EVALUATION OF GK2A AMI RADIOMETRIC PERFORMANCE AFTER THE LAUNCH

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ABSTRACT: Radiometric performances of AMI verified from the ground tests, were re-evaluated during the In-Orbit Test period of GK2A. ART(AMI Radiometric Tool) has been developed for this purpose. The ART has functions to evaluate the BDS(Best Detector Select) Map, Scan Mirror Emissivity, Solar calibrations and IR calibrations respectively. First, the BDS Map are newly generated to investigate the status of the BDS Map pre-defined before the launch. About 1% of the columns of the detector rows were updated based on the analyses. Second, the scan mirror emissivity coefficients were re-examined and updated to compensate small dependence of the scan mirror emissivity according to the AMI scan angle change. Third, performances of the AMI Solar and IR calibrations were investigated. Key parameters, which represent performances of the Solar and IR calibrations such as SNR, NEdT, Dynamic Range and Relative Calibration Accuracy, were examined using the ART. Results showed that all the radiometric requirements of the 16 channels of AMI are fully compliant with sufficient margins.

1. INTRODUCTION

After the GK2A(Jin, 2012) satellite launch, AMI(Jin et al., 2016) instrument entered the Survival Mode during the transfer orbit period. Next, the outgassing activity (~1month) was conducted to eliminate possible contaminants or remnant water vapors by heating the instrument. Optical Port Cover(OPC) has been closed during this period to avoid any hazardous situations. Pre-functional check out activities such as VNIR channels ON, Target Star List upload, Scene and Timeline upload, AMI IOT Timeline upload, etc. were carried out. By opening OPC and transitioning to the Operational Mode, AMI Radiometric IOT (In-Orbit Test) has been started. Evaluation of AMI performance parameters were intensively investigated and analyzed. AMI Radiometric IOT has been performed using the plans and procedures established based on previous experiences of COMS MI radiometric calibrations (Jin and Seo, 2011).

2. METHODS

2.1 BDS MAP Evaluation and Update

BDS(Best Detector Select) MAP was investigated to check up the status of the pre-defined BDS table after the satellite launch. Full stack of two data collections: V-V(Output Voltage vs. Bias Voltage) and Long Time Series(LTS) were acquired to examine any changes of detector performance primarily driven by a cooling down process after the out-gassing activity.

2.2 Scan Mirror Emissivity Evaluation

SME(Scan Mirror Emissivity) according the AMI scan angle variation was checked out to evaluate the pre-defined SME coefficients determined from the ground tests. The data taken at the Earth Limb area with ten different AMI scan angles were employed to investigate the scan emissivity dependence as a function of the AMI scan angle.

2.3 Solar Calibration IOT

Solar calibration IOT was carried out to check up the performance of VNIR channels of AMI instrument. Run-to-Run and Day-to-Day stability of the solar calibrations were examined including the investigation of the key solar calibration performance parameters (e.g. SNR and Dynamic Range.

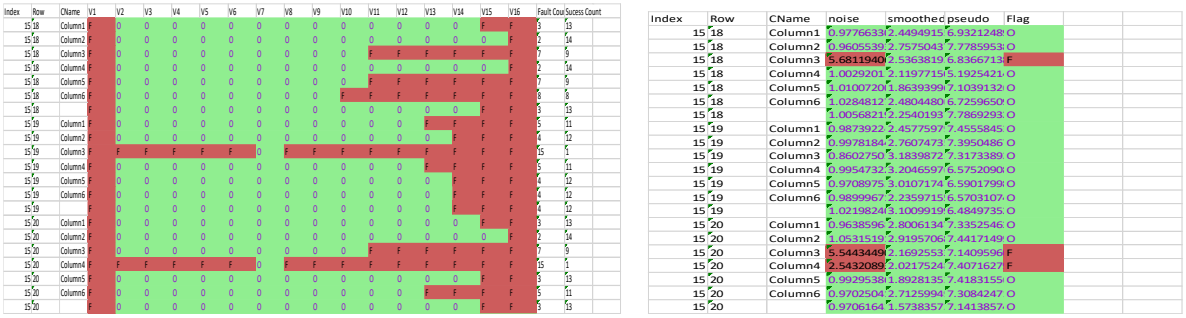
2.4 IR Calibration IOT

IR Calibration IOT was performed by 145 timeline iterations (~10min interval) during a 24-hour period. NEdT@240K, NEdT@300K and Dynamic Ranges of the ten IR channels were checked up. The stability of IR calibration (Relative Calibration Accuracy) were examined as well.

3. RESULTS

3.1 BDS MAP

Fig 1 shows two major BDS evaluation processes using the V-V and LTS data collections. Two reference targets of the space-look (cold radiance) and the ICT (hot radiance) were employed for the detector performance evaluation. Two seconds stares at the two targets are applied for V-V timeline and 30 seconds stares for LTS respectively. The LTS timeline data are mainly used for VNIR screening and the V-V data for IR one. Any columnar data, which passed the specified criteria, are flagged as a green and the others (failed elements) red. After the V-V and LTS screening processes, the ICT(Internal Calibration Target) Outliers (Fig 2) are also examined using the raw digital count data of DPS(Data Processing System). About 1% of the all the elements of VNIR and IR detectors are considered to be updated based on the BDS analyses. After the BDS update, both of the Level 0 and Level 1A data showed that stripping lines shown in the old images were clearly removed. (Fig 3).



Index	Row	CName	noise	smoothed	pseudo	Flag
15	18	Column1	0.9776633	2.4494915	6.9321248	O
15	18	Column2	0.9605539	2.7575043	7.7859534	O
15	18	Column3	5.6811940	2.5363819	6.8366713	F
15	18	Column4	1.0029201	2.1197715	5.1925421	O
15	18	Column5	1.0100720	1.8639399	7.1039132	O
15	18	Column6	1.0284812	2.4804480	6.7259650	O
15	18		1.0056821	2.2540193	7.7869293	O
15	19	Column1	0.9873922	2.4577597	7.4555845	O
15	19	Column2	0.9978184	2.7607473	7.3950486	O
15	19	Column3	0.8602750	3.1839872	7.3173389	O
15	19	Column4	0.9954732	3.2046597	6.5752090	O
15	19	Column5	0.9708975	3.0107174	6.5901799	O
15	19	Column6	0.9899967	2.2359715	6.5703107	O
15	19		1.0219824	3.1009919	6.4849735	O
15	20	Column1	0.9638596	2.8006134	7.3352546	O
15	20	Column2	1.0531519	2.9195706	7.4417149	O
15	20	Column3	5.5443449	2.1692553	7.1409596	F
15	20	Column4	2.5432089	2.0217524	7.4071627	F
15	20	Column5	0.9929538	1.8928135	7.4183155	O
15	20	Column6	0.9702504	2.7125994	7.3084247	O
15	20		0.9706164	1.5738357	7.1413857	O

Fig 1. Flagging and Ranking Processes using V-V(Left) and LTS collections (Right).

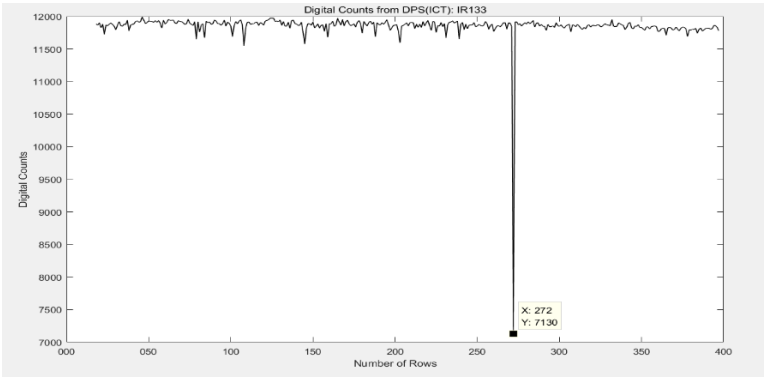


Fig 2. ICT Outlier Evaluation Process Based on the Raw Digital Counts data from DPS.

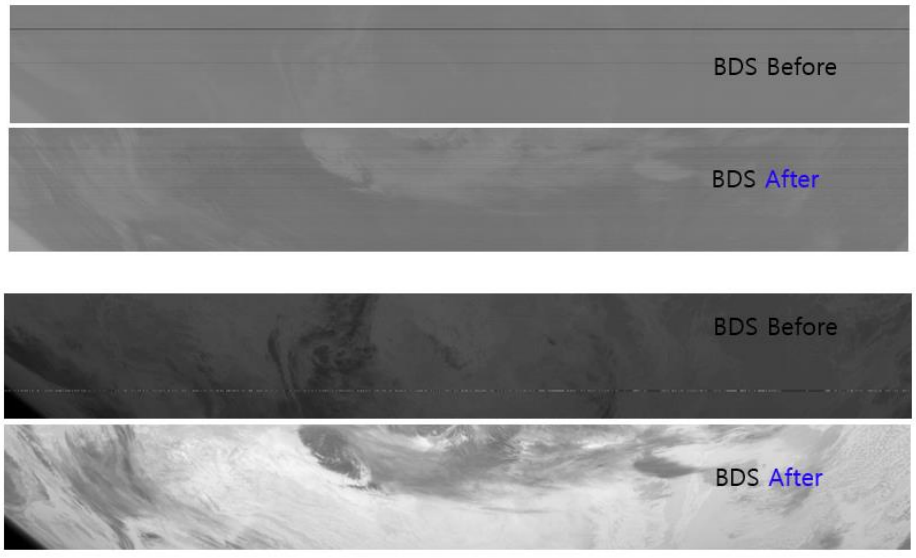


Fig 3. AMI Level 0 (Top) and Level1A(Bottom) Images Before/After the BDS MAP Update.

3.2 Evaluation of Scan Mirror Emissivity

Scan mirror emissivity variation with the AMI scan angle were evaluated using the ten observations of the Earth Limb area with a different scan angle. Some dependency of the scan angle was substantially removed after the update of the scan mirror emissivity coefficients. (Fig 4).

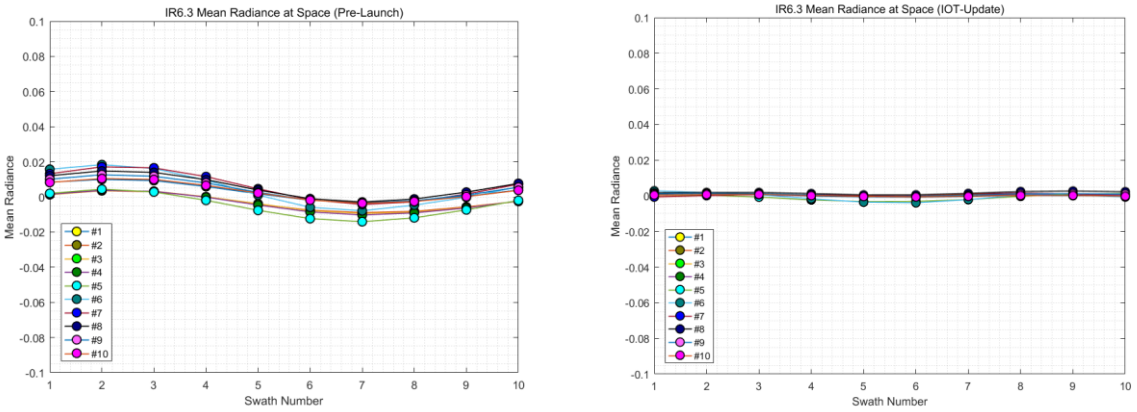


Fig 4. IR6.3 Channel Mean Radiance as a Function of the Swath Number: Pre-Launch Values(Left) and Updated One(Right).

3.3 Solar Calibration Performance

With the ART, performance of the AMI VNIR channels was investigated. Gain, SNR and Dynamic Ranges of the six VNIR channels were computed using the downlinked raw data (Fig 5). The performance parameters of entire detector elements of each channel were compared w.r.t specification values. Fig 6 shows the SNR values of all the elements have sufficient margins against the spec (blue reference line).

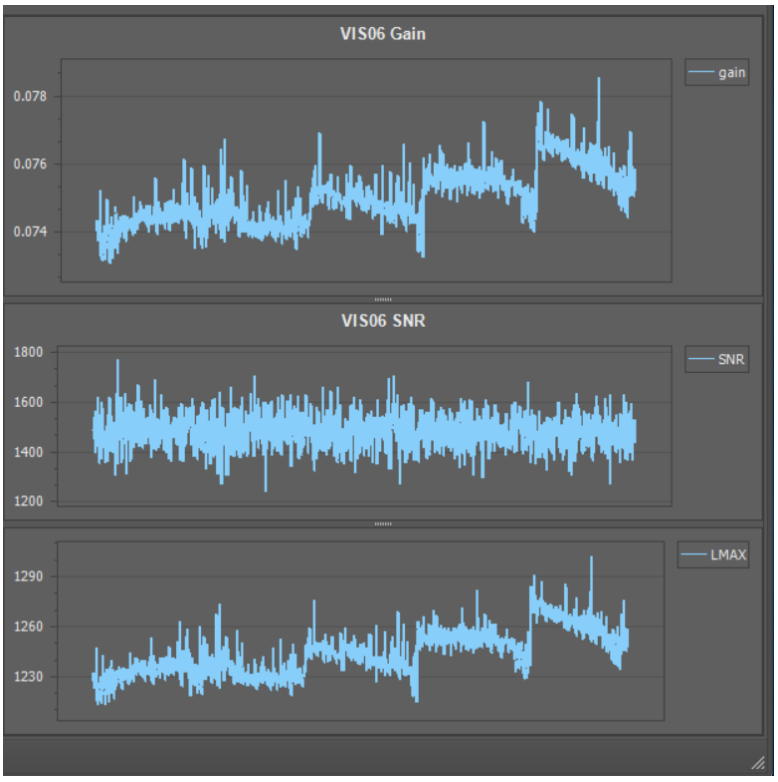


Fig 5. Plotting of Three Key Parameters of VNIR Channel's Solar Calibration: Gain(Top), SNR(Middle), Dynamic Range(Down).

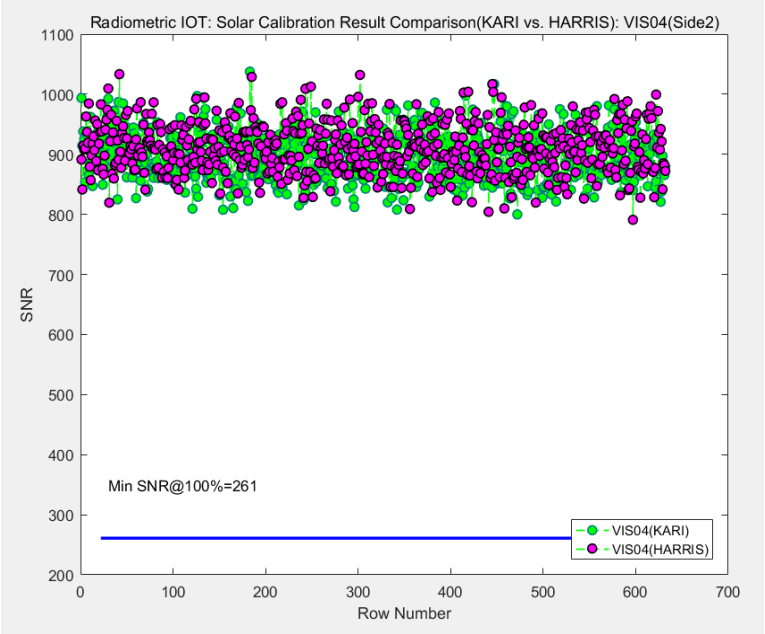


Fig 6. Computed SNR Values w.r.t the Spec. (VIS04, Side 2).

3.4 IR Calibration Performance

The radiometric performances of ten AMI IR channels were also examined using the ART (Fig 7). Gain, NEdT@240K/NEdT@300K and Dynamic Range values were computed and compared with respect to the requirement specifications. All the elements showed sufficient margins against the spec (Fig 8).

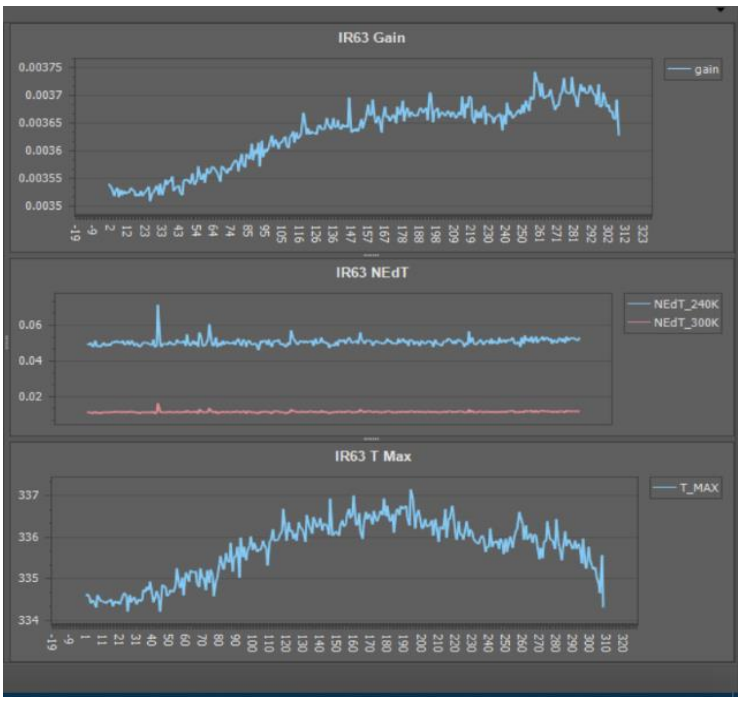


Fig 7. Plotting of Three Parameters of IR Calibrations: Gain(Top), NEdT(Middle), Dynamic Range(Down).

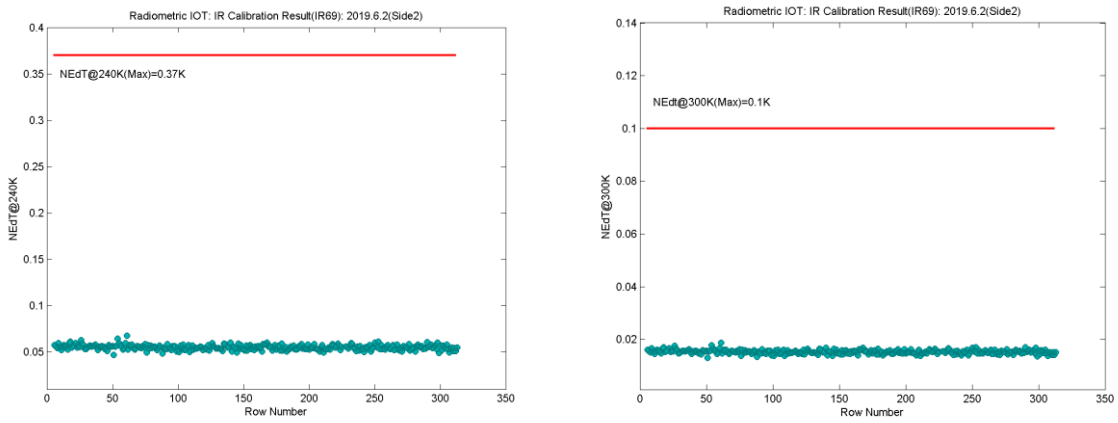


Fig 8. Computed NEdT@240K & NEdT@300K w.r.t. the Spec.(Red Reference Line). (IR6.9, Side 2).

3.5 AMI Radiometric Calibration Performance

The results of the AMI 16 channels' radiometric performances are summarized in Tables 1~3. Key performance parameters met the requirement spec. with sufficient margins.

Table 1. SNR(Side 2)

Channel	Spec.	Min/Mean/Max
VIS0.4	261	791/**910**/1033
VIS0.5	299	671/**758**/887
VIS0.6	130	395/**488**/567
VIS0.8	300	331/**562**/631
NIR1.3	300	515/**790**/944
NIR1.6	300	1128/**1369**/1593

Table 2. NEdT@240K(Side 2)

Channel	Spec. (K)	Max/Mean/Min
IR3.8	2.7	2.5/**1.3**/1.2
IR6.3	0.40	0.074/**0.051**/0.047
IR6.9	0.37	0.075/**0.054**/0.049
IR7.3	0.32	0.097/**0.076**/0.069
IR8.7	0.27	0.061/**0.050**/0.045
IR9.6	0.22	0.051/**0.044**/0.040
IR10.5	0.21	0.077/**0.043**/0.040
IR11.2	0.19	0.147/**0.038**/0.034
IR12.3	0.26	0.038/**0.034**/0.030
IR13.3	0.48	0.130/**0.065**/0.058

Table 3. NEdT@300K(Side 2)

Channel	Spec. (K)	Max/Mean/Min
IR3.8	0.18	0.2/**0.1**/0.1
IR6.3	0.10	0.017/**0.012**/0.011
IR6.9	0.10	0.021/**0.015**/0.014
IR7.3	0.10	0.029/**0.023**/0.021
IR8.7	0.10	0.024/**0.019**/0.017
IR9.6	0.10	0.023/**0.020**/0.018
IR10.5	0.10	0.037/**0.021**/0.019
IR11.2	0.10	0.078/**0.020**/0.018
IR12.3	0.12	0.022/**0.020**/0.017
IR13.3	0.30	0.079/**0.040**/0.036

4. CONCLUSION

The major performance parameters of AMI data were checked out during the GK2A IOT period. The radiometrically calibrated AMI data (L1A data) were evaluated using the ART. Results showed that SNR, NEdT, Dynamic Range of the AMI has sufficient margins against the requirement specifications.

References

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