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Information technology — Radio frequency identification for item management — Unique identification for RF tags

Technologies de l'information — Identification par radiofréquence pour la gestion des objets — Identification unique des tags RF

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*, Working Group 4, *Radio frequency identification for item management*, prepared ISO/IEC 15963

This second edition cancels and replaces the first edition (ISO/IEC 15963:2004)

Introduction

ISO/IEC 15963 is one of a series of International Standards and Technical Reports developed by ISO/IEC JTC 1/SC 31 for the identification of items (Item Management) using radio frequency identification (RFID) technology.

ISO/IEC 15963 describes numbering systems for the unique identification of RF tags.

It is intended for use in conjunction with other International Standards developed by SC 31 for "RFID for item management" and "Real time locating systems" such as ISO/IEC 18000 and ISO/IEC 24730.

Information technology — Radio frequency identification for item management — Unique identification for RF tags

1 Scope

ISO/IEC 15963 describes numbering systems that are available for the identification of RF tags.

The unique ID may be used

- for the traceability of the integrated circuit itself for quality control in their manufacturing process,
- for the traceability of the RF tag during its manufacturing process and along its lifetime,
- for the completion of the reading in a multi-antenna configuration,
- by the anti-collision mechanism to inventory multiple tags in the reader's field of view,
- for the traceability of the Item to which the RF tag is attached.

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.

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

ISO 6346, *Freight containers — Coding, identification and marking*

ISO/IEC 7816-6, *Identification cards — Integrated circuit cards — Part 6: Interindustry data elements for interchange*

ISO/TS 14816, *Road transport and traffic telematics — Automatic vehicle and equipment identification — Numbering and data structure*

ISO/IEC 18000-3, *Information technology — Radio frequency identification for item management — Part 3: Parameters for air interface communications at 13,56 MHz*

ISO/IEC 18000-6, *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz*

ISO/IEC 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*

ISO/IEC 19762-3, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 3: Radio frequency identification (RFID)*

ANS INCITS 256, *Radio Frequency Identification (RFID)*

ANS INCITS 371, *Real Time Locating Systems (RTLS)*

GS1 General Specifications (GS1, Brussels)

EPCglobal Tag Data Standards (GS1, Brussels)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1, ISO/IEC 19762-3 and the following apply.

3.1

RF tag unique identifier

number that uniquely identifies an RF tag

3.2

RF tag issuer

company or organization that allocates the RF tags to the items they identify

3.3

IC manufacturer

company that manufactures the RF tag integrated circuit

3.4

RF tag manufacturer

company that manufactures the RF tag in a ready-to-use configuration

3.5

allocation class

8-bit value used to classify companies or organizations allowed to allocate unique tag identification

3.6

IC manufacturer registration number

number allocated to IC manufacturers according to ISO/IEC 7816-6 or ANSI ASC INCITS T6

3.7

RF tag issuer registration number

number allocated to RF tag issuers according to ISO 6346, ISO/TS 14816, GS1, or ANSI ASC INCITS T6

3.8

unique identifier (UID)

generic term to encompass Chip ID (CID), Tag ID (TID), Unique Item ID (UII).

3.9

chip ID (CID)

unique permanent ID of the integrated circuit in an RF tag

3.10

tag ID (TID)

unique permanent ID of the actual RF tag

Note: May or may not be the same as the Chip ID.

Note: There may be multiple chips within a tag.

Note: The tag ID may identify the manufacturer of a completed tag device and constituent parts of that tag

3.11**unique item identifier (UII)**

identification that uniquely identifies a specific entity during its life

Note: An item ID may not change though the data carrier may be used to identify a different item. In that case, the Item ID within the data carrier would change.

Note: A DoD Unique Identifier "UID" and an "EPC" are both forms of Item ID. A GS1 SSCC is an example of a time limited Item ID (IID). A GS1 GRAI is an example of an Item ID (IID) assigned to a returnable asset. A GS1 sGTIN is an example of an Item ID (IID) assigned to a commercial product

3.12**object identifier (OID)**

unambiguous identifier for an "Informational Object" that can identify a product, an organization, a person, a standard, a drawing, a (computer) file, etc.

Note: In general an Object Identifier is associated with a type of object, and is used to label information on an instance of that type as such.

4 Symbols and abbreviated terms

AC	Allocation Class
AID	Application Identifier
ANS	American National Standard
ANSI	American National Standards Institute
ASC	Accredited Standards Committee
CID	Chip Identifier
GS1	a set of standards administered by GS1
IC	Integrated Circuit
ID	Identifier
INCITS	InterNational Committee for Information Technology Standards
LSB	Least Significant Bit
MSB	Most Significant Bit
OID	Object Identifier
RFU	Reserved for Future Use
TID	Unique Tag Identifier
UID	Unique Identifier
UII	Unique Item Identifier

5 Unique identifiers

There are several types of identifiers associated with an RF tag. The most basic form is a chip ID (CID), which is assigned by the integrated circuit (I.C.) manufacturer to a specific semiconductor device at the time of manufacture in a manner that prevents it from being changed. Multiple semiconductor devices may be associated with a single RF tag, though one I.C. per tag is common. In such a case, the identity of the RF tag (TID) might simply assume the CID as its identity or it may assign an identifier distinct from the I.C. In many cases, and as a recommendation of this standard, the TID is assigned at the time of RF tag manufacture in a manner that prevents the TID from being changed.

The RF tag is then attached to some item. In some implementations the TID might then become the unique item identifier (UII). In others, such as ISO/IEC 18000-6, Type C and ISO/IEC 18000-3, Mode 3 the UII is held in a separate part of memory and is written subsequent to being attached or associated with a specific item. The UII may either be locked or available for reprogramming.

Global uniqueness requires a central body (registration authority) to either assign manufacturer identities or to assign unique identities to various agencies that in turn assign manufacturer identities. Manufacturers then assign unique identification to the chip, tag, or item. This standard serves as the central body for assignment of unique identifiers to RF tags. This standard assigns various Allocation Classes to various agencies that issue manufacturer codes.

Some tags only have identity down to a specific lot, batch, or mask identifier. Other tags, and as recommended by this standard, are serialized so that all RF tags are globally unique from all other RF tags.

The combination of globally unique serialized tag (TID) programmed and locked at the time of manufacturer, with the unique item identifier (UII) programmed when attached or associated with a specific item and trusted trading partner communications are the cornerstones of several anti-counterfeiting techniques used within the supply chain.

For anti-collision, inventorying, reading from, and writing to an RF tag, techniques exist to utilize the TID, UII, or a randomly generated number. Neither the UII nor the randomly generated number provide life-cycle traceability for the RF tag. A TID does provide for such traceability

6 Possible ways to uniquely identify an RF tag

When a UID is required, it can be done in several ways. The following sub-clauses list and explain some of them.

6.1 Virtual ID

A virtual tag ID is a temporary ID based on tag parameters that may vary over the life of the tag. It may take several forms. A virtual ID is also known as a logical ID or a session ID. Several tags could have the same virtual ID at different times, but all tags at the same time for the same interrogator should have a different virtual ID, allowing an unambiguous identification of each tag at any time relative to any given interrogator.

The technical means to achieve and guarantee such uniqueness is outside of the scope of this International Standard. However clauses 6.1.1, 6.1.2, and 6.1.3 discuss possible approaches.

6.1.1 Data as a unique ID

Data is a possible way to implement a virtual ID where the tag contains data that when read is unique in time and location to a single tag. An example is a tag that contains date and time information. The time information can be unique to a single tag from a manufacturer, but is not guaranteed to be unique over all tags at all times. Another situation is a closed application where tag data describes only one set of information. Taken globally, the tag bit pattern might be repeated, but in a closed application the tag data uniquely identifies a single tag.

6.1.2 Time as a unique ID

Time is a possible way to implement a virtual ID where bit patterns alone do not necessarily identify a single tag unambiguously. Tag response time slot can be part of a uniquely identifying parameter set. For example, some tags use time slots to differentiate between several tags appearing to a reader at the same time. If these time slots are fixed for a single interrogation exchange, then the time slot may be used to help define a single tag at a particular time.

NOTE If the time slots are randomly defined each time a tag responds, then time slots are not suitable for determining a unique tag ID.

6.1.3 Position as a unique ID

In some applications, tag position may define a unique tag ID at a particular time. For instance, some tags have a read and write distance of only a few millimetres. In this case it is difficult to have more than one or two tags in the interrogation zone at any time. Thus any tag continually in the reading zone may be considered unique at that single time and location. A common example of this case is the tag used for fare collection on public transportation or telecommunication charges.

6.2 Permanent unique ID

When a completely and globally unique ID is required, it shall be programmed into the tag, and therefore becomes permanent.

Annex A contains an example of a manner to specify a permanent unique ID.

6.2.1 Benefits of permanent unique ID versus virtual ID

The advantage of a virtual (session) ID is the reduced number of identification bits required. The disadvantage is the absence of a unique ID, independent of the reader, application, time or data configuration used. The virtual ID is unique only at a specific time and location, and is sufficient to allow the identification of a singular tag relative to time and space.

The advantage of a permanent unique ID is that it guarantees a single ID over all application, space and time situations. It is the only identification method where a completely unique ID is guaranteed in all situations.

6.2.2 Selection of the size of a permanent unique ID

Several criteria must be taken into account when selecting the size (i.e. the number of bits) of a permanent unique ID:

- a) To comply and coexist with existing ISO/IEC standards, so that the uniqueness is guaranteed globally, and that the objectives of the ISO standards are met.
- b) To structure it such that its technical implementation is optimized. This results for RF tags in the selection of an "N power 2" number of bytes (1, 2, 4, 8).
- c) To guarantee a number of combinations large enough to ensure that no two tags will be allocated the same ID within the maximum expected lifetime of a tag, under reasonable conditions, e.g. 10 years.
- d) To ensure that individual ID assignments can be delegated to IC or tag manufacturers in an efficient manner.
- e) To limit it to the absolute minimum size (i.e. number of bits) required to meet the above criteria, as its size might penalize the performance of the interrogator-to-tag communication by increasing the number of bits to transmit. As an example, a small number of bits (e.g. 32 bits) may be sufficient for applications with a small number of tags.

Annex A (normative)

Numbering system of a permanent unique RF tag identifier (TID)

A.1 General

This annex contains the recommended numbering system for RF tags using permanent unique RF tag identifiers (TIDs). For the realization of such a numbering system it is necessary to incorporate the specification below and the specification of associated registration procedures in an international standard.

In order to ensure the uniqueness of the RF tag identifier, the following rules specify its structure and length.

A.2 TID issuer identifier

To ensure the uniqueness of each TID, each TID issuer must be uniquely identified. Five classes of issuer are defined.

The registration authorities identified below assign the length of the RF tag unique identifier. It consists of three fields, as shown in Table A.1.

Table A.1 — Structure of the permanent unique identifier (TID)

AC	TID issuer registration number	Serial number
8 bits	Size defined by AC value	Size defined by AC and TID issuer value

MSB LSB

A.3 Allocation class (AC)

The size of the allocation class is 8 bits. Five classes of TID issuer are defined as shown in Table A.2.

Table A.2 — Classes of unique tag ID (TID) issuer

Allocation class value	Class	TID issuer identifier size	Serial number size	Registration authority (of TID issuer registration number)
'11100000'	ISO/IEC 7816-6	8 bits	48 bits	APACS (ISO/IEC 7816-6 registration authority)
'11100001'	ISO/TS 14816	per NEN	per NEN	NEN (ISO/TS 14816 registration authority)
'11100010'	GS1	per ISO/IEC 18000-6	per ISO/IEC 18000-6	GS1
000xxxxx	INCITS 256	per ANS INCITS 256 & 371	per ANS INCITS 256 & 371	autoid.org (INCTIS 256 and 371 registration authority)
'11100011' to '11101111'	RFU	N/A	N/A	Reserved for future use by ISO

A.4 TID issuer registration number

The TID issuer registration number is assigned by either the registration authority for ISO/IEC 7816-6 (for ISO/IEC 7816 I.C. card manufacturers), the registration authority for ISO/TS 14816 (for freight container and transport applications), the registration authority for GS1 standardized numbering, or the registration authority for ANS INCITS 256 and ANS INCITS 371.

A.5 Serial number

The TID issuer issues the serial number and has the responsibility to ensure its uniqueness.

It shall be unique in the sense that the issuer does not re-issue a number until a sufficient period of time has passed so that the first number has ceased to be of significance to any user.

The serial number is a binary value. The length of the unique tag ID is dependent upon the specific allocation class used.

A.6 Allocation classes

A.6.1 In support of ISO/IEC 7816-6

The I.C. manufacturer is registered in ISO/IEC 7816-6 through application to the registration authority.

If AC = '11100000', the unique identifier is allocated by an I.C. manufacturer, identified by an 8-bit (1 byte) number.

The I.C. manufacturer shall be registered in ISO/IEC 7816-6 through application to the registration authority.

The AC is followed by the 8-bit I.C. manufacturer registration number and a 48-bit serial number allocated by the IC manufacturer. See Table A.3.

The E0 Allocation Class I.C. Manufacturer registration numbers assigned by the publication date of this standard can be found in Annex B.

Table A.3 — ISO/IEC 7816-6 unique TID

Allocation class	I.C. manufacturer registration number	Serial number
8 bits	8 bits	48 bits
'11100000'	As registered in ISO/IEC 7816-6	Allocated by the I.C. manufacturer

MSB

LSB

A.6.2 In support of ISO 14816

If AC = '11100001', the unique identifier is issued by an RF tag manufacturer in support of ISO 14816, identified consistent with ISO 14816.

The RF tag manufacturer shall be registered in accordance with the procedures defined in ISO 14816.

The AC is followed by the convention shown in Annex C.

Table A.4 — ISO/TS 14816 unique TID

AC	RF tag issuer registration number	Serial number
8 bits	As defined ISO/TS 14816	As defined ISO/TS 14816
'11100001'	As defined ISO/TS 14816	As defined ISO/TS 14816

MSB LSB

A.6.3 In support of GS1 standardized numbering

If AC = '11100010', the unique identifier is issued by an RF tag manufacturer in support of GS1 standardized number, consistent with the GS1 General Specifications and ISO/IEC 18000-6, Type C or ISO/IEC 18000-3, Mode 3.

The RF tag manufacturer shall be registered in accordance with the procedures defined in the GS1 General Specifications.

NOTE The Electronic Product Code (EPC) is a code structure, and part of the EPC Network, which is managed by EPCglobal. The EPC has been expressly designed to uniquely and unambiguously identify items using standardized, managed, serialized codes, with RFID tags as the data carriers. EPC structure(s) are standardized by GS1 and published in the *GS1 General Specifications*.

The AC is followed by the convention shown in ISO/IEC 18000-6, Type C or ISO/IEC 18000-3, Mode 3.

The E2 Allocation Class is further explained in Annex D.

Table A.5 — ISO/IEC 18000-6, Type C or ISO/IEC 18000-3, Mode 3 unique TID

AC	RF tag issuer registration number	Serial number
8 bits	As defined in the <i>GS1 General Specifications</i>	As defined in the <i>GS1 General Specifications</i>
'11100010'	As defined in the <i>GS1 General Specifications</i>	As defined in the <i>GS1 General Specifications</i>

MSB LSB

A.6.4 In support of ANS INCITS 256

If AC = '000xxxxx', the unique identifier is issued by an IC manufacturer in support of ANS INCITS 256.

The I.C. manufacturer shall be registered in accordance with the procedures defined in ANSI ASC INCITS T6.

The AC is followed by the convention shown in ANS INCITS 256. The total length of this unique identifier including allocation class (AC), I.C. manufacturer registration number, and serial number is 64 bits (or in the case of 18000-7: 32 bits).

Table A.6 — ANS INCITS 256 unique TID

AC	I.C. manufacturer registration number	Serial number
8 bits	As defined in ANS INCITS 256	As defined in ANS INCITS 256
'000xxxxx'	As defined in ANS INCITS 256	As defined in ANS INCITS 256

MSB LSB

The “00” to “1F” Allocation Classes are further explained in Annex E.

A.6.5 Reserved for future use

If AC = ‘11100011’ to ‘11101111’, the unique TID is reserved for future use (RFU) by this standard.

The tag manufacturer shall be registered in accordance with the procedures defined by the registration authority of that standard.

Table A.7 — Reserved for future use (RFU) unique identifier

AC	RF tag issuer registration number	Serial number
8 bits	RFU	RFU
‘11100011’ to ‘11101111’	RFU	RFU

MSB

LSB

Annex B (normative)

ISO/IEC 7816-6 numbering systems for RFID

Within supply chain applications for RFID, there are several numbering structures that are used by JTC 1/SC 31, ISO TC 104, ISO TC 122, and ISO TC 204. These structures are shown in Table B.1, below.

At the time of publication of this document the following ISO/IEC I.C. Manufacturer ID assignments had been made:

Table B.1 – ISO/IEC 7816-6 issuer codes (as of 2007-09-28)

Identifier	Company	Country
'01'	Motorola	UK
'02'	STMicroelectronics SA	France
'03'	Hitachi, Ltd	Japan
'04'	Philips Semiconductors	Germany
'05'	Infineon Technologies AG	Germany
'06'	Cylink	USA
'07'	Texas Instrument	France
'08'	Fujitsu Limited	Japan
'09'	Matsushita Electronics Corporation, Semiconductor Co.	Japan
'0A'	NEC	Japan
'0B'	Oki Electric Industry Co. Ltd	Japan
'0C'	Toshiba Corp.	Japan
'0D'	Mitsubishi Electric Corp.	Japan
'0E'	Samsung Electronics Co. Ltd	Korea
'0F'	Hynix	Korea
'10'	LG-Semiconductors Co. Ltd	Korea
'11'	Emosyn-EM Microelectronics	USA
'12'	INSIDE Technology	France
'13'	ORGA Kartensysteme GmbH	Germany
'14'	SHARP Corporation	Japan
'15'	ATMEL	France
'16'	EM Microelectronic-Marin SA	Switzerland
'17'	KSW Microtec GmbH	Germany
'18'	ZMD AG	Germany
'19'	XICOR, Inc.	USA
'1A'	Sony Corporation	Japan
'1B'	Malaysia Microelectronic Solutions Sdn. Bhd	Malaysia
'1C'	Emosyn	USA
'1D'	Shanghai Fudan Microelectronics Co. Ltd.	P.R. China
'1E'	Magellan Technology Pty Limited	Australia
'1F'	Melexis NV BO	Switzerland
'20'	Renesas Technology Corp.	Japan
'21'	TAGSYS	France
'22'	Transcore	USA
'23'	Shanghai belling corp., ltd.	China
'24'	Masktech Germany GmbH	Germany
'25'	Innovision Research and Technology Plc	UK
'26'	Hitachi ULSI Systems Co., Ltd.	Japan
'27'	Cypak AB	Sweden
'28'	Ricoh	Japan

Identifier	Company	Country
'29'	ASK	France
'2A'	Unicore Microsystems, LLC	Russian Federation
'2B'	Dallas Semiconductor/Maxim	USA
'2C'	Impinj, Inc.	USA
'2D'	RightPlug Alliance	USA
'2E'	Broadcom Corporation	USA
'2F'	MStar Semiconductor, Inc	Taiwan, ROC
'30'	eeDar Technology Inc.	USA
'31'	RFIDsec	Denmark
'32'	Schweizer Electronic AG	Germany
'33'	AMIC Technology Corp	Taiwan

Annex C (normative)

ISO 14816 – Numbering systems for supply chain applications of RFID

Within supply chain applications for RFID, there are several numbering structures that are used by ISO/IEC JTC 1/SC 31, ISO TC 104, ISO TC 122, and ISO TC 204. These structures are shown in Table C.1, below.

Table C.1 — Coding structure identifiers (CSI)

CSI	Length	Coding structure data field			
0	Variable	Reserved for CEN/ISO			
		Not defined			
1	7 octets / 56 bits	Country code ^a	Issuer identifier	Service number	
		10	14	32	
2	6 octets / 48 bits	Manufacturer identifier		Service number	
		16		32	
3	22 octets / 176 bits	Start time	Stop time	Geographic limit	Application limit
		80	80	8	8
4	Variable	Country code ^a	Alphabet indicator	License plate #	
		10	8	Not defined	
5	17 octets / 136 bits	Vehicle identification (chassis) number			
		126			
6	Variable	Reserved for CEN/ISO			
		Not defined			
7	93 bits	Freight container numbering			
		93			
8	Variable	Country code ^a	Tax code		
		10	Not defined		
9	Variable	Reserved for CEN/ISO			
		Not defined			
...	Variable	Reserved for CEN/ISO			
		Not defined			
30	Variable	Reserved for CEN/ISO			
		Not defined			
31	Variable	Reserved for CEN/ISO (extension)			
		Not defined			
^a Country code is in accordance with ISO 3166-1.					

Maintenance of CSI-1 and CSI-2 in ISO/TS 14816 is managed by NEN.

Current assignments can be found at the following URL:

<http://www.nen.nl/cen278/>

Maintenance of CSI-7 is in accordance with ISO 6346, whose Registration Authority is the International Container Bureau (BIC).

Registration Authority
c/o International Container Bureau
167, rue de Courcelles
F-75017 Paris
France
Tel: +33 1 47 66 03 90
Fax: +33 1 47 66 08 91
E-mail: bic@bic-code.org

Annex D
(normative)

ISO/IEC 18000-6C or ISO/IEC 18000-3m3 numbering systems for RFID

The EPCglobal Tag Data Standard describes how to encode an Allocation Class “E2” TID. Figure D.1 shows the existing EPC TID format. Figure D.2 shows the proposed EPC TID format. The first field after the Allocation Class is the TID issuer code. Table D.1 shows the EPCglobal Tag mask-designer identifier code assignments. Current assignments can be found at <http://www.onsepc.com/MDIDAssignment.xls>

TID MEM BANK BIT ADDRESS	BIT ADDRESS (In Hex)															
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
10 _h -1F _h	TAG MDID [3:0]				TAG MODEL NUMBER [11:0]											
00 _h -0F _h	E2 _h								TAG MDID [11:4]							

Figure D.1 — EPCglobal Short TID

TID MEM BANK BIT ADDRESS	BIT ADDRESS (In Hex)															
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Figure D.2 — EPCglobal Extended TID (to be completed by EPCglobal)

Table D.1 – EPCglobal task mask-designer codes (as of 2008-02-14)

Company	Decimal Value
Impinj	1
Texas Instruments	2
Alien Technology	3
Intellex	4
Atmel	5
Philips	6
ST Microelectronics	7
EP Microelectronics	8
Symbol Technologies	9
Sentech Snd Bhd	10
EM Microelectronics	11
Renesas Technology Corp.	12
Mstar	13
Tyco International	14
Quanray Electronics	15
Fujitsu	16

Annex D

(normative)

INCITS 256 and INCITS 371 numbering systems

As the INCITS 256:2001 standard was being developed, it became apparent that a unique tag ID (TID) was required. autoid.org is the Registration Authority for INCITS 256 and INCITS 371. Many of the INCITS 256 and INCITS 371 air interfaces have become various parts of the ISO/IEC 18000 series.

This standard defines Allocation Classes "00" to "1F" for the INCITS TID. Any manufacturer whose products comply with an ISO/IEC or ITU standard may apply for an INCITS TID manufacturer code.

Current assignments can be found at

http://www.autoid.org/INCITS/INCITS_256_371_Manufacturer_ID_Registration.htm

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