

10Pin External Interface Specification for Mobile Equipment

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Vodafone K.K.

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References

Reference	Description
[RC-5240]	RC-5240 "Rectangular connector for Mobile Phone", JEITA
[10Pin-EAR]	10Pin Earphone/Microphone Specification for Mobile Equipment Revision 1.1.0, Vodafone K.K.
[10Pin-ODC]	10Pin Optical Digital Converter Specification for Mobile Equipment Revision 0.9.0, Vodafone K.K.
[10Pin-AC]	10Pin Analog Converter Specification for Mobile Equipment Revision 0.9.0, Vodafone K.K.
[10Pin-AV]	10Pin Audio Visual Input/Output Specification for Mobile Equipment Revision 0.9.0, Vodafone K.K.

1. Objective

This document clarifies specifications of the interface between handset and external device in the case where the handset and an external device are connected with a square-shaped (10 pins) connector.

2. Applicable Range

This document applies to any generation handset, regardless of whether it is 2G, 2.5G or 3G handset..

3. Definition Range

This document defines communications specifications in the interface part between handset and external device as shown in [Figure 3-1. Definition Range]:

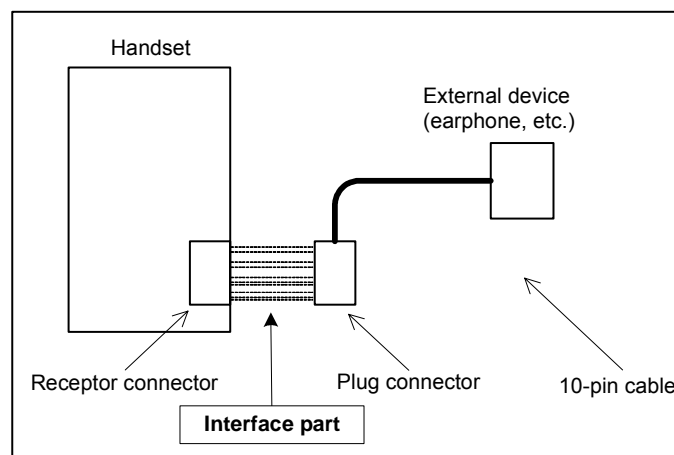


Figure 3-1. Definition Range

4. Connector Specification

The connector to be used for the interface part shall be compliant with [RC-5240]. (Hereafter called “10-Pin connector”)

4.1. Connector Shape

[Figure 4.1-1 Connector Shape] illustrates the overview of the connector shape and pin arrangement direction.

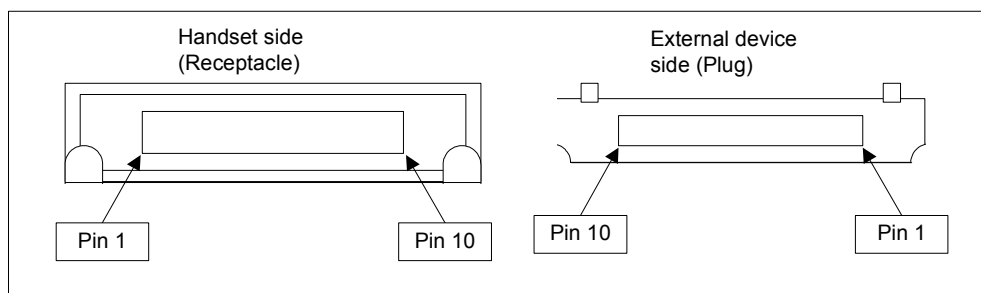


Figure 4.1-1 Connector Shape

4.2. Place to Implement the Connector

10-Pin connector must not be mounted to any place of the handset where trouble in use may occur when an external device is connected, considering where the connector cover and handset face, user convenience, etc.

5. Connector Terminal

Table 5-1 illustrates specifications of the 10-Pin connector terminal defined in this document.

Written below are the prohibited matters regarding the use of connector terminal in this document:

- Terminal specification that is different from those defined in Table 5-1 and separately-defined external device specifications shall not be assigned for original objective.
- Terminal specification defined as Reserved shall not be assigned for original objective.

Abnormal behavior, etc. shall not occur when a terminal receives an undefined signal.

Appropriate measures shall be taken to the handset and external devices so that they won't get easily damaged by unified signal level input/output.

Table 5-1.Connector Terminal Specification

Pin No.	Signal Direction		Terminal Specification	Signal Level	Note
	Hand set	Ex De vice			
1	-		Analogue GND	GND connection at the handset	-
2	-		Reserved	-	Defined for each external device type ^(*)
3	←		External device detection Lo = Detected Open = Not detected	When an external device is connected Lo: GND connection on the external device part When no external device is connected Open: Pull up on the handset part (VDD)	-
4	-		Reserved	-	Defined for each external device type ^(*)
5	-		Reserved	-	Defined for each external device type ^(*)
6	-		Reserved	-	Defined for each external device type ^(*)
7	→		Power supply	VDD=3±0.3V	Power shall be supplied only when an external device is detected.
8	←		Upstream serial Lo(Within one second) =UART control Hi=OFF or Control wait Switch detection ^(*) Lo(Over one second) = Switch on Hi=OFF	Hi:0.8VDD - VDD Lo:0 - 0.2VDD	To be used for transmitting a serial signal from external device to handset.
9	→		Downstream serial (UART control)	Hi:0.8VDD - VDD Lo:0 - 0.2VDD	To be used for transmitting a serial signal from handset to external device.
10	-		Digital GND	GND connection at the handset	-

(*) Comply with “3. Connector Terminal” described in [10Pin-EAR] if it falls under Case 1 of unsupported external device. (Refer to “6.3. Connection of unsupported external device”)

(*) When connecting an external device (earphone, etc.) that is not supported by upstream/downstream serial terminal, switch control is performed.

An earphone microphone function with a switch compliant with [10Pin-EAR] shall be implemented.

If the handset determines from external device detection that it is not connected, signals from external device shall be invalid.

Comply with separately defined specifications, if any.

5.1. Basic Communications Specifications

5.1.1. Data Communications Method

Table 5.1.1-1 illustrates the data communication method:

Table 5.1.1-1. Data Communications Method

Sync Method	Asynchronous Communication (Full duplex)
Communications Speed ^(*)	9,600(Default) / 19,200 / 38,400 / 57,600 / 115,200 / 230,400 / 460,800 bps
Data Length	8bit
Stop Bit	1bit
Parity	Even
Bit Order	LSB First

(*) To be selected through negotiation between handset and external device. 9,600bps is a must, which is used for negotiation.

5.1.2. Packet Structure

Communications between handset and external device will be made in units of packet. The sender sends one byte transmission request code before sending a packet to notice the receiver of the start of transmission. The receiver prepares for transmission after receiving the transmission request code, and sends a transmission approval code back when it is ready for transmission.

Written below are details of the structure of a normal packet:

Each packet is composed with the order illustrated in Figure 5.1.2-1.

SOP	Byte0	Byte1	---	Byte n	BCC	EOP
-----	-------	-------	-----	--------	-----	-----

Figure 5.1.2-1. Order of Packet Constructors

Table 5.1.2-1 explains each packet constructor:

Table 5.1.2-1. Packet Composing Content

Composing Content	Explanation
SOP	Fix the start packet(Start Of Packet) value to 0xFD
Byte0	Command code. LSB is used as toggle bit
Byte1-Byten	Parameters of command
BCC	(xOR)is removed from Byte0-Byten
EOP	End packet(End Of Packet) The value is fixed to 0xFE

Special commands described in Table 5.1.2-2 are adopted to cope with distortion between command and ACK and data garble.

Table 5.1.2-2. Special Code

Special Code Value	Content
0xF1-0xF7	Reserved
0xF9	Reserved
0xFA	Normal ACK(When toggle bit is 0)
0xFB	Normal ACK(When toggle bit is 1)
0xFC	Reserved
0xFD	SOP(Start packet)
0xFE	EOP(End packet)
0xFF	ESC(Escape Code)
0xF8	Transmission Approval
0xF0	Transmission Request

For adopting special codes, Table 5.1.2-3 illustrates how to handle the cases where the same value as a special code appears in Byte/BCC:

Table 5.1.2-3. How to handle the cases where a special code appears

Packet Constructor	Processing
Byte0 (command code)	It is prohibited to assign a value that falls under special code.(Use a value under 0xF0)
Byten / BCC	If a value falls under special code, ESC will be prefaced. (Insert 0xFF immediately before such byte)

5.2. Packet Type

Two types of packets described in Table 5.2-1 are defined:

Table 5.2-1. Packet Type

Type	Definition
Command packet	Packet sent from handset to external device. Used to require external device for some processing.
Notification packet	Packet sent from external device to handset. Used to notice handset of the state of external device.

Packets are identified by their command codes (the part of Byte0).

Although command code ranges are assigned as written in Table 5.2-2, since the lowest bit for command code is toggle bit, two types of values exist for the same commands.

Details about command are described in “11. Packet Format” of this document.

Table 5.2-2. Code Range

Packet type	Code range
command packet	0x02-0x7F
Notification packet	0x80-0xEF

5.3. Toggle Bit

When handset is late sending back an ACK code responding to a retry transmission from external device, and the external device sends next command, the external device may misrecognize this behind time ACK code for the ACK code for the next command . Also, when ACK is garbled, resent command may be processed inappropriately. To prevent these kinds of problems, a toggle bit shall be established for the command of packet.

Written below are rules on the toggle bit:

- LSB is set for toggle bit both for command code and ACK code.
- Not retry but every time a new packet is sent, copy it to the toggle bit to sync command and ACK code.
- When the toggle bit receives an illegal packet, it will send back ACK code but the packet will be deleted and the requested processing will not be performed.
- Illegal ACK codes received by the toggle bit will be deleted.

Table 5.3-1 illustrates the processing to initialize the toggle bit

Table 5.3-1. Toggle bit initialization proceeding

	Toggle bit initialization proceeding on the handset part	Toggle bit initialization proceeding on the external device part
When handset sends acommand packet	The toggle bit of the command the handset issues after receiving a reset notification packet from an external device is 1.	The external device sets the toggle bit to 0 when power is turned on or hardware is reset, and sets it to the toggle bit of the reset notification packet. The toggle bit of the notification packet to be issued next is 1. Thereafter, to be toggled every time a new notification is issued.
When external device sends an notification packet	The handset judges the toggle bit of the packet the handset receives after receiving a reset notification packet is normal if the value is 1.	The external device judges the toggle bit of the next command to come after power is turned on or hardware is reset if the value is 1.

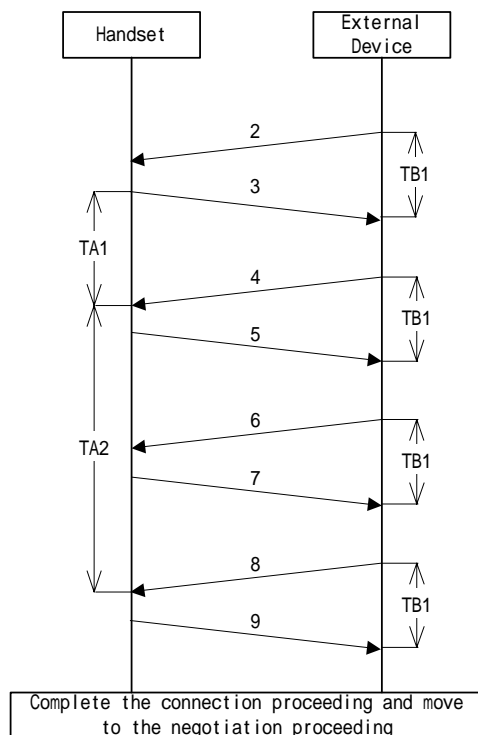
6. External Device Connection Proceeding

6.1. External Device Detection Proceeding

Written below is the connection proceeding of after the external device connector is inserted to the handset connector:

Proceeding	Device	Explanation
1	handset	Detect that an external device gets connected when the external device detection terminal changes from Hi to Lo, and supply the external device with power.(*)
2	external device	When supplied with power, the external device is turned on/reset, and the sends a transmission request code.
3	handset	Send a transmission approval code after receiving the transmission request code.
4	external device	Send a reset notification packet after receiving the transmission approval code.
5	handset	Send an ACK code after receiving the reset notification packet.
6	external device	Send a transmission request code after receiving the ACK code.
7	handset	Send a transmission approval code after receiving the transmission request code.
8	external device	Send a class reset notification packet after receiving the transmission approval code.
9	handset	Send an ACK code after receiving the class reset notification packet.
		Complete the connection proceeding with the proceeding above and move the negotiation proceeding.

(*) When handset is being activated or shutdown by turning on/off the power, power supply to the external device will be stopped.



6.2. Negotiation Proceeding

When the handset detects that an external device is connected, negotiation will be performed by the following proceeding.

Up to three repetitions by re-supplying with power due to external device problem during negotiation is allowed. If another problem occurs after that, the power supply will be stopped.

Proceeding	Device	Proceeding
10	handset	Send a transmission request code.
11	external device	Send a transmission approval code after receiving the transmission request code.
12	handset	Send a setting commands packet(Communications speed change request command, Character area scroll setting command, Bit map data registration command, etc.) after receiving the transmission approval code.
13	external device	Send ACK codes after receiving the setting commands packet.
14	handset	Send a behavior control command packet (negotiation complete notification) after receiving all the ACK codes for the setting commands packet.
15	external device	Send a ACK code after receiving the behavior control command packet. (negotiation complete notification)
		Hereafter, normal communications (*5)

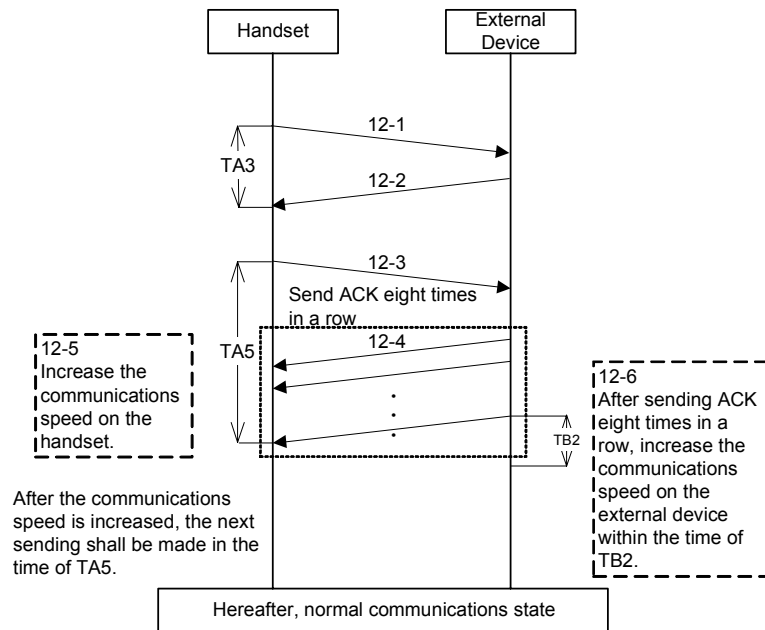
(*5) Go to a standby state when communications is not conducted. The handset outputs Pin 9 with Hi-Z, and the external device outputs Pin 8 with Hi-Z.

6.2.1. Communications Speed-up Proceeding

The handset determines whether or not to increase communications speed based on information about class reset notification packet defined per external device. The communications speed between external device and handset shall be increased with the following proceeding. The communications speed can be increased only during negotiation.

Proceeding.	Device	Proceeding
12-1	handset	Send a transmission request code.
12-2	external device	Send a transmission approval code after receiving the transmission request code.
12-3	handset	Send a communications speed up request command packet after receiving the transmission approval code.
12-4	external device	Change to the communications speed specified by the handset after receiving the communications speed up request command and sending the same ACK code eight times in a row. ^(*) (12-6)
12-5	handset	Change to the specified communications speed if the handset normally receives the AKC code once or more. ^(*)
		Hereafter, the communications speed increases ^(*)

- ^(*) If the external device doesn't support the communications speed requested by the handset, the communications speed up request from the handset shall be ignored and ACK code shall not be sent.
- ^(*) To shorten the recovery time, eight ACK codes shall be sent, and if any of which is received, the communications speed shall be increased. If none of the ACK codes are normally received, the same sequence as the reset of external device shall start by Keep Alive/Time Out.
- ^(*) After the communications speed is increased, the handset shall regularly send a behavior control command (Keep Alive).



6.3. Connection of unsupported external device

The handset shall identify those that fall under Case (1),(2) or (3) as unsupported external devices.

The handset shall perform the following behaviors according to” Whether the first packet (reset notification) is sent” and “Content of reset notification packet and class reset packet” sent from external device:

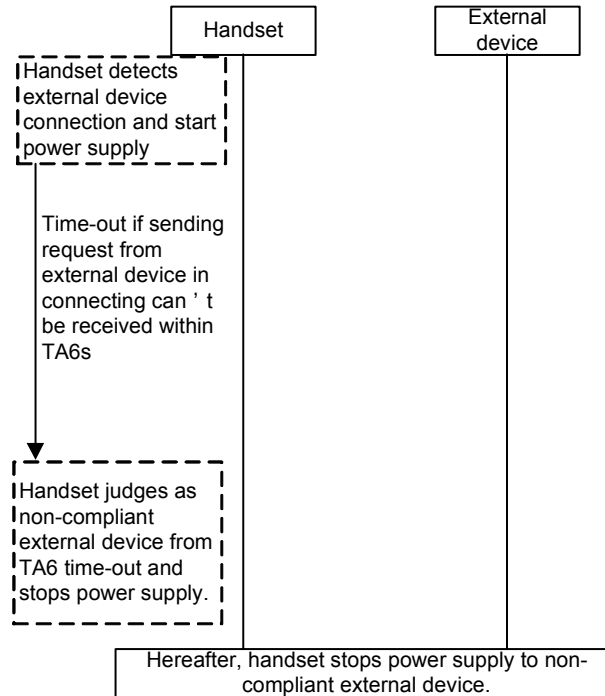
When falling under Case (1):

Since the handset can't receive the first packet (reset notification) sent from the external device, it shall identify that the external device is not compliant with serial communications. In such case, the handset shall stop the power supply to the external device and identify the external device just as an earphone microphone (normal earphone, stereo earphone, microphone functions only) pursuant to [10Pin-EAR].

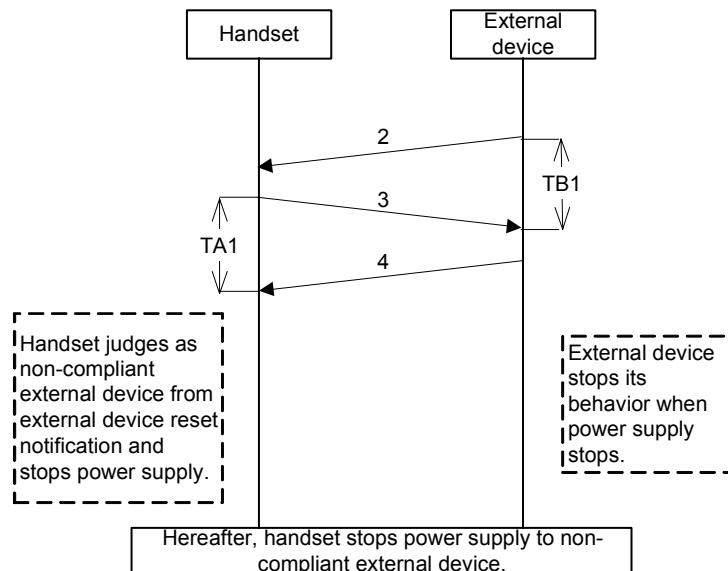
When falling under Case (2):

The handset identifies by the first packet (reset notification) sent from the external device whether the external device is compliant with serial communications. If it is identified by the content of the reset notification, class reset notification, etc. that the external device is unacceptable by the handset, the power supply shall be stopped and it can't be used even as an earphone microphone. For details about earphone microphone, refer to [10Pin-EAR].

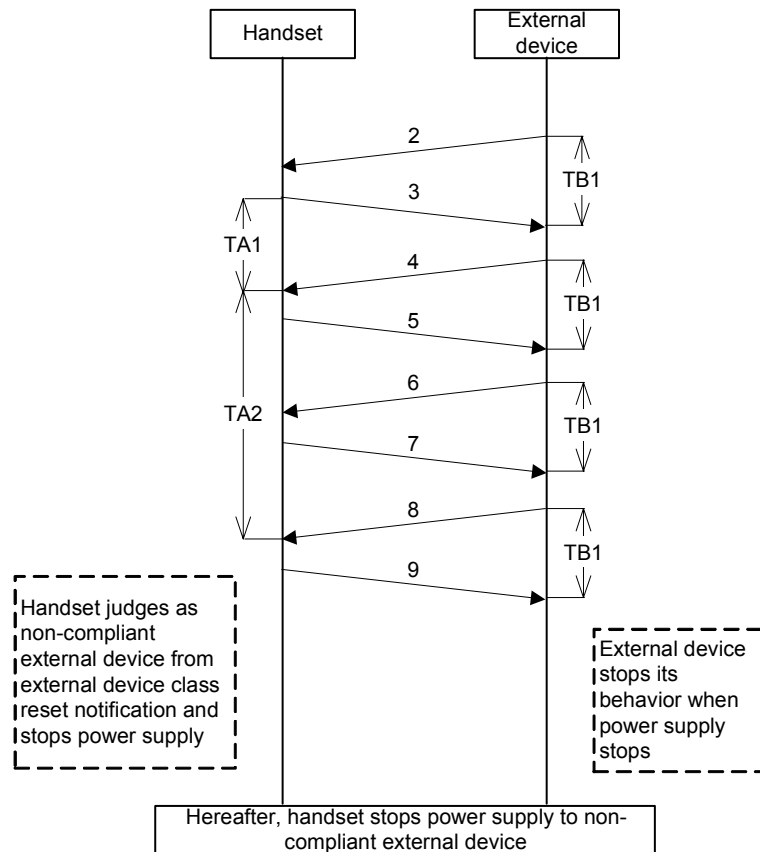
Case (1): Where external device doesn't support serial communications



Case (2): Where judged as non-compliant external device by reset notification packet



Case (3): Where judged as non-compliant external device by class reset notification packet

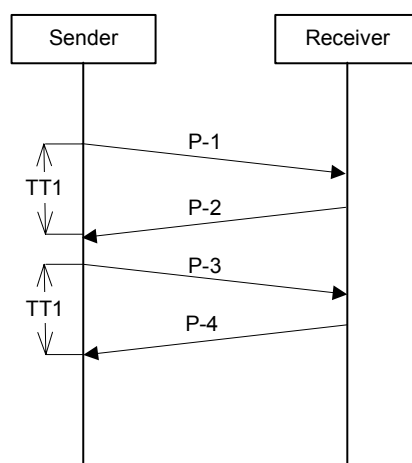


6.4. Normal Communications Proceeding

6.4.1. Packet Transmission

Proceeding.	Device	Proceeding
P-1	Sender	Send a transmission request code.
P-2	Receiver	Send a transmission approval code after receiving the transmission request code.
P-3	Sender	Send the packet after receiving the transmission approval code.
P-4	Receiver	Send an ACK code after receiving the packet. (⁹)
		If continuing to send packets, repeat Proceeding P-1 - P-4

(⁹) Should the notification content be illegal, ACK will be sent back if the BCC of the notification packet is normal.



6.4.2. Keep Alive

Handset sends Keep Alive in behavior control command packet to maintain a normal communications state between handset and external device. Keep Alive shall be effective even if it is sent in other packet than behavior control command packet.

However, if TA7 passes after the last communications in packet, the handset judges that Keep Alive is time out and shall power on/reset the external device.

6.5. Processing transfer confliction

If handset and external device send a transfer request code at the same or almost the same time, they may conflict. Table 6.5-1 illustrates the recovery processing for such case.

When transfer confliction occurs, transfer from external device shall be processed first.

Table 6.5-1. Recovery processing for transfer confliction

Device	Recovery Processing
handset	- In case where the handset receives a transfer request code when waiting for a transfer approval code after sending a transfer request code. -> Send a transfer approval code and give priority to the processing of the notification packet sent from external device. Then, send a transfer request code again after returning an ACK code and send the command packet on hold.
external device	-In case where the handset receives a transfer request code when waiting for a transfer approval code after sending a transfer request code. -> Destroy the received transfer request code. Then send a notification packet after receiving a transfer approval code.

6.6. Communications Error Detection and Recovery Processing

6.6.1. Recovery Proceeding for Packet Communications

Written below is the recovery processing when sending a packet.

Synchronize packet and ACK code by the toggle bit.

Device	Recovery Processing
Sender	<ul style="list-style-type: none"> - In case where the sender can't receive a transfer approval code within TT1 after sending a transfer request code. -> Send a transfer request again (Refer to Figure 6.6.1-1) - In case where the sender can't receive an ACK code within TT1 after completing a packet sending. -> Start packet retry. In this case, the retry starts from the second transfer request code. (Refer to Figure 6.6.1-2)
Receiver	<ul style="list-style-type: none"> - If the receiver can't identify the transfer request code or the BCC of the received notification packet is abnormal, the sender shall destroy the packet and shall not respond. - Not being able to receive a packer within TR1 after sending a transfer approval code, the receiver transits to a standby state.

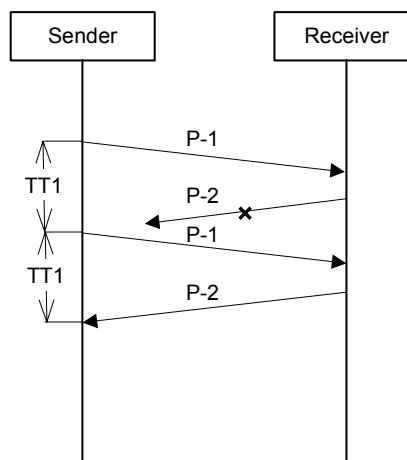


Figure 6.6.1-1. In case where transfer request code is time out

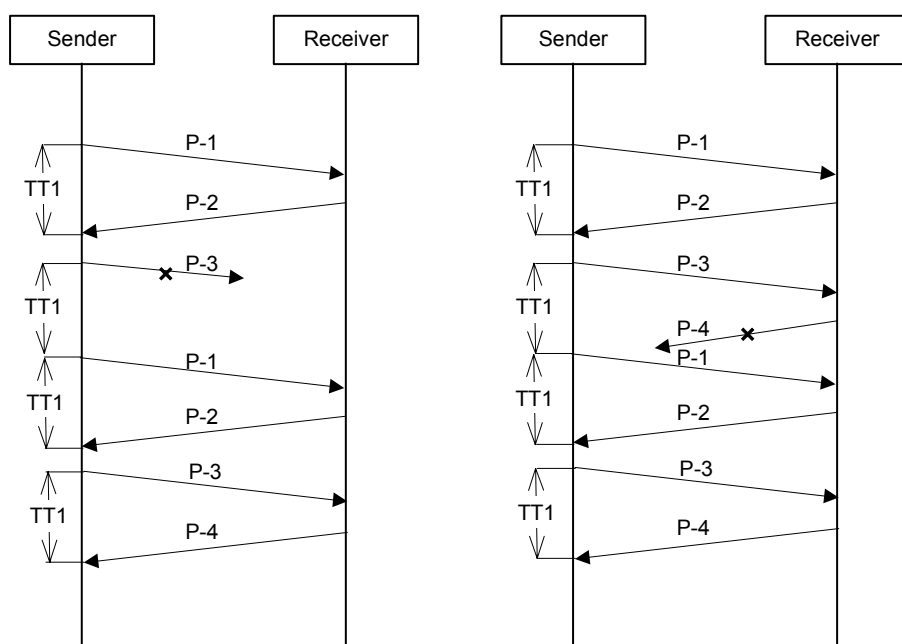


Figure 6.6.1-2. In case where notification packer is time out

6.7. Retry Out Processing

If the handset can't receive a returned ACK even after sending 10 times by retry in a normal communication state, it will retry out and the processing described in Table 6.7-1 shall be performed.

Table 6.7-1. Processing for Retry Out

State	Processing for Retry Out
ACK is not returned from external device	Judge that the external device is abnormal, stop the power supply to the external device and then turn on the power again.

Recovery shall be made by re-supplying power from the handset as written above. In case where the handset re-supplies power, the time from turning off the external device to re-supplying power shall be up to one second.

7. Processing in the connection with an external device

When connecting with an external device during communications (voice call, browsing, JAVA application download, etc.), the handset shall continue the communications without abnormal behavior (disconnecting the communications, etc.). Abnormal behavior (reset, etc.) shall not occur during application processing in the handset without communications.

External devices connected during the communications or processing at the handset as written above shall be able to behave in the same manner as connected before such processing occurred.

8. Processing in the disconnection with an external device

Since power supply to the external device stops when it is removed from the handset, detection of external device disconnection and processing by the handset thereafter are not defined in this document. However, the handset shall not behave abnormally when stopping the behavior of the external device. Comply with definitions, if any, in the specifications for the handsets to which this document applies.

9. Behavior when handset battery is low

When handset is turned off due to low battery, the behavior of external device must stop. As illustrated in Table 9-1, there are two cases according to the way of power supply to the external device. Either way, abnormal behavior shall not occur when the external device is in action or stopped when the handset battery is low or turned off.

Table 9-1. Types of power supply

Type	Behavior when handset battery is low
External device that behaves only by the power supply from handset	When the handset is turned off, power supply to the external device shall stop. Consequently, the external device shall stop to behave. However, external device shall not behave abnormally when stops.
External device that behaves by the power supply from something other than handset	Since the power is supplied to the external device from something other than handset, it doesn't matter if the power supply from handset stops. To stop such device safely, the external device itself monitors the power supply, and syncs the turning off of the handset and the halting of the external device behavior. However, external device shall not behave abnormally when stops.

10. Definitions on timer values

Table 10-1 illustrates the timer values used in this document.

Note that the timer values defined here are actual times, not timer values to be set to the internal timer of CPU. When setting values to the internal timer of CPC, values with a margin of error in the CPU clock and in the measurement of the internal timer, etc. in mind shall be set.

Table 10-1. Timer Value

Mar k	Defined range	Counter	Time
TA1	Send a transfer code from handset -> Receive a reset notification packet from external device	handset	50
TA2	Receive a reset notification packet from external device -> Receive a class reset notification packet from external device		1,000
TA3	Send a transfer request code from handset -> Receive a transfer approval code from external device		50
TA4	Send a behavior control command from handset -> Receive an ACK from external device		50
TA5	Send a communications speed up request from handset -> Receive a ACK from external device		50
TA6	Start power supply to external device -> Receive a transfer request code from external device		500
TA7	Keep Alive time-out period		2,000
TB1	Send a special code (ACK) notification packet from external device -> Receive a reply from handset	external device	50
TB2	Complete a sending of continuous ACK when increasing the communications speed -> Completeing increasing the communications speed at the external device side		20
TT1	Send a special code (ACK) packet from sender -> Receive a reply from receiver	Sender	50
TR 1	Send a special code (ACK) packet from receiver -> Receive a reply from receiver		50

[in ms]

(ACK) ACK is excluded

11. Packet Format

Only commands that are used commonly regardless of external device between external device and handset connected via 10-pin connector are defined in this document. For information on commands other than these, refer to the specifications of the external device since they are defined separately according to the type of external device.

11.1. Command Packet Format

Table 11.1-1 illustrates a list of command packets defined in this document:

Table 11.1-1. Command Packet List

Byte0	Toggle bit	Meaning of Command Packet
0x02	0	Behavior Control
0x03	1	
0x04	0	Communications Speed-up Request
0x05	1	

11.1.1. Behavior Control Command

- This command controls the behaviors for keep alive and negotiation completion

Byte	Bit	Specification
Byte0	Bit7-1	0000 001
	Bit0	Toggle bit
Byte1	Bit7-0	0x00 : Keep Alive 0x01 : Negotiation Completion 0x02-0xFF : Reserved
Byte2	Bit7-0	BCC

11.1.2. Communications Speed-up Request Command

- This command shall be effective only during negotiation between handset and external device.
- handset designate a communications speed it wants to set in Byte1 based on information of compliant communications speed acquired from external device in negotiation.
- When the baud rate the handset requests is not supported by the external device or multiple bit are set, the external device shall ignore this command.

Byte	Bit	Specification
Byte0	Bit7-1	0000 010
	Bit0	Toggle bit
Byte1	Bit7-0	Communications Speed Bit7 : 0 (Fixed) Bit6 : 460,800 bps Bit5 : 230,400 bps Bit4 : 115,200 bps Bit3 : 57,600 bps Bit2 : 38,400 bps Bit1 : 19,200 bps Bit0 : 9,600 bps (Set the bit of a baud rate it wants to set (= "1") and clear (= "0") the other bit)
Byte2	Bit7-0	BCC

11.2. Notification Packet Format

Table 11.2-1 illustrates a list of notification packets defined in this document:

Table 11.2-1. Notification Packet List

Byte0	Toggle bit	Meaning of notification packet
0x80	0	Reset notification
0x81	1	
0x82	0	Class reset notification
0x83	1	

11.2.1. Reset Notification

- When reset occurs, the external device notifies the handset that reset occurred to the external device, with this command.
- When receiving a reset notification, the handset shall perform appropriate recovery processing.
- Since the content the external device notices to the handset by reset notification packet differs according to the external device, it shall be defined in the specifications of each external device.

11.2.2. Class Reset Notification

- When reset occurs, the external device notifies the handset of the performance class of external device such as communications speed, with this command.
- After receiving this command, the handset performs communications according to the notification content.
- Since the content the external device notices to the handset by class reset notification packet differs according to the external device, it shall be defined in the specifications of each external device.

Appendix A.

Revision History

Revision History

Version	Date	Comments
1.0.0	2003/05/26	First edition
1.1.0	2003/10/15	Version changed due to addition of external device