



# **“DRAFT” Developer’s Guide**

## **iO200 OEM Module Module Description**

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# 1. Introduction

## 1.1. USING THIS GUIDE

This guide presents critical research and development issues affecting the design and development of products incorporating the Motorola io200 800/900MHz iDEN Integrated Wireless Modem, used in North America, Asia, Africa and Europe.

The purpose of this document is to describe the technical details needed to integrate io200 Data Module into a host device. There are several configurations of this product that provide flexibility in meeting full system integration requirements, as described in this manual.



Note

A product that incorporates the modem is referred to as the Original Equipment Manufacturer (OEM) host or simply the host.

## 1.2. PURPOSE

Data terminal equipment (DTE) OEM teams are often pulled together quickly from other work groups. For this reason, OEM team members often need advice about how to best sustain a concerted design and development effort. The purpose of this guide is to assist your team to successfully produce a wireless product that integrates the Motorola IO200 wireless modem.

This guide strives to bridge the gap between the various engineering and business disciplines that make up OEM teams. Our approach is to provide a practical disclosure of useful information that can offer a common understanding of the problems you may encounter and examples of probable solutions.

We at Motorola want to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements. You can reach us by email at: **TBD**

## 1.3. INTENDED AUDIENCE

The intended audience of this manual are data terminal equipment (DTE) OEM integration team members. Teams historically consist of representatives from the disciplines of hardware, software and RF engineering. These readers will probably find the entire document useful, if not enlightening. Other readers include marketing, business, and program managers. These readers might find the first chapter, which discusses the integrator's task, to be sufficiently informative for their needs. The remaining chapters go into more detail.

## 1.4. DISCLAIMER

This guide provides advice and guidelines to OEM teams. Responsibility regarding how the information is used lies entirely with the OEM. Statements indicating support provided by, or offered by, Motorola are subject to change at any time. Motorola reserves the right to make any changes to this manual.



## 2. GENERAL NOTICES

### 2.1. Safety Notice - ATTENTION



This iDEN iO200 Module is restricted to Occupational use to satisfy FCC RF energy exposure requirements. This radio device is not authorized for general population, consumer or similar use. The integrator shall be aware that after integrating this module and connecting it to an antenna and DC power supply, the integrated device shall be treated as a Two-Way Radio.

Before using this product, read the awareness information and operating instructions for usage and RF safety in the following section.

### 2.2. FCC Regulation - Letter of Notice

The iO200 module is intended for integration into a host device. Any integrator who will integrate the module into his product and connect it to an RF antenna, DC power supply, and internal signaling, must treat this product as a Two-Way radio that can transmit RF signals.

**Important: To meet the FCC's RF Exposure Guidelines, the antenna should be installed so there is at least 20 cm of separation between the body of the user and nearby persons and the antenna.**

After integration, this device uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses radio frequency (RF) energy or radio waves to send and receive information. The integrated radio generates measurable RF energy only while it is transmitting (during talking or sending data), not when it is receiving (listening or receiving data) or in standby mode.

Experts in science, engineering, medicine, health, and industry work with organizations to develop standards for safe exposure to RF energy. These standards provide recommended guidelines of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection.

**Important: To meet the FCC's RF Exposure Guidelines, the antenna gain shall not exceed 7.3 dBi. Note that the antenna supplied with the developer evaluation board has maximum gain of 1.4 dBi. The antenna should be located so there is at least 20 cm of separation between the body of the user and nearby persons and the antenna, during transmission.**

In the United States, the Federal Communications Commission requires that RF transmitting devices obtain approval before being offered on the market, unless the device is exempt. While the iO200 has been designed to meet applicable FCC requirements, provided in the code of Federal Regulation 47CFR Part 2 subpart J and 47CFR Part 90 subpart S, the Final Product's compliance with the FCC's requirements, including RF Exposure requirements, must reflect product usage, positioning of the iO200 within the product, the type of antenna used, the location of the antenna, and other factors that may vary with the design and nature of the Final Product. Therefore, the manufacturer of the Final Product is responsible for taking all steps needed to insure compliance with FCC requirements, for making the necessary testing to verify compliance and for obtaining FCC approval for the sale and the operation of the Final Product.

### 3. THE INTEGRATOR'S TASK

#### 3.1.GENERAL

This chapter provides background information and indicates the objectives and tasks required to achieve a successful implementation.

Area of Focus	Benefits
Serial Port Pass Through Capability	<ul style="list-style-type: none"><li>• Enables modem diagnostics without the need to disassemble your OEM device</li></ul>
Understanding RF Design	<ul style="list-style-type: none"><li>• Provides the required network coverage</li><li>• Sets end-user performance criteria - your competitive advantage</li><li>• Reduces risk of costly re-designs</li></ul>
Software and Hardware	<ul style="list-style-type: none"><li>• Provides reliable operation through a state-of-the-art functional interface</li><li>• Helps ensure longer service life and fewer field returns</li></ul>

**Table 1 Integrator's Tasks**

#### 3.2. INTRODUCTION

As an OEM integrator, you must accurately choose where and how wireless technology will facilitate communication for your customers. You will also have to evaluate which technical considerations will give your product an edge over the competition. To successfully integrate Io200 wireless modems into your host platforms, you must perform the following tasks:

- Plan the product and create the design
- Develop and validate the hardware
- Develop supporting applications software
- Test and approve the product

As you review these tasks, allow sufficient time for required activities, such as the regulatory approval process, to identify critical path activities ahead of time.

### **3.3. PLANNING THE PRODUCT AND CREATING THE DESIGN**

To plan the product and create the design, perform the following steps:

- Develop a usage model
- Develop a message model
- Define a service strategy
- Define remote diagnostic functionality
- Investigate and obtain regulatory approval

#### **3.3.1. Developing a Usage Model**

The usage model answers the question, “How will the end product be used - will it be portable or mobile, how many hours a day will it be used, how many days a week?” and so on.

Perhaps the most important factor for success is a clear understanding and decision regarding how the final product is to be used. This guides the development process, since all design considerations drive toward meeting the needs of the end user. For example, design issues related to a mobile device, such as alternator noise and vibration, are completely different from considerations required for a fixed-point telemetry application powered by a solar panel. Defining what is and is not important to the end user helps to make the critical engineering trade-off decisions that are inevitable in every product design.

As the integrator, it is your responsibility to develop the usage model. Motorola is available to provide assistance and answer questions, but is not directly involved in this phase of the project.

#### **3.3.2. Developing a Message Model**

The message model defines the number of messages that are sent and received and their frequency. To create the message model, determine the quantity and frequency of data sent in each of the uplink (terminal to network) and downlink (network to terminal) directions.

Answer the question, “Is there a requirement for the terminal to be powered on and ready to receive eight hours a day, or does the user turn the unit on only when making a query to the host system?” The answer has a direct bearing on the battery size and capacity requirement for powering the device. The amount of data sent and received is relevant in calculating the cost of airtime and deciding which type of network connection to use. In short, the message model is essential for making many engineering design decisions, especially in calculating values such as sleep time versus wake time and in determining battery capacity requirements.

You are responsible for developing the message model. The typical approach to creating the model is to define the peak and average network throughput requirements based on input from the user. Motorola can provide current consumption figures for each of the various modes of operation, for example, receive and transmit.

The network throughput of the host device depends on various factors, in addition to the raw throughput of the radio channel. For example, in addition to the overhead involved in forward error correction and support for packet headers, the number of active users on the network can directly affect network throughput.

### **3.3.3. Defining a Service Strategy**

The service strategy determines whether the integrated modem is the cause of a user's problem and sets a policy for keeping the end user operational during repair. The service strategy must consider all potential service situations and evaluate them in light of the usage model. You can create the service strategy jointly with Motorola. Contact your Motorola OEM sales representative for details.

To ensure that a final product can be efficiently serviced, it is recommended that you design for serviceability early in the R&D process. At a minimum, you could develop a functional service strategy that contains a well-considered procedure for performing unit-level screening. The test may primarily determine whether a fault lies with the modem or with the product. The test must also screen for network problems and human error.

Motorola supplies an evaluation board (a standalone test fixture) that provides a mounting platform and electrical interface to the modem. (Refer to Developer's Kit Manual for further information.) Testing is performed much more efficiently when the modem is integrated within the OEM host, whether for a factory end-of-line test or while at the user's site.

In order for your product to allow integrated testing of the modem, you may decide to provide a modem pass-through mode.

A thoroughly developed OEM serviceability plan typically includes a needs assessment for developing software utilities that can assist in identifying communication problems between the product and the modem and between the modem and the RF network.

These utilities must be able to send commands to the modem, evaluate the modem responses, perform network connectivity testing, and verify data communication with the network.

Such a software utility is essential for field service engineers and shop technicians to diagnose problems with the product and to troubleshoot a problem to a failed assembly or mismanaged communication link.

### **3.3.4. Defining Remote Diagnostic Functionality**

When customer problems are reported from the field, you must isolate the source of the problem remotely. You will need to determine which part of the overall system is not functioning correctly. The following items need to be considered as a possible source of the problem:

- Network
- Io200 wireless modem
- Host product

Often a problem is caused by a user's lack of knowledge of how to use the product correctly. Regardless, remote troubleshooting is essential in reducing the number of returned products and lowering service costs, particularly if the host must be disassembled in order for the modem to be removed.

Motorola recommends that your product application (both at the terminal and host ends) incorporates sufficient problem diagnostic software to determine the cause of the problem remotely. Often, the best approach is to incorporate progressively deeper loopback tests to determine the point at which the communication link fails.

This remote diagnostic functionality should be an integral part of your standard software load.

### 3.3.5. Investigating and Obtaining Regulatory Approval

It is your responsibility to obtain regulatory approval of products that integrate an io200 Integrated Wireless Modem. The specific details for achieving regulatory approval vary from country to country. Refer to “Regulatory Requirements”, page [xvi](#) ?, for further information.

## 3.4. DEVELOPING AND VALIDATING THE HARDWARE

To develop and validate the hardware, perform the following steps:

- Design the hardware platform
- Consider power supply options
- Select the antenna
- Set up a development test environment

### 3.5. Designing the Hardware Platform

Integrating a wireless modem into a hardware design requires many steps. Here again, the usage and message models are necessary to calculate issues such as battery size, heat dissipation, isolation from EMI, and physical mounting of the unit to ensure proper grounding. Refer to Chapter 3, “Design Considerations”, [page 13](#) ?, for further information.

Hardware design is your responsibility. The host device can introduce electromagnetic interference, which will interfere with the performance of the modem. This EMI can be conducted into the modem via the serial and power lines, or radiated into the antenna and antenna cable. It is your task to minimize the generation of EMI by your device so that the modem’s RF performance is minimally affected. Contact your Motorola OEM representative for details.

### 3.6. Considering Power Supply Options

Power supply requirements vary according to the usage and message models. In addition to accounting for the current drain of the modem in its various operating modes, you should also consider ripple and noise on the power lines and the ability to supply sufficient instantaneous current to enable correct operation of the transmitter. You should also ensure that your power supply can accommodate the highest power consumption for Io200 modem that you want to integrate.

Together, these requirements define the type and size of power supply (for example, linear versus switched) to use with the wireless modem. Refer to Chapter 3, “Design Considerations”, [page 13](#) ?, for further information.



Note

It is recommended that the power applied to Io200 have a rise time of less than 1 ms to prevent potential latch up.

### 3.7. Selecting the Antenna

Io200 is terminated by 50Ω; therefore, any antenna terminated by 50Ω will work with Io200. In order to protect the module from ESD discharge, the selected antenna must be rubber-coated.. Refer to “Antenna Considerations”, page 5.16, for further information.

You are responsible for selecting a suitable antenna and submitting the final product to the network operator for certification.



Note

### 3.8. Setting Up a Development Test Environment

A number of development test aids are available to assist in hardware and application development. Modem hardware and an evaluation board can be purchased from Motorola. The evaluation board is a specially developed circuit board with test points and jumper switches, which allows for maximum flexibility in accessing and controlling connections into and out of the modem. Refer to “iO200 Developer’s Kit Manual” for further information. Motorola also provides various software utilities that can help in performing development tests. Refer to chapter 0, “Testing” for further information.

The network operator may sometimes provide a live development network, supplementing the test environment supported by Motorola. This development network, on which you can develop and test your application, is separate from the production network. You must negotiate directly with the network operator for airtime and for building and maintaining a development test environment at their facility.

### 3.9. DEVELOPING SUPPORTING APPLICATION SOFTWARE

To develop supporting application software, perform the following steps:

- Select a communications model
- Develop end-to-end application software

### 3.10. TESTING AND APPROVING THE PRODUCT

To test and approve the product, perform the following steps:

- Perform EMI and desense testing .
- Set up a final test environment
- Install and field-test the product

### 3.11. Setting Up a Final Test Environment

To ensure correct assembly of the final product (that the antenna is properly connected, the serial port is operational, and so on), perform an end-to-end test that proves that the final product can receive and transmit at the required signal levels. In locations where the final assembly test is performed within network coverage area, this test is relatively simple. However, in locations where network coverage is not available, or for products being shipped to other countries, it is necessary to test by secondary means.

The final assembly test must verify that all connections to the modem are made correctly. Testing on a network is not required.

Io200 can support an antenna with 0 Ω (in DC).  
For 800/900MHz and GPS, the antenna should  
be 50 Ω.

### 3.12. Installing and Field-Testing the Product

When the product is shipped to a site, it is installed or mounted in a location that may restrict RF communications. It must be verified whether the behavior of a dysfunctional product is caused by poor coverage or is due to the fact that the network service

provider is down. To guarantee that the modem is located in an area with good coverage, and that an end-to-end loopback message is possible, your product needs a software application to perform the test.

The most effective approach to field-testing is to include an installation test procedure as part of your standard software load. Motorola can recommend specific network information that you can obtain from the modem describing how to implement an end-to-end loopback test. Refer to Chapter 7, “Testing”, page 83 ?, for further information.

### 3.13. RESOURCE ASSISTANCE

Developing and testing a wireless integrated product requires a well-equipped development lab and access to resources and outside information. Table 1, “Parts and Tools Requirements”, below, identifies the required development and service tools. Information is also provided regarding where to obtain the tools and how to obtain further assistance.

### 3.14. Integrating Engineering Support

Questions on this manual and the integration process are handled by Motorola’s integration engineering teams located in North America. Send an email to TBD, with your name, phone number, company name, description of the project and your question. An engineer will be assigned to your project and will contact you by phone or by email to assist you in resolving any issues.

**Table 2      Parts and Tools Requirements**

Related Documentation		
Unique Development and Service Aids		
IO200 Evaluation Board	P/N FCN6529 This board provides interface connectors and circuitry that allow the modem to be powered and interfaced to a host device (PC) via a serial port and cable. Includes instructions, interface ribbon cable, jumpers, mounting hardware, antenna and antenna cable.	
Modem Test Equipment		
iDEN Test Set	Communication Test Set R-2660	<a href="http://www.motorola.com.cn/cgiss/solutions/test_ep/r2660/2660.html">http://www.motorola.com.cn/cgiss/solutions/test_ep/r2660/2660.html</a> <a href="http://www.qdds.com/cte/2660d.html">http://www.qdds.com/cte/2660d.html</a>
Wireless Verification Equipment		
Live Network	When available, a live network can be used	Network Operator
Traditional Shop Equipment		

Power Supply	Dual Power Supply with 3-6V/2A and 12V/2A output supplies	Commercial Items
Oscilloscope Digital Volt Meter	900Mhz, digital storage Fluke 77 multimeter or equivalent	Commercial Item Commercial Item

### 3.15. ENVIRONMENTAL ISSUES

Io200 Integrated Wireless Modems are designed for a combination of easy serviceability and general robustness. These integrated modems are designed to be housed in an OEM host product. The modem is tested to conform to the environmental levels (for example, industrial use specifications) that meet the intended applications of most integrators. If you need additional robustness and safety in your products, you must engineer the environmental characteristics of your host product to achieve a special safety rating.

### 3.16. General Precautions

Follow these precautions when working with wireless modems:

- Minimize the handling of static-sensitive modules and components.
- Wear a grounded anti-static wrist strap while handling static-sensitive components.
- Do not bend or stress the modem in any way.
- Reinsert connectors straightly and evenly to avoid causing short and open circuits.

### 3.17. ESD Handling Precautions

All electronic devices contain components that are sensitive to ESD (electrostatic discharge). For example, people typically experience up to 35 kV ESD, while walking on a carpet in low humidity environments. In the same manner, many electronic components can be damaged by less than 1000 V of ESD. For this reason, you must observe the following handling precautions when servicing this equipment:

- Always wear a conductive wrist strap.
- Eliminate static generators (plastics, styrofoam, and so on) in the work area.
- Remove nylon or polyester jackets, roll up long sleeves, and remove or tie back loose hanging neckties, jewelry, and long hair.
- Store and transport all static sensitive components in ESD-protective containers.
- Disconnect all power from the unit before ESD-sensitive components are removed or inserted, unless instructed otherwise.
- Use a static safe-guarded workstation, which can be set up by using an anti-static kit (Motorola part number 0180386A82). This kit includes a wrist strap, two ground cords, a static control table mat, and a static control floor mat. The Motorola part number for a replacement wrist strap that connects to the tablemat is 4280385A59.

When anti-static facilities are unavailable, use the following technique to minimize the chance of damaging the equipment:

- Rest the static-sensitive component on a conductive surface when you are not holding it.
- When setting down or picking up the static-sensitive component, make skin contact with a conductive work surface first and maintain this contact while handling the component.
- If possible, maintain relative humidity of 70-75% in development labs and service shops.



## 4. MODEL DESCRIPTION

### 4.1. GENERAL

This chapter provides an overview of Io200 integrated wireless modem.  
For model number, and specifications, refer to “Specifications”, on page 0.

### 4.2. INTRODUCTION

Io200 is an iDEN modem providing circuit/packet data connectivity, interconnect and dispatch calls. The modem operates in iDEN 800 & 900 MHz networks using the iDEN Packet-switched and Circuit-switched Data protocols. The modem is of a standard interface consisting of a main board to board connector, an RF antenna connector and a SIM flex connector. The modem has the smallest footprint possible for ease of embedding into multiple 3rd party manufacturers' products including those with space limitations such as Remote Terminal Units, special purpose terminals, PDA's, hand-held terminals, etc. The SIM card is removed from the physical layout of the board to enable a smaller module footprint as well as provide flexibility to the integrator to locate the SIM card for ease of product-maintenance.

This product operates on iDEN 800 and 900 MHz bands as specified below.

iDEN/WiDEN 800:

Tx: 806-825 MHz Rx: 851-870 MHz

iDEN/WiDEN 900:

Tx: 896-902 MHz Rx: 935-941 MHz

WiDEN capability is dependent on the availability of the network and associated radio firmware. The modem has WiDEN-enabled hardware that requires an upgraded software to support WiDEN functionality. The availability date of WiDEN within this module will be determined by the WiDEN network implementation schedule.

The iDEN IO200 modem supports the following modulation types:

- Quad-16QAM
- Quad-QPSK (packet data mode only)
- Quad-64QAM (packet data mode only)

### 4.3. PRODUCT FEATURES

- Packet switched data
- Circuit switched data (AT commands compliant)
- AGPS via second UART and through UDP on the primary UART
- Fax
- Split 3:1 Interconnect (Voice Cellular)
- Dispatch (Push To Talk™/Direct Connect™)
- SMS
- Full 600 entry Falcon Contacts
- Minimal Mechanical Form factor
- Host wake-up capabilities.
- Remote SIM
- Thermal Protection Mechanisms through Power Reduction.
- OTA Firmware Update and Provisioning (to be performed by the host, which will then flash the module).
- Firmware Update Utility on Host.
- RF & EMI shielded
- Regulatory / Network Approved for Host Independent Modular Applications.

### 4.4. INTERFACE CONNECTORS

The modem has 3 Interface connectors:

Main Interface Connector (40-pin board-to-board)

SIM Interface Connector (6-pin ZIF)  
RF Antenna Connector (coaxial)

#### **4.5.INTEGRATOR'S KIT**

The Integrator's Kit includes the RF modem and Developers' Kit with installation SW via a CD or on-line. The kit has sufficient documentation for integrators to be able to successfully embed the device into their products.

#### **4.6.MOUNTING**

The RF module includes 4 mounting holes.

## 5. DESIGN CONSIDERATIONS

### 5.1. GENERAL

When integrating a wireless modem, internal connections and placements are critical for a successful implementation. Specific attention must be paid to the following support mechanisms:

- Power supply considerations
- Audio circuit considerations
- Data port considerations
- SIM card considerations
- ESD considerations
- Antenna considerations
- Mechanical mounting
- Desense control
- GPS considerations



Antennas must be separated by a minimum of 10 inches (25.4 cm).

Note

### 5.2. POWER SUPPLY CONSIDERATIONS

#### 5.3. Power Supply Losses

IO200 is specified to operate between 3.2V and 4.2V on the Main Connector. To enable operation with the lower battery values, it is important to reduce the losses in the power supply lines. IO200 has to support iDEN training pulses of approximately 0.4 mS. The peak current is up to 3A.

**Table 3 Module Input Voltage Specifications**

	Conditions	Min.	Nom.	Max.	Unit
Input Voltage	Standby/ Rx mode	3.2	4.0	4.2	V
Input Voltage	At peak TX current 3.0A	3.1	4.0	4.2	V
Ripple	In STBY mode			50	mV (peak)

In order to minimize ripple, noise and voltage loss it is recommended to use short and thick battery lines and to connect a low-ESR, 1000 uF capacitor (or maximum possible) on the DC input.

In addition it is recommended to have a current limit in the power supply (3.5-5 A), in order to avoid damage if a short-circuit occurs.

#### 5.4. IO200 Current Consumption

In order to design the power supply correctly, you need to take into account the current consumption of IO200 in its different modes.

**Table 4 IO200 Current Consumption**

<b>Mode</b>	<b>Current Consumption</b>

**5.5. IO200 Output Voltage**

IO200 can supply DC voltage to accessories.

Option\_V+ line (Main Connector, pin #14) can drive 100mA @ 2.775VDC. Using this source for external RS232 transceiver ensures proper communication at correct voltage levels.

**5.6. Turning the Unit On**

IO200 is powered from a single power supply in the range of 3.2 to 4.2 VDC.

The unit will not power up automatically by connecting the power. To turn the unit ON, apply 4V to ON/OFF pin (Main connector, pin 5).

To verify that the unit is On or Off, check the OPTION\_V+ line (pin #14). If it is high, the unit is on; if it is low, the unit is off.

## 5.7. Turning the Unit OFF By ON/OFF pin

There are two ways to turn off the unit: apply logic low, 0V, to ON/OFF pin or by “turn off” AT command. When IO200 is powered off by disconnecting the power to the unit, IO200 doesn’t deregister. SIM card might be damaged, and units containing IO200 that need to pass SIM card type approval tests will fail due to the SIM’s incorrect power off sequence.

There is a risk that if power is removed too soon after applying OFF, the Flash or SIM may be corrupted since the radio would still be in process of writing to these memories. Therefore, 11 seconds delay from Off event (AT command or de-assertion of 4V from ON/OFF pin) to B+ removal is required.

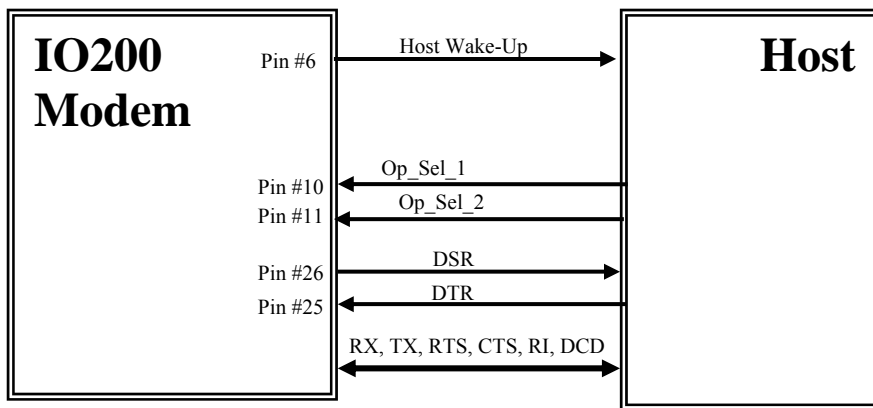


Figure 1. On/Off

## 5.8. AUDIO CIRCUIT CONSIDERATIONS

IO200 supports both voice calls and data calls.

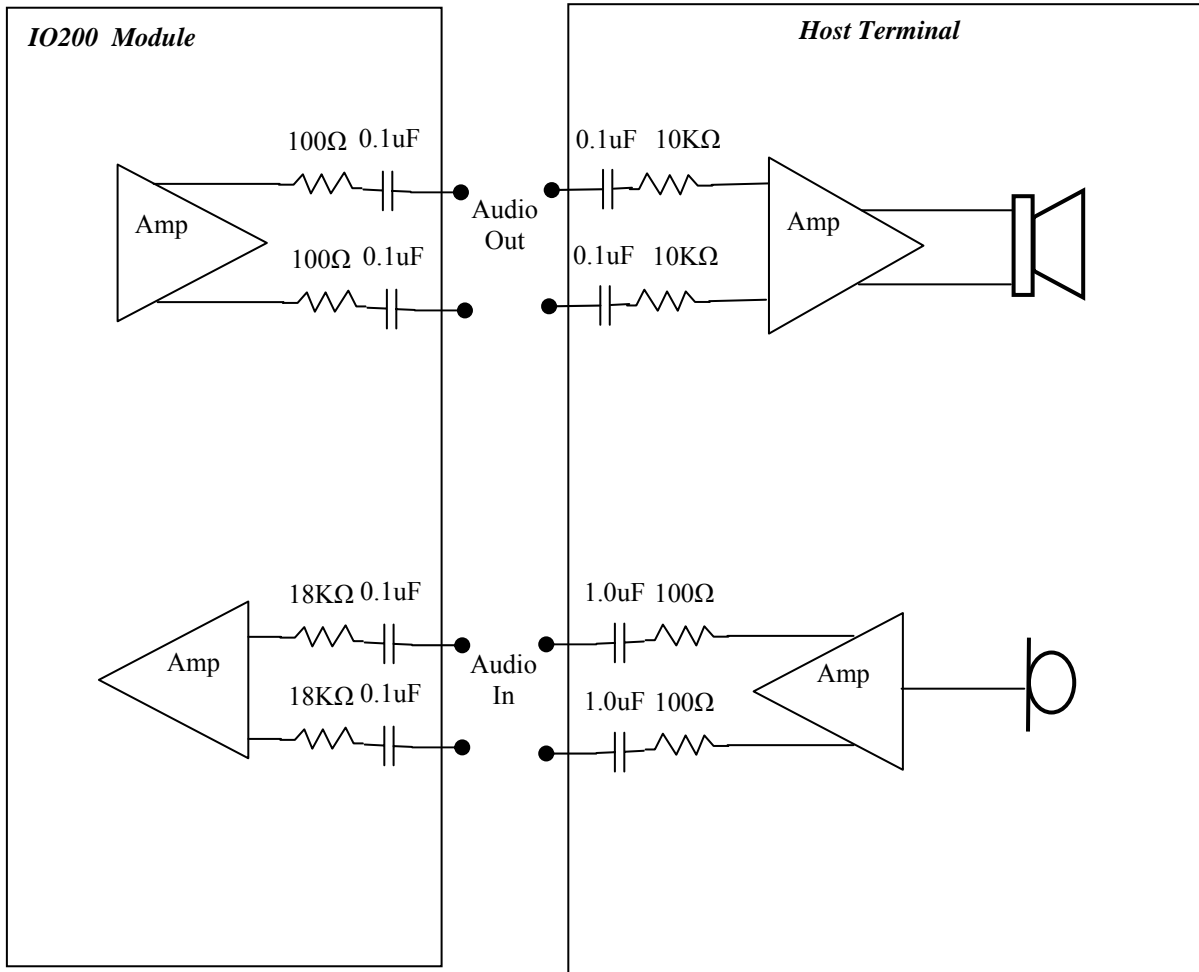
IO200 module supports 3 modes of operation for voice communication:

- Speakerphone
- Headset
- Raw

For both received audio (speaker) and transmit audio (microphone), the module will utilize standard iDEN audio signal conditioning and processing.

## 5.9. Audio Interface

The following figure shows the expected electrical interface for audio input and output signals:



**Figure 2. Electrical interface for audio input and output signals**

Note that it is the integrator's responsibility to properly interface a High Audio speaker or a Headset earpiece to the module's differential Audio Out terminals.

Notes:

- 15pf and 39pF capacitor should be place on audio out/ in lines to avoid chopper noise.
- Audio In/Out are differential lines, they need to be routed close to each other and need to be parallel.

## 5.10. Nominal Audio Signal

## Audio In

The nominal differential Audio In signal shall have a level of:

TBD mVrms in Speakerphone mode

TBD mVrms in Headset mode

TBD mVrms in Raw mode

## Audio Out

The nominal differential Audio Out (volume 4) signal shall have a level of:

TBD mVrms in Speakerphone mode

TBD mVrms in Headset mode

TBD mVrms in Raw mode

## 5.11. Audio Processing and Control

The available audio AT commands will support the following functions:

- Speaker Volume control (0-5 Steps, TBD Resolution)
- Mic gain adjustment (0 to 31dB at 1 dB step size)
- Mode selection: Speakerphone, Headset, Raw

It is the responsibility of the integrator to detect the presence of a Headset and send the appropriate AT command to the module to switch its audio mode to 'Headset'.

On removal of a headset the host device should send an AT command to switch the module to 'Speakerphone' mode.

The following table lists the applicable signal conditioning processes applied in each audio mode, Speakerphone, Headset and Raw and in each connection mode, Interconnect or Direct connect.

	Phone (Interconnect)			Dispatch (Direct Connect)		
	Speakerphone	Headset	Raw Audio	Speaker	Headset	Raw Audio
Echo cancellation/Suppression	Y	Y	N	N	N	N
Noise Suppression	Y	Y	Y	Y	Y	Y
Sidetone	N	Y	N	N	N	N

**Figure 3. Audio Mode**

Note that the characteristics of these processes will be the same as on other iDEN portables.

## 5.12. COMMUNICATION

IO200 Modem can communicate via RS232 CMOS levels (0-2.7V) or USB by configuring the following main connector lines.

MODE	OPTION1 Pin 10	OPTION2 Pin 11	RTS1 / USB_PWR Pin 24
Default (Normal)	1	1	0
USB	1	1	>4.0V

RS-232 (8 wire)	0	1	X
-----------------	---	---	---

**Table 5 main connector lines**

Notes:

Default state is internally set by the modem via pull up resistors.

To configure the modem for USB operation, the host terminal should only apply >4V to RTS1/USB\_PWR pin.

To configure the modem for RS-232 operation, the host terminal should only pull OPTION1 pin to ground level.



### 5.13. SIM CARD CONSIDERATIONS

IO200 includes a SIM card driver, however it does not contain a SIM socket. SIM signals are routed to the 6-pin ZIF interface connector.

The connector includes all the functionality required for SIM card operation. The SIM card socket must be located on the customer's board and connected to IO200 interface connector as shown in Figure below.

### 5.14. SIM Connection

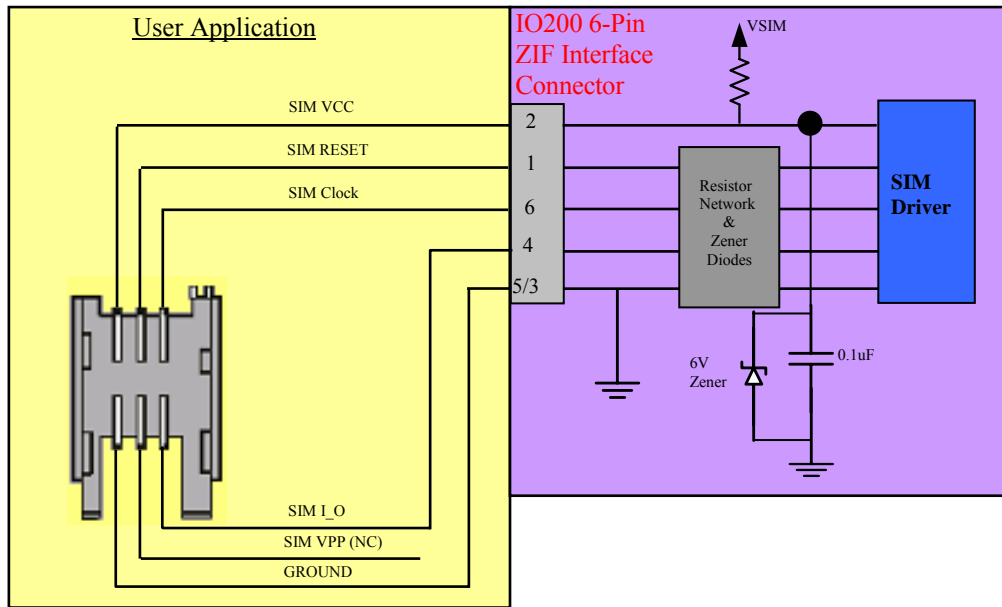


Figure 4. Shows IO200 SIM connection

The following applies to IO200 SIM connections:

- IO200 passes all SIM ETSI tests when an external socket is connected to IO200 with lines shorter than 6.5 cm.
- Longer connections require SIM testing, under integrator's responsibility.
- IO200 works with 3V SIM cards.
- IO200 provides ESD protection on SIM VCC line (6V Zener diode with low capacitance and 0.1uF cap).
- RC network was added on all lines to protect against EMI interference.



Note

A SIM card should be replaced with the unit powered off. If the SIM card is replaced with the unit powered on then the user must cycle power (turn off and then turn on) after the replacement.

## 5.15. ESD CONSIDERATIONS

Generally, ESD protection, up to 8KV, can be provided by using ceramic capacitors of 0.1uF or higher. The capacitors protect against ESD on all static lines, power and so on. The protection is performed inside IO200. IO200 also contains ESD Zener diode protection on almost all external lines; however, it is recommended to add protection on user PCB. For lines with high data rates, it is recommended to use Transguard with low capacitance. There are Transguards of 3pF or less. In order to protect against ESD, the IO200 is required to operate only with rubber antennas.

## 5.16. ANTENNA CONSIDERATIONS

The antenna must be mounted like any other cellular or land mobile radio antenna. The best position for the antenna is usually the center of the vehicle roof, which provides a fairly symmetric ground plane on metal cars. For vehicles of non-metallic material, such as fiberglass, mount the antenna where it will not be obstructed by items, such as mirrors.

## 5.17. Antenna Systems

Use this information to assist you in selecting the appropriate antenna to incorporate into your product package. For specific detailed information, Motorola recommends that you use the expertise of an antenna design engineer to solve individual application concerns.

## 5.18. Antenna Safety

The following statement from the American National Standards Institute (ANSI) specifies the safety criteria that integrators must use when designing the antenna for a product integrating Io200 modem.



For Mobile operation with external antenna the modem must be installed in a manner that provides a minimum separation distance of 20 cm or more between the antenna and all persons to satisfy FCC RF exposure requirements for mobile transmitting

“The design of the integrated product must be such that the location used and other particulars of the antenna comply with the then current American National Standards Institute (ANSI) Guidelines concerning Radio Frequency Energy Exposure and with any other nationally recognized radio frequency standards that may be applicable thereto.”

### 5.18.1.1. User Operation

For Mobile installation with external antenna do not operate your modem when a person is within 8 inches (20 centimeters) of the antenna. A person or object within 8 inches (20 centimeters) of the antenna could impair call quality and may cause the modem to operate at a higher power level than necessary and expose that person to RF energy in excess of that established by the FCC RF Exposure Guidelines.

## 5.19. ESD Protection

In order to protect the module against ESD damage, the IO200 is required to operate only with rubber-coated antennas.

## 5.20. Antenna Performance

The network operator usually sets the antenna network requirements.

## 5.21. Portable Devices

In an environment where portable devices are in use, many variables exist that can affect the transmission path. In this case, it is preferable to use a vertically-polarized, omni-directional antenna.

Antennas for portable devices include the following designs:

- Internal antenna (invisible or pull-up)
- External antenna, removable and directly connected to the device
- External, remote antenna

#### 5.21.1.1. Internal Antenna (Invisible or Pull-up)

This is the most difficult antenna design scenario. Despite greater physical constraints, an internal antenna must still provide a gain sufficient to meet network specifications. Metal-cased products cannot have internal antennas since the metal acts as a shield around the antenna and prevents RF signals from reaching the antenna. (A metal case acts like a Faraday cage.) The antenna should be positioned so that it is vertically oriented when the device is carried normally. This will ensure that the optimal antenna performance is available the majority of the time.

Cable routing from the modem to the antenna needs to avoid RF-sensitive circuits and high-level, high-speed clock circuits. The following points should be considered:

- The location of the antenna to avoid RFI to a computing device.
- Good shielding of the display and other RF-sensitive components.
- The most efficient method of cable routing.

If the above points are not considered, antenna gain can be offset by cable loss. A typical coaxial cable is very thin, such as the RG178B used in portable devices, and cable loss can be as high as 0.5 dB per foot. Some coaxial cable manufacturers market relatively thin double-braid coaxial cables. These cables show much better isolation than single-braid cables, typically by 30 to 40 dB. Double-braid cables reduce radiation and RF pick-up when routed inside a portable device.

#### 5.21.1.2. External Antenna, Removable and Directly Connected to the Device

You can design a portable device that can use an off-the-shelf, plug-in antenna, such as a 1/4 wave monopole or 1/2 wave dipole antenna. The typical gain of these omni-directional antennas is 0 dBi and 2.14 dBi, respectively. Like the internal antenna, these antennas should be oriented vertically when the device is carried normally to ensure the best antenna performance.

Cabling in this case demands the same consideration as an internal antenna application. In a typical laptop application, the antenna must be placed as far as possible from the display to avoid deflection. This usually causes a deep null in radiation patterns.

#### 5.21.1.3. External, Remote Antenna

For remote antenna applications, use the same design approach as internal designs, including the RF cable routing of the external connector. You can choose an off-the-shelf mobile antenna of omni-directional 1/2 wave length. The antenna should have a gain of 2.14 dBi. Higher gain than this may not be appropriate for portable applications.

A double-braid coaxial cable, (such as RG223) from the device to the antenna is recommended, if the cable length is more than a few feet long. The difference in cable loss between low-cost RG58 cable and the more expensive RG223 cable is approximately 4.5 dB per 100 feet. If the cable must be routed through noisy EMI/RFI environments, a double-braid cable such as RG223 can reduce radiation and pick-up by 30 to 40 dB.

### 5.22. Fixed Devices

Fixed data device applications use the same design recommendations as a portable device with a remote antenna.

The most economical and practical choice for the RF connector of an external antenna is a TNC threaded connector, whether it is a plug-in type or a remote type. TNC has a good frequency response to 7 GHz, and leakage is low. A mini UHF threaded connector provides adequate performance and is an economical choice. If the size of the TNC and mini UHF connectors becomes critical, consider an SMA threaded connector or an SMB snap fit connector. (The SMB connector does not accept RG58 or RG223 cables).

### 5.23. Antenna Test Methods

Whether portable or fixed, the device antenna is the critical link to the network. A poorly performing antenna reduces the coverage of the device within the network footprint. The antenna performance must meet the impedance and match the criteria of the modem (refer to Chapter 8, "Specifications", page 235.), and have the appropriate amount of gain to meet the network ERP requirements.

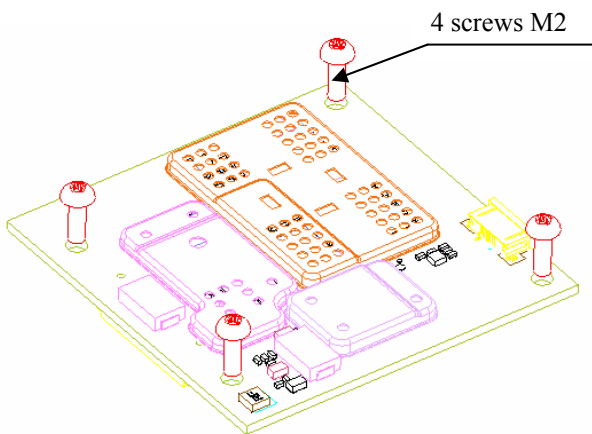
Two tests must be performed on the antenna to ensure that it meets the requirements. For both tests, the antenna must be integrated in its final form. That is, the antenna must be mounted on a representative housing that includes all metal objects forming the ground plane or counterpoise.

Antenna testing requires an experienced operator and an anechoic chamber, a GTEM cell, or approved open field site. Your Motorola OEM support representative can provide advice on this type of testing.

### 5.24. MECHANICS - MOUNTING IO200

### 5.25. Fastening Units into the terminal

Mount Io200 modem to the terminal, using four M2-2a machine screws or substitute screws.



**Figure 5. Mounting IO200 Modem (Iso View)**

### 5.26. GPS CONSIDERATIONS

The IO200 includes an internal GPS receiver from Motorola. The GPS receiver is powered internally from the IO200 unit with 2.775 V DC. All communication lines of the GPS are routed to the user 40 pin main connector through UART 2 as follows:

**Table 6 The GPS Lines**

IO200 User Connector Pin #	Function
20	GPS RXD receives data in 3V logic.
19	GPS TXD transmits data in 3V logic.

More details about the GPS in the IO200 module can be viewed on the web.

## 6. AT COMMANDS

### 6.1. Data Services

AT command set for data services (Circuit Data, Packet Data, and Facsimile) is described in iDEN Mobile Subscriber DTE/DCE Interface for Data Services document, Motorola Publication part number 6881129E10.

You may download this document from:

[http://idenphones.motorola.com/iden/developer/developer\\_documentation.jsp](http://idenphones.motorola.com/iden/developer/developer_documentation.jsp)

### 6.2. Supplementary AT commands

Supplementary AT command set for Io200 OEM Module is described in “iO200 Supplementary AT Commands” document, Motorola Publication part number **TBD**.

You may download this document from: [TBD](#)

## 7. GPS AT COMMANDS

### 7.1. GPS Request +WVGPS

GPS Request +WVGPS commands set for Io200 OEM Module is described in Supplementary AT commands document section (GPS Request +WVGPS).

Motorola Publication part number **TBD**.

You may download this document from: [TBD](#)

### 7.2. GPS and Location Services

GPS and Location Services commands set for Io200 OEM Module is described in Supplementary AT commands document section, GPS LES: AT+WVRLA

Motorola Publication part number **TBD**.

You may download this document from: [TBD](#)

## 8. SOFTWARE INTERFACE

### 8.1. Extended Error Codes

**Table 7 Extended Error Codes**

<b>Error</b>	<b>Error Description</b>
FLASHStrap <Flashstrap_version> <Flash_identity> <ROM_version> MEM_MAP Blank Service Req'd Ready to Program	This Error will display when there is no memory map (blank)
FLASHStrap <Flashstrap_version> <Flash_identity> <ROM_version> CSD Blank Service Req'd Ready to Program	This Error will display when there is no CSD (blank)
FLASHStrap <Flashstrap_version> <Flash_identity> <ROM_version> ROM Mismatch HW:ROM<ROM version> SW:ROM<SU ROM version> Ready to Program	This Error will display when there is ROM mismatch between the SW and the HW
FLASHStrap <Flashstrap_version> <Flash_identity> <ROM_version> SW Mismatch SW: p<SW version> Ready to Program	This Error will display when there is SW mismatch (the SW doesn't match)
FLASHStrap <Flashstrap_version> <Flash_identity> <ROM_version> Code Corrupt! Ready to Program	This Error will display when the SW is corrupted.

Note: Text inside <> is a field which would be filled with the proper data

## 9. CALL SCENARIO

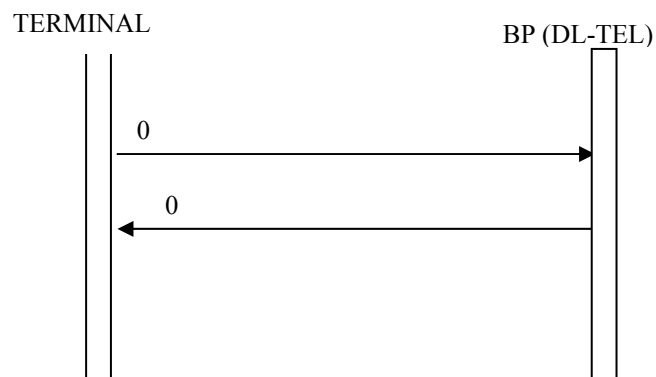
### 9.1. General

This section describes interfaces usable by the TERMINAL to the io200 during any call type. The TERMINAL can use these interfaces whenever the io200 is unlocked: prior to call or during call. Responses will however vary based on the current state of the radio.

### 9.2. List Current Voice Calls

The TERMINAL can gather information about any active calls from the io200. This is used to gather the call identifier to be used for other in-call services, direction of call, state of the call, the bearer service of the call, and the called/calling number.

**Figure 6. List Current Voice Calls**

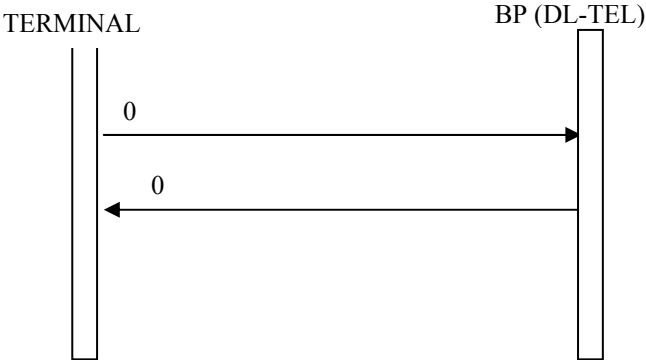




**9.3. Get Subscriber Numbers**

The TERMINAL can gather information about subscriber numbers used and stored in the io200. These numbers are: Voice for lines 1 and 2, Circuit Data, Private ID, Carrier IP, Primary Talkgroup ID, Secondary Talkgroup IDs (available in advanced feature models), Talkgroup Mode, and Group Affiliation.

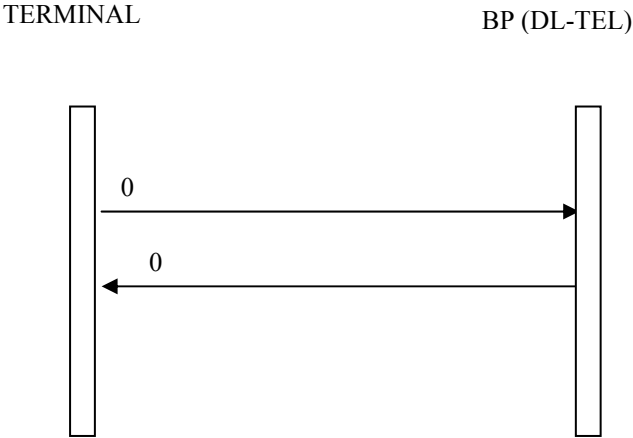
**Figure 7. Get Subscriber Numbers**



**9.4. Phone Activity Status**

The TERMINAL can query the io200 for its current activity status. This can be used to interrogate the io200 before requesting action from the io200. The following illustrates this interaction.

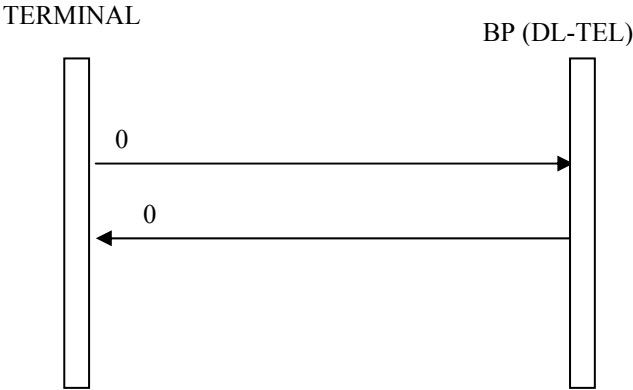
**Figure 8. Phone Activity Status**



**9.5. Get User Identity**

The TERMINAL can query the io200 for its mobile identity (either IMSI or SIM ID). The following illustrates this request.

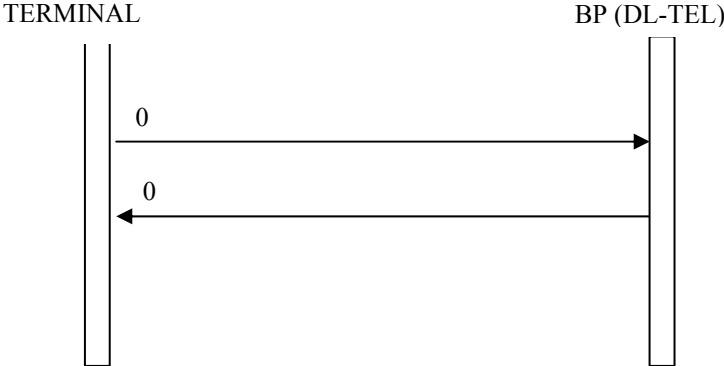
**Figure 9. Get User Identity**



**9.6. SIM access**

The TERMINAL can access the SIM for read/write/execute commands. The following illustrate this access.

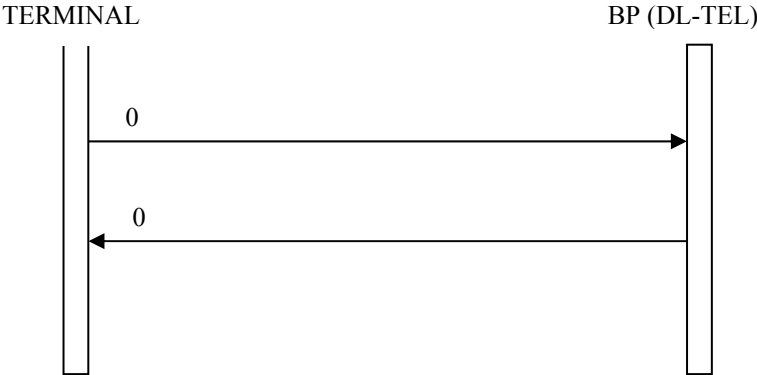
**Figure 10. SIM Access**



**9.7. Signal Strength Access**

The TERMINAL can request from the io200 the signal strength of the cell it is currently camped on.

**Figure 11. Signal Strength Request**



**9.8. Call Timers**

The TERMINAL can request the time durations of voice services performed by the io200. Each service has a current cumulative time interval and a lifetime time interval. The TERMINAL can reset the cumulative back to 0.

The following illustrates querying one call timer value.

**Figure 12. Call Timer Query**



The following illustrates the TERMINAL resetting a call timer value to 0.

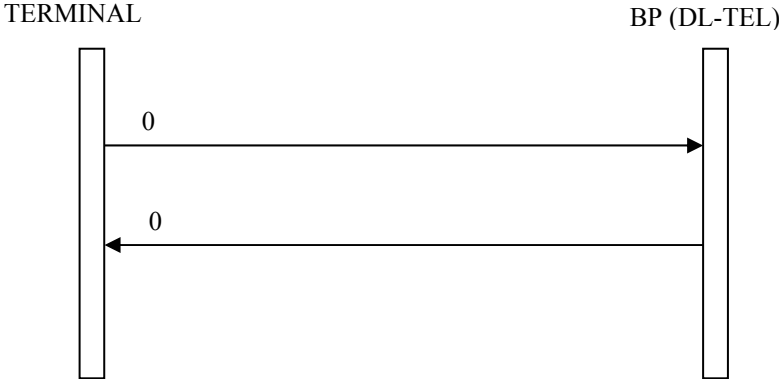
**Figure 13. Reset Call Timer**



**9.9. Cell Tower Information**

The TERMINAL can request from the io200 the identification of the cell it is currently camped on.

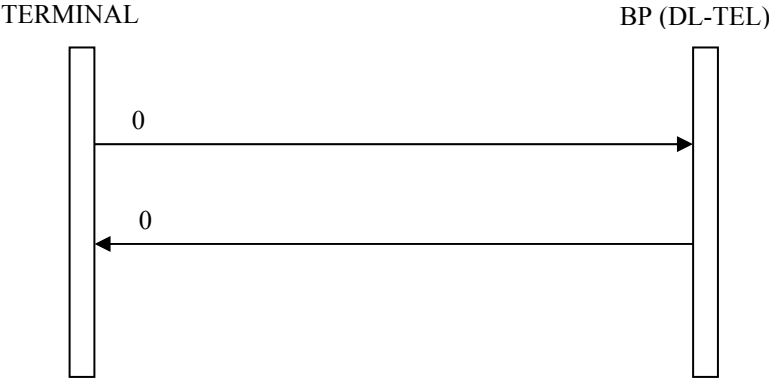
**Figure 14. Cell Info Request**



**9.10. Equipment Information**

The TERMINAL can request information about the io200 hardware.

**Figure 15. Equipment Information**



**9.11. Trace Mode**

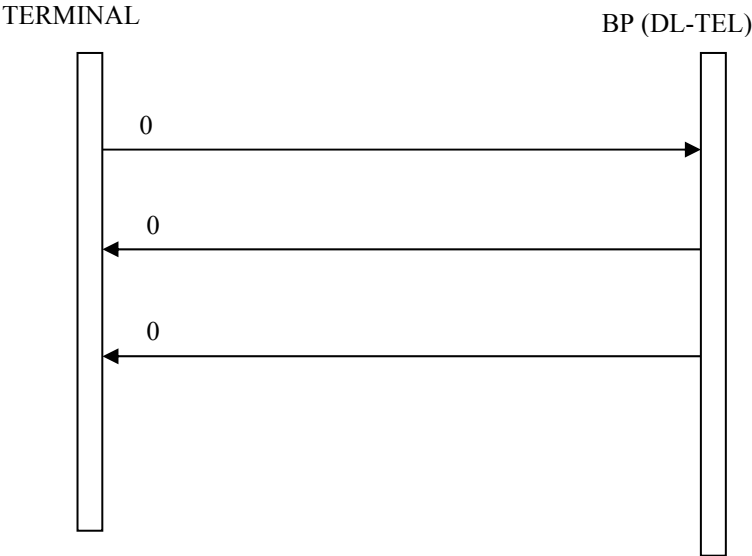
The TERMINAL can request trace data from the io200. In addition, the TERMINAL can enable 2-second updates from the io200 of 1 or more trace data fields. The following diagram shows a normal trace mode query operation.

**Figure 16. Trace Mode Query**



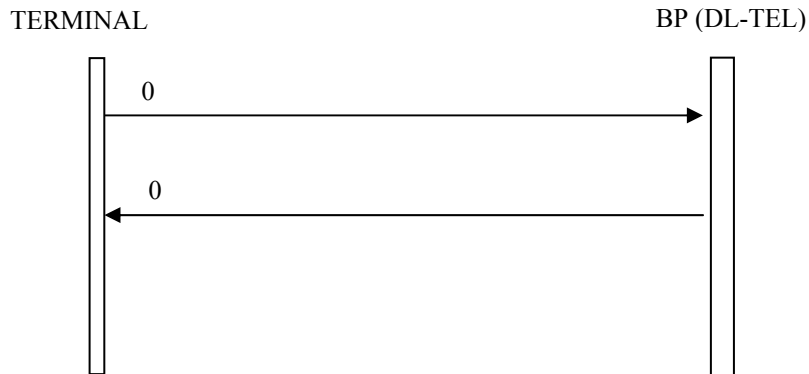
The following shows a trace mode query and enable of the 2-second trace of data.

**Figure 17. Trace Mode Query and Enable**



The following shows disabling of trace mode updates. The io200 will send a final response after being disabled.

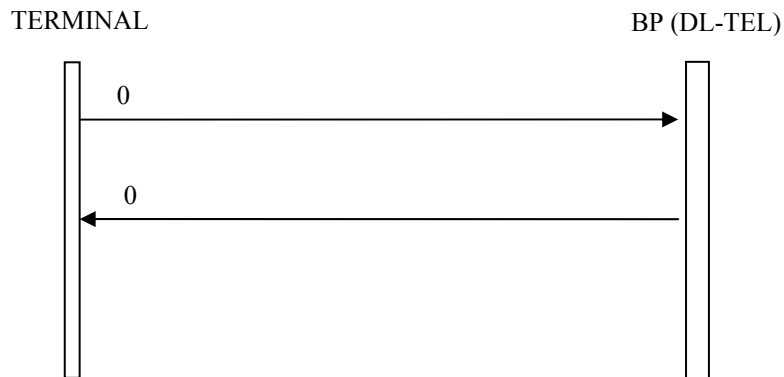
**Figure 18. Trace Mode Query and Disable**



### 9.12. GPS data

The IDEN io200 supports streaming NMEA data. The io200 can send the data to the TERMINAL via any serial I/O.

**Figure 19. GPS Enable and Disable**

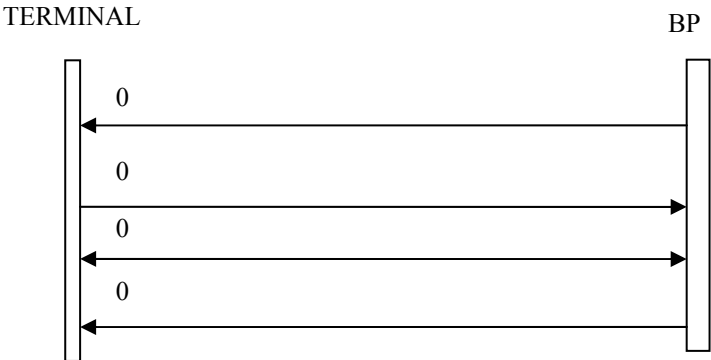


**9.13. Operating Mode change**

The TERMINAL or external device can request the io200 to configure itself into different operational modes. When going from different subscriber modes, the io200 only needs to update its operation parameters. However, when going to special modes (i.e. programming mode), the io200 needs to perform a reconfiguration (warm re-start). The following diagrams illustrate the mode transitions. The TERMINAL is responsible for re-initializing the transport layer interface and uses the correct protocol for the new selected mode. Some modes use the multiplexer interface, while others are a simple UART without any multiplexing.

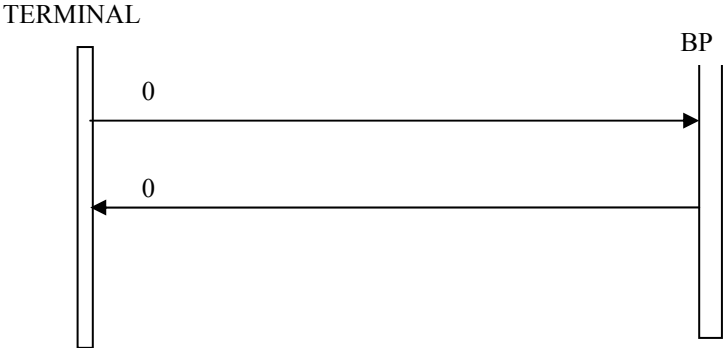
The following diagram illustrates the io200 entering a mode in which the GSM27.010 multiplexer is not currently active. The most typical is after the power-up sequence.

**Figure 20. Invoking GSM27.010 Multiplexer**



The following diagram illustrates the TERMINAL changing the io200 operational mode, which does not require the io200 to reconfigure.

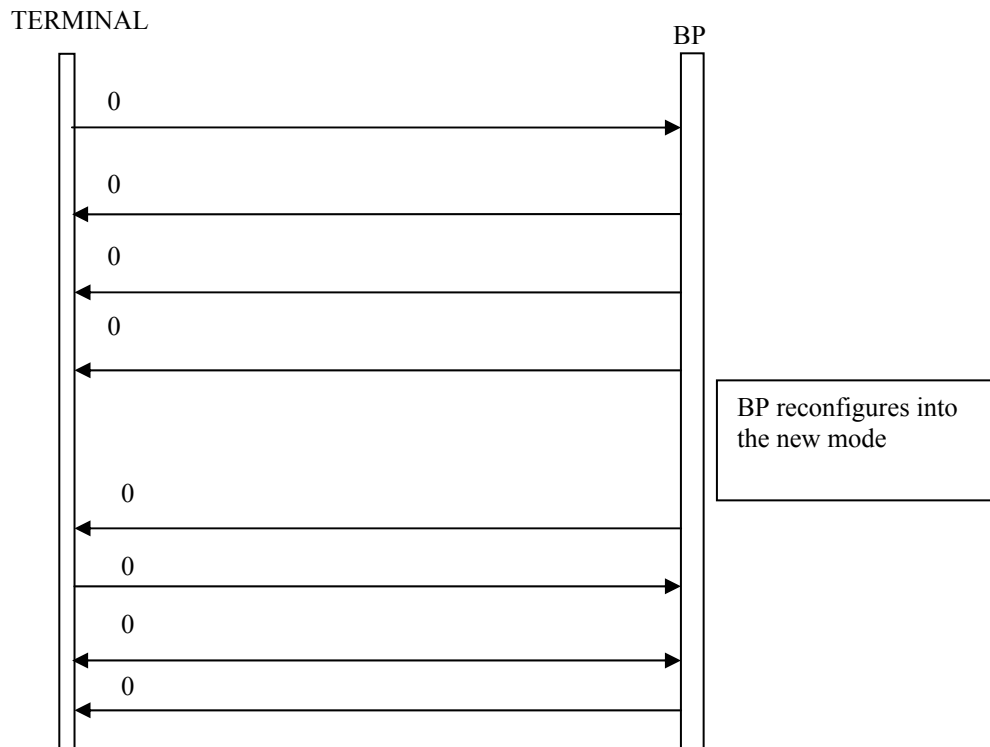
**Figure 21. Non-Reconfigure Mode Change**



The following diagram illustrates the TERMINAL changing the io200 operational mode which does require the io200 to reconfigure and the new mode supports the GSM27.10 multiplexer.

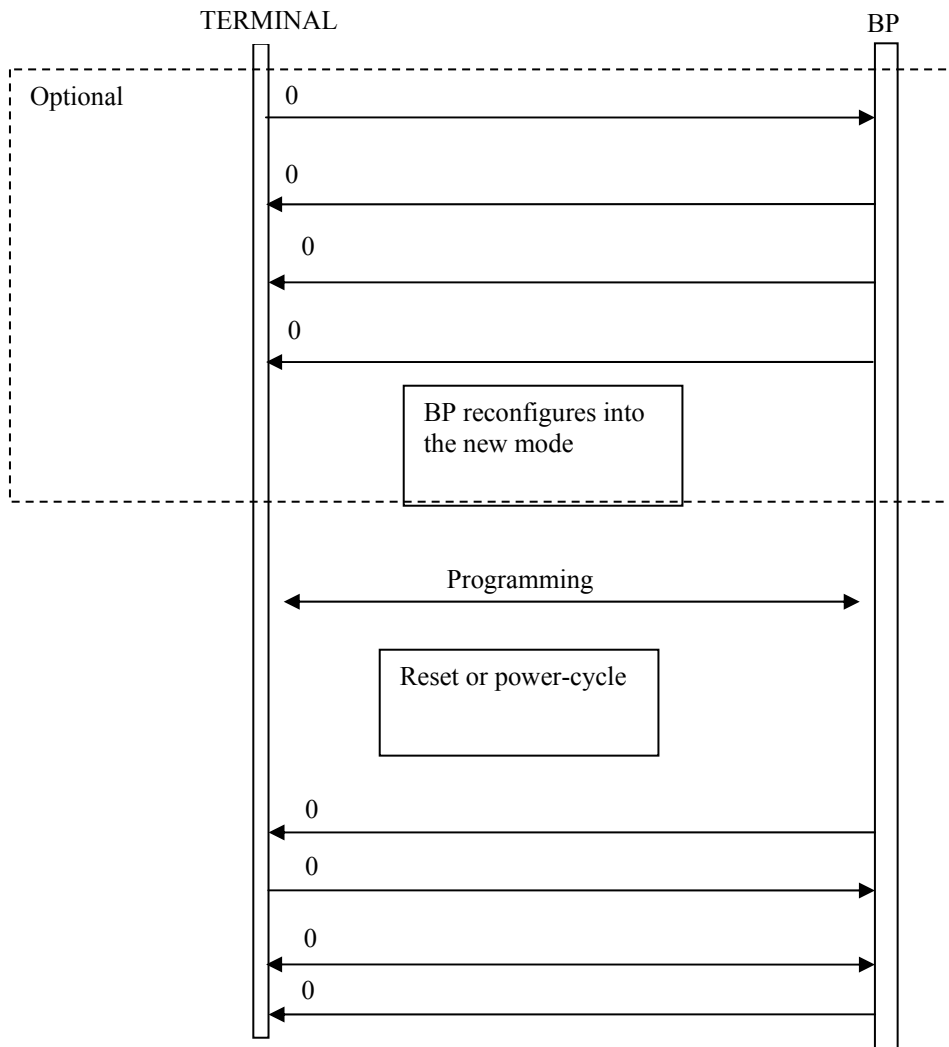
**Figure 22. Reconfigure Mode Change with Mux**





The following diagram illustrates the io200 exiting a programming mode. The io200 can enter the programming mode either from a TERMINAL request or upon power-up.

**Figure 23. Reconfigure Mode Change with Mux**



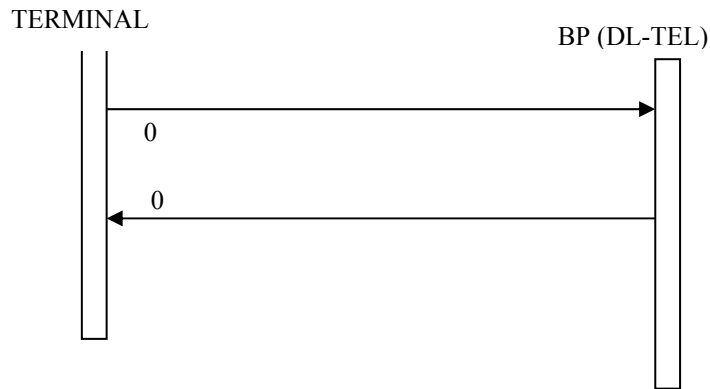
## 9.15. Security Functionality

This section describes the interface as it relates to security.

### 9.15.1.1. Lock io200

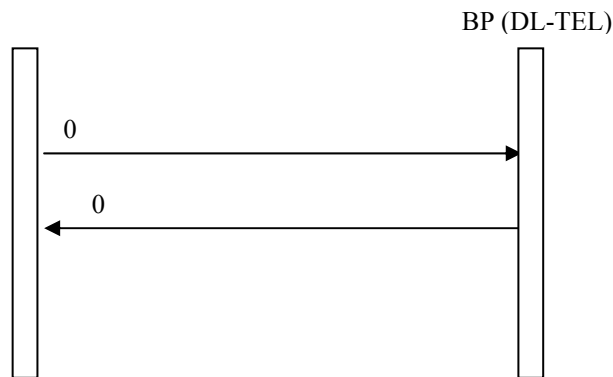
The TERMINAL can lock various io200 facilities, thus requiring the TERMINAL to supply a password to unlock the facility. The iDEN io200 does not support all the facilities defined in GSM (most notable is call barring), thus the TERMINAL should query the baseband for supported facilities as shown below. In addition since various facilities can have variable password length, the TERMINAL should query the facility password length using 0 .

**Figure 24. Locking io200 Facility Capabilities Query**



The following diagram illustrates using a locking facility.

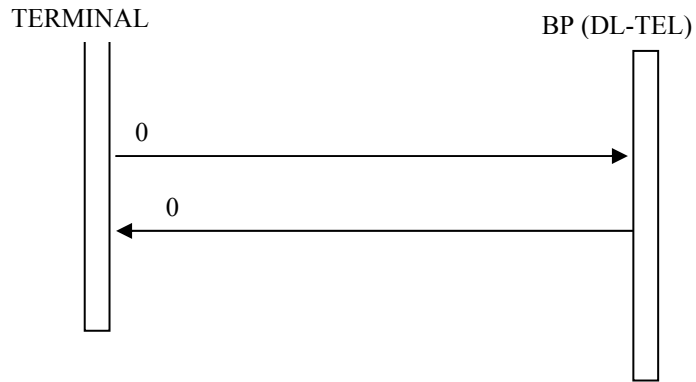
**Figure 25. Locking io200 Facility**



### 9.15.1.2. Unlock io200

The TERMINAL is required to supply a password to enable access to any io200 facility.

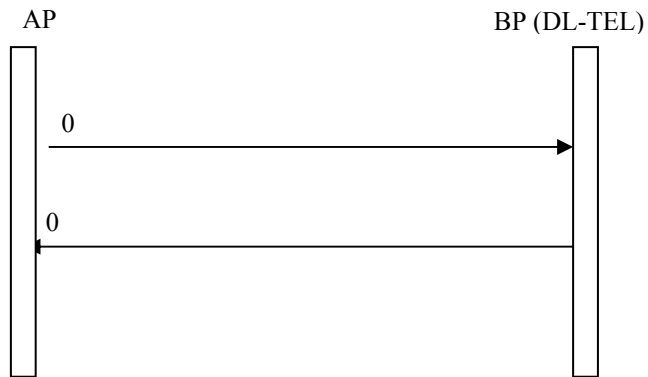
**Figure 26. Unlocking io200 Facility**



### 9.15.1.3. Change Locking Password

The TERMINAL can change the password the io200 uses for each facility that can be locked.

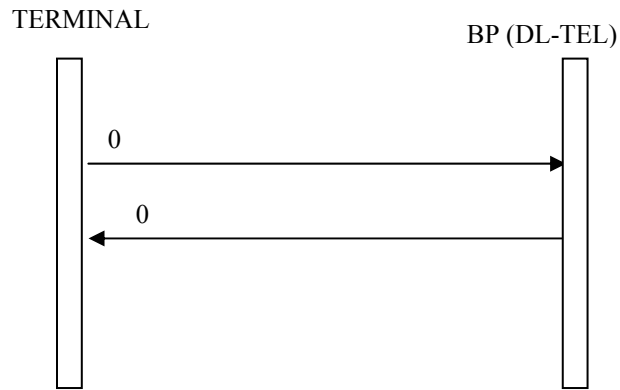
**Figure 27. Change Lock Password**



#### 9.15.1.4. Get Locking Status

The TERMINAL can query the status of any io200 facility that is supported and can be locked. In addition, the TERMINAL can query the state of the SIM (Lock, PUK, etc.)

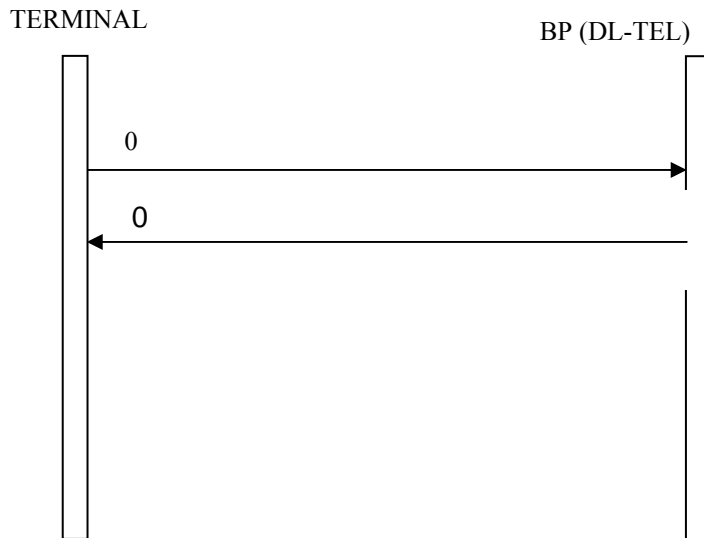
**Figure 28. Get Lock Status**



#### 9.16. Master Reset

The TERMINAL can request the io200 to perform a master reset. This clears all registration information in the SIM, so the next registration cycle is a full IMEI/SIMID registration. After completion, the io200 shall be powered down.

**Figure 29. Master Reset**



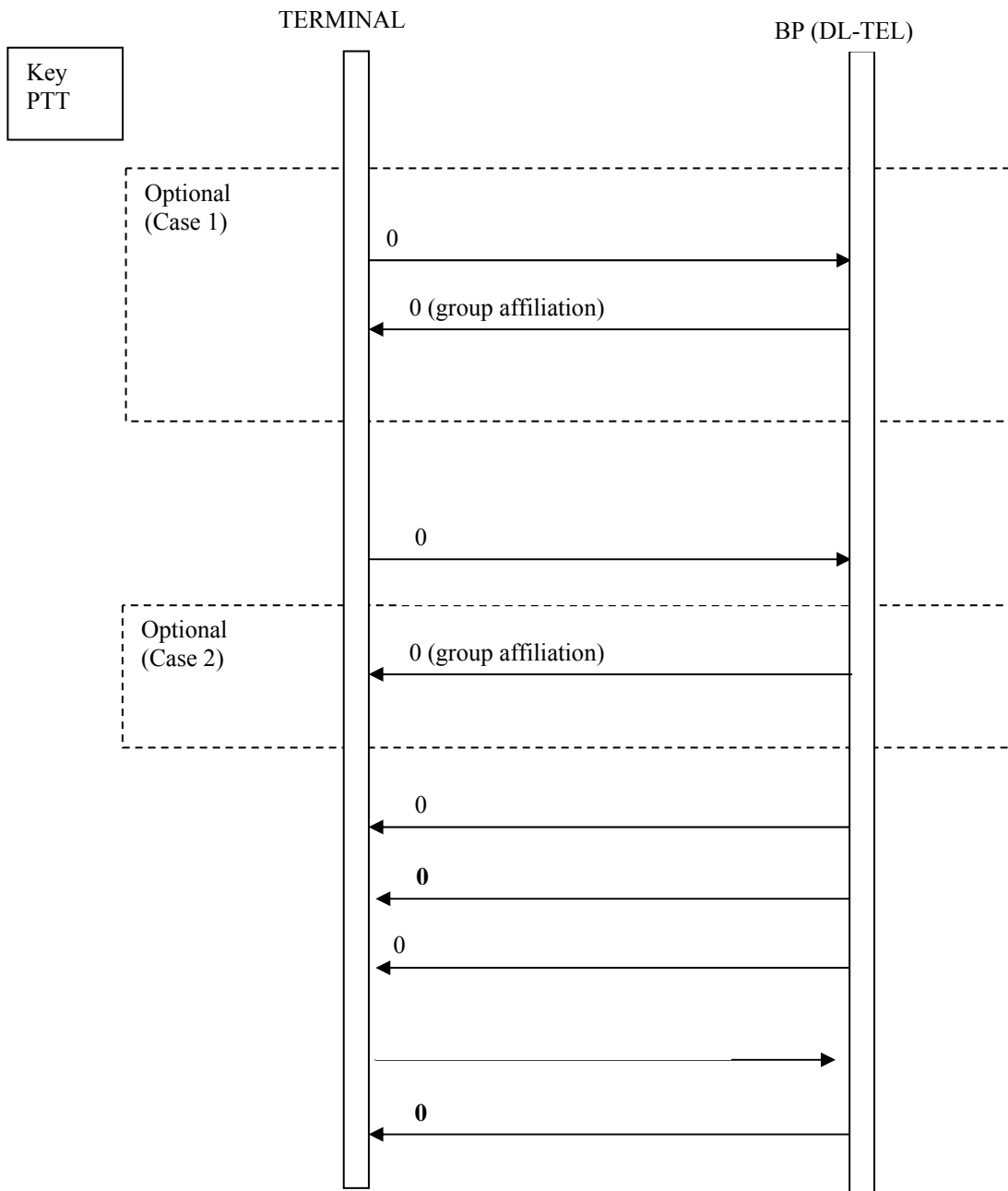
## 9.17. Normal Group

This section describes the interface as it relates to the normal group call service. In the diagrams, **bold** indicate unsolicited messages that may be unavailable (not provided by system). These messages are shown in typically occurrence, but may occur 0, once, or many times within the life of the call.

### 9.17.1.1. Normal Group Call Origination

The following figure illustrates a group call origination.

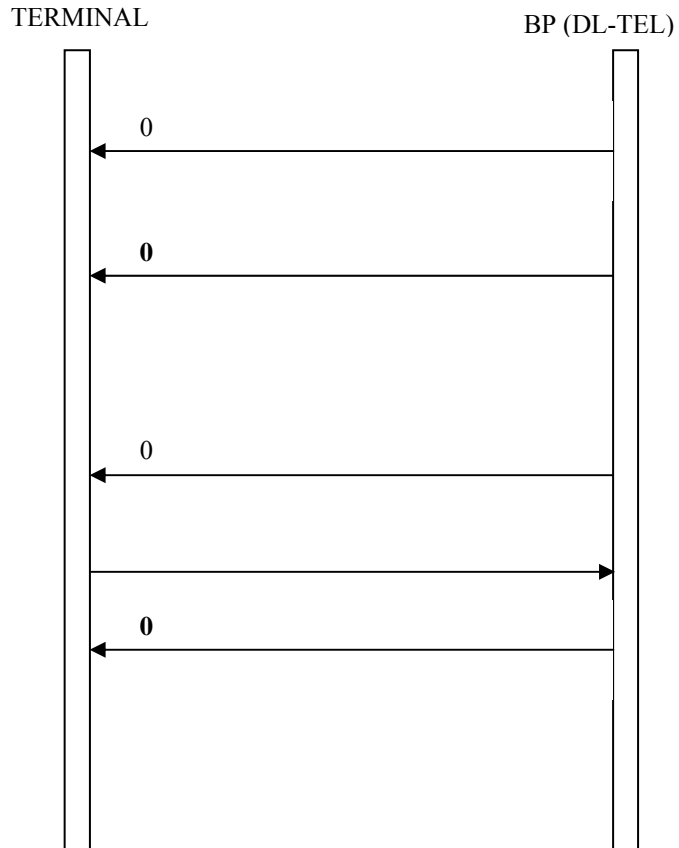
Figure 30. Normal Group Call Origination



### 9.17.1.2. Normal Group Call Join

The following diagram illustrates how the MS is invited to join a normal or an emergency group call. The GC Status message is an optional message, which may be delivered as part of the normal group call sequence.

**Figure 31. Normal Group Call Join**





### 9.17.1.3. Normal Group Call Transmit/Receive

The following diagram illustrates the normal case scenario for transition between half-duplex transmission and reception during a group call.

**Figure 32. Normal Group Call Transmit/Receive**

