Description of TLL35X Code Operation

CA0520 TLL35x Iss8t Code Document 090819

This document is reorganised version of the earlier 'Operation of PA240 Twin Probe (8) 230112'

1. The software takes capacitance information from three channels;
    a. P0 refers to values taken from the electronics only. No capacitance probe connected.
    b. P1 refers to values taken from the measuring probe P1. The capacitance probe with the 4mm outer diameter PTFE and 12mm inner diameter aluminium tube is connected.
    c. P2 refers to values taken from the measuring probe P2. The capacitance probe with the 5mm outer diameter PTFE and 10mm inner diameter aluminium tube is connected.
2. Set up probe output, output range and high/low alarm levels etc using GUI setup screen.
3. Calibrate probe in Diesel:
    a. Do not pre-wet probe before taking empty readings
    b. Power up at empty with calibration pad connected to ground (for 10 seconds)
        i. Value of $P1\_at\_empty$ is recorded 16 bit
        ii. Value of $P2\_at\_empty$ is recorded 16 bit
        iii. Value of $P0\_at\_empty$ is recorded. P0 is the value obtained when both probes are deselected. 16 bits
    c. Remove ground connection from calibration pad and insert in diesel up to full level. Reconnect calibration pad to ground (for another 10 seconds)
        i. Value of $P1\_at\_full$ recorded 16 bit
        ii. Value of $P2\_at\_full$ recorded 16 bit
    d. Calculate value of P1 raw span:

$$raw\_p1\_span = P1\_at\_full - P1\_at\_empty$$ 16 bit

    e. Calculate value of P2 raw span:

$$raw\_p2\_span = P2\_at\_full - P2\_at\_empty$$ 16 bit

f. Calculate m. Constants 14.4 and 7.07 are derived from multi fluid testing:

$m = 14.4 – (7.07 \times (raw\_p1\_span) / (raw\_p2\_span))$

g. Calculate & record divisor at calibration. Constant 6.3 derived from multi fluid testing:

$div@cal = (m \times (raw\_p1\_span) / (raw\_p2\_span)) – 6.3$

h. Calculate value of probe span:

$p1\_span = raw\_p1\_span / div@cal$

i. Probe now fully calibrated

4. Probe now inserted into application fluid. Calculate current level in probes as follows:

a. Temperature effects on Electronics.

$P0_x = P0 - P0\_at\_empty$

If this is negative then set negative flag

$NEG = 1$

and create complement

$P0_x = (P0_x \ XOR\ 1111111111111111) + 1$

b. Temperature effects on Probe 1. Value of constant, 1.4, is based on empirical data. Value will be negative if negative flag set:

$P1\_drift\_factor = 1.4 \times (P0 - P0\_at\_empty)$

c. Temperature effects on Probe 2. Value of constant, 1.05, is based on empirical data. Value will be negative if negative flag set:

$P2\_drift\_factor = 1.05 \times (P0 - P0\_at\_empty)$

d. Current level in Probe 1.

$p1 = P1 - P1\_drift\_factor – P1\_at\_empty$

e. Current level in Probe 2

$p2 = P2 – P2\_drift\_factor – P2\_at\_empty$

f. Calculate live divisor

$div = m \times (p1/p2) - 6.3$

g. Average divisor is

$div\_average = (div_n + div_{n-1} + div_{n-2} \ldots\ldots + div_{n-15}) / 16$

h. Lower limitation on value of divisor is

$0.97 \times div@cal$

i. Every 15 minutes the average value of divisor is stored to EPROM. The EPROM has 1 x 10^6 write cycles so assuming 24-hour operation the probe has a life of 28.5 years.

$div\_average\_store = div\_average$

j. At low immersion levels the divisor calculation can be affected by turbulence and mechanical variations (probe eccentricity). To stop the calculation at low levels, a 20% diesel fill limitation is used

If $p1 < 0.2 \times raw\_P1\_span$,

then ignore *div_average* and use *div_average_store*

k. At power up condition, before a new divisor can be calculated, stored divisor is used. In the case of switching off and refilling the tank with a different fluid, an error might be apparent for first 5-10 seconds after power up while recalculation occurs.

l. Calculate level of fluid

$Q1 = p1/ div\_average /p1\_span$

m. Level Q1 is turned into a PWM signal from 0 to 1024. At this point the lower output offset and span are taken into account.

PWM 0 = 0% +ve duty cycle (output from micro is 0V)

PWM 1024 = 100% +ve duty cycle (output from micro is 5.1V)