

## **ARGOS-3 A-DCS UHF Downlink Description**

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With ephemeris message decoding (Annex 1) by B.M. Ewen-Smith, COAA.

### **Version of 1 August 2009 – Annex 1 update of 23 July 2009 – CNES document released**

This note presents the result of my efforts to decode a sample of A-DCS UHF downlink [11]. Informative descriptions of the ARGOS Data Collection System can be found at References 1 to 6.

### **Downlink Parameters**

ARGOS-3 Transmitter Unit (TXU) on METOP-A [7] and NOAA-19.

|                       |  |
|-----------------------|--|
| Frequency             | 465.9875 MHz   |
| Bit rate              | 400 bps or 200 bps (ARGOS-2+ PTT compatibility)                              |
| Protocol              | HDLC bit stream, opening, closing and idle Flag is 7E hex, bit-stuffing      |
| Format                | Flag, a number of 8-bit data, 16-bit CRC, Flag. No Address or Control fields |
| Coding                | Bi-Phase-Level (Manchester)  |
| Carrier Modulation    | Phase modulation   |
| Modulation Index      | 0.8  |
| Power                 | 5 Watt   |
| EIRP                  | +37 dBm  |
| Polarisation          | Right hand circular  |
| Received Signal Level | -124 dBm at 0° to -105 dBm at 90° elevation [8]                              |

### **Downlink Messages**

Descriptions of the ARGOS-3 downlink indicate there are 3 types of Broadcast messages, Platform Message Transceiver (PMT) Inter Active Data Collection (IDC) Protocol messages and PMT commands or directives messages.

### **Broadcast Messages**

The broadcast messages are for ARGOS Satellite ephemeris (orbital elements), ARGOS Satellite Constellation Status and UTC time. These are repeated every 256 seconds. There is provision for up to 16 different types of broadcast messages.

#### **1. ARGOS Satellite Ephemeris messages**

```
00000BE 500 A 41C48888C152A1E4528C6BAFC190042B7 4A68 [9]
00000BE 500 5 4240DC88195E251CD9ABF82D138053D73 27D5 [11] See Notes 1 & 2
00000BE 500 6 4240D08CCC120B41BECAD3734F0154EA AB06
00000BE 500 7 4240D4851C9ABA05D80C112DA7A093AC8 8E67
00000BE 500 8 4240E4888D51BF833BADDBB8448094A13 72CA
00000BE 500 A 4240E08914A29AF7D28C6BAFC150042B2 AD46
00000BE 500 C 4240E401400D81AFBACDE6B88470043B4 7066
```

28-bit Broadcast ID + 12-bit Service code+ 4-bit SCID +132-bit data + 16-bit CRC

|         |   |
|---------|---|
| 00000BE | 28-bit Argos ID for spacecraft elements broadcast. See Note 3.      |
| 500     | 4 bit instrument serial number and 8 bit service code ? See Note 4. |
| C       | ID of ARGOS equipped spacecraft                                     |
|         | 1 ADEOS-II ceased operation 25/10/2003                              |
|         | 2 NOAA-12 ceased operation 10/8/2007                                |
|         | 3 NOAA-11 ceased operation 16/6/2004                                |

4 NOAA-14-ceased operation 23/5/2007  
 5 NOAA-15 started operation 15/12/1998  
 6 NOAA-16 started operation 20/3/2001  
 7 NOAA-17 started operation 15/10/2002  
 8 NOAA-18 started operation 30/8/2005  
 9  
 A METOP-A started operation 26/10/2006  
 B  
 C NOAA-19 started operations 2/6/2009  
 42 ..... 132 bits of orbit parameters, See Annex 1  
 7066 16 bit CRC

## 2. ARGOS Constellation Status message

00000C7 500 5 A 5C 5 02 6 02 7 02 8 02 2314 [11]  
 00000C7 500 6 A 5C 5 02 6 02 7 02 8 02 C 03 0 13DC  
 00000C7 500 6 A 5C 5 02 6 02 7 02 8 02 C 63 0 7066

28-bit ID + 12-bit service code + N bits of status + 16 bit CRC

00000C7 28-bit Argos ID for Argos constellation status broadcast  
 500 ?  
 6 number of spacecraft status reported  
 A 5C SC ID=METOP-A, Instrument serial number=5 and status bits=C 1100?  
 5 02 SC ID= NOAA-15 and status bits - Argos 2 DCS ?  
 6 02 SC ID, NOAA-16 and status bits - Argos 2 DCS ?  
 7 02 SC ID, NOAA-17 and status bits - Argos 2 DCS ?  
 8 02 SC ID, NOAA-18 and status bits - Argos 2 DCS ?  
 C 63 SC ID=NOAA-19, Instrument serial number=6 and status bits=3 0011?  
 0 4-bit filler  
 7066 16-bit CRC

## 3. UTC Time message

00000E1 508 2009 042 10 06 19 260 66F7  
 00000E1 508 2009 042 10 10 35 260 F31C [11]

28-bit ID + 12-bit service code + 64 bit BCD time code + 16 bit CRC

00000E1 28-bit Argos ID for UTC time broadcast  
 508 ?  
 2009 Year  
 042 Day of Year  
 10 UTC Hour  
 10 UTC minute  
 35.260 UTC seconds  
 F31C 16-bit CRC

## Inter Active Data Collection (IDC) Session messages

The IDC protocol provides a secure (as in reliable and error-free reception) method for the PMT transmit its data to the spacecraft and vice versa. An IDC session is started by a PMT sending a IDC 'Request' message to the spacecraft. The spacecraft will neither send a 'Reject' message if it unable to service the request or a 'Go-Ahead' message if it can. The PMT then sends a data message and if it is received error free, an 'Acknowledgement' message is sent to the PMT. This is then repeated until all the PMT data messages have been sent and acknowledged.

The uplink messages can be at 400 or 4800 bps. All downlink messages are at 400 bps.  
Commands or user directives can be sent to and acknowledged by the PMT using the same protocol.  
4. Interactive Session Request message. As this message is on the uplink, it is not seen on the downlink

5. Interactive Session Go-ahead message

28-bit PMT ID + 12 bit service code + 24 bit message + 16 bit CRC

```
40EDE8B 502 31F200 E574 [9]
23CCB6A 102 AE8D01 570B [10]
```

6. Interactive session rejection message

28-bit PMT ID + 12 bit service code + 72 bit message + 16 bit CRC

```
23CCB6A 104 000123456789ABCDEF F67D [10]
```

7. Interactive Session data message. As this message is on the uplink, it is not seen on the downlink

8. Interactive Session Acknowledgement message, error-free reception of uplink data

28-bit PMT ID + 12 bit service code + 16 bit message + 16 bit CRC

```
40EDE8B 501 D673 AA67
40EDE8B 501 65DE 857E [9]
23CCB6A 101 58A5 29B7 [10]
5783626 501 C7DA 831F
5783626 501 2AE0 72E8
5783626 501 CEBA 49B8 [11]
```

|         |   |
|---------|---|
| 5783626 | 28-bit Argos-3 PMT address  |
| 501     | Service code?   |
| CEBA    | First 16 bits of the successfully uplinked message being acknowledged |
| 49B8    | 16 bit CRC  |

9. PMT user directives or commands

These are transmitted by the ARGOS-3 TXU in Programmed mode or Triggered mode [12].

Programmed Mode:

Commands are sent to a PMT or a group of PMTs at a given time for a given period to PMTs whose location known.

Triggered mode:

Commands are sent when the required PMT is detected by the reception of an uplink message from it. This mode is used when the location of the PMT is not accurately known or only operates intermittently.

28-bit ID + 12 bit service code + N bit message (up to 128 bits) + 16 bit CRC ?

No example available yet

Notes:

1. CRC is CRC-16-CCITT, polynomial is  $x^{16}+x^{12}+x^5+1$  (0x1021, initial value 0x0000) [14]
2. CRC not provided with data [11]. It has been calculated [15] and appended to the data.
3. The 28-bit extended Argos ID code was introduced in 2000 to extend the ID capacity beyond 32768.

It is a regular Argos 20-bit ID code [13] with an 8-bit extension, i.e. a 14 or 15 bit platform ID + 6 or 5 bit error correction code + 8-bit extension code.

The 8-bit extension codes are 00 13 26 35 4C 5F 6A 79 8B 98 AD BE C7 D4 E1 and F2 ie. a 4 bit address with a 4 bit error correction code. All PTM addresses are 28 bit.

4. The Service code could be a 4 bit Argos-3 instrument serial number and one of eight 1 bit flags for message type.

4.1 Argos-3 instrument serial number could be 3 bit Flight Model number [16] and 1 bit even parity

|                                      |   |
|--------------------------------------|---|
| Flight Model 1 is 001 + 1 = 0011 (3) | <a href="#">SARAL</a> , to be launched in October 2010. |
| 2 is 010 + 1 = 0101 (5)              | METOP-A, in orbit                                       |
| 3 is 011 + 0 = 0110 (6)              | NOAA-19, in orbit                                       |
| 4 is 100 + 1 = 1001 (9)              | METOP-1, -B after launch in June 2012.                  |
| 5 is 101 + 0 = 1010 (A)              | METOP-3, -C after launch in October 2016.               |

4.2 Message type bit flags

|    |                      |
|----|----------------------|
| 00 | Ephemeris            |
| 00 | Status               |
| 01 | Acknowledgement      |
| 02 | Go-ahead             |
| 04 | Command or Directive |
| 04 | Request              |
| 08 | UTC Time             |
| 10 | Undefined            |
| 20 | Undefined            |
| 40 | Undefined            |
| 80 | Undefined            |

## **Software**

An ARGOS-3 A-DCS UHF downlink software decoder program called **Argos3Plotter** has been written by B.M. Ewen-Smith of COAA and is available from the COAA website:

<http://www.coaa.co.uk/argos3plotter.htm>

## **Version History**

Original email [version](#) posted on Hearsat email list on 14 April 2009.

Updated on 5 May, 12 June, 16 July (labeled as 1 August) and 23 July 2009 (labeled as 1 August – Annex 1 update).

Annex 1 has now been superseded by part of a CNES ARGOS-3 Services and Messages Format [document](#) which was released publicly by CLS on 22 July 2009.

### Annex 1 – Ephemeris messages\*

#### Possible Ephemeris Message bit coding using METOP-A example

00000BE 500 A 41C48888C152A1E4528C6BAFC190042B7 [9] (hex)

#### Bits 0 to 27 – 28-bit PMT id

00000BE (hex)

#### Bits 28 to 39 – Service code (500 for Metop-A, 600 for NOAA 19)

500 (hex)

#### Bits 40 to 43 – Spacecraft identifier (A)

A (hex)

#### Bits 44 to 43 – Fixed (possibly a century code for the following year or type of orbital parameters used)

01 (bin)

#### Bits 44 to 89 – Equator crossing time of reference orbit coded hex as decimal.

0000 0111 0001 0010 0010 0010 0010 0011 0000 0101 0100 (bin)

07122223054 (hex)

[year = 20]07[day = ]122[time = ]22[: ]20[: ]54[UTC]

The day value is the day number of the year.

#### Bits 90 to 108 – Equator crossing longitude of reference orbit

1010100001111001000 (bin)

345032 (decimal)

354.032 degrees East = value/1000

#### Bits 109 to 132 – N (orbits per day)

101001010001100011010111 (bin)

10819799 (dec)

14.215 orbits per day = 13.8441 + value\*3.42914E-8

#### Bits 133 to 159 – Orbital period

010111111000001100100000000 (bin)

50075904 (dec)

6078.147 seconds = 5830.409 + binary value\*4.94725E-6

#### Bits 160 to 175 – Orbital Inclination

0100001010110111

17079

98.7079 degrees = 97 + binaryvalue/10000

Notes: The observed data agrees precisely with actual equator crossing times. The excellent agreement and the simplicity of the conversion of the equator crossing longitude and the inclination, gives a high degree of confidence in the interpretation of those fields. Despite the good agreement, the irrational conversions for N and the orbital period, coupled with the fact that they seem to be reporting the same data, suggests that the interpretation for these fields is suspect. Please report any better interpretation.

\* Ephemeris message expertly decoded by B.M. Ewen-Smith of COAA, <http://www.coaa.co.uk>, who is also author of the Argos3Plotter software, <http://www.coaa.co.uk/argos3plotter.htm>.

## References:

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