RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #7

Notes on DME ACI Figures

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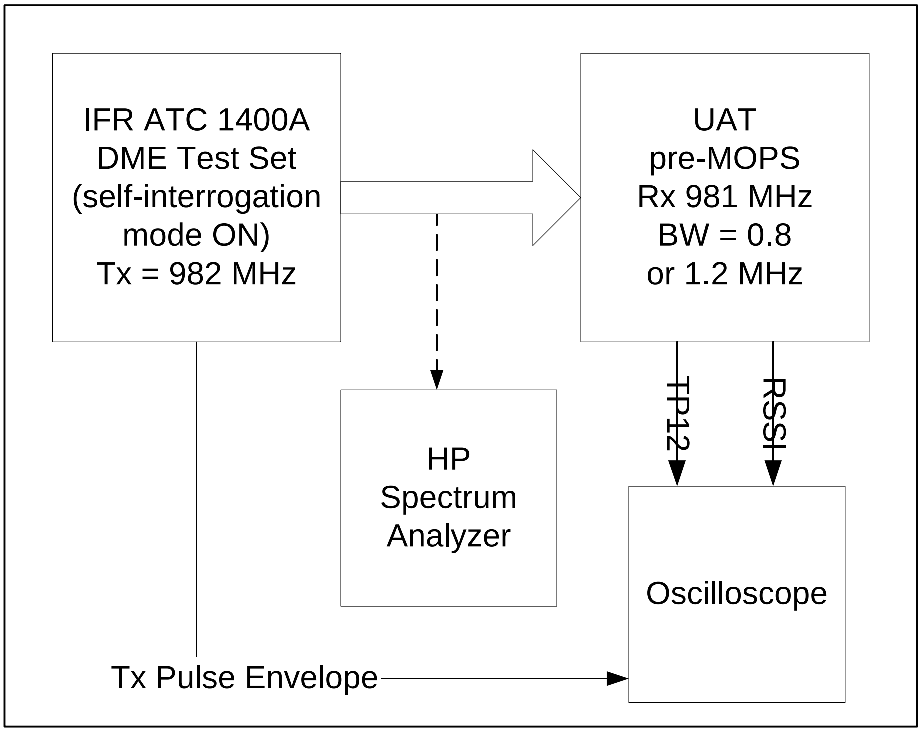
SUMMARY
This document provides a discussion of some measurements of the effect of DME pulse pairs on the prototype UAT receiver output. This material was originally presented via a conference call to Meeting #7, in response to Action Item 6-2.

Introduction:
Action Item 6-2 asked for an experimental evaluation of the effect of adjacent channel DME pulse pairs on the prototype UAT receiver output, for both receiver bandwidths provided by the pre-MOPS UAT units. The following diagram shows the experimental setup.



Note that in the text and figures, the wider of the two receiver bandwidth filters is referred to as either 1.0 MHz (the 3dB BW), or 1.2 MHz (the 6 dB BW). Similarly, the narrower filter is referred to as 0.75 MHz or 0.8 MHz BW.

Figure 1:
Figure 1 shows the spectrum of the output of the DME test set. The spectrum analyzer was set for a 1.0 MHz bandwidth, centered at 981 MHz, with the display set for Peak Hold. The test set output level was 0 dBm. The DME output spectrum is very clean, due to the shape of the DME pulse pairs, but still occupies a significant amount of adjacent spectrum. The spectrum analyzer bandwidth setting that most closely matches that of the UAT receiver is 1.0 MHz. The markers in the figure show that when measured in a 1.0 MHz bandwidth, the adjacent channel DME signal emits energy that is on-channel for the UAT with only 10 dB of attenuation from the DME signal peak.

Figure 2:
Figure 2 shows the prototype UAT receiver output (TP12) and Received Signal Strength Indication (RSSI) while receiving a low-level DME adjacent channel pulse pair (-70 dBm). The receiver bandwidth is 1.2 MHz. The Tx Pulse Envelope signal is used as the trigger for the oscilloscope, and shows both halves of the DME pulse pair separated by 12 usec. The oscilloscope display is set for infinite persistence. The DME pulse can be seen to appear at the receiver RSSI output, delayed by about 1.5 divisions, or about 3.7 usec. Delays in the receiver are predominated by the SAW filter absolute delay parameter, which has a typical value of 3.6 usec. The DME pulse delay is consistent with expectations.

Since the RSSI signal is only a manufacturing tuning aid, it has very limited dynamic range, and does not provide a calibrated signal level output.

The TP12 receiver baseband output is shown at the top of Figure 2. Since the receiver uses a FM discriminator, and since there is no desired signal present, the receiver output is wide noise prior to the arrival of the DME signal. When the pulse arrives, it quiets the receiver output, and pulls the FM discriminator to a lower output voltage. This is due to the inverting characteristic of the prototype receiver (higher frequencies give lower output voltages, and vice versa). The receiver output does not become totally quiet, nor does the RSSI signal become saturated, both of which show that the level of DME signal received is fairly weak.

TP12 also shows that the duration of the receiver output is closely related to the length of each DME pulse.

Figure 3:
Figure 3 shows the result of increasing the DME signal level to by 30 dB, to –40 dBm. Note that the RSSI output now is saturating, and the TP12 receiver output is now at full quieting. The length of time that each DME pulse affects the receiver output is now much longer than the duration of the DME pulse itself. Note that the Tx Pulse Envelope signal from the DME test set is not scaled relative to the output power

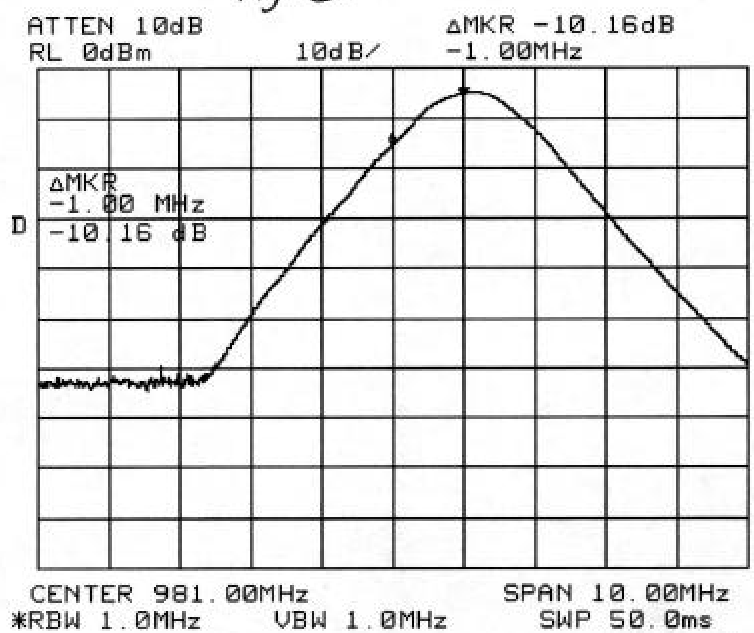
Figure 4:
Figure 4 shows the output of a 0.8 MHz BW receiver, under the same conditions as Figure 3. There is more noise on the TP12 and RSSI outputs than in Figure 3, which shows that the narrower receiver bandwidth is reducing the affect of the DME pulse on the receiver. The length of time that the DME pulse affects the receiver is less than that for the wider filter, but is still wider than the DME pulse itself.

Summary:
High levels of adjacent channel DME have been shown to have an affect on the prototype UAT receiver output. The affect persists beyond the duration of the DME pulse itself. The affect is reduced by using a narrower receive bandwidth.

The cause of the pulse-stretching effect remains to be determined. Some candidates for investigation are charge storage due to saturation of the IF amplifiers, or (as hinted to by Figure 4) possibly excessive triple-transit distortion in the receiver SAW filter.

Further research into this effect will be carried out if the test evaluation of the pre-MOPS UATs shows that it is necessary. It is likely that some improvement in performance is possible, but the scope of the effort is not immediately clear.

Fig ①



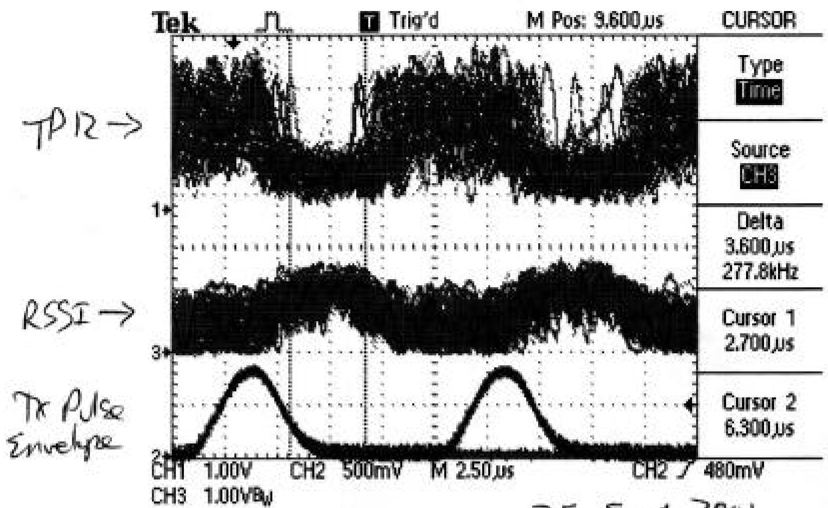
24 Sept 2001
T. Meshar

ATC1400A DME OUTPUT. RF Level Ø dBm

f_0 = 982 MHz

BW = 1.0 MHz

Fig ②



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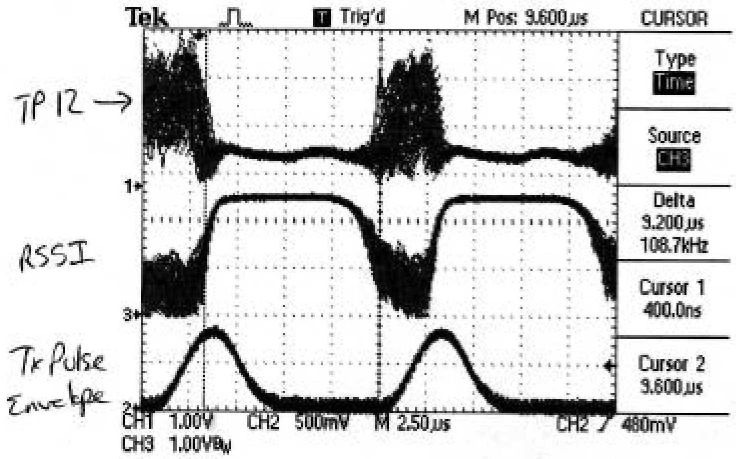
Rx BW 1.0 MHz

RF Level (DME) -70dBm

Fig. 3



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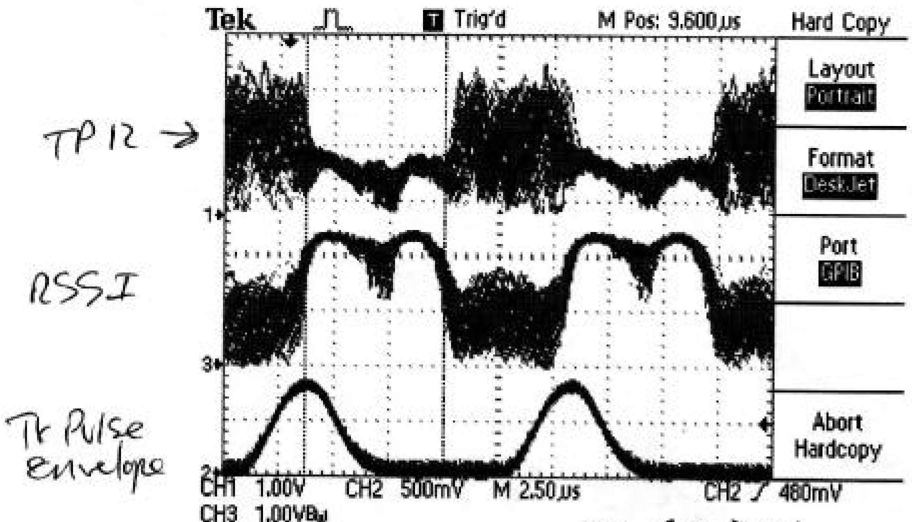
Rx BW 1.0 MHz
RF Level (DME) -40 dBm

Fig (4)



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Rx BW 750 KHz

RF Level (DME) = −40 dBm