Satellite Communication Experiment 1

Application of Geostationary Satellites – Broadcasting

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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.
☑ To estimate the signal to noise ratio (S/N) for a FM modulated TV signal.
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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	80.0°E	Express AM2		120321
115.5°E	ChinaSat 6B	111026		Express MD1		120217
113.0°E	Koreasat 5	120308	78.5°E	Thaicom 5		120326
	Palapa D	120321	76.5°E	Apstar 2R		120314
110.5°E	ChinaSat 5B *(incl. 0.5°)*		75.0°E	ABS 1		120326
110.5°E	ChinaSat 10	110821	74.9°E	ABS 1A *(incl. 4.7°)*		
			74.0°E	Insat 3C		110909
				Insat 4CR		120321

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.

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

Spectrum Analyser Mode

Digital/Analog measurement mode

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**
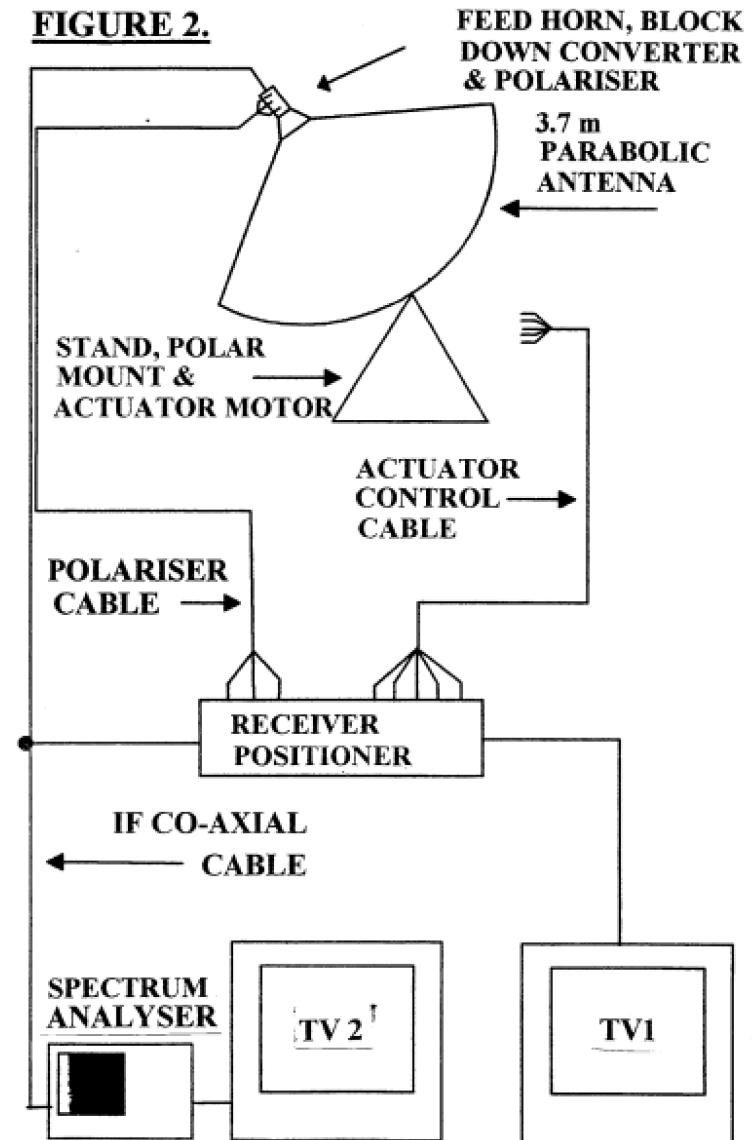
TVRO System setup

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)

FIGURE 2.

FEED HORN, BLOCK DOWN CONVERTER & POLARISER

3.7 m PARABOLIC ANTENNA

STAND, POLAR MOUNT & ACTUATOR MOTOR

ACTUATOR CONTROL CABLE

POLARISER CABLE

RECEIVER POSITIONER

IF CO-AXIAL CABLE

SPECTRUM ANALYSER

TV 2

TV1

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 http://www.lyngsat.com/asia.html, to obtain the TVRO satellites available in Asia & South Pacific Region

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	115.5^0E	C	CCTV 3840H/3880H	Hebei 4192V…etc.
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 http://www.lyngsat.com/asia.html, select Satellite **Chinasat 6B** and look at the CCTV 3840 MHz as shown below :

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.

RF Carrier (Freq Tp)	IF Carrier Frequency (MHz)	IF Carrier Power (dBm)	BER (VBER)	C/N Ratio (dB)	Estimated S/N 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 (Freq Tp)	Channel Name	Channel Numbers (SID)	Bit Rate (bps) Video	Bit Rate (bps) Audio
	Video			
	CCTV 1			
	CCTV 2			
3840 H	CCTV 17			
	CCTV 10			
	CCTV 11			
	CCTV 12			

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

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

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

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

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.

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

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.

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

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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