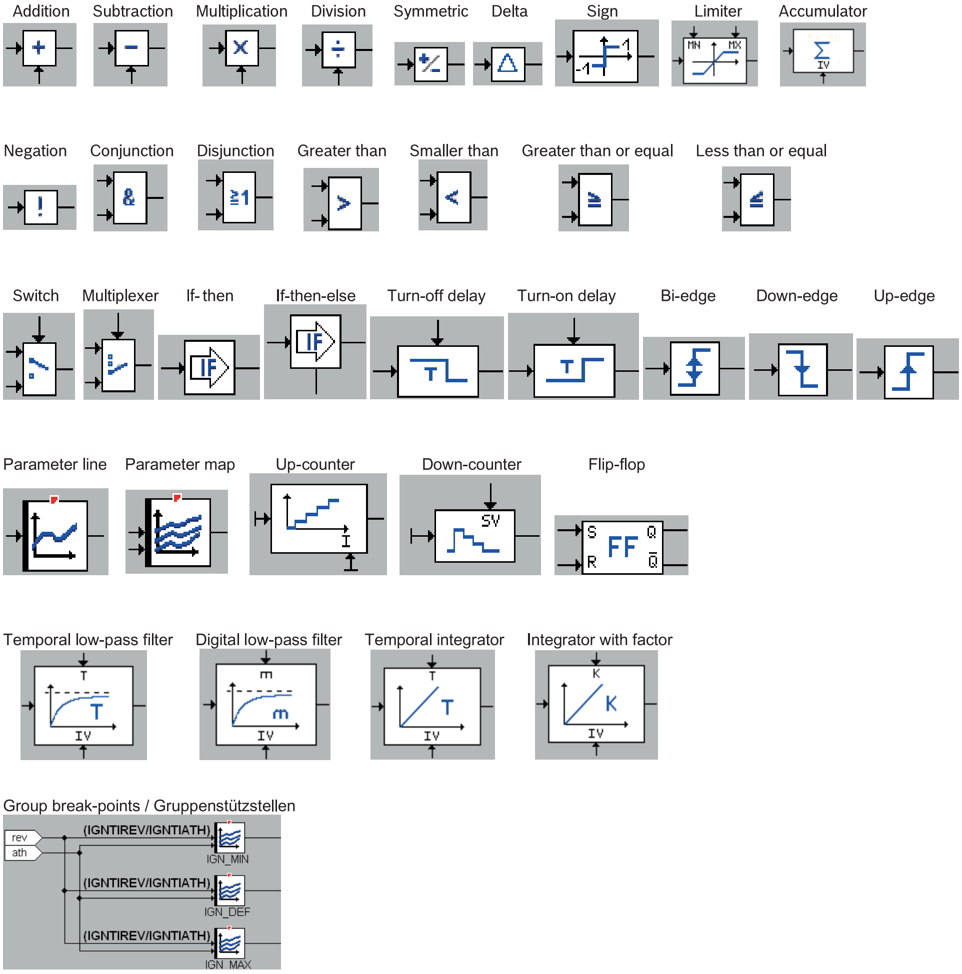
Lambdatronic LT4

Functionsheet

Version 2.0 03/11/2022

Inhaltsverzeichnis

1 Icons Description

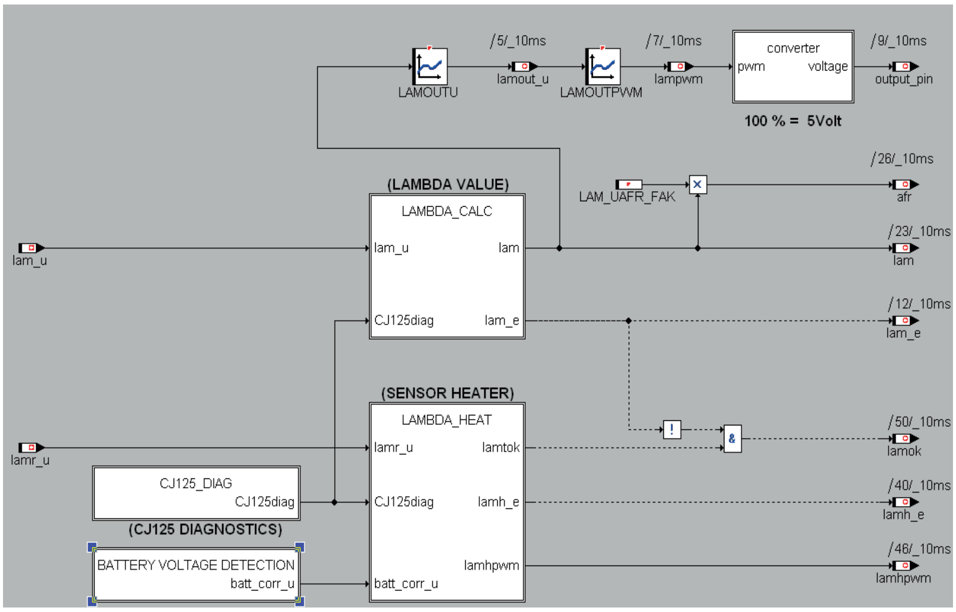


2 Pin Layout Life-Plug (AS 614 – 35 PN)

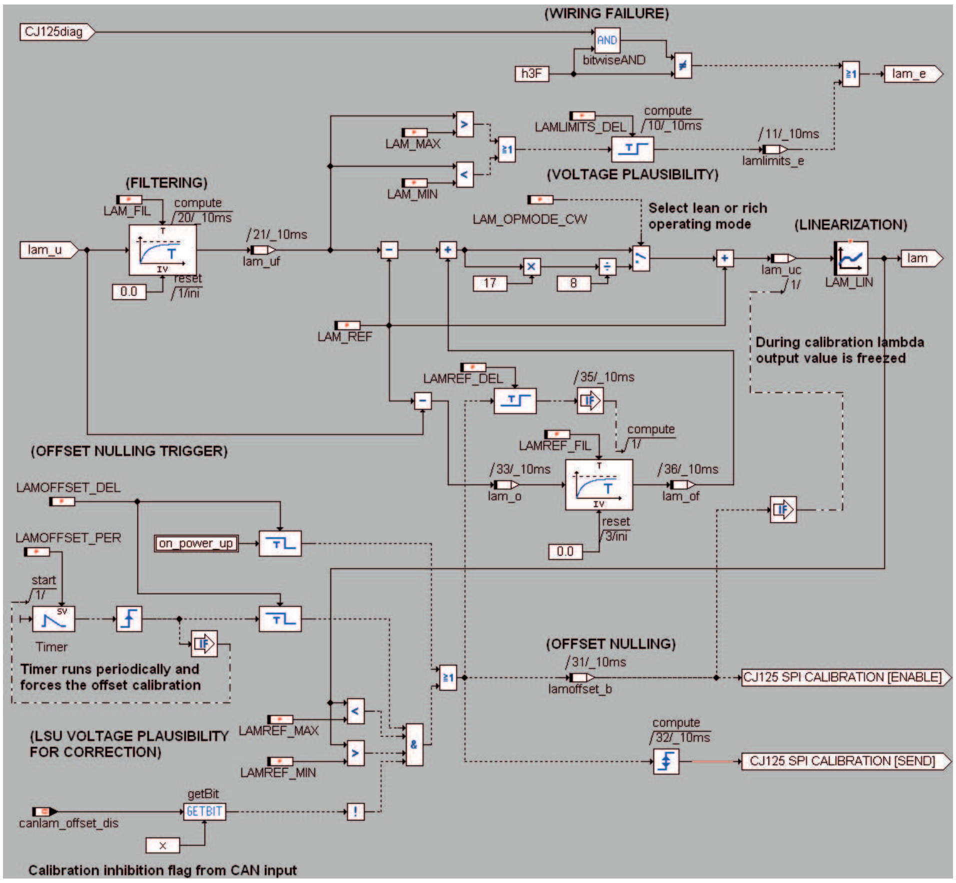
Pin	Function
1	+12 V (Battery +)
2	+12 V (Battery +)
3	Ground (Battery -)
4	Ground (Battery -)
5	K-Line Diagnostic Connection
6	CAN1 + (high)
7	CAN1 – (low)
8	Analog out 1
9	Analog out 2
10	Analog out 3
11	Analog out 4
12	Reference GND for anal. out
13	Shield
14	Pump Current LSU1 IP1
15	Virtual GND LSU1 VM1
16	Heater PWM LSU1 Uh-1
17	Heater (Batt +) LSU1 Uh+1
18	Setup Current LSU1 IA1
19	Nernst Voltage LSU1 UN1
20	Pump Current LSU2 IP2
21	Virtual GND LSU2 VM2
22	Heater PWM LSU2 Uh-2
23	Heater (Batt +) LSU2 Uh+2
24	Setup Current LSU2 IA2
25	Nernst Voltage LSU2 UN2
26	Pump Current LSU3 IP3
27	Virtual GND LSU3 VM3
28	Heater PWM LSU3 Uh-3
29	Heater (Batt +) LSU3 Uh+3
30	Setup Current LSU3 IA3
31	Nernst Voltage LSU3 UN3
32	Pump Current LSU4 IP4
33	Virtual GND LSU4 VM4
34	Heater PWM LSU4 Uh-4
35	Heater (Batt +) LSU4 Uh+4
36	Setup Current LSU4 IA4
37	Nernst Voltage LSU4 UN4

3 Function Diagrams of Lambda Value Detection

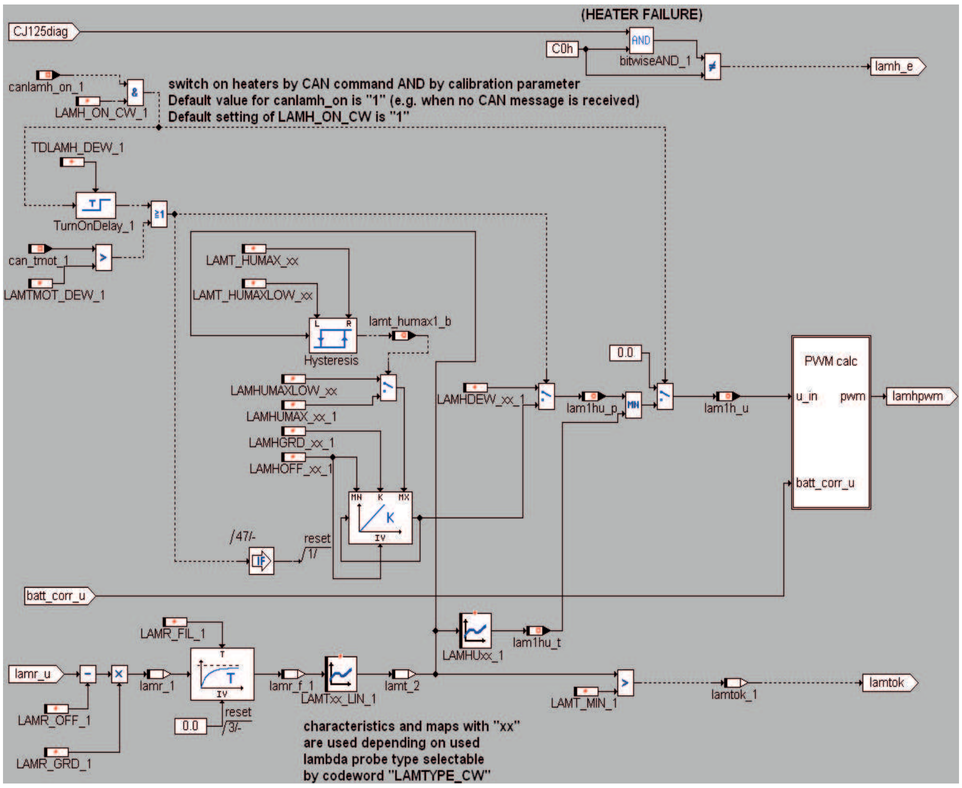
3.1 Lambda Main



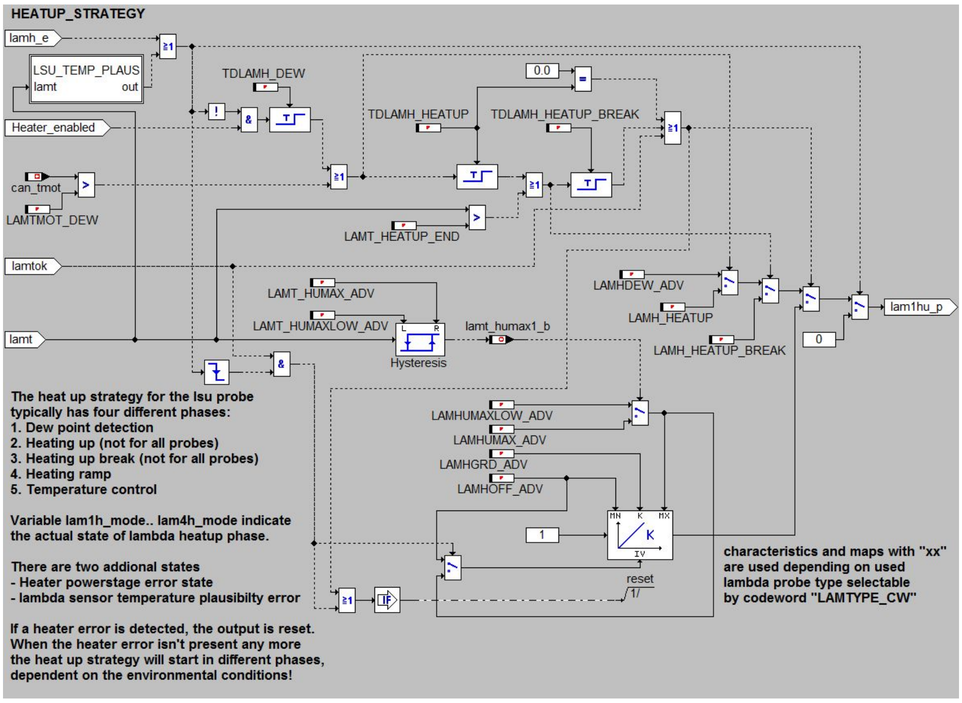
3.2 Lambda Calc

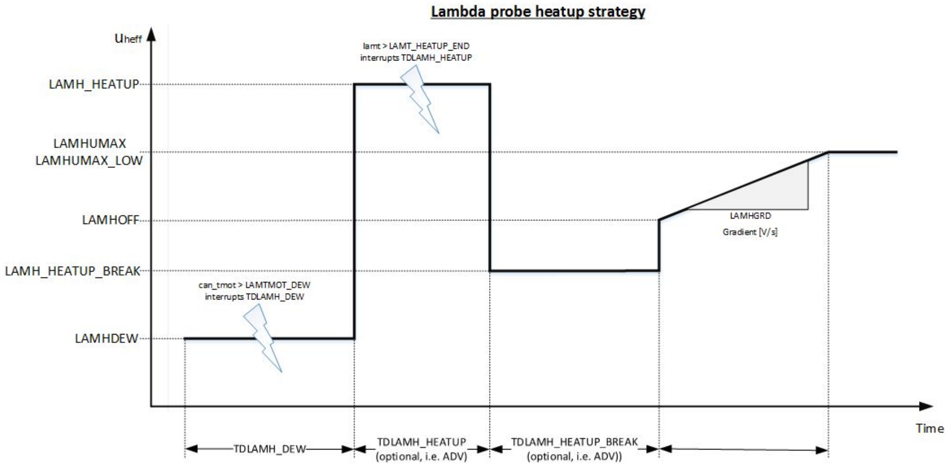


3.3 Lambda Heat

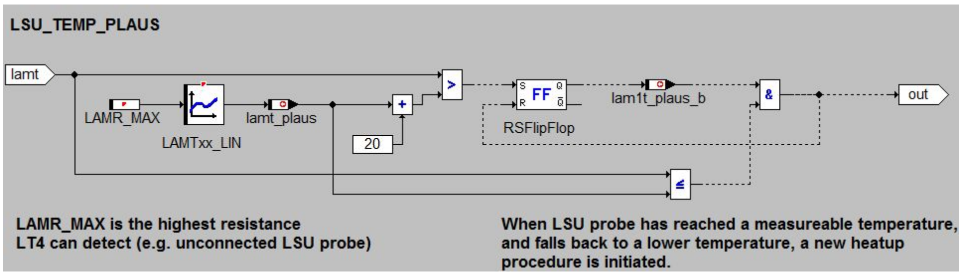


3.4 Heatup Strategy

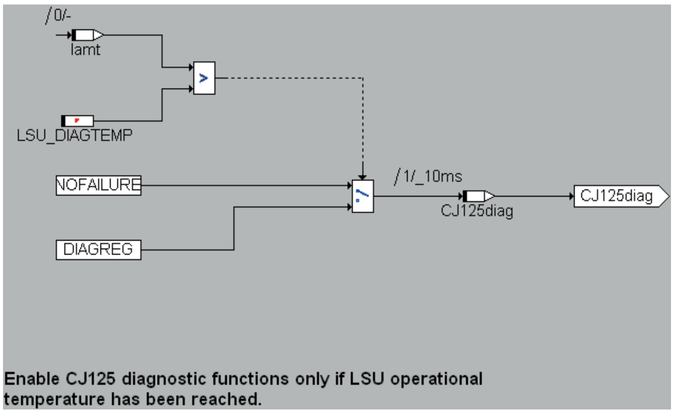




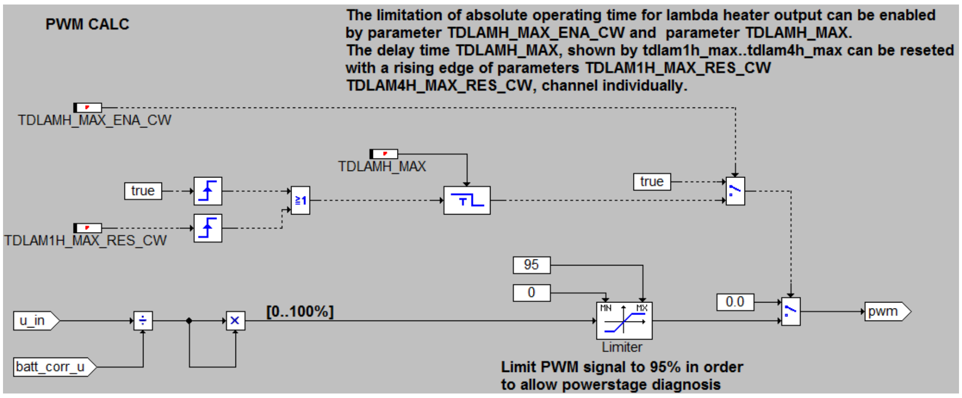
3.5 LSU_TEMP_PLAUS



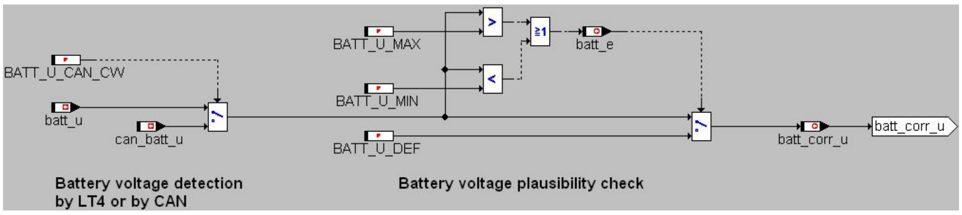
3.6 Lambda Diagnosis



3.7 PWM Calc



3.8 Battery Voltage Detection



3.9 Lables

afry	Air fuel ratio
B_can1OK	State of CAN1 chip
B_can2OK	State of CAN2 chip
batt_e	Error battery voltage detection
batt_u	Battery voltage
batt_corr_u	Correction battery voltage
can_batt_u	Battery voltage via CAN
can_tmot	Engine temperature via CAN
canlam_offset_dis	Inhibition flag for offset calibration (CAN Input)
canlamh_on	Lambda heaters switched on via CAN
CJ125diagy	Lambda-chip CJ125 internal error code
lamy	Lambda value
lamy_e	Lambda value error
lamy_o	Lambda value calibration offset
lamy_of	Lambda value calibration offset filtered
lamy_u	Lambda sensor voltage
lamy_uc	Lambda sensor calibrated voltage
lamy_uf	Lambda sensor filtered voltage
lamyh_e	Lambda heater error
lamyh_mode	Heater mode lambda probe
lamyh_u	Heater voltage lambda probe
lamyhpwm	Lambda heater PWM
lamyhu_p	Heater voltage lambda probe provisory
lamyhu_t	Heater voltage lambda probe from characteristic line
lamylimits_e	Lambda value beyond limits
lamyoffset_b	Lambda calibration active
lamyok	Lambda sensor operational
lamyout_u	Lambda output voltage
lamypwm	Lambda PWM output value
lamyr	Lambda sensor internal impedance
lamyr_f	Lambda sensor internal impedance filtered
lamyr_u	Lambda sensor internal impedance voltage
lamyt	Lambda sensor temperature

lamt_plaus	Plausible Lambda sensor temperature
lamyt_plaus_b	Measurable Lambda sensor temperature reached
lamt_humaxy_b	Condititition enabling maximum heating power lambda probe
lamytok	Lambda sensor operation temperature reached
tdlamyh	Timer heatup phases for lambda probe 8
tdlamyh_max	Timer for heatup restriction time for lambda probe

BATT_U_CAN_CW	Battery voltage detection selection switch
BATT_U_DEF	Power supply voltage of LT4
BATT_U_MAX	Upper battery voltage threshold for plausibility check
BATT_U_MIN	Lower battery voltage threshold for plausibility check
CANENABLE_CW	CAN enable
CANID	Lambda CAN messages IDs (reconfigurable)
CANRATE	CAN send frequency
CANSPEED_CW	CAN baud rate *(0->500 kBaud 1->1,000 kBaud)*
LAM_FIL	Lambda filter time-constant
LAM_LIN	Lambda value linearization curve
LAM_MAX	Lambda value maximum limit
LAM_MIN	Lambda value minimum limit
LAM_OPMODE_CW	Operating mode of Lamdatronic module channel x (lean/rich)
LAM_REF	Lambda calibration reference voltage
LAM_UAFR_FAK	Factor air fuel ration
LAMH_HEATUP	Heater voltage for heatup phase
LAMH_ON_CW	Activating lambda heater by codeword
LAMHDEW_xx	Lambda heater voltage for dewpoint phase
LAMHGRD_xx	Lambda heater gradient
LAMHOFF_xx	Lambda heater offset voltage
LAMHUxx	Lambda heater voltage predefined value
LAMHUMAX_xx	Lambda heater voltage maximum value
LAMHUMAXLOW_xx	Maximum heater voltage lower temperature range
LAMLIMITS_DEL	Lambda value delay for limits passing
LAMOFFSET_DEL	Lambda calibration duration
LAMOUTPWM	Linearization curve from pwm -> voltage conversion
LAMOUTU	Desired voltage output lambda -> voltage
LAMR_FIL	Lambda internal impedance filter time-constant
LAMR_GRD	Lambda internal impedance gradient
LAMR_OFF	Lambda internal impedance offset
LAMR_MAX	Maximum detectable resistance by LT4
LAMREF_DEL	Lambda calibration delay
LAMREF_FIL	Lambda calibration offset filter time-constant
LAMREF_MAX	Lambda value upper calibration limit
LAMREF_MIN	Lambda value lower calibration limit

LAMT_MIN	Lambda sensor minimum operation temperature
LAMTxx_LIN	Lambda sensor temperature linearization curve
LAMT_HEATUP_END	Temperature threshold for end of heatup phase
LAMH_HEATUP_BREAK	Heater voltage for heatup break phase
LAMT_HUMAXLOW_xx	Lower temperature threshold disabling high heating power
LAMT_HUMAX_xx	Upper temperature threshold for enabling high heating power
LAMTDIAG_MIN	Lambda sensor minimum temperature for diagnosis
LAMTMOT_DEW	Engine temperature threshold for dewpoint detection
LAMTYPE_CW	Lambda type (0->LSU 4.2 / 1->LSU 4.9 / 2-> Mini-LSU)
TDLAMH_DEW	Heating time for dewpoint phase
TDLAMH_HEATUP	Time for heatup phase
TDLAMH_HEATUP_BREAK	Time for heatup break phase
TDLAMH_MAX	Maximum time for Lambda probe heating
TDLAMH_MAX_ENA_CW	Enable restriction of time for heatup break phase
TDLAMyH_MAX_RES_CW	Reset variable for timer heatup restriction time for Lambda probe y

Hints:

- Variable names in table above containing a "y" are channel individual. Available are channels 1 to 4.
- Parameter names in table above containing an "xx" are Lambda probe dependent. Available are probes "42", "49" and "49m".

3.10 Description

Description

The LT4 Lambdatronic unit is lambda-control device created for use with the Bosch lambda sensor LSU 4.2 / LSU 4.9 / Mini LSU 4.9. The unit consists of four CJ125 evaluation IC's (thereby allowing the use of up to 4 lambda sensors with a single LT4) and a microcontroller. The CJ125 outputs a voltage proportional to the pump current generated by the lambda sensor. This voltage "lam_u" is a measure for the lambda value and is updated every 10 ms. By relating "lam_u" to the linearization table "LAM_LIN", the actual lambda value "lam" is calculated and sent to the output.

An accurate reading of the exhaust lambda is only possible once the sensor has been heated to an appropriate temperature ("lamt"). While the sensor is cold, a lambda value of 1 ("lam" = 1) will be indicated. Once the sensor has been heated to an appropriate temperature, the flag "lamok" will be indicated. For this to happen, the lambda sensor heater must be operational. Lambda value accuracy can also be improved by selecting a lean or rich operating mode for the codeword "LAM_OPMODE_CW" depending on the application.

If any errors are detected by the CJ125's internal diagnosis mechanisms, an error flag "lam_e" will be indicated. These error conditions include short-circuits, under-voltages and implausible voltages for "lam_u" (note that this is only possible once the sensor temperature "lamt" has exceeded the setpoint "LAMTDIAG_MIN"). A properly-functioning sensor and CJ125 combination should result in an output voltage for "lam_u" between 0.2 and 4.0 volts. It is possible that voltages above or below this range can result from extreme exhaust mixtures (extreme enrichment or extremely lean conditions), in which case a delay "LAMLIMITS_DEL" is used for diagnosis detection.

The lambda sensor heater is switched on and off by the variables "LAMH_ON_CW" and "canlamh_on". "LAMH_ON_CW" is the primary codeword for enabling the heaters. If switched to "Heaters off", the sensor heaters are disabled. If switched to "Heaters CAN controlled", the sensor heaters will be controlled via CAN. Please note that if CAN is not being used for lambda sensor heater control, then selecting "Heaters CAN controlled" for "LAMH_ON_CW" will result in the sensor heaters being switched on by default. The variable "canlamh_on" is an indicator of the requested sensor heater operation mode over CAN. This is only an "on-off" flag.

Upon power initially being supplied to the LT4 and the lambda sensors, the sensor heaters enter a dew point heating mode. A small effective voltage "LAMHDEW_xx" is supplied in order to evaporate moisture that may have gathered around the sensing element. This prevents sensor damage once full heater power is used to bring a sensor up to its operating temperature. The duration of this heating mode can be set using the variable "TDLAMH_DEW". By default, dew point heating mode will always be activated upon power-up. However, if engine temperature is supplied over CAN to the LT4 (indicated by the variable "can_tmot"), this can be compared to the setpoint variable "LAMTMOT_DEW" to determine whether dew point heating is required. If the engine temperature exceeds the setpoint "LAMTMOT_DEW", then dew point heating is skipped.

Once the dew point mode is complete (or if the dew point mode is skipped), the main heating mode begins. The sensor heater effective voltage is ramped up from a setpoint "LAMHOFF_xx" according to a gradient "LAMHGRD_xx" until a maximum voltage "LAMHUMAX_xx" is reached. This effective voltage is maintained until the sensor is brought up to its operating temperature, at which point the heater proceeds to a controlled heating mode. The controlled heating mode varies the sensor heater effective voltage according to the sensor temperature using the table "LAMHUxx" with the intent of maintaining the sensor's optimum operating temperature (750°C LSU 4.2 / 780°C LSU 4.9 and Mini LSU 4.9). If the sensor temperature drops below the setpoint "LAMT_HUMAXLOW_xx", the sensor heater will enter a safety mode where the main heating mode will be restarted. In this case, the maximum voltage during the heater ramp is restricted according to the variable "LAMHUMAXLOW_xx". This is done to keep heat in the sensor without damaging the sensing element.

The amount of current delivered to the lambda sensor heater is relative to the voltage of the power supply in order to protect the sensing element. The variables "BATTU_DEF" and "can_batt_u" represent this voltage information in the LT4. If power supply voltage information is available over CAN, this can be read into "can_batt_u". Note that in order for CAN-supplied voltage to be used, "BATTU_DEF" must be set to 0. If no power supply information is available over CAN, then "BATTU_DEF" should be set to the maximum expected power supply voltage. If "BATTU_DEF" is set to 0 and no CAN information is supplied, the LT4 will default to an assumed voltage of 16 volts to protect the sensing element.

The lambda signal output is realized over both CAN and via an analog voltage output. Further information regarding the CAN specification can be found in the section "CAN messages / CAN Botschaften" below. For the analog output, the table "LAMOUTU" relates the lambda value to an output voltage (defined from 0 to 5 volts). To compensate for hardware tolerances, the linearization table "LAMOUTPWM" can be used.

The LT4 has a new voltage compensation function. The LT4 will detect the voltage supply from either “batt_u” or “can_batt_u“, the selection can be made in the parameter name “BATT_U_CW” in ModasSport. During operation the LT4 monitors the voltage value “BATTU_MIN” and “BATTU_MAX”. If the voltage drops below BATTU_MIN or raises above the BATTU_MAX, the voltage value will then reset into default value call BATTU_DEF. The voltage supply value must retain in between BATTU_MIN and BATTU_MAX. This function is to prevent any damage to the ceramic in the lambda probe due to excessive voltage supply.

NOTICE

If the analog output is desired rather than CAN, then it is necessary to connect the analog ground from the LT4 to the battery ground.

The LT4´s analog ground is not internally connected to the supply ground.

3.11 Typical Values

BATT_U_CAN_CW	= 0	Internal battery voltage detection
BATT_U_MAX	= 18 V	
BATT_U_MIN	= 3 V	
BATT_U_DEF	= 14 V	Value of ”can_batt_u” is used to define power supply
CANENABLE_CW	= 1	CAN interface enabled
CANRATE	= 10 ms	
CANSPEED_CW	= 1,000 kBaud	
LAM_FIL	= 20 ms	
LAM_MAX	= 4.5 V	
LAM_MIN	= 0.2 V	
LAM_OP_MODE	= “lean mode”	
LAM_UAFR_FAK	= 14.7	
LAM_REF	= 1.5 V	
LAMH_ON_CW	= “CAN controlled”	Heater is enabled without CAN communication!
LAMHU_DLIMHI	= +10 V/sec	
LAMHU_DLIMLO	= -10 V/sec	
LAMLIMITS_DEL	= 1 s	
LAMOFFSET_DEL	= 0.15 s	
LAMOFFSET_PER	= 300 s	
LAMR_FIL	= 320 ms	
LAMR_GRD	= 408 Ohm/V	
LAMR_OFF	= 0.3 V	
LAMREF_DEL	= 0.05 s	
LAMREF_FIL	= 0.011 s	
LAMREF_MAX	= 1.02	
LAMREF_MIN	= 0.98	

LAMT_MIN	= 650°C
LAMTDIAG_DEL	= 10 s
LAMTMOT_DEW	= 50°C
TDLAMH_DEW	= 30 s

LAMTYPE_CW	= “LSU 4.9”

lam_uc	LAM_LIN
0.51	0.65
0.71	0.70
0.88	0.75
1.04	0.80
1.18	0.85
1.25	0.88
1.30	0.90
1.41	0.95
1.46	0.98
1.48	0.99
1.50	1.00
1.53	1.03
1.55	1.05
1.57	1.08
1.60	1.10
1.66	1.18
1.72	1.26
1.87	1.50
2.00	1.78
2.07	1.99
2.29	3.03
2.40	4.00

lam	LAMOUTU
0.2	0.2
0.4	0.4
0.6	0.6
0.8	0.8
1	1
1.2	1.2
1.4	1.4
1.6	1.6
1.8	1.8
2	2
2.2	2.2

2.4	2.4
2.6	2.6
2.8	2.8
3	3
3.2	3.2
3.4	3.4
3.6	3.6
3.8	3.8
4	4
4.4	4.4
4.6	4.6

Further application data have to be taken from datasheets of supported LSU types.

4 CAN Messages

4.1 Send Messages

Using the CANID parameter line, the CAN messages can be reconfigured. Note that these IDs must be in decimal form and not the usual hexadecimal one! To change an ID, simply select the index number starting with 1 for ID1, 2 for ID2 and so on, and change the corresponding parameter-line value.

Default IDs

ID	ID1 (send)	ID2 (send)	ID3 (send)	ID4 (send)	ID5 (receive)
CANID	0x770 (1904)	unused	0x772 (1906)	0x773 (1907)	0x774 (1908)

MESSAGE ID 1	
Byte	Value
0	lam1 (low)
1	lam1 (high)
2	lam2 (low)
3	lam2 (high)
4	lam3 (low)
5	lam3 (high)
6	lam4 (low)
7	lam4 (high)

MESSAGE ID 3	
Byte	Value
0	lam1t
1	lam2t
2	lam3t
3	lam4t
4	-
5	-
6	-
7	-

MESSAGE ID 4	
Byte	Value
0	lamx_e
1	lamxheat_e
2	lamxok
3	canlamheat_on
4	lamxoffset_b
5	-
6	-
7	-

Notes 1

Configuration for Message ID 4 ("x" in each variable name designates a number 1 through 4 indicating the applicable lambda sensor.)

Bit	lamx_e	lamxheat_e	lamxok	lamxoffset_b
0	lam1_e	lam1heat1_e	lam1ok	lam1offset_b
1	lam2_e	lam2heat_e	lam2ok	lam2offset_b
2	lam3_e	lam3heat_e	lam3ok	lam3offset_b
3	lam4_e	lam4heat_e	lam4ok	lam4offset_b
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
7	-	-	-	-

Notes 2

- All values are unsigned (positive) values.
- All word-wide values are in Intel (little-endian) byte-order.
- All lambda-values are quantized with 0.000244/bit and zero offset (range = 0 to 16).
- All temperatures are quantized with 5°C/bit and offset -40°C (range = -40 to 1,235°C).
- The CAN refresh rate is 100 Hz (10 ms).

4.2 Receive Messages

This message can be used to switch off the lambda heaters by CAN command.

MESSAGE ID 5	
Byte	Value
0	canlamheat_on
1	canlam_offset_dis
2	batt_u
3	tmot
4	-
5	-
6	-
7	-

Note 1

Bit	Parameter
0	canlam_offset_dis channel 1
1	canlam_offset_dis channel 2
2	canlam_offset_dis channel 3
3	canlam_offset_dis channel 4
4*	canlam_offset_dis channel 5
5*	canlam_offset_dis channel 6
6*	canlam_offset_dis channel 7
7*	canlam_offset_dis channel 8

NOTICE

If canlamheat_on and LAMHEAT_ON_CW equal 1: heaters are switched on.

After 2 seconds time out of message ID 5 the heaters are switched on again.

4.3 Configuration of CAN Communication

CANSPEED_CW selects the baud rate of the CAN.

– CANSPEED_CW = 0: 500 kBaud

– CANSPEED_CW = 1: 1,000 kBaud

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