

## **CLS-45i CIRCUIT DESCRIPTION**

### **CONTENT**

1. Introduction
2. Functional Blocks of CLS-45i Handset
3. CLS-45i Handset Unit Circuit Block Description
4. Functional Blocks of CLS-45i Base unit
5. CLS-45i Base Unit Circuit Block Description
6. Functional Blocks of the RF Module
7. RF Module Circuit Block Description
8. CLS-45i Basic Operation (Base)
9. CLS-45i Basic Operation (Handset)
10. CLS-45i Basic Operation (Base and Handset)
11. Test Mode Operation
12. RF Channels

## **1. Introduction**

The model CLS-45i is a 20 channel (2.4GHz) cordless telephone.

This unit is made up of two parts:

- a. A Handset unit.
- b. A Base unit.

A security code of over 65,000 different combinations is used to prevent access by a different phone on a different line. This code is randomly and automatically changed each time the handset is placed in the cradle.

## **2. Functional Blocks of CLS-45i Handset**

The block diagram of CLS-45i handset unit is as shown below. It is made up of the following parts:

- 2.1 Keyboard Matrix, Switches and Function LED
- 2.2 MCU and MCU Interface
- 2.3 RF Module
- 2.4 Comander
- 2.5 Data Shaper
- 2.6 Charge and Control
- 2.7 Low Battery Detector
- 2.8 Buzzer
- 2.9 Audio Circuit

### **3. CLS-45i Handset Unit Circuit Block Description**

#### **3.1 Keyboard Matrix, Switches and Function LED**

The keyboard consists of the following keys:

- CALL ID – for Caller ID operation
- DELETE (◀BACK) – for menu operation
- FLASH (EXIT) — provides timed On/Off hook function
- TALK – for On/Off hook control
- UP/DOWN – for menu operation
- REDIAL (FWD ▶) – redials the last number or provides a pause during dialing.
- 1, 2, 3, 4, 5, 6, 7, 8, 9, \*, 0, # – numeric keys
- CHANNEL (SETUP) – for changing RF carrier frequency
- SPEAKER – for On/Off hook control in speakerphone mode
- INTERCOM (ENTER) – for base and handset communication
- AMPLIFY – provides amplifier On/Off hook function
- MEM – for memory program and dialing

The keyboard is connected to Pins 84 to 94, 97 of the MCU (MCU1).

The switches consist of the followings:

- RINGER ON/OFF – turns On/Off the ringer buzzer

This is connected to pins 97 and 88 of MCU.

The jacks consist of the followings:

- HEADSET – for connection of an external microphone and receiver
- AUDIO – for connection of an external speaker
- REMOTE – for connection of an external switch. This is connected to pins 97 and 90 of MCU.

The function LEDs consist of the followings:

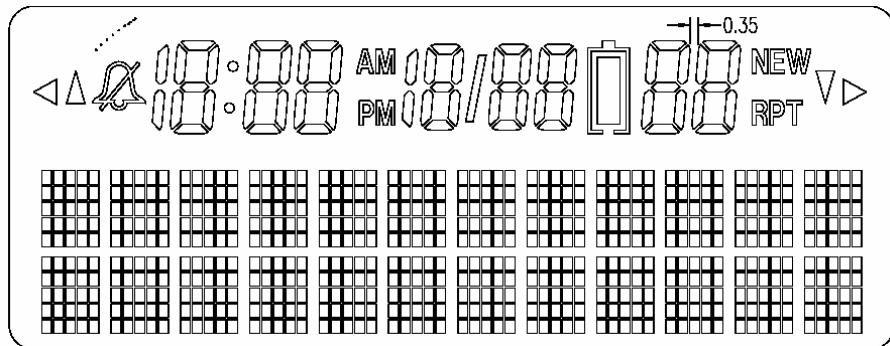
- NEWCALL/INUSE (NCALL1 – RED) – Located under the lens on the top right hand corner. On/Off when handset is Off-hook/On-hook. Blinks when there is New Call to be reviewed.
- AMPLIFIER (AMP1 – RED) – Located under the “AMPLIFY” key. On/Off when the receiver amplifier extra gain is On/Off.
- SPEAKERPHONE (SPK1 – RED) – On/Off when the speakerphone is On/Off. Located under the “SPEAKERPHONE” key.
- BACKLIGHT (LED1 – LED14, LED15 - Amber) – Located under the

keyboard and LCD backlight. On for a short time when any key is pressed

- RINGER (RING1 - Red) – Located under the red lens on the back of the unit. Flashes when the telephone line rings

These LEDs are controlled by pins 91, 98, 96, 66 and 99 of MCU.

The display format of the LCD is as shown below.



The display is controlled by pins 13 – 70 of MCU.

### 3.2 MCU and MCU Interface

The controller of the handset is MCU1. The frequency of the crystal used is 32.768 KHz.

It controls the functions of the handset through the keyboard interface and signals from the base unit. The data to and from the base goes through pin 69 (data from base) and pin 71 (data to base).

### 3.3 RF Module

For operation and frequency see RF module section.

It receives the PLL data through pins 5, 6, 7 from MCU pins 93, 94 and 95.

The antenna located at the top of the unit and is permanent attached to RF module through a copper wire.

### 3.4 Compander

A compander U3 is used for improving the S/N of transmit and receive audio signals.

### 3.5 Data Shaper

The information which sent from base unit is recovered by the amplifier Q306 and Q305.

### **3.6 Charge and Control**

ZD1, D304, D305, D306, D307, Q1 provide polarity and over-voltage protection during battery charging. The charge signal is detected by pin 84 of the MCU.

When the handset is put into the base cradle, a negative pulse is sent to pin 74 of the MCU.

### **3.7 Low Battery Detector**

The battery voltage is detected by U4 and Q14. The signal is sent to pin 67 of MCU.

### **3.8 Buzzer**

Q3 is the buzzer signal amplifier and driven by the MCU pins 72.

### **3.9 Audio Circuit**

When operating in receiver mode, speech signal is picked up by the internal microphone MIC1 and sent to the telephone line through amplifier U1B, the compander U3 and the RF module. The incoming speech is received through the RF module, the compander, the amplifier U1A, and amplifier U6. When AMPLIFIER is On,, extra gain is inserted in this audio path by speakerphone IC U11, and tone control U1C and U1D.

When operating in speakerphone mode, speech signal is picked up by MIC1 and sent to the telephone line through U11, the compander U3 and the RF module.

The incoming speech is received through the RF module, the compander, the amplifier U11, and amplifier U5.

The tone control and amplifier functions are disabled when in speakerphone mode.

The headset jack is for external receiver and microphone. The audio jack is for external speaker when in receiver mode.

#### **4. Functional Blocks of CLS-45i Base Unit**

The block diagram of CLS-45i base unit is as shown below. It is made up of the following parts:

- Power Supply
- MCU and MCU Interface
- RF Module
- Compander
- Data Shaper
- Charge and Control
- Telephone Line Interface
- Ring Signal Detector
- Base Ringer
- Keyboard Matrix, Switches and Function LED

## **5. CLS-45i Base Unit Circuit Block Description**

### **5.1 Power Supply**

The base unit is powered by an AC adapter (9V dc). The voltage regulator (BU3) regulates the input DC to 5V. This provides power to every part of the unit. When there is no AC power, BQ10 and BQ11 are turned on to connect the backup batteries to power the base while BZD2 controls the regulated battery output voltage to approximately 5V. The backup batteries are checked periodically by BU10 and this signal is connected to pin 92 of the MCU.

### **5.2 MCU and MCU Interface**

The controller of the base is BU11 and controls the function of the unit. The frequency of the crystal used is 32.768 KHz.

It communicates with the handset through the RF module. PLL data to the RF module RFM1 is sent through pins 83, 84 and 97.

The data between Handset and Base is via the pin 94 (data from handset) and pin 96 (data to handset) through the RF module. The transmitter and receiver powers are controlled by the signal from pin 2 and pin 5 of BU8 which latches the data from MCU.

The MCU monitors ring signal from telephone line through the telephone line interface at pin 5. MCU pin 2 provides DTMF signal. The keyboard interface is provided by pins 75 to 86.

### **5.3 RF Module**

For operation and frequency see RF module section..

It receives the PLL data through pins 5, 6, 7 from MCU pins 83, 84 and 97.

The antenna partly located inside the plastic rod at the side the unit is permanent attached to RF module.

### **5.4 Comander**

The compander BU2 is used for improving the S/N of the transmit and receive audio signals.

### **5.5 Data Shaper**

The information sent from handset unit is recovered by the amplifier BQ29 and BQ6.

### **5.6 Charge and Control**

BQ12 detects the handset charging current and sends signal to MCU pin 91.

BQ2, BQ13, BQ14 and BQ16 control the charging current delivered to the handset. Resistors BR108 and BR109 provide current limiting function. BD34 and BR183 provide handset in cradle detection when 9V supply is not available. BQ20 detects the 9V supply and sends a negative pulse to MCU pin 14.

### **5.7 Telephone Line Interface**

BL1, BL2, BR32 and BC61 provide telephone line surge protection. BQ3, BD24, BD25, BD26, BD27, BU6 provide telephone On/Off hook function. BD3, BR34 and BT1 line transformer are the audio interface to the telephone line. The transformer BT1 is also used for telephone line isolation.

### **5.8 Ring Signal Detector**

BL1, BC57, BR31, BZD6, BZD5, BD2, BU5, BR32 and BL2 form the ring signal detector. The signal is sent to pin 5 of MCU.

### **5.9 Base Ringer**

BU4 and speaker BSPK1 provide base ringer sound output. MCU pin 87 provides the ringer output signal and the level is controlled by switch BSW1 (RINGER OFF-LOW-MED-HI).

### **5.10 Keyboard Matrix, Switches and Function LEDs**

The keyboard and switches consist of the followings:

- M1, M2, M3, M4 – one touch memory keys
- ER5, ER6, ER7 – one touch memory keys
- PROG – for memory program and dialing
- INTERCOM – for base to page handset
- FLASH – provides timed On/Off hook function
- REDIAL – redials the last number or provides a pause during dialing
- 1, 2, 3, 4, 5, 6, 7, 8, 9, \*, 0, # – numeric keys
- SPEAKER - turns Off/On the base speakerphone
- MUTE – turns Off/On the base microphone

The switches and controls consist of the followings:

- RINGER (OFF/L/M/H) – controls the ringer output level
- T/P – for selecting Tone or Pulse mode dialing
- AMPLIFIER ON/OFF – turns On/Off handset receiver extra gain
- RING TONE (L – H) – controls the ringer output frequency.
- SPEAKER VOL – controls the base speakerphone output level.

The switches are connected to pins 3, 8 – 12 and 19 of MCU (BU2).

The function LEDs consist of the followings:

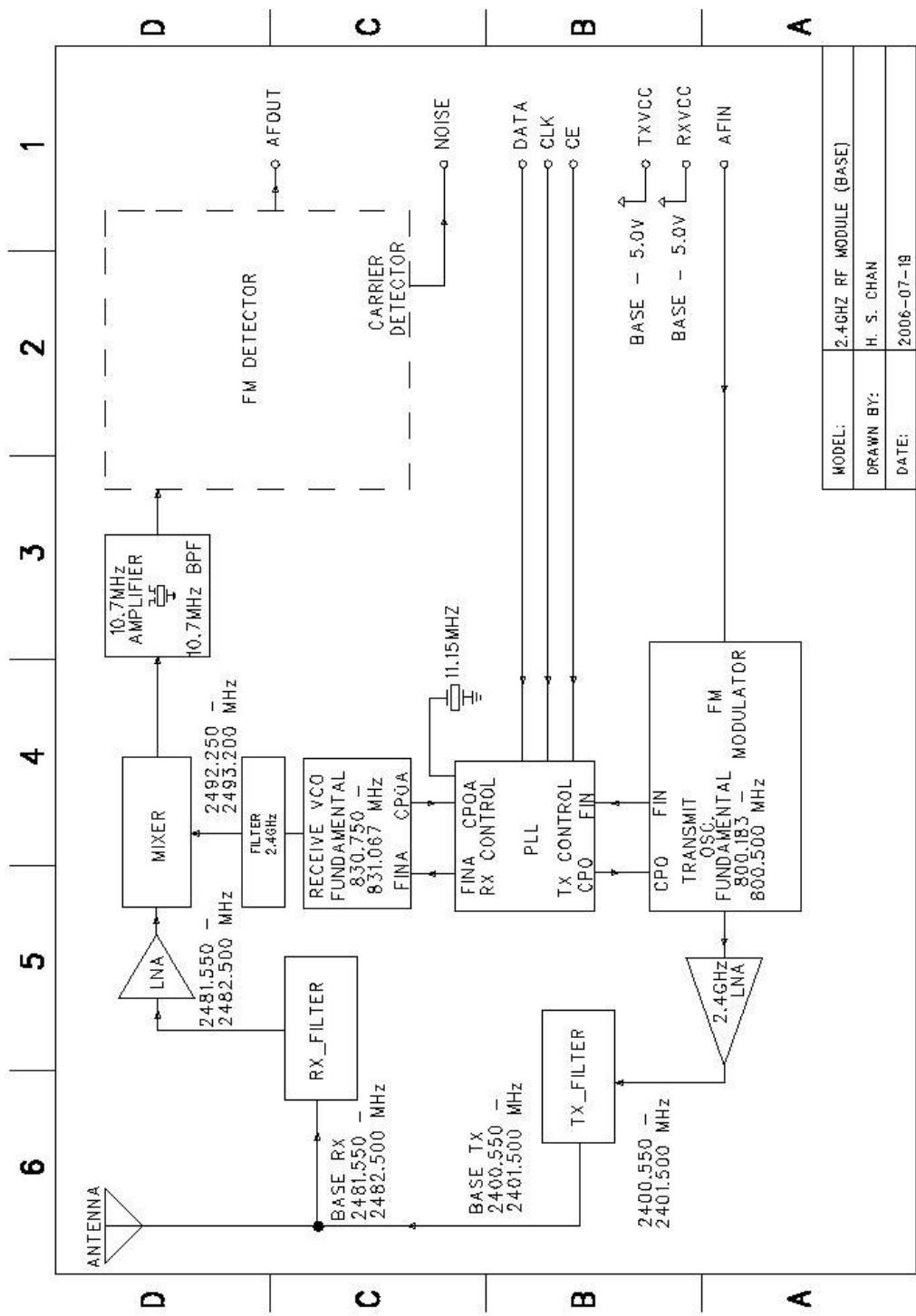
- **RINGER** (BLED1, BLED2, BLED3 – Red) – Located under the red lens. They are controlled by transistor BQ26 and pin 15 of BU9 which latches the necessary data from MCU (BU2).
- **INUSE** (BLED18 – Green) – On when CLS-45i is talking to the telephone line. It is controlled by transistor BQ24 and pin 12 of BU9.
- **CHARGE** (BLED20 – Red) - On when handset is the cradle. It is controlled by transistor BQ12.
- **SPEAKERPHONE** (BLED4 – Red) – It is located under the “SPEAKER” key. On/Off when the speakerphone is On/Off. It is controlled by transistor BQ22 and pin 9 of BU9.
- **MUTE** (BLED1 – RED) - Located under the “MUTE” key. On when microphone is off. It is controlled by transistors BQ21, BQ22 and pin 19 of BU8 which latches the necessary data from MCU (BU2).
- **BACKLIGHT** (BLED6 – BLED17 – Amber) – Located under the keyboard. On for a short time when any key is pressed during off-hook. They are controlled by transistor BQ23 and pin 2 of BU9.
- **POWER** (BLED19 - Red/Green) – Indicates base power conditions. This is controlled by transistor BQ17, BQ25 and pin 16 of BU9.
  - Green – when the base is powered by 9V and good batteries.
  - Red – when the base is powered by 9V only.
  - Blinking Red/Green – when the base is powered by 9V with bad batteries.
  - Blinking Red – when the base is powered by good batteries only.
  - Flashing Red – when the base is powered by batteries and the battery voltage is low.

## **6. Functional Blocks of the RF Modules**

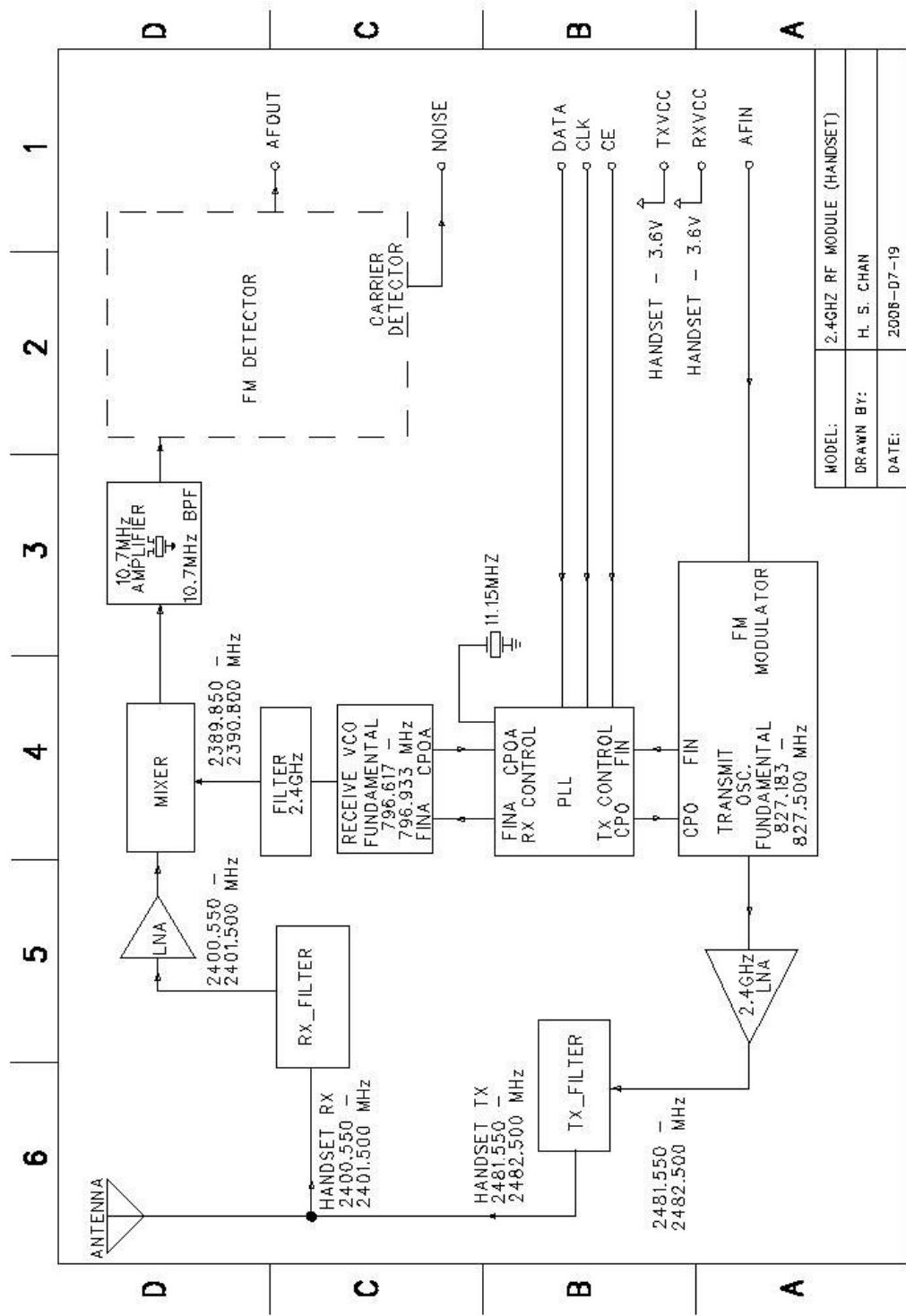
The block diagram of RF Module is as shown below. It is made up of the following parts:

- 6.1 Power Supply
- 6.2 PLL and MCU Interface
- 6.3 RF Transmitter
- 6.4 RF Receiver
- 6.5 Audio Detector

## RF Module (Base) Block Diagram



## RF Module (Handset) Block Diagram



## **7. RF Module Circuit Block Description**

### **7.1 Power Supply**

The RF transmitter (Q6, Q7 and Q1) receives power from TXVCC. This voltage is 5V for the base unit and 3.6V for the handset unit. For the base unit, TXVCC is enabled only during TALK or RINGING mode. For the handset unit, TXVCC is enabled only during TALK mode.

The RF receiver (Q3) receives power from RXVCC. This voltage is 5V for the base unit and 3.6V for the handset unit.

For the base unit, RXVCC is enabled all the time. For the handset unit, RXVCC is enabled only during TALK or scanning for ringing signal from the base unit.

### **7.2 PLL and MCU Interface**

The frequencies of the RF transmitter and RF local oscillator are controlled by a PLL IC (U1). The MCU transmit PLL data through DATA, CLK and CE signal lines. The basic clock frequency of the PLL is derived from an 11.15MHz crystal inside the RF module.

### **7.3 RF Transmitter**

The RF transmitter frequency for the base is 2400.550 MHz – 2401.500 MHz and the handset is 2481.500 MHz – 2482.500 MHz.

The RF transmitter signal is derived from Q1 which consists of a fundamental (1/3 the frequency of the transmitter) and its 3<sup>rd</sup> harmonic. The transmit frequency is controlled by the signal pin CPO of the PLL IC (U1). The PLL samples the RF frequency through FIN. The audio signal AFIN is fed to this RF oscillator through the FM modulator VD1.

The third harmonic of RF oscillator output is amplified through the “2.4GHz LNA” (Q7, Q6) and coupled to the RF antenna through the TX\_FILTER (DF1).

### **7.4 RF Receiver**

The incoming RF signal is coupled from the antenna through RX\_FILTER (DF2) to a LNA (Q3) where it is amplified and fed to the 1<sup>st</sup> mixer (Q4). Q2 is the local oscillator and its signal output is a fundamental (1/3 frequency of the required local oscillator) and its 3<sup>rd</sup> harmonic. The 3<sup>rd</sup> harmonic is selected by the filter “FILTER 2.4GHz” (C50, C26, C25, ML13, ML11 and C28). The frequency of the output from Q2 is controlled by the signal pin CPOA of the PLL IC (U1). The PLL samples the local oscillator RF frequency through signal pin FINA.

For the base unit, the operating frequency is 3xVCO – 10.7MHz.

For the handset unit, the operating frequency is 3xVCO + 10.7MHz.

## 7.5 Audio Detector

The audio detector receives the incoming signal from the 10.7MHz filter and amplifier (Q5). The audio signal is recovered by a FM detector (U2) and sent to AFOUT. The quality of the incoming RF signal is indicated by logic output NOISE.

## 12. RF Channels

RF CHANNEL	HANDSET (KHz)		BASE (KHz)	
	TX	RX	TX	RX
01	2,481,550	2,389,850	2,400,550	2,492,250
02	2,481,600	2,389,900	2,400,600	2,492,300
03	2,481,650	2,389,950	2,400,650	2,492,350
04	2,481,700	2,390,000	2,400,700	2,492,400
05	2,481,750	2,390,050	2,400,750	2,492,450
06	2,481,800	2,390,100	2,400,800	2,492,500
07	2,481,850	2,390,150	2,400,850	2,492,550
08	2,481,900	2,390,200	2,400,900	2,492,600
09	2,481,950	2,390,250	2,400,950	2,492,650
10	2,482,000	2,390,300	2,401,000	2,492,700
11	2,482,050	2,390,350	2,401,050	2,492,750
12	2,482,100	2,390,400	2,401,100	2,492,800
13	2,482,150	2,390,450	2,401,150	2,492,850
14	2,482,200	2,390,500	2,401,200	2,492,900
15	2,482,250	2,390,550	2,401,250	2,492,950
16	2,482,300	2,390,600	2,401,300	2,493,000
17	2,482,350	2,390,650	2,401,350	2,493,050
18	2,482,400	2,390,700	2,401,400	2,493,100
19	2,482,450	2,390,750	2,401,450	2,493,150
20	2,482,500	2,390,800	2,401,500	2,493,200