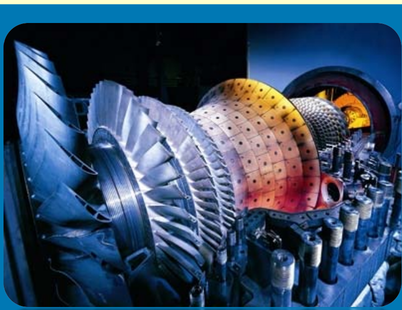

MARK-V GROUND FAULT RECTIFICATION CASE STUDY

Adeel Imtiaz
FFC, Pakistan

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INTRODUCTION

MARK-V control system is installed on one of our two gas turbines. Mark-V 125VDC supply ground problem appeared intermittently for past few years. In Turnaround 2010 instrument team rectified this ground fault.

This report gives a brief overview of nature of job performed by instrument team. The report also presents a comparative analysis of complexity of ground fault rectification procedure in MARK-II and MARK-V system.

BACKGROUND

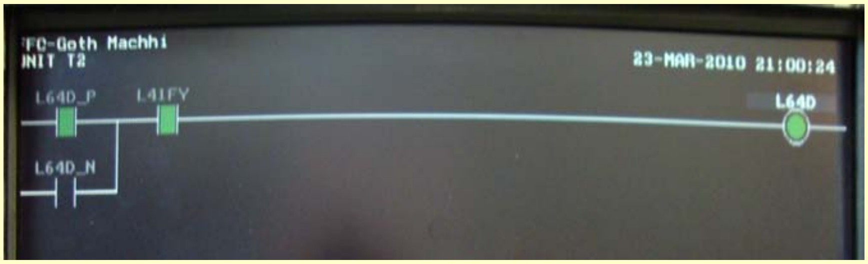
Mark-V has two main types of power supply sources

- 125VDC
- 125VAC

125VDC is further regulated to ±24 VDC, ±15 VDC and 5VDC.

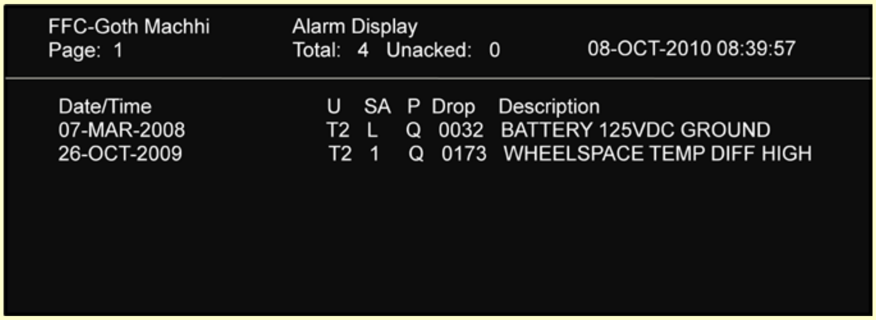
125VDC continuously monitored by a ground detector soft relay L64D. In case positive or negative pole of supply set out limit then 125VDC SUPPLY GROUND FAULT alarm appears in MARK-V <I> alarm list.

"MARK-V system gives valuable ground fault diagnostic information and voltage level variation"



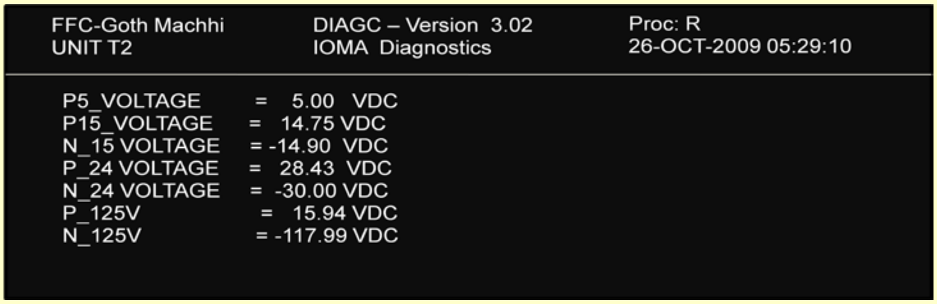
L64D Energized

In above picture it is clear that 125VDC positive terminal ground contact L64D_P was energized actuating L64D ground detector soft relay.



Above piece of information was further verified by the voltage on both poles of 125VDC with respect to ground. This information is also available on DIAGNOSTIC software module (DIAGC).

"Speedtronic and Thermocouple Ground Faults do not exist in MARK-V system."



MARK-V <I> DIAGNOSTIC SCREEN

TERMINAL	AS FOUND VOLTAGE (VDC)	ACCEPTABLE VOLTAGE RANGE (VDC)	NORMAL IMPEDANCE (KΩ)
POS-GND	**15**	More than 31	33
NEG-GND	**-117**	Less than -31	33
P15-COM	14.75	17 to 13	-
N15-COM	-14.90	-17 to -13	-
P24-COM	28.43	28 to 22	-
N24-COM	-30	-24 to -22	-
P5-COM	5	7 to 4	-

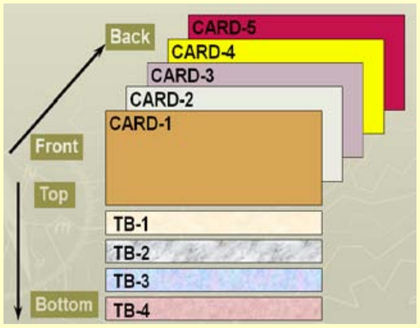
MEASURED VOLTAGE LEVELS

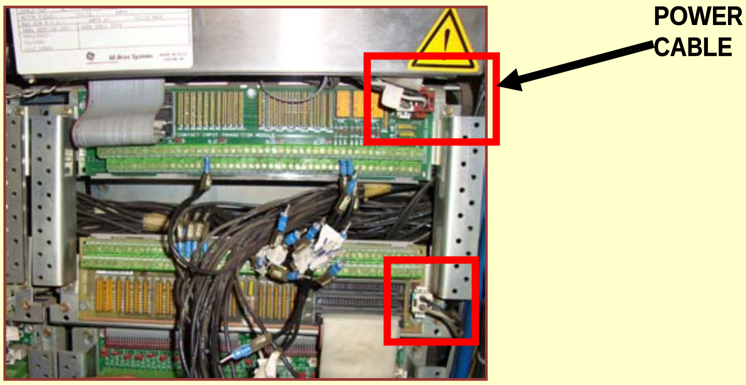
Above values shows that positive and negative poles with respect to ground are out of acceptable range. Since only 15VDC developed across positive pole and ground which refers to the grounding of positive pole.

No ground detector is installed for regulated supplies of ±24VDC, ±15VDC and 5VDC in MARK-V system. These supplies are protected with fuses and under voltage alarms.

125VDC GROUND FAULT RECTIFICATION

MARK-V system is composed of six cores and one protective interface module. Each core has a maximum of four terminal blocks. Analog IOs are terminated on processor<R>, communication <C> and protection <P> cores while digital IOs are terminated on <QD> and <CD>. 125VDC is supplied to each core and terminal block by power distribution core <PD>.





125VDC Power Cables to TBs

MARK-V Cores & Terminal Block

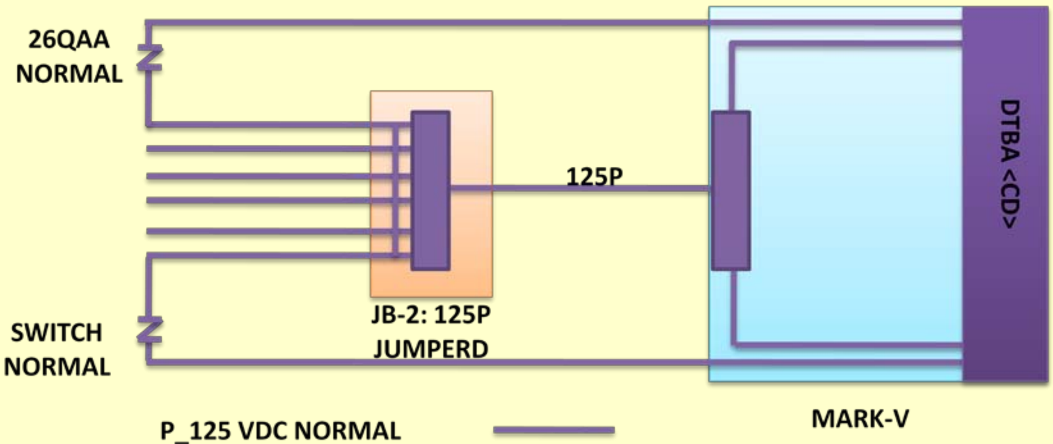
The goal of this procedure was to disconnect all TBs and cores from power distribution core one by one till L64D reset.

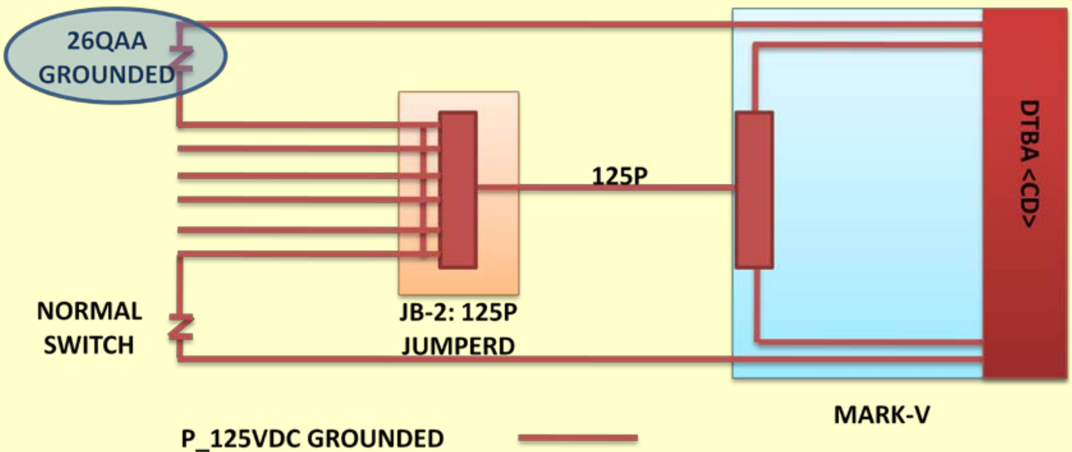
- The procedure started by disconnecting 125VDC power cables to terminal block DTBA of <QD> core. Two multi-meters were also placed to measure supply against ground. L64D did not reset.
- In the next step power cable of terminal block DTBB of <QD> was removed but L64D did not reset.
- In this way all the digital inputs of <QD> core were isolated. Digital inputs on <CD> core were to be disconnected in the next phase.
- The L64D relay was reset when power cable was disconnected from terminal block DTBA of <CD> core.

L64D Relay Reset

- DTBA contained 19 pairs of cables which were suspicious. Each pair was removed one by one to narrow down the fault. It revealed that out of 19 pair 14 pairs were grounded.
- On the basis of analysis it was concluded that positive grounded supply cable coming from field is looped in JB-2 from where ground fault is spread to every field device looped from JB-2 terminal block as shown in the picture. The figure shows that a single grounded sensor 26QAA caused ground fault in all loops due to cable looping at JB-2.


JB-2






26QAA SWITCH

- To identify the root cause cables were disconnected from JB-2: TB-A. As soon as the cable from grounded switch 26QAA atomizing air high temperature was disconnected L64D reset, “125VDC Battery Ground” alarm disappeared while “Atomizing air high temperature” alarm initiated.
- On field inspection 125VDC supply cable was found damaged and switch was in bad conditions. Voltages were sinking to ground from both cable and switch. Cable was repaired and protected. Switch power terminal to ground resistance was 2KΩ, far less than MARK-V ground threshold (33KΩ). Switch was bypassed.


26QAA SWITCH

Ground Fault Detection Comparison

26QAA SWITCH

The Speedtronic regulated supplies are contained to MARK-V cabinet through few jigs whereas thermocouples are directly terminated on input TBs while logic is implemented in software. Therefore, Speedtronic & Thermocouple ground fault does not exist in MARK-V system which makes it less vulnerable to ground faults as shown in the table. Recently we also removed 125VDC ground fault in MARK-II a hence a comparison is given below

125VDC GROUND	MARK-V	MARK-II
Fault Detection Time	3 hours	48 Hours
Cables Disconnected	24	300
Fault Tracing	Systematic	Hit & trail
Ground Fault Information	Detects which pole is grounded and also shows live voltage values	Detects only ground fault
Field/JB Cable Topology	Same	Same
SPEEDTRONIC GROUND		
Speedtronic Ground Fault	Does not Exist	Probable
SGDD CARD/Soft Relay	Non	YES
SPD. Fault Det. Time	-	>90 Hours
Cables Disconnected	-	>680
Thermocouple GROUND		
THRM. Ground Fault	Does not Exist	Probable

CONCLUSION

Mark-V 125VDC ground fault was detected in three hours while same activity in MARK-II took more than 48 hours. A clear difference in number of cables/modules disconnected was also observed in both cases.

MARK-II Thermocouple, Speedtronic and 125VDC circuits are floating/ungrounded systems. Any ground fault occurrence in these circuits can cause damage to human and equipment. On the other hand MARK-V system possesses only 125VDC ungrounded circuit. Speedtronic and thermocouple circuit are shifted to MARK-V soft logic. Consequently, MARK-V control system architecture makes it less susceptible to ground faults.

However field cable structure and JB looping does not have much difference in both systems. Improvement in filed cable topology and JB looping can reduce the 125VDC ground detection time in both systems.