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Handbook: Standard Electrical and Logical Interface for Airborne Fuzing Systems

RATIONALE

SAE AS-1 Technical Committee Aircraft Systems and System Integration, formed SAE AS-1B6, Fuze Systems Task Group, to generate an Aerospace Standard (AS) to support interoperability and interchangeability of airborne weapons and their fuzing systems. This effort was initiated in response to a request made to the SAE AS-1 Technical Committee by the North Atlantic Treaty Organization (NATO) Air Armament Panel for AS-1 to undertake a study or series of studies related to airborne weapons fuzing system standardization.

As a result of this request, Aerospace Standard AS5716 was published in February 2010 and subsequently updated as AS5716A in December 2012, providing definitions for a standard interface for fuzing system incorporated into weapons using MIL-STD-1760, aircraft to weapon interfaces as this is the interface generally employed for all modern airborne weapons of NATO countries.

This Handbook provides background information regarding the rationale and principles of the standard and has been written to give guidance on implementation of the standard.

FOREWORD

The information in this Handbook is intended to provide explanation and rationale for the requirements contained in AS5716 and to provide equipment design guidance on implementation of the requirements. The original intention was to delay the first issue of the Handbook until information could be included that was based on actual design experience. However, no such information has been received to date. It is intended therefore, that future issues of the Handbook will incorporate such information as and when it becomes available.

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1. SCOPE

This Handbook is intended to provide useful information on the application of AS5716A. It is for use by System Program Offices, aircraft prime contractors, avionics and store system designers, system integrators and equipment manufacturers and users.

This Handbook was prepared to provide users of the standard of the rationale and principles considered during the development of the standard. It is anticipated that the handbook will serve to assist developers in introducing new technology to achieve compliance with the standard and the underlying principles of the standard.

It is intended that the Handbook be used alongside the standard, as it does not contain significant extracts of the standard.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AS5680 Fuze Well Mechanical Interface

AS5716 Standard Electrical and Logical Interface for Airborne Fuzing Systems

2.1.2 NATO Publications

STANAG 4187 Fuzing Systems – Safety Design Requirements

2.1.3 US Government Publications

Copies of these documents are available online at <http://quicksearch.dla.mil>.

MIL-STD-704 Aircraft Electrical Power Characteristics

MIL-STD-1760 Aircraft/Store Electrical Interconnection System

MIL-STD-1553 Aircraft Internal Time Division Command/Response Multiplex Data Bus

MIL-STD-1316 Safety Criteria for Fuze Design

2.1.4 TIA Publications

Available from Telecommunications Industry Association, 2500 Wilson Boulevard, Suite 300, Arlington, VA 22201, Tel: 703-907-7700, Web address: <http://www.tiaonline.org/standards/>

TIA-422-B Electrical Characteristics of Balanced Voltage Digital Interface Circuits

TIA-485-A Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

2.1.5 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>, or from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

2.2 Definitions

No additional terms to be defined.

2.3 Abbreviations

ac:	Alternating Current
ACK:	Acknowledge
BC:	MIL-STD-1553 Bus Controller
BIT:	Built In Test
CTS:	Commit to Separate Store or Submunitions
CTSS:	Committed to Store or Submunitions Separation
dc:	Direct Current
EOD:	Explosive Ordnance Disposal
FIA:	Fuze Inhibit Arming
FCM:	Fuze Cancel Mission
FAD:	Fuze Arming De-Inhibit
FPR:	Fuze Prepare for Release
FRI:	Fuze Release Imminent
FRR:	Fuze Ready for Release
FSMH:	Fuzing System Main Housing
FSQ:	Fuze Status Query
ICD:	Interface Control Document
LB:	Lower Byte
LSB:	Least Significant Bit
MSB:	Most Significant Bit
MSI:	Mission Store Interface
NSAA:	National Safety Approving Authority
PDU:	Protocol Data Unit

PRASS: Post Release Air Speed Sensor

PRES: Post Release Environment Sensor

RC: Release Consent

RCM: Release Consent Monitor

RF: Radio Frequency

RI: Release Indication

RMS: Root Mean Square

RT: MIL-STD-1553 Remote Terminal

SDU: Service Data Unit

TBD: To Be Defined / To Be Determined

TDD: Target Detection Device

UART: Universal Asynchronous Receiver/Transmitter

UB: Upper Byte

2.4 Nomenclature

See AS5716A for all terms used in that standard.

3. GENERAL INFORMATION

3.1 General Interface Information

Unlike current bomb fuzes, the fuzing system in the AS5716A definition has a single connector, mounted on the fuzing system main housing. The standard defines all the interfaces through this connector.

The use of a single connector does however introduce a small complication in that the Post Release Environment Sensor (PRES) is located on the “weapon” side of the connector despite it being considered to be part of the fuzing system.

Because this sensor is designed to detect the anticipated “post release environment” associated with the specific munition, it is anticipated that the PRES can and usually will be munition specific and will generally not be intended to be exchanged with other weapons.

However, from a safety perspective, since the fuzing system must be designed and qualified as a whole, the potential does exist for the use of a fuzing system main housing with a PRES with which it was not previously tested or qualified and raises safety issues. Although such safety issues are beyond the scope of the interface standard, the issue of interchangeability and safety was the subject of much debate during the development of the standard and has strongly influenced the design of the Class 3 interfaces. Nevertheless, system safety should demand attention during any fuzing system development.

There are several key elements in this standard that enable the implementation of a safe system:

- Power application is staggered with regard to voltage and available power. Application of each supply is related to the phases of pre-release, release and free-flight/engagement.
- All messages from the weapon to the fuzing system contain a checksum and protocol checks are required for each message.

- Safety critical commands from the weapon that influence the arming status are only valid if a specific discrete signal relating to aircraft safety, is enabled.
- The presence of a compatible Post Release Environment Sensor (PRES) is confirmed prior to release (for Class 3, Subclasses AD and D only).

The standard expects that these elements (power, command messages with protocol checks, checksums and responses, safety-related discretely, PRES) will be controlled by independent mechanisms such that common mode faults can be avoided.

See 3.1.1.1 for an additional discussion on the subject of fuzing system safety.

3.1.1 Functional Interface Classes

The task group identified the following three “classes” of interface:

- Class 1 is an electrical only interface that facilitates use of MIL-STD-1760 type platform store interfaces for the fuzing system to monitor intentional release and defines the fuzing system interface bus communications protocol to allow sending and receiving data between a weapon and a single fuzing system or multiple fuzing systems.
- Class 2 interfaces add a defined connector and additional interfaces to facilitate the exchange of compatible fuzing systems, consisting of a fuzing system main housing, a PRES and the connection between these two.
- Class 3 interfaces add further interface definitions to facilitate the exchange of AS5680A compatible fuzing systems components, such as the fuzing system main housing or the PRES.

The Class 1 interface is the basis of the standard and defines a standardized data bus and two power supplies that can be used for a wide range of fuzing systems, whether interchangeable or not. It was envisaged by the Task Group that this standard might be used for weapon to fuzing system communications for non-interchangeable as well as interchangeable fuzing system components. The adoption of this element of the standard should avoid the need, for example, for the use of proprietary communications standards for different weapons.

The Class 2 interface is an intermediate interface class that was planned to be PRES agnostic. It was recognized during development of the standard that without specific PRES definitions, only the exchange of a whole fuzing system (i.e. fuzing system main housing in the AS5680A space envelope and the PRES) could be undertaken. In this instance, the PRES would be specific to, or specifically qualified for, the fuzing system main housing design. This configuration was designated Class 2. However, in order to standardize Class 2 interfaces sufficiently to permit the full fuzing system exchange, the electrical, electronic, logical and mechanical interface for the fuzing system main housing as well as for the PRES would have to be defined. While this has been accomplished for the fuzing system main housing, there is currently no standardized mechanical interface for the PRES. After careful consideration it was found that the effort to standardize a single mechanical interface (i.e., standardize shape, dimensions, fixture, location on/within the munition) is impossible (and – if achievable – would cause severe safety concerns) and that defining multiple standardized mechanical interfaces would not provide sufficient benefit to warrant the effort. Therefore, a Class 2 interface has not been fully standardized.

In order to provide the full fuzing system interchangeability as requested by NATO, the standard allows for a method by which both the fuzing system main housing and/or the PRES may be swapped individually. This is the Class 3 interface defined in AS5716A. In order to develop the standard, it was necessary to note that arming environments are specific to a munition. Due to this, it would then be possible to permanently install the PRES (together with the connecting cables) in the munition. This is in contrast to the more common current approach where the PRES usually is delivered with the fuzing system main housing and assembled in the field. This new approach would prevent the assembly of the wrong PRES into the munition, potentially preventing duds or unsafe situations that might arise from assembly of a “wrong” PRES for that weapon. To allow for “exchangeable fuzing system main housings” whilst ensuring safety, the standard calls for the compatibility between the fuzing system main housing and the (weapon fitted) PRES to be automatically checked at power-up.

Class 3 Subclasses: A series of three master subclasses has been defined for the PRES interface: A (Analog), D (Digital) and AD (Analog and Digital). These refer to the communications from the PRES to the fuzing system main housing via a separate serial data communications interface defined in AS5716A. A Class 3 Subclass A design is thus one in which communication and data from the sensor to the fuzing system main housing is in analog format, i.e., an electrical signal. Subclasses AD and D add digital data to allow the fuzing system main housing to confirm that the connected PRES is one that it “understands” and has been qualified to use. Subclass A does not allow for this confirmation, but was included because it is similar in concept to some current practice.

3.1.1.1 Fuzing System Safety

The fuzing system is the critical element of a weapon that maintains the weapon payload safe during storage and flight, until the weapon is intentionally deployed and has achieved a safe distance from the platform. As such it is subject to multiple safety requirements that are outside the scope of this fuze interface standard. The interface standard is in all cases subsidiary to these safety standards.

Whilst the standard has been defined with the intention that it is possible to design a fuzing system that is both safe and meets the interface standards, the development of a fuzing system meeting the AS5716A interface standard does not imply that it will necessarily be safe or acceptable to safety authorities. The caution note in the standard has been placed at the start of the document in order to emphasize this point.

A fuzing system is the combined total of sensors and logic that together control the safety of the weapon. In some weapon applications these elements can be physically housed in a single case. However, for other applications, and especially for those that employ an external arming sensor for the second arming environment as per STANAG 4187 and MIL-STD-1316 (referred to as a PRES in this handbook and the standard) as part of the safety system, the fuzing system will comprise two parts, the fuzing system main housing and PRES. A typical example of a PRES is an air driven generator or other external air speed sensor. For Class 3, AS5716A defines a standardized electrical and logical interface between the PRES and the fuzing system main housing in order to allow for interchangeability between the components.

This capability for interchangeability has led to concerns in the safety community that potentially dangerous mixes of PRESs and fuzing systems might be possible if unconstrained interchangeability is possible in the field. It is conceivable that a fuzing system main housing designed for one type of weapon might be assembled into a different weapon in which it misinterprets the signals from the PRES, and arms at a point that could be dangerous to the user.

In order to prevent such safety critical situations, it is required that the logic within the fuzing system main housing checks its compatibility with the PRES on power up. However, this safety feature requires and therefore is limited to fuzing systems with a digital link between the fuzing system main housing and the PRES (Class 3, subclasses AD and D).

It should be noted that Class 3, subclass A, is considered particularly dangerous, because this class defines a single, universal signal with no safeguards to indicate that the “second arming environment” has been detected. It is, in effect, a version of the current practice of evaluating the analog signal of air-speed sensors utilizing a wind turbine (e.g., FZU) and was included in AS5716 to allow for backwards compatibility. The single usage of this simple analog signal may potentially lead to unsafe (mixed) configurations if the sensor and/or the fuzing system main housing are indiscriminately swapped in the field. The use of Class 3, subclass A, interfaces therefore is strongly discouraged.

All future subclasses therefore must be evaluated with regard to safety prior to inclusion into future edition of the standard or slash sheet increments to AS5716A.

See APPENDIX A for a detailed evaluation of the risk of possible mis-matches between fuzing system components and weapons.

3.1.2 Interface Connections

This section describes the connections for the different interface classes.

3.1.2.1 Class 1 Interface

No comments.

3.1.2.2 Class 2 Interface and Contact Allocations

No comments.

3.1.2.3 Class 3 Interface and Contact Allocations

The standard defines the electrical and logical interface between the fuzing system and the weapon. The main interface therefore is across the single connector between the fuzing system main housing on one side and the weapon as well as the remainder of the fuzing system components (Post Release Environment Sensor, Target Detection Device) on the other side. Due to this concept, the Post Release Environment Sensor and the Target Detection Device are defined on the weapon side of this standard (e.g., in 4.1.4, which defines the requirements on the weapon).

3.1.2.3.1 Class 3 Functional Interface Subclasses

The current edition of the standard offers a limited selection of subclasses to Class 3 interfaces.

Later editions of the standard, or slash sheet increments, are anticipated to provide additional subclass definitions and information on fuzing systems interchangeability.

The standard anticipates that designers will ultimately develop and submit additional subclasses for AD- and D-interfaces for inclusion in the standard. These additional subclasses will then be reviewed by SAE with respect to compatibility and interface safety. As AS5716 is published by SAE as an open standard, any subclass submissions for inclusion into AS5716A are required to be free of intellectual property (IP) rights or the owners of any IP rights contained in any submissions to the document shall grant the unlimited, free use of the interface, class and subclass information to everybody. By submitting the proposed new subclass information for inclusion, the submitting person or company agrees to this.

3.2 Digital Communication

The standard provides two separate digital serial data communication interfaces between the fuzing system, its external components, and the weapon.

The Fuzing System Serial Data Interface is for general communications between the fuzing system and weapon (e.g., loading data such as arm time, function delay times). This serial data interface provides the main communications channel between the fuzing system main housing and the weapon and is available for all classes of interfaces.

The Post Release Environment Sensor Serial Data Interface is for communication between the fuzing system main housing and a post release environment sensor. It is standardized for Class 3 Subclass AD and D interfaces only, but may also be used for Class 1 and Class 2 systems.

3.2.1 Fuzing System Serial Data Interface

The Fuzing System Serial Data Interface is a four-wire TIA-485 compliant interface. Two wires are used for weapon to fuzing system communication; two wires are used for fuzing system to weapon communication.

The four wire configuration was used in order to allay safety fears that a fuzing system main housing or Target Detection Device (TDD) on the data bus could erroneously send a valid message to another fuzing system main housing and alter its safety critical data.

By using the four wire configuration, only the weapon can send data to any of the fuzing system data receivers.

In order to allow a backwards compatibility with existing two wire communication links, where safety is a lesser concern or is achieved by other means, the protocol has been defined so that it is compatible with half duplex communications over a two wire interface should the need arise.

The interface is designed as a master-slave communication. It is therefore the responsibility of the weapon to initiate any communication, such as commands or status requests. This approach is already commonly used in weapon/fuzing system interfaces.

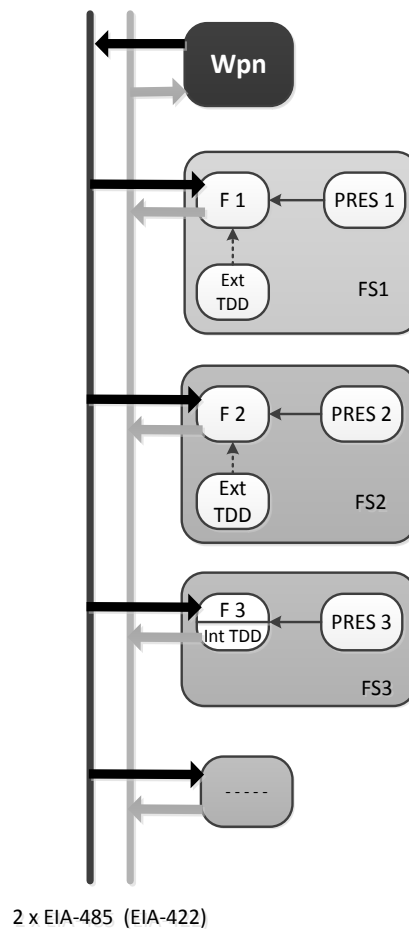


Figure 1 - Possible multi fuzing system communications architecture

3.2.2 Post Release Environment Sensor Serial Data Interface

The Post Release Environment Sensor Serial Data Interface was introduced in AS5716A, and provides unidirectional data from the PRES to the fuzing system main housing. It is standardized for Class 3 interfaces only, but can be used for Class 1 and Class 2, if required. The use of a unidirectional interface is intended to establish a constant stream of PRES data with a new data frame every 10 milliseconds. There are multiple benefits to this approach:

- The data stream allows a constant monitoring of the PRES' state.
- Any change of PRES state would be expected to be of a minimum duration of several data frames. Thus temporary glitches or single erroneous data frames can be detected and ignored.
- The 10 millisecond interval allows for short reaction times during the arming process.

3.3 Power Requirements

No comment.

3.3.1 Port 1 Power, Port 2 Power and Port 3 Power and Returns

The standard provides for three distinct power supplies.

These supplies have been defined to allow the fuze designer to accommodate safety requirements aimed to ensure safety.

Port 1 Power is defined as the power available to support fuzing system communications and fuzing system general operation prior to the weapon release sequence.

Port 2 Power is aimed to support the fuzing system prior to and during the release sequence, and communications and functionality during weapon flight post release.

Port 3 Power is specifically defined to allow the use of environmentally derived power sources for arming after separation.

Voltage definitions on the three supplies are intended to permit the Port 2 Power to support communications, but to prevent Port 2 Power from being able to be used to arm the fuzing system. For Class 1 interfaces it is assumed that arming power is provided through an additional connection not standardized in this standard; Port 3 Power as defined here may be used.

Because the Port 3 Power source may be intermittent during flight (because weapon maneuvers may shield an air generator, for example), the requirements on the functionality of the fuzing system in response to the presence of the power source were relatively complex to define. The intent of the standard is that the fuzing system should be able to arm if the power source is present. However, it is recognized that long interruptions of the power source will limit the ability of the fuzing system to arm or remain armed.

3.4 Discrete Signal Requirements

The interface provides connections for Release Consent Monitor, Release Indication, Explosive Ordnance Disposal (EOD) Arm State Monitor, Initiation Inhibit, Target Detection Device Signal, Post Release Environment Sensor Signal, and Address Bit Discretes connections.

3.4.1 Release Consent Monitor

The Release Consent Monitor provides an indication to the fuzing system of the status of the Release Consent signal at the aircraft-store interface (see MIL-STD-1760). As defined in MIL-STD-1760, this signal provides an independent confirmation to the weapon, and subsequently to the fuzing system, that the information being sent on the data bus effectively has the direct authority of the pilot.

As this signal is used by the fuzing system for safety confirmation, it is essential that the signal has as simple as possible a path from the MIL-STD-1760 interface to the fuzing system. It would not be acceptable from a safety perspective for the signal to be weapon sourced, for example, in a weapon controller.

3.4.2 Release Indication

The Release Indication signal is included in the interface to provide the fuzing system with an indication of the mated status of the umbilical connector between the weapon and platform. The original intention was to define an interface that enabled the fuzing system to use the same circuit as that employed by the weapon control system, i.e., monitor the current path associated with the data bus address lines. However, review of the methodologies used for this, and the nature of the MIL-STD-1760 address line electrical specification, meant that it would be difficult to define a universally adoptable approach to safely monitoring these lines in conjunction with any MIL-STD-1760 weapon controller. It was decided therefore to retain the concept of using a current loop but define a single set of parameters for the required signal levels.

As with the Release Consent interface, care in the weapon design is required to ensure that the Release Indication interface is as simple as practicable, but still indicates unambiguously that the weapon either is or is not connected to the aircraft. It should if possible directly reflect the state of the MIL-STD-1760 address lines.

3.4.3 EOD Arm State Monitor and Return

In order to provide EOD personnel with a standardized interface to detect the armed/ safe status of the fuzing system, the standard has defined a pair of contacts that are intended for EOD use only. These contacts are located deliberately at the center of the connector to simplify use.

The electrical interface has been designed so that it can be used with both out-of-line and in-line arming systems with minimum risk to EOD personnel.

For out-of-line fuzing systems, this will allow the monitoring of two characteristic resistances, where one value indicates that the system is in a safe state and a different value indicates an armed state.

For in-line fuzing systems, the armed status is detected by sensing the presence of voltage on the firing capacitor. The EOD interface allows for voltage monitoring in addition to the resistance monitoring for out-of-line designs.

For inline fuzing systems, the standard implicitly requires a 1000:1 ratio between the voltage on the high voltage firing capacitor and the voltage available at the EOD connections. Currently, the maximum no fire voltage for inline fuzing systems is 500 V dc (as per STANAG 4187 and MIL-STD-1316), which would create 0.5 V dc at the EOD lines. This can be achieved by designing a passive resistor network, which safely allows direct monitoring, but prevents any charging of the firing capacitor through the EOD Arm State Monitor lines.

When the fuzing system type is unknown, it is anticipated that EOD personnel can either initially confirm that no voltage is present and then confirm from the measured resistance whether the fuzing system has no EOD Arm State Monitor or is in- or out-of-line and its armed status; or, they can use a safety ohmmeter first to attempt to measure the resistance, bearing in mind that if the fuzing system incorporates an inline design, then a voltage may be present on the contacts that will affect the ohmmeter function.

3.4.4 Initiation Inhibit

In order to provide a rapid and direct mechanism to inhibit the fuzing system from firing, the Initiation Inhibit contact is included in the interface.

This interface does not affect the arming process, and should not be confused with a disarm/rearm function, which uses the digital interface.

3.4.5 Target Detection Device Signal and Return

Although many fuzing systems can be expected to employ an internal Target Detection Device (TDD, typically an impact sensor), sensors external to the fuzing system main housing may also be used. These can provide for example a more rapid response to impact, detect proximity to the target, or detect other parameters associated with the weapon function, such as water depth.

The Target Detection Device (TDD) Signal allows such sensors to send a trigger signal to the fuzing system when they sense the appropriate environment or target.

The selection of “internal” (to the fuzing system main housing) or “external” is indicated to the fuzing system using data bits [B3|B2] of byte 0 of Fuzing Mode 2, contained with the Mission Store Control Message sent from the aircraft to the weapon and transferred to the fuzing system through the Fuzing System Serial Data Interface as part of the “M” Command Data message.

3.4.6 Post Release Environment Sensor Signal and Return

Class 3, subclass A and subclass AD interfaces contain two connections, Post Release Environment Sensor (PRES) Signal and PRES Signal Return to enable the fuzing system to directly monitor and evaluate the analog signal derived by the sensor within the PRES.

In order to permit monitoring of analog signals from sensors in current use, e.g., current air speed sensors, the PRES Signal and Return lines and fuzing system circuits must be able to handle or at least withstand up to ± 300 V.

3.4.7 Address Bit Discretes

Whilst many weapons use only a single warhead with a single fuzing system, some employ multiple warhead systems or fuzing systems. The data communications interface addressing system defined in the standard enables the weapon to communicate with one or more fuzing systems, either individually or in a broadcast mode.

To allow interchangeable fuzing systems, the electrical interface therefore allows for the electrical address of the specific fuzing system main housing location to be defined by the configuration of three contacts on the weapon side of the fuzing system connector.

3.5 Reference Lines

3.5.1 Signal Return

In order to reduce the number of lines, Signal Return is utilized as a common return line for several signal and data lines.

3.5.2 Structure Ground

The interface provides a single connection to be used as a Structure Ground in order to establish the same nominal electrical potential for the structures of all equipment.

3.6 Sequence of Operations

This standard defines three different phases of weapon operations of the interface which also correlate to the different stages of supplied power, these are:

- Carriage phase,
- Release Preparation phase,
- Release and Free Flight phase.

The Carriage phase is the phase of operation during which the fuzing system is installed in the weapon, up to the initiation of the release process. The operations defined for this phase may also be applicable to ground operations of weapons prior to being fitted to the aircraft. Typically, only communication power (Port 1 Power) should be available at this stage.

The Release Preparation phase starts with the end of Carriage phase and includes all of the interface operations necessary to prepare weapon and fuzing system for release. This usually requires Port 2 Power in order to provide sufficient power for all release-related activities.

The Release and Free Flight phase starts with the end of Release Preparation phase and includes all of the interface operations during actual release and subsequent free flight of the weapon. Port 2 Power is required to provide power for all fuzing system operations except arming of the payload. Payload arming requires Port 3 Power, which is usually established only after the weapon has left the aircraft.

4. DETAILED REQUIREMENTS

Section 4 of AS5716A contains detailed interface requirements placed on the weapon and the fuzing system. To ease cross-reference between the Handbook and the standard, this section of the Handbook is structured and numbered in the same sequence as that used in the standard, so that 4.1.x refers to the weapon side and 4.2.x refers to the fuzing system side of the interface.

4.1 Detailed Requirements on the Weapon

This section describes requirements on elements of the weapon that reside on the weapon side of the fuzing system main housing connector.

4.1.1 Connector Type, Contact Identification, and Interface Functionality

4.1.1.1 Class 1 Connector Type and Contact Locations

The standard envisaged that the use of the communications protocol and power specifications could have application in weapons systems that do not require that the fuzing system be physically interchangeable. The use of a "Class1" interface provides the opportunity to avoid the need to define a proprietary communications standard for these applications.

4.1.1.2 Class 2 and Class 3 Connector Type and Contact Locations

The allocation of functions to specific connector contacts is defined in this standard for both Class 2 and Class 3 in 3.1.2. The definition of the connector for Class 2 and Class 3 use is contained in AS5680A.

It was originally expected that it would be possible to define a “Class 2” interface in which the second environment sensor would not be defined, but which would add the connector to the Class 1 interface. The “Class 3” interface was planned to then add and standardize the second environment sensor.

The intention of the Class 2 definition was to avoid the strong safety concerns advised regarding the potential safety issues of swapping / mixing second environment sensors that were implied by the Class 3 component interchangeability.

In the event, it was not possible to agree and define a post release environment sensor mechanical housing and as a result, the Class 2 definition is essentially limited to fuzing systems with internal post release sensors. Given that there are only a very few such fuzing systems, the Class 2 interface was substantially overtaken by the development of the Class 3 version.

4.1.2 Requirements for Digital Communication

4.1.2.1 Fuzing System Serial Data Interface

See notes in 3.2.1.

4.1.2.2 Post Release Environment Sensor Serial Data Interface

See notes in 3.2.2.

4.1.3 Power Requirements

Port 1 Power is provided to power those functions required to be carried out prior to the weapon being released from the aircraft. These functions may be carried out on a stand-alone weapon or at any time it is connected to the aircraft, either on the ground or during air carriage. These functions will include power up self-test and any built-in-test commanded by the weapon, as well as establishing that any post release environment sensor operating on the digital interface is compatible with the fuzing system.

4.1.3.1 Port 1 Power

Port 1 Power and Port 2 Power utilize a common return. Since both are not related to arming this was considered acceptable.

4.1.3.1.1 Power Application

The intention of making the weapon wait a minimum of 60 milliseconds between intentionally removing Port 1 Power and its re-application is to ensure the fuzing system does not interpret the interruption as a supply failure and report it as such when power is re-applied.

4.1.3.1.2 Voltage Level

Port 1 Power is restricted to the range of 7 to 12 V to allow the fuzing system to employ simple internal circuitry (such as digital communication or monitoring of analog lines) and to restrict what functionality is activated by the circuit.

4.1.3.1.3 Voltage Stabilization Time

In essence, the requirement is that in addition to ensuring the minimum voltage level is reached within 10 milliseconds of application, any transients during the application do not occur after the minimum voltage has been reached. Although less critical, the equivalent requirement regarding transients during supply removal, i.e., once the voltage has dropped below the minimum level, no subsequent transient is to take it back above that level.

4.1.3.1.4 Current Capacity

The current capacity of the supply includes a higher current initial pulse to accommodate charging of power supply capacitors and inrush current. The low power capability of Port 1 Power has been selected to ensure that in the event of the fuzing system developing an internal fault, the available power is insufficient to provide arming power that could initiate the payload.

4.1.3.1.5 Overcurrent Protection

No comments.

4.1.3.1.6 Off-state Leakage Current

No comments.

4.1.3.1.7 Power Drop-Out

This requirement is based on the presumption that the weapon has itself recognized a break in the supply to the fuzing system and may therefore send a request to the fuzing system for status information. In practice, the weapon controller may not be aware of any such break, resulting in the fuzing system having to make such an event known to the weapon at the next available opportunity, i.e., when transmitting the “r” Fuzing System Response Data for the transmission of error codes (see 4.2.3 and 4.3.3).

4.1.3.2 Port 2 Power

This power source is provided from an internal weapon power source and will be applied by the weapon early in the weapon release phase and continue to be provided through the remainder of the release preparation, actual release and weapon free flight until target impact. It is provided to power all fuzing system operations except payload arming, for which Port 3 Power is provided.

Fuzing system designers should note that in cases where payload initiation is required to take place after the weapon has impacted the target, physical damage to the weapon may result in the loss of Port 2 Power and/or Port 3 Power. No reliance should therefore be placed on its provision being maintained after target impact. This situation has to be recognized as being different from a power interrupt prior to first arming, when the fuzing system may delete or reset certain data items as required in this standard that could therefore result in no initiation of the payload.

4.1.3.2.1 Power Application

Typically, the power source will be a thermal battery initiated by the weapon once the weapon has determined that it has received both the Release Consent signal and a valid command Commit to Separate Store or Submunition (CTS) command from the aircraft.

Although this power may often be sourced from a weapon thermal battery, initiated before launch, the presence of this power should not be taken to indicate that any specific phase of the weapon release sequence has been achieved.

4.1.3.2.2 Voltage Level

This power is intended to be within the range 18 to 24 V, to allow simple differentiation from Port 1 Power and thus provide an extra element of safety into overall system operation.

4.1.3.2.3 Voltage Stabilization Time

In addition to requiring the weapon to not exceed stabilization times of 10 milliseconds for both application and removal, it must be noted that on power application, once $V_{\min}$ has been exceeded, the supply must not fall below that value. This is to prevent the fuzing system from responding to the crossing more than once and thus risking incorrect system operation. Conversely during power removal, once the voltage has fallen below V_{off} , it is required to remain below that value. The voltage range between V_{off} and $V_{\min}$ is intended to provide additional margin.