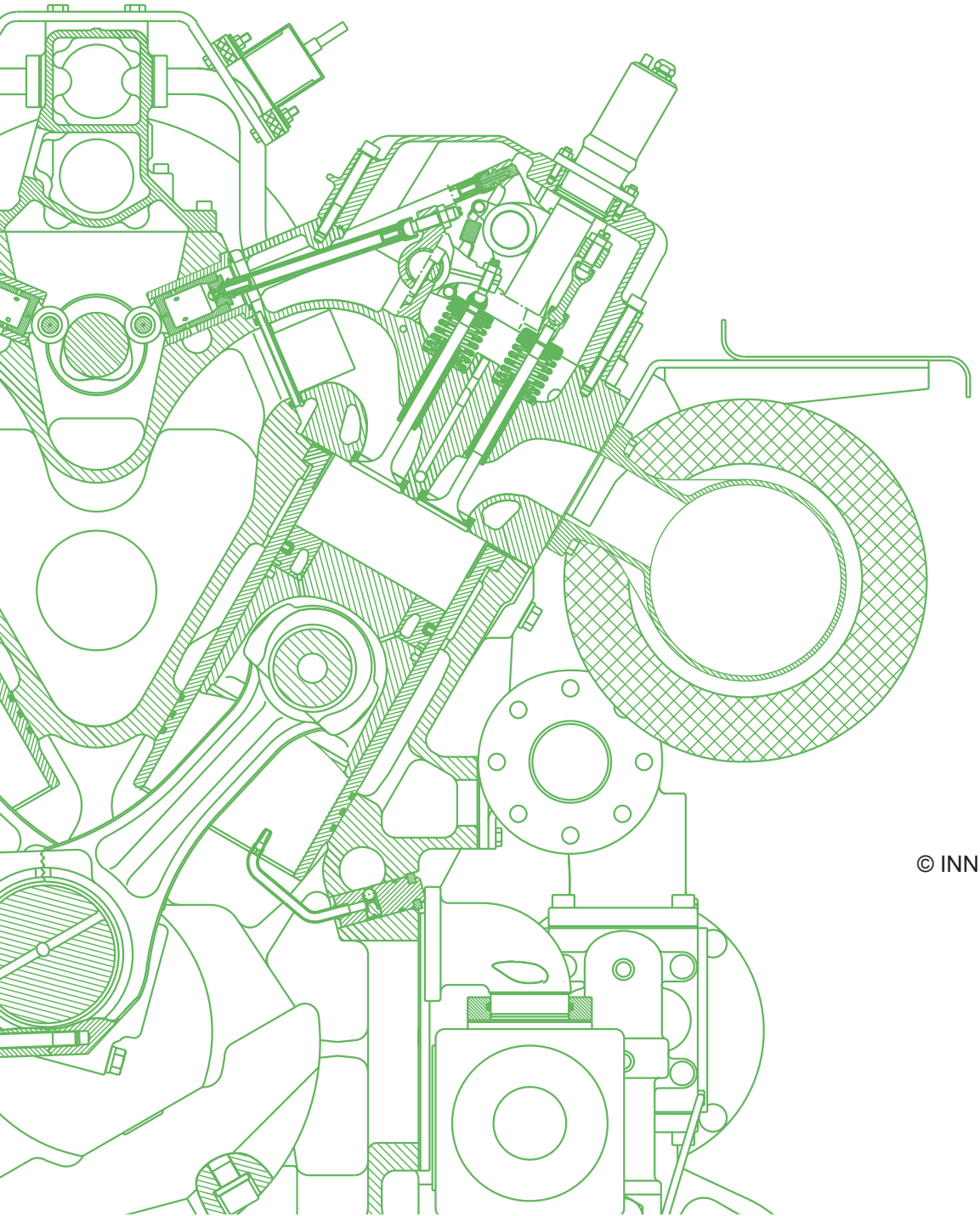
JENBACHER

TA 1503-0047

Technical Instruction

Engine adjustment instruction - Type 6 (DIA.NE XT)



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1 Scope

This Technical Instruction (TA) applies to the following Jenbacher Gas Engines:

- Type 6 with DIANE XT

2 Purpose

This Technical Instruction (TA) describes the engine settings for Type 6 gas engines with DIA.NE XT.

3 Safety regulations

⚠ DANGER

Explosion hazard due to escaping gas!

Escapes of gas can occur when the residual gas is released from the gas train.

- ➢ Do not use any naked lights.
- ➢ Switch on the room ventilation.

⚠ WARNING

Personal injury

Failure to use personal protective equipment and comply with safety instructions or employee protection information may lead to personal injury.

- ➢ Wear the relevant personal protective equipment (PPE).
- ➢ Observe the safety instructions as per TA 2300-0005.
- ➢ Observe the employee protection information as per TA 2300-0001.

4 Additional information

This adjustment instruction relates to standard applications in natural gas operation. Parameters may have to be changed for special gas applications. The parameters shown must be regarded as examples! Refer to the default parameter set and the technical diagram for the exact version-specific and customer-specific parameter sets.

Reference should be made to the Technical Instructions listed below when carrying out commissioning. If there are any problems, consult the SES (Service Expert System) for help.

Relevant documents:

TA 1000-0300 – Fuel gas and combustion air requirements

TA 1000-0531 – AUTOTUNE controller

TA 1100-0110 – Boundary conditions for GE Jenbacher gas engines

TA 1100-0112 – Installation of GE Jenbacher modules

TA 1400-0100 – Running-in procedure for Jenbacher engines

TA 1400-0154 – Knock control system KLS98

TA 1502-0068 – MORIS ignition

TA 1502-0069 – MPM (MORIS Power Module)

TA 1502-0070 – Rail System

TA 1502-0071 – SAFI (Sensor Actuator Function Interface)

TA 1510-0064 – Gas quantity controller (TecJet 110, 50 plus and 52)

TA 2110-0023 – Prechamber differential and gas pressure monitoring on Type 6 engines

5 Setting the fuel gas train

5.1 Gas train

Check the gas line and ensure that fuel gas of the required quality is available at the gas train, see TA 1000-0300.

5.2 Adjusting the setpoint for the gas prepressure controller

The description below relates solely to adjusting the set point of the prepressure regulator and is based on the assumption that the gas train has undergone a leak and function test.

Gas trains supplied by INNIO Jenbacher GmbH & Co OG with a nominal pressure of < 500 mbar are fitted with a blanking plate between the ball valve and the prepressure regulator, which closes off the gas train when it is ready for shipping. The plate is used to protect against any unduly high pressures that may result when customers check the gas train for leaks.

When the gas train is put into operation, the blanking plate must be inserted in such a way that the passage between the ball valve and the prepressure regulator is open.

The gas prepressure regulators are preset using their spring pressure range. When the shut-off valve on the gas trains supplied by INNIO Jenbacher GmbH & Co OG is opened slowly, the gas train is pressurised as far as the solenoid valves. The preset output pressure at the prepressure regulator can be controlled on the gas trains during engine standstill at the regulator output using the pressure gauge provided (back pressure).

The gas prepressure depends on the fuel gas quality and gas pressure actually available on the customer's premises and must therefore be checked once again when the engine is at full load (flow pressure) and adjusted if necessary.

With the engine at full load, check the position of the flap in the gas proportioning valve (TecJet) under Details/Gas in DIA.NE WIN.

It should be in a range between 50 % and 70 %, ideally 60 %, and a control reserve of at least 20 % must be available.

If these values are not achieved, adjust the output pressure at the prepressure regulator.

If the TecJet flap position is >70 %, with the engine running, tighten the pressure adjustment screw by turning it clockwise until the desired flap position is reached, which will increase the output pressure at the gas prepressure regulator. If the TecJet flap position is <50 %, unscrew the pressure adjustment screw by turning it anti-clockwise with the engine running until the desired flap position is reached, thereby lowering the output pressure at the gas prepressure regulator, until the desired flap position is reached, see also TA 1510-0064.

When the engine is at standstill, the pressure adjustment screw can only be used to increase the pressure at the gas prepressure regulator, as it is impossible to reduce the pressure without venting the gas! If the required output pressure is exceeded while making adjustments when the engine is at standstill, the gas pressure must be released first, as described in the following Sections.

If you are unable to obtain the optimal flap position in the gas proportioning valve (TecJet), you can insert a set point spring with a different pressure range in the gas prepressure regulator.

Do not insert a different set point spring when the gas train is under pressure.

5.2.1 Venting gas from high-pressure gas trains (operating pressure > 500 mbar)

⚠ DANGER

Explosion hazard due to escaping gas!

Escapes of gas can occur when the residual gas is released from the gas train.

- Do not use any naked lights.
- Switch on the room ventilation.

When gas is vented from gas trains supplied by INNIO Jenbacher GmbH & Co OG, it must always be done safely to atmosphere.

Procedure

Slowly close the shut-off valve on gas trains supplied by INNIO Jenbacher GmbH & Co OG.

Caution! The gas train is pressurised as far as the solenoid valves! Screw the safety blow-off valve (SBV) into the blow-off line (mark the position so as to be able to restore the original position later). The gas is safely vented to atmosphere through the blow-off line. Check the pressure at the pressure gauges as it drops. Safety shut-off valve (SSV) is tripped by Pmin. Screw the pressure relief valve back into its original position. Then reset the Safety shut-off valve (SSV).

5.2.2 Venting gas from low-pressure gas trains (operating pressure < 500 mbar)

⚠ DANGER

Explosion hazard due to escaping gas!

Escapes of gas can occur when the residual gas is released from the gas train.

- Do not use any naked lights.
- Switch on the room ventilation.

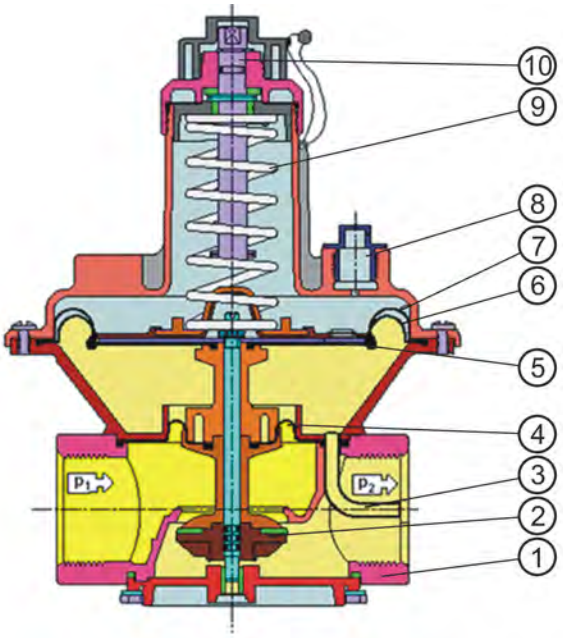
When gas is vented from gas trains supplied by INNIO Jenbacher GmbH & Co OG, it must always be done safely to atmosphere.

Procedure

Slowly close the shut-off valve on gas trains supplied by INNIO Jenbacher GmbH & Co OG.

Caution! The gas train is pressurised as far as the solenoid valves! Use an anti-static hose to vent the gas safely to atmosphere. To connect the hose, thread it on to the screw plug at the solenoid valve inlet. Newer versions of gas trains have a separate hose connector with ball valve and plug. A manometer is fitted to the regulator outlet for checking the gas pressure in gas trains supplied by INNIO Jenbacher GmbH & Co OG.

Next, slowly open the shut-off valve before the prepressure regulator again and use the adjusting screw on the prepressure regulator to adjust the output pressure to the required pressure as stated on the technical diagram. For this no more gas should be vented to atmosphere. The only thing you should note is that if you have exceeded the required output pressure while adjusting, turning the adjusting screw back, without releasing the pressure, will no longer reduce the pressure!



Pressure regulator in working position

①	Housing	⑥	Working membrane
②	Control plate	⑦	Safety membrane
③	Pulse sensor, internal	⑧	Vent plug
④	Compensating membrane	⑨	Set point spring
⑤	Membrane plate	⑩	Adjustment mechanism

5.2.3 Testing the pressure transducer for booster pressure and prechamber differential pressure

The requirement for this check is that the pressure conditions should be the same at the measuring points for the pressure sensors. For this reason, the prechamber gas rail has to be depressurised.

The boost pressure is displayed in DIA.NE and must be the same as the ambient pressure when the engine is at a standstill.

To check the prechamber gas pressure transducer, read off the prechamber differential pressure in DIA.NE. As the prechamber differential pressure displayed is a calculated value (prechamber gas pressure minus boost pressure) this value should be displayed as 0. Deviations of 10 mbar are possible

on account of the manufacturers tolerances for the pressure transducers. If deviations exceed 10 mbar, the range of the prechamber gas pressure transducer must be adjusted. **Parameter list AUXILIARIES / Prechamber differential pressure / Measurement range 4 mA and measurement range 20 mA.**

6 Starting the engine for the first time and adjusting the LEANOX controller

6.1 Guidelines for adjusting the lambda values

Before starting the engine for the first time, ensure that it is being supplied with fuel gas of the required quality.

On Type 6 engines with a scavenged prechamber, additional gas is supplied to the prechamber through the prechamber supply system. This results in a mixture around the spark plug in the prechamber which is richer than that in the main chamber. To ensure reliable ignition and avoid misfiring due to an excessively rich mixture in the prechamber, the lambda in the main chamber should not be allowed to drop to a value of **lambda less than1.2**.

All the set values below relate to applications requiring a constant gas quality (natural gas).

We know from experience that a somewhat lower lambda (richer) is required to start a cold engine than is the case when the engine is warm. The oil temperature is used as the basis for the engine temperature.

Enter 2 points to define a straight-line adjustment. The oil temperature measured is restricted in the linear equation in the parameter list: **GAS PROPORTIONING VALVE / Gas type 1 with oil temperature POINT 1 and oil temperature POINT 2**.

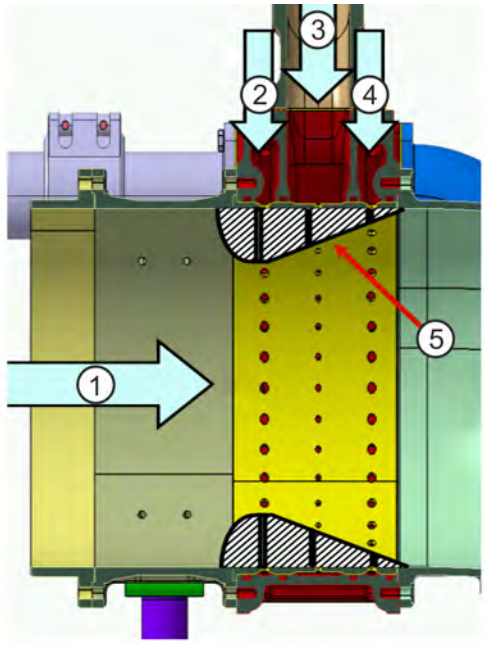
The Lambda idling controller should be deactivated on all Type 6 engines with TecJet, as a deflagration can occur if the lambda value is set too low in the parameters.

To deactivate the lambda idling controller, set the following parameters to zero!

GAS PROPORTIONING VALVE\ Idle mode lambda controller:

Idle mode lambda controller \ Gas type x \ Throttle valve set point position	0%
Idle mode lambda controller \ Gas type x \ Lambda control range	0

6.2 Adjusting the TecJet lambda for starting and idling positions (GAS PROPORTIONING VALVE parameter list)



3-K mixer

①	Air	④	CB
②	BB	⑤	Loading ring with overflow holes
③	Fuel gas		

The values indicated relate to gas type 1.

New engines are run in at the test department in Jenbach. The lambda points in the DIA.NE parameter lists are bench values and are generally values which can be used to restart the engines on site, provided that they run on natural gas.

Before starting, switch off the synchronisation with the synchronisation selector switch.

Start the engine and observe the idling behaviour, watching the engine speed as an indicator. If the engine is exhibiting erratic idling behaviour, i.e. the engine speed varies by more than +/- 3 rpm, switch the LEANOX controller to manual mode and try to make the engine run more smoothly by raising or lowering the lambda value. The variation in engine speed must not exceed +/- 3 rpm (ISO standard).

If the engine is idling in a stable manner, check the ignition point and the prechamber gas pressure.

The engine idling time must always be reduced to a minimum to prevent prolonged operation at high exhaust gas temperatures.

The prechamber gas supply pressure downstream from the prechamber gas pressure regulator must always be set higher than the charge pressure downstream from the throttle valve according to the following table. The spring preloading in the mechanical prechamber gas pressure regulator may need to be adjusted for this while the engine is idling, see the measuring points for the differential pressure sensor in the Figure below.

Setting values for the prechamber gas supply pressure relative to the charge pressure:

Cylinder head	Prechamber gas valve	Pre-combustion chamber gas differential pressure relative to the charge pressure
"F"	All	+50 mbar
"H"	9018255 (7J-V10)	+50 mbar
	8000262 (7J-V16)	+150 mbar

Cylinder head	Prechamber gas valve	Pre-combustion chamber gas differential pressure relative to the charge pressure
	9029070 (7J-V16+)	
	1239066 (7J-V17)	+180 mbar

Then read off and note the current throttle valve position.

All you need to do to adjust the starting position defined by the oil temperature is to note the current lambda value on DIA.NE, as the engine will have warmed up in the course of adjustment operations.

You can find these values on the Ctrl screen in DIA.NE XT and under Main / Overview in DIA.NE XT3.

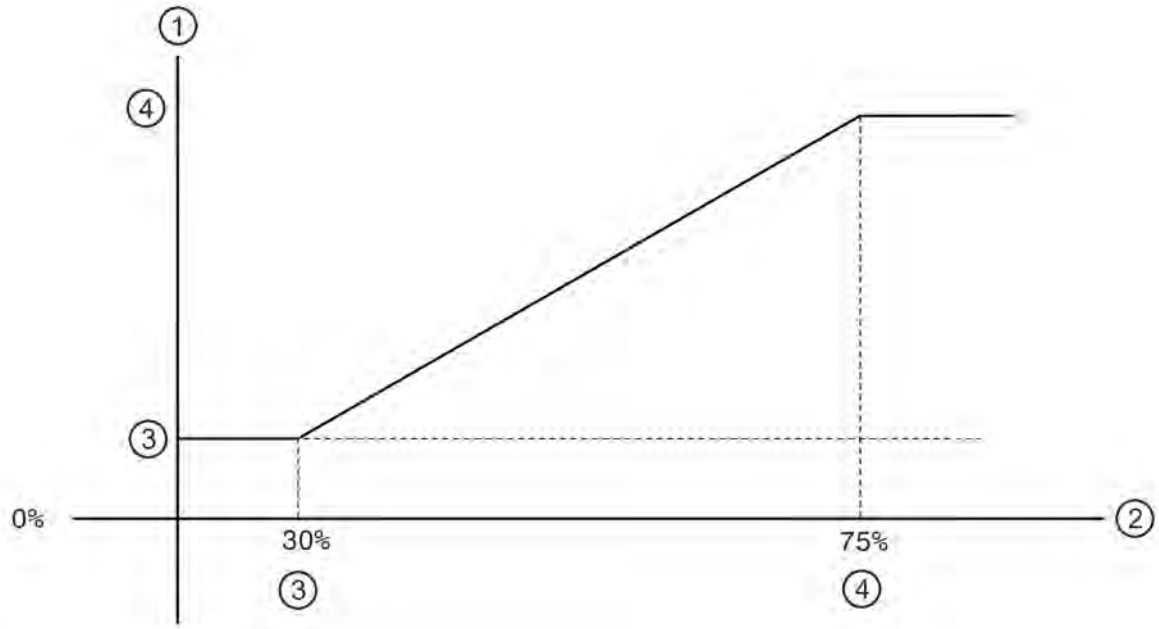
Picture showing measuring points for prechamber pressure ① dp see table above

Stop the engine again.

In the parameter list **GAS PROPORTIONING VALVE / Gas type 1**, enter the starting position as determined under **Lambda POINT 2** (hot engine). Set **Oil temperature POINT 2** to 75°C (= oil temperature in steady condition at full load). First, set Lambda POINT 1 to 0.2 less than Lambda POINT 2. Set **Oil temperature POINT 1** to 30 °C (oil temperature at standstill). The optimum lambda value for **POINT 1** must be determined during the commissioning process and, in terms of lambda value, may be approx. 0.2 - 0.4 less than the lambda value for POINT 2.

Enter the optimum central throttle valve position previously noted in idling mode (engine running smoothly, good idling behaviour) in the parameter list **GAS PROPORTIONING VALVE / Idle mode lambda controller / Gas type 1 / Throttle valve set position**.

After synchronising, the throttle valve position can no longer be used to control the LAMBDA VALUES, as the throttle valve opens to achieve the preset engine output. For this reason, a LAMBDA offset for mains parallel operation has been installed to set the LAMBDA VALUE as defined by the oil temperature, plus the set offset. Experience indicates that the value to be entered as the offset in the parameter list **GAS PROPORTIONING VALVE / Gas type 1 / Lambda Offset for mains parallel operation** is 0.000.



①	Lambda value	③	Point 1
②	Oil temperature	④	Point 2

Next, set the LEANOX controller back to automatic mode.
Enter the remaining parameters in the parameter list under Gas proportioning valve acc. to default parameters.

LEANOX / COMPENSATION parameter list:

Set the **ENGINE FRICTION POWER** values as follows:

Engine	ENGINE FRICTION POWER [kW]
J612	190
J616	250
J620	320
J624	380

Caution
These values must not be changed.

6.3 Boost pressure compensation for speed

This function is only required for variable-speed operation (e.g. island operation) and can be activated in the parameter list **LEANOX / Compensation / Speed compensation active** (0 = inactive; 1 = active).

6.4 Fine-tuning the TecJet lambda values for starting and idling operation

Start the engine and, if necessary, optimise the parameters (for starting positions and idling behaviour) entered in the **GAS PROPORTIONING VALVE** parameter list.

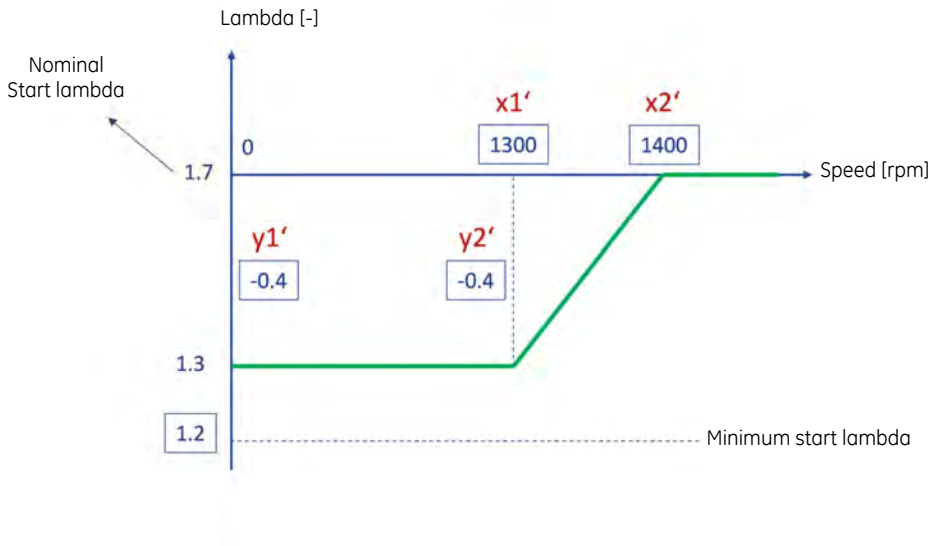
6.5 Lambda adaptation at engine start-up

This function must be used in plants with a prechamber mixture formation system (ASPS) (for details, see TA 2110-0024) and can be adjusted in the parameter list GAS**DOSIERVENTIL / Lambda adaptation during engine start** in the case of DIA.NE XT3 and in the parameter list **ENGINE/Lambda precontrol** in the case of DIA.NE XT4.

At engine start-up you can choose between two options regarding the behaviour of the compressor bypass (for systems with DIA.NE XT3 only):

- Compressor bypass closed at start-up and opening in idle mode by means of a ramp
- Compressor bypass open at start-up

An adaptation of the start lambda is implemented by means of an offset to maintain improved combustion during start-up and therefore achieve an improved starting sequence. This offset is deducted from the current start lambda, which is dependent on the oil temperature. The start lambda is limited by a lower limit value so as not to start with a mixture that is too rich during a cold start. The parameters y1' and y2' reduce lambda between engine standstill and the speed parameter x1'. The lambda offset is linearly interpolated between the speed parameters x1' and x2'. When the speed value is x2', the lambda offset is 0. Parameter y2' has been omitted from DIA.NE XT4 as it is identical to parameter y1'.



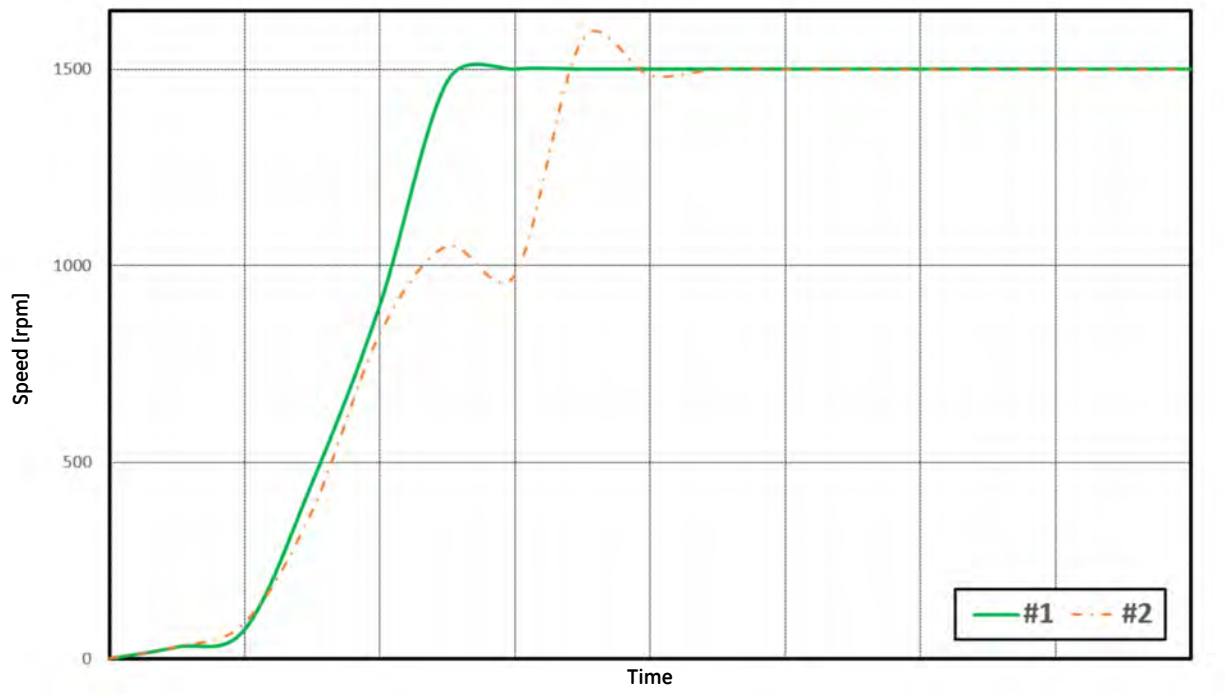
Variables, speed-dependent start lambda for ASPS engines

Parameter name	Value (default)	Value (ASPS) XT3	Value (ASPS) XT4	Value (QUICK START)
Engine start-up with compressor bypass open	FALSE	FALSE (Version F/ G) TRUE (J624-H)	n/a	n/a
Lambda offset curve - lambda value y1'	0	0.4	0.4	0
Lambda offset curve - lambda value y2'	0	0.4	n/a (y1‘=y2‘)	n/a
Lambda offset curve - speed value x1'	1200 rpm	1200 rpm	1200 rpm	1200 rpm
Lambda offset curve - speed value x2'	1400 rpm	1400 rpm	1400 rpm	1400 rpm
Lower limit value for start lambda	1.2	1.2	1.2	1.2

Exception: when the quick start function has been activated (see Section ⇨ Quick-start function): A fixed lambda offset during the speed build-up is already calculated internally in the software. Lambda value 1 and lambda value 2 (see above diagram) should then be set to 0.0 by default. Different values should only be chosen for lambda values 1 and 2 in the event that the speed build-up does not have the desired shape (see diagram below and next paragraph) (the maximum from the fixed offset and the parameterised curve (see above diagram) is then used in the software to calculate the lambda offset).

Caution

The quality of the speed build-up must be checked. The diagram below shows an example of a correctly set speed build-up (#1) and a speed build-up set too lean (#2). In the event of drops during the speed build-up (#2), the start lambda offset should be increased on the basis of the parametrised curve (see above diagram).



Speed build-up correctly parametrised (#1) and too lean (#2).

Note: when the quick start function has been activated (see Section ⇨ Quick-start function): A fixed ignition point offset during the speed build-up is also calculated internally in the software.

6.6 Normal operation below LEANOX control operation

Set LEANOX CONTROLLER POWER ACTIVE (parameter list LEANOX / GAS TYPE 1) to approx. 70% of P/rated. In this way, the LEANOX controller does not become active immediately if the engine is synchronising.

The power set point should be set to approx. 20 % of the rated power. Connect the exhaust gas test kit to the point provided in the exhaust gas line.

Set the synchronisation selector switch to "Automatic" and start the engine.

When the engine has been synchronised at a power level below the LEANOX activation level, the lambda value is formed from the starting position defined by the oil temperature and a fixed offset (**GAS PROPORTIONING VALVE / Gas type 1 / Lambda offset for mains parallel operation**) .

Observe the power consumption of the engine after synchronisation, i.e. the power fluctuations should be as low as possible until the preset power set point is reached (+/- 1 %).

When the engine has reached 20% of its rated load, switch the LEANOX controller to "manual mode" and check the cylinder exhaust gas temperatures. The exhaust gas values should be approx. 200-250 mg/Nm³ NOx and the exhaust gas temperatures of all the cylinders should be approx. 550 °C (± 30 °C) (F / G / H / J Versions).

Note: In the case of engines with activated GEN2 controller (in Engine/Power/Quick start - parameter 133672 "GEN2 controller active": TRUE), the LEANOX controller is active over the entire load range – see Section ⇨ Leanox operation for engines with quick start option (GEN2 controller activated)

6.7 Leanox operation

Increase the engine output gradually, checking the control of the NOx level (exhaust gas test kit) until the rated load is reached.

Raise or lower the lambda value to set the required NOx level (below the limit value specified in the technical diagram) and then click the SAVE 1 button to save the current parameters relevant to the LEANOX controller in full-load operation.

Reduce the engine output gradually, checking the NOx level, back to half load. Raise or lower the lambda value to set the required NOx level and then click the SAVE 2 button. This saves the current parameters relevant to the LEANOX control system in half-load operation.

When you have successfully saved the LEANOX straights, check the control error “p2´err“ in the DIA NE LEANOX screen. The deviation should be as small as possible (approx. 0 – 10 mbar).

Next set the starting power of the LEANOX controller (engine type 612 = 300 kW, 616 = 400 kW, 620 = 500 kW) in the parameter list **LEANOX / Gas type 1 / Leanox controller power active**.

The LEANOX controller can now be switched to automatic mode. This switches the LEANOX control system to automatic mode.

Note: In the case of engines with quick start option activated (in Engine/Power/Quick start - parameter 133672 "GEN2 controller active": TRUE), the LEANOX straights are set as described in Section ⇨ Leanox operation for engines with quick start option (GEN2 controller activated).

6.8 Leanox operation for engines with quick start option (GEN2 controller activated)

When the parameter for the GEN2 controller (required for the quick start function, see Section ⇨ Quick-start function: General) has been activated (in Engine/Power/Quick start parameter 133672 "GEN2 controller active": TRUE), the LEANOX controller is active over the entire load range and a third LEANOX point is defined at 0% in addition to the two LEANOX points at 100% and 50% load.

When the parameter for the GEN2 controller (required for the quick start function) has been activated (Engine/Power/Quick start "GEN2 controller active": TRUE), the behaviour changes during the switch to manual LEANOX operation: instead of the lambda setpoint value the setpoint for the charge pressure can be set and the corresponding lambda is then calculated in the software. The method for saving the LEANOX points is the same in both cases (with/without activating the GEN2 controller) and the additional corrections from Section ⇨ Additional functions for adjusting the LEANOX straights also apply to both cases.

Setting the LEANOX parameters:

Increase the engine output gradually, checking the control of the NOx level (exhaust gas test kit) until the rated load is reached.

Raise or lower the charge pressure setpoint value to set the required NOx level at rated load (below the limit value specified in the technical diagram) and then click the SAVE 1 button to save the current parameters relevant to the LEANOX controller in full-load operation.

Reduce the engine output gradually, checking the NOx level, to half load. Raise or lower the charge pressure setpoint value to set the required NOx level at half load and click the SAVE 2 button to save the current parameters relevant to the LEANOX controller in half-load operation.

In addition to the two LEANOX points at 100% and 50% load, a third LEANOX point is defined: the charge pressure at 0% load (set in parameter Engine/LEANOX: "Charge pressure setpoint value at 0 kW"). It is best to set this point at 20% of rated load by raising this parameter (leaner – less NOx) or lowering it (richer – more NOx) until the emission values at 20% load meet the following specifications: The exhaust gas values should be approx. 200-250 mg/Nm³ NOx at 20% load and the exhaust gas temperatures of all the cylinders should be approx. 550 °C (± 30 °C) (F / G / H / J Versions).

6.9 Fine-tuning the Leanox characteristic

After saving the LEANOX straights, re-measure and document (e.g. print out) the exhaust-gas emissions (NOx) with the engine running at half-load. If the required NOx limit value is not reached, the engine is switched to full load and the measurement repeated. The measurement at full load must also be documented.

If, for example, the required NOx limit value is exceeded at full load, the LEANOX straights can be corrected (fine-tuned):

Leave the LEANOX controller operating in automatic mode with the engine at full load.

In the DIA.NE screen “Engine Controller“ / LEANOX / Point 1 (point for full load) increase the boost pressure “p2´mbar“ in small increments. The increments can be up to 20 mbar.

The control system copies the changed value immediately und begins to make the engine more lean. After about 5 minutes you can read off the NOx value on the exhaust gas test kit.

The measured NOx value should be approx. 20 - 30 mg/Nm³ below the required NOx value.

Next, print the values displayed on the exhaust gas test kit and switch the engine to half load. Normally, there will have been no changes in the exhaust gas emissions at half load. If an adjustment is required however, the same adjustment method is used at full load point, except that, following the adjustment, it is saved in the DIA.NE screen "Engine Controller" / LEANOX / POINT 2 (point for half load).

Caution: If the rated ignition point is changed or if there are changes in the gas quality, the exhaust gas emissions will also change.

Normally, the system corrects changes in the mixture temperature automatically.

6.10 Subsequent adjustment of the LEANOX controller

In addition to the adjustment instruction described in Section ⇨ Leanox operation, it is possible to make a quick adjustment to any NOx deviations at full load or half load.

This type of adjustment is mostly used for engines which have been running for a prolonged period and whose exhaust gas emissions have to be re-measured and if necessary adjusted.

To adjust the LEANOX straights, switch the engine to full load and measure the exhaust gas emissions. If you find that NOx limit values have been exceeded, switch the LEANOX controller to “manual mode“ and set it to “rich“ or “lean“ until the desired NOx levels are reached. Then save the current values with “SAVE 1“.

Follow the same procedure at half load as well. If the NOx values are maintained at half load, there is no need to save the half-load point "SAVE 2".

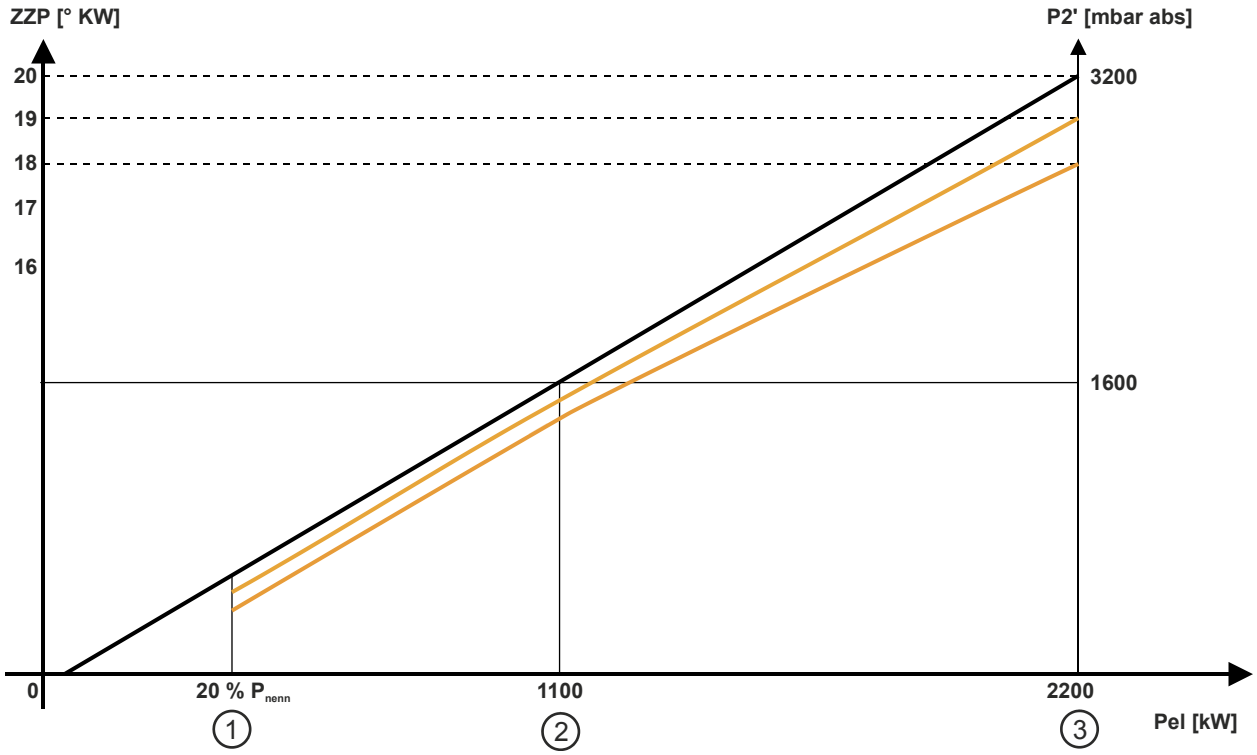
7 Additional functions for adjusting the LEANOX straights

7.1 Boost pressure compensation as a result of ignition point adjustment

The boost pressure compensation resulting from IP adjustment is preset in natural gas engines. The IP boost pressure compensation can be activated or deactivated in the parameter list **LEANOX / COMPENSATION / Boost pressure compensation via IP active** (0 = inactive; 1 = active).

Parameter name	Value (default)	Unit
Power point 1 (IP)	xxxx	kWPel, engine at full load
Boost pressure change point 1 (IP)	xxxx	mbar / °IP
Power point 2 (IP)	xxxx	kWPel, engine at half load
Boost pressure change point 1 (IP)	xxxx	mbar / °IP
Start power (IP)	10	%

The boost pressure is changed at the specified power levels **Power Point 1 (IP)** and **Power Point 2 (IP)** exactly by the value in mbar/degrees IP entered in the parameter list **Boost Pressure Change Point 1 (IP)** and **Boost Pressure Change Point 2 (IP)** respectively. A linear interpolation is carried out between these two values. This applies between **Start Power (IP) and Power Point 1 (IP)** (engine output rating). Below that, the value of **Boost Pressure Change Point 2 (IP)** applicable at **Start power (IP)** is used.



①	Leanox start power
②	Half-load power point 2 (IP)
③	Full-load power point 1 (IP)

7.2 Additional boost pressure compensation as a result of mixture temperature

The boost pressure compensation resulting from a deviation in the mixture temperature is already taken into account in the Leanox algorithm. In special cases, this function provides an additional adjustment option.

This option should only be activated in special applications and only in consultation with Technology.

The IP boost pressure compensation can be activated or deactivated in the parameter list **LEANOX / COMPENSATION** with the parameters **BOOST PRESSURE COMPENSATION VIA MIXTURE TEMP. ACTIVE** (0 = inactive; 1 = active).

Parameter name	Value (default)	Unit
Power point 1 (charge temp.)	xxxx	kW, engine at full load
Boost pressure change point 1 (charge temp.)	xxxx	mbar / °C
Power point 2 (charge temp.)	xxxx	kW, engine at half load
Boost pressure change point 2 (charge temp.)	xxxx	mbar / °C
Start power (charge temp.)	50	%

The boost pressure is changed at the specified power levels **Power Point 1 (charge temp.)** and **Power Point 2 (charge temp.)** exactly by the value in mbar/degrees IP entered in the parameter list **Boost Pressure Change Point 1 (charge temp.)** and **Boost Pressure Change Point 2 (charge temp.)** respectively. A linear interpolation is carried out between them. This applies between **Start Power (charge temp.)** and the engine output rating. Below this, the current value of the **Boost Pressure Change Point 2 (charge temp.)** at **Start Power (charge temp.)** is used.

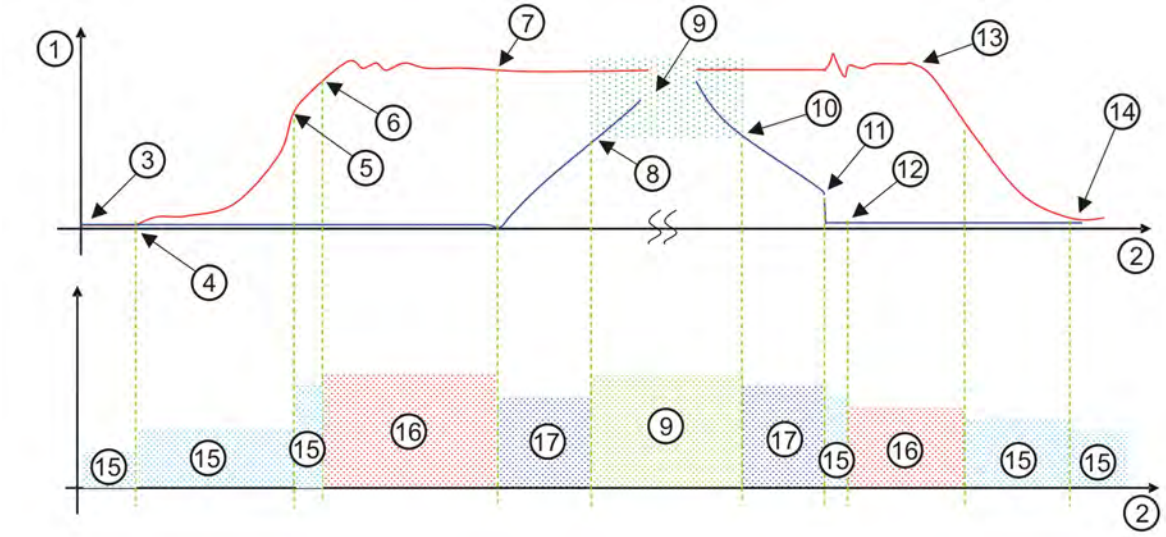
7.3 Reducing the ignition point when the engine is at full load

A situation may arise at increased engine intake air temperatures where the engine fails to reach its full output. A later ignition point may improve this situation as the turbine in the turbocharger will then be supplied with more energy.

Ignition point reduction can be activated or deactivated in the parameter list **POWER / IP ADJUSTMENT BY COMPRESSOR BYPASS ACTIVE** (0 = inactive; 1 = active).

Ignition point reduction starts when the turbo bypass falls below the parameter value **POWER / Compressor bypass position** with the engine at full load.

7.4 Summary graph



①	Speed power output
②	Time
③	Engine standstill
④	Engine start
⑤	Engine run-up
⑥	Engine start-up plus delay T1
⑦	Mains parallel operation
⑧	Leanox - start delay
⑨	Leanox - operation
⑩	Leanox - stop
⑪	Idling, generator switch off
⑫	Generator switch off plus delay T2
⑬	Switching-off phase
⑭	Engine standstill
⑮	Gas mixer position is oil temperature-dependent
⑯	Oil temperature and throttle valve dependent gas mixer position controller
⑰	Oil temperature dependent gas mixer position + offset (set value)

8 Knock control systems KLS 98 / Safi 1/Safi 2

8.1 Knock control system in general

The general function of the knock control system is described in TA 1400-0154 for KLS98 and TA 1502-0071 for Safi.

You can find the parameters for the knock control system in the default parameter list.

The parameter values listed below are used as guide values for Type 6 natural gas engines.

ANTIKNOCK

KNOCK MONITORING ACTIVATION POWER	400 kW	J 612
KNOCK MONITORING ACTIVATION POWER	500 kW	J 616
KNOCK MONITORING ACTIVATION POWER	700 kW	J 620
KNOCK MONITORING ACTIVATION POWER	850	J 624
KNOCK MONITORING ACTIVATION POWER HYSTERESIS	5 %	
	Mixture temperature control	
	without	whereby
IP REDUCTION START	0 %	0 %
MIXTURE TEMPERATURE REDUCTION START	100 %	30 %
POWER REDUCTION START	50 %	50 %
IP AMPLIFICATION FACTOR	2.5	2.5
MIXTURE AMPLIFICATION FACTOR	5	5
POWER AMPLIFICATION FACTOR	2.5	2.5
MIXTURE TEMPERATURE REDUCTION MAXIMUM	10° C	10° C
MINIMUM IP GAS TYPE xx	12° CA	12° CA
DECREASE INTEGRATION TIME	25 s	25 s
INCREASE INTEGRATION TIME	2500 s	2500 s

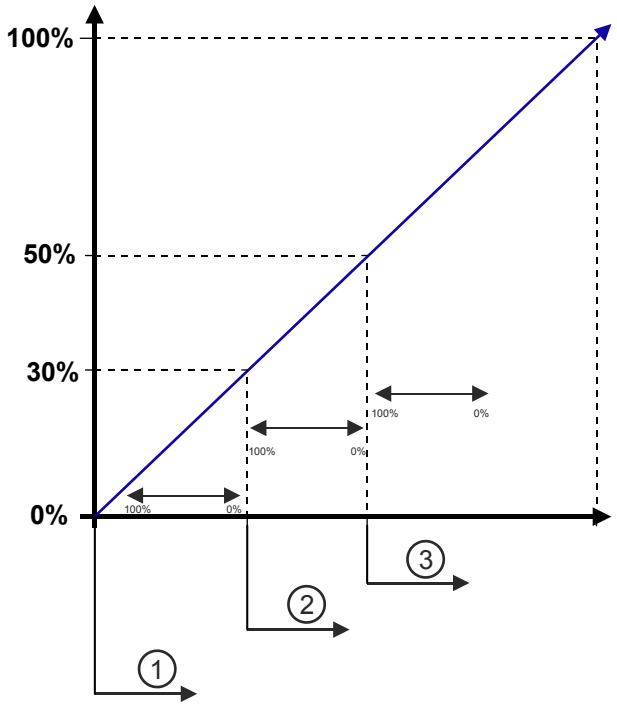
ANTIKNOCK / KLS 98

RESET IMPULSE POSITION	-144° CA
START ANGLE FOR KNOCKING DETECTION RANGE	0° CA
ANGLE RANGE FOR KNOCK DETECTION	45° CA
START ANGLE FOR VALVE NOISE DETECTION RANGE	50° CA

ANTIKNOCK / KLS 98	
ANGLE RANGE FOR VALVE NOISE DETECTION	660° CA
MEASUREMENT SIGNAL FAILURE LIMIT	30 mV
KNOCK LIMIT	500 mV
VALVE NOISE LIMIT	8,000 mV
GLOBAL IP ADJUSTMENT	(1 = Global; 0 = Selective)

Diagram showing knock reductions

Integrator threshold



①	Start of power reduction from 100 % Prated to 50 % Prated
②	Start of mixture temperature reduction (if any). Nominal mixture temperature minus MIXTURE REDUCTION MAXIMUM in the recipe list.
③	Start of ignition point reduction. Nominal ignition point up to IP MINIMUM IP GAS TYPExx in the parameter list.

The integrator rises when knocking occurs (signal > knock limit) and slowly falls again when there is no knocking.

It rises faster when knocking is more intensive than when knocking is lighter.

For example:

At 0 % integrator threshold, ignition point reduction begins.

At 30 % integrator threshold, mixture temperature reduction begins.

At 50 % integrator threshold, power reduction begins.

At 50 % integrator threshold, the engine trips due to knock limit.

9 Quick-start function

9.1 Quick-start function: General

The quick-start function requires the activation of the GEN2 controller (in Engine/Power/Quick start - parameter 133672 "GEN2 controller active" – only when defined in the Configurator, this requires authorisation level 50):

The GEN2 power controller operates on the following principles:

- The power set point is converted to a power set point ramp:
  - If quick start is activated: Adaptive load ramp
    The slope of the ramp is calculated on the basis of the selected total time from activation until full load (parameter in Engine/Power/Quick start). In addition, the measured actual power is included in the calculation of the ramp in order to take account of the actual engine behaviour.
  - If quick start is not activated: The slope of the ramp calculated directly by means of parameter Engine/Power/Ramp.
- The LEANOX principle is used to calculate a charge pressure set point ramp from the power set point ramp.
- The charge pressure set point is controlled by the throttle valve and the blow-off valve.
- The power set point is controlled by the setting for excess air and the gas dosing quantity.
- This controller is used when required to make the mixture richer in the load ramps in order to facilitate fast load ramps.

The quick-start function is active if the following conditions have been met:

- GEN2 controller activated (in Engine/Power/Quick start - parameter 133672 "GEN2 controller active")
- Digital input No. 15.2 "Quick start activation":
  - Contact closed: quick start activated.
  - If digital input No. 15.2 has not been wired up: quick start activated.

Note: Digital input No. 15.2 enables the customer to influence whether the engine changes according to the preset ramp (Engine/Power/Ramp), or whether the ramp is adjusted in the software in order to achieve the desired (contractually agreed) target time from activation to full load.

The only time that quick start is not activated is in the case of a wired input with an open contact.

Activating the quick start function triggers the following functions in the software:

- J624: activation of reduced prelubrication time (currently optional through special release)
- Adaptation of speed build-up (see Section ⇨ Lambda adaptation at engine start-up)
- The start-up ignition point is chosen according to the engine temperature:
  - The parameter Engine/Power/Quick start/ "Ignition point for quick start with cold engine" is used when the engine is cold (preheated).
  - The parameter "Ignition point before LEANOX activation" is used when the engine is warm (operating temperature).
  - For intermediate engine conditions, the ignition point is determined by interpolation based on the measured exhaust gas temperatures.

- The ignition point is changed by the software during the power ramp to the ignition point after LEANOX activation.
- Activation of the adaptive load ramp (the slope of the ramp is calculated on the basis of the selected total time from activation to full load).

Note: if the GEN2 controller is active and quick start has not been activated using the digital input, the speed build-up (Lambda/Ignition point) and the setting of the ignition point has not been adjusted during the output control, the same rules apply as if the GEN2 controller had not been activated. The difference lies in the LEANOX setting (see Section ⇨ Leanox operation for engines with quick start option (GEN2 controller activated)) and the output control (see Section ⇨ First use of the output control with the GEN2 controller).

9.2 First use of the output control with the GEN2 controller

During the first use of the GEN2 power controller in mains parallel operation, the target time for the whole start-up process (parameter Engine/Power/Quick start) is set to 280 s or the quick start function is deactivated via the digital input (the default ramp parameters then apply). Now enter 40% load as the setpoint value, start the engine and run up to full load. Next, increase the rated load in 20% steps until full load is reached. At each load point, check the stability of the controller at the steady-state point. If the output control is unstable (e.g. unsteady power signal, vibrations, etc.), you can make adjustments using the amplification parameters of the PI controller under Engine/Power/Controller: "GEN2 controller P component" and "GEN2 controller I component" (reducing the I component generally reduces the vibrations).

9.3 First use of the quick start function

Once the output control with activated GEN2 controller has stabilised (see Section ⇨ First use of the output control with the GEN2 controller) and the LEANOX controller has been set (see Sections ⇨ Leanox operation for engines with quick start option (GEN2 controller activated) and ⇨ Fine-tuning the Leanox characteristic), the quick start function is activated (see Section ⇨ Quick-start function: General) and a quick start with hot engine gets under way. To this end, the setpoint value for the power is set to full load when the engine is at a standstill.

Test 1:

The target time for the whole start-up process (parameter Engine/Power/Quick start) is set to the value contractually warranted to the customer (by default: 280 s). Start-up activation is then triggered in automatic mode and the engine passes through the prelubrication, speed build-up, synchronisation and load ramp phases. You should check whether the total time from activation to full load matches the set value by observing the trends in DIA.NE. (Note: in many cases, the time may be less than the time set as there is a lower limit for the slope of the load ramp).

Test 2:

During first use on the customer's premises, Test 1 should be repeated with a preheated engine in order to verify that the contractually warranted time (by default: 280 s) from activation to full load is being observed.

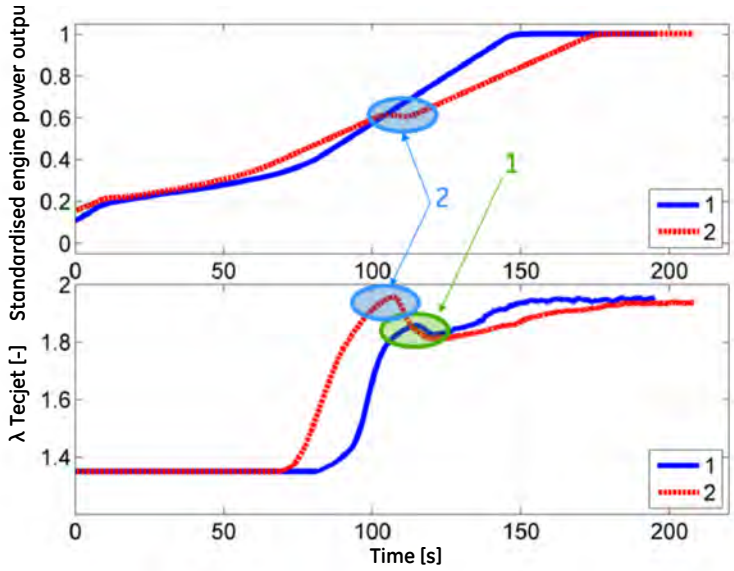
If anything is unclear with regard to the first use of the quick start function, please contact the Excellence Center.

9.4 Adjustment to avoid risk of backfiring

Check the gas parameters! They should be set as accurately as possible.

Safety check: a load ramp with a preheated engine is the deciding factor in the first use/inspection. You must ensure that the power set point ramp does not show any drops during the load ramp. The diagram shows how an excessively aggressive setting of the control parameters affects the set point ramp of the power controller:

- Case 1: good choice of PI parameters:
  - Making the mixture leaner to absorb the power overshoots does not result in misfires.
  - Power overshoots can be absorbed without affecting the power set point ramp.
- Case 2: excessively aggressive choice of PI parameters:
  - Making the mixture leaner to absorb the power overshoots too aggressively – risk of misfires.
  - INDICATOR: Power set point ramp does not rise monotonously but is even reduced during run-up.
  - Corrective measure: Incremental reduction of "GEN2 controller I component", size of increment approx. 0.05 until behaviour 1 reached.



1	Desired load ramp without drop in power rating ramp during run-up.
2	Load ramp with drop in power rating ramp during run-up – adjustment of control parameters required.

10 Revision code

Revision history

Index	Date	Description / Revision summary	Expert *Auditor*
7	11.04.2019	GE durch INNIO ersetzt / GE replaced by INNIO	**Opoku** *Pichler R.*
6	31.01.2019	Update für neues Vorkammergasventil 7J-V17 / Update for new prechamber gas valve 7J-V17	**Grotz M.** *Boewing R.*
5	31.03.2017	Ergänzungen in Kapitel 6.5, 6.6 und 6.7 / Additions in chapter 6.5, 6.6 and 6.7 Kapitel 6.8 und 9 hinzugefügt / Added chapter 6.8 and 9	**Huber J.** *Boewing R.*
		Änderung Kapitel 6.5 / Change of chapter 6.5	**Farre Lozano G.** *Boewing R.*
		Ergänzung in Kapitel 6.2 / Addition in chapter 6.2	**Lang J.** *Boewing R.*
4	20.12.2016	Strukturelle Anpassungen / Structural adaptions Änderung Kapitel 6.2 / Change of chapter 6.2	**Lang J.** *Boewing R.*