THERM
CASCADE BOILER ROOMS

CASCADE CONTROL SYSTEM FOR THERM TRIO 90(T), DUO 50(T), (FT), 20 and 28 (LX, LXZ, TLX, TLXZ), 14 (X, XZ, KX, TX, TXZ, TKX) BOILERS (with DIMS01 –TH01 automatics)

1. WHAT IS A CASCADE SYSTEM

A cascade is a connected system of more Therm boilers. Its unique way of connection and the construction of Therm boilers allow continuous increase of the installed output starting at 35% of nominal capacity of the smallest boiler. If more capacity is required (up to 1MW) the cascade system has many advantages. Especially, using Therm DUO 50(T) or TRIO 90 is highly advantageous because of the relatively little used space and the high installed output, with all the advantages of a cascade and its continuous output modulation maintained. However, not only DUO or TRIO boilers can be used in a cascade. THERM DUO 50(T) and THERM TRIO 90 can be combined with other THERM boilers and in this way, the system can be adapted to the calculated heat loss of the building and to the DHW need. In the field of heating system technology, the cascade system is a pioneering method of optimizing installations with high output. Instead of one boiler with high capacity which would have to work as a whole even when only little output is demanded, in the cascade system as many boilers as you need at the moment will work. The number of boilers to work is controlled electronically.

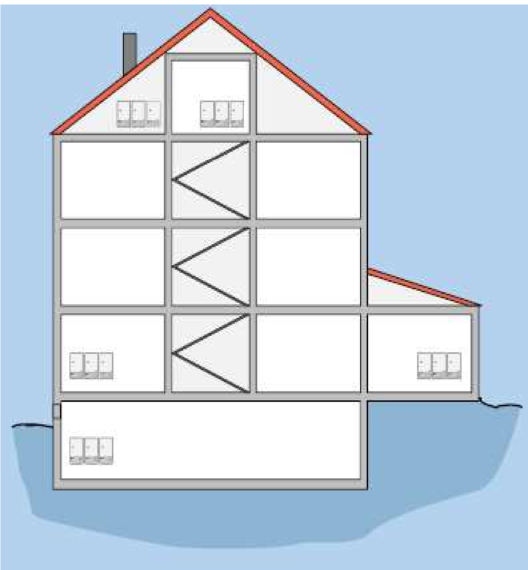
Experience proves that 80% of time in the heating season the boiler capacity is used at only 50%. During the entire season the boiler is used at only 30%. It means bad use and inefficient operation. As obvious, a cascade system provides the immediate needed capacity by connecting more “small” boilers as opposed to one big boiler with inefficient operation at small outputs. The cascade programmed control removes the troubles of setting the optimum ration of the system capacity and heat consumption. The wide range of control enables long-time operation with lower heating water temperatures, which reduces the losses caused by emissions and the losses arising when the system is in the emergency mode. This enhances use of the system and makes the conditions in the heated environment more pleasant, in other words, this improves the user’s comfort.

The consistent use of information technologies makes a control optimising the boiler room performance in every moment possible. So far, the boiler room operation was controlled by an expensive system of cascade controllers. Using a communication interface, which enables the information transfer among the boilers and also a continuous output modulation of all boilers at the same time, has been a major step. It means not only that the boilers can achieve the most efficient output at any moment of the operation but also that there is an immediate access to current information and possible analysis of any problem which could arise. A today’s cascade boiler room is really intelligent equipment which works independently, without a “fallible” man’s intervention.

The solution with a clever use of standard hardware and software at reasonable prices is then accessible for everybody.

Cascade boiler rooms are the best response for the acute demand for optimum solution for current problems of middle-sized and small heat and DHW consumers. They are of a great interest to both professionals and investors because of their basic advantages:

- exceptionally advantageous investment
- uniquely economical operation
- fully automated operation
- environment-friendly
- high operational reliability
- simple and easy technical solution
- little used space – saves floor space
- adapted for possible external DHW tank connection



The fact the cascade boiler room does not require any special location means it can be placed almost anywhere. Installing boilers in the loft saves space and removes the need of a high chimney because of bad atmospheric conditions.

It is possible to use several THERM DUO 50, 50T boiler units (up to 16 units in one cascade system, which means the maximum output of 720 kW) or THERM TRIO 90 (up to 10 units in one cascade system, which means the maximum output of 1 MW). A tailor-made cascade system then provides an optimum heat source and it is the required compromise between an individual and central (external) heat delivery for flats and facilities. To sum up, the cascade boiler rooms can be set up quickly using pre-prepared modules, they can be reconstructed while the boiler room is fully operational, they are easy to service and maintain and they have long life; last but not least, their surrounding remains untouched with no non-aesthetic external distribution nets. Moreover, THERM boiler cascade can be located at almost any place. Since the start of the THERM boilers development and their cascading in 1993, it has been attracting attention of experts both in the Czech Republic and abroad. Cascade boiler rooms have been awarded many prestigious professional prizes, mainly because of their flexible innovations and immediate use in the practice. Nowadays, they are the unrivalled technological top in their category, thanks to the perfect programming and unlimited communication possibilities. If you are interested, you can get the best idea of the cascade boiler room economy at www.thermona.cz where some examples of the real installations including the assessment of their costs and return on investment are provided.

2. DESIGNING A CASCADE SYSTEM

When designing a cascade, it is necessary to consider the following points:

2.1 Calculate the heat need from the point of view of heat transmission of the installed heating system, which has to correspond to the cascade capacity.
The number of boilers is to be determined in relation to this capacity.

2.2 Choose the location of heat sources.

2.3 Design the composition and the dimensions of the individual hydraulic parts of the cascade system according to the cascade capacity.

2.4 Determine the bulk flow from the system capacity and determine the output of the main circulation pump behind the hydraulic equalizer of dynamic pressures.

2.5 Design the flue exhaust, or a common collector.

2.6 The control, the operations and the setting of the cascade.

2.1 Calculating the number of boilers

The basic data for designing a boiler room, for choosing the wiring diagram and for dimensioning all the equipment is the installed capacity of boilers, which is called the connecting heat output of the heat source. That is the heat output necessary to cover the heat losses of the building and the heat needs of other appliances (DHW heating, airing, etc.). The boiler room capacity is not just the sum of all maximum power requirements because the heat consumption changes with time; it has to be determined individually. Norm **ČSN 06 0310** provides the calculation for these kinds of operation.

1. Heating a facility with interrupted airing and DHW heating.

$$\mathbf{Q_{PRIP} = 0.7 \times Q_{TOP} + 0.7 \times Q_{AIR} + Q_{DHW}} \text{ (W, kW)}$$

2. Heating a facility with permanent airing or permanent technological heating.

$$\mathbf{Q_{PRIP} = Q_{TOP} + Q_{VT}} \text{ (W, kW)}$$

3. Heating a facility and DHW heating with a through-flow system with preferential DHW.

Q_{PRIP} = the higher value out of the need for heating or DHW heating.

where:

Q_{PRIP} – installed boilers capacity (total boiler room capacity) (W, kW)
Q_{TOP} – facility heat loss with local external calculated temperature (W, kW)
Q_{AIR} – heat input of air-conditioning technology (forced airing) (W, kW)
Q_{DHW} – heat input of DHW heating (W, kW)
Q_{VT} – heat input for airing or technological heating

It is recommendable to give the design of boiler room capacity great attention. The calculation of the heat consumption and the heat loss is often underestimated and the result is a boiler room with over-dimensioned boilers or with insufficient capacity. This leads to inefficient and uneconomical operation and useless increase of investment costs or the heat source is considered insufficient by the user.

It is especially necessary to proceed carefully and properly when reconstruction solid fuel boiler rooms, where the installed output of the current boilers is in almost every case over-dimensioned, sometimes by more than 100%.

2.2 Choosing the location of heat sources

It is necessary to use the diagram of the heating system to consider if a central heating system or a system of more decentralized groups of boilers with calculated outputs is more convenient. The decentralization can be more suitable because of easier control and lowering of hydraulic and heat losses in the system. Also, it is necessary to decide what kind of flue exhaust will be more convenient – a common chimney or an exhaust of every individual boiler etc. Moreover, the kind of airing needs to be considered and adapted to the kind of boilers.

2.3 Designing the individual hydraulic parts of the cascade system

Several basic technical regulations need to be observed when designing and installing a cascade system. If these are met, you will avoid some basic mistakes that could later influence the use of the system. Especially, these points need to be given attention:

- non-return flap valve, filter, draining and closing valve under each boiler
- hydraulic distributor + hydraulic equalizer of dynamic pressures (HEDP)
- safety device
- DHW heating solution
- the main circulation pump in the secondary circuit (see the following chapter)

Non-return flap valve

There must be a non-return flap valve under each boiler in the cascade. The valve when the excess pressure is about 20 mbar. It is installed to prevent heat losses that could be caused by the emission of heat over the heat exchangers that are not operational at the moment.

Filter

It is strongly advisable to use filters in the system. There is a lot of dirt, impurities, rust and stone, especially in the older heating systems. Filters prevent the dirt from getting to boilers and their damage. Filters need to be place in the non-return valve of every boiler. Besides these filters that are located under each boiler, there can be a system filter. This one is located in the return branch of the primary circuit in front of the hydraulic equalizer of dynamic pressures.

Draining valve

We recommend placing a draining valve under each boiler in the cascade. This will be especially convenient for service technicians in cases of emergency or even a regular check. Draining valves are related to closing valves.

Closing valves

Installing closing valves is a very good investment. These valves are located on the inlet and outlet of the heating water from the boiler and they allow the user to close the inlet of heating water to the boiler, which then can be easily drained using the draining valve. *These valves can be used only when the boiler is disconnected and unoperational, e.g. because of maintenance work! The valves should never be used when the boiler is running!*

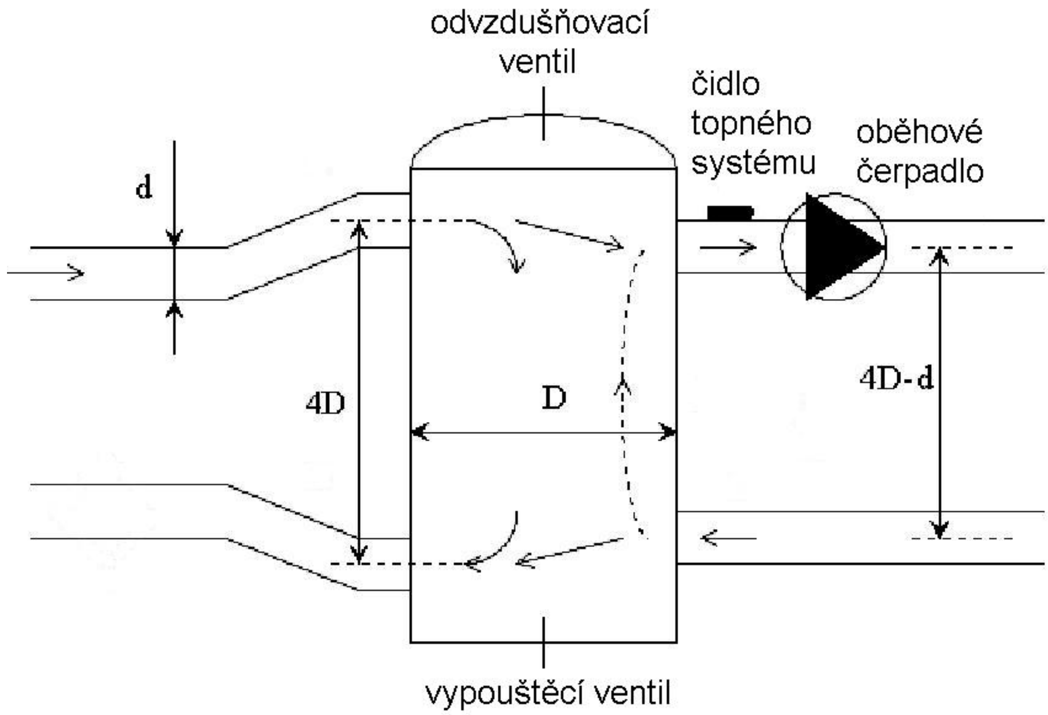
Hydraulic distributor + hydraulic equalizer of dynamic pressures (HEDP)

If the cascade system is to work properly, it is necessary to separate the boiler circuit and the heating circuit because the bulk flow of boiler circuit water is variable dependent on the number of working boilers. The bulk flow of the water in the heating circuit also changes when mixing valves are used to regulate independent heating zones. To separate the boiler circuit and the heating circuit, a hydraulic equalizer of dynamic pressured **HEDP** (torus) is used.

We recommend using a typified **hydraulic distributor with an integrated torus Thermset** for specific connection of hydraulic parts of **Therm** boiler cascade. The producer provides a wide range of distributors that can be chosen in relation to the number and the kind of connected boilers and the dimensions of the boiler rooms. Thermset hydraulic distributors are produced as a left version (HEDP on the left) and as a right version (HEDP on the right). These versions are further divided into Thermset LINE and Thermset BACK. Thermset LINE serves for easy connection of boilers located in a line. Thermset BACK is used to connect boilers standing in two lines with their back to each other. This system is used in cascades installed for example in the centre of a boiler room, where boilers are suspended on a common support frame.

A diagram of equalizer of dynamic pressures including the approximate recommended ratio dimensions:

deaerating valve - heating system sensor - circulation pump



draining valve

Examples of signs of Thermset hydraulic distributor types:

DUO THERMSET BACK 180 / 4

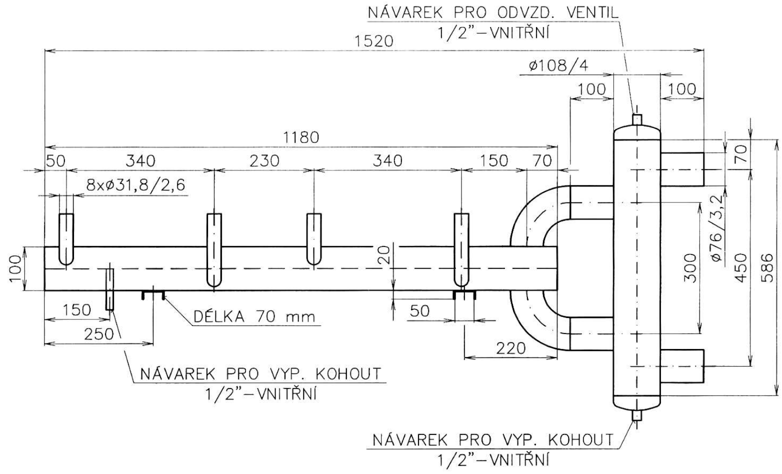
- 4 – Number of boilers in a cascade (4 units)
- 180 – Total cascade capacity (180 kW)
- BACK – Layout of boilers (Back - two lines with backs to each other)
- DUO – Type of boilers in the cascade (Therm DUO 50)

TRIO THERMSET LINE L 360 / 4

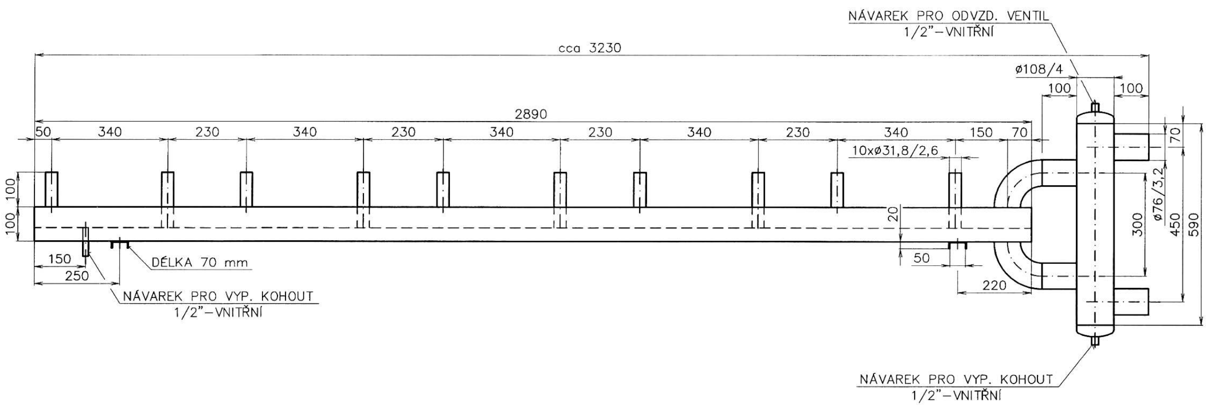
- 4 – Number of boilers in a cascade (4 units)
- 360 – Total cascade capacity (360 kW)
- L – Torus location (onthe left)
- LINE – Layout of boilers (Line - in one line)
- TRIO – Type of boilers in the cascade (Therm TRIO 90)

EXAMPLES OF THERMSET HYDRAULIC DISTRIBUTOR VERSIONS

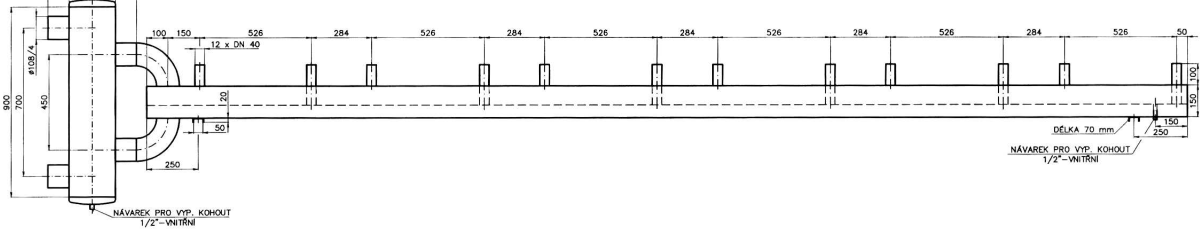
DUO THERMSET BACK 180/4



DUO THERMSET LINE P 225/5



TRIO THERMSET LINE L 540/6



Safety system of the boiler room

The system of the heat source (a boiler room and the heating system) is directed by valid regulations (**ČSN 06 0830**). Its current version makes designers quite free as far as the safety precautions are concerned. The total volume of water in the heating system changes with its temperature. Water cannot be compressed and when heated up its volume increases. The extra volume needs extra space. For these reasons, expansion vessels are used to “store” the extra volume and a safety device prevents the system from exceeding the allowed pressure.

To calculate the expansion vessel volume, the dimension of the safety pipings and to design the safety valve use the calculations included in valid regulations (**ČSN 06 0830**).

The volume of the expansion vessel depends on the volume of heating media in the heating system!

When designing a new system of central heating, it is easy to calculate the water volume. The volume is then the sum of the volume of water in boilers, in pipings, in heating radiators and in other parts. The data on the water volume in individual parts are provided in project documents of their producers and the water volume in the piping can be calculated out of the tables of piping dimensions. Some producers of expansions vessels provide a simple application to calculate the heating media volume in the system; such an application can usually be downloaded free from their websites.

The trouble is if we need to find out the water volume in a current (old) heating system, which is virtually impossible given the lack of documents. When determining the water volume in current system, the experience and comparison with new systems are used. The volume is then recalculated to 1 kW of installed heating radiators (not the heat losses or boiler output!):

Systems with plate radiators.......................... 9 - 12 litres
Systems with sectional radiators..................14 - 16 litres
Systems with convectors................................ 7 - 9 litres

The lower value is applicable to smaller systems or to systems with forced heating water circulation and the higher value is applicable to larger systems or to systems with gravity circulation. Be aware, this is only an estimate, and it is necessary to proceed carefully and to consider all possible influences. Further, it is necessary to add the volume of the water in boilers! If in doubt, it is better to consider higher volumes. Under-dimensioned expansion vessel would cause considerable troubles with operational pressure fluctuation (which can cause an accident), an over-dimensioned expansion vessel is “only” more expensive, but the heating system can then work without troubles.

DHW heating

As the introduction chapter has shown, the Therm cascade can also provide a reliable and efficient solution for DHW heating. Heating DHW is in some ways specific, which is necessary to observe. The basic rules to calculate the DHW heating equipment are stated in valid regulations (**ČSN 06 0320**).

Other specific points:

- the boiler is connected to the tank via a three-way valve (see the photo)

- the time the three-way valve needs to reset itself must be **maximum** 8 seconds

- the connection needs to be as close under the boiler as possible

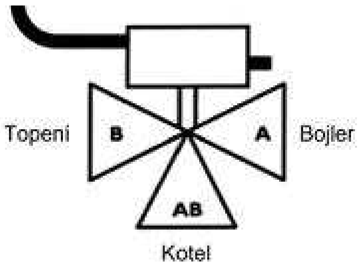
- the output of the boiler connected to the DHW tank should correspond with the output of the heater or heat exchanging surface in the tank. If the boiler is over-dimensioned in relation to the heater, the heating water in this circuit is overheated and the boiler starts cycling.

- DHW heating can be provided by all controlled boilers. Only the controlling boilers cannot heat up a tank.

Example: *A cascade consists of 5 DUO 50 boilers. One boiler is the controlling one – superior to the others. The other four boilers are controlled. It means all the four boilers can be connected to a DHW tank over a three-way valve.*

<u>*Terms such as a controlling boiler, a controlled boiler etc. are defined in the chapter Control.*</u>

- the three-way valve needs to be connected in the following way (see fig.):



- DHW heating is always dominant over the heating system; it means if the DHW temperature falls, the boiler resets the valve from the heating system to the tank heater and starts heating DHW.

Time of heating water in Therm tanks

The following table was created out of empirical measuring of time needed to heat up a tank when the tank was filled with cold water (10°C) and then heated up to the temperature set be the tank thermostat (60°C). Times are indicated in minutes.

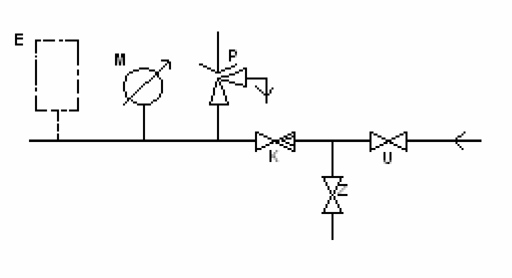
Tank type	DHW volume [l]	DHW heated by °C	Heater capacity [kW]	Boiler capacity [kW]				
				14	20	28	45	90
				the time of tank heat-up in minutes				
OKC 40 NTR	38	50	14	10	-	-	-	-
Therm 40	36	50	22.4	9	6	6	unsuitable	unsuitable
Therm 55 stainless	55	50	25	13	9	7	unsuitable	unsuitable
Therm 60	58	50	17	13	9	unsuitable	unsuitable	unsuitable
Therm 100	95	50	24	25	17	14	unsuitable	unsuitable
OKC 125 NTR	120	50	24	29	20	17	unsuitable	unsuitable
OKC 160 NTR	160	50	24	38	27	22	unsuitable	unsuitable
OKC 200 NTR	210	50	24	38	27	22	unsuitable	unsuitable
OKC 200 NTRR	200	50	48	48	34	24	14	unsuitable
OKC 300 NTRR	292	50	72	70	49	35	22	unsuitable
OKC 400 NTRR	380	50	82	91	64	46	28	16
OKC 500 NTRR	470	50	98	113	79	56	35	18
OKC 750 NTRR	731	50	93	175	123	88	54	27
OKC 1000 NTRR	958	50	100	229	161	115	71	36

For DHW consumption in litres we can use the following values:

The type of facility	Some specifications	Consumption min.-max.:
flats	work days	100–110 l/person/day
	weekends	140-160 l/person/day
lodging houses	with showers	90-110 l/person/day
	with a kitchen in the building	120-130 l/person/day
hotels	including staff	130-200 l/person/day
camps, restaurants	including staff	80-100 l/person/day
kitchens		10 l/meal
schools	including staff	20-30 l/pupil
sports facilities with showers		50-70l/person/day
roofed swimming pools		60-100 l/customer
industrial buildings	clean workshops	20-25 l/person/day
	engineering industry	35-50 l/person/day
	dirty and dusty workshops	50-60 l/person/day
	hot and dusty workshops	80-100 l/person/day

Connecting the tank to cold water inlet

The connection must be carried out in compliance with valid regulations (**ČSN 06 0830**) – for safety precautions of central heating and DHW heating, will all fittings (see fig.)



U-closing tap at the cold water inlet
Z-testing tap
K-return valve
P-safety valve
M-manometer
E-expansion vessel (recommended)

Besides these necessary fittings it is possible to fit **an expansion vessel** to the cold water inlet, which will cover the DHW expansion when the tank is being heated up and will prevent opening the safety valve. However, it is necessary to use an expansion vessel designed for this purpose! Never can be used an expansion vessel for heating systems! (different pressures, different material…)

The tanks without a draining hole have to be fitted with T piece with a draining valve at the DHW inlet. Tank exchanger is fitted to the heating water source (e.g. a gas boiler) and the thermostat controls DHW heating. If the three-way valve and the pump are connected suitably, the heating water source heats up the domestic water automatically and the DHW heating is dominant over “space” heating. To reach the demanded DHW temperature set on the thermostat, the heating water temperature must be min. 5°C higher (15°C is recommended). Tanks work on a pressure basis. There is a permanent water pressure in the tank. In this way, DHW can be taken to locations with a higher pressure fall from the tank. If the DHW distribution net is long, we recommend using a circulation system. All connecting nets need to be properly insulated.

Cold water is to be connected to the inlet marked with a blue ring or a sign "VSTUP TUV" = “DHW INLET”. The safety valve is to be fitted according to the manual. Hot water is to be connected to the outlet marked with a red ring or a sign "VÝSTUP TUV" = “DHW OUTLET”. The heating circuit is connected to the marked inlets and outlets of the heater exchanger and the deaerating valve is fitted to the topmost spot.

Electrical connection of the DHW tank to the boiler

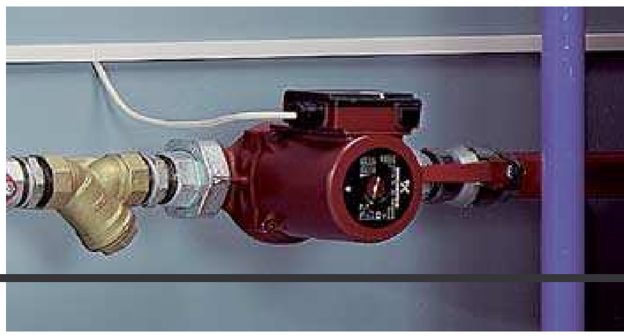
Type 14, 20, 28, DUO 50 boiler with a closing voltage of tank thermostat 24V DC are only connected with the tank by a twisted pair (this must be a cable, not a wire!) and they require a tank thermostat with **gilded contacts**. Boilers marked LO have the closing voltage of tank thermostat 230V/50Hz. With this voltage, it is necessary to use a twin and earth cable with double insulation, to connect by protection green/yellow conductor and to carry out protective interconnection. Boilers marked EZ/B sense the DHW in temperature in the THERM 100/B tank by NTC resistance sensor wound in the rear part of the boiler.

The tank must be earthed with proper connection of earth conductor at the fastening bolt.

For more information on tank products go to www.thermona.cz.

2.4 Designing the system pump

It is quite easy to design the right system pump but it cannot be underestimated. An over-dimensioned pump can cause troubles as well as an under-dimensioned one. The heat input to the central heating system and the heat drop of water determines the needed volume of heating water and the pump needs to provide its circulation. The appropriate pump can be chosen from the catalogues of producers of pumps; this pump’s characteristics should correspond to the required capacity parameters for the



transported amount. The optimum operational point is selected on the operational curve of the pump; the point determines the pressure the pump can provide for the transported amount. This pressure is then considered when calculating the rest of the central heating system for the hydraulic calculations of the piping. Thus, the operational point of the pump and the operational characteristics of the system are determined. On the basis of the transport output, the weight transported amount m_{dop} (kg/sec) or the volume transported amount m_{obj} (l/sec) of the pump are set.

The basic relation of the heat usable from the heating water is expressed as a relation of the weight volume of water, specific heat water capacity (specific heat) and temperature difference (water cooling when heat is transferred):

$$Q = m_{dop}.c.\Delta t \qquad \text{(J)}$$

When modified, we can acquire the relation for the calculation of water weight with the set volume of heat we can get from water when cooling it. The water weight can be calculated using this formula:

$$m_{dop} = \frac{Q}{c.\Delta t} \qquad \text{(kg)}$$

where:

Q = transferred heat volume (J)
m_{dop} = weight of water (kg)
c = water specific heat (J/kg.°K); when the water temperature is medium tm = 80 °C then c = 4230 J/kg.°K
Δt = water cooling – the difference between the inlet and the outlet temperature – after heat transfer (°C)

2.5 Designing flue exhaust

The basic guideline for calculating a common chimney is a valid norm (**ČSN EN 13384-2**). The calculation of the flue exhaust carried out in compliance with the guideline expects a computer application to be used for every boiler room.

The issue of flue exhaust is often underestimated when reconstructions are carried out although the norm makes it clear that every flue exhaust must be calculated. The application that is often used to calculate a common chimney is one developed by ProTech, which also includes Therm boilers.

Some principles that have to be taken into consideration when designing a chimney:

- maximum of four appliances can be connected to one chimney ventilation pipe. If there are more boilers in the cascade, it is necessary to design more chimneys.

- for the calculation, the temperature conditions of the chimney and its pressure conditions are to be assessed individually.

- the chimney must be designed for all extreme conditions, i.e. for summer and winter, for minimum and maximum operation etc.

- DUO 50 T boilers cannot be connected to a common flue collector! (type B appliance) *If this condition is not met, the flue can escape to the neighbouring boiler over the exhaust interrupter!* The flue exhaust of DUO 50 T boilers needs to be carried out independently, using ∅80mm piping. The maximum possible length of the exhaust is then 5m.

The boilers used most frequently for cascades are Therm Duo 50(T) and Trio 90 boilers. These appliances are of type B – they have an open combustion chamber. Therefore, it is necessary to consider sufficient airing of the boiler room!

2.6 Control, functions and setting of a cascade

Description of controls

As the **cascade boiler rooms** with autonomous control using an interface are extremely popular, we are offering a new generation of this simple control that can use all the qualities of the boilers. The basic criterion was the possible use of highly advantageous qualities of **Siemens QAA 73.110** **communication controller**. This made us develop new interface for the control boiler of the cascade called **IU05q (when using the older Chronotherm CX 51 MC the interface is marked IU05)**, which transmits information not only among the other boilers in the cascade but also with **Siemens QAA 73.110**. The controller analyses the output temperature of the heating system, therefore, the regulation software was modified and the temperature sensor of the heating system was relocated to the torus outlet. At the same time, the communication among boilers (RS 485) has been expanded by operational and failure information from the control boilers to be indicated in the controller; in the future it will be possible to monitor the cascade operations from a computer. The modified interface for control boilers is marked **IU04.10**. Several changes have also been done to the boiler processor with a new control panel marked DIMS01-TH01. For the control boiler with **IU05** and controlled boilers with **IU04.10**, software version 1.00 MB and higher is necessary **(for TRIO 90 boilers v. 1.03 MB and higher**).

At the beginning of 2005 the production of Chronotherm CX 51 MC controller was finished and then it was sold out. Currently, we are offering Siemens QAA 73.110 controller, which has similar features and qualities. A detailed manual for this controller can be downloaded from www.thermona.cz.

For a very comfortable control of the cascade, there is a regulation system with **programmable Tronic 2008E controller**. This can provide an independent control of up to 6 regulation circuits and it is able to send orders via communication line and control the entire cascade according to their current needs. At the same time, it is able to collect operational data from technological circuits and from the cascade and present them (e.g. using a common serial interface RS232 or RS485, or a GSM gate or a modem) to a possible remote boiler room control centre. Other features of this controller: remote processing of signals, simple programming, remote comfortable graphic visualisation of parameters and their settings, data archiving and management, variable time programs etc. Examples – versions – of typical project cases that are already available in Thermona include *designs of **TRONIC 2008E** regulation system hw and sw equipment* and they can be adapted to the specific needs of the controlled technology, if the user wants more than the standard solution. **TRONIC 2008E** systems can be programmed on a PC in WINLEDA graphic environment. This comfortable software enables designers and users – not only programmers – to work with control program efficiently and without delays.

Typical examples of TRONIC 2008E control system for cascade boiler rooms:

Version no. 1: *2 heating branches regulated by weather compensation - analogue electric actuators 0-10V DC/24V*

- safety precautions of the boiler room – safety valve; signalization of flooding, gas leaks, fire; automatic refilling of heating circuit by solenoid valve; control of heating circuit pumps, of DHW circulation

Version no. 2: *2 heating branches regulated by weather compensation - three-point electric actuators 230V (e.g. Komextherm)*

- safety precautions of the boiler room - signalization of flooding, gas leaks, fire; control of heating circuit pumps

Version no. 3: *3 heating branches regulated by weather compensation - 2 analogue electric actuators. 0-10V DC/24V, 1 three-point electric actuator 230V*

- safety precautions of the boiler room - safety valve; signalization of flooding, gas leaks, fire; automatic refilling of heating circuit by solenoid valve; control of heating circuit pumps, of DHW circulation

Version no. 4: *4-6 heating branches regulated by weather compensation - analogue electric actuators 0-10V DC/24V*

- safety precautions of the boiler room - safety valve; signalization of flooding, gas leaks, fire; automatic refilling of heating circuit by solenoid valve; control of heating circuit pumps, of DHW circulation

Communication principles and its description:

Specifications:

- interface **IU05** is in contact with interface **IU04.10** via bipolar serial line (RS485)
- 8 bit DIP switch to set the number of boilers in the system and the operation mode
- 2 LED's at **IU05** signal the status of the serial communication line (RS485)

IU05 provides control of all the system in connection with:

- regulation electronics of the control boiler DIMS01-TH01 directly
- interface **IU04.10** of the controlled boilers via serial line (RS 485)
- controller QAA 73.110 (TRONIC 2008 E) using modified communication (Open-Therm)

The control boiler connected with IU05 does not allow for DHW tank heating, and these are connected to it:

- system temperature sensor – connection to DHW temperature sensor connectors (connector X9)
- system pump – connection over a closing relay to 3-way valve control terminals (connector X19)
- boiler room switch (either a closing contact of auxiliary regulation or a room thermostat) – connection to room thermostat connectors (terminal box X7)
- outside temperature sensor – (terminal box X6)

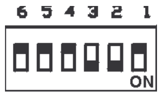
Interface IU05 cooperates with Siemens QAA 73.110 and they inform each other on:

- outside temperature
- heating temperature modulation (the demanded and the real temperature of the system)
- status or a failure of each boiler in the system (failure indication)
- enabling or disabling of DHW tank heating for every controlled boiler
- makes emergency mode possible if communication with QAA 73.110 (TRONIC 2008E) is interrupted

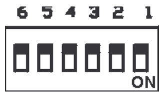
THERM CASCADE BOILER ROOMS

<u>Regulation with external controller Siemens QAA 73.110</u>
Interface – IU05 in control boiler, IU04.10 in controlled boilers
DIMS01-TH01 automatics setting:

- ***Using service buttons, set parameters 3 and 4 to zero in all boilers (pump run-down and anticycling time).***
- ***Control boiler: SW1 Outside temperature sensor connected, parameter switch (SW1) 1, 4, 5, 6 = OFF; 2, 3 = ON, room thermostat connector interconnected (it is possible to use the external contact for forced switch-off).***



Controlled boilers: Parameter switch (SW1) 1–6 = OFF, room thermostat connector interconnected.



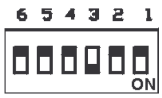
If you choose this kind of regulation, QAA 73.110 carries out all calculations of the demanded heating system temperature according to the chosen way of regulating (service setting). The value of the demanded temperature is transferred into interface IU05, where it is processed further in view of the demanded output of the boiler room (the ideal number of working boilers and the kind of their modulation are chosen). The information between the control and the controlled boilers is transmitted in both ways along a serial line (RS 485) with the help of interface IU04.10.

For the wiring between the boiler and the controller a double line is used with the max. length of 50 m and max. resistance of 2 x 5Ω. This wiring also provides the electric supply for the controller (it does not need batteries). To prevent any possible information transfer interference the wiring must not run in parallel with the supply distribution wires in the building. To be able to use the regulation's features it is necessary to connect the outside temperature sensor **THERM Q 01** into the appropriate terminal box of **the control boiler**.

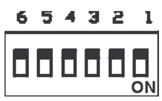
<u>Heating without the weather compensated regulation and without QAA 73.110</u>
Interface – IU04.10 in control boiler, IU04.10 in controlled boilers
Setting of DIMS01-TH01 v. 2.01MB and higher:

- ***Using service buttons, set parameters 3 and 4 to zero in all boilers (pump run-down and anticycling time).***

Control boiler: Outside temperature sensor not connected, parameter switch (SW1) 1, 2, 4, 5, 6 = OFF; 3 = ON, room thermostat connector interconnected (it is possible to use the external contact for forced switch-off).



- ***Controlled boilers: Parameter switch (SW1) 1 – 6 = OFF, room thermostat connector interconnected.***



The heating starts when the contacts of the room thermostat or of the auxiliary control switch on the control boiler close (if the room thermostat or the auxiliary regulation is not used, it is necessary to interconnect the terminal connectors of the room thermostat with a jumper) – if the mode switch is set to winter mode. If the heating system temperature is lower than the demanded temperature (control boiler temperature knob), the control boiler and the heating system pump are activated (over the closing relay). With the help of communication the control boiler then activates the controlled boilers according to their addresses.
When the demanded temperature is reached, it is maintained by continuous modulation of the boilers connected in the cascade, including the control boiler. The output of the earlier activated boilers will approximate the maximum, the last boiler (or the last two boilers) will only help to balance the output needed by more intensive modulation. If the regulation range of the last boiler is not sufficient and the heating system temperature starts increasing, the control boiler starts disconnecting the working boilers until the temperatures are balanced.

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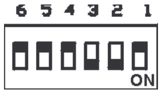
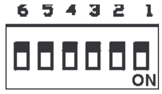
If the heating temperature exceeds the set value more considerably (for example by opening the contact of the night reduction), all the boilers are switched off. The system pump works for an hour after the last boiler is switched off.

<u>Heating with weather compensated regulation</u>
Interface – IU04.10 (or IU05 if the communication with the controller is interrupted) in the control boiler, IU04.10 in the controlled boilers
<u>Setting of DIMS01-TH01 v. 2.01MB and higher:</u>

- ***Using service buttons, set parameters 3 and 4 to zero in all boilers (pump run-down and anticycling time).***
- ***Control boiler: Outside temperature sensor connected, parameter switch (SW1) 1, 4, 5, 6 = OFF; 2, 3 = ON, room thermostat connector interconnected (it is possible to use the external contact for forced switch-off).***



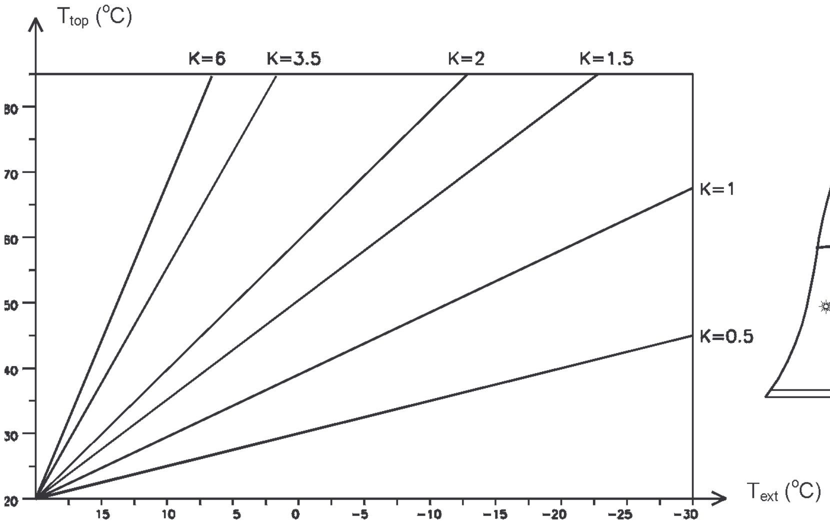
- ***Controlled boilers: Parameter switch (SW1) 1 – 6 = OFF, room thermostat connector interconnected.***

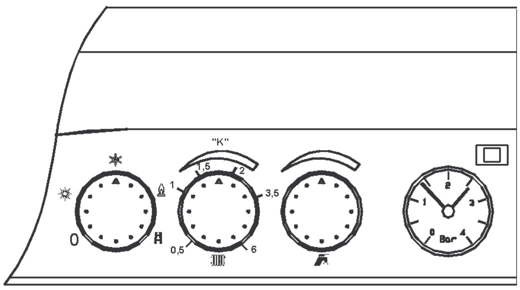


The boiler's operations are the same as in the mode mentioned in paragraph 1.1, the only difference being that the heating system temperature is set automatically according to the outside temperature (measured by the sensor). Calculation of the demanded heating system temperature is the function of the outside temperature and the function of **K** factor, which is set by the heating water temperature knob on the control panel of the control boiler, according to the following formula:

$$T_{top} = (20 - T_{ext}) * K + 20\ ^{o}C$$

T_{top} = heating water temperature
T_{ext} = outside temperature





System temperature reduction (only for IU04.10)

The night reduction is carried out by the change of the curve on the control boiler and its value is set by the DHW temperature knob in the range of 0 – 30 °C (by turning from the left to the right). The value of the night reduction is zero in the extreme left position. The night reduction starts when the contacts of the time switch, connected to X14 connectors = tank thermostat open (DHW tank heating is not enabled in the control boiler). If you do not use the night reduction, the connectors X14 must be connected by a jumper.

DHW heating in the tank

A DHW tank can be connected to each controlled boiler in the cascade by a three-way valve. This mode starts after tank thermostat (or auxiliary control) contacts close and this boiler is disconnected from the controlled cascade during heating the water. When tank heating is finished the boiler is connected again if required.

CONFIGURATION OF SWITCHES

Field 1 – setting the operation mode – IU05 only as the controlling, IU04 as the controlling or the controlled.

Field 2 up to Field 5 - in the control boiler - number of controlled boilers in the cascade
- in the controlled boiler - the address of the rank of the boiler in the cascade

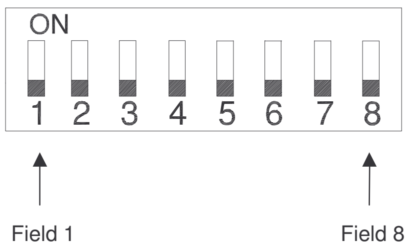
Field 6 - not used

Field 7 - in the control boiler - ON = heating system pump spin is disabled

Field 8 - in the control boiler - ON = rotation of boilers in the cascade is disabled

There has to be only one control boiler in the cascade.
The set number of controlled boilers (set on the control boiler) has to correspond to the real number of boilers in the cascade.

Field 1	FUNKCE KOTLE
OFF	IU04.10 as the controlled
ON	IU05, IU04.10 as the controlling



Example of an 8-boiler cascade:

Field 1	Field 2	Field 3	Field 4	Field 5	Rank of the boiler in the cascade	Address of the controlled boiler (Field 2– 5)	
ON	ON	ON	ON	OFF	1	controls 7 boilers	the control boiler
OFF	ON	OFF	OFF	OFF	2	1	1st controlled boiler
OFF	OFF	ON	OFF	OFF	3	2	2nd controlled boiler
OFF	ON	ON	OFF	OFF	4	3	3rd controlled boiler
OFF	ON	OFF	ON	OFF	5	4	4th controlled boiler
OFF	ON	OFF	ON	OFF	6	5	5th controlled boiler
OFF	OFF	ON	ON	OFF	7	6	6th controlled boiler
OFF	ON	ON	ON	OFF	8	7	7th controlled boiler

Anomalies

1. Serial communication failure

Each boiler which does not receive a signal from the serial line switches over to the local mode function after 1 minute.

2. Damage of temperature sensors

If a temperature sensor of the system is damaged (short circuit or disconnection) and the serial communication among boilers continues, all boilers are started gradually and they work according to the temperature set on the control boiler, or the temperature set in the controller. The control of boilers' output will operate in the whole range of their modulation.

DHW heating continues in the given boiler.

If the internal sensor of the heating temperature fails, the affected boiler (control or controlled) is disconnected from the cascade control (see the Boiler Service Manual).

If the outside temperature sensor is damaged, the system temperature control is set based on the control boiler setting or according to the controller (see manual for the controller).

Cascade control

1. Delayed ignition

In order to avoid more boilers being ignited at the same time in response to an impact requirement for heat increase, there is a variable time interval added to the connecting sequence of boilers in the cascade (according to difference of the demanded and the real temperature of the heating system in the range of 20 to 180 s). Therefore, the boilers ignite in the most suitable delay to reach the demanded temperature as soon as possible.

2. System pump

The system pump is activated just before the ignition of the first boiler in the cascade. It stops one hour after the last boiler in the cascade is switched off. After each 24 idle hours the control boiler interface (IU05 or IU04.10) activates the pump for 2 minutes (to avoid pump blocking). This function is optional and is set by dip-switch bit 7 setting (see setting).

Important: The heating system pump must be connected over 230V relay because of possible overloading of the noise filter on DIMS01-TH01. The relay coil is connected to connector X19 (pins 1 and 3) DIMS01-TH01 of the control boiler.

3. Cyclic rotation of boilers

To optimize the boilers' wear the system uses the cyclic rotation of boilers. The sequence of ignition of boilers is rotated once a day and it is enabled by setting of the dip-switch on the control boiler. If the bit 7 of the dip-switch is ON, the rotation is disabled – the control boiler is always the first in the sequence.

Example of 4 boilers (1 control and 3 controlled boilers):

Day	**Sequence of ignition**	**Sequence of switch-off**
1	0 – 1 – 2 – 3	3 – 2 – 1 – 0
2	1 – 2 – 3 – 0	0 – 3 – 2 – 1
3	2 – 3 – 0 – 1	1 – 0 – 3 – 2
4	3 – 0 – 1 – 2	2 – 1 – 0 – 3

4. The boiler room main switch

A boiler room switch (a superior controller, a limiting room thermostat etc.) can be connected to the control boiler's room thermostat terminals. If the contact closes, heating of the system is enabled. If it is opened, the heating is stopped but the pump spin (after 24h for 2 min.) and of course the antifreeze protection of individual boilers continue operating.

The same happens when the control boiler switches over to the summer mode (DHW heating is enabled).

5. Signalization of operation

Boiler:

Data flow (reception and transmission) between the boiler processor and the appropriate interface is signalled by a short flash of the red LED (LD2) on the boiler control panel when the cascade is operating. The flash is so short that no confusion with the failure indication can arise.

Interface IU05:

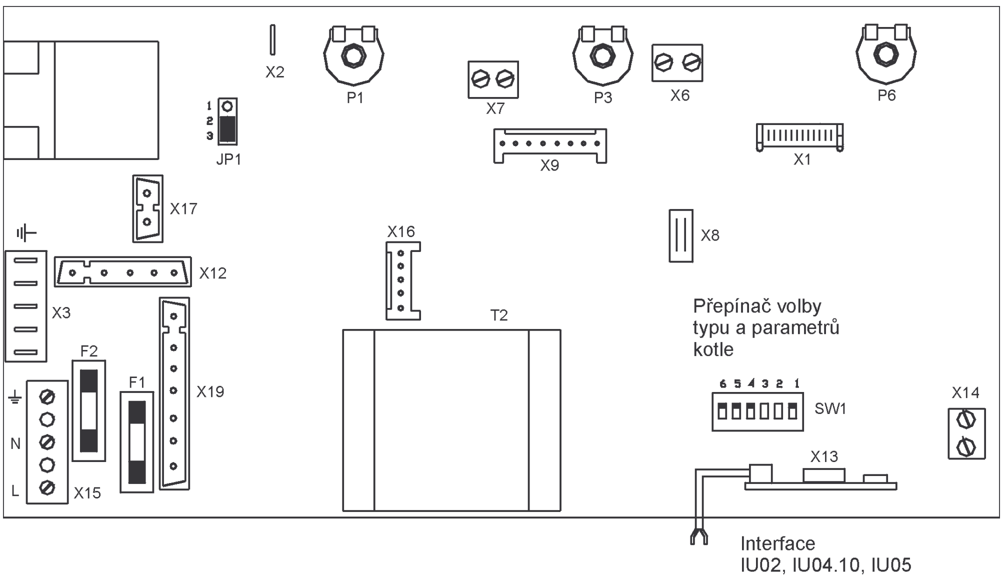
It is equipped with two LED's (a red one and a green one) indicating data flow in the serial line (RS 485). Because the interface is only for the control boiler, both diodes flash in cycles (transmission and reception of data from the controlled boilers).

Interface IU04.10:

It is also equipped with two LED's (a red one and a green one). If the interface is set as the control one, both diodes flash (see interface IU05).

If it is set for the controlled boilers, the red diode flashes in shorter cycles (signalling data flow in RS 485 for all boilers). The green diode signals a data backflow from the appropriate boiler (according to the boiler address) therefore it flashes in longer cycles (dependent on the number of boilers in the cascade).

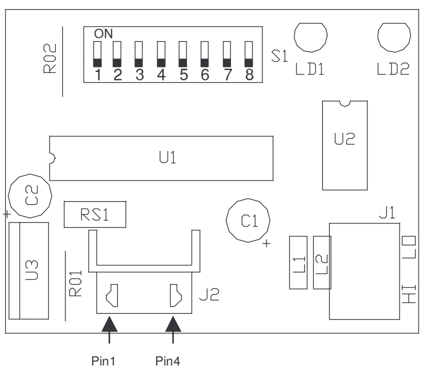
6. Placing of interface IU05 and IU04.10 on DIMS01-TH01



Type and parameters switch

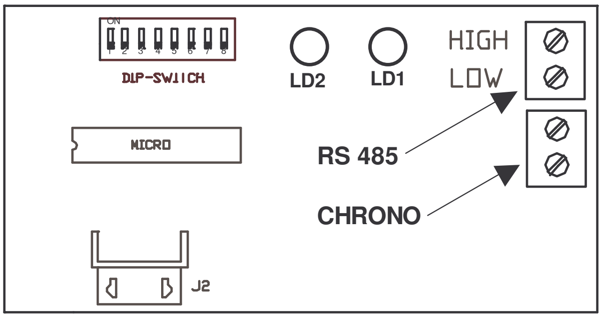
7. Placing of components

Interface IU04.10



Pin - title	Function
J1-HI	Serial RTX
J1-LO	Serial RTX
J2-1	RX
J2-2	TX
J2-3	Vcc (5V)
J2-4	GND

Interface IU05

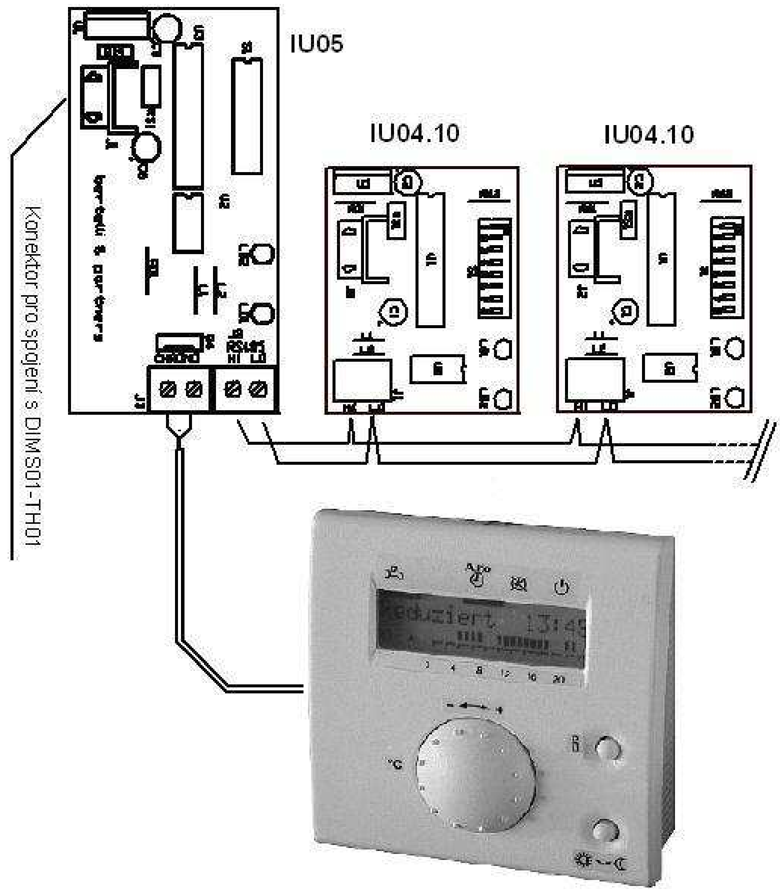


Pin - title	Function
J2-1	RX
J2-2	TX
J2-3	Vcc (5V)
J2-4	GND
J1-HI	Serial RTX
J1-LO	Serial RTX
J3	CX 51 MC
J3	CX 51 MC

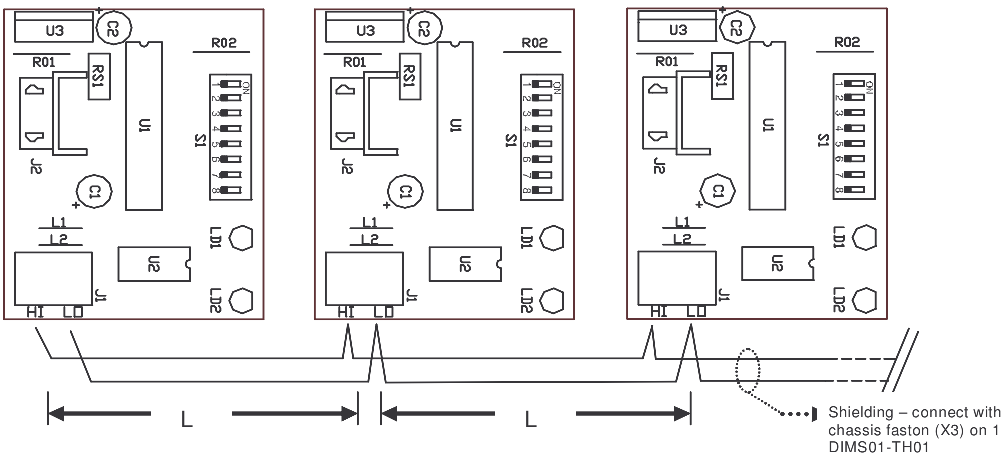
8. Wiring diagram

8.1 Wiring of IU05Q, IU04.10, QAA 73.110 (CX 51 MC)

Connector for connection with DIMS01-TH01



8.2 Wiring of IU04.10



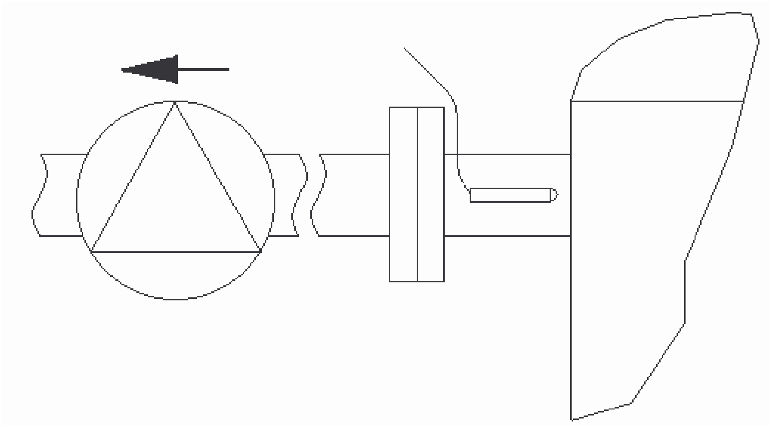
Communication serial line (RS 485) specifications:

Number of wires installed:	2
Maximum length of row:	L = 5 m
Polarity of connection:	polarized

In surroundings with electric interference, it is necessary to use a twisted pair or a shielded cable.
The cable shielding must be connected to one board on the chassis faston (X3).

Placing of the heating system sensor:

The sensor is to be placed on the hot water outlet from HEDP (torus) into heating system (in front of or behind the flange). It is to be fastened by a conductive sleeve or a conductive tape, horizontally into the centre of the piping as shown in the picture.



*** Pay attention to the fact the sensor is placed on a spot different from the last cascade version (only IU04), (earlier in front of, now behind HEDP (hydraulic equalizer of dynamic pressures).**

Service settings and a shortened description of Siemens QAA 73.110:

Characteristics:

Siemens QAA 73.110 is a programmable controller with individually selected weekly programs (with max. of three periods in one day) for room heating and DHW heating. Temperature comfort can be programmed in two temperature levels (comfort temperature and reduction temperature). In the times of long absence of the user, it is possible to use antifreeze temperature level in the holiday program.

The device as an expanded standard uses the general functions of OpenTherm-Plus (OT^+) protocol and it is able to *display information data* which are, however, not used for gas boilers (e.g. temperatures of solar heating, time program of the second heating circuit etc.). All settings (except buttons of fast mode change and correction of comfort temperature on the front panel) are carried out by modification of the appropriate line in the parameters chart (see manual).

Types of control:

1. **DHW**

If the boiler is equipped with DHW tank heating, the DHW heating can be controlled by time program (either independent or dependent on the heating time program). The basic option is according to 91st line, the program itself on lines 30-36 of parameters chart.

2. **Heating**

❖ ***Weather compensated regulation only***

This option is usually used for larger buildings where it is difficult to choose a reference room or space. The demanded temperature of the heating water is automatically set according to the weather-compensation curve dependent on the outside temperature with no influence of the temperature of the room where the controller is placed.

In this case, the outside temperature sensor must be connected to the boiler automatics and DIP-SWITCH (2) must be set to ON.

Set line 75 (room temperature influence) on the controller to “none”. Set the demanded trend of weather-compensation curve on line 70 (heating curve trend).

❖ ***Weather compensated regulation with room temperature compensation***

This option uses the feedback from the room temperature and it is therefore able to eliminate the influence of other heat sources. The room temperature difference (of the set and the real temperature) directly influences the weather-compensation curve and in this way ensures higher comfort of control.

In this case, the outside temperature sensor must be connected to the boiler automatics and DIP-SWITCH (2) must be set to ON. Set line 75 (room temperature influence) on the controller to “Na TO1”, set the demanded trend of weather-compensation curve on line 70 (heating curve trend). Further, it is possible to choose automatic adaptation of heating curve on line 77. Then, the controller will use the collected information during several days to optimize the settings of weather-compensation curve.

❖ ***Regulation dependent on room temperature only***

This option works in dependence to the temperature of the room where the controller is placed only. It does not need any outside temperature sensor. It is usually used for smaller building where the regulation according to a reference room is sufficient. It is highly flexible and it uses PID algorithm to reduce overshoots.

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In this case, no outside temperature sensor must be connected and DIP-SWITCH (2) is to be set to OFF. Set line 75 (room temperature influence) on the controller to “Na TO1”.

Controller settings:

The basic control elements and setting of time programs are described in the Manual including the description of used buttons. For better information on this controller, there is a list of information and settable parameters. The basic setting of parameters 51 - 98 (default) is suitable for standard applications and it is not necessary to change them (except parameter 70 for weather compensated regulation only).

List of parameters – for end users

(access and browsing by pressing button Prog)

Line	Function	Range	Unit	Resolution	Basic setting
Time setting					
1	Time	0 ... 23:59	hh:mm	1 min	–
2	Date (day, month)	1 Jan ... 31 Dec	dd.mm	1 day	–
3	Year	2000 ... 2094	yyyy	1 year	–
Demanded values					
5	Demanded reduction temperature (TRRw)	TRF ... TRN	°C	0.5	16
6	Demanded antifreeze temperature (TRF)	4 ... TRRw	°C	0.5	10
7*	Nominal demanded temperature of DHW (TBWw)	TBWR ... TBWmax	°C	1	55
Program of time switch TO1 (heating circuit 1)					
10	Day of week – selection	Mon...Sun, week	day	1 day	–
11	Switch-on time 1st period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	06:00
12	Switch-off time 1st period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	22:00
13	Switch-on time 2nd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
14	Switch-off time 2nd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
15	Switch-on time 3rd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
16	Switch-off time 3rd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
Program of time switch 3 (domestic hot water) accessibility dependent on line 91 setting					
30	Day of week – selection	Mon...Sun, week	day	1 day	–
31	Switch-on time 1st period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	06:00
32	Switch-off time 1st period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	22:00
33	Switch-on time 2nd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
34	Switch-off time 2nd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
35	Switch-on time 3rd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
36	Switch-off time 3rd period	– – : – – / 00:00 ... 24:00	hh:mm	10 min	– – : – –
Holiday					
40	Beginning (day.month) – – : – – = not active	1 Jan ... 31 Dec	dd.mm	1 day	– – : – –
41	End (day.month) – – : – – = not active	1 Jan ... 31 Dec	dd.mm	1 day	– – : – –
42	The operation of the heating circuit during holiday	Freeze, Reduction	–	–	Freeze
Other					
45	Standard time programs TO1, TO2 and DHW	No, Yes	–	–	No
	(concurrent pressing of buttons +/- for 3 s)				
46	Temperature of switch-over summer/winter	8 ... 30	°C	0.5	17
47	Language	Czech, English...	–	–	Deutsch
50***	Failure reports (failure code and text	0 ... 255	–	1	–
	QAA73.110 or boiler control)				

– – : – – = switching point not active

THERM CASCADE BOILER ROOMS

*** boiler failure code on line 50 is signalled by # and the failure number according to the manual of the boiler.

List of parameters – for professionals!

(access and browsing by pressing both buttons Prog for about 5 seconds)

Line	Function	Range	Unit	Resolution	Basic setting
Service values					
51	Current demanded room temperature TO1	4 ... 35.0	°C	0.5	20
	Nominal-, reduction- or antifreeze demanded temperature				
53	Reduction outside temperature	–50 ... +50	°C	0.5	–
	Reset is done by concurrent pressing of -/+ for 3 s				
54	Geometrical outside temperature	–50 ... +50	°C	0.5	–
55	Real DHW temperature	0 ... 127	°C	1	–
56	DHW through-flow	0 ... 16	l/min	0.5	–
57*	Real temperature of boiler return pipe	–40 ... 127	°C	1	–
58*	Real temperature of flue	–40 ... 500	°C	1	–
59*	Real temperature of solar	–40 ... 250	°C	1	–
61*	Real temperature of solar tank	–40 ... 127	°C	1	–
62	OpenTherm mode	Lite, Plus	–	–	–
63	Demanded temperature of heating water of heating circuit 1	0...100	°C	1	–
Room heating (TO1 and TO2)					
70	TO1 heating curve trend – – . – = TO1 not active	2.5 ... 40.0	–	0.5	15
71	Minimum limit of TO1 heating water temperature (TV1min)	8 ... TV1max	°C	1	8
72	Maximum limit of TO1 heating water temperature (TV1max)	TV1min ... TKmax	°C	1	80
73	Parallel change of TO1 heating curve	–4.5 ... +4.5	K	0.5	0
74	Type of building	Heavy, Light	–	–	Light
75	Influence of room temperature (room control)	None, Na TO1,Na TO2,	–	–	Na TO1
		Na TO1 + TO2			
76	Room closing difference – – . – = not active	0.5 ... 4.0	K	0.5	0.5
77	Adaptation of heating curve	Not active, Active	–	–	Active
78	Maximum advance of optimizing of heating switch-on	0 ... 360	min	10	100
79	Maximum advance of optimizing of heating switch-off	0 ... 360	min	10	30
Domestic hot water					
90*	DHW reduction demanded temperature (TBWR)	8 ... TBWw	°C	1	40
91	DHW preparation program	24h/a day,	–	–	Program
		Program TO –1h,			TO –1h
		Program TO,			
		Program DHW			
92*	Legionella function	Off, Weekly, Daily	–	–	Weekly
93*	Button of DHW preparation type	Without ECO, With ECO	–	–	Without ECO
94*	Program for circulation pump	According to DHW prep.			Program DHW
		Program DHW			
		Program2			
Other					
95	Parameterisation	Enables, Disabled	–	–	Enabled
96*	Time master	QAA73, External	–	–	QAA73

97	Beg. of summer time	1 Jan ... 31 Dec	dd.mm	1 day	25/3
98	End of summer time	1 Jan ... 31 Dec	dd.mm	1 day	25/10

* these lines are not supported by the boiler automatics.
Lines 55 and 56 are only used for CX boilers (with DHW through-flow heating).

Usage of Info button

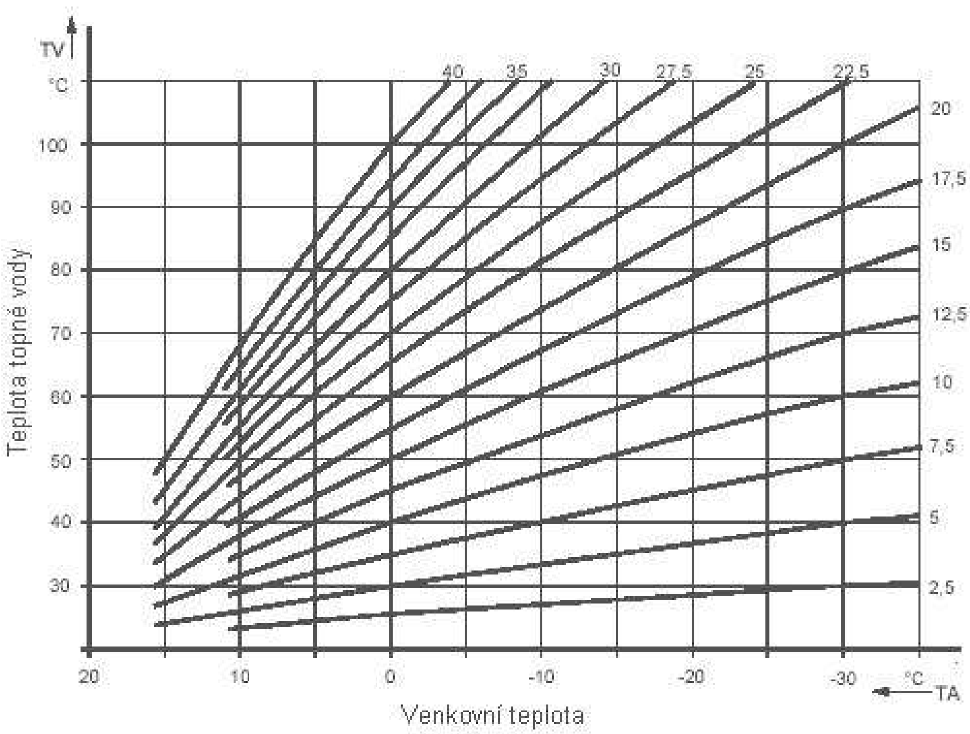
When you press this button, you can browse the system information parameters, as is shown in the following chart:

Line	Displays
1	Time, real room temperature and operation mode
2	Failure report
3	Time and heating circuit 1 operation mode
4	Day of week, time and date
5	Real outside temperature
6	The lowest outside temperature **
7	The highest outside temperature **
8	Real room temperature
9	The lowest room temperature **
10	The highest room temperature **
11	Real DHW temperature
12	Real boiler temperature
13	Burner modulation
14*	Water pressure in the heating circuit (not implemented)

* these lines are not supported by the boiler automatics.
Line 11 is only used for CX boilers (with DHW through-flow heating).
** To set it back to the current value, press + and – at the same time for 3 s.

Trend of weather-compensation curves (setting on line 70):

Heating water temperature



Outside temperature

!!! Important: Always consider the failure reports displayed on QAA 73.110 only as for your information according to the following chart. **The real failure code** (and its cause) **is always and only displayed on the boiler display!**

Failure report (failure code and text QAA73.110 /line 50/ or boiler controller)

FAILUER REPORTS with connection over interface IU05.Q			
#_ _ 1		E01	boiler ignition failed
#_ _ 2		E02	insufficient through-flow of heating water (between repeated attempts)
#_ _ 4		E04	heating water sensor damaged
#_ _ 5		E05	heating system sensor damaged /behind torus/
#_ _ 6		E06	heating water temperature limit exceeded (safety thermostat) /in D50T-i boilers flue thermostat/
#_ _ 7		E07	outside temperature sensor damaged (DIP-SWITCH 2 - ON)
#_ _ 8		E08	flue exhaust failure (flue thermostat), or manostat failure (turbo boilers)
10	Outside sensor		room temperature influence disabled on QAA and on boiler DIP-SWITCH 2 - OFF
#_ _ 2		E12	insufficient through-flow of heating water (after several attempts)
# _ 13		E13	microswitch of flow fuse closed with the pump open /or transition resistance between microswitch contacts/
# _ _ y			the control boiler failure code
# x x+y y			a controlled boiler failure code (xx=boiler address, yy=failure code)

Operation with Siemens QAA 73.110 damaged or communication interrupted (e.g. disconnected wiring)

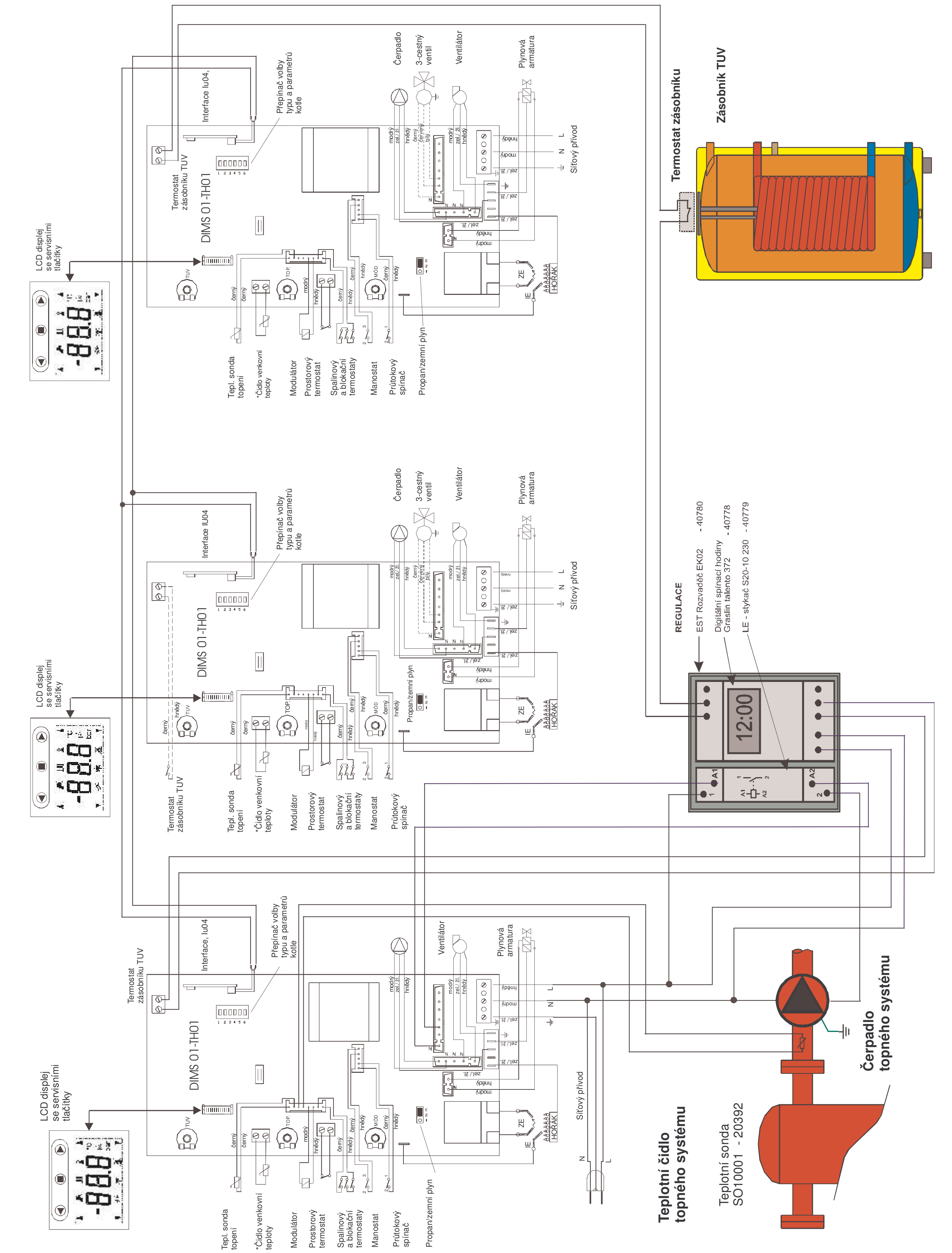
If the communication between IU05 and the controller is interrupted, the heating system temperature control is transferred to interface IU05 after the time sequence of attempts at reconnecting (about 60 s). The interface then controls the cascade according to its own weather-compensation curve in dependence on K factor setting (see the description of heating with weather compensated regulation). DHW tank heating is enabled on all controlled boilers.

As soon as the communication with the controller is resumed, the system comes back to its standard operation.

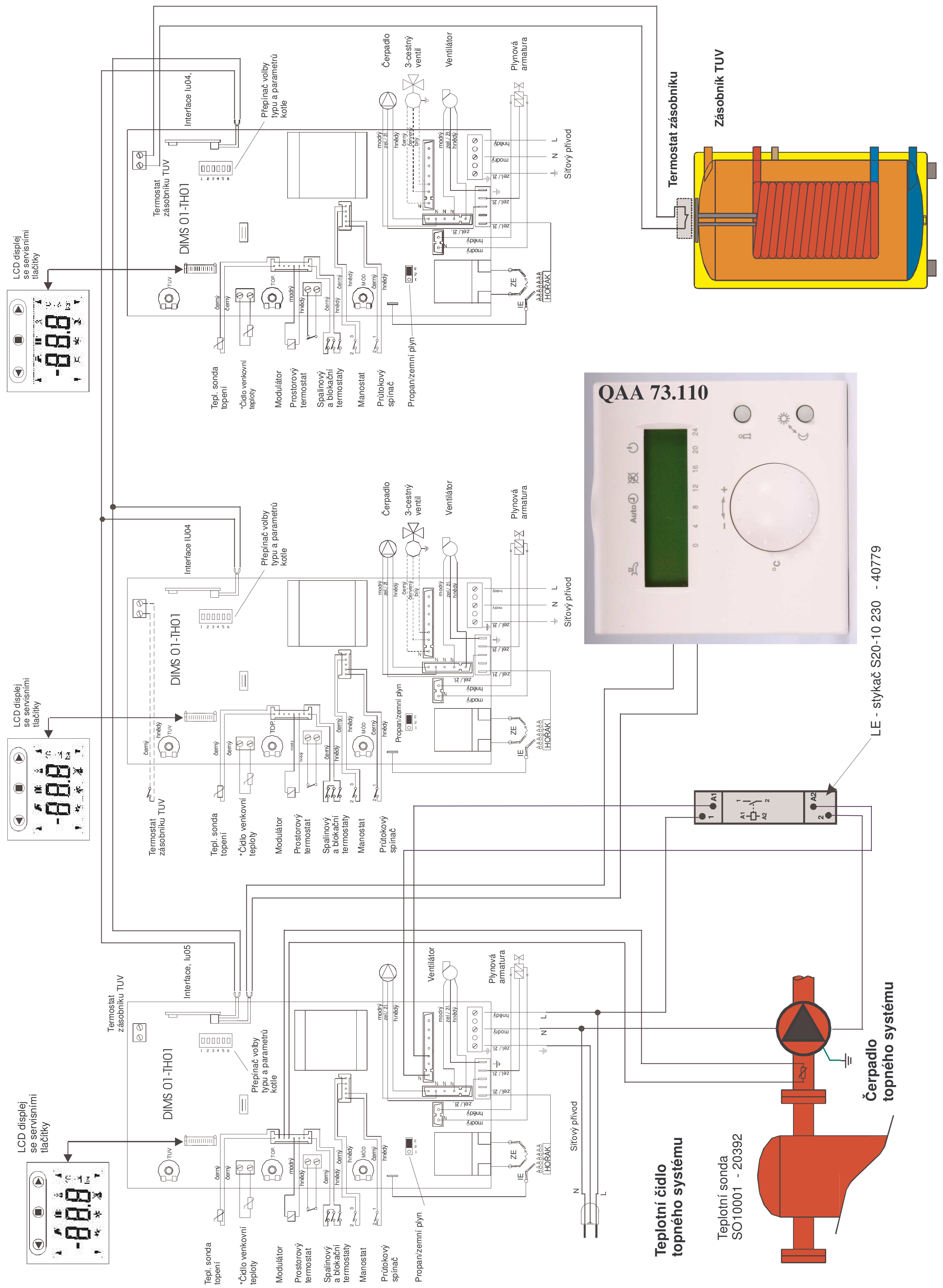
Transmission line features:	between IU 05 and controller	among boilers (RS 485)
Number of wires installed:	2	2
Type of electric wiring:	bipolar (*)	bipolar (*)
Max. length of wiring:	50 m	5 m
Max. resistance of wiring:	2*5Ω	2*5Ω
Polarity:	free	polarized

THERM CASCADE BOILER ROOMS

WIRING OF 3-BOILER CASCADE WITH INTERFACE IU04.10 (set 2)



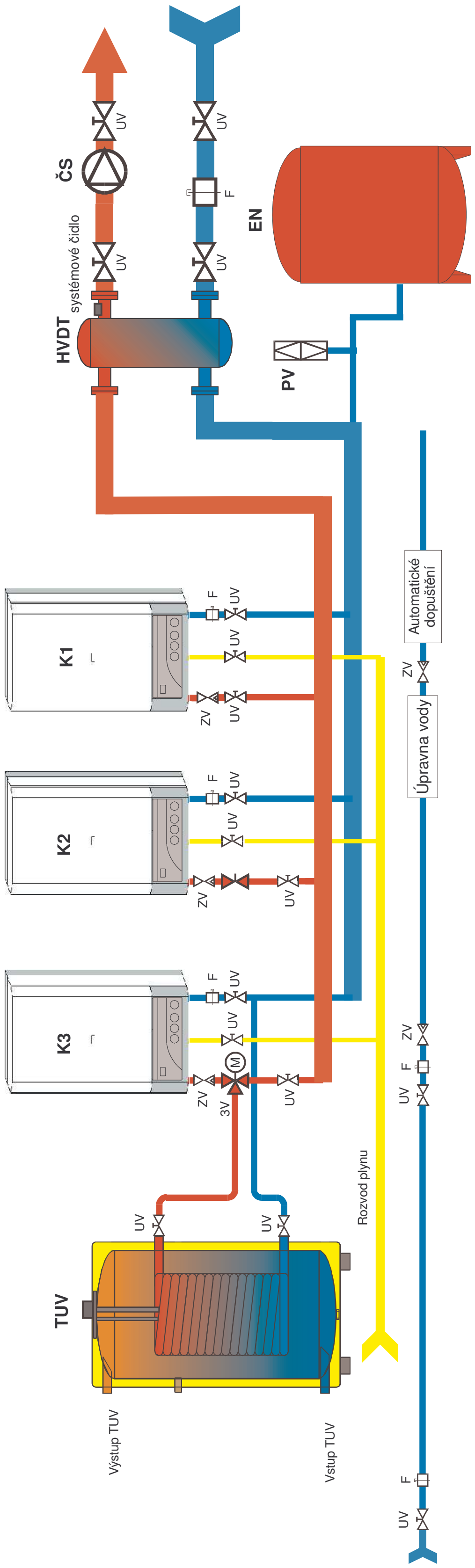
WIRING OF 3-BOILER CASCADE WITH INTERFACE IU05Q, IU04.10 (SET 1)



BOILER ROOM HYDRAULIC DIAGRAM

Zjednodušené hydraulické schéma kaskádové kotelny

sestava pro komunikaci s interface IU 04 - THERMONA

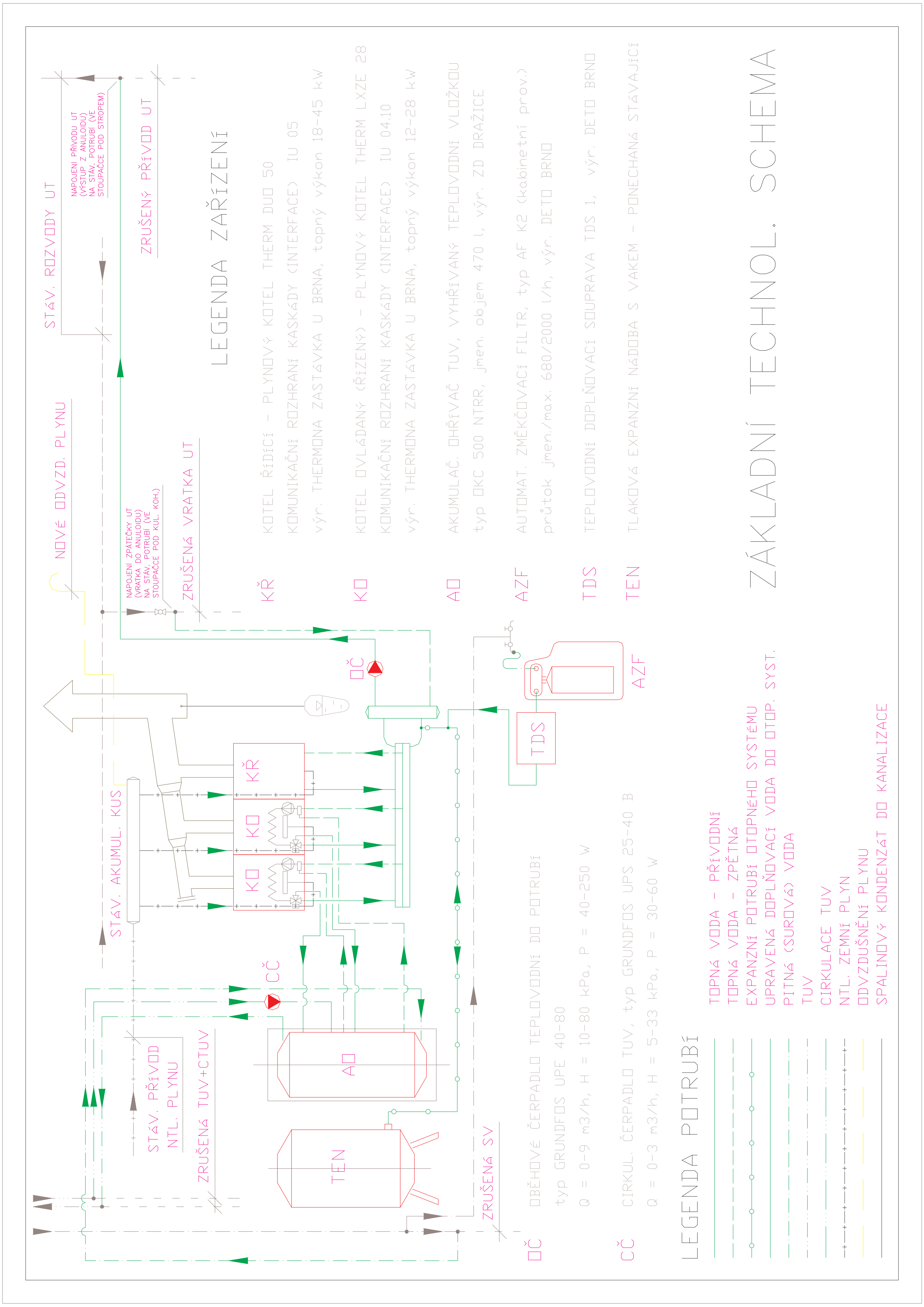


Legenda:

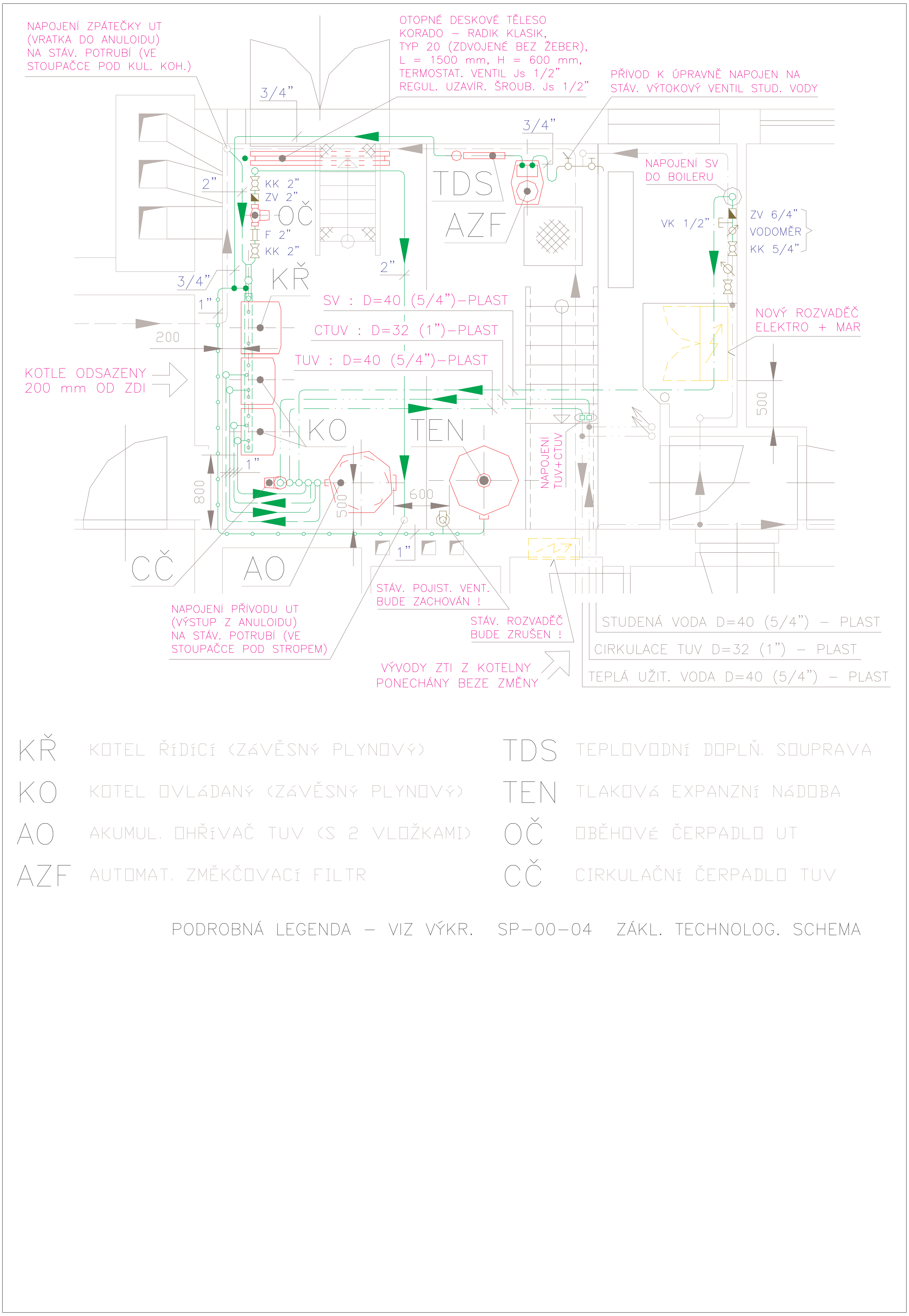
K1,K2,K3 - kotle THERM DUO 50 (s pojistným ventilem)
TUV - zásobník TUV
HVDT - hydraulický vyrovnávač dynamických tlaků
ČS - čerpadlo topného systému
EN - ezpanzní nádoba tlaková s membránou

UV - uzavírací ventil
ZV - zpětný ventil
F - filtr
3V - třícestný rozdělovací ventil
PV - pojistný ventil

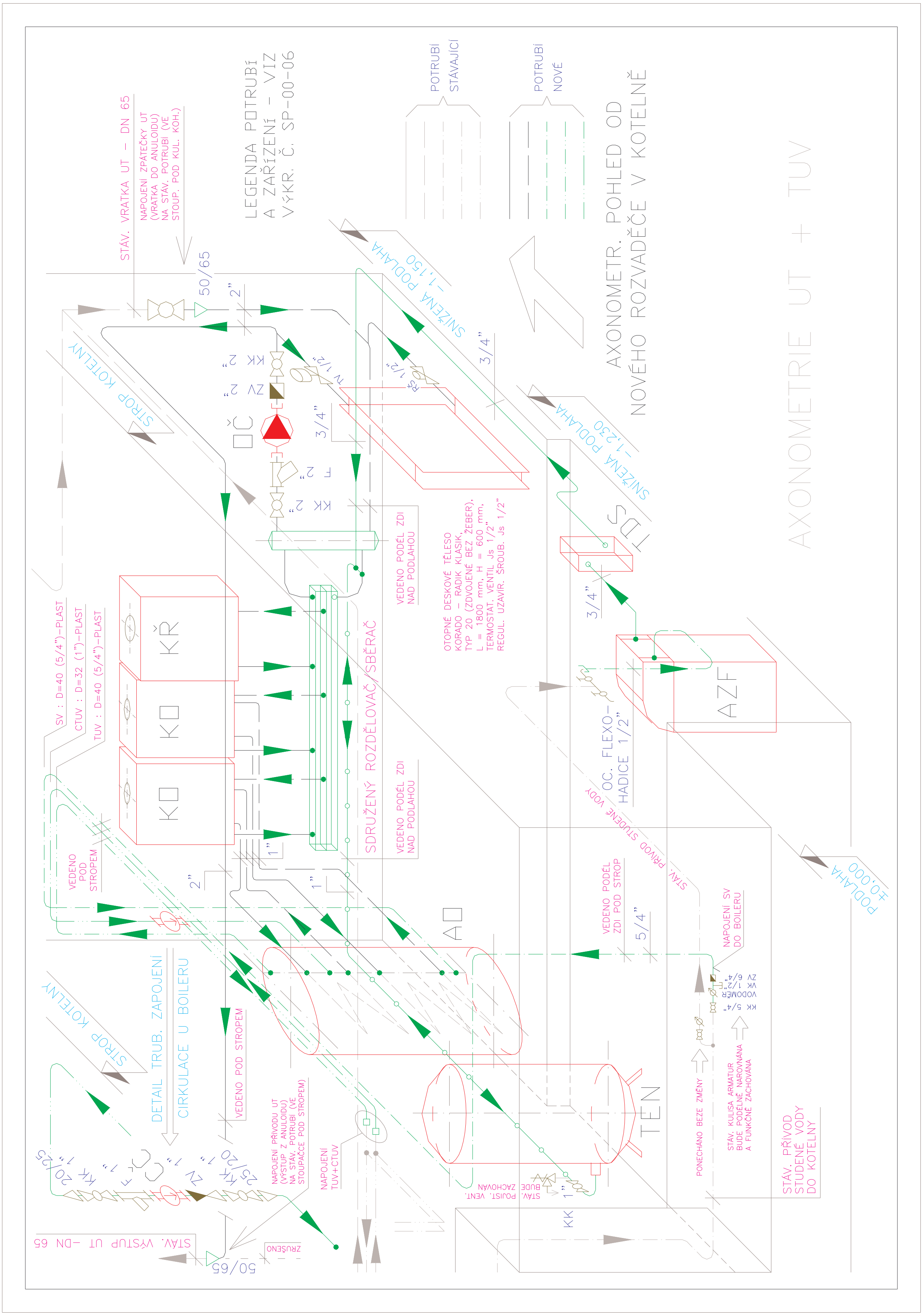
EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 3X THERM DUO 50



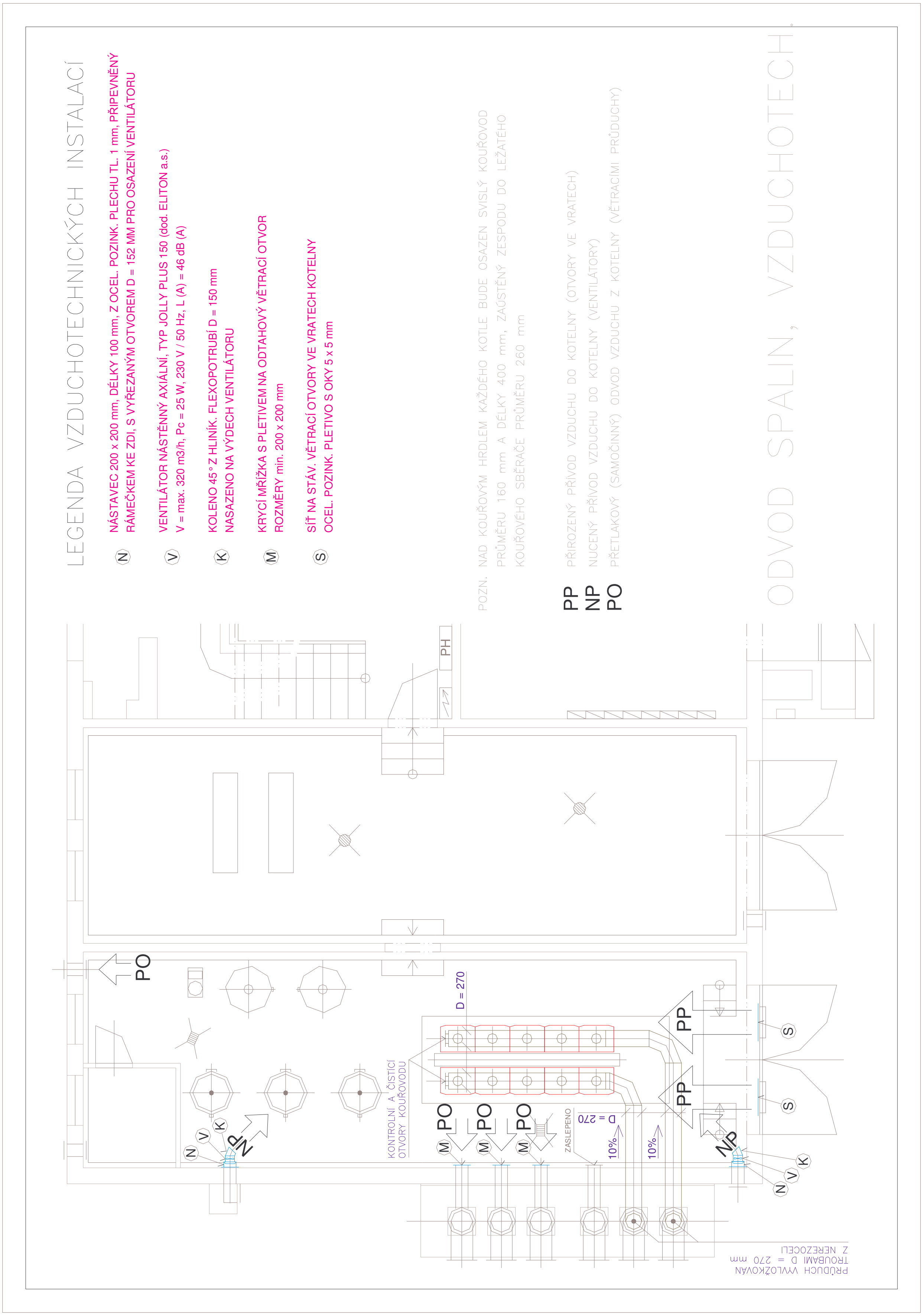
EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 3X THERM DUO 50



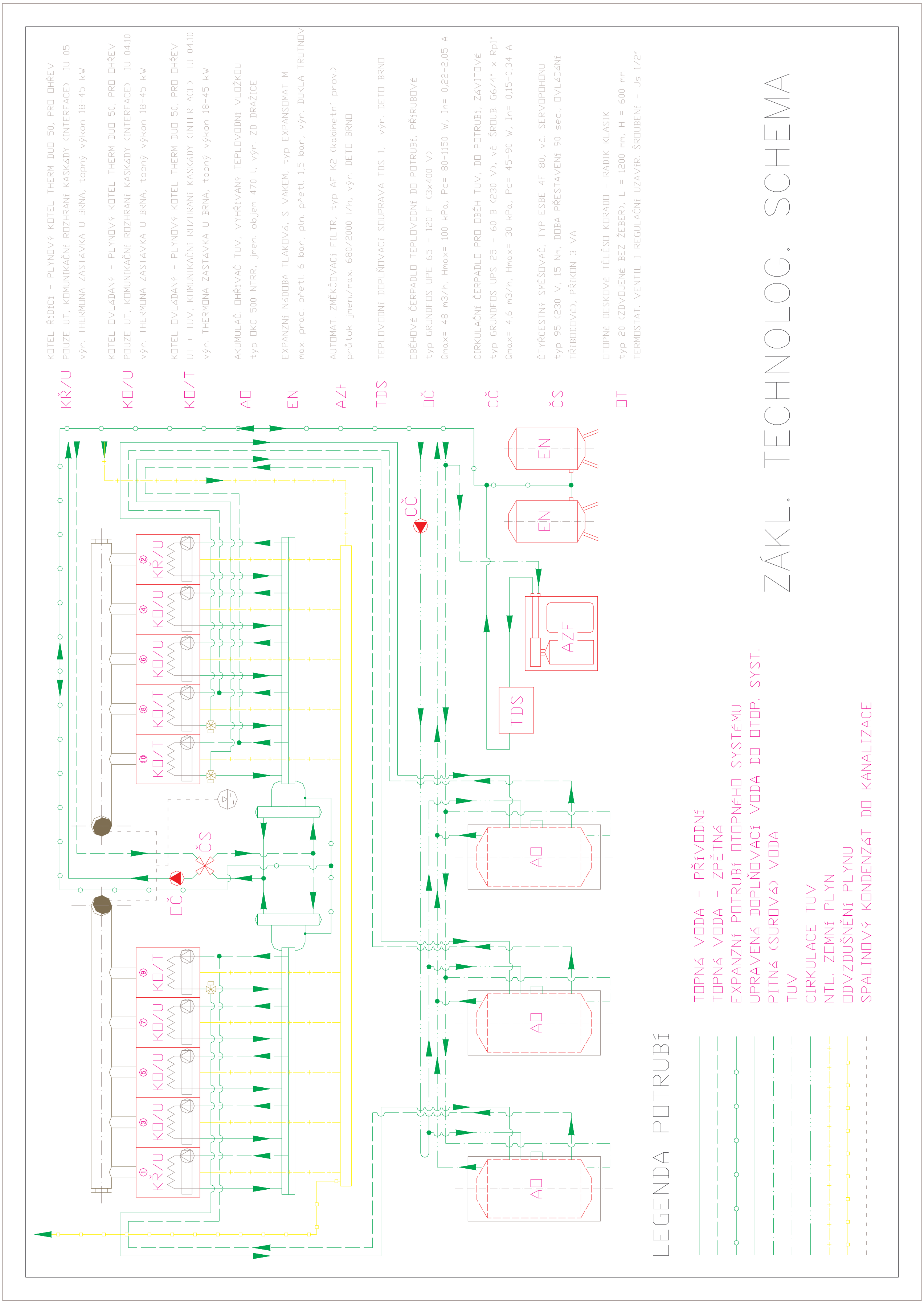
EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 3X THERM DUO 50



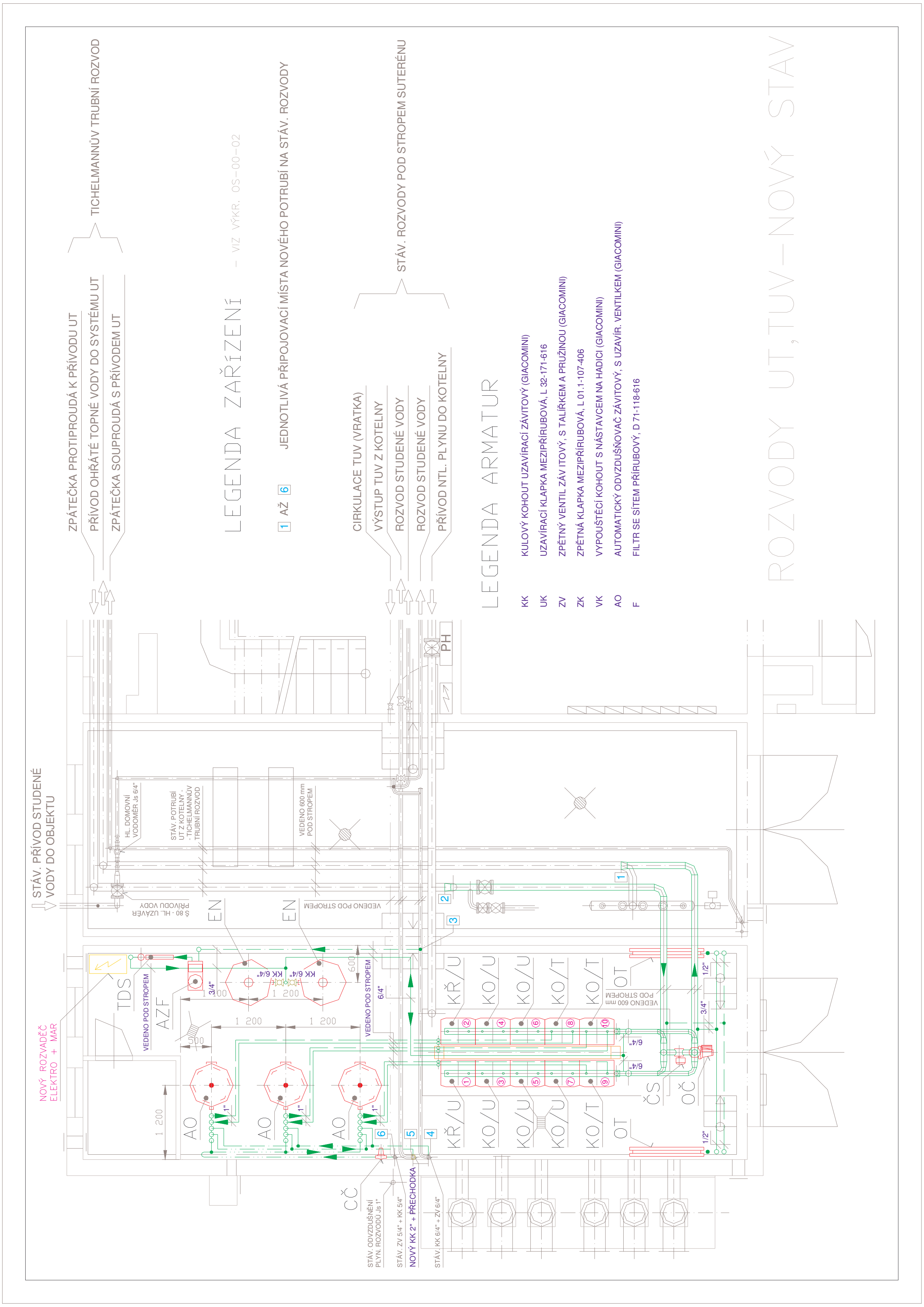
EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 10X THERM DUO 50



EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 10X THERM DUO 50

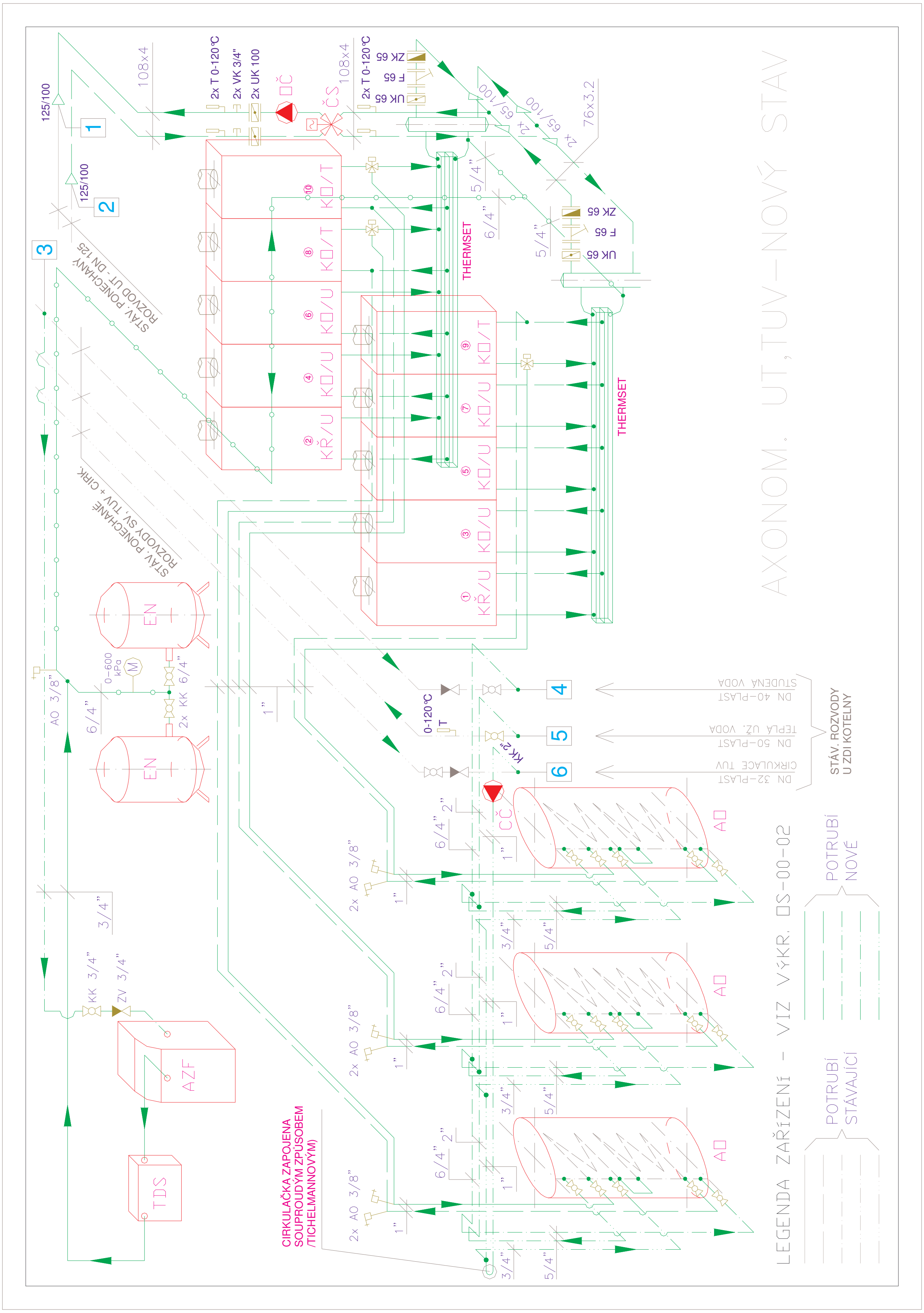


EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 10X THERM DUO 50



THERM CASCADE BOILER ROOMS

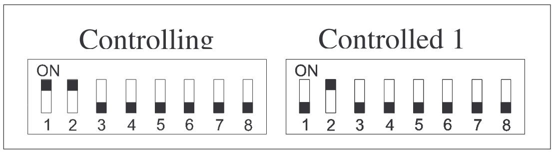
EXAMPLE OF A PART OF CASCADE BOILER ROOM PROJECT – 10X THERM DUO 50



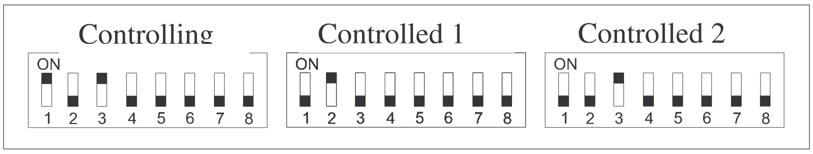
THERM CASCADE BOILER ROOMS

SETTING OF DIP-SWITCHES IU05 AND IU04.10 FOR VARIOUS BOILER SETS

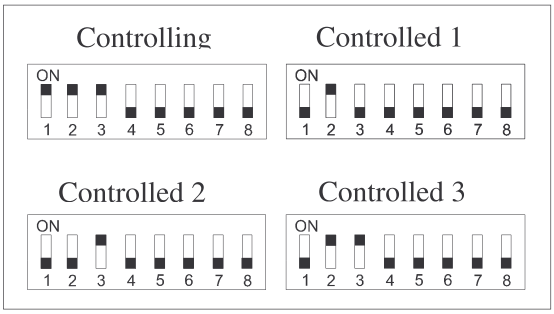
A set of 2 boilers



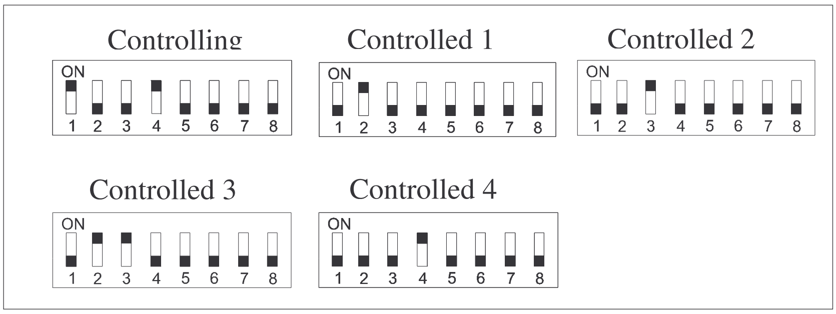
A set of 3 boilers



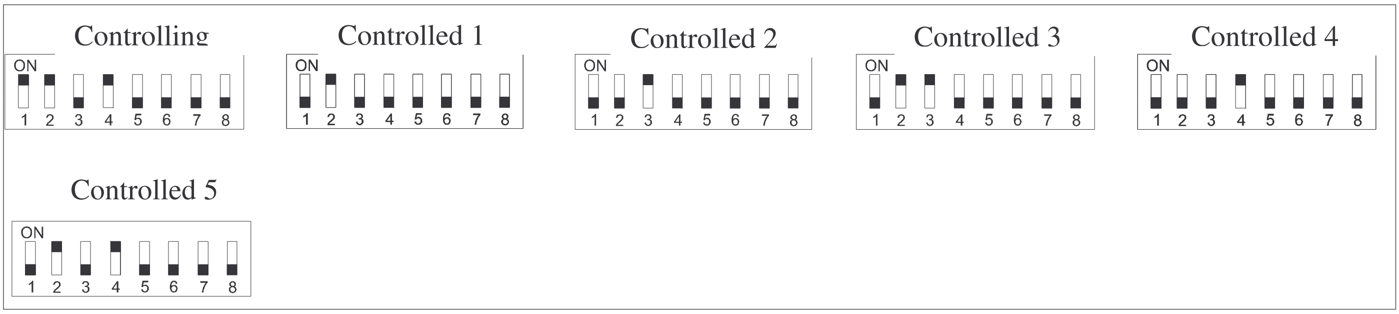
A set of 4 boilers



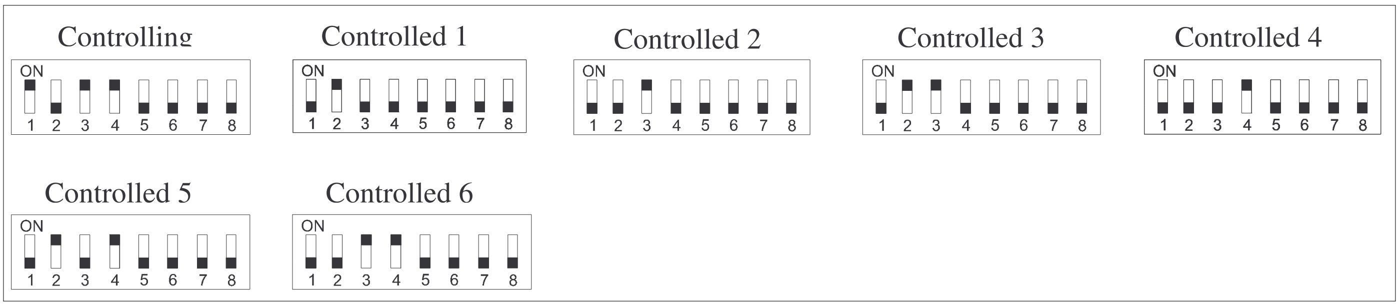
A set of 5 boilers



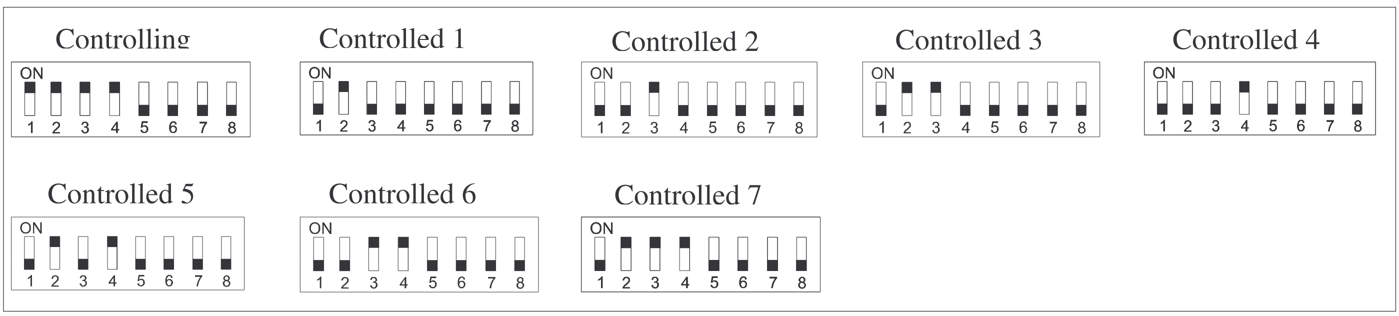
A set of 6 boilers



A set of 7 boilers

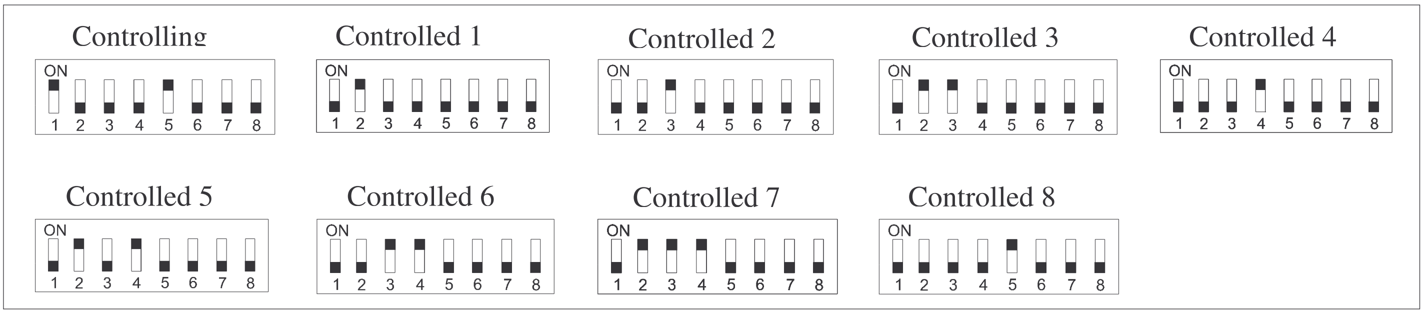


A set of 8 boilers

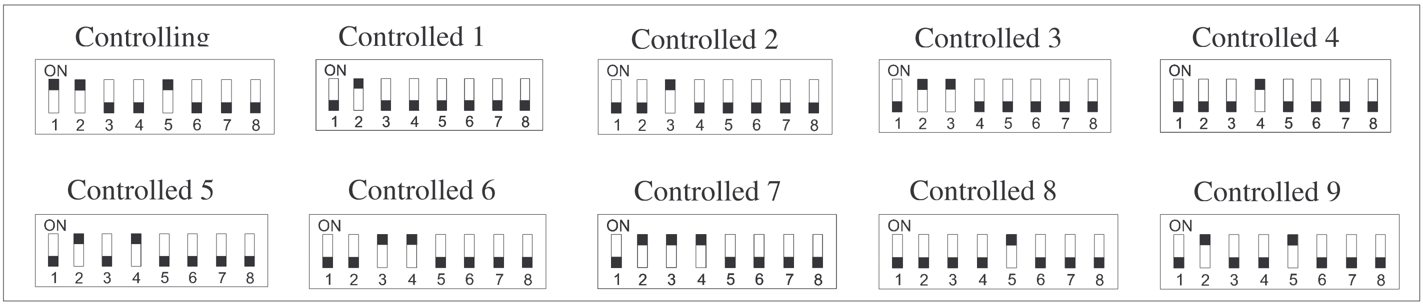


THERM CASCADE BOILER ROOMS

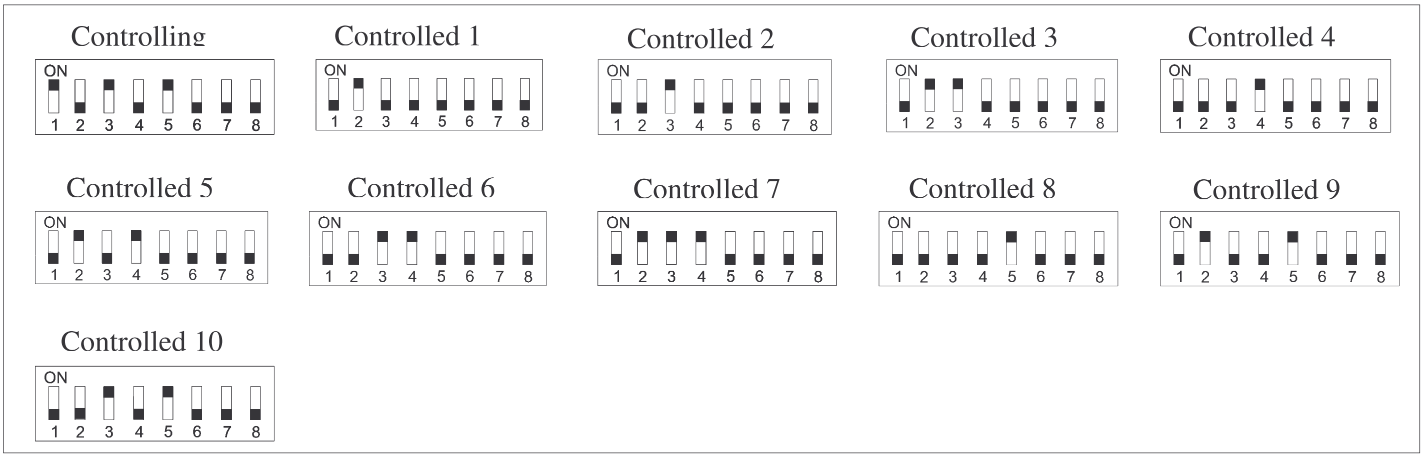
A set of 9 boilers



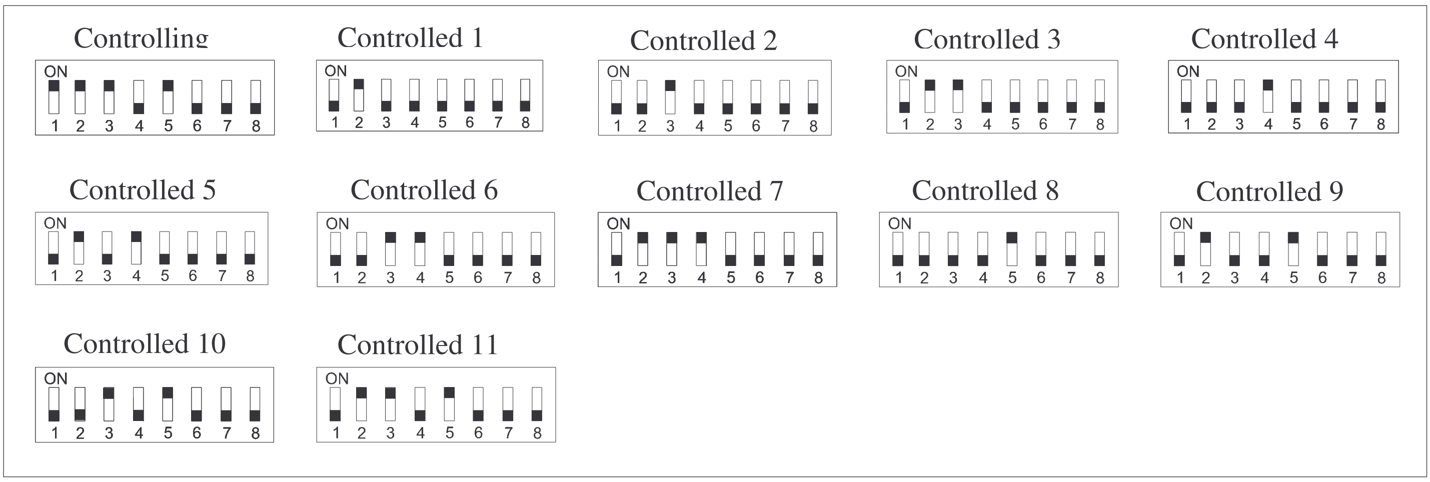
A set of 10 boilers



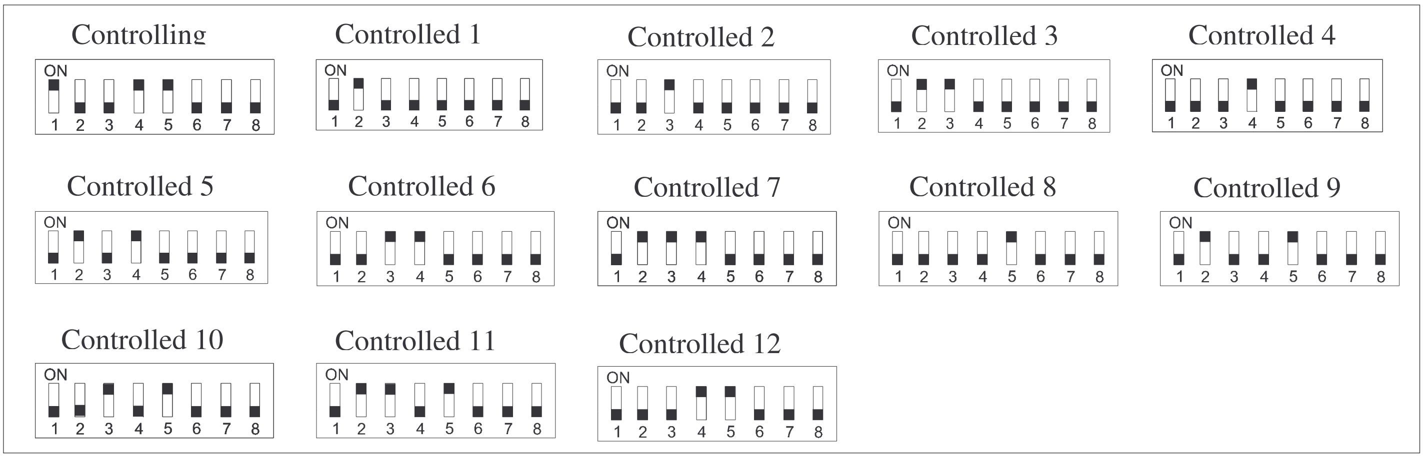
A set of 11 boilers



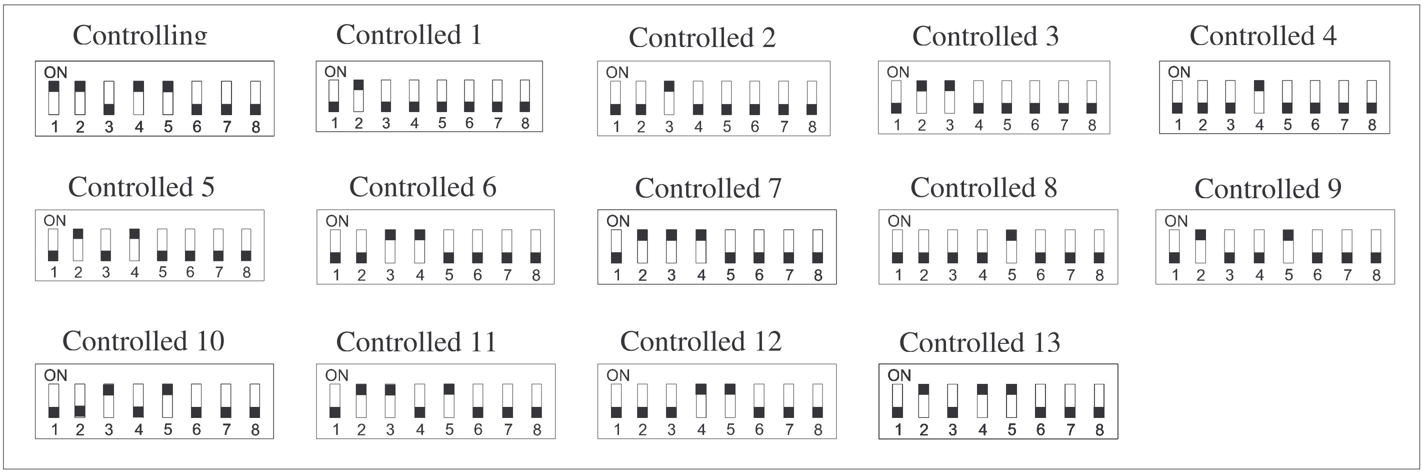
A set of 12 boilers



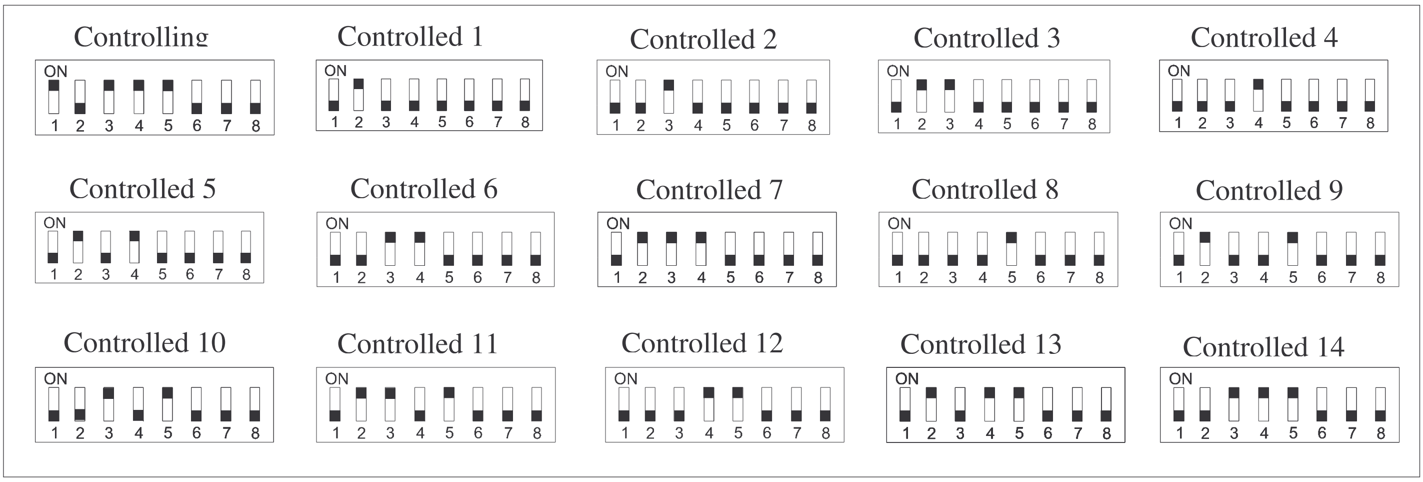
A set of 13 boilers



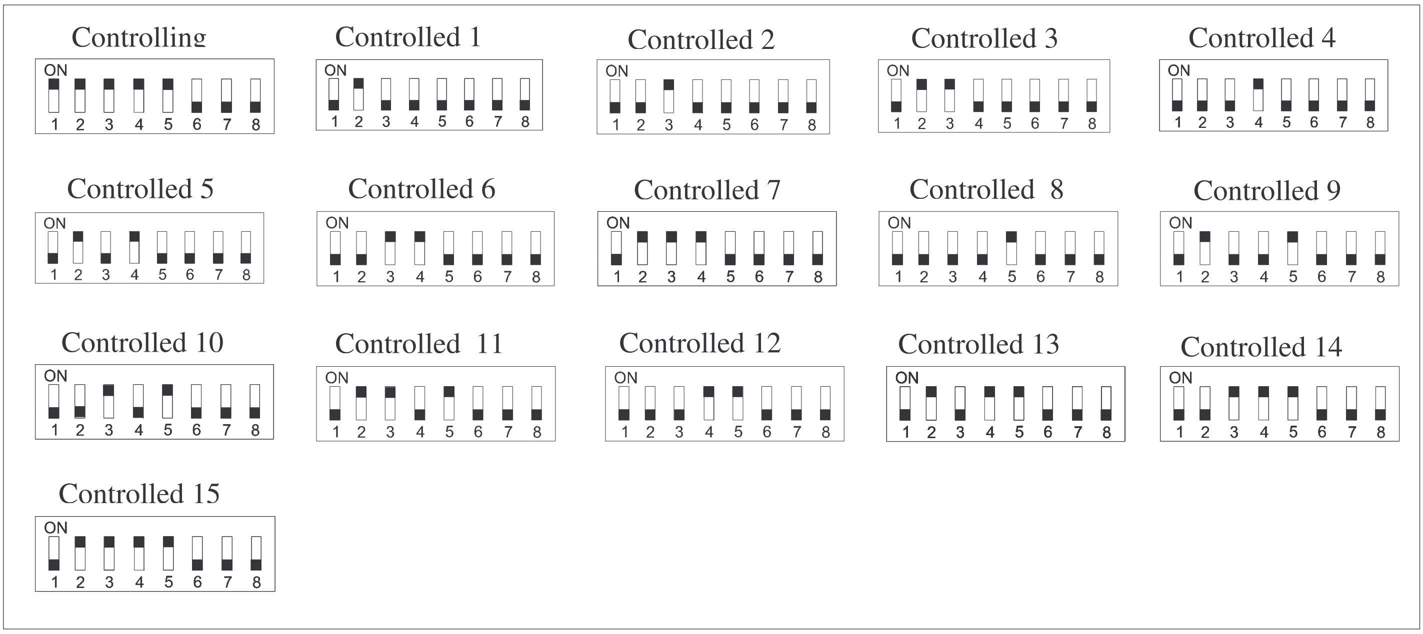
A set of 14 boilers



A set of 15 boilers



A set of 16 boilers



LIST OF ACCESSORIES FOR BOILER CASCADE

Regulation

Set no.	Type	Store no.	pcs
1	Programmable controller QAA 73.110	40942	1
2	Digital switch clock GRASLIN PA TALENTO 372	40778	1
1+2	EST Distributor EK 02 small	40780	1
1+2	LE – contactor S 20-10 230	40779	1

The control boiler

1	Interface IU05q **(for TRIO 90 boilers software version 1.03 and higher)**	40922	1
2	Interface IU04.10	40068	1
1+2	Outside sensor THERM Q01	40579	1
1+2	Temperature sensor with cable (SO 10001)	23657	1
1+2	End piece BS 95/7	21650	1
1+2	DHW connector	21645	2
1+2	Connector 2,54	21540	2

The controlled boiler

1+2	Interface IU04.10	40068	1

Controlled boiler with DHW tank

1+2	Interface IU04.10	40068	1
1+2	3-way distribution valve – VC 6613MQ6000 1“ 230V (external thread)	23370	1
1+2	Cable for 3-way valve	24294	1
1+2	End piece BS 95/7	21650	1
1+2	DHW connector	21645	3

Set 1 = cascade regulation with QAA 73.110
Set 2 = cascade regulation with digital switch clock GRASLIN.

RECOMMENDED PROCEDURE FOR PUTTING CASCADE INTO OPERATION

!!! Important:

When inserting or taking out interface (IU 05, IU04.10) to or from connector X13 on DIMS01-TH01 board, the boiler must be unplugged. Otherwise, there is the danger of destroying microprocessors!

Boiler cascade with interface IU04.10

1. **Checking individual boilers:** Unplug the boilers from the supply mains. Take out interface IU04.10 from all boilers while the cascade is still connected. Switch all levels of parameter switch (SW1) to OFF, disconnect one cable wire on X14 terminal box and turn the knob for night reduction (the right knob on the control panel) to the extreme left position. Make sure the terminal connectors of the room thermostat are interconnected in all the boilers. Connect boilers to the supply mains, switch them on one by one, and check their operational features and gas pressure setting (starting power). Correct any possible faults. Set parameters 3 and 4 (pump run-down and anticycling time) to zero using service buttons in all boilers. Again disconnect the boilers from the supply mains.

2. **Connecting the cascade:** Connect the disconnected cable wire on X14 terminal box in the control boiler and check the connection of components for cascade control according to the wiring of connection. Set dip-switches on interface IU04.10 according to the appropriate chart and insert them to the connector X13 on DIMS0-TH01 of individual boilers (only one boiler can be the controlling one in the cascade). Set the parameter switch on the control boiler (SW1) 3 = ON, others OFF. In controlled boilers all levels of parameter switch (SW1) remain OFF. If a tank is connected to the boiler, disconnect one cable wire from X14 terminal box (cancel tank heating so that it cannot disturb checking of boiler switching for system heating). Set the controlled boilers' knobs for heating water temperature to the middle of the track about 60 °C (with cascade functional this setting is not valid, it is only used when there is a communication failure). Set the control boiler's knob for heating system temperature to about 1/3 - to about 50 °C, the night reduction knob remains in the extreme left position (no reduction). Connect boilers to the supply mains.

3. **Checking the control boiler's operation:** Switch on the control boiler to the position "Winter". After the initial processor diagnostics (about 15 s no data on display) two arrow are displayed on the bottom edges of the display (signalling data transmission into interface). Within the next about 20 s both LED's start flashing on the control boiler's interface (signalling reception and processing of data from the microprocessor and data transmission into interfaces of controlled boilers). After the communication starts the control boiler is ignited and the system pump starts. The starting ramp of the graduate boiler output increase is shortened by software from 50 s to 5 s because of faster cascade output reaching. After this operational check switch the boiler off by the mode switch.

4. **Checking the controlled boilers' operation:** Connect all cascade boilers to the supply mains. Switch on the control boiler to the position "Summer" and wait for the communication to start. Then switch the controlled boilers to the position "Winter". Red LED signalling data flow from the control boiler flashes on the interface IU04.10 on the controlled boilers and green LED flashes in longer intervals (returning status data according to the boiler address). There are also down arrows displayed on the control panel of controlled boilers signalling the data reception from the appropriate interface IU04.10 to the processor on DIMS01-TH01. The boilers do not ignite yet because the control boiler is in the "Summer" mode. If a controlled boiler ignites one minute after switch on, it means this boiler does not receive data and it has been switched over to the local mode. The starting ramp of output increase will be 50 s in this case.

5. **Checking the cascade's operation:** Switch the control boiler over to the "Winter" mode. The control boiler ignites and the system pump starts at the same time. The controlled boilers in the cascade ignite one by one with a variable delay (according to the temperature differences in the range of 20 – 180 s). The continuous modulation of boilers is done according to the temperature difference between the set temperature (should be about 50 °C) and the heating system temperature. When the set temperature is reached, boilers are disconnected one by one. The pump of the boilers being disconnected runs for another 4 to 8 s. If the night reduction contact is open (X14 terminal box on control boiler), it is possible to test this function by reducing the demanded temperature with the right knob (range of 0 – 30 °C from the left to the right). When the demanded temperature is reduced bellow the heating system temperature, all boilers are put out but the system pump runs for another hour in this case. In this way we have tested the cascade's operation under no influence of the outside temperature.

6. **Final setting:** On the control boiler (with a connected outside temperature sensor), set the parameter switch (SW1) 2 and 3 = ON, others OFF and check the night reduction contact connection. Connect the tank thermostat cable if there is a tank connected in the boiler. Then we can put the boiler in the case. Set the heating curve knob to the middle position (factor K = about 1.6) and set also the night reduction knob to the middle position (weather compensated curve reduced by 15 °C). Then set the times of the comfort and reduction temperatures on the time switch according to the customer's requirements. Correct the setting (or the user can) according to the thermal characteristics of the building and the demanded thermal comfort in winter. The function of cascade's heating in summer can be switched off in two possible ways.

   All boilers which do not heat up the DHW tank can be switched off by the mode switch (they will be in the "Summer" mode). Or the control boiler can be set to the "Summer" mode and the other boilers setting need not be changed. In this case the function of cyclic spin of the heating system pump after 24 hrs of idleness will be operational.

Boiler cascade with interface IU05 in the control boiler, IU04.10 in the controlled boilers

The procedure of checking boiler's operation and cascade putting into operation is the same as in the previous section. The only difference are the parts concerning setting the control by knobs on the control panel. Check the microprocessor version **(IU05 on TRIO 90 control boiler needs to be v. 1.03 MB and higher).** In this set all cascade control is transferred to QAA 73.110 controller. It means: after you connect all necessary elements on the control boiler (outside temperature sensor, pump relay and heating system temperature probes) set the parameter switch (SW1) 3=ON, others OFF. Set QAA 73.110 to the most suitable control mode. Switch on the control boiler to the "Summer" mode and then switch on all the controlled boilers to the "Winter" mode. Switch the control boiler over to the winter mode and put the cascade into operation by increasing the demanded room temperature on the controller.

To sum up:

The proper cascade operation depends on suitably chosen hydraulics of the boiler room. The heating system and boiler circuits need to be separated by HEDP (torus). Not less important are the non-return flap valves on the heating water outlets in all boilers in the cascade. They prevent the unwanted water circulation through the disconnected boilers caused by overpressure in the collecting main. Energy loss (by chimney exhaust) is reduced considerably and the regulation is not confused by mixing of heating and returning water in the boiler circuit.

Boilers must be protected against sedimentation of dirt from the heating circuit. Therefore, the boiler room has to be equipped with filters. The filters can be placed on the returning water inlets in all boilers or there can be a central filter on the collecting main of return water near the torus. A filter in front of the heating system pump will not do for the protection in any way. It is also important that the electrical distribution in the boiler room is carried out properly.

<u>If the cascade uses TRIO 90 (T) boilers, it is necessary that the minimum distance between neighbouring boilers is 100 mm to ensure better cooling.</u>

Communication lines (OpenTherm and RS485) must be shielded from the energy distribution net in the boiler room (this mainly concerns the placing in the same cable channel etc.) so that the transmitted information is not disturbed (in serious cases, this is signalled by disappearance or shifting of arrows on the boiler display). Also, the connection of other boiler room elements (main switch, tank thermostat, outside temperature sensor etc.) needs to be carried out so that voltage peaks cannot induce in the wiring (mainly concerns distributions in the common distributor, common cable channels etc.); these could cause microprocessor reset (data on display disappears and it resets) and worse failures.

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