# The MTP gain equation

An analysis of the MTPBin VB code and an alternate approach

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In reverse engineering the Visual Basic (VB) code which implements the retrieval algorithm (known as MTPBin) for the Microwave Temperature Profiler (MTP), the gain equation has proven to be significantly challenging. Gain is used to convert MTP counts into a temperature (TA indexed by channel number and scan angle) in this equation from the function MTPbin::TBcalculation:

1. *TA(i, j) = OAT + (C(i, j) - C(i, LocHor)) / g(i)*

Where:

* C() is an array of raw counts from the instrument indexed by channel number (i) and angle (LocHor is the angle associated with the horizontal scan).
* OAT is the outside air temperature (provided in the Iwgadts line) in degrees kelvin.
* g() is an array of per channel gain values (for converting counts to temperatures)

*It is curious that OAT which is a measurement of the ambient outside air temperature is being adjusted by a value that ostensibly is a brightness temperature.*

g() in equation (1) is initialized to a value at the beginning of a flight and then is adjusted on a scan by scan basis in an iterative fashion. The latter piece is described first.

# Scan to Scan Adjustment to the per channel gain: g(i)

g() in equation (1) is determined iteratively for each MTP scan using the following equation:

Where:

* i is channel number
* Wtg is a constant = 0.1
* Gnd is calculated as follows:

*Gnd(i) = dND(i) / (Cnd0(i) \* (1# + Cnd1(i) \* dT + Cnd2(i) \* dT ^ 2))*

Where:

* i is channel number
* dND(i) is the difference in counts between the scan of the target with the noise diode turned on, and with it turned off. AKA Noise Diode Deflection.
* Cnd0, Cnd1 and Cnd2 are values whose origin I’m still trying to define, but I can say that they are found on the gain tab as shown in figure 1
* dT = Tnd – TrefND (which is irrelevant in our case because Cnd1 andCnd2 are always 0.00)

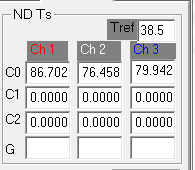


Figure 1: Cnd array values

Thus for the NCAR MTP instrument the equation simplifies to:

*Gnd(i) = dND(i) / (Cnd0(i))*

This implies that Cnd is a representation of the difference in “temperature” of the target with the noise diode on and with the noise diode off.

Looking at comments about Cnd0 in the code nets the following:

* “Noise Diode fit parameter”
* “Noise Diode Noise Temperatures”
* “Noise Diode Temperature Fit – Offset”

**Most notable about the gain adjustment is that it in no way uses Outside Air Temperature (OAT). It has been our understanding that OAT is a key component in the gain determination.**

# Initialization of the per channel gain: g(i)

Initialization of g(i) is described with the following bit of code:

' First time thru; give running avg gains: g(1), g(2), g(3) gain equation value

If g(1) = 0 Then g(1) = Geqn(1): g(2) = Geqn(2): g(3) = Geqn(3)

The VB code used to calculate Geqn has myriad options for determining how to go about the calculation. For this reason, I’ve chosen to assume that certain elements of the options are set in a particular way (which is consistent with how the software is used in post-production). The key to this is how the user interface is configured on the Gain tab in the Gain Equation section of the window (shown in Figure 2).

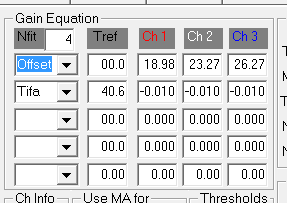


Figure 2: The Gain Equation portion of the Gain Tab in MTPBin