Recommended Bypass Capacitance Values for the V_{CC} Pins of the UT63M147 MIL-STD-1553 Bus Transceiver and SμMMIT™ Family Controllers with Integrated 5V Transceivers

Table 1: Cross Reference of Applicable Products

Product Name	Product Revision	Internal PIC Number
UT63M147 Bus Transceiver	Rev G	JB01
UT63M147 Bus Transceiver	Rev A	JB03
UT69151 SμMMIT DXE	Rev D	MM016
UT69151 SμMMIT DXE	Rev C	MM023
UT69151 SμMMIT DXE	Rev C	MM025
UT69151 SμMMIT DXE	Rev C	MM027
UT69151 SμMMIT XTE	Rev G	MM019
UT69151 SμMMIT RTE	Rev D	MM022

1.0 Overview

The UT63M147 Transceiver is a complete transmitter and receiver pair for MIL-STD-1553 applications. Each transceiver has dual channels with independent power supply inputs for each channel. The SμMMIT controllers with integrated transceivers also have dedicated power supply inputs for the transceivers. During 1553 transmission, the transient currents on these V_{CC} inputs can be as high as several hundred milliamperes, requiring the designer to use a careful approach to power supply decoupling. This application note looks at the characterization of typical current transients on the V_{CC} inputs and makes recommendations for the proper bypass capacitance.

2.0 Lab Setup

In order to characterize the bypass requirements for the V_{CC} pin, it is first necessary to characterize I_{CC} under typical conditions. These conditions are listed in Table 2.

Table 2: UT63M147 Test Configuration

Parameter	Value
V_{CC}	5.0V
Input Frequency	1 MHz
Load	Standard Direct-Coupled Load with 35Ω Termination
Temperature	-40^{o}C, 25^{o}C, 125^{o}C

TXIN and $\overline{\text{TXIN}}$ are driven by a 1 MHz signal to simulate the case where the output drivers are being driven constantly. The load termination is a standard direct-coupled configuration as shown in Figure 6 of the UT63M147 data sheet. The laboratory setup is shown in Figure 1. To measure I_{DD} several capacitors are tied close to the input pin to ensure there is adequate charge needed to supply the ac component of the current. An ac-coupled current probe is used to monitor the ac component of I_{DD}.

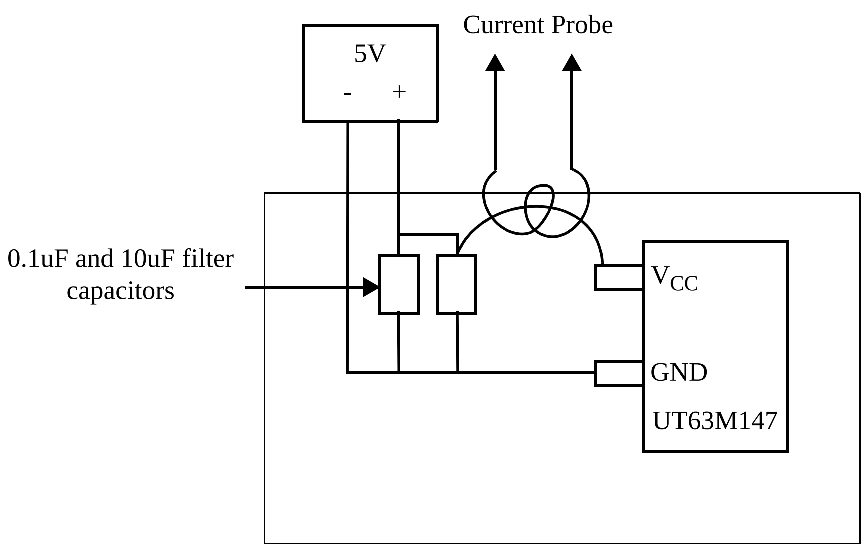

Figure 1. Laboratory Setup for Current Characterization.

3.0 Lab Results

The ac component of I_{DD} is shown in Figures 2, 3, and 4, corresponding to case temperatures of -40^{o}C, 25^{o}C, and 125^{o}C, respectively. The worst-case transient current is assumed to correspond to the occurrence of the highest peak-to-peak current, which occurs at 25^{o}C with a peak-to-peak current of 538mA. The current probe has a scaling factor of 1mA/mV.

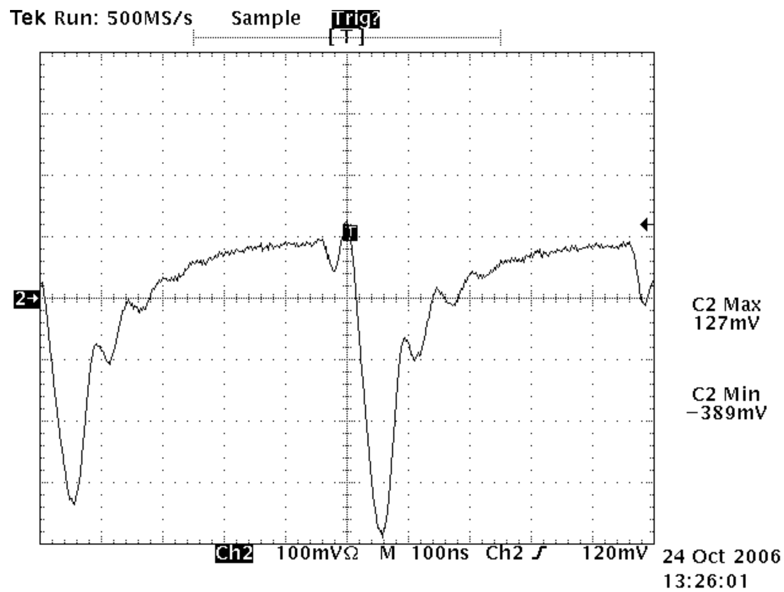

Figure 2. I_{DD} at T_c = -40^{o}C

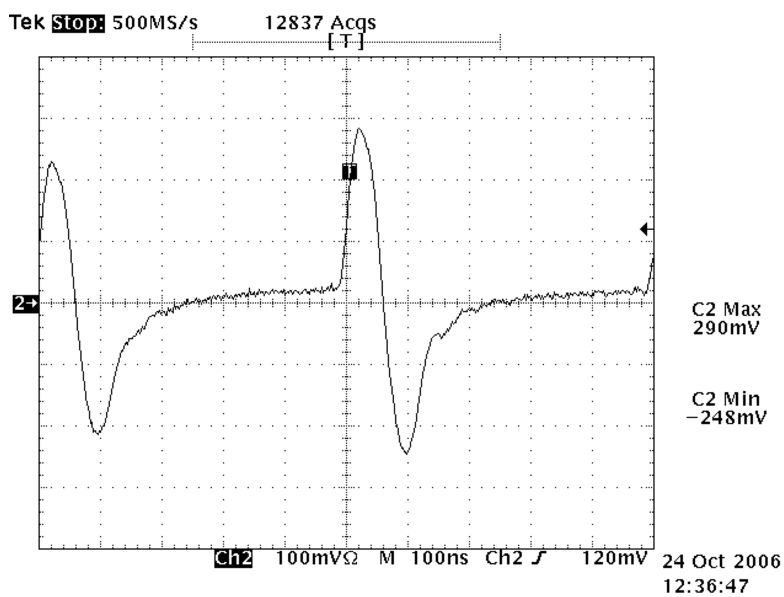

Figure 3. I_{DD} at T_c = 25^{o}C

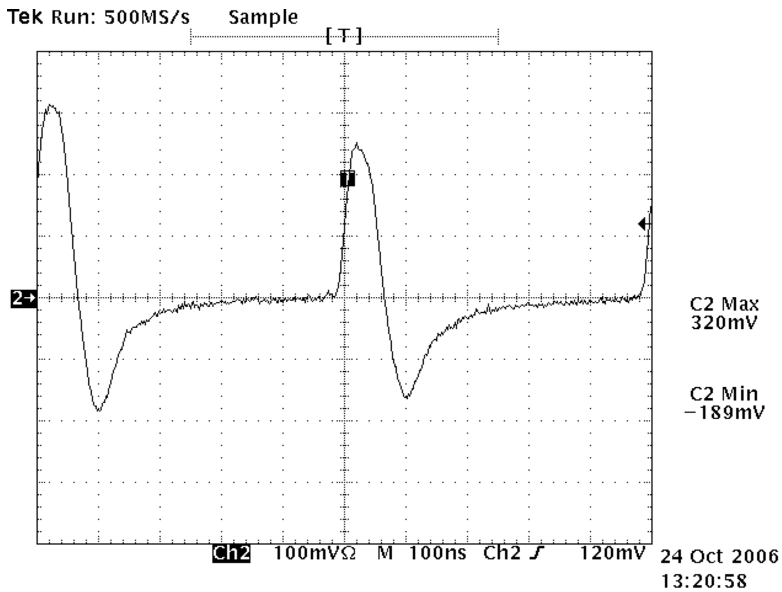

Figure 4. I_{DD} at T_c = 125^{o}C

4.0 Simulation Results

The voltage seen at the supply pin is determined by simulating a circuit using a piece-wise linear model for the current waveform in Figure 3, which corresponds to worst-case transient current. The voltage source is an ideal 5.0V dc source separated from the UT63M147 by a 60cm trace represented by a 680nH inductor and 0.1Ω resistor on both sides of the power supply. This represents a case where the power supply might be located remotely (e.g. where power is supplied via a backplane). A capacitor is placed directly on the power pin whose ESR is determined by assuming a 2.5% dissipation factor, typical for ceramic multi-layer chip capacitors. The circuit is simulated and the ripple voltage on the power pin is measured. The objective is to keep the supply voltage well within the recommended operating range of 4.5V to 5.5V. Table 3 shows the ripple voltage for several different capacitance values.

Table 3: Ripple Voltage for V_{CC}

Capacitance	ESR	Ripple Voltage	Minimum Voltage	Power Dissipation
0.01uF	0.4Ω	2.1V		
0.1uF	0.04Ω	134mV	4.9V	3.6mW
1.0uF	0.004Ω	13mV	>4.9V	3.6mW

The values in the table are approximations only, as the ripple voltage and power dissipation of the capacitor both depend upon the ESR, which depends upon the particular capacitor used. Furthermore, the power supply is assumed to be located remotely from the transceiver, and no ground plane is assumed in the simulation. Therefore, the ripple voltage will be lower in a properly designed system.

5.0 Conclusion

From the table it can be observed that a bypass capacitance of 1.0uF is sufficient to keep the supply voltage well within recommended operating conditions. In addition to this, a 0.1uF capacitor should be placed on each pin for higher frequency noise. Since the UT63M147 has dual channels, the bypass capacitors are required on each V_{CC} pin. The SμMMIT controllers should have these bypass capacitors on each V_{CC} pin. Use of these recommended bypass capacitors will reduce only the ripple voltage due to the ac component of the supply current. The designer should use additional filtering as required to reduce the coupling of lower or higher frequency noise and transients within the system due to neighboring components or other factors.