Prepared by NSMC/CMA
Discussed in WG-1

Operational Direct Broadcast Systems Status Report & Status of Implementation of Best Practices at CMA

Working Paper summary: This paper presents status of implementation at CMA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274) for each of the FY-3D and FY-3E LEO satellite missions.

Action/Recommendation proposed:
WG1 is invited to take note and comment on the status of implementation at CMA of the CGMS best practices in support to local and regional processing of LEO direct broadcast data.

1 INTRODUCTION

This paper presents status of implementation at CMA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274) for each of the FY-3D and FY-3E LEO satellite missions.

2 STATUS OF OPERATIONAL DIRECT BROADCAST SYSTEMS

The Status of Operational Direct Broadcast Systems at CMA is summarised in Table 1 below:

Instruments	FY3C	FY3D	FY3E	FY3F	FY3G
MERSI	Retired	Operational	Operational	Operational	Operational
MWRI	Retired	Operational	Operational	Operational	Operational
MWHS	Operational	Operational	Operational	Operational	N/A
MWTS	Retired	Operational	Operational	Operational	N/A
IRAS	Retired	N/AA	N/A	N/A	N/A
HIRAS	N/A	Operational	Operational	Operational	N/A
GNOS	Operational	Operational	Operational	Operational	Operational

Table 1: Status of Operational Direct Broadcast Systems at CMA

3 STATUS OF IMPLEMENTATION

In the following sections, the status of implementation is given for both FY-3D and FY-3E for each of the nine Best Practices (BP) defined in CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274).

3.1 BP.01 Global Specification for Direct Broadcast

Best Practice BP.01: Operators should implement the agreed CGMS Direct Broadcast Services: LRPT/AHRPT Global Specification (Document No. CGMS 04).

Document No. CGMS 04 is available at: https://www.cgms-info.org/documents/Direct_Broadcast_Services__LRPT_AHRPT_Global_Specification,_Issue_2_01.pdf

3.1.1 FY-3D

The FY-3D Direct Broadcast is compliant with the CGMS Global Specification for Direct Broadcast.

3.1.2 FY-3E

The FY-3E Direct Broadcast is compliant with the CGMS Global Specification for Direct Broadcast.

3.1.3 FY-3F

The FY-3E Direct Broadcast is compliant with the CGMS Global Specification for Direct Broadcast.

3.1.4 FY-3G

The FY-3E Direct Broadcast is compliant with the CGMS Global Specification for Direct Broadcast.

3.2 BP.02 Timely provision of Space-to-Ground Interface Control Documents

Best Practice BP.02: CGMS operators should provide up-to-date and satellite-specific Space-to-Ground Interface Control Documents in English language at least 3 years before the launch of each satellite, including at least:

a) Frequency usage
b) Polarization
c) Encoding
d) G/T requirements
e) Data stream layout and content
f) Conformance with CCSDS.
g) Conformance with the CGMS Global Specification (see section 1)

3.2.1 FY-3D

NSMC/CMA maintains a website to provide the space-to-ground interface control documents. The document now has been publicly released at the website ~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=14&currentculture=en-US~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14. ~~Or directly download from http://satellite.nsmc.org.cn/PortalSite/StaticContent/FileDownload.aspx?CategoryID=1&LinkID=447.~~

3.2.2 FY-3E

Compliant, Space-to-Ground Interface details is publicly at:

~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=14~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

3.2.3 FY-3F

Compliant, Space-to-Ground Interface details is publicly at:

https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

3.2.4 FY-3G

Compliant, Space-to-Ground Interface details is publicly at:

https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

3.3 BP.03 Provision of Current Orbit Information

Best Practice BP.03: CGMS operators should ensure timely provision of accurate and up-to-date orbit information based on their operational orbit determination and knowledge of satellite manoeuvres. The orbit information should be made available to Direct Broadcast reception station operators:

a) In TLE format via FTP or HTTP over the Internet;
b) Additionally, if required for the processing and geolocation of the sensor data, in the relevant mission specific format via FTP or HTTP over the Internet and/or via the satellite's Direct Broadcast signal;
c) Additionally, if the satellite operator chose to do so, in TLE format via the satellite's Direct Broadcast signal.

The satellite operator shall document:

d) The details of how and where the orbit information is made available;
e) For any mission specific format, the format definition and its application.

3.3.1 FY-3D

The TLE for FY-3D is provided on the website ~~http://satellite.nsmc.org.cn/PortalSite/Satellite/Satelliteinfo.aspx?satellitetype=0&usedtype=twoline#~~https://www.nsmc.org.cn/nsmc/en/operation/leo.html?satellite=FY3D&parameter=TwoLine

The detailed orbit information is described in Part IV of the TBUS file. For example,

PART IV:
2005 018A 16719 231021377872 080818003047048 3344486
（1）（2）（3） （4） （5）
01012205 01014840 00008039 19150112 06585988 09875012
（6）（7） （8）（9）（10）（11）
16862246 07201516 P029477892 P065774914 P000000180
（12）（13） （14） （15）（16）
P01010412 P01254260 P02659589 002529581 110144008 9449
（17） （18）（19） （20）（21） （22）
0000500000 M00287420 P00098816 P00511107
（23）（24） （25）（26）
APT 137.50 MHZ, HRPT 1698.0 MHZ, BCN DSB 136.77 MHZ. APT DAY/NIGHT CH 2,4/3,4. VIS CH 2 /0.725 TO 1.0/ AND IR CH 4 /10.5 TO 11.5/ XMTD DURING S/C DAY. IR CH 3 /3.55 TO 3.93/ AND IR CH 4 /10.5 TO 11.5/ XMTD DURING S/C NIGHT. DCS CLK YR/DAY/TIME 1994 185 69079.016 LAST TIP CLK CORR 03/13/01 CLK ERR AFTER CORR PLUS
（27）

The orbital information is indicated as follows:
(1) Satellite identification indicator code (international standard code)

(2) The number of epoch tracks (the following parameters directly belong to this track)
(3) The ascending intersection time of the above epoch track, the unit is day (cumulative days from January 1), 9 decimal places
(4) The epoch time of the ascending intersection point is 1: 30: 47.048 seconds on August 18, 2008, 3 decimal places:
(5) Greenwich Mean Time at epoch time, unit is degree, 4 decimal places;
(6) Perigee period, unit is minute, 4 decimal places;
(7) Intersection period, unit is minute, 4 decimal places;
(8) Eccentricity, 8 decimal places;
(9) Perigee angular distance, unit is degree, 5 decimal places;
(10) Ascension of ascending intersection, unit is degree, 5 decimal places;
(11) Track inclination, unit is degree, 5 decimal places;
(12) Average ground angle, unit is degree, 5 decimal places;
(13) Semi-long axis, unit is kilometers, 3 decimal places;
(14), (15), (16) are represented as the X.Y.Z components of the satellite position at the epoch, the first one is the sign (P is positive, M is negative), unit kilometer, 4 decimal places;
(17), (18), (19) are the velocity of the X.Y.Z component of the satellite position at the epoch, the first is the sign (P is positive, M is negative), unit km / s, 6 decimal places;
(20) Emission characteristic coefficient, the unit is M2 / KG;
(21) The first three digits and the middle three digits represent the daily daily radiation flux and the average daily radiation flux for 90 consecutive days, and the last three digits are the planetary magnetic index;
(22) is the modulation coefficient, 4 decimal places;
(23) Radiation pressure coefficient, 10 decimal places;
(24) The first is the sign bit, followed by the perigee movement, unit degree / day, 5 decimal places;
(25) The first is the sign bit, followed by the ascension movement of the ascending junction, unit degree / day, 5 decimal places;
(26) The first is the sign bit, followed by the average rate of change of perigee at epoch time, unit degree / day, 2 decimal places;
(27) Explanation of some application parameters of the satellite, such as the transmission frequency, the code rate of the modulated signal, the wavelength range of each channel, etc. Sometimes it also publishes satellite usage information such as satellite frequency changes and satellite malfunctions.

3.3.2 FY-3E

The TLE for FY-3E is provided on the website ~~http://satellite.nsmc.org.cn/PortalSite/Satellite/Satelliteinfo.aspx?satellitetype=0&usedtype=twoline#~~https://www.nsmc.org.cn/nsmc/en/operation/leo.html?satellite=FY3E&parameter=TwoLine with the same format as FY3D mentioned above.

3.3.3 FY-3F

The TLE for FY-3F is provided on the website https://www.nsmc.org.cn/nsmc/en/operation/leo.html?satellite=FY3F&parameter=TwoLine with the same format as FY3D mentioned above soon.

3.3.4 FY-3G

The TLE for FY-3G is provided on the website https://www.nsmc.org.cn/nsmc/en/operation/leo.html?satellite=FY3G&parameter=TwoLine with the same format as FY3D mentioned above soon.

3.4 BP.04 Provision and maintenance of Product Processing software packages

Best Practice BP.04: Each LEO satellite operator should therefore ensure that:

a) Software packages for the relevant instruments are made available with a test version made available prior to launch and the operational version made available after end of commissioning of the satellite and as soon as feasible for the satellite operator;
b) To enable deployment of the software packages within organisations not permitting installation of pre-compiled software, source code should be made available;
c) Global and local product processing shall be harmonised in that brightness temperature products derived from both paths agree within tolerances that are not greater than few tenths (goal is 10%) of the respective performance requirements for bias error at a reference brightness temperature;
d) User support and maintenance services are available for the duration of the mission;
e) Notifications for software changes are provided to the user community;
f) Complete and comprehensive user documentation and S/W release documentation is supplied in English language;
g) The software installation procedure is designed to be easily executed by an untrained user;
h) The software package is executable on a standard computer platform, typically Linux/x86-64, providing a performance compatible with the timeliness requirements defined in the Guide to DBNet (CGMS-44-WMO-WP-10);
i) For reasons of performance, it should be possible to configure the software to process only the instruments and processing levels required locally;
j) Test data for verifying the installation of the S/W packages are made available.

3.4.1 FY-3D

Partially compliant for source code not provided now.
The Direct Broadcasting software packages are required by application. Download the FY-3 pre-processing software packages application form through the website ~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=8~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=25
Complete the form and send it to the E-mail listed to acquire a FTP account.
The SW has provided the L0 to L1 pre-processing for MERSI-Ⅱ, MWTS-Ⅱ, MWHS-Ⅱ, MWRI, and HIRAS.

3.4.2 FY-3E

Partially compliant for source code not provided.
FY3E's software packages ~~is~~has been provided together with FY3D's.
The SW has provided the L0 to L1 pre-processing for MERSI-LL, MWTS-Ⅲ, MWHS-Ⅱ, and HIRAS-Ⅱ.

3.4.3 FY-3F

Partially compliant for source code not provided.
FY3F's software packages will be~~is~~ provided ~~together with FY3E's~~in Jul 2024.
The SW will provide the L0 to L1 pre-processing for MERSI-III, MWTS-Ⅲ, MWHS-Ⅱ, MWRI-II and HIRAS-Ⅱ.
~~The SW will provide the L0 to L1 pre-processing for MERSI-III, MWTS-Ⅲ, MWHS-Ⅱ, MWRI-II and HIRAS-Ⅱ.~~

3.4.4 FY-3G

Partially compliant for source code not provided.
FY3G's software packages will be provided by the end of 2024.
The SW will provide the L0 to L1 pre-processing for MERSI-RM, MWRI-RM.

3.5 BP.05 Provision of auxiliary data for instrument product processing

Best Practice BP.05: Each operator of instruments requiring auxiliary data for the product processing must make available the necessary auxiliary data on the Internet in a user-friendly and timely manner. Announcements of the availability of new auxiliary data should be issued giving the Direct Broadcast reception station operators sufficient time to update their systems.

3.5.1 FY-3D

The auxiliary data is provided together with the software packages by FTP.

3.5.2 FY-3E

The auxiliary data is provided together with the software packages by FTP.

3.5.3 FY-3F

The auxiliary data is provided together with the software packages by FTP.~~The auxiliary data is provided together with the software packages by FTP.~~

3.5.4 FY-3G

The auxiliary data is provided together with the software packages by FTP.

3.6 BP.06 Recommendations of channel selection for hyperspectral instruments

Best Practice BP.06: Each CGMS operator of hyperspectral instrument is responsible for defining a recommended channel selection scheme for global NWP purposes. The channel selection shall be made available to DB station operators prior to the launch of the first instrument and subsequently whenever the channel selection is modified.

3.6.1 FY-3D

Compliant. All the FY-3D/HIRAS geo-located and calibrated radiances are processed and delivered. The recommendation for channel selection is attached here. Please click the following icon to obtain.

select_ch_FY-3D-hiras.txt

3.6.2 FY-3E

~~To be c~~Compliant. ~~Will be provided after FY-3E all the ground and products processing system on-orbit test finished~~Same with 3D/HIRAS.

3.6.3 FY-3F

Compliant. Same with 3D/HIRAS.

3.6.4 FY-3G

FY-3G does not have hyperspectral instruments. Not applicable.

3.7 BP.07 Spacecraft and Instrument Operational Status

Best Practice BP.07: Each CGMS operator to publish and maintain up to date spacecraft and instrument operational status information on the Internet. The CGMS operators should establish a scheme to review on a regular basis that the published status information is up to date.

3.7.1 FY-3D

Compliant, NSMC/CMA has maintained a website to provide the basic operational status for the spacecraft and instrument. The information is accessible from http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.7.2 FY-3E

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.7.3 FY-3F

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.7.4 FY-3G

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.8 BP.08 Operational Announcements

Best Practice BP.08: Each CGMS operator to announce planned operations and status changes as well as any observed degradation of the spacecraft and its instruments via e-mail and optionally via other channels.

3.8.1 FY-3D

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.8.2 FY-3E

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.8.3 FY-3F

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.8.4 FY-3G

Compliant, provided on http://www.nsmc.org.cn/nsmc/en/operation/status.html#FY-LEO.

3.9 BP.09 Satellite Direct Broadcast and Reception Station Performance Requirements

Best Practice BP.09: When planning, designing, and developing satellite Direct Broadcast (DB) downlink capabilities, the CGMS agencies will strive to minimize, when possible, negative impacts on the DB community by communicating with

manufacturers and users; coordinating with the other CGMS agencies; and considering these potential impacts during the CGMS agency's decision-making process.

The performance of the satellite's DB X-Band (7.8 GHz, ITU MetSat Band) downlink should be sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees and a G/T value of at least 25.9 dB/K. The calculation of the satellite DB performance shall include an allocation of at least 7.05 dB for reception station losses, rain and atmospheric losses, and link budget margin. The G/T is defined at the input of the IF receiver, at 5 degree antenna elevation and clear sky conditions.

A reception station operator may be required to establish a reception station with additional performance margin to account for local conditions, including climate, RF interference or the impact of an antenna radome.

3.9.1 FY-3D

Compliant, provided in the FY-3D space-to-ground interface document. ~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=14~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

See Appendix A for the link budget. See Appendix A for the link budget.

3.9.2 FY-3E

Compliant, provided in the FY-3E space-to-ground interface document.

~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=14~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

See Appendix B for the link budget. The Link Budget assumes a reception station G/T value of 22.7 dB/K as defined in BP.09. The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to 6.56 dB, giving a negative of 0.59 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

3.9.3 FY-3F

Compliant, provided in the FY-3F space-to-ground interface document. ~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=14~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

3.9.4 FY-3G

Compliant, provided in the FY-3G space-to-ground interface document. ~~http://satellite.nsmc.org.cn/PortalSite/StaticContent/DocumentDownload.aspx?TypeID=14~~https://satellite.nsmc.org.cn/DataPortal/en/support/document.html?TypeID=14

2.10 BP.10 Monitoring of the Direct Broadcast Downlink

Operators of satellites with DB should routinely monitor the quality of the DB downlink and address any anomalies in accordance with each organization's established procedures, and notify users of degraded performance. Monitoring should include:

a) For each satellite, during the six months following DB signal activation, a validation that nominal reception is possible for a DB reception station anywhere within the footprint of the satellite DB antenna by acquiring all passes at an elevation of 5 degrees or more above the local horizon throughout a full satellite ground track repeat cycle. Nominal reception implies a positive link budget margin as well as the signal and data quality parameters defined under d) and e) below, being in their nominal range for a reception station corresponding to the minimum requirements of BP.09;
b) During at least one pass per day for each satellite, monitoring of the signal quality parameters and the data quality parameters, as defined under d) and e) below respectively, for the part of the pass which is at an elevation of 5 degrees or more above the local horizon;
c) During at least one pass per day for each satellite, monitoring of the data quality parameter degradation, attributable to frames or packets discarded or degraded on the spacecraft, prior to transmission to the ground;

Where

d) Signal quality parameters should include receive signal strength, signal to noise ratio, spectral power distribution, and carrier, bit and frame lock statistics; and
e) Data quality parameters should include discarded frames and packets (failing error free decoding/reconstruction), missing frames and packets (calculated from measured frame and packet sequence counters), bad lengths (frame or packet out of tolerance length), and sequence errors (frame or packet detected gaps/sequence error) per Virtual Channel Identifier (VCID) for frames and Application Process Identifier (APID) for packets.

3.10.1 FY-3D

For a), partially compliant. Ground Stations in Jiamusi, Guangzhou and Urumqi use 12-meter antenna to receive FY3D MPT.

b) through e) partially compliant. Signal and data quality are monitored automatically but the quality information are not published in website or broadcasted.

3.10.2 FY-3E

For a), partially compliant. Ground Stations in Jiamusi, Guangzhou and Urumqi use 12-meter antenna to receive FY3E MPT.

b) through e) partially compliant. Signal and data quality are monitored automatically but the quality information are not published in website or broadcasted.

3.10.3 FY-3F

For a), partially compliant. Ground Stations in Jiamusi, Guangzhou and Urumqi use 12-meter antenna to receive FY3F MPT.

b) through e) partially compliant. Signal and data quality are monitored automatically but the quality information are not published in website or broadcasted.

3.10.4 FY-3G

For a), partially compliant. Ground Stations in Jiamusi, Guangzhou and Urumqi use 12-meter antenna to receive FY3G MPT.

b) through e) partially compliant. Signal and data quality are monitored automatically but the quality information are not published in website or broadcasted.

4 ACTIONS AND/OR RECOMMENDATIONS FOR CONSIDERATION BY CGMS WG-I

WG-I members are invited to take note and comment on the status of implementation at CMA of the CGMS Best Practices in support to local and regional processing of LEO direct broadcast data.

Appendix A Link Budget Table for FY3D Direct Broadcasting

Supporting information for BP.09 *Satellite Direct Broadcast and Reception Station Performance Requirements*.

The Link Budget below assumes a reception station G/T value of 22.7 dB/K as defined in BP.09. The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to7.64 dB, giving a positive margin of 0.59 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Please note that the Link Budget is provisional and that the Space-to-Ground Interface details for the FY-3D Direct Broadcast are not yet publicly released.

Table 2: FY-3D DB Link Budget

FY-3D DB Link Budget			
Parameter	**Unit**	**Design Value**	**Source**
Frequency	GHz	7820	FY-3D Space to Ground ICD
Satellite EIRP	dBW	19.92	FY-3D Space to Ground ICD
Propagation Path Length	Km	2848.77	Alt=831 Km, Elev Angle=5°
Free Space Loss	dB	179.40	
Polarisation Loss (a)	dB	1.00	FY-3D Space to Ground ICD
Rain & Atmospheric Loss (b)	dB	4.50	FY-3D Space to Ground ICD
Multipath Loss (c)	dB	0.20	FY-3D Space to Ground ICD
Ground Antenna Pointing Loss (d)	dB	0.50	FY-3D Space to Ground ICD
Ground Station G/T	dB/K	22.70	FY-3D Space to Ground ICD antenna Diameter: 3M
Boltzmann's Constant	dBW/Hz-K	-228.60	
DATA CHANNEL (QPSK)			
Data Power/No	dBm/Hz	85.62	
Information Rate	dB-Hz	77.78	60 Mbps with Reed Solomon (255/223) + Convolutional rate 3/4
Available Eb/No	dB	7.84	FY-3D Space to Ground ICD
Required Eb/No for 10^{-6}FER	dB	6.4	FY-3D Space to Ground ICD
Implementation Loss (e)	dB	1.8	FY-3D Space to Ground ICD
Available Signal Margin (f)	dB	-0.36	The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to

			6.46 dB, giving a positive margin of 0.59 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Appendix B Link Budget Table for FY3E Direct Broadcasting

Supporting information for BP.09 *Satellite Direct Broadcast and Reception Station Performance Requirements*.

The Link Budget below assumes a reception station G/T value of 22.7 dB/K as defined in BP.09. The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to6.56 dB, giving a negative of 0.59 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Please note that the Link Budget is provisional and that the Space-to-Ground Interface details for the FY-3E Direct Broadcast are not yet publicly released.

Table 3: FY-3E DB Link Budget

Parameter	**Unit**	**Design Value**	**Source**
Frequency	MHz	7860	FY-3E Space to Ground ICD
Satellite EIRP	dBW	19.92	FY-3ESpace to Ground ICD
Propagation Path Length	Km	2846.00	Alt=831 Km, Elev Angle=5°
Free Space Loss	dB	179.50	
Polarisation Loss (a)	dB	1.00	FY-3E Space to Ground ICD
Rain & Atmospheric Loss (b)	dB	4.50	FY-3E Space to Ground ICD
Multipath Loss (c)	dB	0.20	FY-3E Space to Ground ICD
Ground Antenna Pointing Loss (d)	dB	0.50	FY-3E Space to Ground ICD
Ground Station G/T	dB/K	22.70	FY-3E Space to Ground ICD antenna Diameter: 3M
Boltzmann's Constant	dBW/Hz-K	-228.60	
DATA CHANNEL (QPSK)	□		
Data Power/No	dBm/Hz	85.52	
Information Rate	dB-Hz	78.86	77MHz, after Reed Solomon (255/223) + Convolutional rate 3/4
Available Eb/No	dB	6.66	FY-3E Space to Ground ICD

Required Eb/No for 10^{-6}FER	dB	6.4	FY-3E Space to Ground ICD
Implementation Loss (e)	dB	1.8	FY-3E Space to Ground ICD
Available Signal Margin (f)	dB	-1.54	The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to 6.46 dB, giving a negative of 0.59 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Appendix C Link Budget Table for FY3F Direct Broadcasting

Supporting information for BP.09 *Satellite Direct Broadcast and Reception Station Performance Requirements*.

The Link Budget below assumes a reception station G/T value of 22.7 dB/K as defined in BP.09. The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to 9.62 dB, giving a positive margin of 2.57 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Table 4: FY-3F DB Link Budget

Parameter	**Unit**	**Design Value**	**Source**
Frequency	MHz	7790	FY-3F Space to Ground ICD
Satellite EIRP	dBW	20.12	FY-3F Space to Ground ICD
Propagation Path Length	Km	2848.7	Alt=831 Km, Elev Angle=5°
Free Space Loss	dB	-179.36	
Polarisation Loss (a)	dB	-1.5	FY-3F Space to Ground ICD
Rain & Atmospheric Loss (b)	dB	-4.5	FY-3F Space to Ground ICD
Multipath Loss (c)	dB	-0.3	FY-3F Space to Ground ICD
Ground Antenna Pointing Loss (d)	dB	-1	FY-3F Space to Ground ICD
Ground Station G/T	dB/K	22.7	FY-3F Space to Ground ICD antenna Diameter: 3M
Boltzmann's Constant	dBW/Hz-K	-228.6	
DATA CHANNEL (QPSK)	□		
Data Power/No	dBm/Hz	84.75	
Information Rate	dB-Hz	77.03	77 Mbps with Reed Solomon (255/223) + Convolutional rate 3/4
Available Eb/No	dB	7.72	FY-3F Space to Ground ICD
Required Eb/No for 10^{-6}FER	dB	5.4	FY-3F Space to Ground ICD

Implementation Loss (e)	dB	-2.5	FY-3E Space to Ground ICD
Available Signal Margin (f)	dB	-0.17	The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to 9.62 dB, giving a positive margin of 2.57 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Appendix D Link Budget Table for FY3G Direct Broadcasting

Supporting information for BP.09 *Satellite Direct Broadcast and Reception Station Performance Requirements*.

The Link Budget below assumes a reception station G/T value of 22.7 dB/K as defined in BP.09. The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to 16.25 dB, giving a positive margin of 9.2 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.

Table 5: FY-3F DB Link Budget

Parameter	**Unit**	**Design Value**	**Source**
Frequency	MHz	7790	FY-3G Space to Ground ICD
Satellite EIRP	dBW	14.8	FY-3G Space to Ground ICD
Propagation Path Length	Km	1823.79	Alt=407 Km, Elev Angle=5°
Free Space Loss	dB	-175.49	
Polarisation Loss (a)	dB	-1.5	FY-3G Space to Ground ICD
Rain & Atmospheric Loss (b)	dB	-4.5	FY-3G Space to Ground ICD
Multipath Loss (c)	dB	-0.3	FY-3G Space to Ground ICD
Ground Antenna Pointing Loss (d)	dB	-1	FY-3G Space to Ground ICD
Ground Station G/T	dB/K	22.7	FY-3G Space to Ground ICD antenna Diameter: 3M
Boltzmann's Constant	dBW/Hz-K	-228.6	
DATA CHANNEL (QPSK)	□		
Data Power/No	dBm/Hz	83.30	
Information Rate	dB-Hz	68.96	12 Mbps with Reed Solomon (255/223) + Convolutional rate 3/4
Available Eb/No	dB	14.34	FY-3G Space to Ground ICD
Required Eb/No for 10^{-6}FER	dB	5.4	FY-3G Space to Ground ICD

Implementation Loss (e)	dB	-2.5	FY-3G Space to Ground ICD
Available Signal Margin (f)	dB	6.44	The reception station losses (a), (c), (d), (e) rain and atmospheric losses (b), and link budget margin (f) add up to16.25 dB, giving a positive margin o9.2 dB relative to the 7.05 dB defined in BP.09 and sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees.