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Nicholas Abbondante
Transmitter Staff Engineer
Intertek
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Dear Nicholas:

Please see below our report on the duty cycle of the radio module used in the Ingersoll Rand QX tool.

Purpose:
To determine the duty cycle of the CEL's ZFSM-201-1 / ZFSM-201-2 radio module in our application.

Equipment:

a) Tektronix MSO 4104-6 Mixed Domain Oscilloscope
b) Source transceiver: Ingersoll Rand QX tool with VP1-A888W wireless back cap programmed with EOR generator software version 2.0.4.48
c) Destination transceiver: Ingersoll Rand 84737-A499-PCM

Test / Calculation:
The scenario that will result in the highest duty cycle in our application is defined as the source transceiver sending 1200 End-of-Run data (EOR's) backlog to the destination transceiver. For this test, the EOR generator software was used to simulate this worst case scenario where an EOR packet was transmitted every 500 ms interval (shown in Fig. 1). The EOR packet was received on pin 37 (active LOW and idling HIGH) of the source transceiver radio module through the Universal Asynchronous Receiver/Transmitter (UART) interface which has a data rate of 57600 bit/s. The packet was then sent wirelessly at a data rate of 250000 bit/s. The destination transceiver was disconnected after the source transceiver was mapped so that each EOR would have three additional attempts/resends at the wireless level.

The duty cycle was determined by using a mixed domain oscilloscope. As shown in Figure 2, the yellow signal was the EOR packet through the UART interface and the orange signal was the EOR packet through the wireless interface. From the oscilloscope shot (shown in Fig. 3), the wireless transmission period of an EOR packet was measured to be 3.620 ms.

With the destination transceiver disconnected, the source transceiver will have 3 retries per packet on the wireless interface due to it not receiving an acknowledgement from the destination transceiver. The transmission period of the retries is the same length as the original transmitted packet (shown in Fig. 4 – Fig. 6).

Transmission period of an EOR with 3 additional retries = (3.620 ms)*4 = 14.48 ms

Since the EOR transmission is repetitive and has the same pattern every 500 ms (measured to be 506.9 ms on the oscilloscope), the average duty cycle for 6 minutes is the same as the duty cycle for 500 ms where an EOR and three additional retries are transmitted wirelessly.

Duty cycle = 14.48 ms/500 ms = 2.896%

Appendix:

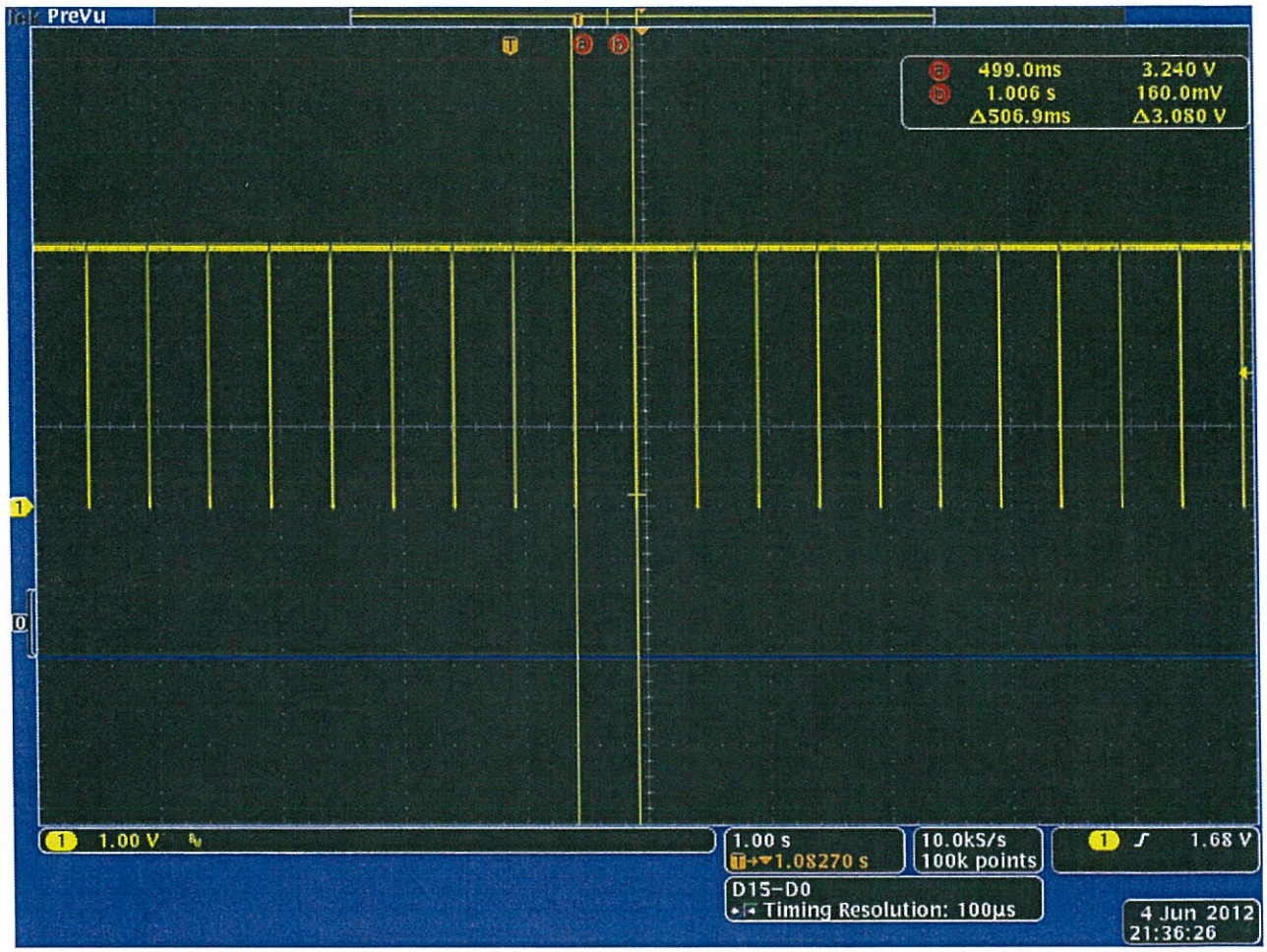

Figure 1: Oscilloscope shot of EOR transmission on the UART interface over the course of 10 seconds. An EOR was transmitted every 500 ms.

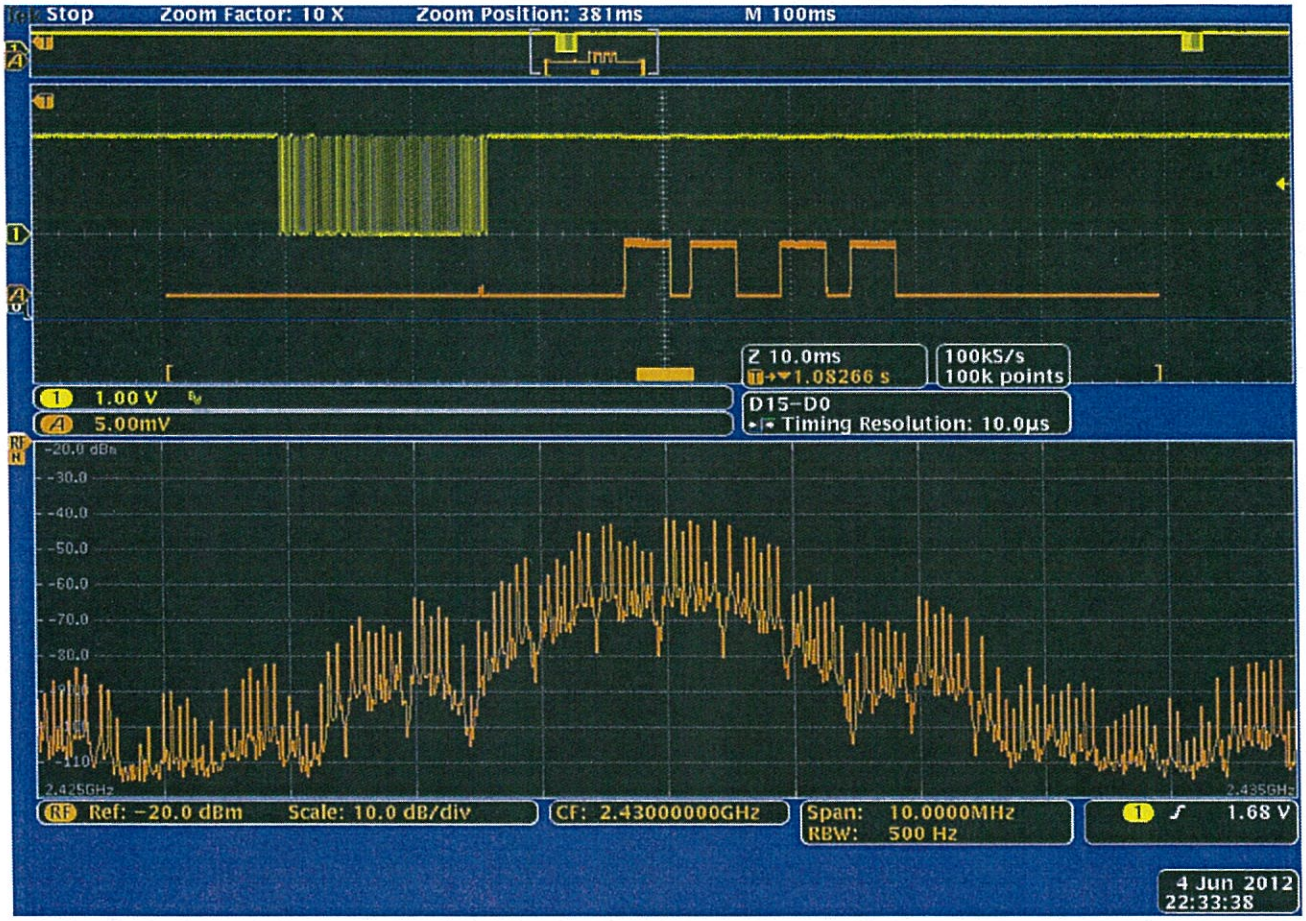

Figure 2: Zoomed in view of a single EOR packet. The yellow signal is the EOR packet through the UART interface and the orange signal is the EOR packet through the wireless interface.

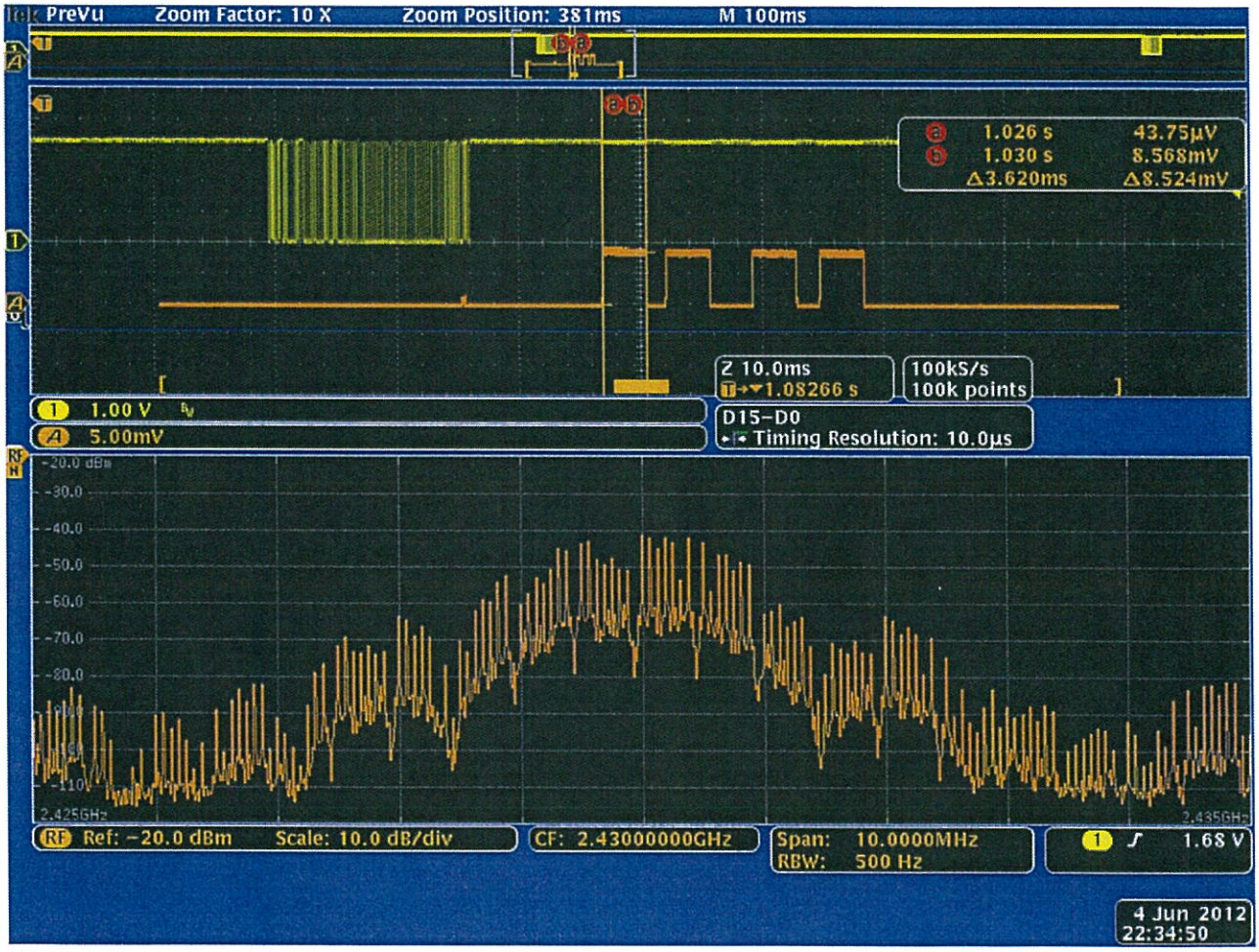

Figure 3: Wireless transmission of an EOR packet was measured to be 3.620 ms.

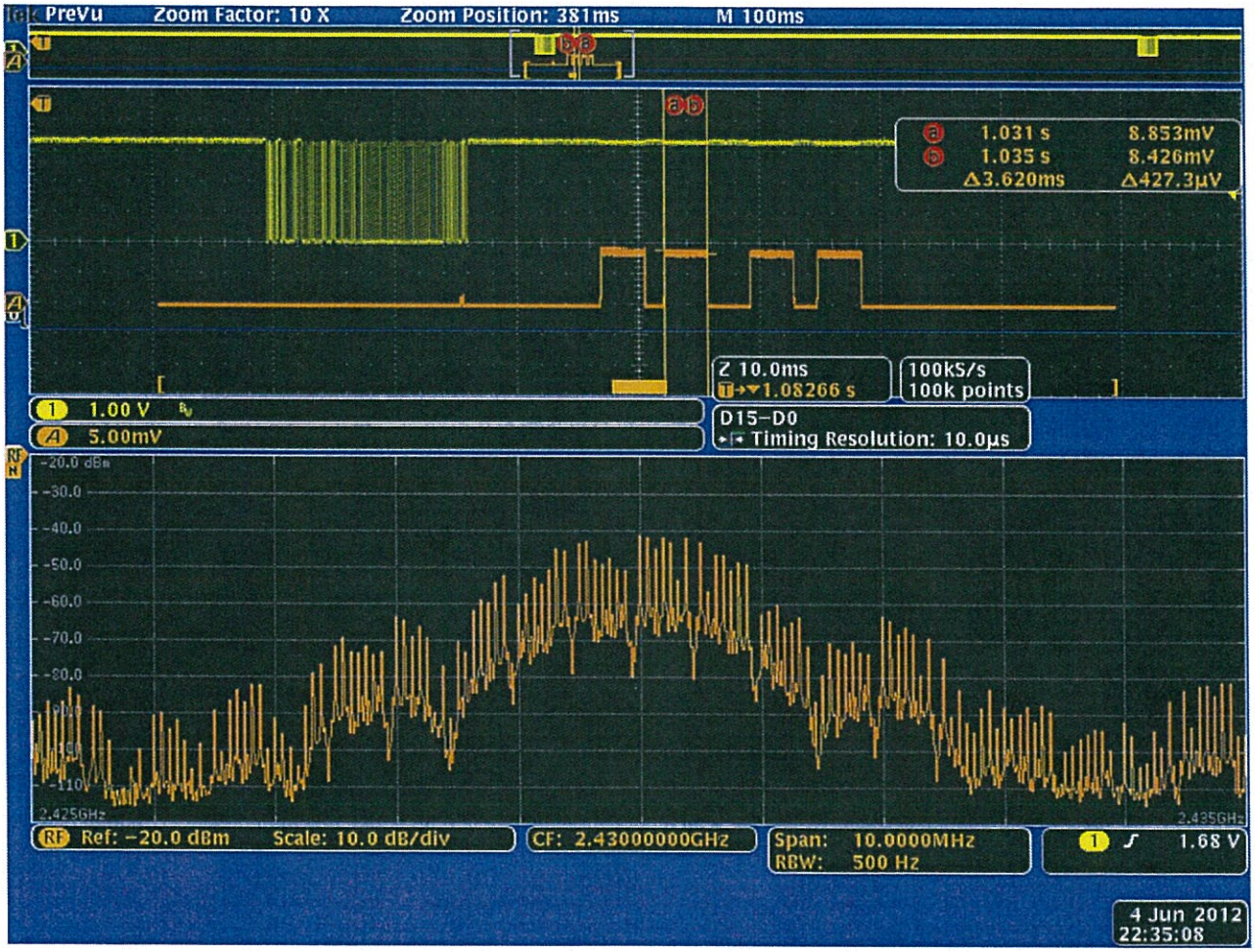

Figure 4: First retry of the EOR packet transmission was measured to be 3.620 ms.

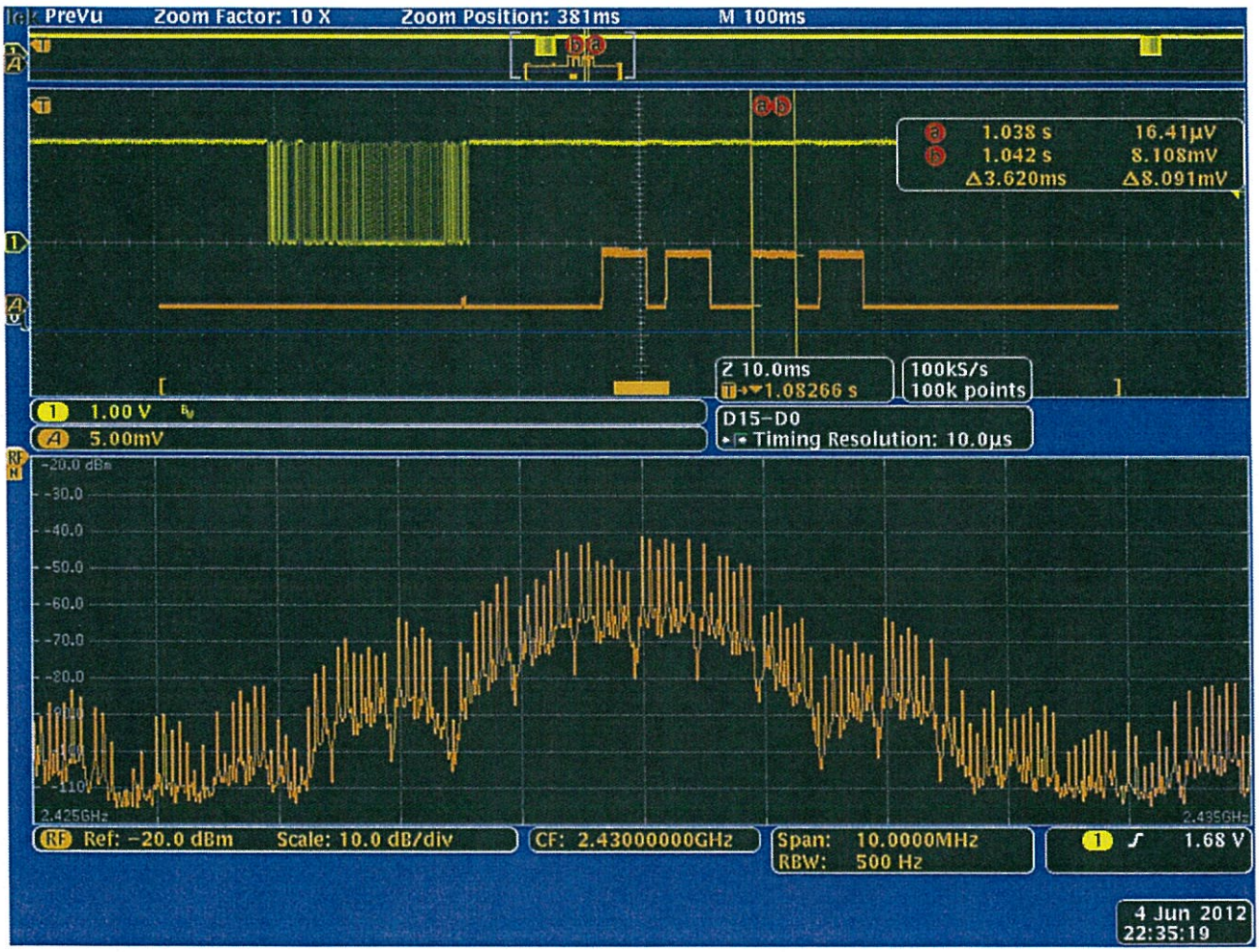

Figure 5: Second retry of the EOR packet transmission was measured to be 3.620 ms.

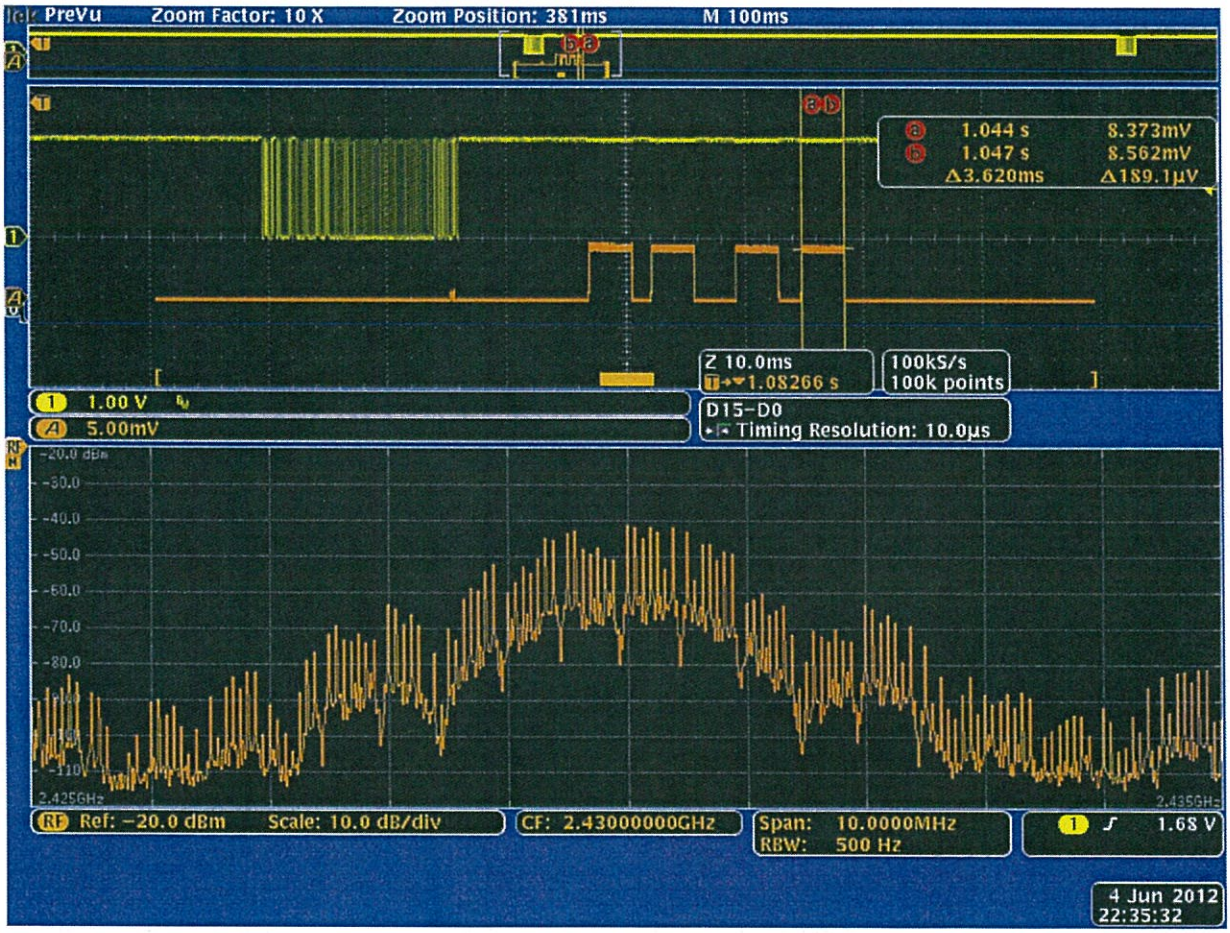

Figure 6: Third retry of the EOR packet transmission was measured to be 3.620 ms.

Test conducted by,

Kenny Tang
Controls Development Engineer

Test approved by,

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Director, Motors, Controls & Software Engineering