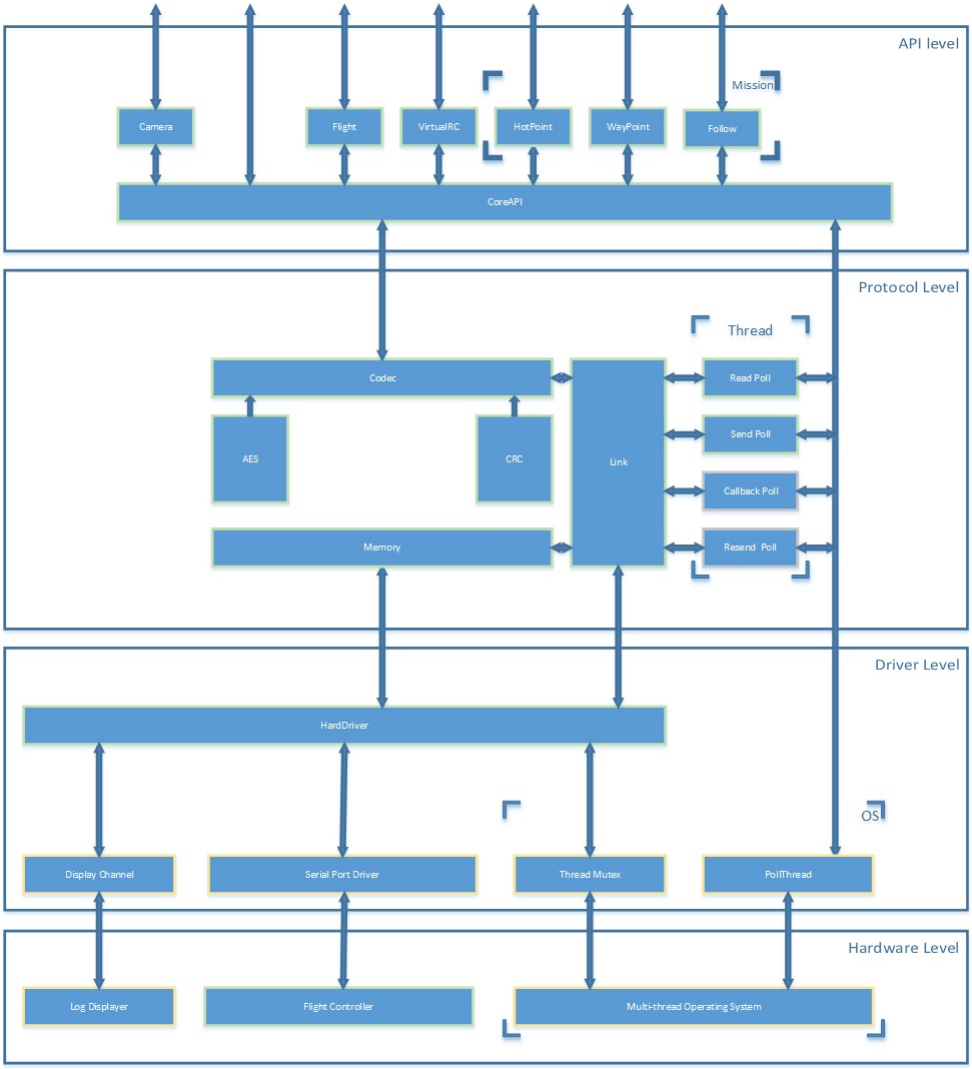
APPENDIX

2017-03-14

Updated with new flight status struct for newer A3/N3/M600 FW

Detailed Architecture



Control mode byte

Control mode byte

The control mode byte is an important bitmask - depending on the mask, you can execute horizontal control, vertical control and yaw control by giving position or rate. Each part has several sub modules.

Control mode byte	bit 7:6	0b00: HORI_ATTI_TILT_ANG 0b01: HORI_VEL 0b10: HORI_POS
	bit 5:4	0b00: VERT_VEL 0b01: VERT_POS 0b10: VERT_THRUST
	bit 3	0b0: YAW_ANG 0b1: YAW_RATE
	bit 2:1	0b00: horizontal frame is ground frame 0b01: horizontal frame is body frame
	bit 0	0b0: non-stable mode 0b1: stable mode

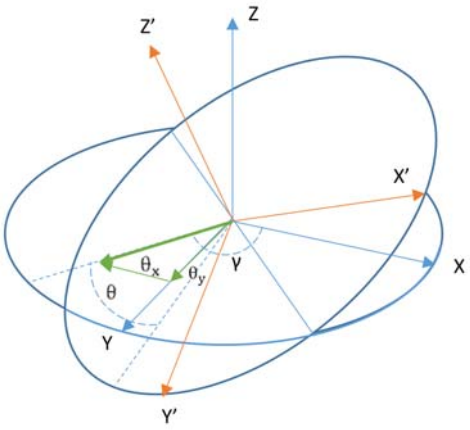
Control mode

We suggest developers do not use VERT_POS control mode indoor when your UAV does not have Guidance installed or the flight height is larger than 3 meters. This is because in indoor environments, barometer can be inaccurate, and the vertical controller may fail to keep the height of the UAV.

> Please note that if the following conditions are met, the control mode is functional:

- Only when the GPS signal is good (health_flag >=3)，horizontal position control (HORI_POS) related control modes can be used.
- Only when GPS signal is good (health_flag >=3)，or when Guidance system is working properly with Autopilot，horizontal velocity control（HORI_VEL）related control modes can be used.

Category	Mode	Explanation
Vertical	VERT_POS	Control the height of UAV
	VERT_VEL	Control the vertical speed of UAV, upward is positive
	VERT_THRUST	Directly control the thrust, the range is from 0% to 100%
Horizontal	HORI_ATTI_TILT_ANG	Pitch & roll angle, need to be referenced to either the ground or body frame
	HORI_POS*	Position offsets of pitch & roll directions, need to be referenced to either the ground or body frame
	HORI_VEL	Velocities on pitch & roll directions, need to be referenced to either the ground or body frame
Yaw	YAW_ANG	Yaw angle is referenced to the ground frame. In this control mode, Ground frame is enforeced in Autopilot
	YAW_RATE	Yaw angular velocity



The input of HORI_POS is a position offset instead of an actual position. This design aims to take both GPS flight and vision-based flight into consideration. If the developer wants to use GPS navigation, the GPS information sent by the UAV can be used to calculate position offset. While in vision-based flight application, developers should have their own positioning device (along with Gudiance or GPS to provide velocity measurement) to do position control.

Combinations

Attitude control accuracy is about 0.5 degrees, speed control accuracy of about 0.2 m/s.

Index	Combinations	Input Data Range (throttle/pitch&roll/yaw)	control_mode_byte
1	VERT_VEL HORI_ATTI_TILT_ANG YAW_ANG	-4 m/s ~ 4 m/s -30 degree ~ 30 degree -180 degree ~ 180 degree	0b00000xxy
2	VERT_VEL HORI_ATTI_TILT_ANG YAW_RATE	-4 m/s ~ 4 m/s -30 degree ~ 30 degree -100 degree/s ~ 100 degree/s	0b00001xxy
3	VERT_VEL HORI_VEL YAW_ANG	-4 m/s ~ 4 m/s -10 m/s ~ 10 m/s -180 degree ~ 180 degree	0b01000xxy
4	VERT_VEL HORI_VEL YAW_RATE	-4 m/s ~ 4 m/s -10 m/s ~ 10 m/s -100 degree/s ~ 100 degree/s	0b01001xxy
5	VERT_VEL HORI_POS YAW_ANG	-4 m/s ~ 4 m/s offset in meters (no limit) -180 degree ~ 180 degree	0b10000xxy

Index	Combinations	Input Data Range (throttle/pitch&roll/yaw)	control_mode_byte
6	VERT_VEL HORI_POS YAW_RATE	-4 m/s ~ 4 m/s offset in meters (no limit) -100 degree/s ~ 100 degree/s	0b10001xxy
7	VERT_POS HORI_ATTI_TILT_ANG YAW_ANG	0m to height limit -30 degree ~ 30 degree -180 degree ~ 180 degree	0b00010xxy
8	VERT_POS HORI_ATTI_TILT_ANG YAW_RATE	0m to height limit -30 degree ~ 30 degree -100 degree/s ~ 100 degree/s	0b00011xxy
9	VERT_POS HORI_VEL YAW_ANG	0m to height limit -10 m/s ~ 10 m/s -180 degree ~ 180 degree	0b01010xxy
10	VERT_POS HORI_VEL YAW_RATE	0m to height limit -10 m/s ~ 10 m/s -100 degree/s ~ 100 degree/s	0b01011xxy
11	VERT_POS HORI_POS YAW_ANG	0m to height limit offset in meters (no limit) -180 degree ~ 180 degree	0b10010xxy
12	VERT_POS HORI_POS YAW_RATE	0m to height limit offset in meters (no limit) -100 degree/s ~ 100 degree/s	0b10011xxy
13	VERT_THRUST HORI_ATTI_TILT_ANG YAW_ANG	10 ~ 100 (use with precaution) -30 degree ~ 30 degree -180 degree ~ 180 degree	0b00100xxy
14	VERT_THRUST HORI_ATTI_TILT_ANG YAW_RATE	10 ~ 100 (use with precaution) -30 degree ~ 30 degree -100 degree/s ~ 100 degree/s	0b00101xxy

xx presents horizontal frame，00 means ground frame，01 means body frame.
y presents stable flag，0 means non-stable mode，1 means stable mode. Stable mode only works in horizontal control.

Flight Data

Flight Data

Item Name	Variables	Data Type	Description	Unit	Default Frequency
Time Stamp	time	uint32_t	400hz time stamp	1/400s	100Hz
	time	uint32_t	ns time stamp	ns	
	time	uint8_t	Sync signal flag	---	
Quarternion	q0	float32	Attitude quaternion From ground frame to body frame	---	100Hz
	q1	float32			
	q2	float32			
	q3	float32			
Linear acceleration	agx	float32	Linear acceleration (Raw/Fusion)	Fusion: m/s^2 Raw: G	100Hz
	agy	float32			
	agz	float32			
Linear velocity	vgx	float32	Linear velocity in Ground Frame	m/s	100Hz
	vgy	float32			
	vgz	float32			

	vgstatus	uint8_t	Status byte of linear velocity • bit 0：data valid flag 0：invalid 1：valid • bit 1:7 ： reserved	---	
Angular velocity	wx	float32	Angular velocity (Raw/Fusion)	rad/s	100Hz
	wy	float32			
	wz	float32			
GPS and altitude	longti	double	GPS location	rad	100Hz
	lati	double			
	alti	float32	Altitude (Raw/Fusion)	m	
	height	float32	Height relatively to ground (Raw/Fusion)	m	
	health_flag	uint8_t	GPS healthiness	0-5, 5 is the best condition	
GPS detailed info (A3 only)	date	uint32_t	date	yy-mm-dd	50Hz
	time	uint32_t	time	hh-mm-ss	
	longitude	int32_t	longitude	degree*10^7	
	latitude	int32_t	latitude	degree*10^7	
	AMSL	int32_t	height above mean sea level	mm	
	vel_N	float32	velocity in North direction	cm/s	
	vel_E	float32	velocity in East direction	cm/s	
	vel_D	float32	velocity in Down direction	cm/s	
RTK detailed info (A3 only)	date	uint32_t	date	yy-mm-dd	50Hz
	time	uint32_t	time	hh-mm-ss	
	longitude_RTK	double	longitude by RTK	degree	
	latitude_RTK	double	latitude by RTK	degree	
	AMSL_RTK	float32	AMSL by RTK	m	
	vel_N	float32	velocity in North direction	cm/s	
	vel_E	float32	velocity in East direction	cm/s	
	vel_D	float32	velocity in Down direction	cm/s	
	yaw	int16_t	angle between antenna baseline and South	degree	
	position_flag	uint8_t	positioning flag		
	yaw_flag	uint8_t	yaw flag	---	
Magnetometer	mx	int16_t	Magnetometer data	Magnetometer data	0Hz
	my	int16_t			
	mz	int16_t			
Remote controller channel	roll	int16_t	roll channel	---	50Hz
	pitch	int16_t	pitch channel		
	yaw	int16_t	yaw channel		
	throttle	int16_t	throttle channel		
	mode	int16_t	mode channel		
	gear	int16_t	gear channel		
Gimbal	roll	float32	roll, pitch and yaw of ground frame	°	50Hz

	pitch	float32			
	yaw	float32			
	limit_byte	uint8_t	limit flag • bit 0: Pitch limit flag • bit 1: Roll limit flag • bit 2: Yaw limit flag • bit 3:7 reserved	---	
Flight status	status	uint8_t	Flight status	---	10Hz
Battery	status	uint8_t	Battery percentage	%	1Hz
Source of Control	cur_mov_control_mode	uint8_t	current api control mode	---	0Hz
	status	uint8_t	Control device • bit 0:2： Control device 0b000： Remote Controller 0b001： Mobile Device 0b010： Onboard Embedded System (OES) • bit 3： Flag of OES control authorization request signature 0：No request 1：Been requested • bit 4： Flag of Virtual RC 0：Disabled 1：Enabled • bit 5:7： reserved	---	

current api control mode

```
typedef enum
{
  ATTI_STOP                  = 0,
  HORIZ_ANG_VERT_VEL_YAW_ANG  = 1,
  HORIZ_ANG_VERT_VEL_YAW_RATE = 2,
  HORIZ_VEL_VERT_VEL_YAW_ANG  = 3,
  HORIZ_VEL_VERT_VEL_YAW_RATE = 4,
  HORIZ_POS_VERT_VEL_YAW_ANG  = 5,
  HORIZ_POS_VERT_VEL_YAW_RATE = 6,
  HORIZ_ANG_VERT_POS_YAW_ANG  = 7,
  HORIZ_ANG_VERT_POS_YAW_RATE = 8,
  HORIZ_VEL_VERT_POS_YAW_ANG  = 9,
  HORIZ_VEL_VERT_POS_YAW_RATE = 10,
  HORIZ_POS_VERT_POS_YAW_ANG  = 11,
  HORIZ_POS_VERT_POS_YAW_RATE = 12,
  HORIZ_ANG_VERT_THR_YAW_ANG  = 13,
  HORIZ_ANG_VERT_THR_YAW_RATE = 14,
  HORIZ_VEL_VERT_THR_YAW_ANG  = 15,
  HORIZ_VEL_VERT_THR_YAW_RATE = 16,
  HORIZ_POS_VERT_THR_YAW_ANG  = 17,
  HORIZ_POS_VERT_THR_YAW_RATE = 18,
  GPS_ATII_CTRL_CL_YAW_RATE   = 97,
  GPS_ATTI_CTRL_YAW_RATE      = 98,
  ATTI_CTRL_YAW_RATE          = 99,
  ATTI_CTRL_STOP              = 100
}
```

Raw/Fusion

Raw/Fusion can be chosen by DJI assistant software.

Because raw data is generated from actual sensor on UAV, this kind of data will not be available in simulator. Please choose Fusion when you use DJI simulator.

Item Name	Raw/Fusion	Description	Unit
Linear acceleration	Fusion(Ground)	Fusion data	m/s^2
	Fusion(Body)	Fusion data	m/s^2
	Raw(Body)	Accelerometer data	G
Angular velocity	Fusion(Body)	Fusion data	rad/s
	Raw(Body)	Gyro data	
Altitude	Fusion	Barometer & IMU	m

	Raw	Barometer data	
Height	Fusion	Barometer、IMU & Ultrasound	m
	Raw	Ultrasound data（within three meters vaild）	

If the flight plantform has no ultrasonic sensor, or its distance to the ground is higher than 3 meters, the height is supported by barometer and IMU only. Since the barometer is inaccurate when used indoor, height is unreliable in this case.

Flight status

In late 2016, the Flight status enums were updated to better reflect the internal state of the FC. Please refer to the compatibility table to figure out which struct you need to work with:

Aircraft/FC	Firmware Package	Old/New Enum
M100	All	Old
A3	< 1.5.0.0	Old
M600	< 1.0.0.80	Old
A3	>= 1.5.0.0	New
M600	>= 1.0.0.80	New
N3	All	New

Old Flight Status Enum

Flight status val	status name
1	standby
2	take_off
3	in_air
4	landing
5	finish_landing

flight status will enter the 'standby' state after 2s in 'finish_landing state'.
flight status will immediately enter 'in_air' state when UAV leave the ground.

New Flight Status Enum

Flight status val	status name
0	motor_off
1	on_ground_motor_on
2	in_air_motor_on

On takeoff, status transitions from 0-->1-->2. On landing, it is the exact opposite transition.

Remote controller channel

Channel	Range	Description
roll	[-10000,10000]	Left: -10000 Right: 10000
pitch	[-10000,10000]	Down: -10000 Up: 10000
yaw	[-10000,10000]	Left: -10000 Right: 10000
throttle	[-10000,10000]	Down: -10000 Up: 10000
mode	-8000, 0, 8000	P: -8000 A: 0 F: 8000

Channel	Range	Description
gear	-10000, -4545	Gear down: -4545 Gear up: -10000