FORD SYNC GEN 3 HARDWARE SPECIFICATION

Version 1.15
January 31, 2023~~October 17, 2013~~
Uncontrolled Copy If Printed

The information contained in this Hardware Specification is Confidential to Ford Motor Company.

Disclosure or distribution to unauthorized persons outside Ford Motor Company is strictly prohibited.

FORD CONFIDENTAL

This Specification contains information developed and accumulated by and for FORD MOTOR COMPANY. As such, it is a confidential document which, if disseminated outside the Company would provide others with restricted information, data, or procedures not otherwise available, exposing the Company to potential harm.

Employees having custody of this specification or authorized to use it must be cognizant of its confidential nature and ensure that the information herein is not made available to unauthorized persons.

FORD MOTOR COMPANY reserves the right to protect this work as an unpublished copyrighted work in the event of an inadvertent or deliberate unauthorized publication. FORD MOTOR COMPANY also reserves its rights under copyright laws to protect this work as a published work.

This specification or portions thereof shall not be distributed outside FORD MOTOR COMPANY or its designated supply base. Refer all questions concerning disclosure to the author(s) or to the Core Multimedia Engineering Department, Ford Motor Company.

TABLE OF CONTENTS

Table of Contents 2

1 OVERVIEW 6

2 GEN 3 Hardware Architecture 6

2.1 Application Processor 6

2.2 Vehicle Microcontroller 7

2.3 Bulk Flash Storage Interface 7

2.4 Random Access Memory 7

2.5 Power Supply 7

2.6 CAN Interfaces 7

2.6.1 I-CAN 8

2.6.2 HS-CAN 8

2.7 SDARS Data Link 8

2.8 Audio Interfaces 8

2.8.1 Analog Audio I/O 8

2.8.2 Digital Audio I/O 9

2.9 Video Interfaces 9

2.9.1 Video Output Interface 9

2.9.2 Video Input Interfaces 9

2.10 Bluetooth/WiFi 9

2.11 GNSS / Positioning 10

2.12 Apple iPOD Interface 10

2.13 Diagnostics-on-board 10

3 GEN 3 Software Architecture 10

3.1 CCPU Software Re-flash 10

3.2 VMCU Software Requirements 11
4 Design Dependencies 11
4.1 Mechanical Package 11
4.2 Module Weights 12
4.3 Branding and Label 12
4.4 Material 13
4.5 Connector Pinouts 13
4.5.1 GEN 3 Module MAIN Connector J1 14
4.5.2 USB 1 Connector J2 15
4.5.3 USB 2 Connector J3 16
4.5.4 LVDS Connector J4 – Rosenberger HSD D4S10E-40MA5-C 17
4.5.5 GPS Antenna Connector J5 17
5 BEHAVIORAL REQUIREMENTS 18
5.1 Power Management 18
5.2 Watch Dog 18
5.3 CAN 18
6 Security Requirements 19
7 System Requirements 19
7.1 Power State Requirements 19
7.1.1 Power Modes 20
7.2 Certification Requirements 20
7.3 Performance Requirements 20
7.3.1 Electrical Requirements 20
8 Settings 3938
8.1 Configurable Settings 3938
8.1.1 DIAGNOSTICS AND CONFIGURATION 3938

9 Testing Requirements 4039
9.1 ENVIRONMENTAL (NON-EMC) REQUIREMENTS 4039
9.2 Additional Requirements for Transport Robustness 4140
9.3 KEY LIFE REQUIREMENTS 4140
9.3.1 GEN 3 TEMPERATURE REQUIREMENTS 4140
9.3.2 Exterior Surface Contact Temperature 4140
9.4 ELECTROMAGNETIC COMPATIBILITY CONFORMANCE (EMC) 4241
10 VALIDATION REQUIREMENTS 4342
10.1 Design Validation (DV) Requirements 4342
10.2 Production Validation (PV) Requirements 4443
10.3 In-Process (IP) Requirements 4443
10.4 Software Validation Requirements 4544
10.5 Environmental Non-EMC: 4544
10.5.1 Classifications 4544
10.5.2 Test Temperatures 4544
10.5.3 Test Voltages 4645
10.5.4 Environmental Tests 4645
10.5.5 Environmental Performance, Function and Inspection Evaluations 5150
10.5.6 Environmental Test Flow Sequence 5251
10.5.7 Environmental Test Evaluations 5352
10.5.8 Environmental Performance, Function and Inspection Evaluations 5453
10.5.9 DV/PV Functional Tests 5554
10.5.10 IP Functional Checks 5655
10.6 Revalidation Requirements 5756
11 INSTRUCTION AND NOTES 5756
11.1 Control Plans 5857

11.2 Service Goals 5857
11.3 Record Retention 5857
11.4 Failure Analysis 5958
11.5 Approval List 6059
11.6 Initial Production 6059
11.7 FMEA 6059
11.8 Supplier Submission to Ford Before PSW 6059
11.9 Packaging 6160
11.10 Test Equipment and Procedures 6160
11.11 FS Test Failure 6160
11.12 Marking of Recyclable Material 6160
12 References 6261
13 Revision History 6261

1 OVERVIEW

The SYNC Gen 3 may be referred to in this specification as Gen 3, a component, device, module, product or DUT (device under test).

This specification is intended to provide a listing of hardware requirements for a global hardware replacement for the SYNC Gen 2 design. All variations from the Gen 3 Hardware Specification due to local market requirements shall be approved by the Ford Motor Company Core Multimedia D&R prior to the sourced lead program's FDJ milestone. Local market requirements shall be found in the sourced Product Direction Letter(s) (PDL).

2 GEN 3 HARDWARE ARCHITECTURE

The GEN 3 hardware shall be designed to meet the diagrams provided in this specification. The requirements of each functional block will be described in this specification. Variations or proposed changes to the hardware architecture shall be approved by Ford Motor Company before final implementation. Specific interfaces not described in this document may be proposed by the supplier and approved by Ford Motor Company.

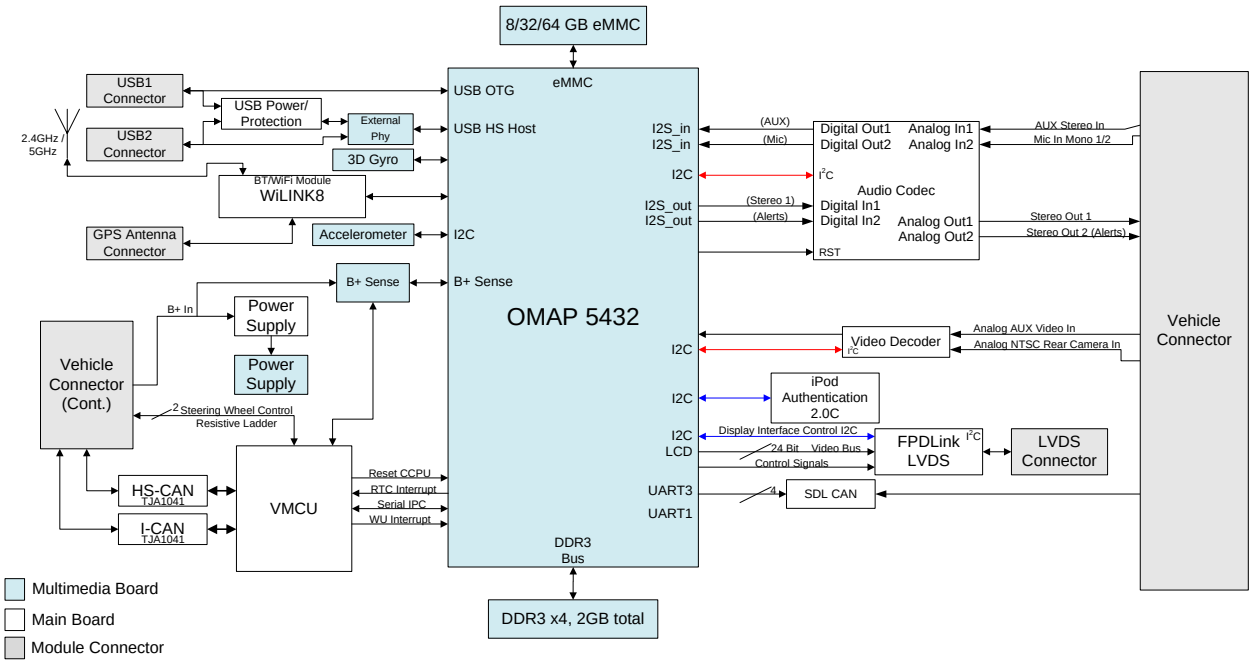


Figure 2-1: GEN 3 Hardware Architecture Diagram

2.1 APPLICATION PROCESSOR

The Application Processor, also referred to as the Consumer CPU (CCPU), for the module shall be the Texas Instruments automotive OMAP 5432 (OMAP 5). The CCPU shall host the consumer operating system, QNX 6.5 SP1. The CCPU shall be responsible for all infotainment related processing; i.e. audio, video, speech, etc. The CCPU shall interface to the VMCU (Vehicle MCU) via an Inter-processor Communication (IPC) strategy which shall allow the CCPU to communicate on the vehicles' CAN networks.

2.2 VEHICLE MICROCONTROLLER

The Vehicle Microcontroller (VMCU) shall serve as a hardware firewall to the vehicle networks preventing any unapproved CAN traffic from going onto the vehicle CAN buses and vice versa. The VMCU shall also have the ability to remove power and reset the CCPU if necessary. The VMCU shall also connect to a resistive ladder for the vehicle's steering wheel control switch. The VMCU shall be the power master of the GEN 3, including the responsibility for enabling and disabling power rails as necessary to facilitate power mode state changes.

2.3 BULK FLASH STORAGE INTERFACE

The CCPU shall implement an interface to external Flash memory storage. The Flash interface shall be eMMC v4.5 (or better) compatible interface. The bulk Flash storage shall store the operating system and applications including the Automatic Speech Recognition (ASR) engine and Text-to-Speech (TTS) engine, as well as the currently resident voice/TTS acoustic model, media player, navigation map data, voice application data, etc.

The GEN 3 shall be designed to support varying storage capacities including 8GB, 32GB, and 64GB. The production storage capacity configuration(s) shall be determined during the development phase.

2.4 RANDOM ACCESS MEMORY

The GEN 3 shall implement 2 Gigabytes of automotive DDDR3L which shall interface to the OMAP 5 external memory interface. The GEN 3 shall implement a 532 MHz clock for the DDR3 interface.

2.5 POWER SUPPLY

The power supply shall be designed to support all required voltage rails by components on the board, as well as the display interface. Final voltage requirements shall be defined based on final component selection.

2.6 CAN INTERFACES

The GEN 3 Hardware shall implement two CAN nodes each running FNOS (Ford Network Operating System). The CAN hardware design shall meet the requirements of the Ford CAN Hardware checklist and shall implement CAN transceivers approved by the Ford NETCom group. All CAN nodes shall be designed to be optionally configured as a terminating node.

The GEN 3 shall comply with E/E Systems SDS requirement EY-0088, regarding the implementation of HS-CAN protocols.

The DUT shall comply with E/E System SDS requirement EY-0053, regarding the implementation of Controller Area Network Diagnostics.

The DUT shall comply with E/E System SDS requirement EY-0056, regarding the implementation of CAN module programming.

The DUT shall comply with E/E System SDS requirement EY-0057, regarding the implementation of CAN module configuration.

The DUT shall comply with In-Vehicle Diagnostics Specification (IDS), using the latest version available at the time of sourcing.

2.6.1 I-CAN

The I-CAN interface shall be a high speed (500kbps) CAN node. The I-CAN network is a private network used only for infotainment components. The I-CAN interface shall be connected to the VMCU directly.

2.6.2 HS-CAN

The HS-CAN interface shall be a high speed (500kbps) CAN node. The HS-CAN network is a public vehicle network. The HS-CAN interface shall be connected to the VMCU directly.

2.7 SDARS DATA LINK

The GEN 3 module shall implement a peripheral CAN transceiver via UART. This CAN transceiver shall be used to receive SDARS UART data via the CAN physical layer. The CAN physical bus shall be terminated at the GEN 3 module with a 120 ohm resistor.

2.8 AUDIO INTERFACES

The GEN 3 module shall have both analog audio I/O as well as digital audio I/O.

2.8.1 ANALOG AUDIO I/O

The following analog audio outputs shall be supported by GEN 3:

- Stereo Out – supplies stereo audio to the Audio Head Unit (AHU)
- Alert Out – supplies two mono audio channels to the AHU for prompts and beeps

The following analog audio inputs shall be supported by GEN 3:

- Microphone Inputs – (2x) used for hands free phone and voice recognition functions
- Aux Stereo Input – used for connecting analog audio outputs from an external device (i.e. Personal Media Player) to GEN 3

2.8.2 DIGITAL AUDIO I/O

The following digital audio inputs shall be supported by the CCPU:

- Stereo Aux input (from the CODEC)
- Microphone input (from the CODEC)
- Bluetooth Audio from the wireless module

The following digital audio output shall be supported by the CCPU:

- Alert Out (to the CODEC)
- Bluetooth Audio to the wireless module

2.9 VIDEO INTERFACES

The GEN 3 module shall support one video output interface and two independent video input interfaces.

2.9.1 VIDEO OUTPUT INTERFACE

The GEN 3 module shall support one digital display interface that will connect to an external display.

- The external display output shall be capable of handling 24-bit color and resolutions up to 1280 x 720 pixels
- The connection to the external display shall be via TI FPD Link III LVDS interface.
- The LVDS link shall support a back-channel I2C interface for display configuration, diagnostics, and touch screen input.
    - The LVDS interface shall also allow for the transfer of GPIO data over the back channel
    - The details of the display interface behavior shall be defined in the Display Interface Specification.
- The LVDS interface used shall make use of a 4-wire system to include display power.

2.9.2 VIDEO INPUT INTERFACES

The following video input interfaces shall be supported

- Two balanced differential analog PAL/NTSC compliant inputs
    - One input for Rear View Camera
    - One input for the Aux Video Input

2.10 BLUETOOTH/WIFI

A combo Bluetooth/Wi-Fi IC shall be connected to the CCPU. The interface chosen to connect the IC shall be able to support all data and audio formats supported by the Bluetooth/Wi-Fi IC including but not limited to SCO, eSCO, WBS, TC/IP data, and A2DP audio. The combo IC shall support co-existence features which allow Bluetooth and Wi-Fi to operate simultaneously.

2.11 GNSS / POSITIONING

The GEN 3 module shall implement a Global Navigation Satellite System receiver as the positioning solution for the platform. Positioning shall be used for navigation and location based services. The GNSS received may be integrated in the BT/Wi-Fi combo as shown in the architecture diagram, although alternative proposals will be considered as well. The GEN 3 module shall support a 3D gyroscope and accelerometer for enhanced dead reckoning

2.12 APPLE IPOD INTERFACE

The GEN 3 Module shall provide an Apple authentication IC connected to an I2C port on the CCPU. Some information on the authentication IC is provided below. Detailed information is available from Apple under NDA.

- Part: iPod Authentication Coprocessor 2.0C
- Supply Voltage: 1.62V – 5.5V
- Supply Current: 7.5mA Max
- Operating Temperature: -25C to +85C
- Communicates with the CCPU via I2C with 400 kHz
- Purchased Pre-programmed from an Apple directed source

The GEN 3 module shall support all requirements detailed in the Apple MFi Specifications.

2.13 DIAGNOSTICS-ON-BOARD

The GEN 3 shall support diagnostic interfaces for application development, testing, and debugging. The diagnostic interfaces included shall be Ethernet and a serial interface. The diagnostic interfaces may be interfaced via a separate daughter board if required.

The GEN 3 shall also provide a debug interface for monitoring, testing, and simulating the IPC communication between the VMCU and the CCPU.

On engineering and test boards the GEN 3 module shall populate all components necessary for the debug interface to function. These connectors shall be accessible without disassembly of the module. The housing may require modification to expose these connections. The debug board connector shall be defined upon completion of the GEN 3 electronics schematic.

3 GEN 3 SOFTWARE ARCHITECTURE

The overall Software architecture of GEN 3 Module consists of two software stacks running on each processor (VMCU and CCPU). The manufacturer will be responsible for compiling and burning the final software image for the CCPU and VMCU into the GEN 3 modules prior to delivering any level of Hardware to Ford Motor Company during any development, validation or production phase.

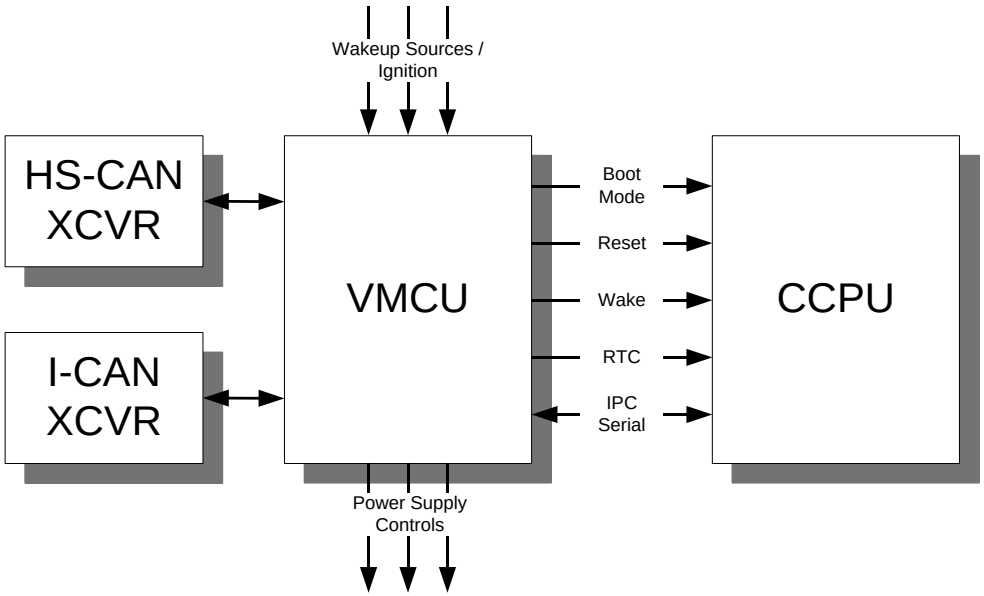
3.1 CCPU SOFTWARE RE-FLASH

The CCPU's software shall have re-flash capability via the Media Connectivity Module's USB ports. A tool shall be provided to Ford Motor Company to support this feature. The CCPU shall have the capability to securely reflash the VMCU software. The CCPU shall be capable of receiving Over-the-Air (OTA) software updates via Wi-Fi or connected devices. The detailed requirements for the flashing and OTA process are beyond the scope of this document.

3.2 VMCU SOFTWARE REQUIREMENTS

The Vehicle MCU shall implement FNOS, and will connect directly to high speed CAN busses. This CPU shall also control the power supplies of the GEN 3, and connect with the Consumer CPU through a multi-wire interface consisting of a wakeup line, serial communication link, real time clock, boot mode selection signal, and a reset line as shown in the diagram below.

The vendor shall work with Ford Motor Company to define the inter-processor communication (IPC) requirements including security and diagnostics.



Table

Figure 3-1: Dual CPU Architecture

4 DESIGN DEPENDENCIES

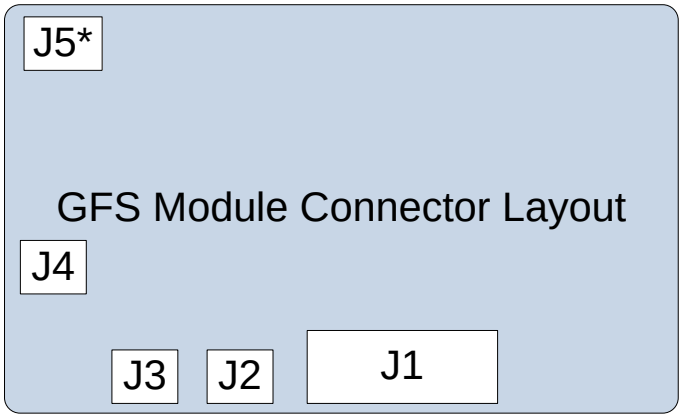
4.1 MECHANICAL PACKAGE

The GEN 3 module package shall conform to the external dimensions of the existing SYNC Gen 2 hardware. The location of connectors shall conform to the existing SYNC Gen 2 hardware connector locations, with the addition of new connectors required for the GEN 3 module. The final mounting/bracketing features shall be reviewed and approved by Ford Motor Company before tooling is kicked off.

The current SYNC module drawing is provided as a reference document for dimensions. The screw hole locations for mounting to the display shall be assumed to be located in the same location within the package; changes to these locations may be considered upon request.

The BT/Wi-Fi antenna(s) shall be located on the module. Provisions shall be made in the housing to provide transparency for transmission of RF signals from the BT/Wi-Fi antenna(s).

The LVDS connector (J4) shall be located next to USB2 (J3), the GPS antenna connector (J5) may be placed in a location of the vendors choosing with Ford's approval.



***J5 position to be proposed by the vendor and approved by Ford**

Figure 4-1: GEN 3 Module Connector Layout

The GEN 3 module shall comply with Instrument panel SDS requirement IP-0044, regarding the natural frequency of the GEN 3/bracket assembly.

The GEN 3 module shall comply with Connector SDS requirement EL-0052, regarding the connector fixture block.

4.2 MODULE WEIGHTS

The GEN 3 module shall have a maximum weight of 900 grams.

4.3 BRANDING AND LABEL

The GEN 3 module shall abide by the Ford Service ARL V.34 which includes Ford Branding initiative E108.

The GEN 3 module shall include a main label that meets the Ford label specification.

The label shall include BT MAC, BDID – Bluetooth device ID, Wi-Fi MAC, and all required global certification markings for markets sourced. The final information included on the label shall be approved by EESE Ford Motor Company

Location of all labels shall be as indicated in the package created by the vendor and approved by Ford Motor Company.

4.4 MATERIAL

The GEN 3 module shall meet the requirements of Restricted Substance Management Standard: **WSS-M99P9999-A1**. In addition, GEN 3 module shall be HEX Chrome free. The GEN 3 module shall be designed for manufacturing using a lead-free solder process. The GEN 3 module supplier shall also include a list of all declarable substances used in production.

4.5 CONNECTOR PINOUTS

The GEN 3 Module shall have the following connectors:

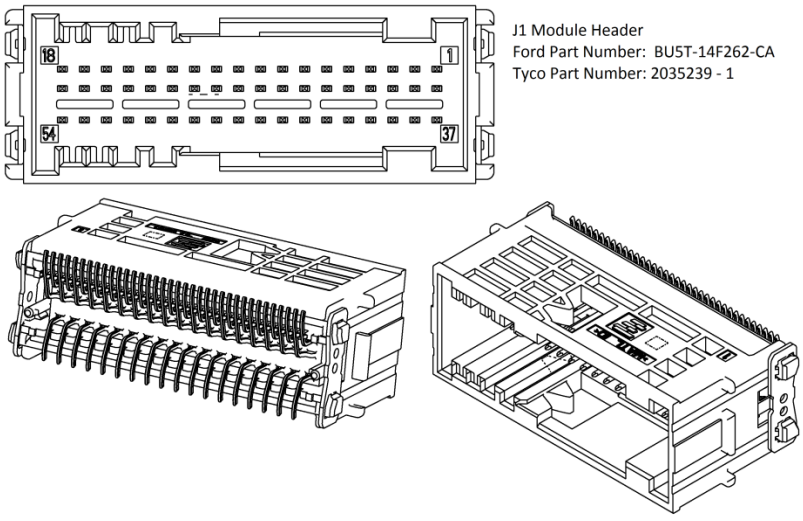
- J1 – Main connector with 54 pins
- J2 – USB 1 connector
- J3 – USB 2 connector
- J4 – LVDS connector
- J5 – GPS Fakra connector

4.5.1 GEN 3 MODULE MAIN CONNECTOR J1

J1 Connector Pinout								
Pin	Name	Type	Pin	Name	Type	Pin	Name	Type
1	Battery B+	Input	19	I-CAN H	I/O	37	Power Ground	Ground
2	N/C		20	I-CAN L	I/O	38	MCM Ground	Ground
3	Alert Audio Out+	Output	21	Alert Out Shield	Ground	39	N/C	
4	Alert Audio Out-	Output	22	Stereo Out Shield	Ground	40	N/C	
5	N/C		23	Stereo Out Left+	Output	41	N/C	
6	N/C		24	Stereo Out Left-	Output	42	N/C	
7	N/C		25	Stereo Out Right+	Output	43	N/C	
8	MCM Power	Output	26	Stereo Out Right -	Output	44	N/C	
9	Aux In Shield	Ground	27	N/C		45	N/C	
10	Aux In Left +	Input	28	Aux In Right+	Input	46	SWC +	I/O
11	Aux In Left -	Input	29	Aux In Right-	Input	47	SWC -	I/O
12	Mic 1 In+	I/O	30	Mic 2 In +	I/O	48	N/C	
13	Mic 1 In-	I/O	31	Mic 2 In -	I/O	49	N/C	
14	Rear Video Camera In +	Input	32	Mic Shield		50	N/C	
15	Rear Video Camera In -	Input	33	Rear Camera Video In Shield*	Ground	51	SDL H	Input
16	N/C		34	Aux Video In+	Input	52	SDL L	Input
17	N/C		35	Aux Video In-	Input	53	HS-CAN H	I/O
18	N/C		36	Aux Video In Shield	Ground	54	HS-CAN L	I/O

N/C indicates no connection
***Camera Shield shall be capable of handling the camera module ground current**

There are multiple views of the connector below:



J1 Module Header
Ford Part Number: BU5T-14F262-CA
Tyco Part Number: 2035239 - 1

Figure 4-2: J2 GEN 3 Module 54-way Pin-Out View

4.5.2 USB 1 CONNECTOR J2

J2 Connector Pinout		
Pin	Name	Type
1	USB1 Vbus	Output
2	USB1 Data -	I/O
3	USB1 Data +	I/O
4	N/C	
5	USB1 Ground	Ground
Shell	USB Shield	Ground

There are multiple views of the connector below:

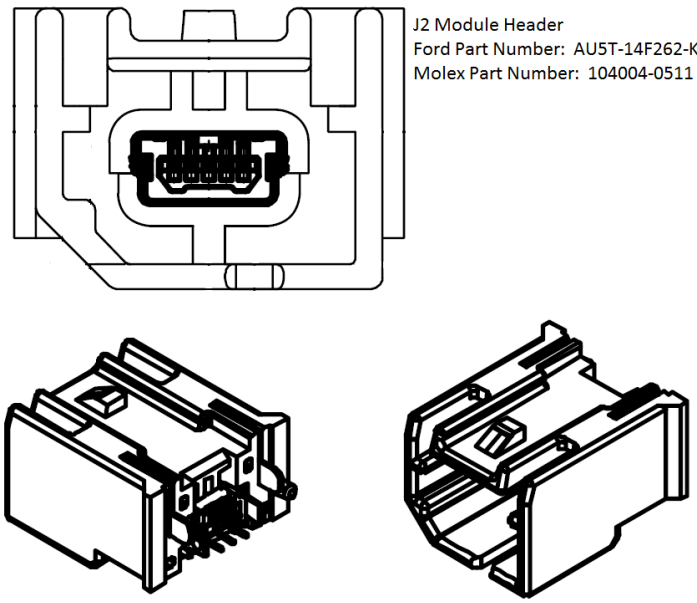
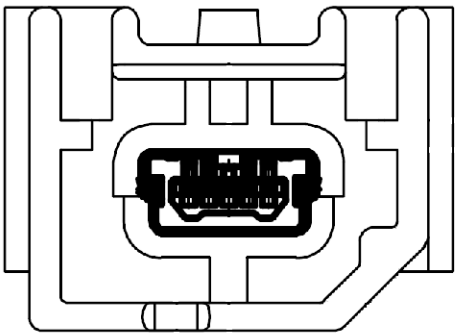


Figure 4-3: J2 GEN 3 Module USB Pin-Out View

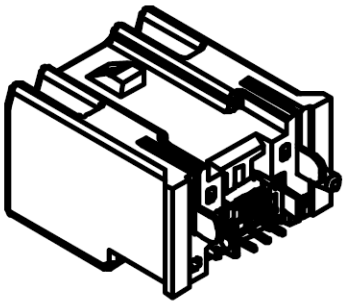
4.5.3 USB 2 CONNECTOR J3

J3 Connector Pinout		
Pin	Name	Type
1	USB2 Vbus	Output
2	USB2 Data -	I/O
3	USB2 Data +	I/O
4	N/C	
5	USB2 Ground	Ground
Shell	USB Shield	Ground

There are multiple views of the connector below:



J3 Module Header
Ford Part Number: AU5T-14F262-MAA
Molex Part Number: 104004-0515



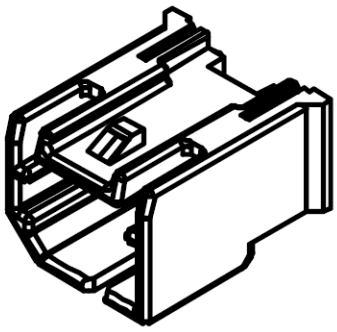


Figure 4-4: J3 GEN 3 Module USB Pin-Out View

4.5.4 LVDS CONNECTOR J4 – ROSENBERGER HSD D4S10E-40MA5-C

J4 Connector Pinout		
Pin	Name	Type
1	TPA+	I/O
2	Display Power	Output
3	TPA -	I/O
4	Display Ground	Ground

There are multiple views of the connector below:

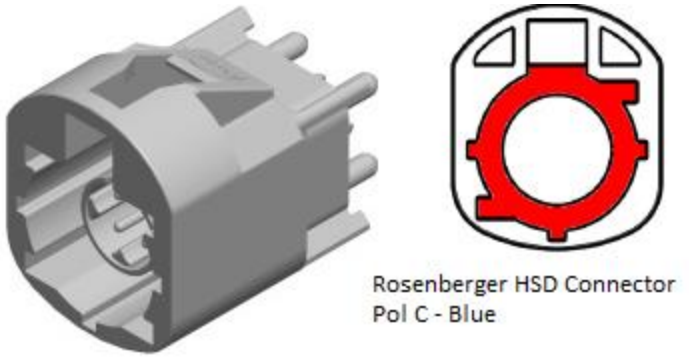


Figure 4-5: J4 GEN 3 Module LVDS Pin-Out View

4.5.5 GPS ANTENNA CONNECTOR J5

J5 Connector Pinout		
Pin	Name	Type
1	GPS Signal	Input

There are multiple views of the connector below:

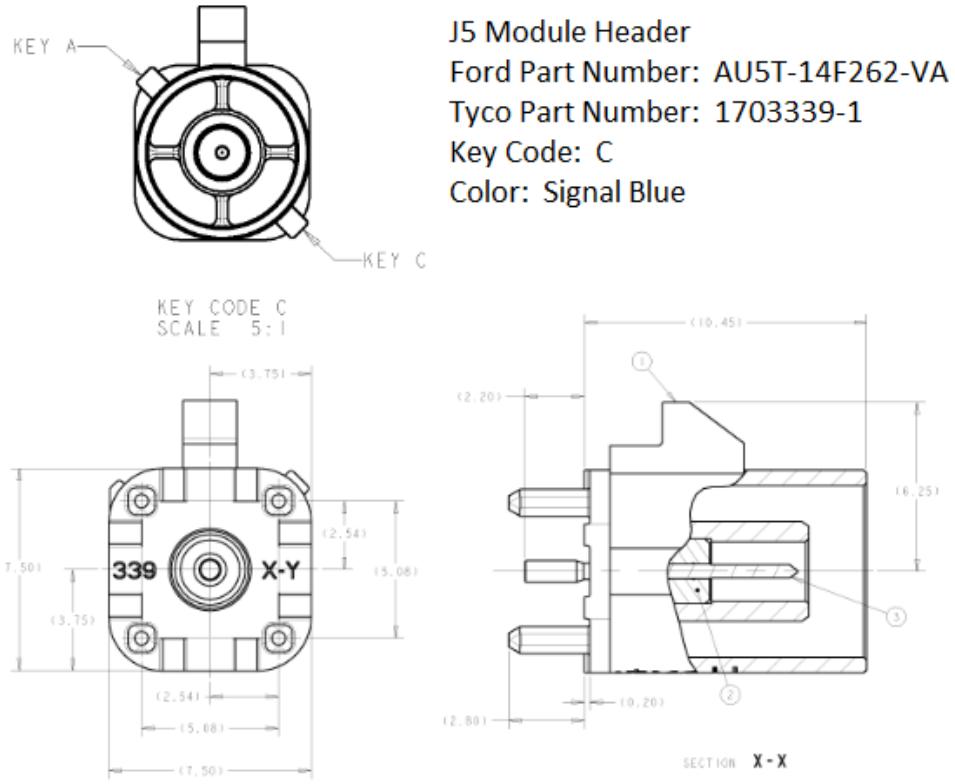


Figure 4-6: J5 GEN 3 Module GPS Antenna Connector Pin-Out View

5 BEHAVIORAL REQUIREMENTS

The behavioral requirements for the GEN 3 module are beyond the scope of this document and are defined in several other specifications.

5.1 POWER MANAGEMENT

The power management strategy and behavioral requirements are beyond the scope of this document, the power states that are required to be implemented are described in a later section.

5.2 WATCH DOG

The VMCU shall act as a watch dog with the ability to reset the CCPU if it stops responding. The exact details of the watchdog function shall be defined in the specifications for Security and IPC.

5.3 CAN

The behavioral requirements for CAN are beyond the scope of this document.

6 SECURITY REQUIREMENTS

The VMCU and IPC link to the CCPU shall implement security features to prevent unauthorized messages from being transmitted on to any vehicle buses and from unauthorized access via any vehicle buses. Detailed security requirements including threat modeling are beyond the scope of this document.

7 SYSTEM REQUIREMENTS

7.1 POWER STATE REQUIREMENTS

The GEN 3 shall at a minimum support the power states described in this specification. Power states may be consolidated if they eliminate higher power states with states that have lower power consumption.

Power State	Description	Max Current Draw*
Unpowered	Power is removed from the module	0 mA
Deep Sleep	Battery power is applied, module wakes on CAN, consumer OS must boot on wake up	200 µA
Sleep	Battery power is applied, module wakes on CAN, consumer OS can Resume from RAM (for faster resume)	5 mA
Functional	Battery power is applied and module is fully functional for the User	9 A

***Max Current Draw is with respect to Battery Voltage (12 V) limits may be reviewed after WCCA completion**

Table 7-1: GEN 3 Power States

The GEN 3 module shall support additional sub states in Functional mode to meet the system level requirements. These subsets of functional mode shall disable power from some peripherals but will not have specific limits on the current draw. The current draw of these subsets shall be defined after WCCA completion. The design goal for the power control of the GEN 3 shall always be to achieve the lowest possible power.

The table below shall describe which peripherals are required to be powered in different power state subsets.

Power State	Display	CCPU	Audio	SDL	BT	USB	Wi-Fi	GNSS	RVC	MCM** Power	CAN	VMCU
Unpowered	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Deep Sleep	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Low	Low
Sleep*	Off	Low	Low	Low	Low	Low	Low	Low	Low	Off	Low	Low
Functional	On	On	On	On	On	On	On	On	On	On	On	On

Functional (Extended Play)	On	On	On	On	On	On	On	Off	Off	On	On	On
Functional (Transport)	On	On	On	On	Off	Off	Off	On	On	Off	On	On

***Peripherals in Sleep labeled as in low power mode may be off, if the OS can meet the system level requirements.**
****MCM or Media Connectivity Module is an external USB hub and audio input which is powered through the GEN 3, the GEN 3 is responsible for enabling and disabling power to the MCM**

Table 7-2: GEN 3 Power State Peripheral Settings

7.1.1 POWER MODES

The GEN 3 module's power moding detailed requirements are beyond the scope of this document. The details of the boot / sleep strategy shall be defined in the power specification.

7.2 CERTIFICATION REQUIREMENTS

The GEN 3 module hardware shall be certified by the certification programs for the following protocols:

- USB (USB implementer forum)
- Wi-Fi (Wi-Fi Alliance)
- Bluetooth (Bluetooth Sig)
- Apple Certification

The GEN 3 module hardware shall be certified for compliance to all governing bodies requiring certification including but not limited to FCC, Industry Canada, CE, etc. The complete listing shall be agreed to by Ford Motor Company and the vendor.

7.3 PERFORMANCE REQUIREMENTS

7.3.1 ELECTRICAL REQUIREMENTS

7.3.1.1 VOLTAGE

The GEN 3 shall be designed to be powered via an unfiltered, 20.0Amp fused link to the vehicle battery with the following operational ranges:

Range (volts)	Description
0-6	HSCAN/ICAN communication is allowable but is not required.
6-16*	Normal operating range. All power modes shall be supported.
>16	HSCAN/ICAN communication is allowable but is not required. However, FUNCTIONAL operation is allowed as long as this does not damage other components.

***Note:** Module function below 8V is a transient condition in line with the Global Power Supply Start/Stop Voltage Curve Specification

Table 7-3: GEN 3 Voltage Requirements

7.3.1.2 POWER SUPPLY DESIGN REQUIREMENTS

The GEN 3 Module's Power Supply shall be designed per the following requirements:

1) The power provided to the display interface shall be a filtered battery feed. This power rail shall match the battery input voltage, but should be filtered by the GEN 3 module to contain voltage transients. The output to the display shall not exceed 21V under any condition.
2) The power rail feeding the MCM shall be a 12V rail designed to supply a maximum of 3A.
    (1) The MCM power rail shall be protected against over voltage and short circuits in line with other power outputs as indicated below.
    (2) The MCM power rail shall be protected from being damaged by all voltage transients and battery input conditions the GEN 3 modules battery input is subject to.
3) The power supply shall be designed with enough hold up capacitance to power the GEN 3 module electronics for up to 50ms in a momentary voltage drop-out. This shall not include the MCM or display interface power rails.
4) The power feeds to the MCM and Display shall be isolated from the GEN 3 module bulk capacitance to prevent these modules from dissipating the charge stored in Gen 3 bulk capacitance.
5) The GEN 3 shall have a means to detect a low voltage condition on the battery input.
    (1) The GEN 3 shall protect the contents of memory and the process from corruption due to a low battery voltage condition.
6) All power outputs shall be protected for over voltage, short to battery, and short to ground.
    (1) Power outputs shall support protection for an indefinite short circuit
    (2) If a fault is detected the GEN 3 shall have the capability to report a fault via diagnostics.
    (3) While a fault exists, the output shall be disabled.
    (4) The output shall be enabled when the fault is removed.
7) All powered IC outputs of the GEN 3 shall be capable of detecting shorts to B+ or GND and open circuit conditions and reporting these faults using the defined DTCs.
8) The power supply shall be designed to be capable of meeting the voltage transients defined in the Global Power Supply Start/Stop Voltage Curve Specification.
    (1) The GEN 3 power supply shall presume an additional 1V offset from the nominal curve, i.e. 7V on the curve could be 6V measured at the module.

7.3.1.3 CONTROL SIGNALS

7.3.1.3.1 CAN

The GEN 3 shall provide an HS-CAN (500kbps), and I-CAN (500kbps) network interface and shall operate in accordance with all Ford Motor Company vehicle-networking requirements.

The GEN 3 shall meet all CAN requirements listed in the System Model Specification and SYNC SPSS.

The GEN 3 shall implement the latest version of the Infotainment CAN Vehicle Database.

The GEN 3 shall be in compliance with the Ford Network Operating System, which includes:

- Purchasing and implementing the FNOS MS-CAN and HS-CAN Network Package.
- Purchasing and implementing the Multiple Connection version of the FNOS Transport Protocol.
- Purchasing and implementing the FNOS Boot loader for re-flash capabilities.

The GEN 3 I-CAN node shall be a sleep node.

The GEN 3 I-CAN, and HS-CAN nodes shall support diagnostics via the I-CAN and HS-CAN interface.

The GEN 3 shall have the provisions to populate and depopulate I-CAN, and HS-CAN termination resistance (120 ohms).

The hardware implementation of the CAN design shall meet the requirements of the reference document NETCom HW Checklist.

7.3.1.4 AUDIO ELECTRICAL

The GEN 3 shall support the following audio electrical requirements.

7.3.1.4.1 AUDIO SHIELDS

The GEN 3 module's audio output shield pins shall be connected internally to the module ground.

The auxiliary audio input shield to the GEN 3 module shall be connected internally to the module ground.

7.3.1.4.2 SHORT CIRCUIT PROTECTION/SURVIVAL

All audio inputs and outputs shall be able to survive indefinite short circuits (Zsc $\leq$ 350 mΩ) to ground or battery.

When a short circuit occurs on an output, that output shall be disabled for the duration of the short circuit.

The output shall return to its normal state, once the short circuit condition is removed.

7.3.1.4.3 ANALOG AUDIO OUTPUT REQUIREMENTS

The GEN 3 module audio outputs shall be capable of meeting the following output types:

Table 7-4: Audio Output Types

Output Channel	Variable Line-Level	Fixed Line-Level
Stereo Right		X
Stereo Left		X
Alert 1	X	X
Alert 2	X	X

7.3.1.4.4 VARIABLE AND FIXED LINE-LEVEL OUTPUTS

The GEN 3 module shall support the signal characteristics for the Variable and Fixed Line-Level Outputs provided in the following table when Bass, Middle, Treble, Balance and Fade are at detent.

Table 7-5: GEN 3 Line-Level Output Characteristics

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
THD+N	Total Harmonic Distortion + Noise, 22kHz filter, unweighted			0.2	%
Ros	Output Resistance	----	330	1000	Ohms
Rbe	Output Resistance Worst Case Balance Error on any output +/- pair	----	0	2.5	%
Vbias	Output DC Bias Voltage	----	½ Vbatt	----	Vdc
Wr1	Frequency response tolerance (Deviation From Flat, 20 Hz to 15 kHz)	-1	0	+1	dB
Wr2	Frequency response tolerance (Deviation From Flat, 15 kHz to 20 kHz)	-2.5	0	+1	dB
Vout	Output Level for 1KHz, 0 dB test signal	3.17	3.56	4.00	Vrms
fpl	Audio Passband Low Frequency (3dB Down Point)	2.0	7.0	10.0	Hz
fph	Audio Passband High Frequency (3dB Down Point)		----	40.0	kHz
S/N(1)	Output Signal–to–Noise Ratio	87		----	dB

(1) S/N – A-weighted, using a 1 kHz, 0dB test file. Any noise shall be uniform with no periodic or impulsive components.

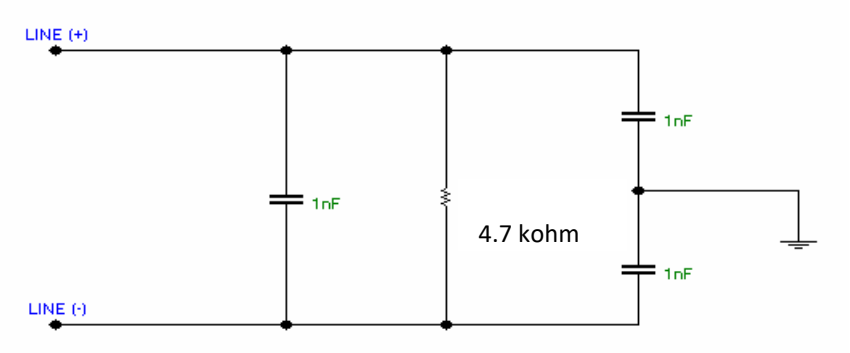


Table 7-6: Test Load for Fixed Line-Level Outputs - all Channels

The GEN 3 shall adhere to noise floor requirements to avoid issues with a full mute at volume step zero and transitioning to a "hiss" at volume step 1. This shall be avoided.

When playing a silent* mp3 file the A-weighted rms output noise voltage shall not exceed the limits as outlined below.

*Ford can provide the reference file

Room Temperature (25°C ±3°C) Limit: Vnomloudnoise < 110µVrms

Performance Operating Temperature Limit: Vnomloudnoise < 110µVrms

(65°C ±3°C, -30°C ±3°C)

7.3.1.4.4.1 VARIABLE LINE-LEVEL OUTPUTS

The GEN 3 module shall be able to dynamically adjust the volume for all variable line-level outputs. The volume adjustment shall occur based on the reception of a CAN signal. The GEN 3 shall be capable of software controlling the volume levels for the variable line-level outputs. The functional requirements for setting the volume shall be defined in the functional requirements, which are beyond the scope of this document.

7.3.1.4.4.2 FIXED LINE-LEVEL OUTPUTS

All Fixed Line-Level Outputs shall have Bass, Middle, Treble, Balance and Fade set to detent and any Infotainment Volume adjustments shall have no effect.

7.3.1.4.5 STEREO ANALOG AUDIO INPUT REQUIREMENTS

The external audio inputs shall be AC coupled balanced, differential inputs. The stereo audio inputs include the AUX stereo input. The stereo analog audio inputs shall meet the performance requirements in the following table:

Table 7-7: Aux Audio Input Signal Characteristics

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
Z_{in}	Input Impedance	9	10	11	K ohms
CMRR	Common–Mode Rejection Ratio (20 Hz through 20 kHz)	35	60	----	dB
V_{clip}	Clipping Level (0.05% THD max).	0.58	----	----	V_{rms}
V_{in}	Input Level	400	475	565	mV_{rms}
W_{r1}	Frequency response tolerance (Deviation From Flat, 20 Hz to 15 kHz)	-1	0	1	dB
W_{r2}	Frequency response tolerance (Deviation From Flat, 15 kHz to 20 kHz)	-4	0	1	dB
f_{pl}	Low Frequency Pole (3 dB Down Point)	2.0	7.0	10.0	Hz
f_{ph}	High Frequency Pole (3 dB Down Point)		----	75	KHz
S/N	Signal–to–Noise Ratio	83	>90	----	dB

(2) S/N – A-weighted, measured at the Fixed Line Level outputs. All signal processing defeated, using a 1 kHz 475 mVrms differential input signal. Any noise present shall be uniform with no periodic or impulsive components.

7.3.1.4.5.1 GEN 3 AUX STEREO INPUT REQUIREMENTS

The GEN 3 Stereo Input shall be able to detect whether audio is present or not.

7.3.1.5 MICROPHONE INTERFACE REQUIREMENTS

The GEN 3 module shall support up to two VDA 1.5 compliant microphone interfaces. Interface requirements shall be as defined in the VDA 1.5 specification and reference document Microphone Functional Specification: ES EL2T-19A391-AAW

7.3.1.6 VOICE/SPEECH AUDIO PIPELINE REQUIREMENTS

The module shall be capable to interface to in-vehicle mounted microphone(s) and route and process operator/passenger voice/speech commands and/or voice/speech for hands free BT phone communication. The module shall provide the necessary electronics, computational power and software necessary to process in digital and analog voice/speech while retaining a quality speech signal regardless of the signal chain route through the module. Table 7-8: Speech System Block Diagram~~Table 7-9: Speech System Block Diagram~~ below illustrates the voice/speech subsystem.

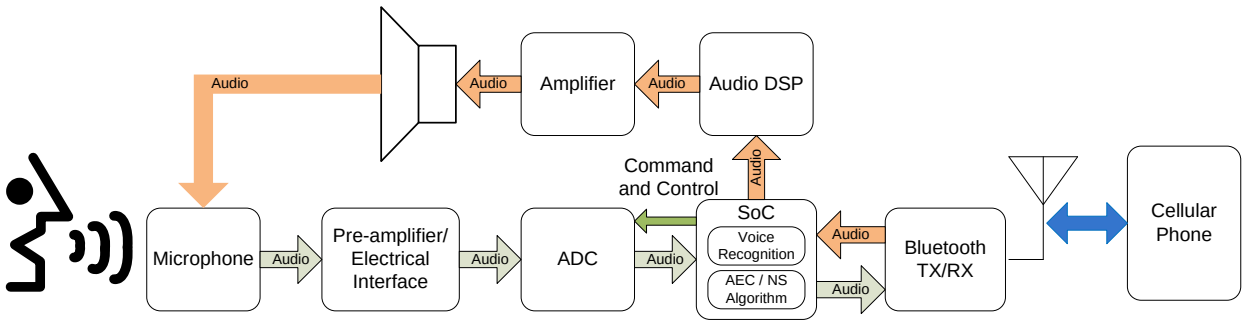


Table 7-89: Speech System Block Diagram for Far End Phone Call

7.3.1.6.1.1 MICROPHONE PHANTOM POWER SUPPLY

The module shall be provisioned to provide "phantom" power to each of its speech microphones. The phantom power shall be a DC bias which is superimposed on the microphones signal output. Specifically for each microphone supported:

- The module shall power the microphone by providing an 8V DC Bias on the microphone signal pin.
    - The module's 8V DC power supply shall meet the microphone engineering specification requirements for ripple voltage

7.3.1.6.1.2 1.1.1.2 DIAGNOSTIC REQUIREMENTS

- The module shall provide open circuit and short circuit protection and detection on the microphone circuit.
    - Circuit protection shall meet SDS ELCOMP v21 requirements
- The module shall set a DTC if a persistent (t > 1 s) short or open circuit is detected.

7.3.1.6.2 VOICE MICROPHONE AUDIO INPUT REQUIREMENTS

The module microphone input(s) shall be single-ended input(s). The voice/speech signal flow is indicated below in Figure 7-1: Signal Flow Block Diagram. The module shall implement the functional blocks shown in the figure below:

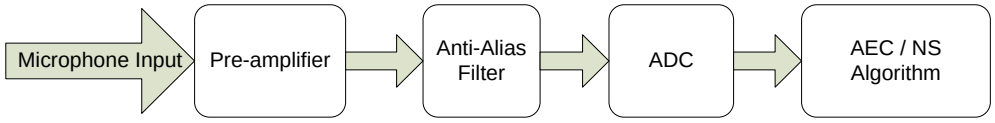


Figure 7-1: Signal Flow Block Diagram

7.3.1.6.3 SYSTEM FREQUENCY RESPONSE:

The signal chain shown in Figure 7-1: Signal Flow Block Diagram shall have a system frequency response as indicated in Figure 7-2: System Frequency Response and Table 7-9: System Frequency Response Characteristics~~Table 7-10: System Frequency Response Characteristics~~ below.

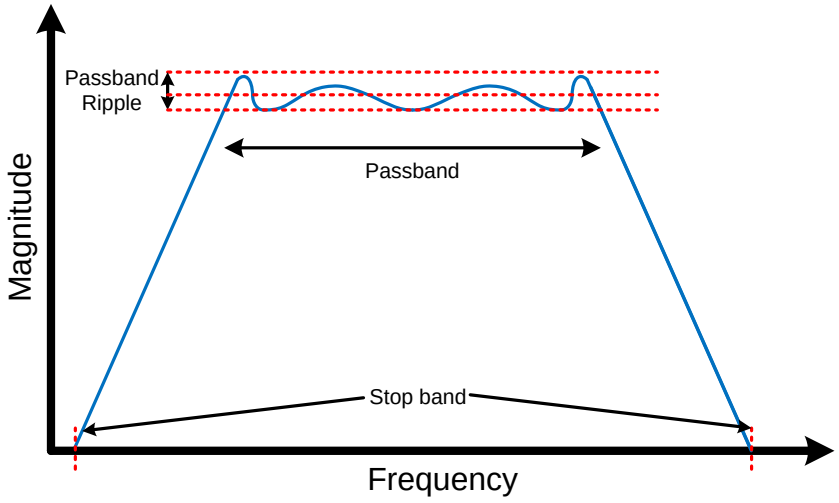


Figure 7-2: System Frequency Response

Table 7-~~9~~10: System Frequency Response Characteristics

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
CMRR	Common–Mode Rejection Ratio (150 Hz through 7 kHz)	35	60	----	dB
Wr	Pass-band Ripple tolerance (Deviation From Flat, 150 Hz to 7 kHz)	-1	0	1	dB
fL	Low Frequency Cut-off (3 dB Down Point)	90	115	120	Hz
fH	High Frequency Cut-off (3 dB Down Point)		----	8	kHz
fstop	Frequency Stop bands (70 dB Down)	1	----	48	kHz
SNR	Signal-to-noise Ratio	87	>90	----	dB

7.3.1.6.4 MICROPHONE INPUT(S) ELECTRICAL SPECIFICATIONS

The microphone input(s) shall be configured for a clipping level set for an input to the microphone at 106 dB SPL. The microphone specification shall provide the input voltage level for the given clipping level, V_{Clip}.

The gain of the preamplifier shall be set to maximize the signal level to the ADC such that the V_{Clip} is the full scale input to the ADC.

7.3.1.6.4.1 PREAMPLIFIER

The microphone analog input signal shall be preconditioned using an active amplifier with a band-pass filter frequency response. The preamplifier circuit shall be as recommended by the ADC supplier. The ADC supplier applications engineer shall review and approve the circuit.

The performance parameters of the preamp circuit are provided in table 2 below:

Table 7-1011: Preamplifier Parameters

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
RP	Pull up Resistor Value on the DC bias	646	680	714	ohms
Zin	Input Impedance	20		100	K ohms
CMRR	Common–Mode Rejection Ratio (150 Hz through 7 kHz)	35	60	----	dB
Wr	Passband Ripple tolerance (Deviation From Flat, 150 Hz to 7 kHz)	-1	0	1	dB
fL	Low Frequency Cut-off (3 dB Down Point)	90	115	120	Hz
fH	High Frequency Cut-off (3 dB Down Point)		----	8	KHz
fstop	Frequency Stop bands (70 dB Down)	1	----	415,000	Hz
S/N	Signal–to–Noise Ratio		TBD	----	dB

7.3.1.6.4.2 ANALOG TO DIGITAL CONVERTER (ADC)

The ADC selected shall meet the following performance criteria outlined in the following table:

Table 7-1112: ADC frequency response

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
Wr	Passband Ripple tolerance (Deviation From Flat, 150 Hz to 7 kHz)	-1	0	1	dB
fL	Low Frequency Cut-off (3 dB Down Point)	90	115	120	Hz
fH	High Frequency Cut-off (3 dB Down Point)		----	8	kHz
fstop	Frequency Stop bands (70 dB Down)	1	----	48	kHz
S/N	Signal–to–Noise Ratio	87	90	----	dB

7.3.1.6.4.3 DIGITAL SIGNAL PROCESSING

Based on the intended use of the voice/speech signal the module shall route the digital signal produced by the ADC to either pass to the Voice Recognition software without further processing OR route the signal to downstream signal processing necessary for hands free phone. The signal chain block diagram in *Table 7-8: Speech System Block Diagram for Far End Phone Call*~~*Table 7-9: Speech System Block Diagram for Far End Phone Call*~~ shows both of these optional paths.

Formatte

7.3.1.6.4.3.1 DSP FOR HANDS FREE PHONE

The system shall have a maximum convergence time of 50 ms.

7.3.1.6.4.3.2 MICROCONTROLLER COMPUTATIONAL CAPACITY

- The microcontroller shall have the capacity to process up to 4 voice/speech stream inputs.
- The algorithm to process noise reduction and echo cancellation shall take no more than 12ms of CPU time.

7.3.1.6.5 AUDIO SYSTEM CASCADED REQUIREMENTS

The audio system which "plays" back the far end speaker on a hands free BT phone call must meet the following requirements in order to ensure overall system quality performance.

7.3.1.6.5.1 AUDIO SYSTEMS WITH DSP ELEMENTS IN THE SIGNAL CHAIN

The audio system DSP must be capable of switching to a "flat" by-pass mode to ensure no additional DSP processing is done to the far end talker. Nonlinearities introduced can interfere with the Echo and Double Talk cancelation algorithm resulting in diminished voice quality and the introduction of perceived "noise" into the system.

7.3.1.6.6 AUDIO SYSTEM DELAY

The overall end to end delay for the audio system cannot exceed 3.6ms.

7.3.1.7 VIDEO ELECTRICAL REQUIREMENTS

The GEN 3 module shall support the following video inputs and outputs:

- 18 bit or 24bit color LVDS output to drive an LCD panel with a resolution up to 1280x720 pixels
- Analog NTSC/PAL input from the Rear Camera module
- Analog NTSC/PAL input from the Aux Video Input

7.3.1.7.1 PRIMARY DISPLAY INTERFACE

The primary display interface for GEN 3 shall be flexible to support touch screen and non-touch screen displays with up to 24bit color. At a minimum display resolutions supported by the GEN 3 module shall be Wide VGA resolution of 800x480 AND 1280x720 pixels. Touch screen displays shall provide the touch screen feedback from a touch screen controller, built into the display module, via I^2C interface. The GEN 3 module shall provide all required signals to drive the primary display.

The GEN 3 primary display interface shall support resistive and capacitive touch panels.

The GEN 3 shall support single and multi-touch touch panels.

The GEN 3 shall interface to the primary display via an FPDLink III LVDS transceiver.

- The LVDS interface shall support I2C and control lines via back channel.
- All required signals to drive the LCD from the GEN 3 shall be sent via the LVDS link.
  - 24 bit color signals
  - Horizontal Sync
  - Vertical Sync
  - Data Enable
  - Pixel Clock
  - I2C interface
  - GPIO's to support interrupt and backlight controls
- 12 V (filtered battery) power shall be provided to the LCD module from the GEN 3 via the LVDS cable.
  - This power shall be provided on the pins of the LVDS connector as defined previously.

7.3.1.7.2 VIDEO INPUT REQUIREMENTS

The GEN 3 module shall implement two video inputs for the following functions:

- Rear view camera
- Auxiliary Video Input

The Rear view camera shall be viewable on the display within 1.5 seconds from shifting the vehicle into reverse.

The Rear view camera and auxiliary video inputs shall support analog NTSC and PAL formatted video.

All video inputs to the GEN 3 module shall be able to detect when a video signal is present.

All video inputs shall be able to be displayed on the primary display.

7.3.1.7.3 DIFFERENTIAL ANALOG VIDEO RECEIVER INPUT PERFORMANCE REQUIREMENT

The GEN 3 modules composite video inputs shall meet the video receiver input performance requirements as provided in the following table.

- The video input shall be fully balanced and differential.
- The video input shall be AC coupled.

Table 7-1213: Video Receiver Input Performance Requirements

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
Vcc	Supply Voltage Range	8	8.5	9	V
V_{Com}	Input Common Mode Voltage	4	4.25	4.5	V
PSSR	Power Supply Rejection Ratio @ Vcc = 8 to 9V	50	70		dB
V_{CVBS}	Video Input Signal Voltage		1	1.2	V_{P-P}
F_{High}	High Pass Frequency (-3dB) of the Video Signal	10	15	20	Hz
F_{Low}	Low Pass Frequency (-3dB) of the Video Signal	8	10	12	MHz
CMRR	Common Mode Rejection Ratio	70	90		dB

R_{In}	Differential Input Impedance [(1)]	74.25	75	75.75	Ω
SNR	Signal to Noise Ratio @ 4.2 MHz Low Pass and 100KHz High Pass	60			dB

Notes:
(1) This specification applies for STP (Shielded Twisted Pair) only. The nominal wiring differential characteristic impedance (including interconnect) will be 75Ω. Differential input impedance considers initial tolerance variation.

7.3.1.7.4 VIDEO INTERFACE SHIELD REQUIREMENT (REFERENCE ONLY)

- The video interface wiring shall be twisted and must be shielded to minimize EMI susceptibility from RFI-radiating device and EMI-radiating harnesses and accessories.
- Video shielding conventions shall be such that all video shields shall be grounded at the origination (source) by a zero ohm jumper and float on the other end (sink).
- Video interface harness shall meet the vehicle interface harness requirement as provided in the following table.

Table 7-1314: Video Interface Shield Requirement

Symbol	Parameter	Value			Unit
		Min	Nom.	Max	
Shield	Shielding Foil Wrap		100		%

7.3.1.8 UNIVERSAL SERIAL BUS

The GEN 3 module's external USB ports shall meet the USB 2.0 specification.

The GEN 3 module's USB ports shall meet USB Battery Charging Specification 1.2 for charging downstream ports (CDP).

The USB ports on the GEN 3 module shall be capable of supplying a minimum of 2.1A of current for charging devices.

The current rating of the USB ports shall be hardware configurable to at least the following settings: 500 mA, 1.1 A, 2.1 A.

The system shall detect and report any hub or peripheral which consumes more power than supplied.

The USB ports shall have compensation for voltage drops in the cable between the SYNC module and the end user connection location. This compensation shall be configurable, a final setting or settings shall be agreed to by Ford Motor Company and the vendor before production.

The USB ports shall support Apple iAP lingo for charging Apple iOS Devices.

The GEN 3 module shall pass USB certification testing for a high speed embedded host.

The GEN 3 module shall pass Made for iPhone/iPod/iPad certification.

- Including TDMA noise testing as specified by Apple (MFi Accesory Testing specification, MFi Accessory Hardware Specification – latest version on date of release of this specification).

It shall be possible to register a device as unsupported device for each USB device class by populating the system with the USB Vendor ID and any portion of the USB product ID.
Remark: This requirement is a generic implementation of the iPod/iPhone requirement for mass storage and should be able to be applied to any device from any vendor which may not work correctly with the system.

The GEN 3 module shall have the ability to detect short circuits on any of the module's USB ports independently.

The GEN 3 module's USB ports shall be protected from indefinite short circuits to the 5V Vbus, ground, and battery.

The GEN 3 module shall also be capable of resetting each host controller and each physical layer independently and shall not block the power-up and initialization of the other host controllers or physical layers in the system.

Each device supported by the USB subsystem must be enumerated and available for use by the user within five (5) seconds of attachment to the user-exposed Standard A receptacle if this device is in its normal, functional mode.

The system shall be able to identify the error state that the number of supported tiers of hubs connected to the system is exceeded and hand this information over to the HMI.

The over current notification shall be sent to the CCPU which shall handle the error per the GEN 3 USB functional requirements (Not in this document).

A developer shall be able to debug all USB traffic to and from each host controller in the system.

7.3.1.9 BLUETOOTH

The GEN 3 module's hardware shall implement a Bluetooth Core Specification v4.0 design. The GEN 3 module shall be qualified through a Bluetooth SIG approved qualification program. The GEN 3 module shall be a Class 2 Bluetooth device compliant to all requirements imposed on Class 2 devices by the Bluetooth SIG.

The GEN 3's printed circuit board shall include HCI Bluetooth sniffing/tracing leads.

7.3.1.10 WIRELESS LAN IEEE 802.11 B/G (WI-FI)

The GEN 3 module shall implement an IEEE 802.11 b/g/n Wireless LAN (Wi-Fi) interface compliant to all standards defined by the IEEE and shall meet certification requirements of the Wi-Fi Alliance. The GEN 3 module's Wi-Fi implementation shall support infrastructure connections.

- Support infrastructure modes for client STA, plus Wi-Fi Direct.
- Additional certification such as HS2.0/PassPoint are beyond the scope of this document
- The Wi-Fi module shall be capable of simultaneous acting as an access point and connect to a network
- The Wi-Fi module shall support dual band antennas for 2.4GHz and 5GHz bands

The GEN 3 module shall be designed such that an external antenna may be mounted for regional radio frequency regulatory certifications.

7.3.1.11 BLUETOOTH / WI-FI CO-EXISTENCE

The GEN 3 module shall implement a co-existence strategy that is supported by the selected Bluetooth / Wi-Fi chipset. The Bluetooth and Wi-Fi radios in GEN 3 shall share a 2.4 GHz antenna. The antenna shall be shared using both coupled and switched connections to the Bluetooth and Wi-Fi radios. This allows both Bluetooth and Wi-Fi to receive at the same time, eliminates coupler loss for Wi-Fi transmission, and eliminates coupler loss for Bluetooth transmission.

7.3.1.12 GNSS SYSTEM REQUIREMENTS

The GNSS system shall support the following Positioning Constellations at a minimum:

- GPS
- GLONASS

The GNSS system shall support the following features:

- Auto-ephemeris calculation for a minimum 24 hour period
- Jamming Detection, reporting and internal mitigation
- Capability to use data hosted on the CCPU to enhance position via feedback loop
    - The system shall be capable of functioning regardless of the availability of data from the CCPU
    - CCPU hosted data shall include external data, not limited to:
        - Navigation Application Map Matched Location
        - Position provided by attached user devices
        - Wi-Fi Positioning
- Full featured PC Monitoring suite for issue debugging/resolution via connection to the system hardware. Example features for the monitoring tool are listed below:
    - GPS configuration and control
    - Structured data visualization in real-time
        - Message, binary and text output
        - Tabular outputs with on-line statistics
    - Graphical data visualization with zooming, panning and scaling functions:
        - 2-dimensional plots from large choice of data sets
        - Sky plots
        - Deviation map
    - Visualization with maps
    - GPS Camera View: photographic data can be stored in the log file together with the navigation data and later be replayed in the application.
    - Export data files to Google Earth and Google Maps
    - Docking views (real-time cockpit instrumentation displays):

- Satellite constellation
- Compass
- Clock
- Altimeter
- Speedometer
- Satellite and GPS information panels

- Data recorder and playback
- Full Copy Paste Support to transfer information to standard PC application software

7.3.1.12.1 GNSS ANTENNA INTERFACE REQUIREMENTS

The GNSS antenna sourced separately will be connected to the GEN 3 module through a length of coaxial cable. The combined loss of cable and connectors between the GEN 3 unit and the GPS antenna will not exceed 6db.

The requirements listed in the table below apply to the GNSS antenna and are provided here for completeness. The GEN 3 unit supplier shall be responsible for ensuring that their system functions to specification when used with an antenna complying with these specifications.

Table 7-~~14~~15: GNSS Antenna Requirements

Parameter	Symbol	Min	Max	Unit
Linear Average Gain at 1575.42 +/- 1.023 MHz	G	24	30	dBic
Linear Average Gain @ +/-50MHz from 1575.42MHz	G	-	-22	dBic
Axial Ratio @90° at 1575.42MHz	AR	-	5	dB
Axial Ratio over θ = 30° at 1575.42MHz	AR	-	12	dB
VSWR into 50Ω impedance @1575.42MHz	VSWR	-	2:1	-
Supply current at 4.75, 5.00, and 5.22 VDC	I_{CC}	12	28	mA
Noise Figure at 1575.42MHz 20°C	F	-	1.5	dB
Noise Figure at 1575.42MHz (-40°C & 85°C)	F	-	3	dB
Output 1db compression point for 1575.42MHz +/- 3MHz	-	-	+1	dBm
Input IP3	-	-14	-	dBm

7.3.1.12.2 GNSS RECIEVER

The GEN 3 module shall contain a GNSS receiver that will be used as its primary location device. The GNSS receiver shall use the NAVSTAR GPS and GLONASS system to obtain 2D or 3D positioning information (latitude, longitude, dilution of precision (DOP), velocity, heading, date, and time). The receiver shall be capable of tracking at least 12 satellites simultaneously.

This receiver will be connected to an external antenna mounted on the vehicle. The receiver shall provide a regulated, short circuit protected, power supply for the GPS antenna as specified below. There are multiple antenna configuration that the receiver shall be capable of interfacing to:

- Stand-alone GPS antenna
- GPS / SDARS combo antenna
  - Direct connection to this antenna without SDARS band notch filter
  - Connection to a signal splitter with SDARS band notch filter
- GPS / GLONASS combo antenna

The receiver shall have appropriate out of band filtering on the input to avoid any out of band signals from saturating the LNA or effectively negating the GNSS signals.

The GEN 3 module shall be able to detect and report open circuits, and shorts circuits on the antenna connection.

The positioning accuracy of the GNSS receiver shall be augmented by 3D dead-reckoning inputs including vehicle speed and an onboard 3D gyroscope. Any additional sensors to obtain acceptable positioning / dead reckoning performance in 3 dimensions shall be implemented in the hardware. Positioning and guidance accuracy requirements are beyond the scope of this document.

7.3.1.12.2.1 GNSS RECEIVER REQUIREMENTS

The GNSS receiver shall meet or exceed the performance defined in GPS Standard Positioning Service Performance Standard, reference http://www.igeb.gov/SPS-2001-final.pdf , designed in accordance to ICD-GPS-200C.

Parameter	Min	Max	Unit
Receiver Sensitivity	-132	-	dBm
VSWR into 50Ω impedance @1575.42MHz	-	2:1	-
Antenna Supply Voltage	4.75	5.25	V
Antenna Supply current @ 5V +/- 5%	12	150	mA

Table 6-2: GPS Receiver Requirements

7.3.1.12.3 GNSS ACQUISITION TIME REQUIREMENTS

The GNSS receiver shall provide reacquisition time and time to first fix (TTFF) performance as defined in the following table. All times are for a receiver operating –20°C to 50°C with a minimum of four satellites in track with a Geometric Dilution of Precision [GDOP]< 8.

Receiver State	Typical Acquisition Time	Unit

Reacquisition (Signal loss < 1 minute)	1.2	S
Hot Start	2	S
Warm Start	8	S
Cold Start	40	S

Table 6-3: GPS TTFF Performance

- **Reacquisition:** A reacquisition occurs when the GPS antenna experiences a signal blockage for less than 15 seconds.
- **Hot Start:** A hot start occurs when the receiver has valid ephemeris, almanac, time and position.
- **Warm Start:** A warm start occurs when the receiver has valid almanac, time and position.
- **Cold Start:** A cold start occurs when the receiver has no valid almanac or position.

7.3.1.13 MEDIA CONNECTIVITY MODULE (MCM) INTERFACE

The GEN 3 Module's USB1 connector shall connect to the Media Connectivity Module. The MCM shall be supplied with a 12V (filtered battery) power supply from the GEN 3 module; this supply shall be capable of providing up to 2 amps of current (24W) to power the MCM, its internal electronics, and the customer facing USB ports on the MCM.

The MCM shall provide an analog audio and video input that is connected to the GEN 3 via the GEN 3 module's 54 pin connector.

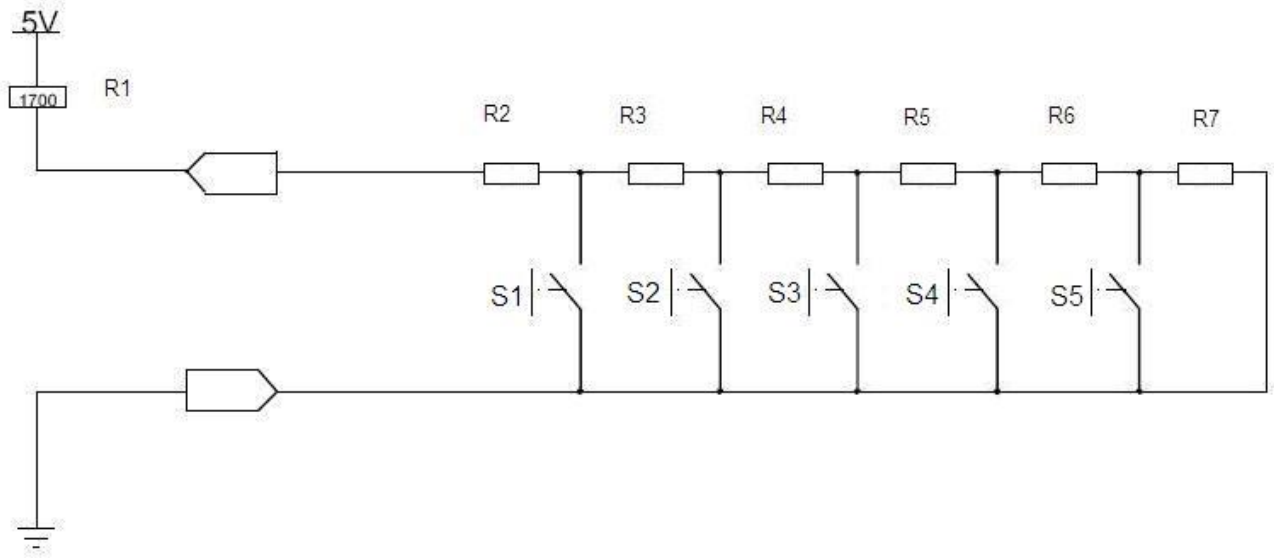
The ground and shield pins from the MCM shall be grounded internally to the GEN 3 module.

7.3.1.14 STEERING WHEEL CONTROL INTERFACE

The GEN 3 shall support a resistive ladder interface to accept input from an external steering wheel control (SWC). The GEN 3 shall be capable to support press and hold functions on all buttons on this interface. The GEN 3 shall be End Of Line configurable to support at least 3 variations of SWC button configurations. The GEN 3 shall also be capable of being configured for no hardwired SWC.

7.3.1.15 RESISTIVE LADDER SCHEMATIC

The SWC (Steering Wheel Control) GEN 3 circuitry shall use this configuration;



7.3.1.16 ERROR DETECTION

If the circuit is shorted between the SWC+ and SWC- pins on the GEN 3 connector, the measured resistance shall be near to 0 Ohm a DTC is to be set.

If the SWC+ pin is shorted to vehicle GND, the measured resistance shall be near to 0 Ohm a DTC is to be set.

If the SWC- pin is shorted to vehicle GND, the resistance is as expected, this error cannot be detected.

7.3.1.17 SWC KEY PRESS SAMPLING RATE

The sampling rate of the buttons shall be 8ms. After three measurements a majority decision shall be made. If a key is pressed for two or more measurements, a <KEY PRESS> button event shall be triggered.

7.3.1.18 SWC KEY PRESS ARBITRATION

Short Press Button

The button status shall be detected as a <Short Press>, when the previous corresponding button was pressed for less than 2 seconds.

Long Press Button

The button status shall be detected as a <Long Press>, when the previous corresponding button was pressed for 2 seconds or more.

Stuck Button

The button status shall be detected as <Stuck>, when the previous corresponding button was pressed for more than 120 seconds.

Repeat Button

The button status shall be detected as <Repeat>, when the previous corresponding button was pressed for more than the timer value as referenced in VOL-GREQ-169707-Press & Hold Volume Control. If a user seeks in a USB/iPod file, CD file or uses the Volume, the <Stuck> should be deactivated until the button is released.

8 SETTINGS

8.1 CONFIGURABLE SETTINGS

8.1.1 DIAGNOSTICS AND CONFIGURATION

8.1.1.1 DIAGNOSTICS

The GEN 3 shall meet the diagnostics requirements as defined in the Ford Motor Company Global Diagnostic Specification Part 1, Generic Requirements for ECU Modules.

The GEN 3 shall be diagnosable via the HS-CAN meeting the requirements in the Ford Motor Company CAN (Controller Area Network) Generic Diagnostic Specification.

The GEN 3 shall support the Diagnostics Behavioral Requirements.

The GEN 3 shall support special system diagnostic modes of operation for functional testing and diagnosis. These would include the following:

- Parameter Identification (PID) data output including:
  - Supply Voltage
  - Touch Screen Errors

The GEN 3 shall perform a self-test at each power-on and a continuous diagnostic test while the system is active, as defined in the GEN 3 Diagnostics Part 2 Specification.

The GEN 3 shall support all PIDs required by the Global Diagnostics Part 1and HS-CAN specifications.

8.1.1.1.1 SELF DIAGNOSTICS

The GEN 3 shall only run diagnostics within normal operating voltage range see ***Note:** Module function below 8V is a transient condition in line with the Global Power Supply Start/Stop Voltage Curve Specification

Table 7-3: GEN 3 Voltage Requirements~~Table 7-3: GEN 3 Voltage Requirements~~.

The GEN 3 shall be able to diagnose all inputs and outputs (I/O) for the faults defined in the GEN 3 Part II Specification

The GEN 3 shall shut off the faulted I/O until the fault has cleared.

Audio line diagnostic shall be determined via tone generation initiated by bezel diagnostics via radio or via Part II Specification.

The GEN 3 shall run a self-test testing all I/O and internal failures when operational.

The GEN 3 shall detect the following errors, at a minimum:

- Battery over and under normal operating voltage
- GEN 3 internal errors
- ROM checksum error
- All GEN 3 I/O for shorts to ground, shorts to B+, and open states.
- Missing CAN messages

The final list of self-diagnostic items must be reviewed and agreed to by Ford Motor Company, and documented within the GEN 3 Diagnostics Part 2 Specification.

8.1.1.1.2 MODULE CONFIGURATION AT EOL/SERVICE

The GEN 3 shall be configurable at Vehicle Assembly Plant EOL, via the HS-CAN network, for vehicle specific interfaces per the Module Programming & Configuration Design Specification.

The GEN 3 shall provide a means for re-configuration of its default parameters, vehicular interface data and software.

The GEN 3 shall be configurable upon receiving an I-CAN or HS-CAN request to enter diagnostic mode.

The configurable parameters shall be programmable at the supplier assembly line to the default configuration documented in the GEN 3 Part 2, Diagnostics Specification.

Specific configurations shall be provided based on vehicle-type and shall be documented in the GEN 3 Part 2, Diagnostics Specification.

Specific requirements shall be provided in the GEN 3 Part 2, Diagnostics Specification.

8.1.1.1.3 FLASH ROM REQUIREMENTS

The GEN 3 shall support the download of FLASH ROM for the VMCU over HS-CAN per the Module Programming and Configuration Design Specification.

The GEN 3 shall support erase all flash sector blocks and erase flash sector (n) commands for flashing.

9 TESTING REQUIREMENTS

9.1 ENVIRONMENTAL (NON-EMC) REQUIREMENTS

The GEN 3 Hardware Design supplier shall perform and provide a thermal characterization of the board for the range expected operational temperatures.

The GEN 3 supplier shall provide all required test collateral and tools required for testing the modules in the production facility.

The GEN 3 shall meet the climatic, mechanical, chemical resistance, and demonstrated life requirements listed in SDS EY-0128 E/E System Environmental (Non-EMC). The GEN 3 shall show compliance with these environmental requirements by testing in accordance with Ford Corporate Engineering Test Procedure CETP 00.00-E-412, Electrical and Electronic Component Environmental Compatibility Test, relevant requirements in this section, and Section 10 below, Validation Requirements.

Table 4.10, Design Verification Test Sequence, of the SDS specifies the environmental test flow sequence required.

The Environmental CETP 00.00-E-412 is a generic test procedure for all electronic components. Section 10, Validation Requirements, specifies what unique GEN 3 operational sequences shall be required, if any, during specific environmental test procedures.

Any proposed changes to the requirements, test flow and/or test conditions listed in the referenced WCR, CETP or this specification shall be discussed and agreed upon prior to supplier submission of the GEN 3 DVP, and must be approved by Ford Infotainment Core Engineering in writing.

9.2 ADDITIONAL REQUIREMENTS FOR TRANSPORT ROBUSTNESS

The GEN 3s, through the use of packaging, shall be robust to the stresses of shipment throughout the regular shipping process from the supplier's manufacturing plant to the Ford assembly plant. Passing the Transport Process Test in Section 10, Validation Requirements shall show compliance with this requirement.

9.3 KEY LIFE REQUIREMENTS

At a minimum, each GEN 3 and Media Connectivity Module shall meet the following key life requirements. Other key life requirements may be required as identified through the Ford Reliability Guide process.

9.3.1 GEN 3 TEMPERATURE REQUIREMENTS

Ford CETP 15.01-L-400, Component Level Thermal Management for Infotainment, shall be the component level test procedure used to show compliance with the following temperature requirements. Ford CETP 15.01-L-401, Vehicle Level Thermal Management for Infotainment, shall be the vehicle level test procedure used to show compliance with these requirements also. The GEN 3 shall pass both CETPs mentioned above to show compliance with the temperature requirements listed in this section.

The vehicle level test shall be performed by Ford engineering if required.

9.3.2 EXTERIOR SURFACE CONTACT TEMPERATURE

The GEN 3 shall not generate and/or dissipate heat such that its exterior surface temperatures exceed 95C +/- 2%. This test shall be performed at a 55°C ambient temperature condition. Surface temperatures greater than this requirement are acceptable only if the area is covered with a cage to protect against direct contact with the surface. Cage venting holes or openings shall not be greater than 10mm in diameter. This includes the base of the heat sink if the gap between fins is greater than 10mm. The exposed cage surface temperature shall also meet this requirement. Exterior dimensions of the Infotainment component shall not change due to the addition of a protective cage.

9.4 ELECTROMAGNETIC COMPATIBILITY CONFORMANCE (EMC)

The GEN 3 Hardware Design supplier shall conduct and provide a characterization of the GEN 3 hardware's EMC radiation profile during expected operation.

The GEN 3 shall meet the requirements specified in the *Electromagnetic Compatibility Specification For Electrical/Electronic Components and Subsystems: EMC-CS-2009.1*.

Per EMC-CS-2009.1, the (GEN 3) is

- Functional Importance Classification A
- Component Category A

The table contained in **Section 6.0** of EMC-CS-2009.1 defines the required tests.

The supplier AND Ford Motor Company shall

- choose which audio parameter(s) to measure and document them in the EMC test plan

The supplier shall

- quantify the degradation of the parameter(s) during testing

Final approval of the level of degradation shall be reserved to Ford Motor Company.

Component and Vehicle level test plans must be submitted and approved by Ford Motor Company, Core RVT EMC group prior to the start of testing.

EMC Testing must be conducted on a minimum of 3 production representative parts. These samples cannot be the same samples used for any other environmental test.

10 VALIDATION REQUIREMENTS

10.1 DESIGN VALIDATION (DV) REQUIREMENTS

The GEN 3 design(s) shall be validated to meet the requirements in this specification and all applicable requirements in the functional specifications. Specific test requirements and/or procedures delineated in this specification shall also apply.

Prior to the submission of a detailed Design Validation Plan (DVP), the supplier shall provide evidence (for example, a Requirements Traceability Matrix) that each requirement in this specification, referenced specifications, and functional and application specifications is traceable to a component or vehicle level DVP activity.

Prior to the start of design validation testing, the supplier shall submit a detailed Design Validation Plan (DVP) for Ford Infotainment Core Engineering approval. Ford Infotainment Core Engineering must approve the Design Validation Plan in writing. The DVP shall follow the format used in the DVP template provided by Ford Infotainment Core Engineering. A separate DVP shall be required for each unique GEN 3 design.

In addition to the testing requirements contained in this specification or referenced specifications, the supplier shall be responsible for ensuring that the Ford Reliability Guidelines (FRG) process is conducted to support the definition of the DVP. The DVP shall be amended to include any additional tests not already part of the DVP that are identified through the FRG process. This includes, but is not limited to, additional testing identified by the GEN 3 Failure Modes and Effects Analysis (FMEA), P-diagram analysis, Noise Factor Management Matrix analysis, Robustness and Reliability Checklist, and/or the Reliability Demonstration Matrix.

As noted in the Statement of Work, the component DVP is required to be completed prior to the start of the Verification Prototype build of the program.

The supplier shall submit 5 engineering samples or units to be tested prior to the start of DV testing.

After DV testing, the supplier shall submit a completed Design Validation Plan and Report (DVP&R) to Ford Infotainment Core Engineering for review and approval. Neat, organized and tabbed binder(s) with all supporting test procedures and data shall be provided to the Ford Infotainment Core Engineering department with the DVP&R results. All DVP&R information (test procedures, test results, etc.) shall be provided in English.

In the event that a failure occurs during DV testing, the supplier shall provide a Global 8D analysis for every failure. Ford Infotainment Core Engineering shall be notified of every DV failure within 24 hours of the occurrence of the failure. Ford Infotainment Core Engineering shall approve each Global 8D before it shall be considered closed.

The supplier shall maintain a master copy of the DVP&R information (including all supporting documentation) for the record retention time period required for Part Supply Warrant (PSW).

Ford Infotainment Core Engineering must approve the DVP&R results prior to the beginning of Production Validation. Any deviation to this sequence of events shall require Ford Infotainment Core Engineering and Ford Program(s) approval, and an approved timing/work plan provided by the supplier.

Measurements shall be made using standard test conditions and with all circuits performing their normal functions, unless otherwise specified. Test fixtures shall also use production connectors throughout the test, unless specified otherwise. The power supply shall be capable of supplying the continuous current per the design load and inrush currents, shall recover 63 percent of its maximum excursion with 100 milliseconds, and shall have a maximum 300-millivolt peak-to-peak ripple voltage.

For each test set-up, the following additional data shall be recorded:

- Name of test, name of person running test, date and time of test, location of test.
- For all instrumentation used in each test, list the manufacturer, model number, serial number, and Gauge R&R, including but not limited to all thermal chambers, measurement devices, power supplies, test loads, etc.
- Component part numbers, serial numbers. If no serial number exists on part, a unique number will be placed on the parts in such a way that it will survive testing and still be readable.
- A photograph of each test set-up.
- The temperature 2.5 centimeters away from the part, measured during test.
- The humidity near the part, measured during test.
- All discrepancies – whether or not they constitute a DV failure.
- Copies of the actual test recordings or data.
- Test pass/fail criteria.

Ford will not accept test results requiring unit conversion, interpretation of the meaning of the test results, or interpretation as to whether the test met Ford intent.

10.2 PRODUCTION VALIDATION (PV) REQUIREMENTS

The supplier shall test the Production Validation samples with the same Environmental and EMC tests used for the Design Validation tests. Any deviation to this test plan shall require Ford Infotainment Core Engineering and Ford Program(s) approval, and an approved timing/work plan provided by the supplier.

In addition to these testing requirements, the supplier shall be responsible for ensuring that the Ford Reliability Guidelines (FRG) process is conducted to support the definition of the Production Verification Plan (PVP). The PVP shall be amended to include any additional tests not already part of the PVP that are identified through the FRG process. This includes, but is not limited to, additional testing identified by the Process Failure Modes and Effects Analysis (PFMEA).

In the event that a failure occurs during PV testing, the supplier shall provide a Global 8D analysis for every failure. Ford Infotainment Core Engineering shall be notified of every DV failure within 24 hours of the occurrence of the failure. Ford Infotainment Core Engineering shall approve each Global 8D before it shall be considered closed.

10.3 IN-PROCESS (IP) REQUIREMENTS

In-Process (IP) tests are used to further understand the relationship between significant design and process characteristics and to establish a basis for continuing improvement.
Tests must be completed with production parts on an ongoing basis.
Sampling plans for both IP testing and evaluation of the significant process characteristics must be included in the Control Plan.
When the process is found to be out of control or the test acceptance criteria are not met, the reaction plan approved in the Control Plan shall be invoked.

10.4 SOFTWARE VALIDATION REQUIREMENTS

The software validation plans shall be subject to Ford NAE-EESE software department approval.

10.5 ENVIRONMENTAL NON-EMC:

The GEN 3 shall meet the climatic, mechanical, chemical resistance, and demonstrated life requirements listed in SDS EY-0128 E/E System Environmental (Non-EMC). The GEN 3 shall show compliance with these environmental requirements by testing in accordance with Ford Corporate Engineering Test Procedure CETP 00.00-E-412, Electrical and Electronic Component Environmental Compatibility Test.

Environmental Test Sequence shall be done as described by reference document Mini DV Group G or Mini DV Group H depending on if HALT testing is conducted or not. Sample sizes for each subgroup are listed in the table. A Worst Case Circuit Analysis must be performed and approved by Ford Infotainment Core Engineering in writing. A Finite Element Analysis and Thermal CFD study shall be performed and must be approved by Ford Infotainment Core Engineering in writing.

Any proposed changes to the requirements, test flow and/or test conditions listed in the referenced SDS EY-0128 E/E System Environmental (Non-EMC), CETP, or this specification shall be discussed and agreed upon prior to supplier submission of the GEN 3 DVP, and must be approved by Ford Infotainment Core Engineering in writing.

10.5.1 CLASSIFICATIONS

The GEN 3 and Media Connectivity Modules shall be tested to the relevant environmental classifications referenced in SDS EY-0128 E/E System Environmental (Non-EMC) and Ford Corporate Engineering Test Procedures, CETP 00.00-E-412 shown below:

Temperature:	Class I
Water/Fluid Ingress & Salt Mist:	Class II
Dust:	Class I
Chemical Resistance:	Class III
Vibration:	Class I
Mechanical Shock/Drop:	Class II

10.5.2 TEST TEMPERATURES

The following test temperatures (as denoted in SDS EY-0128 E/E System Environmental (Non-EMC)) shall be used as appropriate during testing:

T_1 = Minimum Operating Temperature = -40°C

T_2 = Maximum Operating Temperature = 85°C

T_3 = Low Temperature for Performance Evaluation = -40°C

T_4 = High Temperature for Performance Evaluation = 85°C

T_5 = Minimum Storage Temperature = -40°C

T_6 = Maximum Storage Temperature = 85°C

T_7 = High Temperature for Functional Evaluation = 85°C

T_N = Nominal Temperature = 20°C ± 15°C

10.5.3 TEST VOLTAGES

The following test voltage levels (as denoted in SDS EY-0128 E/E System Environmental (Non-EMC)) shall be used as appropriate during testing:

V_1 = Low Voltage of Guaranteed MS-CAN and HS-CAN Communication = 8.0 V

V_2 = High Voltage of Guaranteed MS-CAN and HS-CAN Communication = 16.0 V

V_3 = Low Voltage to meet all specification parameters = 10.0 V

V_4 = High Voltage to meet all specification parameters= 16.0 V

V_N = Normal or Nominal Voltage = 13.5 V

V_5 = Function Check Test Voltage = $V_N \pm 1.5V$

V_6 = Monitored Operation Test Voltage = $V_N \pm 0.5V$

Load dump voltage requirements are covered in reference 42.

10.5.4 ENVIRONMENTAL TESTS

The GEN 3 shall be tested in compliance with CETP 00.00-E-412, Electrical and Electronic Component Environmental Compatibility Test, which defines the test procedures for each test in each leg of the subgroups. If necessary, the operational sequences that shall be used during testing have been adjusted and/or clarified below. All operational sequences shall be provided by the supplier and approved by Ford Infotainment Core Engineering prior to approval of the GEN 3 DVP.

10.5.4.1 LOW TEMPERATURE OPERATION

Testing shall be accomplished per Section 5.2 of CETP 00.00-E-412.

10.5.4.2 HIGH TEMPERATURE OPERATION

Testing shall be accomplished per Section 5.4 of CETP 00.00-E-412.

10.5.4.3 POWERED THERMAL CYCLE

Testing shall be accomplished per Section 5.5 of CETP 00.00-E-412.

10.5.4.4 THERMAL SHOCK RESISTANCE

Testing shall be accomplished per Section 5.6 of CETP 00.00-E-412. No cracks, holes, or voids are allowed in the solder/coatings.

10.5.4.5 THERMAL SHOCK ENDURANCE

Testing shall be accomplished per Section 5.7 of CETP 00.00-E-412. The supplier Shall visually inspect the part every 250 cycles which includes pictures during the test and pictures for each test evaluation performed after the Thermal Shock Endurance.

10.5.4.6 HUMIDITY-TEMPERATURE CYCLE

Testing shall be accomplished per Section 5.8 of CETP 00.00-E-412.

Both condensing and non-condensing tests shall be performed.

10.5.4.7 POP SPILL TEST

The DUT design shall withstand the effects of Pop spilling during component use by the customer. Use regular Coca Cola.

10.5.4.7.1 VERIFICATION METHOD

10.5.4.7.1.1 TEST EQUIPMENT

1. Environment Chamber.

2. Test fixture (simulating in vehicle position and actuation) as per master package.

10.5.4.7.1.2 TEST PREPARATION

1. Set up the Environment Chamber to the respective temperature.

2. During the Chemical Resistance Test, DUT must be in the position simulating vehicle condition and "shielding" as per master package.

10.5.4.7.1.3 TEST PROCEDURE

1. Temperature: As shown in the Test Temperature Table. Select component temperature classification and by using this information the maximum temperature for exposure tests.

2. Test time: 96 hours.

10.5.4.7.1.3.1 TEST #1

1. Brush evenly a minimum of 100 milliliters of regular Cola and the specified chemical solutions (see table) onto the components surface where these chemicals can go to under normal operating conditions. You can use separate chemicals on different switch samples. List method of application in DVP and get signoff from Ford EESE.

3. Soak for 96 hours.

10.5.4.7.1.3.2 VALIDATION METHOD

1. After test completion must meet all functional requirements.

2. After Pop spill test DUT must perform per specification.

No cracking, crazing, spotting, staining or other deleterious effect shall be allowed. Using a fingernail or paperclip, gently rub the area to determine is softening has occurred. No film softening shall be allowed.

Module shall be functional.

Applicable chemicals should be appropriately selected based on analysis of vehicle environmental conditions, all possible vehicle design configurations and/or FMEA. The list of applicable chemicals and relevant component surface(s) to be tested must be specified in the component drawing and/or specification.

Appropriate duration shall be selected based on component FMA, FMEA and/or component functional and appearance requirements with respect to corrosion resistance.

10.5.4.8 CHEMICAL RESISTANCE TEST

The DUT design shall withstand the effects of chemical (cleaning products, etc.) encountered during component manufacture, vehicle assembly, service maintenance and during vehicle use by the customer. Testing shall be accomplished per CETP 00.00 E412 section 5.16. Please see below for the list of chemicals. This is a partial list and more chemicals can be added based on FMEA.

Vehicle Interior Components	List of Chemicals
Displays and MCM	1. Leather wax (pick any) 2. Antimist Spray (Holtz). 3. Car wash (pick any) 4. Deodourizer (Febreeze, you can pick any). 5. Coffee (pick any) 6. Tea (pick any) 7. Isopropyl Alcohal/ water, 50% v/v. 8. Vinyl Cleaner (pick any). 9. Suntan lotion (pick any, SPF 30).

	10. Sythetic Sweat (Amalgam with Butryric Acid). 11. Distilled/Deionized water (20 micro-ohm max conductivity at 25oC). 12. Window Cleaner (Windex). 13. Armorol. 14. Deep Woods Off

10.5.4.9 DUST

Testing shall be accomplished per Section 5.10 of CETP 00.00-E-412. Unit shall be non-operational throughout test. All mounting holes shall be covered, and a dummy connector used during the test.

10.5.4.10 POWERED VIBRATION (VIBRATION-SINE)

Testing shall be accomplished per Section 5.11 of CETP 00.00-E-412.

10.5.4.11 AUDIBLE NOISE UNDER VIBRATION

Testing shall be accomplished per (Audible Noise Vibration, Method A) of CETP 15.01-L-402

The supplier shall submit a master sample for audible noise to Ford for evaluation.

Units are to be tested in the vehicle mounting orientation and representative of customer usage. Four (4) Units shall be tested in vehicle mounting orientation with the brackets attached and representative of customer usage. Four (4) units shall be tested without the bracket and vehicle mounting orientation. For the above vibration profile, the NR2 shall not emit more than 2 Sones in the frequency range 300Hz to 20 kHz using a 300Hz HP filter.

10.5.4.12 MECHANICAL SHOCK

Testing shall be accomplished per Sections 5.13.4 (Low Mechanical Shock) of CETP 00.00-E-412.

Use following correction CETP 00.00-E-412, pg 36, section 5.14.2.3:

Use 4kg (39.2N) instead of 4g (39.2m/s^2).

10.5.4.13 CONNECTOR LEAD/LOCK STRENGTH

Testing shall be accomplished per Sections 5.14.1 (Connector Push Test), 5.14.2 (Connector Torque Test), 5.14.3 (Connector Durability Test), and 5.14.4 (Lead/Lock Pull Test) of CETP 00.00-E-412.

10.5.4.14 GEN 3 ASSEMBLY TESTING

This is an optional test performed based on vehicle specific requirements for bracket assemblies. This test is to be performed per Section 5.11 of CETP 00.00-E-412. Resonance frequency measurements before and after, in all directions, shall be documented in evidence binder. The GEN 3 audible noise testing will be performed per 13.5.4.12. Ford and supplier team will review the data to assess the suitability of design for vehicle application during Development Validation (DV) phase. During production validation phase (PV), this data will be generated for information only. There is no Pass/Fail criterion for DV and PV tests, simply concurrence by the Ford and supplier team that the design is acceptable

10.5.4.15 PACKAGE DROP TEST

Testing shall be accomplished per Section 5.13.1 of CETP 00.00-E-412.

10.5.4.16 CHEMICAL RESISTANCE

Testing shall be accomplished per Section 5.16 of CETP 00.00-E-412.

10.5.4.17 HIGH TEMPERATURE ENDURANCE

Testing shall be accomplished per Section 5.17 of CETP 00.00-E-412. However, test will be waived if a Worst Case Circuit Analysis (WCCA) is performed and signed off by both the Ford Reliability Engineer and Ford GEN 3 D&R Engineer prior to the start of environmental testing.

10.5.4.18 HIGH TEMPERATURE/HUMIDITY ENDURANCE

Except for the following paragraph, please refer to CETP 00.00-E412 for this test procedure.

This test shall be performed with GEN 3 and Display modules attached together with all their housing/casing on.

Operate the Component continuously at the specified load at 75°C and 85% RH for 300 hours. If a failure occurs, the rest of the units shall continue testing for a total test time of 600 hours. The component shall operate properly throughout the test with the following operational sequence: Cycle between different modes every 10 hours until the end of the test sequence. Component shall operate properly throughout the test. This test shall be performed at with GEN 3 and Display modules attached together with all their housing/casing on.

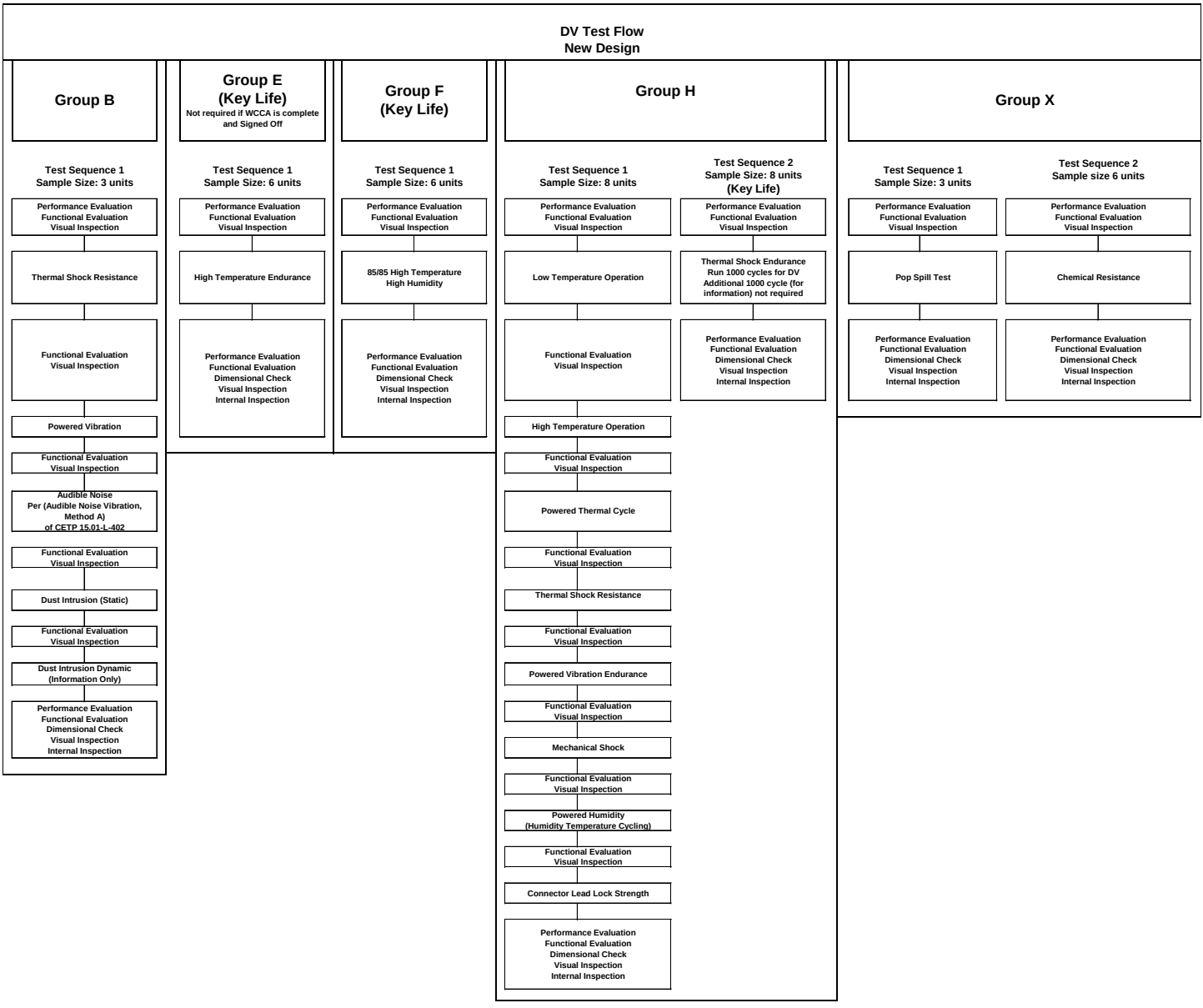
10.5.5 ENVIRONMENTAL PERFORMANCE, FUNCTION AND INSPECTION EVALUATIONS

SDS EY-0128 E/E System Environmental (Non-EMC) requires Performance, Function, and Inspection evaluations (Table 3.3, Specification of Performance, Function and Visual Evaluations). Each type of evaluation (Performance Evaluation, Functional Check, Monitored Operation, Functional Evaluation, Visual Check, and Internal Inspection) procedure and acceptance criteria shall be agreed upon between the supplier and Ford Infotainment Core Engineering as part of approval of the GEN 3 DVP.

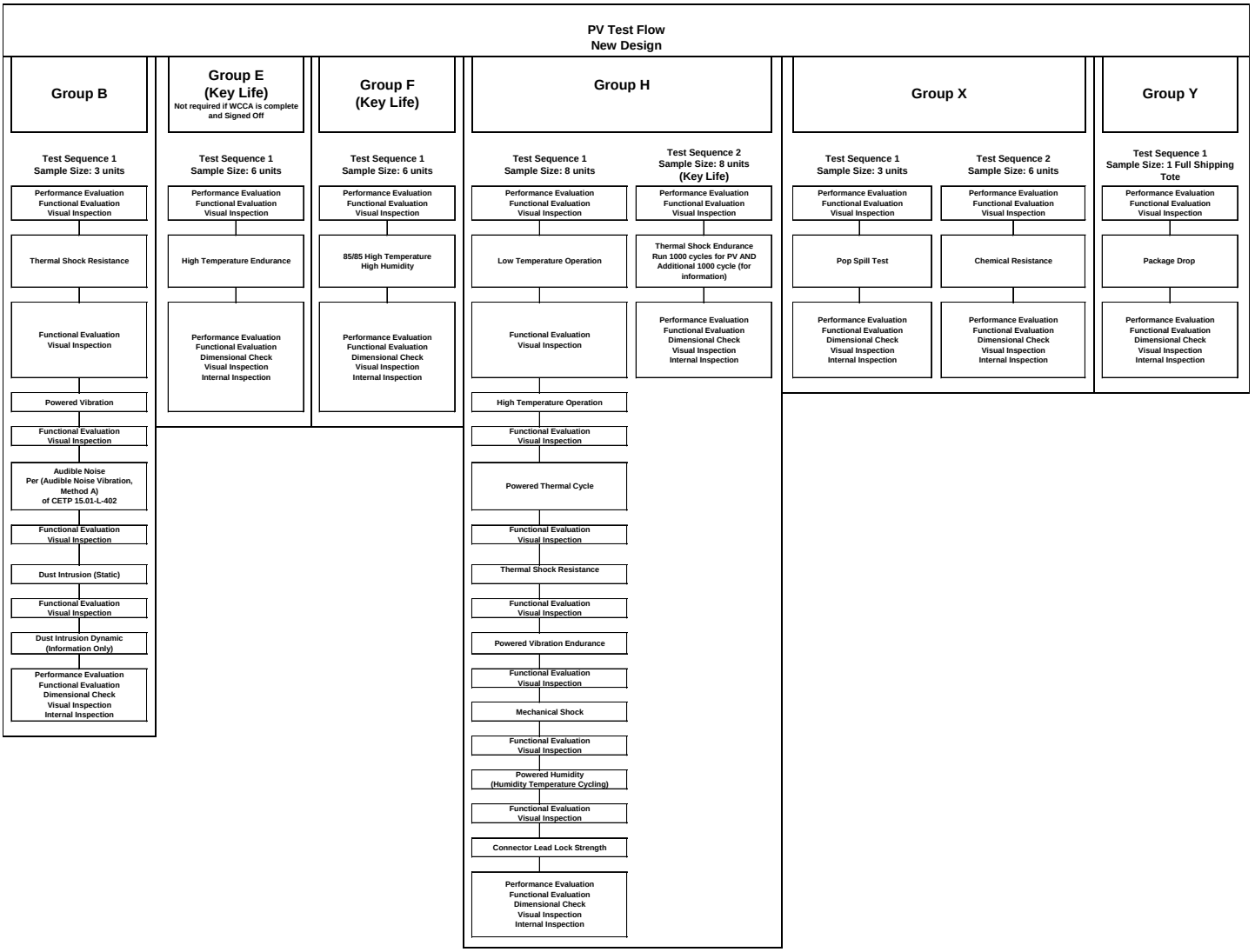
10.5.6 ENVIRONMENTAL TEST FLOW SEQUENCE

As stated previously in this specification, the Environmental test flow sequences are governed by SDS EY-0128, CETP 00.00-E-412, and requirements within this specification. The Environmental Test Flow Sequence requirements are depicted in the pictorial below to provide additional clarification. The Environmental Test Flow Sequence shown below shall be run during both DV and PV.

10.5.6.1 DV TEST FLOW



10.5.6.2 PV TEST FLOW



10.5.7 ENVIRONMENTAL TEST EVALUATIONS

Evaluations contained in Table 10-1~~Table 10-1~~ are to be performed prior to and following environmental tests as indicated in the environmental test flow in Section 0. These tables shall be used as references for quoting purposes, all final testing requirements shall be based on a intended design. A final table shall be created with the supplier and Ford Motor Company which shall be used during DV and PV testing.

Table 10-1: Environmental Test Evaluations

Evaluation Method	Parameter Measured	Pass/Fail Criteria
Monitor During Test (M)	Current draw in Functional state	limits are not exceeded
Monitor During Test (M)	**Verify Tx/Rx of CAN transceiver**	Successful Tx/Rx of valid CAN messages
Visual Check	Visual signs of deterioration, part dimensions	No visible signs of deterioration or damage. Perform dimensional measurements to ensure part is within dimensional specification. Visual Checks shall be performed at 2 hrs and 24 hrs following each environmental test.
Performance Evaluation	**Verify Tx/Rx of CAN transceiver**	Successful Tx/Rx of valid CAN messages
Performance Evaluation	Sleep Current Draw	limits are not exceeded
Performance Evaluation	Functional Current Draw	limits are not exceeded
Functional Evaluation	**Verify Tx/Rx of CAN transceiver**	Successful Tx/Rx of valid CAN messages
Internal Inspection	**Visual signs of deterioration. Internal inspections shall be performed at 2 hrs and 24 hrs following the environmental tests.**	Inspect internal components and evaluate the condition of electrical interfaces and connections. No cracks, holes, or voids are allowed in the solder/coatings. No signs of water or water damage.

NOTE: The above table is for example only. The final Functional Check tests shall be defined in the DVP&R and jointly agreed to by Ford Motor Company and the supplier.

10.5.8 ENVIRONMENTAL PERFORMANCE, FUNCTION AND INSPECTION EVALUATIONS

SDS EY-0128 requires Performance, Function, and Inspection evaluations (Table 3.3, Specification of Performance, Function and Visual Evaluations). Each type of evaluation (Performance Evaluation, Functional Check, Monitored Operation, Functional Evaluation, Visual Check, and Internal Inspection) procedure and acceptance criteria shall be agreed upon between the supplier and Ford Infotainment Core Engineering as part of approval of the GEN 3 DVP.

10.5.9 DV/PV FUNCTIONAL TESTS

Table 10-2: DV/PV Functional Tests

Evaluation Method	Parameter Measured	Pass/Fail Criteria
Monitor During Test	Current draw in Power Awake Active state	GEN 3 Power Mode ES Power Awake Active state Requirements
Monitor During Test	Verify Tx/Rx of CAN transceiver	Successful Tx/Rx of CAN message
Monitor During Test	Antenna DC output Voltage	See Section 6.3.1
Functional Check	Visual Inspection	No visible cracks or damage
Functional Check*	Output Level @ 1 kHz (0.0 dBfs and another point, to be approved in DV test plan, to prove linearity)	IESS Audio Output Requirements
Functional Check*	Channel Separation @ 100 Hz, 1 kHz, 10 kHz	IESS Audio Output Requirements
Functional Check*	Frequency Response	IESS Audio Output Requirements
Functional Check*	Output Signal-to-Noise Ratio	IESS Audio Output Requirements
Performance Evaluation	Visual Inspection	No visible cracks or damage
Performance Evaluation	Sleep Current Draw	GEN 3 Power Mode ES Sleep

		Current Draw Requirements
Performance Evaluation	Awake Active Current Draw	GEN 3 Power Mode ES Awake Active current draw Requirements
Performance Evaluation	Output Level @ 1 kHz (0.0 dBfs and another point, to be approved in DV test plan, to prove linearity)	GEN 3 Audio Output Requirements
Performance Evaluation	Channel Separation @ 100 Hz, 1 kHz, 10 kHz	GEN 3 Audio Output Requirements
Performance Evaluation	Total Harmonic Distortion Plus Noise	GEN 3 Audio Output Requirements
Performance Evaluation	Single Ended Output Resistance	GEN 3 Audio Output Requirements
Performance Evaluation	Single Ended Output Resistance Worst Case Balance Error on any single ACM, %	GEN 3 Audio Output Requirements
Performance Evaluation	Frequency Response	GEN 3 Audio Output Requirements
Performance Evaluation	Output Signal-to-Noise Ratio	GEN 3 Audio Output Requirements
Performance Evaluation	Antenna DC output Voltage	See Section 6.3.1
Functional Evaluation	Verify Tx/Rx of CAN transceiver	Successful Tx/Rx of CAN message

*Data in the format of plots to be provided to back-up pass/fail criteria over time.

NOTE: The above table is for example only. The final Functional Check tests shall be defined in the DVP&R and jointly agreed to by Ford Motor Company and the supplier.

10.5.10 IP FUNCTIONAL CHECKS

Table 10-3: IP Functional Checks

Parameter Measured	Pass/Fail Criteria	Sample Size/Frequency
Current draw in Power Awake Active state	item 4	Refer to Control Plan
Verify Tx/Rx of CAN transceiver	Successful Tx/Rx of CAN message	Refer to Control Plan
Visual Inspection	No visible cracks or damage	Refer to Control Plan
Output Level @ 1 kHz (0.0 dBfs)	item 1	Refer to Control Plan
Channel Separation @ 100 Hz, 1 kHz, 10 kHz	item 2	Refer to Control Plan
Frequency Response	item 7	Refer to Control Plan
Output Signal-to-Noise Ratio	item 8	Refer to Control Plan

NOTE: The above table is for example only. The final IP Functional tests shall be jointly agreed to by Ford Motor Company and the supplier and this table shall be updated.

10.6 REVALIDATION REQUIREMENTS

- The manufacturing source and the design-responsible EESE will jointly determine which potential changes to the process, materials or material sources would have significant impact on the product's function, performance, durability or appearance.
- The supplier will describe these conditions in the Control Plan, along with either:
  - The revalidation plan that would be followed in each case, or
  - A provision to submit an amended Control Plan for approval if any of those process changes are planned.
- No change to processing may be allowed without the prior approval of the process changes and the attendant control plan changes.

- The Control Plan must include a provision that, for any significant change in processing and the manufacturing location (internal or supplier) shall jointly determine if PV re-testing is required, and, if so, to what degree, i.e., Full or Mini-PV.

11 INSTRUCTION AND NOTES

11.1 CONTROL PLANS

- Control Plans address all significant design and process characteristics, which include all Verification and functional tests and Control Item characteristics.
  - They describe the process potential studies that will be performed for product validation (including PV tests) and the ongoing product and process evaluation for continuing improvement (including IP tests).
  - They include acceptance criteria, sample sizes, frequencies, data analysis, methods, and reaction plans.
- The Control Plan is developed, and updated as necessary, by the manufacturing source in conjunction with the design responsible EESE and other appropriate functions such as STA.
- The Control Plan defines the management of the upstream production process and part variables (significant process characteristics) that affect the outcome of the Verification tests or other significant design characteristics.
- The control plan also identifies the specific Verification tests, with their sample sizes and frequencies, that will be performed in order to:
  - Confirm whether the process is being managed effectively.
  - Further identify significant process characteristics.
  - Evaluate performance of marginal processes.
  - Better anticipate the customer effect of proposed process improvements.
- For any part on which verification tests have been specified, the manufacturing source must present the Control Plan and any revisions to the STA for approval.
- Examples of formats for Control Plans are shown in Quality System Standard Q-101, and Planning for Quality.

11.2 SERVICE GOALS

- The engineering tests, sample sizes, and test frequencies contained within this Functional Specification reflect the minimum requirements established to provide a regular evaluation of conformance to design intent.
- The design intent is to have GEN 3 assemblies that provide service in accordance to the specification requirements detailed in this document for a period of 10 years or 150,000 miles.

11.3 RECORD RETENTION

- Recording and record retention shall conform to Ford Q-101, "Records".
- Samples used by the supplier to demonstrate compliance with the "Production Validation" portion of this specification must be retained by the supplier for the balance of part production or until replaced by samples from a more recent "Production Validation" tests.
- Data from "Production Validation" tests, "In-Process" tests, and "Plant Returns" are to be retained for 5 years and be made available to appropriate Ford Automotive System representatives upon request.
- Additionally, EQI (Early Quality Indicator) data shall be sent to the appropriate Ford Engineering Group and STA representatives on a monthly basis for the entire duration of part production.
- Format for data submission shall be approved by Ford STA.
- Ongoing process capability (Cpk) information on all significant characteristics is due quarterly to Ford STA.

11.4 FAILURE ANALYSIS

- The GEN 3 supplier is required, on a weekly basis, to analyze all in-line fall-outs, not only at the assembly level, but also at the component level; from incoming inspection to the shipping dock.
- In addition, the GEN 3 supplier is required to continuously analyze and report upon, on a monthly basis, all Ford plant and Field Returns.
- The supplier shall on a timely basis define the fall-out rationale, establish most probable cause, establish corrective action, and verify such action is effective, prior to permanent implementation, using statistically significant data. Additionally, verify such action is effective, after permanent implementation, using statistically significant data before and after such action is implemented.
- Any new concern or recurring concern, for which corrective action had been implemented, found during this analysis program shall be reported to the STA according to the following schedule. (From date of concern or receipt of part.)
    - In-Process fall-out (concern) - 2 working days.
    - Ford Plant or special fall-out (concern) - 5 working days.
    - Field return fall-out (concern) - 10 working days.
    - Report shall include problem description and action plan for resolution with expected timing and will be followed by verification of resolution. Refer to QS-9000 for full description of expected Problem Solving Methods (8 Disciplines).

11.5 APPROVAL LIST

- Ford Motor Company STA approval will be required for compliance with specifications and associated drawings.
- The supplier shall make available for STA approval the following documents:
  - Manufacturing process flow charts.
  - Plant manufacturing process layout.
  - Manufacturing station aids/instruction sheets.
  - In-Process equipment sign-off lists.
  - Repair/rework procedures.
  - Test equipment list/test procedures/test fixture drawings/installation plan/operating procedure.
  - Incoming inspection procedures.
  - Statistical process control procedures/charts.
  - Procedure for plant traceability of assembly shipments by date code and lot.
  - Certificates of analysis and compliance for all incoming materials.
  - Design and process FMEA's.
  - PV report/test data.

11.6 INITIAL PRODUCTION

- The term "initial production" parts shall mean units, which have production level components which have been produced by the production tools and assembled in a sequence and technique equivalent to that used in final production.
- The term "composition" shall mean sub-assembly component brand, rating or value, as well as general material composition and supplier.

11.7 FMEA

- Failure Mode and Effect Analyses (FMEA's) at the component and all assembly levels shall be completed and submitted to the STA for review and approval which conforms to manufacturing practice 203 or Potential Failure Mode and Effects Analysis for Manufacturing and Assembly Process (Process FMEA) Instruction Manual, Ford Manufacturing Staff.

11.8 SUPPLIER SUBMISSION TO FORD BEFORE PSW

- At least two Weeks prior to PSW, the production supplier must submit two full sets of component specifications, detail drawings, part/source list, functional test results from the PV testing and twelve master samples of each assembly to Ford Motor Company.
- These drawings and specifications will be signed and dated by the responsible FORD design engineer upon approval.

- One set of material and at least two master samples will be returned to the supplier to be kept at the manufacturing facility being made available to Ford STA for review upon request.
- Any request for modification to these prints, part/supplier list, component processing, testing procedures, or deviations from the approved control plan must be submitted on a Supplier Request for Engineering Approval Form (SREA Form 1638).
- The approved production supplier shall develop a control plan that conforms to Ford standards. At least two weeks prior to PSW submission, it will be submitted to Ford STA for approval prior to PSW.
- Prior to submission of the control plan to the Ford STA for approval, the supplier shall also obtain the approval of the Manufacturing Plant Quality Control Manager.

11.9 PACKAGING

- Production shipment packaging must conform to Production Parts Packaging and Shipping Guide (Material Handling Engineering - Manufacturing Engineering and Systems Office) and must meet the requirements of the pre-shipment packaging tests in Chapter 12 of the guide.

11.10 TEST EQUIPMENT AND PROCEDURES

- Supplier shall document the test equipment and testing procedures to be followed per test requirements. Accuracy of test equipment shall be indicated.
- Alternate test equipment can be utilized in the event that primary equipment may malfunction. The document shall indicate the time interval between calibration, items used for calibration, and any other pertinent information.

11.11 FS TEST FAILURE

- In the event of FS Test Failure, the supplier shall adhere to the following directions:
  - Shipments shall stop.
  - The consumer location shall be notified.
  - The responsible Ford Reception Group must be notified within 24 hours.
  - All corrective actions must be verbally approved by the responsible Ford Engineer prior to resumption of shipments.
- If these requirements conflict with reaction plans in a control plan signed by the responsible Ford Reception Group and STA, the control plan supersedes the above requirements.

11.12 MARKING OF RECYCLABLE MATERIAL

- All materials shall be optimized for recyclables to provide maximum end of life.
- Recycled content shall be reported to the approving and procuring materials engineering department(s) using the Recycled Content Form

- Marking symbols shall appear centered within the symbols, ><, with letters 3.0 mm high.
- Markings shall be in a visible location during the assembly process.
- The detail drawing shall carry the following note: "Legible plastic compound identification symbol, must appear on this surface. It can be raised or depressed 0.3 - 0.4mm and must not affect appearance, function, or assembly of the module. Omission requires engineering approval."

12 REFERENCES

The requirements of the documents listed in the reference tables below, of the latest revision level, form a part of this Engineering Specification.

Reference Title	Document Comment / Location
ReqSTD-2013-04-04-09-22.pdf	Requirement report compilation of multiple requirements
ReqSTD-2013-04-04-09-28.pdf	Requirement report compilation of multiple requirements
Electrical/Electronic ARL V.37	
Electrical and Electronic Component Environmental Compatibility Test: **CETP: 00.00-E-412**	
Component Level Thermal Management for Multimedia: **CETP: 15.01-L-400**	
Vehicle Level Thermal Management for Multimedia: **CTEP: 15.01-L-401**	
Service ARL V.34	
Packaging and Shipping Guide Rev 1.0, FCSD-PSL-PKG-G-004.pdf	
Restricted Substance Management Standard: **WSS-M99P9999-A1**	
Electrical Distribution System SDS	
NETCom HW Checklist	
Electromagnetic Compatibility Specification For Electrical/Electronics Components and Subsystems	www.fordemc.com
SDS EY-0128 E/E System Environmental (Non-EMC)	
Mirror Mounted Microphone Functional Specification: FS4F1T-19A391-AX	
SYNC Module Mechanical Drawing	
Branding Directive E108	
Eng CAD and Drafting Stds E-3v20	
IP-0044 Natural Frequency – Mounted Subsystems	
IE-0931 Thermal – Component Exterior Surface Temperature	
IE-0205 EU Regulation 594/91 (Environmental) Compliance	
CETP CP.SC-L-005 SYNC Hands Free Phone System Performance	

13 REVISION HISTORY

Date	Version	Created/Modified By	Notes

Date	Version	Created/Modified By	Notes
March 27, 2013	1.0	David Orris / dorris	Initial Version
March 27, 2013	1.1	David Orris / dorris	Updated to first release for review
April 4, 2013	1.12	David Orris / dorris	Minor editorial and typographical corrections
April 5, 2013	1.13	David Orris / dorris	**Section 2** updated Figure 2-1; **Section 2.2** added *and vice versa*; **Section 2.3** change voice fonts to *voice/TTS acouts model*, added *The GEN 3 shall be designed to support varying storage capacities including 4GB, 8GB, 16GB, 32GB, and 64GB. The production storage capacity configuration(s) shall be determined during the development phase.*; **Section 2.11** added *The GEN 3 module shall support a 3D gyroscope for enhanced dead reckoning.*; **Section 4.5.1** added *Pin 32 Mic Shield*; **Section 6** added *and from unauthorized access via any vehicle buses*; **Section 7.3.1.10** removed *Ad Hock* added *Support infrastructure modes for client STA, plus Wi-Fi Direct. Additional certification such as HS2.0/PassPoint are beyond the scope of this document* **Section 7.3.1.12** added *Full featured PC Monitoring suite for issue debugging/resolution via connection to the system hardware. Example features for the monitoring tool are listed below:* ○ *GPS configuration and control* ○ *Structured data visualization in real-time* ▪ *Message, binary and text output* ▪ *Tabular outputs with on-line statistics* ○ *Graphical data visualization with zooming, panning and scaling functions:* ▪ *2-dimensional plots from large choice of data sets* ▪ *Sky plots* ▪ *Deviation map* ○ *Visualization with maps* ○ *GPS Camera View: photographic data can be stored in the log file together with the navigation data and later be replayed in the application.* ○ *Export data files to Google Earth and Google Maps* ○ *Docking views (real-time cockpit instrumentation displays):*

Date	Version	Created/Modified By	Notes
			▪ *Satellite constellation* ▪ *Compass* ▪ *Clock* ▪ *Altimeter* ▪ *Speedometer* ▪ *Satellite and GPS information panels* ○ *Data recorder and playback* *Full Copy Paste Support to transfer information to standard PC application software*; **Section: various** removed references to MS-CAN and the MCM and minor grammar corrections
June 5, 2013	1.14	David Orris/dorris	General Figure numbering updates **2.11** The GEN 3 module shall support a 3D gyroscope for enhanced dead reckoning **4.5.1** added SPDIF shield pin **4.5.4** updated to Rosenberger LVDS connector and pinout **7.3.1.1** added note regarding operation below 8V **7.3.1.2** Item 3 updated to 3A **7.3.1.4.5** Clarification to SPDIF output that both I2S and SPDIF may be supported **7.3.1.4.6** Corrected reference to AHU to be AUX **7.3.1.4.6.1** Updated title and removed some redundancy **7.3.1.7.1** Updated display interface description **7.3.1.12.2** Added: Any additional sensors to obtain acceptable positioning / dead reckoning performance in 3 dimensions shall be implemented in the hardware. Positioning and guidance accuracy requirements are beyond the scope of this document.
October 17, 2013	1.15	David Orris / dorris	Updated module name to SYNC Gen 3 in the document title and throughout the document **Figure 2-1:** Updated to reflect design **2.1** updated to reflect proper QNX version **2.2** grammar updates **2.3** grammar and corrected memory densities **2.8.2** eliminated SPDIF refrences **2.9** updated video inputs to two from three **2.9.2** eliminated DVD input **2.11** updated language to include accelerometer **Figure 3.1:** updated to reflect RTC source **4.5.1** updated to reflect deletion of DVD input and SPDIF

Date	Version	Created/Modified By	Notes
			output **4.5.5** updated connector part number and drawing to reflect “C” key code **7.3.1.2** Added; The output to the display shall not exceed 21V under any condition. Deleted; All GFS Module Power shall be branched from a 3.3V supply rail. This rail shall be the source for all other derived power rails required by the module. Added Clarification: The power feeds to the MCM and Display shall be isolated from the GEN 3 module bulk capacitance to prevent these modules from dissipating the charge stored in Gen 3 bulk capacitance. **7.3.1.4.4** Added: The GEN 3 shall adhere to noise floor requirements to avoid issues with a full mute at volume step zero and transitioning to a "hiss" at volume step 1. This shall be avoided. When playing a silent* mp3 file the A-weighted rms output noise voltage shall not exceed the limits as outlined below. *Ford can provide the reference file Room Temperature (25°C ±3°C) Limit: Vnomloudnoise < 110µVrms Performance Operating Temperature Limit: Vnomloudnoise < 110µVrms (65°C ±3°C, -30°C ±3°C) **7.3.1.4.5** deleted section “Digital Audio Outputs” **7.3.1.6.4.4** deleted section “Noise Cancellation and Reduction” see specification P17 for related requirements **7.3.1.7** eliminated DVD input **7.3.1.7.2** eliminated DVD input **7.3.1.12.2** Added: There are multiple antenna configuration that the receiver shall be capable of interfacing to: • Stand-alone GPS antenna • GPS / SDARS combo antenna o Direct connection to this antenna without SDARS band notch filter o Connection to a signal splitter with SDARS band notch filter • GPS / GLONASS combo antenna The receiver shall have appropriate out of band filtering

Date	Version	Created/Modified By	Notes
			on the input to avoid any out of band signals from saturating the LNA or effectively negating the GNSS signals. The GEN 3 module shall be able to detect and report open circuits, and shorts circuits on the antenna connection. **7.3.1.12.2.1** updated antenna supply current to 150mA