

Recent Status of IEC61326 series standards and on the functional safety of IPMC equipments

Yukio Tani

Safety Design Department Yamatake Corporation

1-12-2, Kawana, Fujisawa Kanagawa, Japan Postal Code: 251-8522

tani-yukio@jp.yamatake.com

Abstract— The histories and recent changes made to the standard of Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1 General requirements : IEC 61326-1 and other parts were described in this report.

The TC65/SC65A/WG4 has initiated a Task Force (TF) meeting to create a new EMC requirements standard for IPMC (Industrial Process Measurement and Control) equipments as Product Standard from back in 1991.

After a long investigation, IEC 61326-1 has been published as First Edition on March 1997. Thereafter series of new EMC requirements were specified as Part 2 of IEC 61326 and it consists of 6 parts now.

Addition to the above, EMC immunity requirements for safety-related system and for equipments intended to perform safety-related functions (functional safety) has been introduced with new Performance criteria of FS. Those were described in this report.

Keyword: Product Family Standard, IPMC(Industrial Process Measurement and Control), EMC, General Requirements, Minimum Requirements, EMC unprotected application, Portable test, measuring and monitoring equipment, Performance Criteria FS(Functional Safety)

I . INTRODUCTION

The first meeting to generate EMC (Electro Magnetic Compatibility) requirement standard was initiated on 1991 at Hamburg Germany. Before the meeting there was no such type of standard and as the results of that many equipments manufacturer companies were experienced the difficulties to meet their customer's requirements to prevent any malfunction or failures related to EMC disturbances. Starting from the Hamburg meeting, TF team has decided to create a common EMC requirement for industrial process measurement and control equipment and agreed to specify the minimum EMC requirements not the highest possible requirements. The IEC standards were categorized into 4 types publications defined by IEC Guides 107, Basic EMC publications, Generic EMC standards, Product family EMC standards and Product EMC standards.

The Basic EMC publications define the test methods, ranges of test levels and establishes test procedures.

Generic EMC standards apply to products operating in a particular environment for which no dedicated product family EMC/product standards exist. They specify a set of essential requirements, test procedures and generalized performance criteria applicable to such products or systems operating in this environment.

Product family EMC standards define specific electromagnetic (EM) requirements and test procedures dedicated to particular product families. They should indicate the relevant installation and operating conditions. They should also give precise performance criteria, taking into account the purpose of the equipment where possible. They should apply the basic EMC standards and be coordinated with the generic EMC standards to the extent practicable.

Product EMC standards relate to a particular type of product for which specific conditions should be considered. The same rules apply as for the product family EMC standards.

Generic EMC standards can be considered as general product standards for EMC in that they specify a number of disturbances and tests applicable to products operating in a given environment.

Product family/product EMC standards take precedence over generic EMC standards. Product EMC standards take precedence over product family EMC standards. However, where neither product nor product family EMC standards exist for a particular group of products, the relevant generic standard should apply.

Understanding these differences and applicability of the standards, the IEC 61326-1 first edition has been published as Product family Standard on March 1997. It has introduced the port concepts like Enclosure port, AC power port, DC power port, I/O signal/control port and I/O signal/control connected directly to main supply port and the following minimum immunity test requirements have defined

Also the emission requirements has been defined as the limit values for class A equipment and class B equipment those values were referencing the CISPR-16, CISPR 16-1, IEC 1000-3-2 and IEC 1000-3-3.

Table 1 Minimum immunity test requirements
At 1997 version

Port	Phenomenon	Basic standard	Test values
Enclosure	Electrostatic discharge(ESD)	IEC 1000-4-2	4 kV/4 kV
	Electromagnetic	IEC 1000-4-3	3 V/m
AC power	Voltage interrupt	IEC 1000-4-11	1 cycle/100%
	Burst	IEC 1000-4-4	1 kV
	Surge	IEC 1000-4-5	0.5 kV/1 kV
	Conducted RF	IEC 1000-4-6	3 V
DC power	Burst	IEC 1000-4-4	1 kV
	Surge	IEC 1000-4-5	0.5 kV/1 kV
	Conducted RF	IEC 1000-4-6	3 V
I/O signal/control	Burst	IEC 1000-4-4	0.5 kV
	Surge	IEC 1000-4-5	1 kV
	Conducted RF	IEC 1000-4-6	3 V
I/O signal/control connected directly to main supply	Burst	IEC 1000-4-4	1 kV
	Surge	IEC 1000-4-5	0.5 kV/1 kV
	Conducted RF	IEC 1000-4-6	3 V

In 1998 first amendment was made to add the following requirements.

- 1) Annex A: Immunity test requirements for equipment intended for use in industrial locations.
- 2) Annex B: Immunity test requirements for equipment used in controlled EM environments.
- 3) Annex C: Immunity test requirements for portable test and measurement equipment

Along with these amendments, continuous modification has been made and the results was published on Feb. 2002 as IEC 61326 First edition which introduced three additional annexes as follows;

- 1) Annex D: Particular requirements – Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications.
- 2) Annex E: Particular requirements – Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems
- 3) Annex F: Particular requirements – Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning Immunity test requirements for portable test and measurement equipment

After generating the Maintenance Cycle Report in 2002, the entire structure modification of the IEC 61326 e.g. re-structuring of the IEC 61326 standard has started. IEC 61326-1 has become the general requirements part and 3 tables have been introduced into this part of the standard. Those were Table 1 Basic immunity test requirements, Table 2 Immunity test requirements for equipment intended for use in industrial locations, and Table 3 Immunity test

requirements for equipment used in controlled EM environments. As the results of this re-structuring, the term of minimum requirements has been changed to the Basic immunity test requirements and the positioning of the part 1 among the entire series of IEC 61326 standards has been changed. Following the IEC 61326-1, series of the part 2 standards has been developed to meet the application or equipments specific requirements and performance criteria as follows;

- 1) Part 2-1: Particular requirements – Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications.
- 2) Part 2-2: Particular requirements – Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems
- 3) Part 2-3: Particular requirements – Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning
- 4) Part 2-4: Particular requirements – Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9
- 5) Part 2-5: Particular requirements – Test configurations, operational conditions and performance criteria for field devices with interfaces according to IEC 61784-1, CP 3/2
- 6) Part 2-6: Particular requirements – In vitro diagnostic (IVD) medical equipment

Finally, it has been specified the EMC test immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety). There are two types of requirements. First one is for General industrial applications and other one is for Industrial applications with specified electromagnetic environment.

II. CURRENT STRUCTURE OF IEC 61326 SERIES STANDARDS

The current version of the IEC 61326 standards are consists of 9 parts as follows;

- 1) IEC 61326-1
- 2) IEC 61326-2-1
- 3) IEC 61326-2-2
- 4) IEC 61326-2-3
- 5) IEC 61326-2-4
- 6) IEC 61326-2-5
- 7) IEC 61326-2-6
- 8) IEC 61326-3-1

9) IEC 61326-3-2

Each standard are explained briefly here.

(1) IEC 61326-1

This standard was prepared to as basis of the series standards and includes Basic Immunity requirements, Requirements for Industrial locations, Controlled EM environments and hand-held (e.g. portable) test and measurement equipments. It defines the above immunity requirements together with the emission requirements for class A and class B equipments.

Table 2 Basic immunity test requirements
At 2005 version

Port	Phenomenon	Basic standard	Test values
Enclosure	Electrostatic discharge(ESD)	IEC 61000-4-2	4 kV/4 kV
	Electromagnetic	IEC 61000-4-3	3 V/m
AC power	Voltage dip	IEC 61000-4-11	0% during half cycle 0% during 1 cycle 70% during 25/30 cycles
	Short interruptions	IEC 61000-4-11	0% during
	Burst	IEC 61000-4-4	250/300 cycles
	Surge	IEC 61000-4-5	1 kV
	Conducted RF	IEC 61000-4-6	0.5 kV/1 kV 3 V
DC power	Burst	IEC 61000-4-4	1 kV
	Surge	IEC 61000-4-5	0.5 kV/1 kV
	Conducted RF	IEC 61000-4-6	3 V
I/O signal/control	Burst	IEC 61000-4-4	0.5 kV
	Surge	IEC 61000-4-5	1 kV
	Conducted RF	IEC 61000-4-6	3 V
I/O signal/control connected directly to main supply	Burst	IEC 61000-4-4	1 kV
	Surge	IEC 61000-4-5	0.5 kV/1 kV
	Conducted RF	IEC 61000-4-6	3 V

(2) IEC 61326-2-1

This part of the standard specifies particular requirements of test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications. Oscilloscope, Logic analyzer, Digital multimeters are categorized into this standard.

(3) IEC 61326-2-2

This part of the standard was prepared to specify more detailed test configurations, operational conditions and performance criteria for equipment which is used for testing, measuring or monitoring of protective measures in low-voltage distribution systems, and powered by battery and/or from the circuit measured, and portable.

(4) IEC 61326-2-3

This part of the standard specifies more detailed test configurations, operational conditions and performance criteria for transducers with integrated or remote signal conditioning. This standard applies only to transducers characterized by their ability to transform, with the aid of an auxiliary energy source, a non-electric quantity to a

process-relevant electrical signal, and to output the signal at one or more ports. This standard includes transducers for electrochemical and biological measured quantities.

(5) IEC 61326-2-4

This part of the standard specifies more detailed test configurations, operational conditions and performance criteria than IEC 61326-1 for equipment for insulation monitoring according to IEC 61557-8; insulation fault location according to IEC 61557-9. This applies to insulation monitoring devices and insulation fault location systems permanently or semi-permanently connected to the distribution system.

(6) IEC 61326-2-5

This part of the standard treats the particular features for EMC testing of field devices with interfaces according to IEC 61784-1, CP 3/2. This part of IEC 61326 covers only the field-bus interface of the equipment.

(7) IEC 61326-2-6

This part of the standard specifies minimum requirements for immunity and emissions regarding electromagnetic compatibility for in vitro diagnostic medical equipment, taking into account the particularities and specific aspects of this electrical equipment and their electromagnetic environment.

III. IEC 61326-3-1 and IEC 61326-3-2

Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) has been developed and published two additional standards as IEC 61326-3-1 and IEC 61326-3-2. The first one is prepared for general industrial applications and the concept of the increased immunity levels for some electromagnetic phenomena compared to immunity levels which are derived without functional safety considerations has been introduced. Addition to the increased immunity levels, complete new performance criterion of FS (functional Safety) has been introduced too. Performance criterion FS is as follows.

The functions of the EUT intended for safety applications are not affected outside their specifications; or may be disturbed temporarily or permanently if the EUT reacts on a disturbance in a way that detectable, defined state or states of the EUT are maintained, or achieved within a stated time. Also, destruction of components is allowed if a defined state of the EUT is maintained or achieved within a stated time. The functions not intended for safety applications may be disturbed temporarily or permanently.

Compared with the IEC 61326-3-1, IEC 61326-3-2 standard is used for the equipments or systems those were built following the NAMUR recommendations. As the results of the precisely specified mitigation methods for EMC, the environments will have less severe disturbances compared with IEC 61326-3-17s requirements.

IV. Next maintenance items

For the next maintenance of the existing IEC 61326 series standards, 65A/515/DC document has been circulated to collect the items to be implemented to next maintenance timing. As the results of that more than 50 comments and request has been made to refine the IEC 61326 standards. The next meeting which will be held at Amsterdam on March 24 through 26 will take care of all of the proposal/requests.

V. Conclusion

The IEC 61326 series standards have been used as the compliance reference standard to the EU EMC Directive for the EMC requirements to achieve safer and more comfortable human being's life. Some portion of them is needed to be improved. TC65/SC65A/WG4 will work hard to meet those requests.

ACKNOWLEDGEMENTS

Special thanks to Dr. Bernd Jaekel (SC65A/WG4 convener)

REFERENCES

- [1] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements*, IEC International Standard 61326-1
- [2] *Corrigendum 1 - Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements* IEC 61326-1 Corr.1 (2008-02)
- [3] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-1: Particular requirements - Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications*, IEC International Standard 61326-2-1
- [4] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-2: Particular requirements - Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems*, IEC International Standard 61326-2-2
- [5] *Corrigendum 1 - Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-2: Particular requirements - Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems* IEC 61326-2-2 Corr.1 (2007-11)
- [6] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-3: Particular requirements - Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning*, IEC International Standard 61326-2-3
- [7] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-4: Particular requirements - Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9*, IEC International Standard 61326-2-4
- [8] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-5: Particular requirements - Test configurations, operational conditions and performance criteria for field devices with interfaces according to IEC 61784-1, CP 3/2*, IEC International Standard 61326-2-5
- [9] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-6: Particular requirements - In vitro diagnostic (IVD) medical equipment*, IEC International Standard 61326-2-6
- [10] *Corrigendum 1 - Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-6: Particular requirements - In vitro diagnostic (IVD) medical equipment* IEC 61326-2-6 Corr.1 (2007-09)
- [11] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications*, IEC International Standard 61326-3-1
- [12] *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - Industrial applications with specified electromagnetic environment*, IEC International Standard 61326-3-2
- [13] *TC65: INDUSTRIAL PROCESS MEASUREMENT, CONTROL AND AUTOMATION MEETING MINUTES, Keio Plaza Hotel Tokyo, Japan, May 23, 2008* [65/426/RM]
- [14] *Report of Comments on DC - Document 65A/515/DC* [2009_04_Comments on 65A-515-CC.doc]