

ANSI/CEA Standard

USB Carkit Specification

ANSI/CEA-936-A

February 2006



CEA[®]
Consumer Electronics Association
www.CE.org

NOTICE

Consumer Electronics Association (CEA[®]) Standards, Bulletins and other technical publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards, Bulletins and other technical publications shall not in any respect preclude any member or nonmember of CEA from manufacturing or selling products not conforming to such Standards, Bulletins or other technical publications, nor shall the existence of such Standards, Bulletins and other technical publications preclude their voluntary use by those other than CEA members, whether the standard is to be used either domestically or internationally.

Standards, Bulletins and other technical publications are adopted by CEA in accordance with the American National Standards Institute (ANSI) patent policy. By such action, CEA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Standard, Bulletin or other technical publication.

This CEA Standard is considered to have International Standardization implication, but the International Electrotechnical Commission activity has not progressed to the point where a valid comparison between the CEA Standard and the IEC document can be made.

This Standard does not purport to address all safety problems associated with its use or all applicable regulatory requirements. It is the responsibility of the user of this Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

(Formulated under the cognizance of the CEA's **R6 Mobile Electronics Committee**.)

Published by

©CONSUMER ELECTRONICS ASSOCIATION 2006
Technology & Standards Department
1919 S. Eads Street
Arlington, Virginia 22202

**PRICE: Please call Information Handling Services, USA and Canada (1-800-854-7179)
International (303-397-7956), or
<http://global.ihs.com>**

All rights reserved
Printed in U.S.A.

PLEASE!

DON'T VIOLATE
THE
LAW!

This document is copyrighted by the Consumer Electronics Association (CEA[®])
and may not be reproduced without permission.

Organizations may obtain permission to reproduce a limited number of copies by
entering into a license agreement. For information contact:

Information Handling Services
15 Inverness Way East
Englewood, Colorado 80112-5704
or call U.S.A. and Canada 1-800-854-7179, International (303) 397-7956
See <http://global.ihs.com> or email global@ihs.com

Foreword

This standard was developed under the auspices of the Consumer Electronics Association (CEA) R6 Mobile Electronics Committee.

The On-The-Go (OTG) Supplement to the Universal Serial Bus (USB) 2.0 Specification has a number of features that make OTG an attractive wired interface for cell phones, including:

- limited host capability for point to point connection between portable devices
- small connectors
- low power features

However, most cell phones have the added requirement that they need to connect to carkits through their wired interface. A carkit is an after-market device that is installed in a car. It contains a speaker and a microphone, and draws current from the car power adapter. A carkit acts as a speaker-phone attachment to a cell phone, and allows hands free operation of a cell phone. A carkit can also be built in to a car stereo system.

If a cell phone has a Mini-USB or Mini-USB Carkit Class Connector (Mini-USB-cr) receptacle, then the options for connecting the phone to a carkit include:

- transfer digital audio between the phone and the carkit using the USB interface
- add a separate connector to the phone for transferring analog audio signals to the carkit
- multiplex the analog audio signals over the mini-USB receptacle on the phone

The first option would add complexity to the carkit, since the carkit would have to include a USB host controller, frequency reference, audio codecs, memory, software driver, etc.

The second option would add additional complexity and size to the phone. Most phones have only one data connector right now, so adding a second data connector is not an attractive option.

The third option provides the least complex solution for both the phone and the carkit. The phone can use a single connector for both digital data and analog audio, thus minimizing both size and complexity. The carkit can implement analog audio signaling, without including codecs or a USB controller.

CEA-936-A supersedes CEA-936.

Contents

1 Scope	1
2 References	1
2.1 Normative References	1
2.1.1 Normative Reference List	1
2.1.2 Normative Reference Acquisition	1
2.2 Informative References	1
3 Acronyms	2
4 Implementation Options	3
4.1 Carkit Implementation	3
4.2 Car Stereo Implementation	4
4.3 Enabled Features	4
5 System Overview	6
5.1 Interface Architecture	6
5.2 Signaling Modes	6
5.3 Carkit Amplifier	7
5.4 Basic Operation	7
5.5 Four-Wire versus Five-Wire	7
6 Electrical Interface	8
6.1 Introduction	8
6.2 Microphone Voltages	8
6.3 Microphone Impedances	8
6.4 Speaker Voltages	8
6.5 Speaker Impedances	8
6.6 Carkit Speaker Gain	8
6.7 Audio Crosstalk	9
6.7.1 Phone Crosstalk	9
6.7.2 Carkit Crosstalk	9
6.8 Serial Signaling Levels	10
6.9 Accessory Interface	10
6.10 Charger Types	11
6.11 Remote Device Types	12
6.11.1 Phone Powered Accessory	13
6.11.2 Charger	13
6.11.3 Carkit	13
6.11.4 PC	13
6.11.5 Hubs	13
6.11.6 OTG Device	13
6.12 Programmable Current	14
6.13 Shield as Ground Sense Line	14
6.14 Speaker Clicks and Pops	14
6.15 Ground Impedances	14
6.16 Short Circuit Withstand	15
7 Four-Wire Protocol	15
7.1 Introduction	15
7.2 Connection Sequence	15
7.2.1 Normal Sequence	16

7.2.2 Carkit vs Charger vs PC Detection	16
7.2.3 UART State	17
7.2.4 USB Connection Sequence	18
7.2.5 Enabling UART Traffic.....	19
7.3 State Transition Mechanisms.....	19
7.3.1 Phone Audio to UART	19
7.3.2 Carkit UART Interrupt – UART Traffic Not Enabled.....	19
7.3.3 Carkit UART Interrupt – UART Traffic Enabled.....	20
7.3.4 Carkit Mono to UART – No Data-During-Audio.....	20
7.3.5 Carkit Mono to UART – With Data-During-Audio.....	20
7.3.6 Carkit Stereo to UART – No Data-During-Audio	20
7.3.7 Carkit Stereo to Mono – With Data-During-Audio	20
7.4 Phone Mono to UART.....	21
7.4.1 Entering Mono Mode	21
7.4.2 Exiting Mono Mode.....	21
7.5 Phone Stereo to UART	22
7.5.1 Entering Stereo Mode.....	22
7.5.2 Exiting Stereo Mode	23
7.6 Carkit Mono to UART.....	23
7.6.1 Entering Mono Mode	23
7.6.2 Carkit Interrupt.....	23
7.6.3 Phone Acknowledge.....	23
7.7 Carkit Stereo to UART	24
7.7.1 Entering Stereo Mode.....	24
7.7.2 Carkit Interrupt.....	24
7.7.3 Phone Acknowledge.....	25
7.8 Phone Detach During Audio.....	25
7.9 Carkit Detach During Audio.....	26
7.10 Phone State Machine.....	27
7.10.1 Transition Events.....	27
7.10.1.1 sess_vld/	27
7.10.1.2 dp_disc_det	27
7.10.1.3 disc_req	27
7.10.1.4 sess_vld	28
7.10.1.5 usb_req	28
7.10.1.6 dm_hi_2_lo	28
7.10.1.7 ph_aud_req.....	28
7.10.1.8 cr_int_det.....	28
7.10.1.9 ph_uart_req	28
7.10.2 ph_disc	28
7.10.3 ph_usb	29
7.10.4 ph_init	29
7.10.5 ph_uart.....	29
7.10.6 ph_aud	29
7.11 Carkit State Machine	30
7.11.1 Transition Events.....	30
7.11.1.1 dm_lo_disc	30
7.11.1.2 dp_lgc_hi	30
7.11.1.3 ph_aud_det.....	30
7.11.1.4 ph_uart_det.....	31
7.11.1.5 cr_int_req.....	31
7.11.1.6 get_sts_cmd	31
7.11.2 cr_disc	31
7.11.3 cr_uart.....	31
7.11.4 cr_aud	31
7.11.5 cr_wait.....	32

7.12 Interrupt Pulses	32
7.12.1 Phone Interrupt Pulse	32
7.12.2 Carkit Interrupt Pulse	33
7.13 Data-During-Audio.....	34
7.13.1 Phone to Carkit	35
7.13.2 Carkit to Phone	36
8 Five-Wire Protocol	37
8.1 Introduction.....	37
8.2 Connection Sequence.....	37
8.3 Phone UART to Audio Mode.....	38
8.3.1 Entering Mono Mode	39
8.3.2 Entering Stereo Mode.....	39
8.4 Phone Mono Interrupt	40
8.4.1 Phone Interrupt	40
8.4.2 Accessory Acknowledge	40
8.4.3 UART Mode.....	41
8.5 Phone Stereo Interrupt.....	41
8.5.1 Phone Interrupt	41
8.5.2 Accessory Acknowledge	41
8.5.3 UART Mode.....	42
8.6 Accessory Mono Interrupt.....	42
8.6.1 Accessory Interrupt	42
8.6.2 Phone Acknowledge.....	42
8.7 Accessory Stereo Interrupt	43
8.7.1 Accessory Interrupt	43
8.7.2 Phone Acknowledge.....	43
8.8 Interrupt Collision.....	44
8.8.1 Phone Interrupt	44
8.8.2 Accessory Interrupt / Acknowledge.....	44
8.8.3 UART Mode.....	45
8.9 Phone State Machine.....	45
8.9.1 Transition Events.....	45
8.9.2 ph_uart.....	46
8.9.3 ph_aud	46
8.9.4 ph_mute_a.....	47
8.9.5 ph_mute_p.....	47
8.9.6 ph_int	47
8.9.7 ph_ack.....	47
8.9.8 ph_wfa.....	47
8.9.9 ph_bias	47
8.10 Accessory State Machine	48
8.10.1 Transition Events.....	48
8.10.2 acc_uart	49
8.10.3 acc_aud.....	49
8.10.4 acc_mute_p	50
8.10.5 acc_mute_a	50
8.10.6 acc_int.....	50
8.10.7 acc_ack.....	50
8.10.8 acc_wfa.....	50
8.10.9 acc_bias.....	50
8.10.10 acc_col_det	50
9 Parameter Values	52
10 UART Protocol.....	57

10.1 Introduction.....	57
10.2 Command Support Requirements	57
10.3 Protocol Structure	57
10.4 Carkit Response Packets.....	59
10.5 Special Characters	59
10.6 UART Timeouts.....	59
10.7 Checksum.....	60
10.8 Bit and Byte Ordering	60
10.9 UART Format.....	60
10.10 Command Types.....	61
10.11 GET_DEVICE.....	61
10.12 GET_FEATURES.....	62
10.13 GET_STATUS.....	64
10.14 SET_CONFIG.....	65
10.14.1 Interrupt Enable Low Bits	66
10.14.2 Interrupt Enable High Bits	66
10.14.3 loc_req_msk.....	66
10.14.4 voice_act_msk	66
10.14.5 stereo_en.....	67
10.14.6 dat_aud_en.....	67
10.14.7 display_led_en	67
10.14.8 at_cmd_en	67
10.15 GET_CONFIG	67
10.16 SET_DISPLAY	68
10.17 SET_LOCATION.....	68
10.18 GET_CRNT	69
10.19 SET_CRNT.....	69
10.20 SET_VLTG	70
10.21 SET_UART.....	71
10.22 GET_CR_PKT_MAX.....	72
10.23 SET_PH_PKT_MAX.....	72
10.24 SEND_AT.....	73
10.25 CR_INT_REQ.....	73
10.26 GET_CMD_SETS.....	74
10.27 SET_CMD_SET.....	74
11 Cables and Connectors.....	76
11.1 Introduction.....	76
11.2 Definition of Terms.....	76
11.3 Connector Dimensions	76
11.4 Backward Compatibility.....	81
11.4.1 Receptacles	81
11.4.2 Plugs	81
11.5 Blind Mate Ability.....	81
11.6 Lead Free Standards	81
11.7 Mated Pair Drop	81
11.8 Mate and Unmate Forces	82
11.8.1 Mate Force – Detent Cycling.....	82
11.8.2 Unmate Force – Detent Cycling.....	82
11.8.3 Unmate Force – Latched Cycling.....	82
11.9 Perpendicular Force Tests	83
11.10 Rotary Pull Test	84
11.11 Current Rating.....	84
11.12 Carkit Class Cables	86

Figures

Figure 4-1	Carkit Implementation	3
Figure 4-2	Car Stereo Implementation	4
Figure 5-1	Interface Architecture.....	6
Figure 6-1	Accessory Interface.....	10
Figure 7-1	Carkit Connection Sequence.....	16
Figure 7-2	Delayed Carkit Connection Sequence	17
Figure 7-3	USB Connection Sequence	18
Figure 7-4	Phone Mono to UART	21
Figure 7-5	Phone Stereo to UART	22
Figure 7-6	Carkit Mono Interrupt	23
Figure 7-7	Carkit Stereo Interrupt.....	24
Figure 7-8	Phone Detach During Audio	25
Figure 7-9	Carkit Detach During Audio	26
Figure 7-10	Phone State Machine.....	27
Figure 7-11	Carkit State Machine	30
Figure 7-12	Phone Interrupt Pulse	33
Figure 7-13	Carkit Interrupt Pulse	34
Figure 7-14	Phone to Carkit Audio Data	35
Figure 7-15	Carkit to Phone Audio Data	36
Figure 8-1	Transition to Audio Mode, Mono.....	38
Figure 8-2	Transition to Audio Mode, Stereo	38
Figure 8-3	Phone Mono Interrupt	40
Figure 8-4	Phone Stereo Interrupt.....	41
Figure 8-5	Accessory Mono Interrupt	42
Figure 8-6	Accessory Stereo Interrupt.....	43
Figure 8-7	Interrupt Collision	44
Figure 8-8	Phone State Machine.....	45
Figure 8-9	Accessory State Machine	48
Figure 10-1	UART Packet Format.....	58
Figure 11-1	Mini-USB-cr Receptacle	77
Figure 11-2	Mini-USB-cr Plugs	78
Figure 11-3	Mini-USB-cr Mating.....	79
Figure 11-4	Mini-USB-cr Receptacle, Mounting Options	80
Figure 11-5	Perpendicular Force Test.....	83
Figure 11-6	Current Capacity	85

Tables

Table 6-1 Current Limit Indication Using the ID Resistor	12
Table 9-1 Voltage Parameters	52
Table 9-2 Five-Wire Voltage Parameters.....	53
Table 9-3 Current Parameters	53
Table 9-4 Impedance Parameters	54
Table 9-5 Time Parameters.....	55
Table 9-6 Audio Parameters.....	56
Table 10-1 Special Characters	59
Table 10-2 Command Types	61
Table 10-3 GET_DEVICE Command	61
Table 10-4 GET_FEATURES Command	62
Table 10-5 GET_FEATURES Parameters	63
Table 10-6 GET_STATUS Command	64
Table 10-7 GET_STATUS Parameters	64
Table 10-8 SET_CONFIG Command.....	65
Table 10-9 SET_CONFIG Parameters.....	66
Table 10-10 GET_CONFIG Command	67
Table 10-11 SET_DISPLAY Command	68
Table 10-12 SET_LOCATION Command.....	68
Table 10-13 GET_CRNT Command	69
Table 10-14 GET_CRNT Parameters	69
Table 10-15 SET_CRNT Command.....	69
Table 10-16 SET_CRNT Parameters.....	70
Table 10-17 SET_VLTG Command	70
Table 10-18 SET_VLTG Parameters	70
Table 10-19 SET_UART Command.....	71
Table 10-20 SET_UART Parameters.....	71
Table 10-21 GET_CR_PKT_MAX Command	72
Table 10-22 SET_PH_PKT_MAX Command.....	72
Table 10-23 SEND_AT Command	73
Table 10-24 CR_INT_REQ Command	73
Table 10-25 GET_CMD_SETS Command.....	74
Table 10-26 SET_CMD_SET Command.....	74

USB CarKit Specification

1 Scope

CEA-936-A defines a standard method for routing audio and Universal Asynchronous Receiver Transmitter (UART) signals through a USB receptacle on a phone to a USB analog carkit and to other accessories such as chargers and RS232 devices.

This specification is intended for developers of On-The-Go (OTG) transceivers, cell phones, carkits, and car stereos.

2 References

2.1 Normative References

The following references contain provisions that, through reference in this text, constitute normative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Section 2.1.1 .

2.1.1 Normative Reference List

- On-The-Go Supplement Revision 1.0a, USB Developers Forum, www.usb.org/developers/docs.html
- Mini-B Connector Engineering Change Notice, USB Developers Forum, www.usb.org/developers/docs.html
- Dallas Semiconductor Application Note 27, Maxim Integrated Circuits, www.maxim-ic.com/appnotes.cfm/appnote_number/542
- CEA-2011, OTG Transceiver Specification, Global Engineering Documents, <http://global.ihs.com>
- UTMI+ Low Pin Interface (ULPI) Specification, Rev 1.1, www.ulpi.org

2.1.2 Normative Reference Acquisition

CEA Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email global@ihs.com

2.2 Informative References

- USB 2.0 Specification, USB Developers Forum, www.usb.org/developers/docs.html