The OpenTherm™ Communications Protocol

A Point-to-Point Communications System
for HVAC Controls

Protocol Specification

The OpenTherm Association is an independent European organisation, constituted under Dutch law, whose object is to promote the introduction and adoption of the OpenTherm technical standard for HVAC system control communication, laid down in this Protocol Specification. The OpenTherm Association controls the application by, and the granting of licences for use of, the OpenTherm trademark and logo.

Change Control History

Version	Date	Description of Changes
1.0		**First official release**
1.1	**1 Feb 1998**	**2.3 OT/+ & OT/- configuration section expanded.** **4.2 Bit-order specified in frame format.** **5.1 Definition of data format expanded and clarified.** **5.3 Message directions changed to indicate read/write instead.** **5.3.1 Special status exchange message mechanism defined.** **6.1 Clarified duty cycle period definition for OT/- signalling.**
1.2A	DRAFT 13 Mar 98	This change control history added. Page numbering corrected. References to Oem/Customer ID Codes changed to Member ID Code 3.2,High-voltage idle-line state is allowed subject to certain restrictions. 3.2.1.1,3.2.2.1 Current, voltage signal level conditions stated. 3.2.1.2,3.2.2.2 Inductance and capacitance test conditions defined. 3.3 New section added on device impedance characteristics. 3.5 New section added on short-circuit feature. 5.1 Definition of data format further clarified. 5.2 Correction to message type references.
1.2B	DRAFT 15 June 98	2.3 State diagram added for OT/+ & OT/- detection. 3.2 Corrected reference to section 3.6 Idle line-high removed - not acceptable to all members. 3.2.1.1 Allowed spec to be different for OT/- and OT/+ 3.2.1.2 Changed “across” to “in series with” (twice) 3.2.2.1 corrected reference to section 3.6 3.3 Changed “capacitance across” to “serial inductance at” 3.6 State machine for short-circuit feature Idle line-high removed - not acceptable to all members. 4.4.1 removed references to 0x00 to allow more general case. 4.4.2 removed references to 0x00 to allow for slave changing data-value. 4.4.3 removed references to 0x00 to allow more general case. 4.5 Added that master & slave should notify communication error. 5.2 changed references to invalid-data-id to Unknown_DataID
1.2C	DRAFT 19 June 98	2.3 Automatic OT plus-lite configuration made mandatory for masters. 3.2 Clarified allowable line signal states. 3.6 Short-circuit detection defined between 5 .. 15 secs. 4.3.1 Inter-message communications period defined as 1.15 sec max. 4.5 Error notification text removed as irrelevant and not always practical. 5.1 Added u16 and s16 data formats for completeness. 5.3 Unused bits/bytes defined as “reserved” (don’t care values) instead of 00.
1.2D	DRAFT 25 June 98	5.1 Reserved/unused bits/bytes should be set to zero, but not checked by receiver.
1.2	**RELEASE 25 June 1998**	**Approved by members of the OpenTherm Association.**
1.3A	DRAFT 5 May 1999	3.4.2.4 Galvanic isolation specified according to EN60730-1 5.2 CH-enable and DHW-enable are now declared mandatory for the master. 5.1 & 5.4 “Member” or “OEM” data id area (128..255) redefined as “Test & Diagnostics” area.
1.3B	DRAFT 17 August 1999	3.2.1.2 Signal dynamic characteristics further clarified in line with test requirements 3.2.2.2 Signal dynamic characteristics further clarified in line with test requirements 3.3 Device Impedance Characteristics removed 4.3.1 Message latency time increased to 100ms New Data ID’s added according to NDI 110399-1 : Product Version Number NDI 110399-2 : Capacity Control for Sequencer Applications NDI 110599-3 : Day & Time NDI 110399-4 : Date & Year NDI 110599-5 : Cooling Control NDI 200599-1 ; Solar System Applications NDI 140599-1 : CH Water Filling 5.3.1 Status bits added for cooling control 5.3.2 Configuration bits added for cooling control 5.3.2 Product version number and type added to Configuration Data class 5.3.3 CH Water Fill command added to Remote Command class

		5.3.4 Day, Time, Date, Year , Solar storage & collector temp. added to Information Data class 5.3.8 New class added for new applications 5.3.8.1 Cooling control signal added 5.3.8.2 Boiler sequence control signal added
1.3C	DRAFT 24 October 1999	5.3.1 Correction made to error in definition of “Remote Reset enable” bit.
1.3	**RELEASE 31 Oct. 1999**	**Approved by members of the OpenTherm Association.**
1.4A	DRAFT 30 May 2000	Document renamed “Protocol Specification” in place of “Technical Specification” 4.3.1 Correction made in text concerning wait time of messages (diagram was correct) 5.3.1 Added status bit (bit3 id0-master status) for OTC systems NDI-071299 5.3.2 Added configuration bit (bit3 id3-slave configuration) for DHW storage systems NDI-1303000 5.3.2 Added configuration bit (bit4 id3-slave configuration) for off-low/pump control systems NDI-210400 5.2 !!! New list of mandatory items specified. 5.3.4 Added new data ids for DHW2 and exhaust temperatures NDI-220500-1 5.3.4 Added new data id for Flow temp 2 NDI-220500-2 5.3.1 Added new data id for Tset2 NDI-220500-2 5.3.1 Added new master status bit (bit 4, id0) and slave status bit (bit5, id0) for second loop NDI-220500-2 5.3.3 Added new slave configuration bit (bit5, id3) for second loop NDI-220500-2
2.0A	DRAFT 22 June 2000	1.3 Added comment to help explain important change in version2.0 for mandatory Ids. 4.2 remove MSB-LSB note in the centre of the data-value definition. 5.1 correct description of message classes (six to seven). 5.2 insert table to define all mandatory data-ids and their use. 5.3.2 redefine “low-off&pump control” flag as “Master low-off&pump control function” with states “allowed” and “not-allowed”. 5.3.2 redefine “DHWconfig” flag default state as “not specified” instead of “instantaneous” 5.3.2 remove statement referring to configuration data as non-mandatory 5.3.8.2 redefine “Capacity-level setting” as “Maximum relative modulation level setting” 5.4 Add new data ids 31,32,33 and engineering units to overview table and updated some terminology.
2.0B	DRAFT 21 September 2000	5.3.1 Description id 8 corrected 5.4 Overview table completed with id8, message and data type.
2.0	**RELEASE 15 Dec. 2000**	**Approved by members of the OpenTherm Association.**
2.1A	DRAFT 12 February 2002	1.3 Note mandatory id’s and backward compatibility updated. 2.3 Mandatory OT/- for OpenTherm logo marked masters deleted. 3.2.1.2. Slope of current signal edge deleted. 3.2.2.2. Slope of voltage signal edge deleted. 5.3.2. OpenTherm version master and slave added (ID 124, 125). 5.3.2. Explanation ID3 bit 4 corrected. 5.3.4. Operation hours boilers, CH pump and DHW pump/valve added (ID120, 121, 122). 5.3.5. OTC not, flags and ID’s removed 5.3.7.3. Remote override room Setpoint added 5.4. Operation hours boilers, CH pump and DHW pump/valve added (ID120, 121, 122).. 5.4. OpenTherm version master and slave added (ID 124, 125). 6 Remark that OT/- is mandatory for masters deleted.
2.1B	DRAFT 27 March 2002	5.3.4. Room Setpoint CH2 (ID23) added. 5.4. Room Setpoint CH2 (ID23) added.
2.1	**RELEASE 9 April 2002**	**Approved by members of the OpenTherm Association.**
2.2A	11 October	3.2.1.1. Max. open-circuit voltage slave added. 3.2.2.3. Receive threshold voltage range extended. 5.3.1. Diagnostic flag (ID0:LB6) and code (ID115) added. 5.3.4. ID’s related to operation hours and number of starts added. 5.3.7.3. Remote override function (ID100) added 5.4. Data-Id overview map updated.
2.2	**RELEASE 7 February 2003**	**Approved by members of the OpenTherm Association.**
2.3A	DRAFT 22 March 2004	5.3.1 Added ID0:HB5 “Summer/winter mode”. Description ID0:LB6 “diagnostic indication” changed to “diagnostic/service indication”. 5.3.2 Added ID3:HB6 “Remote water filling function. 5.3.3 Description ID4 command and response changed.

2.3B	DRAFT 5 May 2004	5.3.2 Description ID3:HB6 “Remote water filling function changed. 5.3.3 Description ID4 command changed to request. 5.3 Ventilation and heat-recovery ID’s added 5.4 Description ID4 command changed to request
2.3C	DRAFT 23 July 2004	5.3.1. DHW block ID0:HB6 added 5.3.1. ID 70 bit numbering corrected 5.3.1. ID 72 bit numbering corrected 5.3.1. ID 74 bit numbering corrected 5.4 Overview corrected
2.3D	DRAFT 17 August 2005	5.3.1. Clarified description ID70HB bi1 1and 2 (bypass mode and position) 5.3.1. Type specification ID71 improved 5.3.1. Updated new ID70LB bit 3 and 4 Automatic bypass and free ventilation status 5.3.1. New ID’s 101 and 102 added 5.3.2. New ID’s 103 and 104 added 5.3.3. ID4 extended with new request code 3..9 5.3.4. Changed description ID116 5.3.4. Type specification ID77 and ID78 improved 5.3.4. New ID’s 34, 35, 113 and 114 added 5.3.5. Type specification ID87 improved 5.3.6. New ID’s 105 and 106 added 5.3.7. New ID’s 107 and 108 added 5.4. Changed description ID116 5.4. Type specification ID71, ID77, ID78, ID87 improved 5.4. New ID’s 34, 35, 101-108, 113, 114 added 5.4. ID 50 and 58 removed (OTC heat curve items)
2.3E	DRAFT 11 November 2005	ID103 page 27. Type should be flag8 instead of u8. ID4 page 28. Msg LB should be the same as for HB. ID4 page 28. request code 10 added ID35 page 29. Name should Actual boiler fan speed. ID116 page 30. Extend description with successful. ID87 page 31. Indicate in Name that value is in HB. ID87 page 36. Change type to u8 /- (meaning HB) ID116 page 37. Extend description with successful.
2.3F	DRAFT 28 May 2006	ID4 page 29: Extension with request code: - 0: Normal operation mode - 11: Service test 1 (OEM specific) - 12: Automatic hydronic air purge ID4 page 29: Remark “Chimney sweep function” added to request code 3.
2.3	**RELEASE 1 October 2006**	**Approved by members of the OpenTherm Association.**
3.0A	DRAFT 26 May 2008	§3.2, §3.4, §5.2 and §5.3.2 Smart Power Mode added §4.3.1 and §4.3.2. Multi Point to Point,Gateway added Page 35: ID27 Outdoor Temperature Type changed from R to RW Page 35: ID36 Flame current added Page 35: ID37 Room temperature 2nd CH circuit added Page 35: ID98 RF sensor status information added Page 40: ID99 Remote Override of Operating Modes for Heating and DHW Page 42: Data-ID Overview Map updated
3.0	**RELEASE 16 June 2008**	**Approved by members of the OpenTherm Association.**
4.0A	DRAFT 22 December 2010	§3.4.2.1 Clarifiication and correction of available power in different power modes §5.3.1. New ID’s 0LB7 added §5.3.2 New ID 3HB7 added §5.3.4 New ID’s 38,109,110,111, 112 added §5.4 Functions and Data-ID mapping added
4.0B	DRAFT 12 April 2011	History 4.0A completed §5.3 Requirement short-circuit feature limited to devices who support central heating §5.2 revised and extended with functions and data-ID mapping
4.0	**RELEASE 12 May 2011**	**Approved by members of the OpenTherm Association.**
4.1A	DRAFT 13 February 2018	§5.3.7.3 New ID39 Remote Override Room Setpoint 2 §5.3.3 New ID96 Cooling Operation Hours New ID97 Power Cycles §5.3.2 New ID93 Brand Index New ID94 Brand Version New ID95 Brand Serial Number §5.2.1 New mandatory IDs (ID93, ID94, ID95, ID125, ID127)

4.1	**RELEASE 08 Oct 2018**	**Approved by members of the OpenTherm Association.**
4.1B	22 Oct 2020	§5.4 Updated Data-Id overview §5.2.1 Updated ID2 Slave description (more explicit): smart power support is mandatory §1.3 Added related documents §1.2, §6 OpenTherm Lite – OT/- demoted to legacy status. §3.4.1 Clarification on Smart Power support Updated Logo §3.2.1, §3.3.2 Updated signal level and bit timing notation style
4.2	**RELEASE 10-11-2020**	**Approved by members of the OpenTherm Association.**

Table of Contents

1. Introduction

1.1 Background

The trend in boiler technologies towards high-efficiency appliances with gas/air modulation and increased sophistication in control electronics has created a requirement for system communication between boilers and room controllers. At the higher end, home-systems buses provide extensive communications capability and several such systems are available, although no single standard has emerged. Generally, they all require hardware/software solutions whose cost is significant at the lower-end of the market, especially for point-to-point systems. Several proprietary solutions at this low-end have been developed, but offer no cross-compatibility with products from different manufacturers.

There is an increasing demand for a new standard to be established to connect room controllers and boilers in a simple point-to-point fashion with very low entry-level costs. OpenTherm was developed to meet this requirement. Since then it has been extended with support for various HVAC applications and is not limited to boiler applications, the protocol is being extended further as required by new technologies and applications.

1.2 Key OpenTherm Characteristics

- Compatibility with so-called “dumb” or non-intelligent HVAC systems.
- Compatibility with low-cost entry-level room thermostats.
- Compatible with electrical supplies typically normally available within HVAC systems.
- Two-wire, polarity-free connection for concurrent power supply and data transmission.
- Provides a suitable power supply for a room controller so that it can operate without the need for an additional power source such as batteries.
- Implemental in low-cost microcontrollers with small ROM / RAM / CPU-speed requirements.
- Installer friendly feature for boiler testing. Shorting the wires at the boiler provides a simulated maximum heat demand (similar to current on/off systems).
- Allows for the transfer of sensor, fault and configuration data between the devices.
- Provides a mandatory minimum set of data objects, which allows for transmission of a modulating control signal from the room controller to the HVAC system.

One of the key characteristics of the OpenTherm standard is the two-level approach which allows analogue-type solutions at the low-end.

OT/+ The OpenTherm/plus protocol provides a digital communications system for data-exchange between two microprocessor-based devices.

OT/- The OpenTherm/Lite* protocol uses a PWM signal and simple signalling capabilities to allow implementation on analogue-only products.
IMPORTANT: As of OpenTherm version 4.1 OpenTherm/Lite – OT/- is no longer being tested nor certified and has been demoted to legacy functionality, it should not be incorporated in new designs. The information should only to be used as reference for existing (legacy) products

Both protocols use the same physical layer for data transmission and power-feeding ensuring that the two levels of communications are physically compatible.

1.3 Document Overview

This document specifies a communication system for use with boilers, heat pumps, ventilation systems and room controls, which can also be applied to similar devices in the same or related applications. The characteristics and communications features of both the infrastructure and the attached devices are specified in detail. This document does not provide a prescriptive solution for OpenTherm-compatible controllers, but rather specifies the requirements for such a solution.

This document is divided into the following sections :

1. Introduction	provides an overview of the background and key features of the OpenTherm communications system and defines some terms used in the document.
2. System Overview	gives a top-level architectural view of the target application system and explains OpenTherm in relation to the OSI reference model and outlines the process for ensuring product compliance.
3. Physical Layer	describes the characteristics of the physical medium and the method for bit-level signalling.
4. OT/+ DataLink Layer	describes the composition of OpenTherm/plus frames and allowable conversation formats.
5. OT/+ Application Layer	defines data objects and the mechanisms for transfer of application data between the boiler and room controllers.
6. OT/- Encoding/Application data	describes the special mechanisms for transferring data in the OpenTherm/Lite system.

1.3.1 Related documents

Please use this document in conjunction with the following related documents:

Function Matrix (Excel sheet)
- This document contains information on the mandatory ID's based on device functions

Application Functional Specification (pdf)
- This documentation contains information on how to implement specific features

Data-Id Overview Map (pdf)
- The OpenTherm ID map, containing all available OpenTherm IDs

Test Specification (pdf)
- The test specification for manually testing OpenTherm implementations

These documents are located in the on the OTA website at the: Members area

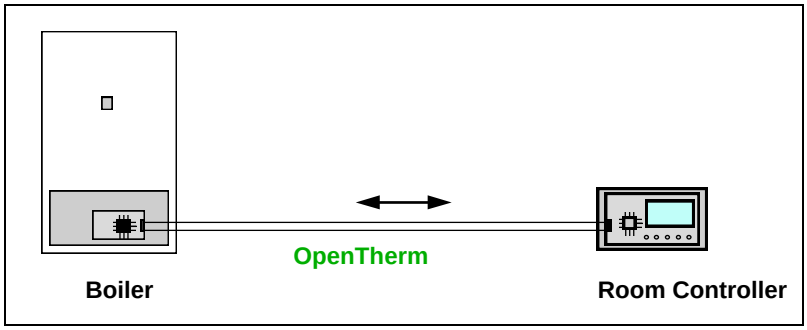
1.4 Nomenclature & Abbreviations

OT/+	OpenTherm/plus
OT/-	OpenTherm/Lite
OSI/RM	The OSI 7-layer protocol reference model.
PWM	Pulse-width modulation
Room Unit	The device which calculates the “demand” in the system, which is communicated to the Boiler Unit. The use of the term *room* is not intended to be literally restrictive but is used for convenience.
Boiler Unit	The device which receives the “demand” from the room unit and typically is responsible for providing energy to satisfy that demand. The use of the term *boiler* is not intended to be literally restrictive but is used for convenience.
AL	Application Layer
DLL	Data-Link Layer
PL	Physical Layer
TSP	Transparent Slave Parameter
RBP	Remote Boiler Parameter
CH	Central Heating
DHW	Domestic Hot Water
OEM	Original Equipment Manufacturer
OTC	Outside Temperature Compensation
FHB	Fault History Buffer

2. System Overview

2.1 System Architecture and Application Overview

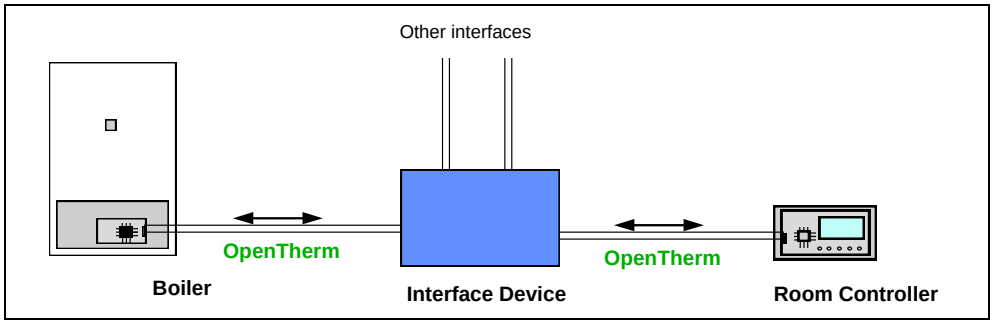
OpenTherm is a point-to-point communication system and connects boilers with room controllers, therefore it is not possible to connect several boilers or room controllers in the manner of bus-based systems. OpenTherm assumes that the room controller is calculating a heating demand signal in the form of a water temperature Control Set point based on room temperature error (or other control form, e.g. OTC) which it needs to transmit to the boiler so that it can control the output of the boiler. The boiler in turn can transmit fault and system information to the room controller for display or diagnostics. A large number of data items are defined in the OT/+ Application Layer Protocol, covering these and many other pieces of system data.



2.2 Provision for Future Architectures/Expansion

The OpenTherm communication system is designed to allow for future expansion at the application layer by provision of reserved data-ids and at the data-link layer by the use of reserved (spare) bits within the frame.

In order to address applications which would normally require a bus-based communications system, it is conceived that intermediate gateways / interface devices would manage multiple OpenTherm communications lines. In the example below, the interface device acts as a “virtual boiler” to the room controller and acts as a “virtual room unit” to the boiler. In this way, other devices can be addressed while maintaining the basic point-to-point approach. See also § 4.3.2

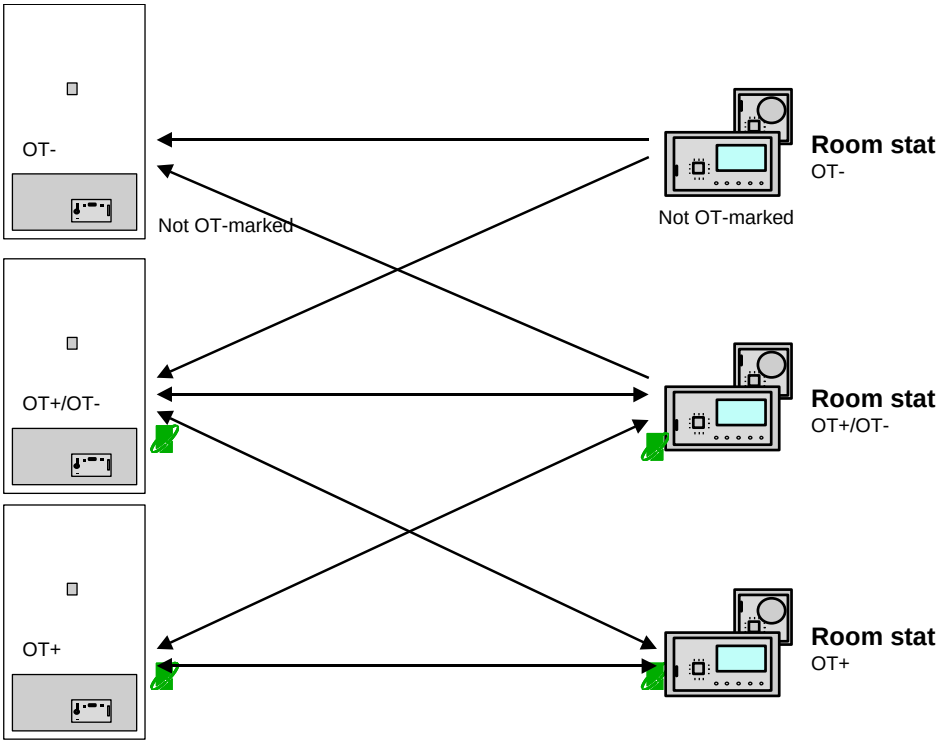


All future revisions of the OpenTherm Protocol Specification must be approved by the Members of The OpenTherm Association.

2.3 Product Compliance and Marking

All products marked with the OpenTherm logo must comply with the requirements of this document. The OpenTherm logo, trademark and the protocol can only be used with the permission of The OpenTherm Association. The OpenTherm Association is responsible for compliance testing procedures and licensing.

- A ***boiler or room controller*** can be marked with the OpenTherm logo if it conforms to the specification contained herein for OT/+.
- A ***boiler or room controller*** can not be marked with the OpenTherm logo if it only conforms to the specification contained herein for OT/-.

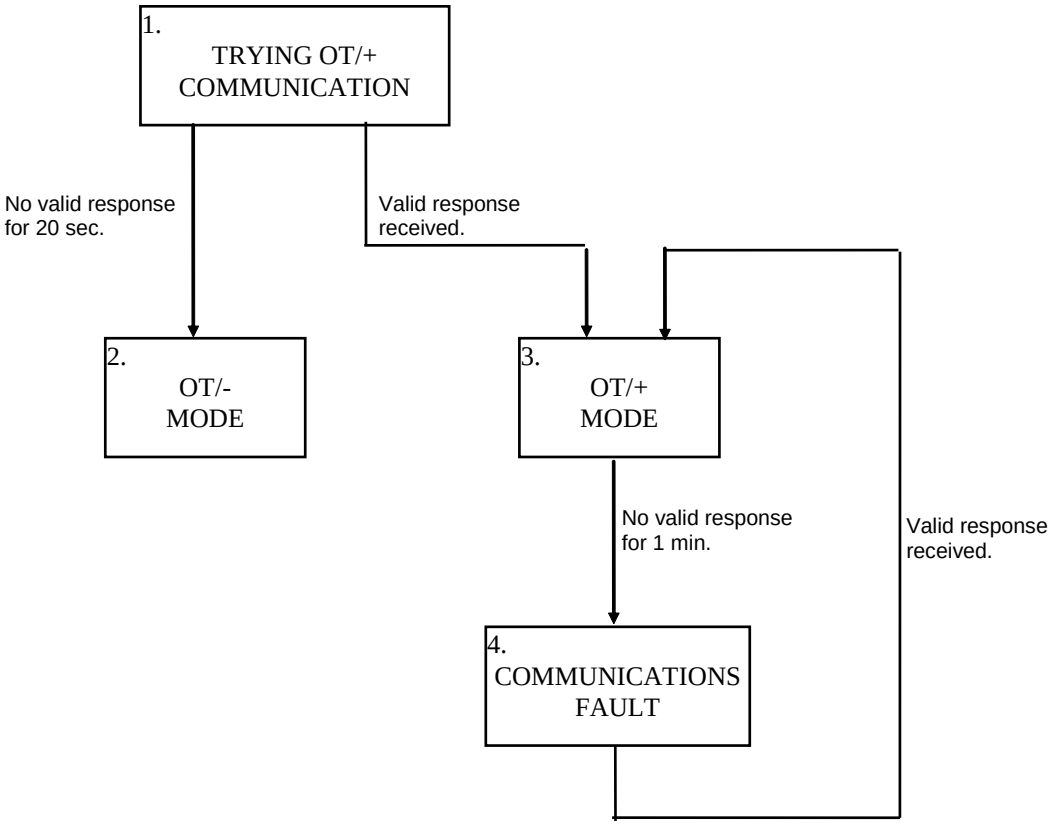


When a room unit which can operate both in OT/+ and OT/- modes is connected to a boiler controller, some configuration needs to take place to determine which protocol to use. This configuration should be achieved automatically as follows :

On power-up or after the physical connection is made, the room unit tries to communicate using OT/+ messages. If the boiler controller does not respond to one of these messages after 20 seconds, then the room unit switches to using OT/- signalling.

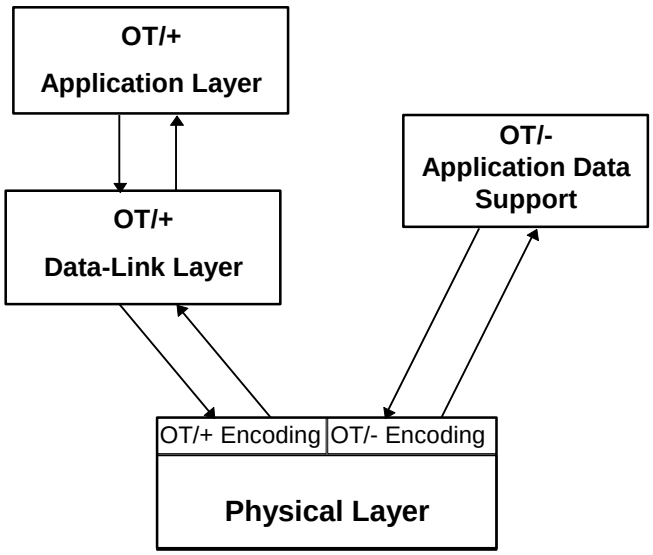
An OT/+ boiler controller must start communications within this 20 second period or future OT/+ communications will not be possible unless the room unit is reset or re-connected.

The state diagram below illustrates the OT/+ to OT/- detection in the master.



2.4 Protocol Reference Model

In order to describe the OpenTherm system, it is split up into a layered architecture based on the OSI Reference Model. The OSI/RM is an abstract description of inter-process data communication. It provides a standard architecture model that constitutes the framework for the development of standard protocols. The OSI/RM defines the functions of each of 7 defined layers and the services each layer provides to the layers above and below it. OpenTherm is only described in terms of the functions of the layers. Inter-layer communication is considered an implementation issue. The diagram below shows the OpenTherm Reference Model.



The **Application Layer** is responsible for transfer of application data between the application software in the boiler and room controllers. It defines data-classes, data-id numbers and format of data-values for transmission. It also specifies the minimum AL support for all OpenTherm-compatible devices.

The **Data-Link Layer** is responsible for building the complete frame incorporating the AL data-id and value and calculating the error-check code. It defines message types and conversation formats and performs error-checking on a received frame. It regulates the flow of information on the line.

The **Physical Layer** defines the electrical and mechanical characteristics of the medium and the mechanism for transmission of a bit, including bit-level encoding. It also performs bit-level error checking on an incoming frame(OT/+)

3. Physical Layer

3.1 Medium Definition- Characteristics of the Transmission Line

Number of Wires	:	2
Wiring type	:	untwisted pair *
Maximum line length	:	50 metres
Maximum cable resistance	:	2 * 5 Ohms
Polarity of connections	:	Polarity-free, i.e. interchangeable.

* In electrically noisy environments it may be necessary to use twisted pair or screened cable.

3.2 Signal Transmission Definition

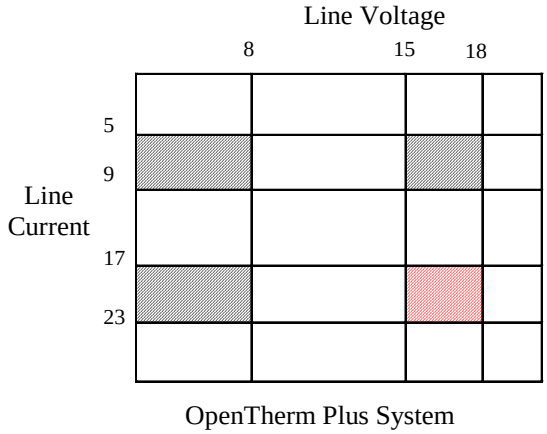
The system operates by sending current signals from the boiler unit to the room unit and voltage signals in the reverse direction. The signals are sent by switching between two defined levels, the idle and active state. The idle and active levels are dependant of the Power Mode the system is working in.

Three Power Modes are defined:

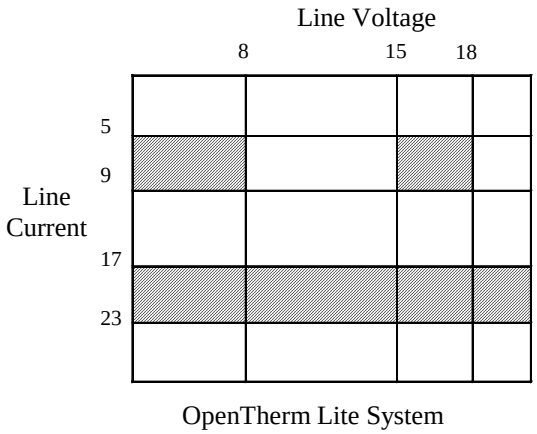
1. Low Power: Idle current is low and idle voltage is low
2. Medium Power: Idle current is high and idle voltage is low
3. High Power: Idle current and idle voltage is both high.

Note that all specifications should be fulfilled within the complete temperature range in which the device is in use.

Summary of allowable line signal conditions:



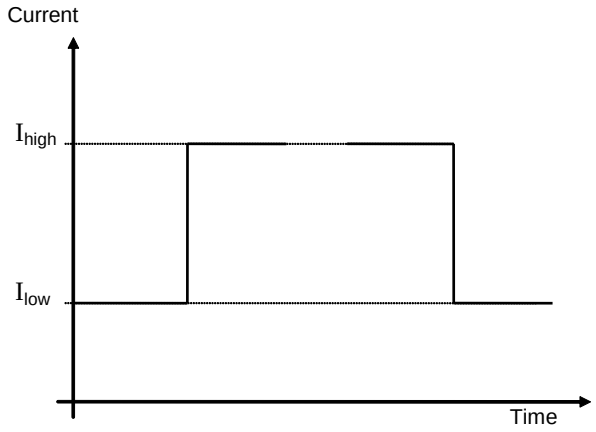
OpenTherm Plus System



OpenTherm Lite System

3.2.1 Transmitted Signal - Boiler Unit to Room Unit

3.2.1.1 Static Characteristics - Amplitude

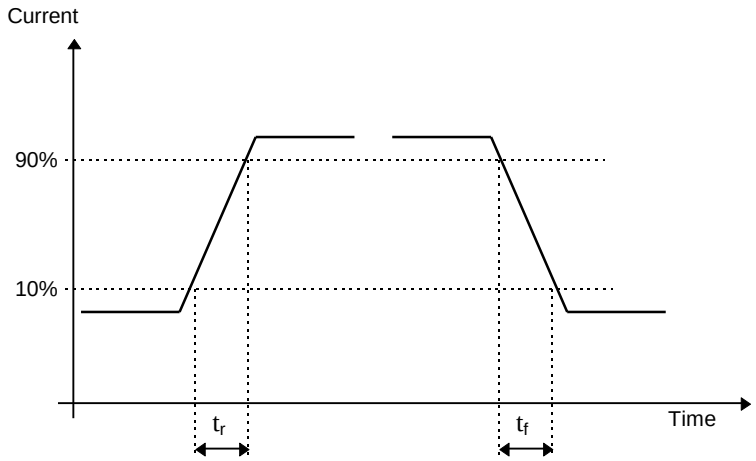


Description	Symbol	Min	Typ	Max	value
Current signal High level	I_{high}	17	-	23	mA
Current signal Low level	I_{low}	5	-	9	mA
Maximum Open circuit voltage	-	-	-	42	Vdc

In low power mode the idle state equals the current signal low level. In medium and in high power mode the idle state equals the current signal high level

Current signal specifications to be maintained when voltage is V_{low} or V_{high}

3.2.1.2 Dynamic Characteristics



Requirement for Room Unit / Master

Description	Symbol	Min	Typ	Max	value
Current signal rise time	t_r	-	20	50	µS
Current signal fall time	t_f	-	20	50	µS

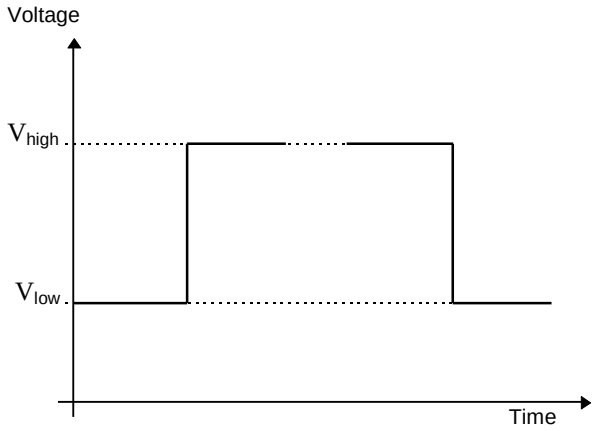
3.2.1.3 Receiver Thresholds

In order to set satisfactory signal-to-noise ratios, the receiver (room unit) should recognise a level change as significant at a threshold point within the following limits :

Description	Symbol	Min	Typ	Max	value
Current receive threshold	I_{rcv}	11.5	13	14.5	mA

3.2.2 Transmitted Signal - Room Unit to Boiler Unit

3.2.2.1 Static Characteristics - Amplitude

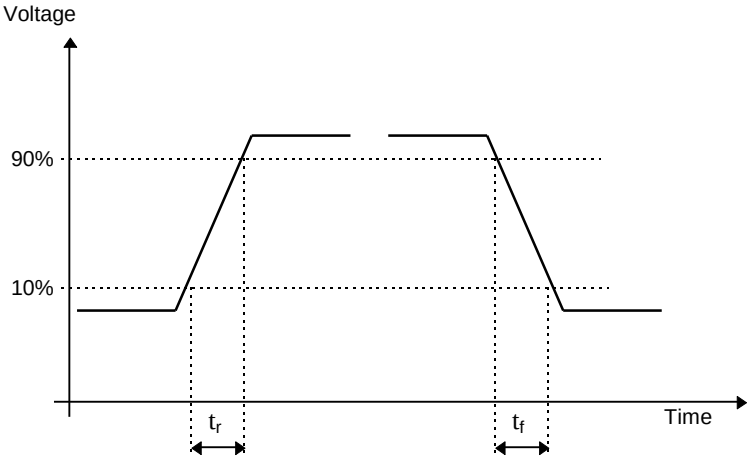


Description	Symbol	Min	Typ	Max	value
Voltage signal High level	V_{high}	15	-	18	V
Voltage signal Low level	V_{low}	-	-	8	V

In low power mode the idle state equals the Voltage signal Low Level. In medium and in high power mode the idle state equals the Voltage signal High Level

Voltage signal specifications to be maintained when current is $I_{low.}$or I_{high}

3.2.2.2 Dynamic Characteristics



Requirement for Boiler Unit / Slave

Description	Symbol	Min	Typ	Max	value
Voltage signal rise time	t_r	-	20	50	µS
Voltage signal fall time	t_f	-	20	50	µS

3.2.2.3 Receiver Thresholds

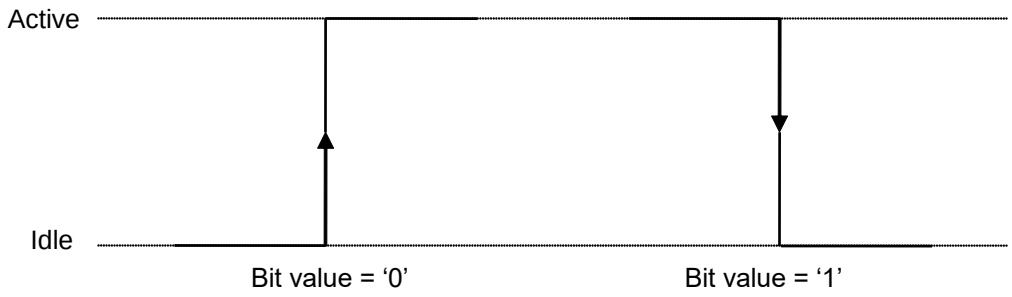
In order to set satisfactory signal-to-noise ratios, the receiver (boiler unit) should recognise a level change as significant at a threshold point within the following limits :

Description	Symbol	Min	Typ	Max	value
Voltage receive threshold	V_{rcv}	9.5	11	12.5	V

3.3 OpenTherm/plus Bit-Level Signalling

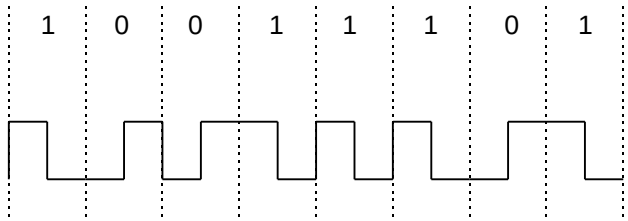
3.3.1 Bit Encoding Method

Bit encoding method	:	Manchester / Bi-phase-L
Bit value ‘1’	:	active-to-idle transition
Bit value ‘0’	:	idle-to-active transition



Manchester encoding is a self-clocking code giving the advantage of bit-synchronisation since there is always at least one transition in the middle of the bit-interval. It also has a fixed average d.c. component over the frame of half the idle and active levels which allows greater predictability of power supply requirements, and additionally the absence of an expected transition can be used to detect errors.

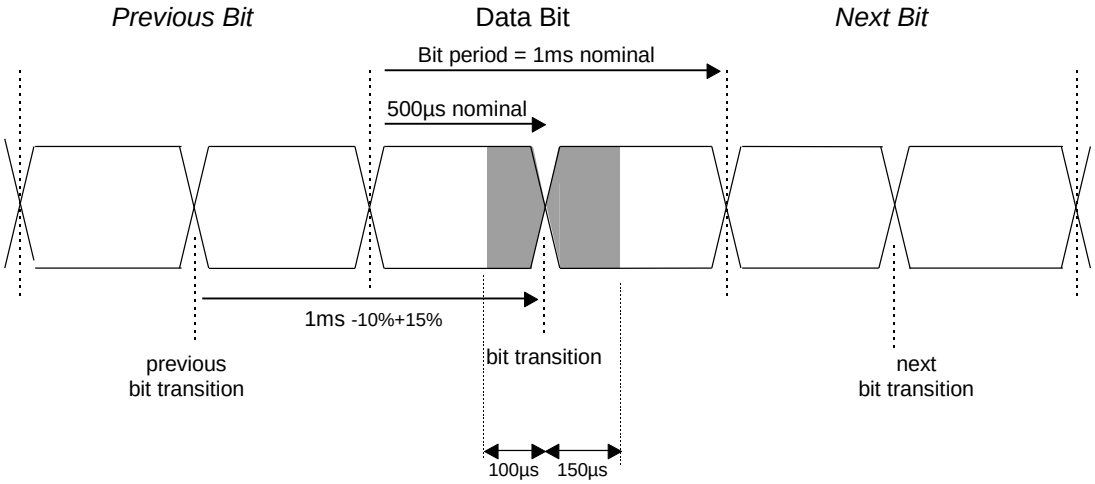
Example



3.3.2 Bit Rate and Timing

Description	Min	Typ	Max	value
Bit rate		1000		bits/sec
Period between mid-bit transitions	900	1000	1150	µS

Timing should be reset on each transition so that any timing errors do not accumulate



acceptable window for transition

3.3.3 Bit-level Error Checking

The primary error-checking method in OpenTherm is provided through the Manchester encoding. Manchester validity should be checked by the receiver and the data frame rejected if an error is detected.

3.4 Power Feeding

It is the intention that OpenTherm provides suitable power from the boiler unit to the room unit such that no additional power connection or use of batteries is required for the room unit. With the Smart Power mechanism the power delivered via OpenTherm can be changed fast and easy.

3.4.1 Power Feed Options

The options for supplying power to an OpenTherm room unit are :

i) Local supply (mains, batteries or other independent power source)
ii) Line (OpenTherm supplied) Low Power.
iii) Line (OpenTherm supplied) Medium Power
iv) Line (OpenTherm supplied) High Power

Any OpenTherm room unit is permitted to exercise option (i) above, or use line-power within one of the defined power modes

If the OpenTherm room unit is using line power, it always has to start-up in Low Power mode,
Normal (basic) operation of the OpenTherm room-unit must be guaranteed in Low Power mode.
*It is mandatory for a slave device to implement Smart Power support since OpenTherm version 3.0

3.4.2 Smart Power Mode mechanism

3.4.2.1 Definition of Power Modes

Three Power Modes are defined:
Low Power:

- Idle current low
- idle voltage is low
- Available power 40 mW (5mA at 8V) *

Medium Power:

- Idle current high
- idle voltage is low
- Available power 136 mW (17mA at 8V) *

High Power:

- Idle current high
- idle voltage is high
- Available power 306mW (17mA at 18V) *

*) Available power at lowest allowed current provided by slave and highest allowed voltage created by master.

3.4.2.2 Master start-up requirements

The Master must be able to start-up in Low Power Mode (idle voltage is low).
Basic operation should be guaranteed in Low Power Mode.

Procedure to check if High or Medium power is allowed:

- Communication must been established in Low Power mode.
- Write ID2 to slave and receive a acknowledge. If invalid data or unknown ID received then medium/high power is not allowed.

- If acknowledge received on ID2 then Initiate High Power:
- If Slave doesn't go to high current after 5 msec then Medium or High power is not allowed. Master switches back to Low idle voltage.

3.4.2.3 Slave start-up requirements

The slave must start-up in Low Power Mode (idle current is low).
Procedure to check if High or Medium power is allowed:

- Communication must been established in Low Power mode and ID2 must be received before Slave reacts on High level idle voltage (i.e. going to High level idle current after 5 msec)
- If Master switches to High idle voltage (i.e. initiates High Power) then switch to High idle current after 5msec

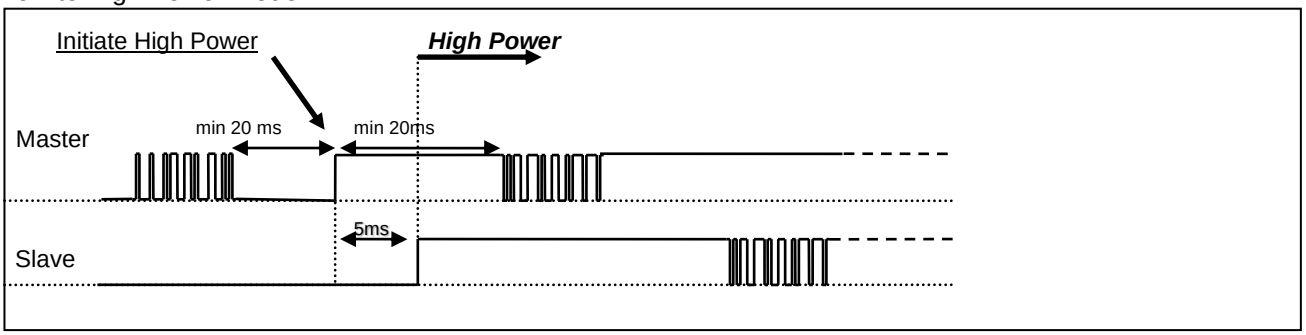
Note: When a master without high power is disconnected for a short time, there's a change that the slave goes to high idle current. To prevent this, the slave must have received ID2 with Smart Power bit set before it's allowed to switch to high idle current.

3.4.2.4 Normal and invert receive mode

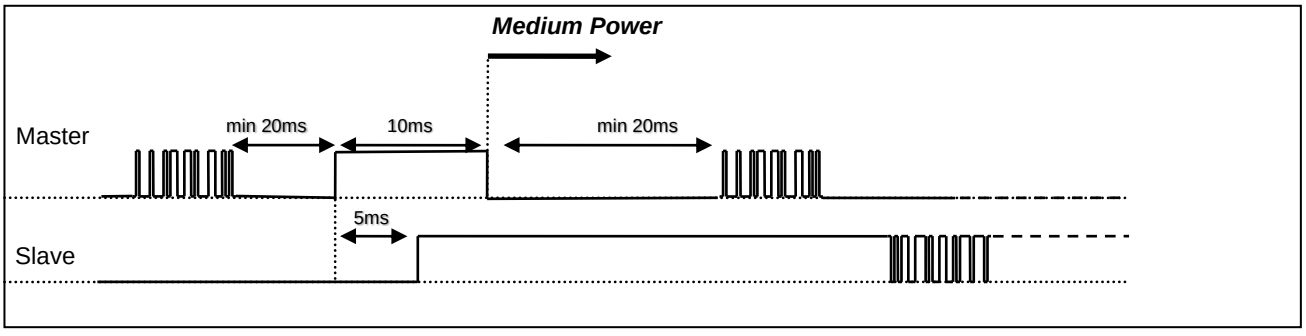
- If the idle voltage switches from low to high level the slave has to switch to invert receive mode after 5 msec.
- If the idle voltage switches from high to low level the slave has to switch to normal receive mode after 5 msec.
- If the idle current switches from low to high level the master has to switch to invert receive mode after 5 msec.
- If the idle current switches from high to low level the master has to switch to normal receive mode after 5 msec.
- Switching receive mode should always be done, even if no communication was established in low power mode at start-up or if Medium or High power mode is not allowed.

3.4.2.5 Initiate High Idle Current (Start for High or Medium Power mode)

Low to High Power mode



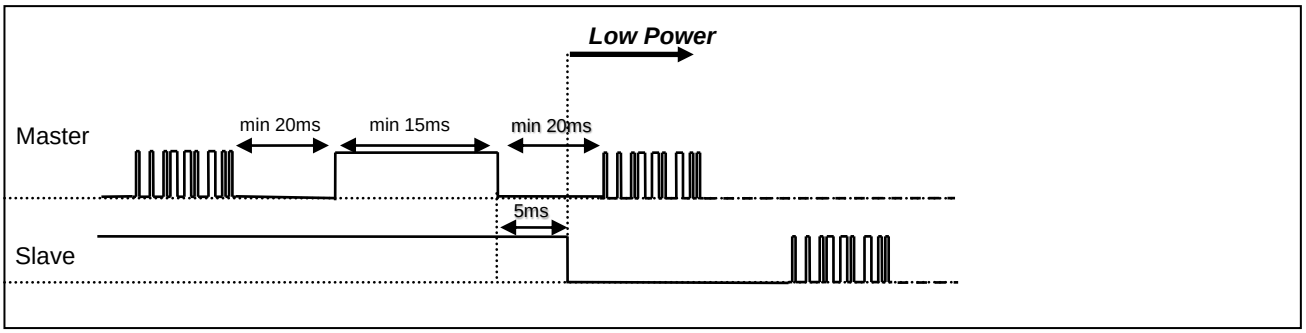
Low to Medium Power Mode



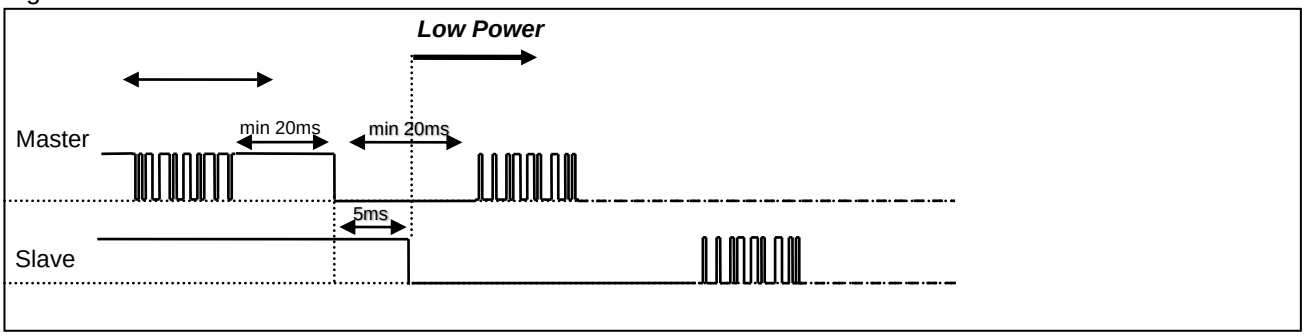
- Master switches to High Idle Voltage.
- The slave switches to High Idle Current after 5 msec.
- Master stays at High level Voltage if High Power mode needed.
- Master switches to Low level Voltage 10 msec after it switched to High level if Medium Power mode is needed.
- Restrictions:
    - Only allowed if communication was established in low power mode and Smart Power configuration (ID2:bit0) sent and answered with acknowledge.
    - Master must wait at least 20 msec after a message sent or received before initiating High Idle Current.
    - If Slave doesn't go to High Idle Current within 3-7 msec after Master switched to high idle voltage, the Master must switch back to Low Idle Voltage.

3.4.2.6 Initiate Low Idle Current (Start for Low Power mode)

Medium to Low Power mode



High to Low Power mode



- Master switches to High Idle Voltage.
- The slave switches to High Idle Current after 5 msec.
- Restrictions:
    - Only allowed if communication was established in low power mode.
    - Master must wait at least 20 msec after a message sent or received before initiating High Idle Current.

3.4.2.7 Exception handling Slave

If the slave receives for one minute or more the same Message it must switch back to low idle current (could be caused by the fact that an old master is connected, because it will repeat messages if no correct answer is received)

3.4.2.8 Message repetition Master

The master should not repeat the same message for more than one minute, because the slave will fall back to low idle current.

3.4.2.9 Timing tolerance

- Timing specifications of transition changes: +/- 1 ms.
- Timing specifications of detecting transition changes: +/- 2 ms.

3.4.3 Connection polarity

The room unit shall provide the functionality to operate regardless of polarity of the line signal.

3.4.4 Galvanic isolation

The boiler interface shall provide safety isolation from the mains power line (ref. EN60730-1).

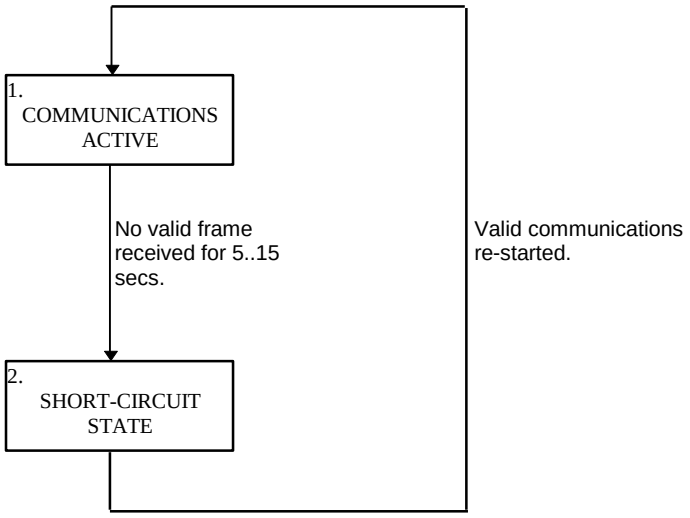
3.5 Special Installation Short-Circuit Feature

This feature is only mandatory for slave units who actually can create a heat demand. For instance a slave with cooling only or ventilation do not have this feature.

A slave unit with heat demand control must support an important installation feature which allows the terminals at the boiler to be short-circuited to simulate a heat demand such as can be done with existing on/off boilers. The boiler unit should interpret the short-circuit as a heat demand within15 secs of the short-circuit being applied. This must be supported by both OT/+ and OT/- boilers.

It is allowable that this can implemented by a software-detection method. The software short-circuit condition is defined as a low-voltage state (V_{low}) with no valid communications frame for at least 5 seconds.

The state diagram below illustrates this.



4. OpenTherm/plus DataLink Layer Protocol

4.1 Overview

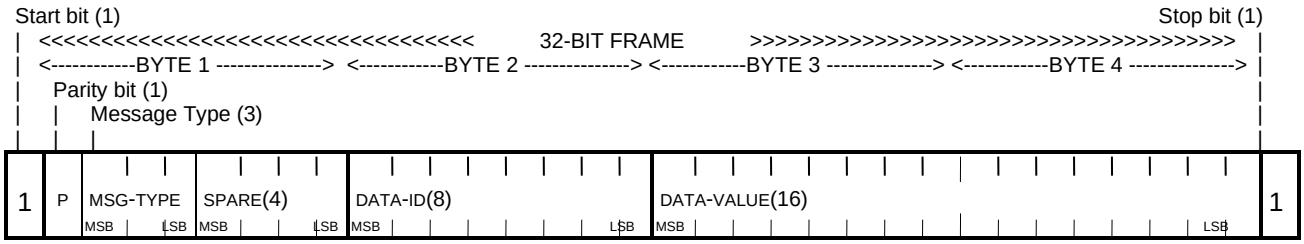
The data-link layer is responsible for the following functions :

- builds the complete frame from the information passed to it from the application layer.
- performs error-checking on an incoming frame.
- defines message types and allowable conversation exchanges.

4.2 Frame Format

Data is transmitted in 32 bit frames, with an added start bit (‘1’) at the beginning and stop bit (‘1’) at the end.

The frame format is identical for both directions, being laid out as follows:



Elements of the frame structure are described in the following sections.

4.2.1 Parity Bit - P

The parity bit should be set or cleared such the total number of ‘1’ bits in the entire 32 bits of the message is even.

4.2.2 Message Type - MSG-TYPE

The message type determines the contents and meaning of the frame. Seven of the eight possible values for the message type are defined.

Master-to-Slave Messages	
Value	**Message type**
000	READ-DATA
001	WRITE-DATA
010	INVALID-DATA
011	*-reserved-*

Slave-to-Master Messages	
Value	**Message type**
100	READ-ACK
101	WRITE-ACK
110	DATA-INVALID
111	UNKNOWN-DATAID

4.2.3 Spare Data - SPARE

These bits are unused in this release of the protocol. They should always be '0'.

4.2.4 Data Item Identifier - DATA-ID

The DATA-ID is an 8 bit value which uniquely identifies the data item or items being transmitted. A full list of data ID's and corresponding data items are listed in the OT/+ Application Layer section.

4.2.5 Data Item Value - DATA-VALUE

This contains the 16 bit value of the data item corresponding to the frame's data identifier. In some messages, the data-value is composed of two separate items, each of 8-bits in length. These will be denoted as DATA-BYTE1 and DATA-BYTE2.

4.3 Conversation Format

4.3.1 Overview

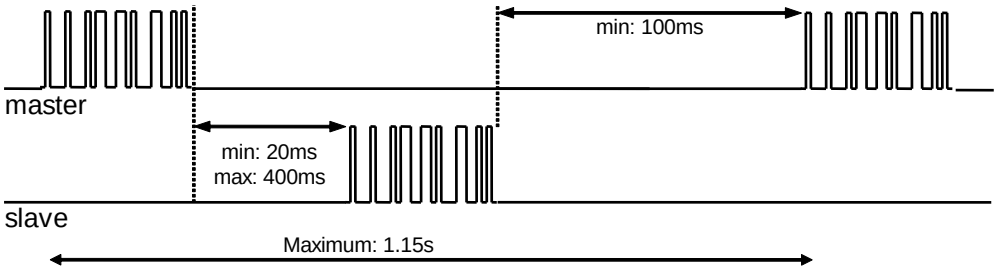
OpenTherm data transfer consists of a series of 'conversations' between the devices controlled by a strict master/slave relationship. OpenTherm requires that the control device, e.g. a room unit, is always the master and the control plant, e.g. a boiler, is always the slave.

In all cases the master initiates a conversation by sending a single frame. The slave is expected to respond with a single frame reply within a defined period of 20ms to 400ms from the end of the master transmission. The typical answering time of a slave should be 100ms or less.

In case the slave is functioning as a gateway (see also § 4.3.2) it must wait for an answer from the next slave in line, so the maximum waiting time does not apply.

The master unit must wait 100ms (MWT) from the end of a previous conversation before initiating a new conversation. The master must communicate at least every 1 sec (+15% tolerance) (MCI).

The timing for a single master-slave system is shown below



A conversation is limited to a single exchange of frames. Three types of conversation are possible, listed in § 4.4..

Description	Min	Typ	Max	value
Slave answering time	20	<100	400	ms
Master wait time (MWT)	100			ms
Master communication interval (MCI)	MWT	<1	1.15	s

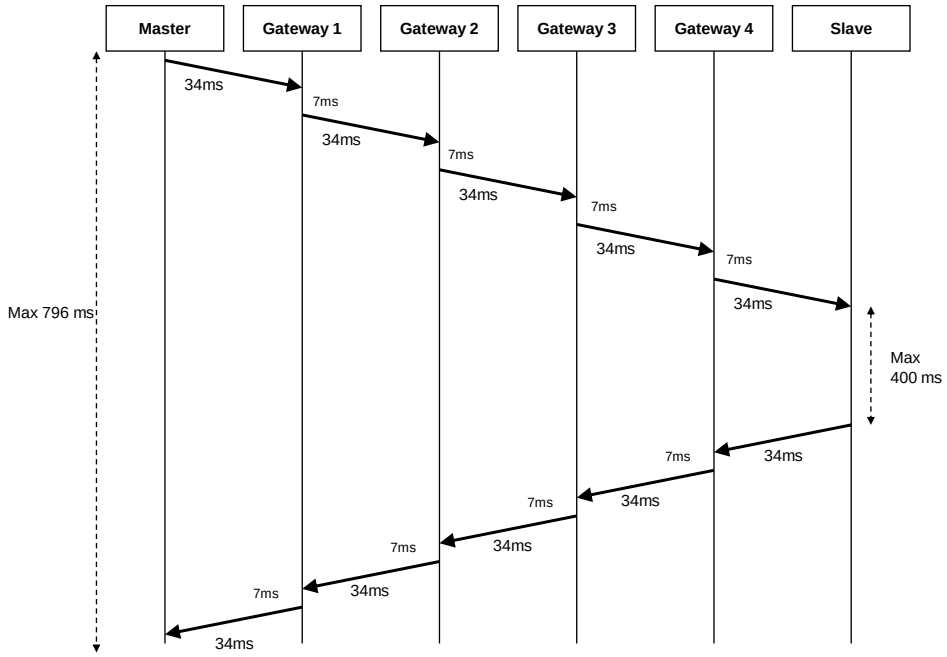
4.3.2 Multi Point to Point, Gateways

A gateway is an intermediate device that acts as a slave to the connected master, and acts as a master to the connected slave. The gateway is transparent for all messages sent by the master, unless the message is mend for the gateway itself. The gateway should try not to disturb the normal operation between Room-unit and Boiler when it needs to sent own commands to the Boiler. If the Boiler responds fast it may be possible to sent an additional command to the boiler before handling the command from the Room-unit.

In order to maintain the normal timing between the first master and last slave in the line, the following applies:

- A message received from the master side is checked. If it is addressed to the gateway, it will be answered by the gateway, otherwise it is sent to the next slave in line.
- Within 7 ms a message has to be sent to the next slave in the line. In most cases the message received will be sent. In case the received message is meant for the gateway itself it can sent another message to the next slave.
- Wait for a answer from the slave (no maximum time of 400ms to answer the master)
- After the answer from the next slave in line is received, a answer is sent to the master. If the original message was meant for the gateway, then the gateway will create the answer, otherwise the received answer is forwarded to the master.
- Within 7ms an answer has to be sent to the master.

With the applied restrictions, a total of 4 intermediate devices can be connected in line, and still the slave response times for the master are met.



4.3.3 Message Notation

In the rest of this section and in the OT/+ Application Layer Protocol section, a function-style notation is used to describe the various messages in order to aide explanation.

<msg-type> (id=<data-id>, <data-value>)

represents a message with msg-type=<msg-type>, data-id =<data-id> and data-value = <data-value>.

<msg-type> (id=<data-id>, <data-byte1>, <data-byte2>)

represents a message with msg-type=<msg-type>, data-id =<data-id> and data-value = <data-byte1>&<data-byte2>.

e.g. READ-DATA (id=1, ControlSetpoint-value)
READ-DATA (id=11, TSP-index, 00)

4.3.4 Default Data-Values

For some messages, no “real” data is being sent. e.g. in a normal Read-Data request. The data-value will be set to a default value of zero. i.e. two bytes of 0x00 and 0x00.

4.4 Conversation Details

4.4.1 Read-Data Request

READ-DATA (DATA-ID, DATA-VALUE)

The master is requesting a data value, specified by the data identifier, from the slave. The message type sent by the master is 'Read-Data', as shown above. Typically no data-value is sent and a value of 0x0000 will be used, but in some circumstances the master may, although it is requesting a value from the slave, also send a value to the slave with this message e.g. for data-verification. This is defined by the OT/+ Application Layer protocol.

The slave should make one of the three possible responses listed below:

- READ-ACK (DATA-ID, DATA-VALUE,)

If the data ID is recognised by the slave and the data requested is available and valid. The value of the data item is returned.

- DATA-INVALID (DATA-ID, DATA-VALUE)

If the data ID is recognised by the slave but the data requested is not available or invalid. DATA-VALUE can be 0x0000 in this case.

- UNKNOWN-DATAID (DATA-ID, DATA-VALUE)

If the slave does not recognise the data identifier. DATA-VALUE can be 0x0000 in this case.

4.4.2 Write-Data Request

WRITE-DATA (DATA-ID, DATA-VALUE)

The master is writing a data value, specified by the data identifier, to the slave. The message type sent by the master is 'Write-Data', as shown above.

The slave should make one of the three possible responses listed below: (Note that DATA-VALUE may be modified by the slave in some circumstances.)

- WRITE-ACK (DATA-ID, DATA-VALUE)

If the data ID is recognised by the slave and the data sent is valid.

- DATA-INVALID (DATA-ID, DATA-VALUE)

If the data ID is recognised by the slave but the data sent is invalid.

- UNKNOWN-DATAID (DATA-ID, DATA-VALUE)

If the slave does not recognise or does not support the data identifier.

4.4.3 Writing Invalid Data

INVALID-DATA (DATA-ID, DATA-VALUE)

A data item to be sent by the master may be invalid in a particular application, but may still require to be sent. In this case the master may use the message type 'data invalid'.

The slave should make one of the two possible responses listed below: (Note that DATA-VALUE may be modified by the slave in some circumstances.)

- DATA-INVALID (DATA-ID, DATA-VALUE)

If the data ID is recognised by the slave.

- UNKNOWN-DATAID (DATA-ID, DATA-VALUE)

If the slave does not recognise or does not support the data identifier.

4.5 Frame Error Handling

In all cases of errors being detected in the incoming frame, the partial frame is rejected and the conversation should be terminated. No errors are treated as recoverable.

If the slave does not respond, then the master should note that the conversation is incomplete.

If a conversation is terminated the master should re-attempt the same conversation at the next appropriate scheduled time for communications.

5. OpenTherm/plus Application Layer Protocol

5.1 Overview

The Application Layer of the OpenTherm protocol is divided into an Open-Area of data-item id's and a Test & Diagnostic area for Member use. Id's 0 .. 127 are reserved for OpenTherm pre-defined information, while id's from 128 .. 255 can be used by manufacturers (members of the association) for test & diagnostic purposes only. The MemberID codes of the master and slave can be used to handshake between two compatible devices and enable the use of the Test & Diagnostic-Area data-items. MemberID codes are assigned and managed by The OpenTherm Association.

There are seven classes of information defined in the Application Layer :

Class 1. **Control and Status Information**
This class contains basic control information from the master and status information exchange (including fault status) and incorporates all the mandatory OpenTherm data.

Class 2. **Configuration Information**
Information relating to the configuration of the master and slave and Member identification.

Class 3. **Remote Commands**
This class allows for commands to be passed from the master to the slave.

Class 4. **Sensor and Informational Data**
This class covers typically sensor temperatures, pressures etc.

Class 5. **Remote Boiler Parameters**
These are parameters of the slave device which may be read or set by the master and are specific to boiler applications.

Class 6. **Transparent Slave Parameters**
This class allows slave parameters to be read or set by the master without knowledge of their physical or application-specific meaning.

Class 7. **Fault History Information**
This data allows historical fault information to be passed from the slave to the master.

Class 8. **Control of Special Applications**
This class defines data id's to be exchanged between the master and a application specific slave.

Special abbreviations and data-types are used in the Application Layer Protocol section and are defined below :

LB	low-byte of the 16-bit data field.
HB	high-byte of the 16-bit data field.
S>M	information flow from slave to master
M>S	information flow from master to slave
flag8	byte composed of 8 single-bit flags
u8	unsigned 8-bit integer 0 .. 255
s8	signed 8-bit integer -128 .. 127 (two's compliment)
f8.8	signed fixed point value : 1 sign bit, 7 integer bit, 8 fractional bits (two's compliment i.e. the LSB of the 16bit binary number represents 1/256th of a unit).
u16	unsigned 16-bit integer 0..65535
s16	signed 16-bit integer -32768..32767

Example : A temperature of 21.5°C in f8.8 format is represented by the 2-byte value `1580` hex
(1580hex = 5504dec, dividing by 256 gives 21.5)
A temperature of -5.25°C in f8.8 format is represented by the 2-byte value `FAC0` hex
(FAC0hex = - (10000hex-FACOhex) = - 0540hex = - 1344dec, dividing by 256 gives -5.25)

- All data-item ID's are in decimal unless denoted otherwise.
- "00" is used to represent the dummy data byte as defined in the Data-Link Layer and is transmitted when valid data-values are not available or appropriate.
- For future compatibility, a bit or byte is marked as unused or reserved, should be set to 0 (zero) by the transmitter; however the receiver should ignore these bits/bytes, since they may be set in future versions of the protocol.
- 'R' and 'W' under the column labelled 'Msg', indicate whether the data object is supported with a Read or a Write command.

5.2 Mandatory OT/+ Application-Layer Support

5.2.1 Mandatory ID's for OpenTherm devices who support central heating

It is required that OpenTherm-compliant devices support the following data items in case they support central heating or in case no OpenTherm functions (see 5.2.2) are defined for the device. Please consult the OpenTherm Function matrix document which contains all mandatory ID's per function for the full mandatory ID list.

ID	Description	Master	Slave
0	Master and slave status flags	• Must sent message with READ_DATA • Must support all bits in master status	• Must respond with READ_ACK • Must support all bits in slave status
1	Control Setpoint i.e. CH water temp. Setpoint	• Must sent message with WRITE_DATA or INVALID_DATA (not recommended)	• Must respond with WRITE_ACK
2	Master Configuration	• Not mandatory (only if Smart Power is needed by Master	• Must respond with WRITE_ACK • Must support bit 0: Smart Power
3	Slave configuration flags	• Must sent message with READ_DATA (at least at start up)	• Must respond with READ_ACK • Must support all slave configuration flags
14	Maximum relative modulation level setting	• Not mandatory • Recommended for use in on-off control mode.	• Must respond with WRITE_ACK
17	Relative modulation level	• Not mandatory	• Must respond with READ_ACK or DATA_INVALID
25	Boiler temperature	• Not mandatory	• Must respond with READ_ACK or DATA_INVALID (for example if sensor fault)
93	Brand Index	• Not mandatory	• Must respond with READ_ACK or DATA_INVALID (if out of range)
94	Brand Version	• Not mandatory	• Must respond with READ_ACK or DATA_INVALID (if out of range)
95	Brand Serial Number	• Not mandatory	• Must respond with READ_ACK or DATA_INVALID (if out of range)
125	OpenTherm Version Slave	• Not mandatory	• Must respond with READ_ACK
127	Slave product version number and type HB : product type LB : product version	• Not mandatory	• Must respond with READ_ACK

The slave can respond to all other read/write requests, if not supported, with an UNKNOWN-DATAID reply. Master units (typically room controllers) should be designed to act in a manner consistent with this rule.

5.2.2 OpenTherm Functions and Data-ID mapping

In OpenTherm are basic functions defined related to central heating, domestic hotwater, information, diagnostics/service etcetera. For each function is defined which data-id's are related and are mandatory to implemented if the function is used. With the definition of functions the interoperability between devices with the same function is improved. Also the function list can help to select the right product or product combination.
If a manufacturer states that specific functions are supported then the related data-id's must be implemented, unless the data is related to sensors or signals which are not always available in the appliance.

The **OpenTherm Function Matrix** (excel sheet) gives an overview of all functions with the related data-id's. Consult the members area on www.opentherm.eu for the latest published version.

Data-ID's marked with "B" for a specific function are mandatory for both master and slave.
Data-ID's marked with "b" for a specific function are mandatory for a master, but only mandatory for the slave if the data is available (i.e. sensor or input is available in appliance). Also called conditional mandatory Data-ID's for a slave.
Data-ID's marked with "M" for a specific function are mandatory for Master devices
Data-ID's marked with "m" for a specific function are conditional mandatory for Master devices
Data-ID's marked with "S" for a specific function are mandatory for Slave devices
Data-ID's marked with "s" for a specific function are conditional mandatory for Slave devices (i.e. only if data or sensor is available)

5.3 Data Classes

5.3.1 Class 1 : Control and Status Information

This group of data-items contains important control and status information relating to the slave and master. The slave status contains a mandatory fault-indication flag and there is an optional application-specific set of fault flags which relate to specific faults in boiler-related applications, and an OEM fault code whose meaning is unknown to the master but can be used for display purposes.

ID	Msg	Name	Type	Range	Description
0	R -	HB: Master status	flag8		*bit: description [clear/0, set/1]* 0: CH enable [CH is disabled, CH is enabled] 1: DHW enable [DHW is disabled, DHW is enabled] 2: Cooling enable [Cooling is disabled, Cooling is enabled] 3: OTC active [OTC not active, OTC is active] 4: CH2 enable [CH2 is disabled, CH2 is enabled] 5: Summer/winter mode [winter mode active, summer mode active] 6: DHW blocking [DHW unblocked, DHW blocked] 7: reserved
		LB: Slave status	flag8		*bit: description [clear/0, set/1]* 0: fault indication [no fault, fault] 1: CH mode [CH not active, CH active] 2: DHW mode [DHW not active, DHW active] 3: Flame status [flame off, flame on] 4: Cooling status [cooling mode not active, cooling mode active] 5: CH2 mode [CH2 not active, CH2 active] 6: diagnostic/service indication [no diagnostic/service, diagnostic/service event] 7: Electricity production [off, on]
70	R -	HB: Master status for ventilation/heat-recovery	flag8		*bit: description [clear/0, set/1]* 0: Ventilation enable [disabled, enabled] 1: Bypass position (only bypass manual mode) [close bypass, open bypass] 2: Bypass mode [manual, automatic] 3: Free ventilation mode [not active, active] 4..7: Reserved
		LB: Status ventilation / heat-recovery	flag8		*bit: description [clear/0, set/1]* 0: Fault indication [no fault, fault] 1: Ventilation mode [not active, active] 2: Bypass status [closed, open] 3: Bypass automatic status [manual, automatic] 4: Free ventilation status [not active, active] 5: Reserved 6: Diagnostic indication [no diagnostics, diagnostic event] 7: Reserved
101	R -	HB: Master Solar Storage status	flag8		*bit: description [clear/0, set/1]* Bit 2,1 and 0 = Solar mode 000 = off (solar completely switched off) 001 = DHW eco (solar heating enabled) 010 = DHW comfort (boiler keeps small part of storage tank loaded) 011 = DHW single boost (boiler does single loading of storage tank) 100 = DHW continuous boost (boiler keeps whole tank loaded)

ID	Msg	Name	Type	Range	Description
101	R -	LB: Solar Storage mode and status	flag8		*bit: description [clear/0, set/1]* Bit 0: fault indication Bit 3,2 and 1 = Solar mode 000 = off (solar completely switched off) 001 = DHW eco (solar heating enabled) 010 = DHW comfort (boiler keeps small part of storage tank loaded) 011 = DHW single boost (boiler does single loading of storage tank) 100 = DHW continuous boost (boiler keeps whole tank loaded) Bit 5,4 = Solar status 00= standby 01= loading of solar storage tank by the sun 10= loading of solar storage tank by the boiler 11= anti-legionella mode active
1	- W	Control Setpoint	f8.8	0..100	degrees C (see notes below)
71	- W	LB: Control Setpoint ventilation / heat-recovery	u8	0..100	Relative ventilation position (0-100%). 0% is the minimum set ventilation and 100% is the maximum set ventilation.
5	R -	HB: Application-specific fault flags	flag8		*bit: description [clear/0, set/1]* 0: Service request [service not req'd, service required] 1: Lockout-reset [remote reset disabled, rr enabled] 2: Low water press [no WP fault, water pressure fault] 3: Gas/flame fault [no G/F fault, gas/flame fault] 4: Air press fault [no AP fault, air pressure fault] 5: Water over-temp [no OvT fault, over-temperat. Fault] 6: reserved 7: reserved
		LB: OEM fault code	u8	0..255	An OEM-specific fault/error code
72	R -	HB: Application-specific fault flags ventilation / heat-recovery	flag8		*bit: description [clear/0, set/1]* 0: Service request [service not req'd, service required] 1: Exhaust fan fault [no fault, fault] 2: Inlet fan fault [no fault, fault] 3: Frost protection [not active, active] 4..7: Reserved
		LB: OEM fault code ventilation / heat-recovery	u8	0..255	An OEM-specific fault/error code for ventilation / heat-recovery system
102	R -	HB: Solar Storage specific fault flags	flag8		*bit: description [clear/0, set/1]* reserved
		LB: OEM fault code Solar Storage	u8	0..255	An OEM-specific fault/error code for Solar Storage
8	- W	Control Setpoint 2 (TsetCH2)	f8.8	0..100	degrees C
115	R -	OEM diagnostic code	u16	0..65535	An OEM-specific diagnostic/service code
73	R -	OEM diagnostic code ventilation / heat-recovery	u16	0..65535	An OEM-specific diagnostic/service code for ventilation / heat-recovery system

Note : The master decides the actual range over which the control Setpoint is defined. The default range is assumed to be 0 to 100.

There is only one control value defined - data-id=01, the control Setpoint. The control Setpoint ranges between a minimum of 0 and maximum of 100. It represents directly a temperature Setpoint for the supply from the boiler. The slave does not need to know how the master has calculated the control Setpoint, e.g. whether it used room control or OTC, it only needs to control to the value. Likewise, the master does not need to know how the slave is controlling the supply.

The CHenable bit has priority over the Control Setpoint. The master can indicate that no CH demand is required by putting the CHenable bit = 0 (i.e. CH is disabled), even if the Control Setpoint is non-zero.

The status exchange is a special form of conversation which should be initiated by the master by sending a READ-DATA(id=0,MasterStatus,00) message. The slave must respond with READ-ACK(id=0,MasterStatus, SlaveStatus) to send back the Slave Status information in the same single conversation. Since it is mandatory to support this data object, the slave cannot respond with DATA-INVALID or UNKNOWN-DATAID. A WRITE-DATA(id=0,…) from the master should not be used.

5.3.2 Class 2 : Configuration Information

This group of data-items defines configuration information on both the slave and master sides. Each has a group of configuration flags (8 bits) and an MemberID code (1 byte). A valid *Read Slave Configuration* and *Write Master Configuration* message exchange is recommended before control and status information is transmitted.

ID	Msg	Name	Type	Range	Description
2	- W	HB: Master configuration	flag8		*bit: description [clear/0, set/1]* 0: Smart Power [not implemented, implemented] 1-7: reserved
		LB: Master MemberID code	u8	0..255	MemberID code of the master
3	R -	HB: Slave configuration	flag8		*bit: description [clear/0, set/1]* 0: DHW present [dhw not present, dhw is present] 1: Control type [modulating, on/off] 2: Cooling config [cooling not supported, cooling supported] 3: DHW config [instantaneous or not-specified, storage tank] 4: Master low-off&pump control function [allowed, not allowed] 5: CH2 present [CH2 not present, CH2 present] 6: Remote water filling function [available or unknown, not available]. Unknown for applications with protocol version 2.2 or older. 7: Heat/cool mode control [Heat/cool mode switching can be done by master, Heat/cool mode switching is done by slave]
		LB: Slave MemberID code	u8	0..255	MemberID code of the slave
74	R -	HB: Configuration ventilation / heat-recovery	flag8		*bit: description [clear/0, set/1]* 0: System type [0= central exhaust ventilation] [1= heat-recovery ventilation] 1: Bypass [not present, present] 2: Speed control [3-speed, variable] 3..7: Reserved
		LB: MemberID code ventilation / heat-recovery	u8	0..255	MemberID code of the ventilation / heat-recovery device
103	R -	HB: Solar Storage configuration	flag8	0..255	*bit: description [clear/0, set/1]* LB: bit 0: system type 0 = DHW preheat system 1 = DHW parallel system
		LB: Solar Storage member ID	u8		MemberID code of the Solar Storage
124	- W	OpenTherm version Master	f8.8	0..127	The implemented version of the OpenTherm Protocol Specification in the master.
125	R -	OpenTherm version Slave	f8.8	0..127	The implemented version of the OpenTherm Protocol Specification in the slave.

ID	Msg	Name	Type	Range	Description
75	R -	OpenTherm version ventilation / heat-recovery	f8.8	0..127	The implemented version of the OpenTherm Protocol Specification in the ventilation / heat-recovery system.
126	- W	Master product version number and type HB : product type LB : product version	 u8 u8	 0..255 0..255	The master device product version number and type as defined by the manufacturer.
127	R -	Slave product version number and type HB : product type LB : product version	 u8 u8	 0..255 0..255	The slave device product version number and type as defined by the manufacturer.
76	R -	Ventilation / heat-recovery product version number and type HB : product type LB : product version	 u8 u8	 0..255 0..255	The ventilation / heat-recovery device product version number and type as defined by the manufacturer.
104	R -	Solar Storage product version number and type HB : product type LB : product version	 u8 u8	 0..255 0..255	The Solar Storage product version number and type as defined by the manufacturer.

Note 1 ID2 is related to the Room unit and the slave interface of the Gateway It's advised to set bit 0 to the value according the Gateway (in practice gateways will not have implemented Smart Power at the Master interface) since protocol version 3.0 it is mandatory to support Smart Power on a slave interface. A gateway therefore must support Smart Power on the slave interface and handle ID2 and Smart Power accordingly.

Note 2 An MemberID code of zero signifies a customer non-specific device.

Note 3 The product version number/type should be used in conjunction with the “Member ID code”, which identifies the manufacturer of the device.

ID	Msg	Name	Type	Range	Description
93	R -	HB: Brand index LB: Brand ASCII character	u8 u8	0..49 0..255	Index number of the character in the text string ASCII character referenced by the above index number
94	R -	HB: Brand version index LB: Brand version ASCII character	u8 u8	0..49 0..255	Index number of the character in the text string ASCII character referenced by the above index number
95	R -	HB: Brand serial number index LB: Brand serial number ASCII character	u8 u8	0..49 0..255	Index number of the character in the text string ASCII character referenced by the above index number

ID93, ID94 and ID95 are mandatory for the slave. Every slave has to be readable concerning the brand information- characters.

Example reading the brand index (ID93), ID94 and ID95 work similarly

To read the string of ASCII characters, the master uses the following command:

READ-DATA (id=93,brand-index-number,00).
The slave response will be either :
1. READ-ACK (id=93,max-brand-index-number, index-character) Everything OK, the requested character is returned.
2. DATA-INVALID (id=93,max-brand-index-number,00) The brand-index-number is out-of-range 00 is returned.
3. UNKNOWN-DATAID (id=93, brand-index-number,00) The slave does not yet support ID93

Example reading the word “boiler”:
Master: READ-DATA ID93 0x00 0x00 Slave answers: READ-ACK ID93 0x06 0x62
HB = 0x00 → read first character HB = 0x06 → 6 characters can be read
LB = 0x00 LB = 0x62→ first character is “b”
The first character is read, the remaining 5 characters can be read in the same way.

5.3.3 Class 3 : Remote Request

This class of data represents commands sent by the master to the slave. There is a single data-id for a request “packet”, with the Request-Code embedded in the high-byte of the data-value field.

ID	Msg	Name	Type	Range	Description
4	- W	HB: Request-Code	u8	0..255	*Request code* 0: Back to Normal oparation mode 1: “BLOR”= Boiler Lock-out Reset request 2: “CHWF”=CH water filling request 3: Service mode maximum power request (for instance for CO2 measurement during Chimney Sweep Function) 4: Service mode minimum power request (CO2 measurement) 5: Service mode spark test request (no gas) 6: Service mode fan maximum speed request (no flame) 7: Service mode fan to minimum speed request (no flame) 8: Service mode 3-way valve to CH request (no pump, no flame) 9: Service mode 3-way valve to DHW request (no pump, no flame) 10:Request to reset service request flag 11: Service test 1. This is a OEM specific test. 12: Automatic hydronic air purge. 13..255: -Reserved - for future use
		LB: Req-Response-Code	u8	0..255	Response to the request 0..127 : Request refused. 128..255 : Request accepted.

Example

The master will send a WRITE-DATA(id=4,Cmd=BLOR,00) message.
The slave response will be either :
1. WRITE-ACK (id=4,Cmd=BLOR, Req-Resp..) The request was accepted; Req-Response-Code indicates completion status.
2. DATA-INVALID (id=4,BLOR,00) The request was not recognised, Req-Response-Code=00;
3. UNKNOWN-DATAID (id=4, BLOR,00) Remote Request not supported, Req-Response-Code=00;.

5.3.4 Class 4 : Sensor and Informational Data

This group of data-items contains sensor data (temperatures, pressures etc.) and other informational data from one unit to the other.

ID	Msg	Name	Type	Range	Description
16	- W	Room Setpoint	f8.8	-40..127	Current room temperature Setpoint (°C)
17	R -	Relative Modulation Level	f8.8	0..100	Percent modulation between min and max modulation levels. i.e. 0% = Minimum modulation level 100% = Maximum modulation level
18	R -	CH water pressure	f8.8	0..5	Water pressure of the boiler CH circuit (bar)
19	R -	DHW flow rate	f8.8	0..16	Water flow rate through the DHW circuit (l/min)
20	R W	Day of Week & Time of Day HB : bits 7,6,5 : day of week bits 4,3,2,1,0 : hours LB : minutes	 special u8	 1..7 0..23 0..59	1=Monday, etc…. (0=no DoW info available)
21	R W	Date HB : Month LB : Day of Month	 u8 u8	 1..12 1..31	1=January, etc
22	R W	Year	u16	0..65535	note : 1999-2099 will normally be sufficient
23	- W	Room Setpoint CH2	f8.8	-40..127	Current room Setpoint for 2nd CH circuit (°C)
24	- W	Room temperature	f8.8	-40..127	Current sensed room temperature (°C)
25	R -	Boiler water temp.	f8.8	-40..127	Flow water temperature from boiler (°C)
26	R -	DHW temperature	f8.8	-40..127	Domestic hot water temperature (°C)
27	R W	Outside temperature	f8.8	-40..127	Outside air temperature (°C)
28	R -	Return water temperature	f8.8	-40..127	Return water temperature to boiler (°C)
29	R -	Solar storage temperature	f8.8	-40..127	Solar storage temperature (°C)
30	R -	Solar collector temperature	s16	-40..250	Solar collector temperature (°C)
31	R -	Flow temperature CH2	f8.8	-40..127	Flow water temperature of the second central heating circuit.
32	R -	DHW2 temperature	f8.8	-40..127	Domestic hot water temperature 2 (°C)
33	R -	Exhaust temperature	s16	-40..500	Exhaust temperature (°C)
34	R -	Boiler heat exchanger temperature	f8.8	-40..127	Boiler heat exchanger temperature (°C)
35	R -	HB: Boiler fan speed Setpoint	u8	0..255	Actual boiler fan speed Setpoint in Hz (RPM/60)
		LB: Boiler fan speed	u8	0..255	Actual boiler fan speed in Hz (RPM/60)
36	R -	Flame current	f8.8	0..127	Electrical current through burner flame [µA]
37	- W	TrCH2	f8.8	-40..127	Room temperature for 2nd CH circuit (°C)
38	R W	Relative Humidity	f8.8	0..100	Actual relative humidity as a percentage
77	R -	LB: Relative ventilation	u8	0..100	Relative ventilation (0-100%). 0% means that ventilation is at minimum set value and 100% means that ventilation is at maximum set value.
78	R W	LB: Relative humidity	u8	0-100	Relative humidity exhaust air (0-100%)

ID	Msg	Name	Type	Range	Description
79	R W	CO2 level	u16	0-2000	CO2 level exhaust air (0-2000 ppm)
80	R -	Supply inlet temperature	f8.8	-40..127	Supply inlet temperature (°C)
81	R -	Supply outlet temperature	f8.8	-40..127	Supply outlet temperature (°C)
82	R -	Exhaust inlet temperature	f8.8	-40..127	Exhaust inlet temperature (°C)
83	R -	Exhaust outlet temperature	f8.8	-40..127	Exhaust outlet temperature (°C)
84	R -	Actual exhaust fan speed	u16	0-6000	Exhaust fan speed in rpm
85	R -	Actual inlet fan speed	u16	0-6000	Inlet fan speed in rpm
96	R W	Cooling Operation hours	u16	0..65535	Number of hours that the slave is in Cooling Mode. Reset by zero is optional for slave
97	R W	Power Cycles	u16	0..65535	Number of Power Cycles of a slave (wake-up after Reset), Reset by zero is optional for slave
98	- W	HB: Type of sensor	special		bits 3,2,1,0: index of sensor bits 7,6,5,4: 0000 = Room temp. controllers 0001 = Room temp. sensors 0010 = Outside temperature sensors 1111 = Not defined type Others are reserved (example: Radiator valves, humidity, CO2 sensors, wind velocity)
	- W	LB : RF and battery indication	special		bits 1,0 00 = No battery indication 01 = Low battery (possible loss of functionality) 10 = Nearly low battery (advice to replace battery) 11 = No low battery bits 4,3,2 000 = No signal strength indication 001 = strength 1: Weak or lost signal str. 010 = strength 2 011 = strength 3 100 = strength 4 101 = strength 5: Perfect signal strength bits 7,6,5 reserved
109	R W	Electricity producer starts	u16	0..65535	Number of start of the electricity producer. Reset by writing zero. Writing is optional for slave.
110	R W	Electricity producer hours	u16	0..65535	Number of hours the electricity produces is in operation. Reset by writing zero. Writing is optional for slave.
111	R	Electricity production	u16	0..65535	Current electricity production in Watt.
112	R W	Cumulative Electricity production	u16	0..65535	Cumulative electricity production in KWh. Reset by writing zero. Writing is optional for slave.
113	R W	Number of un-successful burner starts	u16	0..65535	

ID	Msg	Name	Type	Range	Description
114	R W	Number of times flame signal was too low	u16	0..65535	
116	R W	Successful Burner starts	u16	0..65535	Number of successful starts burner. Reset by writing zero is optional for slave.
117	R W	CH pump starts	u16	0..65535	Number of starts CH pump. Reset by writing zero is optional for slave.
118	R W	DHW pump/valve starts	u16	0..65535	Number of starts DHW pump/valve. Reset by writing zero is optional for slave.
119	R W	DHW burner starts	u16	0..65535	Number of starts burner in DHW mode. Reset by writing zero is optional for slave.
120	R W	Burner operation hours	u16	0..65535	Number of hours that burner is in operation (i.e. flame on). Reset by writing zero is optional for slave.
121	R W	CH pump operation hours	u16	0..65535	Number of hours that CH pump has been running. Reset by writing zero is optional for slave.
122	R W	DHW pump/valve operation hours	u16	0..65535	Number of hours that DHW pump has been running or DHW valve has been opened. Reset by writing zero is optional for slave.
123	R W	DHW burner operation hours	u16	0..65535	Number of hours that burner is in operation during DHW mode. Reset by writing zero is optional for slave.

5.3.5 Class 5 : Pre-Defined Remote Boiler Parameters

This group of data-items defines specific parameters of the slave device (Setpoints, etc.) which may be available to the master device and may, or may not, be adjusted remotely. These parameters are pre-specified in the protocol and are specifically related to boiler/room controller applications. There is a maximum of 8 remote boiler parameters. Each remote-boiler-parameter has a upper- and lower-bound (max and min values) which the master should read from the slave in order to make sure they are not set outside the valid range. If the slave does not support sending the upper- and lower-bounds, the master can apply default bounds as it chooses.

The remote-parameter transfer-enable flags indicate which remote parameters are supported by the slave. The remote-parameter read/write flags indicate whether the master can only read the parameter from the slave, or whether it can also modify the parameter and write it back to the slave. An Unknown Data-Id response to a Read Remote-Parameter-Flags message indicates no support for remote-parameters (equivalent to all transfer-enable flags equal to zero). In these flag bytes bit 0 corresponds to remote-boiler-parameter 1 and bit 7 to remote-boiler-parameter 8.

ID	Msg	Name	Type	Range	Description
6	R -	HB: Remote-parameter transfer-enable flags	flag8	n/a	*bit: description* *[clear/0, set/1]* 0: DHW Setpoint [transfer disabled, transfer enabled] 1: max CHsetpoint [transfer disabled, transfer enabled] 2..7: reserved
	R -	LB: Remote-parameter read/write flags	flag8	n/a	*bit: description* *[clear/0, set/1]* 0: DHW Setpoint [read-only, read/write] 1: max CHsetpoint [read-only, read/write] 2..7: reserved
86	R -	HB: Remote-parameter transfer-enable flags ventilation / heat-recovery	flag8	n/a	*bit: description* *[clear/0, set/1]* 0: Nominal ventilation value [transfer disabled, transfer enabled] 1..7: reserved
	R -	LB: Remote-parameter read/write flags ventilation / heat-recovery	flag8	n/a	*bit: description* *[clear/0, set/1]* 0: Nominal ventilation value [read-only, read/write] 1..7: reserved
48	R -	HB: DHWsetp upp-bound	s8	0..127	Upper bound for adjustment of DHW setp (°C)
		LB: DHWsetp low-bound	s8	0..127	Lower bound for adjustment of DHW setp (°C)
49	R -	HB: max CHsetp upp-bnd	s8	0..127	Upper bound for adjustment of maxCHsetp (°C)
		LB: max CHsetp low-bnd	s8	0..127	Lower bound for adjustment of maxCHsetp (°C)
56	R W	**DHW Setpoint**	f8.8	0..127	Domestic hot water temperature Setpoint (°C)
57	R W	**max CH water Setpoint**	f8.8	0..127	Maximum allowable CH water Setpoint (°C)
87	R W	HB: Nominal ventilation value	u8	0-100	Nominal relative value for ventilation (0-100%), i.e. the value for the mid position in case of a 3-speed ventilation system. 0% is the minimum set ventilation and 100% is the maximum set ventilation.

5.3.6 Class 6 : Transparent Slave Parameters

This group of data-items defines parameters of the slave device which may (or may not) be remotely set by the master device. These parameters are not pre-specified in the protocol and are “transparent” to the master in the sense that it has no knowledge about their application meaning.

ID	Msg	Name	Type	Range	Description
10	R -	HB: Number of TSP's	u8	0..255	Number of transparent-slave-parameter supported by the slave device.
		LB: Not used	u8		-Reserved-
11	R W	HB: TSP index no.	u8	0..255	Index number of following TSP
		LB: TSP value	u8	0..255	Value of above referenced TSP
88	R -	HB: Number of TSP’s ventilation / heat-recovery	u8	0..255	Number of transparent parameters supported by the ventilation / heat-recovery system.
		LB: Not used	u8		-Reserved-
89	R W	HB: TSP index no. ventilation / heat-recovery	u8	0..255	Index number of following TSP for ventilation / heat-recovery system.
		LB: TSP value Ventilation / heat-recovery	u8	0..255	Value of above referenced TSP for ventilation / heat-recovery system.
105	R -	HB: Number of TSP’s Solar Storage	u8	0..255	Number of transparent parameters supported by the Solar Storage.
		LB: Not used	u8		-Reserved-
106	R W	HB: TSP index no. Solar Storage	u8	0..255	Index number of following TSP for Solar Storage.
		LB: TSP value Solar Storage	u8	0..255	Value of above referenced TSP for Solar Storage.

The first data-item (id=10) allows the master to read the number of transparent-slave-parameters supported by the slave. The second data-item (ID=11) allows the master to read and write individual transparent-slave-parameters from/to the slave.

Example

To read a TSP, the master uses the following command: READ-DATA (id=11,TSP-index,00).
The slave response will be either :
1. READ-ACK (id=11,TSP-index,TSP-value) Everything OK, the requested data-value is returned.
2. DATA-INVALID (id=11,TSP-index,00) The TSP-index is out-of-range or undefined, 00 is returned.
3. UNKNOWN-DATAID (id=11, TSP-index,00) The slave does not support transparent-slave-parameters.

To write a TSP, the master uses the following command: WRITE-DATA(id=11,TSP-index, TSP-value)
The slave response will be either :
1. WRITE-ACK (id=11,TSP-index,TSP-value) Everything OK, the value is echoed back. Note however, that the TSP-value may be changed by the slave if it is out-of-range.
2. DATA-INVALID (id=11,TSP-index,00) The TSP-index is out-of-range or undefined, 00 is returned.
3. UNKNOWN-DATAID (id=11,TSP-index,00) The slave does not support transparent-slave-parameters.

5.3.7 Class 7 : Fault History Data

This group of data-items contains information relating to the past fault condition of the slave device.

ID	Msg	Name	Type	Range	Description
12	R -	HB: Size of Fault Buffer	u8	0..255	The size of the fault history buffer..
		LB: Not used	u8		-Reserved-
13	R -	HB: FHB-entry index no.	u8	0..255	Index number of following Fault Buffer entry.
		LB: FHB-entry value	u8	0..255	Value of above referenced Fault Buffer entry.
90	R -	HB: Size of Fault Buffer ventilation / heat-recovery	u8	0..255	The size of the fault history buffer for ventilation / heat-recovery system.
		LB: Not used	u8		-Reserved-
91	R -	HB: FHB-entry index no. ventilation / heat-recovery	u8	0..255	Index number of following Fault Buffer entry for ventilation / heat-recovery system.
		LB: FHB-entry value ventilation / heat-recovery	u8	0..255	Value of above referenced Fault Buffer entry for ventilation / heat-recovery system.
107	R -	HB: Size of Fault Buffer Solar Storage	u8	0..255	The size of the fault history buffer for Solar Storage.
		LB: Not used	u8		-Reserved-
108	R -	HB: FHB-entry index no. Solar Storage	u8	0..255	Index number of following Fault Buffer entry for Solar Storage.
		LB: FHB-entry value Solar Storage	u8	0..255	Value of above referenced Fault Buffer entry Solar Storage.

The first data-item (id=12) allows the master to read the size of the fault history buffer supported by the slave. The second data-item (ID=13) allows the master to read individual entries from the buffer.

Example

To read an entry from the fault history buffer, the master uses the following command:
READ-DATA (id=13,FHB-index,00).
The slave response will be either :
1. READ-ACK (id=13,FHB-index,FHB-value) Everything OK, the requested value is returned.
2. DATA-INVALID (id=13,FHB-index,00) The FHB-index is out-of-range or undefined, 00 is returned.
3. UNKNOWN-DATAID (id=13, FHB-index,00) The slave does not support a fault history buffer.

5.3.8 Class 8 : Control of Special Applications

5.3.8.1 Cooling Control

ID	Msg	Name	Type	Range	Description
7	- W	Cooling control signal	f8.8	0..100%	Signal for cooling plant.

The cooling control signal is to be used for cooling applications. First the master should determine if the slave supports cooling by reading the slave configuration. Then the master can use the cooling control signal and the cooling-enable flag (status) to control the cooling plant. The status of the cooling plant can be read from the slave cooling status bit.

5.3.8.2 Boiler Sequencer Control

ID	Msg	Name	Type	Range	Description
14	- W	Maximum relative modulation level setting	f8.8	0..100%	Maximum relative boiler modulation level setting for sequencer and off-low&pump control applications.
15	R -	Maximum boiler capacity & Minimum modulation level HB : max. boiler capacity LB : min. modulation level	 u8 u8	 0..255kW 0..100%	 expressed as a percentage of the maximum capacity.

The boiler capacity level setting is to be used for boiler sequencer applications. The control Setpoint should be set to maximum, and then the capacity level setting throttled back to the required value. The default value in the slave device should be 100% (i.e. no throttling back of the capacity). The master can read the maximum boiler capacity and minimum modulation levels from the slave if it supports these.

5.3.8.3 Remote override room Setpoint

ID*	Msg. Type	NAME	Format	Range	DESCRIPTION
9	R -	Remote Override Room Setpoint	f8.8	0..30	0= No override 1..30= Remote override room Setpoint
39	R -	Remote Override Room Setpoint 2	f8.8	0..30	0= No override 1..30= Remote override room Setpoint 2
99	R W	LB: Remote Override Operating Mode Heating	special	0..255	Bit0..3: Operating Mode HC1 (0..15) 0 = No override 1 = Auto (time switch program) 2 = Comfort 3 = Precomfort 4 = Reduced 5 = Protection (e.g. frost) 6 = Off 7…15 = reserved Bit4..7: Operating Mode HC2 (0..15) 0 = No override 1 = Auto (time switch program) 2 = Comfort 3 = Precomfort 4 = Reduced 5 = Protection (e.g. frost) 6 = Off 7…15 = reserved

		HB: Remote Override Operating Mode DHW	special	0..255	Bit0..3: Operating Mode DHW (0..15) 0 = No override 1 = Auto (time switch program) 2 = Anti-Legionella 3 = Comfort 4 = Reduced 5 = Protection (e.g. frost) 6 = Off 7…15 = reserved Bit4..7: Process bits DHW (Bitset) [clear/0;set/1] Bit4 = Manual DHW push2 [no push; push] Bit5..7 = reserved (set to 0)
100	R -	LB: Remote Override Room Setpoint function	flag8	0..255	*bit: description [clear/0, set/1]* 0: Manual change priority [disable overruling remote Setpoint by manual Setpoint change, enable overruling remote Setpoint by manual Setpoint change] 1: Program change priority [disable overruling remote Setpoint by program Setpoint change, enable overruling remote Setpoint by program Setpoint change] 2: reserved 3: reserved 4: reserved 5: reserved 6: reserved 7: reserved
		HB: reserved	u8	0	reserved

Note's to Remote Override Room Setpoint (ID9, ID39 and ID100):
There are applications where it's necessary to override the room Setpoint of the master (room-unit).
For instance in situations where room controls are connected to home or building controls or room controls in holiday houses which are activated/controlled remotely.

The master can read on Data ID 9 the remote override room Setpoint. A value unequal to zero is a valid remote override room Setpoint. A value of zero means no remote override room Setpoint. ID100 defines how the master should react while remote room Setpoint is active and there is a manual Setpoint change and/or a program Setpoint change.

On ID39, the master can read the Remote Override Room Setpoint of a second zone (comparable to ID9).

The master can read on Data ID 99 (proposal) the remote override Operating Modes. A value unequal to zero is a valid remote override Operating Mode. A value of zero means no remote override Operating Mode.

Note's to Remote Override of Operating Modes for CH and DHW:
With the 'No Override' feature for Heating and DHW you are able to change Heating or DHW only.

'Manual DHW-push' means: rise the DHW temperature once to Comfort level and return to previous Operating Mode (for DHW storage tanks)

The Operating Modes are choosen according to prEN 15'500 with some extensions.

5.4 Data-Id Overview Map

Nr.	Msg	Data Object	Type	Description
0	R -	Status	flag8 / flag8	Master and Slave Status flags.
1	- W	Tset	f8.8	Control Setpoint i.e. CH water temperature Setpoint (°C)
2	- W	M-Config / M-MemberIDcode	flag8 / u8	Master Configuration Flags / Master MemberID Code
3	R -	S-Config / S-MemberIDcode	flag8 / u8	Slave Configuration Flags / Slave MemberID Code
4	- W	Remote Request	u8 / u8	Remote Request
5	R -	ASF-flags / OEM-fault-code	flag8 / u8	Application-specific fault flags and OEM fault code
6	R -	RBP-flags	flag8 / flag8	Remote boiler parameter transfer-enable & read/write flags
7	- W	Cooling-control	f8.8	Cooling control signal (%)
8	- W	TsetCH2	f8.8	Control Setpoint for 2e CH circuit (°C)
9	R -	TrOverride	f8.8	Remote override room Setpoint
10	R -	TSP	u8 / u8	Number of Transparent-Slave-Parameters supported by slave
11	R W	TSP-index / TSP-value	u8 / u8	Index number / Value of referred-to transparent slave parameter.
12	R -	FHB-size	u8 / u8	Size of Fault-History-Buffer supported by slave
13	R -	FHB-index / FHB-value	u8 / u8	Index number / Value of referred-to fault-history buffer entry.
14	- W	Max-rel-mod-level-setting	f8.8	Maximum relative modulation level setting (%)
15	R -	Max-Capacity / Min-Mod-Level	u8 / u8	Maximum boiler capacity (kW) / Minimum boiler modulation level(%)
16	- W	TrSet	f8.8	Room Setpoint (°C)
17	R -	Rel.-mod-level	f8.8	Relative Modulation Level (%)
18	R -	CH-pressure	f8.8	Water pressure in CH circuit (bar)
19	R -	DHW-flow-rate	f8.8	Water flow rate in DHW circuit. (litres/minute)
20	R W	Day-Time	special / u8	Day of Week and Time of Day
21	R W	Date	u8 / u8	Calendar date
22	R W	Year	u16	Calendar year
23	- W	TrSetCH2	f8.8	Room Setpoint for 2nd CH circuit (°C)
24	- W	Tr	f8.8	Room temperature (°C)
25	R -	Tboiler	f8.8	Boiler flow water temperature (°C)
26	R -	Tdhw	f8.8	DHW temperature (°C)
27	R W	Toutside	f8.8	Outside temperature (°C)
28	R -	Tret	f8.8	Return water temperature (°C)
29	R -	Tstorage	f8.8	Solar storage temperature (°C)
30	R -	Tcollector	f8.8	Solar collector temperature (°C)
31	R -	TflowCH2	f8.8	Flow water temperature CH2 circuit (°C)
32	R -	Tdhw2	f8.8	Domestic hot water temperature 2 (°C)
33	R -	Texhaust	s16	Boiler exhaust temperature (°C)
34	R -	Tboiler-heat-exchanger	f8.8	Boiler heat exchanger temperature (°C)
35	R -	Boiler fan speed Setpoint and actual	u8 / u8	Boiler fan speed Setpoint and actual value
36	R -	Flame current	f8.8	Electrical current through burner flame [µA]
37	- W	TrCH2	f8.8	Room temperature for 2nd CH circuit (°C)
38	R W	Relative Humidity	f8.8	Actual relative humidity as a percentage
39	R -	TrOverride 2	f8.8	Remote Override Room Setpoint 2
48	R -	TdhwSet-UB / TdhwSet-LB	s8 / s8	DHW Setpoint upper & lower bounds for adjustment (°C)
49	R -	MaxTSet-UB / MaxTSet-LB	s8 / s8	Max CH water Setpoint upper & lower bounds for adjustment (°C)
56	R W	TdhwSet	f8.8	DHW Setpoint (°C) (Remote parameter 1)
57	R W	MaxTSet	f8.8	Max CH water Setpoint (°C) (Remote parameters 2)
70	R -	Status ventilation / heat-recovery	flag8 / flag8	Master and Slave Status flags ventilation / heat-recovery

Nr.	Msg	Data Object	Type	Description
71	- W	Vset	- / u8	Relative ventilation position (0-100%). 0% is the minimum set ventilation and 100% is the maximum set ventilation.
72	R -	ASF-flags / OEM-fault-code ventilation / heat-recovery	flag8 / u8	Application-specific fault flags and OEM fault code ventilation / heat-recovery
73	R -	OEM diagnostic code ventilation / heat-recovery	u16	An OEM-specific diagnostic/service code for ventilation / heat-recovery system
74	R -	S-Config / S-MemberIDcode ventilation / heat-recovery	flag8 / u8	Slave Configuration Flags / Slave MemberID Code ventilation / heat-recovery
75	R -	OpenTherm version ventilation / heat-recovery	f8.8	The implemented version of the OpenTherm Protocol Specification in the ventilation / heat-recovery system.
76	R -	Ventilation / heat-recovery version	u8 / u8	Ventilation / heat-recovery product version number and type
77	R -	Rel-vent-level	- / u8	Relative ventilation (0-100%)
78	R W	RH-exhaust	- / u8	Relative humidity exhaust air (0-100%)
79	R W	CO2-exhaust	u16	CO2 level exhaust air (0-2000 ppm)
80	R -	Tsi	f8.8	Supply inlet temperature (°C)
81	R -	Tso	f8.8	Supply outlet temperature (°C)
82	R -	Tei	f8.8	Exhaust inlet temperature (°C)
83	R -	Teo	f8.8	Exhaust outlet temperature (°C)
84	R -	RPM-exhaust	u16	Exhaust fan speed in rpm
85	R -	RPM-supply	u16	Supply fan speed in rpm
86	R -	RBP-flags ventilation / heat-recovery	flag8 / flag8	Remote ventilation / heat-recovery parameter transfer-enable & read/write flags
87	R W	Nominal ventilation value	u8 / -	Nominal relative value for ventilation (0-100 %)
88	R -	TSP ventilation / heat-recovery	u8 / u8	Number of Transparent-Slave-Parameters supported by TSP's ventilation / heat-recovery
89	R W	TSP-index / TSP-value ventilation / heat-recovery	u8 / u8	Index number / Value of referred-to transparent TSP's ventilation / heat-recovery parameter.
90	R -	FHB-size ventilation / heat-recovery	u8 / u8	Size of Fault-History-Buffer supported by ventilation / heat-recovery
91	R -	FHB-index / FHB-value ventilation / heat-recovery	u8 / u8	Index number / Value of referred-to fault-history buffer entry ventilation / heat-recovery
93	R -	Brand	u8 / u8	Index number of the character in the text string ASCII character referenced by the above index number
94	R -	Brand Version	u8 / u8	Index number of the character in the text string ASCII character referenced by the above index number
95	R -	Brand Serial Number	u8 / u8	Index number of the character in the text string ASCII character referenced by the above index number
96	R W	Cooling Operation Hours	u16	Number of hours that the slave is in Cooling Mode. Reset by zero is optional for slave
97	R W	Power Cycles	u16	Number of Power Cycles of a slave (wake-up after Reset), Reset by zero is optional for slave
98	- W	RF sensor status information	special / special	For a specific RF sensor the RF strength and battery level is written
99	R W	Remote Override Operating Mode Heating/DHW	special / special	Operating Mode HC1, HC2/ Operating Mode DHW
100	R -	Remote override function	flag8 / -	Function of manual and program changes in master and remote room Setpoint
101	R -	Status Solar Storage	flag8 / flag8	Master and Slave Status flags Solar Storage
102	R -	ASF-flags / OEM-fault-code Solar Storage	flag8 / u8	Application-specific fault flags and OEM fault code Solar Storage
103	R -	S-Config / S-MemberIDcode Solar Storage	flag8 / u8	Slave Configuration Flags / Slave MemberID Code Solar Storage

Nr.	Msg	Data Object	Type	Description
104	R -	Solar Storage version	u8 / u8	Solar Storage product version number and type
105	R -	TSP Solar Storage	u8 / u8	Number of Transparent-Slave-Parameters supported by TSP's Solar Storage
106	R W	TSP-index / TSP-value Solar Storage	u8 / u8	Index number / Value of referred-to transparent TSP's Solar Storage parameter.
107	R -	FHB-size Solar Storage	u8 / u8	Size of Fault-History-Buffer supported by Solar Storage
108	R -	FHB-index / FHB-value Solar Storage	u8 / u8	Index number / Value of referred-to fault-history buffer entry Solar Storage
109	R W	Electricity producer starts	U16	Number of start of the electricity producer.
110	R W	Electricity producer hours	U16	Number of hours the electricity produces is in operation
111	R	Electricity production	U16	Current electricity production in Watt.
112	R W	Cumulativ Electricity production	U16	Cumulative electricity production in KWh.
113	R W	Un-successful burner starts	u16	Number of un-successful burner starts
114	R W	Flame signal too low number	u16	Number of times flame signal was too low
115	R -	OEM diagnostic code	u16	OEM-specific diagnostic/service code
116	R W	Successful Burner starts	u16	Number of succesful starts burner
117	R W	CH pump starts	u16	Number of starts CH pump
118	R W	DHW pump/valve starts	u16	Number of starts DHW pump/valve
119	R W	DHW burner starts	u16	Number of starts burner during DHW mode
120	R W	Burner operation hours	u16	Number of hours that burner is in operation (i.e. flame on)
121	R W	CH pump operation hours	u16	Number of hours that CH pump has been running
122	R W	DHW pump/valve operation hours	u16	Number of hours that DHW pump has been running or DHW valve has been opened
123	R W	DHW burner operation hours	u16	Number of hours that burner is in operation during DHW mode
124	- W	OpenTherm version Master	f8.8	The implemented version of the OpenTherm Protocol Specification in the master.
125	R -	OpenTherm version Slave	f8.8	The implemented version of the OpenTherm Protocol Specification in the slave.
126	- W	Master-version	u8 / u8	Master product version number and type
127	R -	Slave-version	u8 / u8	Slave product version number and type

All data id's not defined above are reserved for future use.

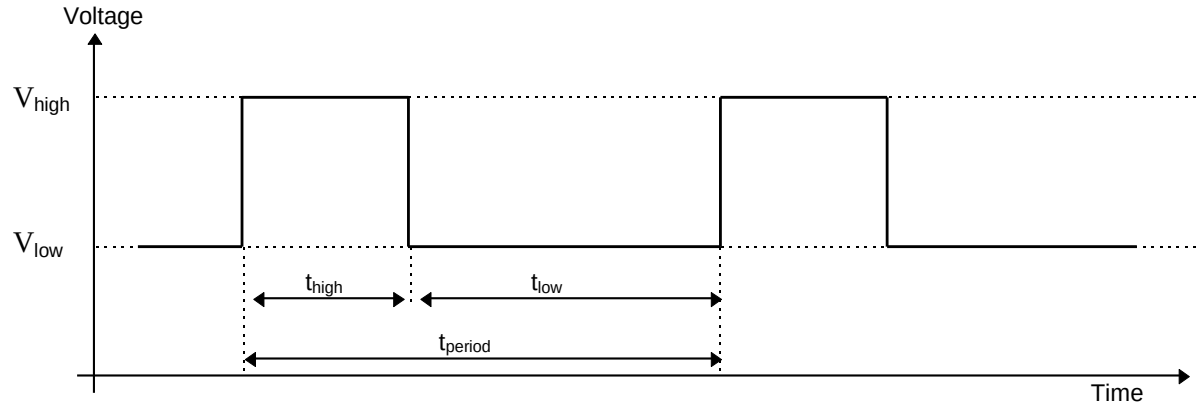
6. OpenTherm/Lite Data Encoding and Application Support

IMPORTANT: As of OpenTherm version 4.1 OpenTherm/Lite – OT/- is no longer being tested or certified and has been demoted to legacy functionality, it should not be incorporated in new designs

OpenTherm / Lite uses the same medium and physical signalling levels as OpenTherm/plus as described in section 3. It can be implemented using the same hardware as for OT/+.

6.1 Room Unit to Boiler Signalling

The room unit transmits a PWM signal to the boiler.

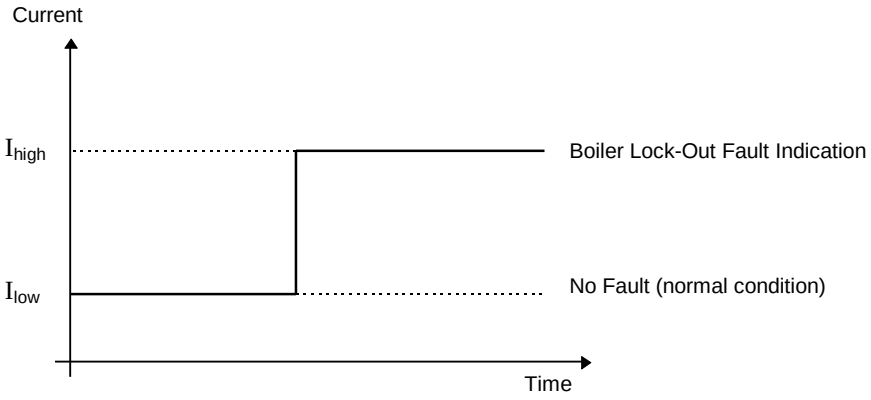


Duty Cycle (%) = t_{low} / t_{period} i.e. the % time over the period that the line is **low**.

The Duty Cycle Period (t_{period}) does not require to be constant. The frequency of the PWM signal must lie between 100Hz and 500Hz (2ms < t_{period} < 10ms). The duty cycle can vary between 0% and 100%.

6.2 Boiler to Room Unit Signalling

The boiler signals only by changing the current between the I_{low} and I_{high} states. The high current state represents the presence of a boiler lock-out fault. Different from OpenTherm/plus, it can permanently keep the line in the high current state. It is mandatory for the room and boiler controller to support the transmission and detection of this feature.

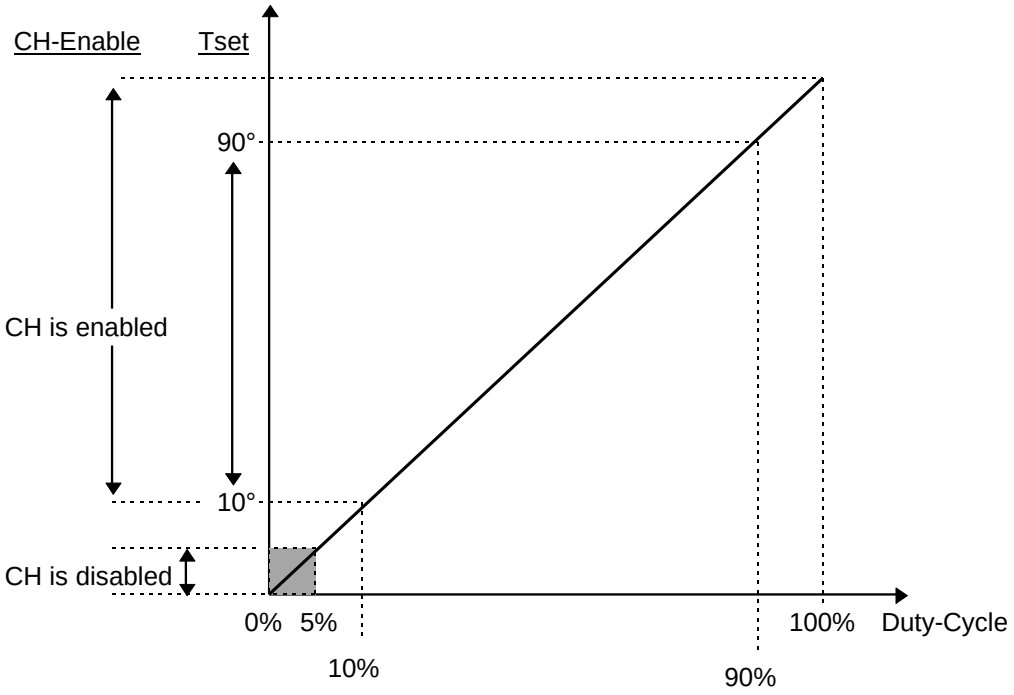


6.3 OT/- Application Data Equivalence to OT/+

The PWM voltage signal sent from the room unit to the boiler unit, principally represents the water temperature Control Setpoint It is mandatory for both the room and boiler units to support the transmission and detection of this signal.

OpenTherm/Lite supports the following application data items, which are shown with their equivalent OT/+ Application Data-IDs.

OpenTherm/Lite Data Item	**Equivalent OT/+ Data Item and Data-ID**	
Tset Control Setpoint *(mandatory)*	id=1	Tset Control Setpoint *(mandatory)*
CH-Enable *(mandatory)*	id=0, bit 0.0 *(mandatory)*	Master Status : CH-Enable flag
Boiler Lock-Out Fault *(mandatory)*	id=0, bit 1.0	Slave Status : Fault Indication *(mandatory)*



The tolerance of both generation and measurement of the Duty-Cycle signal should be less than ±2%.

A Duty-Cycle less than 5% is used to indicate a CH-disabled state (i.e. “positive-off” or no CH-demand condition). It is not mandatory for the boiler controller to support this feature, or for the room unit to use it.