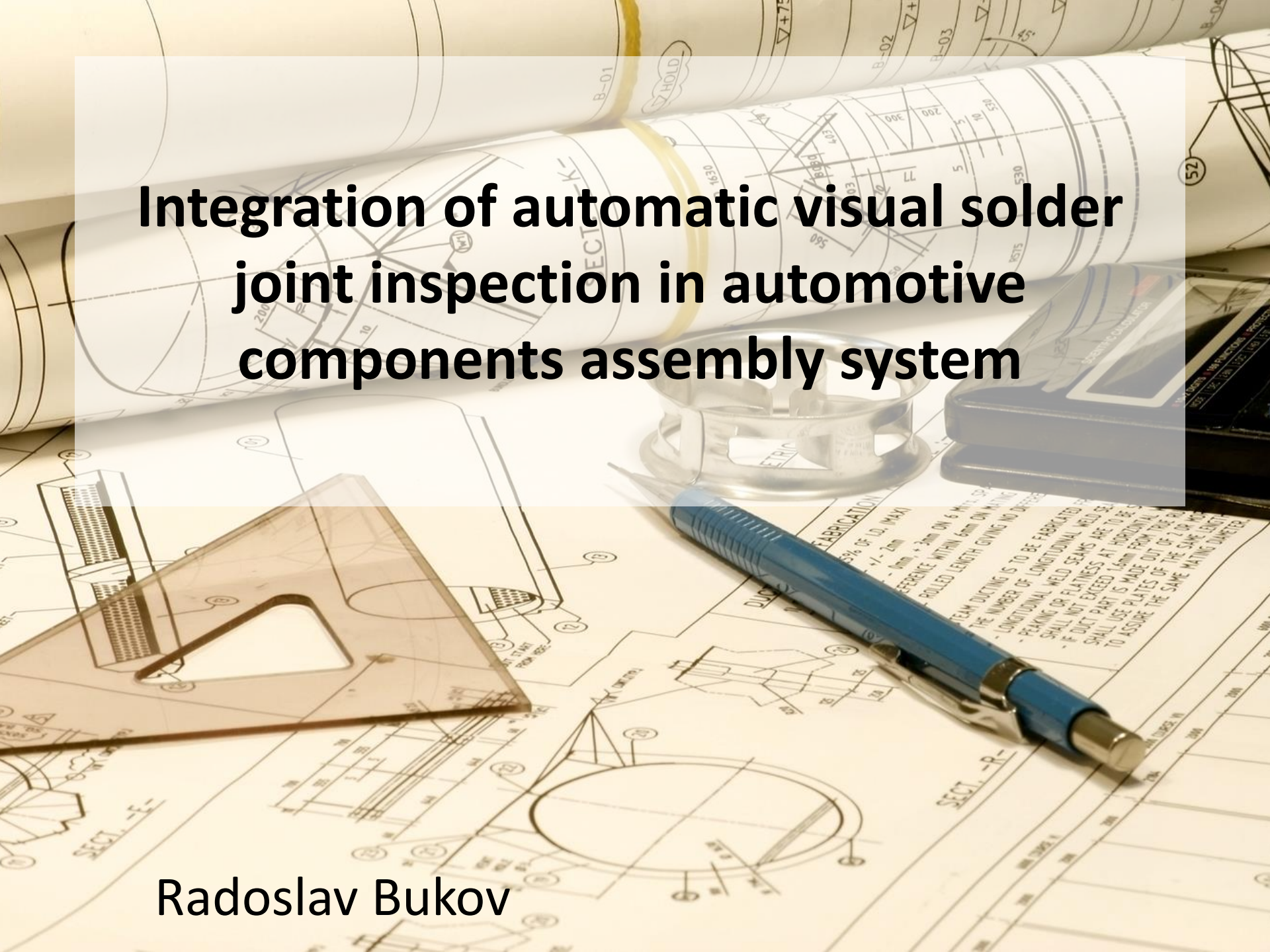


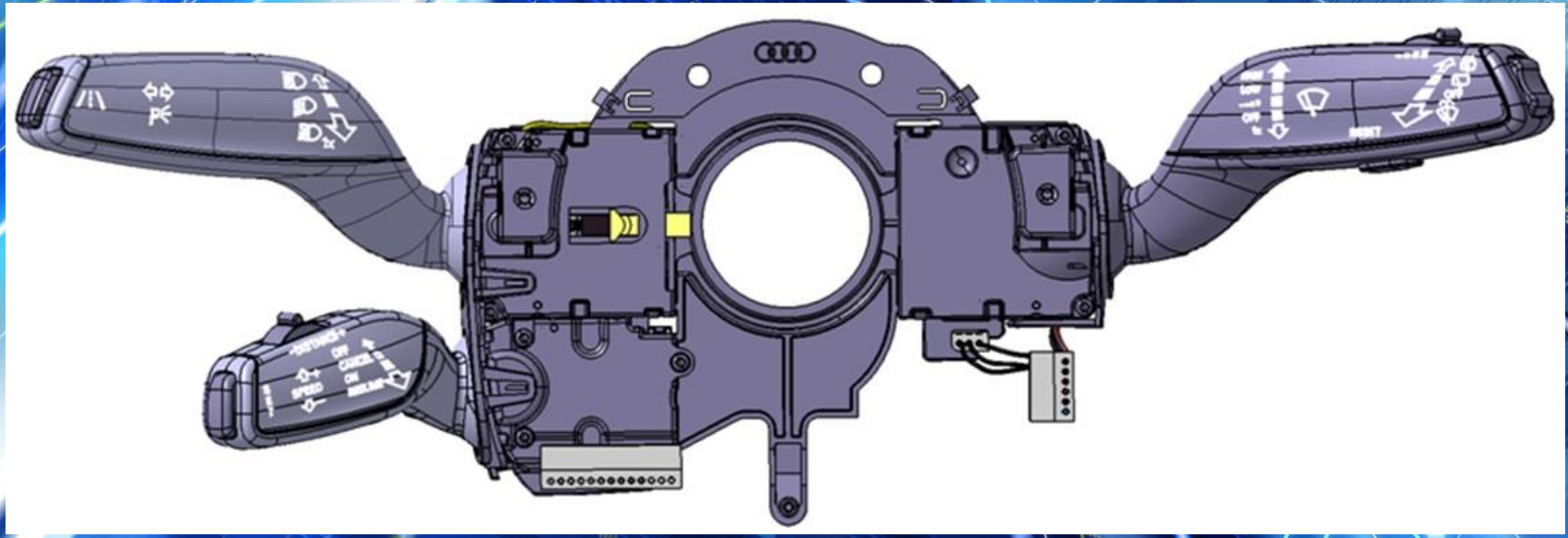
Integration of automatic visual solder joint inspection in automotive components assembly system

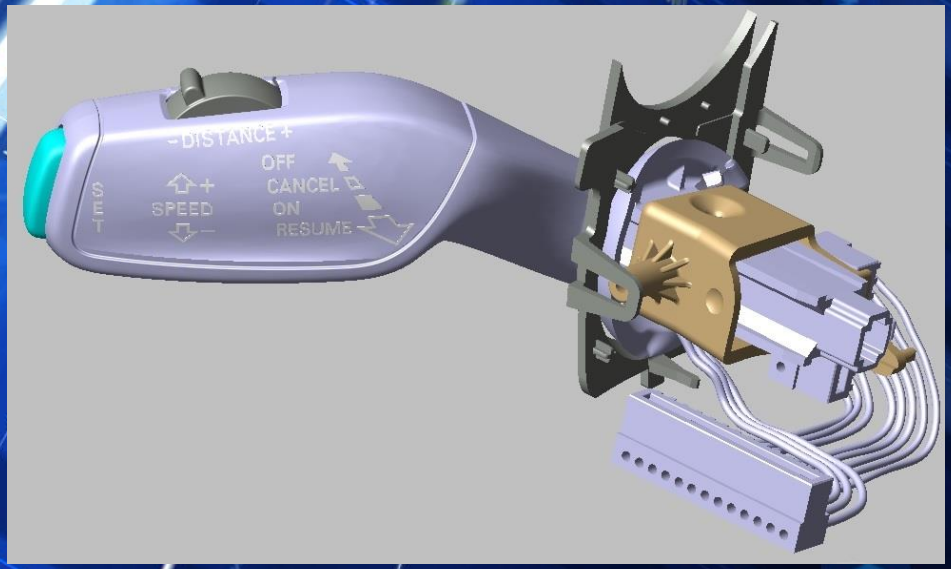
Radoslav Bukov

Product range of the company

Various control panels of electrical equipment in the automobile.

Under steering wheel module - AUDI

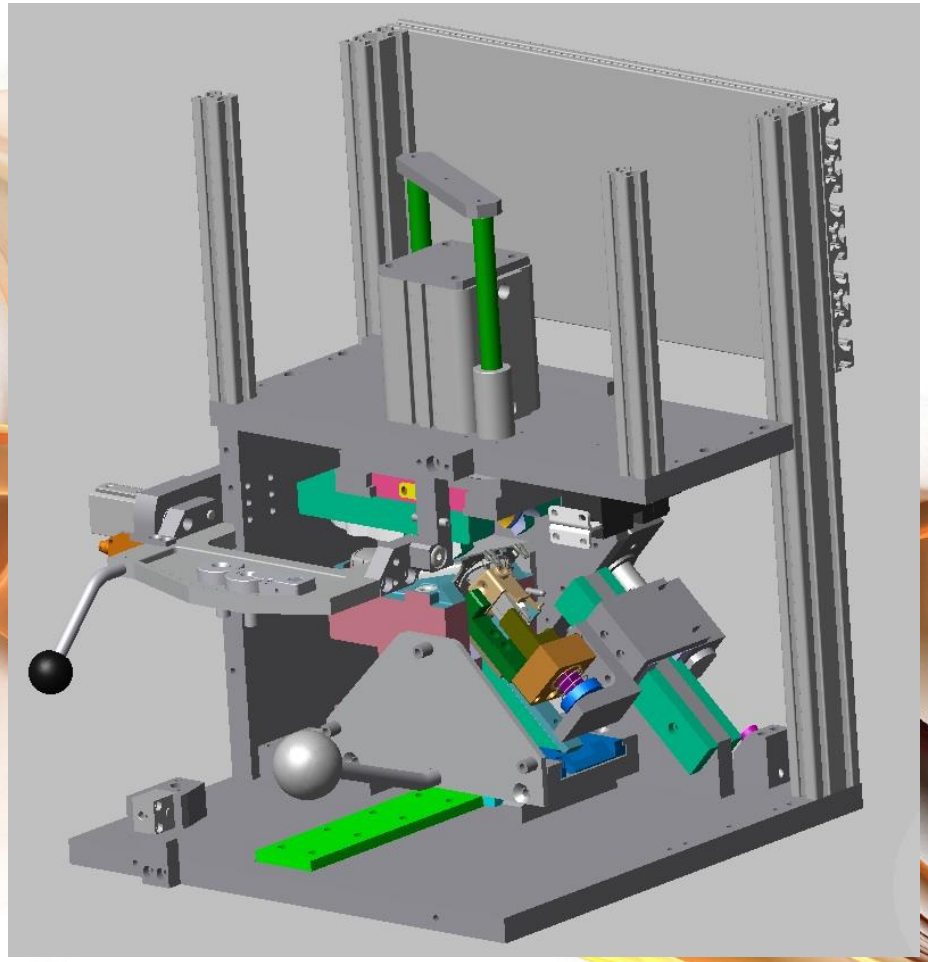




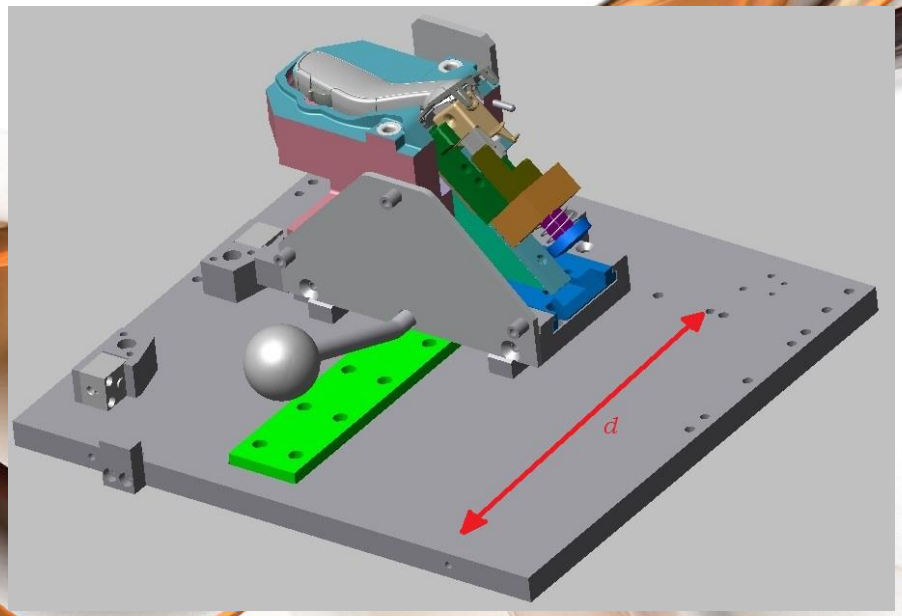
The lever GRA - it is managed automatic speed control and tracking distance of the front car.

Assembly station

Assembly all components of the speed levers.



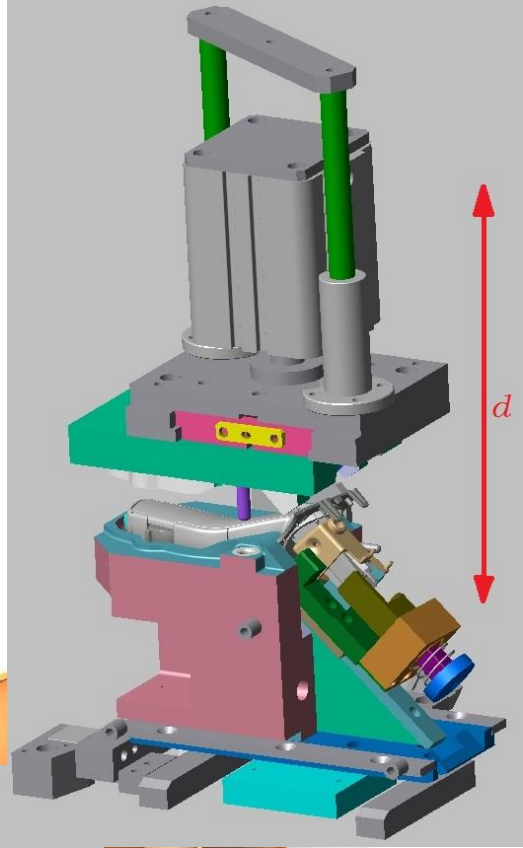
3D model of the system

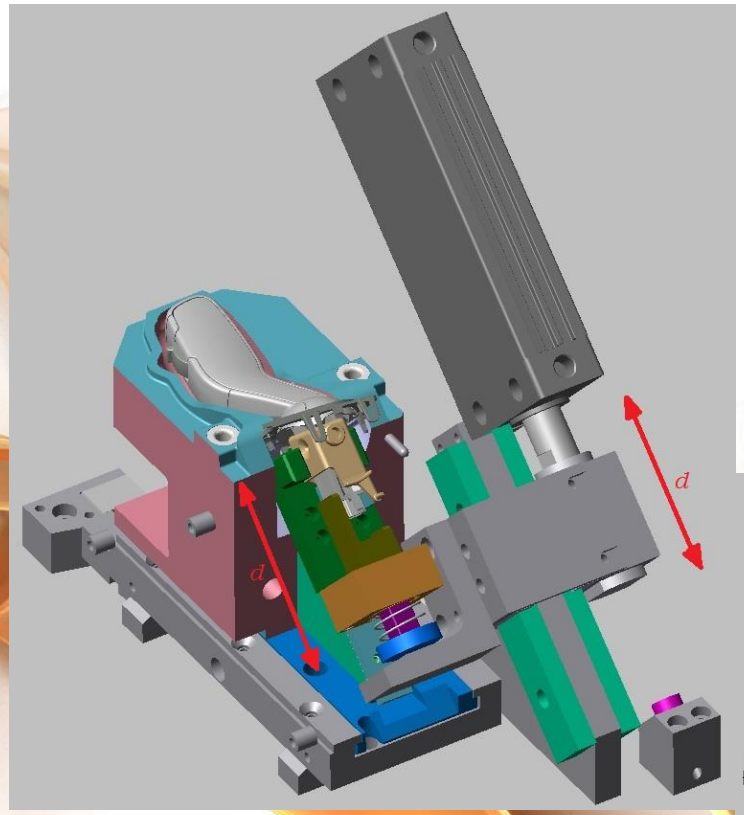


Two basic work condition:

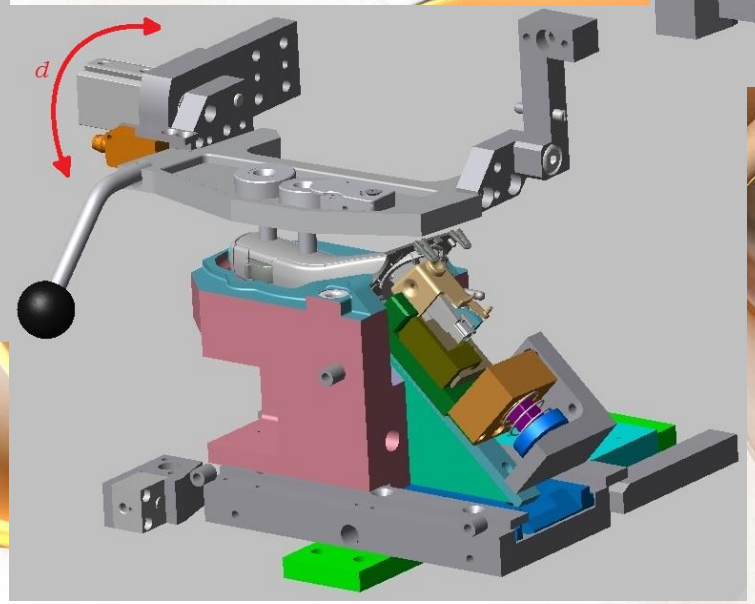
Basic working state:

Assemble position of the top cover to the base.





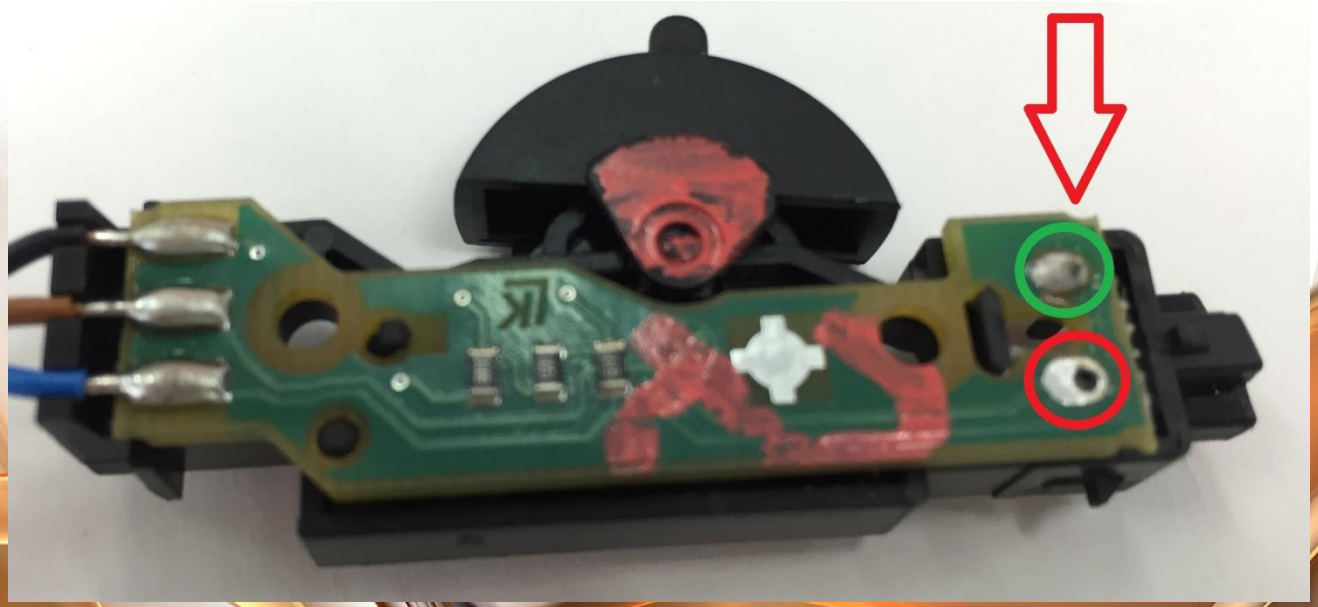
Assemble position of the handler to the base.

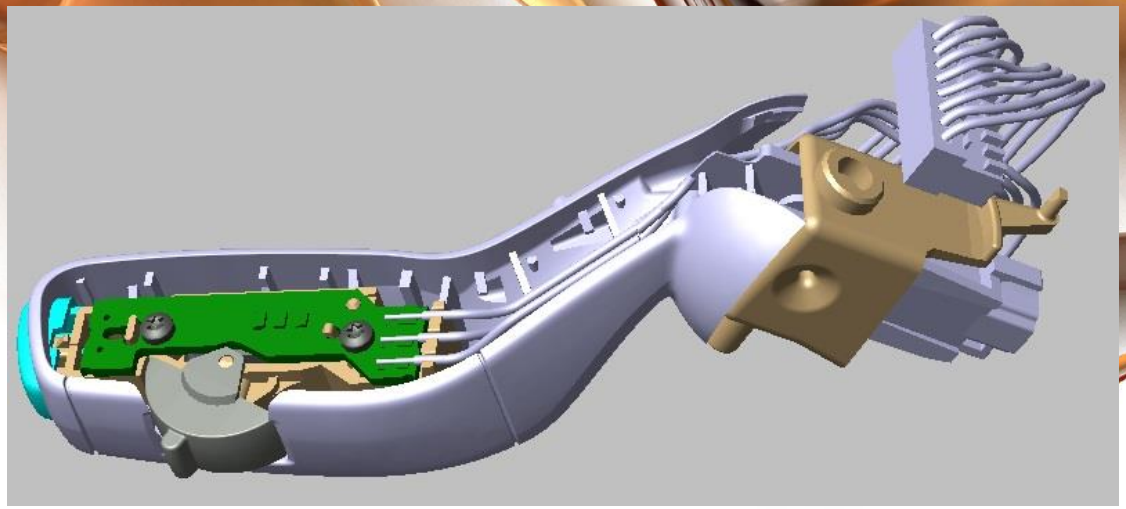


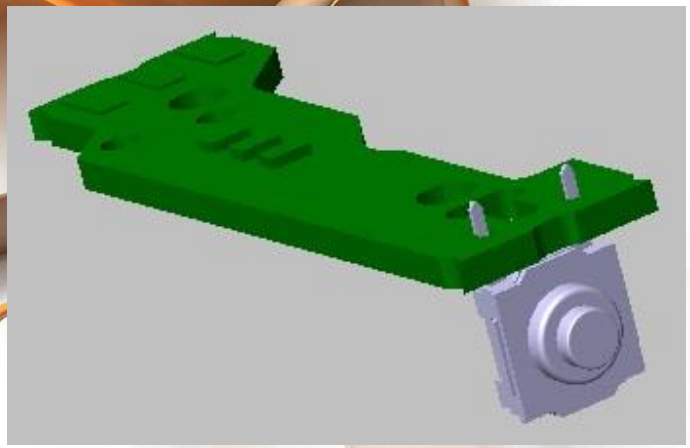
Screwing position of the trager to the main.

Customer Claim – missing soldering

Successfully passed electrical test and send to the customer:



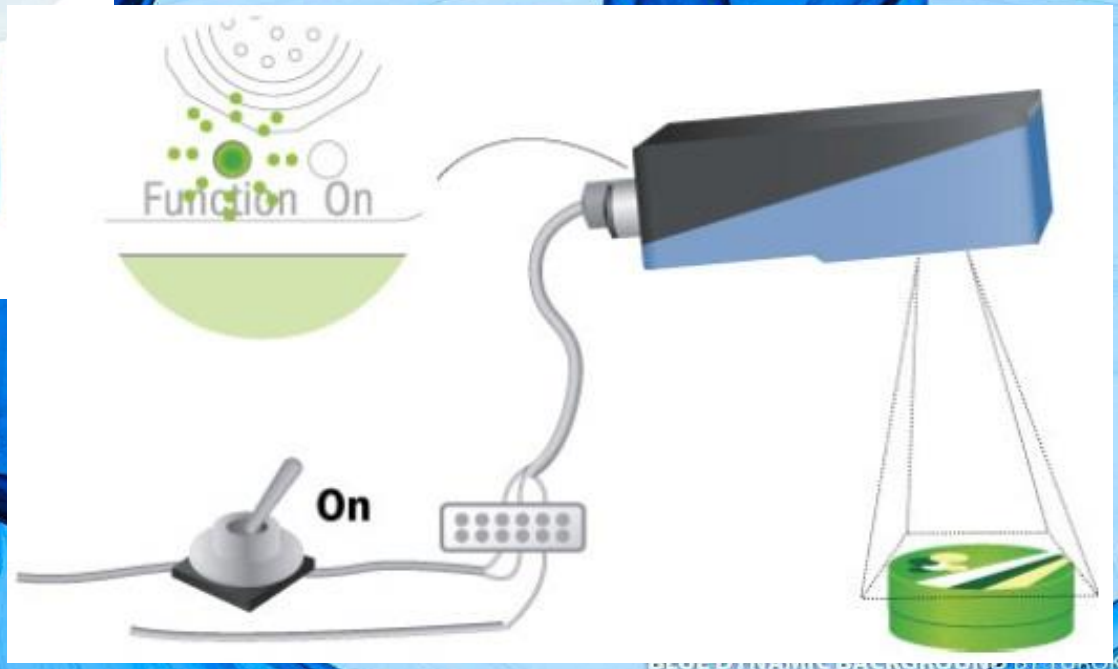




Problem solving

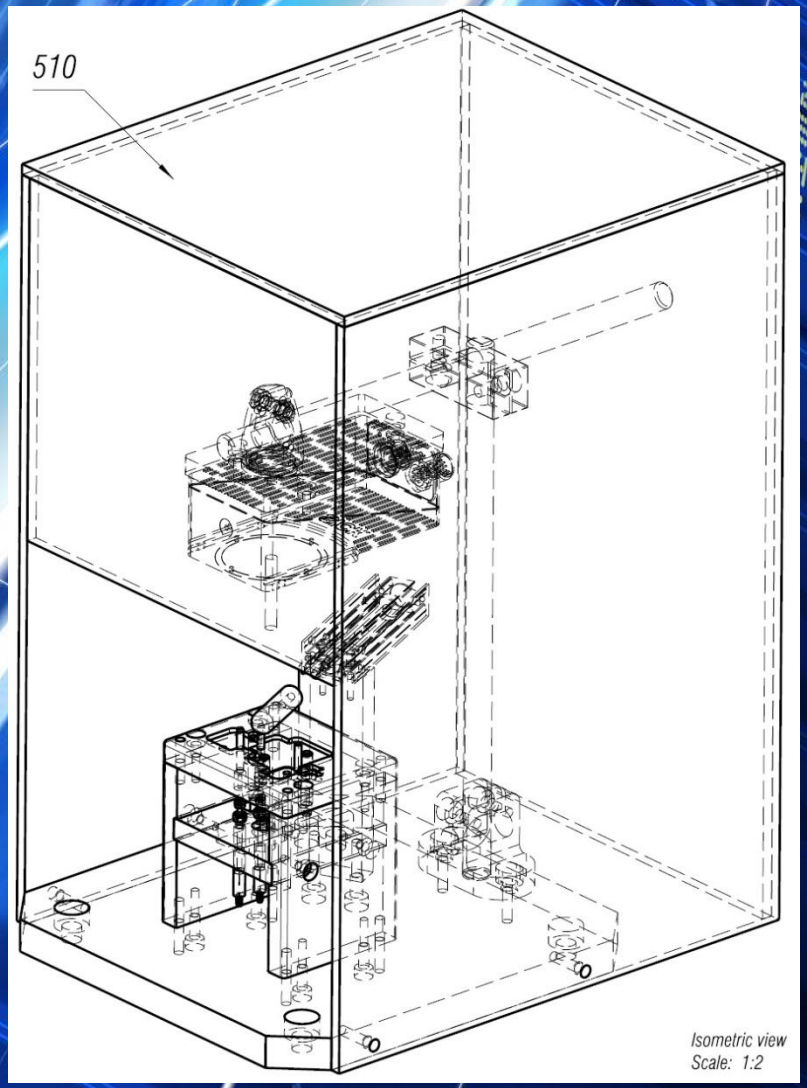
Integrating a visual inspection system is one of the few solutions that can guarantee stability in the production process, due to the specificity of the solder.

The selection of the visual sensor was made after carrying out tests with:
- Sick
- Cognex
- Keyence RGB

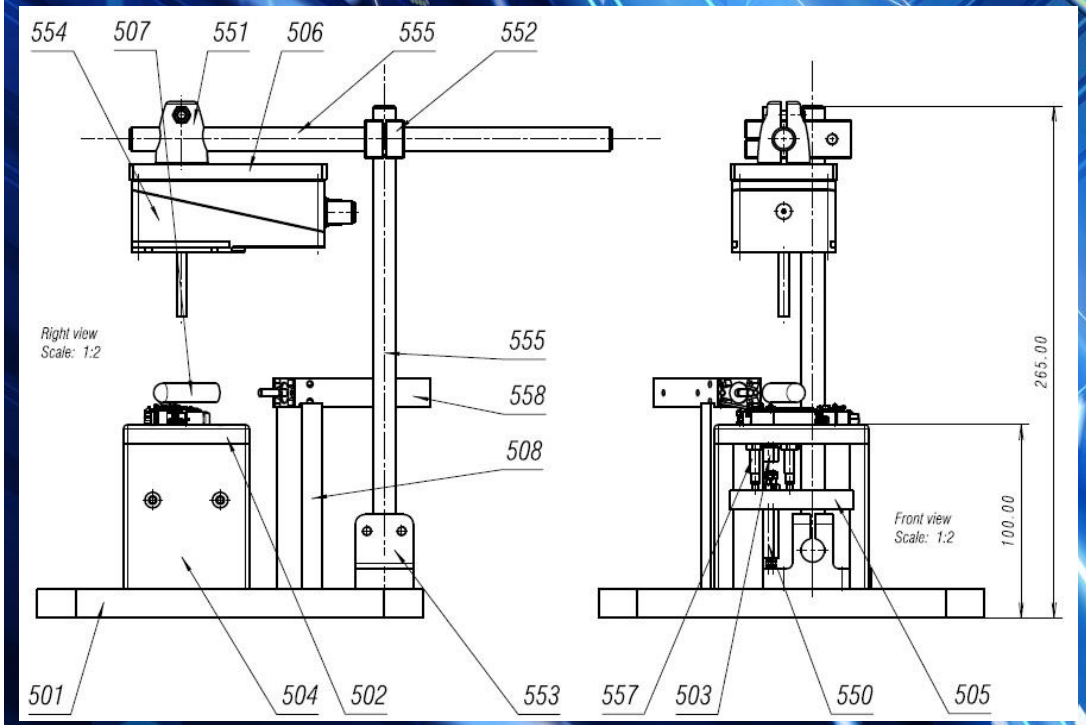


New station project:

Due to the impossibility of performing the visual inspection at the existing station.

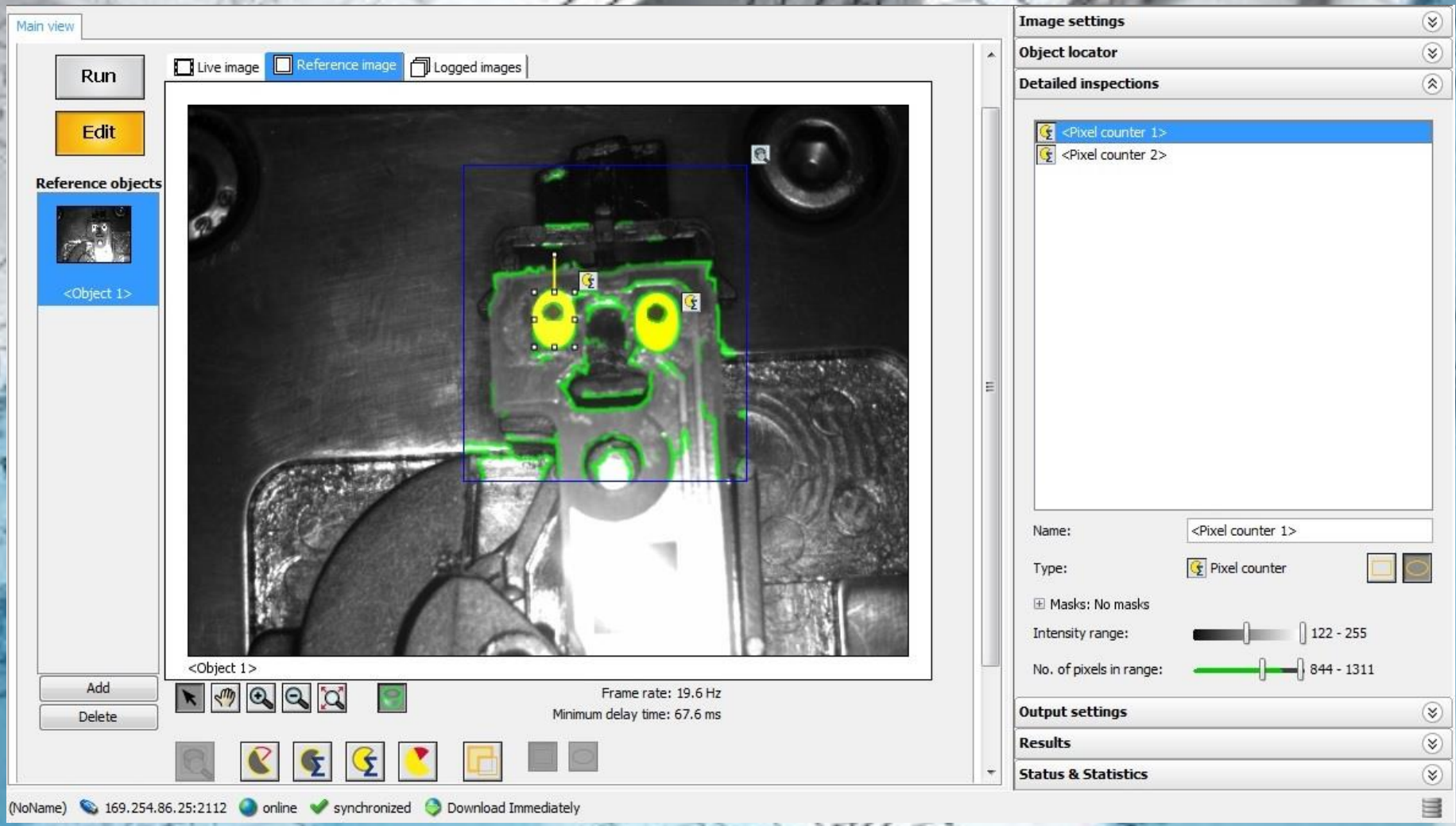


- Executive mechanisms
  - Pneumatic cylinder
- Sensors
  - Part present
- Red box

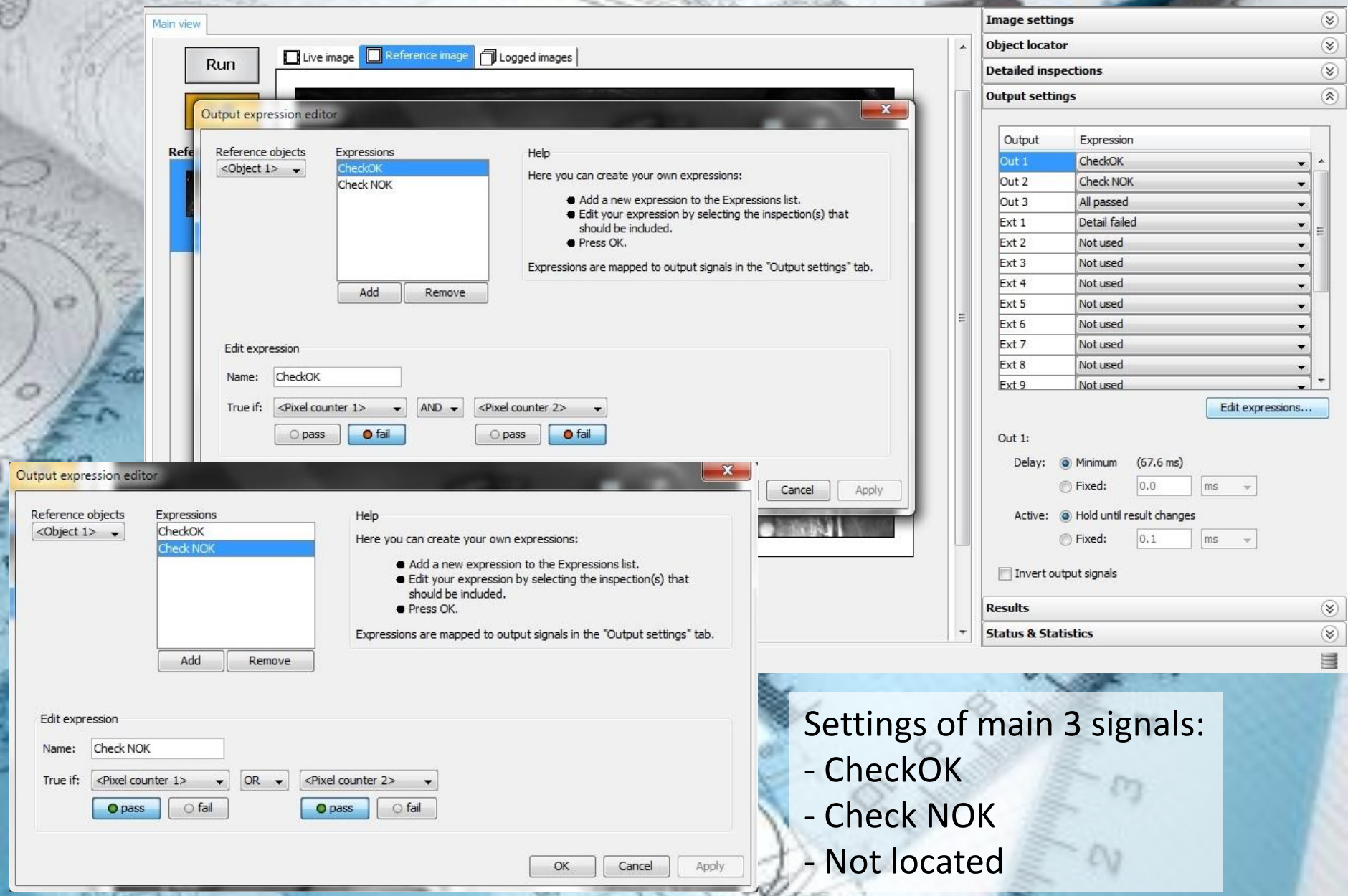


Setting of Visual inspector

A pixel counting tool is used to inspect the object in detail.The main consideration of the setup is the impossibility of guaranteeing uniform spillage of the tinol.



Settings of output signals



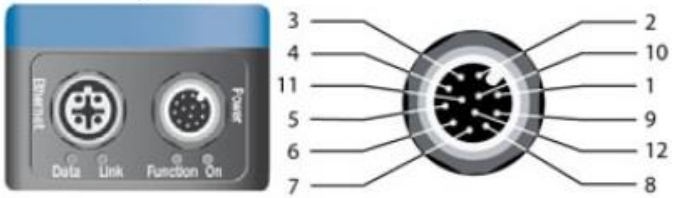
Settings of main 3 signals:

- CheckOK
- Check NOK
- Not located

Electrical connection with PLC

The communication between the visual inspector and the PLC is carried out by means of digital I/O signals:

Power In/Out

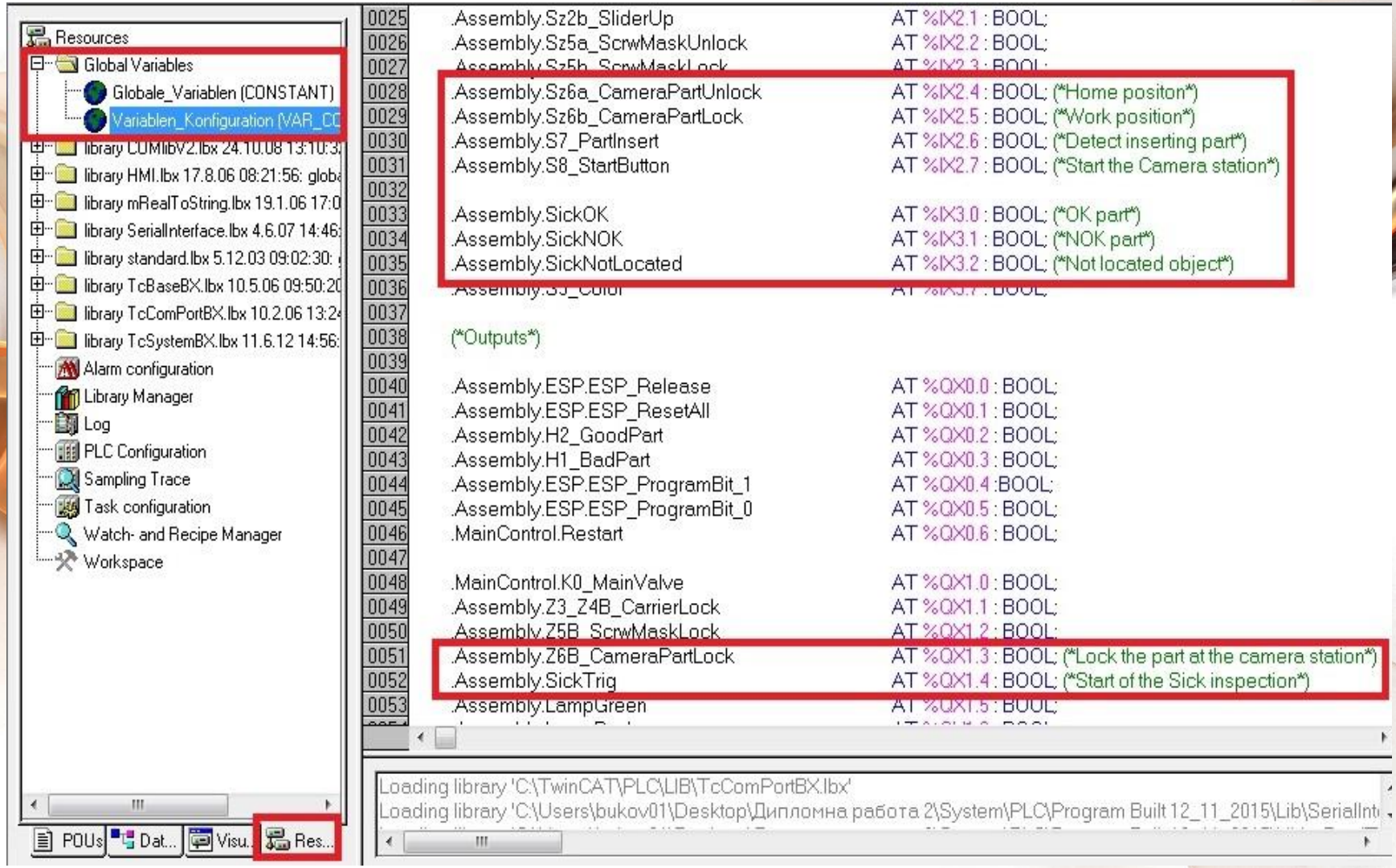


Inspector connector pinning – Power In/Out, 12 pin, M12 connector			
Pin	**Color***	**Signal**	**Signal description**
1	Brown	Power	24 V power supply
2	Blue	GND	Ground 0V
3	White	In3	Image trigger + External object selection (24 V)
4	Green	Out1	Output 1 – Object not located (B-type)
5	Pink	In2	External teach + External object selection (24 V)
6	Yellow	Out2	Output 2 – Inspection failed (B-type)
7	Black	Out3	Output 3 – All pass (B-type)
8	Gray	In1	External object selection (24 V)
9	Red	Ext trigger	External trigger, external illumination, (5 V TTL)
10	Violet	In4	Encoder + External object selection (24 V)
11	Gray/pink	TRB	Reserved
12	Red/blue	TRA	Reserved

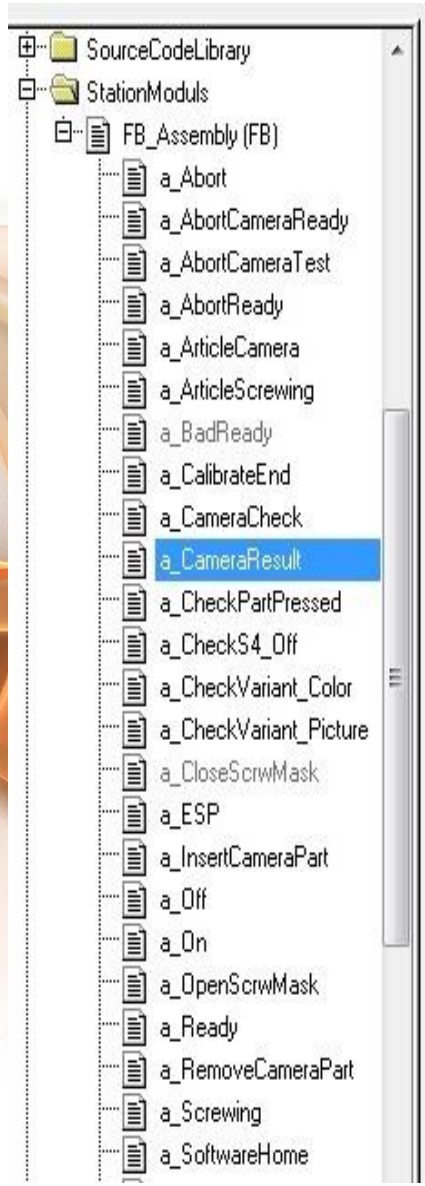
* Colors are valid for cable type DOL-1212-G02MA/G05MA.

PLC Programming

PLC - Beckhoff with TwinCAT programming environment and ST programming language.
Registering the required I/O signals:

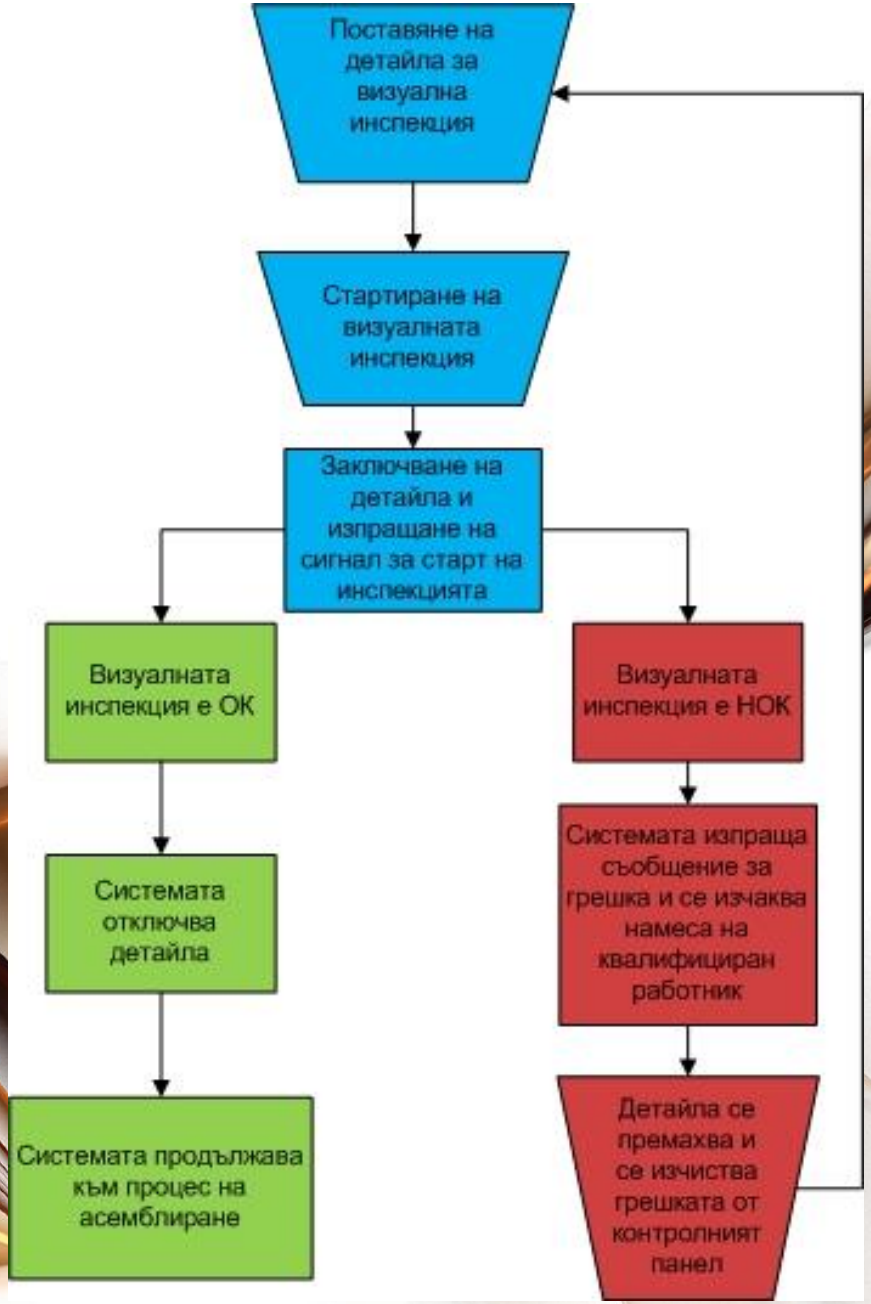


Main action in assembly function block:



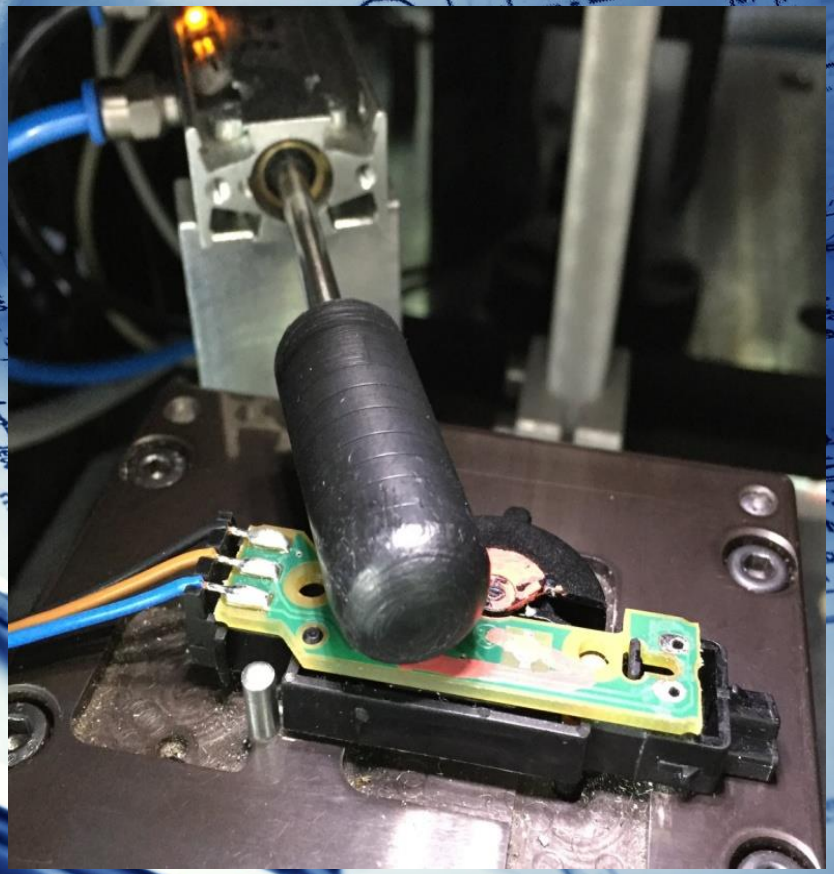

```
0001 IF SickOK THEN
0002
0003 LampGreen:=TRUE;
0004 mZ6_CameraPartLock(Direction:=FALSE);
0005
0006       Stations.Data[Me].Step(      User:= Me, WithSens:=FALSE,
0007                                    ExternalSign:=SickOK,
0008                                    JumpAddress:= 0,
0009                                    BackStep:= TRUE,
0010                                    Ack=> );
0011
0012 ELSIF SickNOK OR SickNotLocated OR NOT SickOK AND NOT SickNOK AND NOT SickNotLocated  THEN
0013
0014 LampRed:=TRUE;
0015
0016 SetError(User:= Me, Text:= Text.Name.Fail , sValue01:= 'Sick');
0017
0018 END_IF;
0019
0020 IF  KeyBoard.Key.Pulse.xEsc AND KeyBoard.Key.Sign.xManual THEN
0021       Stations.Data[Me].iRequestedStepNumber:=  Stations.Data[Me].iAddressAbortCameraTest;
0022 ELSE
0023       Stations.Data[Me].Step(      User:= Me, WithSens:=FALSE,
0024                                    ExternalSign:=VariantGood,
0025                                    JumpAddress:= 0,
0026                                    BackStep:= TRUE,
0027                                    Ack=> );
0028
0029 END_IF;
0030
```

Logical block diagram of the operation of the additional station:



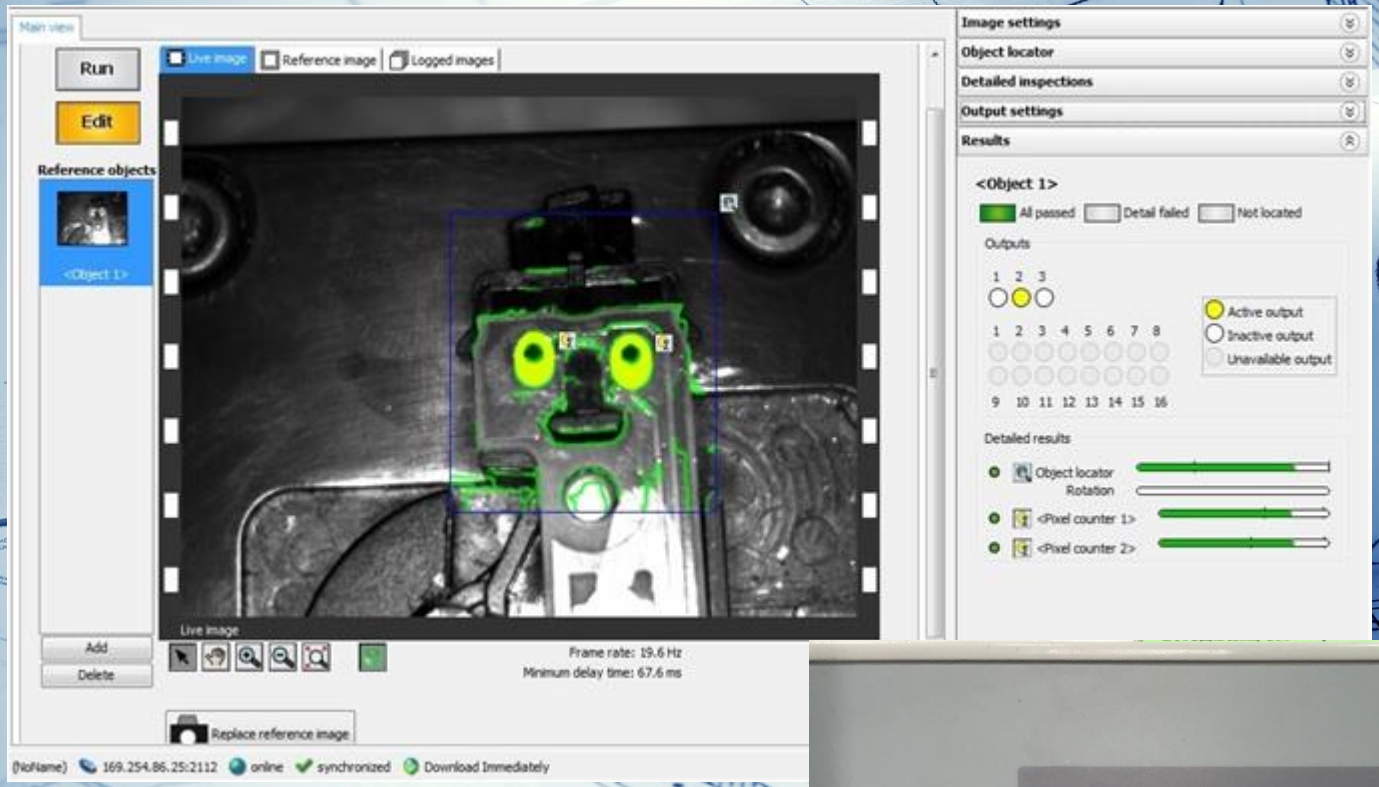
System tests

Experiment 1: Part with two missing solders:



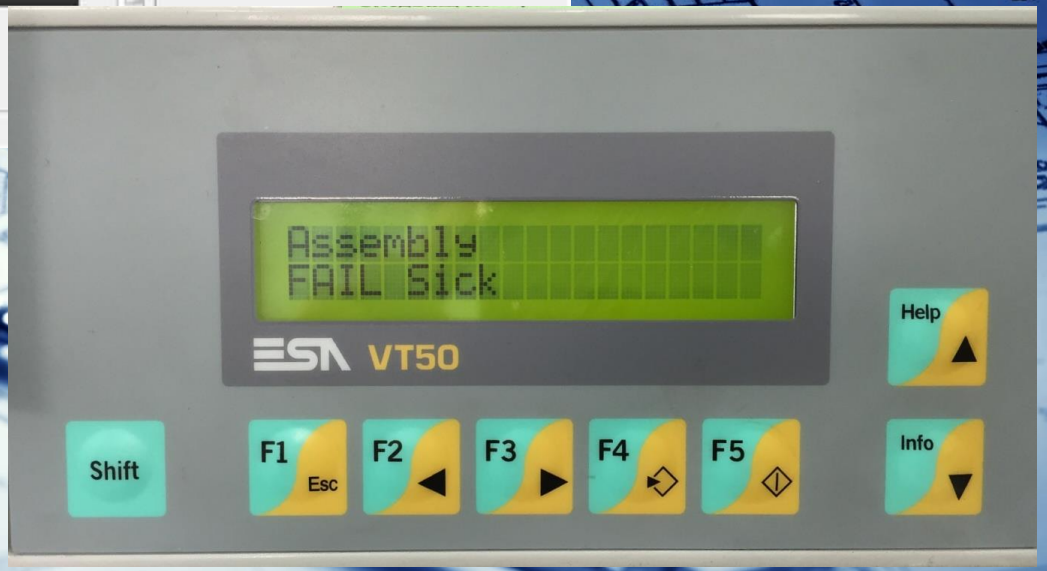
Visual inspection position

Results of simulation experiment 1:



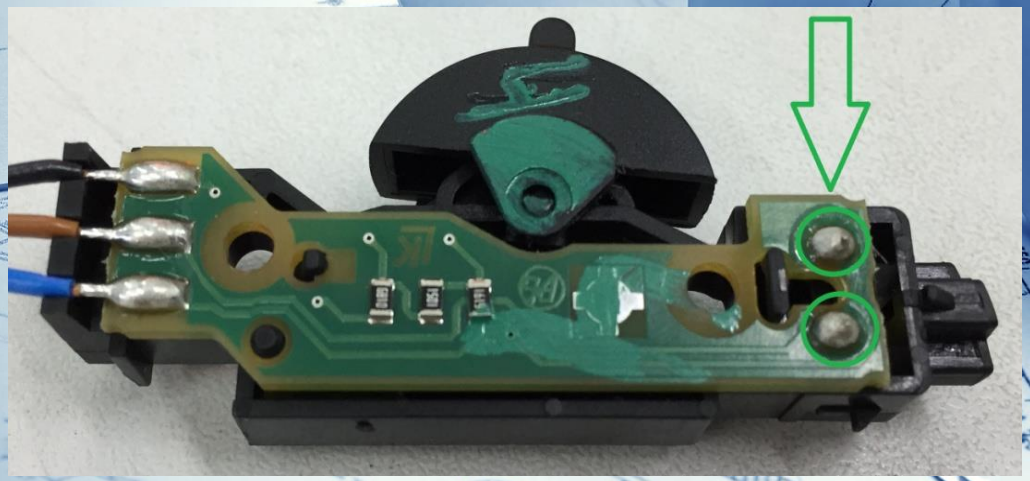
Visual inspector result:

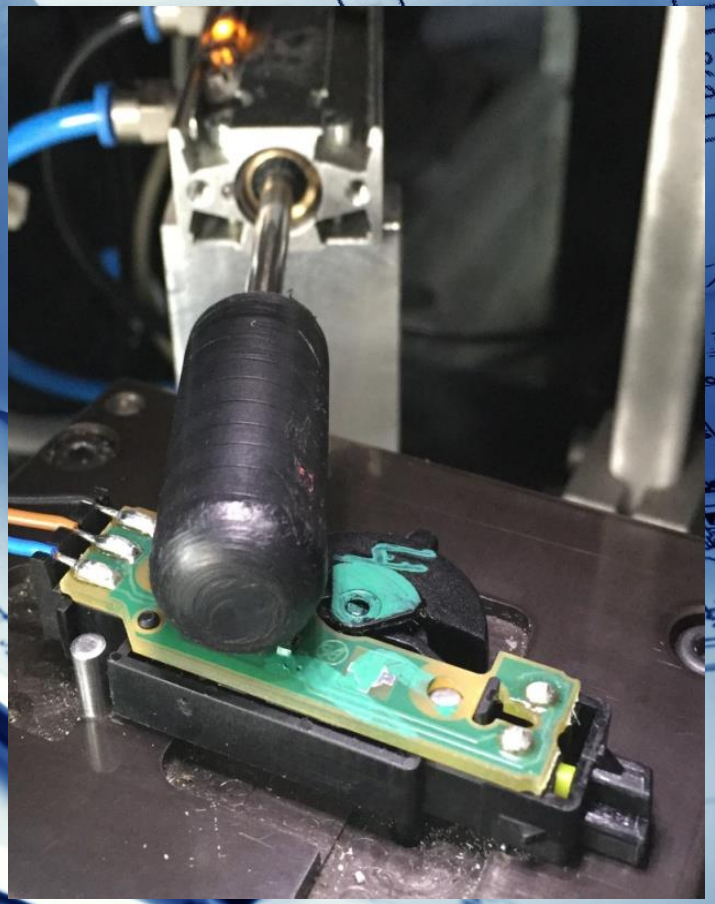
PLC feedback:



System tests

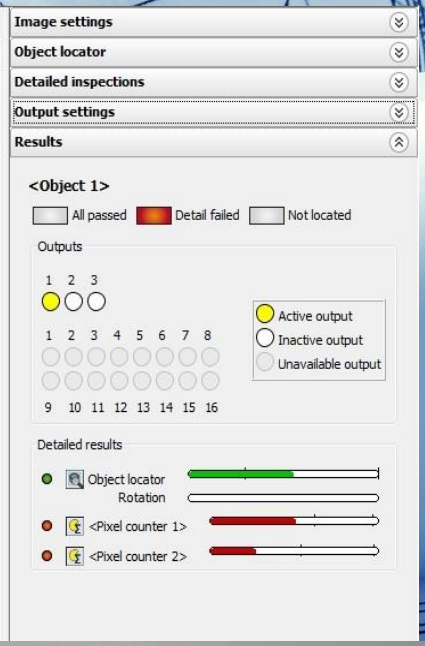
Experiment 2: Part with two OK solders:





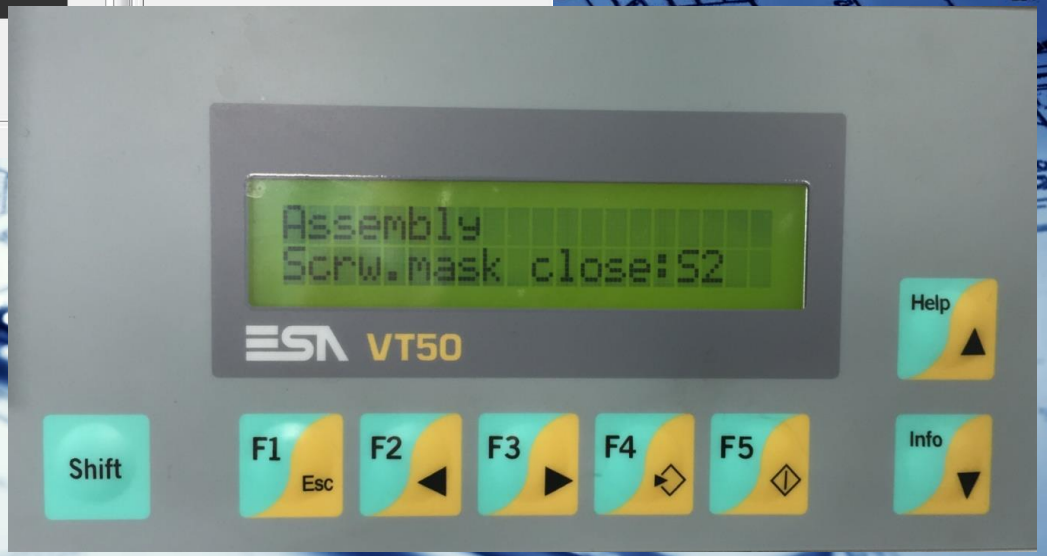
Visual inspection position

Results of simulation experiment 2:



Visual inspector result:

PLC feedback:



Machine capability test results:

It is performed by the quality department by testing different types of errors with good/bad parts and monitoring the machine performance for 50 parts produced.

Машинна пригодност
Machine Capability

KOSTAL

Дата: *Date:*	17.11.2015	Отдел: *Department:*	AQM- Aliev, Yozlen
Част №: *Part No.*	10051552 1005057	Знак: *Sign:*	Сензор за следене на качеството на спойките
Наименование: *Part name:*	GRA Audi C7	Мерна единица: *Parameter:*	-
Операция №: *Operation No.*	table 229	Измерено с: *Measured by:*	Визуална проверка

Номинална стойност: *Nominal value:* OTG: *UTL:* UTG: *LTL:*

1	2	3	4	5	$\bar{x}$	R	S
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!
i.O.	i.O.	i.O.	i.O.	i.O.	i.O.	0,00000	#DIV/0!

$\bar{\bar{x}}$	$\bar{R}$	$\bar{S}$
0,00000	0,00000	#DIV/0!

Статистика

Средно: *Average*	0,000000
$\bar{x}+5s$	#DIV/0!
$\bar{x}-5s$	#DIV/0!
$\hat{\sigma}$:	#DIV/0!
Размах: *Range(1-50)*	0,000000
OEG(x): *UCL(x):*	#DIV/0!
UEG(x): *LCL(x):*	#DIV/0!

Cm:

Cmk: **i.O.**

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Speichern

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Drucken 1+2+3

Seitenanp.

Cm:
Cmo:
Cmu:
Cmk: i.O.

Conclusions

- Based on the obtained results, it can be claimed that the aim of the thesis - integration of a visual inspection system for the presence of solder has been fulfilled, and the obtained results have been confirmed by performing a real-time machine suitability test.


Thank you for your attention!