INTERNATIONAL STANDARD

IEC 62286

First edition
2003-05

Service diagnostic interface for consumer electronics products and networks – Implementation for IEEE 1394

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Reference number
IEC 62286:2003(E)

Publication numbering

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PRICE CODE R

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SERVICE DIAGNOSTIC INTERFACE FOR CONSUMER ELECTRONICS PRODUCTS AND NETWORKS – Implementation for IEEE 1394

FOREWORD

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International Standard IEC 62286 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

This standard was developed by a project team of service and interface specialists within the European Association of Consumer Electronics Manufacturers (EACEM). EACEM subsequently merged with EICTA in September 2001. EICTA is the European Information, Communications and Consumer Electronics Technology Industry Association.

The text of this standard is based on the following documents:

CDV	Report on voting
100/432/CDV	100/493A/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

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INTRODUCTION

Consumer products are often repaired by service workshops who are servicing all kinds of products developed by different manufacturers.

For high complexity products, the fault diagnosis becomes more and more difficult and time consuming. To make diagnosis possible, manufacturers often develop some built-in diagnostic software which can be used for fault finding together with an external diagnostic unit through a Service Diagnostic Interface (SDI).

To avoid the need for a service workshop to purchase several different diagnostic units from different manufacturers for different products, a standardized SDI is proposed for use by all manufacturers and in all products in which such diagnostic interfaces are required. The result will be that only one SDI is needed in the service workshops.

The SDI should also be suitable for diagnosis in a network (A/V or multimedia network) in which different products from different manufacturers are connected together. The interface should also allow for future development.

The standard SDI which has to be specified, should:

- be usable in future products;
- be easily connectable to a product or a network;
- be cheap;
- not limit product design.

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SERVICE DIAGNOSTIC INTERFACE FOR CONSUMER ELECTRONICS PRODUCTS AND NETWORKS – Implementation for IEEE 1394

1 Scope

This International Standard specifies the requirements that have to be implemented in future products that incorporate a digital interface, and service diagnostic software developed for these products. The Service Diagnostic Interface (SDI) requires the use of a PC (desktop or laptop) into which service diagnostic software can be loaded. A part of this PC software has to be standardised while another part of this PC software is manufacturer/product related.

To reach a common approach in servicing all products from all manufacturers, it is necessary to standardise specific items in the products (Device Under Test/DUT) as well as in the diagnostic software on the PC.

The Service Diagnostic Interface (SDI) is based on the IEEE 1394:1995 specification because this interface will be used in most future products. The use of this connection and existing communication protocols enable implementation in products at low cost, and gives maximum flexibility and efficiency.

The SDI consists of:

- Specific hardware and software requirements of the DUT.
- Specific requirements of the PC:
  - the Service software,
  - an IEEE 1394 interface (to be built in if not already present).
- The connection between the PC and the DUT.

This specification is a minimal specification necessary to be able to carry out computerised diagnosis and covers the standardised software of the PC as well as the standardised software and provisions in the DUT.

If an IEEE 1394 interface is present on the product, then the requirement for product identification as described in this document (see 6.3) is mandatory. In addition, all communication for any service application should go through the IEEE 1394 interface only, as described in this document (in Clause 7).

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2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61883-1:2003, *Consumer audio/video equipment – Digital Interface – Part 1: General*

IEEE 1212:2001, *Microprocessor Systems – Control and Status Registers (CSR): Architecture for microcomputer buses*

IEEE 1394:1995, *IEEE Standard for a High Performance Serial Bus – Firewire*

IEEE 1394a:2000, *IEEE Standard for a High Performance Serial Bus –* Amendment 1

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1.1
configuration ROM
area of memory within an IEEE 1394-enabled device which holds specific information about the device, as defined in IEEE 1212. Device information is held in a hierarchy of directories within the ROM

3.1.2
EACEM unit directory
see unit directory

3.1.3
HW_Version
hardware version. IEEE 1212 optionally uses this to identify diagnostic software

3.1.4
instance directory
second level in the directory hierarchy. The instance directories provide a method to group unit architectures (software protocols) to identify shared physical components. This directory contains the offset into memory of various Unit directories, including the EACEM unit directory

3.1.5
IEEE 1394 repeater
another IEEE 1394 device in the network capable of relaying or repeating data. This device may have more IEEE 1394 sockets and can provide a suitable connection into the system

3.1.6
Key_ID
Key IDentifier. IEEE 1212 use this to identify the contents of the remaining 3 bytes of a quadlet in a directory. Key_ID is 6 bits long: the proceeding 2 bits are the type, which identifies whether the data in the following 3 bytes is immediate (i.e. they contain the actual data) or whether the 3 bytes are an offset to another place in memory

3.1.7
minimal ASCII
IEEE 1212 defines a limited set of Latin characters that can be used for text. The particular set specified in SDI uses the 1 byte coding specified in IEEE 1212

3.1.8
model_ID
model IDentifier. IEEE 1212 optionally provide this to identify the model. The model should represent a family or class of products and should not be unique to individual devices

3.1.9
multimedia
products or networks combining audio, video, computer and/or communication data

3.1.10
network
two or more CE (audio, video or multimedia) products connected together

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3.1.11
quadlet
group of four bytes (32 bits). IEEE 1394 transmission is based on the transfer of quadlets and all data is quadlet-aligned

3.1.12
remote diagnosis
diagnosis of product via telephone, internet, etc.

3.1.13
root directory
the top level directory in the hierarchy of directories. This contains some basic information about the device, such as the Vendor_ID, and also the offset into memory of the Instance directory

3.1.14
unit directory
the third and lowest level in the hierarchy of directories. Each unit directory uniquely identifies the software interface (unit architecture) used to control the unit. The EACEM Unit directory provides additional information, either directly or indirectly, needed to specify locations used in the SDI specification

3.1.15
Vendor_ID
vendor IDentifier. This is the RID for the vendor

3.2 Abbreviations

ASCII-1	American Standard Code for Information Interchange. This defines a set of Latin characters and control codes representing text. See also Minimal ASCII in 3.1.7.
A/V	Audio/Video
AV/C	Audio, Video/Control
AV/C-CTS	Audio, Video/Control – Command and Transaction Set
CE	Consumer Electronics
CSR	Control and Status Register
DUT	Device Under Test
EACEM	European Association of Consumer Electronics Manufacturers
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
OEM	Original Equipment Manufacturer
PC	Personal Computer
RID	Registration authority Identifier
ROM	Read Only Memory
SDI	Service Diagnostic Interface

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4 Different types of service diagnostics

4.1 Stand-alone products

In this situation, a connection is made between the diagnostic PC and the DUT, where the DUT is from any manufacturer and of any type.

4.2 A/V or multimedia network

In this situation, a connection is made between the diagnostic PC and a network of A/V or multimedia products.

In an A/V or multimedia network, several different products are interconnected and not all of them are necessarily from the same manufacturer.

In this case, the SDI must be able to list the products on the network, detect which product is causing a problem, and diagnose the product concerned.

4.3 Remote diagnosis

In addition to the configurations described above (stand-alone product or network), a link can be made (for example via telephone, Internet, etc.) between the diagnostic PC in the workshop and a DUT/network at the customer’s home. Therefore, if a product has both an IEEE 1394 interface and a remote connection capability, this product should be able to transfer the diagnostic data, as described in this document, through the remote connection.

It has to be specified how this type of communication is carried out, and which level of diagnosis will be possible. These items are not in the scope of this document, and will be defined later on.

5 Specification of the SDI

5.1 General

The SDI consists of:

- hardware and software, both in the DUT and in the test equipment (“tester”);
- the connection between the tester and the DUT.

The total SDI can be divided into the elements specified in 5.2 and 5.3.

5.2 Hardware

5.2.1 Tester hardware requirements

This can be a computer (for example desktop or laptop PC, MAC, or workstation) provided with at least one suitable IEEE 1394 interface as specified in IEC 61883-1 and running the necessary diagnostic software. (Minimum specification depends on the respective tester platform).

5.2.2 Connection cable

One IEEE 1394 connection cable is required. The type of cable depends on the connector (4pin or 6pin) configuration that is used on the DUT and the PC.

For the specification of the cable, please refer to IEC 61883-1, IEEE 1394 and IEEE 1394a.

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5.2.3 Device Under Test (DUT) hardware requirements

5.2.3.1 General

The DUT shall be provided with at least one IEEE 1394 connector (4 or 6 pins) as specified in IEC 61883-1, IEEE 1394 and IEEE 1394a.

5.2.3.2 Stand alone products

For diagnosis in a stand-alone product, one connector, as specified in 5.2.3.1, is adequate.

5.2.3.3 A/V or multimedia network

In a network, several products are connected to each other in serial, star or parallel configuration. In this case, most products will be provided with two IEEE 1394 connectors.

For diagnosis on a network, the PC should be connected to any connector that is not in use on one of the products in the network.

If no IEEE 1394 connector is free in the network, there are 3 possibilities:

1) Use an IEEE 1394 repeater.
2) Disconnect one of the products from the network.
3) Use a tester provided with two IEEE 1394 connectors.

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5.3 Software

5.3.1 General

The software for the SDI can be divided into two parts (tester and DUT) of which each part again can be divided into mandatory (SDI common) software and non-mandatory (manufacturer-dependent) software.

The manufacturer dependent software will not be specified in this document.

5.3.2 Tester software requirements

The software platform of the tester must be able to handle IEEE 1394 communication (for example on a PC implementation, Windows® 98 2nd edition, Windows® 2000 or higher, or an equivalent operating system is required).

The SDI common software on the tester (developed under the responsibility of EACEM) has the following functionalities:

a) To initiate a Self_Test as described in this document. (7.1.1.6 and 7.1.1.7).
b) To read out the Self_Test response (available in the Test_Result_Register) of all products.
c) To display a list of all products connected to the IEEE 1394 network to which the tester is connected. On the display should be listed:
   - name of the manufacturer,
   - model number of the products,
   - textual description of the products.
d) To indicate which product has passed its Self_Test and is found to be “OK” or “Not OK”.
e) To start up all product/manufacturer specific diagnostic software. The start-up mechanism to which the specific diagnostic software shall conform is described in 6.1.

5.3.3 DUT software requirements for the SDI

The DUT shall be able to communicate diagnostic information, which is available in the configuration ROM (as specified in 7.1), to the tester via IEEE 1394.

In addition, the SDI common software in the DUT shall be able to:

a) run a selftest routine;

b) load information into the Test_Result_Register.

6 Tester software requirements

6.1 Interface to manufacturer service program

The common application, from which a possible example is described in Annex A, is able to launch the manufacturer's service program; the manufacturer's service program shall fulfil the following requirements:

The manufacturers service program shall be installed in a subdirectory located immediately under the main SDI installation directory. The subdirectory name shall be that of the manufacturers ID.

The service program is launched with the following command line:

vvvvvv<SEP>SPvvvvvv/SDI/GUID:hhhhhhhhllllllll/CON:z/HWV:wwwwww

- <SEP> is the standard file-system sub-directory separator of the tester platform, for example “\” on Windows®.
- **vvvvvv** is the ASCII representation of the Vendor_ID in hexadecimal.
- **/SDI** informs the service program that it has been started from the common application.
- **/GUID**:hhhhhhhhllllllll, where "hhhhhhhh" is the ASCII representation of the Company_ID + Chip_ID_hi in hexadecimal, and "llllllll" that for Chip_ID_lo, together making the GUID.
- **/CON:z**, where “z” is the ASCII representation of the connection type (“R” = remote, “D” = direct).
- **/HWV**:**wwwwww**, where “wwwwww” is the ASCII representation of the hardware version in hexadecimal (if available).

Example:
A company with the Vendor_ID 00A095$_{16}$ must provide a service program called “SP00A095”. When this program is invoked from the SDI application the command line could look like this:

00A095\SP00A095 /SDI /GUID: 00A0950000222222 /CON:D /HWV:000001

6.2 Connecting the diagnostic unit

The DUT is connected to the tester using one of the standardised IEEE 1394 cables or one of the adapter cables (4 pins to 6 pins).

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6.3 Product identification

The common application is able to retrieve and show following information from the SDI compliant devices.

6.3.1 General information (company identification)

A plain text version of the name of the manufacturer or vendor will be read from the DUT and displayed. This text is always available in "Minimal ASCII" format (see IEEE 1212). Optionally, there is a provision for text in other character sets and languages. The tester should display this information for all devices in the system. Note that the name displayed might not be the same as the name on the physical device.

6.3.2 Company specific information

The model number will be read from the DUT and displayed. This text is always available in "Minimal ASCII" format (see IEEE 1212). Optionally, there is provision for text in other character sets and languages. The tester will display this information for all devices in the system. Note that the model number displayed might not be the same as that of the physical device.

6.3.3 Product-specific information

After startup of the product-specific service software, the hardware version of the product and the test software version should be displayed.

The specific test software for a device can be identified from the combination of VENDOR_ID and MODEL_NUMBER. However, this can also be specified with HW_VERSION, see 7.1.1.2

7 Control protocol

7.1 Direct diagnosis

The protocol makes use of the existing low-level Quadlet read/write protocol, which is used in IEEE 1394. This is defined in Subclause 6.2.2 of IEEE 1394 and also Subclause 10 of IEEE 1394a.

This protocol allows quadlets (32 bits) of data to be read from or written to addresses in the DUT, which are specified in the EACEM Unit Directory (see 7.1.1.2.2).

These directories are in the "configuration ROM" memory area inside the register space, as defined by IEEE 1212. The directories contain pointers to addresses in the configuration ROM or the unit memory (also defined in IEEE 1212).

7.1.1 Configuration ROM directory structure

IEEE 1212 defines a hierarchy of directories that contain specific information about a device. The hierarchy begins at the root directory, which starts at an absolute address (FFFF F000 0414 $_{16}$) specified in IEEE 1212. This directory contains a pointer to the address of the instance directory. The instance directory contains a pointer to several unit directories (if the device supports EACEM SDI). One of these unit directories is the EACEM unit directory.

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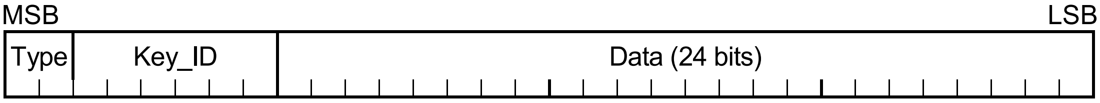
7.1.1.1 Configuration ROM data structure

Data relevant to EACEM in the configuration ROM has the following general format:



Type: describes whether the data is immediate or an offset (to a location in memory, a leaf or a directory). For full details of *Type* value and the relevant absolute or relative referencing, see IEEE 1212. Note that offsets are specified in quadlets: the actual offset in bytes is 4 times the quadlet value specified in the data field above (see IEEE 1212).

Key_ID: specifies the type of data (for example *Vendor_ID*) which is contained in the following 24 bits.

The byte order and the addressing order is specified in Subclause 3.2 of IEEE 1212.

7.1.1.2 Root directory

The information in the root directory that is relevant to EACEM SDI is shown in Table 1.

Table 1 – Root directory

IEEE 1212	**EACEM SDI**	*Type*	*Key_ID*	**Root directory**
M	**M**	00_2	03_{16}	Vendor_ID
O	**M**	[1)]	01_{16}	Vendor_ID_Text_Descriptor
				Optional entries for Vendor Icon(s)
O	**M**	00_2	17_{16}	Model_ID
O	**M**	[1)]	01_{16}	Model_ID_Text_Descriptor
				Optional entries for model icon(s)
				Other mandatory entries, for example Node_ Capabilities
				. . .
O	**M**	11_2	11_{16}	Unit directory (for example AV/C)
M	**M**	11_2	18_{16}	Instance directory
				. . .
O	**O**	00_2	04_{16}	HW_Version
				. . .
M = Mandatory; O = Optional.				
[1)] These Text Descriptors can be in CSR offset, leaf or leaf directory and use different values of type accordingly – see 7.1.1.2.2.				

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Note that Table 1 shows only the information required for EACEM SDI: there will also be other information in the root directory. For details, see IEEE 1212. This latter document also describes the order in which information is stored in the directory.

Vendor_ID: this contains the 24-bit RID (Registration Authority ID) of the manufacturer of the device. In the case of OEM products, this can be either the RID of the manufacturer or vendor of the device.

Vendor_ID_Text_Descriptor: this follows immediately after the *Vendor_ID* entry and points to a text string that contains the manufacturer's name. In the case of OEM products, this can be either the name of the manufacturer or vendor of the device and may differ from the owner of the RID in *Vendor_ID*. Note that there may be other entries for vendor icons following this entry. For details of text, descriptor entries and structure, see 7.1.1.2.2.

Model_ID: this contains the Identification of the model number.

Model_ID_Text_Descriptor: this follows immediately after the *Model_ID* entry and points to a text string that contains the model name. For details of text, descriptor entries and structure, see 7.1.1.2.2.

Unit directory: this contains the offset into CSR memory of the unit directory, relative to the current directory entry. There must be at least one unit directory in every device, corresponding to the control protocol that the device uses. For example, in CE devices, this is often the AV/C-CTS protocol. Note that the AV/C directory is included in the root only for backwards compatibility.

Instance directory: this contains the offset into CSR memory to the start of the instance directory, relative to the current directory entry.

HW_Version: this contains an identification number for the test software. See 7.1.1.2.1.

7.1.1.2.1 Identifying the diagnostic software

The combination of *Model_ID* and *Vendor_ID* is usually sufficient to identify the necessary test software. However, the *HW_Version* may optionally specify this. Where *HW_Version* exists, the combination of *HW_Version* and *Vendor_ID* overrides the software specified by the *Model_ID* and *Vendor_ID* combination.

7.1.1.2.2 Text_Descriptors and icons

If only one language is used, then the text pointed to by any of the text descriptors uses the minimal 1-byte ASCII character set, as defined in IEEE 1212. The text can be specified in a CSR offset, leaf or leaf directory. The tester must read and display the minimal 1-byte ASCII string.

Optionally, if more than one language is used, then the text descriptor should point to a leaf directory that contains the text, with the minimal 1-byte ASCII character string as the first entry. The tester need only read the minimal 1-byte ASCII string. Similarly, icons may also be optionally provided for the vendor and model. For further details, see IEEE 1212.

In all cases, the *type* (CSR offset, leaf or leaf directory) must be identified accordingly.

7.1.1.3 Instance directory

The instance directory contains pointers to the unit directories of the DUT. In IEEE 1212 there must be at least one unit directory. For a device that supports EACEM SDI, there must be an EACEM unit directory, which must have a pointer in the instance directory (see Table 2).

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Table 2 – Instance directory

IEEE 1212	**EACEM SDI**	*Type*	*Key_ID*	**Instance directory**
M	**M**	11_2	11_{16}	Unit directory (for example AV/C)
O	**O**	11_2	11_{16}	Unit directory
				. . .
O	**M**	11_2	11_{16}	EACEM unit directory
M = Mandatory; O = Optional.				

Unit directory: contains the offset into CSR memory of the unit directory. There must be at least one unit directory in every device, corresponding to the control protocol that the device uses. For example, in CE devices, this is often the AV/C-CTS protocol.

EACEM unit directory: contains the offset into CSR memory of the EACEM unit directory. This is mandatory for a device that supports EACEM SDI.

7.1.1.4 EACEM unit directory

This directory contains information and pointers for the EACEM SDI.

Table 3 – EACEM unit directory

IEEE 1212	**EACEM SDI**	*Type*	*Key_ID*	**EACEM unit directory**
O	**M**	00_2	12_{16}	EACEM_RID **00 B0 EC$_{16}$**
O	**M**	00_2	13_{16}	Version (**10 00**$_{16}$ for this version)
O	**M**	01_2	38_{16}	Test_Result_Reg_Offset
O	**O**	10_2	01_{16}	Descriptor Entry
O	**M**	01_2	39_{16}	Test_Start_Offset
M = Mandatory; O = Optional.				

EACEM_RID: this identifies this directory as the EACEM unit directory and has the value of the EACEM registration authority ID, 00 B0 EC$_{16}$.

Version: this identifies the EACEM specification and its version. The format of this field is:

Type	Key_ID	EACEM_Specification _type	EACEM_Specification_Version
0 0	13_{16}		10 00$_{16}$ for this version

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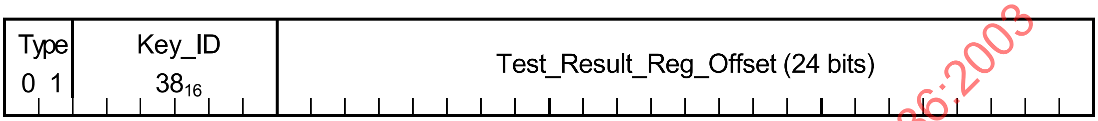
EACEM_Specification_type: identifies the EACEM specification. For EACEM SDI, this value is 01_{16}. All other values are reserved.

Note that a SDI-compliant device can be identified by the combination of the *EACEM_RID* with an *EACEM_Specification_Type* of 01_{16}.

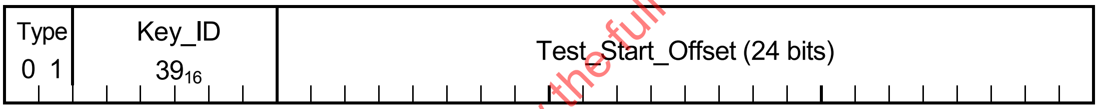
EACEM_Specification_Version: this identifies the version of the *EACEM_Specification_type,* in *major_version* and *revision* format. For example, the first version of a specification will be version 1.0, giving a *major_version* of 01_{16} and a *revision* of 0.

Test_Result_Reg_Offset: this give a 24-bit offset (relative to FFFF F000 0000_{16}) into unit memory for the *Test_Result_Register.* The value of *Key_ID* for this field is 38_{16}.



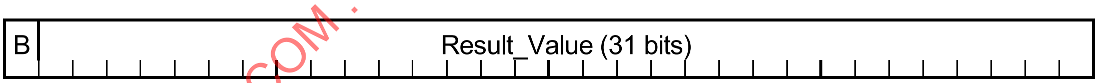
Descriptor entry: this gives a 24-bit offset (relative to the current directory entry) for an optional text string which can be used to provide information to the tester. The format is that of a single text descriptor according to IEEE 1212.

Test_Start_Offset: this give a 24-bit offset (relative to FFFF F000 0000_{16}) into unit memory for the *Test_Start_Register.* The value of *Key_ID* for this field is 39_{16}.



7.1.1.5 Test_Result_Register

The *Test_Result_Register* is used to provide diagnostic information back to the tester. The Test_Result_Register returns a 31-bit value in response to a 31-bit Test_Command (see below). The structure of this quadlet is:

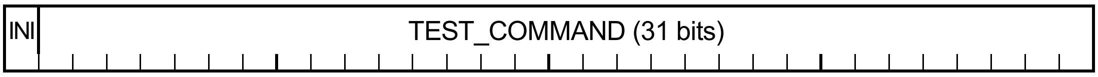


B: is the *Busy_Flag.* This value is set to "1" while a test is in progress or the register is being written. When the *Result_Value* is stable, this value is set to "0".

Result_Value: this is a 31-bit value which is used to return the result of tests initiated by writes to the *Test_Start_Register*. In response to a *Self_Test* command (see below), the device should return a *Result_Value* of 0 if no fault is detected. All other values are not defined in this specification and manufacturers are free to define their own values.

7.1.1.6 Test_Start_Register

Diagnostic tests can be initiated by writing to the Test_Start_Register.



INI: the transition of this flag from 1 to 0 is an acknowledgement to the tester that the device has received a Test Command and is currently performing the test specified in the *TEST_COMMAND.*

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