# Adjusting the Over Temperature Protection Trip Point in NCP1250-Based Adapters

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## APPLICATION NOTE

The NCP1250 features a multi−function pin in which the user can implement Over Power Protection (OPP) and Over Voltage Protection (OVP). If you add a Negative Temperature Coefficient (NTC) resistor in parallel with the OVP Zener diode, you have a means to protect the adapter against thermal runaway. The operating principle is simple: the latch detection is made by observing the OPP pin level via a comparator featuring a 3 V reference voltage. When the NTC resistance decreases as the temperature increases, the off−time voltage on the OPP pin goes up. When it touches the 3 V reference four consecutive times, the controller permanently latches off.

Customers often re−use an NTC they have already implemented in previous projects and define the pull−down resistor on the OPP pin in relationship with this NTC value. This technique can lead to rather high pull−down resistors on the OPP pin to ground. If this resistance is too high and the converter noisy, the converter immunity can be reduced with possible erratic operations. The solution to fix this kind of problem is to reduce the pull−down resistance. Values below 3 kΩ give good operating results. There are cases where the noise in the adapter will require low values such as 1 kΩ. To still meet the OTP trip point, you will need to install a resistor in parallel with the existing NTC device. The solution appears in Figure 1.

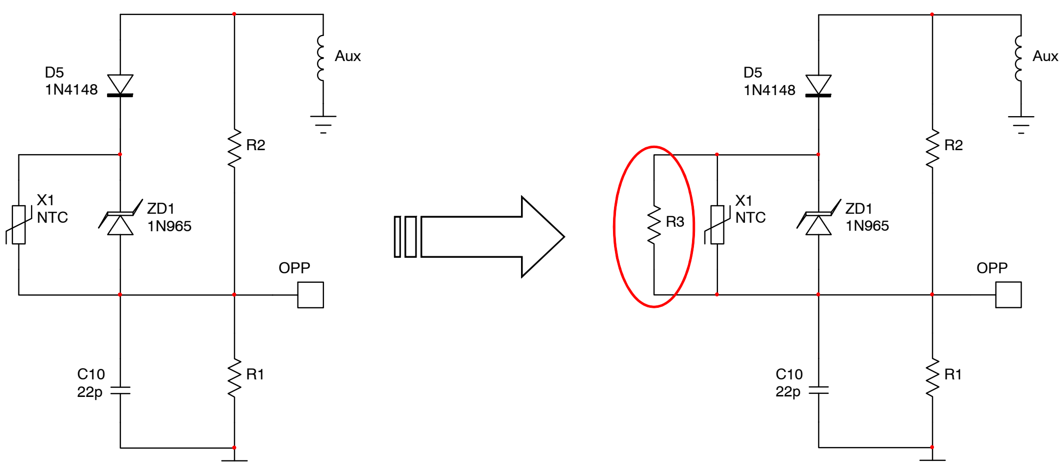


**Figure 1. This Picture Shows How to Adapt an Existing NTC Value to Adjust the OTP Trip Point**

As a design example, let us assume that we have the following component values around the NCP1250:

- $R_1$ = 1 kΩ; the NCP1250 pull−down resistor on the OPP pin.
- $R_{NTC}$ = 15 kΩ; the NTC value at the select OTP trip point.
- $N_{pa}$ = 0.2; the turns ratio between the primary and auxiliary windings.
- $N_{ps}$ = 0.09; the turns ratio between the primary and secondary windings.
- $V_{out}$ = 5 V ; the converter output voltage.
- $V_f$ = 0.6 V; the diodes forward drops in the auxiliary and secondary windings.

At first, we need to know the voltage across the NTC in fault mode, e.g. when the OPP pin level reaches 3 V. This voltage is defined by the plateau voltage on the auxiliary winding during the off time. It also depends on the 0.6 V forward drop of diode $D_1$ and the 3 V OVP level:

$$V_{NTC} = \left(V_{out} + V_f\right) \times \frac{N_{pa}}{N_{ps}} - V_{OVP} - V_f \quad \text{(eq. 1)}$$

$$= (5 + 0.6) \times \frac{0.2}{0.09} - 3 - 0.6 = 8.8\ \text{V}$$

Based on 1 kΩ pull−down OPP resistor, the current in fault mode ($V_{OVP}$ = 3 V) is:

$$I_{R1} = \frac{V_{OVP}}{R_1} = \frac{3}{1000} = 3\ \text{mA} \quad \text{(eq. 2)}$$

From Equations 1 and 2, we can derive the equivalent resistance made of the NTC in parallel with the resistor we are looking for ($R_3$):

$$R_{eq} = \frac{V_{NTC}}{I_{R1}} = \frac{8.8}{3m} = 2.9\ \text{k}\Omega \quad \text{(eq. 3)}$$

Knowing that the equivalent resistor is the NTC paralleled with the added resistance ($R_3$), we have:

$$R_{eq} = \frac{R_3 R_{NTC}}{R_{NTC} + R_3} \quad \text{(eq. 4)}$$

Solving for $R_3$ leads to:

$$R_3 = \frac{R_{eq} R_{NTC}}{R_{NTC} - R_{eq}} = \frac{2.9k \times 15k}{15k - 2.9k} = 3.7\ \text{k}\Omega \quad \text{(eq. 5)}$$

The next step is to recalculate the OPP resistor ($R_2$ in Figure 1). For instance, if we need a 300 mV decrease from the 0.8 V setpoint at high line, then the auxiliary diode anode during the on−time swings to:

$$V_{ANODE} = -N_{pa} \times V_{IN} = -0.2 \times \left(264 \times \sqrt{2}\right) = -74.7\ \text{V} \quad \text{(eq. 6)}$$

We can evaluate the voltage drop around $R_2$ as:

$$V_{R2} = 74.7 - 0.3 = 74.4\ \text{V} \quad \text{(eq. 7)}$$

The current flowing in the pull−down resistor $R_1$ in this condition will be:

$$I_{R1} = \frac{300m}{1k} = 300\ \mu\text{A} \quad \text{(eq. 8)}$$

The $R_2$ value is therefore easily derived:

$$R_2 = \frac{74.4}{300\mu} = 248\ \text{k}\Omega \quad \text{(eq. 9)}$$

**Conclusion**

This application note explains how we can easily adjust the Over Temperature Protection trip point by paralleling a resistor with an available NTC device. In case of noisy layouts, it helps to decrease the OPP pin pull−down resistor to a value close or below one kΩ, naturally improving the converter robustness to external perturbations.



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