



## Modem Application Note

### M500 Modem AUPC Guide

#### Revision History

Rev 0.1	6-30-2011	Initial Release.
Rev 0.2	7-15-2011	New diagram.
Rev 0.3	10-2-2011	Add AUPC Local mode.

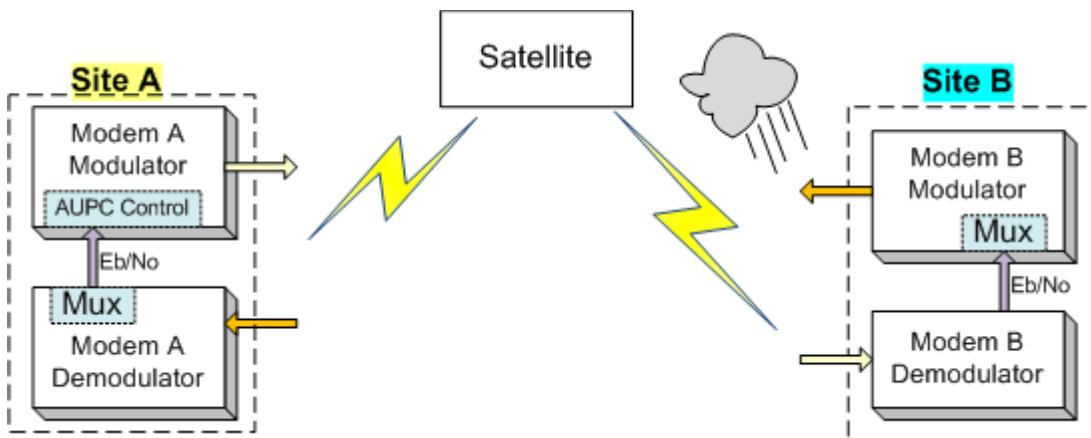
#### 1.0 AUPC Overview

AUPC or Automatic Uplink Power Control, is a link based automated feature intended to maintain a constant receive  $E_b/N_0$  over a varying link. Especially Ku Band satellite links suffer from varying amounts of loss due to weather and rain conditions on one or both ends. The M500 series modems accomplish this in each direction independently by communicating  $E_b/N_0$  information back to the transmitting end. AUPC is an integral part of all Datum Systems' M5 and M500 Series of satellite modems. This is referred to as Normal or Remote mode.

Beginning with M500 series modem software version 1.19 and above a second mode name Local is available. Local mode gets  $E_b/N_0$  information for controlling its transmit power from its own receive side. Although not the perfect method, this permits AUPC operation in a point to multi-point network.

#### 1.1 How AUPC Operates – Standard Remote Mode:

The basic AUPC “remote” operation is described as follows: Assume that the two modems, one at each end of the link, are set to AUPC operation. Only one direction is discussed, but the same functions could be occurring in both directions simultaneously. Modem “A” is transmitting to modem “B” under normal conditions and modem “B” has a receive  $E_b/N_0$  of 7.5 dB. Modem “A” has been set to an AUPC  $E_b/N_0$  on the front panel of 7.5 dB, and is currently outputting  $-15$  dBm. Next it begins raining at location “B”, and the  $E_b/N_0$  drops to  $-7.0$  then  $-6.8$  dB. Modem “B” is constantly sending update messages to “A” and reports the current  $E_b/N_0$ . When “A” sees the drop in  $E_b/N_0$ , it slowly begins to raise the output power, and raises it again when it sees further drops. As the rain increases in intensity, and the  $E_b/N_0$  decreases again, “A” continues to increase its power level to compensate. When the rain diminishes and later quits, it also lowers its power level to compensate. The operation is therefore a feedback control loop with the added complication of a significant time delay.



For this one direction example the normal method to provide a channel for the B modem to send its receive Eb/No information back to modem A is via a channel available in the modem's multiplexer. This requires that the B modulator multiplexer be enabled and also the A demodulator multiplexer. The multiplexers do not need to be enabled in the other direction if AUPC is not needed in that direction.

The multiplexer mode can be selected based on various criteria, but in most cases if no other overhead communications is needed then the "Custom" mode offers the lowest overhead to provide required channel bandwidth. Enhanced mode can also be used, but the standard mode is not usable as it has no dedicated Eb/No channel embedded.

There must be safeguards built into the AUPC system. First, the Modulator AUPC setup has two additional parameters which allow control of the maximum and minimum power output level. The other controls are built into the operating control software to limit response times and detect adverse operating conditions.

### **1.1.1 Basic Remote AUPC Setup**

The normal method for setting up AUPC over a point to point link is to use the PSM-500's built in multiplexer to provide the necessary communications channel. Since AUPC can be enabled in a single direction the multiplexer must be enabled in only the direction necessary to return Eb/No information to the controlled transmit modem. The best way to illustrate this is with an expansion of the example shown above for sites A and B. Here are the steps assuming that we start with a working link between A and B without any multiplexers or AUPC enabled. We will also assume that the desired receive Eb/No that we wish to maintain at site B is 7.0 dB.:

#### **Site B AUPC Setup**

1. Set the B Modulator Multiplexer to Custom mode.
2. If not using the ESC channel for another reason, set the ESC Overhead to "Disabled".
3. Set the MCC Overhead Rate to 1200 bps. This carries the AUPC information and 300 baud is the absolute minimum required. But in most cases you should start at this higher rate. You can always go back and try lower values. The speed here determines the time it takes to send the information.

#### **Site A AUPC Setup**

4. Set the A Demodulator Multiplexer to Custom mode (or match the B setup above).
5. If not using the ESC channel for another reason, set the ESC Overhead to "Disabled".
6. Set the MCC Overhead Rate to match that set for Site A above e.g. 1200 bps.  
[ The link should now be working again from B to A. ]
7. Set the Modulator IF AUPC to "Remote", Mode 1.
8. Set the Modulator IF AUPC Eb/No to that desired, e.g. 7.0 dB.
9. Set the Modulator IF AUPC Maximum Level to that desired allowing at least several dB above the nominal operating point for margin, e.g. -10.0 dBm.
10. Set the Modulator IF AUPC Minimum Level to that desired, e.g. -32.0 dBm.

The link should now be operating and using AUPC to set the A transmit level keeping the B receive Eb/No constant. Alarms will be generated if the transmit level reaches either the max or min level attempting to maintain the receive E/b/No.

The exact settings required can be further adjusted to account for the type of fading expected. For example if in a tropical environment with sudden heavy showers you may want to allow more power margin and possibly speeding up the response time by using a higher speed MCC channel.

To set the other direction to use AUPC, simply repeat the above instructions reversing the A and B site. Both can operate simultaneously and independently.

## **1.2 How AUPC Operates – Local Mode:**

Local AUPC operation of transmit carrier level being controlled by an Eb/No value is the same as in the remote mode. The difference is that the Eb/No is provided by the receive side of the same modem. Therefore no external or mux overhead Eb/No return channel is required. For a point to point link, the path to and from the satellite are the same but the direction of the data source is reversed and thus the frequencies relative to the location are also reversed. That means that the path frequency between Site B and the satellite is the B Site transmit frequency, where it was the B Site receive frequency in normal remote mode. Assuming Ku-Band for example if the rain attenuation at 14 GHz is different than at 12 GHz then an error is introduced into the correction loop. The same applies to the path and frequencies between Site A and the satellite.

Another potential source of error is that the controlled transmit Site A in many cases may have a large antenna, while the Site B may be small. The absolute Eb/No may therefore be different at Site A than at Site B, and this difference must be taken into account.

The local AUPC mode is also usable in a point to multi-point link as long as the common transmit device is a full modem and the demodulator is receiving a carrier from one of the remotes. The errors are worse when receiving at any other remote site because there is no Eb/No information to base setting of the carrier level.

So the local mode is simpler, does not require a mux channel and can work in a point to multi-point network. But it may have errors that can make it not ideal, and you must be aware of them.

### **1.2.1 Basic Local AUPC Setup**

The local AUPC setup simply requires setting up the AUPC parameters in the Site A transmitting modem. No changes are required at Site B. Here are the steps assuming that we start with a working link between A and B without any multiplexers or AUPC enabled. We will also assume that the desired receive Eb/No that we wish to maintain at site B is 7.0 dB.:

#### **Site A Local AUPC Setup**

1. Determine the current receive E/b/No at Site B, preferably in good conditions.
2. Read your own Site A Eb/No.
3. Set the Modulator IF AUPC to "Local", Mode 2.
4. Set the Modulator IF AUPC Eb/No to that desired, e.g. 7.0 dB + (Eb/No(A) – Eb/No(B)). As an example Eb/No(A) might be 10 and Eb/No(B) at 8, so the set point is 9.0 dB.
5. Set the Modulator IF AUPC Maximum Level to that desired allowing at least several dB above the nominal operating point for margin, e.g. -10.0 dBm.
6. Set the Modulator IF AUPC Minimum Level to that desired, e.g. -32.0 dBm.

The link should now be operating and using AUPC to set the A transmit level keeping its own receive Eb/No constant and therefore the B receive Eb/No almost constant. Alarms will be generated if the transmit level reaches either the max or min level attempting to maintain the receive E/b/No.

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