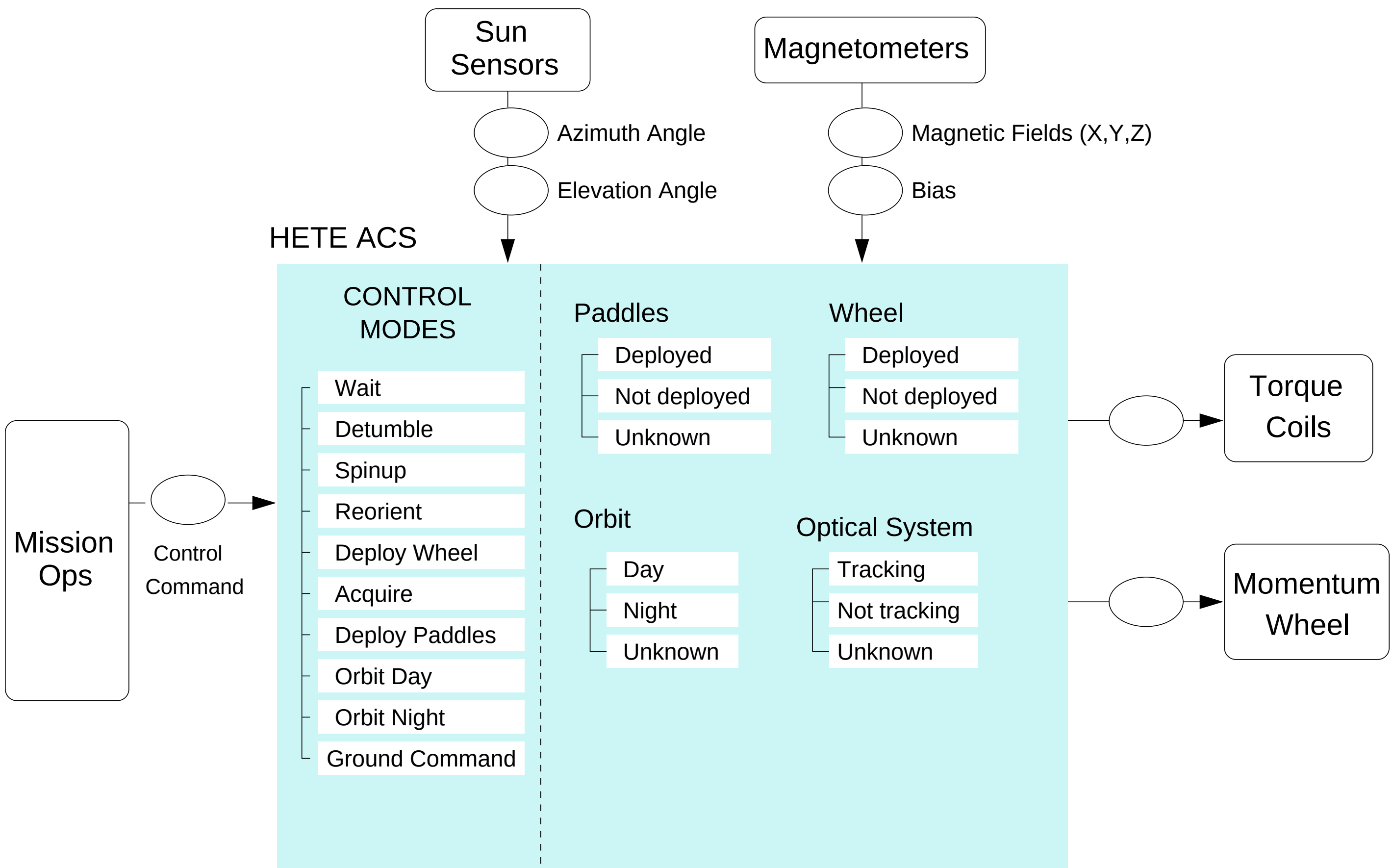
DRAFT (INCOMPLETE)



ACS Mode

Description: The ACS has 10 modes. In nominal operation, the control system will progress through the initial modes and stablize in modes 5, 7, and 8. The system goes through modes 0 to 6 during the deployment sequence. During the operations phase, modes 7 and 8 are activated alternatively. Mode 9 is the backup ground command mode.

Comments:

References:

Appears in:

DEFINITION

= Wait (Mode 0)

The default mode on startup or reset. The software stays in this mode until a set number of cycles have passed, then switches to mode 1. This allows the sensors to collect enough data to accurately represent the vectors required to control the spacecraft. In this mode, none of the actuators should be active (wheel should be commanded to zero torque, torque coils should be commanded to zero torque, and the paddle deployment should not be activated).

Control Mode	Startup	T		
	Any		T	
	Wait			T
State Values	Reset Command Received		T	
	t - t(entered wait) < 10 sec_{WMD}			T

ACS Mode (2)

= Detumble (Mode 1}

The purpose of detumble mode is to minimize the magnitude of body momuntum vector in the X-Z plane. As soon as the magnitude falls below a threshold, the software should transition to spinup mode. The mode delay provides hysteresis in the mode transitions to prevent the software from jumping between modes too rapdily.

In detumble mode, the wheel actuator shall be controlled such that the wheel maintains the velocity it had upon entering the mode, and the magnetic moment along the Y axis shall be controlled to minimize the angular velocity about the X and Z axes.

Control Mode	Wait	T					
	Detumble		T	T			
	Spinup				T	T	
	Ground Control						T
State Values	t - t(entered wait) >= 10 sec_{WMD}	T					
	t - t(entered detumble) < 100 sec $_{DMD}$		T	F			
	xz momentum error > xz momentum error threshold			T	T	T	
	t - t(entered spinup) >= 100 sec_{SMD}				T	T	
	paddles in-state deployed				F		
	Optical system in-state tracking					F	
	t - t(entered ground control) >= 10 sec_{GCMD}						T

ACS Mode (3)

= Spinup (Mode 2)

Spinup mode induces a +5 degrees per second rotation around the Y axis, to help stabilize the spacecraft's attitude. This is the safety mode for the ACS; anytime the controller is uncertain of what needs to be done, it enters this mode.

The Y magnetic moment shall be used to perform nutation damping while the X and Z magnetic moments should be commanded to spin up the satellite to the desired momentum vector.

Control Mode	Detumble	T								
	Spinup		T	T	T					
	Reorient					T	T			
	Acquire							T		
	Orbit Day								T	
	Orbit Night									T
State Values	t - t(entered detumble) >= 100 sec $_{DMD}$	T								
	xz momentum error <= xz momentum error threshold	T		T	T					
	t - t(entered spinup) < 100 sec $_{SMD}$		T	F	F					
	paddles in-state deployed		F	F	F					
	Optical system in-state tracking		F	F	F				F	T
	Momentum error > spinup momentum error			T			T			
	Orbit in-state day				F	F	T	F	F	F
	t - t(entered reorient) >= 6000 sec $_{RMD}$						T			
	angular-velocity > max tumble rate									T
	sine sun azimuth > fine azimuth error									F
	sine sun elevation > fine elevaaion error									F

ACS Mode (4)

= Reorient (Mode 3)

Reorient mode tries to orient the spacecraft so that the sun vector lies in the spacecraft X-Z plane. Momentum about the Y axis is not regulated, as the spacecraft needs to be spinning about that axis on entry to mode 4.bpu

This goal is achieved by commanding the magnetic moment on the X and Z axes to minimize sun elevation error. The Y magnetic moment is used to perform nutation damping, similar to that in mode 2 (spinup)

Control Mode	Spinup	T	T			
	Reorient			T	T	
	Acquire					T
State Values	t - t(entered spinup) >= 100 sec $_{SMD}$	T	T			
	xz momentum error <= xz momentum error threshold	T	T			
	Momentum error > spinup momentum error	F	F		F	
	Orbit in-state day	T	T	T		T
	paddles in-state deployed	F				
	Optical system in -state tracking		F			
	t - t(entered reorient) >= 6000 sec $_{RMD}$			T	F	
	sine sun elevation >coarse sun elevaaion error				T	T
	t - t(entered acquire) >= 10 sec $_{AMD}$					T

ACS Mode (5)

= Deploy Wheel (Mode 4}

This modes serves only to spin up the momuntum wheel so as to transfer the Y axis momuntum of the spacecraft from the body to the wheel. the ACS assumes that the wheel takes a particular amount of time to spin up, and after that, automatically transitions to mode 5 (Acquire).

No torquing of the spacecraft body is done in this mode via the torque coils, and the wheel is spun up to it nominal rate.

Control Mode	Reorient	T	
	Deploy Wheel		T
State Values	t - t(entered reorient) >= 6000 sec_{RMD}	T	
	Orbit in-state day	T	
	Momentum error > spinup momentum error	T	
	sine sun elevation >coarse sun elevaaion error	T	
	wheel spin rate < nominal wheel rate	T	
	t - t(entered deploy wheel) < 180 sec_{DWMD}		T

ACS Mode (6)

= Acquire (Mode 5)

Acquire mode attempts to make coarse corrections to the attitude in order to bring it within tolerances for normal operation. It tries to bring the +Z axis (where the solar panels are, once they hvae been deployed) to an orientation such that it points directly at the sun, to within +-100 degrees. This having been accomplished, it then goes to Mode 6 (Deploy Paddels) if the panels have not deployed or to Mode 7 or 8 depending on what part of its orbit the spacecraft is in.

Control Mode	Reorient	T							
	Acquire		T	T					
	Deploy Wheel				T				
	Deploy Paddles					T	T		
	Orbit Day							T	T
State Values	t - t(entered reorient) >= 6000 sec$_{RMD}$	T							
	Orbit in-state day	T	T	T				T	
	Momentum error <= spinup momentum error	T							
	sine sun elevation <= coarse sun elevation error	T		T				T	T
	wheel spin rate >= nominal wheel rate	T							
	t - t(entered acquire) < 10 sec$_{AMD}$		T	F					
	sine sun azimuth > coarse sun azimuth error			T				T	T
	t - t(entered deploy wheel) >= 180 sec $_{DWMD}$				T				
	paddles in-state deployed					T	F		
	t - t(entered deploy paddles) >= 120 sec$_{DPMD}$						T		
	t - t(entered orbit day) >= 10 sec $_{ODMD}$							T	
	Optical system in-state tracking								T

ACS Mode (7)

= Deploy Paddles (Mode 6)

Mode 6 is entered once only. It cuts all magnetic moments to zero, attempts to maintain the wheel velocity, and and deploys the solar paddles (which have the solar panels mounted on their outer surfaces).

Control Mode	Acquire	T	
	Deploy paddles		T
State Values	t - t(entered acquire) >= 10 sec_{AMD}	T	
	Orbit in-state day	T	
	sine sun elevation <= coarse sun elevaaion error	T	
	sine sun azimuth <= coarse sun azimuth error	T	
	paddles in-state deployed	F	F
	t - t(entered deploy paddles) < 120 sec_{DPMD}		T

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ACS Mode (8)

= Orbit Day (Mode 7)

Mode 7 has the same control behavior as mode 5, but with smaller tolerances and better accuracy. Should the momentum or attitude error exceed tolerances, the ACS will transition to mode 2 or mode 5, as necessary, depending on the severity of the error.

Control Mode	Acquire	T						
	Orbit Night		T	T	T			
	Orbit Day					T	T	T
State Values	t - t(entered acquire) >= 10 sec_{AMD}	T						
	Orbit in-state day	T	T	T	T	T	T	T
	sine sun elevation <= coarse sine sun elevaaion error	T					T	T
	sine sun azimuth <= coarse sun azimuth error	T					T	T
	paddles in-state deployed	T						
	sine sun azimuth => fine azimuth error			T				
	sine sun elevation => fine elevation error		T					
	Optical system in-state tracking				T	T	F	T
	t - t(entered orbit day) < 10 sec_{ODMD}					T	F	F

ACS Mode (9)

= Orbit Night (Mode 8)

Orbit night operates identically to orbit day mode, except that all attitude and body rate information is drawn from the optical system, which is used to do star tracking for the ACS.

Control Mode	Spinup	T			
	Orbit Day		T	T	
	Orbit Night				T
State Values	paddles in-state deployed	T			
	Optical system in-state tracking	T		T	T
	t - t(entered orbit day) >= 10 sec_{ODMD}		T	T	
	Orbit in-state day		T		F
	sine sun elevation <= coarse sine sun elevaaion error		T	T	
	sine sun azimuth <= coarse sun azimuth error		T	T	
	angular velocity <= max tumble rate				T
	since sun azimuth < fine azimuth error				T
	sine sun elevation < fine elevation error				T

= Ground Command (Mode 9)

This mode exists so ground control can uplink commands to the satellite. If no command is sent for a given period of time, the satellite transitions to mode 1.

Received ground control command	T