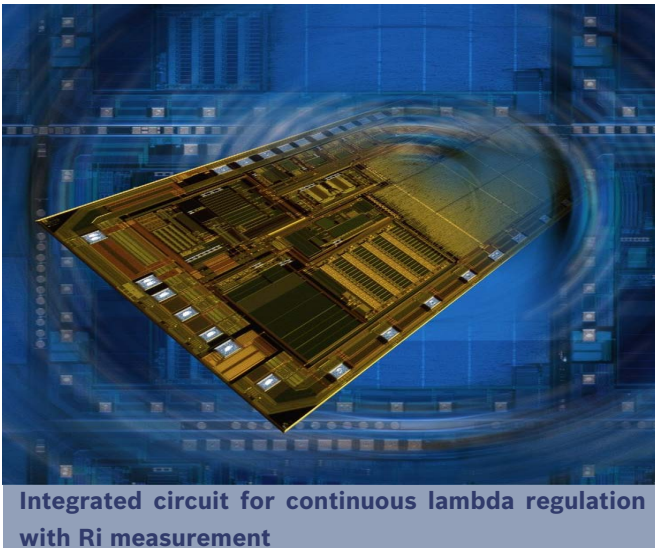


## Product Information Lambda Probe Interface IC - CJ125



**BOSCH**

Invented for life



Integrated circuit for continuous lambda regulation with Ri measurement

The integrated circuit CJ125 is a control and amplifier circuit for a wide range  $\lambda$ -Sensor LSU4.x for the continuous regulation of  $\lambda$  in combination with the sensor in the range of  $\lambda = 0.65... \cdot$  (air).

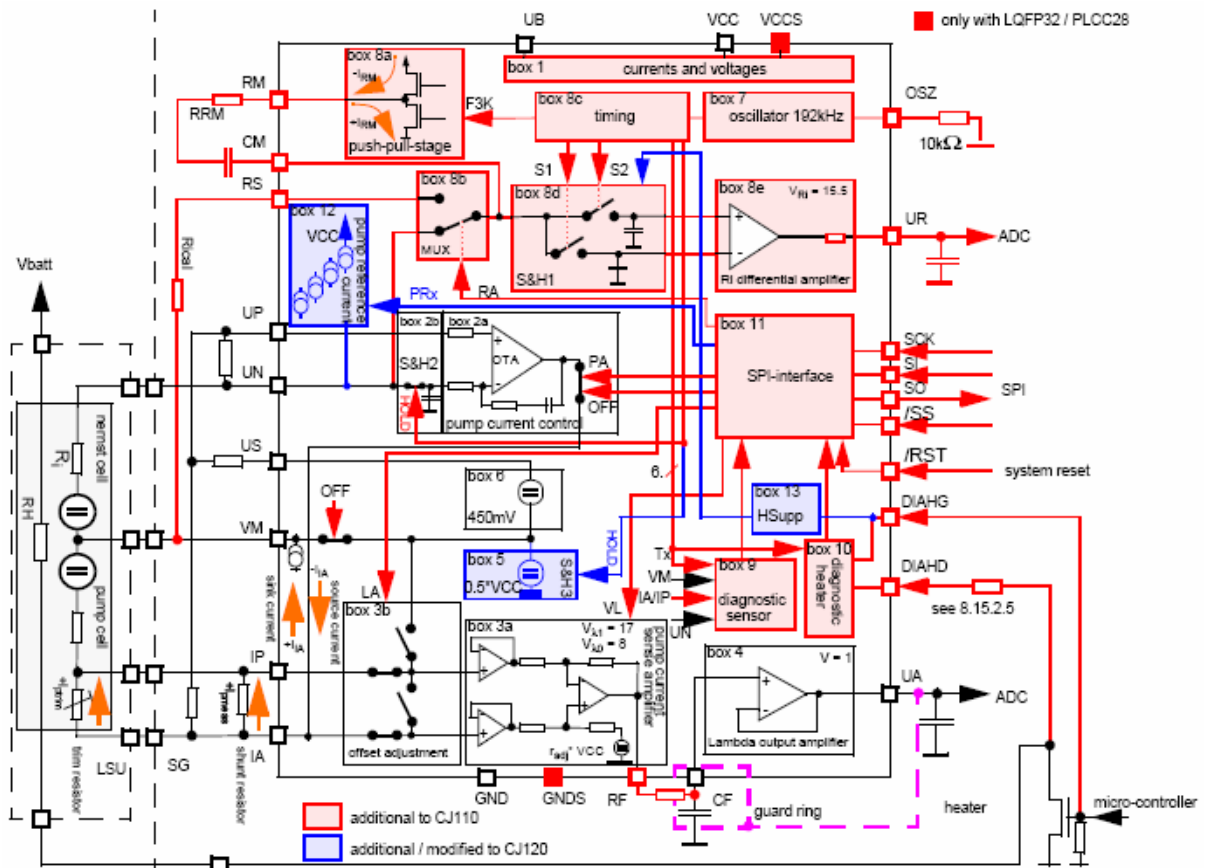
### Customer benefits:

- ▶ Excellent system know-how
- ▶ Smart concepts for system safety
- ▶ Secured supply
- ▶ Long- term availability of manufacturing processes and products
- ▶ QS9000 and ISO/TS16949 certified

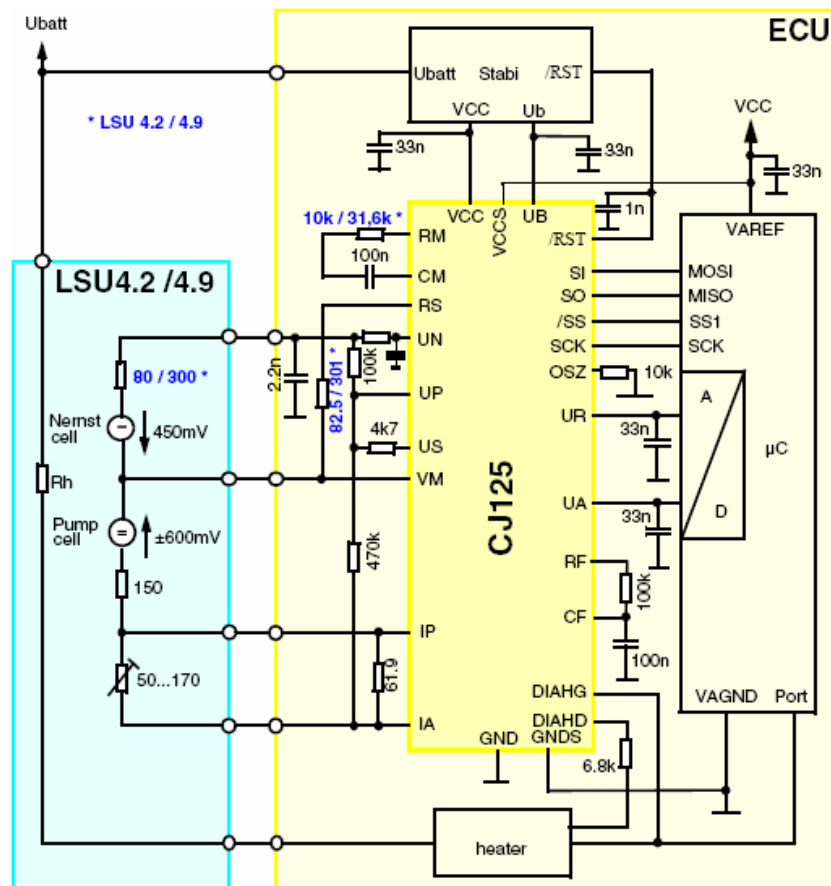
### Features

- ▶ Currents and Voltages (box 1)
- ▶ Pump current control (boxes 2a to 2b)
- ▶ Pump current sense amplifier (boxes 3a to 3b)
- ▶ Lambda output amplifier (box 4)
- ▶ Virtual ground voltage source for sensor and pump current control (box 5)
- ▶ Nernst cell reference voltage source (box 6)
- ▶ Oscillator (box 7)
- ▶ Circuit for Ri or Rical measurement (boxes 8a to 8d)
- ▶ Diagnostic of sensor lines (box 9)
- ▶ Diagnostic of external heater (box 10)
- ▶ Serial-Peripheral-Interface (SPI; box 11)
- ▶ Programmable reference pumping currents (box 12)
- ▶ Suppression of Ri-measurement (box 13)

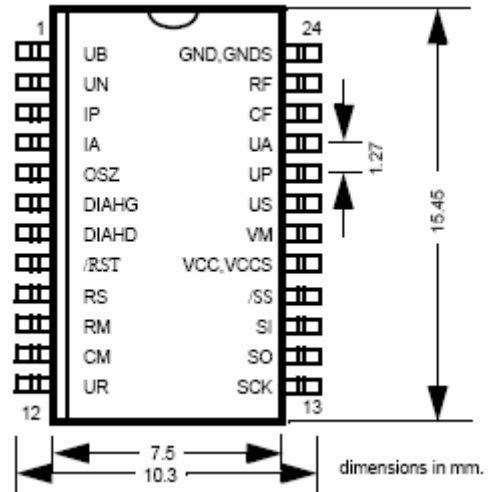
## Block-/ functional diagram



## Application circuit (only proposal!)



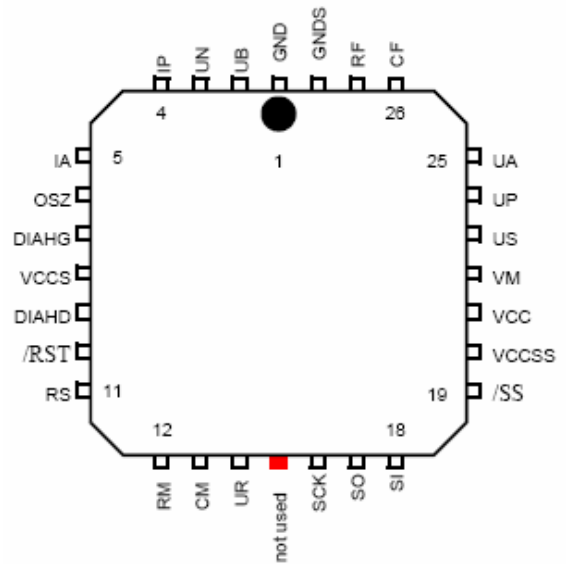
SOIC24



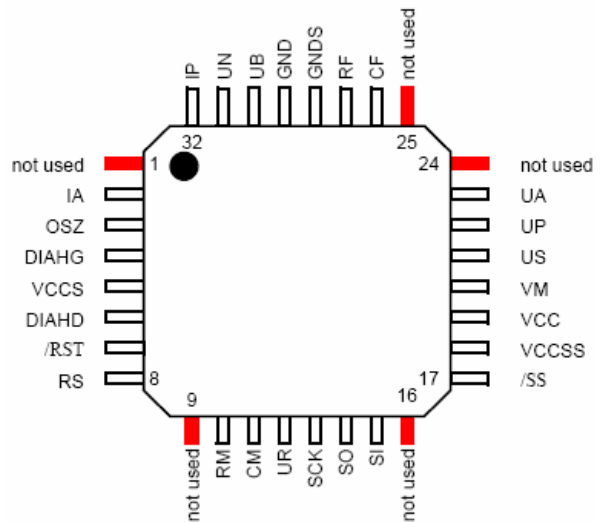
The application circuit of the CJ125 consists of the following parts:

- ▶ Capacitor between [VCC] and [GND] to stabilize the supply voltage VCC
- ▶ Capacitor between [UB] and [GND] to stabilize the supply voltage VUB
- ▶ Capacitor between [CF] and [GND] to filter the lambda signal
- ▶ Capacitor between [UA] and [GND] to stabilize lambda signal output
- ▶ Capacitor between [UN] and [GND] to stabilize nernst signal
- ▶ Capacitor between [/RST] and [GND] to stabilize reset signal
- ▶ Shunt between [IA] and [IP] for pump current sensing
- ▶ Resistor between [IA] and [UP] to compensate parasitic effects of the lambda sensor
- ▶ Resistor between [US] and [UP] to feed the nernst cell reference voltage into the pump current control circuit
- ▶ Resistor between [UP] and [UN] for leakage detection
- ▶ Resistor between [RF] and [CF] to filter the lambda signal
- ▶ Capacitor between [UR] and [GND] to stabilize the output signal for ADC
- ▶ Capacitor between [UN] and [GND] for filtering
- ▶ Resistor between [RM] and capacitor at [CM] for adjustment of Ri measurement current
- ▶ Capacitor between [CM] and resistance at [RM] for DC filtering
- ▶ Resistor between [RS] and [VM] for adjustment
- ▶ Resistor between [DIAHD] and Drain of the external heater
- ▶ Resistor and capacitor before [UN] for filtering

PLCC28



LQFP32



## Pin description

Pin	Description
UB	Power supply input (14V)
VCC, VCCS <sup>a)</sup>	Power supply input (5V)
GND, GNDS <sup>b)</sup>	Ground
VM	Virtual ground of pump current control and of the LSU (0.5VCC)
US	Nernst 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 filter)
CF	Input of lambda output amplifier (after external filter)
UA	Output of lambda output amplifier
UP	Non inverting input of pump current control
UN	Inverting input of pump current control respective in-/output for Ri-measurement (LSU)

Pin	Description
RM	Output Ri-measurement current (DC)
CM	Input Ri-measurement current (AC, DC free)
RS	In-/output Ri-calibration measurement
UR	Output Ri-signal (analogous)
DIAHG	Diagnosis input (gate of external transistor)
DIAHD	Diagnosis input (drain of external transistor)
SCK	Input SPI-clock (from $\mu$ C)
SI	Input serial data (SPI, from $\mu$ C)
SO	Output serial data (SPI, to $\mu$ C)
/SS	Slave select (SPI, from $\mu$ C)
/RST	Input Reset
OSZ	$R_{\text{extern}} = 10\text{k}\Omega$

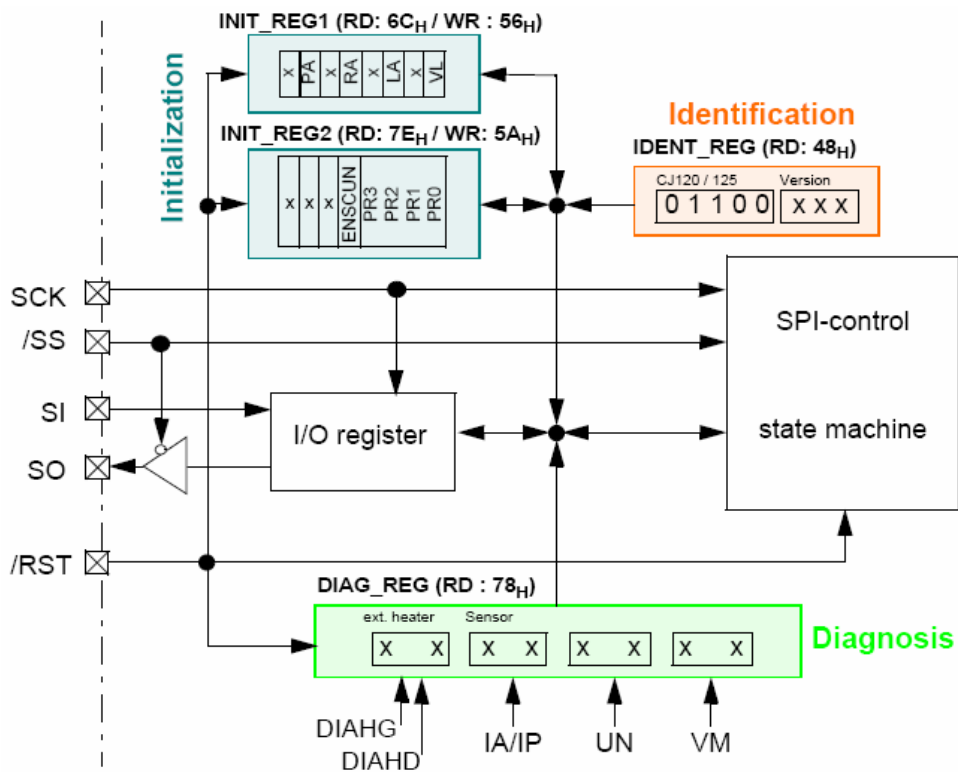
- a.) For hybrid version it is recommended to connect VCCS with the reference VCC for the ADC
- b.) For hybrid version it is recommended to connect GNDS with the reference ground for the ADC

## Maximum Ratings

Parameter	Condition	Symbol	Min.	Max.	Unit
Supply voltage UB		$V_{UB}$	-0.3	35	V
Supply voltage VCC		$V_{VCC}$	-0.3	5.5	V
Temperature	junction	$T_J$	-40	150	$^{\circ}\text{C}$
	storage	$T_{ST}$	-40	150	$^{\circ}\text{C}$
	ambient for SOIC/PLCC	$T_A$	-40	110	$^{\circ}\text{C}$
	for max 50h		-40	125	$^{\circ}\text{C}$
	ambient for LQFP			125	$^{\circ}\text{C}$
	for max 50h			140	$^{\circ}\text{C}$
Maximum allowed voltages valid for pins: RM, UP, US, RF, CF, UA, UR, DIAHG, DIAHD; SCK, SI, SO, /SS, /RST, OSZ		$V_x$	-0.3	$V_{VCC} + 0.3$	V
Allowed current	ext. resistor 6.8 k $\Omega$	$I_{DIAHD}$	-1	10	mA
Maximum allowed voltages, no destruction when ISO-pulses 3a,b are applied. Valid for board pins: RS, UN, VM, IA, IP, CM		$V_x$	-0.3	28	V
Offset between GND and GNDS		$\Delta V_{GND}$	-0.25	0.25	V
Offset between VCC and VCCS		$\Delta V_{VCC}$	-0.25	0.25	V
ESD	Human Body Model R=1.5k $\Omega$ , C=100pF		-2	2	kV

## Electrical Characteristics

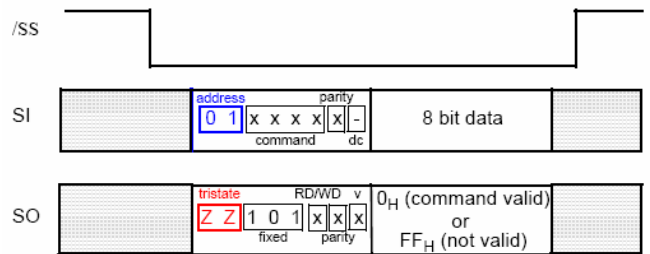
Parameter	Condition	Symbol	Min.	Max.	Unit
<b>Power Supply</b>					
Power supply	$V_{GND} = V_{GNDs}$	$V_{UB}$	9	18	V
Operating range	$V_{VCC} = V_{VCCs}$	$V_{VCC}$	4.75	5.25	V
Current consumption		$I_{VCC}$		76	mA
Current consumption		$I_{VCCS}$		4	mA
<b>Pump current control</b>					
Offset voltage		$V_{off}$	-10	10	mV
Input current	$-40^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$	$I_{UP, UN}$	-1	1	$\mu\text{A}$
Input offset current	$-40^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$	$I_{off}$	-1	1	$\mu\text{A}$
Output current source condition	$V_{UN} < V_{UP}; PA = 1;$ $0.5\text{V} < V_{IA} < V_{CC}-0.5\text{V}$	$-I_A$	10	30	mA
Output current sink condition	$V_{UN} > V_{UP}; PA = 1;$ $0.6\text{V} < V_{IA} < V_{CC}-0.5\text{V}$	$I_A$	10	30	mA
No output current	$PA = 0$	$I_A$	-10	10	$\mu\text{A}$
<b>Pump current sense amplifier (LA = 0: measurement mode; LA = 1: adjustment mode)</b>					
Input current	$-40^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$	$I_{IP}$	-1	1	$\mu\text{A}$
Amplification	SPI-bit VL = 1	$A_0$	16.62	17.24	
Amplification	SPI-bit VL = 0	$A_0$	7,82	8.15	
Common mode rejection ratio	$CMRR^{-1} = \Delta V_{UA} / \Delta V_{IP}$ $V_{IP} = V_{IA} = 1 \dots 4\text{V}$ $0.5\text{V} < V_{UA} < V_{CC} - 0.5\text{V}$ $ I_{UA}  < 10\mu\text{A}$	$CMRR^{-1}$		12	mV/V
Output voltage swing	$ I_{UA}  < 10\mu\text{A}; LA = 0$	$V_{UA}$	0.20	$V_{VCC} - 0.18$	V
Output voltage adjustment	$I_{RF} = 0\mu\text{A}; LA = 1$	$V_{FR} / V_{VCC}$	0.285	0.315	
Output error offset adjust	$\Delta V_{UA} = V_{UA}(LA = 1) - V_{UA}(LA = 0)$ $V_{IP} = V_{IA} = V_{VM}$ $ I_{UA}  < 10\mu\text{A}$	$\bullet V_{UA}$	-3	3	mV
<b>Virtual ground voltage source</b>					
Output current operating range		$I_{VM}$	$-I_A - 2$	$-I_A + 2$	mA
Output voltage ratio	$-I_A - 1\text{mA} < I_{VM} < -I_A + 1\text{mA}$	$V_{VM} / V_{VCC}$	0.48	0.52	
<b>Nernst cell reference voltage source</b>					
Output current operating range		$I_{US}$	-0.4	0.4	mA
<b>Oscillator</b>					
Frequency	external 10k $\Omega$	f	2.49	3.51	kHz
<b>Measurement current for Ri (RA = 0 measurement mode; RA = 1 adjustment mode)</b>					
Output resistor of push-pull-stage	$-1\text{mA} \cdot I_{RM} \cdot 1\text{mA}$	R	5	200	$\Omega$
<b>Ri amplifier</b>					
Leakage current when switch is open		$I_{LEAK}$	-500	500	nA
Amplification		$A_0$	15	16.3	
Ron for a switch		$R_{on}$		200	$\Omega$
Input voltage range at CM, UN and RS		$V_{RI}$	2	$V_{VCC} - 1.1$	V
Output voltage range		$V_{UR}$	$0.06 V_{VCC}$	$V_{VCC} - 0.2$	V
Zero point for output trace		$V_{UR} / V_{VCC}$	0.05	0.063	
<b>Pump reference current</b>					
Current range	programmable with SPI-bits PRx; x = 0 to 3	$-I_{Un}$	0	150	$\mu\text{A}$
<b>Diagnosis of sensor lines</b>					
Short circuit to ground		$V_{VM} / V_{VCC}$	0.35	0.45	
Short circuit to Vbat		$V_{VM} / V_{VCC}$	0.55	0.65	
Short circuit to ground		$V_{UN} / V_{VCC}$	0.30	0.40	
Short circuit to Vbat		$V_{UN} / V_{VCC}$	0.72	0.88	
Short circuit to ground		$V_{IA,IP}$	0.3	1.5	V
Short circuit to Vbat		$V_{IA}$	$V_{VCC}$	$V_{VCC} + 2$	V
<b>Diagnosis of external heater</b>					
Low level		$V_{DIAHG}$	-0.3	$0.3 V_{VCC}$	V
High level		$V_{DIAHG}$	$0.7 V_{VCC}$	$V_{VCC} + 0.3$	V
Input current (no pull up!)		$-I_{DIAHG}$	-1	1	$\mu\text{A}$
Short circuit to ground	DIAHG = low	$I_{DIAHD}$	-1000	-350	$\mu\text{A}$
Short circuit to Vbat	DIAHG = high	$I_{DIAHD}$	-100	10 000	$\mu\text{A}$
Open load	DIAHG = low	$I_{DIAHD}$	-100	100	$\mu\text{A}$
No failure	DIAHG = high	$I_{DIAHD}$	-1000	-350	$\mu\text{A}$
No failure	DIAHG = low	$I_{DIAHD}$	350	10 000	$\mu\text{A}$
Filter time	$T = 1 / f$	$t_{DIAG} / T$	30 / 32	32 / 32	
<b>SPI</b>					
Data rate				2	Mbaud
Bit-frame				16	bit
Number of read / write commands				6	
Number of register				4	



Failure bits <sup>a)</sup>	Ext. heater	Sensor <sup>b)</sup>
0 0	Short circuit to ground	Short circuit to ground
0 1	Open load	Low battery <sup>c)</sup>
1 0	Short circuit to Vbat	Short circuit to Vbat
1 1 <sup>d)</sup>	No failure	No failure

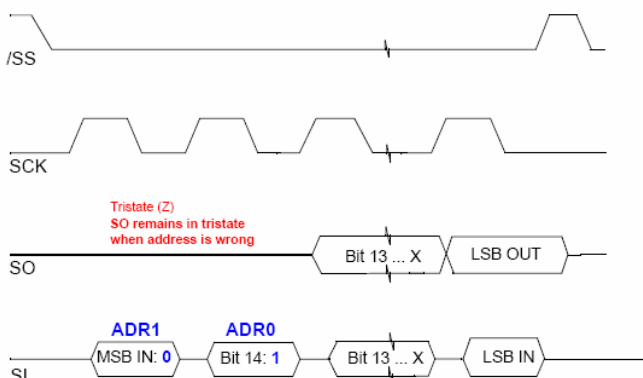
- a) Only each failure of the sensor leads to a switch off of pump current and virtual ground
- b) Failure identification at UN must be enabled with ENSCUN
- c) Open load is not recognizable; bits used for low battery
- d) After RD\_DIAG or if no failure is present; Failure bits will be restored if failure is still present

SPI - Write Access

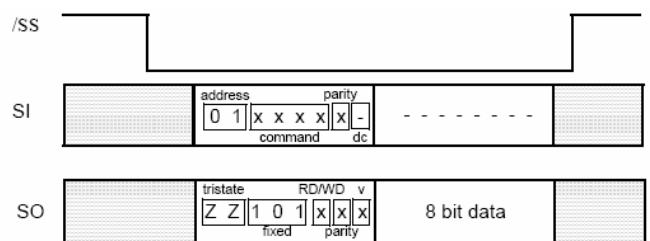


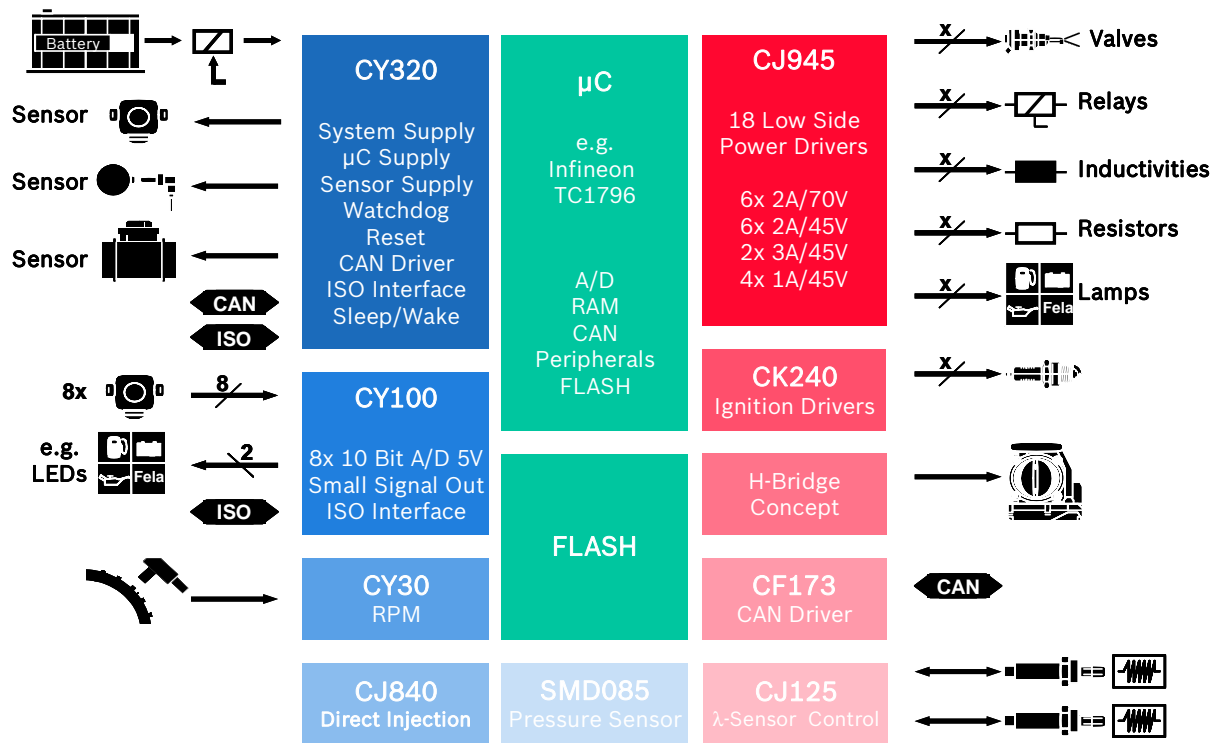
v: command valid/not valid; dc: don't care („-“)  
 x: 0 or 1; Z: tristate

SPI - Timing



SPI - Read Access





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