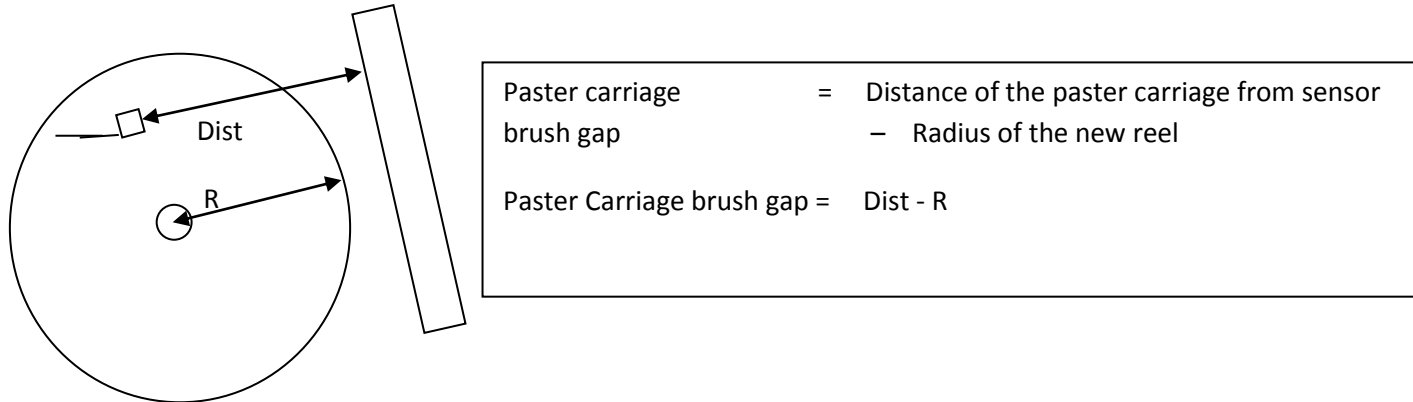


Ultrasonic RTP brush gap distance measurement project

Aim- To measure and log the distance between brush and new reel during pasting period.

Idea- Ultrasonic sensor is used to measure the distance between sensor and Paster carriage arm. The difference of the paster carriage and New Reel Radius gives the brush gap distance. New reel Diameter can be obtained from RTP.



Sensor Selection

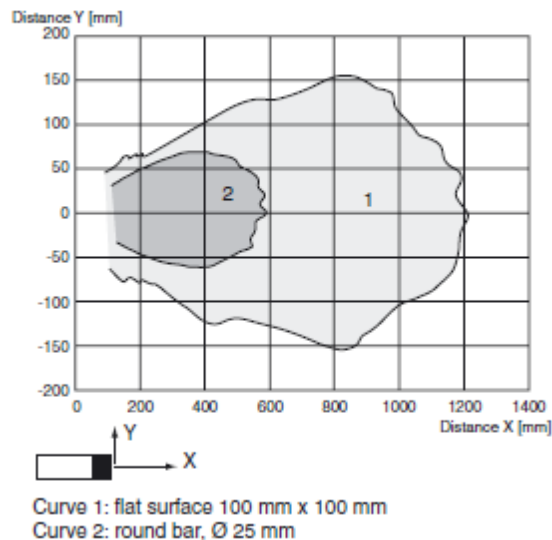
- First, Ultrasonic ink sensor UB300-18GM40A-1-V1 was tested to measure the brush gap but due to limitation of less band of measuring distance and intervention of old reel, Ultrasonic sensor UB800-18GM40-U-V1 was selected.



- Short design 40mm
- Analog output - 0 to 10V
- Sensing range - 50 to 800mm
- Adjustment range - 70 to 800mm
- Dead band - 0 to 50mm
- Operating voltage - 15 to 30V

- Characteristics of the sensor was studied and performance was observed in demo.

Characteristic response curve

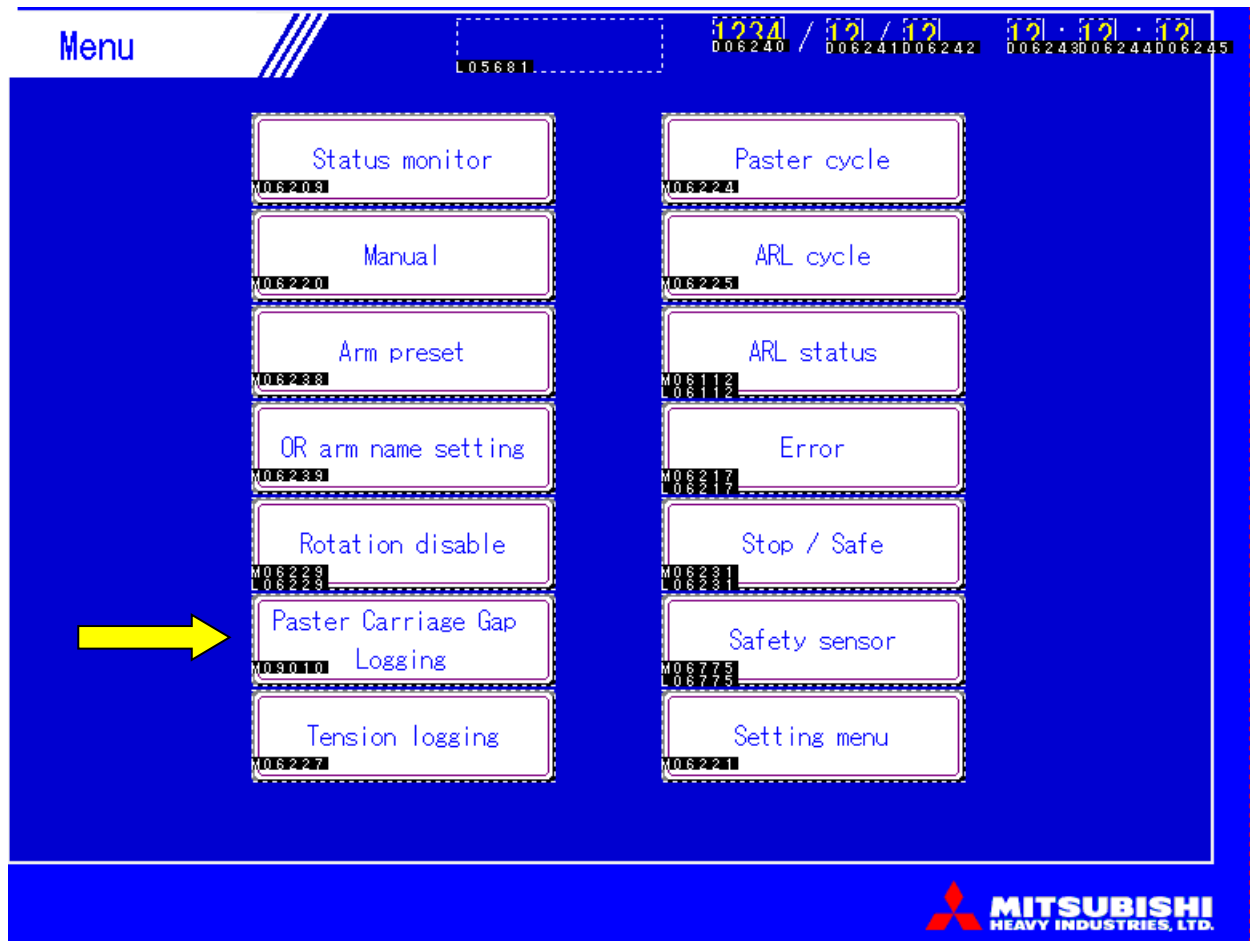


PLC Logic-

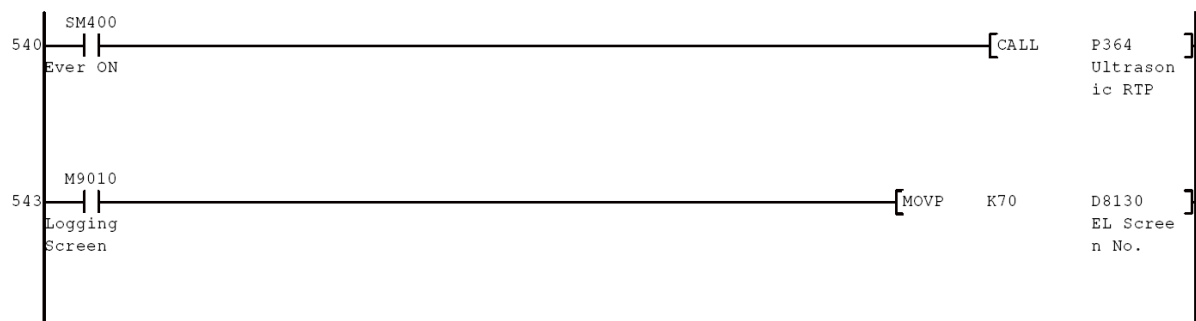
- Ultrasonic program was written in P364 instruction. Its subroutine is always running.
- We have used logging with registers starting from D9000.
- NR diameter value is obtained from MCON. We have used that New reel diameter register D3523 for finding the radius of the reel.
- The sensor output is connected to the spare Channel 5 of the Q68ADV (Analog to Digital module), which is already present in RTP.
- The sensor output is in the voltage range of 0-10V and its measuring distance is upto 800mm. Sensor working band is 730mm with minimum adjustment zone of 70mm. So Distance 70 to 800mm is analogous to 0 to 10V i.e 0-4000 Digits in ADV.
- So 1 Digit= $730/4000 = 0.1825\text{mm}$. Therefore, paster carriage arm distance = (digits*0.1825) + dead zone of 70mm. For example, if the sensor output is 2.5V, then the digit is 1000. So paster carriage arm distance = $(1000*0.1825) + 70 = 252.5\text{ mm}$
- Protrusion of the brush is 11mm. Radius is calculated by dividing D3523 by 2 and saving it in D9023. The offset of the sensor and New reel core is 379mm. So Mathematically arrived formula is **Brush gap = (Sensor calculated distance-11) – ((New reel Diameter/2)-379)**
- Using the above example, provided that NR diameter = 1220
Brush gap = $(252.5-11) - ((1220/2) - 379)$, which is equal to 10.5mm
- Stop sensor input X191 is used as the trigger for logging the New reel diameter and Brush gap distance values with date and time.

Touch screen Modification-

- Paster carriage logging button with Coil M9010 was mapped and added.



- Mapped coil M9010 was added in PLC program and Screen 70 is used for logging purpose.



- Buffer area setting in system setting toolbar has to be done in software for logging. Data sampling settings have to be done and necessary display, count, date and time icon has to be inserted. Sampling Display settings have to be set by clicking screen. Fourth device from Read area should be used for logging. In this comm parameter D8128 is read area, So D8131 is used.

Paster carriage brush gap Logging

Count	Time and Date	RTP name	Reel Diameter	Paster arm Brush gap (mm)
1234	123456789012345	AB	1234	12.3

▼
▲
▼▲
▲▼

GRAPH RETURN
PRINT
RESET

Last Paster arm Brush gap 12.3 (mm)

0.0 9.0 0.2

End

Buffering Area Setting

9			10			11		
0	1	2	3	4	5	6	7	8

☒ Use Sample Buffer

☒ Memory Designation: D09000

Sampling Method: Bit Synchronize

No. of Words: 4

Sampling Time: 0 *sec

No. of Samples: 1000

Output File No.: 0

Message GNo.: 0

Store Target

☐ Internal Buffer

☐ SRAM

☒ CF Card

Full Processing

☒ Continuous

☐ Stop

☐ Use Operation

☐ Use WAV

☐ Use E-Mail

☒ CSV Output

☐ Create Backup

☐ Use Start Bit

☐ Replay Sound Consecutr

Receiver's

OK
Cancel

Data Sampling

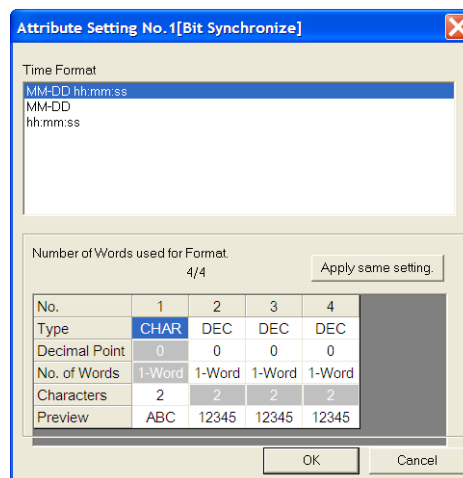
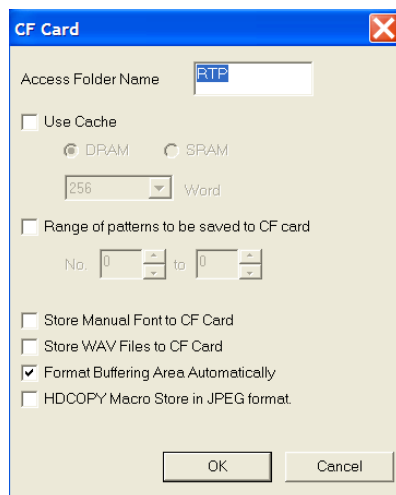
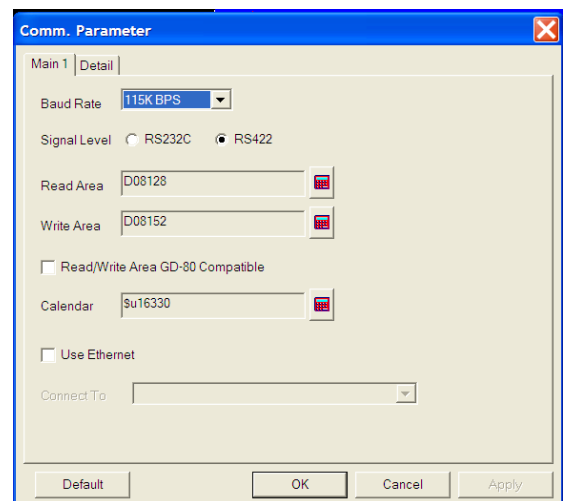
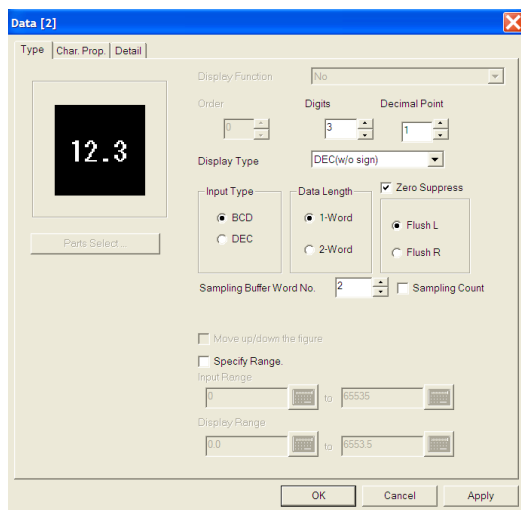
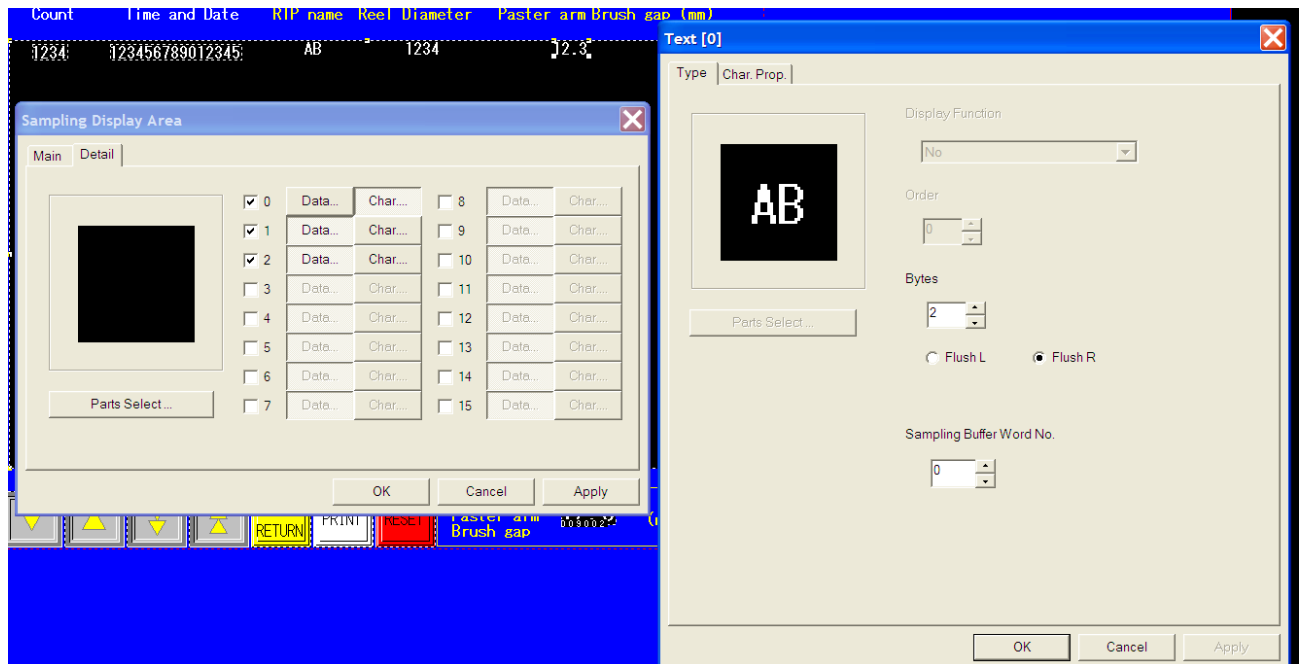
Division No. 0

Buffer No. 1 Refer to buffer Use...

Message to Print GNo. 8 No. 0

☐ Print Command Memory D00100

OK
Cancel



Real time ultrasonic validation

- Ultrasonic sensor was validated using P and F 200PPR encoder, which was coupled to the Paster arm carriage shaft. Pulses were taken for each pastings, tabulated and compared with real time sensor output distance value.

New reel diameter	Encoder pulse count - Forward	Brush gap distance (mm)	Ultrasonic measured distance (mm)	Ultrasonic validated distance from encoder pulse (mm)	Difference (measured - validated) mm
1010	647	14	151	149.845	1.155
1010	646	14	151.57	151.21	0.36
1010	645	16	153.22	152.575	0.645
1010	645	15	152.3	152.575	-0.275
1013	644	14.5	153.22	153.94	-0.72
1013	644	13.5	152.49	153.94	-1.45
1256	556	13	273.85	274.06	-0.21

Validated distance formula

Total paster arm travelling distance - 1012 mm

Total pulse for full travelling distance - 741

So, 1 pulse = $1012/741$, which is equal to 1.365 mm

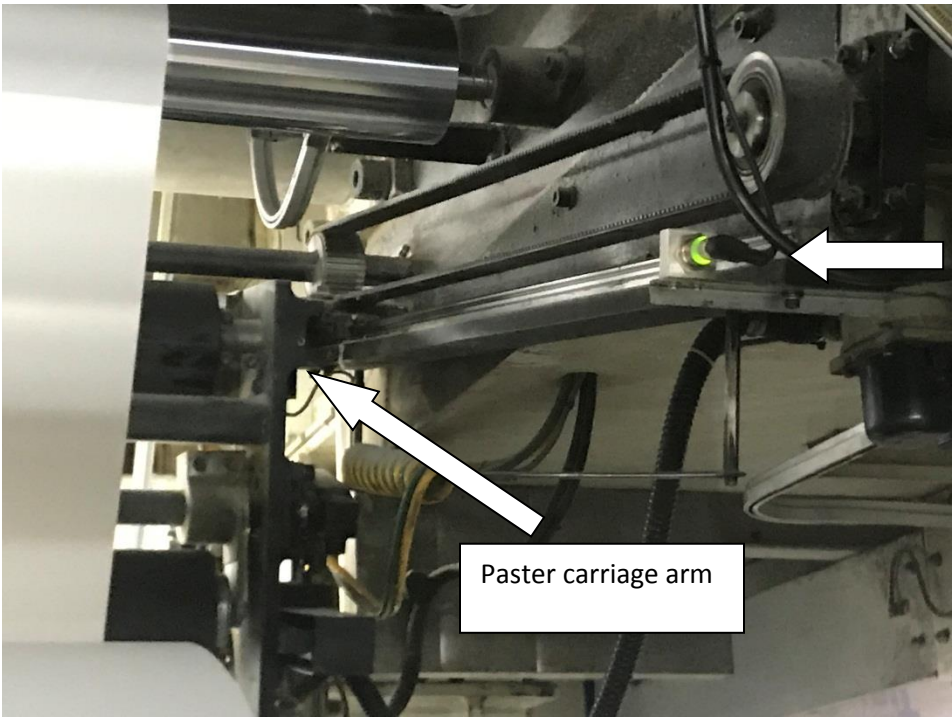
Total length = paster arm travelling distance + gap between sensor and carriage

Total length = $1012 + 21 = 1033$ mm

Ultrasonic validated distance = total length - (encoder pulse Fwd * 1.365)

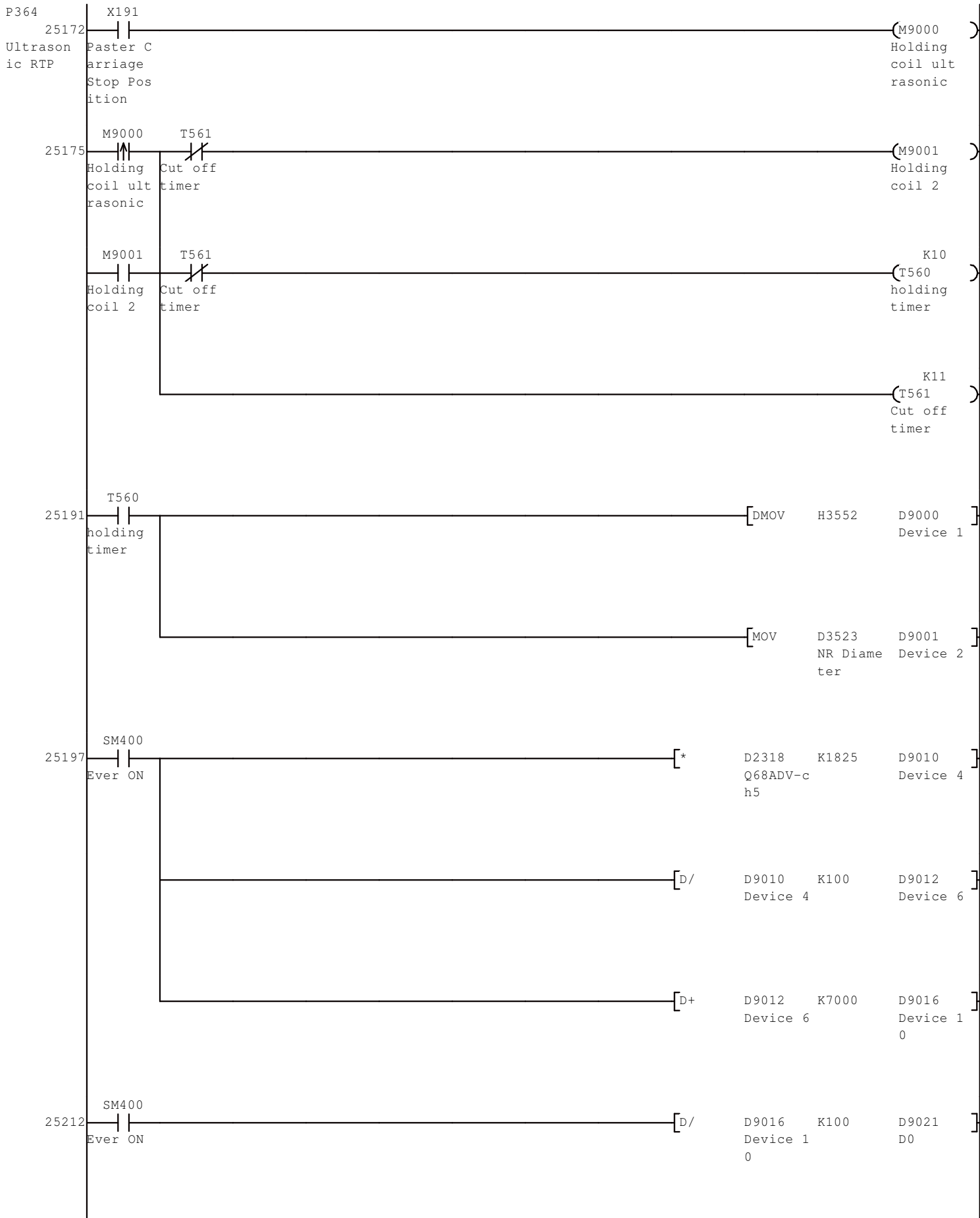
Ultrasonic validated distance = $1033 - (\text{encoder pulse Fwd} * 1.365)$

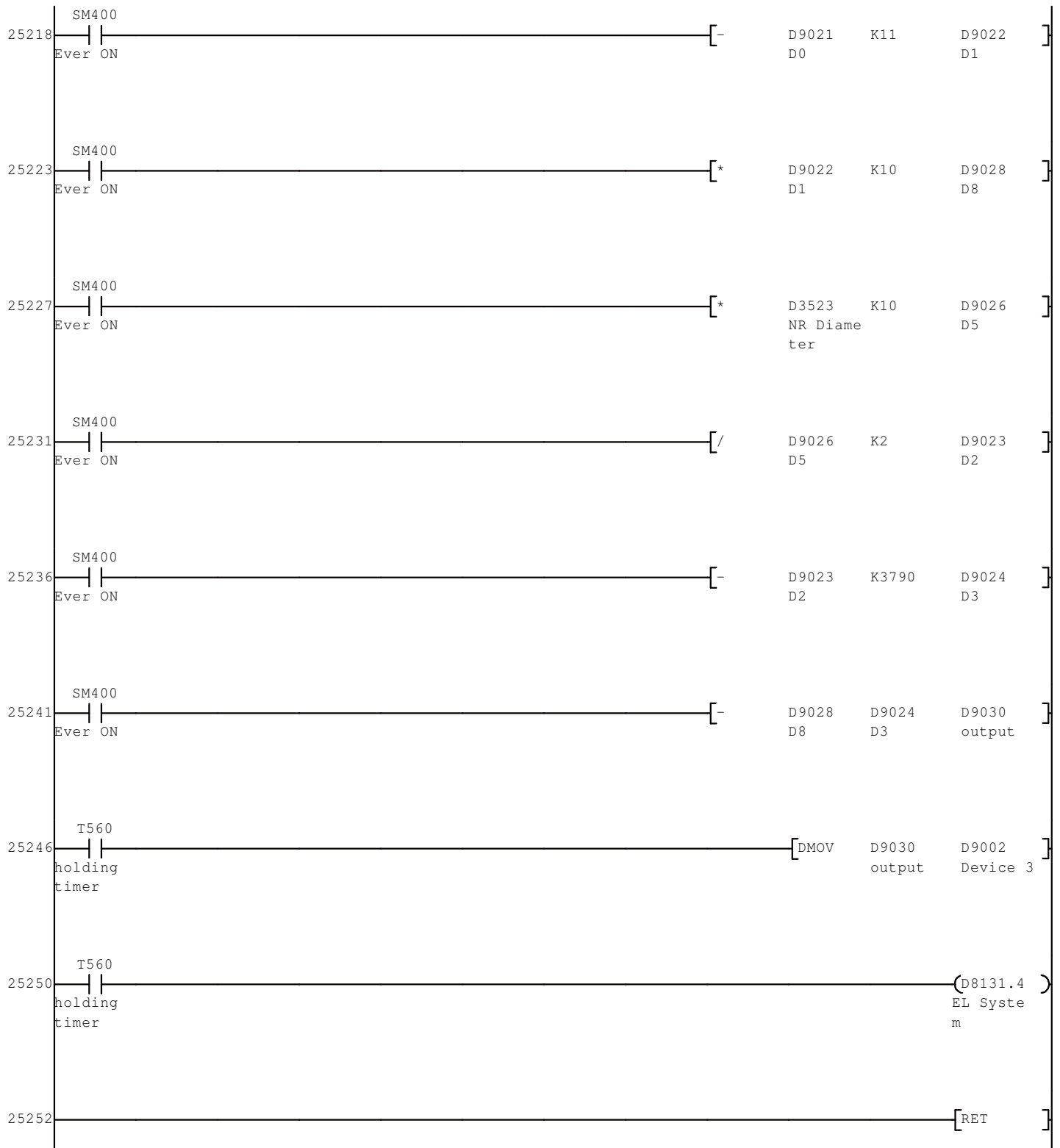
Data logging screen



- Data logged values can be viewed in excel. The logged values are stored in Sample folder in CF card. Sample readings are as follows :

Date and time	RTP name	New reel diameter	Brush gap distance
6/14/2018 14:55	R5	1253	11.5
6/14/2018 14:58	R5	1253	11.5
6/14/2018 15:54	R5	1246	9
6/14/2018 16:46	R5	1258	9
6/14/2018 19:05	R5	1256	9
6/15/2018 0:40	R5	1253	122.5
6/15/2018 0:40	R5	1253	8.5
6/15/2018 1:17	R5	914	281
6/15/2018 1:17	R5	914	8
6/15/2018 2:19	R5	1260	152
6/15/2018 2:19	R5	1260	8
6/15/2018 2:59	R5	1260	171
6/15/2018 2:59	R5	1260	8
6/15/2018 14:11	R5	1219	10.5
6/15/2018 14:15	R5	1219	11.5
6/15/2018 14:35	R5	1219	10.5
6/15/2018 15:37	R5	1212	143
6/15/2018 15:37	R5	1212	9
6/15/2018 16:25	R5	1258	123
6/15/2018 16:25	R5	1258	7
6/15/2018 17:26	R5	1243	10.5
6/15/2018 18:05	R5	1253	175.5
6/15/2018 18:05	R5	1253	7.5
6/16/2018 0:00	R5	1258	131
6/16/2018 0:00	R5	1258	8
6/16/2018 1:55	R5	1222	151
6/16/2018 3:18	R5	1260	8
6/16/2018 15:02	R5	1256	12
6/16/2018 15:02	R5	1256	12
6/16/2018 15:02	R5	1256	12





Connection Diagram of Ultrasonic sensor

