SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB301-ANALOG AND DIGITAL COMMUNICATION

III YEAR/ V SEMESTER

UNIT 4 – DIGITAL MODULATION TECHNIQUES

TOPIC – **QAM**

16/11/2023

QAM -DEFINITION

Definition:-

QAM is a combination of amplitude and Phase Modulation scheme.

If the amplitude and phase of carrier is varied noise immunity is increased. Such a system called QAM (i-e)

"In QAM both amplitude and phase of the carrier signal is are varied in accordance with digital input signal."

REPRESENTATION OF QAM

Representation:-

$$S_i(t) = \sqrt{\frac{2E_s}{T_s}} k_i \cos \omega_c t - \sqrt{\frac{2E_s}{T_s}} L_i \sin \omega_c t \quad \rightarrow (1)$$

Where,

$E_s \rightarrow$ Symbol Energy

$T_s \rightarrow$ Symbol duration

k_i & $L_i \rightarrow$ A pair of constant choosen according to the location of particular signal point.

* Two orthogonal carriers are used (i-e)

$$\psi_1(t) = \sqrt{\frac{2}{T_s}} \cos \omega_c t \longrightarrow (2)$$

$$\psi_2(t) = \sqrt{\frac{2}{T_s}} \sin \omega_c t \longrightarrow (3)$$

(49)

QAM: 2

by substituting (2) & (3) in (1)

(1) can be written as.

$$S_i(t) = \sqrt{E_s}\, k_i\, \psi_1(t) - \sqrt{E_s}\, L_i\, \psi_2(t) - (4).$$

TYPES OF QAM

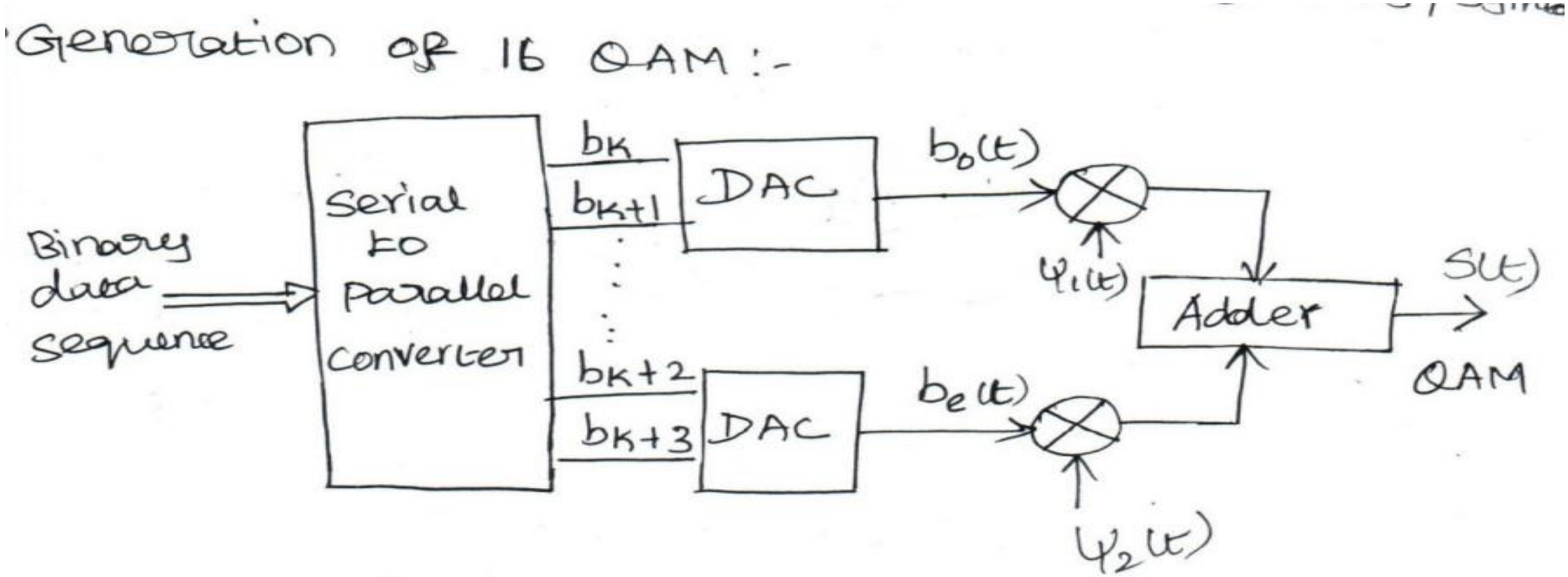
Types of QAM:-

1) 4 QAM 2) 8 QAM 3) 16 QAM 4) 32 QAM

5) 64 QAM.

* In 4 QAM, 4 different symbols available. Each Symbol has 2 bits.
* In 8 QAM, 8 different symbols available. Each Symbol has 3 bits.
* Similarly, 16 QAM,— 16 symbols — 4 bits per symbol
  32 QAM — 32 symbols — 5 bits/symbol
  64 QAM — 64 " — 6 bits/symbol

GENERATION OF QAM



DETECTION OF QAM

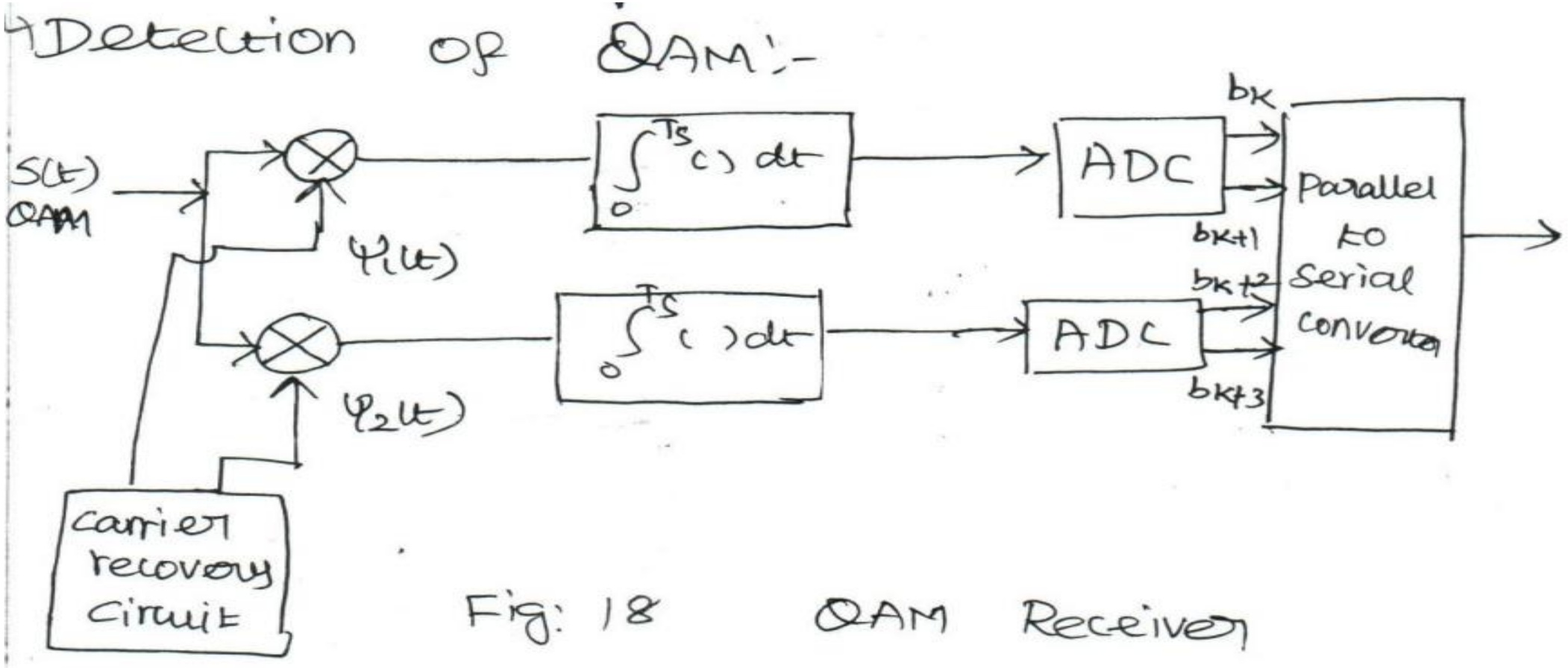
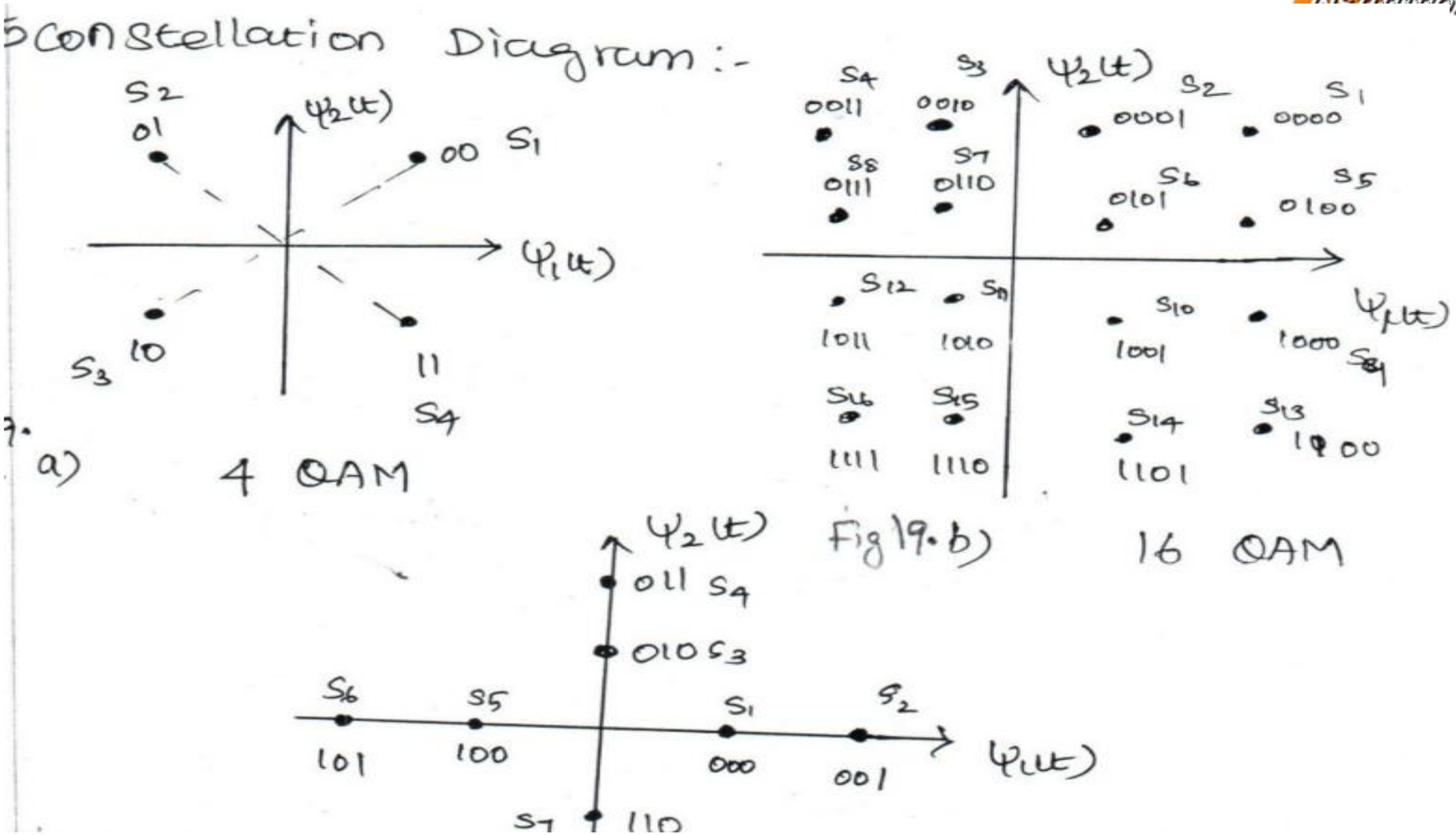


Fig: 18 QAM Receiver

CONSTELLATION DIAGRAM OF QAM

5 Constellation Diagram :-



BANDWIDTH OF QAM

Bandwidth:-

* Bandwidth of QAM = $\frac{2}{NT_b} = \frac{2f_b}{N}$

* Probability of error $P_e \simeq 2\left(1 - \frac{1}{\sqrt{M}}\right) \operatorname{erfc}\left(\sqrt{E_b/N_0}\right)$

THANK YOU