

## **Satellite Communication – INMARSAT Terminal**

**M. R. Nayak<sup>1</sup>**

The age of satellite communication for ships at sea officially began on 1st Feb. 1982, when the International Maritime Satellite Organisation (INMARSAT) began its work. (Main Office:40, Melton Street, London). INMARSAT operates a global marine communication service by means of 3 satellites used today (1984) having a total capacity of approximately 339 channels (25 KHz channel separation). The ship earth station is used in the Indian Antarctic Research Station (Land-based).

The INMARSAT system consists of groundstation-linked satellites in geostationary orbit 22,300 miles (35,700 km) above the equator over the Atlantic, Pacific and Indian oceans at longitudes of W 026, E 179 and E 063 respectively.

The system operates on the following frequency bands

Transmit : 1636.5 to 1645.0 MHz

Receive : 1535.0 to 1543.5 MHz

The communication modes are

- i. Teletype : 50 baud, full duplex, per CCITT requirement.
- ii. Voice : Full duplex, conforms to CCITT requirement for telephone service.

The full technical specifications are given in table.1.

The satellite communication terminal DEBEG 3211 consists of only four items—a telephone, teleprinter, electronics unit and antenna.

The PABX interface is inserted as an additional module in the electronics unit to enable Slow Scan TV transmission/reception. The SS TV system consists of a slow scan TV converter (DSC-2000), TV-Camera (CC-111) and TV Monitor (CTM-2000). The detailed specifications are given in table.2.

The first SATCOM terminal HIND (1640105) was installed at the base camp in a BSA tent on 13-1-1984, and its commissioning tests successfully completed on 19-1-1984 (at 18.12 GMT) for telex and telephone. On 20-1-1984, a slow scan TV picture was transmitted to SATCOM 1640102 MVTT at Goa (for storage in an audio cassette).

The variation in satellite ELEVATION (ELN) and AZIMUTH (AZM) values obtained in this location are:

ELN : 04 to 06 deg.

AZM : 313 deg.

GYR : 010 deg (GYRO reading from FORE of Antenna).

LVL : 155 to 161 (Signal level strength).

The unit was further shifted to its present location (Portacabin) on 27-1-1984. The system was extensively used for official and private traffic for Expedition members.

<sup>1</sup> National Institute of Oceanography, Goa

The second SATCOM 1640106 INDI X was installed in the radio (Communication) room in the Indian Antarctic Research Station on 14-2-1984, and commissioned on 15-2-84 at 15.14 GMT through Goonhilly (Code 02) Coast Earth Station.

The Antenna (ANT) variation values, during the period 15-2-1984 to 28-2-1984 are:

ELN : 05 to 07  
LVL : 171 to 173  
AZM : 280  
GYR : 280

The extension of the system for Telefax Transmission was tried unsuccessfully due to the lack of technical information regarding the interfacing of NEFAX 4500 to DEBEG 3211. Hence, the system is further modified to incorporate Slow Scan TV transmission, as an additional option.

#### The following precautions were taken into consideration

1. Power supply fluctuations (in voltage and frequency)
2. Power supply voltage transient suppression
3. Exposure of CC TV Camera to strong light (to prevent permanent damage to the vidicon tube).
4. The supply voltage for SS TV (Camera Converter and Monitor) is 220 Vac and for the SATCOM equipments 110 Vac, obtained using a power line conditioner.
5. Antenna Flywheel Circuit Breaker : NEVER to Switch—ON
6. Not to use the service lock pin in the Antenna (NEVER)

#### Observations

1. The telex machine ink-flow was not smooth due to out-side low temperature. To overcome this, it was necessary either to keep the printer ON for some time, or use in-house tests like SELF-TEST, ANT, AIM, POS, TME etc., to enable free flow of ink.
2. When it was not possible to go through UK (Code 02) Coast Earth Station, use of US (Code 01) was made (where STORE AND FORWARD facility for telex exist).
3. The present lat. 70°S and long. 12°E is ideally suited for using Atlantic Ocean (WO 26) as well as Indian Ocean (EO 63) satellites.
4. We could hence make use of the following C. E. S.  
Atlantic : UK (02), USA (01), France (11) and Kuwait (06).  
Indian: Japan (03) and Norway (04).
5. ERROR 103, SHIPS GYRO ERR should be ignored as the ship terminal is used as Land-based terminal in Antarctica.

#### Recommendations

1. Stabilized power supply source should be used.
2. Telexes should be stored in memory before transmitting (to save time, cost and human errors).
3. Minimum three sets of spares should be available at the Base Camp (to keep both units functional), in view of:

- i. Boards being not field-repairable.
  - ii. Being a remote location, no replacements could be sent in emergency. List of spares is given in table 3.
4. Power down of the system is not normally required for any reason. Life of the unit will be extended if power downs are minimised.
  5. The spares should be tested occasionally for satisfactory performance. List of items handed over at Base Camp is given in table 4.

**Team**

The wintering team participants who were familiarised with the system's performance, operation, servicing, maintenance and diagnostics are Capt. Paramjit Singh and Capt. R. R. Sinha.

**Acknowledgements**

1. We are extremely grateful to all the members of this Expedition, particularly:  
 Dr. H. K. Gupta (Leader), Maj. P. K. Nair, Capt. H. C. Lohumi, Capt. A. S. Patil, Mr. M. Manoharan, N. K. G. Jadhav, Cdr. V. P. Sathianoorthy, Wg. Cdr. Natarajan, Flt. Lt. Ajit Kumar, Flt. Lt. M. M. Rai, and Maj. B. K. Singh.
2. Staff of INMARSAT, London, Particularly Dr. A. Hendry.
3. Staff of D. O. D.: Dr. S. Z. Qasim, Mr. J. L. Sarin.
4. Staff of Inst. Dir: Dr. E. Desa, Dr. E. S. Desa, Mr. V. N. Chodan Kar, Mr. V. B. Naik, Mr. Shan Kalan-gutker, Mr. A. P. Selvam and Mr. Oswald D' Souza.

TABLE 1  
*Equipment Characteristics*

<i>Characteristic</i>	<i>Requirement</i>
<b>Environmental</b>	
<b>Antenna Group</b>	
Temperature	— 40°C to + 65°C
Wind	Operate up to 100 knots and survive 120 knots.
Humidity	Marine conditions externally and up to 95% internally
<b>Below Decks Group</b>	
Temperature	0°C to + 50°C
Humidity	Up to 95%
Pitch	± 10°
Roll	± 30°
Azimuth	± 270° (540° total including yaw compensation)
Elevation	0° to 90°

<i>Characteristic</i>	<i>Requirement</i>
<b>Physical</b>	
<b>Antenna Unit</b>	
Height	78.5 in. (199 cm)
Diameter	79.0 in. (200 cm)
Weight	650 lb (295 kg)
<b>Electronic Unit</b>	
Height O.A.	26.5 (67.3 cm)
Width O.A.	19.0 (48.3 cm)
Depth O.A.	13.4 (34 cm)
Weight	85 lbs. (38.6 kg)
<b>Power</b>	
Voltage	115 Vac $\pm$ 10% (220 volt adapter available)
Frequency	50 or 60 Hz $\pm$ 5%
<b>Loading</b>	
Nominal	550 W
Startup	1100 W
<b>Communications Modes</b>	
Teletype	Full duplex, 50 baud maximum (60 words per minute)
Voice	Full duplex, 12 kHz FM maximum (300-3000 Hz nominal bandwidth)
Data	Full duplex, voice limits
<b>Channelization Capabilities</b>	
Request	2 channel
Teletype	339 channel pairs
Voice	339 shore-selectable channel pairs
Tracking	1 of 2 frequencies
<b>Automatic Operation</b>	Fully automatic antenna tracking of satellite, transmission and reception of messages.
<b>Antenna</b>	
Polarization	Right-hand circular
Beamwidth (e dB)	11°
G/T	-1.6 dBK typical, -4 dBK worst case
Transmitted Power	37 dBW $\pm$ dB (saturated)
<b>Receiver Sensitivity</b>	
Tracking	-167 dBW/m <sup>2</sup> , -142 dBW/m <sup>2</sup> nominal
Time-Division	
Multiplexed	-155 dBW/m <sup>2</sup> , -143 dBW/m <sup>2</sup> nominal
Voice	-152 dBW/m <sup>2</sup> , -139 dBW/m <sup>2</sup> nominal
Antenna Tracking	$\pm$ 10° pitch, $\pm$ 30° roll, $\pm$ 270° azimuth + yaw compensation, 0° to 90° elevation
<b>Frequency Range</b>	
Receive	1535.0 to 1543.5 MHz (25 kHz steps)
Transmit	1636.5 to 1645.0 MHz (25 kHz steps)

TABLE 2

*Slow Scan TV converter type DSC 2000***Principle of Operation**

Conversion of TV-CCIR-Standard signals to Slow Scan TV signals and vice versa. Transmission and Reception of Slow Scan TV signals via audio channels.

**Modes of Operation**

- a. Receive: Reception of incoming signals
- b. Prepare: Display of own picture on monitor and storage in memory
- c. Transmit Memory: Transmission of pictures from one of the memories
- d. Transmit Tape: Transmission of pictures stored on a cassette or tape of an external recorder.

The pictures which are to be transmitted are stored within 20 m sec.

The pictures can be stored manually or automatically after transmission of the previous picture.

**Technical Data**

Picture                    256 elements per line  
                               256 lines  
                               64 grey levels  
                               120 msec line rate

**Subcarrier Frequencies:**

Sync. pulse    : 1200 Hz  
 Black            : 1500 Hz  
 White            : 2300 Hz  
 Grey             : between 1500 Hz and 2300 Hz

Storage of Pictures: 2 built-in memories or via external cassette recorder

Operating Temperature: -15 . . . . + 45°C

Power Supply        : 220V/50 Hz 30 W

Dimensions         : 305 x 105 x 260 mm

Weight               : 3 kg

**TV-Camera Type CC - 111****Technical Data**

Tube                    : Vidicon 2/3" Type 20 PE 20 (S4097)  
 Output                 : BAS, synch. negativ, IV, CCIR standard  
 Output impedance    : 75 Ohms

Resolution            : Greater than 500 lines horizontal

Sensitivity             : 10 LUX min.

Automatic Light      : 10000 : 1

Amplification  
 Operating Temperature :  $-5^{\circ}$  . . . .  $+ 50^{\circ}\text{C}$   
 Power Supply : 220V/50 Hz 10 W  
 Objective : "C Mount"  
 Objective : Zoom 12,5 - 75 mm, 1 : 1,8  
 Weight : 1.5 kg  
 Dimensions : 60 x 80 x 176 mm

**TV Monitor 12" Type CTM 2000**

**Technical Data**

Screen : 12", white  
 Bandwidth : 18 MHz  
 Scanning Distortion : 1%  
 Scan Linearity : Max. 10%  
 Input : 75 Ohms  
 Power Supply : 220V/50 Hz 35 W  
 Front Controls:  
 Contrast  
 Brightness  
 Mains Indicator  
 ON/OFF Push-Button  
 Operating Temperature : 0 . . . .  $55^{\circ}\text{C}$   
 Dimensions : 290 x 306 x 325 mm  
 Weight : 9 kg

TABLE 3

*Recommended Spares : List for Antarctic Station*

*Description*

<i>Description</i>	<i>Part No.</i>	<i>Quantity</i>
A. SATCOM		
1. Integ. LO. Amplifier	..	2
2. Servo Electronics Assembly	..	3
3. EL Motor	..	3
4. AZ Motor	..	3
5. EL Pot	..	3
6. AZ Pot	..	3
7. Power Supply	5 A1A1	2
8. IF/LO (PCB 1)	910805-801	3
9. TX/FM Synthesizer (PCB 2A)	910820-801	5
10. Modulator (PCB 3)	918051-801	3
11. TEL: INTFC: (PCB 4)	918084-801	3
12. TDM Channel Rx (OCB 5)	910857-801	3
13. FM Channel Rx (PCB 6)	911961-801	3
14. RT INTFC Bd. (PCB 11)	..	3
15. Control INTFC (PCB 12)	910859-801	3
16. CPU/MEM. Ckt (PCB 13)	..	3
17. PABX INTFC	..	2
18. QWINT Teleprinter	MSR-742	1
19. Printhead Carrier Mechanism	..	3
20. Teleprinter Paper	..	30 Rolls

**B. SS TV CONVERTER DSC-2000**

<i>No.</i>	<i>Item</i>	<i>Sl. No.</i>	<i>Quantity</i>
1.	Power supply Bd.	2000-81	2
2.	Main Bd.	2000-72	2
3.	Memory Bd.	2000-68	2
4.	Timer Bd.	2000-67	2
5.	Switch Bd.	2000-73	2
6.	Synchr. Gen. Bd.	2000-71	2

**TABLE 4**

*Third Indian Scientific Expedition to Antarctica Sub: Satellite Communication Terminals at Indian Base (inventory of items)*

<i>No.</i>	<i>Item</i>	<i>Sl. No.</i>	<i>Quantity</i>
1.	RADOM-Antenna for DEBEG 3211	260	1
2.	Electronic Unit	219	1
3.	Electric Typewriting Machine	10207	1
4.	Telephone/Control Unit	348	1
5.	Installation Material	..	used
6.	Accessories	..	1 set
7.	Technical Manual	..	1
8.	Operation Manual	..	1
9.	Option Control Unit	175	1
10.	PABX/DATA/FAX/I/F Card with Ribbon Cable	135	1
11.	Junction Cable Assembly	..	1
12.	Set of Antenna Cable	..	30 Mtrs
13.	TV Camera Type CC-11	09201	1
14.	Monitor Type CTM-2000 12"	4871	1
15.	Slow Scan TV Converter Type DSC 2000	09201	1
16.	Manual for Slow Scan TV Equipment	..	1
17.	DEBEG 7911 Weather Chart Fax Recorder	3001245	1
18.	Instruction Manual	..	1
19.	wallmountings for DEBEG 7911	..	1
20.	Set of Spares for DEBEG 7911	..	1 set
21.	DEBEG W 7911 Power supply 110/220 VAC	4050586	1
22.	Metal Recording Paper for DEBEG 7911	..	10

**(LOCATION OF THE ABOVE ITEMS: PORTACABIN): SATCOM  
IDENTIFICATION NUMBER: 1640105 HIND X:**

23.	RADOM-Antenna for DEBEG 3211	218	1
24.	Electronic Unit	283	1
25.	Electric Typewriting Machine	10177	1
26.	Telephone/Control Unit	299	1
27.	Set of Installation Material	..	1
28.	Set of Accessories	..	1
29.	Technical Manual	..	1
30.	Operation Manual	..	1
31.	Set of Antenna Cable	..	30 Mtrs

No.	Item	Sl. No.	Quantity
32.	T. V. Camera Type CC-111	09191	1
33.	Monitor Type CTM-2000.12"	4853	1
34.	Slow Scan TV Converter Type DSC 2000	09191	1
35.	Manual for Slow Scan TV Equipment	..	1
36.	DEBEG 7911 Weather Chart Fax Rec.	300234	1
37.	DEBEG 7911 Weather Chart Fax Rec.	3001235	1
38.	Instruction Manual for DEBEG 7911	..	1
39.	Wallmountings for DEBEG 7911	..	2
40.	Set of Spares for DEBEG 7911	..	2
41.	DEBEG W 7911 Power supply 110/220 VAC	4050593	1
42.	DEBEG W 7911 Power supply 110/220 VAC	4050596	1
43.	Metal Recording Paper	..	20
44.	Set (12 pc) of Printing nails for DEBEG 7911	..	4
45.	Option Control Unit	146	1
46.	PABX/DATA FAX I/F Card with Ribbon Cable	146	1
47.	Junction Cable Assembly	..	1
<b>48.</b>	<b>SPARE PARTS FOR SS TV AND WEATHER FAX RECORDER</b>		
a.	PCB A1, A2, A3, A4, A5 (One each)		
b.	Grounding brush	..	10
c.	Set of screws	..	2
d.	Contact springs	..	10
e.	Running spare kit type F 239 (Note: (a) to (e) spares for Weather Fax)	..	2
f.	Power Supply board	2000-81	1
g.	Main Board	2000-72	1
h.	Memory Board	2000-68	1
i.	Timer Board	2000-67	1
j.	Switch Board	2000-73	1
k.	Synchr. gen. bd. (Note: Items (f) to (k) are spares for SS TV Converter)	2000-71	1
<b>49.</b>	<b>SPARES FOR SATCOM ELECTRONICS UNIT</b>		
	PCBs 1, 2, 3, 4, 5, 6, 11, 12 and 13 (PCB No. 12 has been used already in the set 1640105 HIND Unit on 14-2-1984, since the original PCB 12 failed). PCB 12 (original) could be used in case ONLY Phone calls to be made, and No Telex possible. Hence, Bd left behind. Quantity ONE each.		
50.	MX-1 Power Line Conditioners	..	One with each SATCOM
51.	Paper Rolls for Telex machine	..	12
52.	TELEFAX Machine (NEFAX)	..	1

(LOCATION OF THE ITEMS Nos. 23 TO 52: RESEARCH STATION)  
TOTAL: FIFTY TWO ITEMS ONLY