



HUAWEI Module

UART Serial Port Design Guide

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About This Document

Revision History

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01	2011-06-30		Creation
02	2011-07-22	4	Deleted 4 UART Multiplexing
03	2014-11-03	3	Added precautions for the UART connection
		4	Added chapter 4: Configurable Commands



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1 Overview

Communications through Universal Asynchronous Receiver/Transmitter (UART) serial ports is convenient and reliable. UART serial ports are widely adopted in Huawei modules. This design guide describes the serial port specifications of Huawei modules and provides recommended design schemes for peripheral circuits. When designing UART serial ports for Huawei modules, customers can refer to this document.

Most of Huawei modules provide 8-wire serial ports with flow control. These 8-wire serial ports can also be used as 2-wire or 4-wire serial ports.

This document is applied to the following Huawei products.

Model	Frequency bands
MC509 and MC509-a	EVDO/CDMA2000 1X
MU509-b, MU509-c and MU509-g	UMTS/HSDPA/GSM/GPRS/EDGE
MU609	UMTS/HSPA/GSM/GPRS/EDGE
MU709s-2 and MU709s-6	UMTS/HSPA+/GSM/GPRS/EDGE
ME909u-521 and ME909u-523	FDD-LTE/DC-HSPA+/HSPA+/HSPA/UMTS/GSM/GPRS/EDGE

2 Specifications

Most of Huawei modules provide 8-wire serial ports that can also be used as 2-wire or 4-wire serial ports.

Take the Huawei MU509 module as an example. Its main specifications include:

- Full-duplex
- Programmable data size
- Programmable stop bits
- Odd parity check, even parity check, or non-check
- Variable baud rates (maximum 230.4 kbit/s; default 115.2 kbit/s)

Table 2-1 describes the signals of the Huawei MU509's UART serial port, in which the Huawei MU509 functions as Data Communication Equipment (DCE) and customers' PCs (hosts) function as Data Terminal Equipment (DTE). For definitions of the pins of other Huawei modules' serial ports, refer to the hardware guide of the modules.

Table 2-1 UART serial port signals

Name	Description	Feature	Direction
UART_TX	Data sending	The DTE receives serial data.	DCE→DTE
UART_RX	Data receive	The DTE transmits serial data.	DTE→DCE
UART_RING	Ring indication	The DTE is notified of a remote call or SMS.	DCE→DTE
UART_RTS	Data sending request	The DTE notifies the DCE of sending requests.	DCE→DTE
UART_DTR	Data terminal ready	The DTE is ready.	DTE→DCE
UART_CTS	Clearing to send	The DCE switches to the receiving mode.	DTE→DCE
UART_DCD	Data carrier detection	Data links are connected, used to indicate data link state	DCE→DTE

Name	Description	Feature	Direction
UART_DSR	Data ready on the wireless module	The DCE is ready.	DCE→DTE

Figure 2-1 to Figure 2-3 show the connection of the UART serial port in the Huawei module (DCE) with the host (DTE).

Figure 2-1 Connection of the 8-wire UART serial port in the Huawei module (DCE) with the host (DTE)

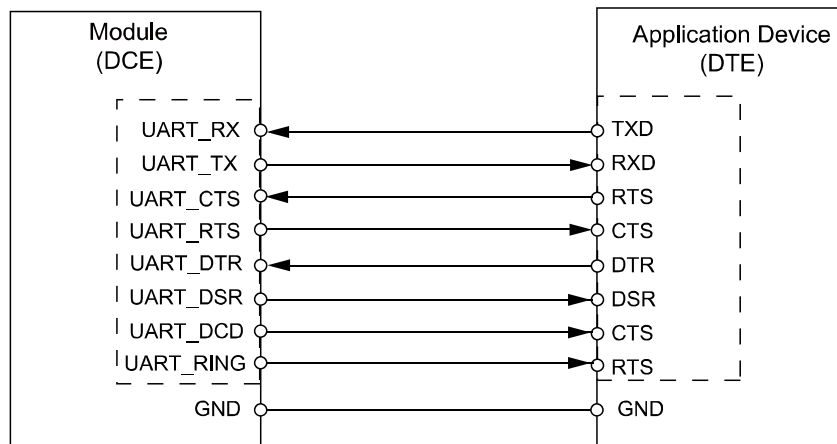
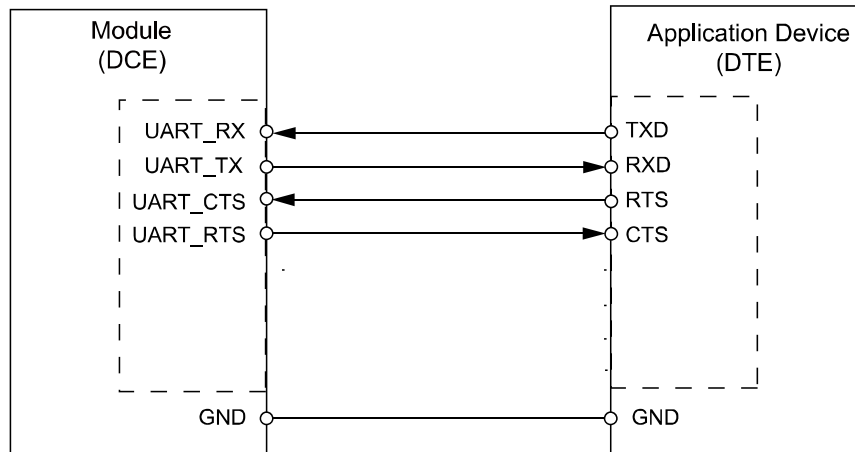


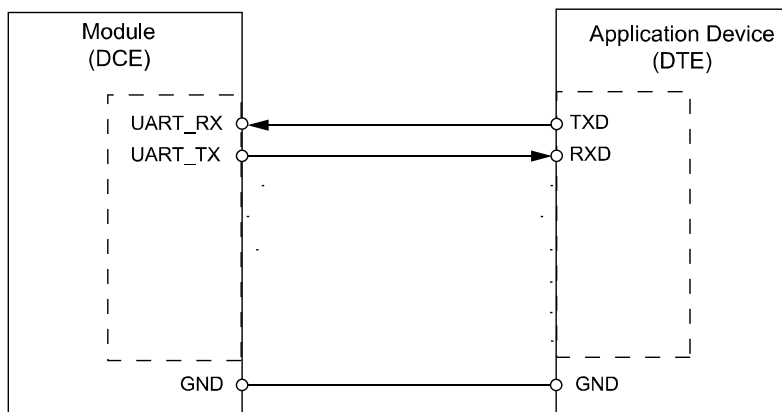
Figure 2-2 Connection of the 4-wire UART serial port in the Huawei module (DCE) with the host (DTE)



NOTE

In a 4-wire serial port, DTE uses TXD, RXD, CTS, and RTS.

Figure 2-3 Connection of the 2-wire UART serial port in the Huawei module (DCE) with the host (DTE)



NOTE

- In a 2-wire serial port, DTE uses TXD and RXD, and cannot implement hardware flow control. For massive data transfers, 4-wire or 8-wire serial ports that can provide hardware flow control are recommended.
- You cannot use `AT+IFC` to enable hardware flow control when using a 2-wire serial port. Otherwise, UART cannot communicate normally.

3 Circuit Design

3.1 Logic Levels

The logic levels of all Huawei module serial ports are Complementary Metal–Oxide–Semiconductor (CMOS) logic levels. Different modules support different logic levels V_{IO} , such as 1.8 V, 2.6 V and 2.8 V. For details about specific logic levels, refer to the hardware guide of the relevant modules.

The following table lists the thresholds for the logic levels.

Parameter	Description	Min	Max	Unit
V_{IH}	High-level input voltage	$0.7 \times V_{IO}$	$V_{IO} + 0.3$	V
V_{IL}	Low-level input voltage	-0.3	$0.35 \times V_{IO}$	V
V_{OH}	High-level output voltage	$0.7 \times V_{IO}$	$V_{IO} + 0.3$	V
V_{OL}	Low-level output voltage	0	0.45	V

In which,

Voltage	Explanation
Input high level threshold (V_{IH})	the allowed minimum input high level voltage that can ensure high level input voltages to the logic gate. If an input voltage is higher than V_{IH} , it is a high level input voltage.
Input low level threshold (V_{IL})	the allowed maximum input low level voltage that can ensure low level input voltages to the logic gate. If an input voltage is lower than V_{IL} , it is a low level input voltage.
Output high level threshold (V_{OH})	the allowed minimum output high level voltage that can ensure high level output voltages from the logic gate. When the logic gate is outputting high level voltages, the output voltages must be higher than this threshold.

Voltage	Explanation
Output low level threshold (V_{OL})	the allowed maximum output low level voltage that can ensure low level output voltages from the logic gate. When the logic gate is outputting low level voltages, the output voltages must be lower than this threshold.

3.2 Connection Between Huawei Modules and Standard RS-232-C Interfaces

The COM1 and COM2 interfaces of PCs comply with EIA-RS-232-C. Their logic levels are:

For TxD and RxD:

- Logic 0 = -15 V to -3 V;
- Logic 1 = +3 V to +15 V.

For control lines such as RTS, CTS, DSR, DTR, DCD and RING:

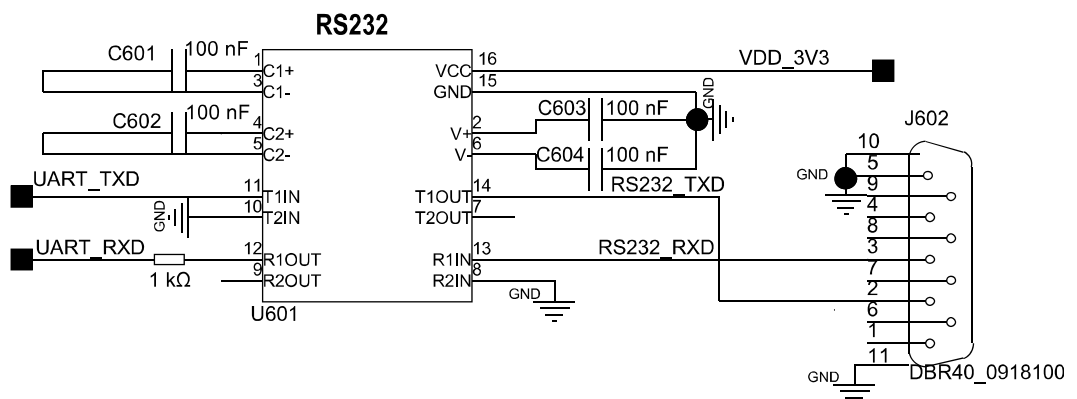
- Signal enabled (connected, ON, positive voltages) = +3 V to +15 V;
- Signal disabled (disconnected, OFF, negative voltages) = -15 V to -3 V.

RS232 chip can be used for connecting Huawei modules to standard RS-232-C interfaces.

If a 2-wire serial port is used, the MAX3232 chip is recommended. The signals from the module's UART_RXD pin are converted by the MAX3232 and then transferred to the DTE's RXD pin. The signals from DTE's TXD pin are converted by the MAX232 and then transferred to the module's UART_TXD pin.

The power supply of the MAX3232 is 3.3 V, not compatible with the logic level (V_{IO}) of Huawei module serial ports. Therefore, after the signals from the UART_RXD pin go through the RS232 chip (MAX3232), a resistor circuit must be added to reduce the voltage from 3.3 V to V_{IO} .

Figure 3-1 Connection of a 2-wire serial port



If a 4-wire or 8-wire serial port is used, the MAX3232, SP3238 or MAX3238 is recommended. Figure 3-2 and Figure 3-3 show the connection.

Like the scenario in which the MAX3232 is used for a 2-wire serial port connection, level conversion circuits are also required if the signals output from the chips are not compatible with V_{IO} , to ensure that the module can receive appropriate signals.

Figure 3-2 Connection of an 4-wire serial port with hardware flow control

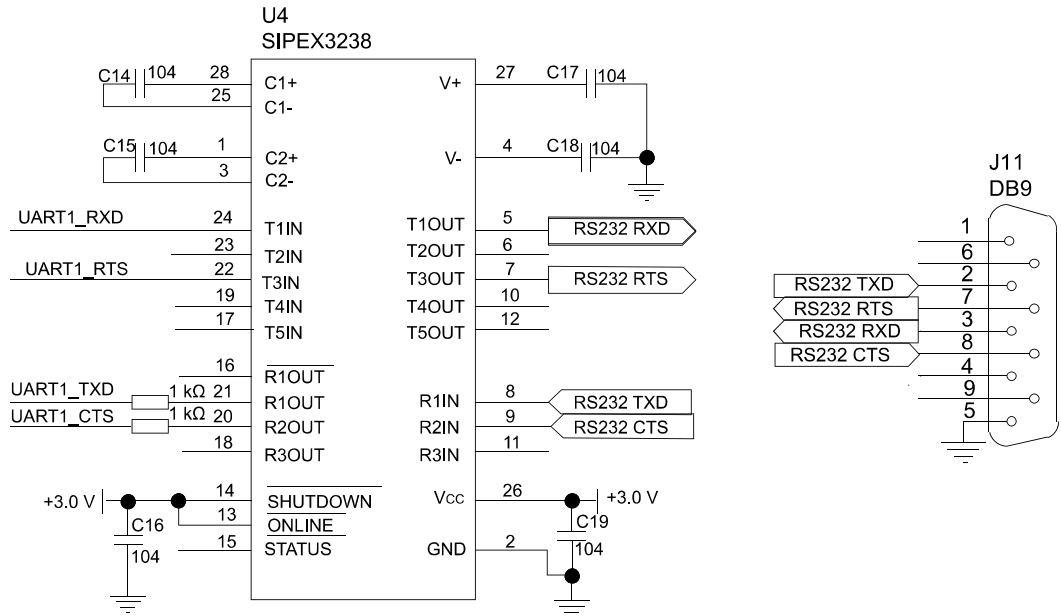
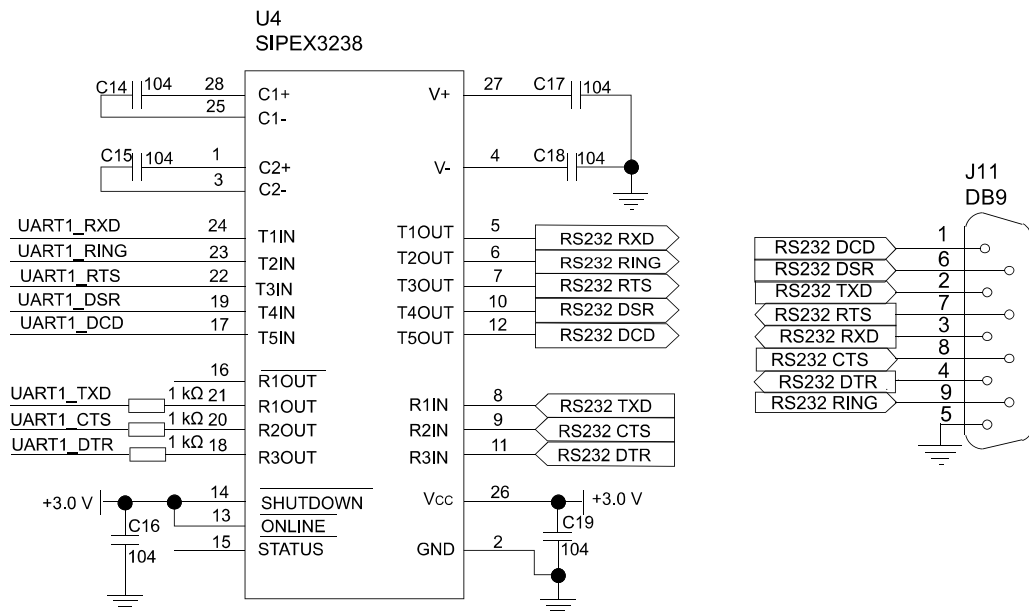


Figure 3-3 Connection of an 8-wire serial port with hardware flow control



3.3 Connection Between Huawei Modules and Other DTE

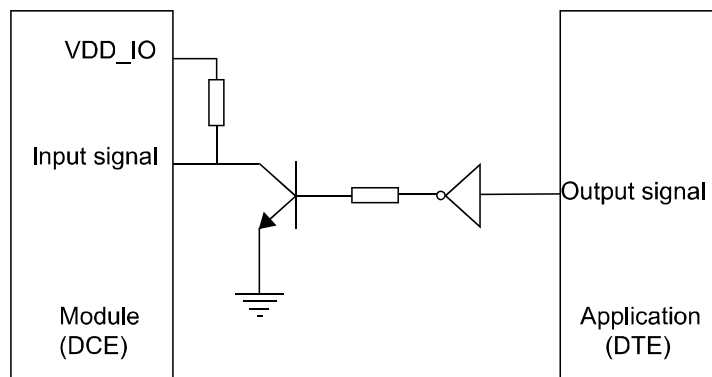
Most DTE uses single-chip microprocessors as central processing units (CPUs). Common serial port logic levels include 5 V, 3.3 V, 3 V, 2.85 V, 2.6 V and 1.8 V. Huawei modules and DTE should be connected based on the compatibility between their logic levels.

- The DTE and DCE logic levels are compatible.
The DTE and DCE logic levels can be deemed compatible if the DTE voltage is equal to or approximately equal to the logic level (V_{IO}) of the module serial port, that is, $V_{OH} > V_{IH}$ and $V_{OL} < V_{IL}$. In this case, DTE and DCE can be connected using resistors or buffers.
- The DTE and DCE logic levels are incompatible.
When the difference between DTE and DCE logic levels is great, a logic level conversion circuit may be required to match DTE and DCE logic levels. There are many methods and mature schemes to match logic levels, such as using logic level conversion ICs and resistors to divide voltages or using transistors and pull-up resistors. Customers can select schemes appropriate for their products.

This document provides a logic level conversion scheme using transistors and resistors for customers' reference. To prevent electric current from flowing backwards, circuits should be designed separately for the input and output of the module.

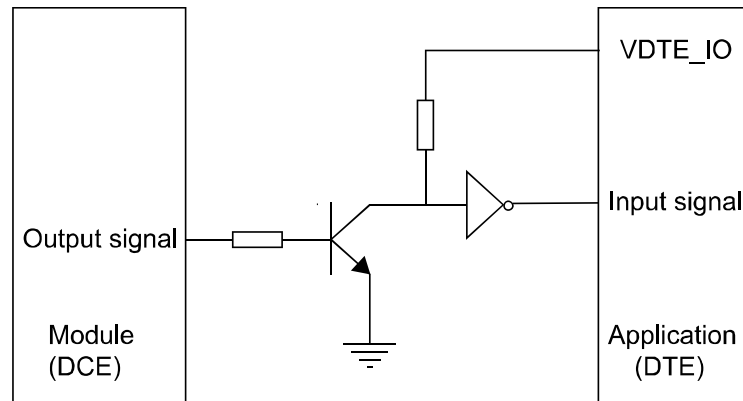
The module's input signals include UART_RX, UART_CTS and UART_DTR. Figure 3-4 shows a recommended conversion circuit for these input signals, in which VDD_IO is the reference voltage of the module's serial port.

Figure 3-4 Logic level conversion circuit for the input signals



The module's output signals include UART_TX, UART_RTS, UART_DSR, UART_DCD, and UART_RING. Figure 3-5 shows a recommended conversion circuit for these output signals, in which VDTE_IO is the reference voltage of the host's serial port.

Figure 3-5 Logic level conversion circuit for the output signals



 **NOTE**

- It is suggested that users keep the UART external interface unconnected when design the hardware, to ensure the convenience of later firmware upgrade and logs obtained.
- It is suggested to connect UART and the host after the module is powered on (Vcc_1.8 and Vcc_2.8 output), to avoid rush-in of the current on the UART which may cause the module cannot powers on normally.
- It is suggested that you keep the pins that you do not use unconnected.

4 Configurable Commands

This chapter introduces the general UART commands. For the details of those commands, you can refer to the module's AT command interface specification.

4.1 AT&C-Set DCD Line Mode

4.1.1 Command Syntax

AT&C[<value>]
Possible Response(s)
<CR><LF>OK<CR><LF>

4.1.2 Interface Description

The AT&C command sets the relation between the status of the Data Carrier Detect (DCD) line and signal detection of the remote receiving line.

4.1.3 Parameter Description

<value>: an integer type; If <value> is not specified, it is equivalent to set <value> to 0.

- | | |
|---|---|
| 0 | Enable the DCD line. |
| 1 | The DCD line is enabled only when data carrier exists. (default value). |
| 2 | The DCD line is enabled only when there are one or more TCP or UDP connections if Huawei's proprietary protocol is used. If FTP or HTTP is used, the DCD line is effective only for data connections. |

4.2 AT&D-Set DTR Line Mode

4.2.1 Command Syntax

AT&D[<value>]
Possible Response(s)
<CR><LF>OK<CR><LF>

4.2.2 Interface Description

The AT&D command sets the result returned by the TA in data service state when the Data Terminal Ready (DTR) circuit is disabled from enabling state.

4.2.3 Parameter Description

<value>: an integer type; If <value> is not specified, it is equivalent to set <value> to 0.

- | | |
|---|---|
| 0 | TA ignores the status of the DTR circuit. |
| 1 | Enter the command mode while holding the current data conversation. |
| 2 | Release the data or voice conversation and enters the command mode. (default value) |

4.3 AT&S-Set DSR Line Mode

4.3.1 Command Syntax

AT&S[<value>]
Possible Response(s)
<CR><LF>OK<CR><LF>

4.3.2 Interface Description

The AT&S command sets the status of the Data Set Ready (DSR) line according to different communication status of the ME.

4.3.3 Parameter Description

<value>: an integer type; If <value> is not specified, it is equivalent to set <value> to 0.

- 0 DSR line always is ON. (default value)
- 1 DSR line is OFF when ME is in command mode; DSR line is ON when ME is in data mode.

4.4 AT+IPR-Set DTE-DCE Baud Rate

4.4.1 Command Syntax

AT+IPR=<rate>
Possible Response(s)
<CR><LF>OK<CR><LF>
In case of an MT-related error:
<CR><LF>+CME ERROR: <err><CR><LF>
AT+IPR?
Possible Response(s)
<CR><LF>+IPR: <rate><CR><LF><CR><LF>OK<CR><LF>
AT+IPR=?
Possible Response(s)
<CR><LF>+IPR: (list of supported auto-detectable <rate>s) [, (list of supported fixed-only <rate>s)]<CR><LF><CR><LF>OK<CR><LF>

4.4.2 Interface Description

This command sets DTE-DCE (Data Terminal Equipment-Data Connection Equipment) baud rate.

The set command sets DTE-DCE baud rate.

The read command queries the current DTE-DCE baud rate.

The test command returns the DTE-DCE baud rate supported by this command.

4.4.3 Parameter Description

<rate>: an integer type, which is saved upon power failure.

- 0 Indicates adaptive baud rate.

Range of adaptive baud rate: 9600, 19200, 38400, 57600, and 115200.

Fixed baud rate: 9600, 19200, 38400, 57600, 115200 and 230400.

Default value: 115200.



NOTE

- To set a fixed baud rate, ensure that the baud rates configured for the TE and TA are the same.
- To set an adaptive baud rate, run `AT+IPR=0`.
- When running the AT command to set an adaptive baud rate and initializing the module, you must send AT command first to synchronize the baud rate of TE with that of TA (ensure that AT ahead of the command is in upper case)
- After an adaptive baud rate is enabled, if you want to change the baud rate of the host, do the following: set the baud rate first, and then restart the module.
- In multiplexing mode, only a fixed baud rate is supported.
- You cannot use `AT+IFC` to enable hardware flow control when using a 2-wire serial port. Otherwise, UART cannot communicate normally.

4.5 AT+ICF-Set Character Frame Format

4.5.1 Command Syntax

<code>AT+ICF=<format>,<parity></code>
Possible Response(s)
<code><CR><LF>OK<CR><LF></code>
In case of an MT-related error:
<code><CR><LF>+CME ERROR: <err><CR><LF></code>
<code>AT+ICF?</code>
Possible Response(s)
<code><CR><LF>+ICF: <format>,<parity><CR><LF><CR><LF>OK<CR><LF></code>
<code>AT+ICF=?</code>
Possible Response(s)
<code><CR><LF>+ICF: (list of supported <format>s), (list of supported <parity>s)<CR><LF><CR><LF>OK<CR><LF></code>

4.5.2 Interface Description

This command sets the character frame format of the serial ports.

4.5.3 Parameter Description

`<format>`: an integer type

- | | |
|---|---------------|
| 0 | Auto detect |
| 1 | 8 Data 2 Stop |

2	8 Data 1 Parity 1 Stop
3	8 Data 1 Stop (default value)
4	7 Data 2 Stop
5	7 Data 1 Parity 1 Stop
6	7 Data 1 Stop

<partity>: an integer type

0	Odd parity (default value)
1	Even parity

4.6 AT+IFC-Control Local Flow

4.6.1 Command Syntax

AT+IFC=<DCE_by_DTE>,<DTE_by_DCE>
Possible Response(s)
<CR><LF>OK<CR><LF>
In case of an MT-related error: <CR><LF>+CME ERROR: <err><CR><LF>
AT+IFC?
Possible Response(s)
<CR><LF>+IFC: <DCE_by_DTE>,<DTE_by_DCE><CR><LF><CR><LF>OK<CR><LF>
AT+IFC=?
Possible Response(s)
<CR><LF>+IFC: (list of supported <DCE_by_DTE>s) , (list of supported <DTE_by_DCE>s) <CR><LF><CR><LF>OK<CR><LF>

4.6.2 Interface Description

This command sets the local flow control mode of the serial ports.

4.6.3 Parameter Description

<DCE_by_DTE>: an integer type specifies the method to be used by the DTE to control the flow of received data from the DCE.

0	Disable flow control. (default value)
---	---------------------------------------

- 1 XON/XOFF software flow control.
- 2 RTS line

<DTE_by_DCE>: an integer type specifies the method to be used by the DCE to control the flow of transmitted data from the DTE.

- 0 Disable flow control. (default value)
- 1 XON/XOFF software flow control
- 2 CTS line

4.7 AT\Q-Set Software or Hardware Flow Control

4.7.1 Command Syntax

AT\Q[<n>]
Possible Response(s)
<CR><LF>OK<CR><LF>
In case of not supporting RTS/CTS when <n>=2: <CR><LF>ERROR<CR><LF>
In case of an MT-related error: <CR><LF>+CME ERROR: <err><CR><LF>

4.7.2 Interface Description

The AT\Q command sets software or hardware flow control mode.

4.7.3 Parameter Description

<n>: an integer type specifies the method to be used by the DTE to control the flow of received data from the DCE.

- 0 Disable flow control. (default value)
- 1 XON/XOFF software flow control
- 2 Only CTS by DCE (TA)
- 3 RTS/CTS hardware flow control

4.8 AT^HRIM-Set the RI Usage State

4.8.1 Command Syntax

AT^HRIM=<RI_Type>,<RI_Time>
Possible Response(s)
<CR><LF>OK<CR><LF>
In case of an MT-related error: <CR><LF>+CME ERROR: <err><CR><LF>
AT^HRIM?
Possible Response(s)
<CR><LF>^HRIM: <RI_Type>,<RI_Time><CR><LF>^HRIM: <RI_Type>,<RI_Time><CR><LF><CR><LF>OK<CR><LF>
In case of an MT-related error: <CR><LF>+CME ERROR: <err><CR><LF>
AT^HRIM=?
Possible Response(s)
<CR><LF>^HRIM: (list of supported <RI_Type>s), (list of supported <RI_Time>s)<CR><LF><CR><LF>OK<CR><LF>
In case of an MT-related error: <CR><LF>+CME ERROR: <err><CR><LF>

4.8.2 Interface Description

This command sets the duration for how long the RI pin is kept at low voltage level when a short message or a voice call is coming in data mode.

The set command sets the duration for how long the RI pin is kept by the specified event at low voltage level.

The read command queries the event type that pulls down the RI pin voltage level and the duration for how long the RI pin is kept at that level.

The read command returns the parameter values supported by the command.

4.8.3 Parameter Description

<RI_Type>: an integer type specifies voice channel number. The value ranges from 0 to 1, and 0 indicates the first channel.

- | | |
|---|---|
| 0 | Enable the RI pin voltage level to be pulled down to indicate the arrival of new text messages. |
|---|---|



- 1 Enable the RI pin voltage level to be pulled down to indicate the arrival of new incoming calls.

<RI_Type>: an integer type specifies the duration for how long the RI pin is kept at low voltage level. The value ranges from 1 ms to 50000 ms.

5 Abbreviations

Abbreviations	Full Spelling
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DTE	Data Terminal Equipment
DSR	Data Set Ready
UART	Universal Asynchronous Receiver Transmitter