NCS37005 External Component Selection Guide

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APPLICATION NOTE

This application note assists in the selection of the external components and current transformer for the NCS37005 GFCI integrated circuit. A typical application for a GFCI is shown in Figure 1. Please see the corresponding datasheet for specific information on the functional behavior of the NCS37005.

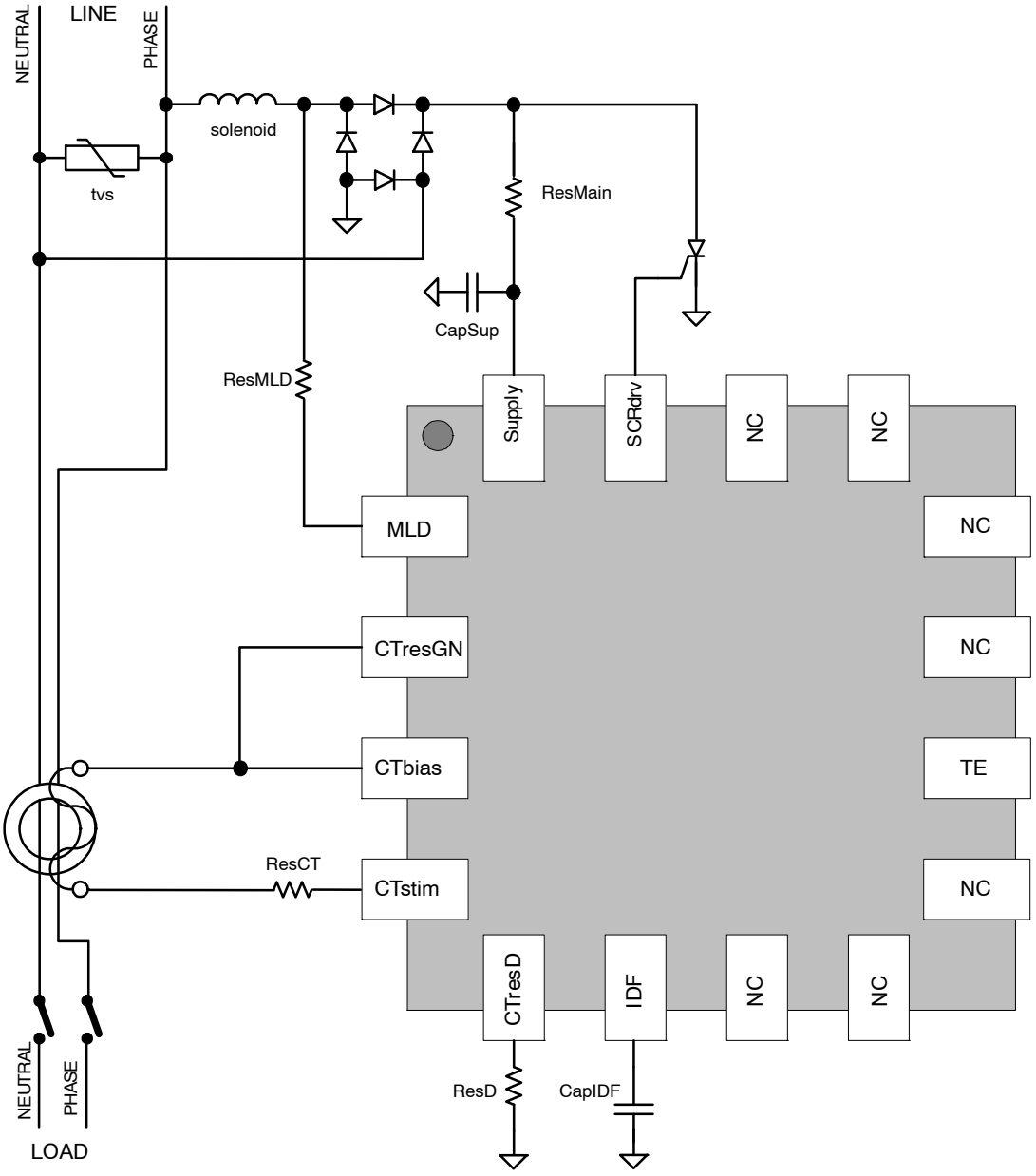

Figure 1. NCS37005 Application Diagram

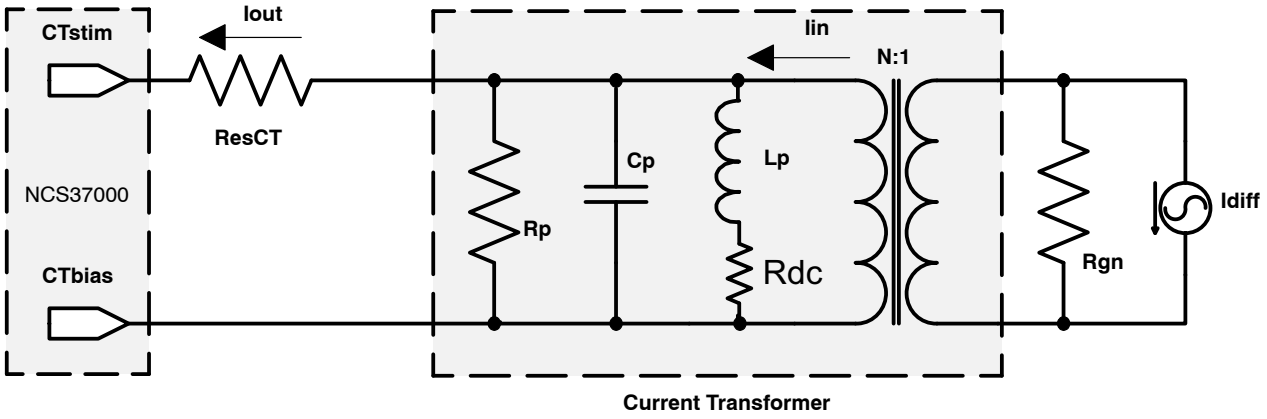

Figure 2. Current Transformer Model

Current Transformer

The current transformer and the corresponding parasitics are shown in Figure 2. Typically the core material is made of either ferrite or nano−crystalline material. The transformer requires a permeability (μ) greater than 10,000. N is the number of turns on the secondary side of the transformer and should be between 200 and 300.

L_p is the parallel inductance on the secondary side of the transformer and is defined by the following equation:

$$L_P = \frac{\mu N^2 A}{2\pi r}$$

Where A is equal to the cross sectional area of the transformer and r is the radius to the center line of the toroid.

R_p is the core loss of the current transformer and for the NCS37005 and typically is large enough that it does not affect performance of the differential detection. C_p is the parallel inter−winding capacitance that is dependent on the gauge of the wire and can be neglected if CapCT is used. Typically this value is very small and can be neglected.

Rdc is the resistance of the windings at the secondary and is very dependent on the gauge of the wire. An LRC meter is an effective tool to measure many of these current transformer parameters. These values should be measured at 60 Hz.

A key performance parameter of the current transformer is load shift which is the change in the differential trip level when a load is present on the primary side of the current transformer. Load shift is very dependent on the routing of the conductors through the primary opening. Optimal performance is achieved when these conductors have a linear path through the core center. Bends in the primary conductors (phase and neutral) should be avoided. If mechanical limitations require bends in the immediate vicinity of the current transformer then care should be taken to ensure that the routing creates balanced boundary conditions for the current transformer. Care should be taken to ensure that the winding on the secondary should be uniform and balanced around the toroid. Silicon steel washers can be placed on the top and bottom of the CT to improve load shift performance.

ResD and ResCT

The values of ResD, ResCT set the differential trip level of the GFCI. For ideal operation and to minimize current offset from the CT, the combination of ResCT and R_{DC} should be greater than 25 Ω.

$$\text{ResCT} + R_{DC} > 25\ \Omega$$

The differential trip level (I_{diff}) is typically set to 5 mA and is controlled by the following equation:

$$\text{ResD} = \frac{2N\left(R_{DC} + \text{ResCT} + 2\pi f_{AC} L_P\right)}{I_{diff}\left(R_{DC} + 2\pi f_{AC} L_P\right)}$$

f_{AC} is the frequency of the AC phase voltage which is usually 50/60 Hz.

CapIDF

The differential current low pass filter corner frequency is set by the following equation:

$$f_{idf} = \frac{1}{2\pi \cdot 1000 \cdot \text{CapIDF}}$$

The typical value for CapIDF is 180 nF to 470 nF.

ResMLD

ResMLD connects to the line−phase and also the MLD pin. It clamps the voltage on the MLD side to −1 V and +4 V. Allowable values are 200k to 1 MΩ and limit the current dissipated. An optional capacitor <1 nF can be added into to the MLD pin to ground for additional filtering.

ResMAIN and CapSUP

ResMAIN and CapSUP set the power up time and power dissipation of the GFCI. Power up time is set by the following equation:

$$t_{on} = 1.386 \cdot \text{ResMain} \cdot \text{CapSup}$$

and power dissipation is calculated with the following equation:

$$P_{max} = \frac{14400}{\text{ResMain}}$$

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