RDAC X OEM communications protocol

The RDAC X OEM sends out 4 different message types.
Frequency of transmissions per type is tuned such that items requiring fast screen updates are sent more frequently.

Baud rate is 19200 baud. Transmission format is asynchronous, 1 start bit, 8 data bits, 1 stop bit. No Parity.
Output is optically isolated. Signal lines are reference ground, data signal and supply. Supply is nominally +12V DC and is used to power a single pull-up resistor on the data signal line. This can also be provided externally so the power supply line can be disregarded. Typical pull-up resistors are recommended to be in the 4K7-10K range.
Please note that the polarity of the output signal is inverted with respect to ordinary RS232 levels.

Data formats used in message protocol:

Word: 16 bits, LSB first.
CKS1: Checksum from Message type to last data byte before CKS1. Seeded with $AA. Addition of all bytes in range modulo 256.
CKS2: Checksum from Message type to last data byte before CKS1. Seeded with $55. Logical xor of all bytes in range.

Message 1 – fuel flow related

$D5	DLE
$02	Start of text
$01	Message type
Flow 1	Word – number of flow sender pulses since last message 1
Flow 2	Word – pulse timing for fuel injector systems
CKS1	linear checksum
CKS2	xor checksum

Message 2 – Analog inputs and miscelaneous items

$D5	DLE
$02	Start of text
$02	Message type
OILT	Word – ADC reading on oil temperature input 0-4095
OILP	Word – ADC reading on oil pressure input 0-4095
LEVEL1	Word – ADC reading on fuel level input 1 0-4095
LEVEL2	Word – ADC reading on fuel level input 2 0-4095
VOLT	Word – supply voltage
ITEMP	Word – internal temperature
CHT1	Word – ADC reading on CHT1/WT input 0-4095
CHT2	Word – ADC reading on CHT2 input 0-4095
MAP	Word – ADC reading of manifold pressure sensor 0-4095
CKS1	linear checksum
CKS2	xor checksum

Message 3 – RPM

$D5	DLE
$02	Start of text
$03	Message type
RPM	Word – Value representing time between pulses on rev counter
CKS1	linear checksum
CKS2	xor checksum

Message 4 – Thermocouple temperature channels

$D5	DLE
$02	Start of text
$04	Message type
TC1	Word – temperature on TC 1 assuming degrees C and K-type
TC2	Word – temperature on TC 2 assuming degrees C and K-type
TC3	Word – temperature on TC 3 assuming degrees C and K-type
TC4	Word – temperature on TC 4 assuming degrees C and K-type
TC5	Word – temperature on TC 5 assuming degrees C and K-type
TC6	Word – temperature on TC 6 assuming degrees C and K-type
TC7	Word – temperature on TC 7 assuming degrees C and K-type
TC8	Word – temperature on TC 8 assuming degrees C and K-type
TC9	Word – temperature on TC 9 assuming degrees C and K-type
TC10	Word – temperature on TC 10 assuming degrees C and K-type
TC11	Word – temperature on TC 11 assuming degrees C and K-type
TC12	Word – temperature on TC 12 assuming degrees C and K-type
CKS1	linear checksum
CKS2	xor checksum

RPM timing information:

To calculate RPM, perform the following:

Calculate a fudge factor:
RevFudge:=(6000 div RevFactor)* 15586;

Where RevFactor is number of pulses for 10 revolutions.

Calculate RPM:

RPM:=RevFudge div RDACRevs;

Where RDACRevs is value from RDAC RPM message.

Note: If RDAC RPM value >30.000, set RPM = 0.

Fuel flow from injector calculations:

Flow2 Value is from 0-1000 representing injector opening times from 0-100.0%. If high side switched injectors are used, value should be inverted, i.e. 100%=0%.
Multiply opening time with user programmable factor to derive fuel flow.

Fuel flow using turbine flow sender:

Value Flow1 is number of pulses since last message. Measure time between messages to derive fuel flow using user progammable K-factor (pulses per liter of fuel flow).

Analog inputs:

All analog inputs have pull-up resistors to +5V DC (internal power supply rail). All measurements are made ratiometric with respect to the internal voltage.

Typical automotive sensors behave like variable resistors with one terminal connected to ground. This is true for NTC type temperature sensors, oil pressure sensors and fuel level senders.

Some capacitive fuel level senders have built in electronics that either emulate a normal resistive fuel level sender or have a voltage output. In the latter case these senders can be used if they are able to drive the pull-up resistor in the RDAC and have a voltage range compatible with a 0-5V DC range. A large range can perhaps be scaled down using a resistive divider network.

While the analog inputs have predetermined functions, they can however be used in any manner that suits a particular application. The predetermined functions should only be used as a guide line.

Thermocouple amplifier:

The thermocouple amplifier is optimised for K-type probes. These are highly linear within the temperature ranges used in automotive applications. Should other probe types be used, first subtract the internal temperature reading converted to degrees C from the TC reading and then convert the result according to the voltage output relationship of your probe to the K-type. Then add the internal temperature reading back.
The thermocouple outputs are calibrated for degrees C and are cold junction compensated using internal temperature.

Internal temperature:

Internal temperature is sensed using a LM335 sensor from National Semiconductor. The reading you get is the voltage produced by the sensor in binary form where 0=0V and 4095 is 5V DC. For conversion to degrees C please refer to the datasheet for the LM335 device.

Manifold pressure sender:

Calculation of pressure:

SensCorrect is a signed value to shift the offset and determined by adjusting the value until the calculated pressure equals a reference pressure (for example ambient pressure from an accurate barometer).

```
procedure CalculatePressure;
begin
  ADCWord:={pressure reading from RDAC}
  ADCWord:=ADCWord+SensCorrect;
  if ADCWord<168 then
  begin
    Pressure:=0;
  end else
  begin
    ADCWord:=ADCWord+180;
    Pressure:=ADCWord*100 div 163;
  end;
end;
```

The resultant pressure is in millibars, i.e. 1000 = 1 bar.
The pressure range of the built in sensor is approximately 0.2 to 2.5 bars.
Media compatibility is restricted to liquids and gases that are compatible with flouro-silicon.

Calibration procedure:
The RDAC comes precalibrated from the factory. Should calibration be required, perform the following procedure:

Internal temperature:
The internal temperature is used in the thermocouple cold junction compensation and needs to be fairly accurate (+/- 2 degrees).

TC amplifier gain:
The gain determines the temperature reading of the thermocouple channels after compensation. No further calibrations are required as the system is able to recalibrate offset drift automatically and continuously.

In order to calibrate internal temperature:
Open the unit and allow the temperature at the PCB to equalize with ambient temperature. Use an accurate reference thermometer to measure ambient temperature.
Close the “CAL” link close to the CPU, leave TC-1 unconnected.
The internal temperature reading is now equal to the TC-1 temperature reading, while the link is closed the internal temperature measurement will slowly increase and eventually wrap around to a low reading before increasing again (this cycle takes a few minutes). Remove the link on “CAL” when the correct temperature is measured. Wait about 30 seconds before removing power to allow the system to store new calibration values.

In order to calibrate TC amplifier gain:
This procedure should be performed after the internal temperature has been calibrated.
Apply 24.9mV DC from a low impedance power source to input TC-1, observing normal polarity. If required wire a large value capacitor across the TC-1 terminals if you have noise problems (suggested value: 100uF).
Verify the voltage with an accurate voltmeter before proceeding.
Close the “CAL” link close to the CPU. Wait until the temperature on TC-1 is measured as 600 degrees C plus internal temperature. For example, if the internal temperature is measured as 24 degrees C, wait for 624 degrees C.
Remove the link when this has been completed and wait 30 seconds before removing power to allow the calibration values to be stored.
Note: If you cannot get an exact temperature on TC-1, allow calibration to the nearest higher temperature reading before removing the link.