**Answer to reset**

After the reset signal is applied by the interface device the IC card responds with an answer to reset. For the active low reset mode the IC should respond between 400 and 40,000 clock cycles after the rising edge of the reset signal. The answer to reset is at most 33 characters (including the initial character) and consists of 5 fields,

* The initial character (TS)
* The format character (TO)
* The interface characters (TAi,TBi,TCi,TDi,)
* The historical characters (T1, T2....TK)
* The check character (TCK)

Each of these fields is sent in order as shown in [figure 12](http://www.sat-digest.com/SatXpress/SmartCard/info/FIG12.GIF). The initial character TS is really a bit synchronisation pattern which may be sent in order to determine the data transmission rate (auto baud rate sensing) and also to determine the sense of the logic. The format of the TS character is shown in [figure 13](http://www.sat-digest.com/SatXpress/SmartCard/info/FIG13.GIF). This shows the two possibilities of the direct and inverse convention. In the inverse convention where the logic level 1 is the space or low state the most significant bit is transmitted first. With the direct convention where the logic level 1 is the mark or high state then the least significant bit is transmitted first. This means that the selection of the appropriate logic sense will result in the initial character being interpreted as `3F' for the inverse convention and `3B' for the direct convention in hexadecimal coding.

The format character TO provides information necessary to interpret the remaining answer to reset characters. The most significant 4 bits use a bit map to indicate the presence or otherwise of TA1, TB1, TC1 and TD1. For example if the most significant bit (b8) is set then TD1 is present in the interface characters field. Similarly the presence of TC1 is indicated by the state of the `b7' bit and so on.

The least significant 4 bits of the TO formal character give the number (binary encoded) of bytes in the historical field. The use of 4 bits restricts the maximum size of the historical character field to 15 bytes.

The interface characters (TAi, TBi, TCi, TDi,) are the complex part of the answer to reset. They carry information relating to the available communication protocols as well as the programming voltage and current parameters for the EPROM. There is currently a proposed revision to the ISO 7816-3 to remove ambiguities and to ensure an effective method of operation for changing the protocol type and the protocol parameters. Much of the complexity is brought about by the desire to achieve backward compatibility with commercial implementations of the T=O communication protocol. At the current time there are commercial applications running either the T=O or T=1 communication protocol while multi-protocol operation is somewhat scarce.

The proposed revisions to the standard may alter this situation. We will discuss the interface bytes and protocol type selection against these proposed revisions but readers are warned that these recommendations are only provisional.

The interface bytes (which are optional) are defined in [figure 14](http://www.sat-digest.com/SatXpress/SmartCard/info/FIG14.GIF). The T0 and TDi characters contain bit maps which indicate the presence or otherwise of the following TAi, TBi, TCi, and TDi bytes.

The TA1, TB1, TC1, and TB2 characters are referred to as the global interface bytes and are fundamental to the operation of the card.

TA1 defines the basic characters of the serial transmission, FI is the clock rate conversion factor and DI is the bit rate adjustment factor. The binary encoded fields are compared against tables supplied in the standard to achieve actual values for F and D as defined below,

* Work etu = 1 / D X F / f sec

An elementary time unit (etu) is the nominal bit duration used in the character frame. Thus as described previously one character frame is equal to 12 etu (1 start etu, 8 data etu, 1 parity etu, 2 guard time etu).

The default values for F1 and D1 are 1 which is defined in the tables to give a value for F of 372 and D of 1. Hence the work and initial etu are the same. At these default values the frequency of the clock should be in the range 1MHz - 5MHz.

TB1 is used to define the EPROM programming voltage and current. The value of II and PI1 are used against tables to obtain the value of I mA and P volts. It should be noted that TB2 is used to define the programming voltage with higher granularity (8 bits instead of 5).

TC1 provides the value of N which defines the extra guard time to be used between successive characters. N can be in the range 0 - 254 etu. When N is equal to 255 this indicates that the minimum guard time ( 2 etu for T = 0 and 1 etu for T = 1 ) should be used. As noted previously the T = 0 communications protocol requires the extra guard time to enable the parity error detection and signalling to be implemented.

TD1 indicates the protocol type TDI as between 0 and 15,

* T = 0 Asynchronous half duplex byte transmission
* T = 1 Asynchronous half duplex block transmission
* T = 2/3 Reserved for full duplex operation
* T = 4 Reserved for enhanced half duplex byte transmission
* T = 5..13 Reserved for further use (RFU)
* T = 14 Non ISO protocols
* T = 15 Reserved for future extension

It should be noted that Japan uses T = 14 for a National block asynchronous protocol.

The TD1 byte also contains a bit map that indicates the presence or otherwise of TA2, TB2, TC2 and TD2.

The proposed revision defines a new use for the TA2 interface byte which has a special role in the selection of communication protocols and parameters. We will discuss this further in the communications section.

**The Historical Characters**

The historical characters may be used to convey information relating to the life cycle of the card. There are clearly other possibilities and the use of these characters is still subject to agreement. This subject is being considered further as part of the emerging part 4 of the ISO 7816 standard.

**The Check Character (TCK)**

The check character should not be sent when only the T = 0 protocol is indicated in the answer to reset. In all other cases TCK is sent as the last character of the ATR. The check character is calculated such that the Exclusive OR of all the bytes from T0 to TCK inclusive is equal to zero.