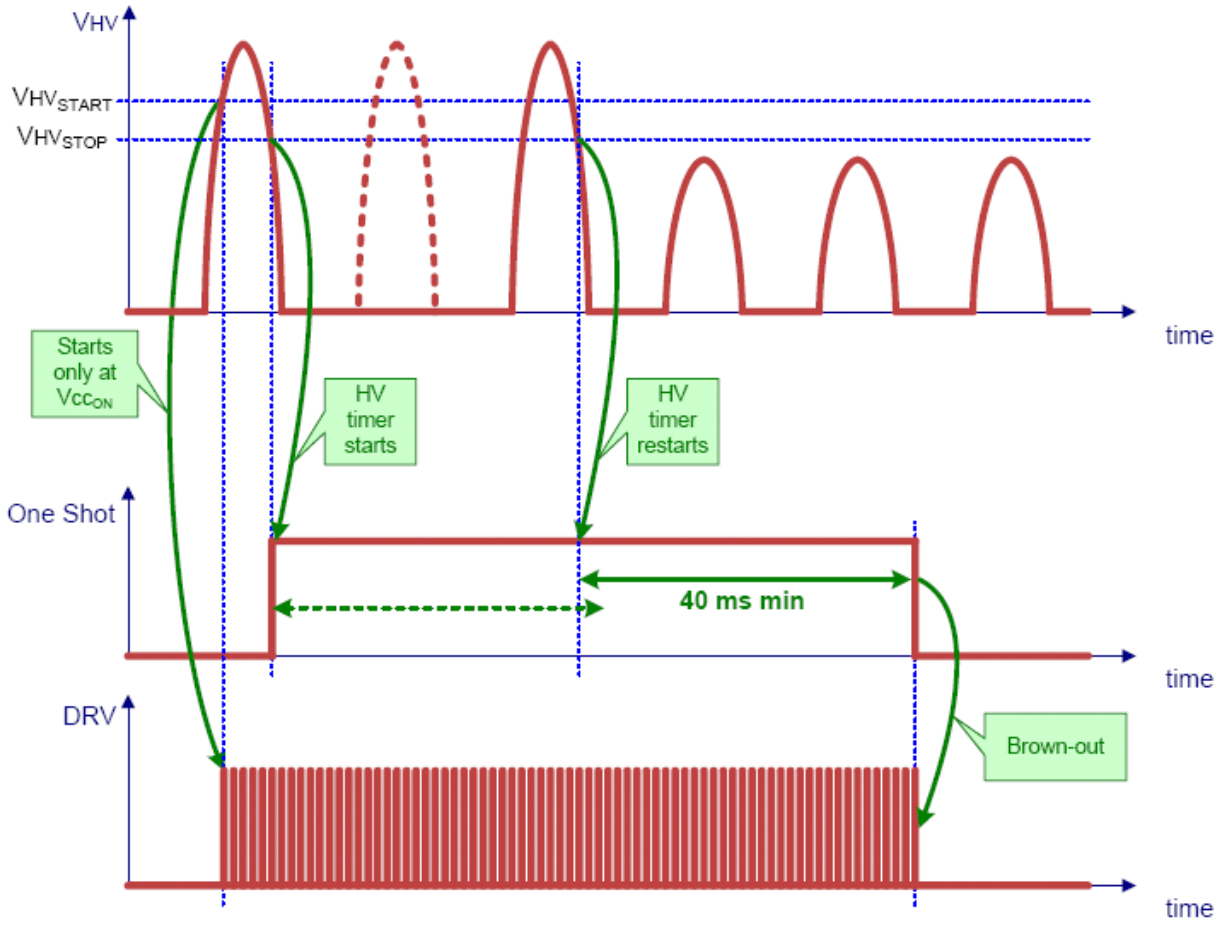
NCP1237/38/87/88 – Brown-out and Mains OVP



Detection independent of Ripple on HV pin

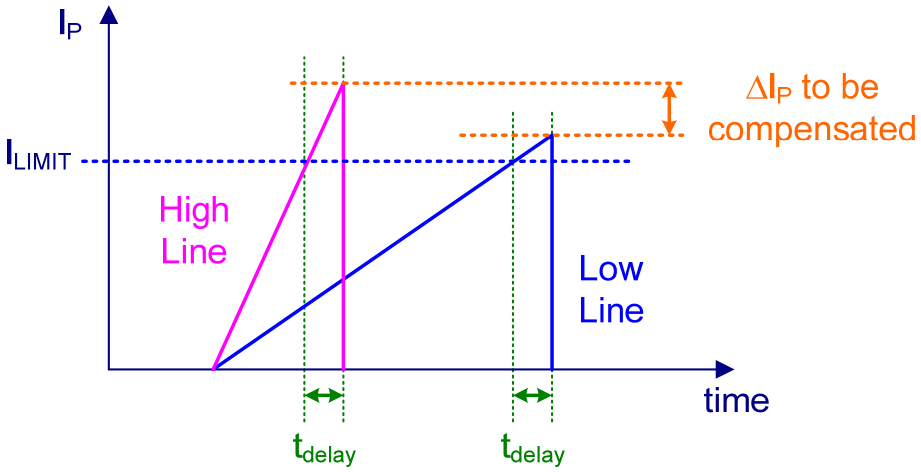
Can be connected to the half-wave rectified ac line

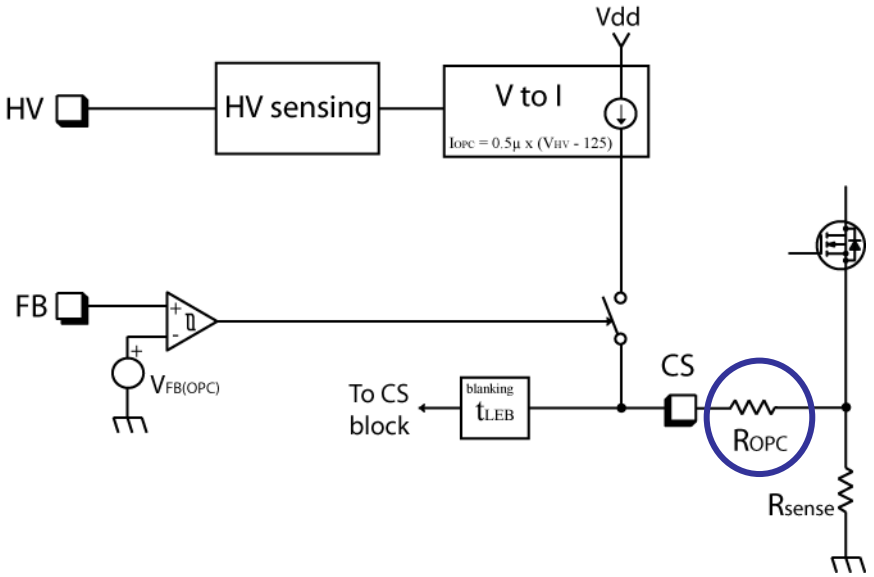
NCP1237/38/87/88 – Brown-out and Mains OVP



Timer-based detection ⇒ Passes full line cycle drop-out

NCP1237/38/87/88 – Over Power Protection



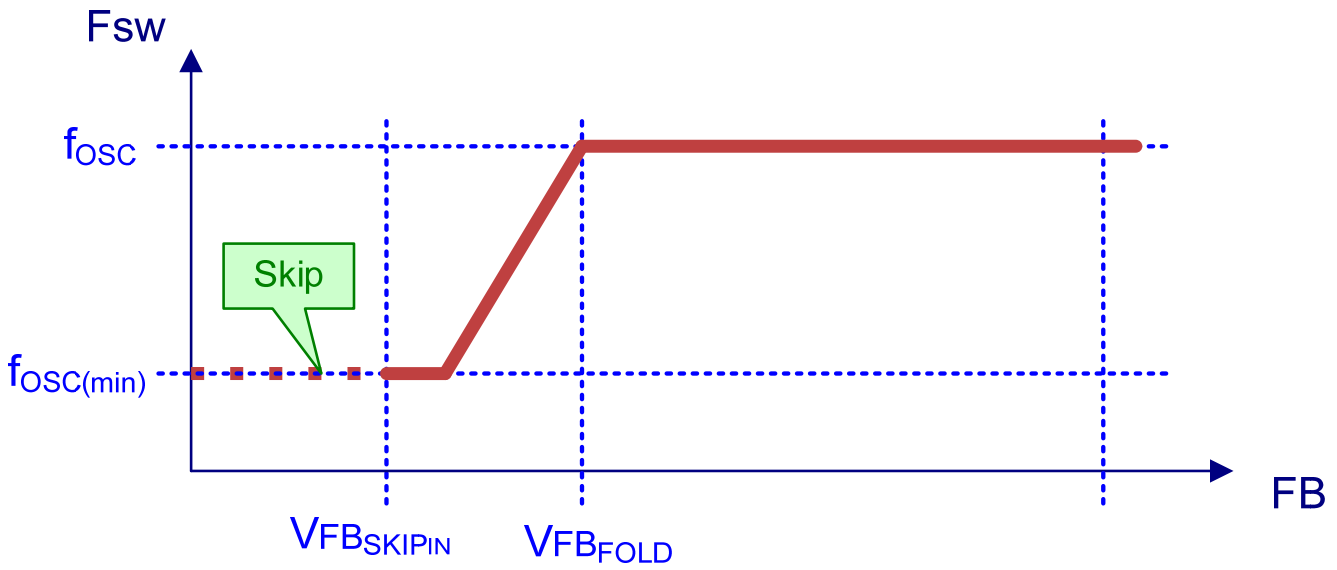


Need to compensate for the effect of the propagation delay

The compensation current creates an offset on the Current Sense signal

Over Power Protection ⇒ Maximum output power clamped

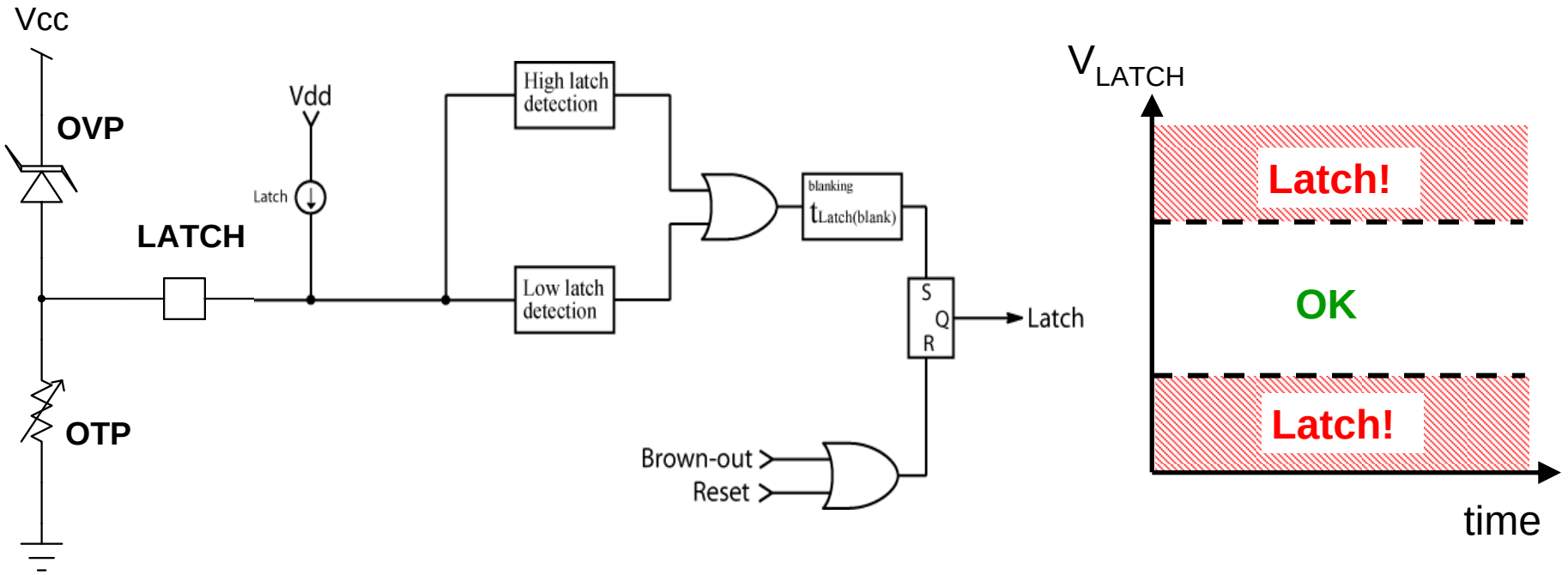
NCP1237/38/87/88 – Frequency Foldback



Switching frequency lowered at light load → Increased efficiency

Switching frequency clamped at 25 kHz → No audible noise

NCP1237/38/87/88 – Latch-off Protection



An NTC thermistor can be directly connected to the IC

Less external components needed

NCP1379/80

Value Proposition

The NCP1380 is a high-performance circuitry aimed to powering QR converters. Capitalizing on a novel valley-lockout system, the controller shifts gears and reduces the switching frequency as the power loading becomes lighter.

Unique Features

- Valley switching operation with valley-lockout
- Freq. reduction in light load condition
- Adjustable Over Power Protection

Benefits

- Excellent efficiency over a wide range and noise free operation
- Extremely low no-load standby power
- Simple option to alter the max. peak current set point at high line

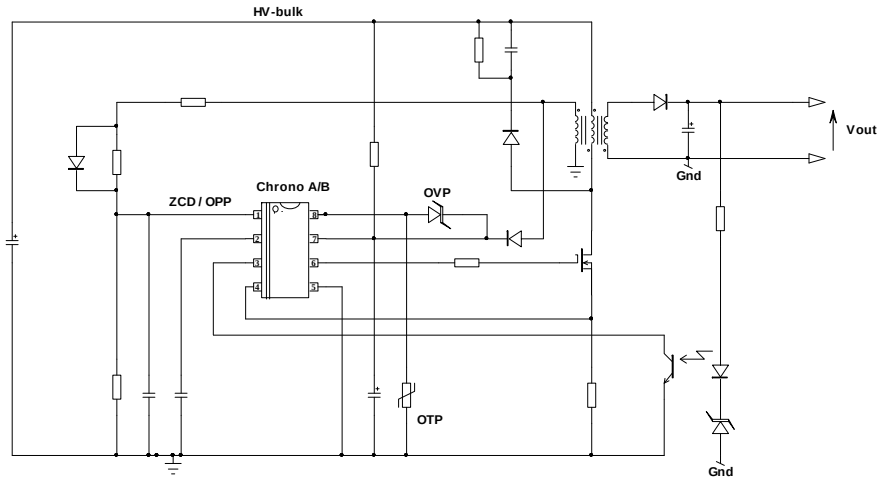
Others Features

- Auto-recovery or latched internal output short-circuit protection
- Fixed 80 ms timer for short-circuit protection
- Combined Over-voltage and over-temperature protection (A and B versions)
- Combined OVP & brown-out (C and D versions)
- 3 µs blanking delay to ignore leakage ringing at turn-off

Market & Applications

- AC-DC adapters for notebooks, LCD monitor, game console
- Auxiliary power for Flat TVs
- CE applications (DVD, STB)

Application Data



Design flexibility

Ordering & Package Information

- NCP1380xDR2G
- SOIC-8 2500p per reel

Pb

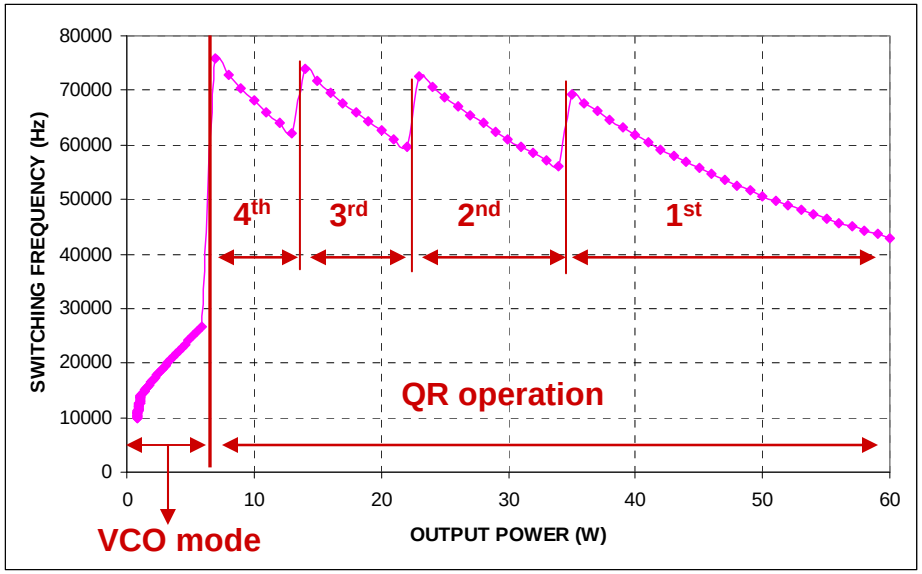
O, DW

NCP1379/80 - QR Mode with Valley Lockout

- As the load decreases, the controller changes valley (1st to 4th valley)
- The controller stays locked in a valley until the output power changes significantly.

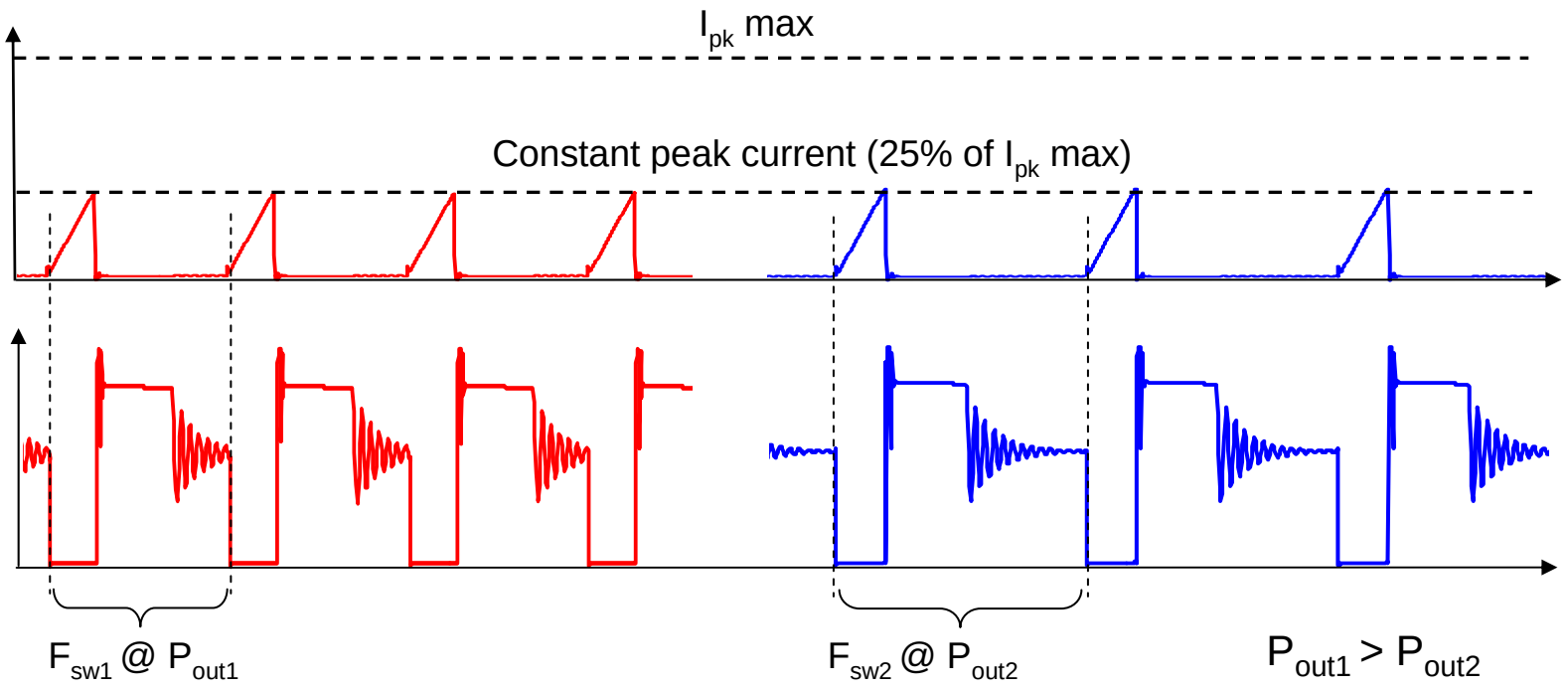
➢ No valley jumping noise

➢ Natural switching frequency limitation



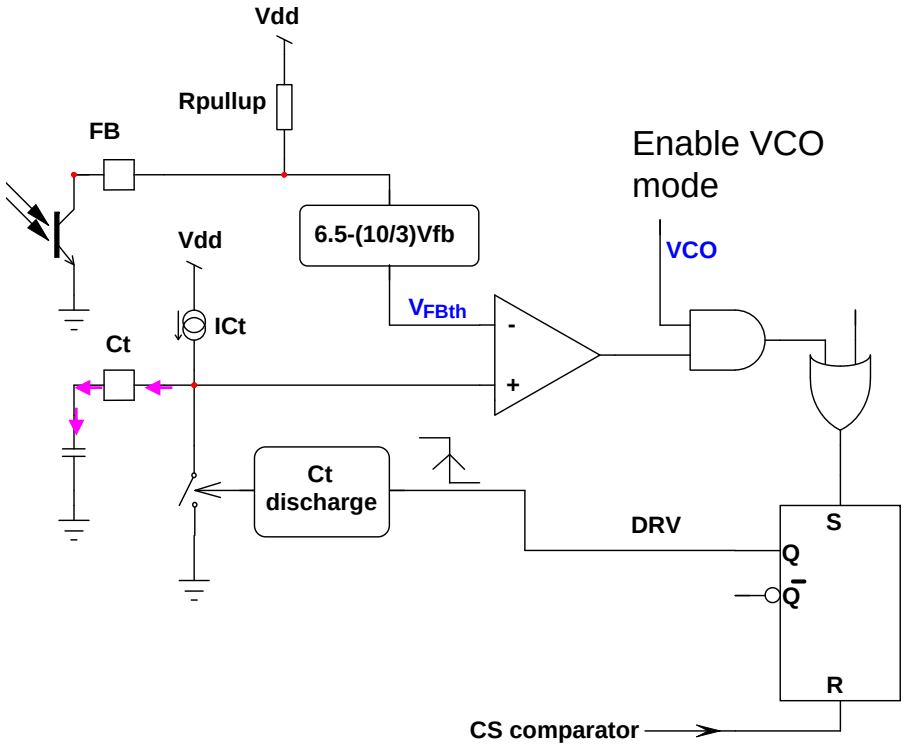
NCP1379/80 - Frequency Foldback

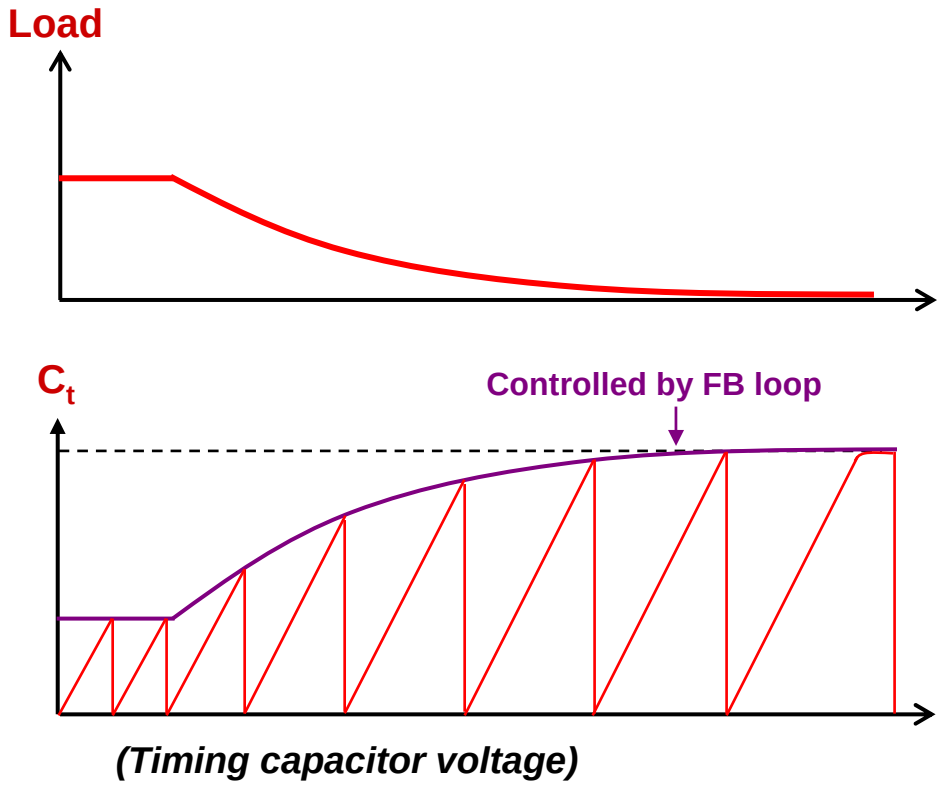
- Occurs when V_{FB} < 0.8 V (P_{OUT} decreasing) or V_{FB} < 1.6 V (P_{OUT} increasing)
- Fixed peak current (25% of $I_{pk,max}$), variable frequency set by the FB loop.



NCP1379/80 - Frequency Foldback

- The switching frequency is set by the end of charge of Ct capacitor
- The end of charge of Ct capacitor is controlled by the FB loop

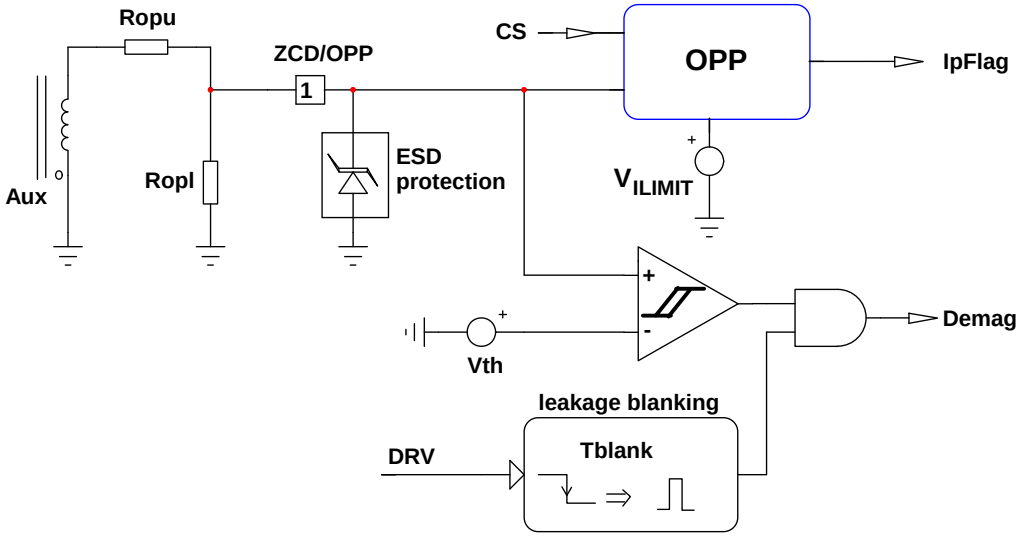


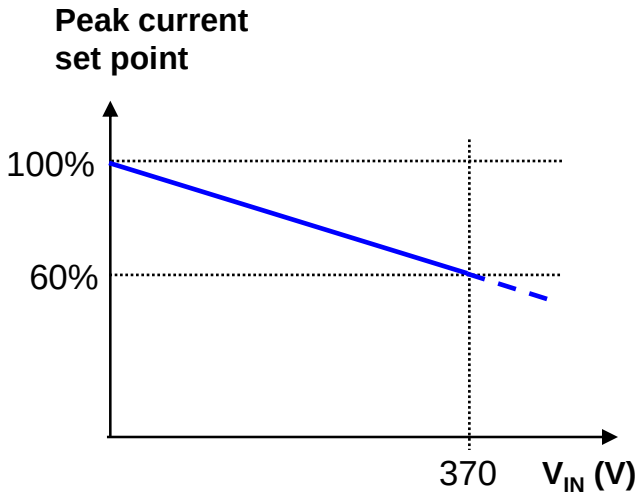


(Timing capacitor voltage)

NCP1379/80 - Overpower Protection

- L_{aux} with flyback polarity swings to $-NV_{IN}$ during the on time.
- Adjust amount of OPP voltage with R_{opu} // R_{opl}.
- $V_{CS,max} = 0.8\ V + V_{OPP}$





Non dissipative OPP !

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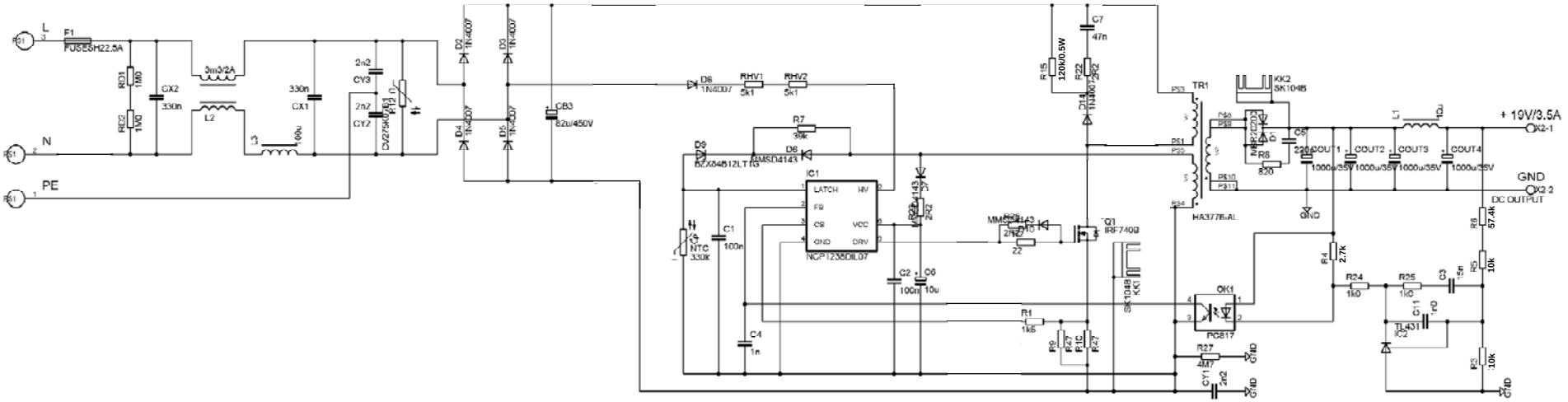
Fixed-Frequency Example: Schematic

A typical 65 W notebook adapter (19 V output)



(not optimized for EPS 2.0)

Fixed-Frequency Example: Efficiency

- EPS 2.0 efficiency (compared to NCP1271, from a previous generation)

V_{IN} / % of P_{OUTnom}	115 Vac	*NCP1271*	230 Vac	*NCP1271*
100 % (65 W)	88.5 %	*88.7 %*	88.4 %	*88.2 %*
75 % (49 W)	89.2 %	*89.1 %*	88.2 %	*88.3 %*
50 % (32 W)	88.9 %	*88.9 %*	86.8 %	*87.0 %*
25 % (16 W)	88.2 %	*88.4 %*	87.3 %	*84.3 %*

Effect of the frequency foldback

Average at 230 Vac: 87.7 %

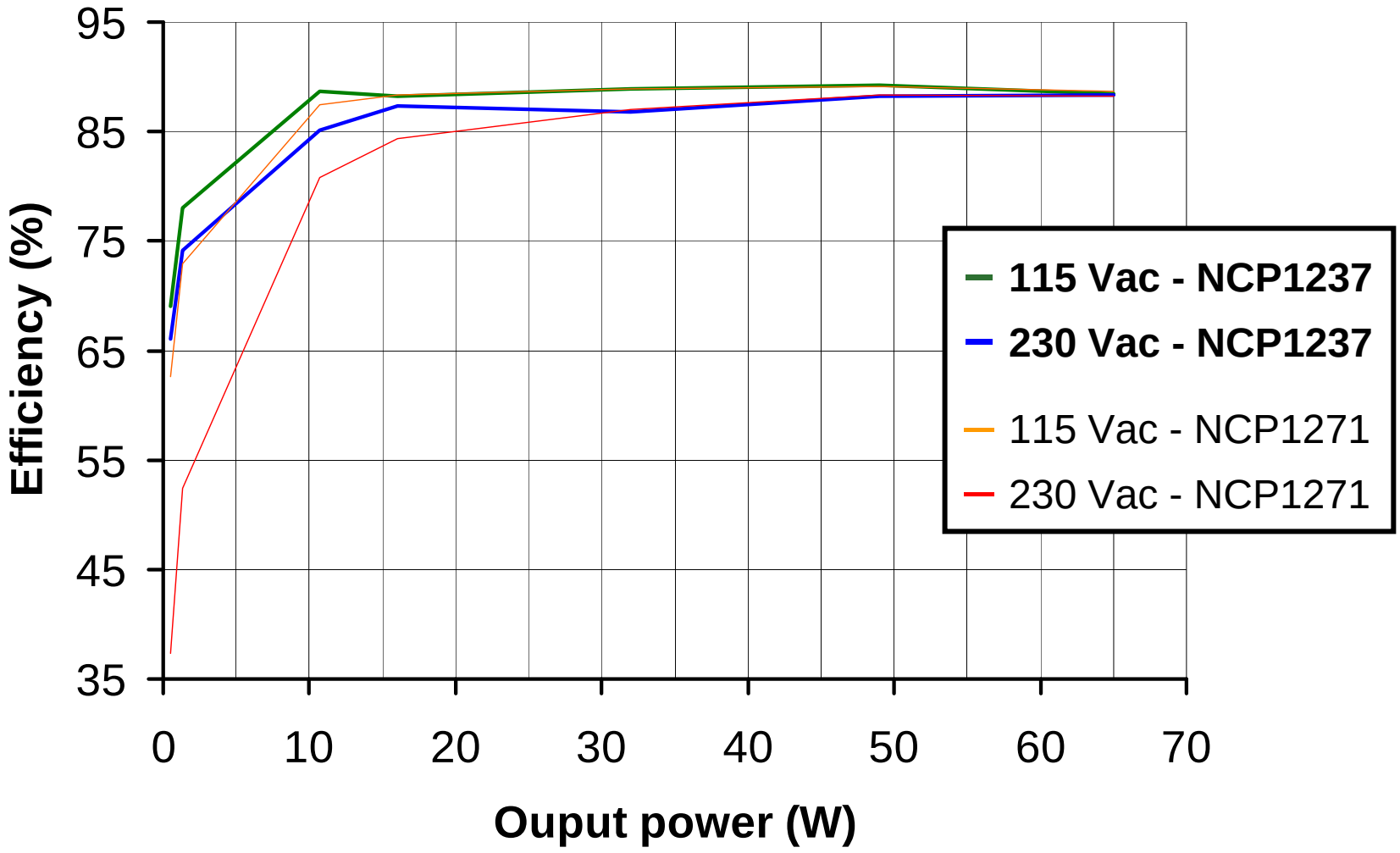
Fixed-Frequency Example: Standby Power

- Light load and no load input power with the NCP1237

(compared to NCP1271, from a previous generation)

P_{OUT} \ V_{IN}	115 Vac	*NCP1271*	230 Vac	*NCP1271*
10.7 W	12.0 W (88.7 %)	*12.2 W (87.5 %)*	12.5 W (85.1 %)	*13.2 W (80.76 %)*
1.3 W	1.67 W (78.0 %)	*1.77 W (72.9 %)*	1.75 W (74.2 %)	*2.46 W (52.4 %)*
0.5 W	0.74 W (69.0 %)	*0.81 W (62.6 %)*	0.76 W (66.0 %)	*1.34 W (37.3 %)*
No load	71 mW	*76 mW*	97 mW	*121 mW*

Fixed-Frequency Example: Summary



Valley Switching Example: Efficiency

- EPS 2.0 efficiency with the NCP1380, valley switching controller

V_{IN} % of P_{OUTnom}	115 Vac	230 Vac
100 %	88.7 %	91.1 %
75 %	88.8 %	90.9 %
50 %	89.2 %	89.1 %
25 %	88.2 %	87.9 %

Average at 115 Vac: 88.7 %

Valley Switching Example: Standby Power

- Light load and no load input power with the NCP1380

V_{IN} / P_{OUT}	115 Vac	230 Vac
10.7 W	12.37 W (86.5 %)	12.44 W (86 %)
1.3 W	1.85 W (70.3 %)	1.82 W (71.4 %)
0.5 W	0.82 W (61 %)	0.78 W (64.1 %)
No load	122 mW	210 mW

No-load standby power meets ENERGY STAR® with a start-up resistor!

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Adapters < 75 W: Conclusion

- Meeting the most recent requirements from ENERGY STAR® or IEC is possible with the classical **Flyback** converter
- Two new controllers sharing the same concept of frequency foldback at light load make it possible:
  - Fixed-frequency: NCP1238 family
  - Valley-switching (Quasi-resonant, QR): NCP1380 family
- Average efficiencies above **87%** are possible
- No-load input power below **300 mW** is possible, even with a **start-up resistor**
- No-load input power below **100 mW** is achievable, although the controller alone cannot ensure this. The whole power supply must be designed to reduce power waste.

For More Information

- View the extensive portfolio of power management products from ON Semiconductor at www.onsemi.com
- View reference designs, design notes, and other material supporting the design of highly efficient power supplies at www.onsemi.com/powersupplies