STS Association

STS101-1

Edition 1.1
January 2022

INTERFACE SPECIFICATION –
Physical Layer Mechanical and Electrical Interface for Virtual Token Carriers

CONTENTS

Revision History

Edition	Clause	Date	Change details
1.1	Editorial	Jan 2022	Added revision history table (this table) Changed to new STS logo. Edited Foreword

STANDARD TRANSFER SPECIFICATION ASSOCIATION

INTERFACE SPECIFICATION

STS 101-1: Standard transfer specification (STS) – Interface specification – Physical layer mechanical and electrical interface for virtual token carriers

FOREWORD

The STS Association is a Not-for-Profit Company registered in terms of South African Law. The organisation holds an annual general meeting of members where the members elect nominated members to the board. The board consists of elected directors as well as one director each from the four founding organisations, Itron, Conlog, Landis+Gyr and Eskom in South Africa.

The Standard Transfer Specification (STS) has become recognized as the only globally accepted open standard for prepayment systems, ensuring inter-operability between system components from different manufacturers of prepayment systems. The application of the technology is licensed through the STS Association, thus ensuring that the appropriate encryption key management practices are applied to protect the security of the prepayment transactions of utilities operating STS systems. It has become established as a de facto worldwide standard for transfer of electricity prepayment tokens since its initial introduction in South Africa in 1993.

It has become established as a worldwide standard for the transfer of electricity prepayment tokens since its introduction in South Africa in 1993 and subsequent publication by the International Electrotechnical Commission as the IEC62055 series of specifications.

Address: The STS Association, P.O. Box 868, Ferndale 2160, Republic of South Africa.
Tel: +27 11 789 1384
Fax: +27 11 789 1385
Email: email@sts.org.za
Website: http://www.sts.org.za

INTRODUCTION

STS is a secure message system for carrying information between a point-of-sale and a meter, and is currently finding wide application in electricity metering and payment systems. STS is not limited to this application (see the section: Future enhancements), but because of the wide interest in this area, this document describes the electricity application.

STS is a South African industry specification described in *NRS 009-6, section 6 to 9, and part 7 which are being considered for publication as publicly available standards through IEC TC 13 working group 15.

The STS series of companion Specifications have been introduced to formalise additional functional functionality available to those users requiring facilities not addressed in the IEC 62055 series of specifications.

It is envisaged that the STS companion specifications will ultimately be adopted by the IEC in the IEC62055 series of specifications.

The Standard Transfer Specification (STS) is a secure message protocol that allows information to be carried between point-of-sale (POS) equipment and payment meters and it caters for several message types such as credit, configuration control, display and test instructions. It further specifies devices and codes of practice that allows for the secure management (generation, storage, retrieval and transportation) of cryptographic keys used within the system.

INTERFACE SPECIFICATION

STS 101-1: Standard Transfer Specification (STS) – Interface specification – Physical layer mechanical and electrical interface for virtual token carriers

1 Scope

This specification STS 101-1 describes the de-facto industry standard(s) “credit reader port” mechanical and electrical interface as implemented by existing prepayment meters, but with minor deviations and enhancements.
The specification aligns with IEC 62055-52.

2 Normative references

IEC 60050-300, International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments

IEC 62051:1999, – Electricity metering – Glossary of terms

IEC 62055-31:2005, – Electricity metering – Payment systems Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)

IEC 62055-41:2007, Electricity metering – Payment systems Part 41: Standard Transfer Specification – Application Layer Protocol for one-way token carrier systems

IEC 62055-51:2007, Electricity metering – Payment systems Part 51: Standard Transfer Specification – Physical Layer Protocol for one-way numeric and magnetic card token carriers

IEC 62055-52, Electricity metering – Payment systems Part 52: Standard Transfer Specification – Physical Layer Protocol for a two-way virtual token carrier for direct local connection

3 Terms and definitions

3.1 General

For the purposes of this document the Terms and Definitions given in IEC 60050-300, IEC 62055-41, IEC 62055-52. IEC 62055-31 and IEC 62055-51shall generally apply.
Where there is a difference between the definitions in this standard and those contained in other referenced IEC standards, then those defined in this standard shall take precedence.

3.2 Definitions

Type A Interface	Concentric padset on PCB via which information from the Server may be accessed using a Direct Probe
Type B Interface	Micro USB (type B) interface via which information from the Server may be accessed using a suitable connection device

3.3 Abbreviated Terms

The following abbreviated terms are used throughout the STS Companion Specifications

3DES	3rd Data Encryption Standard
ACK	Acknowledge
ALFO	Application_Layer_Function_Object

APDU	Application Protocol Data Unit
CRFO	Configuration_Registry_Function_Object
DES	Data Encryption Standard
DL	Data Length
FOIN	FunctionObjectIdentificationNumber
GPS	Global Positioning System
IEC	International Electrotechnical Commission
I_{IN}	Current IN
I_{OH}	Current OUT High
I_{OL}	Current OUT Low
I_{OUT}	Current OUT
ISO	International Standards Organisation
KRN	KeyRevisionNumber
KT	KeyType
kWh	Kilo Watt Hour
MFO	MeterFunctionObject
NAK	Negative Acknowledge
PLFO	Physical_Layer_Function_Object
RID	RegisterIdentifier
Rx	Receiver
SG	Supply Group
SGC	SupplyGroupCode
SC	Social Credit
STA,	Standard Transfer Algorithm
STS	Standard Transfer Specification
STSA	Standard Transfer Specification Association
TCDU	TokenCarrierDataUnit
TI	Tarrif Index
TID	TokenIdentifier
Tx	Transmitter
USB	Universal Serial Bus
VFMO	Virtual_Meter_Function_Object
V_{IN}	Voltage IN
V_{OH}	Voltage OUT High
V_{OL}	Voltage OUT Low

V_{OUT} Voltage OUT

3.4 Notation and terminology

Throughout this standard the following rules are observed regarding the naming of terms.

1. Entity names, data element names, function names and process names are treated as generic object classes and are given names in terms of phrases in which the words are capitalized and joined without spaces. Examples are: SupplyGroupCode as a data element name, EncryptionAlgorithm07 as a function name and TransferCredit as a process name (see Note 1).
2. Direct (specific) reference to a named class of object uses the capitalized form, while general (non-specific) reference uses the conventional text i.e. lower case form with spaces. An example of a direct reference is: “The SupplyGroupCode is linked to a group of meters”, while an example of a general reference is: “A supply group code links to a vending key”.
3. Other terms use the generally accepted abbreviated forms like PSTN for Public Switched Telephone Network.

Note 1 The notation used for naming of objects has been aligned with the so-called “camel-notation” used in the common information model (CIM) standards prepared by IEC TC57, in order to facilitate future harmonization and integration of payment system standards with the CIM standards.

3.5 Numbering conventions

In this standard, the representation of numbers in binary strings uses the convention that the least significant bit is to the right and the most significant bit is to the left.
Numbering of bit positions start with bit position 0, which corresponds to the least significant bit of a binary number.
Numbers are generally in decimal format, unless otherwise indicated. Any digit without an indicator signifies decimal format.
Binary digit values range from 0-1.
Decimal digit values range from 0-9.
Hexadecimal digit values range from 0-9, A-F and are indicated by “hex”.

4 Reference model

The reference model to this specification is described in IEC 62055-52 Clause 4 and IEC62055-41 Clause 5

5 Type A interface

5.1 General

The Type A Interface is an onboard padset comprising eight concentric PCB pads which are accessed via an eight pin probe (Direct Probe) inserted into the server and contacted onto the pads. Orientation is provided by a central guide hole and a peripheral locating pin.

The Type A interface is an industry standard, which is widely used with payment meters installed in South Africa and in several other IEC countries. It is intended for use with clients over an ad-hoc direct local connection. The connection could be extended over a suitable modem link, but such extension is not specifically catered for in this standard and any user would do so at his own risk of causing the

combined equipment to no longer comply with particular type compliance specifications for the individual parts.

It is recognised that that the signal levels specified in the Type A interface are likely to become incompatible with newer semiconductor technology developments over time, operating at different threshold values. An additional new type of interface would then need to be defined in a revised edition of this specification.

The client may optionally provide power to the server on Terminal 6 or Terminal 7 in the case where the server is not connected to its own source of power or when the power supply of the server has been damaged. It must be noted that under these conditions the server may present only limited functionality.

Mechanical interface

5.1.1 Terminal layout

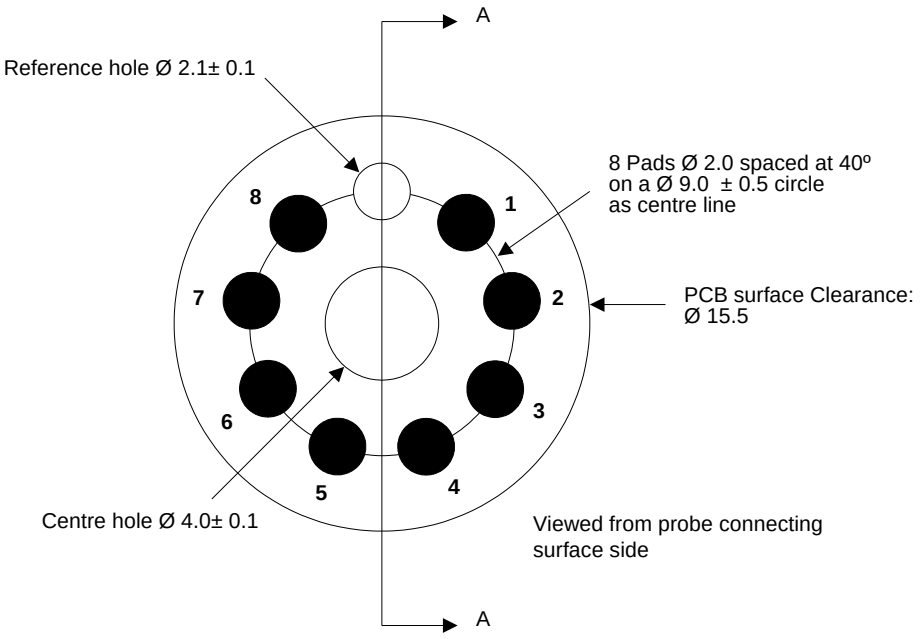

Figure .1 – Contact pads etched on front surface of the server PCB (probe side)

5.1.2 Connector clearances

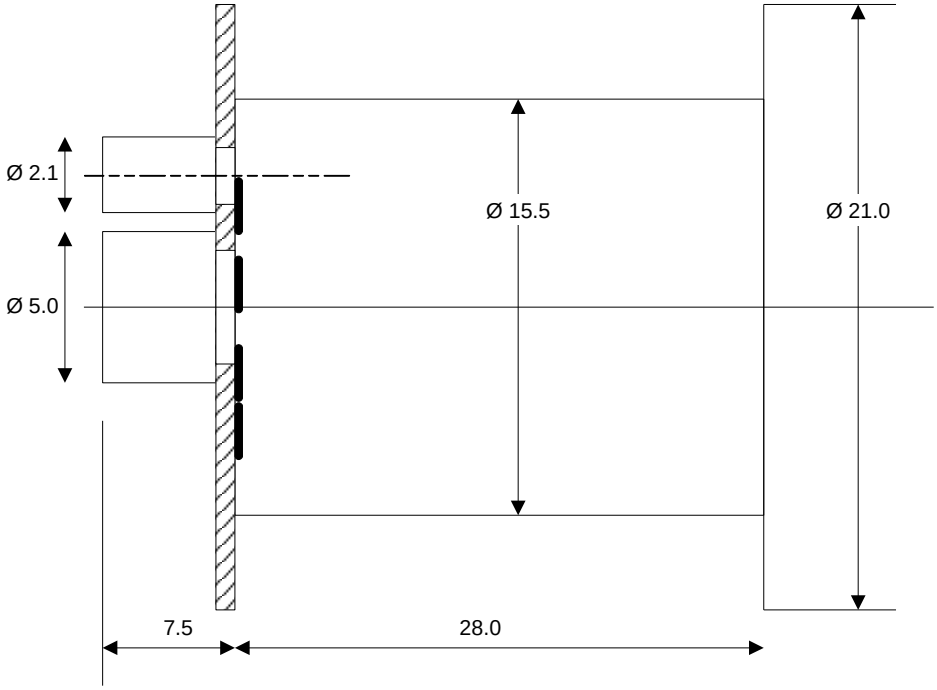

Figure .2 – Section A-A indicating the clearances required for the client connector

DIMENSIONS: 2 mm diameter pads etched onto the front surface of printed circuit board (PCB). Spaced at 40º intervals on a centre-line-circle of 9 mm diameter.

CLEARANCE: 15,5 mm diameter area from the PCB connection pads, up to a distance of 28 mm away from the PCB, and 21 mm diameter area for distances further than 28 mm from the PCB. The

15,5 mm diameter area on the PCB must not be conformal coated.

Access must be provided, to insert the probe through any permanent cover that might be installed on the server. The probe must also protrude 5 mm through the centre and reference holes in the PCB.

5.2 Electrical interface

5.2.1 Electrical characteristics

The voltage and current values given in Table 1 to 5 are valid for the server supply voltage values in the extended operating range as given in 7.2.1 of IEC 62055-31.

NOTE The values given in Table 2 and Table 3 are as for 74LS - series (low power Schottky) taken from the Texas Instruments Data Book.

Table 1 – Terminal assignments

Terminal number	Terminal name	Signal direction	Terminal Function	Reference
1	Proprietary	undefined	Undefined – for proprietary use.	5.2.2
2	TransmitData	output	Data signal to client.	5.2.3
3	ReceiveData	input	Data signal from client.	5.2.4
4	PowerDownDisable	input	Control signal from client.	5.2.5
5	Common	common	Common reference between client and server for signals and supply voltages.	5.2.6
6	+5VoltSupply	input	Power supply from client	5.2.7 Note1
7	+15VoltSupply	Dual function: a) input b) output	Dual function: a) Power supply from client b) Power supply to client	5.2.8
8	Proprietary	undefined	Undefined – for proprietary use.	5.2.9

Note1: see 5.2.7 for low voltage servers.

Table 2 –Voltage and current levels for signal outputs

Symbol	Min	Max	Parameter
V_{OH}	+2.5 V DC		High level output voltage; voltage that signals a logical high level at I_{OH} = max
V_{OL}		+0.5 V DC	Low level output voltage; voltage that signals a logical low level at I_{OL} = max
I_{OH}		0.4 mA	Current that Terminal 2 is able to source at V_{OH}
I_{OL}		0.4 mA	Current that Terminal 2 is able to sink at V_{OL}

Table 3 – Voltage and current levels for signal inputs

Symbol	Min	Max	Parameter
V_{IH}	+2.0 V DC		High level input voltage; required voltage to signal a logical high level

V_{IL}		+0.8 V DC	Low level input voltage; required voltage to signal a logical low level
I_{IH}		0.02 mA	Current that Terminal 3 is able to sink at V_{IH}
I_{IL}		0.4 mA	Current that Terminal 3 is able to source at V_{IL}

Table 4 – Terminal 6 +5VoltSupply voltage and current levels

Symbol	Min	Max	Parameter
V_{IN}	+4.8 V DC	+5.2 V DC	Supply input voltage; required voltage to supply the server
I_{IN}		60 mA	Current that the server will sink from the client at VIN
V_{OUT}	undefined	undefined	Supply output voltage; voltage that the server will supply at I_{OUT}
I_{OUT}	undefined	undefined	Current that the server will source to the client at V_{OUT}

Table 5 – Terminal 7 +15VoltSupply voltage and current levels

Symbol	Min	Max	Parameter
V_{IN}	+14.5 V DC	+15.5 V DC	Supply input voltage; required voltage to supply the server
I_{IN}		60 mA	Current that the server will sink from the client at V_{IN}
V_{OUT}	+8 V DC	+16 V DC	Supply output voltage; voltage that the server will supply at I_{OUT}
I_{OUT}	undefined	2 mA	Current that the server will source to the client at V_{OUT} = Min

5.2.2 Terminal 1 : Proprietary

The function and operation of this terminal is undefined in this specification and is assigned for proprietary use by each manufacturer. The server side should ensure that the client state of these pins do not affect the operation of the server.

5.2.3 Terminal 2 : TransmitData

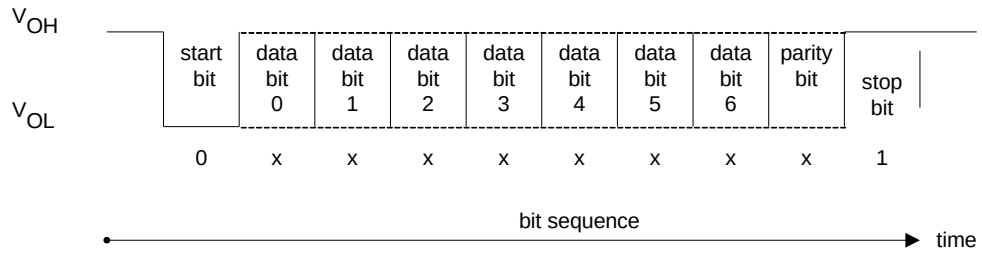

Figure .3 – Serial transmission output signal on Terminal 2

The server signals the serial data transmission from this output terminal to the client.
The voltage thresholds and current levels on the server are given in Table 2.
Signal levels and transmission format complies with Figure 3.

When no transmission is taking place the signal level is at V_{OH}.

A start-bit signal is a transition from V_{OH} to V_{OL} for the duration of a bit-time.

A data-bit or parity-bit with value = 1 is a transition from V_{OL} to V_{OH} for the duration of a bit-time.

A data-bit or parity-bit with value = 0 is a transition from V_{OH} to V_{OL} for the duration of a bit-time.

A stop-bit is a transition from V_{OL} to V_{OH} for the duration of a bit-time.

5.2.4 Terminal 3 : ReceiveData

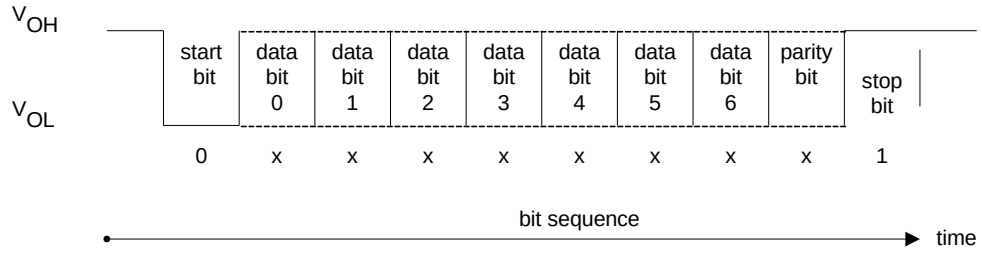

Figure .4 – Serial transmission input signal on Terminal 3

The server receives the serial data transmission signal on this input terminal from the client. The voltage thresholds and current levels required from the client to be applied to the server are given in Table 3.
Signal levels and transmission format complies with Figure 4.
When no transmission is taking place the signal level is at V_{OH}.
A start-bit signal is a transition from V_{OH} to V_{OL} for the duration of a bit-time.
A data-bit or parity-bit with value = 1 is a transition from V_{OL} to V_{OH} for the duration of a bit-time.
A data-bit or parity-bit with value = 0 is a transition from V_{OH} to V_{OL} for the duration of a bit-time.
A stop-bit is a transition from V_{OL} to V_{OH} for the duration of a bit-time.

5.2.5 Terminal 4 : PowerDownDisable

The server may employ a function that puts it in standby or sleep mode during periods of inactivity for the purpose of saving power for example. Under these circumstances a client that wants to initiate a communication session with the server needs to first wake up the server.

An active low level signal = V_{OL} applied to this input terminal causes the server to do the following:

- wake up the server if it is in standby or sleep mode, to resume normal functionality;
- prevent the server from entering standby or sleep mode while the signal is present.

The voltage thresholds and current levels on the server are given in Table 3.

5.2.6 Terminal 5 : Common

This terminal is the common return reference for signal voltages and currents between the client and the server.
It is also the common return reference for the +5VoltSupply and the +15VoltSupply lines between the client and the server.

5.2.7 Terminal 6 : +5VoltSupply

When the server is not powered by its internal source of supply, then the client may supply a voltage on this terminal, which enables the server to become operational. The voltage and current parameters for V_{IN} and I_{IN} are given in Table 4. Note that some battery operated servers (i.e. Gas or water meters) may require protection or voltage regulation to cater for this higher source of supply.

5.2.8 Terminal 7 : +15VoltSupply

As an input this terminal serves the same function as Terminal 6, but operates with +15V DC instead of +5V DC.

When the server is not powered by its internal source of supply, then the client may supply a voltage on this terminal, which enables the server to become operational. The voltage and current parameters for V_{IN} and I_{IN} are given in Table 5.
As an output this terminal serves to supply +15V DC to the client in accordance with the values given in Table 5.

5.2.9 Terminal 8 : Proprietary

The function and operation of this terminal is undefined in this specification and is assigned for proprietary use by each manufacturer. The server side should ensure that the client state of these pins do not affect the operation of the server.

6 Type B interface

6.1 General

The Type B interface is intended for use with client devices such as modems that are powered from an external supply and not from the server.
The Type B interface is based on the Micro USB (type B) receptacle and is the standard interface for use in all split meters; (i.e. measurement units that conform to the BS 7856 enclosure format as well as units that conform to the circuit breaker enclosure format.) The Micro USB (type B) receptacle is an industry standard connection, which is used in the consumer electronics market, world wide. It is intended for use with clients over a direct local connection, but the connection can be extended over a suitable modem link. The connection optically isolates the client from the server and as such, no power is provided to the client from the server. The need for the PowerDownDisable signal also falls away.

6.2 Mechanical interface

6.2.1 Terminal layout

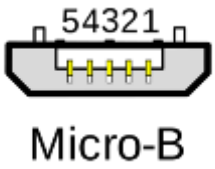

Figure .5 – Micro USB type B – receptacle

The interface port for both types of enclosure formats shall be accessible and usable when the meter is installed and operational. The port for a measurement unit that conforms to the BS 7856 enclosure format, shall be protected behind a cover that can be sealed.. It is preferred that the same terminal cover be used to protect the interface port as well. The interface port shall be usable with the cover installed and sealed in place. This requirement necessitates that there be enough room for the interface cables to protrude around, or through, the sealed cover. The port for a measurement unit that conforms to the circuit breaker enclosure format, does not require a sealing cover when operational since these meters are installed in sealed cabinets. The measurement unit for all types of enclosure formats shall be supplied with a reusable seal/plug to prevent contamination by vermin when the port is unused.

6.3 Electrical interface

Table 6 – Terminal assignments

Terminal	Terminal Name	Terminal Function

Number		
1	Receive Common	+5V supply for Data Signal from Client
2	Receive Data	Data Signal from Client
3	Transmit Data	Data Signal to Client
4	Reserved	---
5	Transmit Common	+0V Supply for Data Signal to Client

Table 7 – Terminal 1 Receive Data Voltage Levels

Symbol	Min	Max	Parameter
Vin	+3V DC	+5.25V DC	Supply Input Voltage required to supply the drive circuit for data signals transmitted from the client

Table 8 – Terminal 1 & 2 Receive Data Loop Current Levels

Symbol	Min	Max	Parameter
I Rx	2 mA +/- 20%	20mA	Current that the Client will source during transmission of Data Signals to the Server

Table 9 – Terminal 3 & 5 Transmit Data Loop Current Levels

Symbol	Min	Max	Parameter
I Tx	2 mA +/- 20%	20mA	Current that the Client will source during reception of Data Signals from the Server

6.4 Electrical Isolation

As per IEC 62055-31 any terminal on the VTC port must be able to withstand 4kV RMS and 6kV impulse
with respect to any of the voltage or current terminals.
There shall be no provision made for DC power transfer between client and server in either direction.

6.5 Example Interface Diagram

A suggested interface implementation for both the Server and Client is given below.

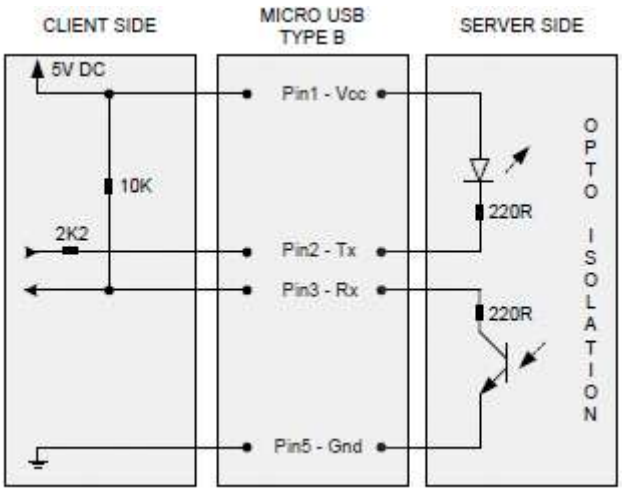

Figure .6 – Diagram of Type B Interface

Bibliography

IEC 60050-300, International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments

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IEC 62055-52, Electricity metering – Payment systems Part 52: Standard Transfer Specification – Physical Layer Protocol for a two-way virtual token carrier for direct local connection

Version control

First draft was issued as D1.01
Second draft was issued as D1.02
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Revision	Date	Author	Comments
D1.01	17/01/2006	DM Taylor	First cut circulated to selected ESKOM suppliers and ESKOM for purpose of discussion at meeting on 14 March 2007
D1.02	20/03/2007	DM Taylor	Editorial changes Parameter updates in Table 1..5 Re-organise format to present Type A and Type B interface options Circulate to same group for feedback.
D1.03	23/03/2007	DM Taylor	Renumbered document to STS 101-1
D1.03	04/09/2007	DM Taylor	Add comments section in back of document before circulation as NP Address several comments. Submit to STSA as NP
D1.04	21/08/2011	BJ Borton	Reviewed References Added Type B Interface
V1.0	02/10/2013	F.G. Pucci	Final draft for comment and vote (CDV)
V1.1	16/02/2014	F.G. Pucci	Corrected grammar in 5.1 and 5.21 Added note for supplies under 5V (i.e. 3.6v for gas meters). Corrected references in Table1. Added comments in 5.2.2 and 5.2.9 to cater for state of proprietary pins on the client side