PACE
Platform for Attitude Control Experiment

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PACE website: www.iaalab.ncku.edu.tw/pace/
Introduction

Significances of cubesat research

Cubesat research in Taiwan

NCKU: PACE (2003- )
PACE Features

- Mass: Less than 2 kg
- Dimension: 100 x 100 x 200 mm
- ADCS Requirement: 3-axis stabilization
- Payload: MEMS temperature sensor
- Dual on-board CPUs
- TCS: Passive thermal control
- Operating Orbit (TBD):
  - Near-circular orbit 600 km, inclination 98°
- TT&C: Amateur Radio Communication;
  - Up/Down link: 433MHz, Data Rate: 1200bps
  - CW: 144 MHz band
- Power: Body mount solar array & Li-ion battery
- Satellite Life Time: 2 months
- Launch Scheduled: 2004-2005
Characteristics of the PACE

- A double cube design
- Three-axis stabilization for pico-satellites
  - Momentum biased wheel + magnetic coil
  - Sensor suite integration for attitude determination: magnetometer, gyro, coarse sun sensor
- Two CPU design
  - 8051-based CPU: C&DH and ADCS
- MEMS sensor technology demonstration
  - Temperature sensor
  - Coarse sun sensor
PACE Orbit

- Orbit altitude = 600 km, inclination = 97.79°
- Period = 96.69 min, mean contact duration = 657 sec
PACE Payload

- PACE payload: MEMS sensor
  - Temperature sensor
  - Coarse sun sensor
PACE Configuration

- C&DH
- Magnetometer
- ADCS
- EPS
- Gyro sensor
- Coil
- TT&C
- CW

Battery
Wheel
Antenna

X
Y
Z
PACE Operating Mode

- **Boot/Reset Mode**
  - Remove Before Flight On
  - Boot Complete

- **Ground Test Mode (Idle)**
  - Ground Command

- **Ground Command**
  - Low Power
  - Max Contact Time Exceed

- **Normal Mode**
  - No Contact > N days
  - Bit error occurred

- **Launch Mode**
  - Charge completed

- **Power Monitor Mode**
  - Low Power

- **Safe Mode**
  - Charge completed

- **Initial & 3-Axis Mode**
  - Charge completed
A momentum wheel is developed for the 3-axis control of the PACE.
PACE ADCS

Orbit information

IGRF Model

Magnetometer

Gyro

Coarse Sun Sensor

\( \omega_{\text{Body}} \)

\( \Phi, \theta, \Psi \)

\( B_{\text{Body}} \)

\( \omega_{\text{measured}} \)

\( \omega_{\text{estimated}} \)

\( \Theta_{\text{measured}} \)

\( \Theta_{\text{estimated}} \)

Attitude Determination

Kalman filter

S/C Dynamic

Attitude Control System

Disturbance Torque
## Summary

### Taiwanese Cubesats

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Thank you