Computing Pressure and Temperature from Frequencies and Coefficients

The temperature-compensated pressure is computed from the two sensor output frequencies [link to freq counting.pdf] and the calibration coefficients. [link to pfile.html]

The output (PRESSURE) in units (psi) can be calculated from the two frequencies as follows:

Scale the frequencies according to the prescale algorithm specified in the coefficient file. All Downhole units use Prescale Algorithm 1 (PT = PP = 1) which has the following form:

PRESSURE PRESCALE: XP = MP(FP - FP0)
TEMPERATURE PRESCALE: XT = MT(FT - FT0).

where FP and FT are the measured pressure and temperature frequencies, respectively (standard or referenced-based, as appropriate).

The pressure is calculated from the coefficients and the two prescaled values, XP and XT, using the following equation:

PRESSURE = A + XP(B + XP(C + XP(D + XP(E)))),

where the coefficients A, B, C, D, and E are computed as:

A = A0 + XT(A1 + XT(A2 + XT(A3 + XT(A4))))
B = B0 + XT(B1 + XT(B2 + XT(B3 + XT(B4))))
C = C0 + XT(C1 + XT(C2 + XT(C3 + XT(C4))))
D = D0 + XT(D1 + XT(D2 + XT(D3 + XT(D4))))
E = E0 + XT(E1 + XT(E2 + XT(E3 + XT(E4)))).

The expansion above is for the maximum number of coefficients (a value of 4 is used for both NP and NT). For the typical case of NP = 3 and NT = 3, the terms A4, B4, C4, D4, and E0 through E4 will not be included.

The QuickBASIC program “compute.bas” provided on the coefficient disk demonstrates the reading of coefficient files and computation of pressure.

Algorithm for Computing Temperature from Frequency and a Coefficient File

Downhole transducers also provide for temperature readout. The temperature is computed from the internal temperature sensor, using the temperature coefficient file.

Note that the temperature indicated by the internal quartz resonator temperature sensor approximates the borehole temperature at equilibrium temperature. The

sensor is not designed for fast-response; because its primary purpose is temperature compensation of the pressure sensor, its response must be matched to the thermal response of the pressure sensor. If a fast response temperature sensor is required, it can be fabricated using a SERIES QT quartz resonator, which is available from Quartzdyne. The SERIES QT is the same temperature sensor that is used internally in the Downhole Transducers; the user can provide a fast thermal response high pressure package.

In all downhole transducers (except the obsolete TMC), the typical order of fit is NP = 0 and NT = 3, so the temperature can be calculated as follows:

TEMPERATURE PRESCALE: XT = MT(FT - FT0)
TEMPERATURE = A0 + XT(A1 + XT(A2 + XT(A3))).

The coefficients A0-A3, . . , D0-D3 above are from the temperature coefficient file [link to file format.html] on the supplied calibration disk; be sure to use the appropriate coefficients.

Four coefficient files are provided on the disk; the general forms are:

999999.CRF	Reference-based pressure coefficient file
999999.CFF	Standard pressure coefficient file
999999.CRT	Referenced-based temperature coefficient file
999999.CFT	Standard temperature coefficient file.

If the transducer's internal 7.2 MHz reference frequency [link to "reference-based" counting], is used as the timebase in frequency counting use the coefficient files with the extension .CRF and .CRT. If some other timebase frequency is used in counting, use the files with the extension .CFF and .CFT.