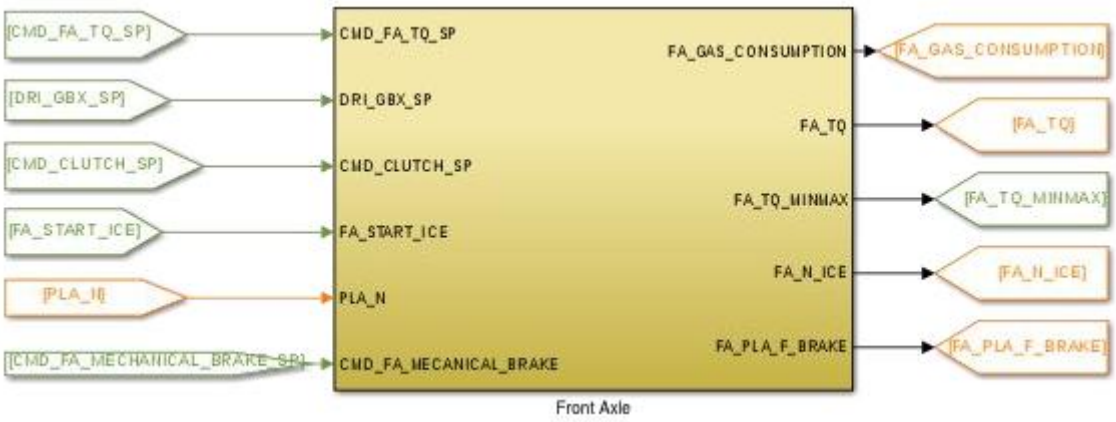
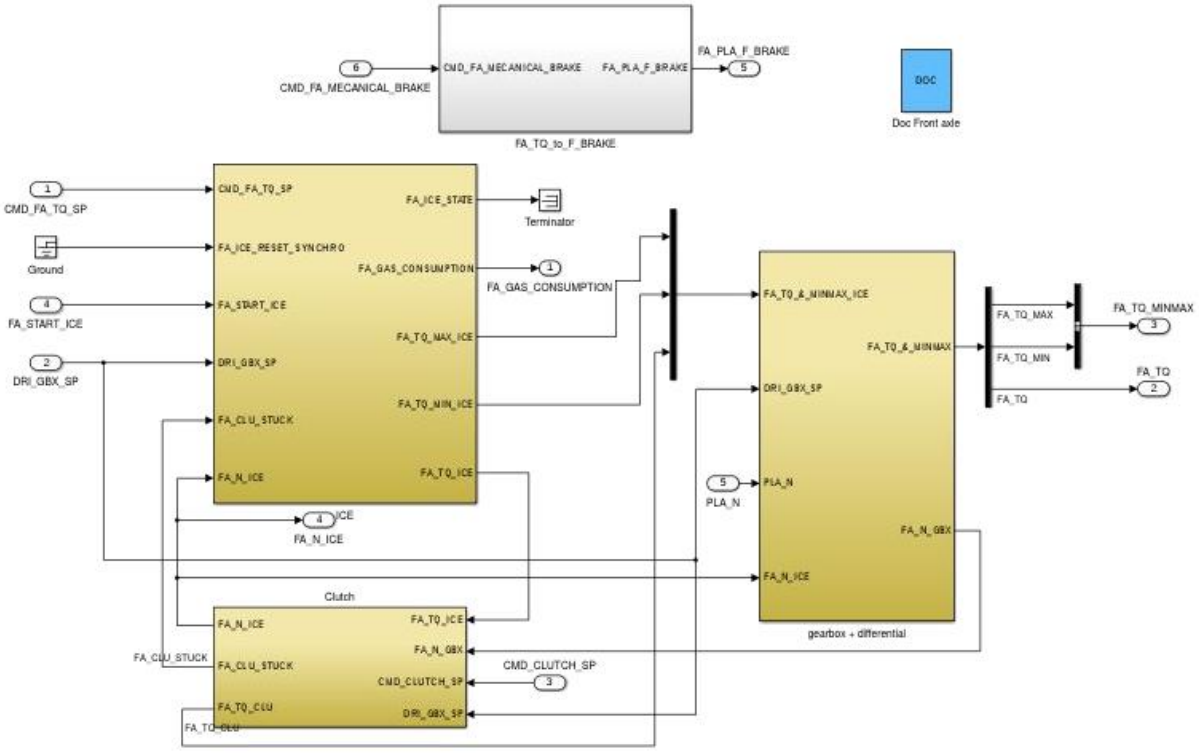
Front axle model

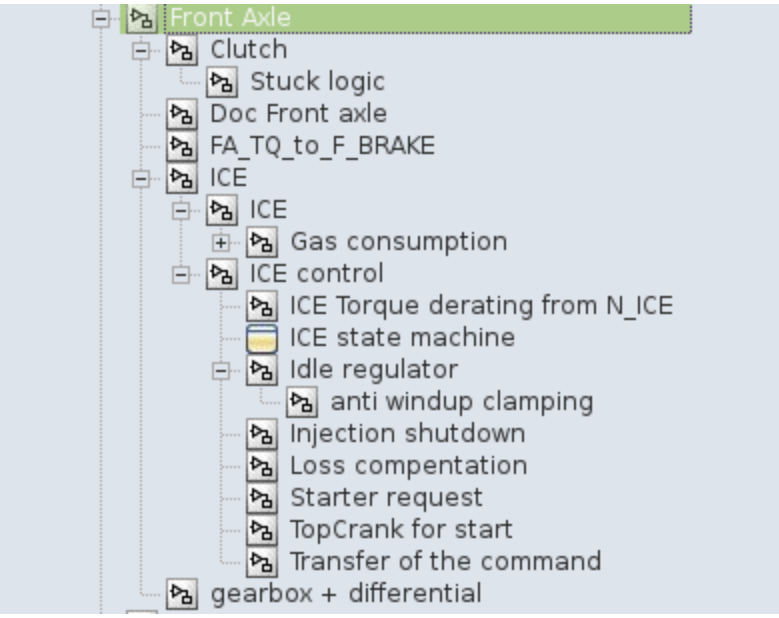
1 System description

Model of the Front axle. The model includes the internal combustion engine and the control system associated, and a transmission composed of a clutch, a gearbox and a differential.



2 System organization





Model browser

3 Signals and parameters

Inputs

Name	Description	Note
PLA_N	Wheel speed	In RPM
CMD_FA_TQ_SP	Torque set point for the ICE	In N.m
CMD_FA_MECHANICAL_BRAKE_SP	Torque set point of mechanical brake of front axle	In N.m
DRI_GBX_SP	Gearbox engaged gear	For a manual gearbox
DRI_CLUTCH_SP	Clutch pedal value	Range [0, 1]
FA_START_ICE	Starts the engine	-

Outputs

Name	Description	Note	Destination
FA_GAS_CONSUMPTION	Instantaneous gas consumption	-	Command
FA_TQ	Torque to wheel from the front axle	-	Platform
FA_PLA_F_BRAKE	Force set point of mechanical brake of front axle	In N	Platform
FA_TQ_MINMAX	Minimum and maximum torque for the ICE	Normalized torque “to wheel”, two signal: - FA_TQ_MIN - FA_TQ_MAX	Command
FA_N_ICE	Rotation speed of the ICE	In rpm	Driver

Parameters

Native

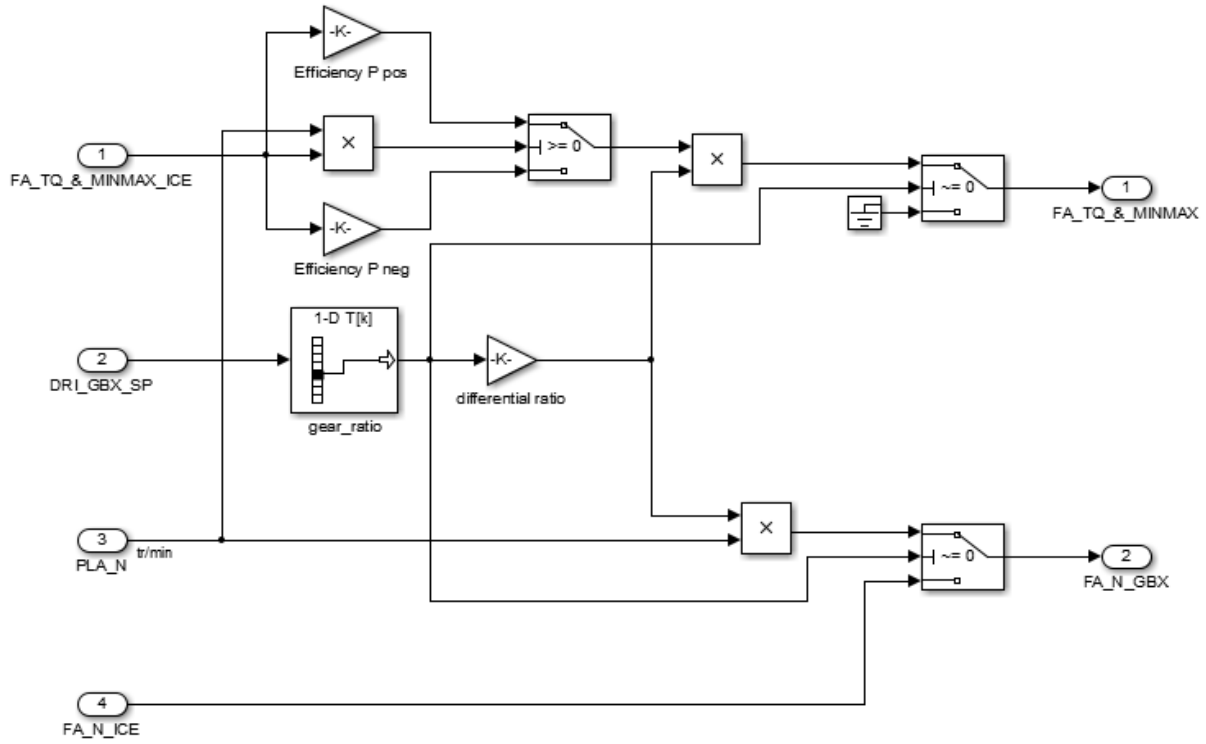
Name	Type	Unit	Description	Source	Linked to
fa_clu_pos	vector	Nm	Clutchmaximum transmitted torque	Internship 2014	fa_clu_pv
fa_clu_pv	vector	-	Clutchpedal position	Internship 2014	fa_clu_pos
fa_conso_speed	vector	RPM	ICE speed input vector for gas consumption	Continental	fa_conso_torque; fa_fuel_consumption
fa_conso_torque	vector	Nm	ICE torque input vector for gas consumption	Continental	fa_conso_speed; fa_fuel_consumption
fa_differential_ratio	var	-	Front axledifferential ratio	Continental	
fa_fuel_consumption	table	g	ICE gasconsumption	Continental	fa_conso_torque; fa_conso_speed
fa_gearbox_ratio	vector	-	Gearbox ratio	Continental	
fa_gearbox_efficiency	var	-	Gearboxefficiency	Continental	
fa_ice_inertia	var	$kg.m^2$	Engine inertia	Continental	
fa_kp_idle_tr_off	var	-	Idle controller parameter – Kp transmission off	Internship 2014	
fa_kp_idle_tr_on	var	-	Idle controller parameter – Kp transmission on	Internship 2014	
fa_max_tq_clu	var	Nm	Maximum transmitted torque for the clutch	Internship 2014	
fa_max_tq_ice	vector	Nm	Maximum ICE torque	Continental	fa_tq_max_speed
fa_n_ice	vector	RPM	ICE speed input vector for ICE loss	Continental	fa_tq_loss
fa_starter_rpm	vector	RPM	Starter speed input vector for starter torque	Continental	fa_starter_tq
fa_starter_tq	vector	Nm	Starer torque	Continental	fa_starter_rpm
fa_tau_ice	var	s	ICE time constant	BEI N7 2014	
fa_taui_idle_tr_off	var	s	Idle controller parameter – Ti transmission off	Internship 2014	
fa_taui_idle_tr_on	var	s	Idle controller parameter – Ti transmission on	Internship 2014	
fa_tq_loss	vector	Nm	ICE loss	Continental	fa_n_ice
fa_tq_max_speed	vector	RPM	ICE torque input vector for ICE maximum speed	Continental	fa_max_tq_ice

Inherited

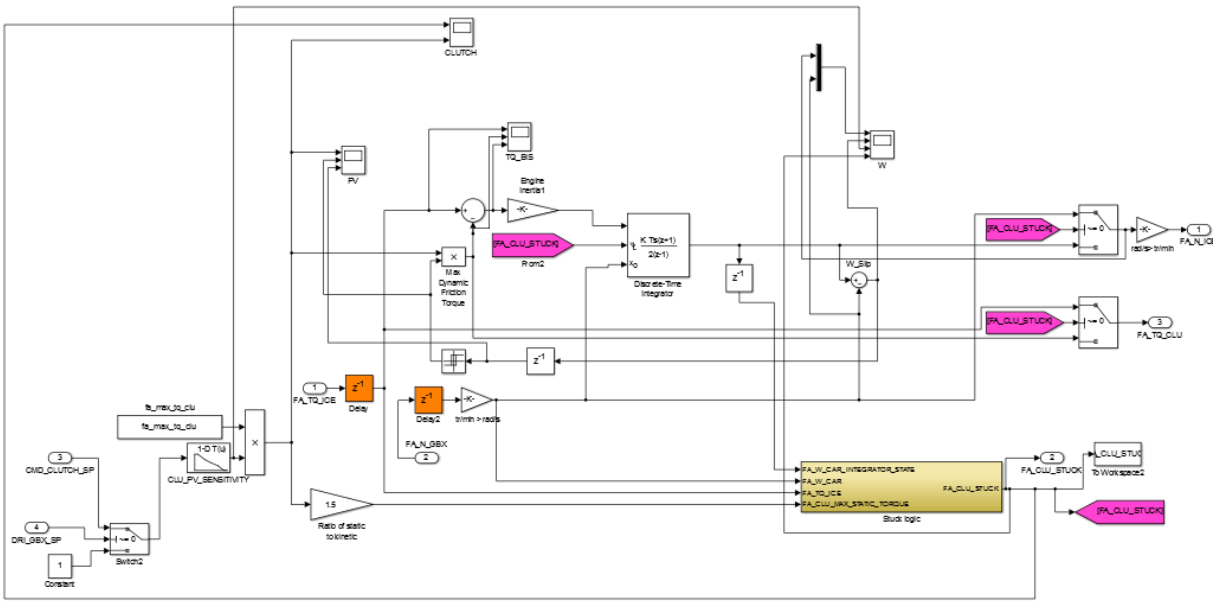
Name	Type	Unit	Description	Source	Linked to
pla_wheel_radius	var	m	Wheel radius (includes tire deformation)	BEI N7 2014	

4 Subsystems description

Gearbox + differential

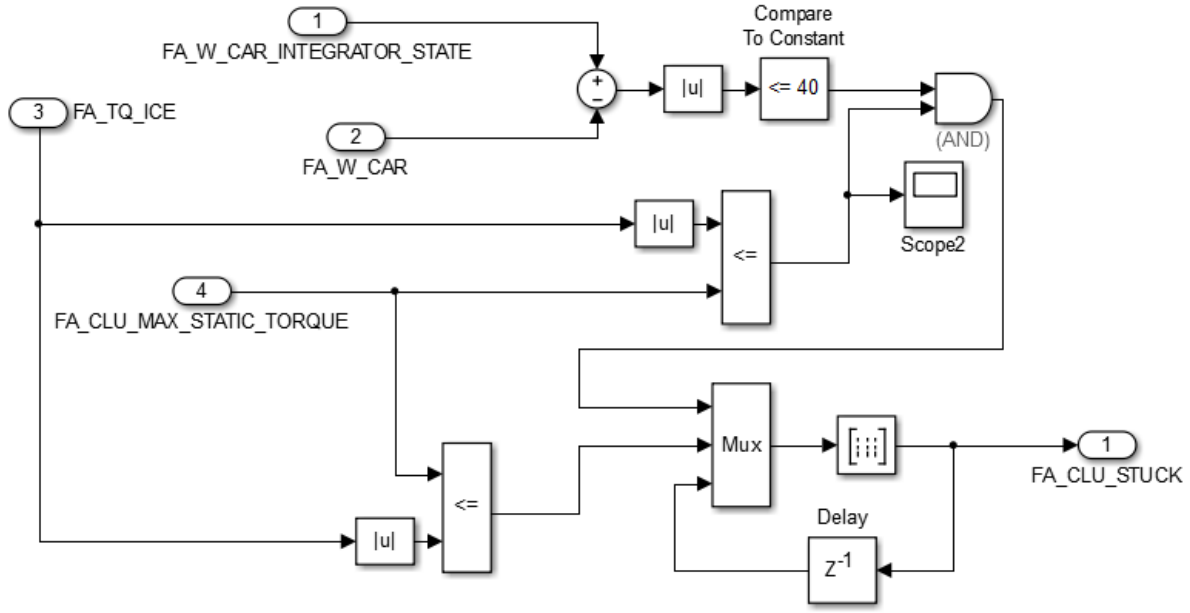


Clutch



Stuck logic

Determine if the clutch is open/slipping or stuck.



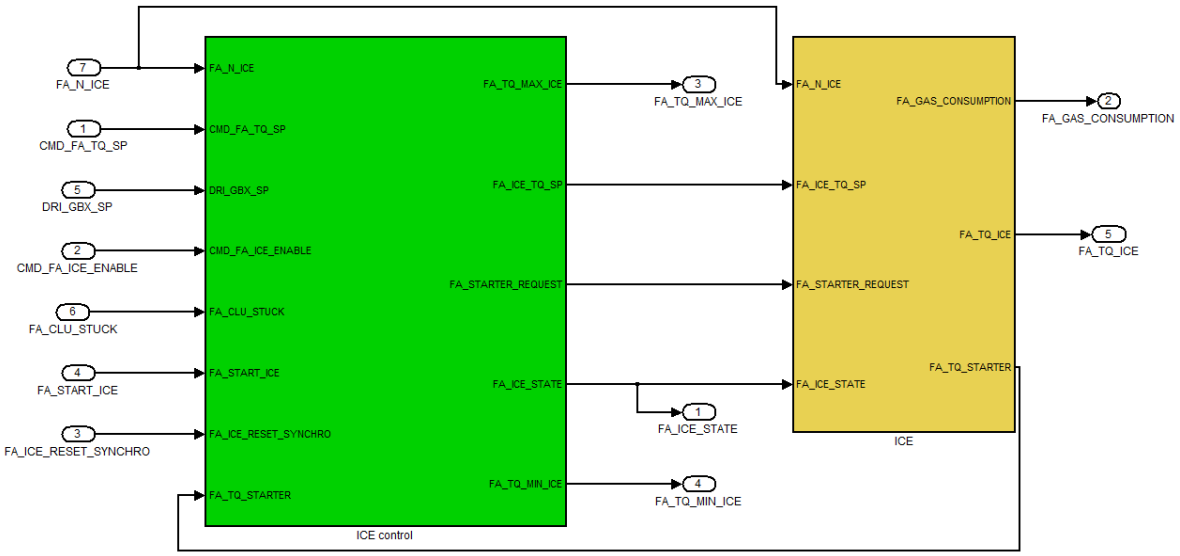
The objective of the stuck logic is to determine if the clutch is slipping or not. If the torque of the ICE is higher than the the maximum clutch static torque, the clutch is slipping. If the torque of the ICE is lower than the the maximum clutch static torqueand the speed of the gearbox and the speed of the ICE are different, the clutch is slipping. If both conditions are true the past state is used.

The truth table is the following :

TQ_ICE >= TQ_STATIC_MAX	TQ_ICE <= TQ_STATIC_MAX & N_ICE ≠ N_GBX	z^{-1}	CLUTCH_STUCK
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

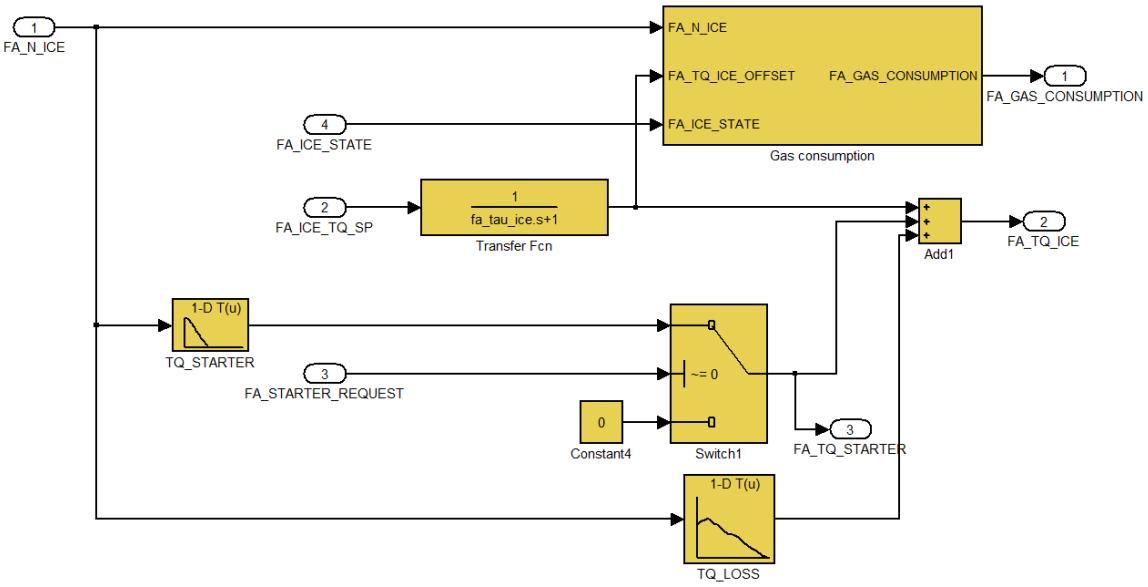
The speed of the gearbox and the speed of the ICE are consider equal when the difference between them is less than 40 rpm (see FA_W_CAR_INTEGRATOR_STATE &FA_W_CAR).

Internal combustion engine



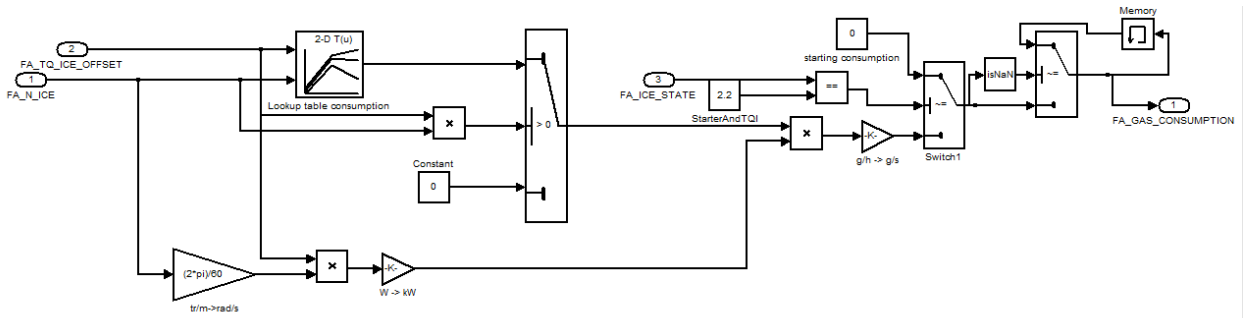
ICE

Behavior of the ICE (torque generation and fuel consumption)



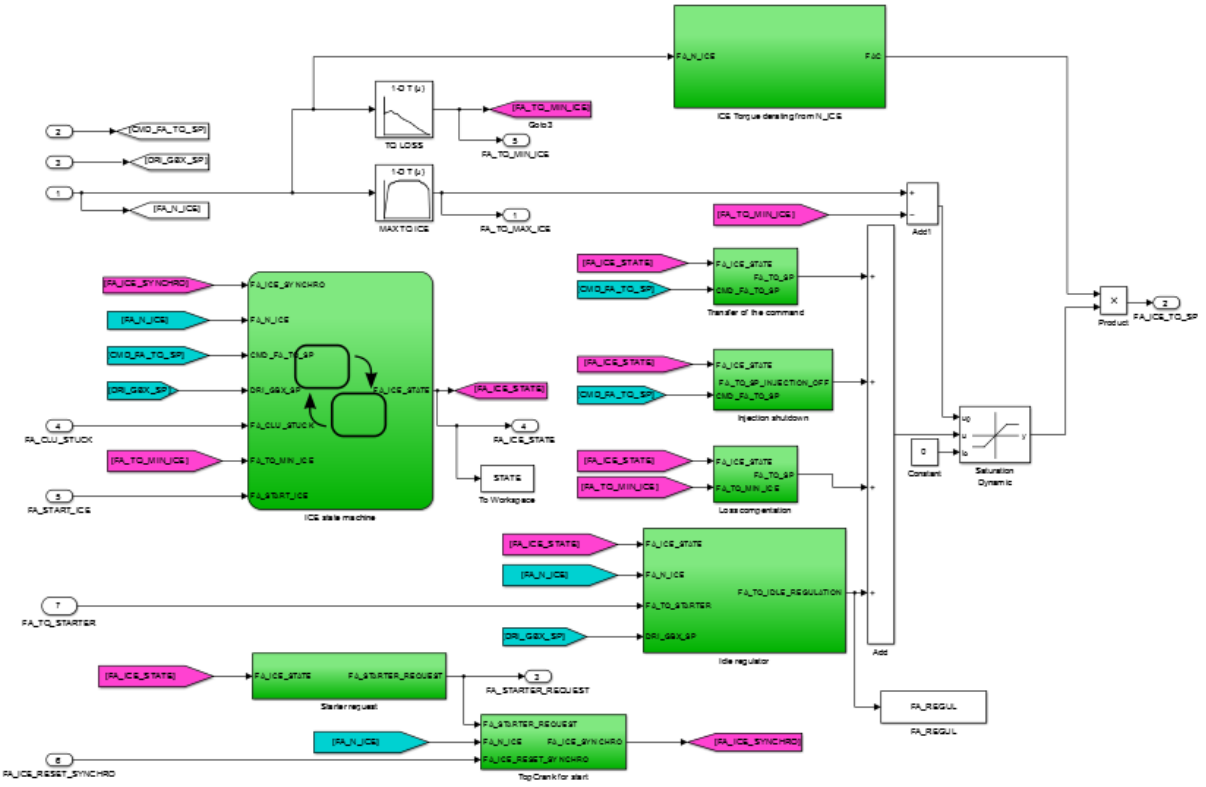
Gas consumption

Estimation of the instantaneous fuel consumption.



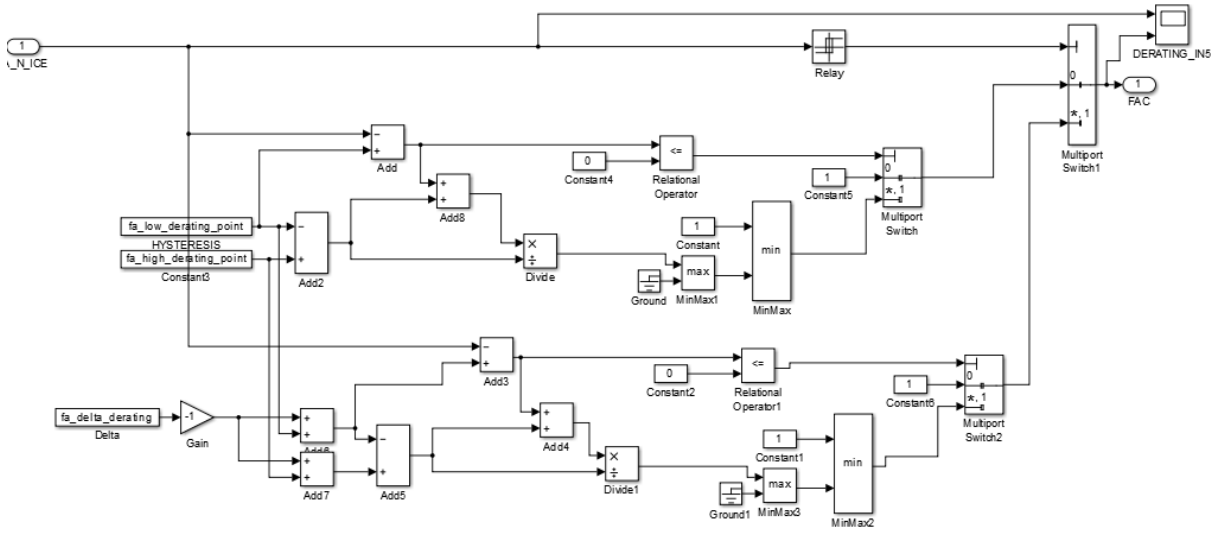
ICE control

Control of the ICE. Determines the running mode and the torque set point.



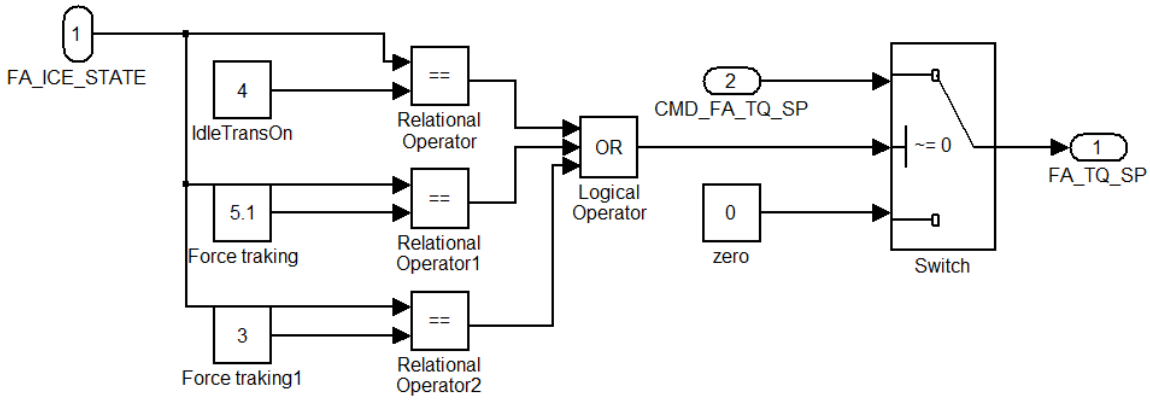
ICE_TORQUE DERATING FROM N_ICE

The derating is used in case of overspeed of the ICE. It regulates the speed at a determined value. The lower the slope, the lower the oscillations. The slope is calculated for being at the limit of oscillations (overshoot of 10 rpm).



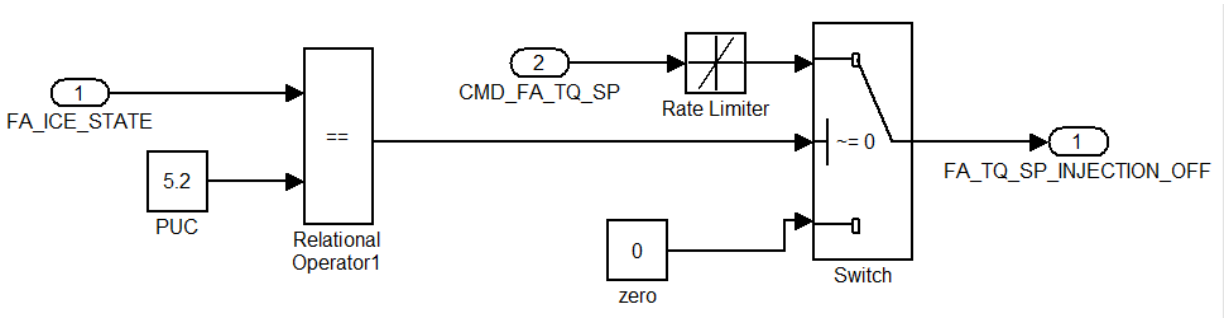
Transfer of the command

Copy the command set point.



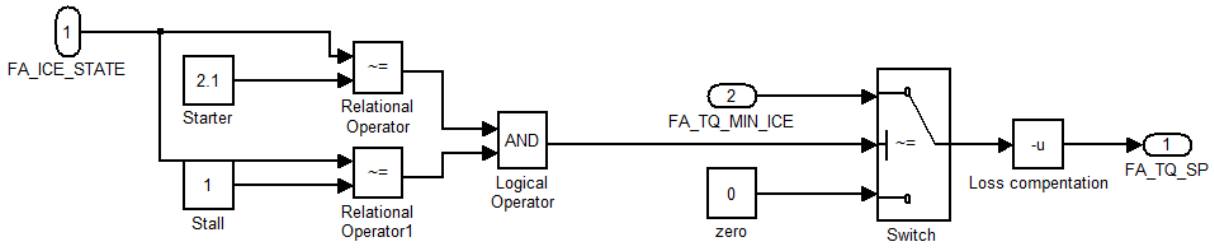
Injection shutdown

Create a set point with a determined slew rate on a quick decrease of the driver set point to the minimum.



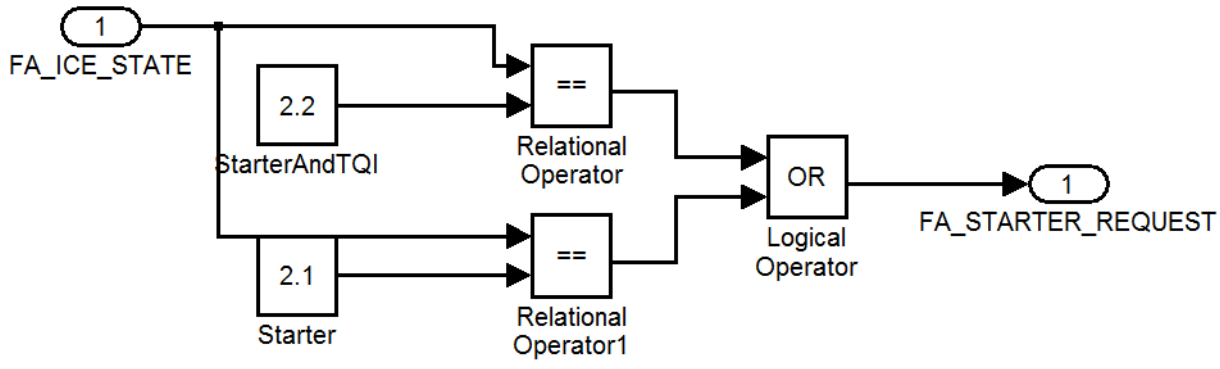
Loss compensation

Compensation of the ICE loss on running set point.



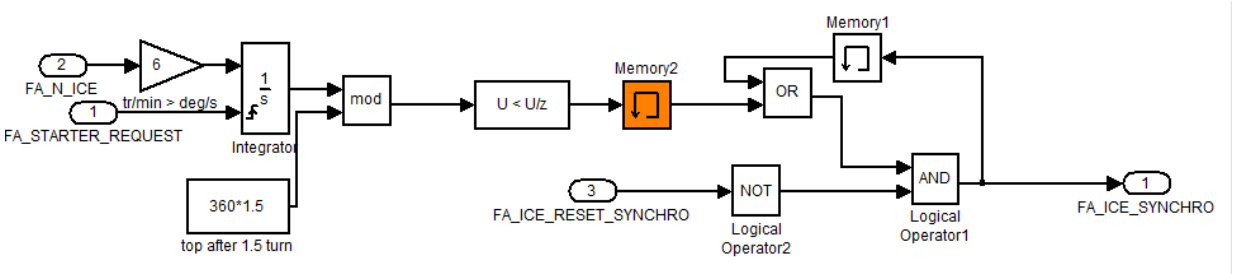
Starter request

Sent an enable signal to the starter.



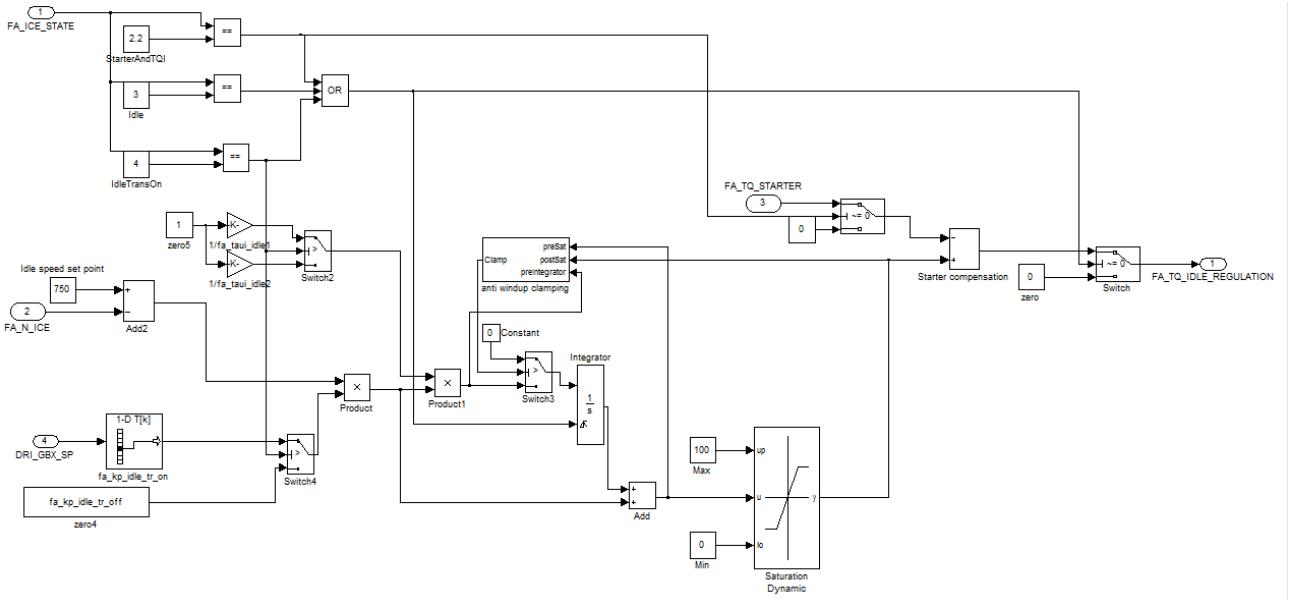
TopCrank for start

Estimation of the crank position for ECU synchronization.



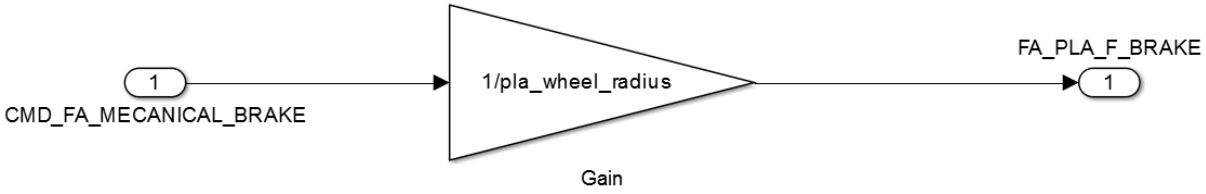
Idle regulator

Idle speed regulator, based on a PI with coefficient depending of the ICE mode. Include a compensation for the Starter toque.

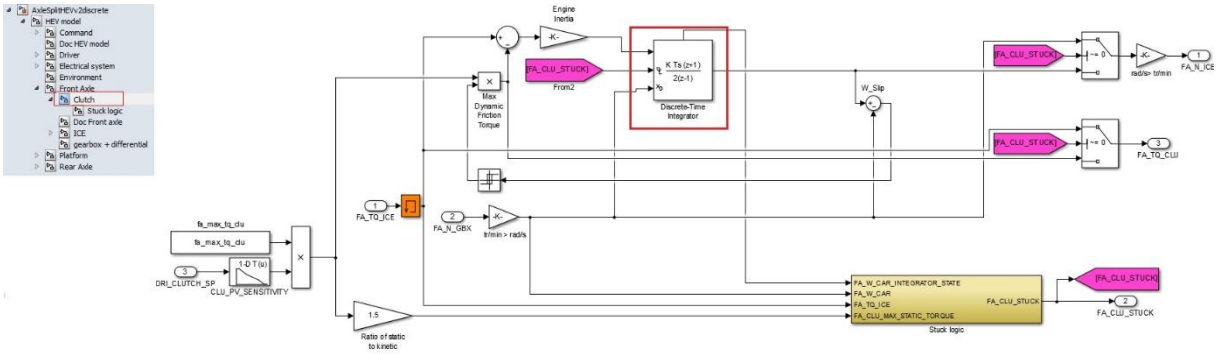


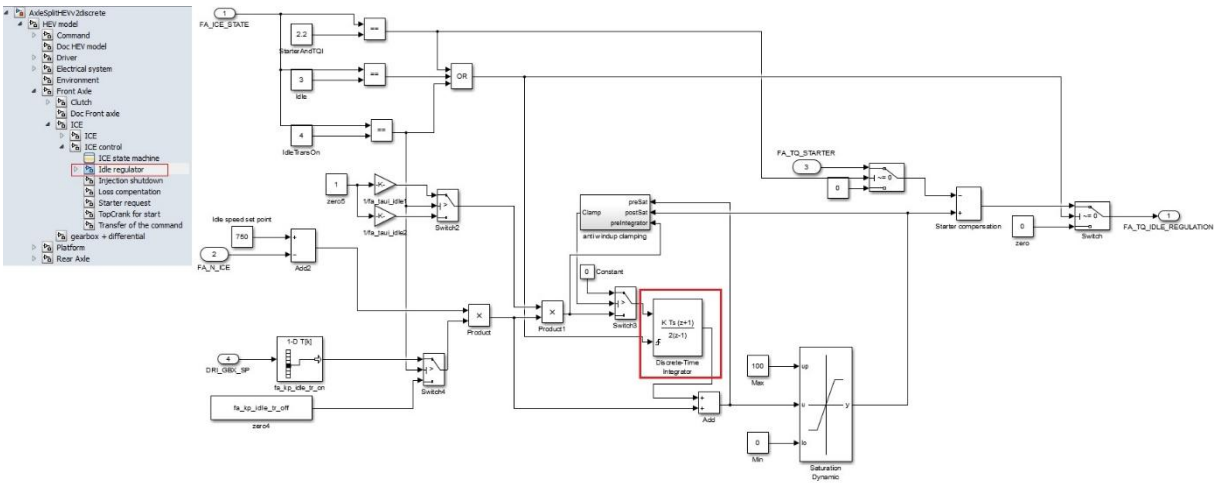
Braking Torque to force conversion

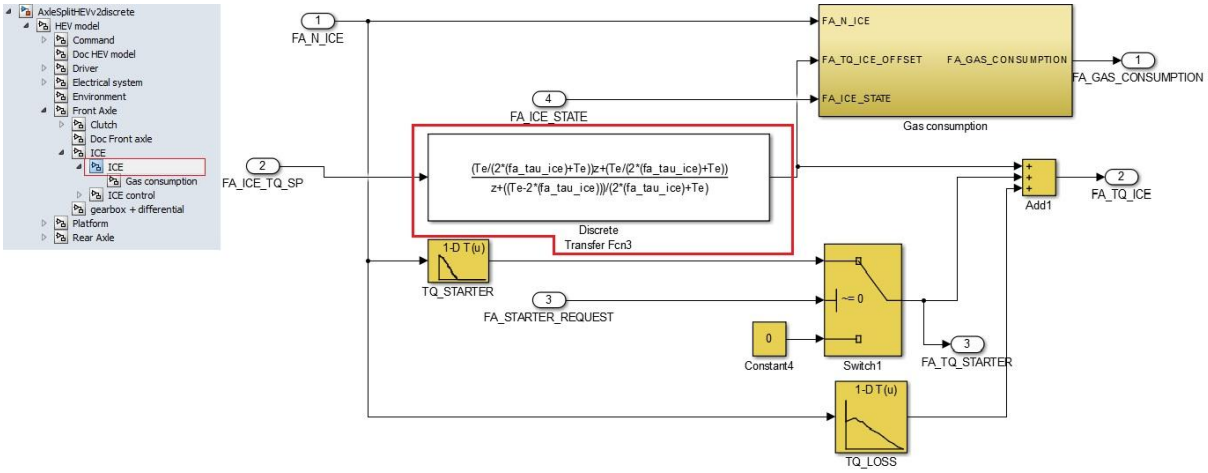
Convert torque to wheel braking to force braking



5 Discrete model







Same inputs, outputs and parameters. The only changes are in the red squares.
See part 5 (“Discrete model”) of the document “HEV model” to know how are made the discrete blocs.