# **Satellite Communication Experiment 1**

## Application of Geostationary Satellites - Broadcasting

#### 1. OBJECTIVES

- ☑ To become familiar with the operation of a multi-satellite TVRO station.
- ☑ To assess signal quality of a TVRO signal received from a geostationary satellite.
- $\ensuremath{\square}$  To estimate the signal to noise ratio (S/N) for a FM modulated TV signal.

### 2. MATERIALS NEEDED

- ☑ Satellite TV Spectrum Analyser r
- ☑ Television + remote control
- ☑ Satellite Receiver/Antenna Positioner + remote control

#### 3. INTRODUCTION

Broadcasting satellites are geostationary satellites at 35,786 km altitude and located at fixed location to provide video (TV), voice (Radio) & data services to the TVRO users. The use of TVRO (TV Receiving Only) systems is becoming widespread throughout Asia, There are quite a lot of satellite televisions broadcasting channels that can be received in Singapore as can be seen in the picture below: Koreasat, Chinasat, Palappa, Thaicom etc.

116.0°E	Koreasat 6	120302		00 a0F	Express AM2	120321		
115.5°E	ChinaSat 6B	111026		80.0°E	Express MD1	120217		
112 o0E	Koreasat 5	120308		<u>78.5°E</u>	Thaicom 5	120326		
113.0°E	Palapa D	120321		<u>76.5°E</u>	Apstar 2R	120314		
110.5°E	ChinaSat 5B (incl. 0.5°)			<u>75.0°E</u>	ABS 1	120326		
110.5°E	ChinaSat 10	110821		<u>74.9°E</u>	ABS 1A (incl. 4.7°)			
			74.0°E	Insat 3C	110909			
	<u>/4.0°E</u> <u>Insat 4CR</u> 12032							
Colour codes on this regional index: no data/L/S/Ka band C band C & Ku band Ku band moving								

It is important for Technologists to know how to assess signal quality of these systems. A picture seen as being acceptable by one person may be seen as a poor quality picture by another person Two of the most important parameters used to assess picture quality are C/N and S/N. Generally if the C/N is >10dB and the S/N is >40dB then a good quality television picture will result.

Page 1 ET0153 v1

This experiment shows how C/N is measured using a spectrum analyzer and how S/N can be estimated from the carrier to noise ratio.

#### The relationship between C/N and S/N

For AM the S/N is equal to the C/N. For a TVRO system to produce a signal of >40dB C/N ratio at the receiver would be impossible. Hence FM must be used for TV transmitter over satellite in order to obtain the required S/N from a much lower C/N ratio signal.

#### Measurement of analog and digital satellite TV channels

The received signal is measured at the input to the satellite receiver in the Intermediate Frequency (IF) line from the Low Noise Block Converter.

The Satellite TV Spectrum Analyzer used in this experiment is the **PRODIG-5 TV Explorer**.







TV Mode



Measurements











**Auto ID / Explorer function** 

#### Measurement mode

For analog channels: Carrier level, frequency, C/N.

For digital channels: Carrier power, frequency, C/N, BER(VBER & CBER).

#### Spectrum analyser mode

It allows user to discover the signals present in the frequency band of the selected satellite quickly and easily to make measurements at the same time

#### TV mode

It demodulates the currently tuned video signal and display the TV picture on the monitor.

#### Estimating S/N

S/N can be measured directly from the baseband video signal using the appropriate filter and weighting network. The equation link S/N to C/N in TVRO system is given by:

S/N = C/N + FM Improvement Factor, OR S/N = C/N + 35

Page 2 ET0153 v1

#### **TVRO System setup**

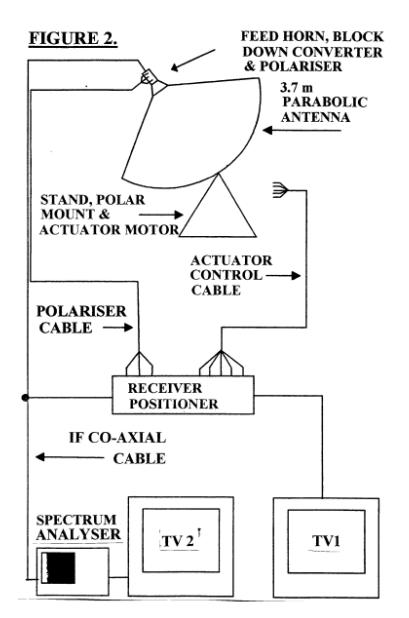
Study the diagram in the left.

Identify the following items in the TVRO system:

- Parabolic dish (at rooftop)
- TVRO receiver
- PRODIG-5 TV Explorer
- LCD TV set.

Referring to the satellite dish next to the setup, identify the following components on the dish:

- Parabolic dish
- Feed horn
- Low Noise Amplifier (LNA)
- Down Converter (DC)



Page 3 ET0153 v1

#### 4. PROCEDURES & RESULTS

- 1. Switch on the TVRO receiver equipment and the Satellite TV Spectrum Analyser and set it to to "Spectrum Analyzer" mode to show the spectrum on the screen.
- 2. Go to the web site <a href="http://www.lyngsat.com/asia.html">http://www.lyngsat.com/asia.html</a>, to obtain the TVRO satellites available in Asia & South Pacific Region

LyngSat Asia & Pacific					LyngSat  ChinaSat 6B at 115.6°E  ChinaSat 6B © LynaSat, last ucdated 2021-05-22 - https://www.hrasat.com/ChinaSat-6B.html														
merica	Main   Asia	P	Asia 😽	UI	ID   Headlin	es   Launches		Euro		Beam RP (dBW)	System SR FEC		Provider Name Channel Name		ONID-TID Compression Format	VPID	C/N lock Audio	Encryption	Source Updated
									(0011)		CCTV.	ссти		2184-3		5.5		Harold Viu 190801	
177.0°W	NSS 9	C	200604		115.5°E	ChinaSat 6B	C	210407				301	CCTV 1	S	MPEG-2/SD	512	650 Chi	Videoguard	175001
180.0°E	Intelsat 18	CKu	210310		112 -05	Koreasat 5	Ku	210302	3	840 H	DVB-S 27500				MPEG-2/SD	513	660 Chi		
172.0°E	Eutelsat 172B	CKu	210511	113.0°E Koreasat 5A	Koreasat 5A	Ku	210201	<u>C</u> 41-42	3/4				MPEG-2/SD MPEG-2/SD	514	670 Chi 680 Chi				
169.0°E	Horizons 3e	Ku	191028		110.5°E	ChinaSat 10	С	210411		41-42					MPEG-2/SD	516	690 Chi		$\overline{}$
166.0°E	Intelsat 19	_	210330			BSAT 4B									MPEG-2/SD	517	700 Chi		
	Intelsat 10 (moving 1.3°E/day)		210000			AsiaSat 7	CKL	210518				307	CCTV 15		MPEG-2/SD	518	710 Chi		
	BRIsat	C	180717		100.5°E	AsiaSat 5	CKL	210518				1	Hebei TV		100-1 MPEG-2/SD	160	80 Chi		E Chua 070806
	JCSAT 18/Kacific 1	-	100/1/		98.0°E	ChinaSat 11		210519	4	192 V		2	Hebei People's Radio				84 Chi		
		-	212511			G-Sat 9	Ku	_		1000	DVB-S 6000		Hebei Music Radio				88 Chi		
146.0°E	Nusantara Satu	С	210514		27.13.5	Thaicom 6	1000	210422		41-42	3/4	4	Hebei Economic Radio				96 Chi		
_	Superbird C2	Ku	200903				2.75.75		5	Hebei Life Radio				97 Chi					
142.0°E	Apstar 9	CKu	210123			Thaicom 8	-	210312				6	Hebei City, Radio				98 Chi		
140 -05	Express AM5	CKu	210403		76.5°E	Apstar 7	-	210521				CCTV.	CCTV		2184-5		55	Videoguard	N Kawano
140.0°E	Express AT2	Ku	210103	1	75.0°E	ABS 2		210522											120801
120 ADE	Toletar 18 Vantage (Anetar 50)	CV	210512	1	72.0 6	G-Saf 17	C	210516	3	880 H				_	MPEG-2/SD	512		Videoguard	
									1	ove n	DVB-S	502	CCTV 5		MPEG-2/SD	513	660 Chi	Videoguard	

4. Click on the Satellite and complete the table below:

Satellite Name	Satellite Location	Frequency Band (C/Ku)	Any 2 Horizontal Polarized Frequencies	Any 2 Vertical Polarized
				Frequencies
Chinasat 6B	$115.5^{0}E$	C	CCTV 3840H/3880H	Hebei 4192Vetc.
Asiasat 7				
ST2				
(Singapore)				
Thaicom 6				

- 5. Use the remote control to move to **CHINASAT** and press **SELECT**. The dish should now move to the CHINASAT satellite and tune to Chinasat 6B Horizontal Polarized Channel 3840H.
- 6. Go to the web site <a href="http://www.lyngsat.com/asia.html">http://www.lyngsat.com/asia.html</a>, select Satellite <a href="http://www.lyngsat.com/asia.html">Chinasat 6B</a> and look at the CCTV 3840 MHz as shown below:

ChinaSat 6B © LyngSat, last updated 2021-05-22 - https://www.lyngsat.com/ChinaSat-6B.html									
Frequency Beam EIRP (dBW)	System SR FEC		Provider Name Channel Name		ONID-TID Compression Format		C/N lock Audio	Encryption	Source Updated
		CCTV.	ссти	I	2184-3		5.5		Harold Viu 190801
		301	CCTV 1	S	MPEG-2/SD	512	650 Chi	Videoguard	
3840 H	DVB-S	302	CCTV 2	S	MPEG-2/SD	513	660 Chi		
c	27500 3/4	303	CCTV 17	S	MPEG-2/SD	514	670 Chi		
<u>C</u> 41-42	3/4	304	CCTV 10	S	MPEG-2/SD	515	680 Chi		
		305	CCTV 11	S	MPEG-2/SD	516	690 Chi		
		306	CCTV 12	S	MPEG-2/SD	517	700 Chi		
		307	CCTV 15	S	MPEG-2/SD	518	710 Chi		

Page 4 ET0153 v1

7. Determine the Intermediate Frequency (IF) carrier using the following equation:

IF carrier (MHz) = \*LO carrier - RF carrier (\*LO carrier is fixed at 5150 MHz) IF carrier (MHz) = 5150 - 3840 = 1310 (MHz)

- 8. Press the Prodig-5 TV Explorer Spectrum button located at the middle of the TV Explorer.
- 9. The display screen will show the satellite spectrum measurements (Frequency, Power, C/N and VBER). Set the frequency value to "1310 MHz".
- 10. Press the Auto Identification button located at the middle of the TV Explorer.
- 11. When the signal is digital, it analyses the modulation type (for Satellite signal QPSK) and all associated parameters (Frequency, C/N, Power, CBER & VBER) are displayed.
- 12. Fine-tune the IF frequency by rotating the tuning dial to obtain **Highest** C/N ratio.
- 13. You can view the TV picture of digital channels (NOT analog) on the monitor by pressing the TV button.
- 14. Press the Measurements button at the middle of the TV Explorer again. Record down the Carrier power (dBm), BER, C/N Ratio in the table below.

ſ	RF Carrier	IF Carrier	IF Carrier	BER	C/N Ratio	Estimated S/N
	(Freq Tp)	Frequency (MHz)	Power (dBm)	(VBER)	(dB)	Ratio (dB)
	3840 H					

Note: IF carrier (MHz) = LO carrier -RF carrier

15. To review all TV /Radio / Data channels in the same IF carrier, press the "Left/Right Arrow key" to view each channel.

RF Carrier		Channel	Bit 1	Rate (bps)	
(Freq Tp)	Channel Name	Numbers (SID)	Video	Audio	
	<b>Video</b>				
	CCTV 1				
	CCTV 2				
204011	CCTV 17				
3840 H	CCTV 10				
	CCTV 11				
	CCTV 12				

Page 5 ET0153 v1

16. Go to the web site <a href="http://www.lyngsat.com/asia.html">http://www.lyngsat.com/asia.html</a>, select Satellite <a href="http://www.lyngsat.com/asia.html">Chinasat 6B</a> and look at the Row with Frequency 4192V as shown below:

RF Carrie	IF Carrier	BER	C/N Ratio	Estimated
(Freq Tp	Power (dBm)	(VBER)	(dB)	S/N Ratio (dB)
4116 H				

Note: IF carrier (MHz) = LO carrier -RF carrier

RF Carrier	Channel Name	Channel Numbers (SID)	Bit Rate (bps)			
(Freq Tp)	Chamiei Name	(312)	Video	Audio		
4116 H						

Page 6 ET0153 v1

#### 5. **DISCUSSIONS**

1. At the TVRO site, carrier signals received from **different satellites** have different measured levels. Analyse the factors that could result in the different measured values. Hints: Use the following **satellite link power budget expression** to analyse.

$$(C)_{dBw} = (P_T)_{dBw} + (G_T)_{dB} + (G_R)_{dB} - (L)_{dB}$$

2. At the TVRO site, carrier signals received from **same satellites** have different measured levels. Analyse the factors that could result in the different measured values. Hints: Use the following **satellite link power budget expression** to analyse.

$$(C)_{dBw} = (P_T)_{dBw} + (G_T)_{dB} + (G_R)_{dB} - (L)_{dB}$$

- 3. Are the TVRO broadcasting satellites in Geostationary or Orbital orbits? Give reason to support your answer.
- 4. Name the different types of baseband signals carried by the TVRO broadcasting satellites.
- 5. What parameters should be used to assess the quality of analogue & digital TV channels?

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