

HONG KONG INSTITUTE OF VOCATIONAL EDUCATION

DEPARTMENT OF ENGINEERING

Higher Diploma in Computer and Electronic Engineering

Module Lab Report: Telecommunication Technology (EEE3460)

Title: *Lab 2 Digital modulation for 8-QAM*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name /  Programme Code /  Class | Student No. | Report  (50%) | Performance  (Demo in class)  (50%) | Participation  (weighting factor [f] for Performance) | Total  (100%) |
| Yeung Wing  EG114403-1B | 230251805 |  |  | f= 1 if no late  f=0.8 if late < 30min  f=0.5 if late > 30 min  f=0 if absent |  |

1. Demo the **Exercise(s)** to the teacher; (50%)

Result[[1]](#footnote-1): Successful / Partially successful / unsuccessful / not demonstrated at all

Content

[1.1 Introduction (2.5%) 3](#_Toc169854501)

[ Quadrature Amplitude Modulation (QAM): 3](#_Toc169854502)

[1.2 Objective (2.5%) 4](#_Toc169854503)

[2. Results for 8-QAM: 4](#_Toc169854504)

[2.1 List of equipment/parts/components (2.5%) 4](#_Toc169854505)

[2.2 Procedure and Results: (17.5%) 4](#_Toc169854506)

[2.3 Conclusion (5%) 7](#_Toc169854507)

[3. Discussion (17.5%) 7](#_Toc169854508)

[4. References: (2.5%) 8](#_Toc169854509)

# 1.1 Introduction (2.5%)

* Quadrature Amplitude Modulation (QAM):

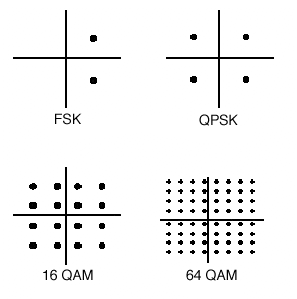
QAM, quadrature amplitude modulation provides some significant benefits for data transmission. As 16QAM transitions to 64QAM, 64QAM to 256 QAM and so forth, higher data rates can be achieved, but at the cost of the noise margin.

* + Quadrature Amplitude Modulation (QAM): combines amplitude and phase modulation
  + it is possible to code n bits using one symbol
  + 2n discrete levels, n=2 identical to QPSK
  + bit error rate increases with n, but less errors compared to comparable PSK schemes

A black text on a white background

Description automatically generated A close-up of a computer screen

Description automatically generated A diagram of a phase angle

Description automatically generated

# 1.2 Objective (2.5%)

Investigate the design of the digital modulation of QAM.

# 2. Results for 8-QAM:

## 2.1 List of equipment/parts/components (2.5%)

Dibit\_I is VPULSE: V1=1, V2=-0, TR=0, TF=0, PW=1m, PER=2m.

Dibit\_Q is VPULSE: V1=1, V2=-0, TR=0, TF=0, PW=2m, PER=4m.

Dibit\_C is VPULSE: V1=1, V2=-0, TR=0, TF=0, PW=4m, PER=8m.

Vsin is VSIN: VOFF=0, FREQ=2000, TD=0, DF=0, PHASE=0, VAMPL=1.

Vcos is VSIN: VOFF=0, FREQ=2000, TD=0, DF=0, PHASE=90, VAMPL=1.

ABM2 (EXP1=IF(V(%IN1)==0 & V(%IN2)==0, -0.541,0), EXP2=+IF(V(%IN1)==0 & V(%IN2)==1,-1.307,0), EXP3=+IF(V(%IN1)==1 & V(%IN2)==0,+0.541,0)), EXP4=+IF(V(%IN1)==1 & V(%IN2)==1,+1.307,0),

## 2.2 Procedure and Results: (17.5%)

|  |
| --- |
| Fig1 |
| Fig2 |
| Fig3 |
| Fig4 |
| Fig5 |

## 2.3 Conclusion (5%)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Debit C** | **Debit Q** | **Debit I** | **Amplitude** | **Phase** | **Summing Outputs** |
| 0 | 0 | 0 | 0.765 | 135 |  |
| 0 | 0 | 1 | -135 |  |
| 0 | 1 | 0 | -45 |  |
| 0 | 1 | 1 | 45 |  |
| 1 | 0 | 0 | 1.848 | 135 |  |
| 1 | 0 | 1 | -135 |  |
| 1 | 1 | 0 | -45 |  |
| 1 | 1 | 1 | 45 |  |

# 3. Discussion (17.5%)

Quadrature Amplitude Modulation, in short, QAM is using different amplitude and phase to represent the information.

In 8-QAM, as the name suggests, there are 2^3 = 8 states (with 2 different amplitude and 4 phase) to represent 3 bits of information which makes QAM efficient. However, QAM signals require a higher signal-to-noise ratio to achieve low error rate, because more states they have, the closer they are. With a larger number QAM, it might be hard to keep working without error.

As a result, 8-QAM is used in a wide range of digital communications systems, including Wi-Fi networks, cable modems, and satellite and terrestrial television broadcasting.

# 4. References: (2.5%)

* [The Hong Kong Polytechnic University - Department of Electronic and Information Engineering - Communication Laboratory - Phase Shift Keying (PSK) & Quadrature Phase Shift Keying (QPSK)] (<https://www.eie.polyu.edu.hk/~em/dtss04pdf/psk.pdf>)
* [Digital Signal Processing - Scientific Figure on ResearchGate] (<https://www.researchgate.net/figure/Digital-modulation-schemes-ASK-FSK-and-PSK_fig3_303471153>)
* [ELEC 7073 Digital Communications III, Dept. of E.E.E., HKU] (<https://www.eee.hku.hk/~sdma/elec7073/Part3-Digital%20Modulation_small.pdf>)
* [EEE3460 CH3 Digital Modulation and Demodulation v1] (<https://moodle2324.vtc.edu.hk/mod/resource/view.php?id=739109>)
* [Quadrature Amplitude Modulation (QAM) Constellation by QUESTTEL Boradcast Systems] (<https://questtel.com/wiki/qam-constellation>)

1. Delete where applicable [↑](#footnote-ref-1)