

BASICS OF IQ SIGNALS

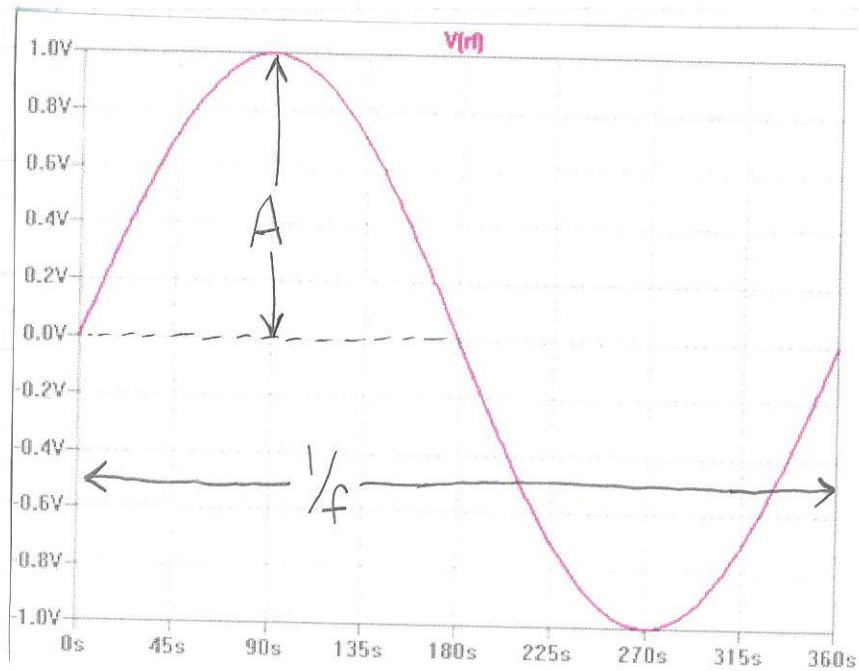
- INCLUDING IQ MODULATION & DEMODULATION

FUNDAMENTAL CONCEPTS:

- COMPONENTS OF A SINE WAVE
- SIMPLE AMPLITUDE MODULATION
- QUADRATURE SIGNALS
- PROPERTIES OF SUMMING QUADRATURE SIGNALS (IQ)
- MODULATION / DEMODULATION AND IQ SIGNALS

WZAEW

COMPONENTS OF A SINE WAVE



$$V(t) = A * \sin(2\pi f t + \phi)$$

A = PEAK VOLTAGE

f = FREQUENCY

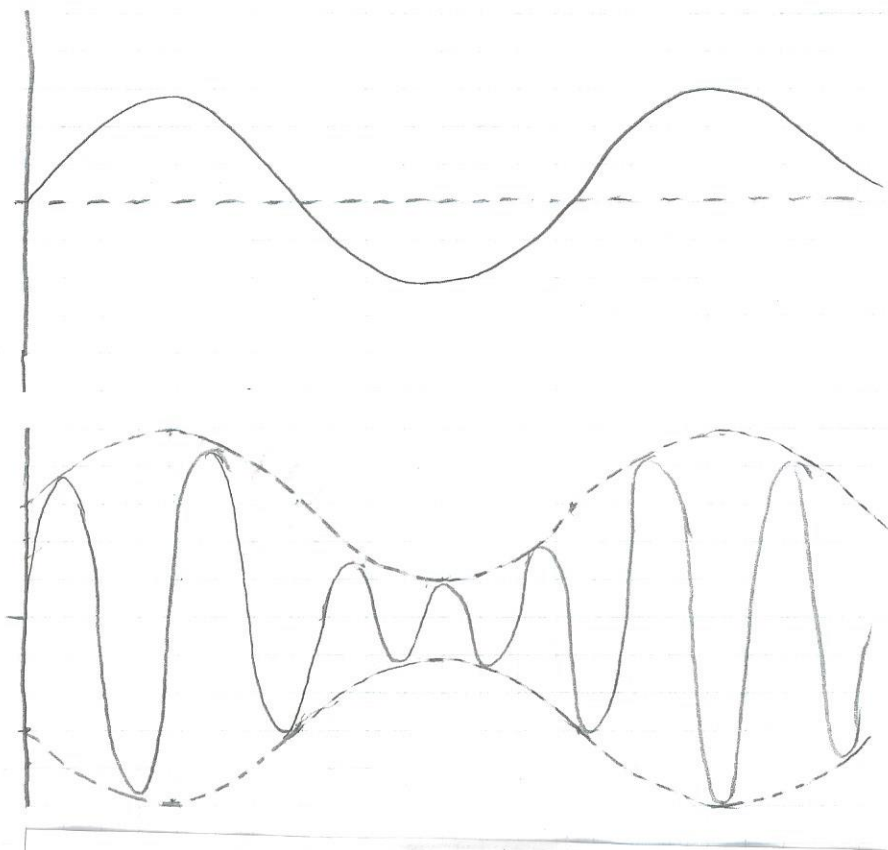
t = TIME

ϕ = PHASE SHIFT

W2AEW

SIMPLE AMPLITUDE MODULATION

$$v(t) = \underline{A(t)} * \sin(2\pi ft + \phi)$$



W2AEW

SIMPLE AMPLITUDE MODULATION

$$v(t) = \underline{A(t)} * \sin(2\pi ft + \phi)$$



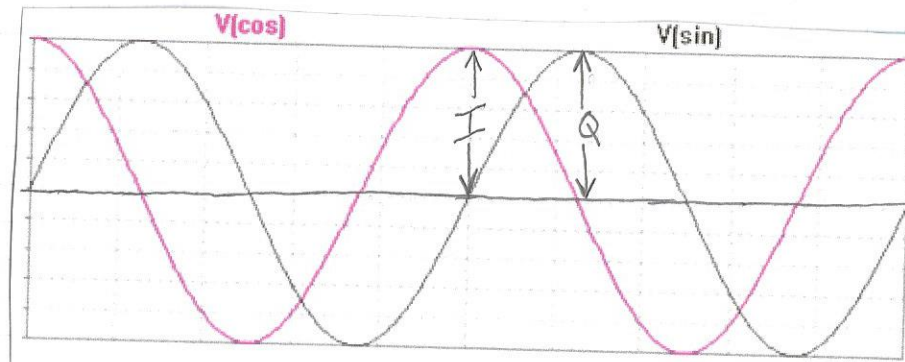
W2AEW

QUADRATURE SIGNALS

DEFINITION: TWO SIGNALS ARE SAID TO BE IN QUADRATURE
WHEN THEY ARE 90° APART IN PHASE

$(\frac{1}{4}$ CYCLE)

EXAMPLE: COSINE & SINE WAVES ARE IN QUADRATURE



BY CONVENTION:

- THE AMPLITUDE OF THE "IN-PHASE" SIGNAL = I

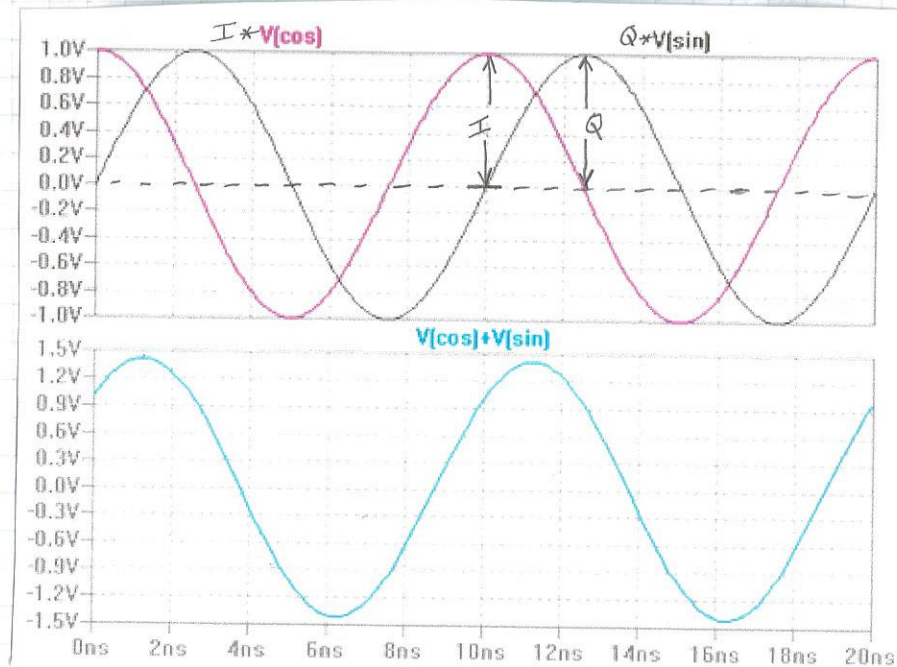
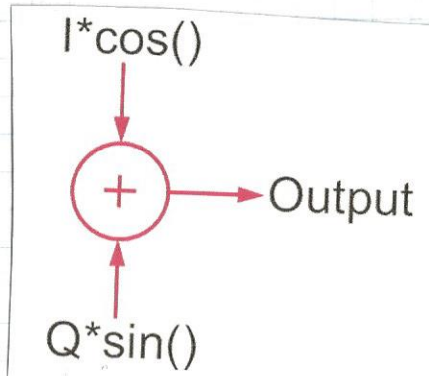
$$\underline{I} * \cos(2\pi ft)$$

- THE AMPLITUDE OF THE "90° SHIFTED" SIGNAL = Q

$$\underline{Q} * \sin(2\pi ft)$$

WZAEW

ADDING QUADRATURE SIGNALS



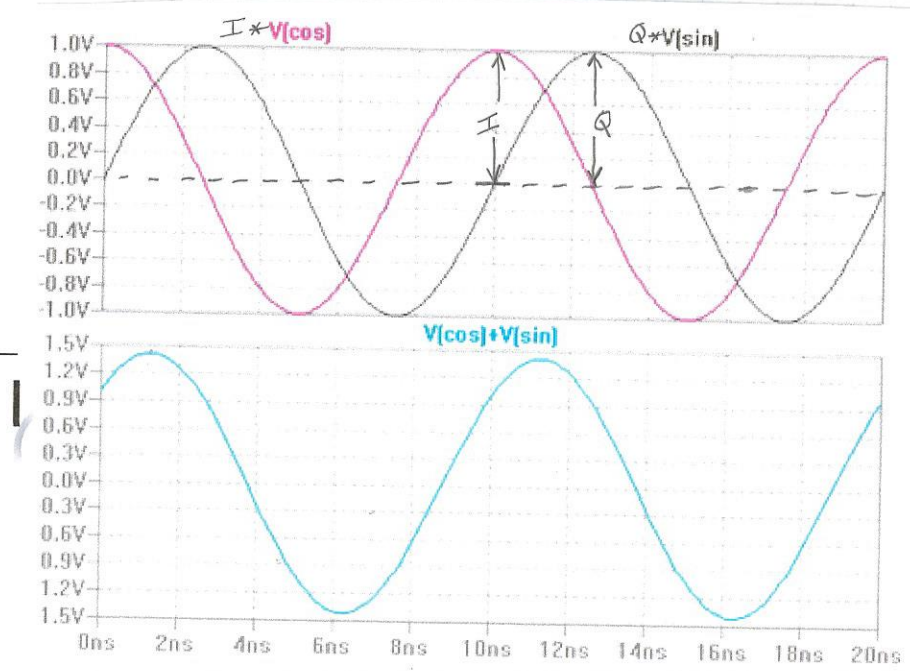
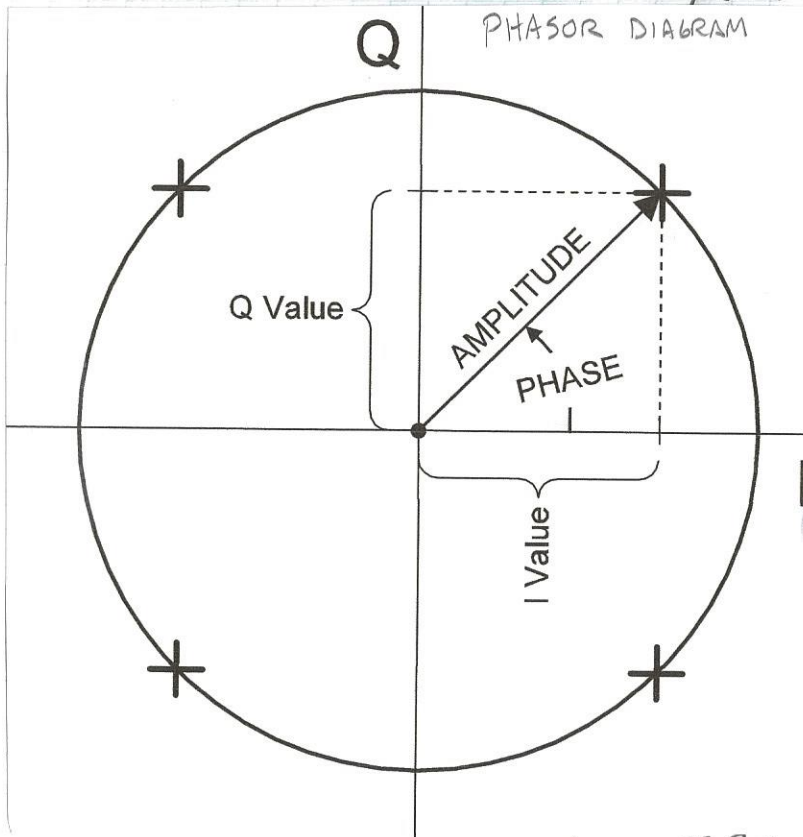
- WHEN $I \neq Q$ VARY "IDENTICALLY", THE AMPLITUDE OF THE SUM VARIES
- WHEN $I \neq Q$ VARY DIFFERENTLY, THE PHASE (\neq AMP) OF SUM VARIES

THEREFORE:

$I(t) \neq Q(t)$ VARIATIONS RESULT IN AMPLITUDE \neq PHASE MODULATION OF THE SUM. (FREQUENCY MODULATION TOO)

W2AEW

ADDING QUADRATURE SIGNALS



- WHEN $I \neq Q$ VARY "IDENTICALLY", THE AMPLITUDE OF THE SUM VARIES
- WHEN $I \neq Q$ VARY DIFFERENTLY, THE PHASE (\neq AMP) OF SUM VARIES

THEREFORE:

$I(t) \neq Q(t)$ VARIATIONS RESULT IN AMPLITUDE \neq PHASE MODULATION OF THE SUM. (FREQUENCY MODULATION TOO)

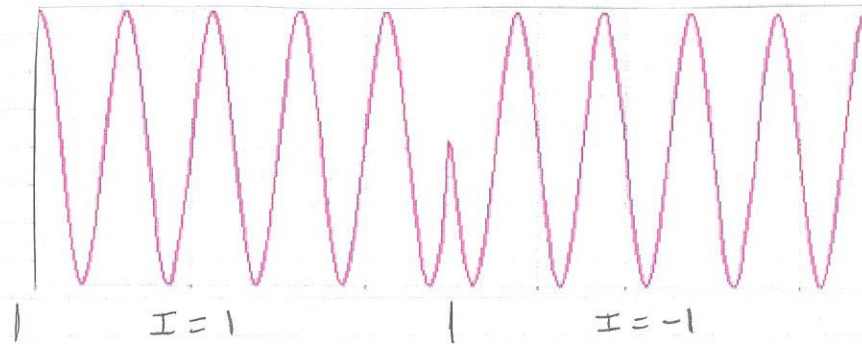
WZAEW

DIGITAL MODULATION

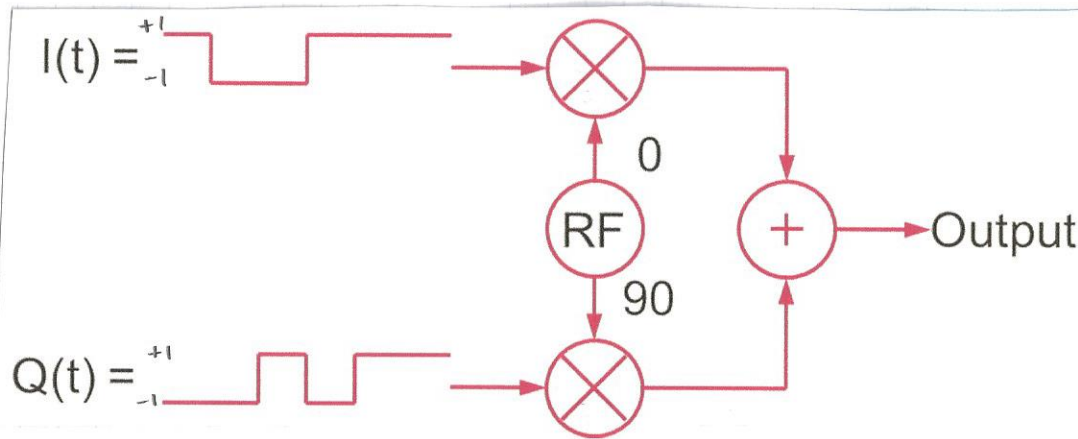
- BINARY PHASE SHIFT KEYING = BPSK

$$\begin{aligned} I(t) & \text{ VARIES BETWEEN } +1 \text{ \& } -1 \\ Q(t) & = 0 \end{aligned}$$

WZAFEW



- QUADRATURE PHASE SHIFT KEYING = QPSK



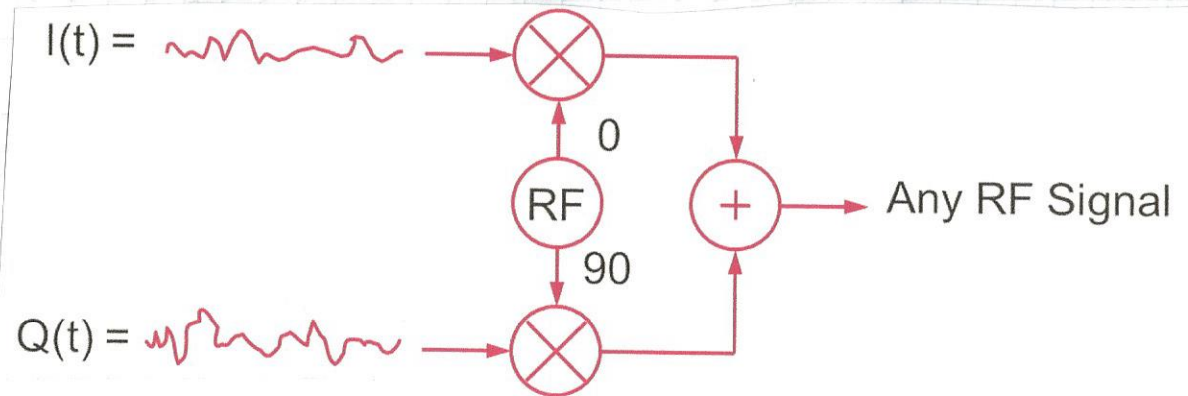
I	Q	OUTPUT
+1	+1	45°
-1	+1	135°
-1	-1	225°
+1	-1	315°

IQ MODULATION & DEMODULATION

W2AEW

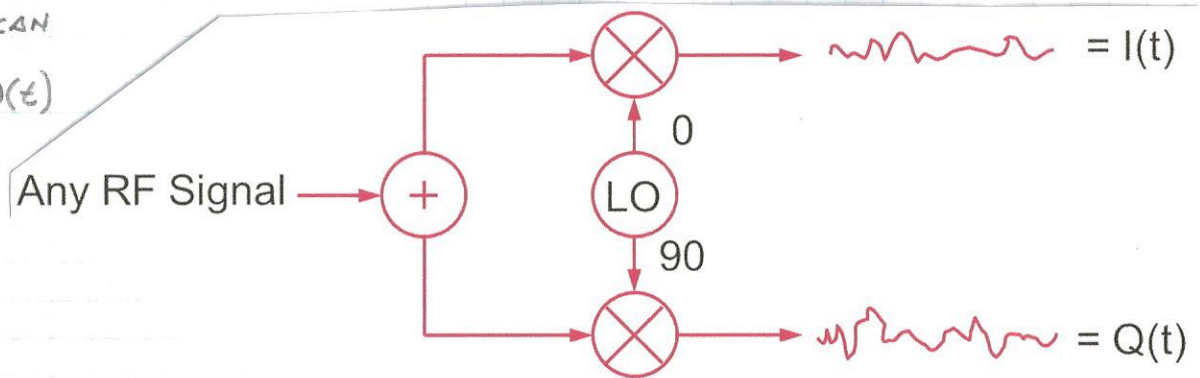
MODULATION:

$I(t)$ & $Q(t)$ SIGNALS CAN BE GENERATED TO RESULT IN ANY MODULATION: AM, FM, PM, SSB, BPSK, QPSK, 16QAM, ETC.



DEMODULATION:

ANY MODULATED RF SIGNAL CAN BE CONVERTED INTO $I(t)$ & $Q(t)$ SIGNALS (IQ SIGNALS)



THIS IS THE BASIS OF SOFTWARE DEFINE RADIO (SDR)

- IQ SIGNALS CAN EASILY BE GENERATED & ANALYZED IN SOFTWARE, AND PROCESSED THROUGH ADCs & DACs
- SOUND CARD OR CUSTOM H/W