

Upgrading NCP1236-Based Converters with NCP1239

The NCP1239 is a fixed-frequency current-mode controller featuring a high-voltage start-up current source to provide a quick and lossless power-on sequence. This controller is pin-to-pin compatible with the former NCP1236. Only few components need to be changed in order to plug this new controller generation in an existing board. This application note will compare the performance of a typical 65-W application evaluation board originally equipped with the NCP1236 controller and upgraded with a NCP1239.

A NCP1236 demonstration board has been selected for this test. The specifications of this board are listed in Table 1.

Table 1. EVALUATION BOARD SPECIFICATION

Parameter	Value
Minimum Input Voltage	85 V rms
Maximum Input Voltage	265 V rms
Output Voltage	19 V
Nominal Output Power	65 W



ON Semiconductor®

www.onsemi.com

APPLICATION NOTE



Figure 1. Evaluation Board Picture

Table 2. MAIN PARAMETERS COMPARISON BETWEEN NCP1236 AND NCP1239

Functions	NCP1236	NCP1239
Fault Pin	Upper Level: 2.5 V (Usually used for OVP Detection)	Upper Level: 3.0 V (Usually used for OVP Detection)
	Lower Level: 0.8 V with $I_{NTC} = 95 \mu A$ (Usually used for OTP Detection) The needed NTC Resistor Value for OTP Detection $\Rightarrow R_{NTC} = 8.4 k\Omega$	Lower level: 0.4 V with $I_{NTC} = 45 \mu A$ (Usually used for OTP Detection) The needed NTC Resistor Value for Similar OTP Level Trip Point $\Rightarrow R_{NTC} = 8.9 k\Omega$
V_{CC} OVP	OVP Threshold on V_{CC} Pin $\Rightarrow 26.5 V$	OVP Threshold on V_{CC} pin $\Rightarrow 25.5 V$ Option Available upon Request
Frequency Jittering	125 Hz – 6% of F_{SW}	240 Hz – 5% of F_{SW}
Frequency Foldback Mode (FF)	Start of FF Mode when $V_{FB} < 2 V$ End of FF Mode when $V_{FB} < 1.35 V$	Start of FF Mode when $V_{FB} < 1.9 V$ End of FF Mode when $V_{FB} < 1.5 V$
Skip Mode	Enter in Skip Mode when $V_{FB} < 0.7 V$ with 100-mV Hysteresis	Enter in Skip Mode when $V_{FB} < 0.8 V$ with 30-mV Hysteresis
FB Pull Up Resistor	$R_{UP} = 20 k\Omega$	$R_{UP} = 30 k\Omega$
V_{FB} to CS Pin Ratio	5	4
CS Limitation	0.7-V Maximum Current Setpoint	0.8-V Maximum Current Setpoint
	If $V_{CS} > 1.05 V$ (50% Higher), Controller Immediately Stops	If $V_{CS} > 1.20 V$ (50% Higher), Controller Stops after 4 Consecutive Pulses
Over Power Protection (OPP)	$V_{HV} = 125 V \Rightarrow I_{OPP} = 0$ $V_{HV} = 162 V \Rightarrow I_{OPP} = 20 \mu A$ $V_{HV} = 325 V \Rightarrow I_{OPP} = 110 \mu A$ $V_{HV} = 365 V \Rightarrow I_{OPP} = 130 \mu A$	$V_{HV} = 125 V \Rightarrow I_{OPP} = 0$ $V_{HV} = 162 V \Rightarrow I_{OPP} = 20 \mu A$ $V_{HV} = 325 V \Rightarrow I_{OPP} = 110 \mu A$ $V_{HV} = 365 V \Rightarrow I_{OPP} = 130 \mu A$
Over Current Protection (OCP)	128-ms OCP Timer 1-s Auto-Recovery Timer	64-ms OCP Timer 1-s Auto-Recovery Timer
	Option with 32-ms OCP Timer and 1.5-s Auto-Recovery Timer	Timer Options Available upon Request
Soft Start Duration	4-ms Duration	8-ms Duration Timer Option Available upon Request
DRV Capability	500-mA Source Current 500-mA Sink Current 13.5-V Clamp Voltage	500-mA Source Current 500-mA Sink Current 13.5-V Clamp Voltage
IC Consumption in Skip Mode	$I_{CC(stb)} = 0.9 mA$	$I_{CC(stb)} = 0.5 mA$
UVLO Levels	$V_{CC(on)} = 12 V$ $V_{CC(off)} = 9.5 V$ $V_{CC(min)} = 10.5 V$	$V_{CC(on)} = 12 V$ $V_{CC(off)} = 8.8 V$ $V_{CC(min)} = 10 V$
High Voltage Current Source	$I_{START1} = 0.5 mA$ $I_{START2} = 6 mA$ HV Leakage Current, $I_{LEAK} = 25 \mu A$ Typ.	$I_{START1} = 0.5 mA$ $I_{START2} = 3 mA$ HV Leakage Current, $I_{LEAK} = 8 \mu A$ Typ.
Dynamic Self Supply (DSS)	Enable by Default	Disable by Default "Enable" Option Available upon Request
Brown-Out	Brown-In when $V_{HV} > 107 V$ Brown-Out when $V_{HV} < 92 V$ 68-ms BO Timer	Brown-In when $V_{HV} > 110 V$ Brown-Out when $V_{HV} < 101 V$ 68-ms BO Timer Options Available upon Request

As shown in Table 2, both controllers are very similar. There are few differences regarding some thresholds but the impact in the application will be negligible. There are also several improvements on the NCP1239 like a lower leakage

current on the HV pin that will bring a better stand-by performance for instance. Let's go through each section to see the impact in a 19-V application.

Over Voltage Event on the Fault Pin (OVP)

Let's take the example of an OVP event on the Fault pin. The upper level is 2.5 V for the NCP1236. For a typical 19-V output voltage in the adapter application, the transformer specifications are:

- Primary to Secondary Turns Ratio: $N_{PS} = 1:0.188$
- Primary to Auxiliary Turns Ratio: $N_{AUX} = 1:0.156$

Assume we detect an OVP on the fault pin when the output voltage reaches 21 V with the NCP1236 controller. Due to the turns ratio between the secondary and auxiliary windings, the auxiliary voltage will be:

$$V_{AUX_OVP} = \frac{N_{PS}}{N_{AUX}} \cdot V_{OUT_OVP} = \quad (eq. 1)$$

$$= \frac{1 : 0.188}{1 : 0.156} \cdot 21 = 17.4 \text{ V}$$

Thus, with a 15-V Zener diode connected between the V_{CC} pin and the Fault pin, the power supply (PSU) will latch when the output voltage increases above 21 V.

Now, with the NCP1239 controller, the fault pin upper level is 3 V. What will be the new output voltage to detect an OVP event on the primary side with the same 15-V Zener diode?

$$V_{OUT_OVP} = \frac{N_{AUX}}{N_{PS}} \cdot (V_{Zener} + V_{Fault_OVP}) = \quad (eq. 2)$$

$$= \frac{1 : 0.156}{1 : 0.188} \cdot (15 + 3) = 21.7 \text{ V}$$

So the needed output voltage to detect an OVP event with the NCP1239 controller will be 21.7 V instead of 21.0 V for the NCP1236. The difference is only 3% for this application.

Figure 2 and Figure 3 illustrate the output voltage deviation during an OVP event detected through the dedicated Fault pin depending on the controller. The board behavior in both cases is identical.

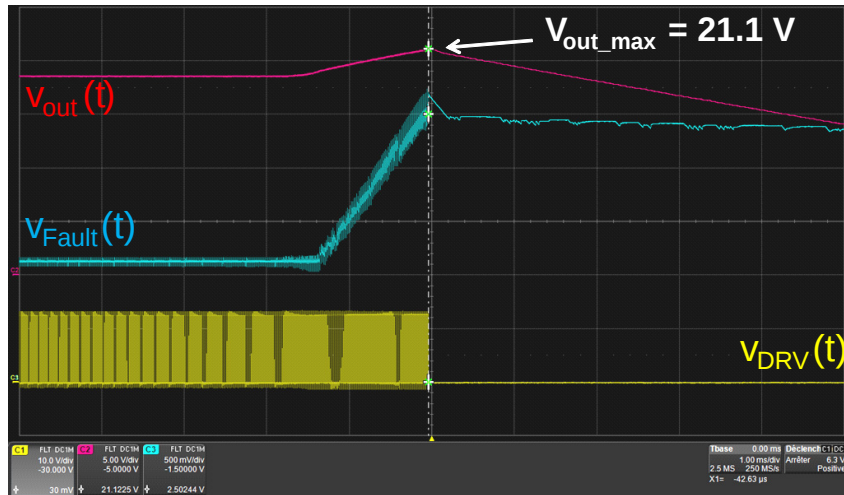


Figure 2. OVP Event on the Fault Pin with NCP1236

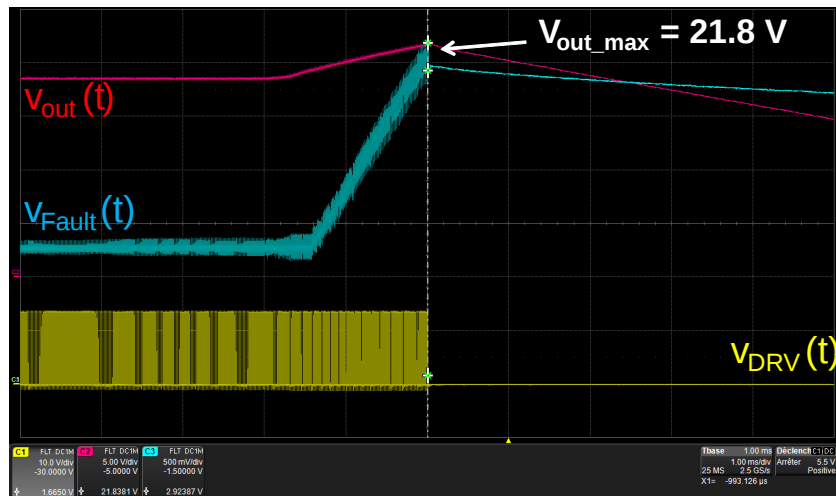


Figure 3. OVP Event on the Fault Pin with NCP1239

Over Voltage Event on the V_{CC} Pin

In some applications, the OVP detection can be implemented through the V_{CC} pin. In this case, the impact on the output voltage will be slightly different.

With the 26.5-V V_{CC} OVP threshold for the NCP1236 controller, the maximum output voltage will be:

$$V_{OUT_OVP} = \frac{N_{AUX}}{N_{PS}} \cdot V_{CC_OVP} = \quad (eq. 3)$$

$$= \frac{1 : 0.156}{1 : 0.1188} \cdot 26.5 = 31.9 \text{ V}$$

With the 25.5-V V_{CC} OVP threshold for the NCP1239 controller, the maximum output voltage will be:

$$V_{OUT_OVP} = \frac{N_{AUX}}{N_{PS}} \cdot V_{CC_OVP} = \quad (eq. 4)$$

$$= \frac{1 : 0.156}{1 : 0.1188} \cdot 25.5 = 30.7 \text{ V}$$

So, for an OVP event detected on the V_{CC} pin, the difference output voltage between both controllers will be less than 4%. Also the over voltage will be lower with the NCP1239 that is better for the following structure connected to the adapter.

The OVP event has been captured with the NCP1236 (Figure 4) and with the NCP1239 (Figure 5) in the same application.

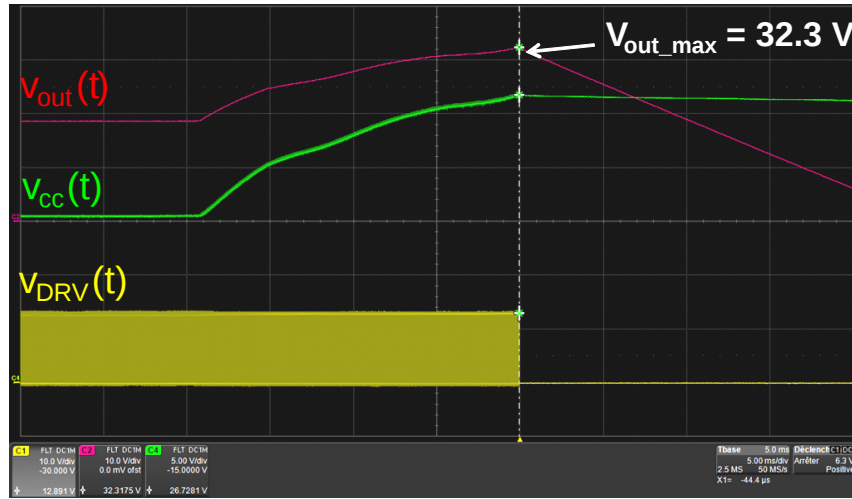


Figure 4. OVP Event on the V_{CC} Pin with NCP1236

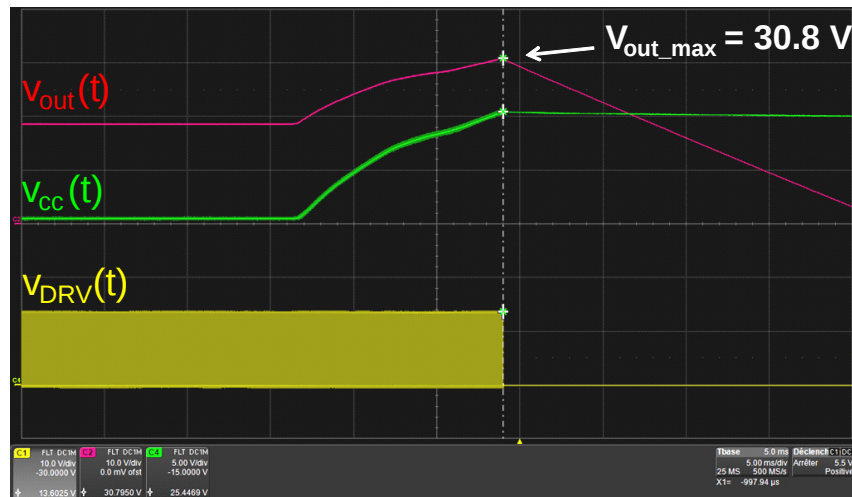


Figure 5. OVP Event on the V_{CC} Pin with NCP1239

Over Temperature Event (OTP)

For safety purposes, the controller offers the possibility to detect an over temperature event owing to the fault pin. Instead of using the upper threshold for the OVP detection, by connecting a NTC resistor between pin 1 and ground, the lower level is dedicated for this typical arrangement.

The NCP1236 and NCP1239 have similar level detections. The NCP1236's lower threshold is 0.8 V compared to 0.4 V for the NCP1239 but the bias current (I_{OTP}) has been reduced in the case of NCP1239 for the benefit of standby consumption. Thanks to this arrangement, the needed pull-down resistance to cross the $V_{Fault(OTP)}$ level is roughly equal. Equations 5 and 6 compute the value respectively for the NCP1236 and NCP1239 controller.

- For NCP1236:

$$R_{NTC} = \frac{V_{Fault(OTP)}}{I_{OTP}} = \frac{0.8}{95\mu} = 8.4 \text{ k}\Omega \quad (\text{eq. 5})$$

- For NCP1239:

$$R_{NTC} = \frac{V_{Fault(OTP)}}{I_{OTP}} = \frac{0.4}{45\mu} = 8.9 \text{ k}\Omega \quad (\text{eq. 6})$$

In the application board, a Vishay's NTC has been used (NTCLE100E3334JB0) to detect the OTP event. The entire board has been placed in an oven. The NCP1236 controller was latched off when the ambient temperature is around 105°C. The trip for the NCP1239 part was 104°C in similar conditions. Both temperatures are very close.

Current Sense Limit

The current sense threshold on CS pin has been changed compared to the NCP1236. The maximum current sense voltage allowed on the CS pin in normal operation is 0.7 V for the NCP1236. This threshold has been increased to 0.8 V for the new NCP1239 controller. This difference induces two components changes. The first one involves the current sense resistor (R_{SENSE}) in order to ensure the same maximum power capability at low mains. The second one deals with the series resistor (R_{CS}) connected between R_{SENSE} and the CS pin. This resistance has two functions:

1. It filters the signal (with the C_{CS}) applied on the CS pin.
2. It adjusts the Over Current Protection (OPP) in relationship to the input voltage.

For the NCP1236 design, the sense resistor is 300 mΩ. Considering a 0.7-V maximum threshold on the CS pin, the maximum peak current on the primary winding is:

$$I_{Peak_Pri_Max} = \frac{V_{CS_Max}}{R_{SENSE}} = \frac{0.7}{300\text{m}} = 2.33 \text{ A} \quad (\text{eq. 7})$$

Moreover, to limit the maximum output current at high mains, the R_{CS} resistor in series with the CS pin is set to 1 kΩ.

At high mains (i.e. 265 V rms), the internal OPP current source generates 130 μA which flows out of the CS pin. In this condition, the new primary peak current will be:

$$I_{Peak_Pri@265V} = \frac{V_{CS_Max}}{R_{SENSE}} = \frac{0.7 - (1\text{k} \cdot 130\mu)}{300\text{m}} = 1.9 \text{ A} \quad (\text{eq. 8})$$

The combination of these two previous elements brings the following Over Current Protection curve (Figure 6).

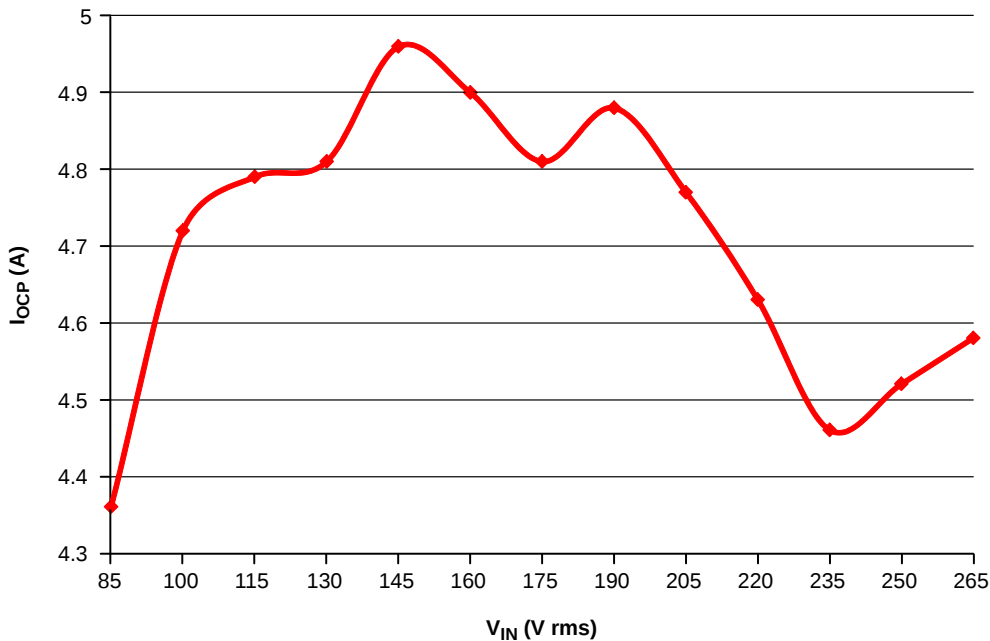


Figure 6. Over Current Protection (OCP) vs. Input Voltage – NCP1236

For the NCP1239, the maximum current sense level has been increased to 0.8 V. Therefore, in order to keep the same primary peak current (i.e. 2.33 A), the sense resistor has to be modified as follows:

$$R_{\text{SENSE_NCP1239}} = \frac{V_{\text{CS_Max}}}{I_{\text{Peak_Pri}}} = \frac{0.8}{2.33} = 343 \text{ m}\Omega \quad (\text{eq. 9})$$

We will use the 330-m Ω normalized resistor (three paralleled 1- Ω resistors).

The next step now is to adjust the series resistance with the NCP1239's CS pin to obtain the equivalent maximum output current at 265 V rms. With the help of Equation 8, we know the primary peak current with the NCP1236 controller at high mains. Let's calculate the needed level on the NCP1239's CS pin to reach the same peak current.

$$\begin{aligned} V_{\text{CS_NCP1239@265V}} &= R_{\text{SENSE_NCP1239}} \cdot I_{\text{Peak_Pri@265V}} = \\ &= 0.33 \cdot 1.9 = 0.63 \text{ V} \end{aligned} \quad (\text{eq. 10})$$

Now, we just have to compute the R_{CS} resistor to have this 0.63-V maximum threshold at high mains.

$$\begin{aligned} R_{\text{CS_NCP1239}} &= \frac{V_{\text{CS_Max_NCP1239}} - V_{\text{CS_Max_NCP1239@265V}}}{I_{\text{OPP @265 V rms}}} = \\ &= \frac{0.8 - 0.63}{130\mu} = 1.3 \text{ k}\Omega \end{aligned} \quad (\text{eq. 11})$$

The new value is really close to that of the resistance used for the NCP1236 (i.e. 1 k Ω). We have the possibility to run the test with the same resistance considering only a sense resistor that has been increased from 0.30 Ω to 0.33 Ω . We can see that the OCP current, plotted in Figure 7, follows the same evolution compared to the NCP1236 current graph (Figure 6).

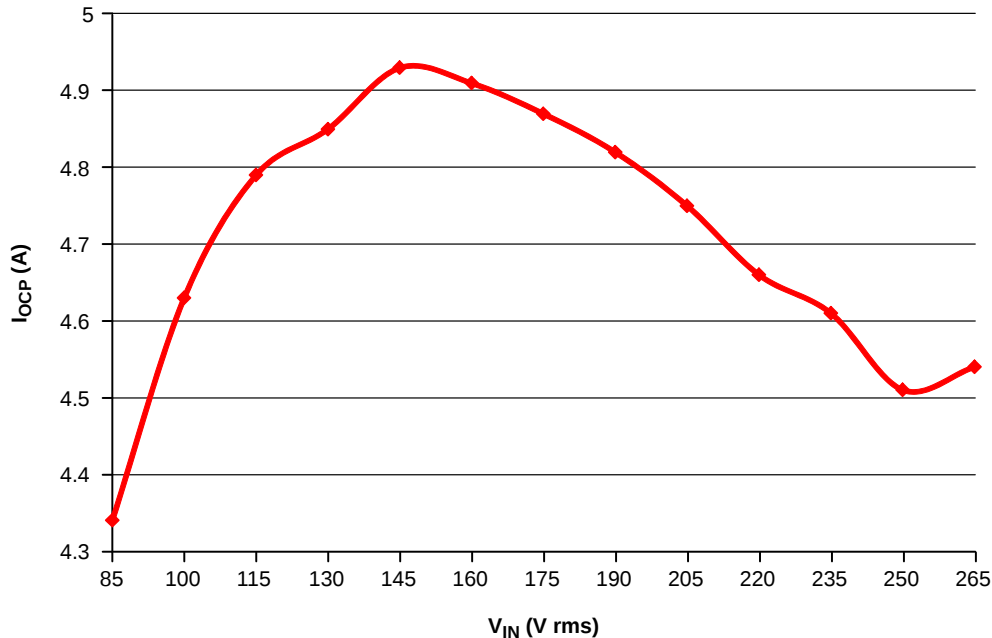


Figure 7. Over Current Protection (OCP) vs. Input Voltage – NCP1239

Abnormal Over Current Protection

Both controllers include a function to protect the PSU against a severe fault. For instance, if the secondary diode is damaged and becomes shorted, the secondary winding will be shorted too. In this case, the primary current can increase very rapidly during the on-time as the inductance remaining in the mesh is the leakage term. The current sense signal significantly exceeds the maximum current sense threshold (0.7 V for the NCP1236 and 0.8 V for the NCP1239). A second comparator, 50% higher than $V_{\text{CS_max}}$ with shorter LEB is present on CS pin. So, for the NCP1236, the level is 1.05 V compared to 1.20 V for the NCP1239. The difference is how the fault is internally handled.

Let's look at the NCP1236. Once the CS pin is higher than the 1.05 V, the controller immediately stops switching and enters in auto-recovery or latch mode depending of the chosen option. This behavior is shown in Figure 8.

The NCP1239 offers an improved noise immunity performance compared to NCP1236. To validate the fault, the controller has to detect 4 consecutive pulses with the CS pin voltage above the 1.2-V threshold. After these four periods, the controller stops operations like the NCP1236 does. This implementation will avoid an unexpected detection in case of surge tests for instance.

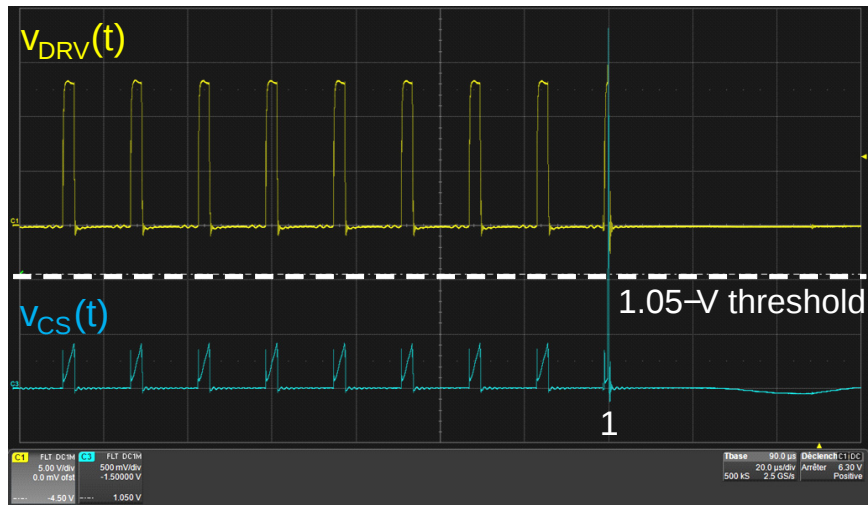


Figure 8. Abnormal Over Current Protection – NCP1236

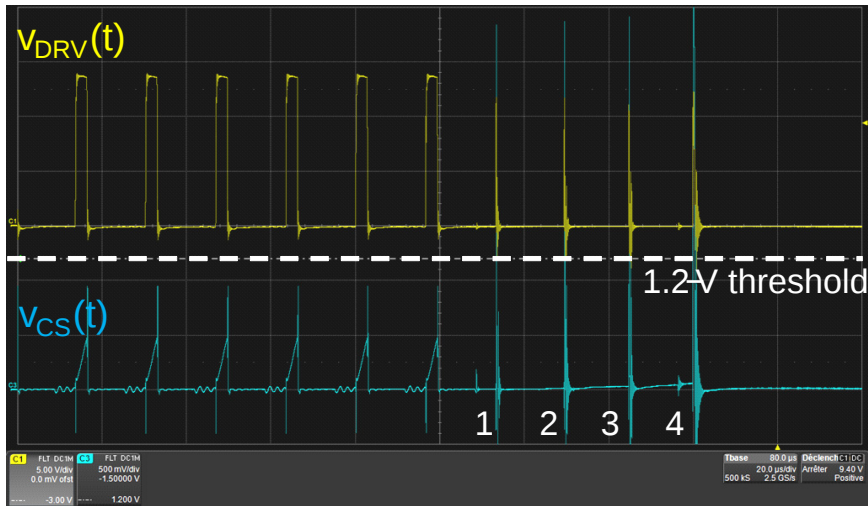


Figure 9. Abnormal Over Current Protection – NCP1239

Start-Up Sequence

A high voltage (HV) current source is embedded in both controllers to ensure a quick start-up. The current capability of the NCP1236 is higher than the NCP1239 (6 mA versus 3 mA) but it will be sufficient to wake-up the controller rapidly. Also, thanks to this lower capability, the HV pin leakage current is lower for the new NCP1239. This will have a significant impact on the stand-by performance, especially at high mains. Equation 12 gives an estimation of the power you can save with the NCP1239 when its HV pin is connected to the bulk capacitor. The standby performance comparison is exposed later in the document.

$$P_{\text{Saved}} = V_{\text{in_max}} \cdot (I_{\text{LEAK_NCP1236}} + I_{\text{LEAK_NCP1239}}) = \quad (\text{eq. 12})$$

$$= 265 \cdot \sqrt{2} \cdot (25\mu - 8\mu) = 7 \text{ mW}$$

The NCP1236 controller starts pulsing after 403 ms (Figure 10) while 523 ms are needed for the NCP1239 (Figure 11). We are still far away from the 3-s limit for classical notebook adapters.

AND9240/D

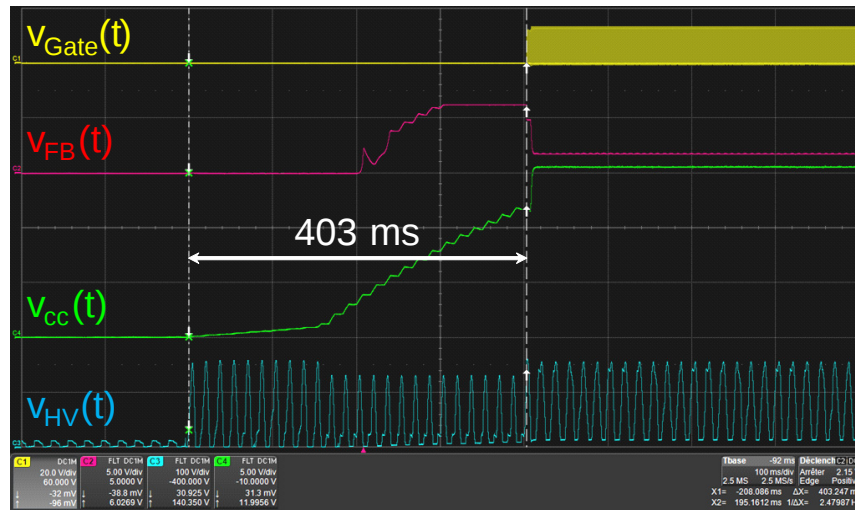


Figure 10. Start-Up Sequence – NCP1236

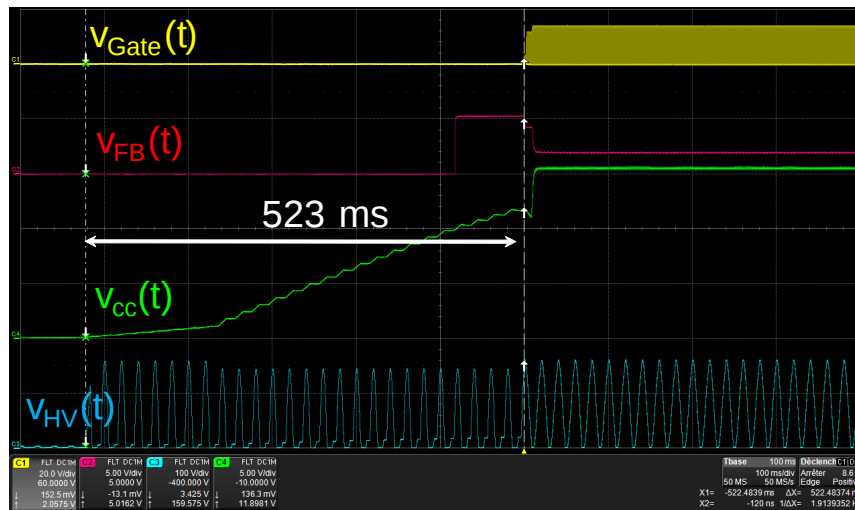


Figure 11. Start-Up Sequence – NCP1239

The start-up sequence also involves the internal soft-start. During this time, the peak current setpoint is linearly increased from a very low value up to the allowable maximum. To reduce the stress on the power supply, the NCP1239 soft-start duration has been increased from 4 ms to 8 ms.

Jittering Function

The jittering function helps spreading out energy in conducted noise analysis and it improves the EMI signature. Both controllers have this function but the levels are different. As shown on the Table 3, the frequency swing has been doubled for the NCP1239 like the famous NCP125x series. The frequency jittering is quite the same.

Table 3. JITTERING FUNCTION PARAMETERS

	NCP1236 Controller	NCP1239 Controller
Frequency Swing	125 Hz	240 Hz
Frequency Jittering	6% of F_{SW}	5% of F_{SW}

AND9240/D

The EMI signature for both controllers is below the limit regardless of the input voltage.

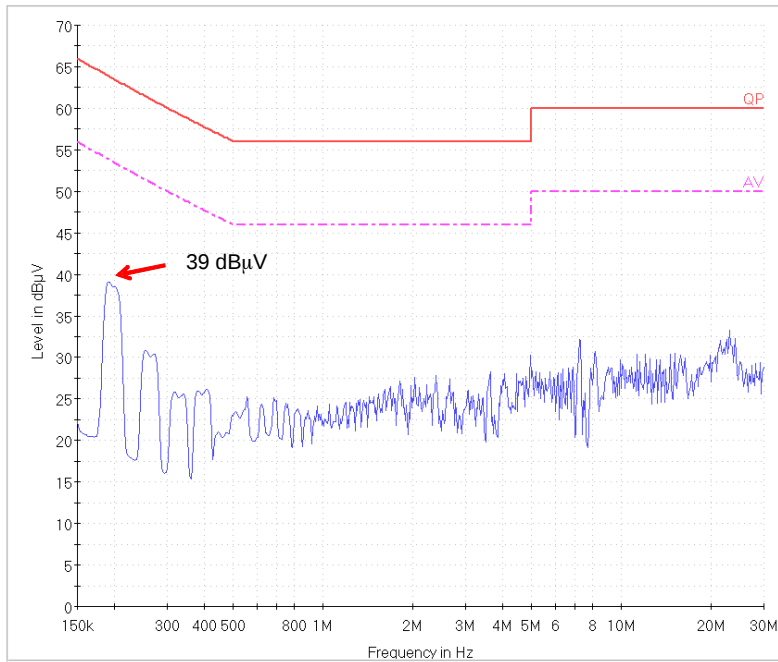


Figure 12. Average EMI Signature @115 V rms/Full Load – NCP1236

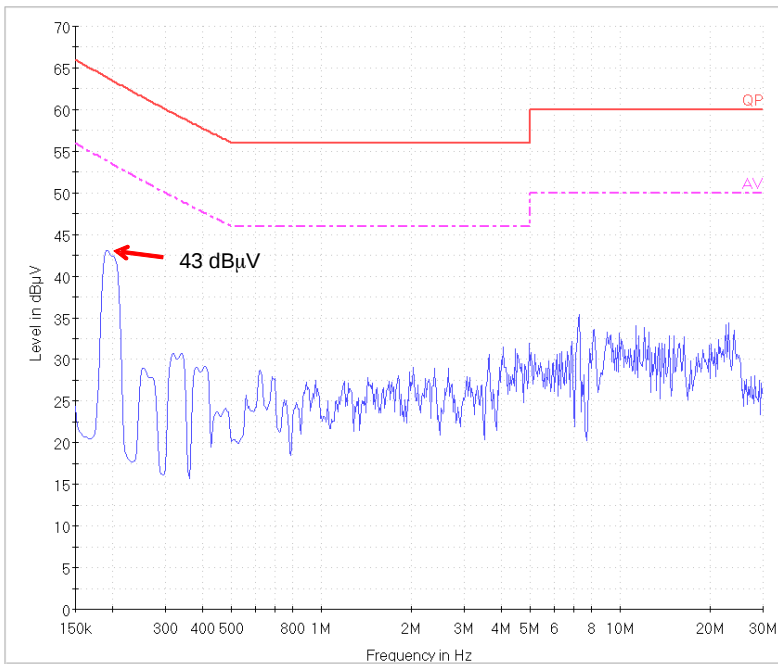


Figure 13. Average EMI Signature @230 V rms/Full Load – NCP1236

AND9240/D

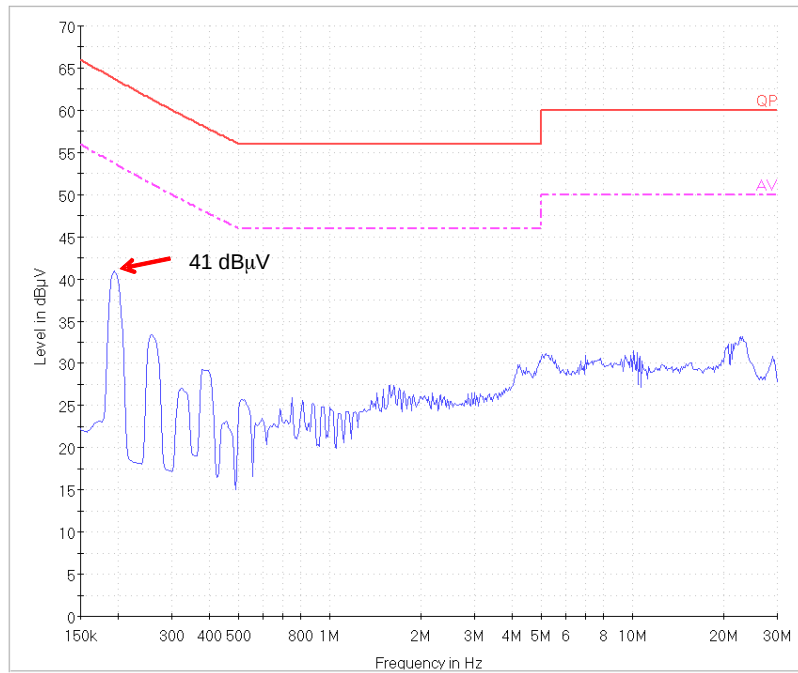


Figure 14. Average EMI Signature @115 V rms/Full Load – NCP1239

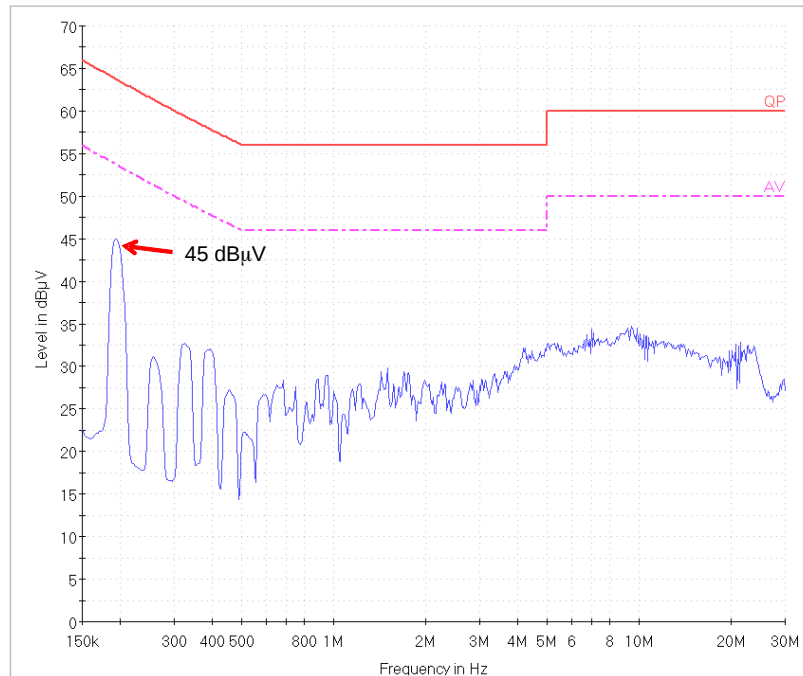


Figure 15. Average EMI Signature @230 V rms/Full Load – NCP1239

Transient Load

Figure 16 and Figure 17 show an output transient load step from 10% to 100% of the maximum output power at low line and high line. The slew rate is 1 A/ μ s and the frequency is 5 Hz.

- For the NCP1236 controller, the step load response is ± 16 mV or $\pm 0.9\%$ of the output voltage
- For the NCP1239 controller, the step load response is ± 29 mV or $\pm 1.8\%$ of the output voltage

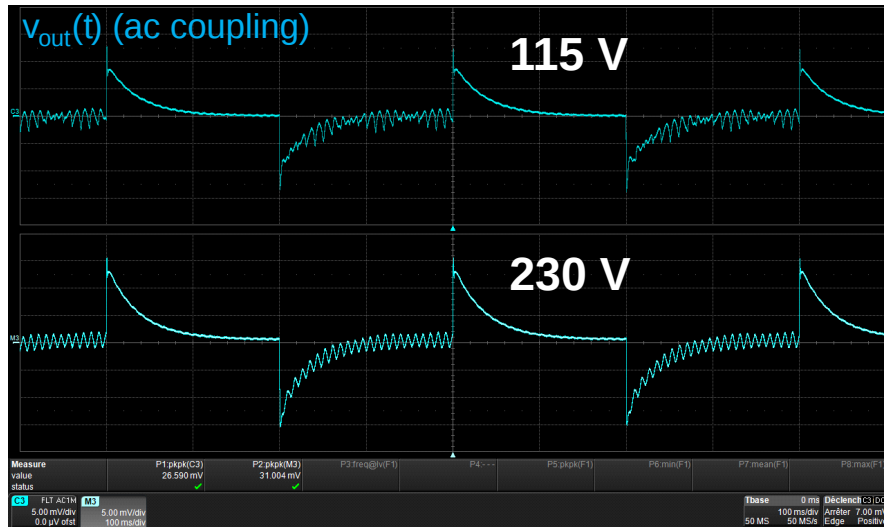


Figure 16. Step Load Response between 10% to 100% – NCP1236

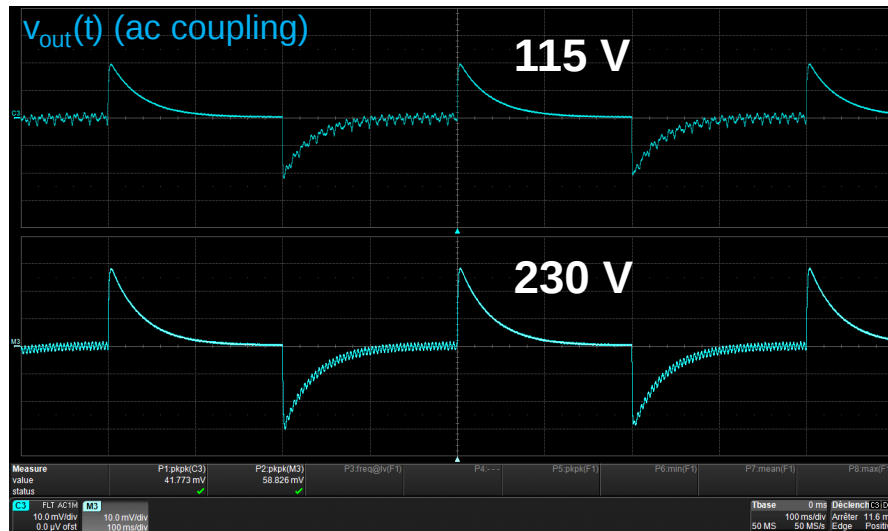


Figure 17. Step Load Response between 10% to 100% – NCP1239

Both responses are good. The NCP1236 offers a better response and it can be explained by the NCP1239 higher internal FB pull-up resistance. Indeed, the internal resistor connected to the FB pin has been increased from 20 k Ω to 30 k Ω in the NCP1239 controller in order to reduce the

circuit consumption and improve the standby performance. This resistor has an impact on the compensation. Please refer the AND8334 application note to have more information about the compensation with the TL431.

To confirm this analysis, several open-loop measurements have been performed. One typical result at 162 V dc (115 V rms) is given in Figure 18 for the NCP1236 and in Figure 19 for the NCP1239. A crossover frequency of 624 Hz is observed, together with a comfortable phase

margin (89°) for the NCP1236. With the NCP1239, the converter is also well compensated. The crossover frequency is 412 Hz with a ≈100° phase margin. Both values explain the slow response during the transient test.

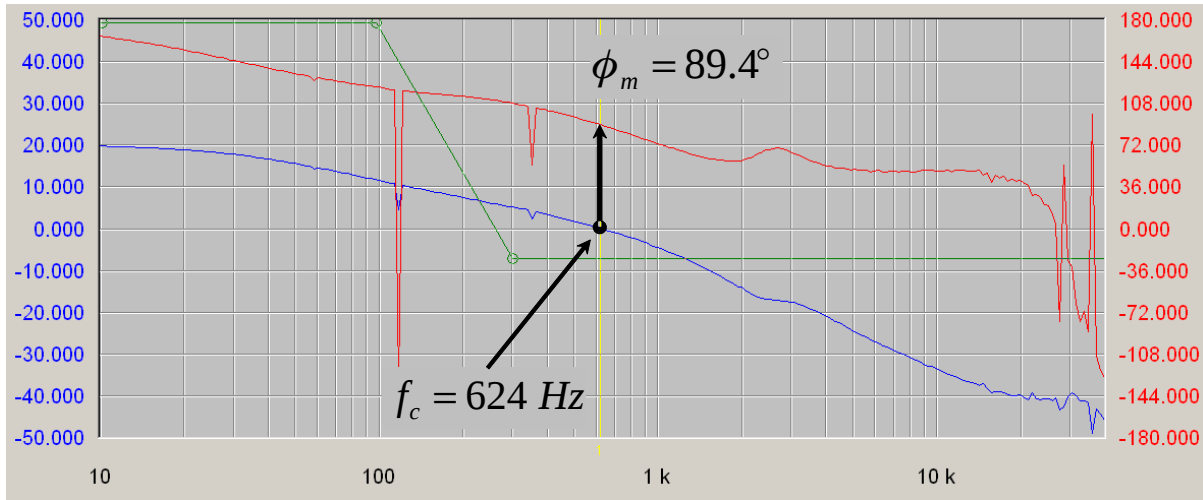


Figure 18. Open-Loop AC Sweep at 162 V dc Input Voltage – NCP1236

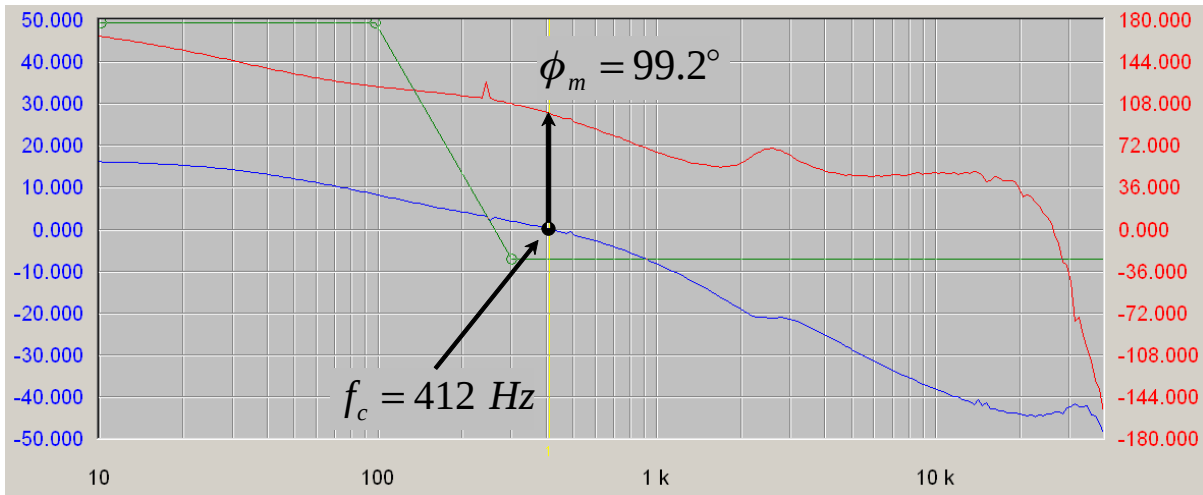


Figure 19. Open-Loop AC Sweep at 162 V dc Input Voltage – NCP1239

Efficiency and Average Efficiency

Thanks to a different Frequency Foldback (FF) implementation, efficiency in middle and light load operation is better with the new NCP1239. NCP1236 features a larger FF window and does not freeze the primary

peak current. On the contrary, the NCP1239 controller freezes the current in light load condition to limit the pulse number in a switching period and accordingly reduces switching losses.

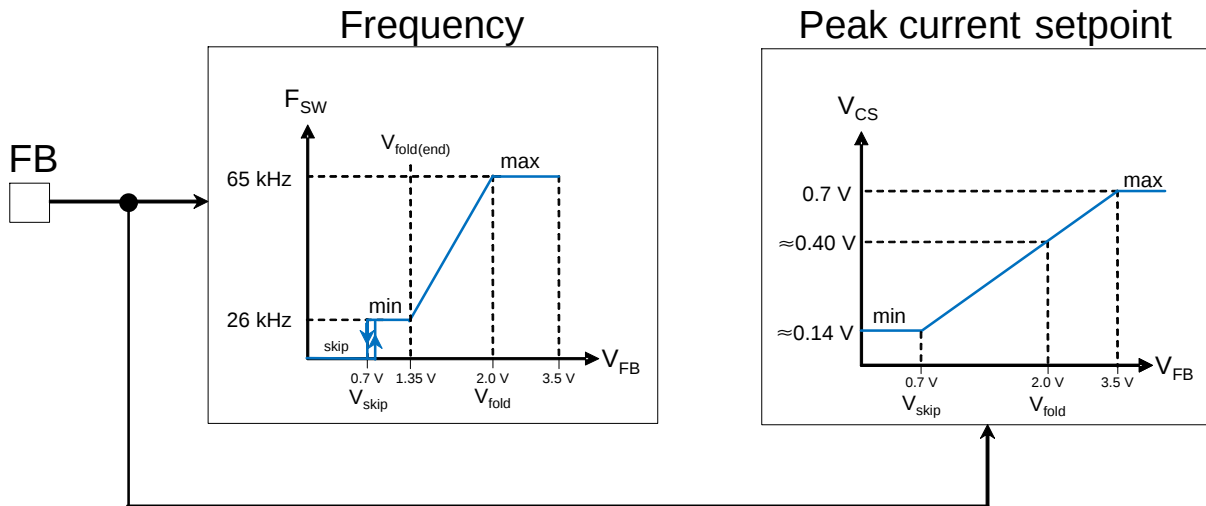


Figure 20. Frequency Foldback Mode – NCP1236

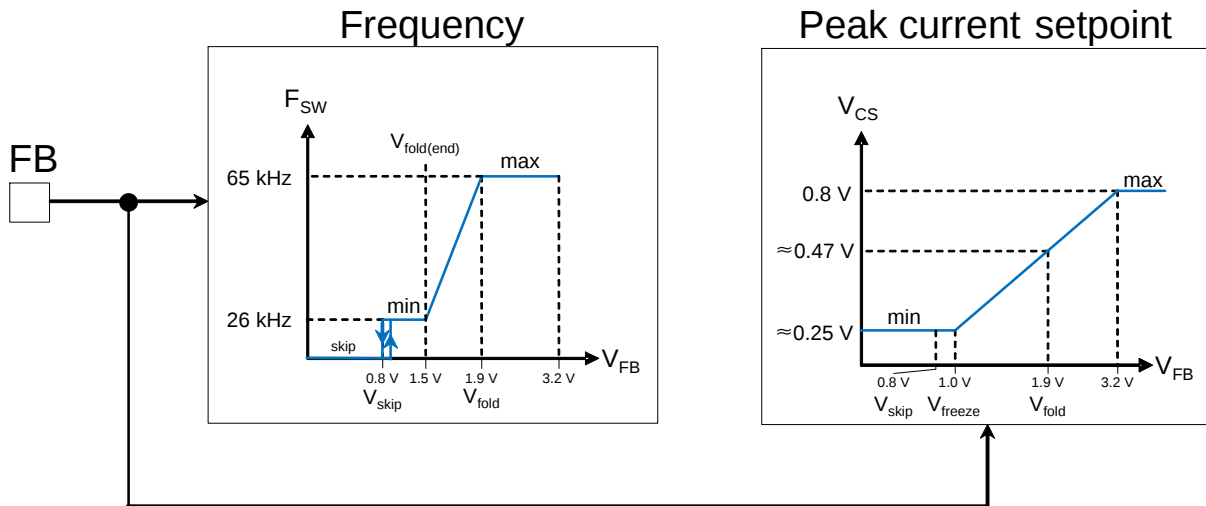


Figure 21. Frequency Foldback Mode – NCP1239

Efficiency measurements in Figure 22 and Figure 23 have been conducted on the same evaluation board, with the same equipment and at room temperature. All measurements have been done following the Code of Conduct specification (CoC). So following a 30 min warm-up phase at full load, all measurements have been performed further to a 5-min loading consideration.

The input power was measured with the 66202 power meter (Chroma) and the output voltage and output current were measured using digital multimeter embedded in the dc electronic load 66103, also from Chroma.

AND9240/D

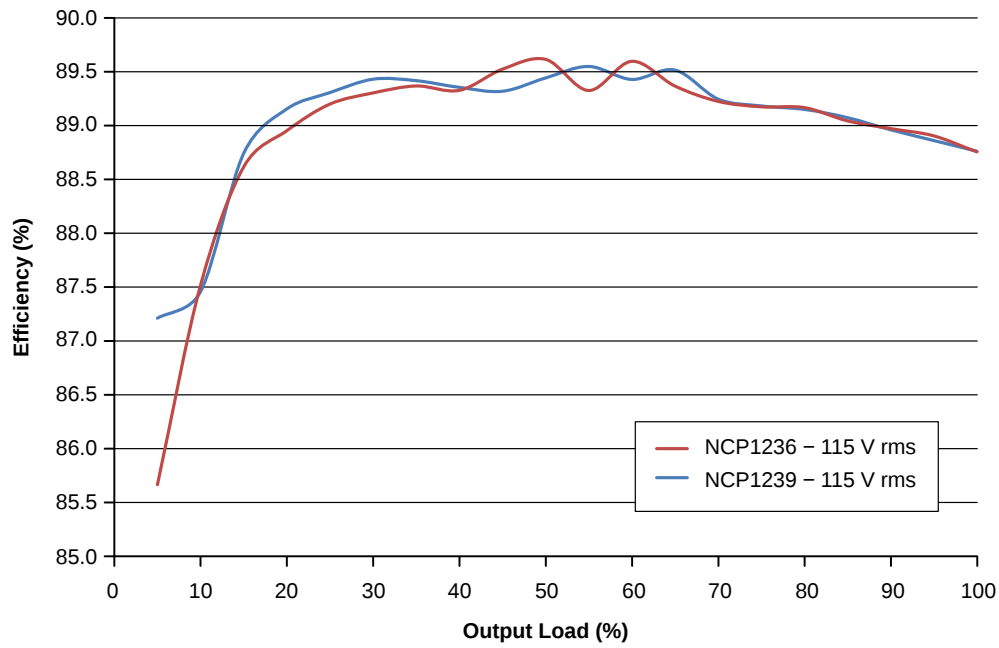


Figure 22. Efficiency (%) vs. Output Power (% of Max) @115 V rms

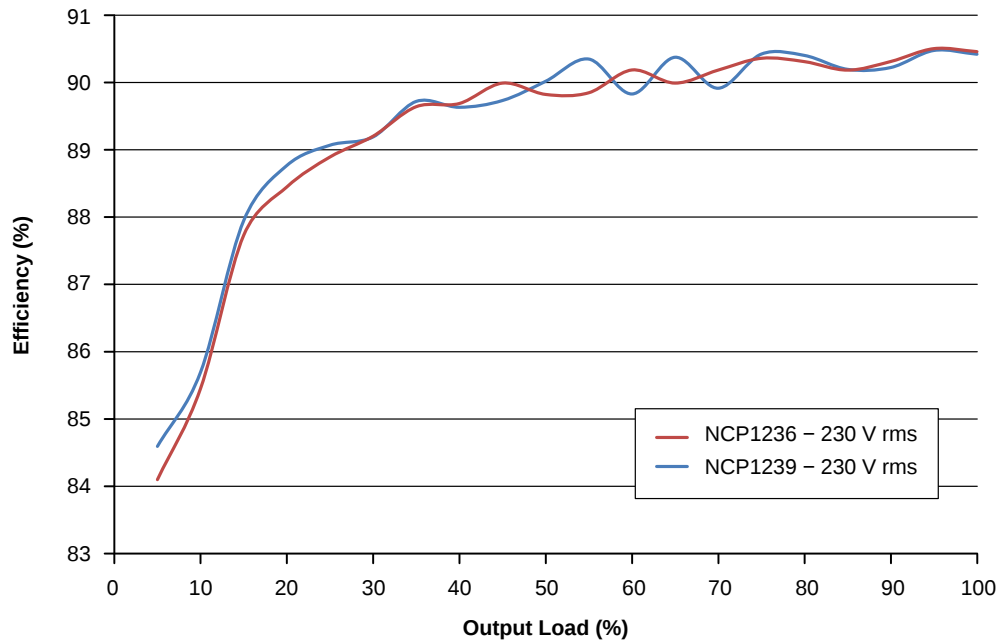


Figure 23. Efficiency (%) vs. Output Power (% of Max) @230 V rms

From the previous curves, we can extract the average efficiency for both controllers. This parameter is calculated from the efficiency measurements at 25%, 50%, 75% and 100% of the full rated output power.

What does the CoC say about efficiency? For a typical 19-V adapter, 65-W output power, the average efficiency

has to be higher than 89% and the minimum efficiency @10% of the maximum load higher than 79%. As described in Table 4, in this application, the NCP1236 is not able to comply with the CoC requirements. On the contrary, thanks to a better efficiency at middle load, the NCP1239 can pass the standard requirements.

Table 4. EFFICIENCY @115 V RMS AND 230 V RMS

Input Voltage	P _{OUT} (%)	NCP1236 Efficiency (%)	NCP1239 Efficiency (%)
115 V rms	100	88.75	88.75
	75	89.17	89.18
	50	89.61	89.44
	25	89.20	89.30
	Average	89.18	89.17
	10	87.51	87.45
230 V rms	100	90.48	90.44
	75	90.38	90.44
	50	89.84	90.04
	25	88.91	89.09
	Average	89.90	90.00
	10	85.46	85.71

If we expand our view on the light-load power consumption, in the range of 1-W output power, we can see the benefit of the NCP1239 compared to the NCP1236 in Figure 24. Again, all measurements have been performed on the same evaluation board, only the controller was changed together with the sense resistor as previously explained.

We can see that we can deliver 0.73 W and keeps the input power below 1 W @115 V rms for the NCP1236 compared to 0.77 W for the NCP1239.

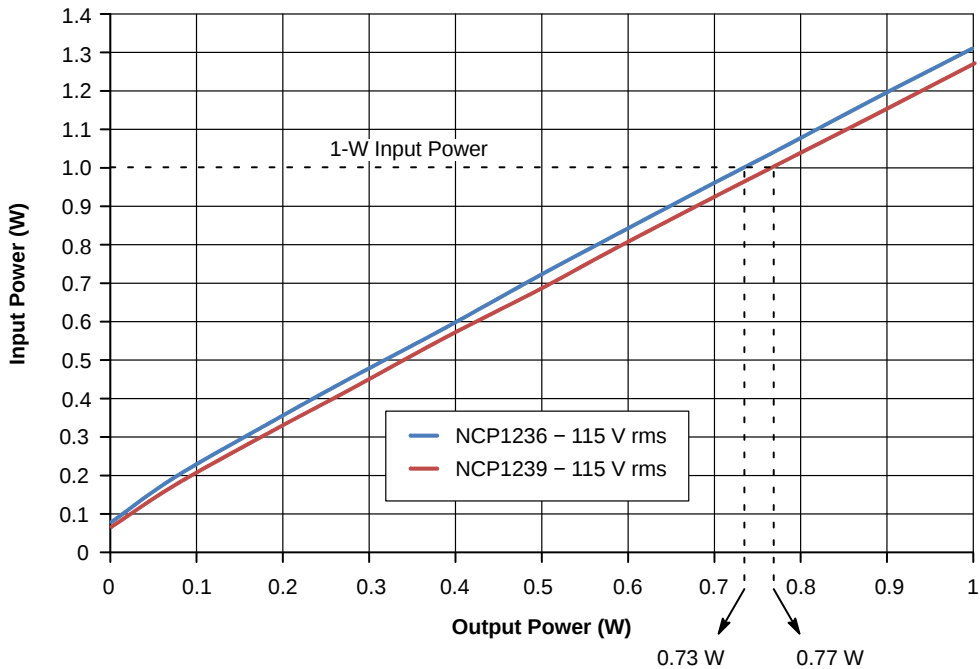


Figure 24. Low Power Consumption

Stand-By Performance

The last point of comparison between both controllers is regarding the stand-by consumption. We already tackled this subject in the start-up section. The NCP1239's HV pin features a lower leakage current that will help saving a few mW. Also, the IC consumption has been optimized in this

new controller to reduce the overall consumption. The NCP1239 consumption in skip mode is only 500 μ A while 900 μ A is absorbed by the NCP1236 in similar operating conditions. If we consider a V_{CC} voltage around 12 V, the saved power will be:

$$P = V_{CC} \cdot (ICC(stb)_{NCP1236} - ICC(stb)_{NCP1239}) =$$

(eq. 13)

$$= 12 \cdot (900\mu - 500\mu) = 5 \text{ mW}$$

Thanks to these two points, the standby consumption has been improved with the NCP1239 like shown in the Table 5.

Table 5. STAND-BY CONSUMPTION

Input Voltage (V rms)	Input Power (mW)		Burst Period (ms)		Pulse Number during each Burst	
	NCP1236	NCP1239	NCP1236	NCP1239	NCP1236	NCP1239
85	68	54	12	10.9	6	3
115	74	58	13.3	11.3	6	3
230	105	79	14.6	8.8	5	2
265	121	88	13	9.2	5	2

Also in this table, we can see that there are some differences regarding the controller operations. There is no impact on the output voltage but it can lead to some improvements regarding the V_{CC} capacitor for instance. Indeed, the NCP1236 controller has 100-mV hysteresis to leave from the skip mode (no pulse) and enters in the frequency foldback mode (clamped 26 kHz). Please refer to the Figure 20. The skip hysteresis level is only 30 mV for the NCP1239. So there are less cycles during each burst sequence and so the time between each burst is shorter. Thanks to that and to the lower IC consumption, the V_{CC}

capacitor can be reduced. Some space will be saved and the start-up duration will be even shorter.

Summary

Considering a single element changed (sense resistor), we were able to replace the NCP1236 controller by the new NCP1239 part and significantly improve the overall performance. Efficiency and the standby consumption have clearly benefited from these improvements. The performance summary for both controllers in a typical 19-V/65-W adapters is listed in Table 6.

Table 6. PERFORMANCE COMPARISON BETWEEN NCP1236 AND NCP1239 CONTROLLER

	NCP1236	NCP1239	NCP1239 Improvement
OVP Event on Fault Pin	21.1 V	21.8 V	+3.3%
OVP Event on V_{CC} Pin	32.3 V	30.8 V	-6%
OTP Event on Fault Pin	105°C	104°C	-1%
OCP Threshold	4.36 A < I_{OUT_Max} < 4.96 A	4.34 A < I_{OUT_Max} < 4.93 A	≈
Start-Up Duration	403 ms	523 ms	+30%
Average Efficiency 115 V rms 230 V rms	89.18% 89.90%	89.17% 90.00%	-0.01% +0.10%
Efficiency @ 10% of Full Load 115 V rms 230 V rms	87.51% 85.46%	87.45% 85.71%	-0.06% +0.25%
Stand-By Power Consumption 115 V rms 230 V rms	74 mW 105 mW	58 mW 79 mW	-28% -25%

Conclusion

This application note has described and compared the performance obtained for 19-V/65-W application between

the NCP1236 and the NCP1239 controller that are pin to pin compatible. The new NCP1239 IC shows several improvements and so better performance.

BOARD SCHEMATIC – CHANGED COMPONENTS CIRCLE IN RED

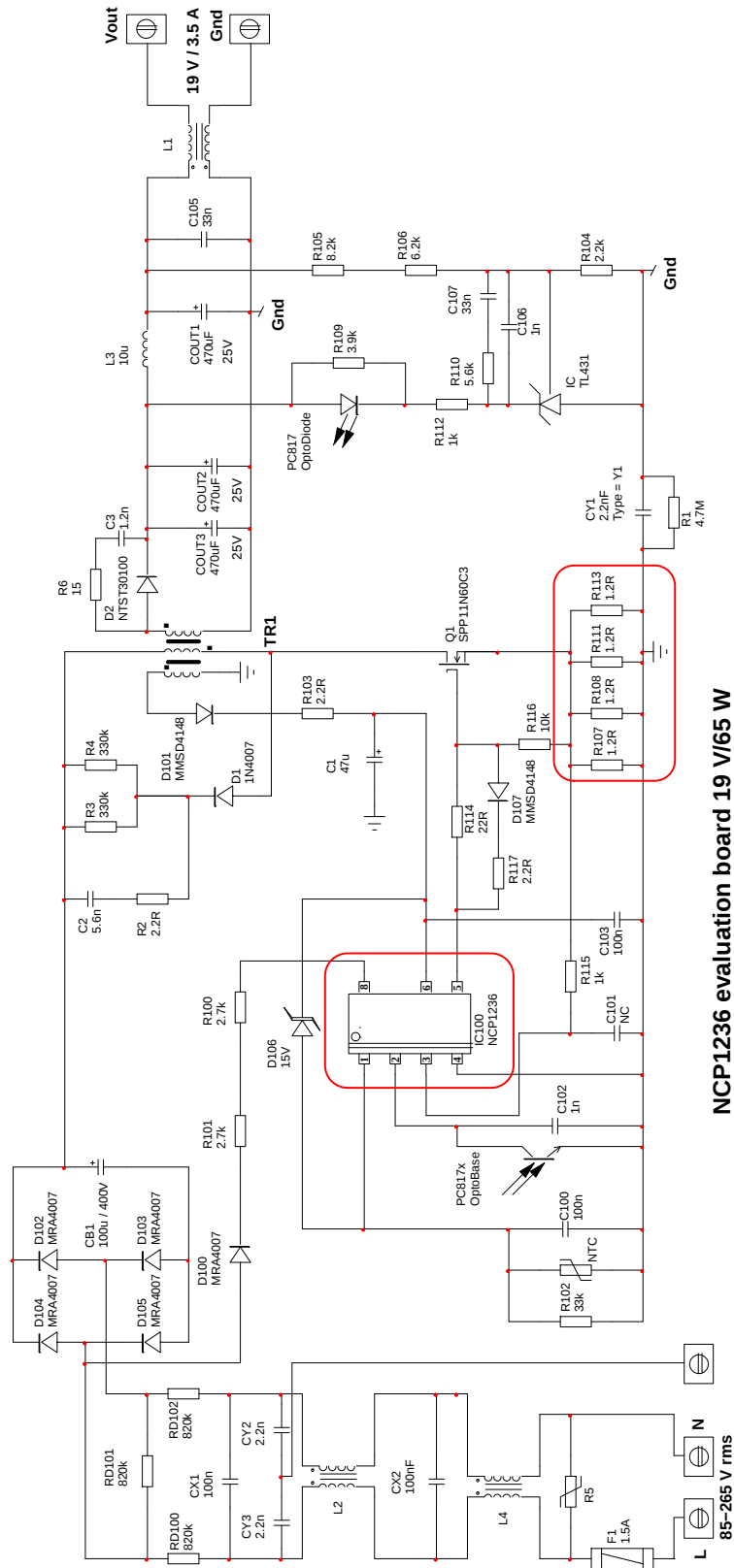


Figure 25. Evaluation Board Schematic

AND9240/D

BILL OF MATERIALS

Table 7. BILL OF MATERIALS

Designator	Qty.	Description	Value	Manufacturer Part Number
C1	1	Electrolytic Capacitor	47 μ F/50 V	KLH-050V470ME110
C100, C103	2	Ceramic Capacitor	100 nF	C1206C104K5RAC
C102, C106	2	Ceramic Capacitor	1 nF	C1206C102K5RAC
C105, C107	2	Ceramic Capacitor	33 nF	C1206C333K5RAC
C2	1	Ceramic Capacitor	5.6 nF/630 V	FK20C0G2J562J
C3	1	Ceramic Capacitor	1.2 nF/630 V	FK26C0G2J122J
CB1	1	Bulk Capacitor	100 μ F/400 V	EKXG401ELL101MMN3S
COUT1, COUT2, COUT3	3	Electrolytic Capacitor	470 μ F/25 V	ECA-1EHG471
CX1, CX2	2	Suppression Film Capacitors	100 nF	B32922C3104K
CY1, CY2, CY3	3	Ceramic Capacitor	2.2 nF/X1/Y1	DE1E3KX222MA5B
D1	1	Standard Recovery Rectifier	1N4007	1N4007G
D100, D102, D103, D104, D105	5	Standard Recovery Rectifier	MRA4007T3G	MRA4007T3G
D101, D107	2	Diode	MMSD4148	MMSD4148T3G
D106	1	Zener Diode	MMSZ15	MMSZ15T3G
D2	1	Diode Schottky 150 V 15 A	NTST30100SG	NTST30100SG
F1	1	Fuse (MST ser.)	1.6 A	0034.6617
IC1	1	Programmable Precision Reference	TL431	TL431BCLPG
IC100	1	SMPS Controller	NCP1236B65	NCP1236BD65R2G
L1	1	Inductor	744 841 414	744 841 414
L2	1	Inductor	2 $\times$ 20 mH/2 A	B82734W2202B030
L3	1	Inductor	10 μ H	DR0810-103L
L4	1	Inductor	744 841 330	744 841 330
NTC	1	Sensing NTC Thermistor	330 k Ω	NTCLE100E3334JB0
OK1	1	Optocoupler	PC817	PC817X2J000F
Q1	1	N MOSFET Transistor	SPP11N60C3	SPP11N60C3
R1	1	Resistor Through Hole, High Voltage	4.7 M Ω	VRW37-4M7JI
R100, R101	2	Resistor SMD	2.7 k Ω	MCR18EZHf2701
R102	1	Resistor SMD	33 k Ω	MCR18EZHf3302
R103, R117	2	Resistor SMD	2.2 Ω	MCR18EZHfL2R20
R104	1	Resistor SMD	2.2 k Ω	MCR18EZHf2201
R105	1	Resistor SMD	8.2 k Ω	MCR18EZHf8201
R106	1	Resistor SMD	6.2 k Ω	MCR18EZHf6201
R107, R108, R111, R113 (for NCP1236)	4	Resistor SMD	1.2 Ω	MCR18EZHfL1R20
R107, R108, R111 (for NCP1239)	3	Resistor SMD	1 Ω	MCR18EZHfL1R00
R109	1	Resistor SMD	3.9 k Ω	MCR18EZHf3901
R110	2	Resistor SMD	5.6 k Ω	MCR18EZHf1001
R112	2	Resistor SMD	1.0 k Ω	MCR18EZHf1001
R114	1	Resistor SMD	22 Ω	MCR18EZHf22R0

AND9240/D

Table 7. BILL OF MATERIALS (continued)

Designator	Qty.	Description	Value	Manufacturer Part Number
R115	1	Resistor SMD	1 kΩ	MCR18EZPF1001
R116	1	Resistor SMD	10 kΩ	MCR18EZHF1002
R2	1	Resistor	2.2 Ω	MBB02070C2208FRP00
R3, R4	2	Resistor	330 kΩ	HVR2500003303FR500
R5	1	Surge Protecting Varistor	B72210P2301K101	B72210P2301K101
R6	1	Resistor	15 Ω	MRS25000C1509FRP00
RD100, RD101, RD102	3	Resistor SMD	820 kΩ	MCR18EZHF8203
TR1	1	Transformer	KA5038-BL	KA5037-BL
X1	1	Terminal Block, 2 Way	CTB5000/2	CTB5000/2
X2	1	Terminal Block, 3 Way	CTB5000/3	CTB5000/3

ON Semiconductor and the  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC) or its subsidiaries in the United States and/or other countries. SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com

Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local Sales Representative