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Input/output protocols and electronic interfaces for water meters — Requirements

Protocoles d'entrée/sortie et interfaces électroniques pour compteurs d'eau — Exigences

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22158 was prepared by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits*, Subcommittee SC 7, *Volume methods including water meters*.

Introduction

The need to be able to communicate with metered systems has become apparent. This International Standard seeks to address the issues associated with water meters, but can be used in conjunction with other metered systems such as gas and electricity supply that utilize common interfaces and protocols.

During recent years, an increasing number of electronic devices have been introduced into water meters, e.g.:

— pulse output systems;

— absolute encoded systems;

— bidirectional addressable bus systems.

Currently, there is no clear definition of either hardware interfaces or the protocols of such systems and this International Standard attempts to solve the problems arising from this.

Existing technology for water meter communications can be split into three distinct groups, which are defined as follows:

— pulse output water meters — referred to in this International Standard as type A;

— non-addressable water meters — referred to in this International Standard as type B;

— addressable water meters — referred to in this International Standard as type C.

This International Standard describes the general requirements of the protocols and electronic interfaces for water meters. It is intended to provide the necessary guidance for designers of meter registers and reading equipment.

The provisions have been determined by analysing applications currently in use and by consultation within the water industry. However, the list of applications is not exhaustive.

Input/output protocols and electronic interfaces for water meters — Requirements

1 Scope

This International Standard specifies the minimum communication requirements for water meters which have the capability to exchange or provide data by means of an electronic interface.

This International Standard only specifies the interface conditions present at the electrical and electronic connections of water meters and does not prescribe any specific equipment such as transponders and inductive pads, which might be connected to the water meter for automatic meter reading or remote meter reading purposes.

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 1155, *Information processing — Use of longitudinal parity to detect errors in information messages*

IEC 60870-5-1, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section One: Transmission frame formats*

IEC 60870-5-2, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 2: Link transmission procedures*

IEC 60947-5-6, *Low-voltage switchgear and controlgear — Part 5-6: Control circuit devices and switching elements — DC interface for proximity sensors and switching amplifiers* (*NAMUR*)

EN 13757 (all parts), *Communication systems for meters and remote reading of meters*

JIS X 5001:1982, *Character structure on the transmission circuits and horizontal parity method*

NABS[1)], *Communication system by addressable 8-bit electronic water meters — Specifications, ver. 1.0*, 2008. Available [2011-04-27] from: http://www.keikoren.or.jp/eng/pub.html

M-bus[2)], *The M-bus*: *A documentation Rev. 4.8*, 1997. Available [2011-04-27] at http://www.m-bus.com

1) Published by the Japan Water Meter Manufacturers' Association.

2) Published by the M-bus User Group.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13757 (all parts) and the following apply.

3.1
interface
⟨water meters⟩ point or means of interaction between two systems

3.2
pulse
⟨water meters⟩ electronic output (generated or passive) from the interface, with pulses at increments equal to a specific defined volume

3.3
non-addressable interface device
interface device that cannot be addressed individually in a reading bus

3.4
addressable interface device
interface device that can be addressed individually in a reading bus

3.5
automatic meter reading
AMR
meter reading normally involving a central computer

3.6
remote meter reading
RMR
meter reading remote from the meter, not necessarily involving a central computer

3.7
switching current
current that can be carried by the switch during switching

3.8
switch closure
device providing a digital pulse (reed switch, transistor, etc.)

3.9
omnidirectional pulse data set
pulse data set where the pulses do not signify flow direction

3.10
unidirectional pulse data set
pulse data set where the pulses signify flow in one direction only

3.11
bidirectional pulse data set
pulse data set where the pulses signify flow direction

3.12
passive output
⟨water meters⟩ non-powered switching device

3.13
active output
⟨water meters⟩ powered switching device (internal or external to interface)

3.14
tamper detection
⟨water meters⟩ facility to detect attempts to corrupt the metering equipment or the data stored in it

3.15
output mode
⟨water meters⟩ electronic characteristics of a pulse

3.16
data set type
electronic characteristics of a group of pulses providing flow information

3.17
V-frame
data sets including variable length fields

4 Pulse output water meters — type A

NOTE The primary function of this output type is to provide real-time metering pulses that represent a specific unit of water passing through the meter.

4.1 General

Compatibility is defined by output modes, data set types and signal output types designated as follows.

Pulse output modes	1, 2, 3, 4, 5, 6, 7, 8
Data set types	O, U, B1, B2, N1, N2
Signal output types	N, P, T

NOTE Compatible products may be marked, e.g. ”A1O”, “A2O”, A3U”, “A4UN”, “A5B2P”, “A7N2”.

Requirements for pulse output modes, pulse waveform definitions, pulse data set types and signal output types are given in 4.2 to 4.5.

4.2 Pulse output modes

Pulse output modes shall meet the requirements set out in Table 1.

4.3 Pulse waveform definitions

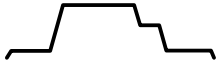
Pulse waveform definitions for pulse output modes A1 to A8 shall meet the requirements set out in Figures 1 to 5.

NOTE In Figures 1 to 5, the timings are illustrative.

4.4 Pulse data set types

Pulse data set types shall conform to the requirements set out in Table 2.

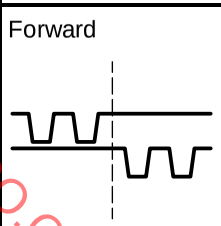
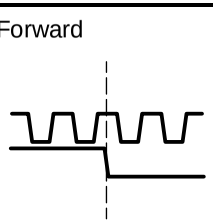
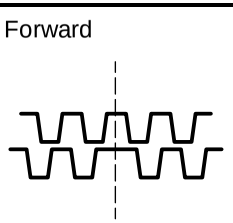
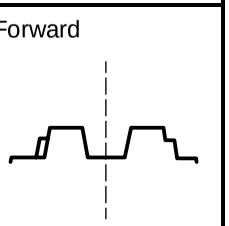
Table 1 — Pulse output modes for pulse output water meters (type A)

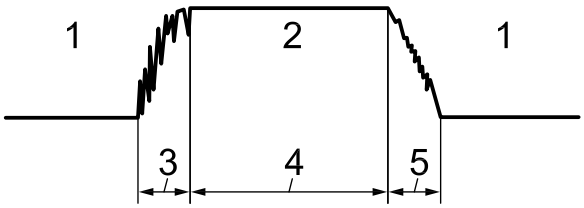
Parameter	Type							
	A1	A2	A3	A4	A5	A6	A7	A8
Character	Passive		Active	Active			Active	
Pulse (see 4.3)	 Volt-free		 Active high	 or 			 Active current loop (see 5.2)	
Engineering	Passive switch closure		Pulse self-powered	Transistor switch self-powered	Transistor switch externally-powered		Current pulse externally-powered	
	signal usage	power usage			sensor usage	buffered usage		
Supply voltage range	—	—	—	—	2 V to 5 V DC	5 V to 15 V DC	IEC 60947-5-6 (8,2 V DC nom. at 1 kΩ source Z)	
Switching current and voltage	3 µA to 20 mA at up to 30 V DC	3 µA to 500 mA at up to 100 V DC	—	⩽20 mA[a] at 20 V DC max.	⩽10 mA[a] at 20 V DC max.	⩽20 mA[a] at 20 V DC max.	—	—
Off-state impedance	>10 MΩ	>10 MΩ	—	—	>10 MΩ		—	—
On-state impedance	<200 Ω	<150 mΩ	—	—	<500 Ω		—	—
Current consumption	—	—	—	—	<20 mA		IEC 60947-5-6 (>2,1 mA)	
Typical data set type (see 4.4)[b]	Omnidirectional		Unidirectional	Omni-, uni- or bidirectional			Omni- or bidirectional	
Typical product type[b]	Micro- or reed-switch or solid state		Generator or piezo sensor	Piezo or magnetic sensor	Piezo, magnetic or optical sensor		Micro- or reed-switch magnetic or optical sensor	

[a] In the case of signal output type T, this voltage is replaced by “power supply voltage”.

[b] Other types may also apply.

Table 2 — Pulse data set types for pulse output water meters

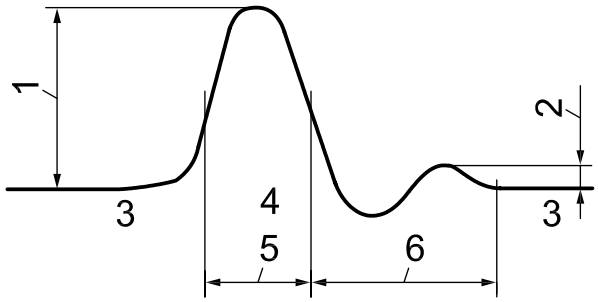
Data-set type	O	U	B1	B2	B3	N1	N2
Format	Omnidirectional	Unidirectional	Bidirectional	Bidirectional	Bidirectional	Omnidirectional	Bidirectional
Pulse(s)							
Definition	Indistinguishable direction	Specific direction	Both unidirections	Omnidirection plus direction signal	Quadrature	IEC 60947-5-6	IEC 60947-5-6 plus “transparent” modifiers



Key

1 switch open
2 switch closed
3 5 ms max. leading noise
4 25 ms min. width
5 5 ms max. trailing noise

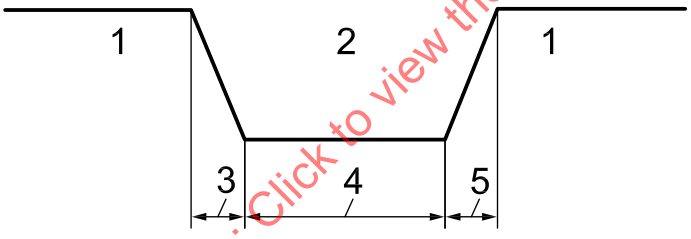
Figure 1 — Types A1 and A2



Key

1 3 V min. primary pulse
2 1 V min. secondary pulse(s)
3 off
4 on
5 1 ms min. width
6 200 ms max. ringing

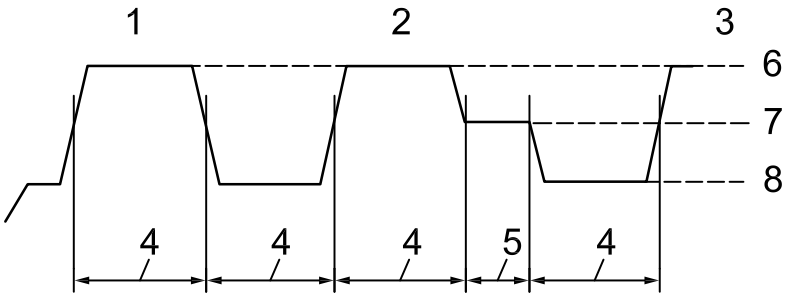
Figure 2 — Type A3



Key

1 off
2 on
3 100 µ max. leading transition
4 2 ms min. width
5 10 ms max. trailing transition

Figure 3 — Types A4, A5 and A6

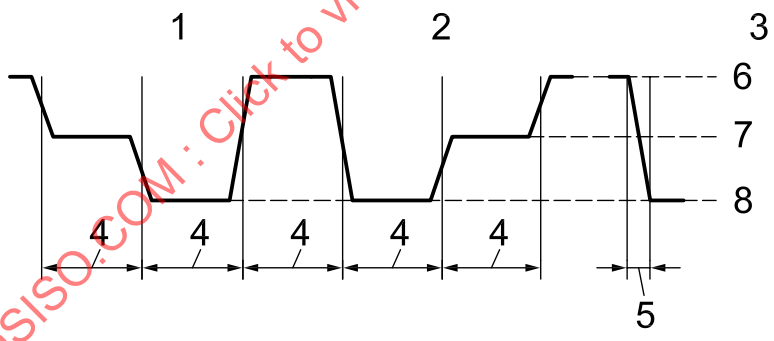


Key

1 forward
2 reverse
3 next pulse
4 1 ms
5 0,5 ms (all minimum widths)
6 2,1 mA min.
7 (1,65 ± 0,165) mA
8 1,2 mA max.

Maximum frequency = 500 Hz forward, 400 Hz reverse

Figure 4 — Type A7



Key

1 forward
2 reverse
3 next pulse
4 1,2 ms (all minimum widths)
5 0,3 ms maximum
6 6,0 mA max., 2,2 mA min.
7 (1,5 ± 0,05) mA
8 1,0 mA max., 0,04 mA min.

Maximum frequency = 150 Hz

Figure 5 — Type A8

4.5 Signal output types

With the exception of data sets N1 and N2, the output signal shall be referenced to either supply rail.

The type of output shall be indicated by a suffix, as follows.

N	signal referenced to 0 volts
P	signal referenced to positive supply volts
T	totem-pole, push-pull output signal
W	floating output without polarity, not referenced signal

The suffix is used in conjunction with the data set type, e.g. ON, UP, B1T.

4.6 Pulse configuration

The signal “set” outputs shall be inherently without reference to measurement values.

EXAMPLE Devices can have more than one “set” of outputs and thus be marked with each compatible output type, which might or might not be different. For example, “A1O + A1O” indicates a single passive volt-free output device providing two signal “sets” meeting the requirements of this International Standard. “A6B1 + A6B2” indicates an active externally powered output device providing two different bidirectional signal “sets” meeting the requirements of this International Standard.

Where a pulse output is polarity conscious, the “most negative” terminal should be so marked, or if it is a wire then a brown core should be used.

Tamper detection or tamper checking facilities can also be provided as a secondary function(s), using one of: cable loop-back, cable impedance-change or magnetic interference signal. These extra connections may optionally utilize the common line, but it is essential that any such use does not compromise the primary pulse function(s).

NOTE Due to the multiplicity of the conceivable pulse, power and tamper connections, it is not practical to allocate all possible core colours to functions.

5 Non-addressable water meters — type B

NOTE The primary function of this output type is to provide a data stream that identifies and reports the registered units of water passed through the meter when exclusively coupled to a reading device.

5.1 General

Compatibility is defined by output modes and data set types (using a common data protocol) designated as follows.

Output modes	1, 2, 3
Data set types	A, S1, S2

Compatible products may be compliance marked, e.g. “B1S1”, “B2A”, “B3A”.

5.2 Non-addressable output modes

Output modes for non-addressable water meters shall meet the requirements set out in Table 3.

Table 3 — Output modes for non-addressable water meters (type B)

Parameter	Type		
	B1	B2	B3
Engineering	Two-wire encoded register	Three-wire encoded register	Two-wire encoded register
Signal	Unidirectional ASCII data frame protocol		Bidirectional ISO data frame protocol
Data set type (see 5.3)	Asynchronous or synchronous		Asynchronous
Supply voltage (if externally powered)	7 to 17 Vp-p AC	2,9 V to 6 V DC (asynchronous) 5 V to 12 V AC (synchronous)	—
AC supply frequency (if externally powered)	10 kHz to 30 kHz		—
Two-wire modulation depth	>10 % inductively	—	Optically isolated — not applicable
Three-wire output low voltage	—	<0,9 V with regard to “COMMON” pseudo-open collector/ open drain external pull-up resistor required	—
Current consumption	<3 mA (asynchronous) <15 mA (synchronous)		—

5.3 Non-addressable data set types

Data set types for non-addressable water meters shall meet the requirements set out in Table 4.

Table 4 — Data set types for non-addressable water meters (type B)

Parameter	Data set type		
	A	S1	S2
Communications	Asynchronous	Externally clocked synchronous	
Data rate	⩾(300 ± 2,25) bit/s	1 clock per bit, from 0 bit/s to 2 000 bit/s	1 clock per bit or 16 clocks per bit at 1 200 bit/s
Character format	1 start, 7 data (LSB first), even parity, 1 stop		
Two-wire data sense	logic 0 = carrier collapsed logic 1 = NO action	logic 0 = impulse burst logic 1 = NO action	logic 0 = biphase change logic 1 = NO biphase change
Three-wire data polarity	logic 0 = output LOW		logic 1 = output HIGH
Inter-character gap	⩽6 bit times	—	—
Data frames	⩾4 identical frames	as clocked, each frame “real-time”	
Inter-frame gap	<2 s	<200 ms	8 “stop” bits
Clock “low” definition	—	250 µs min., 1 000 µs max., stability ±25 %	
Clock “high” definition	—	>1 000 µs	
Power down conditions	>500 ms	>200 ms	

5.4 Non-addressable V-frame data protocol

5.4.1 General

The non-addressable V-frame data protocol is of variable length and has a format as follows:

V S-field [; R-field] [; A-field] [; B-field] [; C-field] [; J-field] <CR>

where

V is the frame start synchronization character (always upper case V);

; is an inter-field separator;

[ ] is an optional field;

<CR> is the frame (& final field) terminator.

V, S-field and <CR> are required in the format.

Applicable fields can have sub-fields, typically as follows:

; RC n [,u [,f [,t]]]

where

R is the field start synchronization character (upper case);

C is the data type (upper case);

n is the actual meter reading;

, is a sub-field separator.

RC n is mandatory, while [,u [,f [,t]]] is optional.

The first field shall be the S-field and optional fields are not sequence dependent.

Fields and sub-fields other than those specified may be included for manufacturer's own purposes, but might not be understood by compliant reading equipment.

5.4.2 Non-addressable V-frame data protocol field definitions

The V-frame data protocol field definitions are set out in Table 5.

Table 5 — Non-addressable V-frame data protocol field definitions

Field	Description	Format
S-field = Serial ID (mandatory)	(manufacturer's code/ID)	f S m s m = manufacturer code, 3 alpha characters … see www.flag-association.com s = id, ⩽16 alpha-numeric characters, 0 to 9, a-z
R-field = Reading (optional)	(quantity or flow-rate)	f ; RC n [,u [,f [,t]]] … data type C = current or: ; RS n [,u [,f [,t]]] … data type S = stored or: ; RH n [,u [,f ,t]] … data type H = highest flow or: ; RL n [,u [,f ,t]] … data type L = lowest flow n = actual meter reading, ⩽ 16 numeric characters 0 to 9, one decimal point is permitted, ? is an error indicator u = units of registration … see 5.4.3, Table 6 f = units factor multiplier/divisor in powers of 10 from –9 to + 9 t = units of time (for flow-rates) … see 5.4.3, Table 7
A-field = Diagnostics (optional)	(manufacturer-specific)	; A a a = ⩽16 ASCII characters
B-field = Billing ID (optional)	(account reference)	; B a a = ⩽16 ASCII characters
C-field = CheckSum (optional)	(block check characters)	; C a a = ⩽4 ASCII characters in accordance with ISO 1155
J-field = Free Text (optional)	(user-specific)	; J a a = ⩽300 ASCII characters
Unless stated above, valid ASCII characters are Hex 20 through Hex 7E, excepting the field separator ";" Hex 3B & <CR>. The message length has no maximum value, but shall include the "V" and "<CR>", in not more than 63 fields.		

5.4.3 Non-addressable V-frame data protocol table allocations

For manufacturer codes, see the FLAG website (www.flag-association.com). Numerical codes for units of registration and time are given in Tables 6 and 7 respectively.

Table 6 — Codes for units of registration

Code	Units of registration
1	cubic metres
2	litres
3	US gallons
4	Imperial gallons
5	cubic feet
6	acre feet
7	hectare metres

Table 7 — Codes for units of time

Code	Units of time
1	second
2	minute
3	hour
4	day
5	year

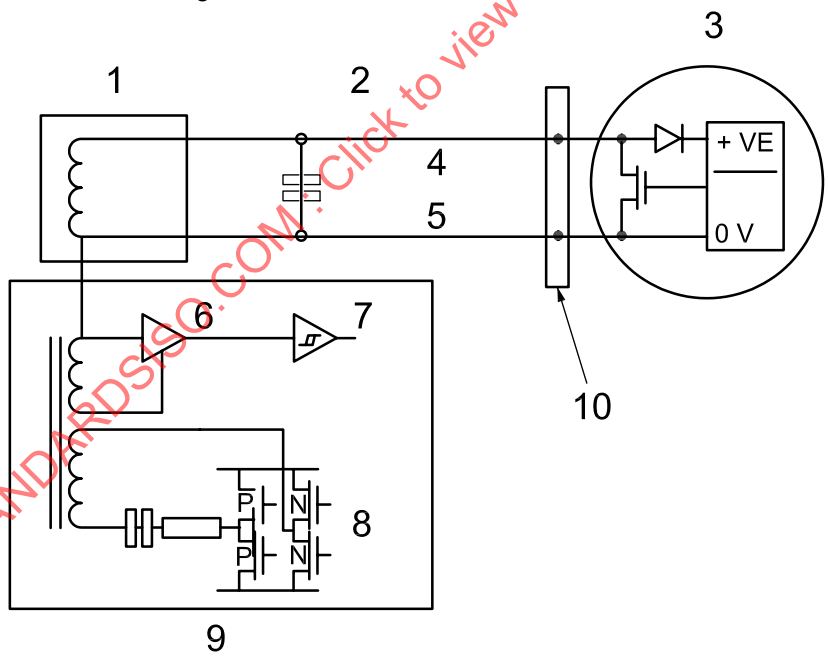
5.5 Non-addressable two-wire asynchronous mode for reading via an inductive pad and probe

This is a two-wire interface whereby an AC voltage (or rectified AC) is applied to the register on the data line to provide an internal supply and a data carrier wave.

After this power-up event, the register is automatically read and data transmitted, at a pre-determined bit-rate as identical data frames, using amplitude modulation, by collapsing the carrier for a logic 0, and not for a logic 1.

If the register is still powered when these transmissions are complete, the register can enter a passive state that allows reception of a manufacturer-specific configuration command; therefore, to re-read the register, it is essential that it is powered down for a brief period and then re-powered, in accordance with 5.3.

A typical configuration is shown in Figure 6.



Key

1	reading pad	6	low-pass filter	N	negative
2	cable	7	digital data	P	positive
3	register	8	AC drive	+VE	positive potential difference
4	data line	9	reading probe (shown for clarity)		
5	common line	10	point of definition of this International Standard		

Figure 6 — Typical configuration for non-addressable two-wire asynchronous mode for reading via an inductive pad and probe

5.6 Non-addressable three-wire asynchronous mode for direct connection to the transponder/bus node

This is a three-wire interface whereby a DC voltage is applied to the register on the power line to provide an internal supply.

After this power-up event, the register is automatically read and data transmitted, at a predetermined bit-rate as identical data frames, directly on the data line, which is effectively an “open-drain” output, so a pull-up resistor is required external to the register.

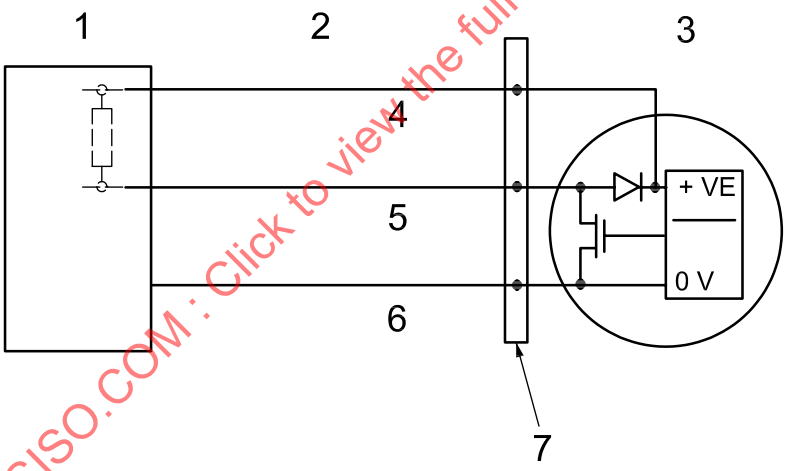
The data consists of a low to indicate a logic “0” or a high to indicate a logic “1”.

If the register is still powered when these transmissions are complete, the register can enter a passive state that allows reception of a manufacturer-specific configuration command; therefore, to re-read the register, it is essential that it is powered down for a brief period and then re-powered, in accordance with 5.3.

Compliant registers might also conform to the two-wire asynchronous mode.

With some engineering implementations for both two- and three-wire use, the use of an internal diode on the data line would cause a power-up event. To avoid this, the pull-up resistor should be gated with the power by the transponder.

A typical configuration is shown in Figure 7.



Key

1 transponder with pull-up resistor
2 cable
3 register
4 power line
5 data line
6 common line
7 point of definition of this International Standard
+VE positive potential difference

Figure 7 — Typical configuration for non-addressable three-wire asynchronous mode for direct connection to the transponder/bus node

5.7 Non-addressable two-wire synchronous mode for reading via an inductive pad and probe

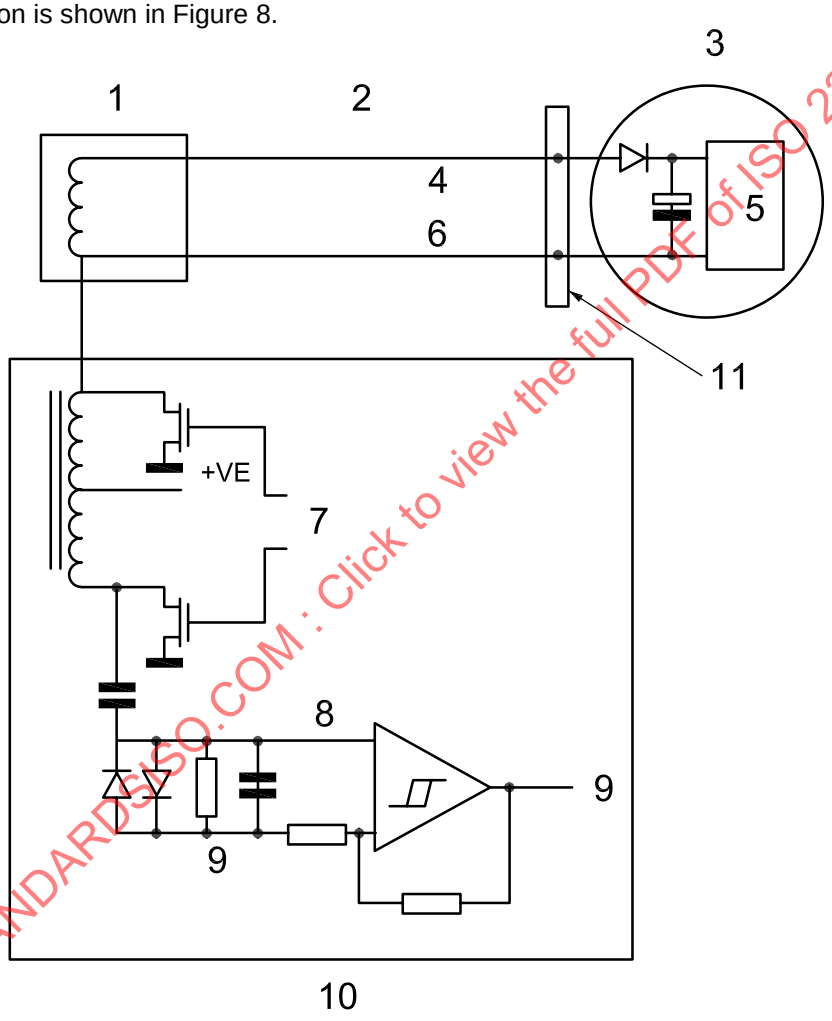
This is a two-wire interface whereby an AC voltage is applied to the register, amplitude shift key modulated 100 %, which acts as the register power source and data clock signal.

After this power-up event, the register is automatically read and data transmitted one bit at a time, synchronized to a brief cessation of the data clock signal.

The data output during this cessation consists of a burst of impulses to indicate a logic “0” or the absence of a burst to indicate a logic “1”.

Between each data frame the register is automatically re-read.

A typical configuration is shown in Figure 8.



Key

1	reading pad	7	AC power drive
2	cable	8	comparator
3	register	9	digital data
4	clock/data line	10	reading probe (shown for clarity)
5	load	11	point of definition of this International Standard
6	common line	+VE	positive potential difference

Figure 8 — Typical configuration for non-addressable two-wire synchronous mode for reading via an inductive pad and probe

5.8 Non-addressable three-wire synchronous mode intended for direct connection to the transponder/bus node

This is a three-wire interface whereby an AC signal is applied to the register, which acts as the register power source and data clock signal.

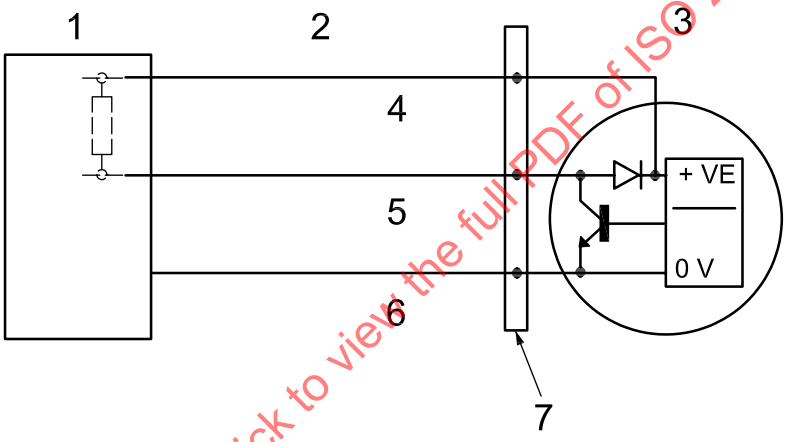
After this power-up event, the register is automatically read and data transmitted one bit at a time, synchronized to the falling edge of the data clock signal, directly on the data line, which is an “open-collector” output, so a pull-up resistor is required external to the register.

The data consists of a low to indicate a logic “0” or a high to indicate a logic “1”.

Between each data frame the register is automatically re-read.

Compliant registers can also comply with the two-wire synchronous mode.

A typical configuration is shown in Figure 9.



Key

1 transponder with pull-up resistor
2 cable
3 register
4 clock/power line
5 data line
6 common line
7 point of definition of this International Standard
+VE positive potential difference

Figure 9 — Typical configuration for non-addressable three-wire synchronous mode intended for direct connection to the transponder/bus node

5.9 Non-addressable two-wire bidirectional asynchronous mode for reading via optocouplers and probe

Data communication shall start by the reading equipment requesting data from the register, which is sent via optocouplers.

The reading equipment transmits data by switching optocoupler 2 as follows:

logic 1 = 0,1 mA to 1,0 mA, node voltage $\leqslant$0,5 V;

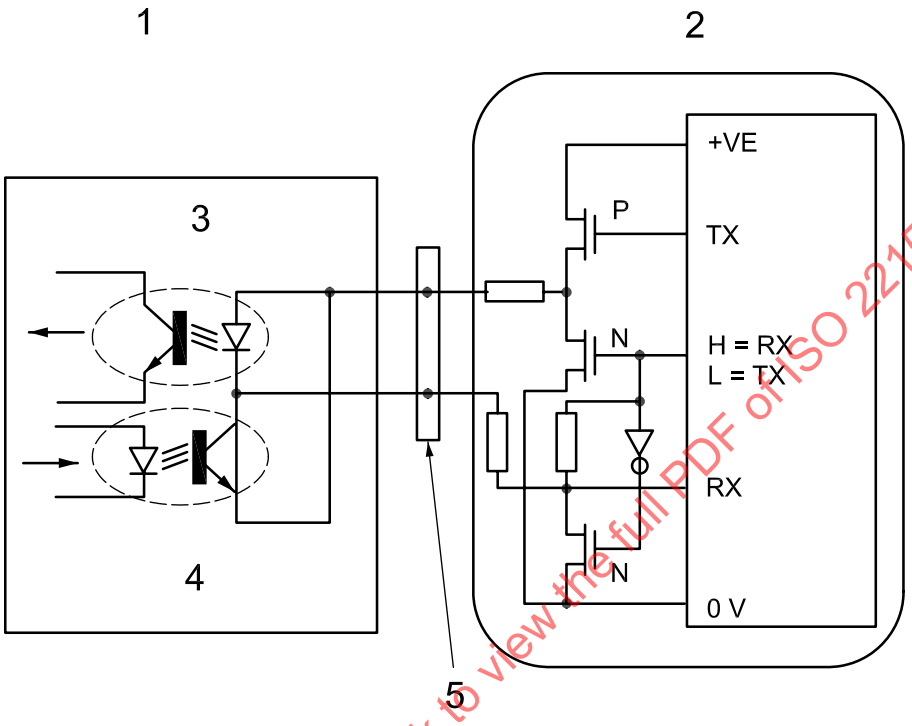
logic 0 $\leqslant$10 µA.

The register transmits data by switching optocoupler 1 as follows:

logic 1 = 2,0 mA to 10 mA, node voltage ⩽1,3 V;

logic 0 ⩽10 µA.

A typical configuration is shown in Figure 10.



Key

1	reader optocouplers (shown for clarity)
2	register
3	optocoupler 1 for receiver, RX
4	optocoupler 2 for transmitter, TX
5	point of definition of this International Standard
H	high
L	low
N	negative
P	positive
RX	receiver
TX	transmitter
+VE	positive potential difference

Figure 10 — Typical configuration for non-addressable two-wire bidirectional asynchronous mode for reading via optocouplers and probe

5.10 Compatibility statement

Table 8 shows the possible relationships of existing engineering and new engineering compliant with this International Standard.

Table 8 — Options for compatibility of old and new engineering

Register	Compatibility	Reader
Existing	Yes	Existing
Existing	Yes … if a new READER is engineered to accept new AND existing protocol fields	New
New	Yes … if a new REGISTER is engineered to emit new AND existing protocol fields	Existing
New	Yes	New

For backwards compatibility in the register:

a) the V-frame protocol could be embedded within uncommitted data areas of a pre-existing protocol;

b) the V-frame protocol and a pre-existing protocol could be arranged sequentially or interspersed;

c) pre-existing protocols could be embedded within the J-field of this V-frame protocol.

6 Addressable water meters — type C

NOTE The primary function of this output type is to provide a data stream that identifies and reports the registered units of water passed through the meter when commonly coupled to a reading bus.

6.1 General

Compatibility is defined by output modes designated 1, 2 or 3.

Compatible products may be compliance marked “C1”, “C2” or “C3”.

6.2 Output mode 1, based on M-bus technology

6.2.1 Physical layer and interface to the physical medium

6.2.1.1 M-bus mode

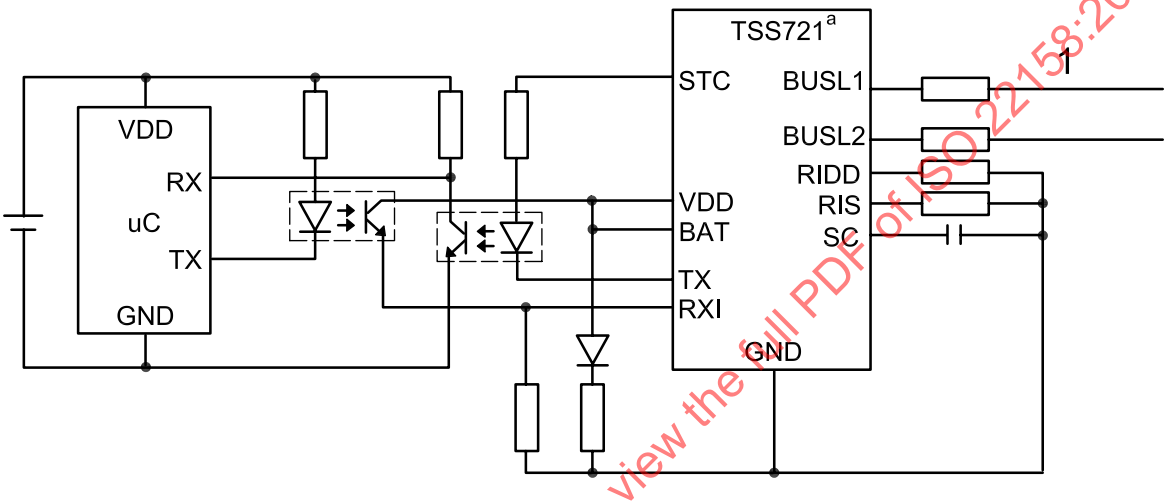
6.2.1.1.1 General

General requirements for the M-bus mode are as set out in Table 9.

A typical configuration is shown in Figure 11.

Table 9 — General requirements for M-bus mode

Requirement	Characteristics	Reference	Clause
No. of connections	2 (no shielding necessary)	M-bus, v.4.8	4.1
Plug	not defined	M-bus, v.4.8	4.2
Connection polarity	free	M-bus, v.4.8	4.4
Polarity sensitivity	no damage in the case of polarity reversal	M-bus, v.4.8	4.4
Bus line earth connection	>1 MΩ at 500 V, bus may be electrically isolated from the meter by optocoupler	—	—



Key

1 M-bus

NOTE For further explanation of the labels, see M-bus, v.4.8, Clause 4.

[a] TSS721 is the trade name of a product supplied by Texas Instruments. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

Figure 11 — Typical configuration for M-bus mode

The power supply for the meter shall be

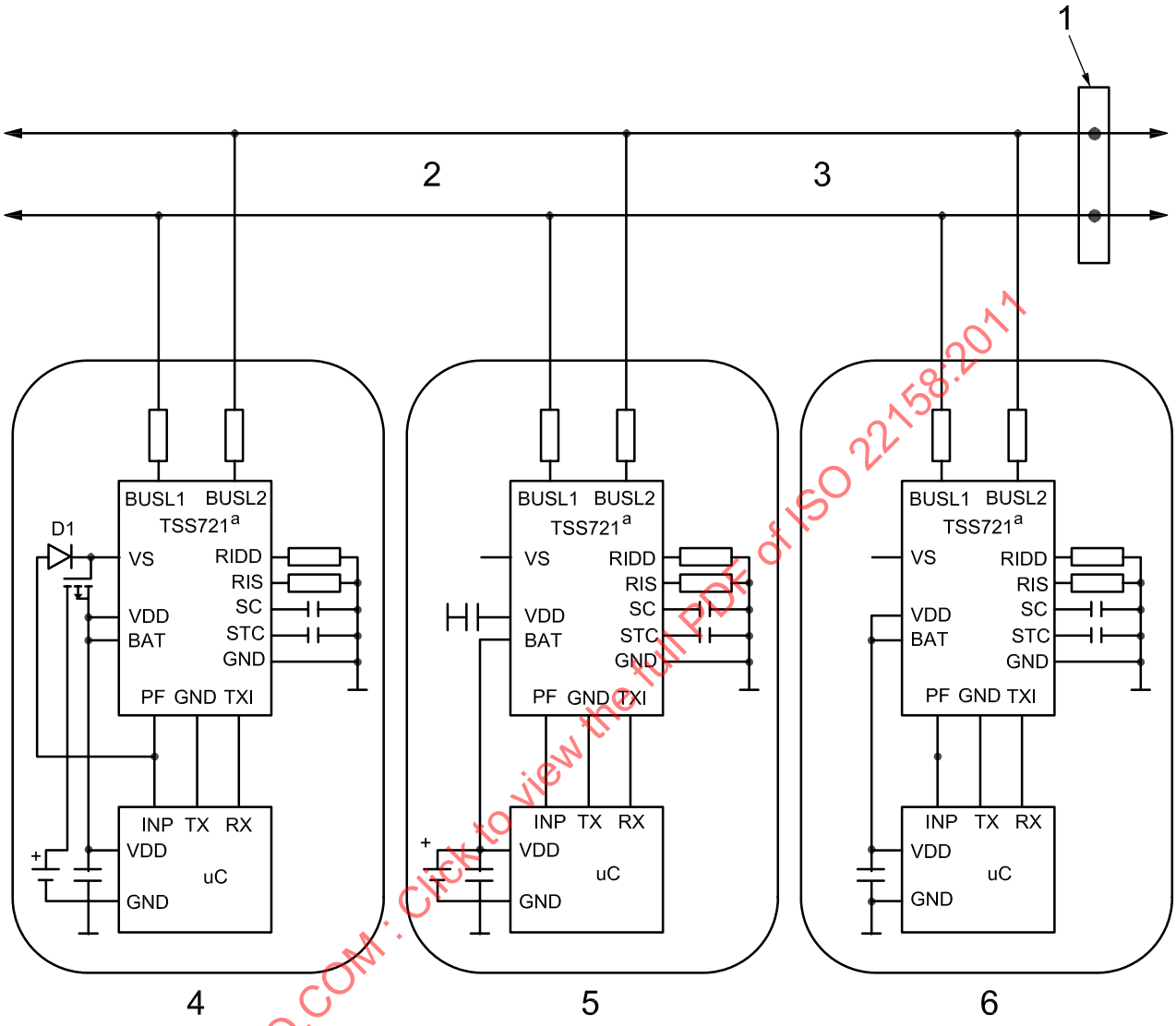
— remote from the bus; or

— remote from the bus with battery support; or

— supplied with a battery

in accordance with M-bus, v.4.8, 4.4.

The power supply shall typically be as shown in Figure 12.



Key

1 point of definition of this International Standard
2 meter
3 bus
4 remote supply/battery support
5 battery supply
6 remote supply

NOTE For further explanation of the labels, see M-bus, v.4.8, Clause 4.

[a] TSS721 is the trade name of a product supplied by Texas Instruments. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

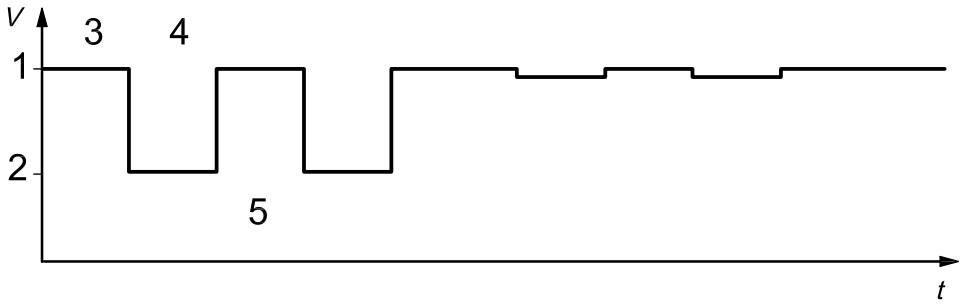
Figure 12 — Example of a typical power supply

6.2.1.1.2 Electrical specifications for M-bus mode

Electrical requirements for the M-bus mode shall be as set out in Table 10 and Figure 13.

Table 10 — Electrical requirements for M-bus mode

Requirement	Characteristics	Reference	Clause
Absolute max. voltage, V	±50 (no damage)	—	—
Mark state (= logic 1)			
Master to meter (slave), V	(U_{max} – 8,2) ... U_{max}	M-bus, v.4.8	4.4
U_{max} nominal, V	36		
U_{max} range, V	21 to 42		
Meter to master, mA	0 ... I_{mark}	M-bus, v.4.8	4.4
I_{mark}, mA	1,5		
tolerance			
$\lvert\Delta I_{mark}\rvert$, %/V	<0,2	—	—
$\lvert\Delta I_{mark}\rvert$, µA/10 s	⩽10		
$\lvert\Delta I_{mark}\rvert$, % over time and temperature	⩽10		
Space state (= logic 0)			
Master to meter, V	bus voltage <(U_{max} – 5,7)	M-bus, v.4.8	4.4
Meter to master, mA	I_{space}	M-bus, v.4.8	4.4
I_{space} range, mA	(11 + I_{mark}) ... (20 + I_{mark})		
Max. capacitance, nF	0,5		
Startup time after power loss of ⩾0,1 s	recovery within ⩽3 s	—	—

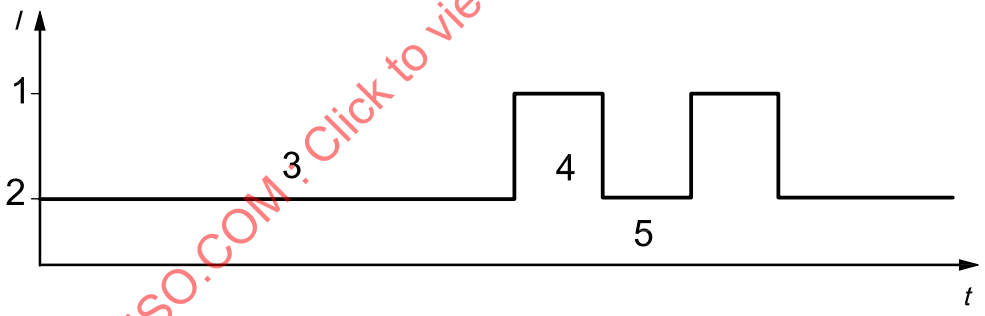


Key

1 V_{mark} = 36 V
2 V_{space} = 24 V
3 mark (“1”)
4 space (“0”)
5 master transmits to slave

t time
V voltage

a) Bus voltage at repeater



Key

1 $I_{space} = I_{mark}$ + (11 to 20) mA
2 I_{mark} < 1,5 mA
3 Mark (“1”)
4 Space (“0”)
5 Slave transmits to master

I current
t time

b) Current consumption of a slave

Figure 13 — Electrical requirements for M-bus mode

6.2.1.2 Electrical requirements for Mini-bus mode

Electrical requirements for the Mini-bus mode shall be as set out in Table 11.

Table 11 — Electrical requirements for Mini-bus mode

Requirement	Characteristics	Reference	Clause
Absolute max. voltage, V	±50 (no damage)	—	—
Mark state (= logic 1)			
Master to meter, V	(U_{max} – 8,2) ... U_{max} (not negative)	M-bus, v.4.8	4.4
U_{max} nominal, V	12		
U_{max} range, V	5 to 15		
Meter to master, mA	0 ... I_{mark}	M-bus, v.4.8	4.4
I_{mark}, mA	1,5		
tolerance			
$\lvert\Delta I_{mark}\rvert$, %/V	<0,2	—	—
$\lvert\Delta I_{mark}\rvert$, µA/10 s	⩽10		
$\lvert\Delta I_{mark}\rvert$, % over time and temperature	⩽10		
Space state (= logic 0)			
Master to meter, V	bus voltage <(U_{max} – 4,0)	M-bus, v.4.8	4.4
Meter to master, mA	I_{space}	M-bus, v.4.8	4.4
I_{space} range, mA	(3 + I_{mark}) ... (6 + I_{mark})		
max. capacitance, nF	0,5		
Startup time after power loss of ⩾ 0,1 s	recovery within ⩽3 s	—	—

6.2.2 Data link layer

Recommendations for the data link layer of output mode 1 are set out in Tables 12 to 18. The data in these tables are examples only.

Table 12 — First set of recommendations for the data link layer of output mode 1

Recommendation	Characteristics	Reference	Clause
Protocol basis		IEC 60870-5-1	
Type of transmission	asynchronous serial bit transmission, half-duplex	M-bus, v.4.8	5.1
Access technique	time division multiplexing	M-bus, v.4.8	2.2.1
Transmission speed	(300 ± 2,25) bit/s mandatory (2 400 ± 18) bit/s, (9 600 ± 72) bit/s optional (rates of 600 bit/s, 1 200 bit/s, 4 800 bit/s are not recommended, and may not be supported)	M-bus, v.4.8	6.4.1
Byte format (= IEC 60870-5-1)	1 start bit space 8 data bits LSB first 1 parity bit even parity 1 stop bit mark	IEC 60870-5-1 M-bus, v.4.8	5.1
— pauses within the telegram	none allowed (between start and stop bit)	IEC 60870-5-1	
— pauses after reception of valid telegram	> (330 bit periods + 50 ms)	M-bus, v.4.8	5.1
Telegrams			
— format class	FT1.2	IEC 60870-5-1	
— data integrity class	I2	IEC 60870-5-2	
— Hamming distance	4	IEC 60870-5-1	
— CheckSum	arithmetical sum without carry digits	IEC 60870-5-1	
— Frame formats (ref./2/chapter 5.2)	single character (1 byte) short frame (5 bytes) control frame (9 bytes) long frame (max. 261 bytes)	IEC 60870-5-1	

Table 13 — Second set of recommendations for the data link layer of output mode 1

Single character	Short frame	Control frame	Long frame
E5h	Start 10h	Start 68h	Start 68h
	C Field	L Field = 03h	L Field
	A Field	L Field = 03h	L Field
	CheckSum	Start 68h	Start 68h
	Stop 16h	C Field	C Field
		A Field	A Field
		CI Field	CI Field
		CheckSum	User Data
		Stop 16h	(0-252 Byte)
			CheckSum
			Stop 16h

Table 14 — Third set of recommendations for the data link layer of output mode 1

Recommendation	Characteristics	Reference	Clause
Link services	— Send_Data/Confirm procedure: SND/CON — Request_Data/Respond procedure: REQ/RSP	IEC 60870-5-2 M-bus, v.4.8	 5.4
Addressing	— primary addressing Address: 0 unconfigured meters (at manufacturing) 1 ... 250 distinct meter address 251 ... 255 reserved for special purposes — secondary addressing (preferred for meters in M-bus)	IEC 60870-5-1 M-bus, v.4.8 M-bus, v.4.8	 5.2 7.3
Signal quality	— P1 for sending — PA for receiving	ISO/IEC 7480:1991[1]	
Minimal meter communication			
	— SND_NKE/E5h (Initialize communication unit, i.e. meter/confirm)	M-bus, v.4.8	5.4

Table 15 — Fourth set of recommendations for the data link layer of output mode 1

Hex	Field	Meaning	Meter's answer	Reference	Clause
10h	start	start character short frame		M-bus, v.4.8	5.2
40h	C	initialize communication	E5h	M-bus, v.4.8	5.3
00h	A	address (e.g. 00h)		M-bus, v.4.8	5.3
50h	CS	CheckSum		M-bus, v.4.8	5.3
16h	stop	end character		M-bus, v.4.8	5.2

Table 16 — Fifth set of recommendations for the data link layer of output mode 1

Recommendation	Reference	Clause
REQ_UD2/RSP_UD (Request User Data2/Respond User Data)	M-bus, v.4.8	5.4

Table 17 — Sixth set of recommendations for the data link layer of output mode 1

Hex	Field	Meaning	Meter's answer	Clause
10h	start	start character short frame		/1/5.2
7Bh	C	REQ_UD2 (7Bh /5Bh alternating)	RSP_UD (see below)	/1/5.3
FEh	A	address for secondary addressing		/1/5.3
79h	CS	CheckSum		/1/5.3
16h	stop	end character		/1/5.2

Table 18 — Seventh set of recommendations for the data link layer of output mode 1

	Hex	bytes	Field	Meaning	Reference	Clause
	68h	1	start	start character long frame	M-bus, v.4.8	5.2
	1Bh	1	L	Length	M-bus, v.4.8	5.2
	1Bh	1	L	Length	M-bus, v.4.8	5.2
	68h	1	start	start character	M-bus, v.4.8	5.2
	08h	1	C	C field for RSP_UD	M-bus, v.4.8	5.3
	00h	1	A	primary address (e.g. 00h)	M-bus, v.4.8	5.3
	72h	1	CI	CI field for variable data structure	M-bus, v.4.8	6.1
	78h	4	identification	meter identification number	M-bus, v.4.8	6.3.1
	56h			(e.g. 12345678)		
	34h		8-digit BCD	(can be set by manufacturer or utility)		
	12h					
	18h	2	man. code	manufacturer code	M-bus, v.4.8	6.3.1
	4Eh		2 bytes	(see below)		
	01h	1	generation	type/software version	M-bus, v.4.8	6.3.1
	07h	1	medium	medium to be measured (water: 07h, hot water: 06h)	M-bus, v.4.8	8.4.1
	00h	1	access	access counter	M-bus, v.4.8	6.3.1
	00h	1	status	error status information	M-bus, v.4.8	6.6
	00h	2	signature	Reserved for future	M-bus, v.4.8	6.3.1
	00h			signature and data encryption		
	0Ch	1	DIF	data following in 8-digit BCD format	M-bus, v.4.8	6.3.2
	78h	1	VIF	data following is: meter number	M-bus, v.4.8	8.4.3
	78h	4			M-bus, v.4.8	8.4.2
	56h		data	meter number		
	34h		8-digit BCD	(e.g. 12345678)		
	12h					
	0Bh	1	DIF	3	M-bus, v.4.8	6.3.2
	15h/16h/17h	1	VIF		M-bus, v.4.8	8.4.3
	23h	4			M-bus, v.4.8	8.4.2
	01h		data	meter index		
	00h		6-digit BCD	(e.g. 000123)		
	xxh	1	CS	CheckSum	M-bus, v.4.8	5.3
	16h	1	Stop	stop character	M-bus, v.4.8	5.2

	these bytes are constant
	(variable) data blocks
	fixed data header; all following data with LSB first
	total number of these bytes: length field L (e.g. 27 dec = 1 Bh)
	these fields (8 bytes) are used as secondary address

6.2.3 Network layer

Requirements for the network layer of output mode 1 shall be as set out in Table 19.

Table 19 — Requirements for the network layer of output mode 1

Requirement	Characteristics	Reference	Clause
Secondary addressing procedure		M-bus, v.4.8	7.1
Selection of the meter	long frame master to meter with — C-field 53h — A-field 253dec = FDh — CI-field 52h/56h — 4 bytes meter identification — 2 bytes manufacturer identification — 1 byte meter generation identification — 1 byte medium identification — response meter to master: $E5		
Request of meter data	— REQ_UD2 with A-field 253dec to meter — RSP_UD from addressed meter		
Addressing range	based on meter-, manufacturer-, generation- and medium-identification	M-bus, v.4.8	6.7.3

6.2.4 Application layer

Requirements for the application layer of output mode 1 shall be as set out in Table 20.

Table 20 — Requirements for the application layer of output mode 1

Requirement	Characteristics	Reference	Clause
Structure of data records	— variable data structure	M-bus, v.4.8	6.3
	— fixed data structure (restricted to 2 indices + physical units only, no longer recommended)	M-bus, v.4.8	6.2
Data records on (e.g. in RSP_UD)	— meter identification number — manufacturer identification — meter generation/version — medium to be measured (e.g. water/ hot water) — meter status information — signature (for data encryption of meter data) — meter index + physical units		
Additional meter data coding	— additional meter data optional		
— types of values	— instantaneous value — minimum value — maximum value — value during error state		
— coding of data records	— 8, 16, 24, 32, 48, 64 bit signed binary integer — 2 bit pos. or neg. floating point number — 2, 4, 6, 8, 10 digit unsigned BCD — variable length ASCII-string — compound type (e.g. for date, time)	M-bus, v.4.8 M-bus, v.4.8	8.2 var. 8.3 fixed
Coding of errors in the application layer	Reported by — 2 bit, coded in status field — 1 byte within respond procedure — 1 byte characterizing data record errors	M-bus, v.4.8	6.6

6.2.5 Availability of documentation

M-bus is an open definition within the public domain and is therefore not proprietary information.

Supplementary information is available on the M-bus User Group website http://www.m-bus.com, which shows official documentation and gives:

— recommendations;

— examples;

— explanations on how to apply and use;

— documentation updates;

— user support (e.g. FAQs).

6.2.6 Additional information

6.2.6.1 Reliability of the interface to the physical medium

Tests on meter hardware with M-bus interfaces [with TSS721[3)]] have been performed as described in Table 21.

Table 21 — Tests on M-bus interface meter hardware

Test	Standards	Remarks
Climatic environments	IEC 60068-2-30[2]	
EMC Surges/lightning	IEC 60801[3]	necessary for declaration of CE conformity test report MBPROT1.doc (available at M-bus website)
Electrical safety		necessary for declaration of CE conformity

6.2.6.2 Testing M-bus protocol compatibility

To ensure the largest degree of interoperability and functional compatibility of meter products of different meter manufacturers on a common M-bus system at the customer site, testing facilities for compliance tests on specifications of the interface to the physical medium and protocol and procedure requirements of the physical, link and application layers have been set up.

6.3 Output mode 2, based on Dialog technology

6.3.1 Physical layer and interface to the physical medium

6.3.1.1 General

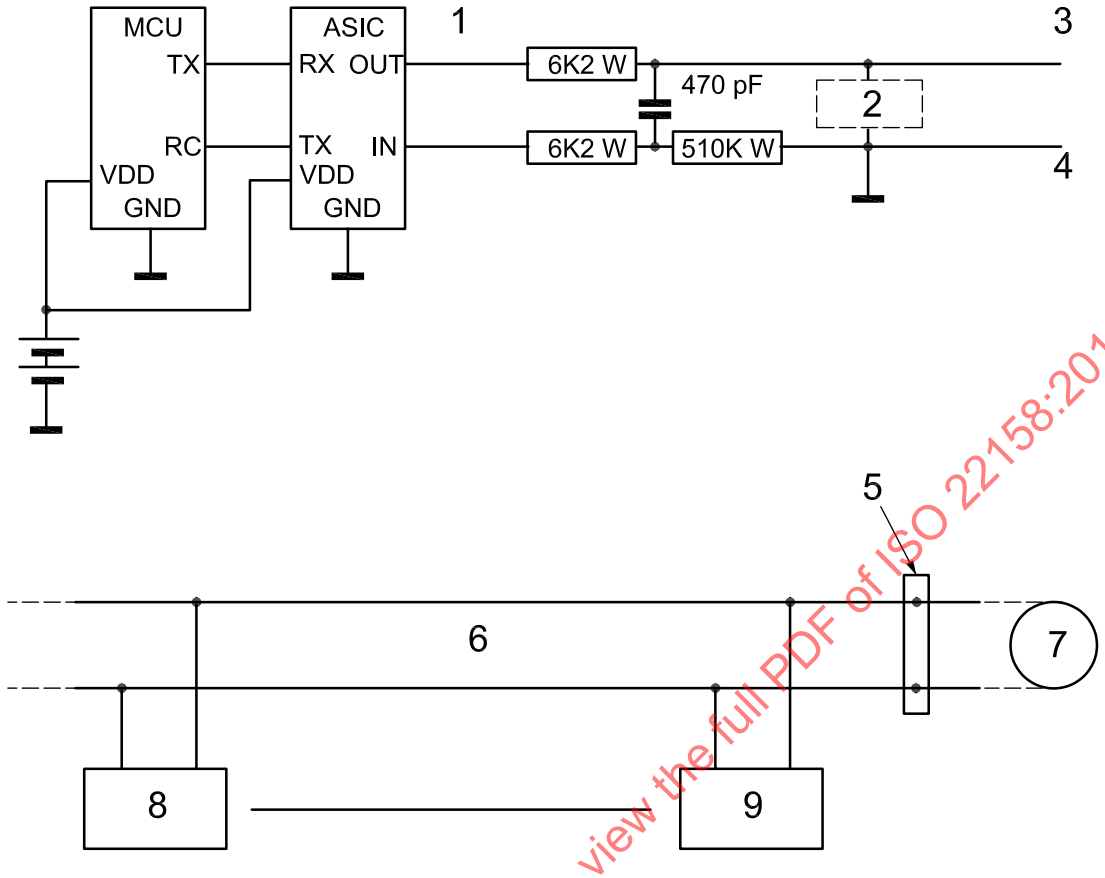
General requirements for output mode 2 shall be as set out in Table 22.

Table 22 — General requirements for output mode 2

Requirement	Characteristics
N° of connections	2 (no shielding necessary)
Plug	Not defined
Connection polarity	Free
Polarity sensitivity	No damage in the case of polarity reversal
Bus line earth connection	> 1 MΩ at 500 V; bus may be electrically isolated from meter by optocoupler
Power supply for the slave unit	Battery supplied

3) TSS721 is the trade name of a product supplied by Texas Instruments. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

A typical configuration is shown in Figure 14.



Key

1	tristate
2	optional lightning protection
3	green
4	red
5	point of definition of this International Standard
6	bus
7	optional read coil
8	slave No. 1
9	slave No. 127
ASIC	application specific integrated circuit
MCU	multipoint control unit

Figure 14 — Typical configuration for output mode 2

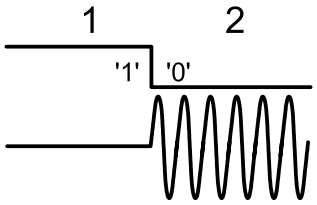
NOTE It is essential that each slave is programmed with a net address before being connected to the net.

6.3.1.2 Electrical specifications

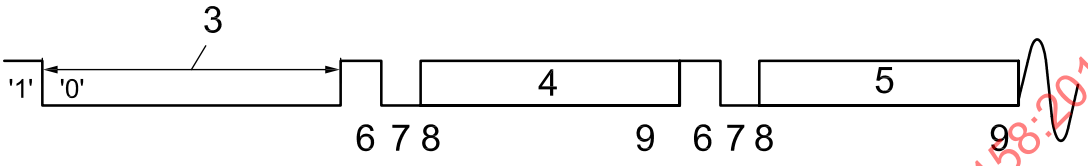
Electrical requirements for output mode 2 shall be as set out in Table 23 and Figure 15.

Table 23 — Electrical requirements for output mode 2

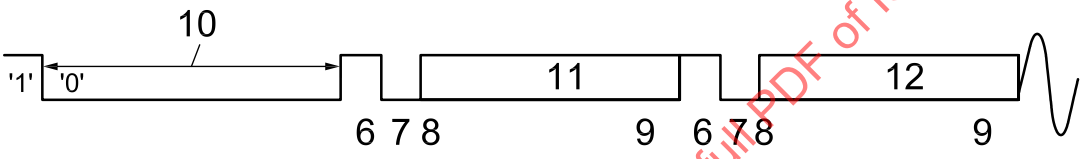
Requirement	Characteristics
Absolute maximum voltage	
DC	–0,5 V to +4 V
AC (60 kHz to 200 kHz)	–25 V to +25 V
Mark state (= logic 1)	No signal
Space state (= logic 0)	Frequency
master to meter	65 kHz to 85 kHz, 2,5 V to 20 V p/p (at slave input)
meter to master	125 kHz, 30 mV to 3,5 V p/p (at master input)
Maximum meter input capacitance	200 pF
Maximum line capacitance	30 nF (including slave capacitance)
Lightning protection	Optional



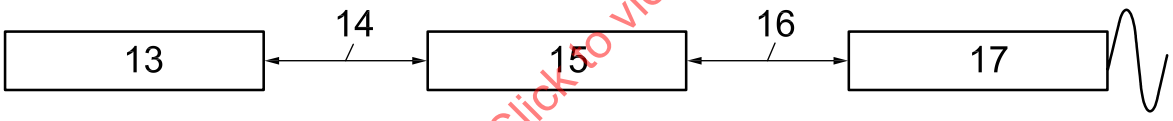
a) Mark and space view



b) Master transmission to slave



c) Slave transmission to master



d) Time frame response

Key

1	mark	7	start bit	13	transmit frame
2	space	8	LS bit 0	14	t < 100 ms
3	break 30 ms	9	MS bit 7	15	receive frame
4	byte 1	10	byte 1 (00hex)	16	t > 50 ms
5	byte 1	11	byte 2	17	transmit frame
6	stop bit	12	byte 3		

Figure 15 — Electrical requirements for output mode 2

6.3.2 Data link layer

6.3.2.1 General

General requirements for the data link layer of output mode 2 shall be as set out in Table 24.

Table 24 — General requirements for the data link layer of output mode 2

Protocol basis	Dialog technology
Type of transmission	Asynchronous serial bit transmission, half-duplex
Access technique	Random by net address from 1 to 7 Fh (1 to 127), address “0”: access for all units
Transmission speed	(1 200 ± 9) bit/s, (600 ± 4,5) bit/s, (300 ± 2,25) bit/s
Byte format	1 start bit 8 data bits LSB first No parity 1 stop bit
Pause within the telegram	None allowed
Link services	R_COM: Read command procedure to unit W_COM: Write command procedure to unit S_ANS: Short answer procedure from unit R_A_COM: Read All DATA command F_ANS: Full answer procedure from unit
Frame formats	R_COM (header + 6 bytes + 1 byte CheckSum) W_COM (header + 6 bytes + 1 byte CheckSum) S_ANS (7 bytes + 1 byte CheckSum) F_ANS (12 bytes + 1 byte CheckSum)
CheckSum	Generated by Exclusive-OR of all valid bytes from a seed of 00h
Signal quality	9xh – Read command Axh – Write command 40h – Write net address
Pause after reception of valid telegram	> 50 ms

6.3.2.2 R_COM: Read command procedure to unit
W_COM: Write command procedure to unit

The Read and Write command procedures to unit shall be as given in Table 25.

Table 25 — Read and Write command procedures to unit

Byte	Hex/binary	Field	Meaning/Read_Answer or Write DATA bytes
Break		HEADER	Low pulse 30 ms long for waking up unit from power down (for all bit rates)
1	20h	Bit rate	Identify the bit rate of the communication
2	B0XXXXXXX	Net address	Network address from 1 to 7Fh (1 to 127)
3	90h	Read command	Read from unit ID, 3 least significant bytes — 6 digits BCD or alpha-numeric binary format[a]
	91h	Read command	Read from unit ID, 3 most significant bytes — 6 digits BCD or alpha-numeric binary format[a]
	92h	Read command	Read from unit QUANTITY, 3 bytes — 6 digits BCD format
	93h	Read command	Read from unit FACTOR (DATA byte 1) FACTOR number in hexadecimal (DATA byte 2)
	94h	Read command	Read from unit STATUS/tamper (DATA byte 2)
	95h	Read command	Read from unit ASIC Frequency, 1 byte Binary format (DATA byte 1, only for factory test)
	96h	Read command	Read from unit METER Type, 1 byte (DATA byte 1)
	97h	Read command	Read from unit VERSION, 1 byte BCD format (DATA byte 1)
	A0h	Write command	Write to unit New ID, 3 least significant bytes – 6 digits BCD format (DATA bytes 1 to 3)[a]
	A1vh	Write command	Write to unit New ID, 3 most significant bytes – 6 digits BCD format (DATA bytes 1 to 3)[a]
	A2h	Write command	Write to unit New QUANTITY, 3 bytes – 6 digits BCD format (DATA bytes 1 to 3)
	A3vh	Write command	Write to unit FACTOR prescaler code, 1 byte (DATA byte 1)
	A4h	Write command	Clear (reset) STATUS/tamper (DATA bytes not carry)
	A6h	Write command	Write to unit new METER Type, 1 byte BCD format (DATA byte 1)
	40vh	Write command	Write to units new net address, 1 byte Binary format (DATA byte 1)[b]
4-6	XXh	DATA	Write: DATA to unit, 3 bytes, from least to most significant Read: DATA bytes not carry
7	XXh	CHECKSUM	Generated by exclusive-OR of all valid bytes from a seed of 00h

[a] See 6.3.2.9 Alpha-numeric slave format.

[b] See 6.3.2.6 W_COM.

6.3.2.3 S_ANS: Short answer procedure from unit

The short answer procedure from the unit shall be as set out in Table 26.

Table 26 — Short answer procedure from unit

Byte	Hex/binary	Field	Meaning
1	00h	HEADER	
2	20h	Bit rate	Echo byte from Master
3	B0XXXXXXX	Net Address	Echo byte from Master
4	XXh	Command	Echo byte from Master
5-7	XXh	DATA	Read command: DATA from unit Write command: Repeat DATA from Master 3 bytes, from least to most significant, BCD format
8	XXh	CHECKSUM	Generated by Exclusive-OR of all valid bytes from a seed of 00h

Example: Quantity = “123456”

byte 5 = 56 BCD

byte 6 = 34 BCD

byte 7 = 12 BCD

6.3.2.4 Factor (prescaler code)

Factors shall be in accordance with Table 27.

Table 27 — Output mode 2 data link layer factors

Factor (division ratio)	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
100	×	×	×	×	×	0	0	0
200	×	×	×	×	×	0	0	1
20	×	×	×	×	×	0	1	0
40	×	×	×	×	×	0	1	1
50	×	×	×	×	×	1	0	0
10	×	×	×	×	×	1	0	1
1	×	×	×	×	×	1	1	0
2	×	×	×	×	×	1	1	1

6.3.2.5 Meter type

Meter types shall be in accordance with Table 28.

Table 28 — Output mode 2 data link layer meter types

Meter type	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Water	×	×	×	×	×	×	0	0
Electric	×	×	×	×	×	×	0	1
Gas	×	×	×	×	×	×	1	0
Other	×	×	×	×	×	×	1	1

6.3.2.6 W_COM: Write command procedure to unit

The Write command procedure to the unit shall be as set out in Table 29.

(Write net address to the unit before connecting it to the net.)

Table 29 — Output mode 2 data link layer Write command procedure

Byte	Hex/binary	Field	Meaning
Break		HEADER	Low pulse 30 ms long for waking up unit from power down (for all bit rates)
1	20h	Bit rate	Identify the bit rate of the communication
2	B0XXXXXXX	Net Address	Network address from 1 to 7 Fh (1 to 127)
3	40h	Write Command	Write to new network address of the unit
4	B0XXXXXXX	New Net Address	New network address from 1 to 7 Fh (1 to 127)
5	00h	DATA	Shall always be 00h
6	00h	DATA	Shall always be 00h
7	XXh	CHECKSUM	Generated by Exclusive-OR of all valid bytes from a seed of 00h

6.3.2.7 R_A_COM: Read all DATA command (9Eh)

The Read all DATA command shall be as set out in Table 30.

Table 30 — Output mode 2 data link layer Read all DATA command procedure

Byte	Hex/binary	Field	Meaning
Break		HEADER	Low pulse 30 ms long for waking up unit from power down (for all bit rates)
1	20h	Bit rate	Echo byte from Master
2	B0XXXXXXX	Net Address	Network address from 1 to 7 Fh (1 to 127)
3	9Eh	Read Command	Read from unit ALL data, 12 bytes BCD/Binary format
4	00h	DATA	Memory begin address
5	0Ch	DATA	Number of bytes is 12
6	00h	DATA	
7	XXh	CHECKSUM	Generated by Exclusive-OR of all valid bytes from a seed of 00h

6.3.2.8 F_ANS: Full answer procedure from unit

The full answer procedure from the unit shall be as set out in Table 31.

Table 31 — Output mode 2 data link layer full answer procedure

Byte	Hex/binary	Field	Meaning
1–3	XXh	QUANTITY	3 bytes — 6 digits, from least to most significant BCD format
4–6	XXh	Identification Code (ID)	ID low, 3 bytes — 6 digits, from least to most significant BCD format
7–9	XXh	Identification Code (ID)	ID high, 3 bytes — 6 digits, from least to most significant BCD format
10	BXXXXXXXS	STATUS	If S = 0, OK; if S = 1, tamper, 1 byte
11	BXXXXXFFF	FACTOR	Prescaler code, 1 byte
12	BXXXXXXMM	METER Type	1 byte
13	XXh	CHECKSUM	Generated by Exclusive-OR of all valid bytes from a seed of 00h

6.3.2.9 Alphanumeric slave format

6.3.2.9.1 General

By using the existing BCD code in the 6 byte of the ID number (ID low + ID high), and following a coding table, it is possible to obtain a code for alphanumeric characters.

6.3.2.9.2 Converting from alphanumeric to serial number

6.3.2.9.2.1 The first six characters (the least significant) are coded according to the representative serial number in the code table.

If there are less than six characters, the remaining spaces are zeros.

6.3.2.9.2.2 The seventh character is coded according to the binary value of the representative serial number in the code table. The less significant bit in the less significant character is encoded according to the following rule:

— in order to represent (ZERO), leave the value of the serial number as it is;

— in order to represent (ONE), add 50.

6.3.2.9.3 Converting from serial number (in BCD) to alphanumeric

6.3.2.9.3.1 The first six characters are decoded as follows:

— if the value is less than or equal to 49, the numerical value is the representative serial number in the code table;

— if the value is greater than 49, subtract 50. The obtained numerical value is the representative serial number in the code table.

6.3.2.9.3.2 The seventh digit is decoded according to the following rule:

— if the LSD character is greater than 49, the corresponding bit value is 1 (ONE);

— if the character is greater than 49, the corresponding bit value is 0 (ZERO), and so forth, until the sixth character.

The LSD character corresponds with the LSB bit.

Table 32 — Code table

Serial number	Character	Serial number	Character
0	SPACE	25	V
1	.	26	W
2	,	27	X
3	;	28	Y
4	A	29	Z
5	B	30	(
6	C	31	:
7	D	32	#
8	E	33	=
9	F	34	0
10	G	35	1
11	H	36	2
12	I	37	3
13	J	38	4
14	K	39	5
15	L	40	6
16	M	41	7
17	N	42	8
18	O	43	9
19	P	44	—
20	Q	45	/
21	R	46	*
22	S	47	)
23	T	48	+
24	U	49	^

EXAMPLE

1) **05 35 36 50 00 00** will correspond in alphanumeric to **AB12**.

2) Slave will correspond to: **12 04 15 68 60 50**.

Starting from the right:

1 ←	50 →	(50 – 50)	= 0 →	' '	(IDL	byte 5)
1 ←	60 →	(60 – 50)	= 10 →	G	(IDL	byte 6)
1 ←	68 →	(68 – 50)	= 18 →	O	(IDL	byte 7)
0 ←	15 ⟶			L	(IDH	byte 5)
0 ←	04 ⟶			A	(IDH	byte 6)
0 ←	12 ⟶			I	(IDH	byte 7)
→	00000111 (Binary)	= 7	→ D			

6.3.3 Documentation

Dialog is an open definition within the public domain and is therefore not proprietary information.

Supplementary information is available on the website http://www.arad.co.il, which shows official documentation and gives:

— recommendations;

— examples;

— explanations on how to apply and use;

— documentation updates;

— user support (e.g. FAQs).

6.4 Output mode 3, based on NABS technology

6.4.1 Physical layer and interface to the physical medium

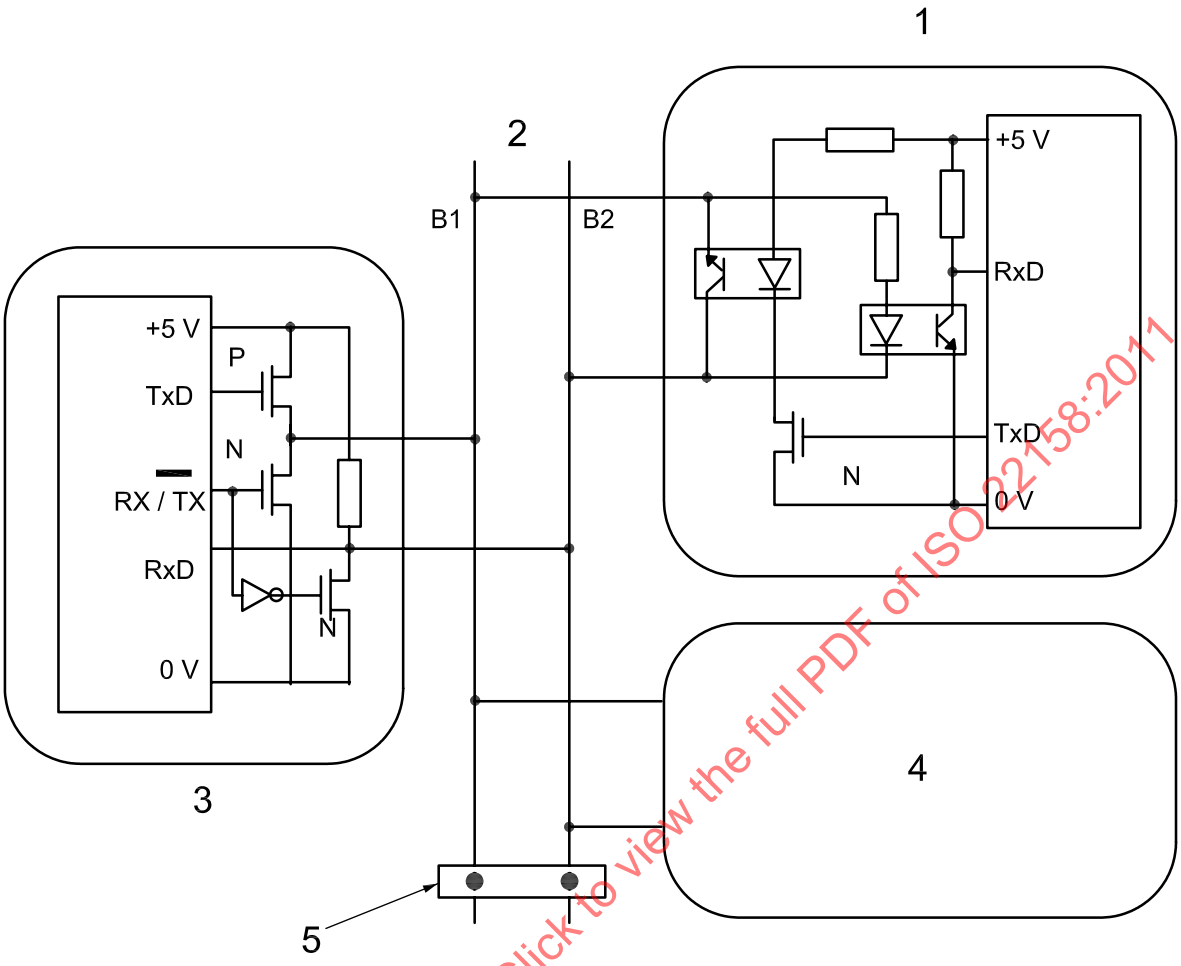
6.4.1.1 General

General requirements for output mode 3 shall be as set out in Table 33.

Table 33 — General requirements for output mode "3"

Requirement	Characteristics	Reference	Clause
No. of connections	2 (no shielding necessary)	NABS, v.1.0	1.1, 4
Plug	not defined		
Connection polarity	polarity reverses on transmission and reception	NABS, v.1.0	1.1
Polarity sensitivity	no damage in the case of polarity reversal		
Bus line earth connection	> 1 MΩ at 500 V, bus may be electrically isolated from meter by optocoupler		
Power supply for the meter	battery supplied		

A typical configuration is shown in Figure 16.



Key

1 slave
2 bus
3 master
4 slave
5 point of definition of this International Standard

Figure 16 — Typical configuration for output mode 3

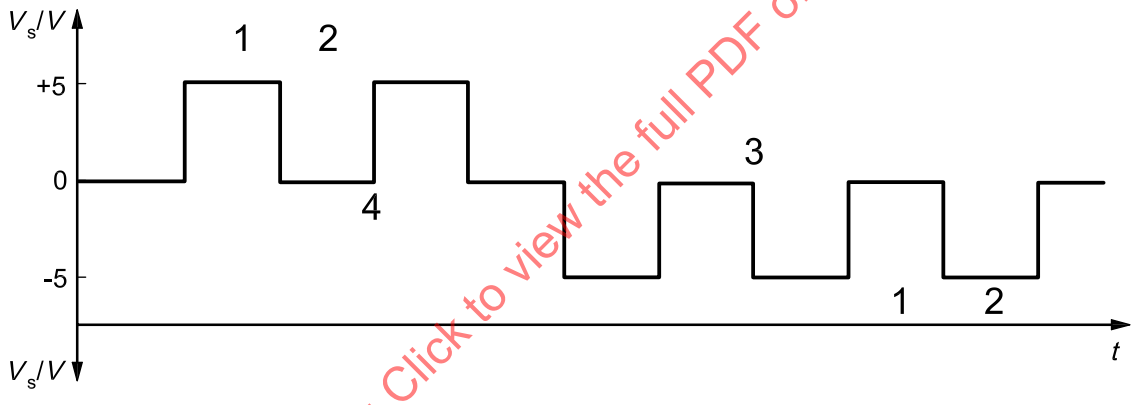
6.4.1.2 Electrical specifications

Electrical requirements for output mode 3 shall be as set out in Table 34 and Figure 17.

Table 34 — Electrical requirements for output mode 3

Direction	$V_S = \lvert B_1 - B_2 \rvert$[a] , V	Reference	Clause
Mark state (= logic 1)			
Master to meter, V	$4{,}5 \leqslant V_S \leqslant 5{,}5$	NABS, v.1.0	5.1.1
Meter to master, V	$V_S \leqslant 1{,}0$	NABS, v.1.0	5.1.2
Space state (= logic 0)			
Master to meter, V	$V_S \leqslant 0{,}5$	NABS, v.1.0	5.1.1
Meter to master, V	$V_S \geqslant 4{,}0$	NABS, v.1.0	5.1.2

[a] Where B_1 is the voltage at B1 and B_2 is the voltage at B2 (see Figure 16).

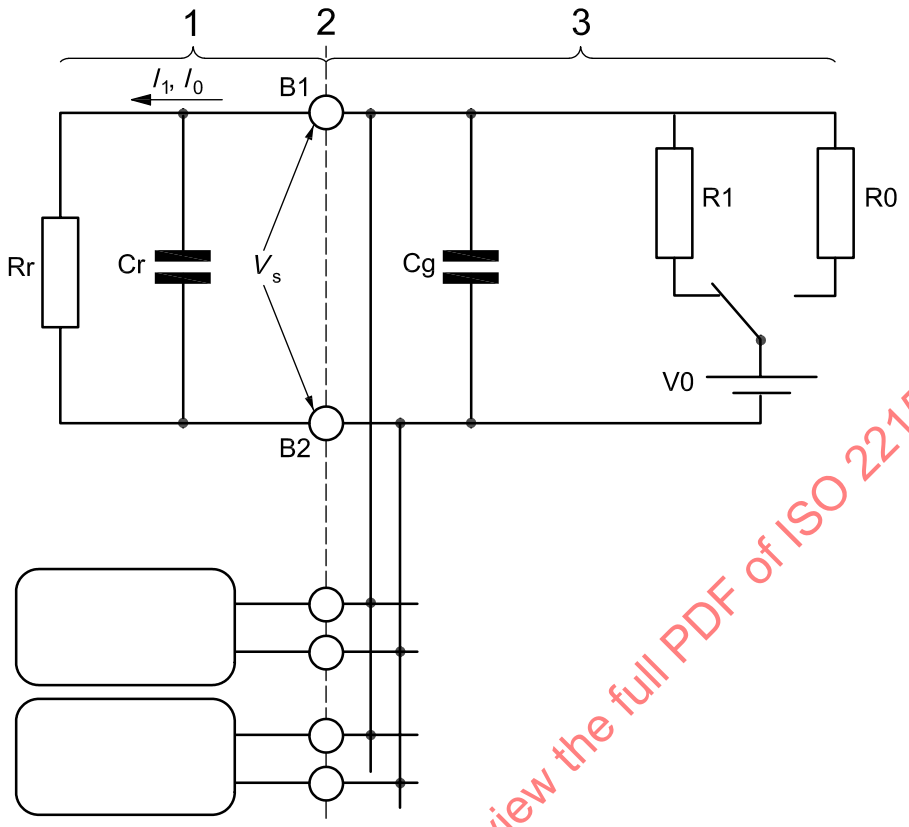


Key

1 mark
2 space
3 meter to master
4 master to meter
t time
V_S $\lvert B_1 - B_2 \rvert$, where B_1 is the voltage at B1 and B_2 is the voltage at B2 (see Figure 16)

Figure 17 — Electrical requirements for output mode 3

6.4.1.3 Equivalent interface circuit between master and meter — when meter receives (communication is made through optocouplers in the meter). See Figure 18.



Key

1 receiver (meter)
2 interchange point
3 transmitter (master)

B1 point
B2 point
Cg transmitter capacitance
Cr receiver capacitance $C < 0{,}01$ µF
I_1 current at “mark” (= logic 1) < 1 mA at $V_s = 5$ V
I_0 current at “space” (= logic 0)
R0 internal resistance of signal source at “space” (= logic 0)
R1 internal resistance of signal source at “mark” (= logic 1)
Rr internal resistance of receiver
V0 transmitting voltage
V_s | $B_1 - B_2$ |, where B_1 is the voltage at B1 and B_2 is the voltage at B2

Figure 18 — Output mode 3 equivalent interface circuit (receiving meter)