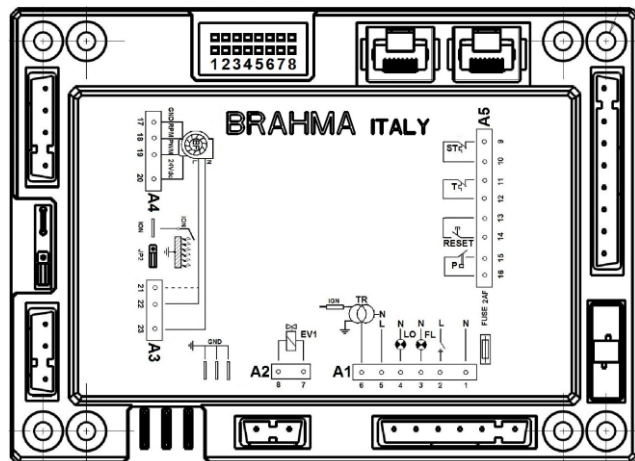


APO... M/E SERIES

DEVICE MANAGED WITH OR WITHOUT RTU MODBUS FOR CONTROLLING COMPLETE PREMIXING GAS BURNERS AND ATMOSPHERIC (WITH OR WITHOUT FAN)



APPLICATION

APO series use the module SRM (Safety and flame Detection for Modulation board, see technical note n°27964) and it is designed specifically to control gas burners for non-permanent operation. APO series is able to perform a volatile or a non-volatile lockout, therefore restarting from a volatile lockout condition can be done by interrupting and then restoring the power supply, while in case of a non-volatile lockout it can be restarted only by a manual reset. In the APO... series with modbus there must be a communication line with "RTU 2-Wire system" protocol through which the device exchanges information. The traditional connection can be used in the APO... series without modbus. APO... series is able to carry out the burner ignition cycle, to detect flame, to monitor the safety devices (air pressure switch, safety thermostat) and to command the fan whether it's a traditional type (on/off) or a variable speed type (brushless fan).

The series can be mounted in:

- Combi ovens;
- Modular cooking.

FEATURES:

The main features of this series are:

- in accordance with EN298:2012 (European Standard for automatic gas and oil burner control systems and flame detection) and with EN60730-2-5 (European Standard for automatic controls with C class software);
- in accordance with **UL**, USA (ANSI/UL 60730-2-5 ed. 3 in conjunction with UL 60730-1, ed. 4) & Canada (CSA-C22.2 No. 60730-2-5-14 ed. 1 in conjunction with CAN/CSA-E60730-1:13 A ed. 4);
- conformity to EC directives, Electromagnetic compatibility* EMC (immunity) 2014/30/EU and Low-voltage directive 2014/35/EU
- flame detection based on the rectification property of the flame (ionisation)
- possible of a traditional (on-off) fan and of a variable speed fan managed by a PID controller (brushless fan);
- control of the application safety components such as air pressure switch and safety thermostat ;
- fuel solenoid valve driven by two independent elements with contacts protected by fuses against eventual bonding
- relay control for the activation of a remote ignitor (type Brahma TC-TD-TSM series);
- acquisition of the reset control coming from a mechanical device;
- ModBus "RTU slave 2-Wire system" for controlling the heat request, the unlock and for analysing the operating status;

*) The compliance with EMC emission requirements must be checked after the burner control is installed in equipment.

TECHNICAL DATA

Power supply voltage: 110÷240V~ -15%/+5%, 50-60Hz
120V~(UL) 60Hz / 230V~(EC) /50-60Hz

Operating temperature range: -20°C +70°C
Upon request -20°C +85°C

Humidity: max. 95% at 40°C

Protection degree: IP 00

Power consumption: <5 VA

Weight: max 200 g

Varnish coating: Upon request

Times:

- Waiting time (TW): 1,5 ... 60s
- Pre-purge time (TP): 1,5 ... 60s
- Safety time (TS): 3 ... 60s
- Response time in case of flame failure: < 1s
- Post-purge time: 0 ... 30min.
- Inter-waiting or Inter-purge time: 1,5... 240s
- Waiting time due to lockout caused by air flow failure at start up 3 ... 120s
- Waiting time due to lockout caused by flame simulation 0 ... 60s
- Pre-ignition or post-ignition time: 0 ... 60s
- Number of ignition attempts: 1 ... 10

Maximum contacts rating:

- Gas valve: 0,25A cos $\varphi \geq 0.4$
- Fan: 1A cos $\varphi \geq 0.4$

NOTE: Unless otherwise specified, the loads output voltage is the same as voltage power supply.

Maximum length of the external components cables:

ModBus RTU	≤3m*
Flame and lockout signal	≤2m*
Heat Request	≤2m*
Solenoid valve	≤2m*
All other	≤1m

*(100 pF/m)

Internal fuse: 2A fast-blow type

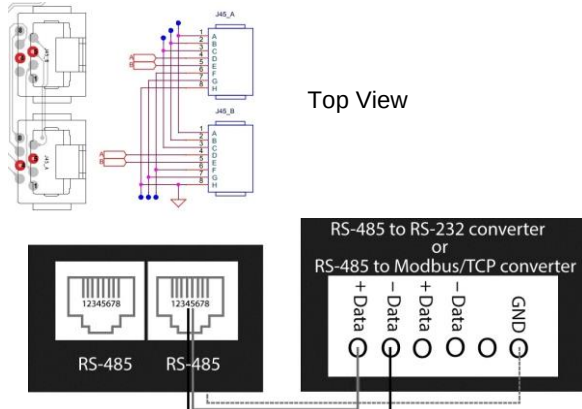
External fuse: The external fuse value must be selected according to the maximum applied load. This value must not anyway exceed the internal fuse value.

Flame control:

The flame detection device makes use of the rectification property of the flame..

- Minimum ionisation current: 0,5μA_{DC}
Upon request 1,2μA_{DC}
- Maximum ionisation current:
 - Polarized: electrode voltage = 193V_{RMS} 8.1μA_{DC}
 - non polarized electrode voltage = 97V_{RMS} 3,8μA_{DC}
- Recommended ionisation current: 3 ÷ 5 times the minimum one
- Maximum cable length: 1 m
- Minimum insulation resistance of detection electrode and cable to earth ≥ 50MΩ
- Max parasitic capacity of the electrode: ≤1nF
- Max short circuit current: < 200μA_{AC}

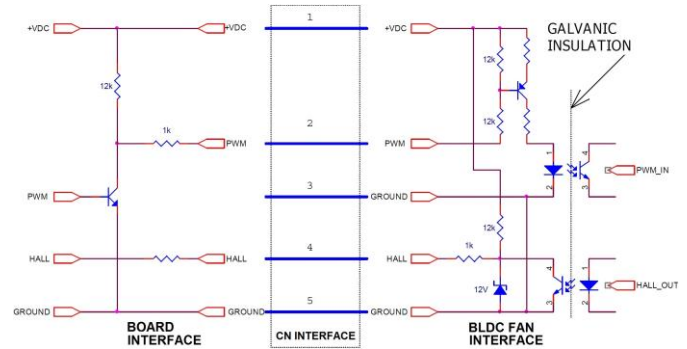
ModBus control:



Motor control

The system is designed for premix applications and allows to drive (PWM) and to measure the rotations of a burner motor.

Working range of supply: 24÷28 Vdc
Working range of PWM and HALL: 4kHz - 0÷500Hz
Response time: 3÷30 s
Impulses per impeller revolution 2

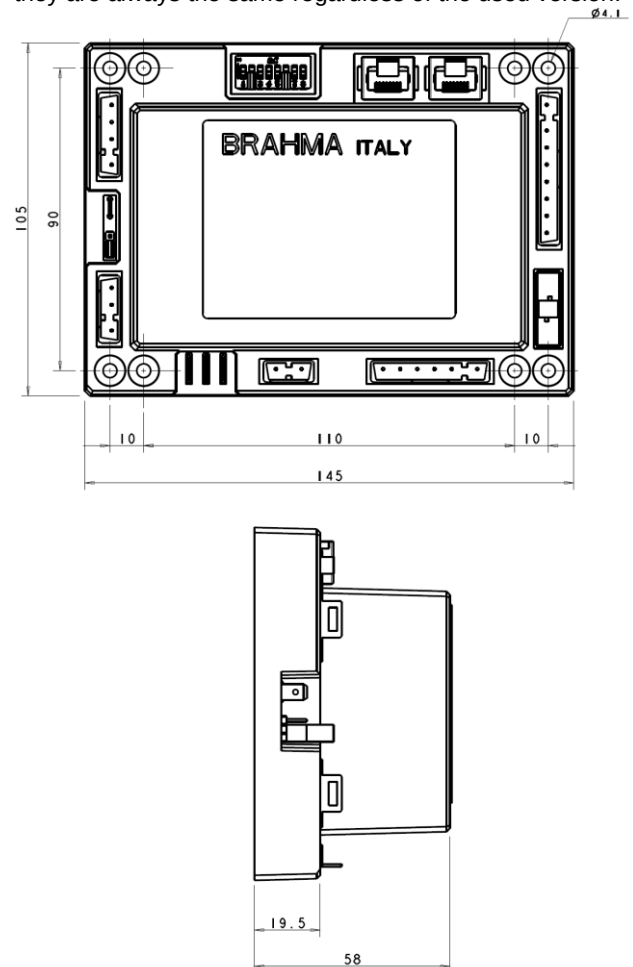


The system does not need any mechanical adjustment, all management parameters of the rotations motor are pre-loaded into the device memory. The values of the parameters, for example maximum and minimum of the rotations motor are chosen by the boiler manufacturer during product development and identified with the options SMn (Letter "n" represents the reference number of a specific adjustment).

In the APO ... series with modbus it is possible to set the working parameters of the motor (see par. "modbus controls and std. parameters").

OVERALL DIMENSIONS

The following figure (Fig.1) shows the overall dimensions, they are always the same regardless of the used version.



CONSTRUCTION

The plastic case (and the PCB painting if requested) protect the controller against mechanical damage caused by crash, tempering, dust, and contact with external ambient. Thanks to a surface mounting components (which constitutes the "logic nucleus" of the system), have allowed to reduce the dimensions of the controller PCB. A varistor protects the controller from peak tensions on the mains supply due to, for instance, atmospheric discharges such as thunderbolts. An internal accessible fuse protects the controller relays in case of short circuit on the outputs (valves, fan and lockout signal).

INSTALLATION INSTRUCTIONS

- The device is designed to stay in the running position for less than 24h (system for non-permanent operation). Reaching this limit causes a regulation shutdown in order to allow the device to check its efficiency.
- The APO... devices use the SRM safety module; Guarantee and responsibility of the manufacturer will be debarred if the device is tempered with by the user.
- The controller must be connected and disconnected without power supply;
- All operations (installation, maintenance, etc.) must be carried out by a qualified technician.
- Before any connection operation, completely isolate the system from power supply (multi-pole disconnection). Place the system safely to avoid accidental switch-on and make sure there is no voltage. If the system is not switched off, there is a risk of electric shock.
- During and after any operation (installation, maintenance, etc.), make sure that the type, timing and code are the ones provided, that the wiring is in good condition and perform the safety check in the "Commissioning notes"
- In the event of a fall or impact, the devices must not be started, as safety functions may be compromised even if no damage is visible to the outside.
- Faulty devices or damaged must be unplugged from power supply and cannot be used.
- Condensation, ice formation and liquids intake are not permitted.
- A moderate temperature is recommended in order to optimize the life duration of the device .
- The appliance where the devices are installed must provide an adequate protection against risk of electric shock (at least IP20) .
- EMC emission requirements, according to the directive EN55014-1, shall be tested after the incorporation of the burner control system into the equipment.
- burner controls has a designed lifetime* of 250,000 burner startup cycles which, under normal operating conditions in heating mode, correspond to approx. 10 years of usage (starting from the production date given on the type field). This lifetime is based on the endurance tests in the standard EN 298. A summary of the conditions has been published by the European Control Manufacturers Association (Afecor) (www.afecor.org). The designed lifetime is based on use of the burner control according to the manufacturer's technical notes. After reaching the designed lifetime in terms of the number of burner startup cycles, or the respective time of usage, the burner control has to be replaced by authorized personnel.

* The designed lifetime is not the warranty time specified in the Terms of Delivery

ELECTRICAL INSTALLATION

- The applicable national regulation and European standards (Ex. EN 60335-1 and EN 60335-2-102) related to the electrical safety must be observed. Not respecting the phase-neutral polarity causes at start-up a non-volatile lockout at the end of the safety time. This doesn't occur in the non-polarized versions.
- Before starting the system check the wiring carefully. Wrong connections can damage the controller and compromise safety;
- Avoid putting the detection cable close to power or ignition cables.
- Use a heat resistant cable and detection electrode well insulated to ground and protected from possible moisture (or water in general).
- Use an ignition cable as short and straight as possible and keep it far from other conductors to reduce the EMC emission (max. length < 2m and insulation voltage > 25 kV).
- In case of a "partial" short circuit or dispersion between phase and earth, the detection electrode voltage can be reduced till causing lockout of the controller due to impossibility of detecting the flame signal..

For further details see wiring diagram

COMMISSIONING NOTES

When commissioning the plant or when doing maintenance work, make the following safety checks:

Safety check to be carried out	Anticipated response
Burner startup without fuel supply	Lockout at the end of safety time (TS)
Burner operation with simulated loss of flame. For that purpose, close the fuel supply during operation and leave it in this state.	Recycle (or immediate lockout with V option).
Burner startup with response from air pressure switch interruption.	Continuous prepurge (or immediate lockout with Q option, delayed lockout with Qnn option).
Burner operation with air pressure failure simulation.	Recycle (or Immediate lockout with R option).
Burner startup with response from safety thermostat switch interruption.	Continuous prepurge.
Burner operation with safety thermostat failure simulation.	Immediate lockout.



NOTES FOR PRODUCT DISPOSAL

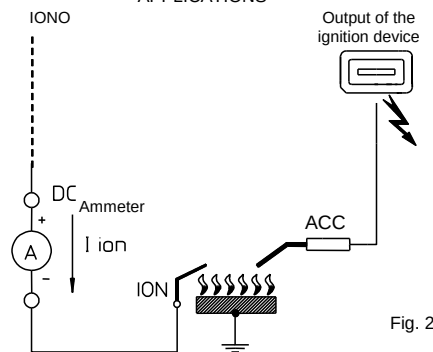
The device contains electronic components and cannot therefore be disposed of as normal household waste. For the disposal procedure, please refer to the local rules in force for special waste.

CHECKING AT START-UP

Check the controller before the first start-up, after every overhaul and after a long period of non-operation. Before any ignition attempt make sure that the combustion chamber is empty, then make sure that:

- If the start-up attempt occurs without fuel supply lockout occurs at the end of safety time of the last ignition attempt (from 1 to max. 10 attempts);
- When gas flow is interrupted (while the controller is in running state) the gas valves are de-energized within 1 second and the controller proceeds to lockout after a recycle (or more than one recycle up to max. 10 according to the settings), and the device proceeds to lockout
- Operating times and cycle are in compliance with those declared for the used controller type
- The flame signal level is high enough (see Fig.2 measurement method);
- The intervention of limiters or safety devices causes a safety lockout or shut down of the controller according to the application type

FLAME LEVEL MEASUREMENT IN DUAL ELECTRODE APPLICATIONS



OPERATION

The following description is related to the standard operation cycle:

At every heating demand sent through bus or wiring, the device checks its own efficiency (state "1" = check). During waiting time (TW) or pre-purge time (TP) (state "3" = prepurge) the SRM safety module monitors the correct operation of the flame signal amplifier. A spurious flame signal or a fault in the amplifier related to the existing flame condition prevents the controller from starting (or lockout with Knn option). In the versions with air pressure switch, before the beginning of the waiting time (TW) or pre-purge time (TP) the air pressure switch contact is checked to ensure a 'no air-flow' condition. Only if the result of this test is positive the air pressure switch commutation makes the pre-purge stage begins. Air pressure switch checking is carried out at every cycle start. At the end of waiting time (TW) or pre-purge time (TP), the safety time (TS) (state "4" = ignition) begins. During safety time the ignition device and the gas valve are energized. If flame is detected during safety time, at the end of this stage the system starts operating (state "5" = running), conversely, at the end of attempts (opt. Ynn), the system proceeds to lockout (state "7" = lockout) and the valve closes. In case of loss of ST safety thermostat (if enabled) in operation, a lockout occurs.

See cycle diagrams to better understand the operation of the single controllers

Operation cycle variations

The possible cycle variations are as follows:

Option 12: Lockout due to flame simulation

If spurious flame is detected at start-up or during waiting/pre-purge time the device goes to immediate lockout or after nn second delay (time is settable upon request)

Option 13: Air flow failure or insufficiency at start-up

If the device detects an air flow failure or insufficiency at start-up or during waiting/pre-purge time, it goes to lockout within nn second (time is settable upon request).

Option 14: Air flow failure during operation.

In case of air flow failure during operation, the device performs an immediate lockout or after nn second delay

Option 15: flame failure in running state

The device proceeds to lockout in case of flame failure during operation.

Option 16: Ignition recycle attempts

After a safety lockout the device performs multiple ignition and recycle attempts (attempts number is settable upon request)

Option 17: Pre-ignition time

The device activates the transformer at the end of safety/pre-purge time and before the beginning of safety time (time is settable upon request).

Option 18: Post-purge time

Fan is energized after a safety lockout or at the end of heating demand for nn seconds (time is settable upon request). The fan will be shut off after a new heating demand in case the post-purge stage is terminable after the up-mentioned event.

Option 19: Inter-waiting or inter-purge time

The device performs a waiting or purge time after an unsuccessful ignition attempt and before the next recycle attempt.

CONTROLLER RESET

Non-volatile lockout (manual reset)

When the device goes to a non-volatile lockout, in order to reset the system use the remote or local reset device (if mounted on the final application). Only for remote reset, device limits to 5 the unlock requests on a span time of 15 min; all remote reset requests after the fifth are ignored (in accordance with EN 15502-1). In the case in which, in all operating states of the device, they require 6 or more unlock(remote) requests within 15 minutes, to unlock the device you will be necessary to act on the local reset or by interrupting of 5 or more seconds and then restoring the power supply (followed by a new remote unlock request).

Volatile lockout (electrical reset)

In case of a volatile lockout the device can be reset by interrupting and then restoring the power supply.

CONTROLS BY MODBUS AND STANDARD PARAMETERS

Here below describes the MODBUS over RS485 Serial Line protocol of the standard APO device.

Main features:

- ModBus RTU Slave with baud-rate of 9600 bits/sec, 1 start bit, 8 data bits, without parity check, 1 Stop bit.
- maximum number of devices equal to 31 slaves connected to the modbus line
- transaction directed to a single slave (without broadcast).
- message format: device address, function code, data exchanged, error control (CRC16)
- Synchronization of messages with a pause between messages of at least 3.5 times the time of a character. If the receiving device does not receive for a time of 3.5 characters, it considers the message completed.
- RTU Message Frame:

Start	Address	Function	Data	CRC Check	End
≥ 3.5 char	8 bits	8 bits	N x 8 bits	16 bits	≥ 3.5 char
- slave response within 3 seconds, 120 ohm termination by DSW (8) (see wiring diagrams)
- Error handling:
 - o in case of an error in the format of the message received, the message is considered invalid and discarded
 - o in case of correct message but not executable there is an operational error (exception codes)
 - Main exception codes implemented:
 - 01 ILLEGAL FUNCTION function not allowed on the addressed slave.
 - 02 ILLEGAL DATA ADDRESS address not allowed on the addressed slave.
 - 03 ILLEGAL DATA VALUE value is not allowed for the associated address.
 - 07 NAKNEGATIVEACKNOWLEDGEMENT function not performed in the current operating conditions or attempt to write to a read-only address.
- The address of the device is managed by 6207 register and can assume the values 30(default), 31, 32. The address 6207 changes take effective by interrupting and then restoring the power supply of the board.
- Main functions implemented in theRTU slave ModBus (in green the enabled functions):
 - o 01 Read Coil Status
 - o 02 Read Input Status
 - o 03 Read Holding Registers
 - o 04 Read Input Registers
 - o 05 Write/Force Single Coil
 - o 06 Write/Preset Single Register
 - o 07 Read Status
 - o 15 Write/Force Multiple Coils
 - o 16 Write/Preset Multiple Registers

Table of setting registers:

Register*		Control Range	U.M.	Meaning
6200 0x1838	E(R/#W)	2000 - 9000	rpm	Maximum burner fan speed: - default value = max value
6201 0x1839	E(R/#W)	10 – 80	%	Minimum burner fan speed: - default value = 30 - percentage of register 6200, rpm min=val(6200)*val(6201)/100 - e.g. if val(6200)=9000rpm & val(6201)=30 then rpm min=2700
6202 0x183A	E(R/#W)	0 - 100	%	Set point of burner fan speed during prepurge T _{p1} and postpurge: - default value = 50 - linearized percentage between max and min fan speed - val(3999)=(val(6200)- val(6200)*val(6201)/100)*val(6202)/100+val(6200)*val(6201)/100 - e.g. val(3999)=(9000-9000*30/100)*50/100+9000*30/100=5850rpm
6203 0x183B	E(R/#W)	20 – 90	%	Minimum fan speed alarm threshold: - default value = 60 - if (val(1999) < (val(6200)*val(6201)/100)*(val(6203)/100)) then (alarm val(2011)=24)
6204 0x183C	E(R/#W)	0 - 100	%	Set point of burner fan speed during prepurge T _{p2} and ignition: - default value = 50 - to disable T _{p2} set val(6204) equal to val(6202). - linearized percentage between max and min fan speed as soon as T _{p1}
6207 0x183F	E(R/#W)	(30/31/32)		Address Slave ModBus: - default value = 30 - if val(6207)=31 then at restoring power supply val(6207)=31 - if val(6207)=32 then at restoring power supply val(6207)=32
6210 0x1842	E(R/W)	1 - 255		Setting register (available) - default value = 3 - not used
6211 0x1843	E(R/W)	1 - 255		Setting register (available) - default value = 8 - not used
6212 0x1844	E(R/W)	100 - 30000		Setting register (available) - default value = 30000 - not used
6213 0x1845	E(R/#W)	40 - 90	°C	Threshold of over-temperature alarm activation of the board - default value = 78 - if board temperature > val(6213) then alarm val(2011)=6, val(2501)=0
6220 0x184C	E(R/#W)	0 / 1-24	10 x sec	Timeout, card/communication missing: - default value = 1x10s - if val(6220)=0 then alarm disabled else if communication timer > val(6220) then alarm val(2011)=40, val(2501)=0

*Read: R Write: W

Required writing with corrupt memory: #W

Value to EEPROM: E

Table of command registers:

Register*		Control Range	U.M.	Meaning
2502 0x09C6	R/W	0 - 100	%	Set point of burner fan speed during working position - default value = max - linearized percentage between max and min fan speed - $\text{val}(3999) = (\text{val}(6200) - \text{val}(6200) * \text{val}(6201)/100) * \text{val}(6202)/100 + \text{val}(6200) * \text{val}(6201)/100$ - e.g. $\text{val}(3999) = (9000 - 9000 * 30/100) * 100/100 + 9000 * 30/100 = 9000 \text{rpm}$
2503 0x09C7	R/W	(0/90/165) 0x00(00/5A/A5)		Request of stop/purging/heat ⁽¹⁾ - default value = 0x0000 - if val(2503)= 0x0000 then Stop purging / Heat Request - if val(2503)= 0x005A then - Start purging - if $\text{val}(2501) \neq (7 \text{ or } 8)$ then $\text{val}(2501)=0$ - if val(2503)= 0x00A5 then - Start Heat Request - if $\text{val}(2501) \neq (7 \text{ or } 8)$ then $\text{val}(2501)=1$
2504 0x09C8	R/W	0 ÷ 65535		Reserved for supplier test
3010 0x0BC2	W	255		Request of Alarm Reset in progress - default value = 0 - if $\text{val}(3010)=255$ then $\text{val}(2501)$ changes from 8 to 9 to 0

⁽¹⁾Requests allowed only without corruption of internal memory and/or after setting of all ModBus registers (only #W types).

Table of operating and system registers:

Register*		Control Range	U.M.	Meaning
1999 0x07CF	R	0 ÷ 9000	rpm	Actual speed of burner fan
3999 0x0F9F	R	0 ÷ 9000	rpm	Set point of burner fan speed - e.g. if $\text{val}(2503) = 0x005A$ then $\text{val}(3999) = (\text{val}(6200) - \text{val}(6200) * \text{val}(6201)/100) * \text{val}(6202)/100 + \text{val}(6200) * \text{val}(6201)/100$ - e.g. if $\text{val}(2501) = (1)$ then $\text{val}(3999) = 0$ - e.g. if $\text{val}(2501) = (2 \text{ or } 3 \text{ or } 4)$ then $\text{val}(3999) = (\text{val}(6200) - \text{val}(6200) * \text{val}(6201)/100) * \text{val}(6202)/100 + \text{val}(6200) * \text{val}(6201)/100$ - e.g. if $\text{val}(2501) = (5)$ then $\text{val}(3999) = (\text{val}(6200) - \text{val}(6200) * \text{val}(6201)/100) * \text{val}(2502)/100 + \text{val}(6200) * \text{val}(6201)/100$ - e.g. if $\text{val}(2501) = 10$ then $\text{val}(3999) = (\text{val}(6200) - \text{val}(6200) * \text{val}(6201)/100) * \text{val}(6202)/100 + \text{val}(6200) * \text{val}(6201)/100$
2500 0x09C4	R	0/1/6		Operating mode: - 0= default value, 1= working position - 6= test mode - if $\text{val}(2501) = 5$ or (4 con fiamma) then $\text{val}(2500)=1$ else $\text{val}(2500)=0$
2501 0x09C5	R	0 ÷ 10		Burner states (low register): 00 Stand by, 01 Check test, 02 Startup fan, 03 Prepurge T _{p1} , 13 Prepurge T _{p2} 04 Ignition, 05 Running, 06 Stop, 07 Lockout Unlockable 08 Lockout Lockable, 09 Reset, 10 Postpurge
2550 0x09F6	R	51 ÷ 65535		Firmware Versions/Revisions
2552 0x09F8	R	0 ÷ 65535		Hardware Versions/Revisions
2554 0x09FA	R	0 ÷ 65535		Reserved for supplier test
2016 0x07E0	R	0/255		Alarm signaling: - 0x0000 = regular, 0x00FF = alarm - if $\text{val}(2501) = (7 \text{ or } 8)$ then $\text{val}(2016) = 255$ else $\text{val}(2016) = 0$
2011 0x07DB	R	0 ÷ 55		Alarm code (see table of error codes)
2012 0x07DC	R	-100 ÷ +1000	10 x °C	Internal board temperature - if temperature <10°C then saturation $\text{val}(2012) = -100$ - if temperature >100°C then saturation $\text{val}(2012) = +1000$
2014 0x07DE	R	0 ÷ 50	10 x µA	Measured ionization current - if ionization >1.9µA then saturation $\text{val}(2014) = 19$ - if ionization <0.01µA then saturation $\text{val}(2014) = 0$

*Read: R Write: W

Table of ModBus Error Codes and system registers, cause of lockout or malfunction:

val(Register*)=dec (error code)		Table of potential causes of the ModBus error code
val(2011)=00	R	No Error
val(2011)=04	R	Lockout for flame failure at the end of safety time «TS»: - Defective or soiled fuel valves - Defective or soiled flame detector - Bad earth connection - Poor adjustment of burner or no fuel - Defective ignition equipment
val(2011)=05	R	Lockout for failure of flame with burner in working position: - Fuel valve doesn't work - Flame sensor doesn't work - Bad earth connection - Defects in the calibration of the burner or no fuel.
val(2011)=06	R	Board over temperature {[val (2012)>[10*val(6213)]}. - In start-up and working position with 3s timeout.
val(2011)=10	R	Generic error
val(2011)=11	R	Lockout for extraneous light/Flame simulation at start-up (only combined with APO... with Knn option). - flame probe dirty or damaged
val(2011)=20	R	Lockout for extraneous light/Flame simulation at start-up after burner shutdown (only combined with APO... with Knn option). - flame probe dirty or damaged.
val(2011)=24	R	Timeout, incorrect fan speed - during start-up position (val(2501)=2) - if [val(1999)>(val(3999)+10%) or val(1999)<(val(3999)-20%)] then (alarm val(2011)=24 after 22s) - during prepurge and ignition (val(2501)=3÷4) - if (val(1999)<(val(6200)*val(6201)/100)*(val(6203)/100)) then (alarm val(2011)=24 after 22s) - during working position (val(2501)=5) - if (val(1999)<(val(6200)*val(6201)/100)*(val(6203)/100)) then (alarm val(2011)=24 after 5s)
val(2011)=26	R	Timeout, the fan does not switch off - if val(2501)=(6) and val(1999)>0 after timeout of 30s.
val(2011)=40	R	Timeout, card/communication missing - communication of modbus master missing for a time greater than val(6220).
val(2011)=41	R	Timeout, communication with SRM safety module - communication with SRM safety module missing for a time greater than 4s.
val(2011)=42	R	Internal memory corrupted* - Set the parameters and the address of the Modbus slave if different from the default value. * the system stops, loads the default values and waits for the setup of all the #W setting registers.
val(2011)=43	R	No or insufficient power supply - Fuse interrupted - Supply voltage <85Vac
val(2011)=51	R	Lockout for failure of air pressure switch with burner in working position: - Defective or soiled fan motor - smoke duct clogged. - air pressure switch doesn't work. (only combined with APO... without G option and with R option).
val(2011)=52	R	Lockout for failure of safety thermostat with burner in working position: - Defective or soiled fan motor (only combined with APOT... versions).
val(2011)=53	R	Lockout for failure of flame with burner in working position: - Fuel valve doesn't work. - Flame sensor doesn't work or bad earth connection. - Defects in the calibration of the burner or no fuel. (only combined with APO... with Vnn option).
val(2011)=54	R	Lockout for failure of air pressure switch with burner in start-up position: - Defective or soiled fan motor - smoke duct clogged. - air pressure switch doesn't work. (only combined with APO... without G option and with Qnn option).
val(2011)=55	R	Lockout for generic internal failure.
val(2011)=60	R	Working cycle stop with auto resolve for safety thermostat open during startup after 22s timeout.
val(2011)=61	R	Working cycle stop with auto resolve due to faulty pressure switch during startup after 22s timeout.
val(2011)=62	R	Working cycle stop with auto resolve for flame / parasitic light during startup after 22s timeout.

*Read: R Write: W

Table of working cycle conditions with device unlocked and supplied within the range described in technical data:

Register ⁽¹⁾		Working Cycle Conditions ⁽²⁾
Query ⁽³⁾	Response ⁽⁴⁾	
val(2503)	val(2501)	
R/W 0x0000	R 0x0000	The conditions for the start-up of working cycle are the following: - Heat request in idle position.
R/W 0x005A	R 0x0000	The conditions for the only purging are the following: - Purging request in working position.
R/W 0x00A5	R 0x0001	The conditions for the start-up of working cycle are the following: - Heat request in working position. - Air pressure switch (if enabled) in idle position. - Safety thermostat (if enabled) in working position. - No flame or parasite flame.
R/W 0x00A5	R 0x0002	The conditions for the start-up of fan are the following: - Heat request in working position. - Air pressure switch (if enabled) in working position. - Safety thermostat (if enabled) in working position. - No flame or parasite flame.
R/W 0x00A5	R 0x0003	The conditions for the start-up of pre-purge time are the following: - Heat request in working position. - Air pressure switch (if enabled) in working position. - Fan with controlled ignition speed within the interval val(3999) +10% /-20%. - Safety thermostat (if enabled) in working position. - No flame or parasite flame.
R/W 0x00A5	R 0x0013	The conditions for the start-up of T _{p2} pre-purge time are the following: - Heat request in working position. - Air pressure switch (if enabled) in working position. - Fan with controlled ignition speed val(1999) greater than (val(6200)*val(6201)/100)*(val(6203)/100)). - Safety thermostat (if enabled) in working position. - No flame or parasite flame.
R/W 0x00A5	R 0x0004	The conditions for the start-up of safety time are the following: - Heat request in working position. - Air pressure switch (if enabled) in working position. - Fan with controlled ignition speed val(1999) greater than (val(6200)*val(6201)/100)*(val(6203)/100)). - Safety thermostat (if enabled) in working position.
R/W 0x00A5	R 0x0005	The conditions for reach the working position are the following: - Heat request in working position. - Air pressure switch (if enabled) in working position. - Fan with controlled ignition speed val(1999) greater than (val(6200)*val(6201)/100)*(val(6203)/100)). - Safety thermostat (if enabled) in working position. - Presence of flame signal.
R/W 0x0000 0x00A5 0x00A5 0x00A5 0x00A5 0x00A5	R 0x000A/6 0x0003 0x0003 0x0003 0x0007 0x000A	The device exits the working position due to one or more of the following reasons: - Heat request in idle position (with/without postpurge Tx[2501]=0x000A/0x0006). - Loss of flame signal. - Air pressure switch (if enabled) in idle position. - Fan with controlled ignition speed val(1999) less than (val(6200)*val(6201)/100)*(val(6203)/100)). - Safety thermostat (if enabled) in idle position. - Device supplied outside the range described in technical data.
-	R 0x0008 0x0007 0x0000	Device state during lockout statuses during blocking: - Lockable lockout. - Unlockable lockout. - Reset (with ModBus Rx[2010]= 0x00FF Tx[1501]= 0x0008 → 0x0009 → 0x0000).

⁽¹⁾: Read: R Write: W

⁽²⁾: Flame, air pressure switch and safety thermostat are safety signals, the motor control signals are functional

⁽³⁾: Heat request enabled by val(2503)=0x00A5

⁽⁴⁾: Burner state read by means of val(2501)

Examples:

03 Read Holding Registers(slave_address,start_address,word_quantity)

```

slave_address  func    start_address  word_quantity*  CRC_0x8005
0x14           0x03    0x05    0xDF    0x00    0x02    0xB7    0xF9
*word_quantity is always equal to 0x0002

```

06 Write/Preset Single Register(slave_address,reg_address,reg_value)

```

slave_address  func    reg_address  reg_value      CRC_0x8005
0x14           0x06    0x05    0xDF    0x00    0xA5    0x7A    0x42

```

CONTROLS DENOMINATION

Type	Options																		
APO(1) (2) (3) (4).Id.Rev.Rev. (5) (6) (7)	(8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19)																		
Descrizione del modello																			
(1)	safety thermostat (ST, option with only hardware modifications)																		
	No letter:	Safety thermostat not available (Standard mode)																	
	T:	With safety thermostat (ST)																	
(2)	lockout state typology (option with only software modification)																		
	M	Non-volatile lockout (stored in EEPROM – standard mode)																	
	E	Volatile lockout (no stored in EEPROM)																	
(3)	drived fan typology (options with hardware and software modifications)																		
	1	controlling an ON/OFF fan																	
	3	controlling an ON/OFF and brushless fan																	
(4)	fuel Valve																		
	1:	Direct ignition																	
(Id)	Identification letter(s) and progressive number identifying the type of board for a specific customer																		
(Rev)	Revision number of the microcontroller software with safety functions (SRM)																		
(Rev)	Revision number of the microcontroller software with temperature adjustment functions (APO)																		
(5)	inter waiting/pre-purge time (option with only software modification)																		
	TW/TP nn	duration of the above—mentioned time expressed in seconds																	
(6)	safety time (option with only software modification)																		
	TS nn	duration of the above—mentioned time expressed in seconds																	
(7)	sensitivity (option with only software modification)																		
	No number	0,5µAdc (standard sensitivity)																	
	1,2	1,2µAdc																	
Options description																			
(8)	modbus/wired inputs (options with hardware and software modifications)																		
	No letter	device with ModBus input (Slave with standard settings, see par. “modbus controls and std. parameters”)																	
	W	device without ModBus input and with wired inputs (T, P, RESET)																	
	MWn*	custom device with ModBus and/or wired inputs (Master/Slave with custom settings)																	
	* Remark:	Letter “n” represents the reference number of a specific configuration.																	
(9)	Modulation (options with hardware and software modifications).																		
	No letter	Standard modulation (standard mode).																	
	SM0:	without modulation.																	
	SMn*:	with custom modulation (see par. “Motor Control” and “Interface Motor Control”).																	
	* Remark:	Letter “n” represents the reference number of a specific operation mode. More details are available in specification data sheet of APO controller.																	
(10)	air pressure switch check (options with hardware and software modifications).																		
	No letter:	Air pressure switch is checked (standard mode).																	
	G*:	without air pressure switch check.																	
	* Remark:	The “G” option in the GAS versions are intended for special applications where checking the air flow is not required by the standard appliance.																	
(11)	ignition mode (option with only software modification)																		
	No letter	The ignition device is active only during TSP time (TS-1 second – standard mode).																	
	A	The ignition device is active during all TS time																	
	B	The ignition device is turned off when flame is detected																	
(12)	behaviour in presence of flame simulation signal (option with only software modification)																		
	No letter	continuous waiting/pre-purge stage (standard mode)																	
	K	Immediate lockout																	
	Knn	nn second delay lockout																	
(13)	failure or insufficiency of air flow (option with only software modification)																		
	No letter	continuous waiting/pre-purge stage (standard mode)																	
	Qnn	nn second delay lockout																	
(14)	failure or insufficiency of air flow during operation (option with only software modification)																		
	No letter	Safety lockout followed by a continuous waiting/pre-purge stage (standard mode)																	
	R	Immediate lockout																	
	Rnn	Lockout at the end of the multiple attempts (nn= number of attempts, the same as those of option Ynn)																	
(15)	flame failure during operation (option with only software modification)																		
	No letter	Ignition recycle without limits (standard mode)																	
	V	Immediate lockout																	
(16)	ignition recycle attempts (option with only software modification)																		
	No letter	Single attempt (standard mode)																	
	Ynn	Multiple attempts (nn = number of attempts)																	
	YnnRmm*	nn multiple recycle attempts, with restoring of mm recycle attempts in operation																	
	* Remark:	Y3R0 3 recycles according to EN676 and EN746-2, single attempt to recycle upon flame failure during operation.																	
(17)	pre-ignition time (option with only software modification)																		
	No letter	Not available (standard mode— ignition device is activated at the beginning of TS time)																	
	Jnn	Pre-ignition time is available and keeps on for nn seconds before the beginning of TS time																	
(18)	post-purge time at the end of heating demand (option with only software modification)																		
	No letter	Not available (standard mode)																	
	PTnn	Post-purge time of nn seconds which ends when a new heating demand occurs (only if enabled by terminal 1 of DSW)																	
(19)	inter-purge time (the option can be activated only in case of multiple ignition recycle attempts – the option entails only software modifications)																		
	No letter	Not available (standard mode)																	
	Inn	Inter-purge time of nn seconds																	
(20)	pre-purge T _{p2} time (option with only software modifications)																		
	No letter	Not available (standard mode, T _{p1} = T _p e T _{p2} =0)																	
	PGnn	pre-purge T _{p2} time of nn seconds, T _{p1} = T _p - T _{p2}																	

Standard Version: APOM31 7 5 G K20 Y5 PT13

Device with slave ModBus and provided with non-volatile lockout (M), able to command a variable speed fan, timing: TW 7s TS 5s, sensitivity 0,5 µA, lockout due to flame simulation during after 20 seconds, 5 ignition attempts, post-purge time = 13 seconds (only if enabled by terminal 1 of DSW), without air pressure switch.

WIRING DIAGRAMS

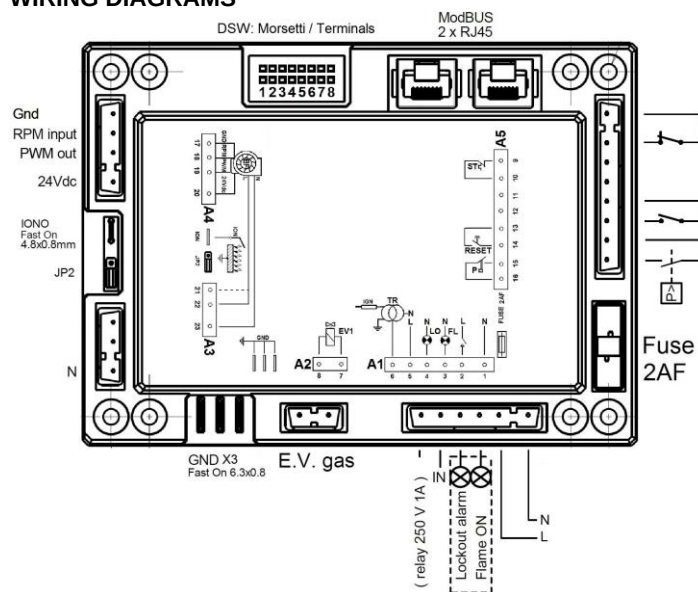


Fig.4 APOTM31

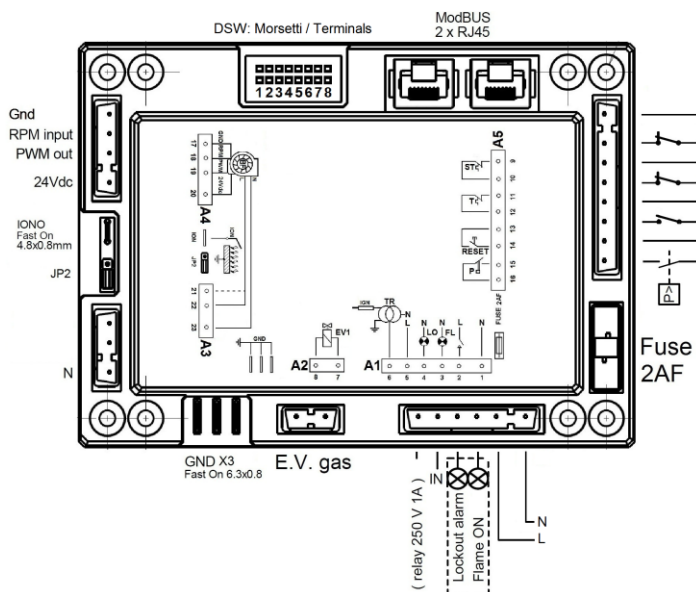


Fig.5 APOTM31 (with W option)

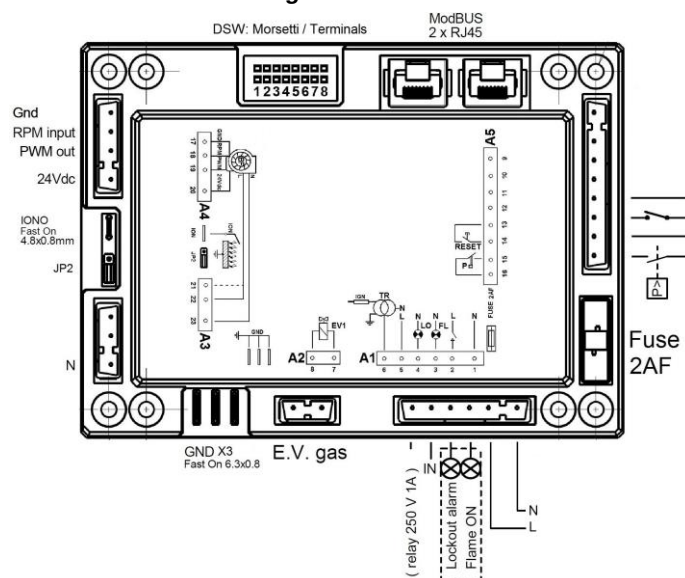


Fig.6 APOM31

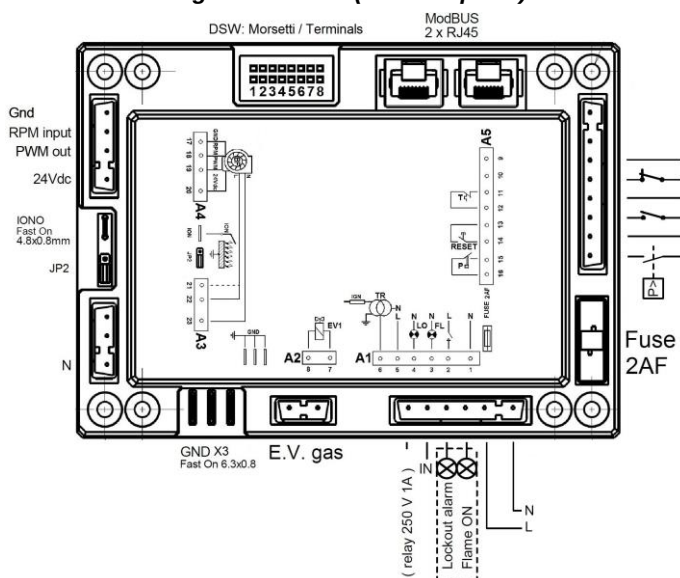
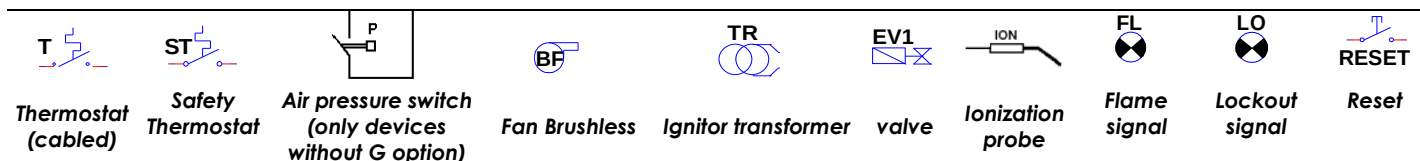


Fig.7 APOM31 (with W option)

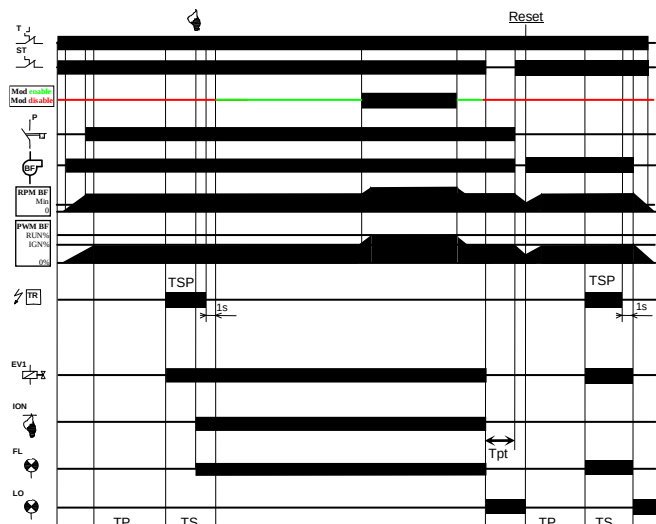


Remarks

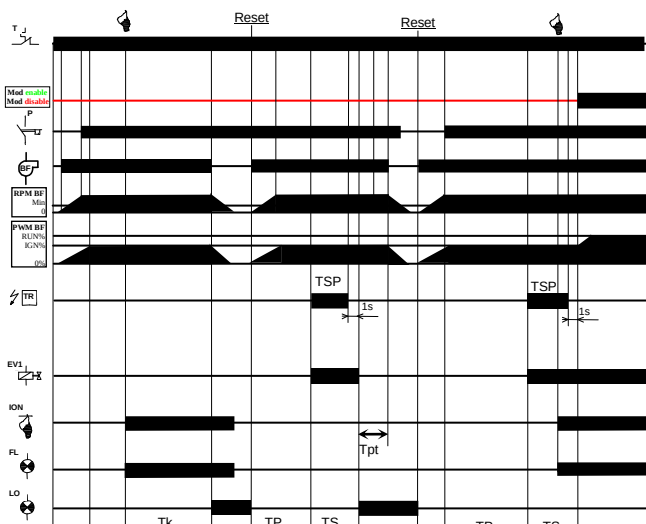
- 1) Fan Outputs**
 - 23 is continuous Neutral, 22 is continuous Live and 21 is Live driven by relay.
- 2) Jumper JP2*:**
 - polarized power supply (phase sensitive device), JP2 in open position to right (see JP2 fig.4/5).
 - non-polarized power supply, JP2 in close position to left.

*only for versions @230V and not safety to touch (NON SELV)!
- 3) Jumper DSW: programming terminals, tests and special settings (strips)**
 - Post-purge enable, set by PTnn option (open→post-purge enabled T_{pt}, closed → without post-purge).
 - Special setting available.
 - Special setting available.
 - Special setting available.
 - Special setting available.
 - Special setting available.
 - Not connected.
 - Termination of 120 ohm ModBus (in close position→120ohm, in open position→open circuit).

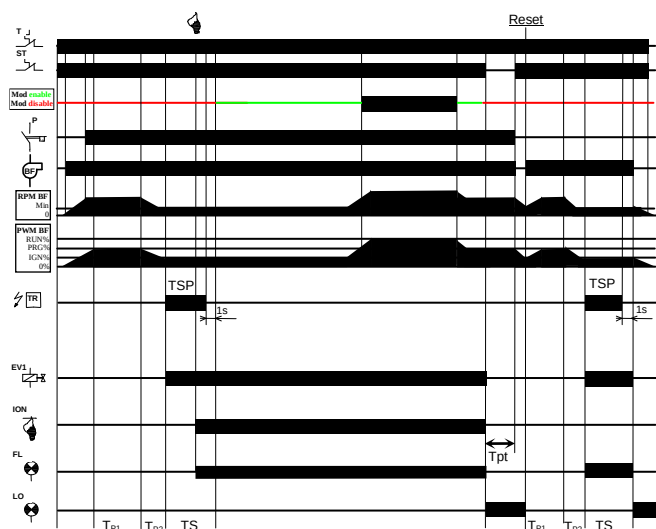
CYCLE DIAGRAMS



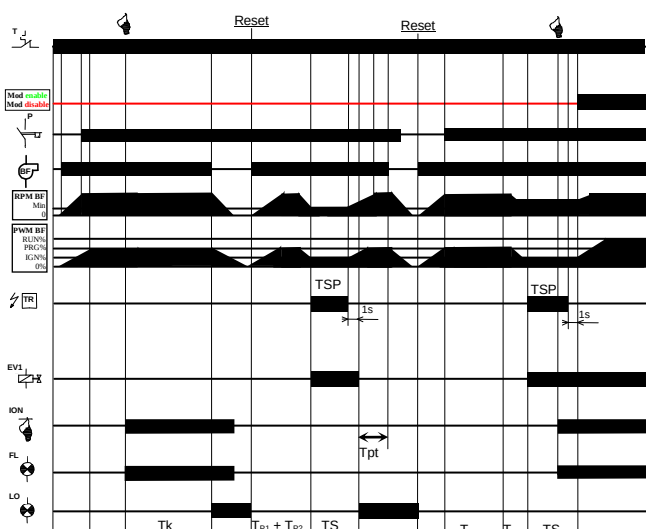
APOTM31



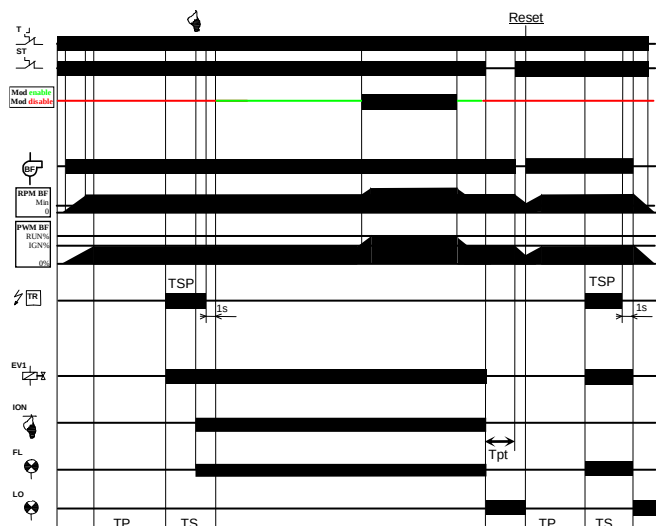
APOM31



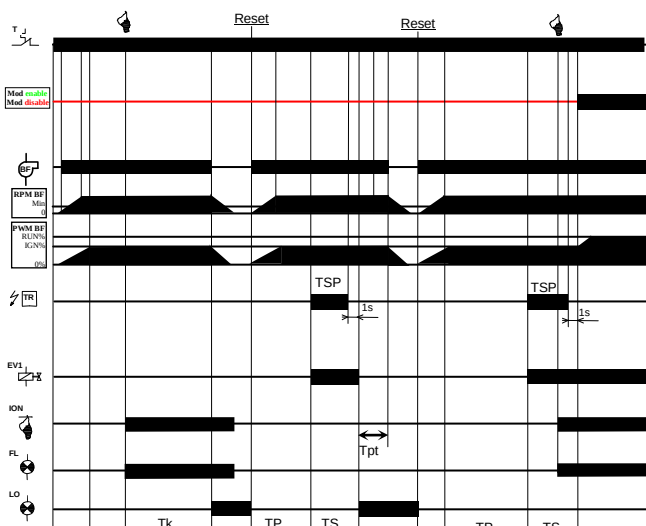
APOTM31 (with PGnn option)



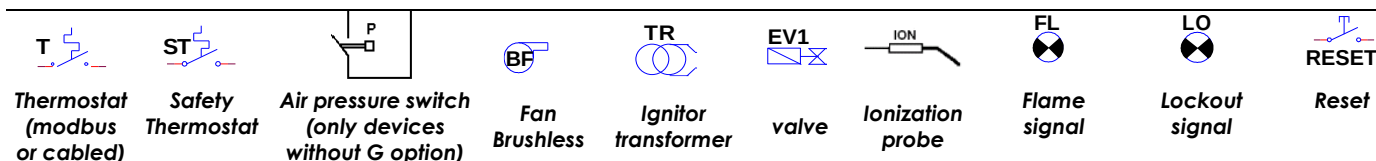
APOM31 (with PGnn option)



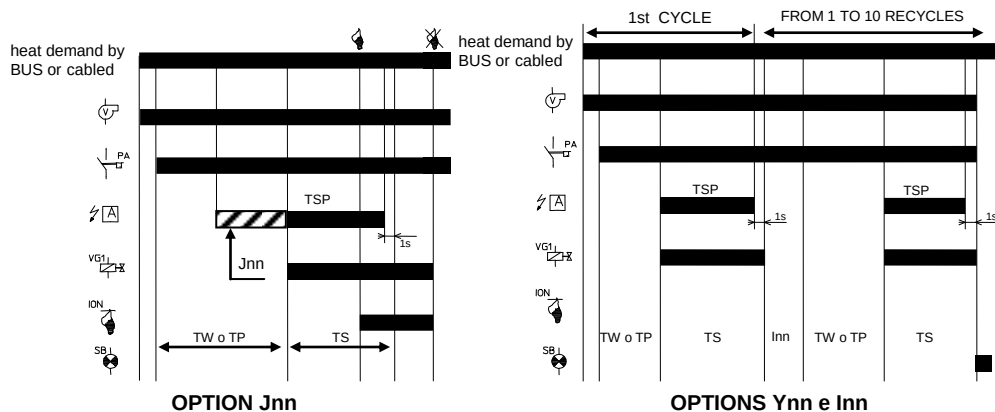
APOTM31 (with G option)



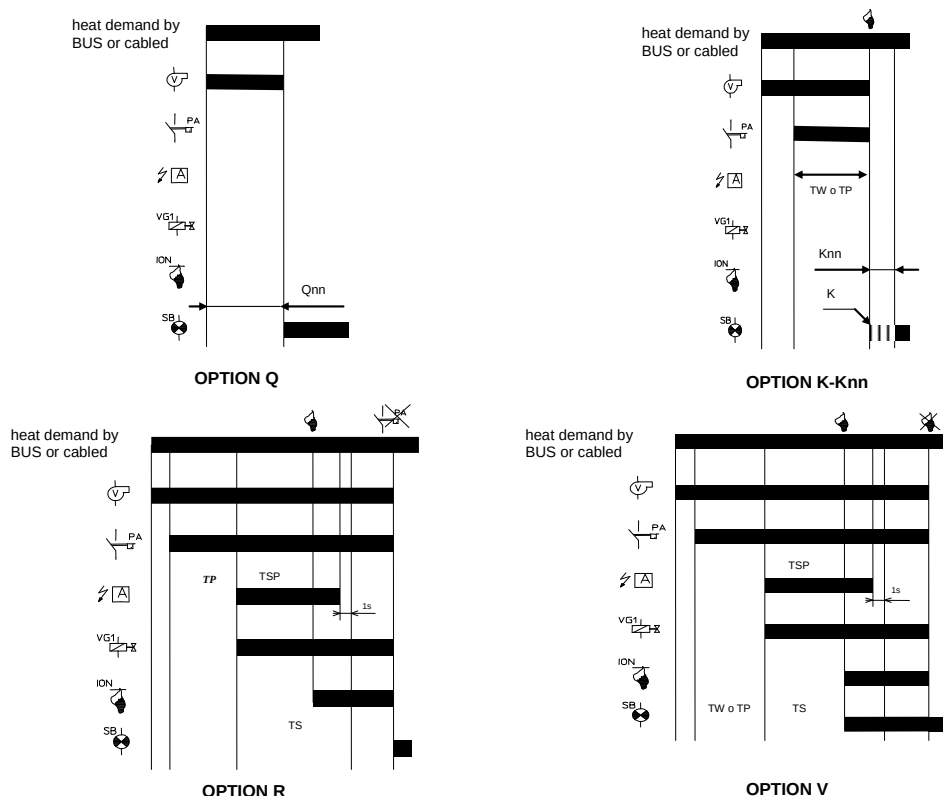
APOM31 (with G option)



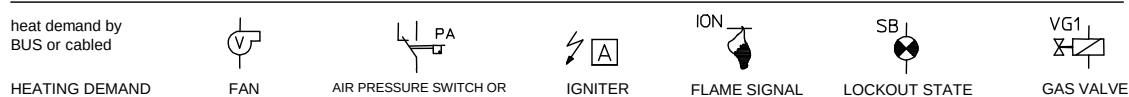
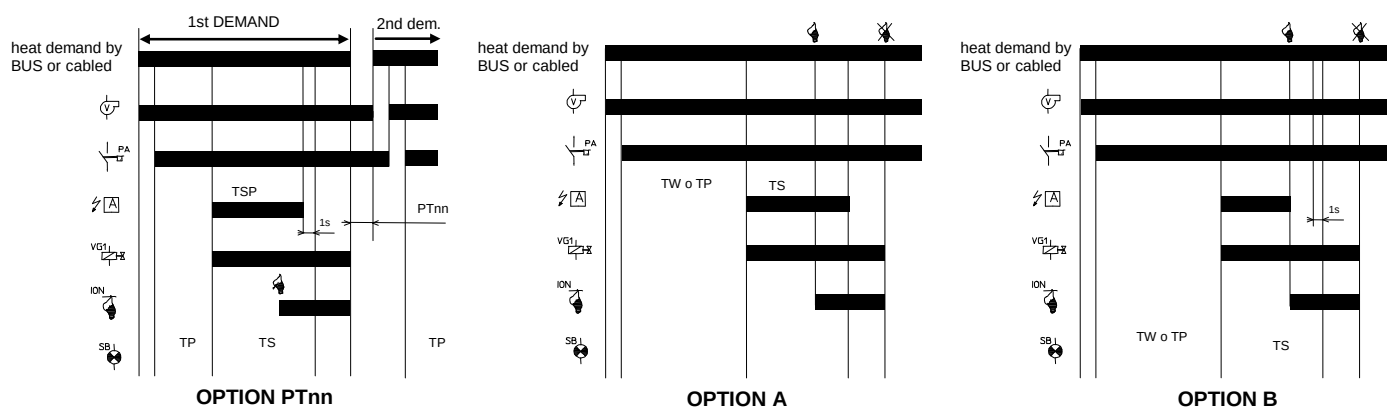
CYCLE DIAGRAM OF OPTIONS Jnn – Ynn – Inn



CYCLE DIAGRAM OF OPTIONS Q – K – Knn – R – V



CYCLE DIAGRAM OF OPTIONS PTnn – A – B



ATTENTION -> Brahma S.p.A. accepts no responsibility of any damage resulting from customer's tampering with the product.

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