

# Product Errata: UT700 MIL-STD-1553 Noise Rejection Limitations

**Table 1.1 Cross Reference of Applicable Products**

Product Name:	Manufacturer Part Number	SMD #	Device Type	Internal PIC Number
UT700 LEON 3FT Microprocessor	UT700	5962-13238	All	WQ03

## 1. Overview/Problem Statement

MIL-STD-1553 paragraph 5.3 requires a terminal to pass a noise rejection test to ensure correct interoperability while exposed to a noisy environment. The noise rejection test requires injecting a band limited, 1.0K to 4MHz, White Gaussian noise at 140 mVrms (transformer coupled) or 200 mVrms (direct coupled) on the bus and transmitting a minimum of 40,000,000 data words without any message errors. This erratum explains why meeting the noise rejection test is a challenge for the GR1553 core contained in the UT700.

## 2. Technical Background

The GR1553 is a MIL-STD-1553 compliant protocol controller for the UT700. The GR1553 has the ability to operate as a Remote Terminal, Bus Controller, and Bus Monitor. Certification of a MIL-STD-1553 device typically involves testing the Remote Terminal operations. The GR1553 protocol controller is configured to operate as a Remote Terminal during the certification testing. The noise rejection test results are a function of the protocol controller as well as the transceiver and transformer. It is typical of most transceivers to pass a narrow pulse as a result of noise on the bus. Protocol controllers designed to filter the narrow pulses are unaffected. Since each protocol controller is designed to evaluate the width and proximity of random pulses differently, sensitivity to noise induced pulses will differ between manufactures.

## 3. Specific Description of the Problem

The MIL-STD-1553 interface used for the UT700 has a potential to fail the noise rejection test requirements specified in MIL-STD-1553 due to two built in features of the GR1553 interface. The GR1553 has the ability to monitor for invalid sync or parity bits. An invalid sync bit or erroneous glitch occurring within 3  $\mu$ s of a valid message will cause the message to be rejected. An invalid parity bit will also cause the message to be rejected. Rejecting a message with invalid symbols is desirable with additional checks to ensure subsequent symbols are not valid. However, the decoder circuit used for the GR1553 interface monitors for pulses greater than 150ns wide and potentially will evaluate the pulse as erroneous or invalid and prevent processing of messages received within 3  $\mu$ s of this pulse. The 3  $\mu$ s window permits time for controller to reset to an operational state. Also, there are times when the decoder may interpret the last received parity bit as too wide or too narrow, which would inhibit a response.

## 4. Implications

Impact on the system/user when encountered:

- Remote Terminal validation testing of the UT700 determined that the product passes the MIL-STD-1553 noise induced word error rate of 1E-7 at a noise amplitude of 100 mVrms. At noise levels >100 mVrms, the associate error rate increased in accordance with the plot shown in figure 21.1
- MIL-STD-1553 testing has a correlation between the message rate and the word rate, since each transfer consists of a command word and 32 data words. Because the UT700 error rate is strongly correlated to the idle time just before the command word's sync pulse and right after the final data word's parity bit, the error rate is a function of the message rate. Assuming a maximum word error rate of 1E-7 that requires a minimum of 303.03 k messages, the

maximum message error rate would be 3.3E-6. Therefore, the retry rate is expected to increase proportionally to the noise level as see in the following figure:

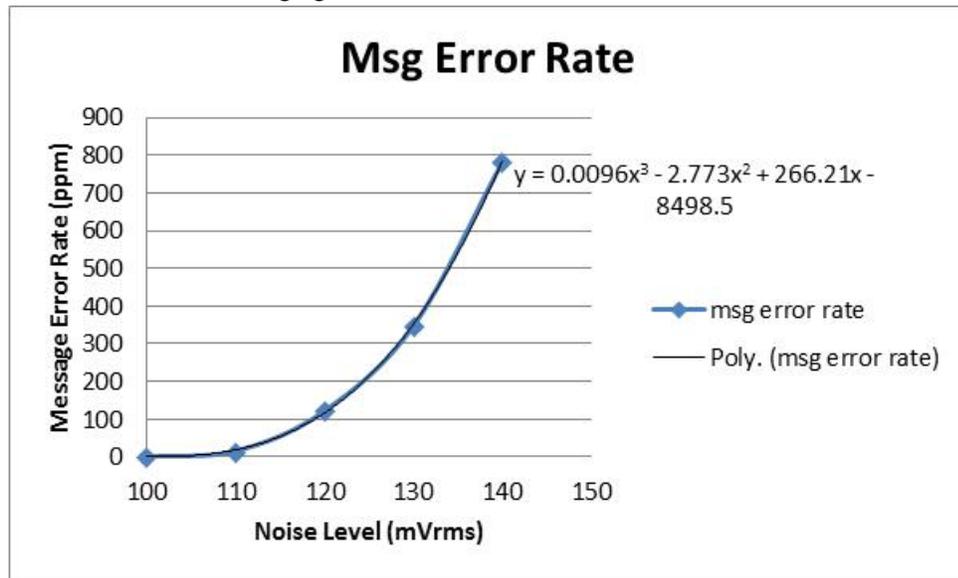


Figure 1.1 UT700 MIL-STD-1553 Message Error Rate vs Noise Amplitude

## 5. Workarounds

### **Best practice for PCB layout of transceiver and transformers**

Designing the PCB with the least amount of skew between receiver input lines on the bus side will help minimize susceptibility to the noise, particularly at zero crossing. Part of the noise protection in a terminal relies on the filtering capabilities of the transformers, using high quality transformers will lower the susceptibility to system noise. Additionally, ensuring there are no signal, ground, or power planes beneath the transformers optimizes the transformer filtering capability.

### **Provide an appropriate budget for noise induced retries**

Planning for a reduction in performance by allowing system retries for any message where the RT did not provide a response ensures the system meets the mission requirements.

### **Reduce the noise exposure to the system**

Enhancing the power filtering, cable shielding, and environmental shielding can reduce the likelihood that noise will affect the system.

### **Summary/Conclusion and Possible Corrective Action**

The protocol controller used in the UT700 may prevent passing the noise rejection test as prescribed by MIL-STD-1553. However, typical space vehicles don't experience the level of noise specified in MIL-STD-1553, paragraph 5.3. The expected performance reduction in data rate can be compensated by proper planning of bus traffic and system bandwidth. Additionally, enhanced shielding and best practices applied to the PCB and operating environment will reduce the susceptibility a system to noise.