CAN Interface Circuit Design Guide

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ABSTRACT

This application note provides recommendations for the Can interface circuit design, including both schematic and layout.

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1. Introduction

This application note containing component, circuits design can guide user's development of CAN interface.

2. Schematic design

The schematic design takes TPT1042VQ for example as figure 1.

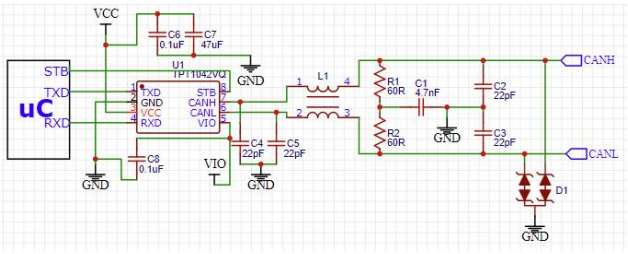

Figure. 1 interface circuit example

2.1 R1/R2 design

The value of R1 and R2 shall be 60 OHM for terminal node design, and in case of CANH short to Battery the current flow over R1 and R2 will increase ,the power consumption of each resistor in dominant level will be $p = (\frac{12}{60+60})^2 * 60 = 0.6W$ in the worst case, the recommended footprint is 1206 considering both failure case and PCB area.

For non-terminal node applications R1 and R2 can improve signal performance, reduce ringing and reflection in multi-node network. If the CAN network have more node the resistor value can be simply calculated as blow to guarantee the max current will not exceed transceiver's max specification.

TPT1042VQ Vcc current： $I_{cc(\max)} = 80mA$

According to ISO 11898-2:2016 max differential voltage $V_{od(\max)} = 3V$

So the total network load shall be:

$R_{load} > V_{od}/I_{cc\ (max)}$

For a network contains 32 nodes, assuming all the non-terminal nodes' resistor $R_{non-terminal}$ are equal, the calculation will be:

$$\frac{30}{R_{non-terminal}} + \frac{1}{120} + \frac{1}{120} < \frac{1}{R_{load}}$$

the actual value can be adjusted in addition to actual signal, and to simply design the common-use value is 1.3kOHM if the network contains less nodes.

2.2 L1 design

The common mode choke (CMC) can be used to reduce RF emission and improve electromagnetic immunity, such as bulk current injection. The value of CMC can be 51uH or 100uH according to OEM's specify requirements.

2.3 C1 design

This capacitor is used to improve bus signal and ability of electromagnetic immunity. C1 with load resistor build a low-pass filter to filter common-mode noise. The corner frequency can be calculated as below:

$$f = \frac{1}{2\pi * R_1 * C_1}$$

For terminal node R1=60OHM，C1 typical value will be 4.7nf and can range from 1 to 100nf. Under the typical value the corner frequency is $f = 560\text{kHz}$, which means noise frequency under 560kHz can be filtered and since this capacitor is not placed in signal trace so the filter will not influence data communication.

2.4 C2/C3 design

The capacitor can be used to also improve bus signal, the value depends on OEM's requirements but shall be under 100pf because large capacitor will slow signal edge, cause incorrect bit sample in actual application.

2.5 C4/C5 design

The capacitor can be used to reduce unwanted waveform in some special application caused by CMC and improve bus signal, it can be reserved in design and assembled when debug. The typical value is 22pf.

2.6 D1 design

This diode is recommended for ESD protection although 3PEAK can transceiver series are designed and

tested in 15kV IEC-ESD standard in some extreme case, the reverse stand-off voltage must be larger than system battery voltage to avoid huge current flowing over D1 in battery short to CANH case. PESD1CAN is Usually used in many OEM.

3. PCB design

The placement and route design guide are as below.

3.1 Placement design

- The ESD protection (e.g., TVS diode) shall be placed close to connector.
- The common mode choke places close to transceiver.
- The capacitor of Vcc and Vio places close to transceiver.

3.2 Route design

- Prohibit traces and copper fill beneath the common mode choke to avoid disturbance from CMC coupling to other signal or ground.
- CAN BUS traces as differential pair constraint to avoid common mode disturbance.
- CAN BUS have integrated Reference plane forbidden splitting crossing, Priority to inner layer routing.
- Hollowing out around CAN BUS signals.
- Avoid routing other signal lines parallel to the CAN BUS trace.
- Avoid loop Trace of CAN BUS.

3.3 Layout Example

This is a layout example highlight trace is CAN BUS.

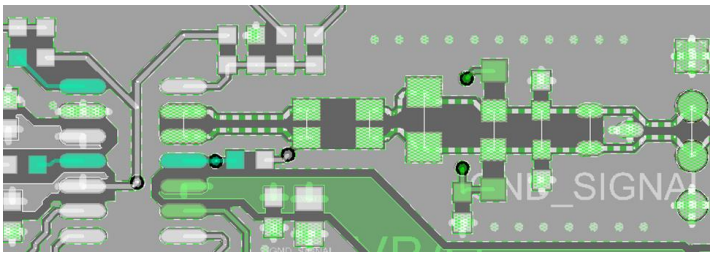

Figure. 2 layout example