Research & Vehicle Technology
"Infotainment Systems Product Development"

Feature – Wireless Accessory Charging

Wireless Accessory Charging Module (WACM) Infotainment Subsystem Part Specific Specification (SPSS)

Version 1.3
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Revision History

Date	Version	Notes	
October 8, 2015	1.0	**Initial Release**	
March 10, 2016	1.1	**Updated Release**	
		IIR-REQ-163263/B-Wireless Charging interface signals	<Jmyslin2 / David Gonzalez> Updated to add signal from the BCM to inhibit Wireless Charging
		WCG-SR-REQ-207775/A-PEPS Charging Interruption	<jmyslin2 / David Gonzalez> new requirement with details of the network based PEPS charging interruption system strategy
December 1, 2016	1.2	**Updated Release**	
		WCG-SR-REQ-162836/D-Detecting AM Band as the Active Source and detecting the Active Frequency	<jmyslin2> Clarified / update requirement on the exit conditions
April 3, 2018	1.3	**Updated Release**	<bgrifka> Updated frequency in AM Avoidance section

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1 Architectural Design

1.1 CLD-REQ-163173/A-Wireless Charging Server

The Wireless Charging Server is responsible for carrying out the wireless charging function (ex charging the phone).

1.2 CLD-REQ-162505/A-Wireless Charging HMI Output

The Wireless Charging HMI Output is responsible for providing the wireless charging HMI.

1.3 Interface Requirements

1.3.1 IIR-REQ-163263/B-Wireless Charging interface signals

1.3.1.1 MD-REQ-162530/C-Wireless Charger Status

Method	Notes	Parameters
WirelessCharging.St	Status signal broadcast by the wireless charging module	0x0 Null 0x1 Charging Not In Progress 0x2 Charging In Progress 0x3 Charging Complete 0x4 Metal Object Detected 0x5 Overheat 0x6 Misalignment 0x7 Reserved

1.3.1.2 MD-REQ-162509/C-AM Interface

Method	Notes	Parameters
«CAN» **ResourceUpdate.St()**	This method is used to inform clients/requesters what the current status is of a request. This method is application event-periodic driven. When there are no resources allocated, the audio source and priority parameters shall be set to 'Not Requested'. ResourceUpdate(Front system, Not Requested, Not requested, De-allocated)	int *RequesterSystem :* 0x0: FrontRequester 0x1: RearRequester int *RequestedAudioSource :* Indicates the respective audio source: 0x0: AM/FM Radio 0x1: Front Disc 0x2: SDARS/DAB 0x3: In Dash CD Changer 0x4: Voice Recogniser 0x5: Telematic Unit 0x6: Bluetooth Phone 0x7: Rear Disc 0x8: APIM 0x9: Front AUX Input 0xA: Navigation 0xB: Rear Aux

Method	Notes	Parameters
		0xC: Not Requested 0xD: BTAudio 0xE: USB 0xF: iPod int *RequesterPriority :* This parameter indicates the priority associated with the respective audio source. 0x0: Emergency Service 0x1: Telephony Service 0x2: Auto Answer 0x3: TA 0x4: PTT Mute & Voice 0x5: Nav. User Voice Cmd 0x6: Nav. System Voice Cmd 0x7: Radio 0x8: Disc 0x9: Alarm 0xA: PTY/NEWS 0xB: Aux_ExtSource 0xC: Mobile NAV/Tel lMute 0xD: Manual Audio Mute 0xE: Not Requested int *ResourceRequestStatus :* The status of the respective audio source: 0x0: No Resource Update 0x1: Deallocated 0x2: Allocated 0x3: Stacked 0x4: Granted 0x5: Granted (no control of audio source)
«CAN» **CurrentTUBand.St()**	Message Type: Status This signal delivers the Band of the actual selected radio station.	int *Mode* Size: 4 bit Values: 0x0 Invalid 0x1 FM1 0x2 FM2 0x3 FM AST 0x4 AM 0x5 AM AST 0x6 FM3

Method	Notes	Parameters
		0x7 DAB1 0x8 DAB2 0x9 SAT1 0xA SAT2 0xB SAT3 0xC DAB3 0xD - 0xF reserved
«CAN» **CurrentFreq.St()**	Message Type: Status This status message delivers the frequency of the currently tuned station. Formulas to apply: AM - Frequency = 153 + Offset kHz. Offset range = 0..1557 FM - Frequency = 76 + Offset*0.05 MHz. Offset range = 0..640	int *Number :* Offset from lowest possible. Depending on the currently tuned band, the offset will be in KHz or MHz. Size: 11 bits
«CAN» **RadioSeekMode2.St()**	Message Type: Status This status message tells the clients in which seek mode the radio is. The PTY Search mode may be entered automatically by the radio when the user selects PTY codes. Note: Added parameters Continuous Automatic Up and Continuous Automatic Down for SDARS functionality. If RadioSeekMode2.St is sent then the radio needs to send RadioSeekMode.St.	int *Mode:* 0x01: Seek Off 0x02: Automatic Up 0x03: Automatic Down 0x04: Manual Single Step Up 0x05: Manual Single Step Down 0x06: Continuous Manual Up 0x07: Continuous Manual Down 0x08: Scan Up 0x09: Scan Down 0x0A: PTY Seek Up 0x0B: PTY Seek Down 0x0C: Autostore 0x0D: TP Seek 0x0E: PISeek 0x0F: Continuous Automatic Up 0x10: Continuous Automatic Down

1.3.1.3   MD-REQ-162529/C-PEPS interface

Method	Notes	Parameters
WrlssAcsyChrgInhbt_B_Rq	Request signal sent by the BCM to Inhibit Wireless Charging during BCM interior Key search event	0x0 No 0x1 Yes

2   Functional Definition

2.1   WCG-FUN-REQ-162483/A-Charging the Phone

2.1.1   Use Cases

2.1.1.1   WCG-UC-REQ-162484/F-Charging a phone on the wireless charging pad

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is not on the Wireless Charging pad Charge pad is capable of charging a phone
Scenario Description	User put their phone on the wireless charging pad to charge their phone
Post-conditions	1. Charger detects an object on the charger pad 2. Charger sends a Ping to identify object 3. If the object is a compatible phone then communication protocol is established 4. Charging session starts, phone may indicate that there is a charge in progress 5. HMI indicates that there is a charge in progress (if HMI supports)
Interfaces	G-HMI
Notes	See HMI specification and screen flows if HMI is supported for this use case If no infotainment system on a vehicle then WACM module would only use Ignition Status and Delayed Accessory for power moding (ie no HMI_HMIMode_St on bus). See Power Management WACM SPSS for details. This use case pre-condition doesn't mention ignition status or delayed accessory since when infotainment system powered ON (ie HMI_HMIMode_St = ON) since when infotainment system is powered on is the only time infotainment HMI is available. The rest of the use cases with HMI in this SPSS follow the same assumption. The functional requirements in this SPSS apply for the wireless accessory charging module whether there is an infotainment system (with HMI) present or not.

2.1.2   Requirements

2.1.2.1   WCG-SR-REQ-163172/C-Wireless Charging - Charging In Progress

The Wireless Charging Server shall set WirelessCharging.St = ChargingInProgress when the Wireless Server is charging a phone.

The Wireless Charging HMI Output shall display the applicable HMI (if HMI supports) when WirelessCharging.St = ChargingInProgress.

2.2 WCG-FUN-REQ-163176/A-Charging Complete

2.2.1 Use Cases

2.2.1.1 *WCG-UC-REQ-162496/E-Phone finishes charging on charging pad*

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is charging on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is present in HMI (if HMI supports)
Scenario Description	Phone finishes charging
Post-conditions	Phone is present on charging pad and charged Wireless charging pad is no longer charging the phone. Charging HMI is updated to indicate charging is complete (if HMI supports)
Interfaces	
Notes	See HMI specification and screen flows if HMI is supported for this use case.

2.2.2 Requirements

2.2.2.1 *WCG-SR-REQ-163179/C-Wireless Charging - Charging Complete*

The Wireless Charging Server shall set WirelessCharging.St = ChargingComplete when the Wireless Server finishes charging a phone.

The Wireless Charging HMI Output shall display the applicable HMI (if HMI supports) when charging is complete when WirelessCharging.St = ChargingComplete.

2.3 WCG-FUN-REQ-162492/A-Phone Charging Interruption / Fault condition

2.3.1 Use Cases

2.3.1.1 WCG-UC-REQ-162494/C-Metal Object on charging pad with no phone present

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON There is no Phone on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is not present on the HMI
Scenario Description	User puts a metal object on the charging pad but does not put a phone on the charging pad
Post-conditions	Metal object warning is not shown on the HMI
Interfaces	
Notes	

2.3.1.2 WCG-UC-REQ-162485/D-Charging phone not successful due to Metal Object detected

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is not present on the HMI
Scenario Description	User put their phone on the wireless charging pad with Metal object(s) present on the charging pad Charger detects an object on the charging pad Charger sends a ping to identify object Charger starts power transfer with the phone Charger detects metallic objects on it
Post-conditions	Charger ends charging session Metal object warning is shown on the HMI (if HMI supports) Charging Icon is not present on the HMI
Interfaces	G-HMI
Notes	

2.3.1.3 WCG-UC-REQ-162497/E-Phone is misaligned on the charging pad

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is charging on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is present on the HMI (if HMI supports)
Scenario Description	Phone misaligned (ex. from vibration)

Post-conditions	Phone is no longer charging Charging Icon is not present on the HMI Misalignment warning is shown on the HMI (if HMI supports)
Interfaces	
Notes	Minor misalignment may reduce charging efficiency, major misalignment may end the charging session

2.3.1.4   WCG-UC-REQ-162499/C-Phone stops charging on the charging pad because of loss of efficiency

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is present on the HMI (if HMI supports)
Scenario Description	Loss of efficiency detected by coil due to z-stack height (nonmetal thick object in-between phone and Charger)
Post-conditions	Charger / phone detects efficiency drop and increases power transfer until maximum input power threshold is exceeded. Charger finishes charging session. Charging Icon is not present on the HMI.
Interfaces	
Notes	End of charging session due to efficiency happens just in case of thermal event

2.3.1.5   WCG-UC-REQ-162495/C-User removes the phone from the charging pad while charging

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is charging on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is present on the HMI (if HMI supports)
Scenario Description	User removes the phone from the wireless charging pad
Post-conditions	Phone not present on charging pad Charging Icon is not present on the HMI
Interfaces	
Notes	

2.3.1.6   WCG-UC-REQ-162498/C-Phone stops charging on the charging pad because of overheat conditions

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON Phone is charging on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is present on the HMI (if HMI supports)
Scenario Description	Phone / Sleeve or Charging Pad exceeded max operating temp.

Post-conditions	Charger or Phone detect max temp threshold Charger ends charging session Charging Icon is not present on the HMI (if HMI supports) Overheat warning is shown on the HMI (if HMI supports)
Interfaces	G-HMI
Notes	See HMI specification and screen flows if HMI is supported for this use case

2.3.2   Requirements

2.3.2.1   *WCG-SR-REQ-163174/B-Wireless Charging - Metal Object Detected*

The Wireless Charging Server shall set WirelessCharging.St = Metal Object Detected when the Wireless Server has detected a metal object.

The Wireless Charging HMI Output shall display the applicable HMI (if HMI supports) when WirelessCharging.St = Metal Object Detected.

2.3.2.2   *WCG-SR-REQ-163180/B-Wireless Charging - Overheat*

The Wireless Charging Server shall set WirelessCharging.St = Overheat when the Wireless Server has exceeded max operating temperature or phone / sleeve request end power transfer due to over temperature condition.

The Wireless Charging HMI Output shall display the applicable HMI (if HMI supports) when WirelessCharging.St = Overheat.

2.3.2.3   *WCG-SR-REQ-163182/B-Wireless Charging - Charging Not In Progress*

The Wireless Charging Server shall set WirelessCharging.St = Charging Not In Progress when the Wireless Server is not charging a phone.

The Wireless Charging HMI Output may display applicable HMI (if HMI supports) when WirelessCharging.St = Charging Not In Progress.

2.3.2.4   *WCG-SR-REQ-195367/A-Wireless Charging - Misalignment*

The Wireless Charging Server shall set WirelessCharging.St = Misalignment when the phone is misaligned.

The Wireless Charging HMI Output shall display the applicable HMI (if HMI supports) when WirelessCharging.St = Misalignment.

2.4 WCG-FUN-REQ-162482/A-AM Band Interference

2.4.1 Use Cases

2.4.1.1 *WCG-UC-REQ-162486/D-AM Band Interference from AM frequency station*

Actors	Wireless Accessory Charging Module
Pre-conditions	Infotainment system is powered ON Phone is charging on the wireless charging pad The user is NOT on AM frequency that would cause a frequency shift of the fundamental wireless charging frequency
Scenario Description	The user changes to AM frequency which could cause interference
Post-conditions	Charging pad shifts frequency to avoid interference to minimize AM noise while keeping the current power session active. No HMI indication of the reduction of charging
Interfaces	
Notes	

2.4.1.2 *WCG-UC-REQ-164304/B-AM Band Interference Scan or Seek function active*

Actors	Wireless Accessory Charging Module
Pre-conditions	Infotainment system is powered ON Phone is charging on the wireless charging pad The user is on the AM band
Scenario Description	Scan, seek or tune is initiated
Post-conditions	Charging pad reduces phone charging power to a value sufficient to eliminate AM noise and keep session active during the AM frequency change. No HMI indication of the reduction of charging
Interfaces	
Notes	

2.4.2 Requirements

2.4.2.1 *WCG-SR-REQ-162836/D-Detecting AM Band as the Active Source and detecting the Active Frequency*

In order to detect AM band as the active source the Wireless Charging module shall monitor the ResourceUpdate_St and the CurrentTUBand_St.

AM Band is the active source when ResourceUpdate_St indicates that AMFM radio is either the granted or stacked source and the CurrentTUBand_St is reporting either 0x4 AM or 0x5 AM AST is the active Band.

Entry Conditions (when AM/FM Granted or Stacked):
    ResourceUpdate_St consists of the following parameters:
    RequestedAudioSource = 0x0 AM/FM Radio
    RequestorPriority = 0x7 Radio
    ResourceRequestStatus = 0x4 Granted

OR

    ResourceUpdate_St consists of the following parameters:
    RequestedAudioSource = 0x0 AM/FM Radio
    RequestorPriority = 0x7 Radio
    ResourceRequestStatus = 0x3 Stacked

- <u>Note</u>: When AM/FM is Stacked the ResourceUpdate_St will alternate between Granted and Stacked sources. Going to the Granted source (not AM/FM) in the ResourceUpdate.St does not mean the AM/FM stacked event is no longer valid.

<u>Exit Conditions (when AM/FM no longer Granted or Stacked)</u>:
    ResourceUpdate_St consists of the following parameters:
    RequestedAudioSource = 0x0 AM/FM Radio
    RequestorPriority = 0x7 Radio
    ResourceRequestStatus = 0x01 Deallocated

OR

    The entry conditions above (AM/FM Granted or Stacked) are both no longer true for more than 5 seconds (error handling if didn't get the Deallocated).

When AM/FM is stacked or granted and AM is the active band, the Wireless Charging module shall look at the CurrentFreq_St signal to determine the active frequency.

2.4.2.2 <u>WCG-SR-REQ-164323/A-AM Scan / Seek in progress</u>

The Wireless Charging module shall monitor the RadioSeekMode2_St signal while AM is the active source to determine when the AM frequency is in the process of changing.

The Wireless Charging module shall treat the following values as an indication that the frequency is not Scanning/Seeking/Tuning:

RadioSeekMode2_St = 0x0 Invalid
RadioSeekMode2_St = 0x1 Seek Off

The Wireless Charging module shall treat the following values as an indication that the frequency is Scanning/Seeking/Tuning:

RadioSeekMode2_St = 0x2 through 0x10

2.4.2.3 <u>WCG-FUR-REQ-164300/B-Reduce phone charging power due to AM frequency or a changing frequency</u>

When the Wireless charger detects the active AM frequency as a harmonic of the fundamental wireless power transfer frequency, it shall shift the fundamental frequency to mitigate interference within that frequency band (see ECU Functional Spec for detailed requirement). When the Wireless Charger detects an AM frequency Scan / Seek, the Wireless Charger shall reduce wireless transmitted power to a value sufficient to eliminate AM interference while keeping the charge session active.

2.5   WCG-FUN-REQ-163223/A-PEPS Charging Interruption

2.5.1   Use Cases

2.5.1.1   *WCG-UC-REQ-162500/D-Phone stops charging on the charging pad when the antennas are looking for the PEPS key*

Actors	Wireless Accessory Charging Module, Display HMI, Vehicle Occupant
Pre-conditions	Infotainment system is powered ON, and/or ignition status is in Accessory or Run, and/or Delayed Accessory is ON. Phone is charging on the Wireless Charging pad Charge pad is capable of charging a phone Charging Icon is present on the HMI (if HMI supports) PEPS key antennas are NOT looking for the PEPS key
Scenario Description	PEPS antennas search for PEPS key
Post-conditions	Charging pad enables PEPS interface avoidance strategy Charging Icon is present on the HMI (if HMI supports)
Interfaces	Vehicle Interface
Notes	

2.5.2   Requirements

2.5.2.1   <u>WCG-SR-REQ-207775/A-PEPS Charging Interruption</u>

The PEPS Avoidance strategy is a method to mitigate possible interference with wireless charging and the PEPS key identification. The feature is event driven where the BCM provides both a hardwired and CAN signal to enable / disable the wireless charging based on when a PEPS query is to be performed / PEPS query is complete. The hardwire and CAN signals are OR'd together so that if either one of them is indicating a PEPS Avoidance event then the wireless charging is deactivated.

<u>Network activated PEPS Avoidance event</u>:
   When "WrlssAcsyChrgInhbt_B_Rq = 0x1 Yes" the WACM module shall initiate the PEPS avoidance charging interruption strategy regardless of the status of the PEPS Avoidance hardwire state (ex hardwire might not indicate a PEPS Avoidance event under hardwire error conditions). As long as WrlssAcsyChrgInhbt_B_Rq = 0x1 Yes" the wireless charging will be deactivated.

   While the PEPS avoidance strategy is active and wireless charging is not occurring the WACM module shall set "WirelessCharging.St = Charging Not In Progress".

<u>Exiting a PEPS Avoidance event</u>:
   When "WrlssAcsyChrgInhbt_B_Rq = 0x0 No", and there is no hardwire input to the WACM module indicating there is a PEPS avoidance event then the Wireless Charging module shall end the PEPS avoidance actions.

3   Appendix: Reference Documents

Reference #	Document Title
1	Netcom SOW and associated specifications
2	Diagnostics SOW and associated specifications
3	CAN dB
4	Start-Stop Power Supply spec or hardware spec with start-stop voltage supported
5	WACM Infotainment Diagnostic Specification
6	WACM Power Management SPSS
7	Infotainment CAN network SPSS