IMAC CONTROLLER O.S. v4.0, v4.1 & v4.2 SIL DECLARATION'S OF CONFORMITY

Integrated Monitoring and Control System

Introduction

In May 2018, the iMAC / iMAC2 Controller operating system firmware was modified to extend the iMAC Module Serial Number range.

These changes occurred in iMAC Controller Operating System Firmware v4.0 (O.S. v4.0).

Marcus Punch Pty Ltd was engaged to perform a safety integrity verification of these changes.

iMAC2 report AMP-15-01-A[1] Revision 3 (including Revisions 4 & 5) and iMAC report AMP-11-05-A[2] Revision 2 (including Revisions 3 & 4) assessed these changes to be in compliance with the requirements pertaining to software modification and as a result the existing safety metrics (PFD and PFH) for the iMAC Controller, iMAC2 Controller, 2-wire and 3-wire iMAC systems remain unchanged.

In August 2018, the iMAC / iMAC2 Controller operating system was modified to ensure iMAC Controller SLP command *NextForceAddr* maintains compatibility with the extended serial number range.

These changes occurred in iMAC Controller Operating System Firmware V4.1 (O.S. v4.1).

Marcus Punch Pty Ltd was engaged to perform a safety integrity verification of these changes.

iMAC2 report AMP-15-01-A[3] Revision 6 and iMAC report AMP-11-05-A[4] Revision 5 assessed these changes to be in compliance with the requirements pertaining to software modification and as a result the existing safety metrics (PFD and PFH) for the iMAC Controller, iMAC2 Controller, 2-wire and 3-wire iMAC systems remain unchanged.

In October 2020, the iMAC / iMAC2 Controller operating system was modified to improve priority scanning of fieldbus data.

These changes occurred in iMAC Controller Operating System Firmware V4.2 (O.S. v4.2).

Marcus Punch Pty Ltd was engaged to perform a safety integrity verification of these changes.

iMAC2 report AMP-15-01-A[5] Revision 7 and iMAC report AMP-11-05-A[6] Revision 6 assessed these changes to be in compliance with the requirements pertaining to software modification and as a result the existing safety metrics (PFD and PFH) for the iMAC Controller, iMAC2 Controller, 2-wire and 3-wire iMAC systems remain unchanged.

The prior SIL Declarations of Conformity for iMAC Controller, iMAC2 Controller, 2-wire and 3-wire iMAC systems have been revised only to the extent of referencing the latest revisions of these reports (the PFD and PFH safety metrics remain unchanged).

References and Disclaimer

- [1]*AMP-15-01-A iMAC2 2-wire & 3-wire - SIL Verification Oct20 Rev5.pdf*
- [2]*AMP-11-05-A iMAC 2-wire & 3-wire - SIL Verification May18 Rev4.pdf*
- [3]*AMP-15-01-A iMAC2 2-wire & 3-wire - SIL Verification Aug18 Rev6.pdf*
- [4]*AMP-11-05-A iMAC 2-wire & 3-wire - SIL Verification Aug18 Rev5.pdf*
- [5]*AMP-15-01-A iMAC2 2-wire & 3-wire - SIL Verification Oct20 Rev7.pdf*
- [6]*AMP-11-05-A iMAC 2-wire & 3-wire - SIL Verification Oct20 Rev6.pdf*

ampcontrolgroup.com
customerservice@ampcontrolgroup.com
+61 1300 267 373

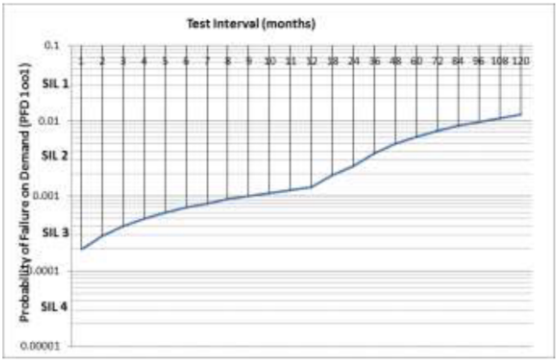
Marcus Punch Pty. Ltd.
Risk and Reliability

Declaration of Conformity (IMAC2_Controller_271020)

Marcus Punch Pty. Ltd. was engaged by Ampcontrol Group to perform a safety integrity verification on their iMAC Controller against the requirements of AS61508.2-2011. The verification was conducted according to the 'proven-in-use' and 'probabilistic' routes.

The details of the analyses and reviews that lead to these findings are provided in our report:
AMP-15-01-A Rev.7, iMAC2 Controller, EOL, MEOL and CRM 2-wire and 3-wire Systems Safety Integrity Level (SIL) 'Proven-In-Use' Verification - *Safety Integrity (SIL) Verification (dated 27th October 2020).*

iMAC2 Controller (Part No's. 171571, 173552)		
Description	**Finding**	**Conclusion**
Hardware Safety Integrity Compliance Approach[1]	Route 1_H	
Architectural Constraints	SFF=98.8%, HWFT=0, Type B	SIL2
Random Hardware Failures (Chi-square (χ^2) estimation at 90% degree of confidence)	λ_{total} = 2.3x10^{-5} / hour, or 23,000 FITS[2] MTTF = 43,478 hours, or 5.0 years λ_{du} = 2.8x10^{-7} / hour, or 280 FITS $MTTF_d$ = 3,571,429 hours, or 407.7 years	
Probability of Failure on Demand (PFD_{ave})	PFD_{ave} = 1.3x10^{-3} (with proof-test interval = one (1) year) See below for PFD_{ave} V's proof-test interval.	SIL2
Probability of Dangerous Failure Per Hour (PFH)	PFH = 2.8x10^{-7}	SIL2
Systematic Safety Integrity (Systematic Capability) Compliance Approach[3]	Route 2_S	
Systematic Capability[4]	SC2	
Overall SIL Capability[5]	SIL2	



Marcus Punch
TÜV FSExpert (Machinery, ID:154/10), TÜV FSEng (SIS, ID:735/07)
CPEng, NPER, RPEQ
Director

[1] Per AS61508.2-2011 Clauses 7.4.2 and 7.4.4.
[2] 1 FIT = 1 failure per billion hours, or a failure rate of 1x10^{-9} / hour.
[3] Per AS61508.2-2011 Clauses 7.4.2 and 7.4.4.
[4] Per AS61508.2-2011 Clause 7.4.3.
[5] Overall SIL capability is determined by the minimum SIL indicated by the above parameters.

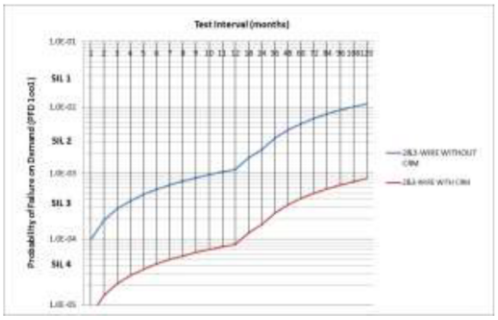
Marcus Punch Pty. Ltd.
Risk and Reliability

Declaration of Conformity (IMAC2_System_2&3W_271020)

Marcus Punch Pty. Ltd. was engaged by Ampcontrol Group to perform a safety integrity verification on their iMAC 2-wire and 3-wire System configurations against the requirements of AS61508.2-2011. The verification was conducted according to the 'proven-in-use' and 'probabilistic' routes.

The details of the analyses and reviews that lead to these findings are provided in our report:
AMP-15-01-A Rev.7, iMAC2 Controller, EOL, MEOL and CRM 2-wire and 3-wire Systems Safety Integrity Level (SIL) 'Proven-In-Use' Verification - *Safety Integrity (SIL) Verification (dated 27th October 2020).*

iMAC2 2-wire & 3-wire Systems (Part No's. 171571, 173552)		
Description	**Finding**	**Conclusion**
Hardware Safety Integrity Compliance Approach[1]	Route 1_H & 2_H	
Architectural Constraints	2&3-wire with-out CRM: SFF>90%, HWFT=0, Type B 2&3-wire with CRM: SFF>90%, HWFT=1, Type B	SIL2 SIL3
Random Hardware Failures (Chi-square (χ^2) estimation at 90% degree of confidence)	2&3-wire with-out CRM: $\lambda_{du} = 2.9x10^{-7}$ / hour, or 290 FITS 2&3-wire with CRM: $\lambda_{du} = 2.1x10^{-8}$ / hour, or 21 FITS	
Probability of Failure on Demand (PFD_{ave})	2&3-wire with-out CRM: $PFD_{ave} = 1.3x10^{-3}$ 2&3-wire with CRM: $PFD_{ave} = 9.1x10^{-5}$ (with proof-test interval = one (1) year) See below for PFD_{ave} V's proof-test interval.	SIL2 SIL4
Probability of Dangerous Failure Per Hour (PFH)	2&3-wire with-out CRM: $PFH = 2.9x10^{-7}$ 2&3-wire with CRM: $PFH = 2.1x10^{-8}$	SIL2 SIL3
Systematic Safety Integrity (Systematic Capability) Compliance Approach[2]	Route 2_S	
Systematic Capability[3]	SC2	
Overall SIL Capability[4]	2&3-wire with-out CRM: SIL2 2&3-wire with CRM: SIL3	



Marcus Punch
TÜV FSExpert (Machinery, ID:154/10), TÜV FSEng (SIS, ID:735/07)
CPEng, NPER, RPEQ
Director

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[2] Per AS61508.2-2011 Clauses 7.4.2 and 7.4.4.
[3] Per AS61508.2-2011 Clause 7.4.3.
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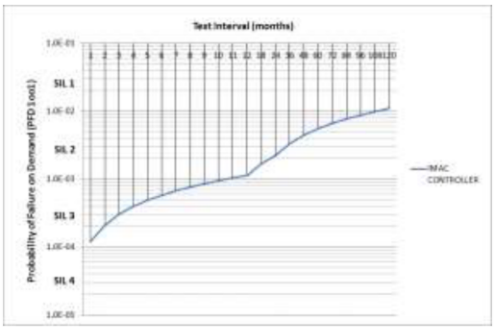
Marcus Punch Pty. Ltd.
Risk and Reliability

Declaration of Conformity (IMAC_Controller_271020)

Marcus Punch Pty. Ltd. was engaged by Ampcontrol Group to perform a safety integrity verification on their iMAC Controller against the requirements of AS61508.2-2011. The verification was conducted according to the 'proven-in-use' route.

The details of the analyses and reviews that lead to these findings are provided in our report:
AMP-11-05-A Rev.6, iMAC Controller, EOL, MEOL and CRM 2-wire and 3-wire Systems Safety Integrity Level (SIL) 'Proven-In-Use' Verification - *Safety Integrity Verifications (SIL) Proven-In-Use Verification (dated 27th October 2020).*

iMAC Controller (Part No's. 101268, 112583, 118532, 118709, 118710, 120964)		
Description	**Finding**	**Conclusion**
Hardware Safety Integrity Compliance Approach[1]	Route 2_H	
Architectural Constraints	SFF=96.5%, HWFT=0, Type B	SIL2
Random Hardware Failures (Chi-square (χ^2) estimation at 90% degree of confidence)	λ_{total} = 5.8x10^{-6} / hour, or 5800 FITS[2] MTTF = 171,524 hours, or 19.6 years λ_{du} = 2.5x10^{-7} / hour, or 250 FITS $MTTF_d$ = 4,000,000 hours, or 457 years	
Probability of Failure on Demand (PFD_{ave})	PFD_{ave} = 1.1x10^{-3} (with proof-test interval = one (1) year) See below for PFD_{ave} V's proof-test interval.	SIL2
Probability of Dangerous Failure Per Hour (PFH)	PFH = 2.5x10^{-7}	SIL2
Systematic Safety Integrity (Systematic Capability) Compliance Approach[3]	Route 2_S	
Systematic Capability[4]	SC2	
Overall SIL Capability[5]	SIL2	



Marcus Punch
TÜV FSExpert (Machinery, ID:154/10), TÜV FSEng (SIS, ID:735/07)
CPEng, NPER, RPEQ
Director

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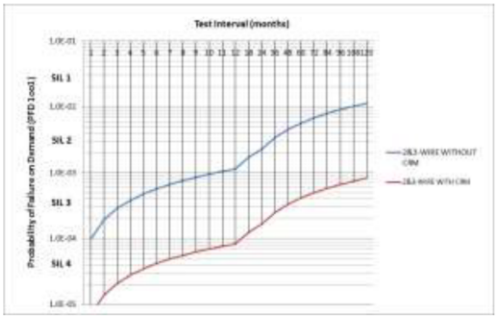
Risk and Reliability

Declaration of Conformity (IMAC_System_2&3W_271020)

Marcus Punch Pty. Ltd. was engaged by Ampcontrol Group to perform a safety integrity verification on their iMAC 2-wire and 3-wire System configurations against the requirements of AS61508.2-2011. The verification was conducted according to the 'proven-in-use' route.

The details of the analyses and reviews that lead to these findings are provided in our report:
AMP-11-05-A Rev.6, iMAC Controller, EOL, MEOL and CRM 2-wire and 3-wire Systems Safety Integrity Level (SIL) 'Proven-In-Use' Verification - *Safety Integrity Verifications (SIL) Proven-In-Use Verification (dated 27th October 2020).*

iMAC 2-wire & 3-wire Systems (Part No's. 101268, 112583, 118532, 118709, 118710, 120964)		
Description	**Finding**	**Conclusion**
Hardware Safety Integrity Compliance Approach[1]	Route 2_H	
Architectural Constraints	2&3-wire with-out CRM: SFF>90%, HWFT=0, Type B 2&3-wire with CRM: SFF>90%, HWFT=1, Type B	SIL2 SIL3
Random Hardware Failures (Chi-square (χ^2) estimation at 90% degree of confidence)	2&3-wire with-out CRM: $\lambda_{du} = 2.6x10^{-7}$ / hour, or 260 FITS 2&3-wire with CRM: $\lambda_{du} = 1.9x10^{-8}$ / hour, or 19 FITS	
Probability of Failure on Demand (PFD_{ave})	2&3-wire with-out CRM: $PFD_{ave} = 1.2x10^{-3}$ 2&3-wire with CRM: $PFD_{ave} = 8.5x10^{-5}$ (with proof-test interval = one (1) year) See below for PFD_{ave} V's proof-test interval.	SIL2 SIL4
Probability of Dangerous Failure Per Hour (PFH)	2&3-wire with-out CRM: $PFH = 2.6x10^{-7}$ 2&3-wire with CRM: $PFH = 1.9x10^{-8}$	SIL2 SIL3
Systematic Safety Integrity (Systematic Capability) Compliance Approach[2]	Route 2_S	
Systematic Capability[3]	SC2	
Overall SIL Capability[4]	2&3-wire with-out CRM: SIL2 2&3-wire with CRM: SIL3	



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