## Oil Burner Controls

## Oil burner controls

- With / without air pressure check for checked air damper control
- Flame supervision with
- photoresistive detectors QRB1...
- blue-flame detectors QRC1..., or
- selenium photocell detectors RAR...

The oil burner controls LAL... are tested and certified to EN 230. They carry the CE mark in compliance with the directives for electromagnetic compatibility!

The LAL... and this data sheet are intended for use by OEMs which integrate the burner controls in their products!

## Use

- Control and supervision of oil atomization burners
- For burners of medium to high capacity
- For intermittent operation (at least one controlled shutdown every 24 hours)
- Universally applicable for multistage or modulating burners
- For burners of stationary air heaters (WLE to DIN 4794)

| LAL1 $\ldots$ | - Yellow- and blue-flame burners without air pressure <br> supervision |
| :--- | :--- |
| LAL2... | - Yellow-flame burners with air pressure supervision |
| LAL3.25 | - For special applications, <br> e.g. burners of incinerator plants <br> (refer to «Type summary» and «Notes») |
| LAL4... | - Yellow- and blue-flame burners with air pressure supervision |

For burner controls used with burners in continuous operation, refer to data sheet 7785 (types LOK16...).

## Warning notes

## Mounting notes

## Installation notes

To avoid injury to persons, damage to property or the environment, the following warning notes must be observed!

- LAL... are safety devices. It is therefore not permitted to open, interfere with or modify the units!
- The unit must be completely isolated from the mains supply before performing any wiring changes in the connection area of the LAL...!
- Check all safety functions when putting the burner control into operation or after performing service work!
- Ensure protection against electric shock on the unit itself and on all electrical connections through appropriate mounting!
- Always press lockout reset button manually, without using any tools or pointed objects!
- In the geographical areas where DIN standards are in use, the installation must be in compliance with VDE requirements, particularly with the standards DIN / VDE 0100 and 0722! In all other areas in compliance with national and local standards and regulations.
- All regulations and standards applicable to the particular application must be observed!
- Installation and commissioning work may only be carried out by qualified personnel!
- Observe the notes on the laying of detector cables (refer to «Technical data»)!
- Ignition cables must always be run separate from the unit and other cables while observing the greatest possible distances!
- Check wiring carefully before putting the burner control into operation!


## Engineering notes

- Electromagnetic emissions must be checked from an application point of view!
- Switches, fuses, earthing, etc., must be installed in compliance with local regulations!
- Valves and other components must be connected as specified in the documentation provided by the burner manufacturer!


| (1) | Live and neutral may not be interchanged! | Connect safety limit thermostat in the line <br> - Manual reset (e.g. «SB») |
| :---: | :---: | :---: |
| (2) | Remote reset | When connecting button «EK2» from terminal 21 to <br> - terminal 3, only remote reset <br> - terminal 1, remote reset and remote emergency shutdown |
| (3) | With LAL...: <br> Required switching capacity | of switching devices connected between terminals 4 and 5 |
|  | With LAL2... / LAL 3... / LAL 4...: Required switching capacity | - of switching devices connected between  <br> terminal 12 and «LP»  <br> - of «LP» $\max . ~ A C ~$ <br> $1 A$ max. AC 5 A |
| (4) | Control contacts of other devices in the burner plant must be connected as follows (when using series connection): |  |
|  | To terminal 4 or 5 | Contacts which must be closed from startup to controlled shutdown $\Rightarrow$ Otherwise no start or shutdown |
|  | To terminal 12 (not with LAL1...) | Contacts which must only be closed on startup $\Rightarrow$ Otherwise no startup |
|  | To terminal 14 (not with LAL1...) | Contacts which must be closed no later than at the beginning of «t3» or «t3'», and which must remain closed until controlled shutdown occurs $\Rightarrow$ Otherwise lockout |
| (5) | Maximum amperage | Refer to «Technical data" |
| (6) | «Z» connected to terminal 15 | «t3'» and «\3n» |
| (8) | Connection of «BV..." to terminal 20 | Refer to «Application examples» |
| ${ }^{8}$ | When using a burner without air damper, or with an air damper not controlled and supervised by the LAL..., terminal 8 must be connected to terminal 6! |  |
| (9) | Wire link «B» <br> (clearly marked on the underside of the LAL... ) | When wire link «B» is fitted, the LAL... initiates lockout if flame failure occurs during operation. <br> For repetition of the startup sequence, wire link «B» on the plug-in section of the LAL... must be cut away; just cutting is not permitted! |
| (10) | For permissible length and laying of detector lines, refer to «Flame supervision» |  |

## Mechanical design

LAL...

LAL3. 25

Housing

Base

Type summary

- Plug-in design
- Exchangeable unit fuse (incl. spare fuse)

Differences to LAL1... / LAL2... / LAL4...

- Extraneous light does not trigger lockout
- during burner off times
- during the pre-purge time
- Extraneous light prevents burner startup
- Made of impact-proof and heat-resistant black plastic
- Lockout reset button with viewing window, located behind it are:
- The lockout warning lamp
- The lockout indicator
- coupled with the program spindle
- visible in the transparent lockout reset button
- uses easy-to-remember symbols to indicate the type of fault and the point in time lockout occurred
- Base and plug-in section of the LAL... are designed such that only burner controls of the LAL... type can be plugged in
- With 24 connection terminals
- With auxiliary terminals «31» and «32»
- With 3 earth terminals in the form of a lug for earthing the burner
- With 3 neutral terminals - prewired to terminal 2
- With 14 knockout holes for the cable entry by means of cable glands
- 8 at the side
- 6 in the bottom of the base
- With 6 lateral knockout holes (threaded) for cable entry glands Pg11

Switching times are given in the burner startup sequence, valid for 50 Hz mains frequency. At 60 Hz , the switching times are about $20 \%$ shorter.

|  | Flash steam generators | Universal application | Medium and heavy oil burners |
| :---: | :---: | :---: | :---: |
| Flame supervision with QRB1... or QRC1... for blueflame burners |  | $\begin{gathered} \hline \text { LAL1.25 } \\ \text { LAL4.25A27 } \end{gathered}$ |  |
| Flame supervision with QRB1... or RAR... <br> Possibility of air pressure supervision Possibility of semi-automatic startup | LAL2.14 | LAL2.25 | LAL2.65 |
| Same as LAL2. 25 with the following exception: extraneous light does not cause burner lockout, but prevents burner startup |  | Special application, e.g. incinerator plants LAL3. 25 |  |
| t1 | 10 s | 22.5 s | 67.5 s |
| t2 | 4 s | 5 s | 5 s |
| t3 | 2 s | 2.5 s | 2.5 s |
| t3' | from start ${ }^{1}$ ) | from start ${ }^{1}$ ) | from start ${ }^{1}$ ) |
| t3n | 10 s | 15 s | 15 s |
| t4 | 8 s | 7.5 s | 7.5 s |
| t5 | 4 s | 7.5 s | 7.5 s |
| t6 | 10 s | 15 s | 15 s |
| t7 | 2 s | 2.5 s | 2.5 s |
| t8 | 30 s | 47.5 s | 92.5 s |
| t10 | 6 s | 10 s | 10 s |
| t11 | optional | optional | optional |
| t12 | optional | optional | optional |
| t13 | 10 s | 15 s | 15 s |
| t16 | 4 s | 5 s | 5 s |
| t20 | 32 s | 35 s | 12.5 s |

${ }^{1}$ ) With air pressure supervision: from the time the air pressure signal is received

| Operating voltage | AC $230 \mathrm{~V}-15 /+10 \%$ | Power consumption | AC 3.5 VA |
| :---: | :---: | :---: | :---: |
| With LAL2 ... also AC $100 \mathrm{~V}-15 \% \ldots .$. AC $110 \mathrm{~V}+10 \%$ |  | Mounting position | optional |
|  |  | Degree of protection | IP 40 |
| Mains frequency | $50 \mathrm{~Hz}-6 \% \ldots 60 \mathrm{~Hz}+6 \%$ |  |  |
| Unit fuse (built-in) | T6,3H250V to IEC 127 | Permissible input current at terminal 1 <br> AC 5 A co | continuously |
| Prefuse (external) | max. 10 A | peaks of | of max. 20 A |
| Weight |  | Permissible amperage |  |
| - Burner control approx. 1000 g |  | at control terminals $3,6,7,9 \ldots 11,15 \ldots 20$ |  |
| - Base | approx. 165 g | 4 A continuously peaks up to 20 A |  |
|  |  |  |  |
| QRB1... | refer to data sheet 7714 | total max. AC 5 A |  |
| QRC1... | refer to data sheet 7716 |  |  |
| RAR... | refer to data sheet 7713 | Required switching capacity of switching devices |  |
|  |  | - Connected between terminals 4 and 5 | 5 AC 1 A |
|  |  | - Connected between terminals 4 and 12 | 12 AC 1 A |
|  |  | - Connected between terminals 4 and 14 | 14 AC 5 A |
|  |  |  | peaks of 20 A |
| Environmental conditions |  | CE conformity |  |
| Transport | IEC 721-3-2 | According to the directives of the European Union |  |
| Climatic conditions | class 2K3 | Electromagnetic compatibility EMC |  |
| Temperature range | $-50 \ldots+60^{\circ} \mathrm{C}$ | 89 / 336 EMC incl. 92 / 31 EEC |  |
| Humidity | < 95 \% r.h. | Low voltage directive 73 | 73 / 23 EEC |
| Mechanical conditions | class 2M2 |  |  |
| Operation | IEC 721-3-3 |  |  |
| Climatic conditions | class 3K5 |  |  |
| Temperature range | $-20 \ldots+60^{\circ} \mathrm{C}$ |  |  |
| Humidity | < 95 \% r.h. |  |  |
| Mechanical conditions | class 3M2 |  |  |
| Condensation, formation of ice and ingress of water are not permitted! |  |  |  |



Legend

| BV... | Fuel valve |
| :--- | :--- |
| FS | Flame signal amplifier |
| LK | Air damper |
| LR | Load controller |


M... Fan or burner motor

R Control thermostat or pressurestat
RV Modulating fuel valve
Z Ignition transformer

General
The following features of the LAL... exceed the standards, thus offering a high level of additional safety:

- Detector and extraneous light test are restarted immediately on completion of the after-burn time «t13».
This means that open or not fully closed valves immediately initiate lockout at the end of «t13».
The test ends only on completion of «t1» of the next startup sequence
- The correct functioning of the flame supervision circuit is automatically checked during each burner startup sequence
- The control contacts for the release of fuel are checked for welding during «t6»
- A built-in unit fuse protects the control contacts against overloading


## Control of burner

- Burner operation with or without post-purging
- Fan motors with an amperage up to 4 A can be connected directly $\Rightarrow$ Starting current max. 20 A
- Separate control outputs for - pre-ignition from start command
- post-ignition until shortly before the burner startup sequence is completed
- short pre-ignition with post-ignition up to the end of «TSA"
- Separate control outputs for the positioning directions OPEN, CLOSE and MIN of the actuator
- Checked air damper operation to ensure pre-purging with the nominal amount of air. Checked positions:
- CLOSED or MIN on startup $\Rightarrow$ Low flame position
- OPEN at the beginning, and
- MIN on completion of «t1»

If the actuator does not drive the air damper to the required position, the burner startup sequence will be stopped

- Two control outputs for the release of the second and third output stage, or for load control
- When load control is enabled, the control outputs for the actuator will be galvanically separated from the unit's control section
- Connection facilities for:
- a remote lockout warning device
- remote reset
- remote emergency shutdown
- In addition, with LAL2... / LAL3... / LAL4...:
- possibility of air pressure supervision with functional test of the air pressure monitor on startup
- possibility of semi-automatic burner startup

LAL...
With a photoresistive detector QRB1.... or, optionally,
LAL1... / LAL4...
With a blue-flame detector QRC1... for the supervision of blue-burning oil burners
LAL2... / LAL3...
With a selenium photocell detector RAR... $\Rightarrow$ Active detector

- Detector and extraneous light test are carried out automatically during the burner off times and the pre-purge time «t1»
- If loss of flame occurs during operation, the burner control initiates lockout
- If automatic repetition of the startup sequence is required, the clearly marked wire link on the plug-in section of the LAL... must be cut away $\Rightarrow$ Start repetition

|  | LAL1... with |  | LAL2... / LAL3... with |  | LAL4... with |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | QRB1... | QRC1... | QRB1... | RAR... | QRB1... | QRC1... |
| Min. detector current required at AC 230 V | $95 \mu \mathrm{~A}$ | $80 \mu \mathrm{~A}$ | $8 \mu \mathrm{~A}$ | $6.5 \mu \mathrm{~A}$ | $95 \mu \mathrm{~A}$ | $80 \mu \mathrm{~A}$ |
| Max. detector current required without flame | $12 \mu \mathrm{~A}$ | $12 \mu \mathrm{~A}$ | $0.8 \mu \mathrm{~A}$ | $0.7 \mu \mathrm{~A}$ | $12 \mu \mathrm{~A}$ | $12 \mu \mathrm{~A}$ |
| Max. detector current that can occur | $160 \mu \mathrm{~A}$ | $130 \mu \mathrm{~A}$ | $35 \mu \mathrm{~A}$ | $30 \mu \mathrm{~A}$ | $160 \mu \mathrm{~A}$ | $130 \mu \mathrm{~A}$ |
| Instrument's + pole | to term. 23 | to term. 23 | to term. $22$ | to term. $22$ | to term. 23 | to term. 23 |
| Length of detector line |  |  |  |  |  |  |
| In the same cable as the control lines | max. 30 m | --- | not perm. | --- | max. 30 m | --- |
| Separate cable in the cable duct | max. 1000 m | --- | 20 m | $\begin{gathered} \hline \text { RAR7...: } \\ 30 \mathrm{~m} \\ \hline \end{gathered}$ | max. 1000 m | --- |
| Three-wire cable | --- | max. 1 m | --- | --- | --- | max. 1 m |
| Two-wire cable for the detector line (bl, sw); separate single-wire cable for the line (br) | --- | max. 20 m | --- | --- | --- | max. 20 m |
| Shielded cable (e.g. RG62, shielding insulated) | --- | --- | 200 m | $\begin{gathered} \hline \text { RAR8...: } \\ 100 \mathrm{~m} \\ \hline \end{gathered}$ | --- | --- |
| Shielding | --- | --- | to term. 23 | --- | --- | --- |



Prerequisites for operation

- If the required input signals are not present,
- the burner control interrupts the startup sequence at the points marked by symbols
- the LAL...initiates lockout where this is required by safety regulations $\Rightarrow$ Refer to diagram
- The symbols used are identical with those on the burner control's lockout indicator

Prerequisites for burner startup

- Burner control not interlocked in lockout position
- Sequence switch in start position
$\Rightarrow$ With LAL1..., voltage present at terminals 4 and 11
$\Rightarrow$ With LAL2... / LAL3... / LAL4..., voltage present at terminals 11 and 12
- Air damper closed
- Limit switch «Z» for the CLOSED position must feed voltage from terminal 11 to terminal 8
- The contact of the limit thermostat or pressure monitor «W» as well as the contacts of any other switching devices in the control loop between terminals 4 and 5 must be closed
$\Rightarrow$ E.g. a control contact for the oil pre-heater temperature


## Other prerequisites for burner startup

With the exception of LAL1...

- Control contacts between terminal 12 and «LP» must be closed!
- Normally closed contact of the air pressure monitor must be closed $\Rightarrow$ «LP» test
- The sequence switch starts to run
$\Rightarrow$ Only pre-purging:
Fan motor connected to terminal 6 immediately receives voltage
$\Rightarrow$ Pre- and post-purging:
Fan motor or flue gas fan connected to terminal 7 receives voltage on completion of «t7»
- On completion of «t16», the control command for opening the air damper is given via terminal 9
- Terminal 8 receives no voltage during the positioning time
- The sequence switch continues to run only after the air damper has fully opened
t1 Pre-purge time with air damper fully open
- During «t1», the correct functioning of the flame supervision circuit is checked
- The burner control goes to lockout if correct functioning is not ensured

With LAL2... / LAL3... / LAL4...
Shortly after the beginning of «t1», the air pressure monitor must change over from terminal 13 to terminal 14.
$\Rightarrow$ Otherwise, the burner control will initiate lockout
$\Rightarrow$ Start of air pressure check
TSA Ignition safety time
On completion of «TSA», a flame signal must be present at terminal 22. It must always be available until controlled shutdown occurs.
$\Rightarrow$ Otherwise, the burner control will initiate lockout and lock itself in the lockout position
t3 Short pre-ignition time
«Z» must be connected to terminal 16 , release of fuel via terminal 18.
t3' Long pre-ignition time
«Z» connected to terminal 15.
With LAL1...
« $Z$ » is switched on when the start command is given.
With LAL2... / LAL3... / LAL4...
« Z » is switched on only when «LP» changes over.
$\Rightarrow$ No later than at the end of «t10»

- On completion of «t1», the LAL... via terminal 10 drives the air damper to the low flame position
$\Rightarrow$ The low flame position is determined by the changeover point of auxiliary switch «m" in the actuator
- During the positioning time, the sequence switch does not move $\Rightarrow$ Until terminal 8 receives voltage via «m"
- The sequence switch motor is connected to the control section of the LAL...
$\Rightarrow$ Positioning signals fed to terminal 8 have no influence now on the further startup sequence and the subsequent burner operation
t3n Post-ignition time
- «Z» must be connected to terminal 15
- With short pre-ignition, «Z» remains switched on until «TSA» has elapsed $\Rightarrow$ Connection to terminal 16
t4 Interval «BV1-BV2» or «BV1-LR»
- On completion of «t4», voltage is present at terminal 19
- The voltage is required to supply power to «BV2» connected to auxiliary switch «v» in the actuator
t5 Interval
- On completion of «t5», terminal 20 receives voltage.

At the same time, control outputs 9 to 11 and input 8 are galvanically separated from the LAL...'s control section
$\Rightarrow$ The LAL... is now protected against reverse voltages from the load control circuit

- With the release of «LR» at terminal 20, the start-up sequence of the burner control ends
- After a few idle steps (steps without contact position changes), the sequence switch switches itself off

B Operating position of the burner
B-C Burner operation

- During burner operation, «LR» drives the air damper to the nominal load or low flame position, depending on heat demand
- Release of the nominal load is given by auxiliary switch «v»in the actuator
- In the event of loss of flame during operation, the LAL... initiates lockout
- For automatic repetition of the startup sequence, the clearly marked wire link «B» on the plug-in section of the LAL... must be cut away

C Controlled shutdown
In the case of a controlled shutdown, the «BV...» will immediately be closed. At the same time, the sequence switch is started to program «t6».

C-D Sequence switch travels to the start position «A»
t6 Post-purge time

- Fan «M2» connected to terminal 7
- Shortly after the start of «t6», terminal 10 receives voltage $\Rightarrow$ Air damper is driven to the MIN position
- Complete closing of the air damper starts only shortly before «t6» has elapsed $\Rightarrow$ Initiated by the control signal at terminal 11
- During the following burner off time, terminal 11 remains under voltage
t13 Permissible after-burn time
During «t13», the flame signal input may still receive a flame signal
$\Rightarrow$ No lockout

D-A End of control program
$\Rightarrow$ Start position
As soon as the sequence switch has reached the start position, having thereby switched itself off, the detector and extraneous light test will start again.

During burner off times, the flame supervision circuit is under voltage.
When the start position is reached:
With LAL1...: a voltage signal is fed to terminal 4
With LAL2... / LAL3... / LAL4...: a voltage signal is fed to terminal 12

## Control program under fault conditions and lockout indication

Whenever a fault occurs, the sequence switch stops and with it the lockout indicator.


## Lockout indicator



LALA...


LAL2... / LAL3... / LALA...
abb Startup sequence
b-b' Idle steps (without contact confirmation)
$b\left(b^{\prime}\right)-a \quad$ Post-purge program

- Burner control can be reset immediately after a lockout
- Do not press the lockout reset button for more than 10 seconds!
- First, the sequence switch always travels to the start position
- after resetting
- after rectification of a fault which had led to a shutdown
- after each power failure

During this period of time, voltage is only fed to terminals 7, 9, 10 and 11

- Then, the LAL... programs a new burner startup


## diagrams

LAL1...


For variants, refer to «Connection examples»
LAL2... / LAL3...


For variants, refer to «Connection examples »
LAL4...


For variants, refer to «Connection examples »

AL Remote lockout indicator (alarm)

Control signals delivered by LAL...
Required input signals:
If these signals are not present during $\left\rangle_{\text {or }}\right.$ , the burner control will stop the startup sequence and initiate lockout
nition safety time

Pre-purge time with air damper open
Pre-ignition time, short («Z» connected to terminal 16)
Pre-ignition time, long («Z» connected to terminal 15)
Post-ignition time («Z» connected to terminal 15)
Interval between voltage at terminals 18 and 19 («BV1-BV2»)
Interval between voltage at terminals 19
and 20 («BV2» load controller)
Post-purge time (with «M2»)


These data do not apply to LAL1...

QRC1... Blue-flame detector

QRB1... Photoresistive detector
RAR... Selenium photocell detector
S
SA
v In the actuator: auxiliary changeover switch for position-dependent release of fuel
Control thermostat or pressurestat
In the actuator: limit switch for air damper's CLOSED position

Permitted input signals

Interval between start command and voltage at terminal 7 (start delay time for «M2")
Duration of startup sequence (excluding «t11» and «t12»)
Only with LAL2... / LAL3... / LAL4...: interval from startup to beginning of air pressure check Air damper running time to OPEN position

Air damper running time to low flame position (MIN)
Permissible after-burn time

Interval to the OPEN command for the air damper
Not with all LAL...: for self-shutdown of sequence switch

LAL1...

## LAL2... / LAL3...



## LAL4...



## Do not press the lockout reset button for more than 10 seconds!

Load relay with contacts «ar...»
Lockout relay with contacts «br...»
Flame relay with contacts «fr...»
Lockout warning lamp

| NTC | Resistor (negative temperature coefficient) |
| :--- | :--- |
| SM | Synchronous motor of sequence switch |
| V | Flame signal amplifier |
| Pre- and post-ignition when «Z» is |  |
| connected to terminal 15 |  |

Connection of actuators without changeover limit switch for the CLOSED position

Control of actuator during operation by control signals fed to terminal 17

Control of «BV...» via terminal 20


Semi-automatic startup

«Z" adjusted to air volume for low flame operation

For signal path, refer to «Connection diagrams»

The relay is not required if «BV3» connected to terminal 20 is hydraulically series-connected with «BV2".
«BV2" is controlled by terminal 18 or terminal 19.
$\Rightarrow$ Burner without air damper or with an air damper not controlled by the LAL...

If an auxiliary contact «d1/d2» of the fan contactor is included in the circuit as shown in the diagram, ignition and release of fuel are possible only when the contact is closed.

The burner is switched on manually by pressing button «l».
Then, LAL... programs startup and flame supervision.
Burner shutdown is also manual by pressing button «0», or automatically when limit thermostat or pressure monitor «W» responds.
«L3» indicates when the burner is ready for startup. It extinguishes shortly after the burner is started up.
For other connections, refer to «Connection diagrams».


Load control with an on / off controller.
During burner off times, the air damper is closed.


Control of actuator based on single-wire control. $\Rightarrow$ Actuator «SA» type SQN..., refer to data sheet 7808.
For other connections, refer to «Connection diagrams»

Pre- and post-ignition when ignition transformer is connected to terminal 15

Modulating expanding flame burner


Load control with a modulating controller with galvanically separated control contacts for OPEN and CLOSED positions.


During burner off times, the air damper is closed.
When using actuators without changeover limit switch «Z» for the CLOSED position, terminals 10 and 11 must be interconnected.
For other connections, refer to «Connection diagrams».

## LAL... with base

 AGM410490500

Base AGM410490500


