CHANDLER PROGRAM

The program running on the CR10X in Chandler basically monitors the encoders every minute and average the values every twenty minutes. Flow is calculated for a twenty-minute period and is accumulated. The accumulated value is compared with a threshold. If reached, water samples are taken first in the downstream side and then in the Upstream side. This is because in the configuration installed in the field most of the water pumped from the Upstream side is dumped in the Downstream side, possibly causing changes in water composition in Downstream side if samples are taken simultaneously.

The equation for full pipe flow is used and adjusted by a factor if channel flow is present.

Flags are used in the following manner:

Flag 1: High to take sample, Low do not take sample yet. Is set high when the manual switch is pressed three times or the accumulated flow threshold is reached.

Flag 2 Control sequence of sampling between high capacity and small pumps. Low activates high capacity pumps, High activates small pumps.

Flag 3 If the bottle is almost full, stops the sampling. If No_of_samples which is the counter reaches 120, sampling is halted. High to halt sampling.

Flag 4 Used to manually set/unset 4 hour sample mode. Instructions for manually setting the flag are as follows:

* Using PC208W to remotely set flag 4 high:
;* 1. open PC208W
;* 2. click on 'Connect' icon
;* 3. select appropriate CR10 from 'station list' window
;* 4. click on 'terminal' tab (located on the bottom left)
;* 5. click on 'connect' (located on the bottom right)
;* 6. type 7h and press enter
;* 7. type '*6' and press enter
;* 8. type 'D'
;* -- display will show 0000.0000 which represents the 8 user flags (1-8)
;* -- numbered from left to right
;* 9. type '4' to toggle flag 4 high
;* -- display will show 0001.0000
;* -- typing '4' again will toggle flag 4 low
;* -- typing any number from 1-8 will toggle the corresponding flag
;* 10. click disconnect

Parameters for Culvert, Constants and Peak of flow used to calculate threshold are entered in routine 9.
The chart flow, formulas used to calculate flow and calculation of threshold are included below.

TABLE 1, Running interval= 10 sec

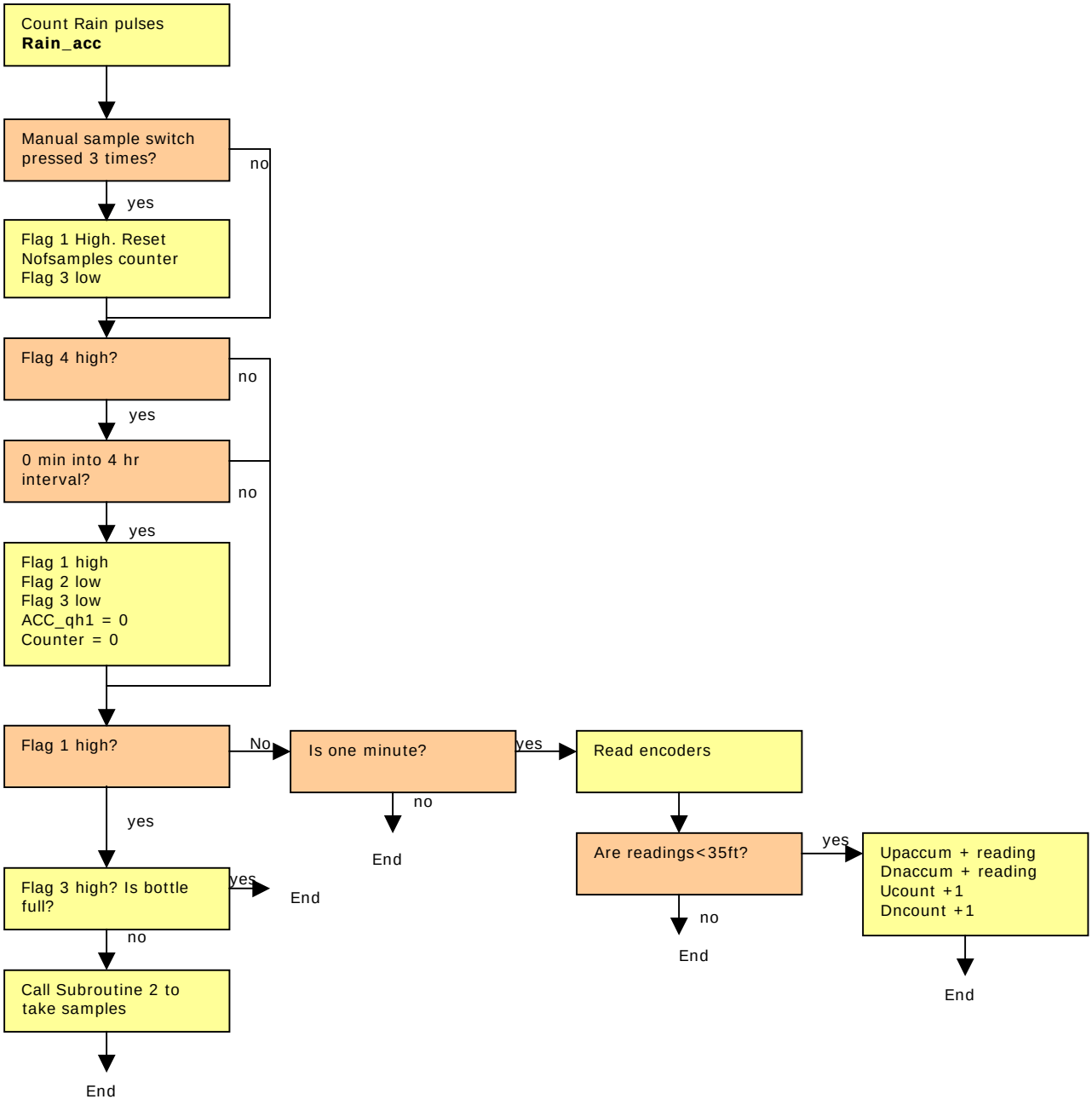
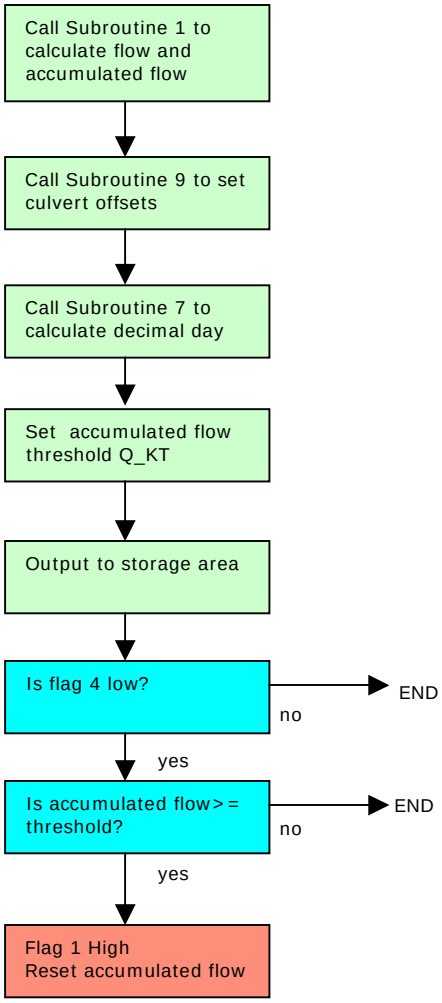


TABLE 2, Running interval= 20 minutes



Threshold calculations as follow:

Total Capacity of Reservoir = 19000 ml
Volume per sample = 150 ml
Total samples to fill reservoir = 19000ml / 150 ml = 127

If one week between samples in reservoir retrieval, the time between samples is:

7day *24hours*60min/127 = 80 min

The Peak of Flow expected in ONE Culvert has to be entered in the parameter Flow_Peak in the CR10 program. As an example with a Flow_peak of 7 cfs, the total volume through the pipes is:

7 cfs * 80 min * 60 sec = 33.600 cf.

This would be the accumulated Q threshold. However we have to set threshold in q (cfs) as the accumulated volume Q might be higher in magnitude than permitted in the CR10 final storage, which is 99999.

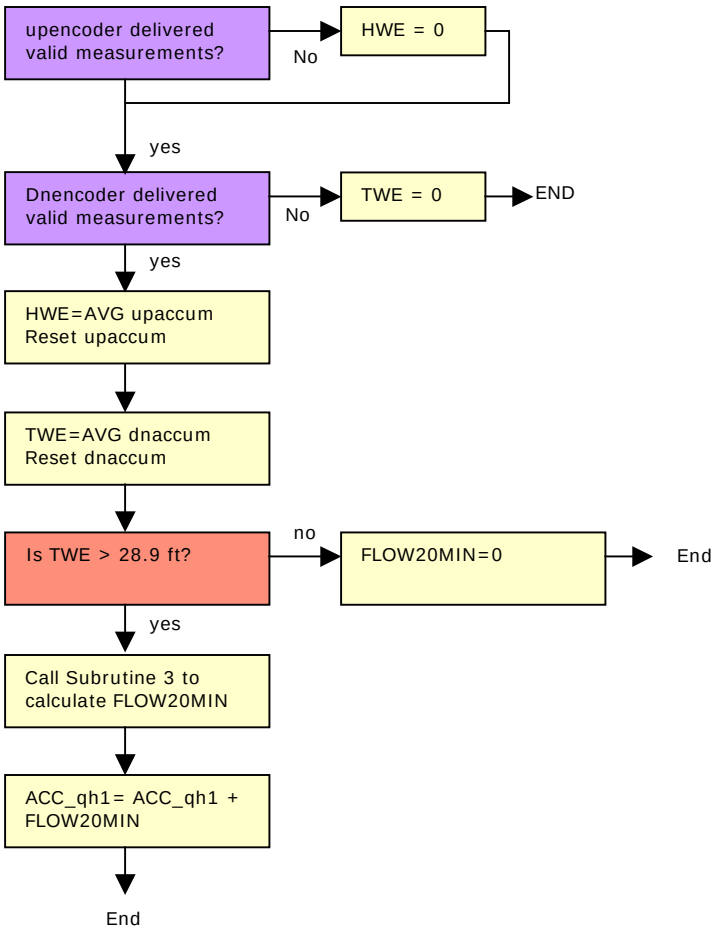
Table 2 which measures flow runs every 1200 sec. The accumulated flow reached with this volume would be:

33.600 cf / 1200 sec = 28 cfs.

Manual retrieval of samples should be done when No_of_ samples is close to 120.

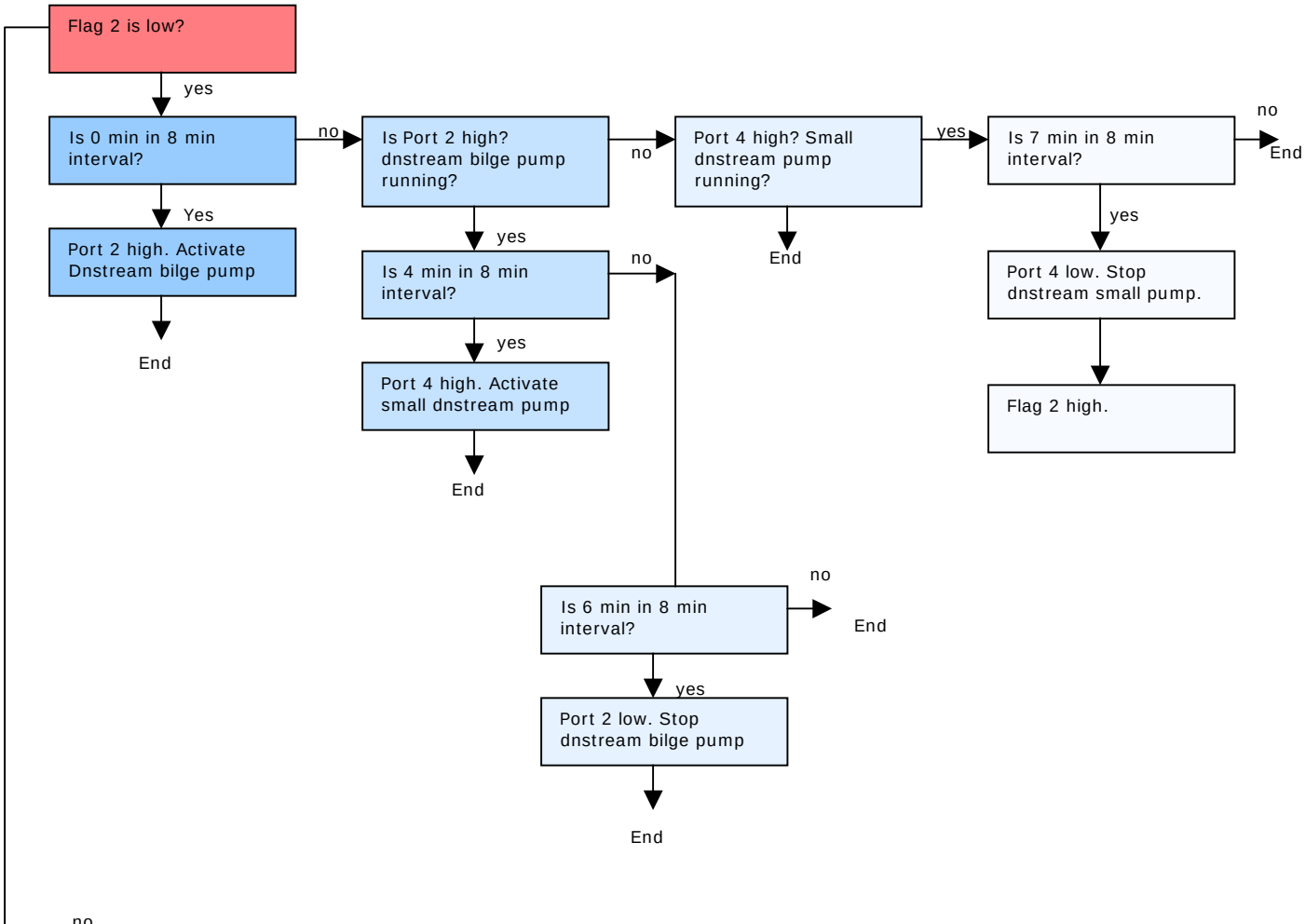
SUBROUTINE 1

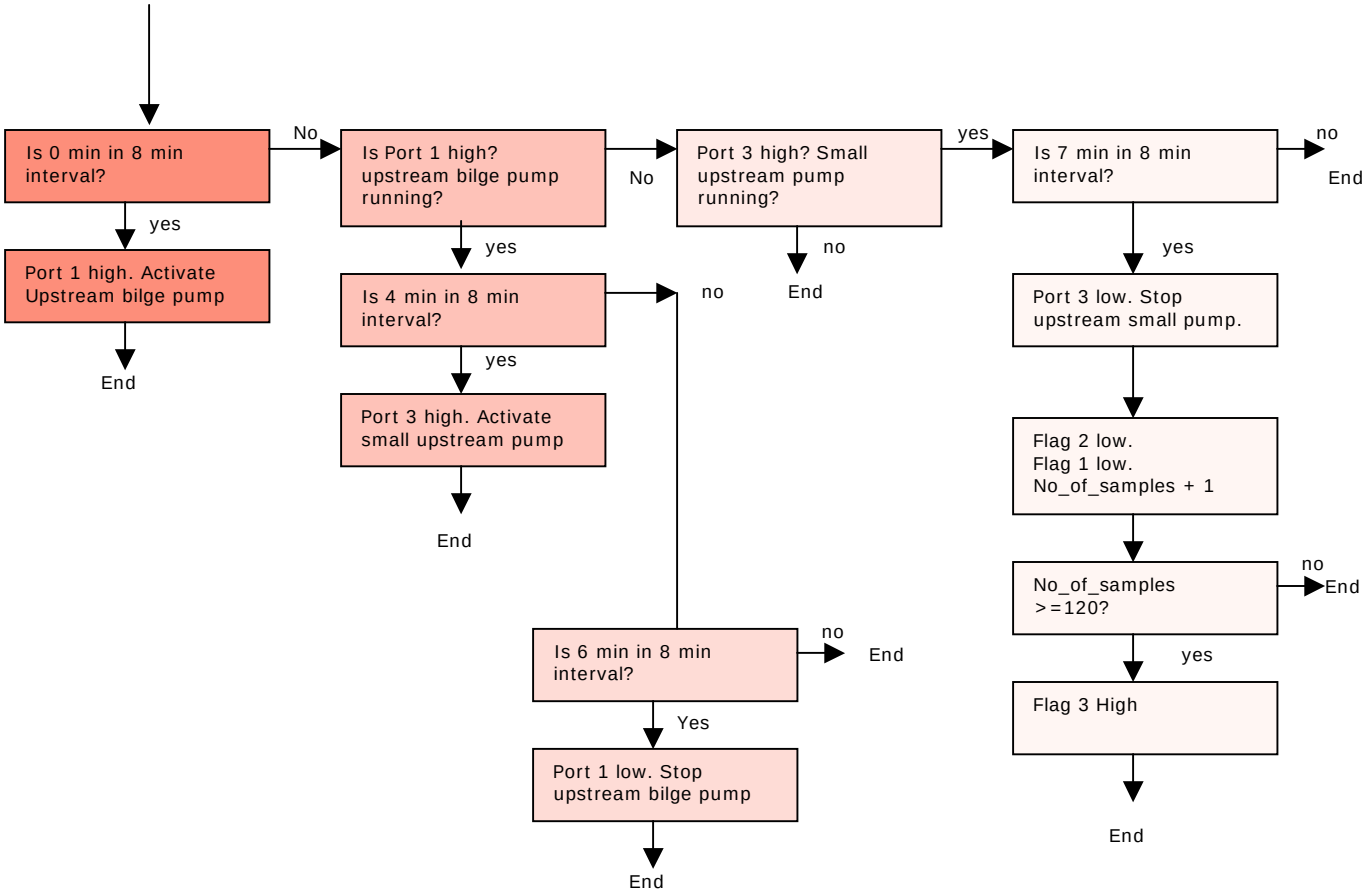
Calculates average HWE and TWE during execution interval (20 minutes), calculates average flow and stores it into FLOW20MIN, calculates accumulated flow, stores it into ACC_qh1
The encoder readings have been accumulated in upaccum and dnaccum from Table 1.
If TWE is less than 28.5, there is no flow in the channel due to the physical characteristics of the terrain.



SUBROUTINE 2

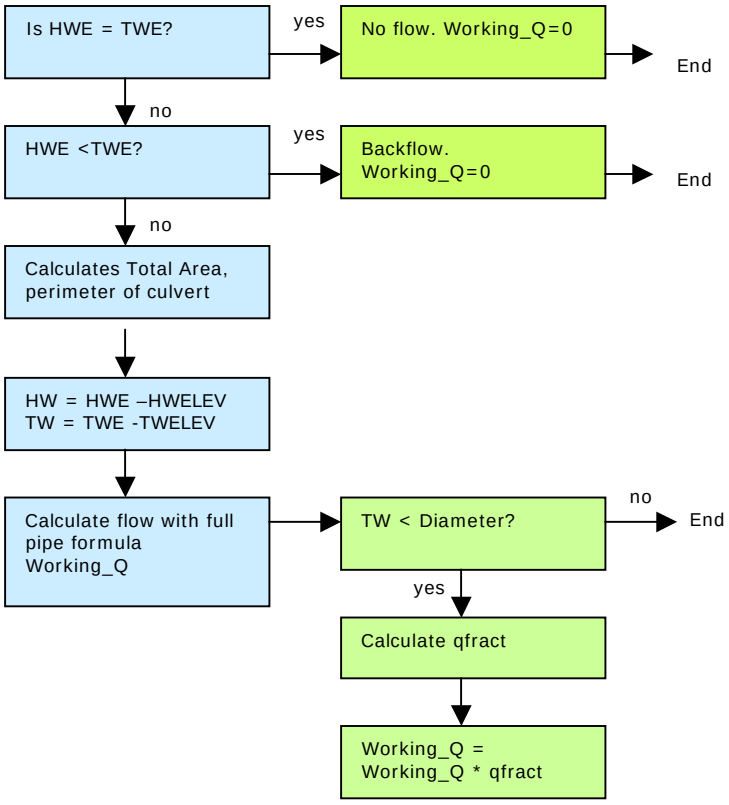
This subroutine is used to take the water samples upstream and downstream.
Flag 2 is used to control sampling sequence. Downstream samples are taken first, Flag 2 is low.
Then, Flag 2 is set high and Upstream samples are taken.




Is 0 min in 8 min interval?
No
Is Port 1 high? upstream bilge pump running?
No
Port 3 high? Small upstream pump running?
yes
Is 7 min in 8 min interval?
no
End
yes
Port 1 high. Activate Upstream bilge pump
End
yes
Is 4 min in 8 min interval?
no
End
yes
Port 3 high. Activate small upstream pump
End
yes
Port 3 low. Stop upstream small pump.
Flag 2 low.
Flag 1 low.
No_of_samples + 1
No_of_samples >=120?
no
End
yes
Flag 3 High
End
Is 6 min in 8 min interval?
no
End
Yes
Port 1 low. Stop upstream bilge pump
End

SUBROUTINE 3

Calculates Flow based on HWE and TWE. Output in Working_Q



FULL PIPE FLOW FORMULA

$$q = \pi r^2 \sqrt{64.4\,(HWE-TWE)/(KF+KE+1)}$$

$$KE = K$$
$$KF = 29.1\,\zeta^2\,L\,/(0.25\,D)^{1.333}$$

L= Length of Culvert
D= Diameter of Culvert

KE = K as we do not expect the case where Inlet is unsubmerged and outlet submerged. Both sides of the Culvert will be submerged if outlet is submerged.

Adjustment factor for channel flow

$$qfract = 0.0043 - 0.2857\,D + 4.7431\,D^2 - 7.5127\,D^3 + 8.3483\,D^4 - 4.2713\,D^5$$

D= TW / Diameter of Culvert

SUBROUTINE 9

Enter values and constants

BULK LOAD
Dia_1 = diameter of culvert
Dia_2 = diameter of culvert
B_elev = base elevation
Length_1 = length of culvert
Flow_Peak = peak of flow for ONE culvert
N/a
N/a
N/a

BULK LOAD
Const1_49 = 1.49
Pi = 3.1416
Manning = 0.024
K = 0.7
Exp_2 = 2
Exp_05 = 0.5
Exp_06667= 0.6667
Exp_13333= 1.3333

SUBROUTINE 7

Store year, day, hr, min, and seconds

SUBROUTINE 79

Enter Offsets

BULK LOAD
Upoffset = upstream culvert offset
Upsgoff = upstream staff gauge offset
N/a
N/a
Upoffset = downstream culvert offset
Upsgoff = downstream staff gauge offset
Hwelev = elevation of bottom of upstream culvert
Twelev = elevation of bottom of downstream culvert

HWOFFSET = UPOFFSET+UPSGOFF . This is the total offset to add to the encoder output.

TWOFFSET = DNOFFSET + DNSGOFF. This is the total offset to add to the encoder output.