**U19EC046 | WMC | LAB 12**

##### Objective

##### To Study about Mobile Phone Trainer Kit.

**Apparatus Required**

TechBook Scientech 2139

##### Technical Specification :

**Cellular System :** EGSM/GSM 900.

**Rx Frequency Band :** EGSM 925 960 MHz

**:** GSM 900 935 960 MHz

**Tx Frequency Band :** EGSM 880 890 MHz

**:** GSM 900 890 915 MHZ

**Output power :** +5... +33dBm/3.2 mW 2 W

**Channel spacing :** 200 KHz

**-Antenna -- :** Loop type, 50 ohms

**Display :** 84 x 48 pixels

**:** Antenna, Keypad, SIM, Charging

**On board sections** Circuit, Clock, User interface: Buzzer, Vibrator, LEDs.

##### No. of Test points : 41

**No. of Switched fault :** 25

**:** Screen saver, Ring tones, Logos,

##### Features that can be set

SMS etc.

**Power supply :** 220V f 10%, 50 Hz

**Power consumption :** 3.6 Watts (Approx.)

**Fuse :** 1.5 amps

**Dimension (mm) :** W 450 x H 113 x D 280.

**Weight :** 2.6 Kg (Approx.)

**An overview of GSM network:**

###### GSM network:

The GSM Network comprises three parts, Mobile Station (MS) which is similar to a cordless phone with extra features, the Base Transceiver Station (BTS) that controls the connection with the Mobile Station, the Base Station Controller (BSC) that controls multiply Base Transceiver Station's and then the rest of the network covered further below.

###### Mobile Station (MS):

A Digital Mobile Phone and a SIM card make up the Mobile Station. The SIM (Subscriber Identity Module) is a card that first into your handset. The SIM microprocessor is based on a silicon chip which is designed to tolerate temperatures between -25°C and +70°C, and will also withstand up to 85% humidity. However silicon is fragile and therefore, if the card is tampered with, physically or electronically, the card will be rendered useless. The SIM contains all of your identification details, such as your IMSI (International Mobile Subscriber Identity).This is a numeric string, where the first 3 digits represent the country where the SIM is from, the next represent the operator in that specific country. The other digits represent the subscriber's identity in his home-network), phone memories, billing Information, SMS text messages, pin numbers and international roaming information.

An IMEI (International Mobile Equipment Identity) card is the serial number of the GSM phone. The SIM card contains a IMSI (International Mobile Subscriber Identity) number that identifies the user to the network along with other user and security information.

###### Base Transceiver Station (BTS):

The Base Transceiver Station consists of a radio transceiver with antenna that covers a single cell. It handles the communications with the MS via radio interface. BTS are all connected together to allow you to move from one cell to another. The antenna can take on various forms.

###### Base Station Controller (BSC) :

The Base Station Controller manages multiple BTS's. It controls the allocation and release of radio channels and handovers between cells. A series of BTS's are connected. To each Base Station Controller, the BSC keeps an eye on each call and decides when to pass the call off to another BTS and to which one.

**The Rest of the Network:**

Several BTC's are controlled by the Mobile service Switching Center (MSC), the MSC works with four databases (HLR, VLR, EIR and the AUC) and together they manage the communications between Mobile Station user and the other network types. Each of the databases has a separate job.

###### Mobile Switching Center (MSC):

The Mobile Switching Center is the interface between the base station system and the switching subsystem of the mobile phone network. Furthermore, the MSC is also the interface between the cellular network and the PSTN. The MSC generates all billing records and ensures that all usage is directed to the appropriate account. The MSC has a relatively complex task, as unlike a conventional telephone exchange, when GSM subscribers make calls they could be anywhere within the network. The MSC must ensure that calls are routed through to those subscribers, wherever they are and wherever they move to throughout the duration of each cell. This situation becomes even more complex when two mobile subscribers wish to contact each other from two distant locations.

In order to simplify the subscriber management function, a specific service area is allocated to each MSC. The MSC has to control the switching of tariff to and from the subscribers within its service area which involves the co-ordination of all radio resources and the inter cell hand-off activities.

###### Home Location Register (HLR) :

The HLR is the central data base for all the subscribers which contain detaiIs on the identity of each subscriber, the services to which they have access and the locations where the subscriber was last registered. Once the Mobile Station's MSISDN has been used to identify the IMSI, the HLR verifies the subscription records to ensure that the call can be delivered to the last known location of the Mobile Station.

###### Visitor's Location Register (VLR):

The VLR is a database that is linked to an MSC and temporarily stares information about each Mobile Station within the area served by that MSC.

###### Equipment Identity Register (EIR):

The EIR ensures that all Mobile Equipment's, are valid and authorized to function on the PLMN.

###### Authentication Center (AUC):

The authentication center is used to validate the SIM Card being used by the Mobile Station. Secret information that is held in the AUC and which is also contained within the SIM Card is used to perform a complex mathematical calculation. Authentication occurs if the results of these two calculations agree.

###### SMSC (SMS Center or Service Center):

The SMSC handled all the SMS messages that are sent. The messages are sent on a data channel so you can receive them while on a call.

###### GMSC (Gateway MSC):

It is a gateway switch where the call is directed when setting up a call to a GSM user. The GMSC looks for the subscriber by interrogating the right HLR which then interrogates the VLR and routes the incoming call towards the MSC where the subscriber can be reached.

#### Outstanding Features:

###### Quality:

With digital, sound quality is sharp and clear. Background sounds and static are vastly reduced and crossed-line conversations are also eliminated. In comparison with analog there are also far fewer dropouts, and overall the quality is more like that of a fixed telephone.

###### Security:

Unlike analog, everything you say and send within the digital network is safe and secure. Some features are user authentication that prohibits unauthorized access, encryption key distribution that guarantees the privacy of the call and caller Identification restrictions that can prevent the delivery & identify calling-user's number to the receiver.

###### Convenience:

With digital, better technology means better battery life. You get up to twice as much talk time from each battery charge, compared with analogue. In addition the digital service allows more calls to be handled at any one time, therefore reducing congestion in areas of dense population and high usage.

###### Roaming:

Roaming is one more feature of GSM technology. With digital, you are able to use your mobile phone, and number in other countries around the world that operate a GSM network.

#### Features:

1. Call Forwarding
2. All Calls
3. No Answer
4. Engaged
5. Unreachable
6. Call Barring
7. Outgoing - Bar certain outgoing calls (e.g. ISD)
8. Incoming - Bar certain incoming calls (Useful if in another country)
9. Global roaming - Visit any other country with GSM and a roaming agreement and use your phone.
10. SMS - Short Message Service - Allows you to send text messages to and from phones
11. Multi Party Calling - Talk to five other parties, as well as yourself at the same time
12. Call Holding - Place a call on Hold
13. Call Waiting - Notifies you of another call whilst on a call
14. Mobile Data Services - Allows handsets to communicate with computers
15. Mobile Fax Service - Allows handsets to send, retrieve and receive faxes
16. Calling Line Identity Service - This facility allows you to see the telephone number of the incoming caller on our handset before answering
17. Advice of Charge - Allows you to keep track of call costs
18. Cell Broadcast - Allows you to subscribe to local news channels
19. Mobile Terminating Fax - Another number you are. Issued with that receives faxes that you can then download to the nearest fax machine.
20. Upgrade and improvements to existing services
21. Majority of the upgrade concerns data transmission, including bearer services and packet switched data at 64 Kbits and above
22. SIM enhancements

#### GMSK Modulation:

GSM uses a digital modulation format called 0.3GMSK (Gaussian minimum shift keying). The 0.3 describes the bandwidth of the Gaussian filter with relation to the bit rate. The bandwidth of 0.3 was chosen as a compromise between spectral efficiency and inter symbol interference.

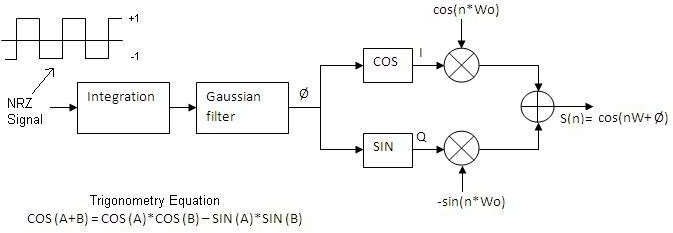
GMSK is a special type of digital FM modulation. 1's and. 0's are represented by shifting the RF carrier by plus or minus 67.-708. KHz. Modulation techniques which use two frequencies to represent one and zero` are denoted FSK (frequency shift keying). In the case of GSM the data rate of 270.833kbit/sec is chosen to be exactly four times the RF frequency shift. This has the effect of minimizing the modulation spectrum and improving channel efficiency. FSK modulation where the bit rates exactly four times the frequency shift is called MSK (minimum-shift keying). In GSM, the modulation spectrum is further reduced by applying a Gaussian pre-modulation filter. This slows down the rapid frequency transitions, which would otherwise spread energy into adjacent channels.

0.3GMSK is not phase modulation (i.e. information is not conveyed by absolute phase states, as in QPSK for example). It's the frequency shift or change of phase state which conveys information. GMSK can be visualized from an I/Q diagram. Without the Gaussian filter, if a constant stream of l's is being - transmitted, MSK will effectively stay 67.708 KHz above the carrier center frequency. If the carrier center frequency is taken as a stationary phase reference, the 67.708 KHz signal will cause ; steady increase in phase. The phases will role 360 degrees at a rate of 67,701 revolutions per second. In one bit period (1/270.833 KHz), the phase will get a quarter of the way round the I/Q diagram or 90 degrees. I's are seen as a phase increase of 91 degrees. Two l's causes a phase increase of

180 degrees, three l's 270 degrees and so on. 0's cause the same phase change in the opposite direction.

The exact phase trajectory is very tightly controlled. GSM use's digital filters and I/( or digital FM modulators to accurately generate the correct trajectory. The GSM specification allows no more than 5 degrees rms and 20 degrees peak deviation four the ideal trajectory.

GMSK, is a form of modulation used in a variety of digital radio communications systems. It has advantages of being able to carry digital modulation while still using the spectrum efficiently. One of the problems with other forms of phase shift keying is that the sidebands extend outwards from the main carrier and these can cause interference to other radio communications systems using nearby channels.



#### GETTING STARTED:

##### Fig. 1 GMSK Transmitter Block Diagram

1. Check the battery is received in proper condition.
2. Insert SIM card of any 900MHz service provides in the SIM assembly.
3. Now, insert the battery so that the battery contacts and assembly Terminal match.
4. Switch ON the trainer by pressing the power ON/OFF switch, located at the top right most corner.

Note: Whenever the switch is operated ON/OFF LED operates.

1. When/If the battery is low. Connect the mains cord and operate the Charging switch located at the top right most corner below the power switch.
2. Mode: This is an improved feature of ST2132. The mode has to be selected prior to switching ON the trainer.

DC Mode: In normal switch position, trainer operates with battery supplied & charging facility functions normally.

AC Mode :When switch pressed trainer operates on AC & mains cord is a must for the supply. The trainer automatically disconnects the battery

contacts when the mode is changed from DC to AC. So, physical presence of the battery in the battery assembly doesn't have any effect. The charging On/Off switch stops the functioning in this mode.

Note: Switch OFF the trainer before switching between the operating modes.

**Procedure:**

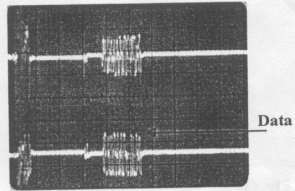
#### Task 1: To study the Tx IQ and Rx IQ signals.

1. Insert the SIM and power ON the trainer.
2. Make a Call to the trainer or from the trainer.
3. Keep the Call ON

Connect the probe of spectrum analyzer at Tp. 1 and observe the signal in the Tx band.

Now connect the probe to Tp. 2 observe the signal in the Rx band.

Connect two probe of CRO one at Tp. 3 and the other on Tp. 4 observe the Rx burst. A similar Rx burst can be observed by connecting probe Tp. 5 and Tp.6 respectively. Signal fig.2 shows a IQ Tx and Rx burst signal.

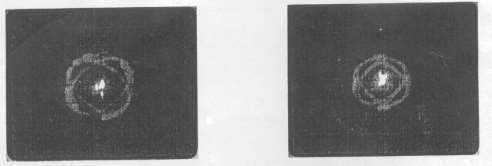


**Fig. 2 Burst Signal**

#### Task 2: To observe signal constellation of GMSK signal.

##### Procedure:

1. Make a Call to the trainer.
2. Receive the Call and Keep the Call ON
3. Connect two probe of CRO one at Tp. 3 and the other on Tp. 4 observe the Rx burst signal fig.3 shows a IQ Rx burst signal.

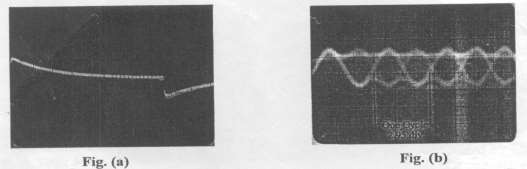


##### Fig 3. Constellation at Receiver end

**Procedure**

#### Task 3: GSM Data Rate and GMSK encoded signal

1. Make a call to the trainer.
2. Connect the probe of CRO at TP. 5 or TP 6.
3. Observe the signal As shown in fig.4 (a).
4. Expand the signal to see the eye pattern.
5. Expand the signal.
6. Observe the GMSK encoded signal



##### Fig. 4 Waveform observed during a call

**Conclusion:**

Using Mobile Phone Trainer Kit TechBook Scientech 2139, we studied and analyzed various signals and operations on DSO and also analyzed frequency spectrum of ongoing call on Frequency Analyzer.