FORMOSAT-2 represents the second satellite of Formosa (Taiwan) and was named ROCSAT-2 formerly. As the first earth observation satellite owned by Taiwan, it is a small satellite of 746 kg mass designed for two remote sensing missions: earth observation and upward lightning (red sprite) observation. FORMOSAT-2 had been launch from Vandenberg, California on May 20, 2004. Fourteen days after launch, the satellite had been raised from 723 km parking orbit to 891 km mission orbit, with functional checkout of all subsystems completed on June 3, 2004. Then the performance verification of bus and two payloads follows. In this paper, the performance verification process and results are presented.

For the bus, the performance verification items are agility in pitch maneuver, small angle agility in roll maneuver, and large angle agility in roll maneuver. Specifications for these three items are (45 deg pitch in 60 sec, 10 deg roll in 25 sec, 30 deg roll in 60 sec), respectively. The success criteria are reaching the specified angle within requested time, with clean angular acceleration and rate. For the case of 30 deg roll, we set the completion time for maneuver at 59 sec. As shown in Figure 1, the test is successful.

![Figure 1 Rolling control test result, angular rates in rad/sec.](image-url)
The primary payload of ROCSAT-2 is an advanced remote sensing instrument (RSI) with the characteristics of high performance, low mass and simplicity in design. Performance verification items for RSI are ground sampling distance (GSD) for panchromatic (PAN) image, GSD for multi-spectral (MS) image, swath, and modulation transfer function (MTF) for both PAN and MS. Their specifications are (2 m, 8 m, 24 km, 0.12 (PAN), 0.30(MS)), respectively. For GSD measurement, a panchromatic image of Peng Hu County of Taiwan was used. As shown in Figure 2, there is a bridge between two major islands of the county. Its length is 2494 m. The number of pixels to cover the bridge is 1230. Therefore, the panchromatic GSD is 2494/1230=2.03 m and is within the allowable 5% variation of 2 m. Since the ratio of GSD between MS and PAN is 3.987 due to optical distortion of 0.3%, the GSD for MS is 8.09 m and is within 5% variation of 8 m. Accordingly both PAN GSD and MS GSD meet the specification. Inside RSI there are 12000 PAN pixels, the specification of swath is also satisfied.

Figure 2 The bridge in Peng Hu for GSD measurement.
For the purpose of MTF measurement, a 60 m by 60 m target as shown in Figure 3 has been painted on an obsolete airport runway with tarmac surface in Peng Hu County. Analysis of the image shown in Figure 4 captured by the satellite allows us to retrieve the image quality. The first step is to correct the raw data with in orbit gain and darkness measurements. Then through the reconstruction of over sampled knife-edge function (KEF), derivation of point spread function (PSF), and Fourier transformation, we can obtain the MTF. The measurement results are 0.175 across track and 0.171 along track. Both meet the requirement. Finally the MTF of MS has been derived from MTF of PAN based on RSI performance measurements made during the on-ground thermal-vacuum test of RSI. The calculation results are 0.46 across track and 0.37 along track. It is concluded that the in-orbit performance is well above the specified value. The checkout and performance verification for satellite bus and RSI were started on May 21 and completed through June 2004.

The secondary payload of FORMOSAT-2 is an imager of sprite, the upper atmospheric lightning (ISUAL). Other phenomena such as airglow, elves, blue jet, aurora, gravity wave, etc. are to be observed, too. A series of tests had been designed to check the function and performance of ISUAL, especially the ramp up of high voltage equipment. Power on command was sent to the imager on June 6, and high voltage ramp up on all instruments was completed on June 21, 2004. Then the imager had seen the first light and demonstrated proper function. On July 4, 2004, the imager observed and captured the first sprite event occurred over Philippines, as shown in Figure 5. Also, an aurora as shown in Figure 6 had been imaged on July 11, 2004. All functions of ISUAL hardware had been verified in-flight with successful results.
The first Sprite image recorded on 22:40:24, 4 July, 2004 (Taiwan time) over Philippines

Figure 5 First sprite event captured by ISUAL.

Image of Event 2004 193/16:01:45.97

Figure 6 Aurora event captured by ISUAL.

All performance requirements of FORMOSAT-2 had been successfully verified in orbit.