MSS54

module description
moment management

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version	Date	comment
S300	1.6.2004	Transfer from MSS60 project
S310	2.10.2004	Overview image for EVT filling control changed and control edge module added
S320	16.11.2004	Document roughly revised (due to lack of time due to software requirements) Ignition angle degrees in the SW temporarily set to 100%
S330	1.12.2004	Consumption torque during generator operation of the KSG in the torque structure included
S330	1.12.2004	Calculation wi moved from operating mode manager to the moment manager
S350	13.2.2005	Document completely revised again
S360	10.3.2005	B_EVT removed, since only EVT engines are served
S370	4.7.2005	Complete torque conversion of the desired moment to negative range
S370	6.7.2005	Complete conversion of the LS/Dashpot filter and removal of the SA/WE filter
S370	30.08.2005 rm	: Calculation of ignition angle engagement / ignition hook
S370	11.9.2005	Actual moment calculation changed
S370	18.9.2005	Moment calculation from HFM signal (according to spec. by F. Mayer)
S380	5.11.2005	Dynamic filter extended by two areas
S380	5.11.2005	Calculation of idle speed controller adaptation md_llra is now subtracted instead of added
S380	16.11.2005	Inclusion of md_e_verbraucher completely changed

1st OVERVIEW MOMENT MANAGER

With the conversion of all engine torque interventions (ASC/DSC, EGS, IHKA) to a standardized torque interface, a central coordination of all torque requirements for the filling and ignition path became necessary. The torque manager is to take on this task.

The following list is intended to provide a brief overview of the individual modules of the moment manager and the modules that are very closely linked to them. For reasons of clarity, the description is reduced to a core sentence and limited to the most important variables for the moment calculation process as input and output variables.

Module: Pedal Value Recording

Determination of the relative driver request torque
Input variables: pwg1, pwg2, n, S_FDYN
Output variables: pwg_soll

Module: minimum moment

Determination of the minimum indicated engine torque
Input variables: n, state_motor, md_llra, md_friction_filter, md_e_consumer
Output variables: md_e_schlepp, md_e_schlepp_hyp

Module: maximum moment

Determination of the maximum indicated engine torque
Input variables: n, md_e_schlepp, rf_pt_korr, md_fw_rel
Output variables: md_e_max

Module: Consumer

Determining Consumer Moments
Input variables: can_kkos_lm, md_ksg, S_KO
Output variables: md_e_verbraucher

Module: Friction torque

Determination of the friction torque of the engine
Input variables: n, tmot, toel
Output variables: md_reib_filter

Module: Calculation of driver desired torque

Determination of the absolute driver desired torque incl. FGR Input
variables: md_fw_rel, md_ind_fgr, b_fgr_aktiv, md_e_schlepp_hyp Output variables:
md_e_fw, d_md_wunsch_rel

Module: Dynamic Filter

filtering driver desired torque
Input variables: md_e_fw, sa_we_st, dyn_st, gang, md_e_schlepp
Output variables: md_fw_filter, md_sawe_filter, md_ind_wunsch

Module: Idle control intervention

Consideration of the I-part of the idle control
Input variables: md_ind_wunsch, md_llri
Output variables: md_ind_wunsch_filter (actually name is not correct)

Module: Vmax regulation

gear-dependent Vmax limitation
Input variables: v_drive, d_v, gear
Output variables: md_ind_vmax, vmax_st

Module: Torque limitation

torque limitation

Input variables: gear, B_Kraftschluss, d_n, md_ind_schlepp, md_eta_zw_ve

Output variables: md_max_begr, md_begr_st

Module: Torque Limitation

coordination of torque limits

Input variables: md_ind_vmax, vmax_st, md_max_begr, md_sk_begr, sk_egas_zustand, n, d_n_segment, gang

Output variables: md_ind_wunsch_begr

Module: torque reserve

Building a torque reserve for catalytic converters

Input variables: kath_zustand, n, wi, tmot, t_ml

Output variables: md_res

Module: DSC intervention

Moment interventions of the DSC system in the filling path

Input variables: asc_st, md_ind_asc, md_ind_msr

Output variables: md_ind_asc_abs, md_ind_msr_abs

Module: Implementation in filling by control edges

Implementation of the torque specification in control edges, basic throttle angle

Input variables: wi, n, rf_pt_korr

Output variables: ao_aw, as_aw, eo_aw, es_aw, ml_soll_bas, wdk_soll_evt, ti_ende_evt

Module: Torque interventions ignition angle

Coordination of torque interventions in the ZW path

Input variables: md_ind_wunsch_begr, md_llr_tz, md_ind_asc_abs, md_ind_msr_abs

Output variables: md_tz_red

Module: Calculation of ZW intervention

Calculation of an absolute ignition angle based on the torque specification and the actual torque of the engine

Input variables: md_tz_red, md_ind_opt_korr, md_eta_zw_min, n, wi

Output variables: tz_md[x]

Module: Calculation of basic quantities

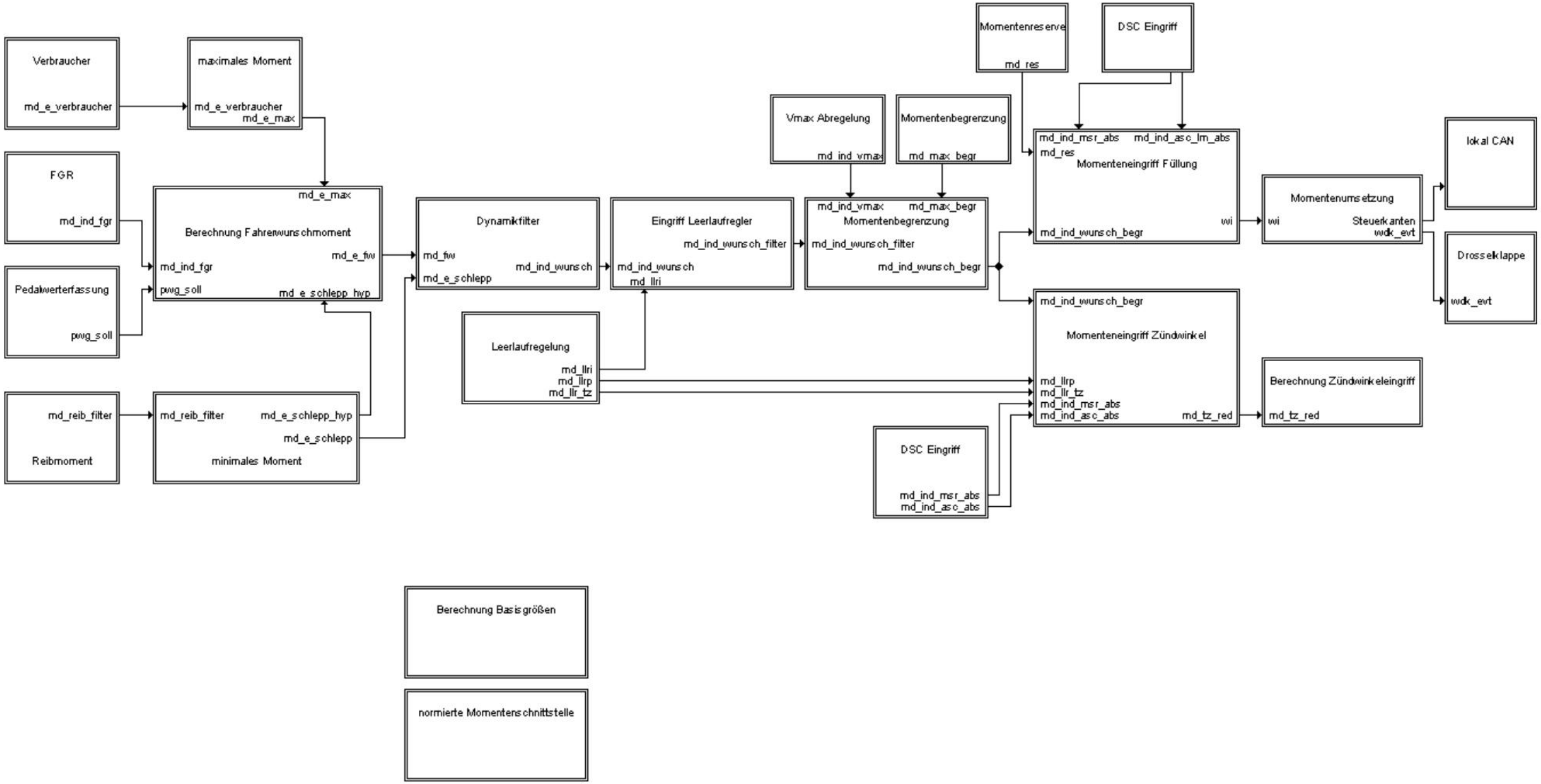
Module for calculating the different actual torques and ZW efficiencies, as well as all

Auxiliary quantities for moment calculation and coordination

Module: standardized moment interface

Implementation of the standardized torque interface and the air conditioning compressor connection according to CAN specification 11H

Image: Overview of Moment Manager (mm.gif)



2. CALCULATION OF BASIC SIZES

A main component of the torque manager is the determination of the actual torque before and after torque interventions, the optimal ignition angle, and the calculation of the efficiency of lambda and ignition angle corrections. The calculation of the individual variables is summarized in the "Calculating basic variables" module.

The indicated actual torque corresponds to the torque applied to the clutch and the friction. In order to make the switching on or off of consumers (or disturbances) torque-neutral, the actual torque is calculated first. It is a smoothed, delayed wi target specification based on extracted data.

2.1. MOMENT CALCULATION

corrected maximum actual wi "md_wi_opt_korr"

The corrected maximum indicated actual wi "md_wi_opt_korr" takes into account the lambda influence on the generated engine torque. It corresponds to the actual torque "md_wi_ind_opt_th", corrected by the current lambda efficiency "md_eta_lambda".

md_wi_opt_korr = md_wi_ind_opt_th * md_eta_lambda

actual torque before torque interventions "md_ind_ve"

The torque "md_ind_ve" represents the actual torque generated by the engine, which it would deliver without the ignition angle interventions of the torque manager. However, the torque reductions caused by ignition angle interventions of other modules such as knock control, catalytic converter heating, etc. are taken into account. This takes the form of an ignition angle efficiency "md_eta_zw_ve", the calculation of which is also described in this chapter.

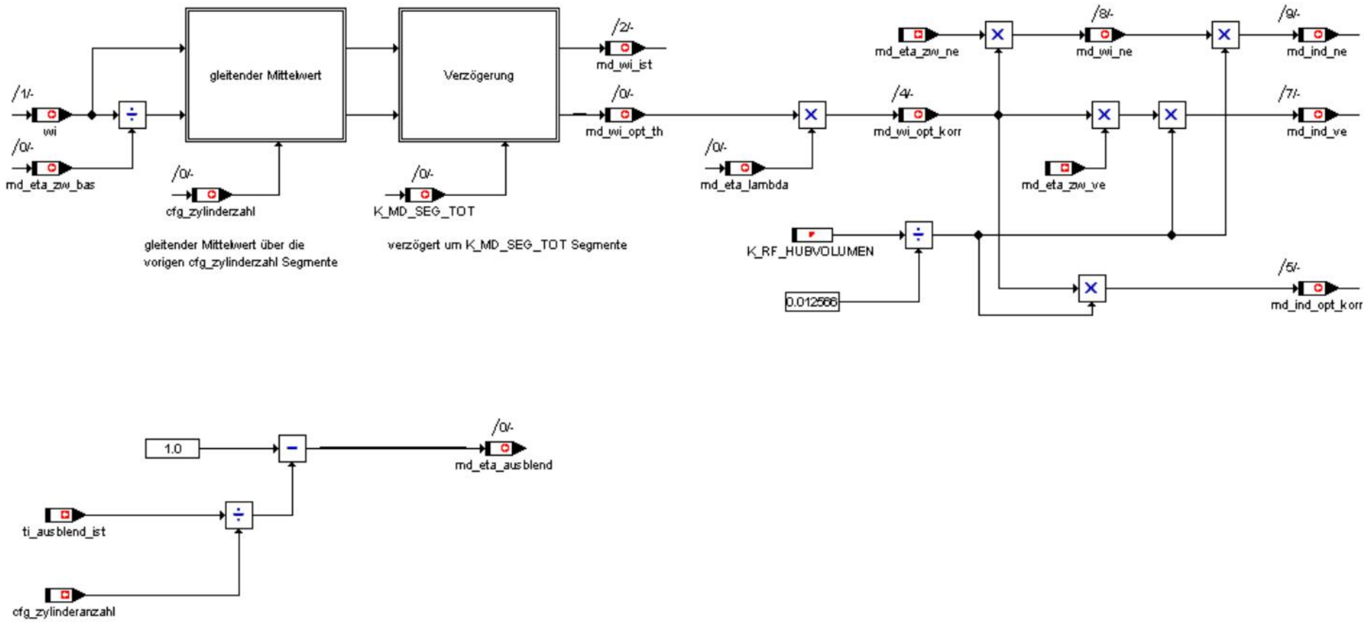
md_ind_ve = (md_wi_opt_korr * md_eta_zw_ve) * K_RF_HUBVOLUMEN / 0.012566

actual moment after moment interventions "md_ind_ne"

The torque "md_ind_ne" represents the actual torque generated by the engine, taking into account all torque interventions. For this purpose, an ignition angle efficiency "md_eta_zw_ne" is taken into account, which also includes the ignition interventions of the torque manager.

md_ind_ne = (md_wi_opt_korr * md_eta_zw_ne) * K_RF_HUBVOLUMEN / 0.012566

Image: Calculation of actual moments (md_ist.gif)



<u>**Description of the actual torque calculation**</u>

The target value "wi" is delayed by the applicable segment counter K_MD_SEG_TOT, which corresponds to the segment dead time. This value is also smoothed with the wi calculated for the last "cfg_cylinder_number" segments. The resulting value "md_wi_act" corresponds in stationary terms to the "wi" determined on the test bench, which is knock-limited in some points or includes an ignition angle lead (in the idling range). The theoretical best value of the ignition hook "md_wi_opt_th" is determined using the efficiency "md_eta_zw_bas". The lambda influence is taken into account in the value "md_wi_opt_korr". The current "md_wi_ne" is then calculated using the efficiency "md_eta_zw_ne" after all ignition angle interventions and with lambda influence. Md_eta_ausblend is no longer used to calculate "md_ind_ne" (md_wi_ne) since S370, because incorrect values would be calculated in case of cylinder deactivation.

md_eta_zw_bas: Efficiency of pilot ignition angle (applied in the map) to theoretical
Best ignition angle without knock limitation and torque lead md_zw_opt_korr, since the theoretical best ignition angle is temperature dependent and Lambda-dependent, the pilot ignition angle should be changed with the physically similar mimic

md_eta_zw_ne: Efficiency of current ignition angle to theoretical best ignition angle without knock limitation

md_eta_lambda: Efficiency influence lambda (full load, component protection, ...)

delayed and smoothed wi:
wi delayed by K_MD_SEG_TOT segments (180 degrees for 4 cylinders) and moving average over the previous cfg_zylinderzahl segments.

Example: cfg_zylinderzahl = 4, K_MD_SEG_TOT = 5
Target specifications: wi(1) wi(2) wi(3) wi(4) wi(5) wi(6) wi(7) wi(8) wi(9) wi(10)
Actual moment in the 10th segment: md_wi_ist(10) = (wi3+wi4+wi5+wi6)/4

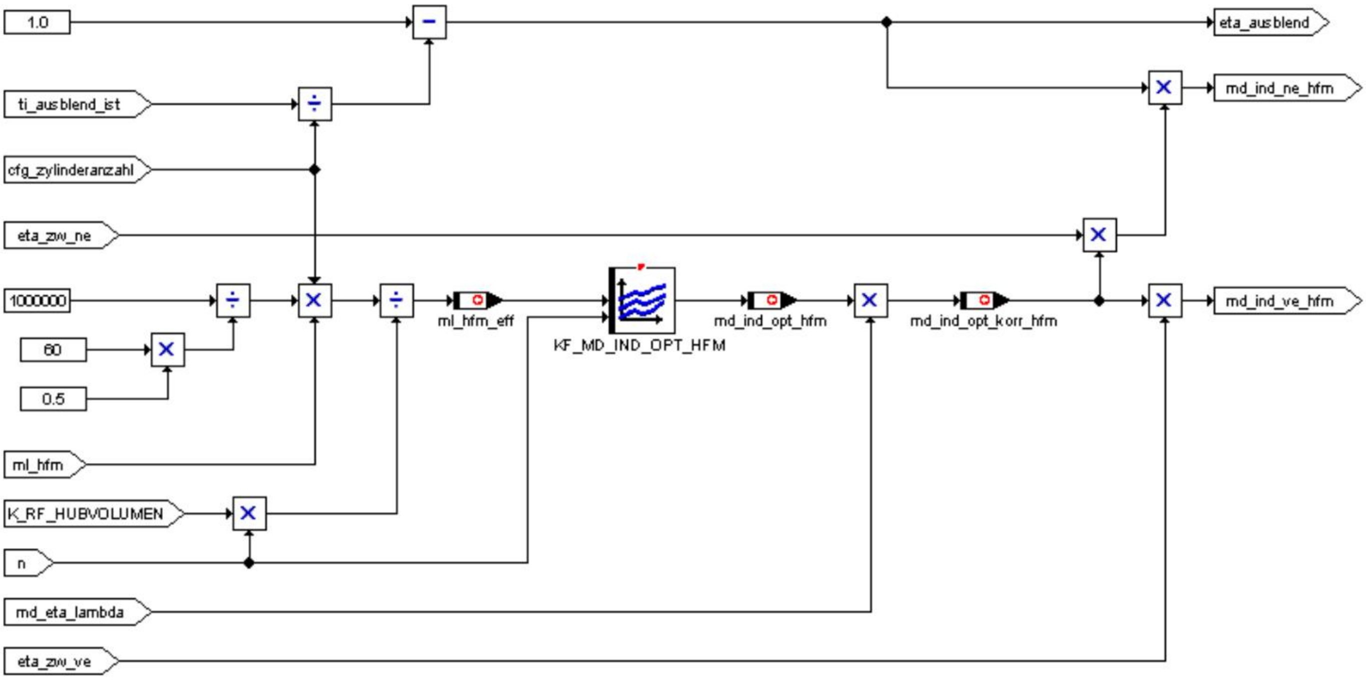
actual torque calculation from HFM signal

Physical Background

In order to be able to make defined torque interventions, the currently set engine torque must be available in the functional structure. The air mass sucked in by the engine is directly proportional to the engine torque under the boundary conditions of optimal ignition angle and lambda = 1.

Taking efficiency interventions into account, the engine torque can be stored in a map via speed and air mass and made available to the functional structure.

Image: Calculation of actual moments (md_ist_hfm.gif)



Optimal indicated actual torque from hfm

The optimal indicated actual torque md_ind_opt_hfm is the torque that the engine generates at the operating point with optimal ignition timing and lambda = 1. The actual torque was determined on the test bench as a function of the speed and the air mass measured by the HFM, per working cycle and cylinder in relation to the cylinder displacement, and stored in the map KF_MD_IND_OPT_HFM.

(1) md_ind_opt_hfm = KF_MD_IND_OPT_HFM(n, ml_hfm_eff)

corrected optimal indicated actual torque from hfm

The corrected optimal indicated actual torque md_ind_opt_korr_hfm takes into account the lambda influence on the generated engine torque. It corresponds to the actual torque md_ind_opt_hfm, corrected by the current lambda efficiency md_eta_lambda.

(2) md_ind_opt_korr_hfm = md_ind_opt_hfm * md_eta_lambda

actual torque before torque interventions from hfm

The torque md_ind_ve_hfm represents the actual torque generated by the engine, which it would deliver without ignition angle interventions by the torque manager. However, the torque reductions caused by ignition angle interventions by other engine modules such as knock control, catalytic converter heating, etc. are taken into account. This is done in the form of an ignition angle efficiency eta_zw_ve (see Chapter 1.1.2.4 "Calculating ignition angle interventions").

(3) md_ind_ve_hfm = md_ind_opt_korr_hfm * md_eta_zw_ve

actual torque after torque interventions from hfm

The torque md_ind_ne_hfm represents the actual torque generated by the engine, taking into account all torque interventions. For this purpose, an ignition angle efficiency eta_zw_ne is taken into account, which also includes the ignition interventions of the torque manager (Chapter 1.2.1).
“Calculation of ignition angle intervention”). Furthermore, injection suppression of individual or all cylinders is also taken into account in the form of a suppression efficiency eta_ausblend.

(4) md_ind_ne_hfm = md_ind_opt_korr_hfm * md_eta_zw_ne * md_eta_ausblend

2.1.1. CALCULATION OF LAMBDA EFFICIENCY

In addition to the ignition angle, the lambda ratio also influences the indicated engine torque. All torque maps were determined for a lambda of 1.0. In real engine operation, the actual lambda ratio must be determined and the corresponding actual and target torques must be corrected using a correction factor.

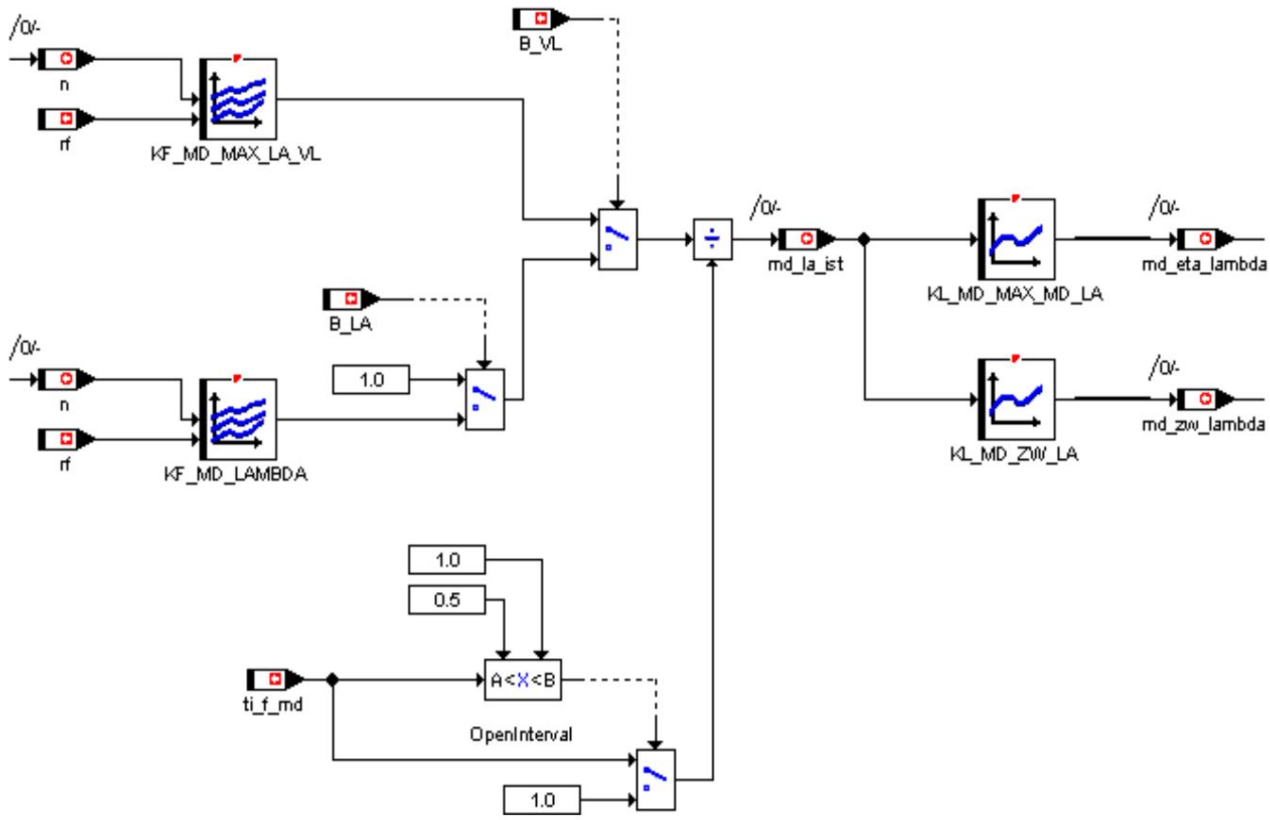
In the lambda-controlled range, lambda is always one and thus the correction factor is also 1.0. In full-load operation, the lambda value is taken from the “KF_MD_MAX_LA_VL” map and converted into a correction factor via the “KL_MD_MAX_MD_LA” characteristic curve.

When lambda control is inactive (e.g. during warm-up), lambda values other than one can also exist due to the mixture pre-control, which must be taken into account in the torque path. For this purpose, the lambda value valid for the operating point must be stored in the "KF_MD_LAMBDA" map.

Lean mixtures during the warm-up phase are taken into account by dividing the lambda value from the characteristic curves by the lean mixture factor "ti_f_md". Rich mixtures (ti_f_md > 1) || (ti_f_md < 0.5) are not corrected.

For the sake of completeness, the calculation of “md_eta_lambda” is also included in the following graphic. This offset ignition angle reflects the influence of the lambda value on the optimal ignition angle.

Image: Calculation of lambda efficiency (lambdawirkungsgrad.gif)



3. TORQUE INTERFACE (CAN)

The torque manager currently has three interfaces via CAN to other systems.

3.1. INTERFACE TO CLIMATE CONTROL AND KSG

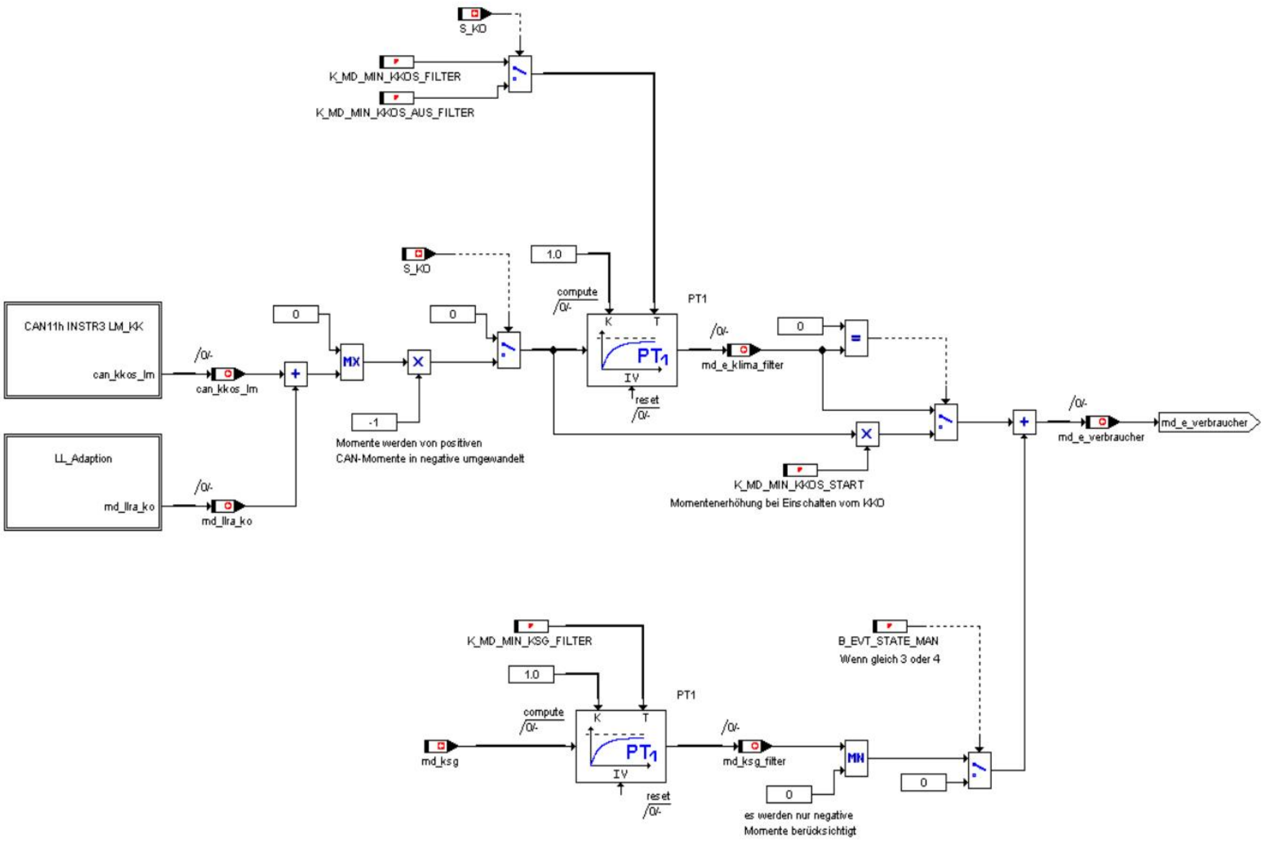
The climate control system transmits the current power consumption of the air conditioning compressor in the signal "can_kkos_lm". The torque manager must take this lost torque into account in the form of a consumer torque "md_e_verbraucher" when calculating the driver's desired torque. Since the torque request and the actual torque requirement do not always match exactly, the difference is compensated by means of a torque adaptation by the idle control.

When a torque request from the climate control is detected for the first time, the requested torque (sum of climate request plus adaptation) is weighted with the factor "K_MD_MIN_KKOS_START", whereby this factor can also be greater than one, which is equivalent to an initial value increase. This initial value is then guided to the requested value via a PT1 filter with the time constant "K_MD_MIN_KKOS_FILTER".

When the air conditioning compressor is switched off, the loss torque is regulated to zero using the filter time constant "K_MD_MIN_KKOS_AUS_FILTER".

In addition, the filtered torque from the KSG "md_ksg_filter" is added in generator mode and when the switch position of "B_EVT_STATE_MAN" (= 3 or 4). "Md_ksg" is transmitted to the engine control via local CAN. The pt1 filtering of "md_ksg" can be influenced with the time constant "K_MD_MIN_KSG_FILTER".

Image: Calculation of loss torque (md_verbraucher.gif)



3.2. INTERFACE TO ASC/DSC - REQUIREMENT FOR TORQUE INTERVENTION

The ASC or DSC control unit is able to influence the indicated engine torque using a standardized torque interface. Three paths are provided for intervention options.

- md_ind_asc_lm : - Torque reduction by reducing the filling
md_ind_asc : - torque reduction via ignition timing retardation
md_ind_msr : Increasing the torque by increasing the filling

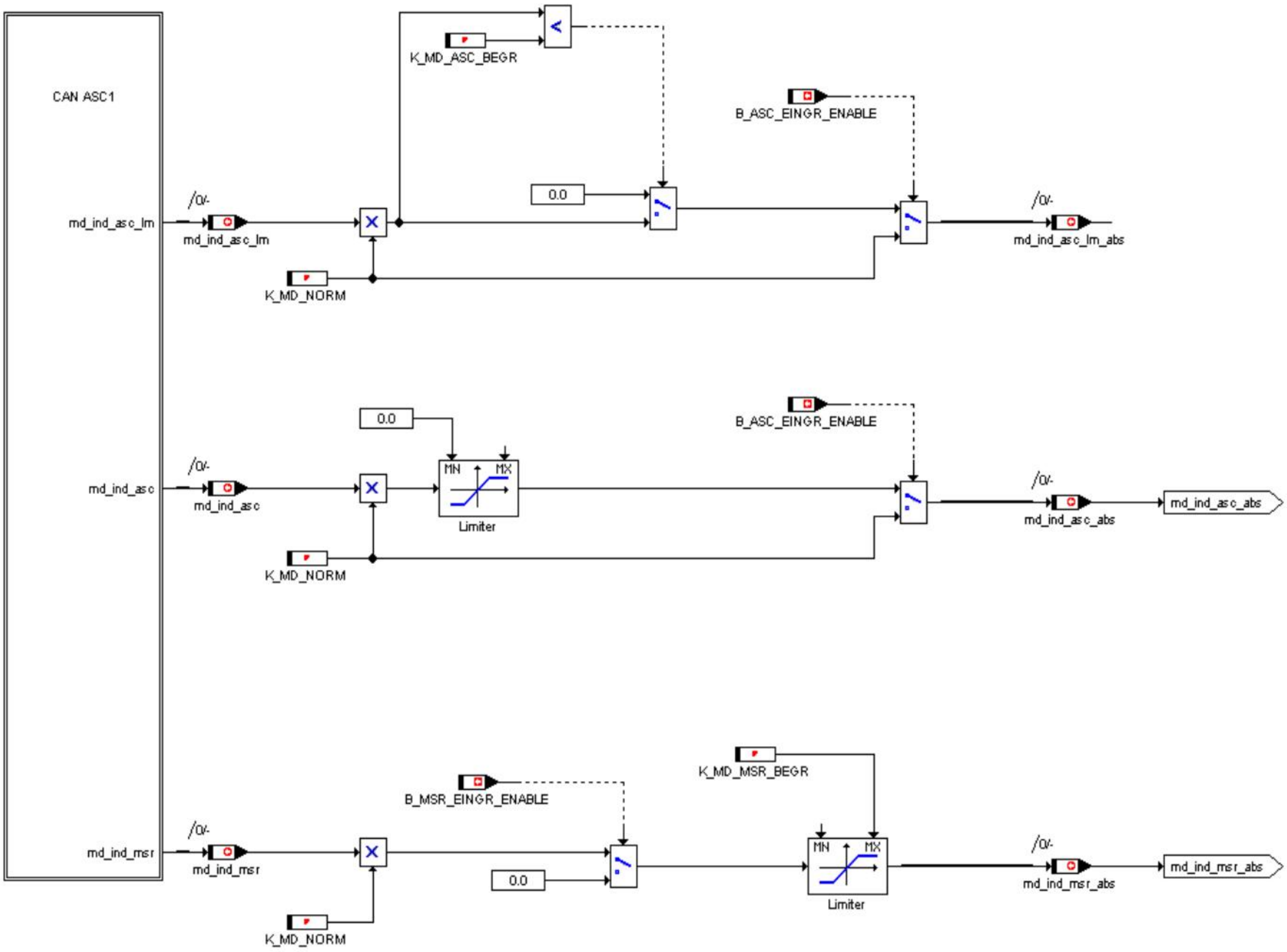
All moment requirements are related to an indicated standard moment “K_MD_NORM”, the value range is between 0% and 99.6%.

The interventions of the ASC/DSC system can be blocked using the application constant “K_MD_ASC_CONTROL”.

Bit 0 = 1 : ASC intervention blocked (corresponds to B_ASC_EINGR_ENABLE = 0)
Bit 1 = 1 : MSR intervention blocked (corresponds to B_MSR_EINGR_ENABLE = 0)

The MSR intervention is limited to the torque “K_MD_MSR_BEGR”.

Image: ASC/DSC interface (asc_dsc.gif)



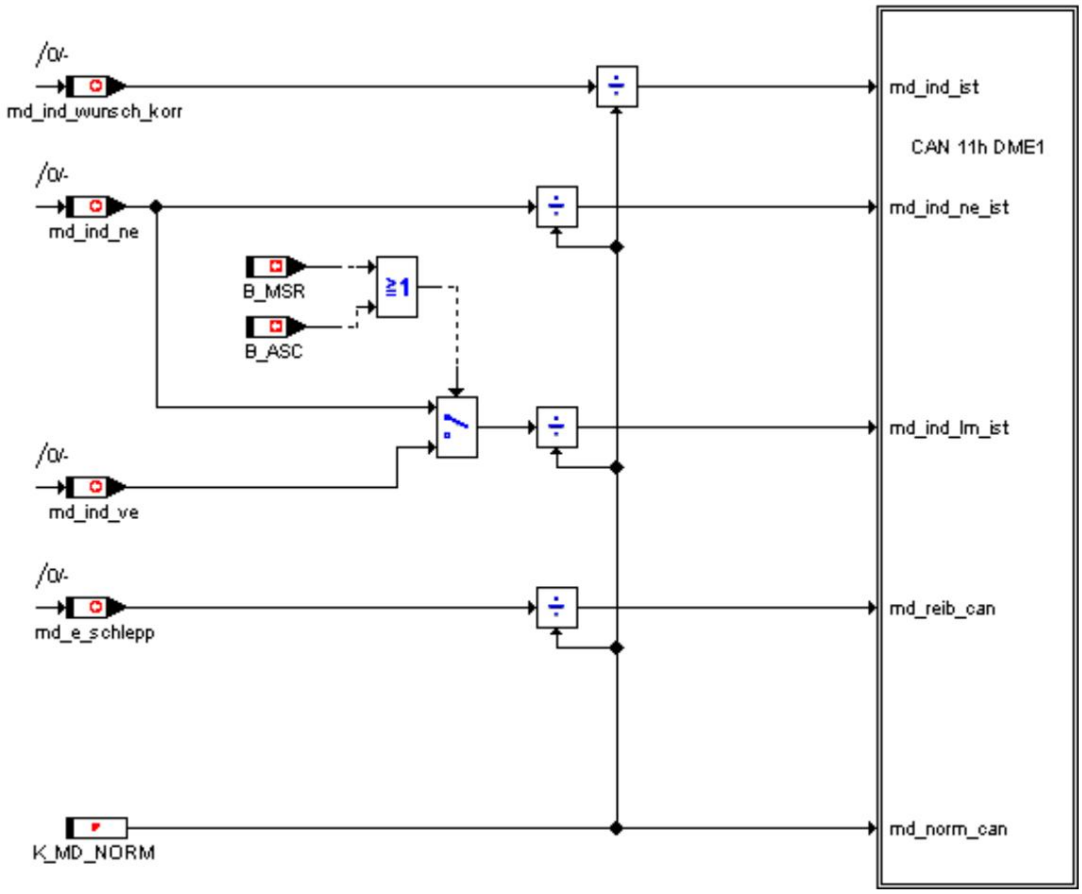
3.3. INTERFACE TO ASC/DSC - FEEDBACK TORQUE INTERVENTION

The DME transmits the following torque information back to the DSC:

- md_norm_can : -	reference torque for all torque specifications
md_reib_can :	Loss torque of the engine including all consumers (alternator, oil pump, air conditioning compressor, ...)
- md_ind_ist :	generated indicated actual torque of the engine without taking into account the DSC interventions
- md_ind_ne_ist :	generated indicated actual torque of the engine taking into account all interventions
- md_ind_lm_ist :	theoretical engine torque, calculated from the measured air mass without taking into account the external ignition angle interventions

Since the MSS60 does not differentiate between internal and external ignition angle interventions, the calculation of "md_ind_lm_ist" is not so simple. If no external ignition angle intervention is active, the torque "md_ind_ne" is used as "md_ind_lm", which also takes all internal ignition angle interventions into account. If, however, an external ignition angle intervention (ASC, MSR) is active, "md_ind_ve" is used, which includes the internal ignition angle influences from the basic ignition angle, knock control, knock path adaptation and dynamic lead.

Image: Feedback to DSC (rueckmeldungdsc.gif)



4th FRICTION TORQUE

The friction torque is the torque required to rotate the engine without firing.

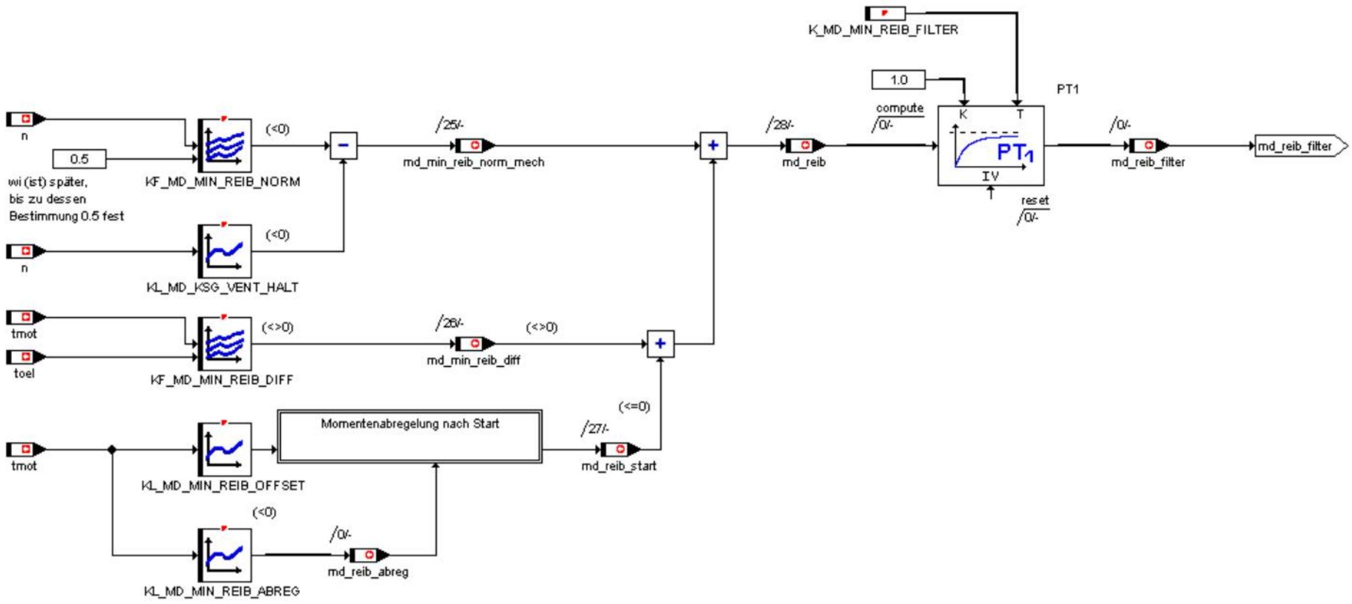
The friction curve is driven out under defined conditions “KF_MD_MIN_REIB_NORM”.
Deviations from these standard conditions are taken into account in “KF_MD_MIN_REIB_DIFF”.
The characteristic curves “KL_MD_MIN_REIB_OFFSET” and “KL_MD_MIN_REIB_ABREG” take into account the additional torque requirement at start-up, which is regulated.

In the characteristic map “KF_MD_MIN_REIB_NORM” the friction curve is determined at “tmot”=80 ÿC and “toel”=80 ÿC and closed valves. The torque required to hold the valves closed is stored in the characteristic curve “KL_MD_KSG_VENT_HALT”.
“Md_min_reib_norm_mech” is the drag torque of the engine at defined temperatures without the electrical friction component of the valve train.

Deviations from the standard temperatures are taken into account in the map “KF_MD_MIN_REIB_DIFF” (negative values for colder temperatures, positive values for warmer temperatures).

In order to meet the increased torque requirement of the engine during start-up and in the first few seconds thereafter, the drag torque is increased during start-up by the offset “md_reib_offset” (KL_MD_MIN_REIB_OFFSET = f (tmot)), which is reduced to zero after completion of the re-start using the torque ramp “KL_MD_MIN_REIB_ABREG” = f (tmot).

Image: Calculation of friction torque (md_reib.gif)



5. DRAG TORQUE

The drag torque is the minimum torque that can be requested by the engine control unit.
It includes the temperature-dependent basic friction of the engine. Other variables are also taken into account.

The drag torque on an effective basis is calculated twice. Together, the friction torque "md_reib" is filtered via a PT1 filter and the torque from the idle speed controller adaptation "md_llra" is subtracted. The differences are as follows:

For "md_e_schlepp_hyp" the torque of the maximum possible charge exchange losses "KL_MD_LW_MIN" is added. The sum is then multiplied by a hyperbolic function so that the drag torque is increased at low speeds (at idle speed to zero effective torque). The torque can also be changed manually using the characteristic curve "KL_MD_MIN_FAK_MAN_LLR" in order to achieve an increase in the low speed range.

For “md_e_schlepp”, the additional torque “md_min_start” required for starting is added, which depends on the speed and tmot.

In the "KF_MD_MIN_START" map, additional torque values required for starting are applied, which are dependent on the speed and cooling water temperature. The following values are calculated differently. In the "KL_MD_LW_MIN" characteristic curve, the torque values that can be additionally achieved with the maximum possible charge exchange losses are stored above the speed. Such strong losses are generated by letting the engine compress the cylinder volume and then opening the valves so that no expansion energy is used.

To calculate “md_e_schlepp_hyp”, “md_temp3” is multiplied by a hyperbolic function in the low speed range (“md_min_fak_man_llr”), which increases the torque at idle speed to zero effective torque. The current speed, the idle target speed and the factor “n_hyp” are calculated in the hyperbolic function. The following applies to this:

n_hyp =lfr_nsoll + KL_MD_MIN_DN_HYP(tmot)

The weighting factor is calculated as follows:

md_min_fak_hyp_llr = 1 - [(n - n_hyp) / (n_ll - n_hyp) * (n_ll / n)]

The steepness of the hyperbola can be influenced using the characteristic curve “KL_MD_MIN_DN_HYP”. High values mean a flat hyperbola, low values a steep hyperbola. The torque can also be changed manually using the characteristic curve “KL_MD_MIN_FAK_MAN_LLR” in order to influence the torque gradient in the idle speed range with great flexibility, for example.

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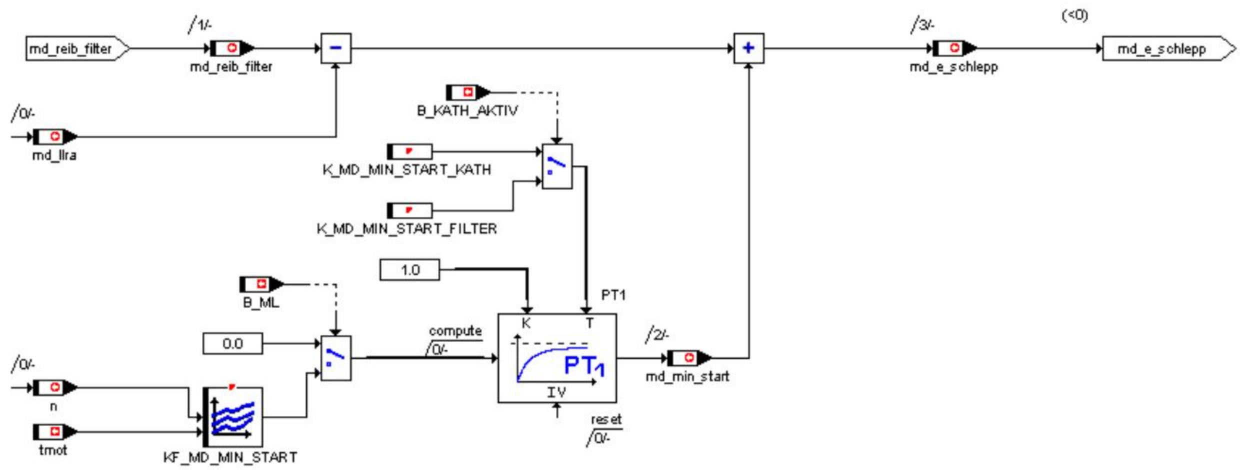
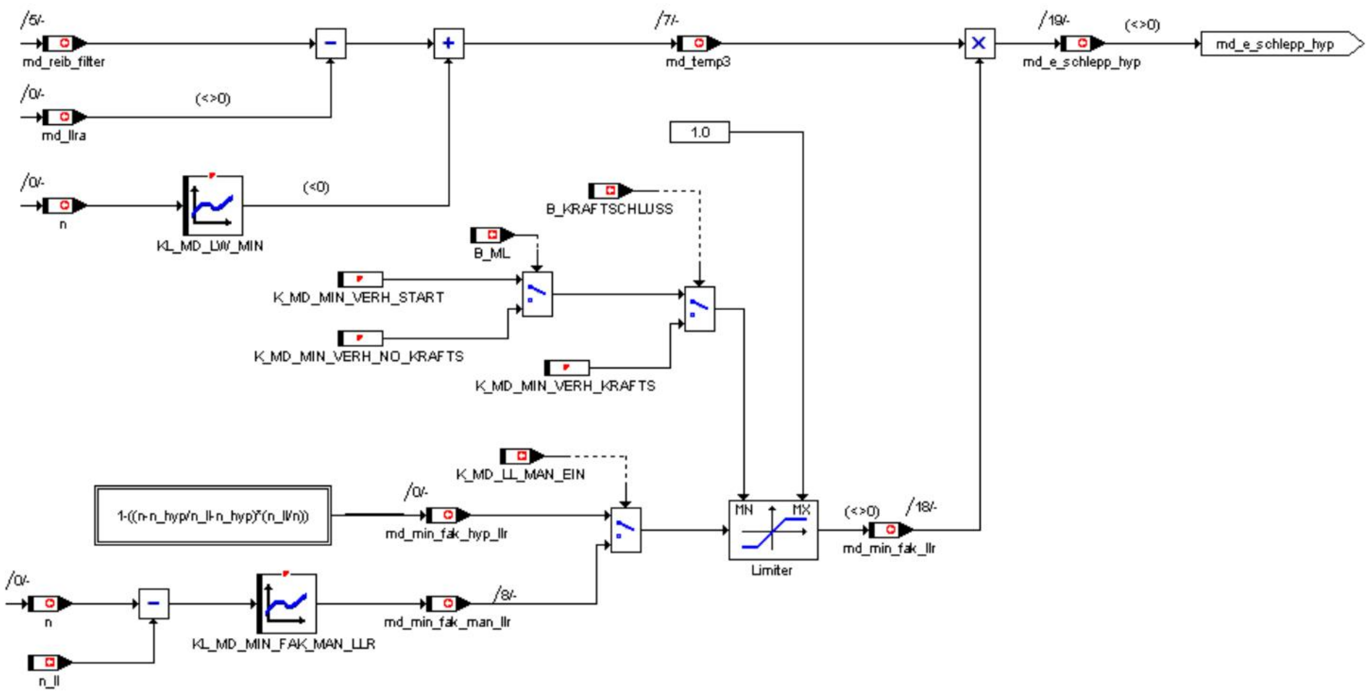
Image: Calculation of drag torque (md_schlepp.gif)





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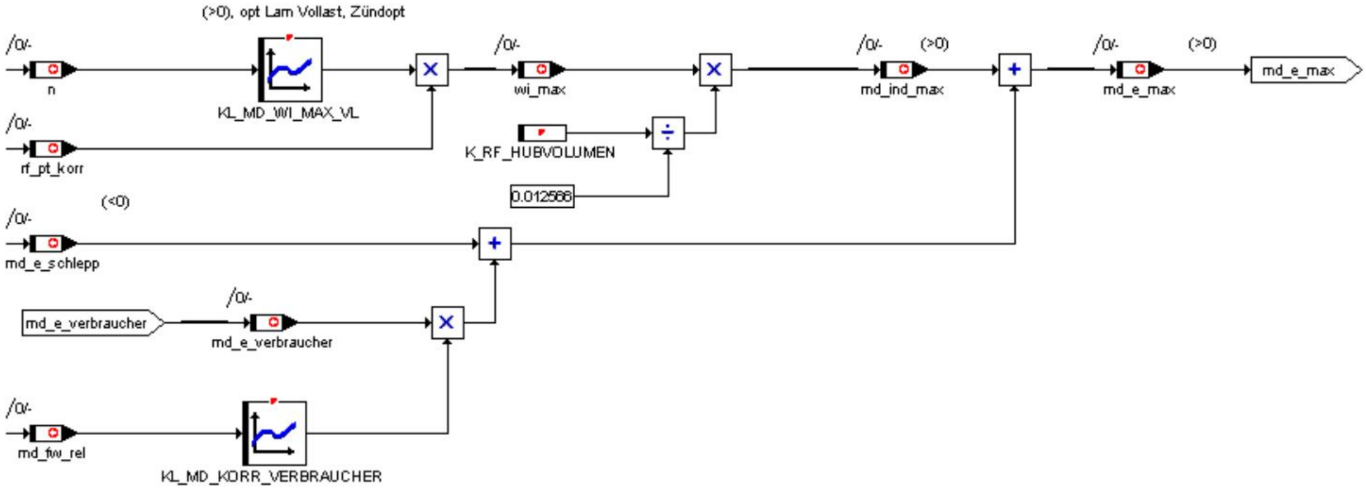
6th MAXIMUM INDICATED MOMENT

The maximum “wi” that the engine can achieve at full load and under standard conditions, full load lambda and ignition optimum at the respective speed is stored in the characteristic curve “KL_MD_WI_MAX_VL”. By correcting for the real ambient conditions, the currently possible maximum “wi_max” is obtained.

The indicated torque is calculated from the indicated work. The drag torque including consumers "md_e_schlepp" and "md_e_verbraucher" are added to this to produce the effective maximum torque "md_e_max". The addition of the consumption torques is weighted using the characteristic curve "KL_MD_KORR_VERBRAUCHER" = f(md_fw_rel). Consumers are not included in the calculation for small accelerator pedal positions up to approx. 80%. Only then is full calculation achieved up to At 100%. This avoids free travel in the pedal at full load.

“Md_e_verbraucher” is the input variable that takes into account all consumers as well as the KSG torque, which, among other things, supplies the current for the valve control.

Image: Calculation of maximum effective moment (md_max.gif)



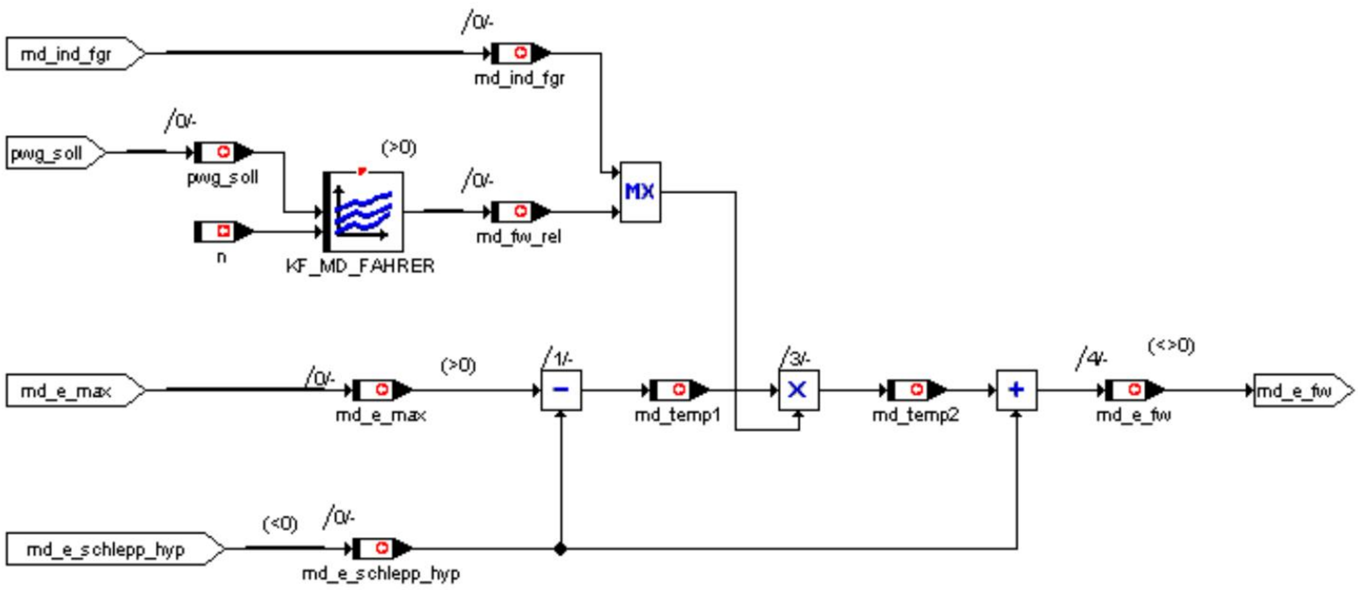
7. CALCULATION OF DESIRED MOMENT

The driver's request is determined by the PWG module in the form of a relative pedal position "pwg_soll", where 0% corresponds to an accelerator pedal not being operated and 100% to the pedal being at full throttle. This relative pedal position is converted via the "KF_MD_FAHRER" map into a relative driver request "md_fw_rel", which in turn lies between 0 and 100%. 100% corresponds to the maximum effective torque "md_e_max". 0% corresponds to the drag torque with hyperbolic increase "md_e_schlepp_hyp" (without consumers).

In parallel, the cruise control module can also determine a relative torque request “md_ind_fgr”.

The effective driver request torque “md_e_fw” is then determined by adding “md_e_schlepp_hyp”.

Image: Calculation of the driver/FGR desired torque (md_fw.gif)



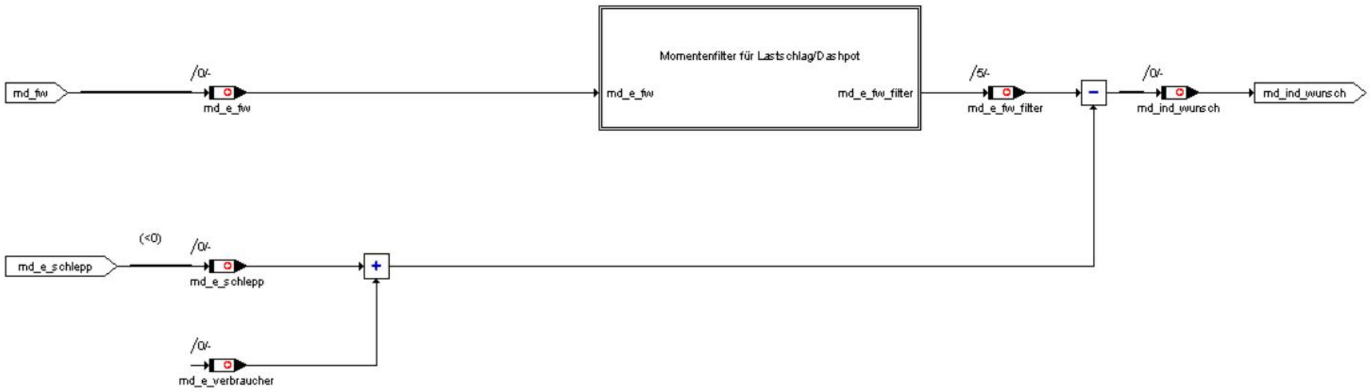
8th TORQUE FILTER

The dynamic filter has the task of filtering the torque requirements in certain states and thus limiting the gradients.

The load impact/dashpot filter filters the driver's desired torque "md_e_fw". Depending on the operating point, a maximum permitted positive (load impact) or negative (dashpot) The torque change per unit of time is calculated and the torque requirements of the driver or FGR is limited to these gradients.

The filtered driver request torque “md_e_fw_filter” is then subtracted from the drag torque “md_e_schlepp” and the consumer torques “md_e_verbraucher” and stored in “md_ind_wunsch”.

Image: Overview of torque filters (md_filter.gif)



8.1. DYNAMIC FILTER FOR DESIRED TORQUE GRADIENTS

For damping large positive (load impact) and large negative (dashpot) torque gradients the dynamic filter becomes active.

Load impact and dashpot filters are constructed in a similar way. In principle, they only differ in the direction of the moment gradient:

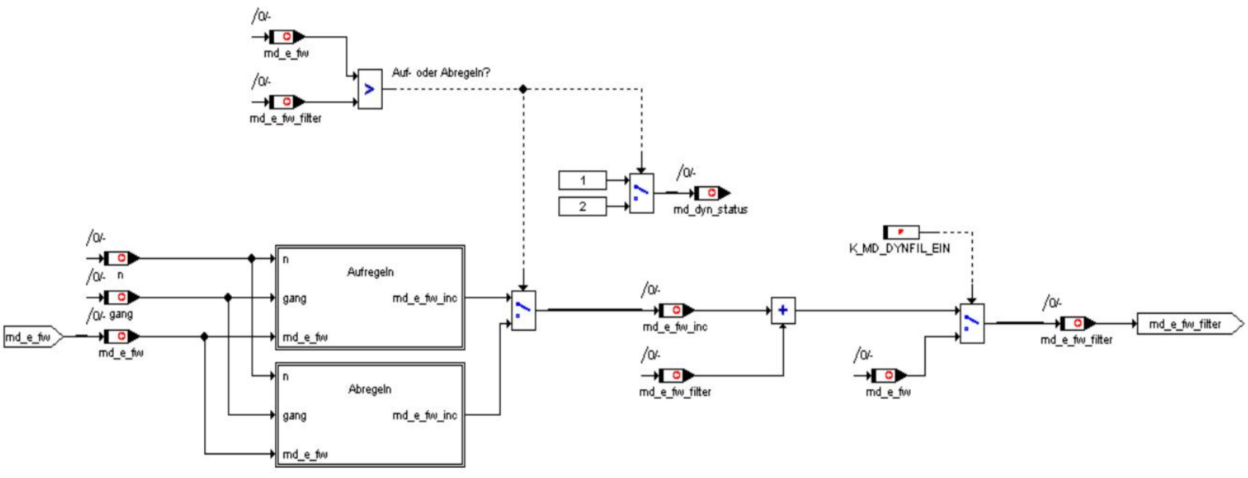
load impact:	positive moment gradient
Dashpot :	negative moment gradient

The dynamic filter can be switched on and off using the application constant “K_MD_DYNFIL_EIN”. If the vehicle is stationary, the dynamic filter is not effective (md_dyn_status = 0).

In the case of open-loop control, there is an applicable threshold value "K_MD_DYNFIL_AUF_12" for the torque, at which the system switches from range 1 to range 2. If a further threshold "K_MD_DYNFIL_AUF_23" is exceeded, the system switches to range 3.
The time-dependent increment is taken from a speed- and gear-dependent map depending on the range. It should be noted that in range 2, flatter ramps are applied in order to minimize the engine tipping in the range of the effective torque = 0. In ranges 1 and 3, steeper ramps are applied.

In the case of derating, there are analogously three ranges and two threshold values “K_MD_DYNFIL_AB_12” and “K_MD_DYNFIL_AB_23”.

Image: Overview of dynamic filters (md_filter_dyn.gif)



The torque increment “md_e_fw_inc”, by which the new filtered driver request is increased, is calculated as follows:

md_e_fw_inc = (md_grenz_r - md_grenz_l) / (map value from KF_DYNFIL_AUF/AB)

md_e_fw_filter = md_e_fw_filter_alt + md_e_fw_inc

The ramp gradients can be influenced in the individual areas via the maps “KF_MD_DYNFIL_AUF/AB1..3”. The higher the applied values of the maps, the flatter the filter regulates the torque up or down.

Table: Ramp gradients

	Area	**target value md_grenz_r**	**old value md_grenz_l**
regulation	1	md_e_fw	md_e_fw_filter_alt
regulation	2	K_MD_AUF23	K_MD_AUF12
regulation	3	md_e_fw	md_e_fw_filter_alt
regulation	3	md_e_fw	md_e_fw_filter_alt
regulation	2	K_MD_AB12	K_MD_AB23
regulation	1	md_e_fw	md_e_fw_filter_alt

Activating the filter

If the filtered output value "md_e_fw_filter" is not equal to the input value "md_e_fw", the filter is activated. If "md_e_fw" > "md_e_fw_filter", then control up/load impact is detected and the bit "md_dyn_status" is set to the value 1. If "md_e_fw" < "md_e_fw_filter", control down/dashpot is detected and the bit "md_dyn_status" is set to the value 2.

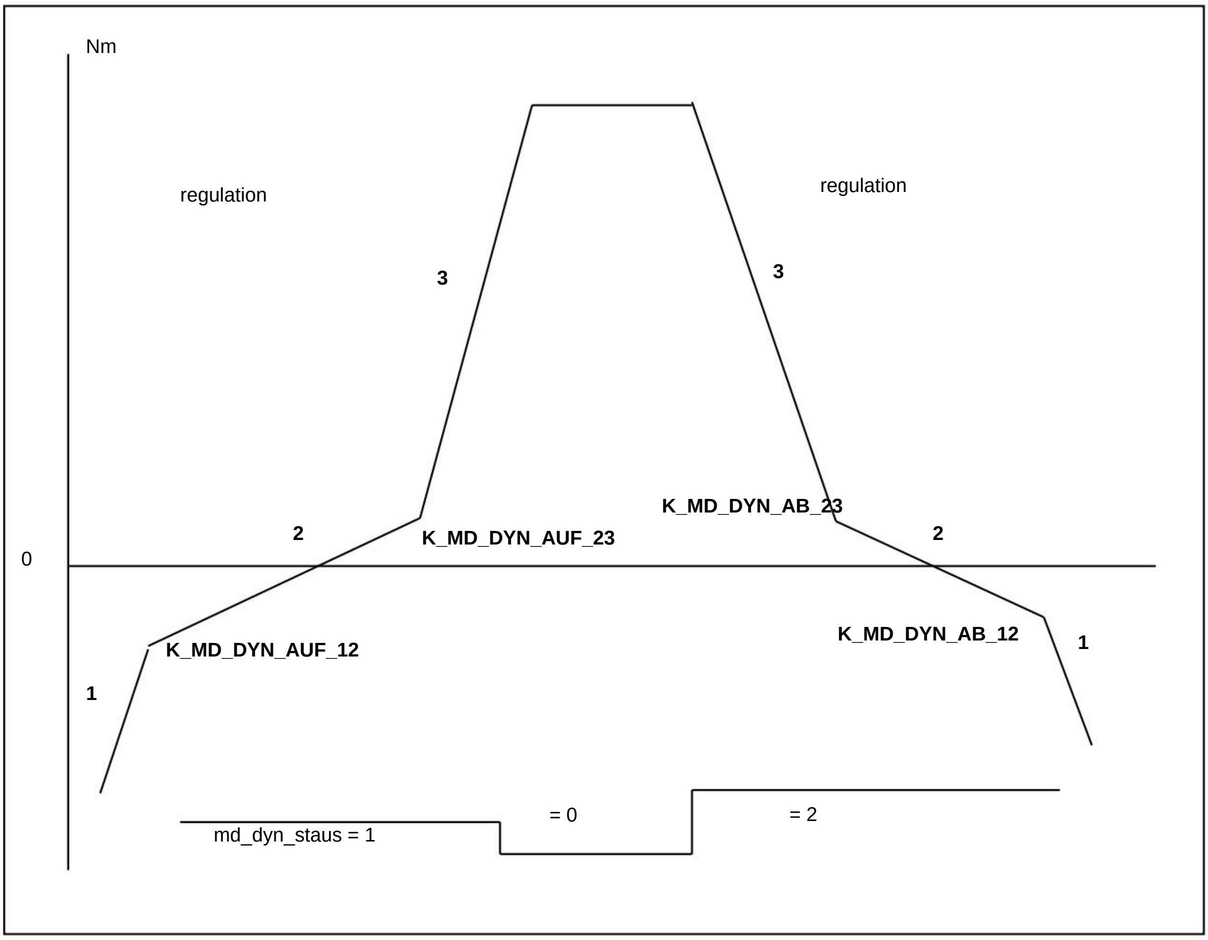
Deactivation from control to stationary operation

If the filtered output value "md_e_fw_filter" exceeds the input value "md_e_fw", the filter is deactivated. The output is directly set equal to the input ("md_e_fw_filter" = "md_e_fw") and the bit "md_dyn_status" is reset to the value 0.

Deactivation from derating to stationary operation

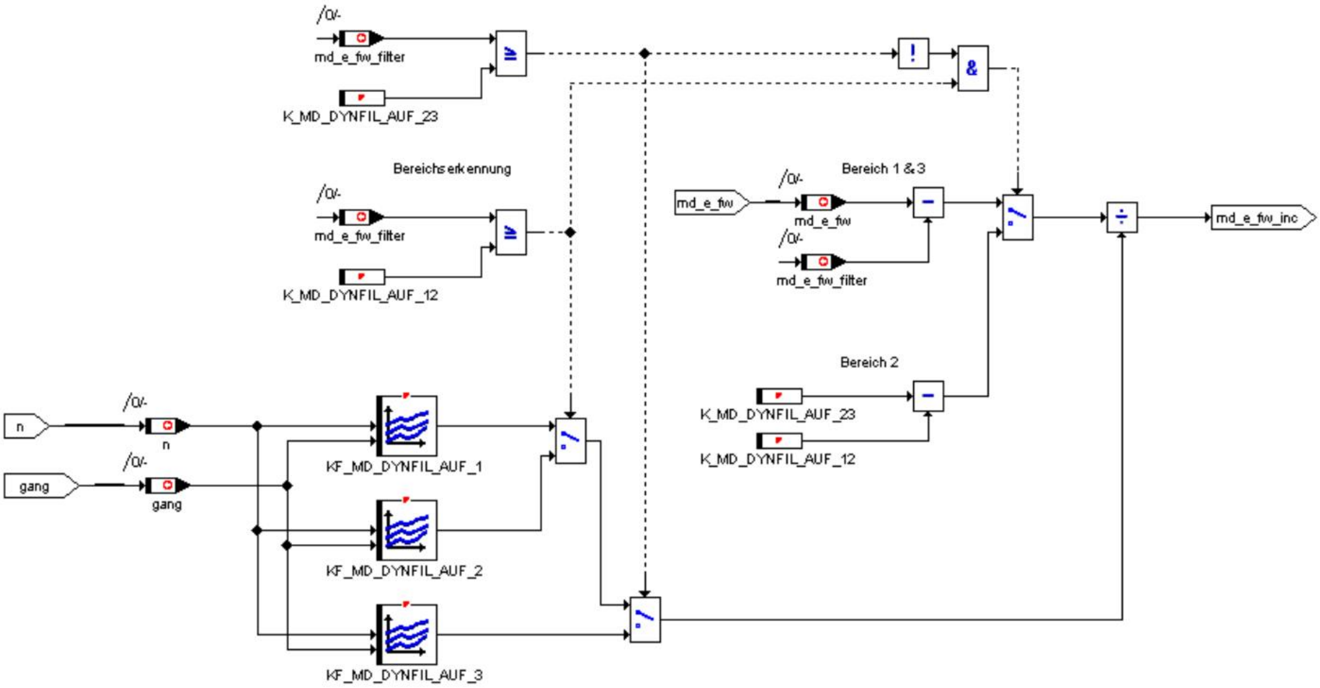
If the filtered output value "md_e_fw_filter" falls below the input value "md_e_fw", the filter is deactivated. The output is directly set equal to the input ("md_e_fw_filter" = "md_e_fw") and the bit "md_dyn_status" is reset to the value 0.

Image: Classification of the dynamic filter areas



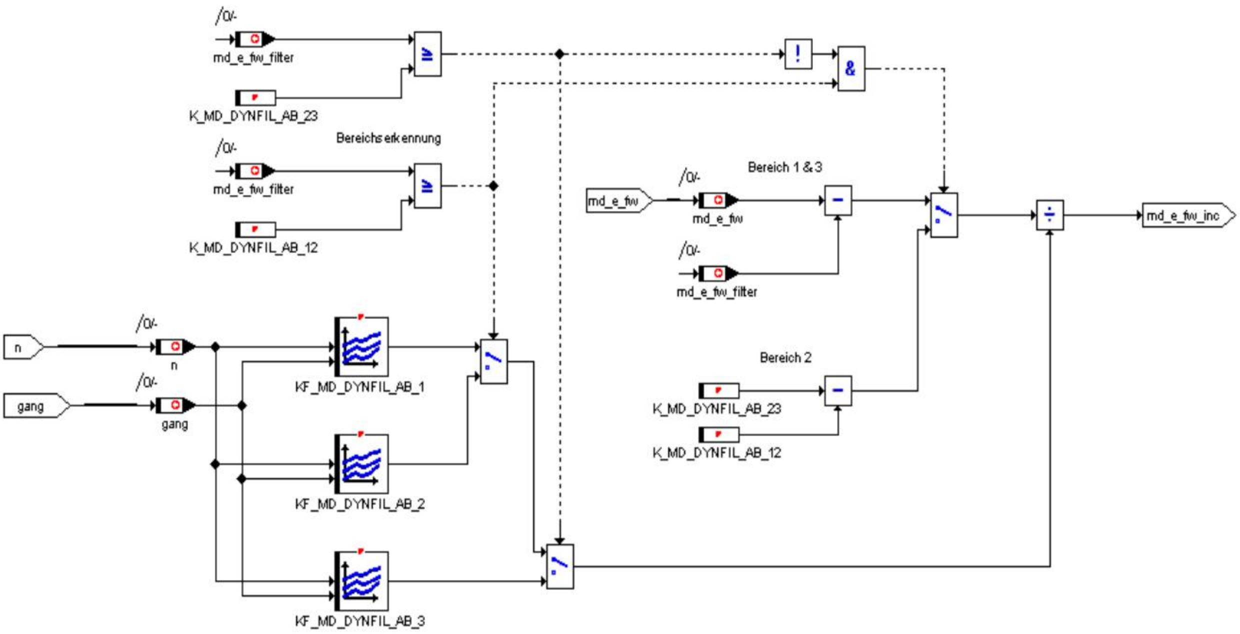
8.1.1. LOAD IMPACT FILTER

Image: Load impact operation of the dynamic filter (md_filter_ls.gif)



8.1.2. DASHPOTFILTER

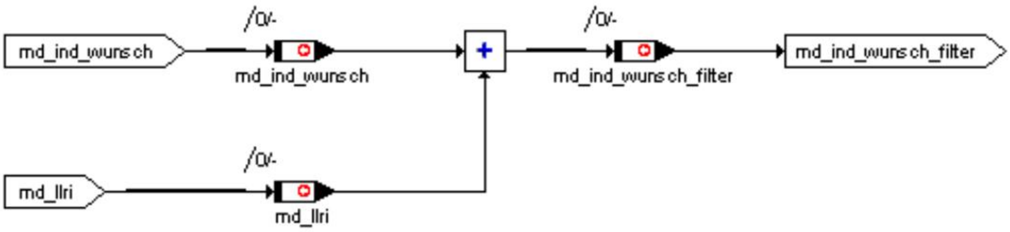
Image: Dashpot operation of the dynamic filter (md_filter_dashpot.gif)



8.2. IDLE CONTROL INTERVENTION

The torque component of the idle speed controller is calculated as shown in the following figure.

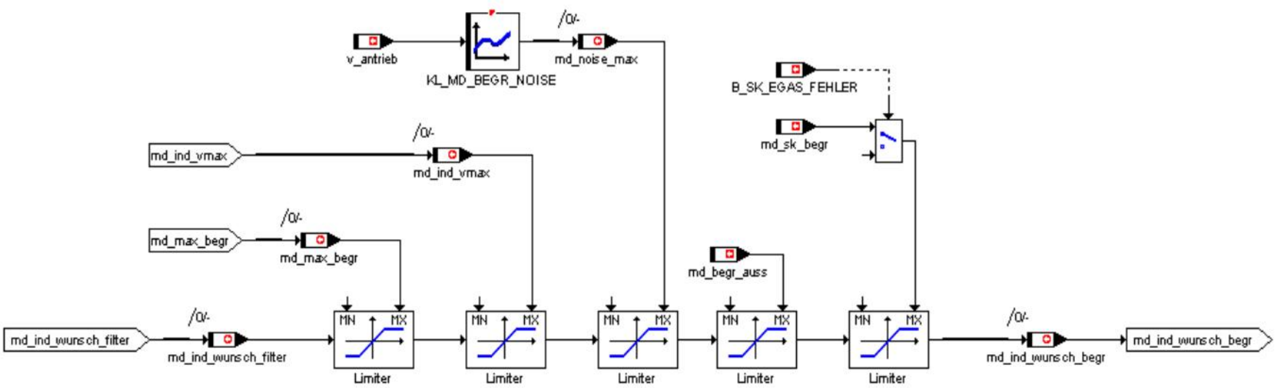
Image: Inclusion of the idle speed controller component (md_eingrlfr.gif))



9. MOMENT LIMITATIONS

An overview of the moment-limiting interventions is shown in the following figure. The individual limitations are described in the following subsections.

Image: Overview of torque limitation (md_begrenzung.gif))



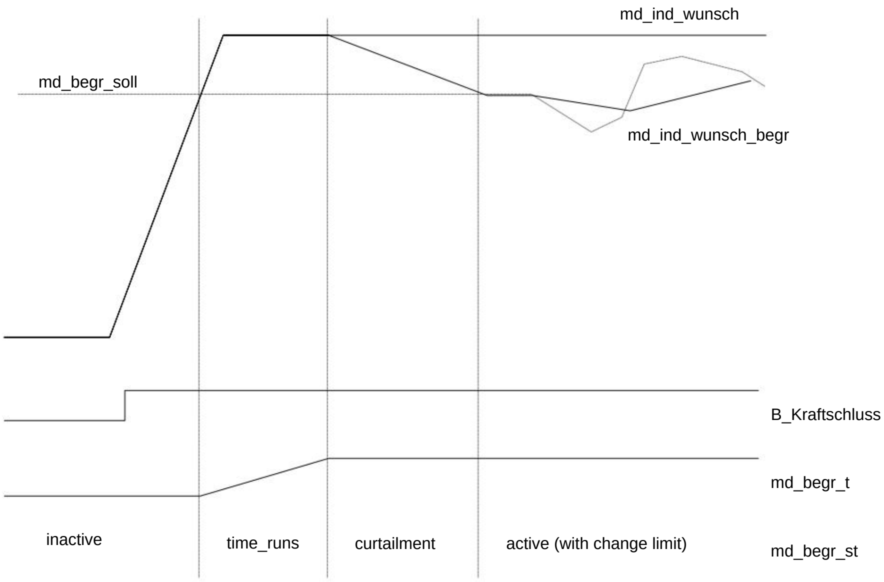
9.1. TORQUE LIMITATION

Due to insufficient torque strength of the transmission, the delivered engine torque (torque at the clutch) must be limited.

The maximum permissible indicated engine torque is calculated from the characteristic curve "KL_MD_BEGR_GANG", which contains the gear-dependent maximum torques, plus the internal engine loss torques "md_ind_schlepp". If the speed gradient is positive, a further correction is made for the engine moment of inertia. The influence of a retarded ignition angle adjustment of the knock control or knock path adaptation is taken into account via the ignition angle efficiency "md_eta_zw_ve".

$$
\begin{aligned}
\text{md\_max\_begr} = (\quad & \text{KL\_MD\_BEGR\_GANG (gear)} \\
& + \text{md\_ind\_schlepp} \\
& + \text{K\_MD\_J\_MOTOR} * \text{d\_n40} \qquad \text{if d\_n40} > 0 \\
& \qquad\qquad) \,/\, \text{md\_eta\_zw\_ve}
\end{aligned}
$$

The torque limitation is only intended to prevent the engine from operating continuously above the maximum torque. A brief exceedance of the torque limit, such as during acceleration measurements, is not considered critical for the transmission. The functionality of the torque limitation is adapted to this. After each traction interruption, the torque limitation is inactive for the period "K_MD_BEGR_T", whereby the time only starts when the maximum threshold is exceeded for the first time. Then, starting from the current desired torque, the limit threshold is regulated down to the target value "md_max_begr" via the ramp "K_MD_BEGR_RAMPE". After the regulation has ended, changes in "md_max_begr", which can be very rapid due to speed gradients and KR/KA influences, are limited by the change limit "K_MD_BEGR_DELTA".



9.2. SPEED LIMIT

The Vmax limit on the MSS60 acts directly on the EGas system via the torque manager. The maximum speed is controlled via an I controller in two stages.

Vmax readiness: v > vmax_readiness

When “vmax_berei” is exceeded for the first time, which must be below the Vmax “K_V_MAX”, a torque is calculated in advance which should enable stationary driving at the Vmax point.

For this purpose, the current indicated torque is corrected by the excess torque which currently provides a vehicle acceleration and is then multiplied by the square quotient of maximum speed to actual speed, since the air resistance also increases quadratically with the vehicle speed.

md_ind_vmax = (md_ind_wunsch_red_korr - K_MD_J_FZ * d_v) * (K_V_MAX / v)2

Vmax control: v > K_V_MAX

When K_V_MAX is exceeded, an I-controller becomes active, which integrates the maximum permissible torque “md_max_begr” up or down according to the controller deviation.

md_ind_vmax = md_ind_vmax + K_MD_I_VMAX * (K_V_MAX - v)

Since “md_ind_vmax” can be very small or even overflow due to the I controller, “md_ind_vmax” is limited to the values K_MD_VMAX_MIN or K_MD_VMAX_MAX.

The Vmax control is deactivated again as soon as the vehicle speed has fallen below the threshold K_V_MAX - K_V_MAX_HYS.

“md_ind_vmax” is only taken into account in the torque manager when Vmax limitation is active, not when Vmax is ready.

9.3. TORQUES IN CATALOGUE DAMAGE -CAUSING MISSOUTS

In the event of misfires that damage the catalytic converter, a torque limiter is activated, which is intended to reduce the filling and thus the air flow through the catalytic converter depending on the current engine speed.

The torque limitation is activated as soon as a cylinder has to be switched off due to misfires that damage the catalytic converter.

Phase 1: Expiry of the waiting time “K_MD_BEGR_AUSS_TIME”, during which no torque limitations are yet in effect in order to prevent possible critical driving situations.
Phase 2: Ramp-shaped reduction with “K_MD_BEGR_AUSS_ABREG”, starting from the driver’s request “md_ind_wunsch” to the limiting torque.
Phase 3: Torque limitation active.

Calculation of the limiting moment:
md_begr_auss = KL_MD_BEGR_AUSS = f (n)

The current state of the torque limitation is visible in the variable “md_begr_auss_st”.

The torque limitation remains **active until the engine is switched off,** even if no further misfires have been detected in the meantime.

9.4. TORQUES IN CASE OF FUEL PRESSURE COLLAPSE

If the fuel pressure collapses and the tank is empty at the same time, a torque limiter is activated, which is intended to reduce the filling and thus the air flow through the catalyst depending on the current engine speed.

The torque limitation is activated as soon as the catalytic converter protection function gives the activation release based on the four lambda sensor signals and the tank level.

Since the engine is no longer running at this point due to the collapsed fuel pressure, the torque limitation occurs immediately and without reduction.

Calculation of the limiting moment:
md_begr_auss = KL_MD_BEGR_FST = f (n)

The current state of the torque limitation is also visible in the variable “md_begr_auss_st”.

The torque limitation remains **active until the engine is switched off.**

9.5. TORQUE LIMITATION FOR NOISE REDUCTION

To minimize noise, a function is implemented which, after setting the noise reduction condition (for more information, see module description: gang.doc), limits the maximum indicated torque of the engine depending on the current vehicle speed.

md_noise_max = KL_MD_BEGR_NOISE = f (v_antrieb)

10. MOMENTUM RESERVE

Since the current ignition angles usually correspond to the optimum ignition angle, only torque reductions are possible via ignition angle interventions. In certain operating ranges, such as idle control, however, it is desirable to be able to build up torque quickly via ignition angle intervention.

To do this, the torque specification for the charge path is increased via the torque reserve module, while the torque specification for the ignition angle path remains unchanged. This leads to the charge and thus the actual torque before intervention increasing. The actual torque before intervention thus exceeds the torque requirement of the ignition angle path and the excess torque is compensated again by retarding the ignition angle. This compensated excess torque is now available for a rapid increase in torque by advancing the ignition angle.

md_res_kath: torque reserve of the catalyst heating function

md_res = md_res_kath

10.1. TORQUE RESERVE FOR CATHEDRAL HEATING FUNCTION

In the case of the catalytic converter heating function, the torque reserve is used to reduce efficiency and thus increase exhaust gas temperatures.

For this purpose, an offset torque is calculated depending on the operating state, speed, load, engine temperature and time since start, which is added to the desired torque for the filling path and compensated again via an ignition angle intervention.

The offset moment is composed as follows:

md_res_kath =	KF_MD_RES_KATH	Offset moment = f(n, wi)
	* KF_MD_RES_KATH_GEW weighting factor = f(tmot, t_ml)	
	* md_res_kath_factor	weighting factor up/down regulation

The determination of the weighting factor “md_res_kath_factor” itself can be divided into five areas:

Area 1: Start or re-start (until the start torque is reduced)
weighting factor = 0

Area 2: Adjusting the weighting factor
the weighting factor is linearly increased from the starting value with the step size “K_MD_RES_KATH_T_AUFREG” adjusted to the value 1.0

Area 3: Torque reserve for catalytic converter heating fully active
weighting factor = 1.0

Area 4: Adjusting the weighting factor

After removing the condition “B_KATH_AKTIV_MDRES”, the weighting factor is linearly regulated to zero with the step size “K_MD_RES_KATH_T_ABREG”.

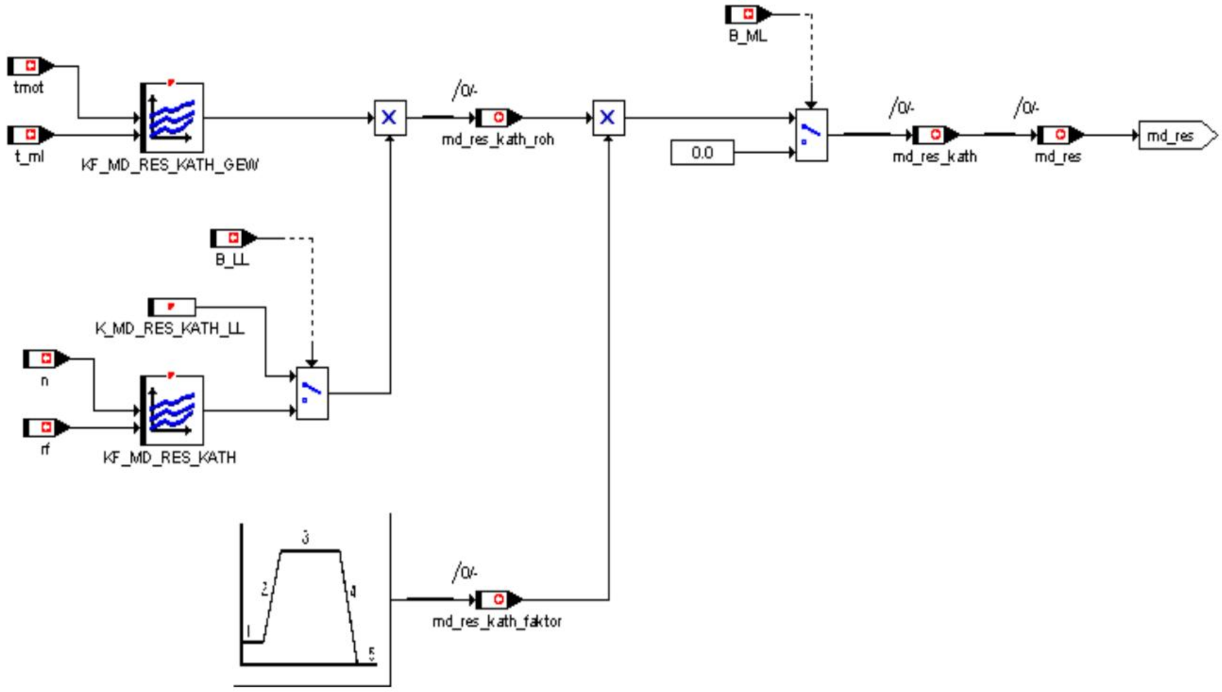
Area 5: Torque reserve for catalytic converter heating inactive

weighting factor = 0

The activation condition for the catalyst heating torque reserve is identical to the activation condition for the catalyst heating ignition angle intervention.

The torque intervention for catalytic converter heating can be blocked via the constant “K_MD_RES_CONTROL”.

Image: Overview of torque reserve for catalytic converters (md_reservekath.gif))



10.2. TORQUE RESERVE FOR STRONG STEERING TURNS (NOT IMPLEMENTED IN EVT !)

When the steering reaches its end stop, the servo pump for the power steering absorbs a lot of torque, which can cause the engine speed to dip when idling, and in some cases even cause the engine to stall. The idle speed regulator's response to increasing the charge is too slow due to the gas running times. Therefore, a torque reserve should be built up in advance depending on the steering wheel angle, which then allows a rapid increase in torque via an ignition angle advance when the idle speed falls below the target speed.

Activation condition: v < K_MD_RES_LRW_V
Deactivation: v > K_MD_RES_LRW_V + K_MD_RES_LRW_VHYS

Calculation algorithm in bullet points:

- Formation of the steering angle
- Calculation of the raw value of the torque reserve “md_res_lrw_loc” via characteristic curve KL_MD_RES_LRW = f(lrw_abs)
- Change limitation of the torque reserve to “K_MD_RES_LRW_DELTA” resulting torque reserve: md_res_lrw_roh
- Consideration of any existing ZW late adjustment from the catalytic converter heating module

md_res_lrw = md_res_lrw_roh - (md_ind_wunsch_begr * md_eta_kath_offset)

The term md_ind_wunsch_begr * md_eta_kath_offset is the torque in Nm that is already available as a torque reserve due to the ZW retardation of the catalytic converter heating function. Any torque reserve for steering assistance that may be available in parallel therefore only needs to take the delta into account.

The status of the torque reserve is visible in the variable “md_res_lrw_st”:
Bit 0: Activation conditions fulfilled
Bit 1: Intervention active, i.e. intervention torque not equal to zero

10.3. LIMITATION OF THE MOMENT RESERVE

The working principle of the torque reserve assumes that the increase in torque in the filling path can be compensated for by an ignition angle intervention. To do this, it must be determined how much scope is still available for a torque reserve at the current operating point.

The remaining scope for ignition timing retardation is the difference between the current (“md_eta_zw_ve”) and the minimum possible (“md_eta_zw_min”) ignition timing efficiency.

The possible factor for increasing the filling specification is calculated as follows:

“md_eta_res” = 1 / (1 - (md_eta_zw_ve - md_eta_zw_min))

If the requested torque reserve exceeds this margin, the torque request is limited to the value “md_ind_wunsch_begr * md_eta_res”.

11. TORQUE **INTERVENTION FILLING PATH**

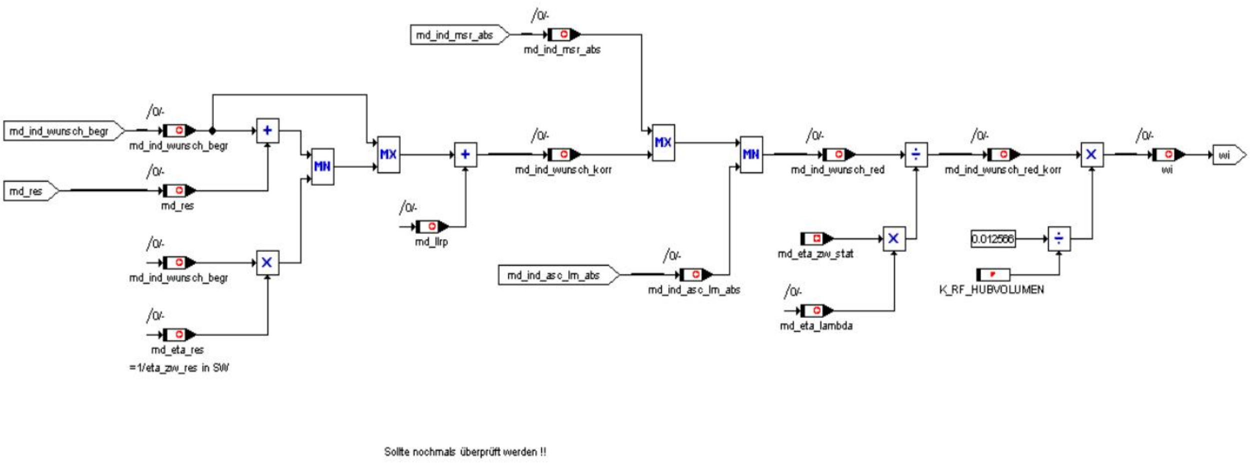
In this module, the torque coordination takes place with the DSC system and with the other torque-reducing modules.

The system has two different intervention options. When MSR (engine drag torque control) intervenes, the DSC requests an increase in torque, which is set purely via the charge. When ASC (automatic stability control) intervenes, the ASC system can request torque reductions separately for the charge and ignition angle paths.

The plausibility check of the DSC interface and the implementation of the requirements into indicated torques is described in the chapter “CAN interface”, so that at this point only the two intervention torques “md_ind_asc_lm_abs” and “md_ind_msr_abs” are considered.

The requested torque interventions are taken into account via max and min selections with regard to the desired torque “md_ind_wunsch_red”. The order of selection is described in the following graphic.

Image: Moment interventions in filling path (md_fuellung.gif)



11.1. EFFICIENCY CORRECTION

A major benefit of the torque manager is that it can easily compensate for torque-influencing actions of other modules such as lean warm-up or catalytic converter heating.

Thus, the influence of a stationary ignition angle retardation and a deliberate deterioration in efficiency for the catalytic converter heating function is calculated in the ignition angle efficiency “md_eta_zw_stat” and the resulting loss of torque at this point is compensated for by a charge correction.

Likewise, the influence of the lambda value on the torque output is recorded in a lambda efficiency “md_eta_lambda” and compensated for by a filling correction. However, only lambda efficiencies smaller than “K_MD_ETA_LAMBDA_MAX” are taken into account.
Efficiencies greater than this value are limited to this value.

The new torque requirement is therefore composed as follows:

md_ind_wunsch_red_korr = md_ind_wunsch_red
/ md_eta_zw_stat
/ md_eta_lambda

The efficiency correction can also be deactivated for application purposes using the constant “K_MD_ETA_MCS”.

Bit 0 = 1 :	Correction via Lambda active
Bit 1 = 1 :	Correction via stationary ignition angle including catalyst heating efficiency active
Bit 7 = 1 :	Correction only via catalyst efficiency, but not via stationary angle active

11.2. CALCULATION OF WI

The specific, indicated work “wi” is calculated from the indicated, corrected desired torque “md_ind_wunsch_red_korr”. “Wi” is used as an input variable for various characteristic maps (e.g. control edges) and has the advantage that it contains the displacement and is therefore independent of the displacement variant.

The corresponding formula is:

$$M_d \text{ ÿ } \frac{V_H \, p_{mi}}{4 \text{ÿ}} \quad (1)$$

or numerical value equation : $M_d \text{ ÿ } \frac{V_H \, p_{mi}}{0.12566}$ (2) M_d[Nm], V_H [dm^3] , p_{mi} [bar]

with $w_i \text{ ÿÿ } \frac{1}{10} p_{mi}$ (3) wi[kJ/dm^3] , p_{mi} [bar]

follows:

$$w_i \text{ ÿ } md\_ind\_wunsch\_red\_korr \cdot \frac{1}{K\_RF\_HUBVOLUMEN} \cdot 0.012566$$

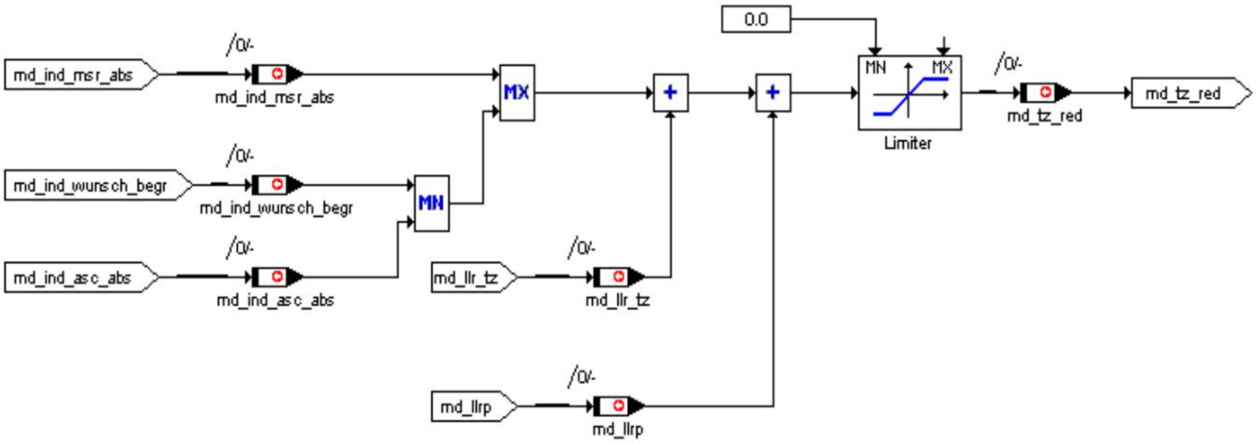
12. CALCULATION OF CONTROL EDGES

In the EVT engine, the filling is not achieved by the throttle valve angle, but by the control edges. In this In the module (Evt_momentenrealisierung.doc and Betriebsartenmanager.doc) the target throttle angle for 50 mbar negative pressure for tank ventilation, the basic ignition angle, the target air mass flow and the advance angle are calculated in addition to the control edges.

13. TORQUE INTERVENTION IGNITION PATH

The DSC torque intervention in the ignition angle path is analogous to the filling path via a maximum value (MSR function) or a minimum value selection (ASC function). The idle control also has a torque intervention "md_llr_tz + md_llrp", which only affects the ZW path of the torque manager and which can counteract torque-reducing measures from other modules. The output variable "md_tz_red" is limited to positive torques.

Image: DSC and LLR torque interventions in ignition angle path (dsc_llr_mdeingriff_zw.gif)



14. CALCULATION OF IGNITION ANGLE INTERVENTION

In this module, the torque requested for the ignition angle path is converted into an engagement ignition angle, taking into account the actual ignition angles of the individual cylinders.

The implementation takes place cylinder-selectively once per working cycle approximately 360 degrees before the ignition TDC of the corresponding cylinder. This is intended to guarantee that, on the one hand, the ignition angle interventions of the knock control are already available, but on the other hand, there is still enough time to update the ignition channel before the ignition coil is energized.

14.1. CALCULATION OF OPTIMAL IGNITION ANGLE

The optimal ignition angle zw_opt is the ignition angle at which the ignition hook has its peak, i.e. the indicated engine torque/ work reaches its maximum value under standard conditions. The theoretically optimal ignition angle can be earlier than the ignition angle that can be achieved at the corresponding operating point. This ignition angle is the reference for calculating the ignition angle interventions in the torque manager.

The calculation of the indicated actual and target wi is based on this optimal ignition angle.
For each EVT operating mode, a map for the optimal ignition angle must be available.

(1) zw_opt = KF_ZW_OPT_x(n, wi)
with x = 0, 1, 2, 3, 4, 5, 7, 11, 12 (operating modes bm_evt_state)

The corrected optimal ignition angle zw_opt_korr still takes into account the influence of engine temperature and the lambda value.

(2) zw_opt_korr = zw_opt + KF_ZW_TMOT(tmot,wi) + zw_lambda

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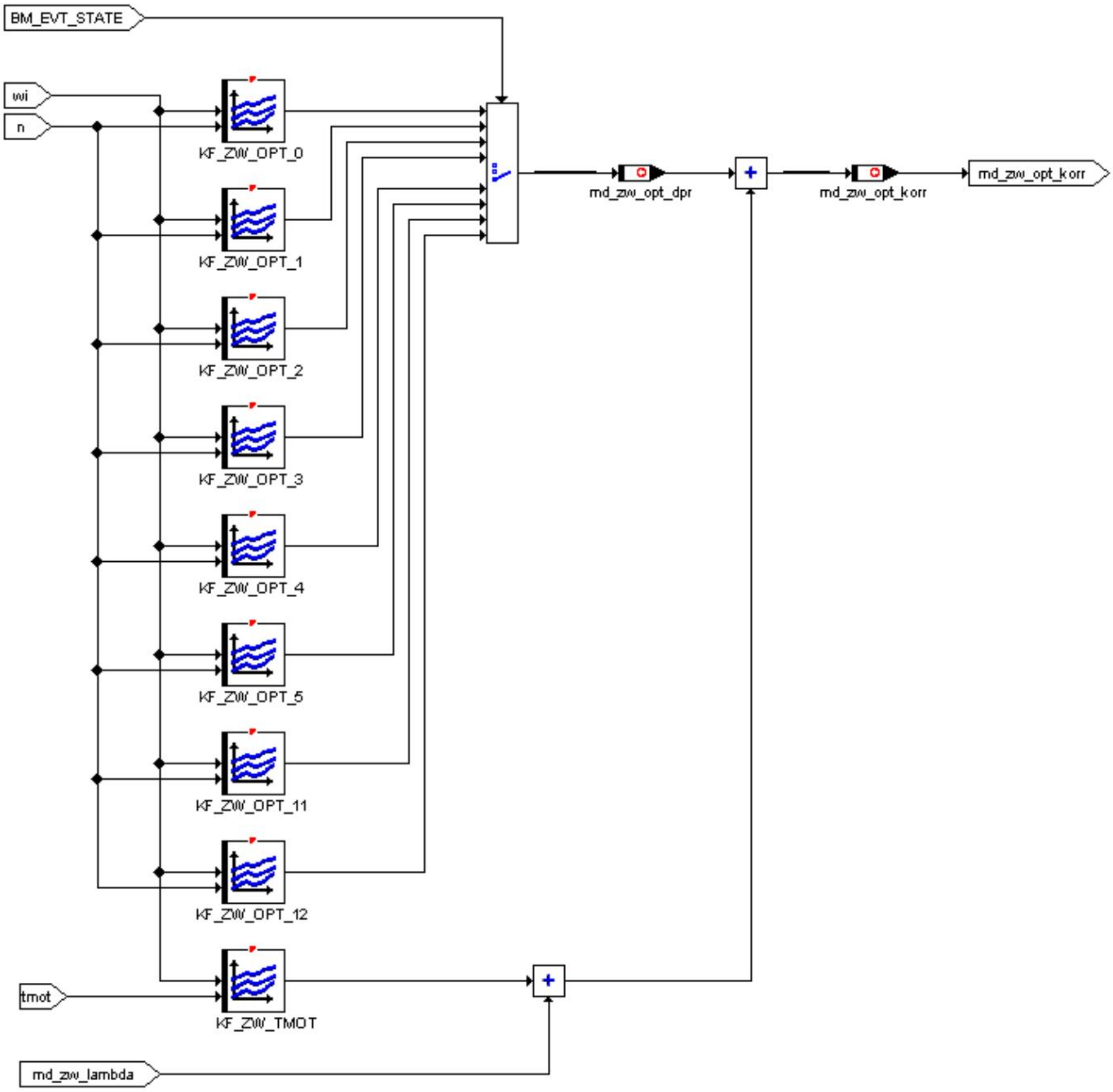

Image: Calculation of optimal ZW (ZW_Eingriff2_2.gif)

14.2. CALCULATION OF IGNITION ANGLE EFFICIENCY

The ignition angle efficiencies are required to take existing ignition angle interventions into account when calculating the actual wi. Furthermore, the existing adjustment range for ignition angle interventions of the torque manager is calculated using the ignition angle efficiencies.

14.2.1. MINIMUM IGNITION ANGLE EFFICIENCY

The value “md_eta_zw_min” contains the efficiency that can be achieved with the latest permitted ignition timing “tz_min”. Wi reductions below this efficiency cannot be fully represented by ignition angle interventions:

(1) md_eta_zw_min = Fct.(Ignition Hook_Polynomial(tz_min))

14.2.2. BASED IGNITION ANGLE EFFICIENCY

The value “eta_zw_bas” contains the efficiency achieved with the current, corrected base ignition angle “tz_bas_korr”. The corrected base ignition angle is made up of the ignition angle basic maps of the operating modes, a correction via engine temperature and an ignition angle offset through lambda variation.

(2) tz_bas_korr = tz_bas + tz_tkorr + md_zw_lambda

The basic ignition angle tz_bas is calculated in the torque realization module.

When catalytic converter heating is active, the base efficiency is reduced by the amount “eta_zw_kath_offset”.

(3) eta_zw_bas = Fkt.(Ignition hook_Polynom(tz_bas_korr)) - eta_zw_kath_offset

14.2.3. CALCULATION OF IGNITION ANGLE EFFICIENCY BEFORE INTERVENTION

The values “eta_veX” are based on the calculated ignition angles before intervention “tz_veX”, which also include adjustments from knock control, knock path adaptation and dynamic lead. Since the individual ignition angles are cylinder-selective, the efficiency must also be calculated cylinder-selectively.

(4) eta_zw_ve[x] = Fct.(Ignition Hook_Polynomial(tz_ve[x]))
with x = 1, ..., number of cylinders

(5) eta_zw_ve = mean (md_eta_zw_ve[x])
with x = 1, ..., number of cylinders

14.2.4. CALCULATION OF IGNITION ANGLE EFFICIENCY AFTER INTERVENTION

First, the segment-synchronous torque intervention of the anti-jerk control “md_ar” is added to the desired torque “md_tz_red”. This intervention can normally only have a negative effect. However, if the torque reserve is active, it can also build up torque.

A target efficiency "md_eta_zw_soll" is calculated from the new target torque by dividing it by a reference torque, which is the measure for the ignition angle intervention. However, the implementation of the type of reference torque differs for six- and eight-cylinder engines, so that the selection can be configured using the constant "K_MD_BEZUG_ZW".

K_MD_BEZUG_ZW = Actual torque:

For all ZW interventions, the actual torque calculated from the speed and relative filling is used as the reference torque.

K_MD_BEZUG_ZW = Target torque:

In the case of active DSC interventions or Egas errors, the actual torque is also used as the reference torque. For all other interventions, the reference torque corresponds to the target torque specification for the filling path. This means that regardless of the

Setting accuracy of the Egas system and all dynamic influences, only the difference between filling and ZW specification is relevant for the ZW intervention.

The value averaged over the cylinders:

(6) eta_zw_ne = mean (md_eta_zw_ne[x])
with x = 1, ..., number of cylinders

In the case of cylinder interventions due to DSC requests or in the Egas emergency program, the number of cylinders currently hidden is still taken into account in the reference moment.

If there is a requirement to guarantee a minimum deterioration in the ZW efficiency for the catalytic converter heating function at all operating points, the calculated target efficiency is limited upwards to the catalytic converter heating efficiency eta_kath.

The subsequent limitation to “eta_zw_min” ensures that the ignition angle interventions remain limited to the latest possible ignition angle.

The constant "K_ETA_EINGRIFF" can be used to define a minimum required efficiency for the ignition angle intervention, ie an intervention is only carried out if it falls below this value. In the variable "st_tz" one bit represents a cylinder (bit 0 = cylinder 1), whereby a set bit means that ignition angle intervention by the torque manager is currently active for this cylinder.

Finally, a plausibility check is carried out with regard to the ignition angle efficiency before intervention.

14.2.5. CALCULATION OF ENGAGEMENT IGNITION ANGLE

The calculated cylinder-selective ignition angle efficiency after intervention eta_zw_ne[x] must now be converted in a second step into an absolute pressure angle related to the ignition TDC.

This is done via the ignition hook stored for this operating point, which indicates the ignition angle efficiency depending on the angle difference to the optimal ignition angle.
In this case, however, an efficiency exists and an ignition angle must be calculated, which is achieved by reversing the calculation algorithm. An ignition hook parabola thus becomes an efficiency root.

parabola equation: $y = a\,x2 + bx + 1$

root equation: $x \;\text{ÿ}\; \frac{\text{ÿ ÿ}bb\; 4a\sqrt{(1\; y)^{2}}}{2a}$

The result of the root equation is an offset ignition angle to the optimal ignition angle “zw_opt_korr”, for which the ignition hook is stored.

The switch at the end of the calculation can be used to decide when an engagement angle should be passed on to the ignition angle calculation. The following intervention conditions are hidden behind the B_IGNITION INTERVENTION switch:

ASC procedure
or MSR intervention
or (Egas emergency program level 3 or 4 active ?? Siko EVT??)
or catalytic converter heating function active
or dynamic filter active due to SA/WE
or dynamic filter due to load impact / dashpot active
or torque reserve active

or anti-jerk control active
or idle stabilization via ignition angle active
or generally activated via K_MD_TZ_CONTROL

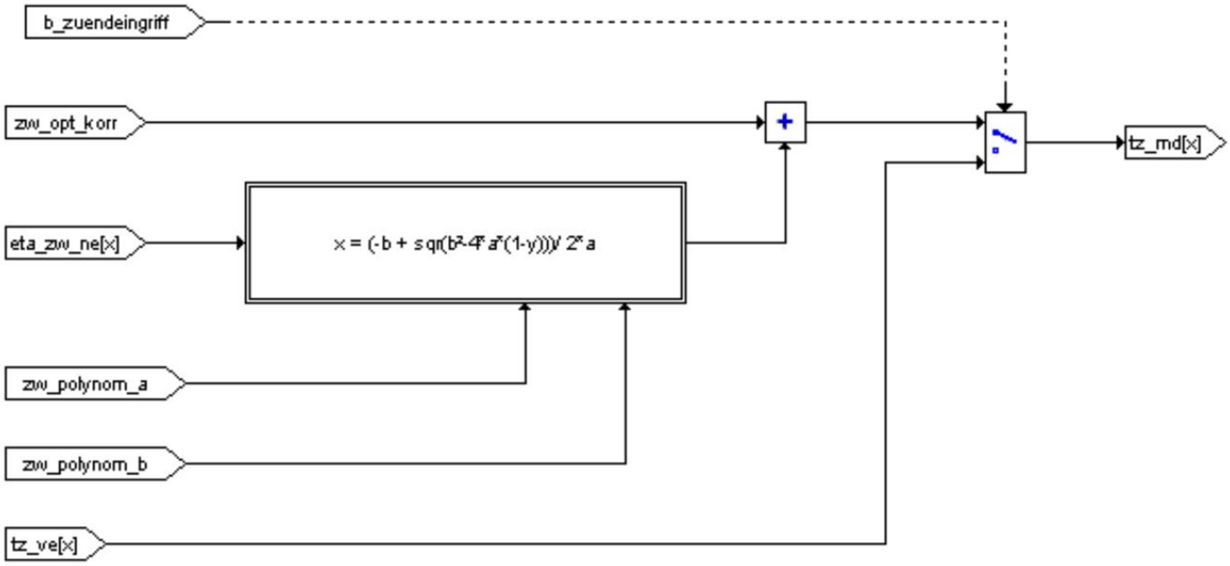

Image: Calculation of ignition angle efficiency after intervention (ZW_Eingriff_13_1.gif)

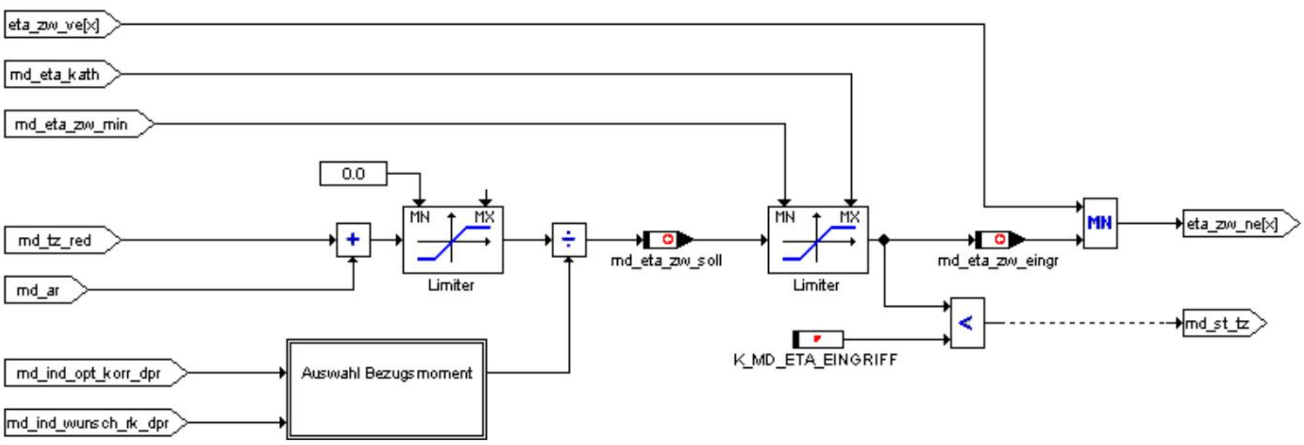

Image: Calculation of the engagement ignition angle (ZW_Eingriff_13_2.gif)

14.3. CALCULATION OF STANDARDIZED IGNITION HOOKS

The calculation of the ignition angle efficiency and the intervention ignition angle of the torque manager is based on the standardized ignition hooks. For this purpose, speed- and wi-dependent standard ignition hooks are stored.

The speed and wi-dependent standard ignition hooks are determined by the parameters a and b of the parabola equation

(1) y = ax2 + bx + 1

described.

The parabola is always open downwards, so that the parameter a must always be negative. The input value x represents the difference between the optimal, corrected ignition angle and the ignition angle to be considered. Since the ignition angle output is limited to the minimum permitted ignition angle "zw_min", the ignition angles are also limited to this value within the ignition hook calculation.

The output value y represents the ignition angle efficiency, which can only reach the value 1.0 with an input value of zero (no infinitely flat ignition hooks). The output value is therefore always between the efficiency possible for the "zw_min" and 1.0.

Substituting the general variables in Eq.(1) with the corresponding labels, we get:

(2) eta_zw_x = zw_polynom_a * (dzw_x)^2 + zw_polynom_b*dzw_x + 1

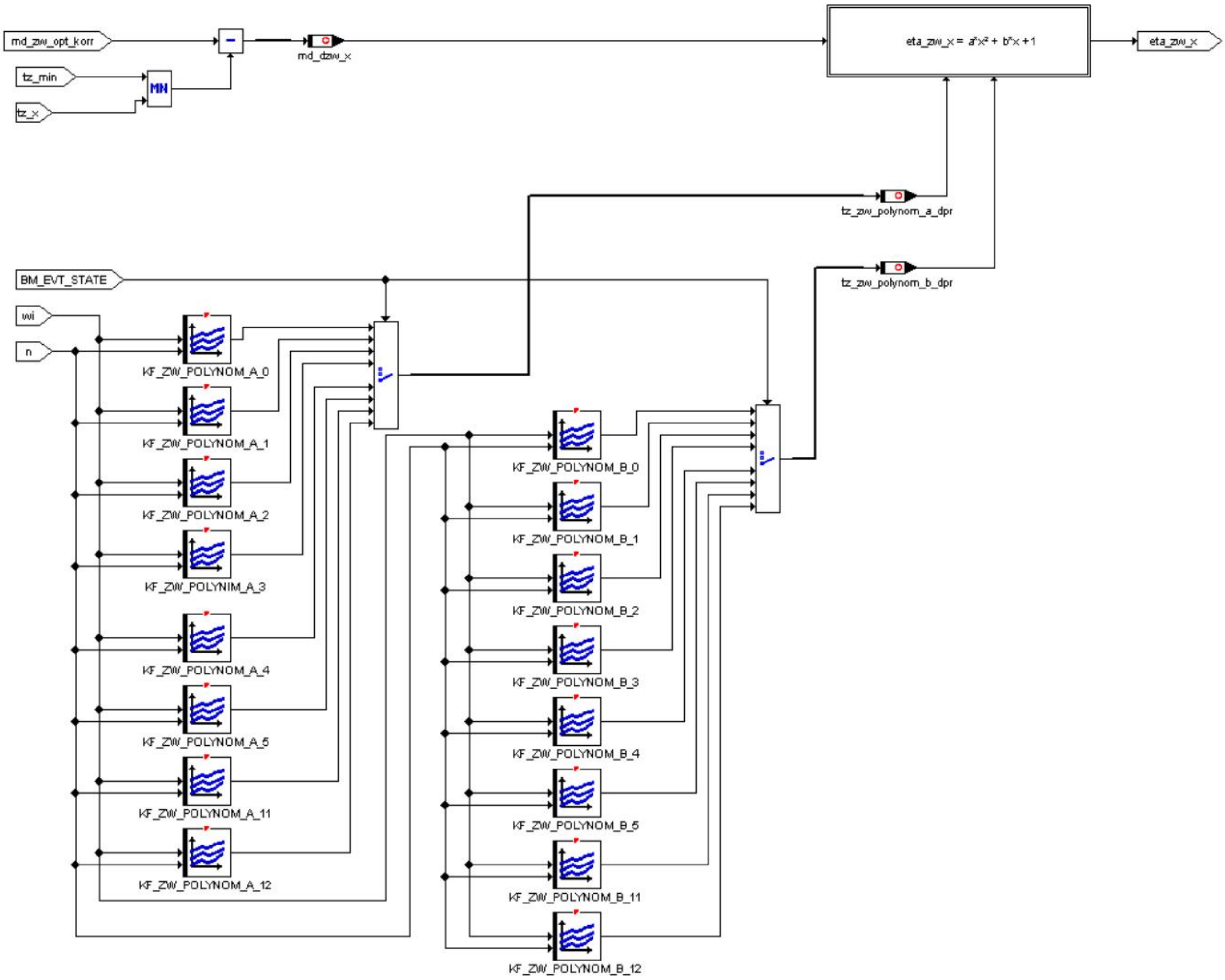

Image: Calculation of standardized ignition hooks (ZW_Eingriff2_3.gif)

15. MONITORING MOMENT CALCULATION

15.1. SECURING MOMENT CALCULATION

The main path of the torque calculation and all offset torques from other modules that affect it are checked for plausibility within the torque manager. If an implausible value is detected, this value is immediately converted to a neutral value and an error filter is started. After the error filtering has been completed, the Egas monitoring function is notified, which then switches the Egas system to emergency running level 2 - emergency driving via the idle control system.

When making efficiency corrections (ignition angle, lambda) within the torque manager, the efficiency is only limited downwards, but no error entry or change to an emergency program occurs, since it cannot be ruled out that the limit value may be undercut during normal operation.

Security queries (error conditions):

- Engine drag torque “md_e_schlepp_hyp” < maximum effective engine torque “md_e_max”
- Loss torque of the engine “md_e_schlepp” > “K_MD_SK_MAX_MDMIN” and
  Speed threshold "n" > "K_MD_SK_N_MDMIN"
- Output MD dynamic filter > maximum torque “K_MD_SK_MAX”
- resulting desired moment "md_ind_wunsch_red_korr" > "K_MD_SK_MAX"
- Lambda lean factor > 2 (overflow)

monitoring torque interventions

- Intervention I-part of the idle control “md_llri” > maximum intervention “K_MD_SK_LLR_MAX”
- Intervention PD component of the idle control “md_llrp” > maximum intervention “K_MD_SK_LLR_MAX”

15.2. MONITORING TARGET TORQUE TO ACTUAL TORQUE

It is very difficult to verify the plausibility of the actual torque of the engine in relation to the driver's desired torque over the entire operating range, since in this case a large number of input parameters, all non-stationary conditions and all torque interventions from other modules would have to be taken into account. This would require that almost the entire calculation path be stored redundantly, which is not possible due to a lack of resources, or the corresponding tolerance limits would have to be greatly expanded.

Two torque monitoring functions have therefore been implemented in the MSS60. One function compares the actual torque with the desired torque, taking all torque interventions into account, and has wider tolerance limits. And one torque monitoring function that is limited to a zero torque setting by the driver (PWG = zero), but is activated accordingly. This has the advantage that the torque calculation can be estimated much better at this operating point, and the tolerance limit can therefore be set more narrowly. It can also be assumed that if the engine delivers an undesirably high torque, the driver will automatically take his foot off the accelerator, thus fulfilling the activation conditions for this test.

15.2.1. MONITORING DESIRED/ACTUAL TORQUE ACROSS THE ENTIRE OPERATING RANGE

Definition of the actual moment md_sk_vergl_ist =
md_ind_ne actually generated indicated actual torque of the motor, determined from Map of speed and load and engine efficiency under consideration of all interventions

Definition of the target torque md_sk_vergl_soll =

md_e_fw_filter	filtered driver request torque from PWG position or cruise control
- md_e_schlepp +	Drag torque of the engine including all consumers
md_ar +	intervention moment of the anti-jerk control
md_llri +	intervention torque of the I-controller of the idle control
md_llrp	intervention torque of the P-controller of the idle control

In the case of a torque-increasing MSR intervention, the maximum of the requested torque and “md_sk_vergl_soll” is used as the target torque.

If the actual torque of the engine exceeds the target torque for the period “K_MD_SK_TIMER_MD” by the amount K_MD_SK_OFFSET + (1 - K_MD_SK_GEWICHTUNG) * md_sk_vergl_ist, it is concluded that there is an error in the Egas system and a change to the emergency program 2 -
Driving via the idle control system.

Monitoring is active in the “engine running” operating state.

15.2.2. MONITORING DESIRED/ACTUAL TORQUE WITH PWG DEFAULT = 0

activation condition for monitoring

- Operating state Engine running
- no FGR operation
- no MSR intervention
- Dashpot function of the dynamic filter reduced
- Pedal value specification <= K_MD_SK_PWGMIN
- Engine speed > idle target speed + K_MD_SK_NHYS

If in this case the calculated driver request torque exceeds the value “K_MD_SK_FWMAX” or the calculated DK target position exceeds the value “KL_MD_SK_WDK” for the period “K_MD_SK_TIMER”, an error in the torque calculation is concluded and the Egas system also switches to the emergency program of level 2.

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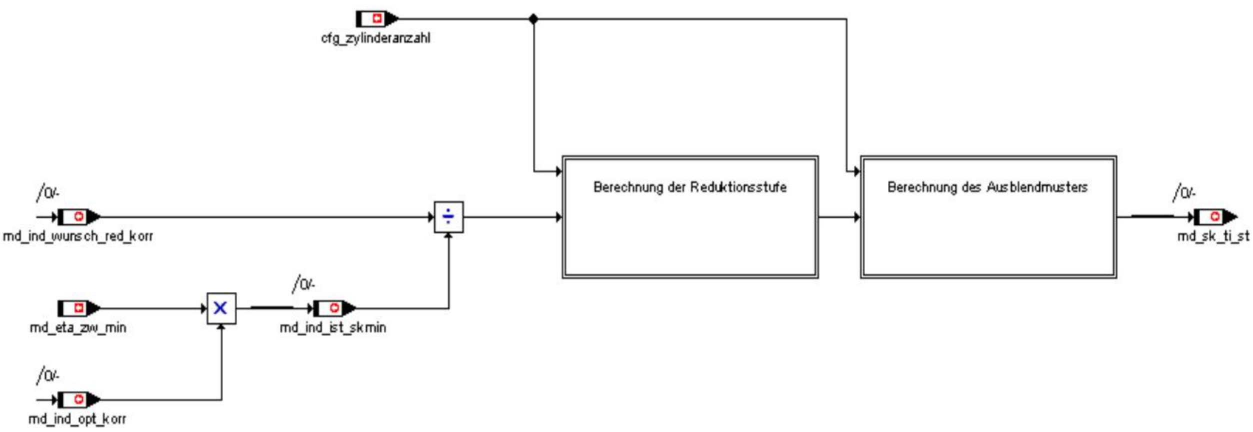
15.3. PARTIAL FIRE WITH OPEN AND STUCK THROTTLE VALVES

If the throttle valves are stuck open, the filling specification calculated by the torque manager can no longer be implemented because the throttle valve system no longer responds. However, in order to continue to be able to control the engine's torque output, the torque manager must use another option to intervene in the torque generation - the injection.

For this purpose, a suppression efficiency "md_sk_verh" is calculated based on the desired torque and the current actual torque of the engine, taking into account the ignition angle interventions possible at this operating point. If this efficiency falls below the value of one, this means that the desired engine torque can no longer be reduced by means of ignition angle interventions alone. A suppression level "md_sk_tired" is therefore calculated, which corresponds to the number of active cylinders and switches off the cylinders that are not required according to a predefined suppression pattern.

Intervention in the injection is carried out via the variable "md_sk_ti_st", whereby each cylinder is represented by a bit. If the bit is set, this means that the corresponding cylinder can be active. If the bit is deleted, the cylinder must be switched off.

Overview: Partial firing (teilfeuerung.gif)



In the partial firing module, there are two applicable constants that are not visible in the overview image. The constant "K_MD_SK_TIRED_HYS" can be used to set a hysteresis for the efficiency that acts between hiding and showing. The constant "K_MD_SK_TIRED_MIN" defines the minimum number of cylinders that must be active. If a reduction level below this value is required, all cylinders are hidden.

16. APPLICABLE DATA OF THE TORQUE MANAGER

name	Meaning
K_MD_ASC_BEGR	minimum moment for ASC intervention
K_MD_ASC_CONTROL	Control byte for activating the ASC interventions
K_MD_BEGR_AUSS_ABREG	Reduction ramp for torque limitation in the event of catalytic converter damage dropouts
K_MD_BEGR_AUSS_TIME	Waiting time until torque limitation in case of cat-damaging dropouts
K_MD_BEGR_DELTA	change limit for torque limitation
K_MD_BEGR_RAMPE	reduction ramp for torque limitation
K_MD_BEGR_T	delay time for torque limitation
K_MD_BEZUG_ZW	Selection for reference torque ZW intervention (control byte ZW-interventions)
K_MD_DELTA_SA_HARD	Step size Md filter with hard SA
K_MD_DELTA_SA_SOFT	Step size Md filter with soft SA
K_MD_ETA_EINGRIFF	ZW efficiency below which an ignition angle intervention is only activated
K_MD_ETA_LAMBDA_MAX	maximum lambda efficiency for the filling correction
K_MD_ETA_MCS	Configuration parameters for consideration md_eta_zw_stat
K_MD_ETA_STAT_TAU	Filter time constant for stationary ZW efficiency
K_MD_I_VMAX	Integrator step size for Vmax control via torque
K_MD_J_FZ	vehicle inertia Nm/s2
K_MD_J_MOTOR	Motor inertia Nm/s2
K_MD_MIN_KKOS_AUS_FILTER	Filter time constant for compressor shutdown
K_MD_MIN_KKOS_FILTER	filter time constant for compressor activation
K_MD_MIN_KKOS_START	factor for filter initial value increase compressor activation
K_MD_MIN_START_FILTER	filter time constant for starting torque control
K_MD_MIN_VERH_KRAFTS	Limitation of the MDmin hyperbola in adhesion
K_MD_MIN_VERH_NO_KRAFTS	Limitation of the MDmin hyperbola without force closure
K_MD_MIN_VERH_START	Limiting the MDmin hyperbola during startup
K_MD_MSR_BEGR	Maximum torque for MSR requirement
K_MD_NORM	standard torque for CAN interface
K_MD_POLYNOM_A_LL	A-polynomial for ignition hook calculation at LL
K_MD_POLYNOM_B_LL	B-polynomial for ignition hook calculation at LL
K_MD_RES_CONTROL	control byte torque reserve
K_MD_RES_KATH_LL	Md reserve at Katheizen in LL
K_MD_RES_KATH_START	Starting value Md reserve for cat heaters
K_MD_RES_KATH_T_ABREG	Reduction ramp for torque reserve catalyst heating
K_MD_RES_KATH_T_AUFREG	Control ramp for torque reserve cat heating
K_MD_SK_AX_IMIN	Min value I controller for acceleration limitation in Egas-emergency program
K_MD_SK_ETA_MIN	minimum value for ZW efficiencies

K_MD_SK_FWMAX	max. permissible md_fw_rel at pwg = 0
K_MD_SK_GEWICHTUNG	Weighting factor target to actual torque for torque monitoring
K_MD_SK_LLR_MAX	max. permissible intervention torque of the idle control
K_MD_SK_MAX	max. permissible indicated moment within the moment calculation
K_MD_SK_MAX_MDMIN	max. permissible md_ind_min
K_MD_SK_N_MDMIN	Speed threshold for md_min monitoring
K_MD_SK_NHYS	Speed offset to llr_nsoll for monitoring Md zero setting
K_MD_SK_OFFSET	Offset for monitoring target to actual torque
K_MD_SK_PWGMIN	PWG threshold below the Md zero setting active
K_MD_SK_TIMER	Filter time for monitoring Md zero setting
K_MD_SK_TIMER_MD	Filter time for monitoring target/actual torque
K_MD_SK_TIRED_HYS	Hysteresis for blanking efficiency in partial firing
K_MD_SK_TIRED_MIN	min. number of cylinders still active in partial firing
K_MD_STAT_ASC	Test parameters for status feedback DSC intervention
K_MD_TZ_CONTROL	Control byte for the ignition angle interventions of the torque manager
K_MD_TZMIN_HYS	ZW hysteresis for SA triggering
K_MD_VMAX_MAX	Minimum torque for I-controller Vmax limitation
K_MD_VMAX_MIN	Maximum torque for I-controller Vmax limitation
K_V_MAX	V activation threshold for Vmax limitation
K_V_MAX_HYS	V-hysteresis for Vmax limitation
KF_MD_FAHRER	relative target torque from pwg_soll and n
KF_MD_LAMBDA	Lambda actual value with inactive lambda controller = f (n, wi) eg warm-up
KF_MD_MAX_MD_IND_OPT	Motor torque map = f (n, wi) determined under standard conditions
KF_MD_MIN_BRENN	maximum negative distance to the drag torque of the engine in fired operation = f (n, tmot)
KF_MD_MIN_REIB_DIFF	Friction torque difference at standard temperature = f (tmot, toel)
KF_MD_MIN_START	additional offset torque during start = f (n, tmot)
KF_MD_POLYNOM_A	Parameter for the quadratic term of the ignition hook parabola =f(n,wi)
KF_MD_POLYNOM_B	Parameter for linear term of the ignition hook hyperbola = f (n, wi)
KF_MD_RES_KATH	Offset torque for torque reserve cat heating f (n, wi)
KF_MD_RES_KATH_GEW	Weighting factor for torque reserve cat heating f (tmot, t_ml)
KF_MD_WE	Ramp moment for re-insertion
KF_MD_ZW_OPT	Best ignition angle value = f (n, wi)
KL_MD_BEGR_AUSS	Torque limitation = f (n) in the event of cat-damaging misfires
KL_MD_BEGR_FST	Torque limit = f (n) with empty tank
KL_MD_BEGR_GANG	gear dependent Maximum torque = f (gear)
KL_MD_BEGR_NOISE	Torque limitation = f (v) for noise limitation Gear weighting of
KL_MD_LS_W_GANG	time constants for MD dynamic filter
KL_MD_MIN_DN_HYP	Speed offset for MDmin hyperbola = f (tmot)

KL_MD_MIN_REIB_ABREG	Friction torque offset after start = f (tmot)
KL_MD_MIN_REIB_OFFSET	Friction torque after start = f (tmot)
KL_MD_SK_AX	max. permissible vehicle acceleration in the emergency program
KL_MD_SK_AX_GANG	gear weighting for acceleration limitation
KL_MD_SK_AX_INEG	I-parameter for acceleration limitation
KL_MD_SK_AX_IPOS	I-parameter for acceleration limitation
KL_MD_SK_AX_P	P-parameter for acceleration limitation
KL_MD_SK_GRAD	Ramp of the transition function at Md limit
KL_MD_SK_MAX	max. engine torque in Egas emergency program
KL_MD_SK_WDK	max. permissible DK position with Md zero specification f (n)
KL_MD_W_GANG_DASHPOT	Gear dependent Weighting factor for MD dynamic filter DASHPOT
KL_MD_WURZEL	Root characteristic for backward calculation of the ignition hook parabola
KL_MD_ZW_LA	Influence of the lambda value on the ignition angle optimum value = f (la)
KL_MD_ZW_TMOT	Influence of engine temperature on ignition angle optimum value = f (tmot)
KL_V_MAX_GANG	gear-dependent maximum speed
KL_V_MAX_SK	maximum speed for Egas emergency program levels

17. MOMENT MANAGER VARIABLES

name	Meaning
can_kkos_lm	Load torque air conditioning compressor from CAN
eta_nex x = 1 .. 8	cylinder-selective ZW efficiencies after ZW interventions of the MM
eta_vex x = 1 .. 8	cylinder-selective ZW efficiencies before ZW interventions of the MM
md_ar	AR intervention
md_begr_auss	Limiting torque in the event of cat-damaging misfires or an empty tank
md_begr_auss_st	Status of the torque limitation in the event of cat-damaging misfires or an empty tank
md_begr_st	status of the torque limit
md_begr_t	Waiting time until activation of torque limitation
md_dyn_ausg	output value of the MD dynamic filter
md_dyn_st	status of the MD dynamic filter
md_eta_ausblend	filtering efficiency
md_eta_kath	target efficiency of catalytic converters
md_eta_lambda	lambda efficiency
md_eta_res	Factor for increasing the filling specification with torque reserve
md_eta_zw_eingr	ZW target efficiency before intervention
md_eta_zw_min	ZW efficiency for the latest possible ignition angle
md_eta_zw_ne	Average cylinder efficiency across all cylinders after torque intervention
md_eta_zw_soll	target efficiency before intervention
md_eta_zw_stat	ZW efficiency for stationary ignition angle
md_eta_zw_ve	Average cylinder efficiency across all cylinders before torque intervention
md_e_fw	Desired moment driver/FGR effective
md_fw_filter	filtered desired moment driver/FGR
md_fw_rel	relative driver desired torque
md_ind_asc	torque intervention ASC
md_ind_asc_abs	indicated torque for ASC ignition angle intervention
md_ind_asc_lm	torque intervention ASC via filling
md_ind_asc_lm_abs	indicated moment for ASC filling procedure
md_ind_fgr	Wunschmoment from FGR
md_ind_ist	driver's desired moment without interventions / corrections
md_ind_ist_skmin	minimum achievable actual torque at tz_min
md_ind_lm_ist	desired moment with moment limits
md_ind_max	maximum indicated moment
md_ind_msr	torque intervention MSR
md_ind_msr_abs	indicated moment for MSR filling procedure
md_ind_ne	Actual torque including ignition angle interventions of the torque manager
md_ind_ne_ist	determined indicated moment including all interventions
md_ind_opt	maximum actual torque under standard conditions

md_ind_opt_korr	maximum actual torque under the current conditions
md_e_schlepp	effective drag torque of the engine
md_ind_ve	Actual torque without ignition angle interventions of the torque manager
md_e_verbraucher	Loss moment effectively caused by consumer
md_ind_vmax	maximum torque at Vmax limit
md_ind_wunsch	indicated desired moment from the driver / FGR
md_ind_wunsch_begr	limited moment of desire
md_ind_wunsch_filter	=md_ind_wunsch + md_llri (not available in Gredi but SW)
md_ind_wunsch_korr	Desired moment for filling path after 1st correction stage
md_ind_wunsch_red	Desired moment for filling path after 2nd correction stage
md_ind_wunsch_red_korr	Desired moment for filling path after 3rd correction stage
md_kr_dtz_mittel	medium ZW-late draw per cylinder from KR/KA
md_ksg	KSG actual moment
md_ksg_filter	KSG actual torque filtered
md_llr_tz	TZ share of the LFR
md_llra	adaptation part of the LFR
md_llra_ko	adaptation share of the LFR at B_KO
md_llri	I-part of the LFR
md_llrp	P-part of the LFR
md_ls_kf	input value for LS filter
md_max_begr	maximum permitted indicated engine torque
md_mcs_zyl	Calculation of ignition angle intervention for cylinder x active
md_min_dn_hyp	Speed offset for calculation MDmin hyperbola
md_min_start	offset moment for start
md_noise_max	Limiting the indicated torque to reduce noise (not in Gredi)
md_norm	reference torque for CAN interface
md_norm_can	Normalization reference for moment interface
md_polynom_a	current parameter for quadratic term of the ignition hook parabola
md_polynom_b	current parameter for linear term of the ignition hook parabola
md_reib	determined friction torque
md_reib_abreg	step size reduction of friction torque
md_reib_offset	offset friction torque
md_res	currently effective torque reserve
md_res_kath	torque reserve for catalytic converters
md_res_kath_factor	Off/reduction factor torque reserve cat heating
md_res_kath_roh	Raw value torque reserve for catalytic converters
md_sawe_filter	filtered desired moment SAWE
md_sawe_verh	start time of the load impact filter
md_sk_begr	maximum moment MD-SK
md_sk_ti_st	release mask for injection channels
md_sk_tired	number of released injection channels

md_sk_vergl_ist	Actual torque in MD monitoring
md_sk_vergl_soll	target torque in MD monitoring
md_sk_verh	Ratio of target torque to min.actual torque
md_st	Statusbyte Moment Manager
md_st_eingriff	status torque intervention
md_st_tz	Status byte ignition angle intervention torque manager
md_tz_red	torque specification tz intervention
md_wunsch_rel	relative desired moment driver/FGR
md_zw_lambda	Lambda compensation optimal ignition angle not in Gredi
md_zw_opt	Optimal ignition angle
md_zw_opt_korr	ignition angle optimum under the current conditions
md_motor	engine torque delivered to the clutch including all interventions =md_ind_ne - md_e_schlepp
wi	specific indicated work [kJ/dm3]