ELIMINATING SHORT CIRCUIT ON PLC SIGNALS THROUGH THE USE OF WIRE JUMPER FOR FAVI MACHINES

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ABSTRACT

Final Auto Visual Inspection Tool (FAVI Tool) is equipment that utilizes eleven (11) cameras to visually inspect Head Gimbal Assembly (HGA). This tool uses a Programmable Logic Controller (PLC) to control both the LED and shutter of the cameras which are then connected on a single terminal block.

One of the main challenges encountered was a short circuit on the terminal block, affecting one of the main components of the equipment which is the Programmable Logic Controller (PLC). In which, 4 out of 42 FAVI machines were affected.

The proposed research helps to eliminate the short circuit problem occurrence during electrical assembly by converting shorting bar to wire jumper. As a result, for the next sets of FAVI machines, short circuit on the PLC signals did not reoccur.

1. 0 INTRODUCTION

1.1 FAVI Machine Terminal Block Assembly and Signal Checking Process

Terminal Block assembly is a process in electrical unit for FAVI machines in which DC power supply (24VDC and 0V) and PLC signals are connected. This sub-assembly begins with cutting of shorting bar (connected to 24V) using side cutter then wires from 0V and PLC signals are crimped. After crimping, these wires will be connected and mounted to the terminal block together with the shorting bar.

Terminal Block assembly is then mounted to the FAVI machine along with other electrical assemblies for continuity checking. After continuity checking, machine will then be powered ON to perform signal checking.

Signal checking is a process where the input and output signals of FAVI machine will be checked through a software called "DIO tool". In the software reflects the three IO cards that contains the input and output signals for the machine. If "green light" is displayed, signal is triggered or in ON state. Otherwise, it is not triggered or in OFF state.

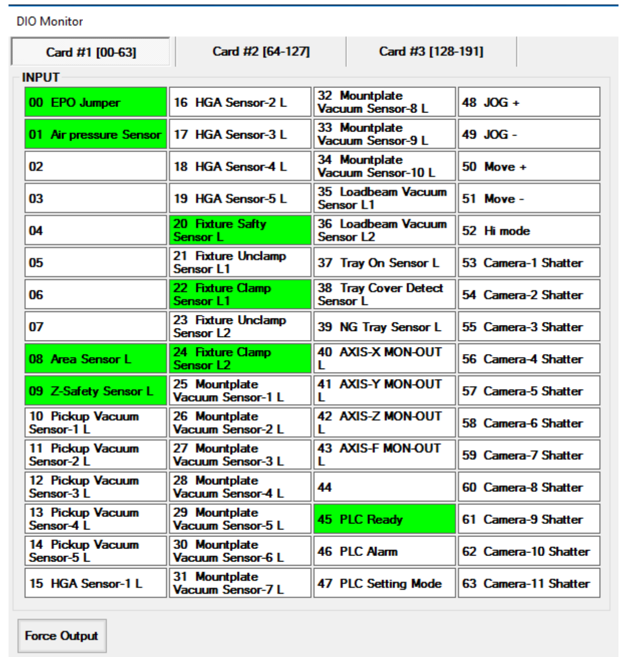
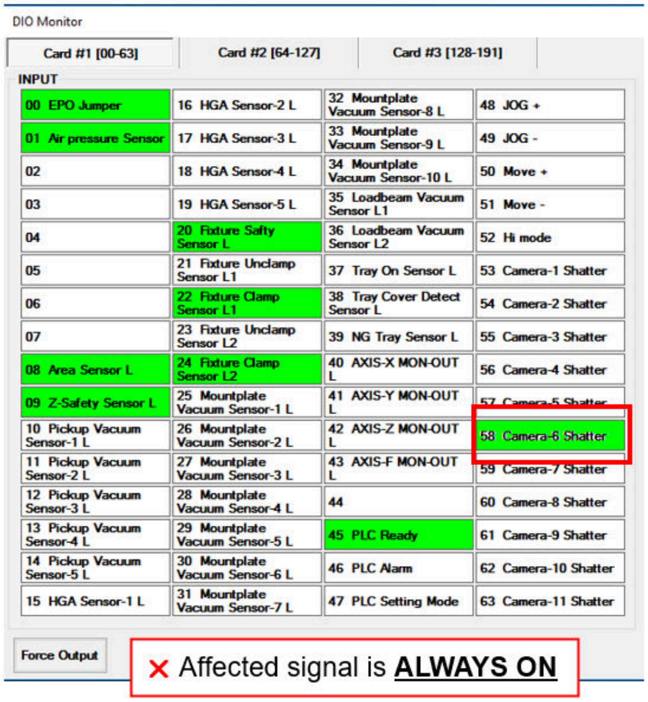


Figure 1: View of the DIO tool

1.2 The Problem

During signal checking of the cameras, it was discovered that a camera signal is always triggered or always in ON state even when shutter and LED is not triggered.



00 EPO Jumper	16 HGA Sensor-2 L	32 Mountplate Vacuum Sensor-8 L	48 JOG +
01 Air pressure Sensor	17 HGA Sensor-3 L	33 Mountplate Vacuum Sensor-9 L	49 JOG -
02	18 HGA Sensor-4 L	34 Mountplate Vacuum Sensor-10 L	50 Move +
03	19 HGA Sensor-5 L	35 Loadbeam Vacuum Sensor L1	51 Move -
04	20 Fixture Safty Sensor L	36 Loadbeam Vacuum Sensor L2	52 Hi mode
05	21 Fixture Unclamp Sensor L1	37 Tray On Sensor L	53 Camera-1 Shatter
06	22 Fixture Clamp Sensor L1	38 Tray Cover Detect Sensor L	54 Camera-2 Shatter
07	23 Fixture Unclamp Sensor L2	39 NG Tray Sensor L	55 Camera-3 Shatter
08 Area Sensor L	24 Fixture Clamp Sensor L2	40 AXIS-X MON-OUT L	56 Camera-4 Shatter
09 Z-Safety Sensor L	25 Mountplate Vacuum Sensor-1 L	41 AXIS-Y MON-OUT L	57 Camera-5 Shatter
10 Pickup Vacuum Sensor-1 L	26 Mountplate Vacuum Sensor-2 L	42 AXIS-Z MON-OUT L	58 Camera-6 Shatter
11 Pickup Vacuum Sensor-2 L	27 Mountplate Vacuum Sensor-3 L	43 AXIS-F MON-OUT L	59 Camera-7 Shatter
12 Pickup Vacuum Sensor-3 L	28 Mountplate Vacuum Sensor-4 L	44	60 Camera-8 Shatter
13 Pickup Vacuum Sensor-4 L	29 Mountplate Vacuum Sensor-5 L	45 PLC Ready	61 Camera-9 Shatter
14 Pickup Vacuum Sensor-5 L	30 Mountplate Vacuum Sensor-6 L	46 PLC Alarm	62 Camera-10 Shatter
15 HGA Sensor-1 L	31 Mountplate Vacuum Sensor-7 L	47 PLC Setting Mode	63 Camera-11 Shatter

Figure 2: A camera signal (Camera-6 Shutter) is always ON even when not triggered indicating that there is a short circuit on the affected signal.

It was later discovered that due to exposed conductor which is caused by the no good cutting of shorting bar, a contact between the PLC signal and 24V occurred causing the circuit to be shorted that affected the PLC. 4 out of 27 FAVI machines were affected.

Furthermore, a proper way of cutting of shorting bar was also proposed but the proposal was then rejected by IMES Japan.

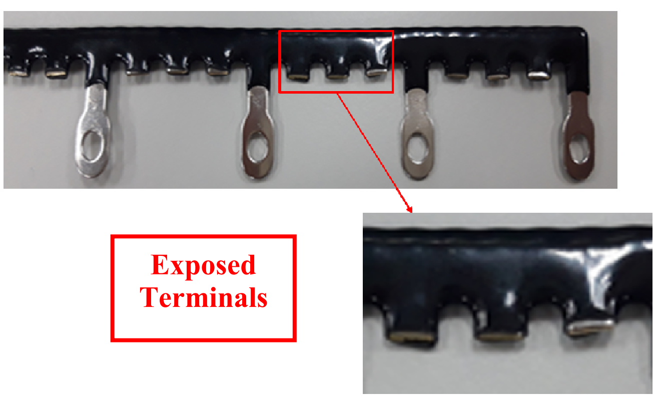


Figure 3: Exposed terminals due to no good cutting of shorting bar.

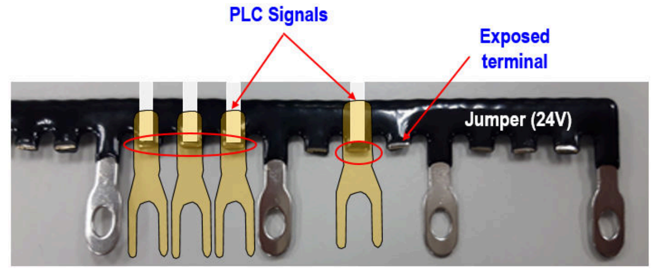


Figure 4: Sample illustration on how short circuit happened

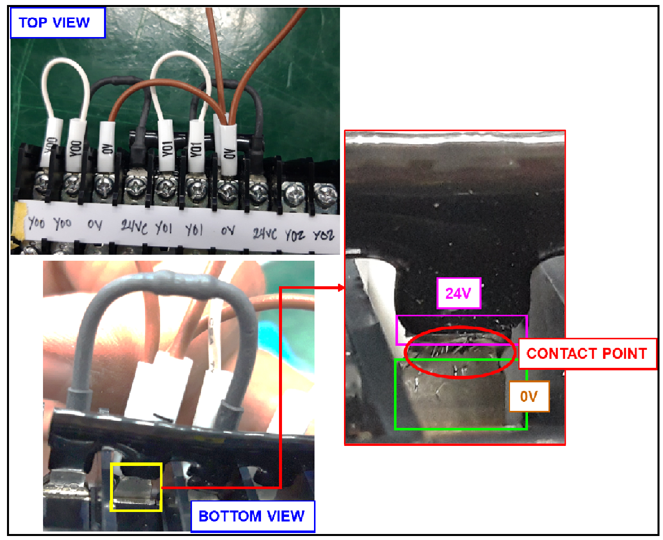


Figure 5: Actual image of short circuit on terminal block (contact between 24VC shorting and 0V wire)

1.2.1 Basic Solution

Converting from shorting bar to wire jumper is the solution for the short circuit problem. The wire jumper has a mark tube that will serve as an insulator to avoid having contact with the PLC signals therefore eliminating the short circuit on the machine.

2.0 EXPERIMENTAL SECTION

2.1 Materials

Terminal Block (BNH15MW-58) – Aids connection of DC power supply (24VDC and 0V) and PLC signals

Wire (UL1007 AWG24 Violet, Brown, White 1000mm each)

- Violet: 24VDC
- Brown: 0V
- White: jumper wire for PLC signals

Wire (Kuramo KVC series) – This will be used for PLC signals

Terminal (R1.25-M3.5) – This will be used for DC power supply

Terminal (F1.25-L3) – This will be used for PLC signals

47kΩ, ¼ Watt resistor – This helps circuit from overcurrent
Mark Tube – This will be used to label the wires. This will also serves as an insulation to the wires.
Shrinkable Tube – This will be used as insulation for the resistor
Mark Sheet for Terminal Blocks (BNM7PN10) – This will be used for labeling the terminal block.
Din Rail (MRA-1000, 500mm) – This will aid the terminal block assembly on mounting to the machine.
Din Rail Stopper (BNL6, 2 pcs) – This holds the terminal block in place.

2.2 Procedure

Using side cutter, wires for both DC power supply and PLC signals is cut about 70mm and 50mm, respectively. Next, with 3mm diameter mark tube, wires are labeled on both ends (24VC for violet, 0V for brown, Y00-Y17 for PLC signals). Do note that label is performed first before crimping since it cannot be labeled once wires are crimped. Using NH-69 solderless crimper, the terminals R1.25-M3.5 are crimped on both ends of the DC power supply (Violet and Brown wire) then the terminals F1.25-L3 are crimped on both ends of the PLC signals (white wire).

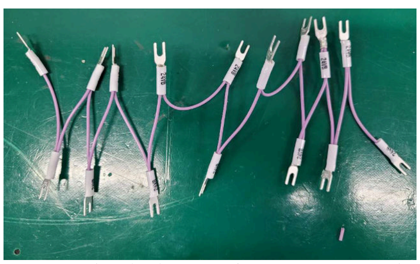


Figure 6a: Sample wire jumpers for DC power supply (24V)

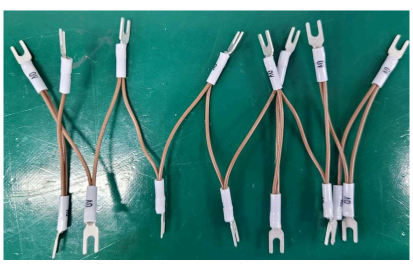


Figure 6b: Sample wire jumpers for DC power supply (0V)

Next, the shrinkable tube is inserted and heated to the 47kΩ resistor to serve as an insulation. Next, with 3mm diameter mark tube, resistors are labeled on both ends. Using, NH-69 solderless crimper, the terminal F1.25-L3 is crimped to both ends of the resistor.

Figure 7: 47kΩ resistor with insulation

Lastly, the resistors and wire jumpers are connected to the terminal block. Mark sheet for terminal blocks are attached for labelling purposes. Terminal block assembly is then mounted to din rail with din rail stopper on both ends.

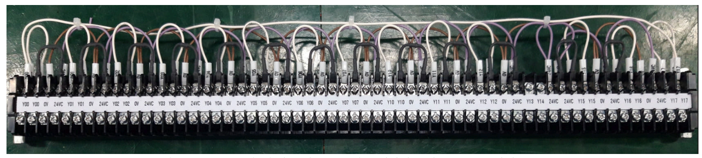


Figure 8: Finished terminal block assembly.

3.0 RESULTS AND DISCUSSION

Application of jumper wires to terminal block gave a significant outcome in cost savings, quality improvement, and customer satisfaction.

Method used	Machine Quantity	Material Cost	No. of Defects
Shorting bar	1	$ 0.29	4
Wire jumper	1	$ 0.60	0

Table 1: Cost comparison between shorting bar and wire jumper.

Table 1 shows that wire jumper is expensive than shorting bar by about 0.31 USD (US Dollar).

Machine Assembly	Machine Unit Qty. Produced	No. of Defects	Cost of Defect (PLC scrappage)
Using shorting bar	27	4	$ 1,952.80
Using wire Jumper	15	0	0

NOTE:	
PLC average price (USD)	$ 488.20

Table 2: The cost of defect (PLC scrappage) using shorting bar vs. using wire jumper

Table 2 shows that using the shorting bar method, there were 4 defects out of 27 FAVI machines which is equivalent to $ 1952.80 of PLC scrappage. After applying wire jumper method to 15 FAVI machines, the reoccurrence of short circuit on PLC was eliminated. Thus, saving up to $ 488.20 per FAVI machine.

In terms cost, it can be seen that wire jumper is expensive than shorting bar but by using the wire jumper method, it can save up to $ 488.20 due to avoidance of PLC defects.

In connection to quality improvement and customer satisfaction, related internal and external rework was eliminated.

Lastly, workmanship error is avoided thus giving assembler more focus on other assembly processes.

4.0 CONCLUSION

By converting from shorting bar to wire jumper, the proponents were able to eliminate the occurrence of short circuit problem on 24V to PLC signals in FAVI machines.

5.0 RECOMMENDATIONS

This study is recommended to parallel application with other machine assemblies that are currently using shorting bar on their terminal block assembly

6.0 ACKNOWLEDGMENT

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7.0 ABOUT THE AUTHORS

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