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2. Key features

The integrated circuit CJ125 (predecessor CJ110; for differences between CJ110, CJ120 and CJ125 see block-/functional diagram on page 4) is a control and amplifier circuit for a wide range λ -Sensor LSU4.x for the continuous regulation of λ in combination with the sensor in the range of $\lambda = 0.65 \dots \infty$ (air).

To increase the accuracy especially in a system for the regulation in the lean region, a measurement of the resistance of the sensor is carried out. Therefore it is possible to regulate the resistance of the sensor to keep the temperature of the sensor constant.

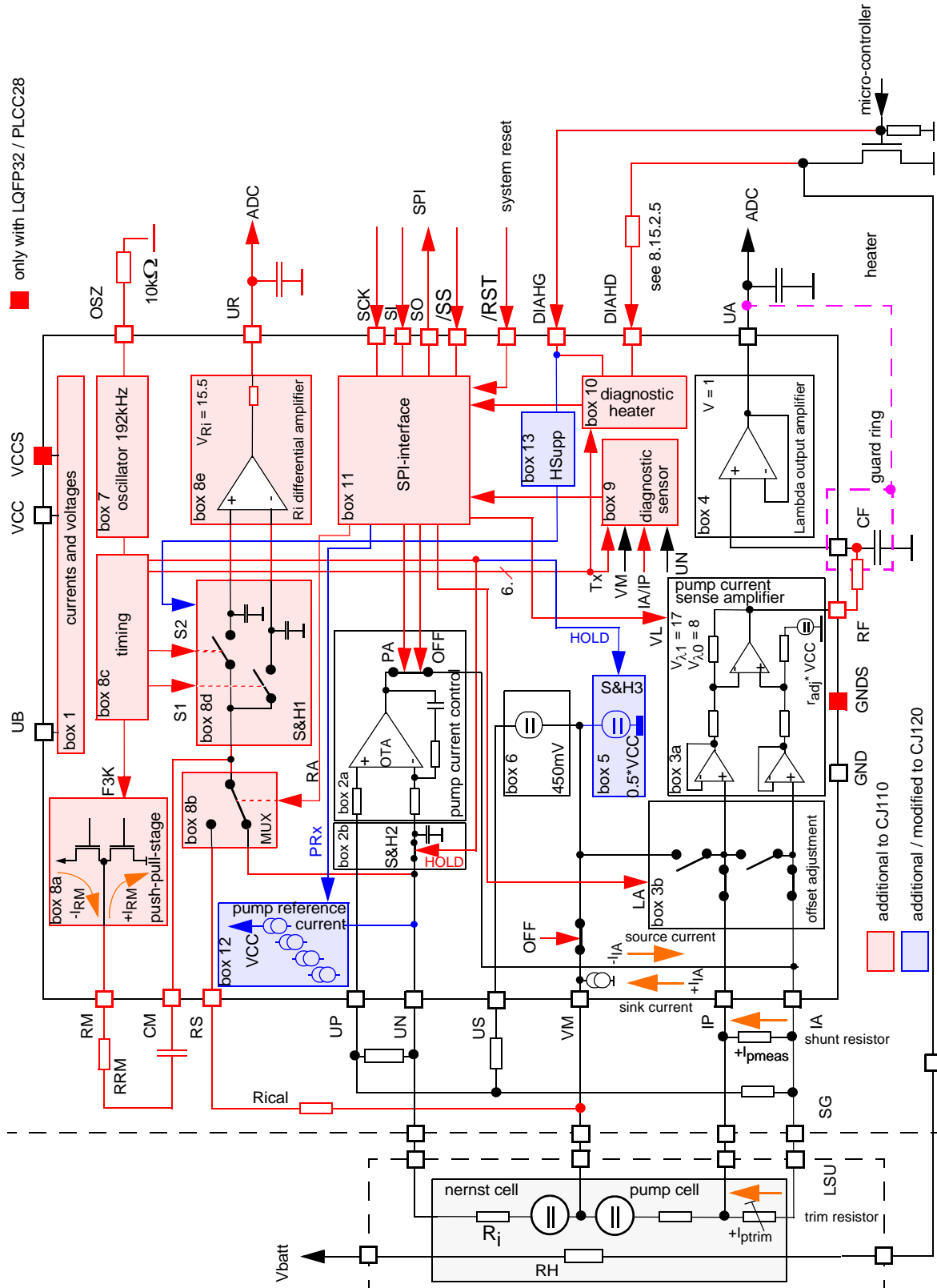
Functional groups realized in CJ125: page

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For internal use. Other currents and voltages are described below.
- 2. Pump current control (box 2a to 2b) 5**
 - a) pump current of OTA is positive when $V_{UN-VM} < 450\text{mV}$ (lean region).
 - b) pump current of OTA is negative when $V_{UN-VM} > 450\text{mV}$ (rich region).
 - c) pump current of OTA keeps his actual value when $V_{UN-VM} = 450\text{mV}$ ($\lambda = 1$)
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- 8. Circuit for R_i or R_{ical} measurement (boxes 8a to 8d) 7**
 - a) push-pull-stage generates AC measurement current (box 8a),
 - b) mux for selection of sensor or calibration resistor (box 8b),
 - c) timing (box 8c),
 - d) Sample&Hold (S&H) for storing the voltage sampled at pin [RS] or [UN] according to designated timing (box 8d),
 - e) R_i differential-amplifier (box 8e) with analogous output which represents the measured resistor (sensor resistor R_i in measurement mode; calibration resistor R_{ical} in calibration mode).
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- 13. Suppression of R_i -measurement (box 13) 14**
 R_i measurement is not carried out during a time interval beginning with a positive or negative slope at pin [DIAHG] and ending with the negative slope of the HOLD-Phase.



3. Block- / functional diagram

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4. Functional description

The integrated circuit CJ125 works together with the wide range sensor LSU4.x to coverage and regulate continuously the ingredients of the exhaust fumes of a combustion engine.

4.1 Currents and Voltages (box 1)

This block makes available all internal used reference currents and voltages. Other currents and voltages are described below.

The information of low-battery-voltage will be stored as a flag in the diagnostic register.

4.2 Pump current control (box 2a to 2b)

The pump current control is realized as an OTA (Operational Transconduction Amplifier). The output is clamped to VCC to protect the sensor. The pump current control compares the reference of 450mV with the voltage of the nernst cell and regulates the current across the oxygen pump cell in such a manner that the ingredients of the gas in the diffusion gap will be constant at $\lambda=1$. This is equivalent to voltage at the nernst concentration cell of $V_{Nernst} = 450mV$.

- If V_{UN-VM} is $< 450mV$, at „lean“ exhaust gas, source current $-I_{IA}$ will be injected by the OTA into the oxygen pump cell so that the oxygen pump cell will be steered to pump out the oxygen from the diffusion gap.
- In the „rich“ region when V_{UN-VM} is $> 450mV$, the current flows in the opposite direction and the oxygen is pumped into the diffusion gap. Due to the diffusion law, the pump current is proportional to the concentration of oxygen in lean exhaust gas respectively to the requirements of oxygen in rich exhaust gas.
- If V_{UN-VM} is $= 450mV$ pump current I_{IA} keeps his actual value ($\lambda = 1$).
- During the Hold-phase used for R_f -measurement, the pump current control is simultaneously controlled with a S&H-stage (S&H2; box 2b) to keep the pump current of OTA constant.

It is possible to compensate couplings in the sensor with external resistor between pins [US], [UP] and [IA]. In this case the $\lambda = 1$ -reference value is affected negligible by a feedback.

For adjustment of individual sensors, the current is splitted by a 61.9Ω shunt and a trim resistance in the sensor plug.

It is possible to shut off the pump voltage at pin [IA] with the internal signal PA (SPI bit PA). At the output at pin [IA] there is still small diagnostic current.

4.3 Pump current sense amplifier (box 3a to 3b)

The pump current is transmitted with 61.9Ω resistor into voltage and amplified by differential amplifier with constant amplification and added to a output offset voltage of typical $0.3V_{CC} = 1.5V$. This voltage is the reference ground for the **output trace**. At $\lambda = 1$ the pump current is 0mA and $V_{UA} = 1.5V$.

To increase the range of measurement down to $\lambda = 0.65$ without losing resolution, it is possible to switch over to another amplification. This is done by the internal signal VL (**SPI-Bit VL**). The „normal“ amplification is $V = 17$ (like CJ110). $V = 8$ is for the rich region.

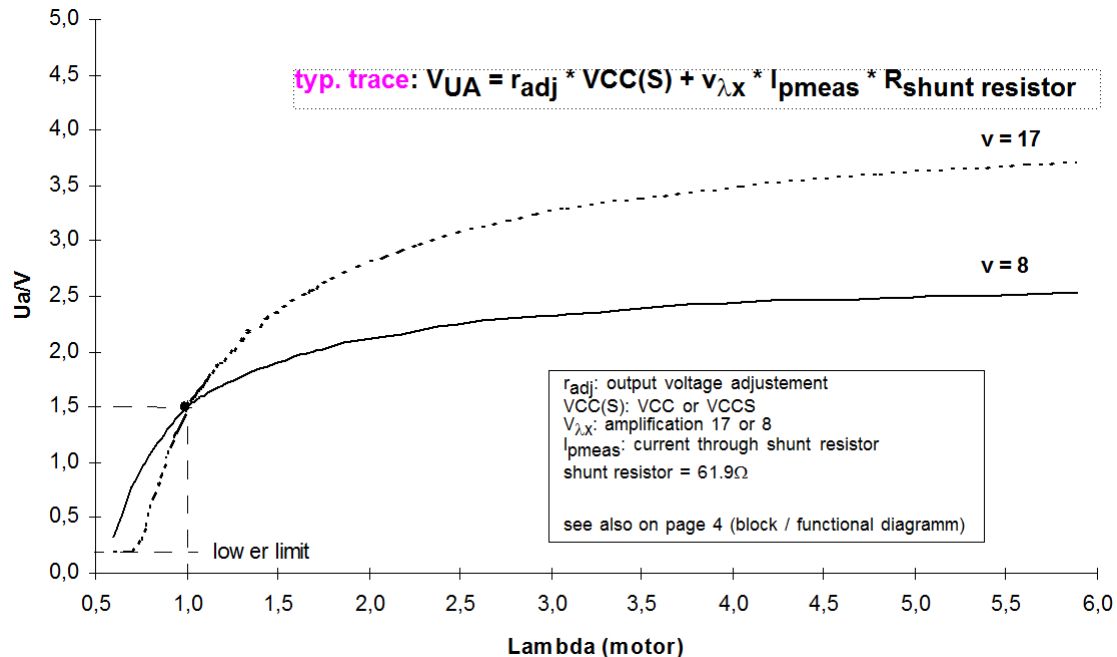
Positive and negative pump currents are depicted with a **0...5V-trace** (see 4.4.1). To eliminate offsets in the amplifier, it is possible to adjust the output voltage with the internal signal LA (**SPI-Bit LA**). In this case the inputs of the amplifier will be shortened. The output voltage at [UA] represents now $\lambda = 1$ and can be used by the software in the ECU for calibration.



4.4 Lambda output amplifier (box 4)

In contrast to CJ110, CJ125 has an additional output [RF]. Due to the splitting of pin [CF] into pin [CF] and pin [RF] it is possible to realize a external low pass filter.

4.4.1 Typical trace for $U_a = f(\text{Lambda})$:



4.5 Virtual ground voltage source for sensor and pump current control (box 5)

The virtual ground voltage for the sensor is typical $0.5V_{CC} = 2.5V$. This is necessary because the pump current can be positive and negative. A S&H stage for V_{VM} (S&H3) is controlled with the same hold phase so that it can reduce the influence of noise at VCC.

In normal condition the current at [VM] is influenced by the current of the pump current control at [IA]. Therefore the necessary driving capability of [VM] is coupled to the actual value of the current at [IA].

4.6 Nernst cell reference voltage source (box 6)

The reference voltage source (450mV) is referenced to virtual ground and is the reference voltage for $\lambda=1$ for the pump current control.

4.7 Oscillator (box 7)

RC oscillator needs fixed external 10kΩ resistor. With this resistor the frequency is 192kHz. Derived from this frequency is the timing

- q for the plus/ minus measurement current (3kHz at [RM]; F3K) for R_i
- q of the **Sample&Hold-Stages** for measurement of R_i (S1, S2, HOLD)
- q for filtering failures at sensor lines or at the external heater stage (Tx).

Annotation: If no resistor is connected to [OSZ], the CJ125 remains in the RESET mode.



4.8 Circuit for R_i or R_{ical} measurement (boxes 8a to 8d)

4.8a Push-pull-stage (box 8a)

Push pull stage between GND and VCC clocked by 3kHz (**F3K = 1**). The measurement current and therefore the output trace of R_i at pin [UR] is fixed by an external resistor R_{RM} . The measurement current is approximated by:

$$I_{RM+} = \Delta V / R = (V_{CC} - V_{VM}) / (R_{RM} + R_{RM_high} + R_{onCMxx} + R_i)$$

$$I_{RM-} = \Delta V / R = (V_{VM} - V_{GND}) / (R_{RM} + R_{RM_low} + R_{onCMxx} + R_i)$$

with $R_{onCMxx} = R_{onCMUN}$ or R_{onCMRS} .

$$I_{RM\pm} = \pm 250 \mu A \quad (R_{RM} = 10.0 k\Omega; \text{LSU4.2})$$

$$I_{RM\pm} = \pm 79 \mu A \quad (R_{RM} = 31.6 k\Omega; \text{LSU4.9})$$

The resulting voltage drop over R_i in the nernst cell is

$$\Delta V_{UN} = R_i * I_{RM} = R_i * (I_{RM+} - I_{RM-}) = R_i * 500 \mu A \quad (\text{LSU4.2})$$

$$\Delta V_{UN} = R_i * I_{RM} = R_i * (I_{RM+} - I_{RM-}) = R_i * 158 \mu A \quad (\text{LSU4.9})$$

The resulting voltage drop over the calibration resistor is

$$\Delta V_{RS} = R_{ical} * I_{RM} = R_{ical} * (I_{RM+} - I_{RM-}) = R_{ical} * 500 \mu A \quad (\text{LSU4.2})$$

$$\Delta V_{RS} = R_{ical} * I_{RM} = R_{ical} * (I_{RM+} - I_{RM-}) = R_{ical} * 158 \mu A \quad (\text{LSU4.9})$$

The serial C is necessary for DC free current to get good accuracy at $\lambda=1$.

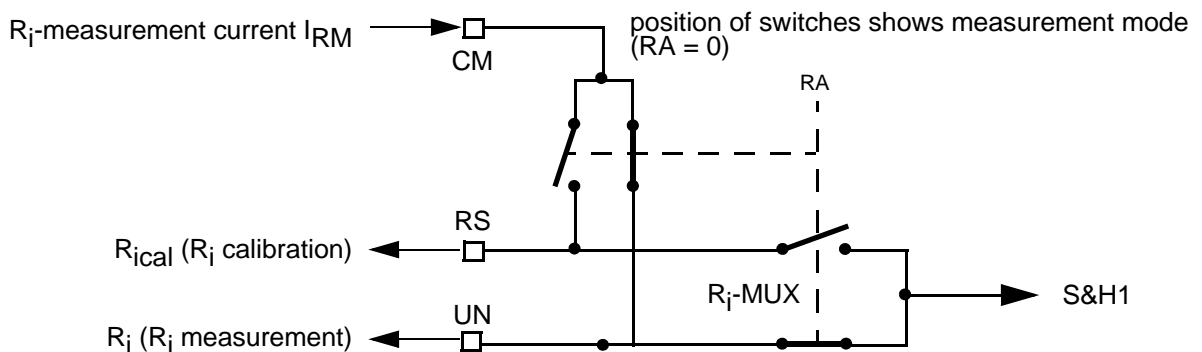
The output voltage at [RM] is low when

q **F3K = 0** or

q /RST = 0.

4.8b R_i -Mux (box 8b)

With the internal signal RA (**SPI-Bit RA**) it is possible to switch the R_i measurement current and the **S&H-stage** to [UN] for the measurement mode or to [RS] for the calibration mode. The output voltage at [UR] during calibration can be used in the ECU software as a reference for R_i . Offsets are also eliminated at the operation point for example at $R_i=82.5 \Omega$ (LSU4.2) or $R_i=200 \Omega$ (LSU4.9).

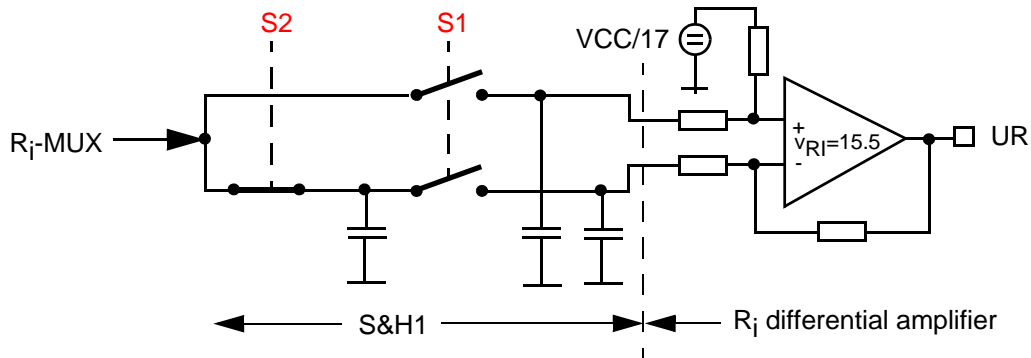




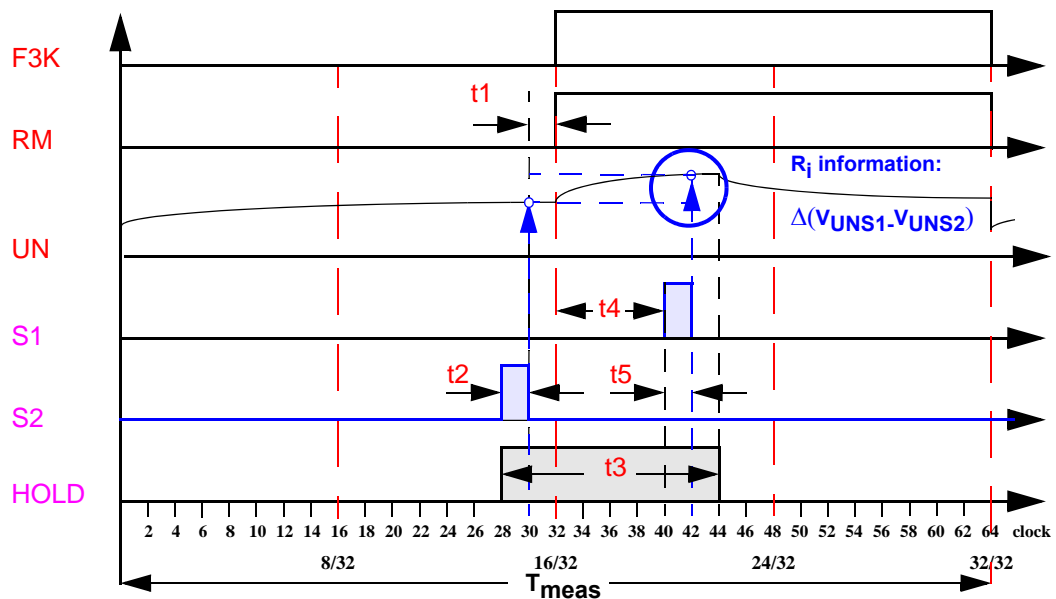
4.8c Sample&Hold (S&H1; box 8c)

The voltage of the nernst cell is sampled before (within S2) and after (within S1) the positive transition of the measurement current. The voltages are usually updated with 3 kHz. The negative transition of the measurement current is not used.

Principle



4.8d Timing (box 8d)



4.8e Ri differential amplifier (box 8e)

The output resistance of the Ri differential amplifier is typically 15kΩ for realization of anti aliasing filter with external C.

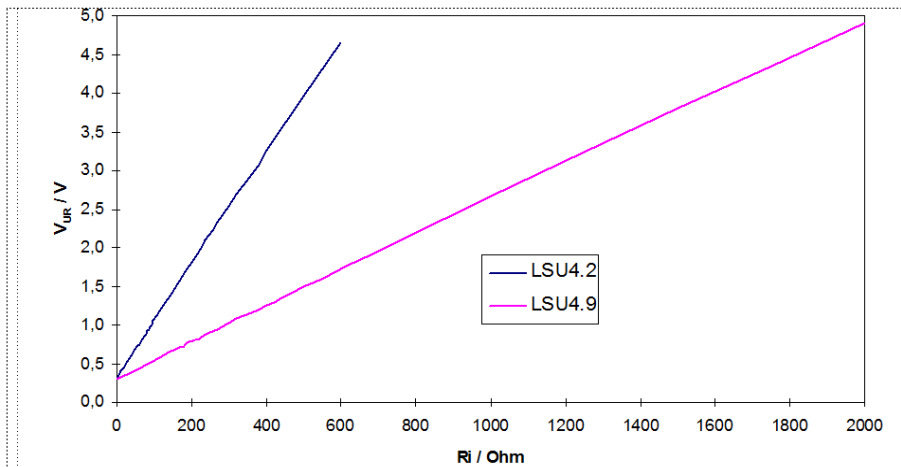
The output voltage at [UR] is calculated by

$$V_{UR} = V_{CCS}/17 + v_{Ri} \times I_{RM} \times R_{iLSU4.x} \text{ (sensor)}$$

$$V_{UR} = V_{CCS}/17 + v_{Ri} \times I_{RM} \times R_{ical} \text{ (calibration)}$$

with

| | |
|----------------------------|------------------------------|
| output offset: | $V_{CCS}/17$ |
| amplifier gain: | $v_{Ri} = 15.5$ |
| measurement current: | $I_{RM} = 500\mu A$ (LSU4.2) |
| | $I_{RM} = 158\mu A$ (LSU4.9) |
| resistance of nernst cell: | $R_{iLSU4.x}$ |


Typical trace for measurement of the sensor resistance:


4.9 Diagnostic of sensor lines (box 9)

The sensor lines [UN], [VM], [IP] and [IA] are monitored for short circuits to V_{batt} or GND. Only with a cold sensor it is possible to assign the failure type and location due to high impedance of sensor. A hot sensor registers several failures due to internal couplings ($R_i < 200\Omega$!). The location of the failure needs to be detected by the micro-controller's software.

Open failures are not dedetected by CJ125. They must be dedetected by the micro-controller's software.

4.9.1 Virtual ground

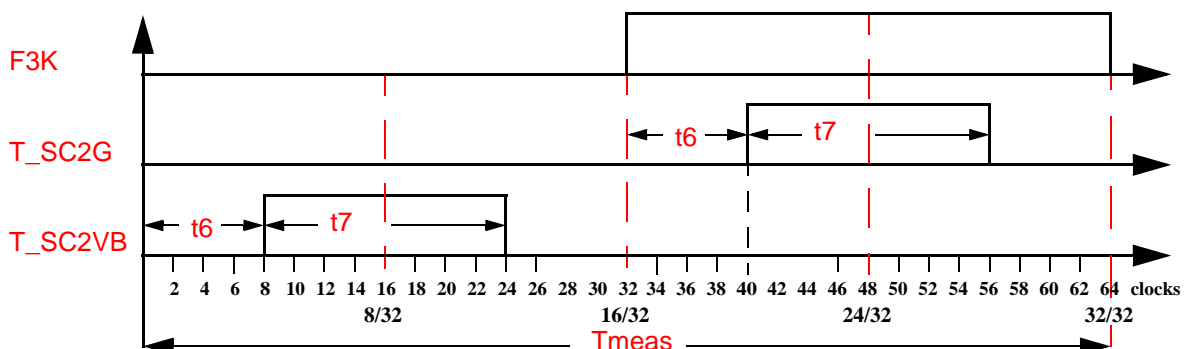
Short circuits at [VM] are detected outside of the threshold voltages $2.5V \pm 0.5V$ (typical) and stored after a filtering time t_{VM} in the diagnostic register.

A short circuit to GND at cold sensor will be registered at [VM] if some failures occur at the other lines. With any failure on sensor lines [VM] will be switched off and the pull down sink of a diagnostic current will force the voltage at [VM] below the threshold voltage 2.0V.

4.9.2 Nernst cell

A short circuit at [UN] to GND can be registered only while T_SC2G is high. A short circuit at [UN] to V_{batt} can be registered only while T_SC2VB is high (see timing diagram below).

Timing diagram for diagnostic at [UN]



To prevent a **failure** storage by mistake due to R_i measurement current at [UN], the failure conditions short circuit to ground or to V_{batt} are masked during the low phase at [RM] respectively the high phase. This means that a short circuit to ground will be detected only when the source current $-I_{RM}$ of the push pull high side stage is turned on (current $-I_A$ into the nernst cell). A short circuit to V_{batt} will be detected only when the sink current $+I_{RM}$ of the push pull low side stage is turned on.

With a resistor between [UP] and [UN] the voltage at [UN] and [UP] with a high impedance (cold) sensor is equal.

4.9.3 Pump cell

A short circuit to Vbat at [IA] will be detected directly. A short circuit at [IP] will be detected at [IA] due to the external shunt between [IA] and [IP]. The failure will be stored after **filtering time t_{IAB}** .

A short circuit to GND at [IA] or [IP] will be detected directly at each pin. The failure will be stored after **filtering time t_{IAM}** .

4.9.4 Failure treatment

While the pump current control is active (SPI bit PA = 0) any failure at the sensor lines leads to the following actions to protect the sensor:

- q synchronous shut off of [VM] and [IA]. [UN] and [IP] are always high impedance.
- q register the failure bits DIA5 to DIA0.

If the pump current control is switched off with SPI bit PA = 1 no failure at [IA] or [IP] will be stored in the diagnostic register bits DIA5 and DIA4. Nevertheless any failure leads to the following actions:

- q synchronous shut off of [VM] and [IA]. [UN] and [IP] are always high impedance.
- q register the failure bits DIA3 to DIA0. No update of Bits DIA5 and DIA4.

4.9.5 Failure registration depends on sensor and application (see DIAG_REG)

Every „0“ in the tables below means a failure.

table: possible failure bits at cold sensor (normal conditions; PRx = 0; see INIT_REG)

| | IA | | UN | | VM ^{1.)} | |
|--------------------------|------|------|------|------|-------------------|------|
| | DIA5 | DIA4 | DIA3 | DIA2 | DIA1 | DIA0 |
| SC2GUN | 1 | 1 | 0 | 0 | 0 | 0 |
| SC2VBUN | 1 | 1 | 1 | 0 | 0 | 0 |
| SC2GIA,IP ^{2.)} | 1 | 1 | 1 | 1 | 1 | 1 |
| | 0 | 0 | 1 | 1 | 0 | 0 |
| SC2VBIA ^{3.)} | 1 | 0 | 1 | 1 | 0 | 0 |
| SC2GVM | 1 | 1 | 1 | 1 | 0 | 0 |
| SC2VBVM | 1 | 1 | 1 | 1 | 1 | 0 |

1.) Failure SC2G at [VM] is a result of turning off [VM] and the diagnostic current at [VM]

2.) a failure will be recognized only if either the source current at output [IA] is detected (internal signal DIA_Q = 1) or Bit 5 (SET_DIA_Q) in INIT_REG2 = 1.

3.) IP is monitored via external resistor between [IA] and [IP]

table: possible failure bits at hot sensor (normal conditions)

| | IA | | UN | | VM | |
|--------------------------|------|------|------|------|------|------|
| | DIA5 | DIA4 | DIA3 | DIA2 | DIA1 | DIA0 |
| SC2GUN | 1 | 1 | 0 | 0 | 0 | 0 |
| SC2VBUN | 1 | 0 | 1 | 0 | 1 | 0 |
| SC2GIA,IP ^{1.)} | 0 | 0 | 0 | 0 | 0 | 0 |
| SC2VBIA ^{2.)} | 1 | 0 | 1 | 0 | 1 | 0 |
| SC2GVM | 1 | 1 | 0 | 0 | 0 | 0 |
| SC2VBVM | 1 | 0 | 1 | 0 | 1 | 0 |

1.) depends on sensor, DIA_Q and Bit 5 (SET_DIA_Q) in INIT_REG2

2.) IP is monitored via external resistor between [IA] and [IP]



4.10 Diagnostic of external heater (box 10)

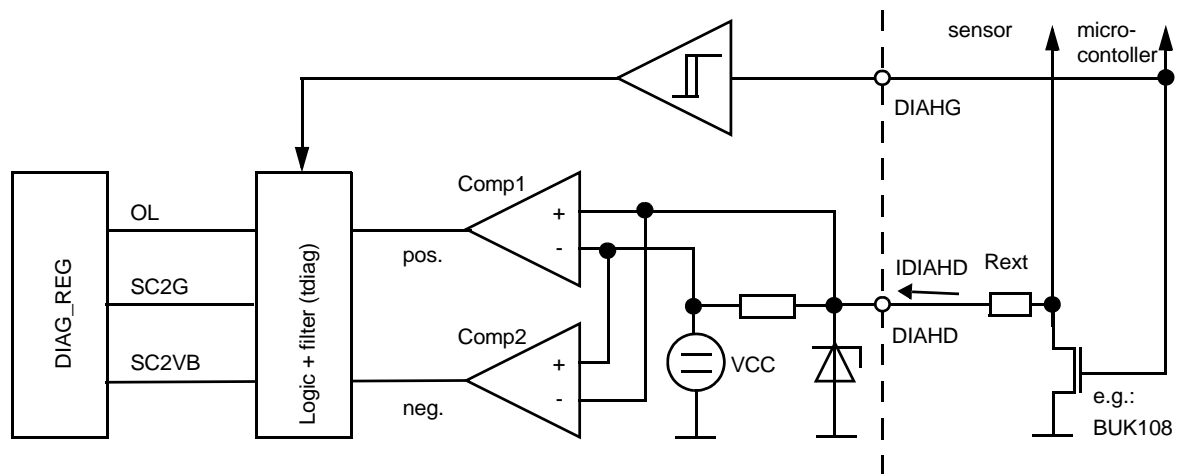
A external heater stage (like BUK108) can be monitored for

- q short circuits to Vbat
 - q short circuits to ground and
 - q open load (OL)
- via [DIAHD] and [DIAHG].

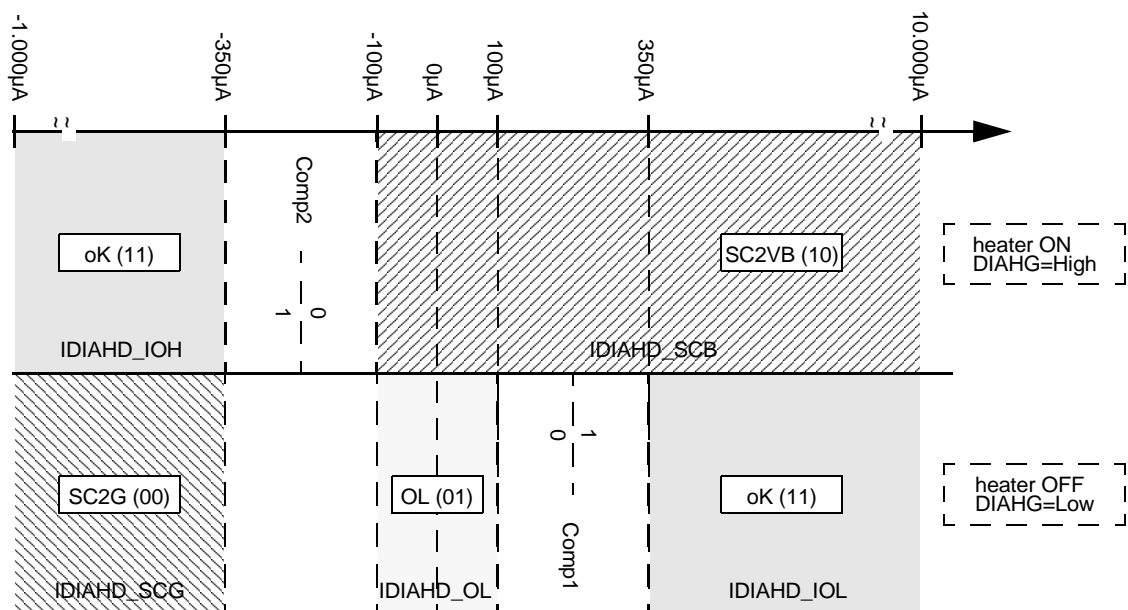
The filtering time t_{diag} is derived from the oscillator frequency (192kHz). The heater stage must be failure save by itself e.g. current limitation, thermal cut off/regulation. The failure bits in the diagnostic register are only failure flags and therefore CJ125 diagnostic stage does not shut off the heater stage in case of a failure.

4.10.1 Principle schematic

A current, depending on the voltage of the external drain, the external resistor R_{ext} and the internal bias current, will be compared with thresholds (see below).



4.10.2 Thresholds:



4.10.3 Hints for diagnostic:

- q If the heater stage is in the failure save mode due to SC2VB, this failure will be recognized as long as [DIAHG] is high.
- q A defect in the heater stage e.g. transistor not on or open input, will be recognized as SC2VB.

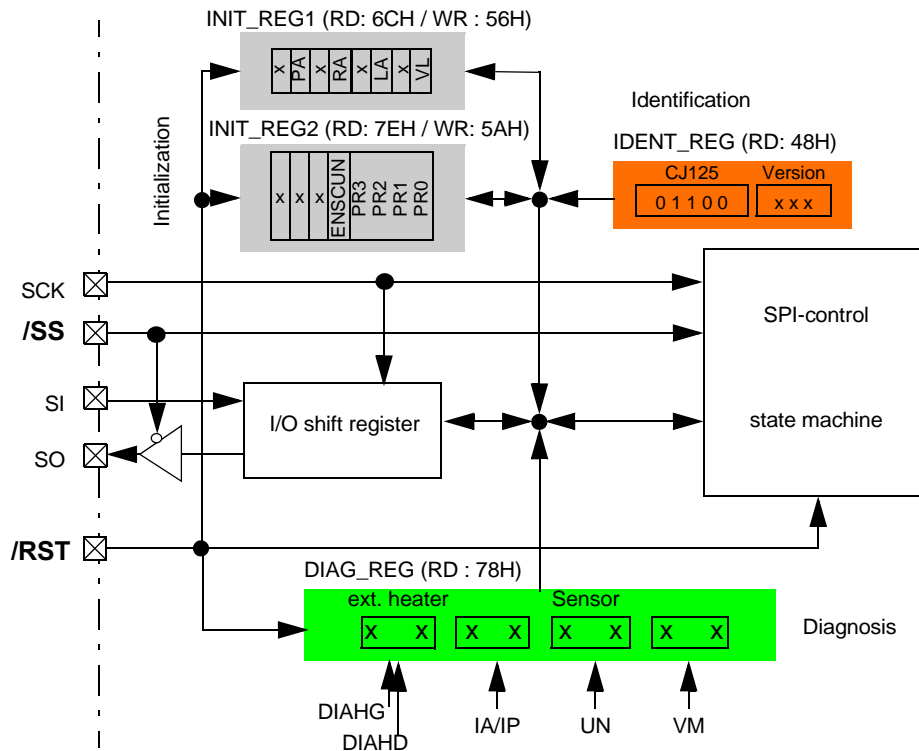
4.10.4 Failure storage in the diagnostic register:

Failures in general will be stored in accordance with failure conditions. The occurrence of the last failure will be stored. A failure in the register can be overridden only by a new failure but not with „no failure“ (bit combination 11). After a **RD_DIAG** diagnostic register will be reseted at the positive transition of /SS. If CJ125 is turned off, due to a failure to protect the sensor, then CJ125 now turns on, the diagnostic register will be updated if there are still failures. Therefore no extra command is necessary to erase any failure.

It is recommended to verify the bits in the diagnostic register with a second RD_DIAG because failures can be registered during reading the diagnostic register. This means that there is no write protection during reading out. The minimum time between two RD_DIAG commands must be in every case greater than the longest filtering time $t_{IAM} = 4T_{meas}$ for correct failure detection.

4.11 Serial-Peripheral-Interface (SPI; box 11):

4.11.1 SPI schematic:



The interface consists of four pins: [SCK], [SI], [SO], and [/SS]. The SPI-Interface makes communication between the CJ125 and the micro-controller possible. The CJ125 always acts as the Slave whilst the micro-controller always acts as the Master. The maximum Baud-rate is 4MBit/s.

The selection of the CJ125 through the SPI-Master is carried out by the Slave-Select-Signal [/SS] and the first two address bits of the command byte sent from the micro-controller. Hence 4 different components can be connected to a single common micro-controller Slave-Select-Signal. SI is the data input (Slave-In), SO is the data output (Slave-Out) and the SPI-Clock is provided by the Master via the input SCK (Serial-Clock-Input). Should the Slave-Select-Signal be inactive (high) then the data output SO shall go into tristate mode.

The component shall begin to evaluate the message sent on SI after detecting the falling edge on /SS and

interpreting the first two bits as an address. Only when the CJ125 is selected via the /SS input and the address is correctly decoded, CJ125 sends data via its SO output. Prior to this, the output SO is high impedance to prevent conflicts with other components connected to a common SO.

/RST = 0 resets the SPI, the registers and [VM] and [IA] are turned off.

SPI communication shall always start with a SPI command sent to the CJ125 from the micro-controller. When writing, the micro-controller shall send the data after the SPI command, whereby the most significant bit (MSB) shall be sent first. When reading, the CJ125 shall send the appropriate data, MSB first, to the micro-controller after receipt of the SPI command.

4.11.2 SPI register

The following internal SPI registers are accessible via the SPI:

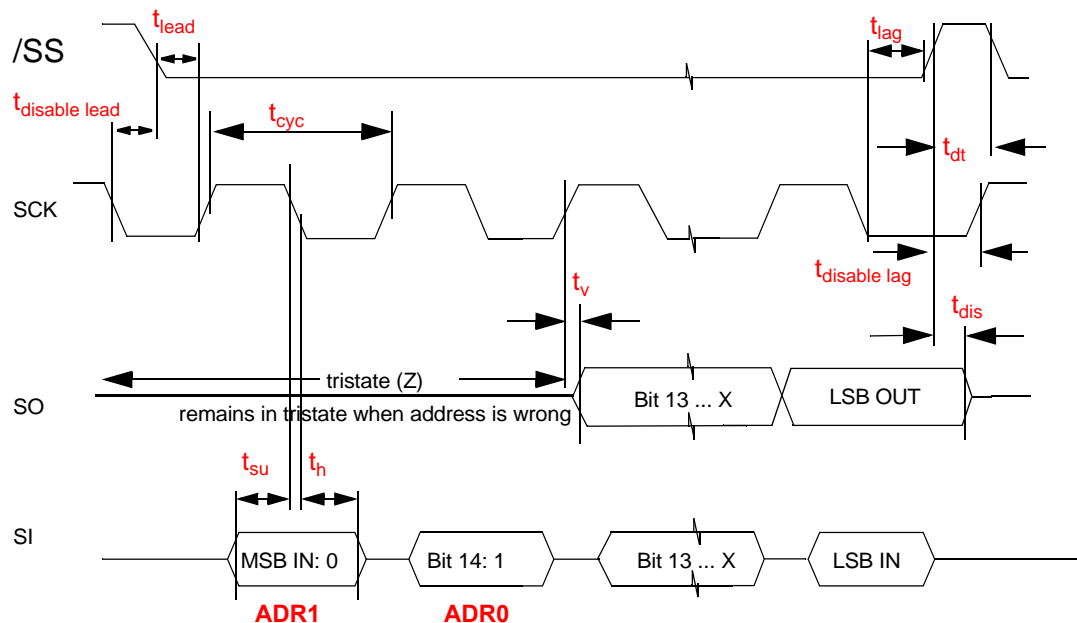
| | |
|-----------|--|
| DIAG_REG | Diagnosis information on the sensor interface and external heater driver |
| INIT_REG1 | Initialisation Register 1 for bits VL, LA, RA, PA |
| INIT_REG2 | Initialisation Register 2 for bits PRx, ENSCUN |
| IDENT_REG | CJ125 IC number & version number. |

4.11.3 SPI commands

The SPI responds to the following commands:

| | |
|----------|--|
| RD_IDENT | Read contents of Identification Register |
| RD_INIT1 | Read contents of Initialisation Register 1 |
| WR_INIT1 | Write to Initialisation Register 1 |
| RD_INIT2 | Read contents of Initialisation Register 2 |
| WR_INIT2 | Write to Initialisation Register 2 |
| RD_DIAG | Read contents of Diagnosis Register |

4.11.4 SPI timing



- q SCK must be low before /SS is low
 - q the value of input signal SI is validated with the falling edge of the SCK signal
 - q the change at output SO occurs with the rising edge of the SCK signal
 - q the timing for SO is based upon 10% and 90% of VCC respectively
 - q the timing for /SS, SI and SCK is based upon 20% and 70% of VCC respectively
- The data in the shift register shall be transferred to the internal registers when exactly 16 SPI clocks have

been counted during /SS is low. For a correctly executed **RD_DIAG** command, the contents of **DIAG_REG** shall be reseted to FFH (no fault) with the rising edge of /SS.

In order to ensure that communication is correct, a minimum pause between two commands shall be necessary.

4.11.5 Characteristic of SPI interface:

- q When a low level is applied to pin [/RST], the SPI shall be reset. The SPI control as well as the shift register and registers INIT_REG1, INIT_REG2 and DIAG_REG shall be reset to their default state. In addition to this, the serial output of the shift register SO shall be placed in a tristate mode.
- q Should the Slave-Select-Signal [/SS] be high or should bits 7 & 6 deviate from „0“ and „1“, then the state machine shall be placed in the initial state, i.e. the state machine shall wait for a new command after a new falling edge on /SS, i.e. /SS shall be required to be inactive between two commands.
- q In order to provide for a number of possible SPI participants on one common /SS line, bits 7 & 6 are defined as „01“. They serve as additional "Address bits" to differentiate between participants. During the receipt of the first two bits, output SO is in a tristate mode, in order to prevent conflicts with other participants. After the receipt of the first two bits, the CJ125 determines whether CJ125 is addressed (Bit 7 = 0, Bit 6 = 1). If the CJ125 is addressed, the following 6 command bits and the data byte shall be accepted to be valid and the appropriate control and data byte shall be sent to the micro-controller. If the command is not valid, the command and data byte shall be ignored and SO shall remain in a tristate mode.
- q Control Byte:
The CJ125 shall return a control byte (6 bit) via [SO] to the micro-controller in parallel to the receipt of the SPI command. This byte shall show, whether the current command is valid, contains the parity bit (even parity) including the parity bit for the data byte of the last access and shall show whether the last access was a read or write cycle.
- q Valid command / access
The CJ125 shall set the SPI output SO low after sending the control byte for write cycles (00H). For read cycles, the 2. byte contains data bits.
- q Invalid command / access:
A command / access shall be determined to be invalid when one of the following conditions is true:
 - unknown command
 - parity bit PR_bit is incorrect
 Should an invalid command be detected, no write access to the registers shall be permitted and FF_H shall be returned after the control byte for write cycles. For read cycles, the byte contains any data bits.
- q For write accesses, the received data shall only be placed in the internal init-register1 or init-register2 when exactly 16 SPI clocks have been counted at the /SS phase change from low to high. After the receipt, the clock counter shall immediately be reset to zero and shall be prepared to count once again after the next falling edge of /SS.
- q The output SO shall be tristate should VCC be missing.

4.12 Programable reference pumping currents (box 12)

With the SPI-Bits PR_x (x = 0 to 3) in the initialisation register 2 it is possible to activate/deactivate 4 internal current sources. The current I_{UN} is determined by $I_{UN} = -(10\mu A * PR_0 + 20\mu A * PR_1 + 40\mu A * PR_2 + 80\mu A * PR_3)$.

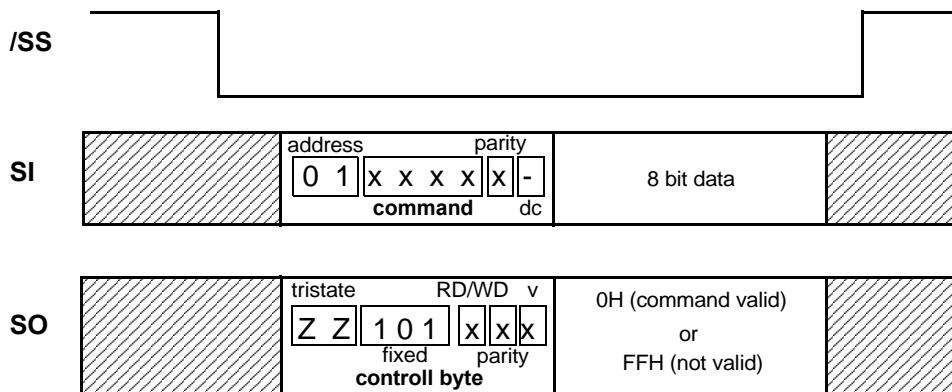
4.13 Suppression of R_i-measurement (box 13)

R_i measurement is not carried out during a time interval beginning with a positive or with a negative slope at pin [DIAHG] and ending with the negative slope of the HOLD-Phase. During this time interval the internal signal HSupp forces the switches S1 and S2 to open.

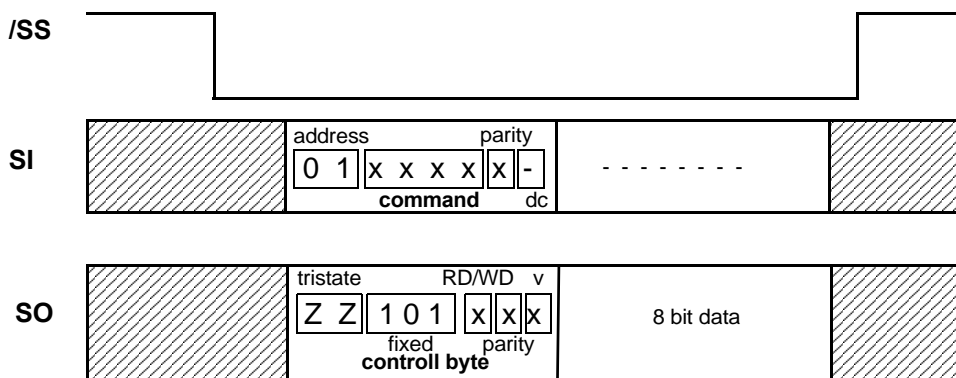
5. SPI

5.1 Access modes

5.1.1 Write access (16 bit: 8-bit command and 8-bit data)



5.1.2 Read access (16 bit: 8-bit command and 8-bit data)



5.2 SPI- commands (SI)

| SPI - command | bit coding | | | | | | | | hex value | description |
|---------------|------------|------|--------|--------|--------|--------|-----------------------|-------------------------|-----------|--------------------------------------|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| | ADR1 | ADR0 | INSTR3 | INSTR2 | INSTR1 | INSTR0 | PR_BIT ^{1.)} | not used ^{2.)} | | |
| RD_IDENT | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 48 | read IC code number from IDENT_REG |
| RD_INIT1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 6C | read INIT_REG1 |
| RD_DIAG | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 78 | read failure condition from DIAG_REG |
| WR_INIT1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 56 | write INIT_REG1 |
| RD_INIT2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 7E | read INIT_REG2 |
| WR_INIT2 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 5A | write INIT_REG2 |
| otherwise | x | x | x | x | x | x | x | x | | command not valid |

1.) check-bit for SPI-command: Parity-bit of bits 7-2 (even parity including PR_BIT)

2.) bit not interpreted.

5.3 Control-byte (SO):

| MSB | 6 | 5 | 4 | 3 | 2 | 1 | LSB |
|------------------|---|---|---|---|-------|--------|---------|
| Z ^{1.)} | Z | 1 | 0 | 1 | RD/WR | PARITY | INSTR_F |

^{1.)} Z: SO-output „tristate“ (high impedance)

| bit | name | value | description |
|-----|---------|-------|---|
| 0 | INSTR_F | 0 | current command is valid |
| | | 1 | current command is not valid |
| 1 | PARITY | x | Parity-bit (even parity inclusive parity bit!) builded from the databyte of the last access of the micro- controller. The parity-bit is undefined if the last transfer terminated not normally or the last command was not valid. RESET value = 0 |
| 2 | RD/WR | 0 | last access was a read access or not valid or there are more or less than 16 SPI-periods during the active /SS-phase or RESET value |
| | | 1 | last access was a write access |
| 3 | | 1 | wired high |
| 4 | | 0 | wired low |
| 5 | | 1 | wired high |
| 6 | | Z | always tristate (high impedance) |
| 7 | | Z | always tristate (high impedance) |

5.4 SPI register

5.4.1 Diagnostic register (SPI command: RD_DIAG) (ASIC with sensor see page 10):

| name | description | bit | | | | | | | | comment |
|--|---|------|------|------|------|------|------|------|------|--|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | | DIA7 | DIA6 | DIA5 | DIA4 | DIA3 | DIA2 | DIA1 | DIA0 | |
| DIAG_REG | Read only | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | RESET -value: FFH after (RD_DIAG and a positive slope at /SS) or /RST=0 |
| Diagnostic VM and low battery | short circuit to GND ^{1.)} | | | | | | | 0 | 0 | SC2GVM = 1 for t_{VM} ^{2.)} |
| | low voltage at V _{UB} | | | | | | | 0 | 1 | LV_UB = 1 (see 8.2.5) |
| | short circuit to Vbatt | | | | | | | 1 | 0 | SC2VBVM= 1 for t_{VM} |
| | no failure | | | | | | | 1 | 1 | RESET -value |
| Diagnostic UN and low battery | short circuit to GND | | | | | 0 | 0 | | | SC2GUN = 1 and T_SC2G = high (see 4.9.2) |
| | low voltage at V _{UB} | | | | | 0 | 1 | | | LV_UB = 1 (see 8.2.5) |
| | short circuit to Vbatt ^{3.)} | | | | | 1 | 0 | | | SC2VBUN= 1 and T_SC2VB = high (see 4.9.2) and ENSCUN = 1 |
| | no failure or short circuit detection at UN to Vbatt disabled | | | | | | 1 | 1 | | RESET -value or SC2VBUN= 1 and T_SC2VB = high and ENSCUN = 0 |
| Diagnostic IA, IP see also bit PA ^{4.)} and low battery | short circuit to GND | | | 0 | 0 | | | | | (SC2GIA=1 and DIA_Q=1) and PA = 0 or (SC2GIA=1 and SET_DIA_Q = 1) ^{5.)} for t_{IA} ^{6.)} and PA = 0 |
| | low voltage at V _{UB} | | | 0 | 1 | | | | | LV_UB = 1 (see 8.2.5) |
| | short circuit to Vbatt | | | 1 | 0 | | | | | SC2VBIA= 1 for t_{IA} ^{7.)} and PA = 0 |
| | no failure | | | 1 | 1 | | | | | RESET -value |

| name | description | bit | | | | | | | | comment |
|----------------------------------|------------------------|------|------|------|------|------|------|------|------|--|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | | DIA7 | DIA6 | DIA5 | DIA4 | DIA3 | DIA2 | DIA1 | DIA0 | |
| Diagnostic heater ^{8.)} | short circuit to GND | 0 | 0 | | | | | | | registered after t_{diag} ^{9.)} |
| | open load (OL) | 0 | 1 | | | | | | | registered after t_{diag} |
| | short circuit to Vbatt | 1 | 0 | | | | | | | registered after t_{diag} |
| | no failure | 1 | 1 | | | | | | | registered RESET-value |

- 1.) Failure displayed due to internal signal OFF = 1 (see box 2a) and pull down sink at [VM]
- 2.) **filtering time** $t_{VM} = 15T_{meas}/32 \dots 16T_{meas}/32$ (32 clocks)
- 3.) Only when ENSCUN = 1; otherwise no failure registration for a SC2VB.
- 4.) failure storage only possible, if PA = 0 i.e. the pump voltage is released.
- 5.) Bit5 in Initialisation register2 (for verification of a short circuit at IA or IP to ground (lean region))
- 6.) **filtering time** $t_{IAM} = (3 \cdot 32/32)T_{meas} \dots (4 \cdot 32/32)T_{meas}$ (256 clocks)
- 7.) **filtering time** $t_{IAB} = 1T_{meas}/32 \dots 2T_{meas}/32$ (4 clocks)
- 8.) see 4.10.2 (thresholds)
- 9.) **filtering time** $t_{diag} = (30/32)T_{meas} \dots (32/32)T_{meas}$ (64 clocks)

5.4.2 IC register (SPI command: RD_IDENT):

| name | description | bit | | | | | | | | comment |
|-----------|----------------|-----|-----|-----|-----|-----|-----|-----|-----|--|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | | ID7 | ID6 | ID5 | ID4 | ID3 | ID2 | ID1 | ID0 | |
| IDENT_REG | Read only | | | | | | | | | each design step is represented by a readable version number (metal mask). |
| | | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | CJ125BA: 62 _H |
| | | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | CJ125BB: 63 _H |
| IC-code | version number | | | | | | x | x | x | |
| | IC-number | 0 | 1 | 1 | 0 | 0 | | | | |

5.4.3 Initialisation register1 (SPI command: WR_INIT1, RD_INIT1):

| name | description | bit | | | | | | | | comment |
|-----------|--------------------|---------|----|------------|----|--------|----|--------|----|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | | EN_HOLD | PA | „Zero“ 1.) | RA | EN_F3K | LA | „Zero“ | VL | |
| INIT_REG1 | | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | RESET value 89H after RES_N = 0: operation without SPI possible |
| VL | amplification = 8 | | | | | | | | 0 | range: $\lambda = 0.65 \dots \infty$ |
| | amplification = 17 | | | | | | | | 1 | range: $\lambda = 0.75 \dots \infty$ |
| LA | measurement mode | | | | | | 0 | | | measurement mode for λ -signal at [UA] |
| | adjustment mode | | | | | | 1 | | | adjustment mode for λ -signal offset at [UA] |
| EN_F3K | F3K off | | | | | 0 | | | | timing active; except F3K |
| | Enable F3K | | | | | 1 | | | | measurement, calibration mode |
| RA | measurement mode | | | | 0 | | | | | measurement mode for R_i in sensor |
| | calibration mode | | | | 1 | | | | | calibration mode for R_i with R_{ical} |

| name | description | bit | | | | | | | | comment |
|------------------------|---|---------|----|-------------|----|--------|----|--------|----|--|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | | EN_HOLD | PA | „Zero“ (1.) | RA | EN_F3K | LA | „Zero“ | VL | |
| PA | on | | 0 | | | | | | | pump current control released |
| | off | | 1 | | | | | | | IA high impedance ($I_{IA} = 0\mu A$ (typ. when $V_{IA} < V_{CC}$)). diagnostic at IA off: write access in DIAG_REG for DIA4 and DIA5 disabled. |
| EN_HOLD ^{2.)} | pump current control without „HOLD-phase“ | 0 | | | | | | | | In connection with RA = 1 operation like CJ110; not recommended to use |
| | Enable hold | 1 | | | | | | | | measurement mode, calibration mode |

1.) only for EWS and final test of CJ125 (for RB internal only); data bit must be „Zero“

2.) only for pump current control; other hold signals not affected.

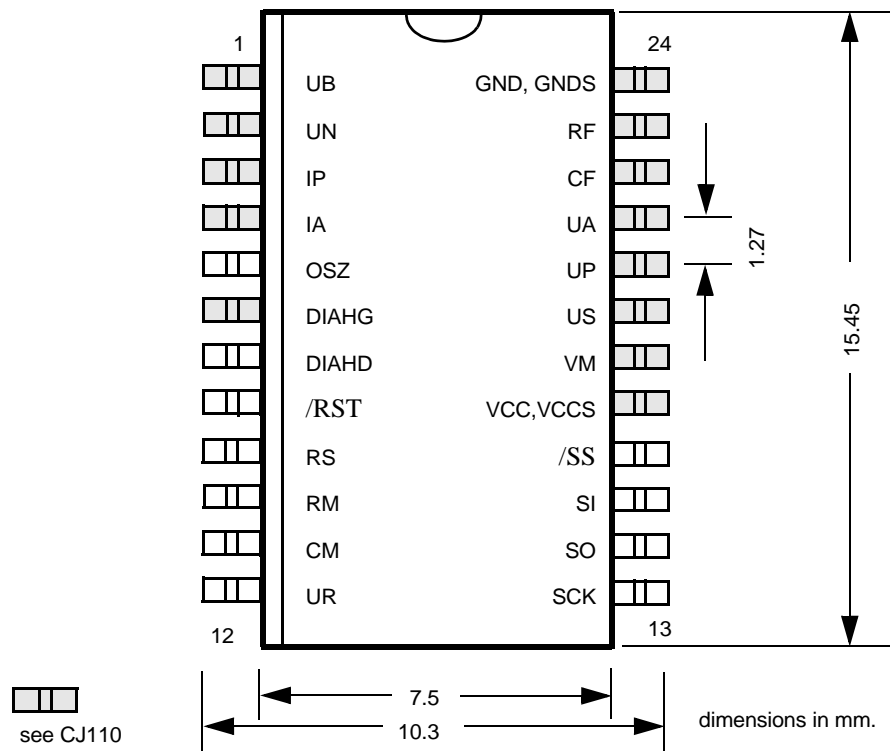
5.4.4 Initialisation register2 (SPI command: WR_INIT2, RD_INIT2):

| name | description | bit | | | | | | | | comment |
|------------|-------------|----------|--------|-----------|--------|-----|-----|-----|-----|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | | not used | SRESET | SET_DIA_Q | ENSCUN | PR3 | PR2 | PR1 | PR0 | |
| INIT_REG2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | RESET value 00 _H after RES_N = 0: operation without SPI possible |
| 10 μA | off | | | | | | | | 0 | pump reference current 10 μA off |
| | on | | | | | | | | 1 | pump reference current 10 μA on |
| 20 μA | off | | | | | | | 0 | | pump reference current 20 μA off |
| | on | | | | | | | 1 | | pump reference current 20 μA on |
| 40 μA | off | | | | | | 0 | | | pump reference current 40 μA off |
| | on | | | | | | 1 | | | pump reference current 40 μA on |
| 80 μA | off | | | | 0 | | | | | pump reference current 80 μA off |
| | on | | | | 1 | | | | | pump reference current 80 μA on |
| ENSCUN | off | | | | 0 | | | | | short circuit detection to Vbat at UN disabled; used when sensor is high impedance and pump reference currents are turned on. |
| | on | | | | 1 | | | | | short circuit detection to Vbat at UN enabled |
| SET_DIA_Q | off | | | 0 | | | | | | short circuit dedection to GND at IA/IP for $V_{UP} > V_{UN}$ („lean“) and voltage below threshold |
| | on | | | 1 | | | | | | short circuit dedection to GND at IA/IP when voltage below threshold |
| SRESET | off | | 0 | | | | | | | |
| | on | | 1 | | | | | | | Software-RESET of SPI and all registers |
| not used | | 0 | | | | | | | | wired 0 |

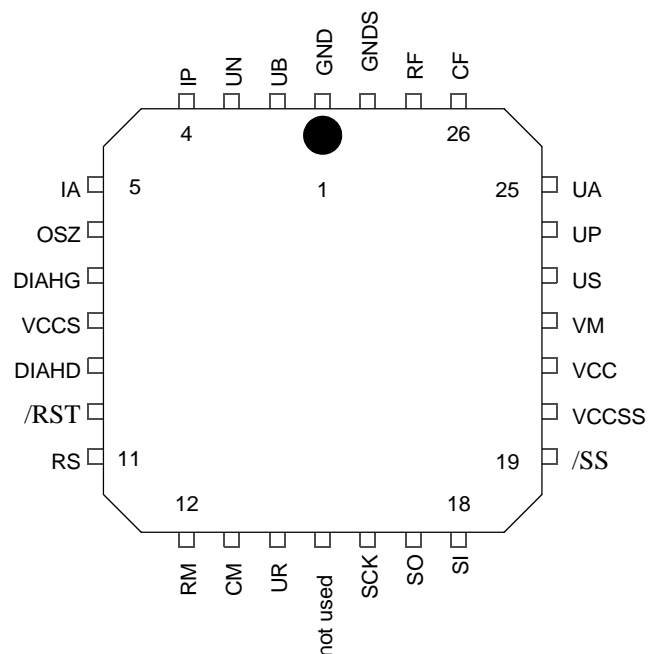


6. Pinning

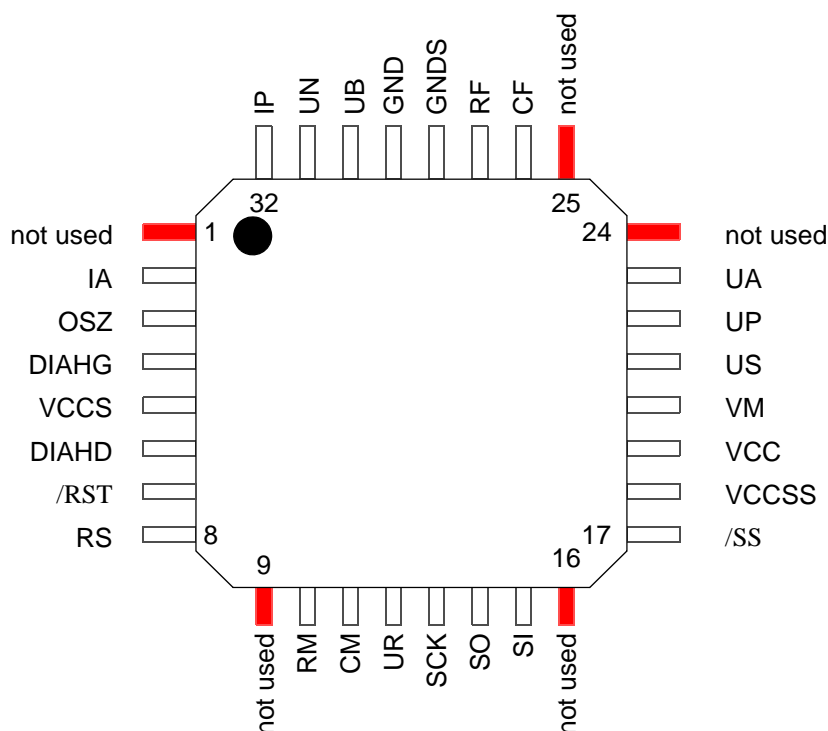
6.1 Pinout SOIC24



6.2 Pinout PLCC28



6.3 Pinout LQFP32



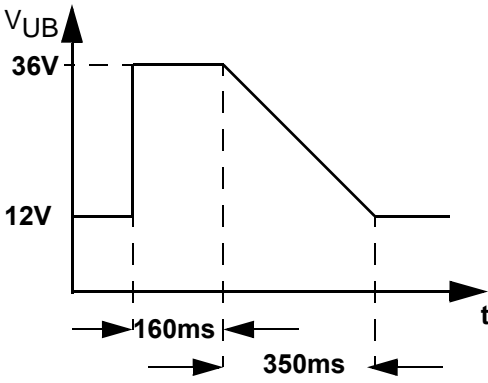
6.4 Pin description (packaged, bare-die)

| pin | description |
|----------------------|--|
| UB | power supply input (14V) |
| VCC | power supply input (5V) |
| VCCS ^{1.)} | sense inputs (5V); only for hybrid, PLCC28, LQFP32 |
| VCCSS ^{2.)} | |
| GND | ground |
| GNDS ^{3.)} | ground; only for hybrid, PLCC28, LQFP32; |
| VM | virtual ground of pump current control and of the LSU (0.5VCC) |
| US | nerst cell reference voltage (450mV) |
| IP | inverting input of pump current amplifier (shunt voltage) |
| IA | non inverting input of pump current amplifier and output of the pump current control |
| RF | output of pump current amplifier (--> external filtering) |
| CF | input of lambda output amplifier (after filter) |
| UA | output of lambda output amplifier |
| UP | non inverting input of pump current control |
| UN | inverting input of pump current control resp. in-/output for R _i -measurement (LSU) |
| RM | output R _i -measurement current (DC) |
| CM | input R _i -measurement current (AC, dc free) |
| RS | in-/output R _i -calibration measurement |
| UR | output R _i -signal (analogous) |
| DIAHG | diagnostic input (gate) |



| pin | description |
|--------------|---|
| DIAHD | diagnostic input (drain) |
| SCK | input SPI-clock (from micro- controller) |
| SI | input serial data (SPI, from micro- controller) |
| SO | output serial data (SPI, to micro- controller) |
| /SS | slave select (SPI, to micro- controller) |
| /RST | input Reset |
| OSZ | R_OSZ = 10kΩ: fixed resistor for 192kHz |

- 1.) For hybrid version it is recommended to connect VCCS with the reference VCC for the ADC
- 2.) VCCS and VCSS are short-circuited on the IC.
- 3.) For hybrid version it is recommended to connect GNDS with the reference ground for the ADC

| parameter / condition | symbol | min | typ | max | unit | |
|---|---|--|--|--|--|--|
| 7. Maximum ratings parameter marked with * (see on the right) are not tested in the standard production flow. A sink current which flows into the ASIC is positive and described as A source current which comes out of the ASIC is negative and described as | I $-I$ | 1 1 | 3.5 3.5 | 5 5 | mA mA | * * |
| 7.1 supply voltage V_{UB} no destruction | | | | | | |
| 7.1.1 static | V_{UB} | -0.3 | | 28 | V | * |
| 7.1.2 V_{UB} for 1ms; repetition rate max. 1Hz | V_{UB} | | | 35 | V | * |
| 7.1.3 Test pulses: 10 times; 1time/30s | V_{UBmax} | | | 36 | V | * |
|  | | | | | | |
| 7.2 supply voltage V_{VCC} abbreviation: $V_{VCC} = VCC$ | | | | | | |
| 7.2.1 static and dynamic | VCC | -0.3 | | 5.5 | V | * |
| 7.2.2 accumulated over 5 minutes | VCC | | | 6 | V | * |
| 7.2.2.1 VCCS | VCCS | VCC -1.5 | | VCC+1.5 | V | * |
| 7.3 temperature | | | | | | |
| 7.3.1 storage | T_{St} | -40 | | 150 | °C | * |
| 7.3.2 junction (constant) | T_J | -40 | | 150 | °C | * |
| 7.3.3 junction (for 50h) | T_J | -40 | | 165 | °C | * |
| 7.3.4 SOIC24 /PLCC28 | | | | | | |
| 7.3.4.1 VCC = VCCS = 5.5V; $V_{UB} = 35V$ | | | | | | |
| 7.3.4.1.1 ambience | T_A | -40 | | 110 | °C | * |
| 7.3.4.1.2 ambience for 50h | T_A | -40 | | 125 | °C | * |
| 7.3.4.2 VCC = VCCS = 5.1V; $V_{UB} = 18V$ | | | | | | |
| 7.3.4.2.1 ambience | T_A | -40 | | 125 | °C | * |
| 7.3.4.2.2 ambience for 50h | T_A | -40 | | 140 | °C | * |

| parameter / condition | | symbol | min | typ | max | unit | |
|---|--|-------------|-------|-----|---------|------|---|
| 7.3.5 | LQFP | | | | | | |
| 7.3.5.1 | ambience | T_A | -40 | | 125 | °C | * |
| 7.3.5.2 | ambience for 50h | T_A | -40 | | 140 | °C | * |
| 7.4 | thermal resistance | | | | | | |
| 7.4.1 | SOIC24 / PLCC28 | R_{thja} | 70 | | 80 | K/W | * |
| 7.4.2 | LQFP32 | R_{thja} | 45 | | 65 | K/W | * |
| 7.5 | voltages | | | | | | |
| no destruction for voltages below breakdown of ESD diodes | | | | | | | |
| 7.5.1 | valid for pins: RM, UP, US, RF, CF, UA, UR, DIAHG, (DIAHD see 7.6) SCK, SI, SO, /SS, /RST, OSZ | V_X | -0.3 | | VCC+0.3 | V | * |
| 7.5.2 | valid for board pins: RS, UN, VM, IA, IP, CM | V_X | -0.3 | | 28 | V | * |
| 7.5.3 | allowed difference between VCC and VCCS(\$) | | | | | | |
| 7.5.3.1 | static | ΔV | -0.25 | | 0.25 | V | * |
| 7.5.3.2 | dynamic | ΔV | -1 | | 1 | V | * |
| 7.5.4 | allowed difference between GND and GNDS | | | | | | |
| 7.5.4.1 | static | ΔV | -0.25 | | 0.25 | V | * |
| 7.5.4.2 | dynamic | ΔV | -1 | | 1 | V | * |
| 7.6 | current (diagnostic heater) | | | | | | |
| current must be limited with an external resistor | | I_{DIAHD} | -1 | | +10 | mA | * |
| 7.7 | overvoltage pulses (board pins) | | | | | | |
| no destruction for ISO-pulses 3a, 3b see ISO7637-1 at UN, VM, IA, IP and RS with external 82.5Ω | | V_X | -100 | | 100 | V | * |
| 7.8 | slewrate (not valid for ISO-pulses) | | | | | | |
| at UN, VM, IA, IP, VCC, UB, RS | | dV/dt | | | 1 | V/μs | * |
| 7.9 | ESD rating | | | | | | |
| human body model (C=100pF,R=1.5kΩ); see MIL883D / 3015 | | all pins | - 2 | | 2 | kV | * |

| parameter / condition | symbol | min | typ | max | unit | |
|---|------------|-------|-----|-------|------|---|
| 8. Electrical characteristics parameter marked with * (see on the right) are not tested in the standard production flow. A: for Characterization otherwise B B: GoNoGo-test | | | | | | * |
| 8.1 Temperature range if not specified otherwise | T_J | -40 | | 150 | °C | * |
| 8.2 Voltage range parameters are valid in the voltage range if not specified otherwise | | | | | | |
| 8.2.1 battery voltage | | | | | | |
| 8.2.1.1 | V_{UB} | 9 | | 18 | V | * |
| 8.2.1.2 extended (refer to 8.5; 8.6; 8.7.8) | V_{UB} | 8 | | 18 | V | * |
| 8.2.2 stabilized voltage | | | | | | |
| 8.2.2.1 unlimited accuracy | VCC | 4.9 | | 5.1 | V | B |
| 8.2.2.2 limited accuracy (refer to 8.12.2) | VCC | 4.75 | | 5.25 | V | * |
| 8.2.3 stabilized voltage at VCCS or VCCSS | | | | | | |
| 8.2.3.1 unlimited accuracy | VCCS(S) | 4.9 | | 5.1 | V | B |
| 8.2.3.2 limited accuracy (refer to 8.12.2) | VCCS(S) | 4.75 | | 5.25 | V | B |
| 8.2.4 Power on/off | | | | | | |
| 8.2.4.1 $V_{UB} > VCC$; $VCC + 2\text{ V} \leq V_{UB} \leq 9\text{V}$ $4.75\text{V} \leq VCC \leq 5.25\text{V}$ $1\text{V} \leq V_{IA} = V_{IP} \leq 3.5\text{V}$ $V_{UN} = V_{UP} = V_{US}$ | V_{UA} | 1.3 | | 1.7 | V | * |
| 8.2.4.2 $V_{UB} \leq VCC$ | | | | | | |
| 8.2.4.2.1 during power on/off | | | | 100 | ms | * |
| 8.2.4.2.2 accumulated over lifetime | t | | | 2 | h | * |
| 8.2.4.3 $-I_{UB} < 200\mu\text{A}$ | t | | | 1000 | h | * |
| 8.2.5 low voltage LV_UB if $V_{UB} < V_{UBlv}$ during the S1 phase, signal LV_UB is set to 1; bits DIA1, 3, 5 are set to 0 | V_{UBlv} | VCC+1 | | VCC+4 | V | A |
| 8.3 Current consumption $-10\text{mA} \leq I_{IA} \leq 10\text{mA}$ and $-I_{IA} = I_{VM}$ No short circuit | | | | | | |
| 8.3.1 from battery | I_{UB} | | | 5 | mA | A |
| 8.3.2 from stabilized voltage | I_{VCC} | | | 76 | mA | A |
| 8.3.3 from stabilized sense voltage | I_{VCCS} | 0.5 | | 4 | mA | A |

| | parameter / condition | symbol | min | typ | max | unit | |
|------------|---|----------------------|------|------|------|------|---|
| 8.4 | Oscillator RC-Oscillator with external R at OSZ; Measurement of frequency and duty cycle at RM | | | | | | |
| 8.4.1 | resistor determinant for the frequency (1%) | R | 9.9 | 10 | 10.1 | kΩ | B |
| 8.4.2 | output voltage | V _{OSZ} | | 1.75 | | V | * |
| 8.4.3 | short circuit current V _{OSZ} = 0V | - I _{OSZ} | | 2 | | mA | * |
| 8.4.4 | frequency | f _{meas} | 2.49 | 3.0 | 3.51 | kHz | A |
| 8.4.5 | duty cycle | TV | | 50 | | % | * |
| 8.4.6 | max. C load | C _{max} | | | 20 | pF | * |
| 8.5 | measurement current for R_i Push-pull-stage driven by oscillator | | | | | | |
| 8.5.1 | output resistor 'High' (to VCC) -1mA ≤ I _{RM} ≤ 0mA | R _{RM_high} | 5 | 40 | 100 | Ω | A |
| 8.5.1.1 | V _{UB} = 8V | R _{RM_high} | 5 | | 200 | Ω | * |
| 8.5.2 | output resistor 'Low' (to GND) 0mA ≤ I _{RM} ≤ 1mA | R _{RM_low} | 5 | 40 | 100 | Ω | A |
| 8.5.2.1 | V _{UB} = 8V | R _{RM_low} | 5 | | 200 | Ω | * |
| 8.5.3 | common mode of output resistor ΔR = R _{RM_high} - R _{RM_low} -1mA ≤ I _{RM} ≤ 1mA | ΔR | | | 50 | Ω | B |
| 8.6 | differential amplifier for R_i the measurement current (input CM) flows on dependency of SPI-Bit RA either through the nernst cell (measurement mode) or through an external calibration resistor (calibration mode). | | | | | | |
| 8.6.1 | analogous switch | | | | | | |
| 8.6.1.1 | resistor in measurement mode SPI-bit RA = 0 | R _{onCMUN} | | | 100 | Ω | A |
| 8.6.1.1.1 | V _{UB} = 8V | R _{onCMUN} | | | 200 | Ω | * |
| 8.6.1.2 | resistor in calibration mode SPI-bit RA = 1 | R _{onCMRS} | | | 100 | Ω | A |
| 8.6.1.2.1 | V _{UB} = 8V | R _{onCMRS} | | | 200 | Ω | * |
| 8.6.2 | common mode of resistor | | | | | | |
| 8.6.2.1 | ΔR _{on} = R _{onCMUN} - R _{onCMRS} | ΔR _{on} | | | 20 | Ω | A |
| 8.6.2.2 | V _{UB} = 8V | ΔR _{on} | | | 30 | Ω | * |

| | parameter / condition | symbol | min | typ | max | unit | |
|-----------|--|------------------|---------|------|---------|------------|---|
| 8.6.3 | leakage current when switch is open | I_{leak} | -500 | | 500 | nA | A |
| 8.6.4 | input voltage range at CM, UN and RS for full accuracy | V_{RI} | 2 | | VCC-1.1 | V | B |
| 8.6.5 | output signal at overdrive $\Delta V_{UN} \geq 1V$ symmetric $V_{UNhigh} \geq V_{VM}$ | V_{UR} | | | 5 | V | B |
| 8.6.6 | sample&hold-stage (S&H1) S&H-stage for sampling of UN- signal before (S2) and after (S1) the positive transition at RM of the measurement current (see 4.8d page 8). $T_{meas} = 1 / f_{meas}$ | | | | | | |
| 8.6.6.1 | delay after S2 and before positive transition | t_1 / T_{meas} | | | 1/32 | | * |
| 8.6.6.2 | sampling time S2 simultaneous start of the hold phase at the beginning of S2 | t_2 / T_{meas} | | | 1/32 | | * |
| 8.6.6.3 | delay after positive transition and before S1 | t_4 / T_{meas} | | | 4/32 | | * |
| 8.6.6.4 | sampling time S1 | t_5 / T_{meas} | | | 1/32 | | * |
| 8.6.6.5 | setup time (n * Tmess) | | | | | | |
| 8.6.6.5.1 | power on: $\Delta V = 3V$ | n | | 30 | | | * |
| 8.6.6.5.2 | measurement / calibration: $\Delta V = 450mV$ | n | | 5 | | | |
| 8.6.6.6 | ΔV of sample C / cycle | ΔV | | | 100 | mV | * |
| 8.6.6.7 | hold failure voltage failure due to the discharge of the sample-C's during the clock period (see 4.8d page 8) | ΔV_{UR} | | 10 | | mV | * |
| 8.6.7 | differential amplifier amplifier with fixed amplification and offset | | | | | | |
| 8.6.7.1 | amplification | | | | | | |
| 8.6.7.1.1 | RA = 0, $V_{UN} = 2.95V$ | V_{RI} | 15.0 | 15.5 | 16.3 | | A |
| 8.6.7.1.2 | RA = 1, $V_{RS} = 2.50V$ | V_{RI} | 15.0 | 15.5 | 16.3 | | A |
| 8.6.7.2 | output voltage swing $I_{UR} = 0\mu A$ | V_{UR} | 0.06VCC | | VCC-0.2 | V | * |
| 8.6.7.3 | maximum output voltage static and dynamic | V_{URmax} | | | VCC | | * |
| 8.6.7.4 | output resistor | R_{out} | 7.5 | 15 | 30 | k Ω | A |

| parameter / condition | symbol | min | typ | max | unit | |
|--|--------------------|------|------|---------|---------|---|
| 8.6.7.5 zero point for output trace $V_{UN} = V_{RS} = V_{US}$ $I_{UR} = 0\mu A$ | V_{UR} / V_{CCS} | 0.05 | 1/17 | 0.063 | | A |
| 8.6.7.6 change of output voltage before/after calibration $V_{UN} = V_{RS} = V_{US}; R_{RS} = 100\Omega$ $\Delta V_R = V_{UR}(RA = HIGH) - V_{UR}(RA = LOW)$ | ΔV_{UR} | -6 | -3 | 3 | mV | A |
| 8.6.7.7 calibration failure $V_{UN} = V_{US}, V_{RS} = V_{VM}$ $\Delta V_R = V_{UR}(RA = HIGH) - V_{UR}(RA = LOW)$ | ΔV_{UR} | -8 | -6 | 3 | mV | A |
| 8.7 pump current control | | | | | | |
| 8.7.1 common mode range at input for full function | | | | | | |
| 8.7.1.1 V_{UP} | V_{UP} | 2.15 | | VCC-0.5 | V | * |
| 8.7.1.2 V_{UN} | V_{UN}/V_{CC} | 0.4 | | 0.9 | | * |
| 8.7.2 offset of OTA $V_{off} = V_{UP} - V_{UN}; I_{IA} = -10mA...+10mA$ $2.15V \leq V_{UP} \leq V_{CC}-0.5V$ $2.15V \leq V_{UN} \leq V_{CC}-0.5V$ $0.50V \leq V_{IA} \leq V_{CC}-0.5V$ | V_{off} | -10 | | 10 | mV | A |
| 8.7.3 input current OTA $2.15V \leq V_{UP} \leq 4.4V$ $1.75V \leq V_{UN} \leq 4.4V$ no pump reference current | | | | | | |
| 8.7.3.1 Condition 1: $-40^\circ C \leq T_J \leq 80^\circ C$ | I_{UP}, I_{UN} | -700 | | 700 | nA | A |
| 8.7.3.2 Condition 2: $80^\circ C < T_J \leq 150^\circ C$ | I_{UP}, I_{UN} | -1 | | 1 | μA | A |
| pump reference current; depending on bits PRx $2.5V \leq V_{UN} \leq 3.5V$ 10 μA per stage accuracy 20 μA -150 μA : $\pm 15\%$ 10 μA : 30% | | | | | | |
| 8.7.4 input offset current for OTA $I_{off} = I_{UP} - I_{UN}$ V_{UP}, V_{UN} so that $I_{IA} = 0$ $2.15V \leq V_{UP} \leq 4.4V$ $2.15V \leq V_{UN} \leq 4.4V$ $0.50V \leq V_{IA} \leq V_{CC}-0.5V$ | I_{off} | -1 | | 1 | μA | * |
| 8.7.5 hold phase the regulator will be frozen for the R_i -measurement for t_3 ; definition of time (see 4.8d page 8) | t_3/T_{meas} | | | 8/32 | | * |

| parameter / condition | symbol | min | typ | max | unit | |
|---|-------------|--------------|-----|----------|---------|---|
| 8.7.6 voltage limitation at output SPI-bit PA = 0: $I_{IA} = 0$ i.e. IA = open | | | | | | |
| 8.7.6.1 source: $V_{UP} > V_{UN}$ („lean“) | V_{IA} | $V_{CC}-0.5$ | | V_{CC} | V | * |
| 8.7.6.2 sink: $V_{UP} < V_{UN}$ („rich“) | V_{IA} | | | 0.5 | V | * |
| 8.7.7 output current $0.5V \leq V_{IA} \leq V_{CC} - 0.5V$, SPI-bit PA = 0 | | | | | | |
| 8.7.7.1 source: $V_{UP} > V_{UN}$; „lean“ | $-I_{IA}$ | 10 | | 30 | mA | A |
| 8.7.7.2 sink: $V_{UP} < V_{UN}$; „rich“ | I_{IA} | 10 | | 30 | mA | A |
| 8.7.8 supply voltage be available $4.9V \leq V_{CC} \leq 5.1V$ $V_{pump} = V_{IA} - V_{VM}$ | | | | | | |
| 8.7.8.1 „rich“ (sink active) | | | | | | |
| 8.7.8.1.1 $I_{IA} = 10mA$ | $-V_{pump}$ | 1.85 | | | V | A |
| 8.7.8.2 „lean“ (source active) | | | | | | |
| 8.7.8.2.1 $I_{IA} = -10mA$ | V_{pump} | 1.85 | | | V | A |
| 8.7.8.2.2 $I_{IA} = -10mA$; $V_{UB} = 8V$ | V_{pump} | 1.35 | | | V | * |
| 8.7.9 voltage off SPI-bit PA = 1: voltage off for sensor-protection, i.e. pin IA high impedance | | | | | | |
| 8.7.9.1 $V_{VM} - 1V \leq V_{IA} \leq V_{CC}$ | I_{IA} | -10 | 0 | 10 | μA | A |
| 8.7.9.2 $V_{CC} < V_{IA}$ | I_{IA} | -10 | | 10 | μA | * |
| 8.7.10 integration time constant | τ_R | 7 | 22 | 80 | μs | A |
| 8.8 pump current sense amplifier differential amplifier which converts the pump current into a 0...VCC - signal | | | | | | |
| 8.8.1 common mode range at input | | | | | | |
| 8.8.1.1 $V_{UB} \geq 9V$ | | | | | | |
| 8.8.1.1.1 pin IP | V_{IP} | 0 | | V_{CC} | V | * |
| 8.8.1.1.2 pin IA | V_{IA} | 0 | | V_{CC} | V | * |
| 8.8.1.2 $7.5V < V_{UB} < 9V$ | | | | | | |
| 8.8.1.2.1 pin IP | V_{IP} | 0 | | 3.5 | V | * |
| 8.8.1.2.2 pin IA | V_{IA} | 0 | | 3.5 | V | * |
| 8.8.2 input current $V_{IP} = 1 \dots 4V$ $0.5V \leq V_{RF} \leq V_{CC}-0.5V$ $ I_{RF} \leq 10\mu A$ | | | | | | |
| 8.8.2.1 condition 1: $-40^\circ C \leq T_J \leq 80^\circ C$ | I_{IP} | -500 | | 500 | nA | A |
| 8.8.2.2 condition 2: $80^\circ C < T_J \leq 150^\circ C$ | I_{IP} | -1 | | 1 | μA | A |

| parameter / condition | | symbol | min | typ | max | unit | |
|-----------------------|---|--------------------|-------|-----|----------|----------|---|
| 8.8.3 | amplification condition: traces $V_{IA} = f(\text{signal})$ $V_O = \Delta V_{RF} / \Delta (V_{IA} - V_{IP})$ $1V \leq V_{IA}, V_{IP} \leq 4V$ $ I_{RF} \leq 10\mu A$ $0.5V \leq V_{RF} \leq 3.0V$ | | | | | | |
| 8.8.3.1 | SPI-bit VL = 0 | $v_{\lambda 0}$ | 7.82 | 8 | 8.15 | | A |
| 8.8.3.2 | SPI-bit VL = 1 | $v_{\lambda 1}$ | 16.62 | 17 | 17.24 | | A |
| 8.8.3.3 | SPI-bit VL = 1 $3.0V \leq V_{RF} \leq VCC - 0.2V$ | $v_{\lambda 1}$ | 16.62 | 17 | 17.24 | | A |
| 8.8.4 | common mode rejection ratio $CMRR^{-1} = \Delta V_{RF} / \Delta V_{IP}$ $V_{IP} = V_{IA} = 1 \dots 4V$ $0.5V \leq V_{RF} \leq VCC - 0.5V$ $ I_{RF} \leq 10\mu A$ | CMRR ⁻¹ | | 7 | 12 | mV/V | A |
| 8.8.5 | output voltage swing $I_{RF} = 0\mu A$ | V_{RF} | 0.20 | | VCC-0.18 | V | A |
| 8.8.6 | driver capability for dynamic | I_{RF} | 100 | | | μA | B |
| 8.8.7 | maximum output voltage statically and dynamically | V_{RFmax} | | | VCC | V | * |
| 8.8.8 | output resistance $V_{UB} = 14V$ | R_{out} | 50 | 200 | 400 | Ω | A |
| 8.8.9 | output voltage adjustment SPI-bit LA = 1 (adjustment) $I_{RF} = 0\mu A$ $r_{adj} = V_{RF} / VCCS$ | r_{adj} | 0.285 | 0.3 | 0.315 | | A |
| 8.8.10 | voltage change before/after adjustment $\Delta V_{RF} = V_{RF}(LA = 1) - V_{RF}(LA = 0)$ $V_{IP} = V_{IA} = V_{VM}$ | ΔV_{RF} | -3 | | 3 | mV | A |
| 8.9 | Pump reference current Current controlled by SPI-bits PRx (x = 0 to 3) Current derived from 10k Ω at OSZ | | | | | | |
| 8.9.1 | typical current per step | $-I_{UN}$ | | 10 | | μA | A |
| 8.9.2 | typical current range | $-I_{UN}$ | 0 | | 150 | μA | A |
| 8.9.3 | accuracy | | | | | | |
| 8.9.3.1 | for $-I_{UN} = 10\mu A$ (first step) | I_{Ist}/I_{Soll} | 0.5 | | 1.5 | | A |
| 8.9.3.2 | for $-I_{UN} \geq 20\mu A$ | I_{Ist}/I_{Soll} | 0.8 | | 1.2 | | A |
| 8.9.4 | Common mode range at input $VCC \geq 4.9V$ | V_{UN} | 0 | | 3.5 | V | B |

| parameter / condition | symbol | min | typ | max | unit | |
|---|----------------|-------------|-----|-------------|----------|---|
| 8.10 Lambda output amplifier Impedance converter for lambda signal with failure signal | | | | | | |
| 8.10.1 common mode range at input | V_{CF} | 0 | | VCC | V | * |
| 8.10.2 input current $V_{CF} = 0.2V \dots VCC$ | | | | | | |
| 8.10.2.1 Condition 1: $-40^{\circ}C \leq T_J \leq 80^{\circ}C$ | I_{CF} | -100 | | 100 | nA | A |
| 8.10.2.2 Condition 2: $80^{\circ}C \leq T_J \leq 150^{\circ}C$ | I_{CF} | -100 | | 500 | nA | A |
| 8.10.3 input offset voltage $V_{CF} = 0.2V \dots VCC$ $ I_{UA} \leq 10\mu A$ | V_{off} | -3 | | 3 | mV | A |
| 8.10.4 amplification | V_0 | | 1 | | | * |
| 8.10.5 output voltage swing (minimum) $ I_{UA} \leq 10\mu A$ | V_{UA} | 0.20 | | VCC-0.18 | V | A |
| 8.10.6 maximum output voltage statically and dynamically | V_{UAmix} | | | VCC | | * |
| 8.10.7 output resistance | R_{out} | 50 | 100 | 200 | Ω | A |
| 8.11 virtual ground voltage source | | | | | | |
| 8.11.1 permissible output current | | | | | | |
| 8.11.1.1 permissible current VM („hot sensor“) driver capability (source and sink) is coupled with the current at IA | I_{VM} | $-I_{IA}-2$ | | $-I_{IA}+2$ | mA | A |
| 8.11.1.2 permissible current VM („cold sensor“) driver capability is <i>not</i> coupled with the current at IA | I_{VM} | -2 | | 1 | mA | A |
| 8.11.2 output voltage during hold phase t_3 the voltage V_{VM} is almost independently of VCC (see 8.11.3) $-I_{IA} - 2mA \leq I_{VM} \leq -I_{IA} + 2mA$ | V_{VM} / VCC | 0.48 | 0.5 | 0.52 | | A |
| 8.11.3 power supply rejection | psr | 20 | | | dB | * |
| 8.11.4 permissible C load | C_{VM} | 0 | | 10 | nF | * |
| 8.11.5 short circuit current to ground $V_{VM} = 0V$, $V_{UP} = 5V$, $V_{UN} = 0V$ | | | | | | |
| 8.11.5.1 before end of filtering time | I_{VM} | | 130 | 250 | mA | B |
| 8.11.5.2 after end of filtering time | I_{VM} | -0,2 | | 0,2 | mA | B |

| parameter / condition | symbol | min | typ | max | unit | |
|--|------------------|----------|-----|---------|----------|---|
| 8.12 nernst cell reference voltage source | | | | | | |
| 8.12.1 permissible current | I_{US} | -0.4 | | 0.4 | mA | A |
| 8.12.2 open load output voltage $V_{Soll} = V_{US} - V_{VM}$, $I_{US} = 0$ | | | | | | |
| 8.12.2.1 $4.90V \leq VCC \leq 5.10V$ | V_{Soll} | 420 | 450 | 470 | mV | A |
| 8.12.2.2 $4.75V \leq VCC \leq 5.25V$ | V_{Soll} | 405 | 450 | 490 | mV | * |
| 8.12.2.3 $4.75V \leq VCC \leq 5.30V$ | V_{Soll} | 405 | 450 | 500 | mV | * |
| 8.12.3 output resistance $R_{out} = \Delta V_{US} / \Delta I_{US}$ | R_{out} | 220 | 450 | 900 | Ω | A |
| 8.13 SPI interface | | | | | | |
| 8.13.1 clock input SCK | | | | | | |
| 8.13.1.1 low | V_{SCK} | -0.3 | | 0.3VCC | V | B |
| 8.13.1.2 high | V_{SCK} | 0.7VCC | | VCC+0.3 | V | B |
| 8.13.1.3 hysteresis | ΔV_{SCK} | 0.1 | | 0.9 | V | * |
| 8.13.1.4 input capacitance | C_{SCK} | | | 10 | pF | * |
| 8.13.1.5 pullup current at VCC $0.3VCC \leq V_{SCK} \leq 0.7VCC$ | $-I_{SCK}$ | 10 | 20 | 50 | μA | A |
| 8.13.2 input slave select /SS | | | | | | |
| 8.13.2.1 low: CJ125 selected | $V_{/SS}$ | -0.3 | | 0.3VCC | V | B |
| 8.13.2.2 high: CJ125 not selected (SO tristate) | $V_{/SS}$ | 0.7VCC | | VCC+0.3 | V | B |
| 8.13.2.3 hysteresis | $\Delta V_{/SS}$ | 0.1 | | 0.9 | V | * |
| 8.13.2.4 input capacitance | $C_{/SS}$ | | | 10 | pF | * |
| 8.13.2.5 pullup current at VCC $0.3VCC \leq V_{/SS} \leq 0.7VCC$ | $-I_{/SS}$ | 10 | 20 | 50 | μA | A |
| 8.13.3 data input SI | | | | | | |
| 8.13.3.1 low | V_{SI} | -0.3 | | 0.3VCC | V | B |
| 8.13.3.2 high | V_{SI} | 0.7VCC | | VCC+0.3 | V | B |
| 8.13.3.3 hysteresis | ΔV_{SI} | 0.1 | | 0.9 | V | * |
| 8.13.3.4 input capacitance | C_{SI} | | | 10 | pF | * |
| 8.13.3.5 pullup current at VCC $0.3VCC \leq V_{SI} \leq 0.7VCC$ | $-I_{SI}$ | 10 | 20 | 50 | μA | A |
| 8.13.4 SPI data output SO tristate when not selected or RESET or $VCC < 3V$ | | | | | | |
| 8.13.4.1 low: $I_{SO} = 2mA$; $VCC > 4V$ | V_{SOL} | | | 0.4 | V | A |
| 8.13.4.2 high: $I_{SO} = -2mA$; $VCC > 4V$ | V_{SOH} | VCC- 0.7 | | | V | A |
| 8.13.4.3 capacitance tristate: /SS = high | C_{SO} | | | 10 | pF | * |
| 8.13.4.4 leakage current tristate: /SS = high $0V \leq V_{SO} \leq VCC$ | I_{SO} | -10 | | 10 | μA | A |

| parameter / condition | symbol | min | typ | max | unit | |
|---|----------------------|-----------|-----|---------|---------|---|
| 8.13.5 timing (see 4.11.4 page 13) | | | | | | |
| 8.13.5.1 transmission rate | | | 4 | | MBit/s | * |
| 8.13.5.2 Cycle time (SPI clock) | t_{cyc} | 250 | | | ns | * |
| 8.13.5.3 Enable lead time (master) | t_{lead} | 50 | | | ns | * |
| 8.13.5.4 Enable lag time (master) | t_{lag} | 125 | | | ns | * |
| 8.13.5.5 Data valid (CJ125), $C_{Load} = 100pF$ HIGH --> LOW: SCK = 0.7VCC --> SO = 0.1VCC LOW --> HIGH: SCK = 0.7VCC --> SO = 0.9VCC | t_v | | | 100 | ns | * |
| 8.13.5.6 Data setup Time (Master) | t_{su} | 50 | | | ns | * |
| 8.13.5.7 Data hold Time (Master) | t_h | 20 | | | ns | * |
| 8.13.5.8 Disable time (CJ125) | t_{dis} | | | 50 | ns | * |
| 8.13.5.9 Disable leadtime (CJ125) | $t_{dislead}$ | 250 | | | ns | * |
| 8.13.5.10 Disable lagtime (CJ125) | t_{dislag} | 250 | | | ns | * |
| 8.13.5.11 Transfer delay (Master) between two commands | t_{dt} | 50 | | | ns | * |
| 8.13.5.12 recommended transfer delay between two RD_DIAG commands (Master, see 8.14.9 page 33) | t_{dt}/T_{meas} | 4*32/32 | | | | * |
| 8.13.5.13 Clear time, time after RD_DIAG command: /SS = 0.7VCC --> DIAG_REG: FFH | t_{clear}/T_{meas} | | | 1 | μs | * |
| 8.13.6 Reset input /RST | | | | | | |
| 8.13.6.1 Low reset of SPI interface and SPI register | $V_{/RST}$ | -0.3 | | 0.3VCC | V | A |
| 8.13.6.2 High no reset | $V_{/RST}$ | 0.7VCC | | VCC+0.3 | V | A |
| 8.13.6.3 Hysteresis | $\Delta V_{/RST}$ | 0.1 | | 0.9 | V | * |
| 8.13.6.4 Pullup current at VCC $0.3VCC \leq V_{/RST} \leq 0.7VCC$ | $-I_{/RST}$ | 10 | 20 | 50 | μA | A |
| 8.13.6.5 necessary reset time after power on | $t_{/RST}$ | 0.5 | | 1 | ms | * |
| 8.13.6.6 necessary reset time when VCC > 4.75V | $t_{/RST}$ | 3 | | 10 | μs | * |
| 8.13.7 Transition to test mode Annotation: only for testing at RB; return to normal mode with 5A _H and „x1xxxxxx“ | $V_{/RST}$ | VCC | | VCC+2 | V | A |
| 8.13.8 Necessary delay for access via SPI after reset | t_{delay}/T_{meas} | (3/32)/64 | | | | * |
| 8.14 Diagnostic of sensor lines When one failure condition is met, the equivalent failure bit in the DIAG_REG will be set until it will be erased with RD_DIAG! | | | | | | |
| 8.14.1 SC2G level at VM bits DIA0 and DIA1 will set to „00“ below the level | V_{VM} / VCC | 0.35 | 0.4 | 0.45 | | A |



| | parameter / condition | symbol | min | typ | max | unit | |
|----------|---|--------------------|-------|------|--------|------|---|
| 8.14.2 | SC2VB level at VM bit DIA0 will set to „0“ above the level after t_{VM} | V_{VM} / V_{CC} | 0.55 | 0.6 | 0.65 | | A |
| 8.14.3 | Filtering time t_{VM} for short circuit detection at VM. Failure will be ignored for t_{VM} $T_{meas} = 1/f_{meas}$ (see 4.8d page 8) | t_{VM}/T_{meas} | 15/32 | | 16/32 | | A |
| 8.14.4 | SC2G level at UN Detection of SC2G only when RM =high! Bits DIA2 and DIA3 will set to „0“ below level during t_7 ; failure will be updated after 1 period of T_{meas} | V_{UN} / V_{CC} | 0.3 | 0.35 | 0.4 | | A |
| 8.14.5 | SC2VB level at UN Bit DIA2 will set to „0“ above level during t_7 Detection of SC2VB only when RM =low! Failure will be updated after 1 period of T_{meas} | V_{UN} / V_{CC} | 0.72 | 0.8 | 0.88 | | A |
| 8.14.6 | Waiting time for failure detection (SC2G and SC2VB) at UN after a transition at RM (see page 9) | t_6/T_{meas} | | 4/32 | | | A |
| 8.14.7 | Failure detection for SC2G and SC2VB activated (see page 9) | t_7/T_{meas} | | 8/32 | | | A |
| 8.14.8 | SC2G detection at IA, IP (only while SPI bit PA = 0) Bits DIA4 and DIA5 will be set to „00“ when $SC2G_{IA,IP} = 1$ and DIA_Q =1 for t_{IAM} | | | | | | |
| 8.14.8.1 | Level for SC2G _{IA,IP} SC2G _{IA,IP} = 1 for $V < V_{IA,IP}$ | $V_{IA,IP}$ | 0.3 | | 1.5 | V | A |
| 8.14.8.2 | Level for DIA_Q DIA_Q =1 for $I_{IA} < I_{IAT}$ | I_{IAT} | -8 | | -0,1 | mA | A |
| 8.14.9 | Filtering time for SC2G detection at IA, IP Failure will be ignored during t_{IAM} $T_{meas}=1/f_{meas}$ (see 8.4.4 page 25) | t_{IAM}/T_{meas} | 96/32 | | 128/32 | | A |
| 8.14.10 | SC2VB level IA (only while SPI bit PA=0) Bit DIA4 will be set to „0“ after t_{IAB} | V_{IA} | VCC | | VCC+2 | V | A |
| 8.14.11 | Filtering time t_{IAB} for SC2VB detection at IA $V_{IA} > V_{IA}$ (8.14.10) Failure will be ignored during t_{IAB} $T_{meas} = 1/f_{meas}$ (see 8.4.4 page 25) | t_{IAB}/T_{meas} | 1/32 | | 2/32 | | A |

| parameter / condition | symbol | min | typ | max | unit | |
|---|---------------------|---------|-----|---------|---------|---|
| 8.14.12 Pulldown current when turned off | | | | | | |
| 8.14.12.1 PA= 0; $V_{IA} > SC2VB$ level V_{IA} (8.14.10) | I_{IA} | 50 | | 500 | μA | A |
| 8.14.12.2 PA= 1; see 8.7.9 | | | | | | |
| 8.14.13 Pulldown current when turned off | | | | | | |
| 8.14.13.1 $VCC > V_{VM} > 1V$ | I_{VM} | 1 | | 40 | μA | A |
| 8.14.13.2 $VCC < V_{VM}$ | I_{VM} | 1 | | 40 | μA | A |
| 8.15 Diagnostic of external heater | | | | | | |
| Diagnostic information for DIAHD and DIAHG stored in DIAG_REG (Bits 6 and 7). If any failure occurs, the CJ125 does not turn off the heater (only flag)! | | | | | | |
| 8.15.1 Input DIAHG | | | | | | |
| Information for: gate turned on/off | | | | | | |
| 8.15.1.1 Low level | V_{DIAHGL} | -0.3 | | 0.3VCC | V | A |
| 8.15.1.2 High level | V_{DIAHGH} | 0.7VCC | | VCC+0.3 | V | A |
| 8.15.1.3 Hysteresis | ΔV_{DIAHG} | 0.1 | | 0.9 | V | * |
| 8.15.1.4 Input current | I_{DIAHG} | -1 | | 1 | μA | A |
| 8.15.2 In-/output DIAHD | | | | | | |
| Monitoring of external Drain voltage | | | | | | |
| 8.15.2.1 $-350\mu A \leq I_{DIAHD} \leq 350\mu A$ | V_{DIAHD} | VCC-1.2 | | VCC+0.6 | V | A |
| 8.15.2.2 detection of short circuit to ground (SC2G) DIAHG = Low | I_{DIAHD_SCG} | -1000 | | -350 | μA | B |
| 8.15.2.3 detection of short circuit to Ubatt (SC2VB) DIAHG = High | I_{DIAHD_SCB} | -100 | | 10000 | μA | B |
| 8.15.2.4 Detection of open load (OL) when DIAHG = Low | I_{DIAHD_OL} | -100 | | 100 | μA | B |
| 8.15.2.5 No failure | | | | | | |
| 8.15.2.5.1 DIAHG = high | I_{DIAHD_IOH} | -1000 | | -350 | μA | B |
| 8.15.2.5.2 DIAHG = low | I_{DIAHD_IOL} | 350 | | 10000 | μA | B |
| 8.15.2.6 Filtering time t_{diag} Failure during t_{diag} will be stored in DIAG_REG after t_{diag} . Each failure triggers t_{diag} | t_{diag}/T_{meas} | 30/32 | | 32/32 | | A |
| 8.15.2.7 voltage | | | | | | |
| 8.15.2.7.1 $I_{DIAHD} = +10mA$ | V_{DIAHD} | VCC+0.5 | | VCC+4 | V | A |
| 8.15.2.7.2 $I_{DIAHD} = -1mA$ | V_{DIAHD} | VCC-1.9 | | | V | * |

9. Disclaimer

Intended use: Provided that the product is used within the conditions (environment, application, installation, loads) as described in this Technical Customer Documentation (TCD) and the corresponding agreed upon documents, Bosch ensures that the product complies with the agreed properties.

Agreements beyond this require the written approval by Bosch. The product is considered fit for the intended use when the product successfully has passed the tests in accordance with the TCD and agreed upon documents.

This product is not designed, intended, or authorized for use in systems intended to support or sustain life, or for any other application in which the failure of the product could create a situation where personal injury or death may occur.

Bosch complied with the following regulations specific to the target market when developing the product: Europe, RoHS (Restriction of Hazardous Substances). Materials used are documented and provided on customer request by IMDS (International material data sheet). The component is RoHS compatible for Pb-free soldering according to IPC/JEDEC J-STD-020

If other or additional regulations are required for marketing the product or marketing is effected outside the named target markets, the customer requests compliance with the specific regulations of the target market from Bosch, or ensures these by itself. It is the responsibility of the customer to ensure the proper application of the product in the overall system/vehicle. Bosch does not assume any responsibility for changes to the environment of the product that deviate from the TCD and the agreed upon documents.

ISO 26262: Bosch points out that the system/product does not implement any ASIL -classified requirements (in the sense of ISO 26262). Therefore, it has not been approved by Bosch for applications in which Bosch delivered system/product has an ASIL related (above QM) role.

Field returns: Products are considered good if they fulfill the specifications/test data for 0 -mileage and field listed in the TCD.

Service and repair: Repair of the product is not possible.

Transport, storage, assembly, start and end of operation: Please pay special attention to the safety and warning notes.

Amendments: Unless otherwise expressly agreed in writing Bosch reserves the right, at any time, to change the technical customer documentation.

10. Additional Customer Information

For additional informations please contact AE Sales:

Robert Bosch GmbH
Sales Semiconductors
Postbox 13 42
72703 Reutlingen
Germany

E-mail: bosch.semiconductors@de.bosch.com
Internet: www.bosch-semiconductors.de

11. Appendix

Ordering

Discontinued - PLCC28

- Package code: 30493

Internal use only 1277.379.012 - LQFP32

- Package code: 40298

1267.379.413 - LQFP32

- Package codes: 40103, 40105

1267.379.414 - SOIC24

- Package codes: 40104, 40106



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Technical Customer Documentation
CJ125



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AE/PAI-PRM
PO box 1342
72702 Reutlingen
Germany

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