SiBEAM
A Lattice Semiconductor Technology

LATTICE SEMICONDUCTOR

MOD6320-T WirelessHD Transmitter Module

Data Sheet

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Glossary

A glossary of terms used in this document.

Acronym	Definition
BB	Baseband
CBUS	Control Bus
DDC	Display Data Channel
eBUS	Enhanced CBUS
EDID	Extended Display Identification Data
ESD	Electrostatic Discharge
FPC	Flexible PCB Cable
FS	Full Speed
HDCP	High-bandwidth Digital Content Protection
HDMI	High-Definition Multimedia Interface
HPD	Hot Plug Detect
HRTR	Defined in the WirelessHD specification. A device that is capable to both transmit and receive the High Rate PHY (HRP).
HRTX	Defined in the WirelessHD specification. A device that is capable of transmitting the High Rate PHY.
HS	High Speed
I^2C	Inter-Integrated Circuit
LS	Low Speed
MHL	Mobile High-Definition Link
MISO	Master In Slave Out
MOSI	Master Out Slave In
OTP	One Time Programmable
RF	Radio Frequency
SPI	Serial Peripheral Interface
SS	Super Speed
TDM	Time-Division Multiplexing
DSC	Display Stream Compression

1. General Description

The MOD6320-T/MOD6320-4K-T WirelessHD Transmitter Module, also known as SK63102A, is a WirelessHD module for highly integrated video source devices and transmitter adapters. The transmitter module provides a digital audio video interface compatible with HDMI, which allows the transmission of high quality video (up to 1080p or 4K) to any WirelessHD-compliant receiver. End consumers can use a system equipped with this module to wirelessly connect their high quality video sources to WirelessHD DTV or WirelessHD receiver adapters by bringing them within range and powering them on.

The MOD6320-T module fits into a variety of industrial designs. Stand-alone software features and user interfaces are predefined; therefore, no software customization at the module level is required to achieve a complete WirelessHD transmitter system independent from the wired connectivity offered.

The MOD6320-T module is a completely self-contained autonomous WirelessHD subsystem that connects to a system board that provides the wired connectivity from a single port to a full featured multiport, multi-standard system. The advantage of this design is that the complexity of the wireless system, radio performance, regulatory requirements, and compliance to standards are all eliminated. This system interface carries video, audio, power, and control signals. The module is precertified and is fully tested for fast time-to-market.

1.1. Applications

- Transmitter adapters
- Multiport transmitter
- Cell phone dock station
- Media player
- Blu-ray player
- AV receiver
- Set top boxes
- Commercial, industrial, and medical video sources e.g. camera, video processor, or video distribution applications

1.2. Features

- WirelessHD V 1.1 compliant device
- 60 GHz interference free link for uncompromised video quality
- Small form factor module
- Wide support for video resolutions
  - VGA through WUXGA
  - 480i/576i to 1080p/60 Hz (MOD6320-T)
  - 480i/576i to 4K/30 Hz (MOD6320-4K-T)
  - 3D video support 720p/1080p
- Subframe latency video for real time control of interactive content, such as video games
- Support for surround sound audio
- Support for CEC or AVC commands
- Content protection for displaying DVD and Blu-ray movies
- Automated advance power control for energy saving energy

2. Module Program Deliverables

- Evaluation hardware is available. Contact Lattice Semiconductor distributors for more information on starter kit availability.
- Transmitter module with the SiI6320 HRTX network processor and the SiI6310 HRTR RF transceiver
- Module data sheet
- I/O board reference schematic for connecting to the module
- Mounting bracket and thermal plate reference
- Control/debug interface connector and cable specification
- Turnkey factory test setting and tools (SWAM3)
- FPC schematics and layout

3. Module Features

- SiI6320 HRTX network processor
- SiI6310 HRTR RF transceiver
- Standalone operation
- Automatic WirelessHD network management
- Automatic advance power management control
- I^2C port for advance features and in-system firmware update from system board
- Integrated USB debug access port with driver and tool suite
- Operates at single 3.3 V
- High density single connector for Flexible PCB cable connection, or board to board connection
- Integrated UI port for status LED and button
- Certified for major worldwide regulations

4. Mechanical Definition

4.1. Module Dimensions

The small footprint of the MOD6320-T module allows for placement in various industrial designs.

The MOD6320-T module PCB board dimensions are 74 mm x 17 mm x 5.4 mm.

The MOD6320-T module is intended to be mounted to a system chassis with ISO 7045:2011 M2x0.4 pan head screws with type H or type Z cross recess.

The MOD6320-T module comes with mounting features for direct assembly to a predefined metal bracket, providing thermal conductivity, grounding planes, positioning pins, and radio emission protection.

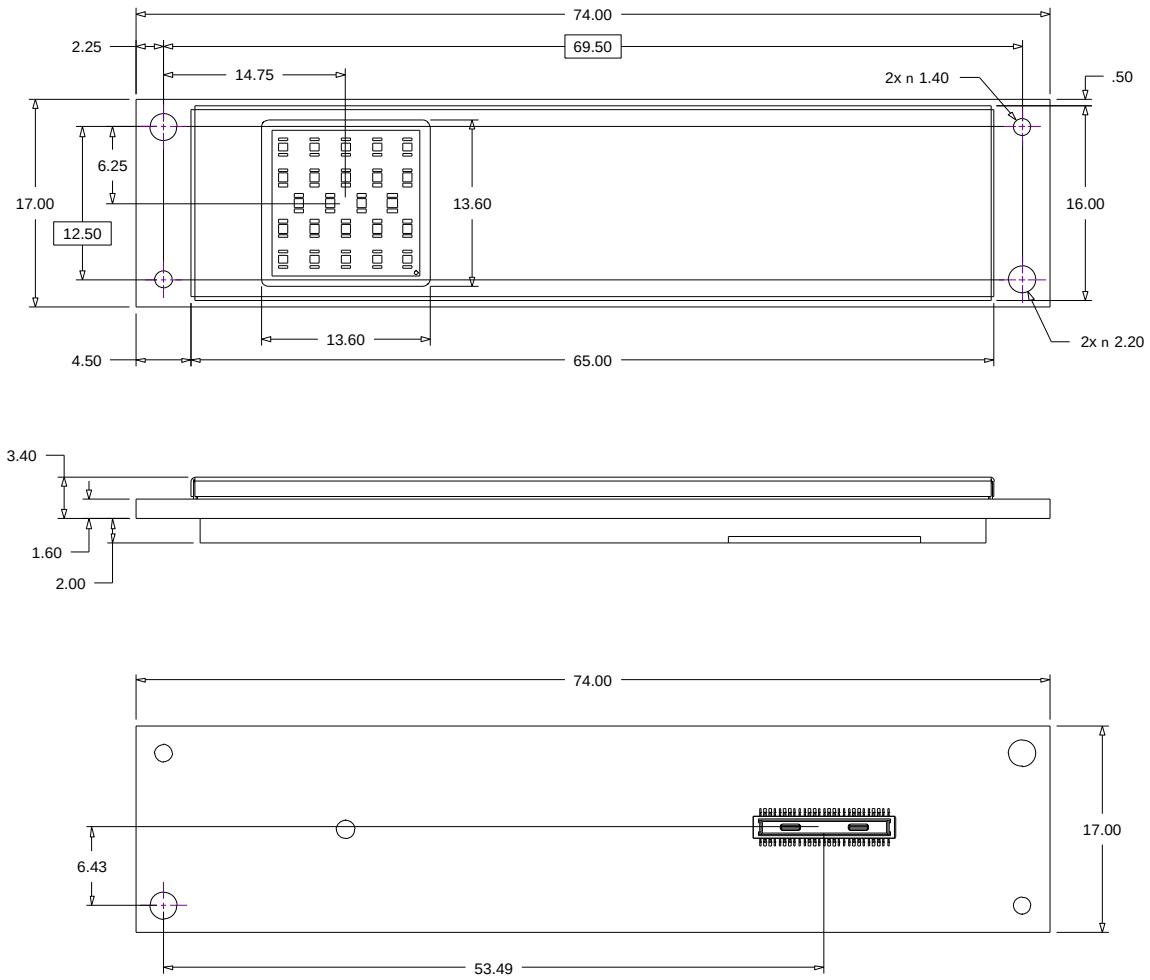


Figure 4.1. Module PCB Mechanical Dimensions

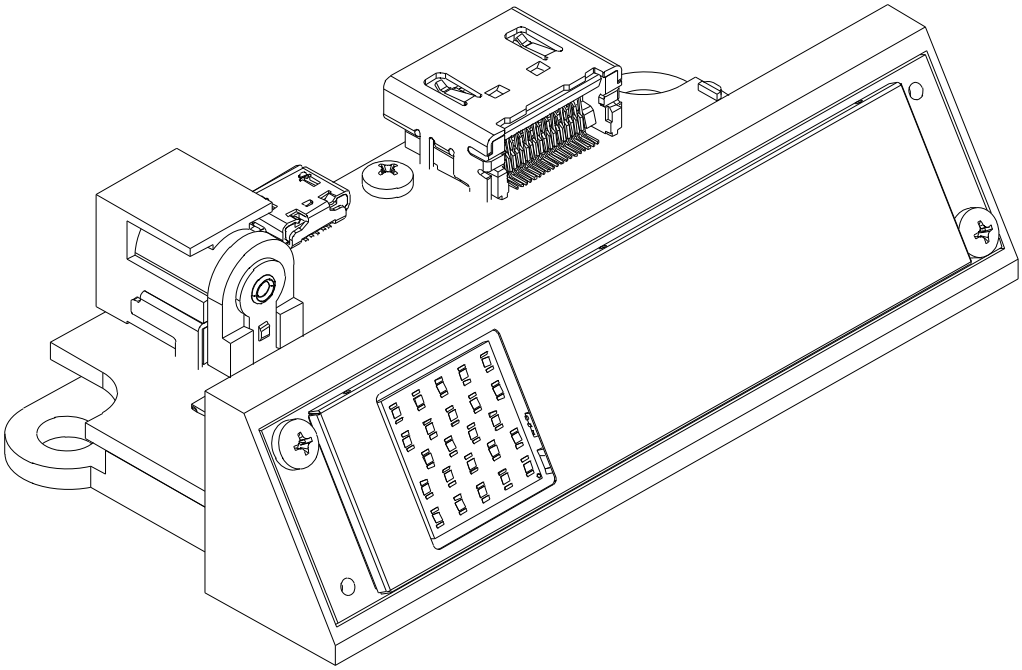


Figure 4.2. Module Installation Example in a Single Port Adapter System

4.2. Module Interface Connector

The module is designed to be connected to the system board through a single board to board connector.

On the module side:

- The connector type: DF40 from Hirose
- Part number: DF40C-50DP-0.4V (51)
- Description: dual row board to board receptacle (plug), 0.4 mm pitch, 50 pins

On the system side, the following connector should be used to mate with the module.

On the system side:

- The connector type is: DF40 from Hirose
- Part number: DF40C-50DS-0.4V(51)
- Description: dual row board to board socket, 0.4 mm pitch, 50 pins

4.3. Module/System Cable

One practical example of connecting the module to a system is to use a Flexible PCB Cable (FPC) solution.

This solution has been qualified by SiBEAM with the following considerations:

- Three-layer FPC with signals on the inner copper layer and ground plane on the bottom and top layers.
- Signals are routed with :
  - Four 100 Ω differential pairs at 3.6 mil trace/6 mil space
  - One 90 Ω differential pair at 4 mil trace/4 mil space
  - Single-ended traces at 4 mil trace/8 mil space
- Cable dimension:
  - Width: W = 15 mm
  - Length: L < 100 mm
  - Thickness: Z < 0.4 mm

This particular implementation has been tested with cable length up to 100 mm and gives successful HDMI eye pattern test up to 1080p60 Hz when used with Silicon Image I/O reference system board. It also provides sufficient radiation control to satisfy most regulation requirements.

Table 4.1. FPC Cable Three Layer Normal Stack-up

Circuit Layer	Thickness	Unit	Material	FPC Construction
—	13	µm	Polyamide	Top Coverlay
—	25	µm	Adhesive	
Top	35	µm	Copper	Single-sided FPC
—	20	µm	Adhesive	
—	50	µm	Polyamide	
—	40	µm	Adhesive	Bonding Sheet
Signal	18	µm	Copper	Double-sided FPC
—	20	µm	Adhesive	
—	50	µm	Polyamide	
—	20	µm	Adhesive	
Bottom	35	µm	Copper	
—	25	µm	Adhesive	Bottom Coverlay
—	13	µm	Polyamide	
Total	364	µm	—	

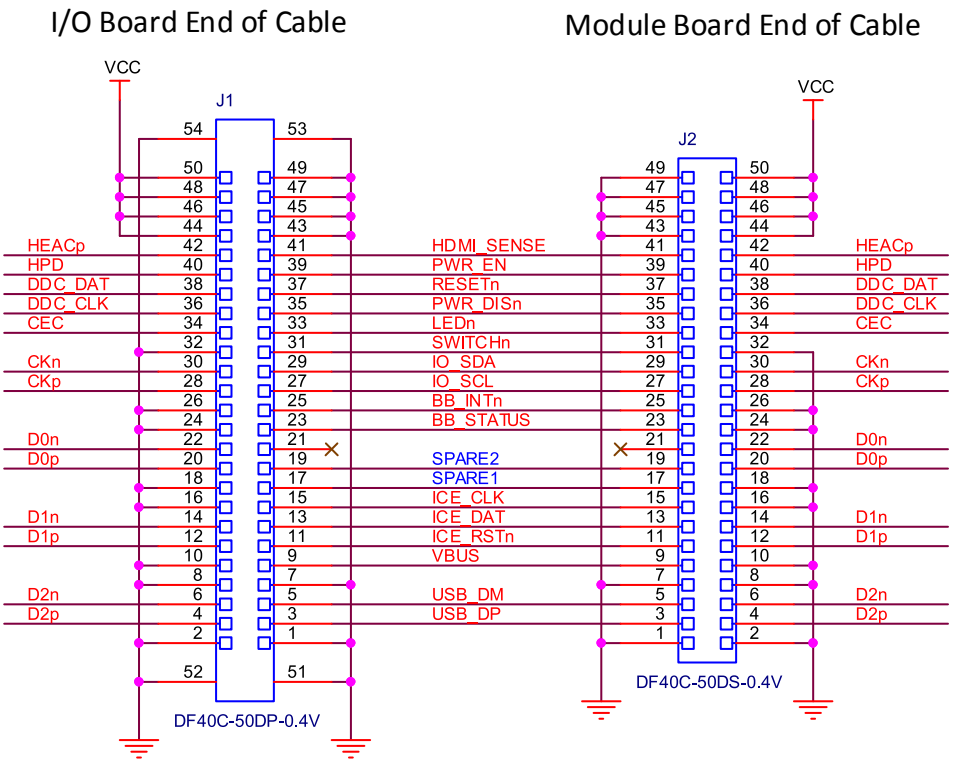


Figure 4.3. System to Module FPC Cable Schematics

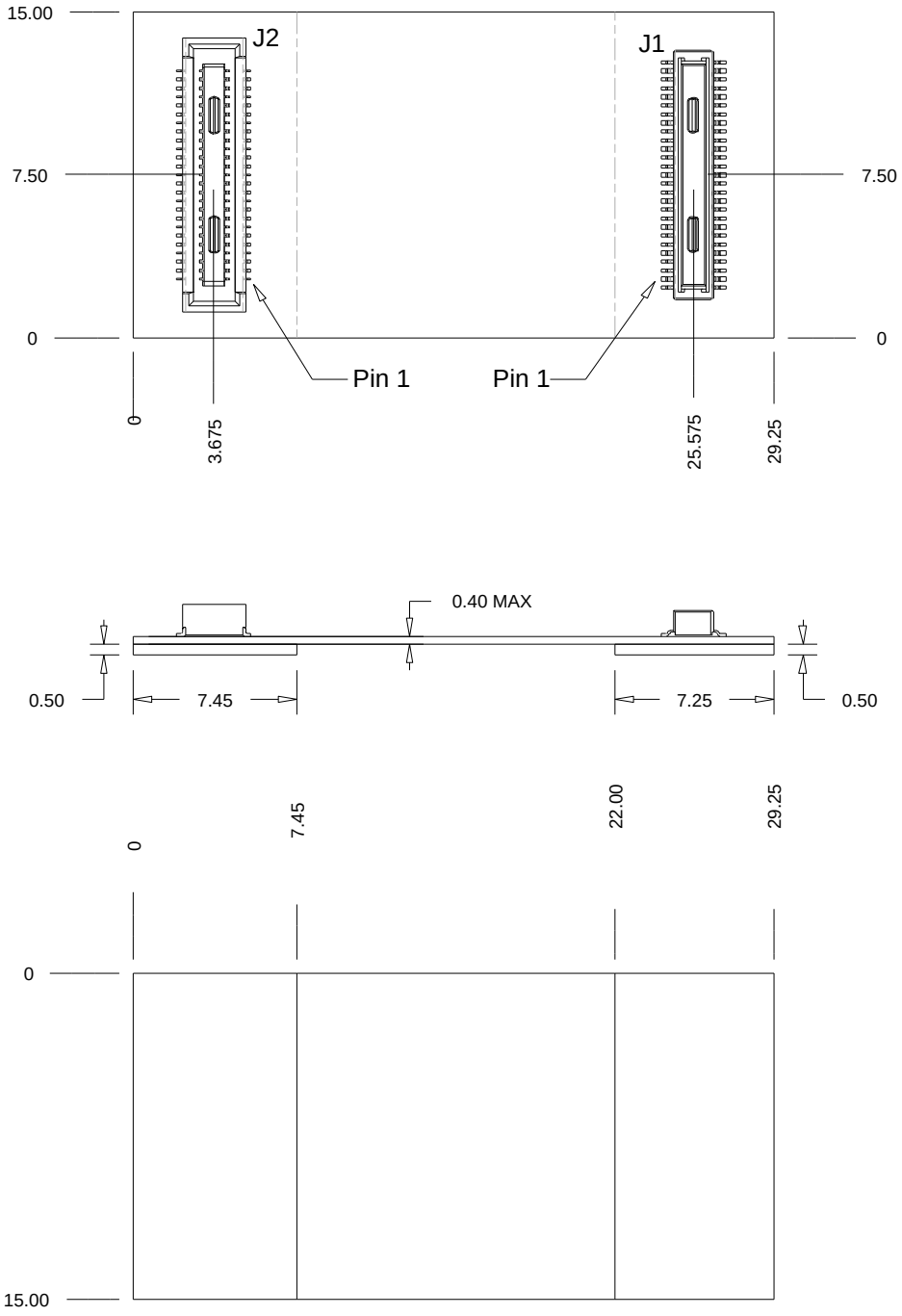


Figure 4.4. Module to System FPC Cable Dimension Example

4.4. Module Placement in a System

In any wireless application, pay special attention when integrating the MOD6320-T WirelessHD Transmitter Module in a system in order to gain full benefit from the radio performance.

The technology used in this module is a highly advanced antenna phase array with automated beam steering. This implies the SiI6310 RF transceiver chip actually emits a directional radio signal at a wide range of angles from the antenna surface plane.

4.4.1. Placement Advice

- Place the module inside the system so the SiI6310 HRTR transceiver faces the room in the most natural system placement.
- Avoid any metallic item in front of the SiI6310 HRTR transceiver.
- Any polymer based enclosure, like ABS, PE, PA material makes very good material to cover the SiI6310 HRTR transceiver.
- Polymer material enclosure wall thickness below 2 mm is nearly transparent to the 60 GHz radio signal.
- Consider placing the module tilted up between 30 and 60 degrees to cover cases where the transmitter is placed below the receiver, in a TV shelf for example.
- Consider an air gap of 2 mm or more between the module SiI6310 HRTR transceiver and the covering enclosure wall for three reasons:
  - Skin temperature considerations due to heat dissipation from the RF transceiver, which can reach up to 90 °C max in operation
  - Warping and discoloration of the enclosure due to heat from the SiI6310 HRTR transceiver
  - Allows the link to be maintained even when a blocking object is right in front of the antenna device touching the enclosure

4.4.2. Conditions to Avoid

- Mounting screws in front of the SiI6310 HRTR transceiver
- Metallic paint finishes over the enclosure covering the SiI6310 HRTR transceiver
- Metallic mesh in front of the SiI6310 HRTR transceiver
- Plastic enclosure with complex ribbing in front of the SiI6310HRTR transceiver
- Glass material in front of the SiI6310 HRTR transceiver
- Narrow opening window in front of the SiI6310 HRTR transceiver

4.4.3. Module-to-System Mechanical Interface

The system is expected to provide a mechanical fixture to addressing the following aspect of the design:

- Mounting brackets to hold the module and the cable in place according to drop test and shake test expectations
- Thermal conductive contact for the module to remove its heat to inside the host system
- Grounding requirements for the module to the system ground
- The system mechanical mount is required to provide an EMI shield for the back side of the module. It is therefore necessary that this fixture seals the back of the PCB to avoid spurious emissions.

For this to be accomplished, SiBEAM defined the footprint of the mounting bracket which has been tested to realize the conditions above as a reference.

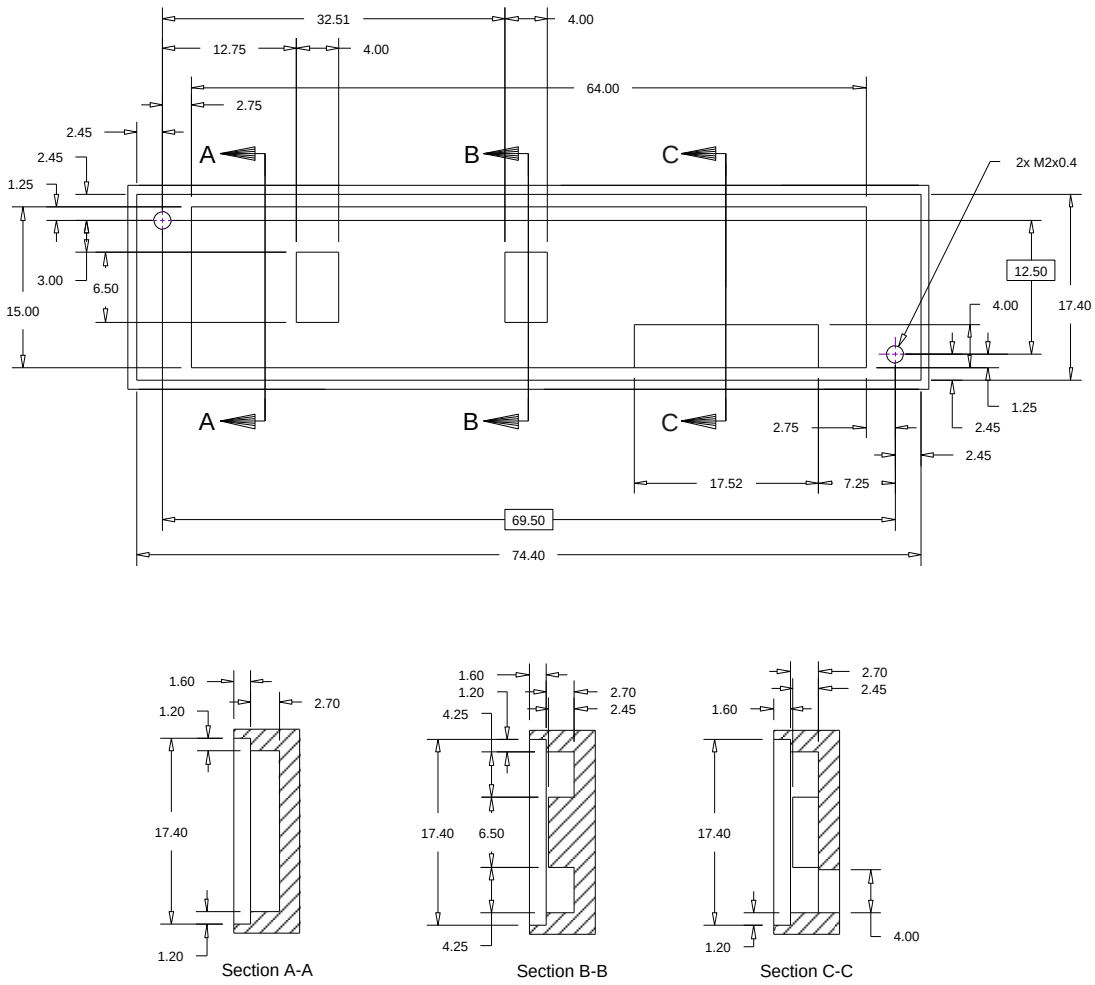


Figure 4.5. Mounting Fixture Recommended for MOD6320-T Transmitter Module

4.4.4. Module Radiation Pattern

To help the system designer find the best placement inside the enclosure, the following radiation pattern should be considered:

- MOD6320-T Transmitter Module Radiation Pattern Azimuth (Figure 4.6)
- MOD6320-T Transmitter Module Radiation Pattern Elevation (Figure 4.7)

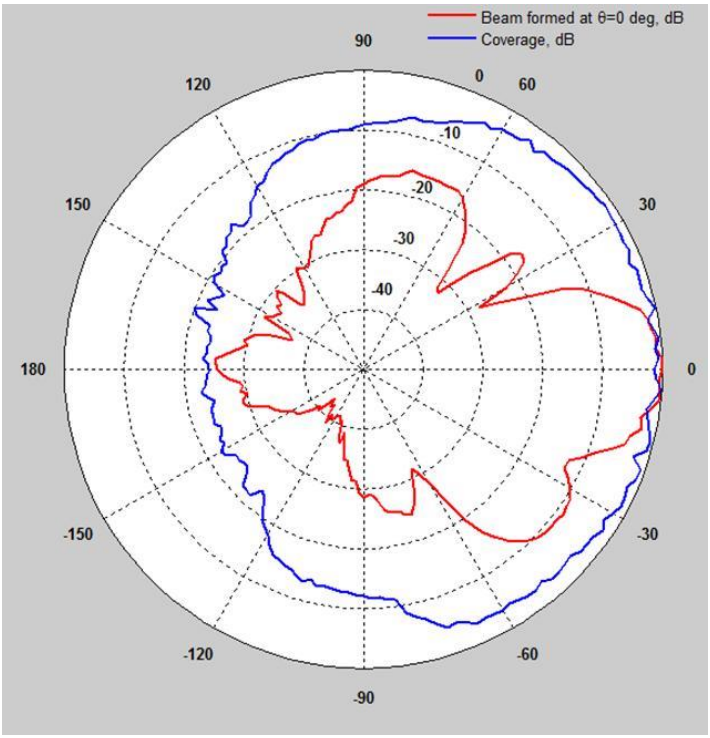


Figure 4.6. MOD6320-T Transmitter Module Radiation Pattern Azimuth (View from Top)

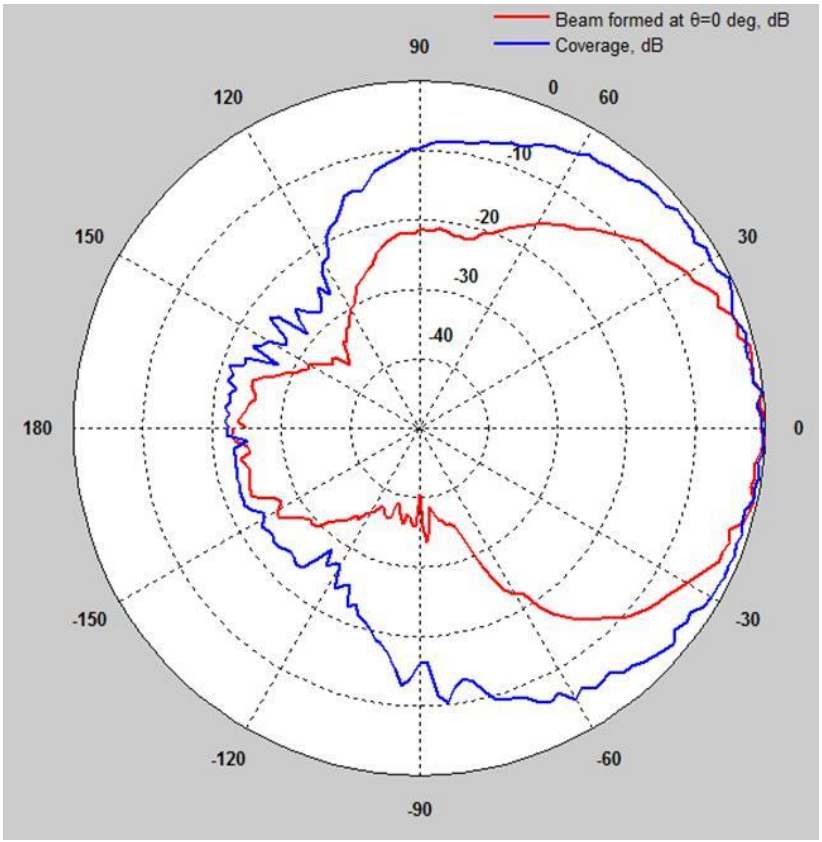


Figure 4.7. MOD6320-T Transmitter Module Radiation Pattern Elevation (View from Side)

4.4.5. Guard Area Solid Angle

This is the recommended minimum guard area in front of the SiI6310 RF transceiver, to ensure maximum radio performance in the end system.

The guard area is a solid angle where no blocking features should reside.

Blocking features are mechanical items like metallic mounting screws, washers, wire mesh, thick plastic ribs, glass items, metallic paint, metallic stickers and labels, and logos and emblems.

If unsure, consult SiBEAM before committing to the system industrial design tooling.

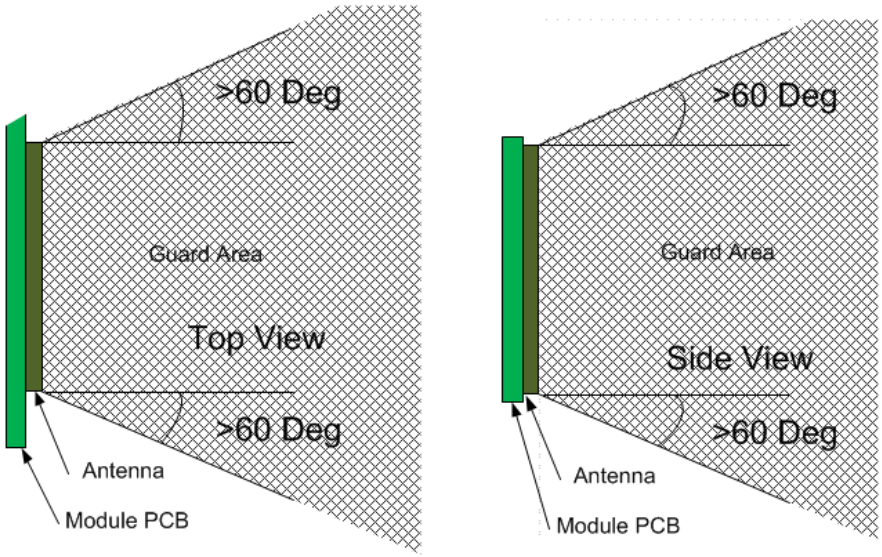


Figure 4.8. Minimum Recommended System Guard Area

System Performance Target

The MOD6320-T transmitter module is intended to be integrated into the end product, giving the performance described in Figure 4.9.

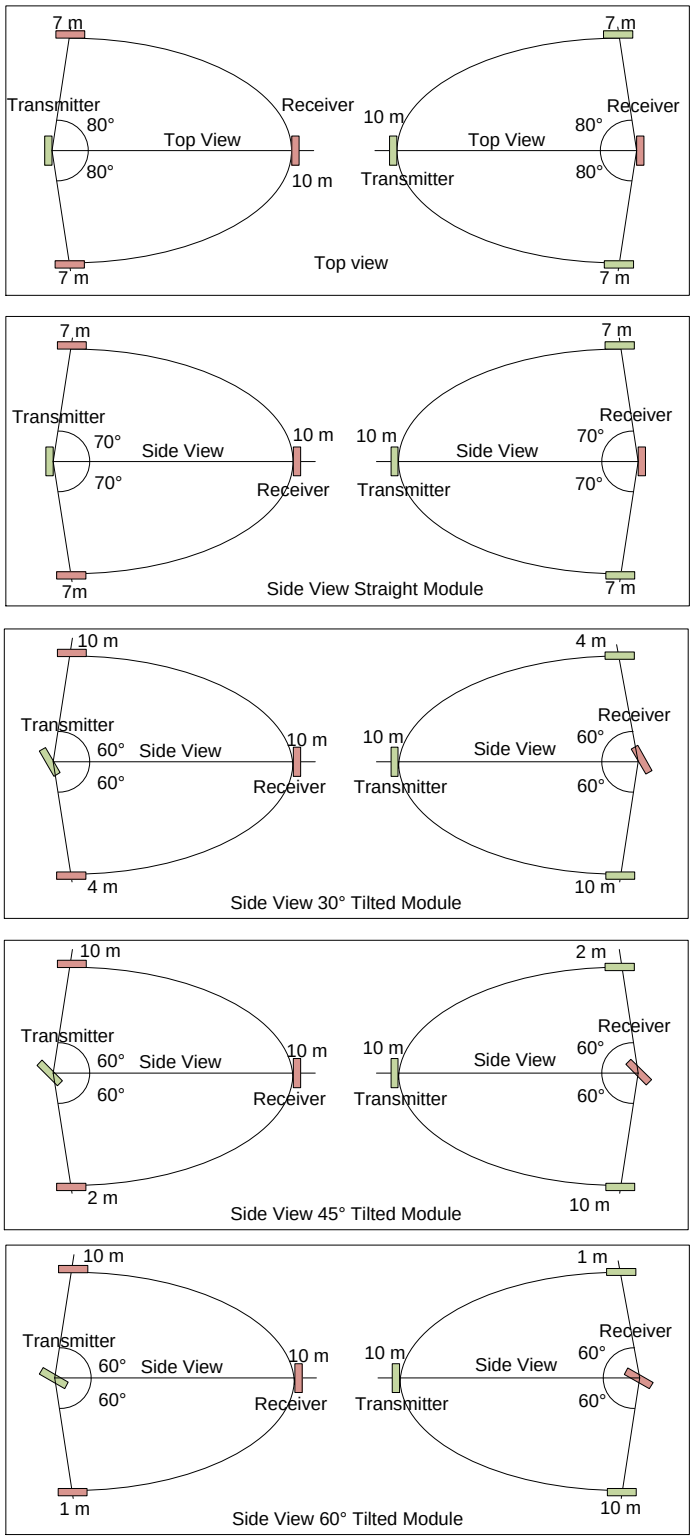


Figure 4.9. Expected System Performance Integrating MOD6320-T Transmitter Module

5. Thermal Considerations

The MOD6320-T module is designed to be integrated in a complete system capable of generating digital audio and video.

This module is specified to operate in an ambient temperature from 0 °C to 60 °C. The system design has to provide adequate heat dissipation to keep the ambient temperature inside the system chassis from exceeding 60 °C.

The module design associated with the reference thermal fixture should guarantee that within the 0 °C to 60 °C ambient range, none of the module ICs, especially the baseband and RF chipset, ever exceeds 90 °C case temperature.

This should allow the customers, depending on system design, to specify that the end product integrating the MOD6320-T module operates within a 0 °C to 40 °C ambient range.

5.1. Thermal Test Conditions

In order to validate the thermal performance of the module design, the following test has been carried out.

Test Setup:

- The module is mounted to the reference aluminum fixture with thermal pads
- Temperature probes are fixed on the BB IC and the RF IC package
- This assembly is set inside a temperature chamber
- A WirelessHD transmission at 1080p 60 Hz is established

Test Case:

- Case temperature on both ICs is monitored
- Audio-video link condition is monitored
- The chamber raises temperatures from 0 °C to 60 °C at 10 °C interval with a soaking time of 20 minutes

Test Conditions:

1. The audio-video link is maintained at all time with stable conditions
2. The IC case temperature never exceeds 90 °C

Test Results:

- If condition 1 and 2 are satisfied, the test result is: PASS
- If condition 1 or 2 are not met, the test result is: FAIL

Table 5.1 shows the results of this test.

Table 5.1. Thermal Performance

Ambient Temp °C	BB Tc °C	RF Tc °C	Video Link	Test
0	27.2	36.6	Stable	PASS
10	36.1	45.8	Stable	PASS
20	45.0	54.3	Stable	PASS
30	54.9	64.7	Stable	PASS
40	70.9	76.8	Stable	PASS
50	80.2	86.1	Stable	PASS
60	84.2	89.1	Stable	PASS

Soaking time: 20 minutes

Note: Module temperatures exceeding 90 °C, case temperature should not be destructive for the module. When the WirelessHD chipset operating conditions are exceeded, the video link drops, the module shuts down, and it cools until environmental conditions allow the module to operate normally. This can be taken into account during safety and reliability testing; however, this feature should not be considered as a normal operating condition.

5.2. Thermal Fixture Design

This section describes the Module thermal features to be considered by WirelessHD module integrators.

Two copper ground areas on the bottom face of the module are specifically designed to be used for heat dissipation.

SiBEAM recommends making good use of those features to help drain the calories accumulated on the module.

Each area is specifically designed to remove heat from the SiI6320 and the SiI6310 integrated circuit.

Two methods are viable and can be considered to conduct heat from module to the system thermal fixture:

- Thermal grease
- Thermal pad

The choice between the two and the characteristic of those are highly dependent on the thermal design on the system side.

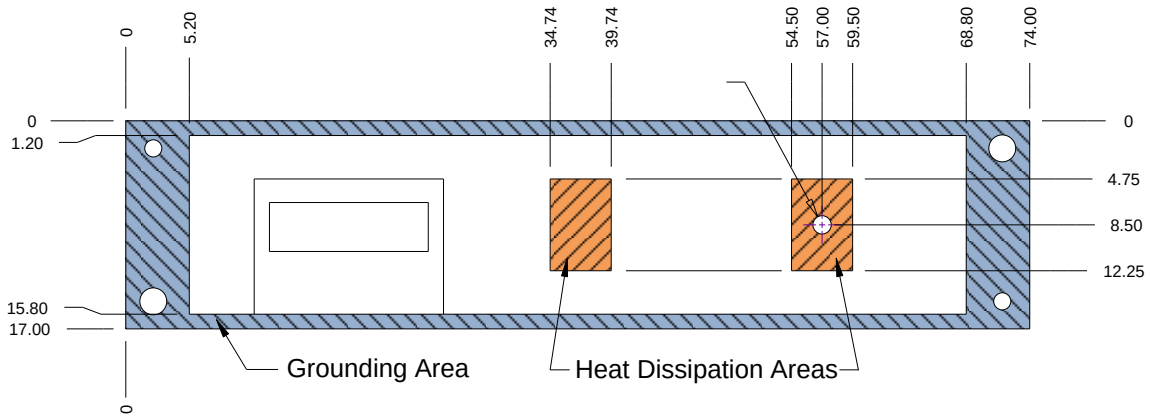


Figure 5.1. Heat Dissipation Areas

6. Electrical Interface Definition

This section describes the electrical signals and capabilities defined between the module and the host system. This interface provides great versatility for a wide range of end-product applications.

6.1. Single Connector Features

The MOD6320-T device is equipped with a single system interface featuring:

- Power: 3.3 V @ 1 A
- System Control:
  - Status LED signal
  - Network switch signal
  - ON/OFF control signal
  - Sleep mode indication signal
  - ON/OFF indication signal
- Advanced control port
  - I^2C interface
- Debug, control, and flash programing
  - USB interface
- Digital video input signal compatible with HDMI signals on the system board

6.2. Application Examples

This interface allows a wide variety of system configuration as illustrated below.

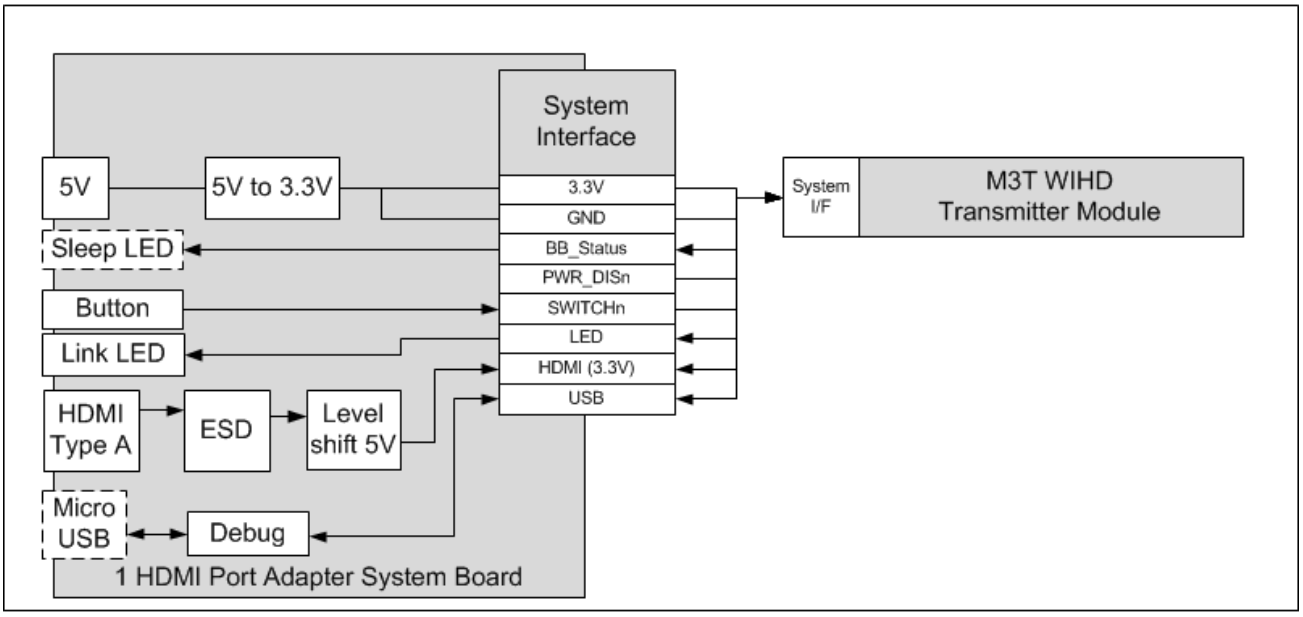


Figure 6.1. MOD6320-T Electrical Interface for Single Port Transmitter Adapter

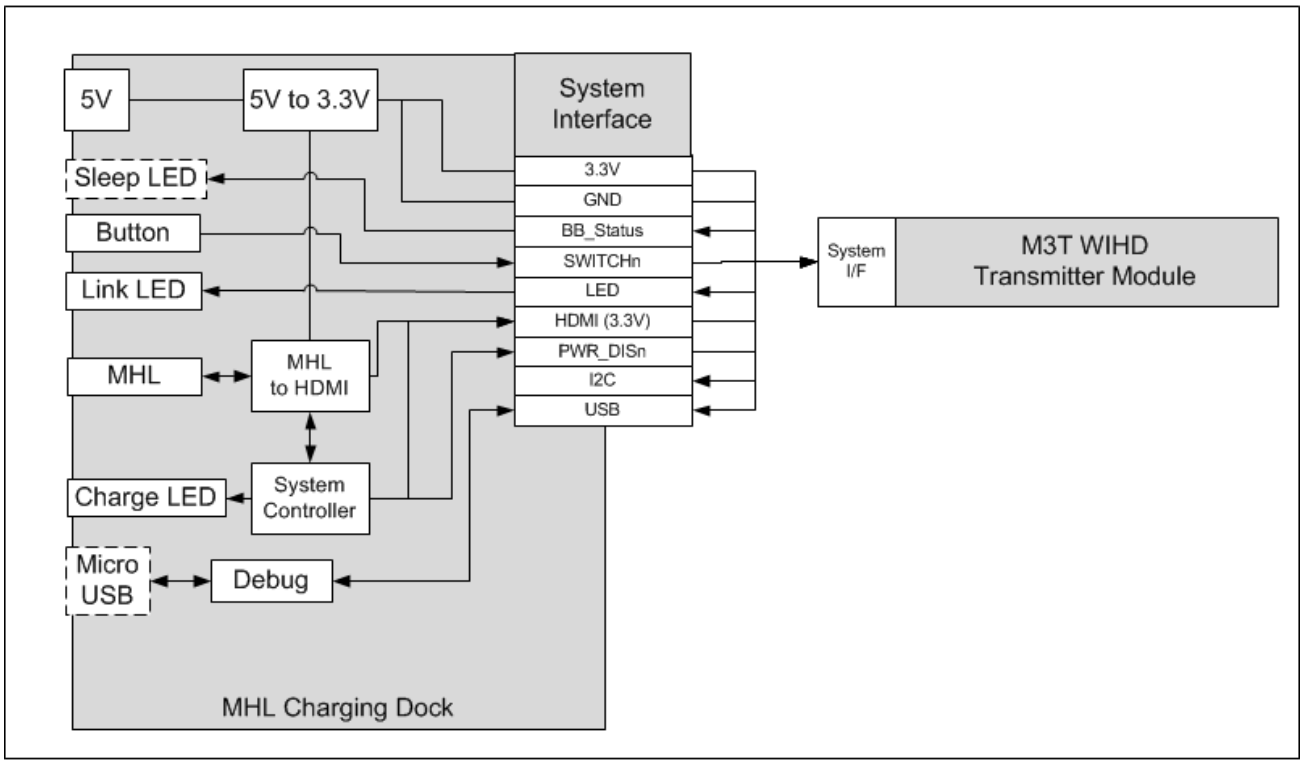


Figure 6.2. MOD6320-T Electrical Interface for MHL Mobile Dock Application

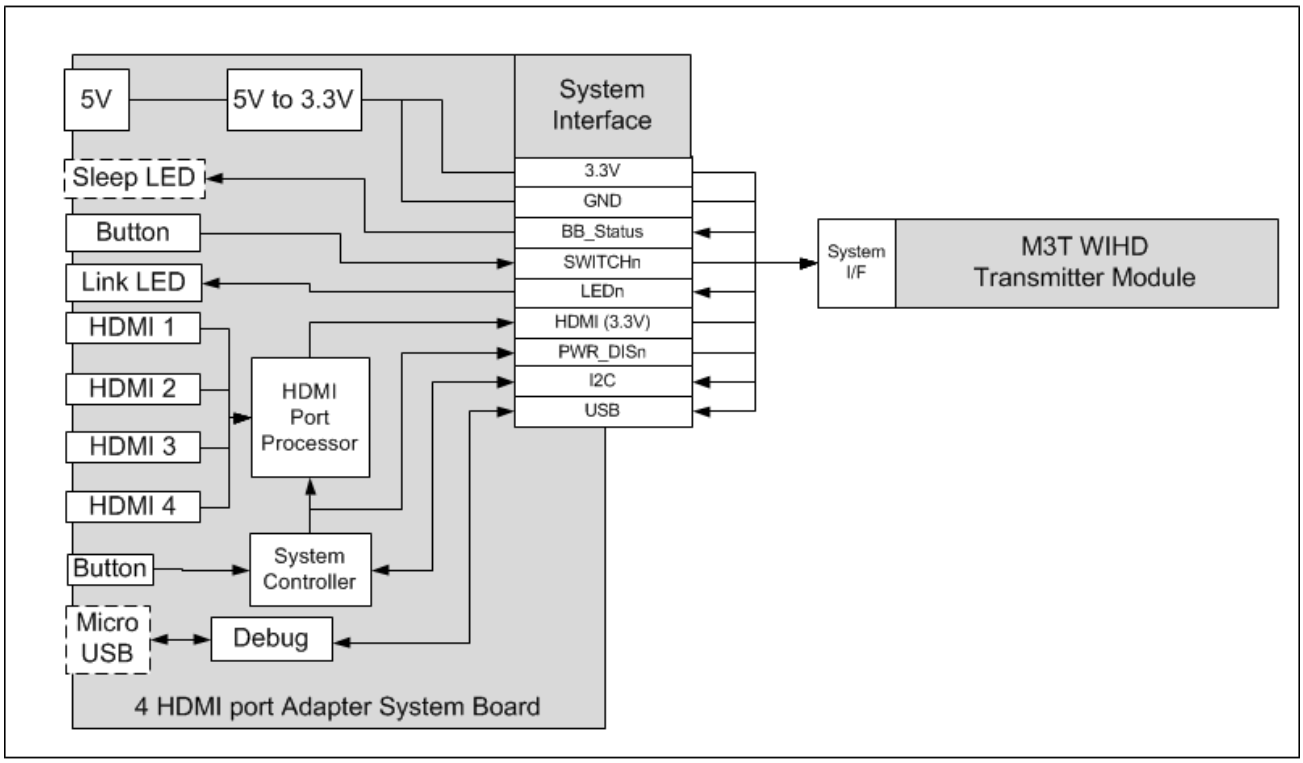


Figure 6.3. MOD6320-T Electrical Interface for Four HDMI Port Adapter

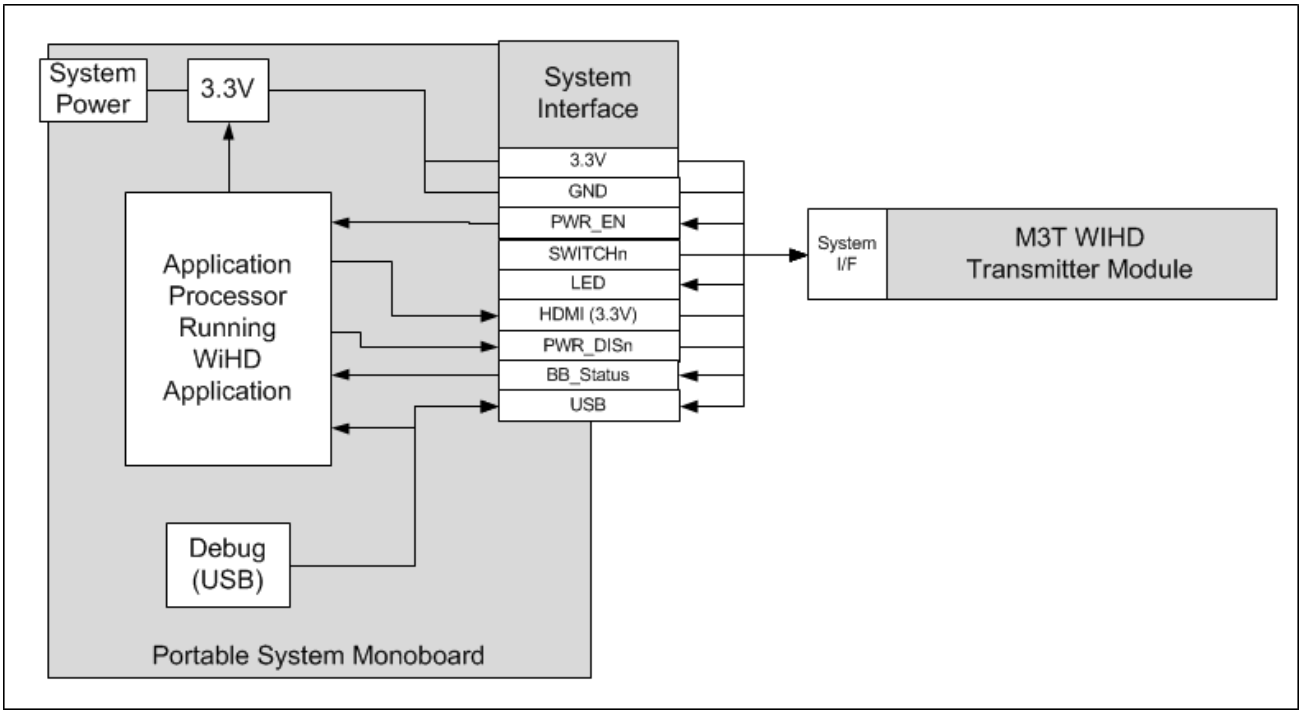


Figure 6.4. MOD6320-T Electrical Interface for Portable Integrated System Application

7. System Interface

This section describes the Electrical Interface between the MOD6320-T device and the host system.

7.1. Connection Pin Out

Table 7.1. System Interface Pin Out

Name	Pin Number	Signal	Type	Description	Function Group
GND	1, 2, 7, 8, 10, 16, 18, 24, 26, 32, 43, 45, 47, 49.	Electrical Ground	—	Ground.	Module power
VIN	44, 46, 48, 50	3.3 V ± 5%, 1 A	—	Single Power Supply Input.	Module power
RSVD/NC	17, 19, 21	N/C	—	Reserved pin, not connected.	Reserved pins
HDMI_5V_SENSE	41	LVCMOS 3.3 V tolerant	Input	HDMI 5 V power sense. Connect to 5 V pin from HDMI connector through level shifter.	Digital video input
USB-DP	3	USB	—	USB Data Positive.	On-board debug
USB-DM	5	USB	—	USB Data Negative.	On-board debug
V-BUS	9	USB Power +5 V	I	USB Detection.	On-board debug
ICE-RST	11	LVCMOS	I	Microcontroller code update.	Module manufacturing
ICE-DAT	13	LVCMOS	I/O	Microcontroller code update.	Module manufacturing
ICE-CLK	15	LVCMOS	CLK	Microcontroller code update.	Module manufacturing
RESETn	37	LVCMOS	I	Baseband Reset, Active LOW.	On-board debug
BB-INTn	25	LVCMOS	O	Baseband Interrupt, Active LOW.	System control option
I2C-SCL	27	LVCMOS	CLK	Module I²C Control.	System control option
I2C-SDA	29	LVCMOS	I/O	Module I²C Control.	System control option
SWITCHn	31	LVCMOS	I	System control, Active LOW.	WirelessHD control
LED*n*	33	LVCMOS	O	Wireless Status, Active LOW.	WirelessHD status
PWR-DISn	35	LVCMOS	I	Wireless Disable.	System control option
PWR-EN	39	LVCMOS	O	Power State.	System control option
BB-STATUS	23	LVCMOS	O	Baseband State.	System control option
HDMI-D0p	20	TMDS	I	HDMI Data pair 0 Positive.	Digital video input
HDMI-D0n	22	TMDS	I	HDMI Data pair 0 Negative.	Digital video input
HDMI-D1p	12	TMDS	I	HDMI Data pair 1 Positive.	Digital video input
HDMI-D1n	14	TMDS	I	HDMI Data pair 1 Negative.	Digital video input
HDMI-D2p	4	TMDS	I	HDMI Data pair 2 Positive.	Digital video input
HDMI-D2n	6	TMDS	I	HDMI Data pair 2 Negative.	Digital video input
HDMI-CKp	28	TMDS	I	HDMI Clock Positive.	Digital video input
HDMI-CKn	30	TMDS	I	HDMI Clock Negative.	Digital video input
HDMI-CE	34	LVCMOS	I/O	HDMI CEC.	Digital video input
DDC-CLK	36	Open Drain 5 V tolerant	CLK	HDMI Control Clock, an external pull-up of 47 KΩ to HDMI_5V is required.	Digital video input
DDC-DAT	38	Open Drain 5 V tolerant	I/O	HDMI Control Data, an external pull-up resistor of 47 kΩ to HDMI_5V is required.	Digital video input
HDMI-HPD	40	Open Drain 3.3 V tolerant	O	HDMI Hot Plug Detect.	Digital video input

Name	Pin Number	Signal	Type	Description	Function Group
HDMI-HEAC	42	LVCMOS	O	HDMI Audio Return Channel.	Digital video input

8. Module Block Diagram

The module block diagram is presented below.

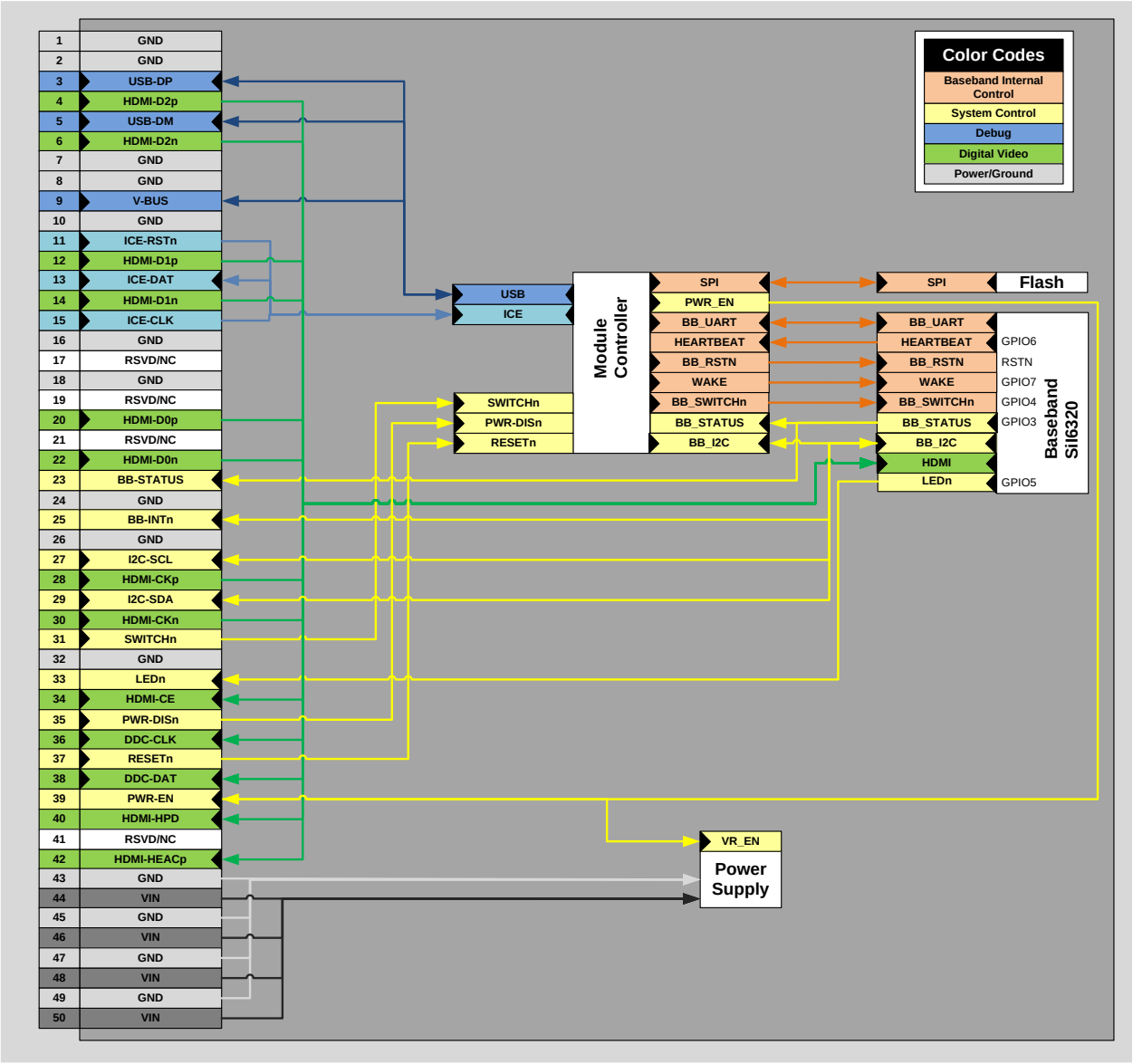


Figure 8.1. MOD6320-T Transmitter Module Block Diagram

9. Signal Description

9.1. Module Power

9.1.1. VIN

The 3.3 V power input must be connected to the system power supply and be able to supply 1 A of continuous power with a ripple of less than ± 5%.

Due to the nature of the wireless power optimization implemented in this chipset, the average power consumed by the module is much lower than the peak power, which is transient. So even though the power supply has to be able to sustain 1 A peak current, the typical current drawn on this power input is below 0.6A.

This pin provides the common power and signal ground for the module.

9.1.2. GND

This pin provides the common power and signal ground for the module.

9.2. On-board Debug

9.2.1. USB

The module is equipped with an on-board microprocessor which provides a direct interface to the system for debugging, testing, and manufacturing.

The three signals USB-DP, USB-DM and V-BUS can be routed to the system board where a USB connector can be mounted. This way, a simple USB cable to a PC can give all debug, test, and manufacturing capabilities.

This USB interface is the port to be used for firmware update, at the factory, at the service center, or in the field.

The USB port functions with a proprietary driver and application provided in the software tool suite called SWAM3.

The USB driver is USB2.0 compatible and uses VID = 0x1A4A and PID = 0x6325 as driver signature.

SWAM3 software suite can be provided. Ask your Lattice Semiconductor sales representative.

The functions and use of this tool are documented separately.

9.3. Module Manufacturing

9.3.1. In-circuit Emulation

Signals USB-DP, USB-DM and V-BUS are used for programming and debugging the microcontroller onboard the module. They are only needed for module manufacturers and developers and are not needed at system level. The module ships preprogrammed and this microcontroller software cannot be updated in the field or by module integrators.

9.4. System Control Option

9.4.1. I²C, RESETn, and BB-INTn

These optional signals are used for advance control of the module in feature-rich systems. The module is capable of standalone operation without any system host control, but in some cases the system would want to take control of the module thought the I²C interface, for example:

- System host wants to upgrade the baseband firmware
- System host wants to query the radio signal strength
- System host wants to force the module in specific configurations

In the cases above, the system designer would route the signals above to its own system host processor.

Note: BB-INTn is the interrupt line from baseband to system host. This interrupt signal is necessary to handle any I²C message transactions.

9.5. WirelessHD Control/Status

9.5.1. SWITCHn (Active LOW)

This input signal to the module is a mandatory function for the module to operate in the WirelessHD network. It allows the user to connect the transmitter module to any existing network or to switch from one network to another.

This signal can be routed to a physical switch on the system that the user can access to or it can be routed to a host processor to offer control to the user.

In all cases, this function required for the user to control the module.

This pin has a short press function and a long press function which depends on the module state:

- When the module is ON:
  - **Short press (< 10 seconds): NEXT-WVAN.** This function allows users to switch the current association over to the next available network. This disconnects the current connection and triggers a channel scan and association to the next available coordinator. Each time the signal goes LOW, the radio switches to the next network in order of channel priority, when available, until the MOD6320-T module is reassociated with its first network.
  - **Long press (> 10 seconds): RESET to FACTORY.** This function allows users to reset the MOD6320-T module to its original shipping condition. All run time settings are erased from memory. The main use of this function is to set the current channel setting to factory default, which is LR2 HR2.
- When the module is OFF or in Power Save:
  - **Any press: WAKE** This function sets the MOD6320-T module to the ON state.

Example of application circuit for SWITCH*n* signal to a user button on the system board.

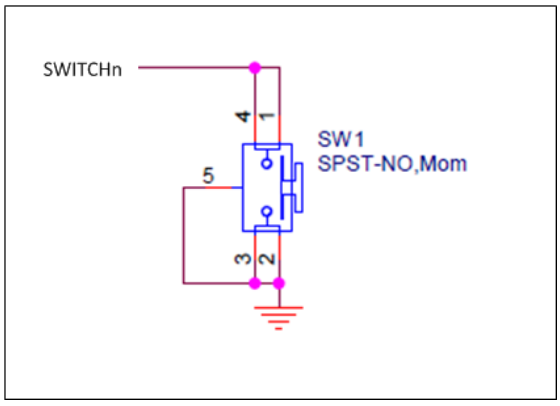


Figure 9.1. SWITCHn Signal Connection Example on System Board

9.5.2. LEDn

This output signal from the module is a mandatory indicator of the state of the module in the context of a WirelessHD network. It indicates if the module is attached to a network, searching for a network, or connected to a receiver.

This signal can be routed to a physical LED on the system that the user can view, or it can be routed to a host processor.

This indication must be available for the user to understand the state of the wireless link.

This pin shows the state of operation of the MOD6320-T module to the user.

The LEDn signal indicates four states:

- **LED is OFF.** The module is not powered, has not yet started, or is in Power Save mode.
- **LED is blinking slowly.** The module has started but has not yet associated with any network.
- **LED is blinking fast.** The module is attached (associated as described in the WirelessHD Specification) to a network but is disconnected (or not yet connected), meaning no video connections are currently processed.
- **LED is ON.** The module is hosting an ongoing audio video connection with a station in the network.

Example of application circuit for LEDn signal to a user LED display on system board:

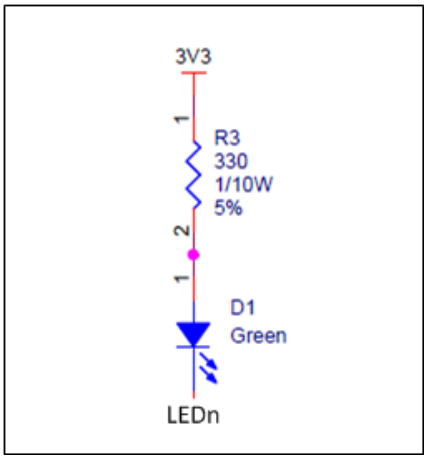


Figure 9.2. LEDn Signal Connection Example on System Board

9.5.3. PWR-DISn (Active LOW)

The Power Disable function is an optional input signal to the module where the system is able to disable the radio from the module. The module host controller acts on this signal to remove power from the baseband and RF chips on the module. In that state the module will not respond to any message on the I^2C control bus. From the USB port the module will report as being OFF.

This signal has an integrated pull-up resistor; if left unconnected the module stays ON by default.

9.5.4. PWR-EN

This Power Enable output signal is an indicator to the system host that the module is ON or OFF. When this pin is HIGH, the module is ON. When this pin is LOW, the module is OFF.

Before the system host can engage in I^2C communication, it should verify that the module is ON by checking the PWR-EN pin.

9.5.5. BB_STATUS

The baseband status output signal is an indicator of the power-save mode of the baseband. When the module is in the full ON state, this pin is driven HIGH. When the module baseband is in Power-Save mode this signal is driven LOW.

9.6. Digital Video Input

9.6.1. HDMI Signals

This interface is a mapping of HDMI signals to the module. This interface is 3.3 V and not level shifted (DCC_CLK and DDC_DAT are 5 V tolerant) and not ESD protected; as such the system must provide the remaining implementation to bring it to a HDMI-compliant interface.

An application example of the system connection to a Type A HDMI receptacle:

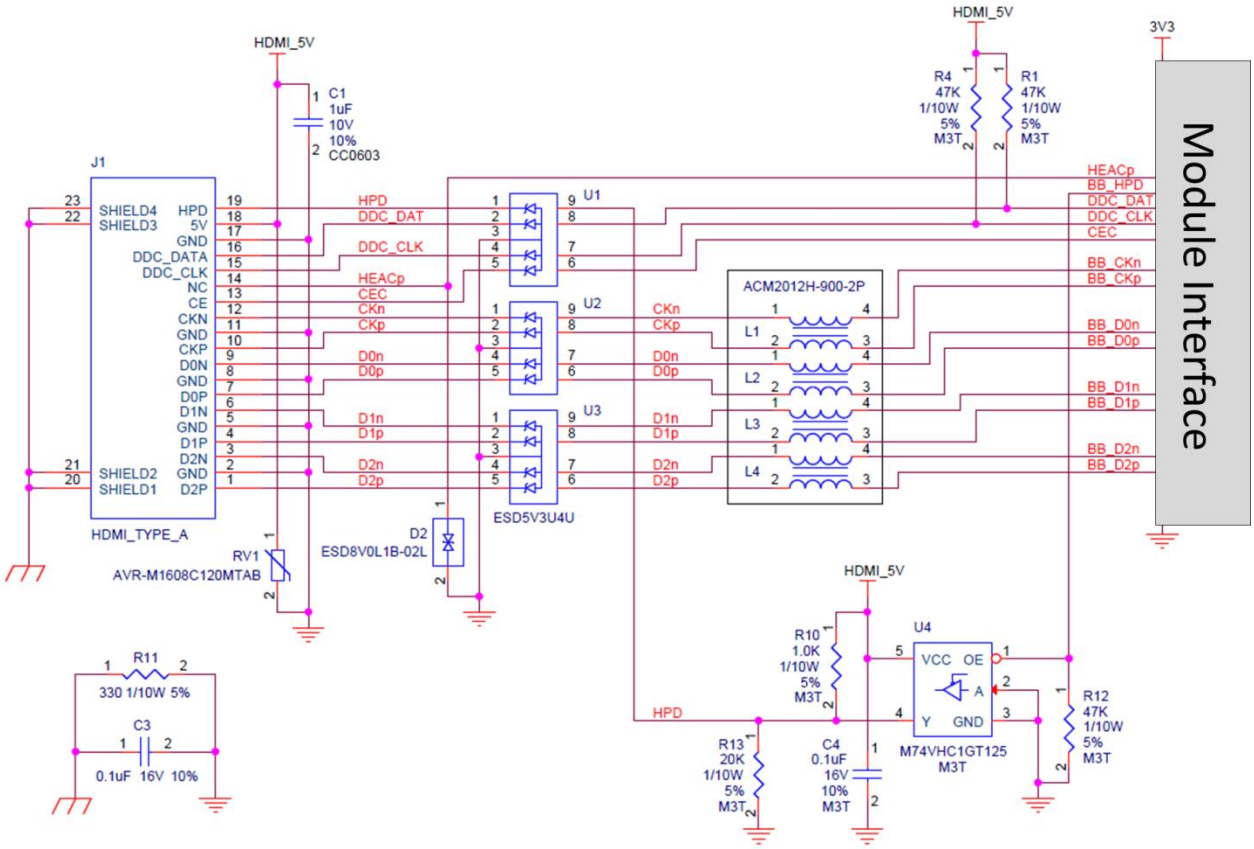


Figure 9.3. HDMI Signal Connection Example on System Board

Note that the level shifters, ESD protection, and common mode chokes are implemented on the system board and are not available on the module itself.

HDMI Compliance consideration:

On the reference system described above, there is a level shift/isolation circuit on HPD. This circuit satisfies the requirements of meeting the HDMI Specification for HPD V_{OH}, V_{OL}, impedance, and valid state. The three-state buffer IC (U4 on connection example) shift the level of the HPD signal from 3.3 V on the module to 5 V on the HDMI connector. It also disconnects the module signal from the connector when either HDMI_5V is LOW or the baseband IC is powered down.

- If HDMI_5V is LOW, U4 is powered off and its pins are high impedance. R10, the 1 kΩ pull-up resistor connected to HDMI_5V, along with the 20 kΩ pull-down resistor R13, pull the HPD signal LOW.
- If HDMI_5V is HIGH and the baseband is powered OFF, U4 is active and its output enable signal is pulled LOW by the BB_HPD signal. U4 actively drives the HPD signal LOW.
- If HDMI_5V is HIGH and the baseband is powered up, U4 is active and its output enable signal is controlled by the BB_HPD signal. When the BB IC drives this signal HIGH, the U4 output pin floats and R10 pulls HPD HIGH. When the BB IC drives BB_HPD LOW, the U4 output is turned on and it pulls HPD LOW.

Since the BB_HPD signal on the module is pulled up to 3.3 V, the level shift/isolation gate needs to see this voltage as logic 1. Normal CMOS gates running off 5 V have a logic 1 threshold of 3.5 V, above what the BB_HPD signal can reach. This means the gate needs to work at TTL logic levels, where 2.0 V is seen as logic 1. The M74VHC family of gates has TTL-level-compatible inputs, so this type works with the 3.3 V BB_HPD signal. System implementations must also work with the 3.3 V BB_HDP signal and provide the level shift/isolation features of this circuitry to ensure proper operation.

10. Power Management

The onboard microcontroller on the MOD6320-T device handles most power management functions, relieving the system host controller of those tasks.

10.1. Power ON and Reset

The module is capable of operating standalone. The system just has to provide power to the module and the module initiates its power sequence automatically and internally. As such there is no power sequence required from the system standpoint.

The reset signal on the system interface RESETn is not required and should not be used by the system host for normal operation.

The module is equipped with an on board watchdog function, which monitors the baseband activity and can reset it if it stops responding. This function should not be implemented on the system host since it is already automatically done internally and could interfere with normal module operation

In order to stop all WirelessHD activity on the module, the system can use the Module Disable signal (PWR_DISn). When the system host drives PWR_DISn LOW, the module immediately enters its OFF state. In this state, both the baseband and RF ICs are powered OFF.

When the system host releases PWR_DISn (driving it HIGH or floating it), the module automatically boots up and prepares for connection on its own.

10.2. Operational Details

There are three State Indicators from the module to the system which are used by the system host to exactly determine the state of the module at any point of time.

- PWR-EN signal indicates ON/OFF module status
- BB-STATUS signal indicates Power Save/ON module status
- LEDn signal indicates WirelessHD network status.

With these three signals the system host can follow the Table 10.1 below to determine the state of the module.

Table 10.1. Module State Indicators

State	PWR-EN	BB-STATUS	LED*n*	I²C	USB	Comments
No power	LOW	—	—	NO	NO	—
OFF	LOW	LOW	HIGH	NO	YES	Module controller is up but rest of the module is powered down.
Boot-up	HIGH	LOW	HIGH	NO	YES	Module controller is resetting and booting the baseband and RF chips.
Scanning	HIGH	HIGH	Slow blink	YES	YES	The first time the LED goes LOW after PWR-EN went HIGH, can be used to detect the I2C is ready for communication.
Associated	HIGH	HIGH	Fast blink	YES	YES	This is a WirelessHD state.
Power save	HIGH	LOW	HIGH	NO	YES	Network is maintained but no audio/video.
Connected	HIGH	HIGH	LOW	YES	YES	Video connection is ongoing.

From Table 10.1 above, it can be concluded that BB-STATUS signal can be used to determine I²C control bus to the baseband is available for transactions from the system.

10.3.Power State Description

The MOD6320-T device has its own power management state machine. Here is a description of those states.

The actual protocol for those state transitions is described in the WirelessHD Specification and is not in the scope of this document. Refer to the WirelessHD Specification for further details.

When the module is:

OFF: It does not respond to any command, the SiI6320 and SiI6310 devices are powered OFF, and there is no radio transmission. Setting the PWR_DISn signal HIGH enables the module to leave this state.

ON: It can be in one of the four states:

- **Module Reset:** This is a transitional state where the power controller asserts the baseband reset for a required duration, and if the module reset pin is disengaged, proceeds to the Module Scan state as soon as the radio is initialized.
- **Module Scan:** The module radio is activated and starts listening for beacons continuously. The module stays in this state until it finds a network coordinator and decides to join this network (association per WirelessHD specifications).
- **Module Associated:** This state is reached after one coordinator receiver module has accepted the transmitter module it its network. This is accomplished when the station has sent an association request to the coordinator and the coordinator has sent a positive association response back to the station.
  From this state, the transmitter module can take one of two paths. The module can go to the Module Power Save state if no video connection has been established for a given period of time, or it can go to Module Connected state if a connection request has been requested and is accepted from both ends.
  The module also returns to this state after a video connection has been disconnected. The module indicates this state to the user or the system by a fast pulsing LEDn signal.
- **Module Power Save:** The SiI6320 and SiI6310 RF devices save power by shutting down some of their internal blocks. The module still listens to beacons to check network activity like pending connect requests, in which case it may wake up. This maintains the WVAN network integrity and allows AVC/CEC communication across the wireless link. This is particularly useful when a transmitter has no current active video connection but wants to remain available as a possible audio/video source for the user. This allows the transmitter to be visible to the user in the TV input menu without consuming as much power as if it was actually transmitting video. The module indicates this state to the user or the system by setting the BB-STATUS signal LOW.
- **Module Connected:** In this state, the transmitter module is actively sending audio and video across the WirelessHD high rate link to an active receiver. A connection request from either side has been granted by the coordinator and all protocol prerequisites for the setup of an audio video connection have been completed. The module indicates this state to the user of the system by setting the LEDn signal LOW.

10.4.Power Saving Mode

Power Saving mode is a specific state of the MOD6320-T device where the Low Rate PHY (LRP) is active but the High Rate PHY (HRP) and Medium Rate PHY (MRP) data-paths are shut down. This allows the module to wake up at beacon time to receive a beacon from the network devices, read Random Access Time Base (RATB) messages, and go back to sleep during the super-frame time. This mode of operation is defined in WirelessHD Specification. This effectively puts the SiI6320 network processor and SiI6310 transceiver in duty cycle at beacon time boundaries.

The benefit of this state is that even if the WirelessHD device has no active audio/video connection, it remains active in the network. The network coordinator can see it and initiate a connection. The WirelessHD device receives and forwards messages in the network.

In this state:

- I^2C commands and messages are not available
- All Audio and Video paths are shut down
- AVC/CEC commands may be going through in both directions

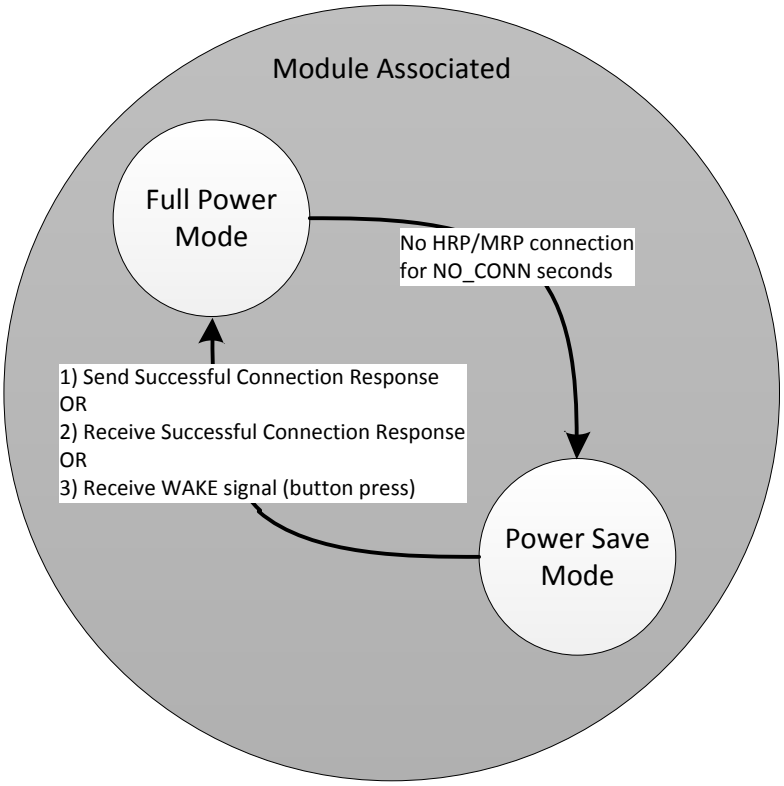


Figure 10.1. State Diagram for Power Save Mode

11. Software Interface

The MOD6320-T module does not require a dedicated host microcontroller on the system board for normal operation or factory testing. However, an I^2C interface and set of commands are provided for high-level control of the module for optional use by the system manufacturer. This interface is not required for simple products such as a single port HDMI adapter, but it may be useful for more complex products which provide features such as graphic user interfaces or in-system firmware updates.

USB should not be used to control the module because this port is also dedicated for debugging, firmware programming, or factory testing functions. USB signals should be made accessible on the system side to allow those required functions.

11.1. I^2C System Control

Application note for I^2C is available upon request.

12. Radio Considerations

This section describes the module radio frequency features.

12.1.Frequencies

The MOD6320-T module operates in the unlicensed millimeter wave radio spectrum, also known as V-Band as defined by RSBG or EHF band defined by ITU.

WirelessHD defines four High Rate Phy (HRP) frequencies and the MOD6320-T module is capable of operating in the two of them known as HR2 and HR3.

WirelessHD also defines subchannels known as Low Rate Phy (LRP). The MOD6320-T module uses five of those in each HRP channels, which are called LR0, LR1, LR2, LR3, and LR4.

Each LR bidirectional channel is used for the establishment of one WirelessHD network. HR and MR channels are used for the high bandwidth audio/video connections. The isolation among LR, MR and HR is done by the time allocation such that they are not present at the same time within the same network.

This can be visually represented in Figure 12.1 below.

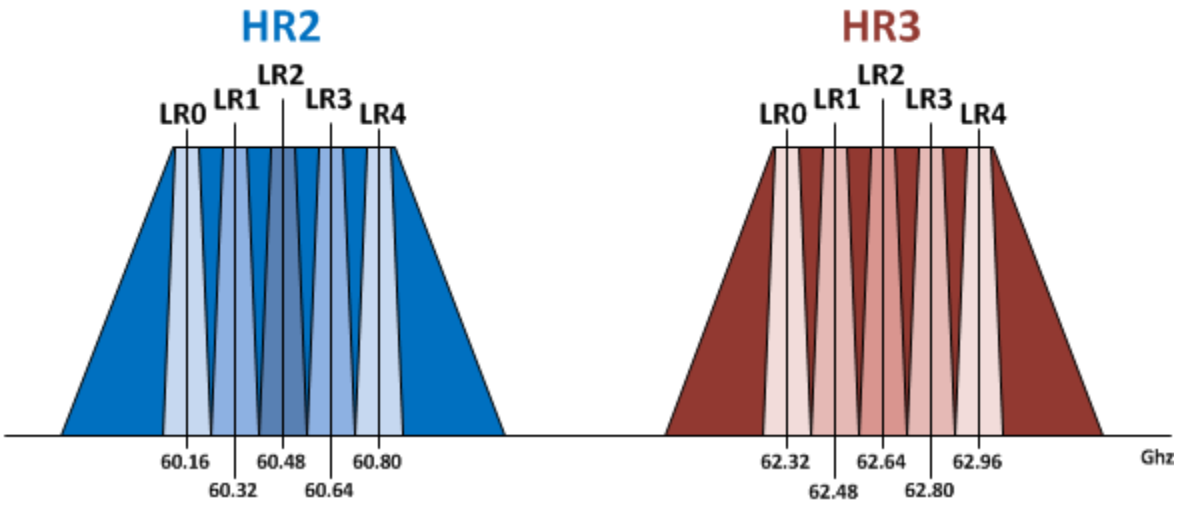


Figure 12.1. Frequency Spectrum of MOD6320-T Transmitter Module

Here, it is simple to realize that there is no interference between any LR of the 10 LR channels, and that HR channels 2 and 3 are not interfering with each other. As such, it is possible to have up to ten different networks in a single room and two A/V links simultaneously without any collision. Because each HR link is high gain and very directional, it is in practice possible to install up to ten HR links (one per network) in the same room without any interference, due to spatial isolation, but it is safe to assume that one cannot guarantee there will not be interference in this extreme case.

12.2.Spectral Mask

The MOD6320-T module spectral mask is tested and believed to be compliant with regulatory requirements in most geographic regions where the module can be legally purchased. Consult your Lattice Semiconductor sales representative or module manufacturer to ensure the intended sale geographic region for the end system is covered.

Use of the module frequency is tested and complies with the WirelessHD Specification as well as with other commercial specifications operating in the same band, such that interferences are not encountered.

The MOD6320-T module has three PHYs available. LRP is the Low Rate PHY. MRP is the Medium Rate PHY. HRP is the High Rate PHY. Figure 12.2, Figure 12.3, and Figure 12.4 on the next two pages are captures of the spectral mask for each of the three PHYs.

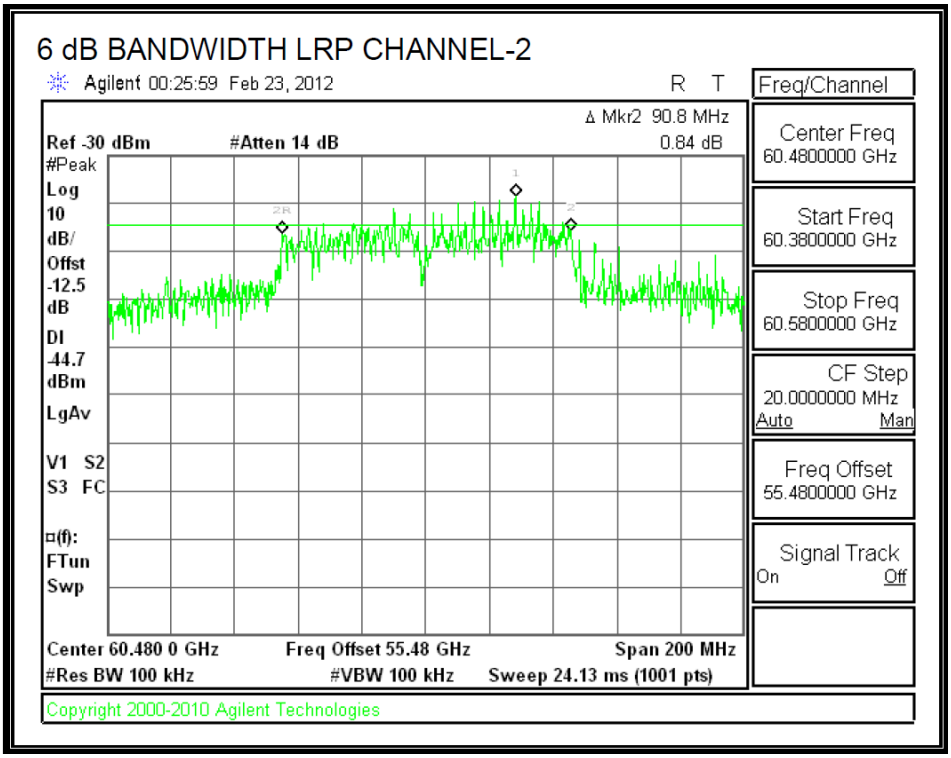


Figure 12.2. MOD6320-T Transmitter Module LRP Spectral Mask Capture

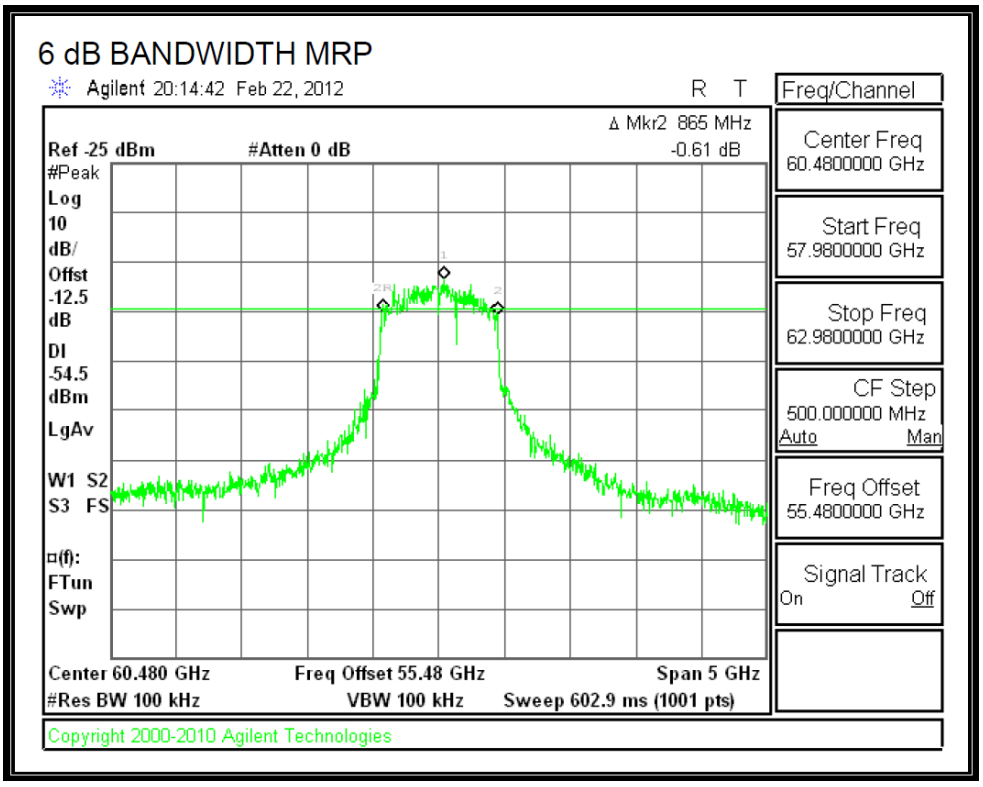


Figure 12.3. MOD6320-T Transmitter Module MRP Spectral Mask Capture

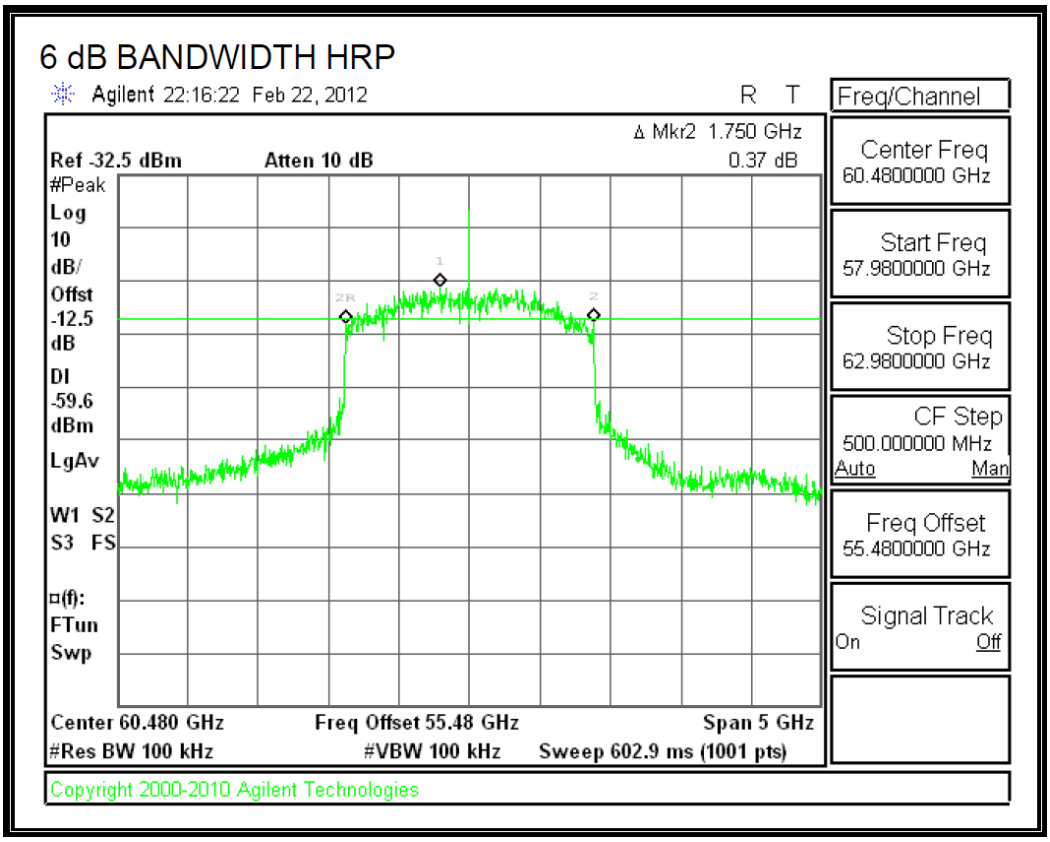


Figure 12.4. MOD6320-T Transmitter Module HRP Spectral Mask Capture

12.3.Emissions

The MOD6320-T device radiated emission is tested and believed to be compliant with regulatory requirements in most geographic regions where the module can be legally purchased.

Some regions have lower emission level acceptance than others; therefore a specific module configuration may be required for systems shipping in some locations.

Consult your Lattice Semiconductor Sales representative or module manufacturer to ensure the intended sale geographic region for the end system is covered by the module design before engaging in that market.

12.4.Modular Regulatory Approval

The MOD6320-T device is subject to modular approval in some regulatory regions for mobile application as defined by FCC; that is to say, the module antenna in its normal operating condition is placed 200 mm away from the user. If the end system in which the module is integrated satisfies this requirement, it is possible that the system integrator can use SiBEAM modular grant of the module without having to obtain a new grant at system level, as far as the 60 GHz radio is concerned.

This implies the SiBEAM grant number at module level can be used at system level to simplify and expedite some of the regulatory tests and may greatly accelerate system integration and time-to- market.

Each sovereign regulatory region has representation bodies like FCC, IC, and ETSI, which govern the rules for modular approval submission in their respective regions. The MOD6320-T device has been either pretested or received a grant at the module level in those regions, so module makers and systems integrator should determine if they can benefit from this.

For portable applications as defined by FCC, that is to say, where the module antenna in its normal operating condition is placed less than 200 mm away from the user, additional requirements apply in most regions, and may require special radio settings.

In most instances SiBEAM has strong experience dealing with worldwide 60 GHz RF regulations and can guide module makers and system integrators; nonetheless it is the responsibility of module makers and system integrators to ensure that use of the MOD6320-T device complies with local applicable laws and user installation guides accompanying any existing grants. For the final product that integrates the MOD6320-T module, it is the responsibility of the system integrator to make sure that the user manual of the final product with all the regulatory related instructions are provided to the consumer.

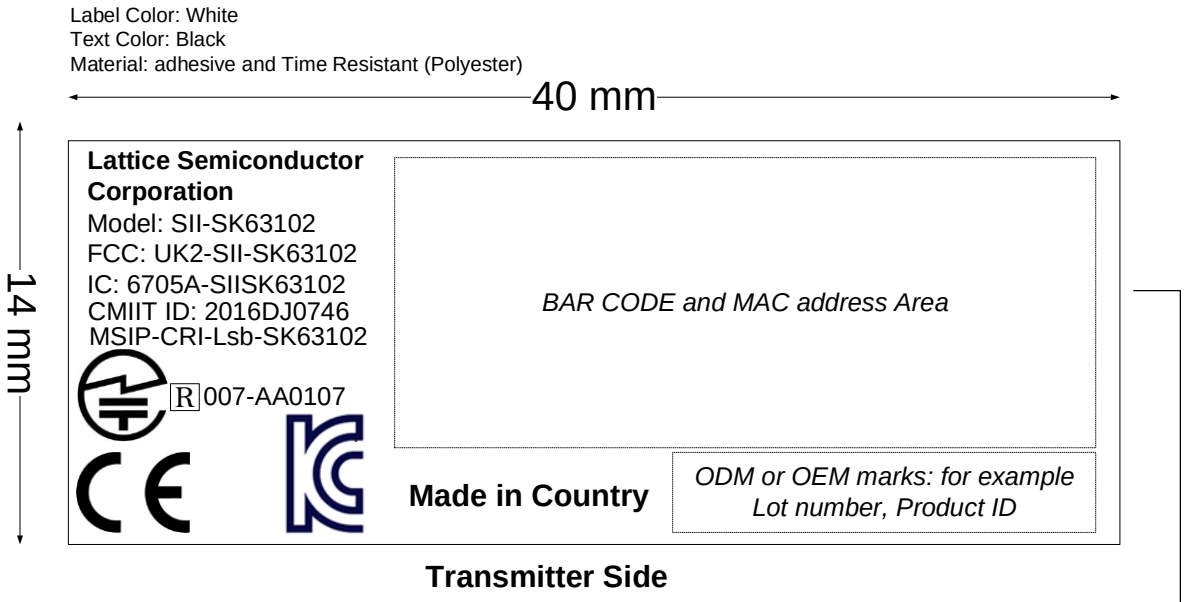
In order to make good use of the existing grants, module makers and module integrators must follow all conditions and restrictions listed in the grants and the final OEM installation manual/user guides attached to the grants.

12.5.Grants and Labeling

The following grants have been issued for the MOD6320-T device:

Model: SII-SK63102:

- FCC (USA): UK2-SII-SK63102
- IC (Canada): 6705A- SIISK63102
- ETSI (EU)
- TELEC (Japan): 007-AA0107
- SRRC (China): 2016DJ0746
- KCC (Korea): MSIP-CRI-Lsb-SK63102



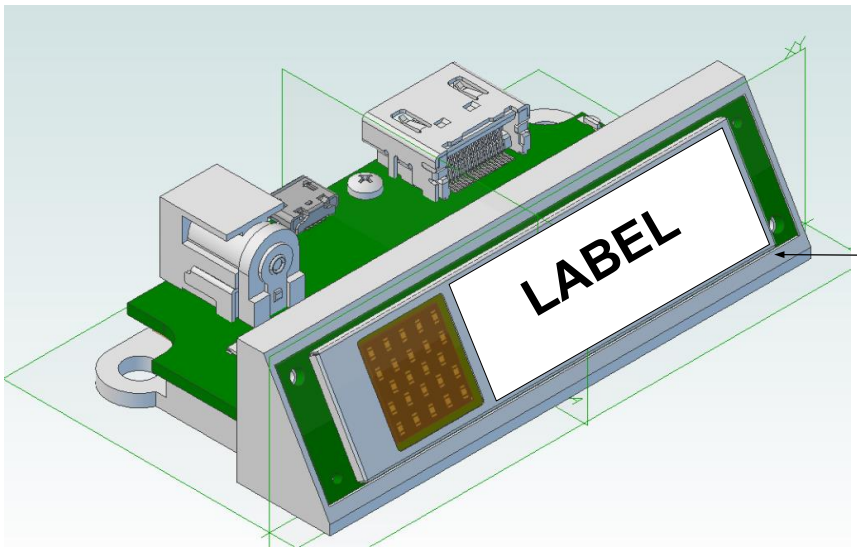


Figure 12.5. Regulatory Label Example

12.6.WirelessHD Modes of Operation

The MOD6320-T module operates within WirelessHD 1.1 Specifications using the PHY Modes described in Table 12.1. For compliance and test reason other PHY modes are actually supported by design, but those PHY modes are not used in typical operation.

Table 12.1. WirelessHD 1.1 PHY Modes in Typical Module Operation

PHY	Rate	Modulation	Approximate Bitrate	Mode Index
HRP	Full	16-QAM	4 Gbps	2
HRP	Half	QPSK	2 Gbps	1
HRP	Quarter	QPSK	1 Gbps	0
MRP	Quarter	QPSK	0.5 Gbps	0
LRP	—	BPSK	5 Mbps	2

The MOD6320-T module supports use case number 1 as described in the WirelessHD 1.1 specification when connected to a WirelessHD transmitter module. This corresponds to one High Definition Audio/Video stream between a WirelessHD transmitter and a WirelessHD receiver.

13. Factory Testing

The MOD6320-T module has a predefined factory setup configuration. This uses the reference USB connection and SWAM3 software suite, which includes test automation function called WiHD Validation Component.

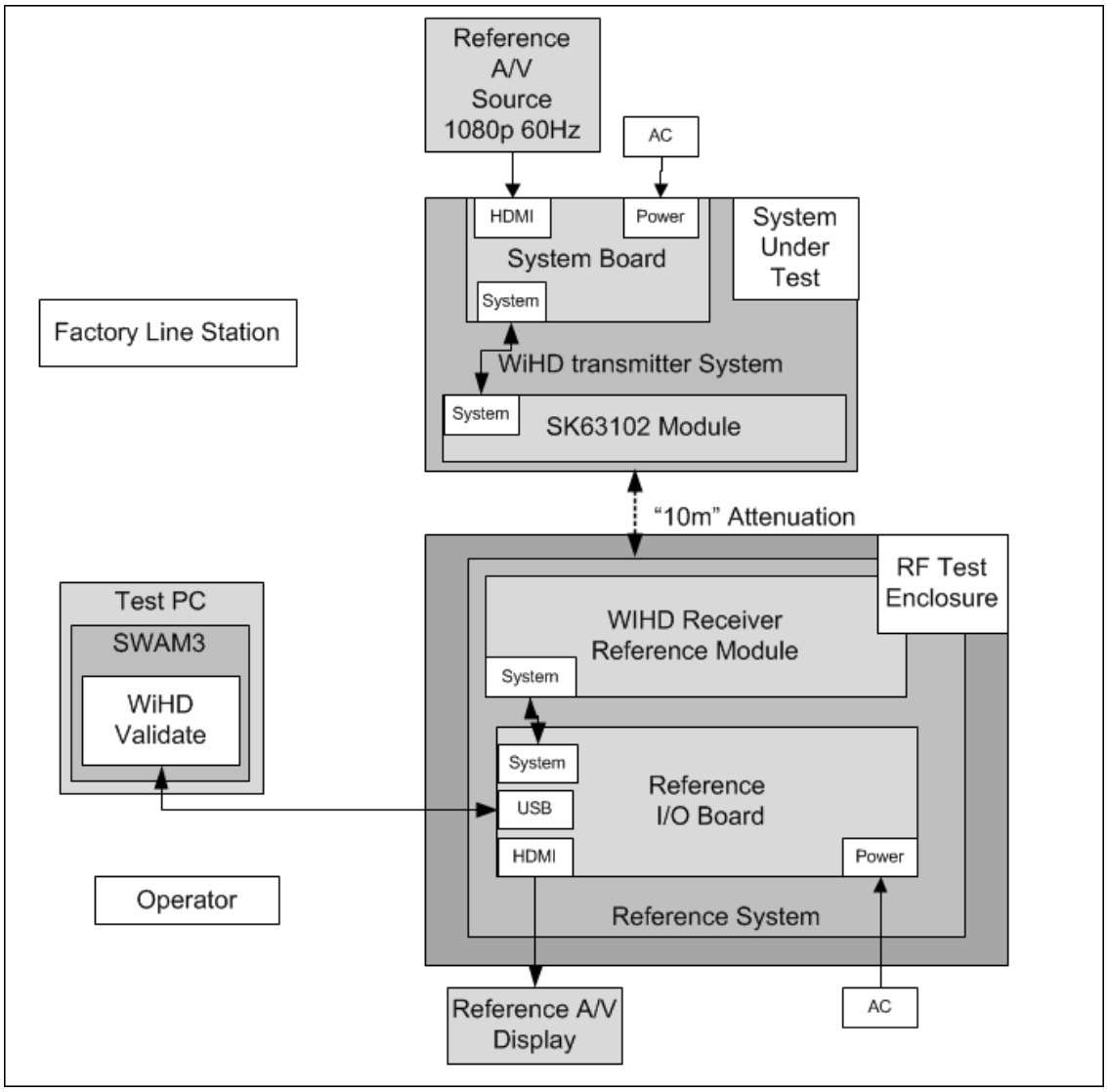


Figure 13.1. Defined Factory Setup for Adapters

14. Performance, Certification, and Reliability Testing

The MOD6320-T module has a predefined setup configuration in order to be tested for performance, WirelessHD Certification, and reliability tests. For those tests to be carried out, it is essential that the system provides access to the USB port of the module so corresponding software tools integrated in SWAM3 can be used. For this setup, the component WiHD configuration component is used.

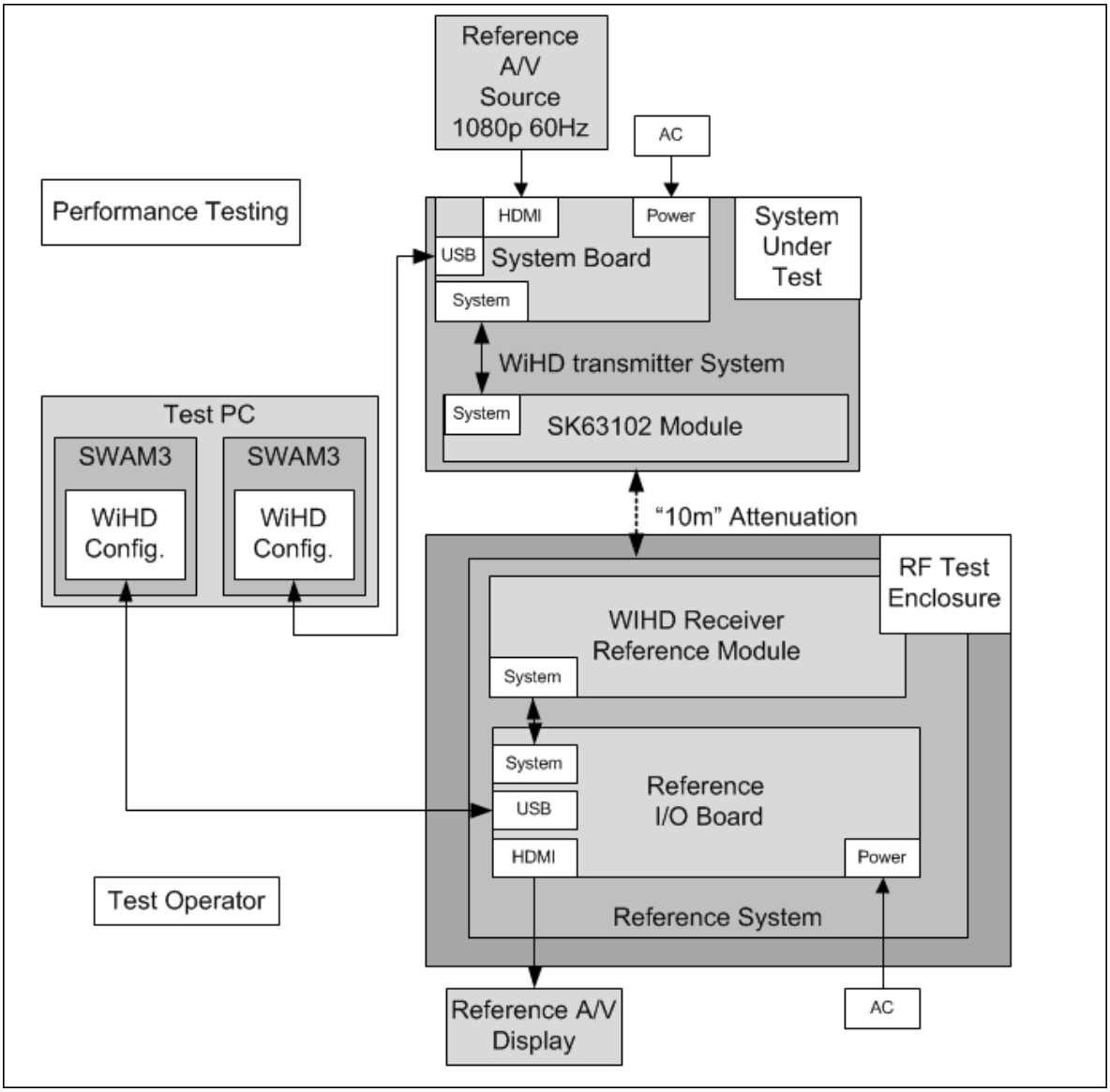


Figure 14.1. Defined Performance Test Setup

15. Module Specifications

Table 15.1. Module Specifications

Parameter	Value
Mechanical	
Dimensions (in mm)	X = 17, Y= 74, Z = 5.4
Mounting Screw (x 2)	M2: ISO 7045:2011 M2x0.4 Pan head screws with type H or type Z
Mounting Post Diameter (in mm)	1
Max Module Case Temperature	90 °C at 60 °C ambient
System Connector	FPC, 0.4 mm pitch, 50 pin,
Electrical	
Power Input VIN	3.3 V DC, 1 A
Max Input Voltage Ripple	< 10% of VIN peak to peak
Control Serial Port	I^2C 400 kHz, 3.3 V
Max Power	3.3 W (max)
Connected Power	2.2 W (typical)*
Sleep/Wake Power	800 mW (max)
OFF, Disable Power	< 10 mA (max)
Audio/Video	
Maximum Pixel Clock	148.5 MHz
Maximum Video Format	1080p 60 Hz, 4:4:4 8 bits (MOD6320-T). 3840 × 2160 30 Hz, 4:4:4:8 bits (MOD6320-4K-T)
Minimum Video Format	480i 30 Hz, 4:2:2 8 bits
Audio formats (PCM)	Up to 8channel 96kHz or 2chchannel 192kHz
Audio formats (HBRA)	Up to 7.1 96 kHz or 2channel 192 kHz
Radio Frequencies	
HRP Channel Index Support	Channel 2, 3
Frequency Range HRP	59.40 GHz to 63.56 GHz
HRP Bandwidth	1.76 GHz per channel
LRP Channel Index Support	Channel 0, 1, 2, 3, 4 per HRP channel
LRP Bandwidth	92 MHz per channel
LRP Radiated Power (EIRP)	14.6 dBm
MRP Radiated Power (EIRP)	24.0 dBm
HRP Radiated Power (EIRP)	24.2 dBm
HRP/MRP Transmit Antenna Gain	18 dBi
Receiver Sensitivity	–72 dBm (typical)
Noise Figure	10 dB (typical)
Line of Sight (LOS) Link Margin	10 dB at 10 m 1080p 60 Hz 4:4:4 with SPER < 0.01, with default setting
Compliance and Regulation	
WirelessHD1.1	Module tested with reference system (actual certification done at system level) Part 1, 2 and 3
HDMI	Module tested with reference system (actual certification done at system level) HDMI repeater category
CEC	Module tested with reference system (certification done at system level)

Parameter	Value
60 GHz Regulatory Modular Approval	CE, FCC, IC, KCC, SRRC, TELEC

***Note:** With 1080p 60 Hz video, movie content @ 10 m.

Table 15.2. Video Format Supported

Index	Resolution	Refresh Rate (Hz)	Color Depth (8, 10, 12bits)	3D	CEA Code
1	640 x 480p (VGA)	60	RGB: 8-bit only	N	vesa
2	720 x 480p	60	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	2, 3
3	1280 x 720p	60	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	4
4	1920 x 1080i	60	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	5
5	720(1440) x 480i	60	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	6, 7
6	1920 x 1080p	60	RGB, Y444, Y422: 8-bit only	N	16
7	720 x 576p	50	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	17, 18
8	1280 x 720p	50	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	19
9	1920 x 1080i	50	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	20
10	720(1440) x 576i	50	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	21, 22
11	1920 x 1080p	50	RGB, Y444, Y422: 8-bit only	N	31
12	1920 x 1080p	24	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	32
13	1280 x 720p	120	RGB: 8/10/12, Y444: 8/10/12 Y422: 8-bit only	N	47
14	1920 x 1080p	48	RGB, Y444, Y422: 8-bit only	N	—
15	1920 x 1080p	24	RGB, Y444, Y422: 8-bit only	Frame Packing	—
16	1280 x 720p	60	RGB, Y444, Y422: 8-bit only	Frame Packing	—
17	1280 x 720p	50	RGB, Y444, Y422: 8-bit only	Frame Packing	—
18	1280 x 720p	60	RGB, Y444, Y422: 8-bit only	Top to Bottom	4
19	1920 x 1080i	60	RGB, Y444, Y422: 8-bit only	Side by Side	5
20	1280 x720p	50	RGB, Y444, Y422: 8-bit only	Top to Bottom	19
21	1920 x 1080i	50	RGB, Y444, Y422: 8-bit only	Side by Side	20

Table 15.2. Video Format Supported (Continued)

Index	Resolution	Refresh Rate (Hz)	Color Depth (8, 10, 12bits)	3D	CEA Code
22	1920 x 1080p	24	RGB, Y444, Y422: 8-bit only	Top to Bottom	32
23	1280 x 720p	60	RGB, Y444, Y422: 8-bit only	Side by Side	4
24	1280 x 720p	50	RGB, Y444, Y422: 8-bit only	Side by Side	19
27	1024 x 768 (XGA)	60	RGB: 8-bit only	N	vesa
28	1280 x 1024 (SXGA)	60	RGB: 8-bit only	N	vesa
29	1680 x 1050 (WSXGA+)	60	RGB: 8-bit only	N	vesa
30	1920 x 1200 (WUXGA)	60	RGB: 8-bit only	N	vesa
31	800 x 600 (SVGA)	60	RGB: 8-bit only	N	vesa
32	848 x 480 (WVGA)	60	RGB: 8-bit only	N	vesa
Additional Resolutions Supported By SiI9396 + MOD6320-4K-T Module					
33	3840 x 2160	24	RGB: 8-bit Y444: 8 bit Y422: 8 bit	N	—
34	3840 x 2160	30	RGB: 8-bit Y444: 8 bit Y422: 8 bit	N	—
35	2048 x 1536 (QXGA)	60	RGB: 8 bit	N	vesa
36	1920 x 1080p	120	RGB: 8-bit Y444: 8 bit Y422: 8 bit	N	63
37	1920 x 1080p	90	RGB: 8-bit Y444: 8 bit Y422: 8 bit	N	—
38	2880 x 1440	60	RGB: 8 bit	N	—
39	2048 x 1200	90	RGB: 8 bit	N	—

Table 15.3. Audio Format Supported

Format	f_s [kHz]	Ch	Speaker	HDMI f_s [kHz]	Comment
LPCM	32	2	—	—	—
LPCM	44.1	2	—	—	—
LPCM	48	2	—	—	—
LPCM	88.2	2	—	—	—
LPCM	96	2	—	—	—
LPCM	176.4	2	—	—	—
LPCM	192	2	—	—	—
LPCM	32	6	—	—	—
LPCM	44.1	6	—	—	—
LPCM	48	6	—	—	—
LPCM	88.2	6	—	—	—
LPCM	96	6	—	—	—
LPCM	32	8	—	—	—
LPCM	44.1	8	—	—	—
LPCM	48	8	—	—	—
LPCM	88.2	8	—	—	—
LPCM	96	8	—	—	—
SPDIF	32	6	—	—	—
SPDIF	44.1	6	—	—	—
SPDIF	48	6	—	—	—
SPDIF	88.2	6	—	—	—
SPDIF	96	6	—	—	—
SPDIF	32	8	—	—	—
SPDIF	44.1	8	—	—	—
SPDIF	48	8	—	—	—
SPDIF	88.2	8	—	—	—
SPDIF	96	8	—	—	—

Table 15.3. Audio Format Supported (Continued)

Format	f_s [kHz]	Ch	Speaker	HDMI f_s [kHz]	Comment
Dolby Digital	48	2	LR	48	—
Dolby Digital	48	5.1	L R C LFE Ls Rs	48	—
Dolby Digital Plus	48	2	LR	192	—
Dolby Digital Plus	48	5.1	L R C LFE Ls Rs	192	—
Dolby Digital Plus	48	6.1	L R C LFE Ls Rs Cs	192	—
Dolby Digital Plus	48	7.1	L R C LFE Ls Rs Lsr Rsr	192	—
Dolby TrueHD	48	5.1	L R C LFE Ls Rs	768	HBR
Dolby TrueHD	48	6.1	L R C LFE Ls Rs Cs	768	HBR
Dolby TrueHD	48	7.1	L R C LFE Ls Rs Lsr Rsr	768	HBR
Dolby TrueHD	96	5.1	L R C LFE Ls Rs	768	HBR
Dolby TrueHD	96	6.1	L R C LFE Ls Rs Cs	768	HBR
Dolby TrueHD	96	7.1	L R C LFE Ls Rs Lsr Rsr	768	HBR
Dolby TrueHD	192	5.1	L R C LFE Ls Rs	768	HBR
Dolby MPEG2-AAC	48	2	L R	48	—
Dolby MPEG2-AAC	48	5.1	L R C LFE Ls Rs	48	—
DTS Digital Surround (Type1)	48	5.1	L R C LFE Ls Rs	48	—
DTS Digital Surround | ES (Type1)	48	6.1	L R C LFE Ls Rs Cs	48	—
DTS Digital Surround | 96/24 (Type1)	96	5.1	L R C LFE Ls Rs	48	—
DTS Digital Surround (Type4)	48	5.1	L R C LFE Ls Rs	192	—
DTS Digital Surround | ES (Type4)	48	6.1	L R C LFE Ls Rs Cs	192	—
DTS Digital Surround | 96/24 (Type4)	96	5.1	L R C LFE Ls Rs	192	—

Table 15.3. Audio Format Supported (Continued)

Format	f_s [kHz]	Ch	Speaker	HDMI f_s [kHz]	Comment
DTS-HD High Resolution Audio	48	5.1	L R C LFE Ls Rs	192	—
DTS-HD High Resolution Audio	48	6.1	L R C LFE Ls Rs Cs	192	—
DTS-HD High Resolution Audio	48	7.1	L R C LFE Ls Rs Lsr Rsr	192	—
DTS-HD High Resolution Audio	48	7.1	L R C LFE Lss Rss Lsr Rsr	192	—
DTS-HD High Resolution Audio	96	5.1	L R C LFE Ls Rs	192	—
DTS-HD High Resolution Audio	96	6.1	L R C LFE Ls Rs Cs	192	—
DTS-HD High Resolution Audio	96	7.1	L R C LFE Ls Rs Lsr Rsr	192	—
DTS-HD High Resolution Audio	96	7.1	L R C LFE Lss Rss Lsr Rsr	192	—
DTS-HD Master Audio	48	5.1	L R C LFE Ls Rs	768	HBR
DTS-HD Master Audio	48	6.1	L R C LFE Ls Rs Cs	768	HBR
DTS-HD Master Audio	48	7.1	L R C LFE Ls Rs Lsr Rsr	768	HBR
DTS-HD Master Audio	48	7.1	L R C LFE Lss Rss Lsr Rsr	768	HBR
DTS-HD Master Audio	96	5.1	L R C LFE Ls Rs	768	HBR
DTS-HD Master Audio	96	6.1	L R C LFE Ls Rs Cs	768	HBR
DTS-HD Master Audio	96	7.1	L R C LFE Ls Rs Lsr Rsr	768	HBR
DTS-HD Master Audio	96	7.1	L R C LFE Lss Rss Lsr Rsr	768	HBR
DTS-HD Master Audio	192	2	LR	768	HBR
DTS-HD Master Audio	192	5.1	L R C LFE Ls Rs	768	HBR

Ordering Information

Production Part Numbers:

Module	Part Number
MOD6320-T (SK63102) WirelessHD TX Module	MOD6320-T
MOD6320-4K-T WirelessHD TX Module	MOD6320-4K-T

Appendix A. Network Operation, WirelessHD Video Area Network

The MOD6320-T module operates seamlessly in a context where multiple WirelessHD devices are in range. This mode of operation follows the WirelessHD specification and is often referred to as WVAN.

The WVAN rules are choices that SiBEAM has made for its module software implementation. The intention of those rules is to create a consistent user experience across different systems.

A.1. WVAN Rules

WirelessHD receivers always create competing WVAN networks. This is a design implementation choice, as it is conceivable that transmitters start their own networks or that receiver aggregate in one network, as supported by the WirelessHD specification. However, for practical purposes and simplification of user cases, receivers should set up their networks on adjacent channels. This implies that receivers are network coordinators and start beaconing as soon as they can.

WirelessHD transmitters always join an existing network and do not compete with receivers. This is an implementation choice, and implies that transmitters are WirelessHD stations, not coordinators. All WirelessHD devices have to support coordinator hand-over and all devices should be able to handle coordination of a network to comply with the WirelessHD specification.

The factory default for all devices is channels HR/MR = 2 and LR = 2 to ensure a consistent first-time experience for users, even in a network made of devices from different suppliers.

All devices are preloaded with a fixed radio channel priority order to maximize spreading of networks without interference.

Channel selection is automatic and sticky. This means that devices do not change channel setting unless they are forced to because another network occupies the channel. If a device is forced to change its channel setting, it gives up its current channel, moves to the next one in the channel order priority list, and does not attempt to go back to its original setting until all other channels are exhausted.

All receiver devices should be equipped with a user interface to reset to the factory default, switch transmitters, and monitor connection status. This implies that the minimum allowable user interface for a receiver consists of one button, using a long press for factory reset and a short press for switching video transmitters, and one LED to display status. The host system can make these functions, such as the DTV graphic user interface or menu, available when the module is integrated.

All transmitter devices should be equipped with a user interface to reset to the factory default, switch networks, and monitor device status. This implies that the minimum allowed user interface for a transmitter consists of one button, using a long press for factory reset and a short press for switching networks, and one LED to display status. When the module is integrated in a feature rich system, the system host may integrate those functions by other means: graphic display, remote control, and software user application; but in any case those functions have to be available to the user.

A.2. Transmitter State Flow Charts

Start State

When it starts, the transmitter has two possible behaviors:

1. If it has already been connected to a network, it tries to reassociate to this network or wait for this network to be re-established.

   This has the following implication:

   The transmitter will not join an existing network, if it is not the last one which it connected to. This avoids devices from roaming freely among networks.

   The decision to go from one network to the other is user driven by triggering Next_WVAN command.
2. If it has never been connected to a network since last time it reset to default conditions, it associates to the strongest network available.

In this state, the decision flow is as follows.

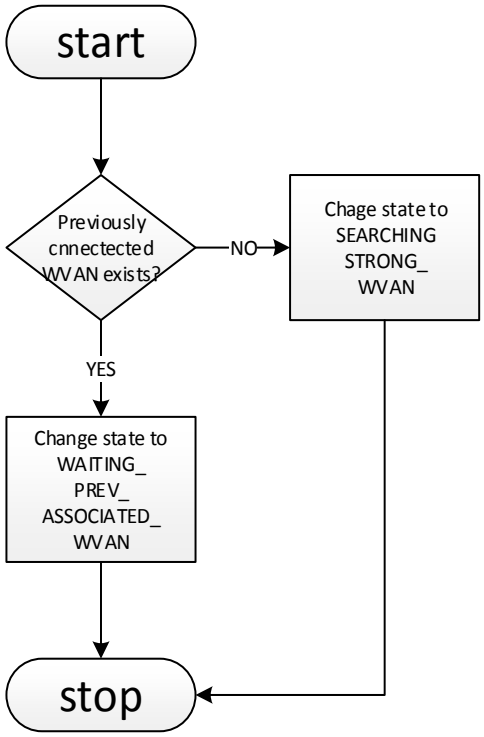


Figure A. 1. Transmitter Module Start State Flow

Transmitter Searching the Strongest WVAN State

In this state, the transmitter has never been connected to a network since the last reset to “default”, and the choice of network is based on proximity. The transmitter scans all channels and associate with the strongest (closest) receiver it finds.

In this state, the decision flow is as follows.

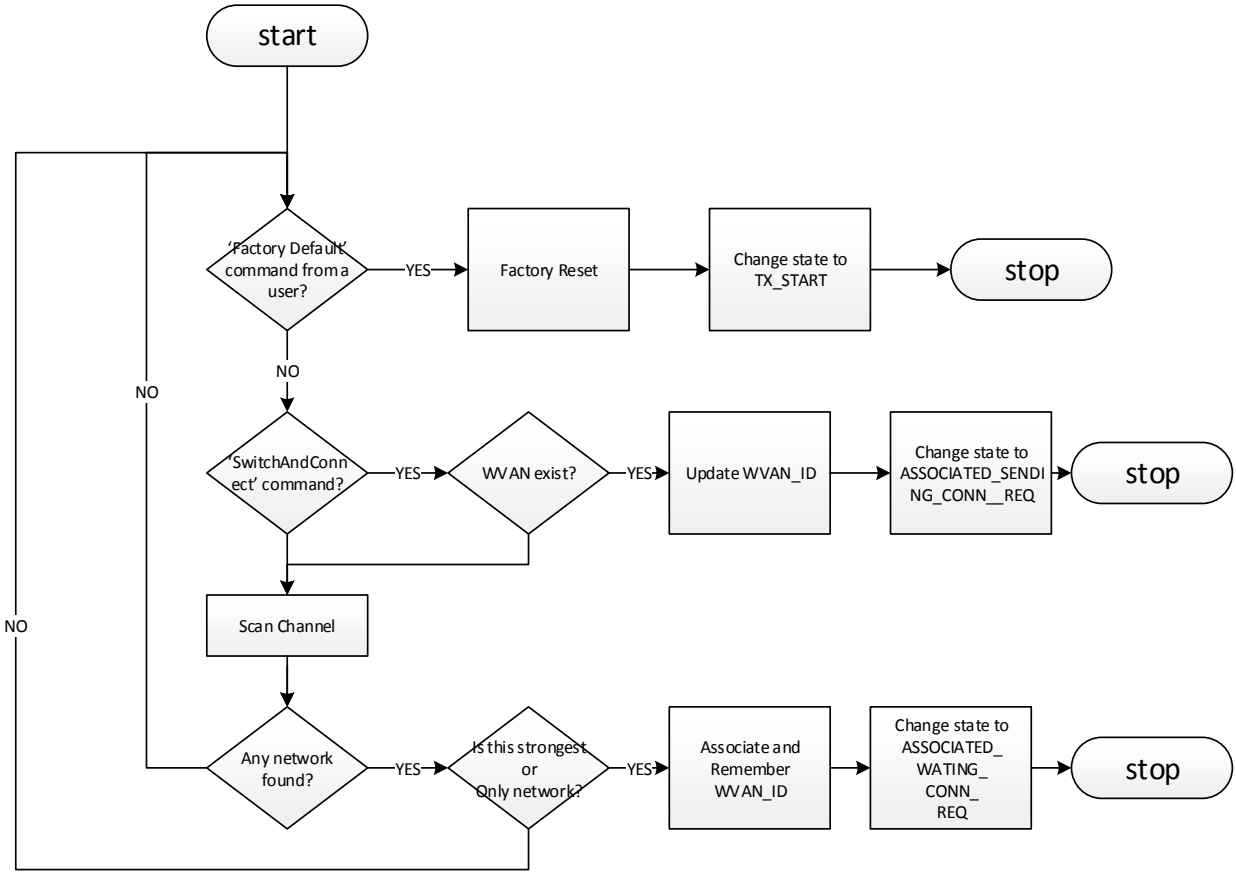


Figure A. 2. Transmitter Searching for the Strongest Network State Flow

Transmitter Associated Waiting for Connect Request State

In this state, the transmitter is associated to a network. This means its device ID is registered to one coordinator. The transmitter is expected to be ready for a connect request coming from the application.

In this state, the decision flow is as follows.

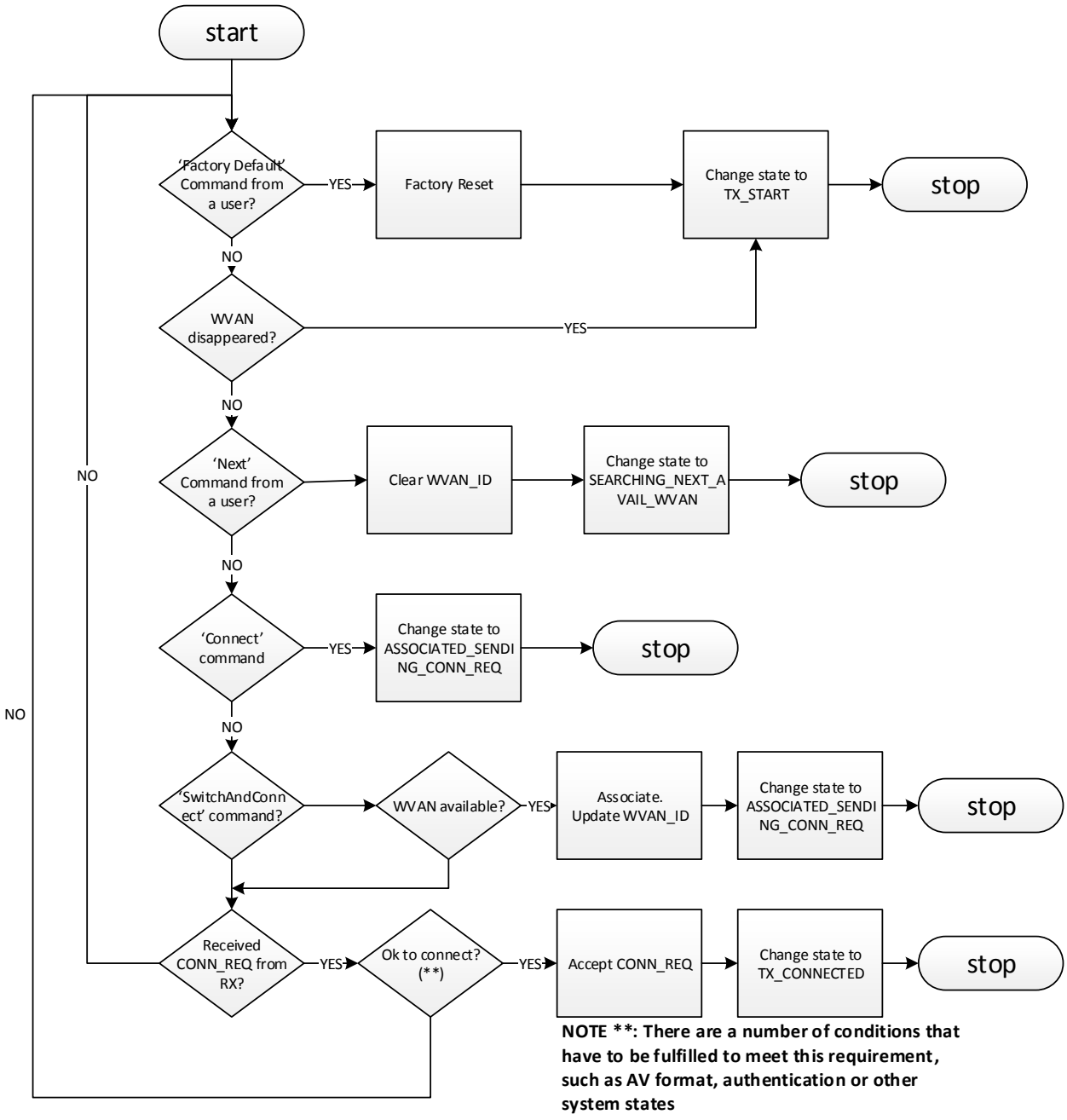


Figure A. 3. Transmitter Waiting for Connect State Flow

Transmitter Connected State

In this state, the transmitter is connected to a receiver and an audio/video stream is being transmitted.

In this state, the decision flow is as follows.

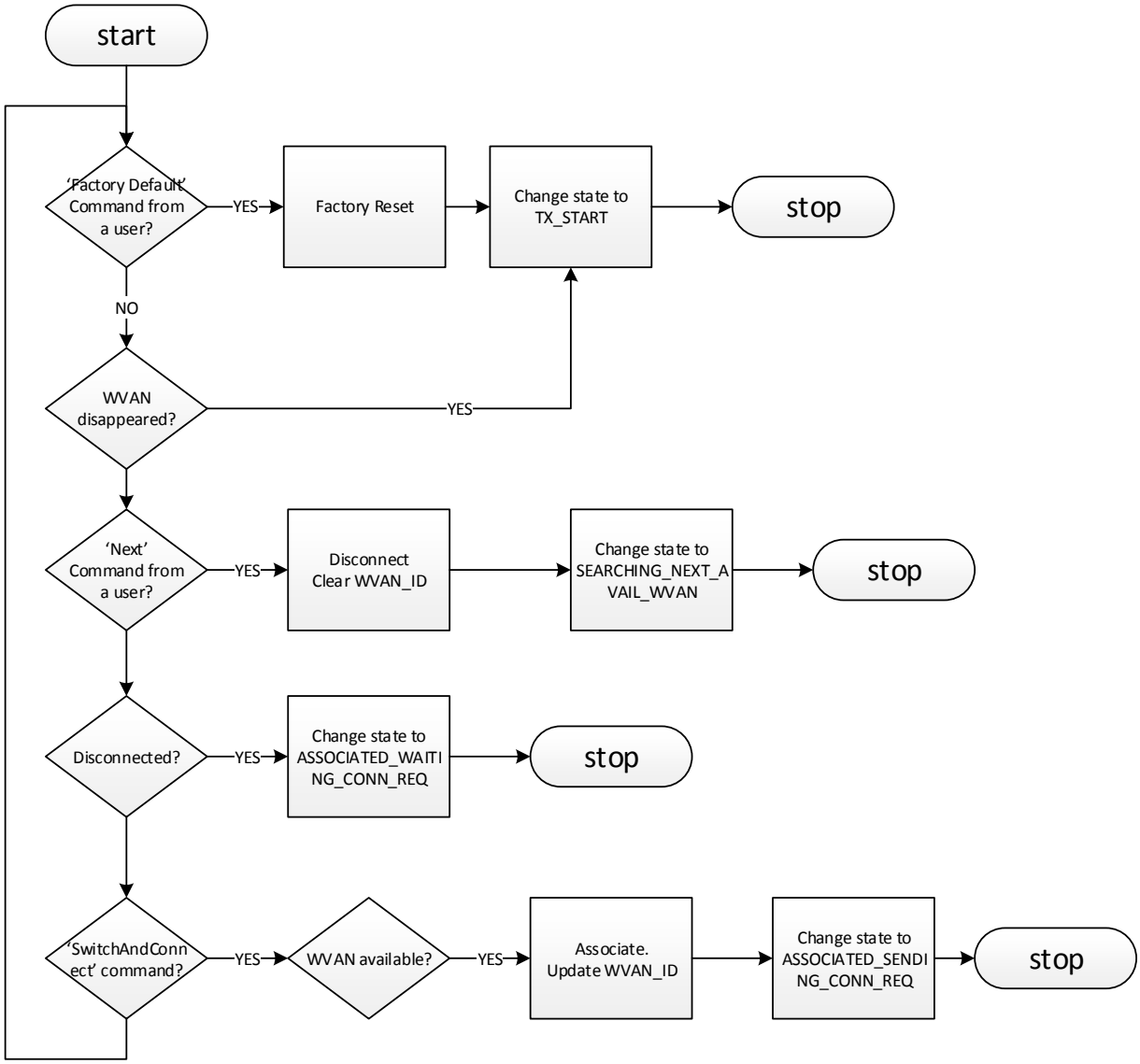


Figure A. 4. Transmitter Connected State Flow

Transmitter in Next_WVAN State

In this state, the user has triggered a Next_WVAN command, which forces the transmitter to abandon its current network and connection and search for next network available in the channel priority order predefined.

In this state, the decision flow is as follows.

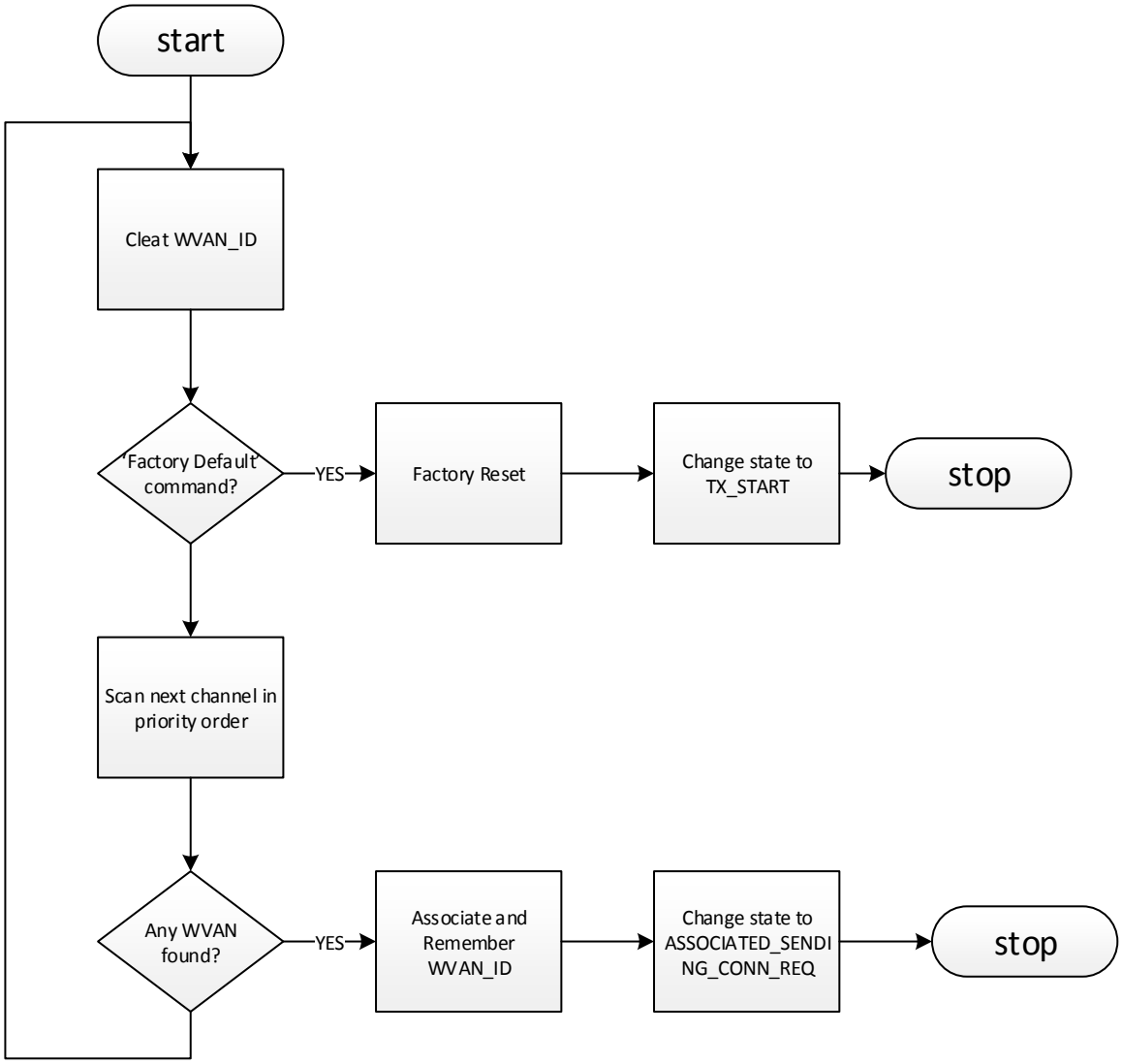


Figure A. 5. Transmitter Next_WVAN State Flow

Transmitter in Connect Request State

In this state, the transmitter is associated to a network and a connect request has been issued.

In this state, the decision flow is as follows.

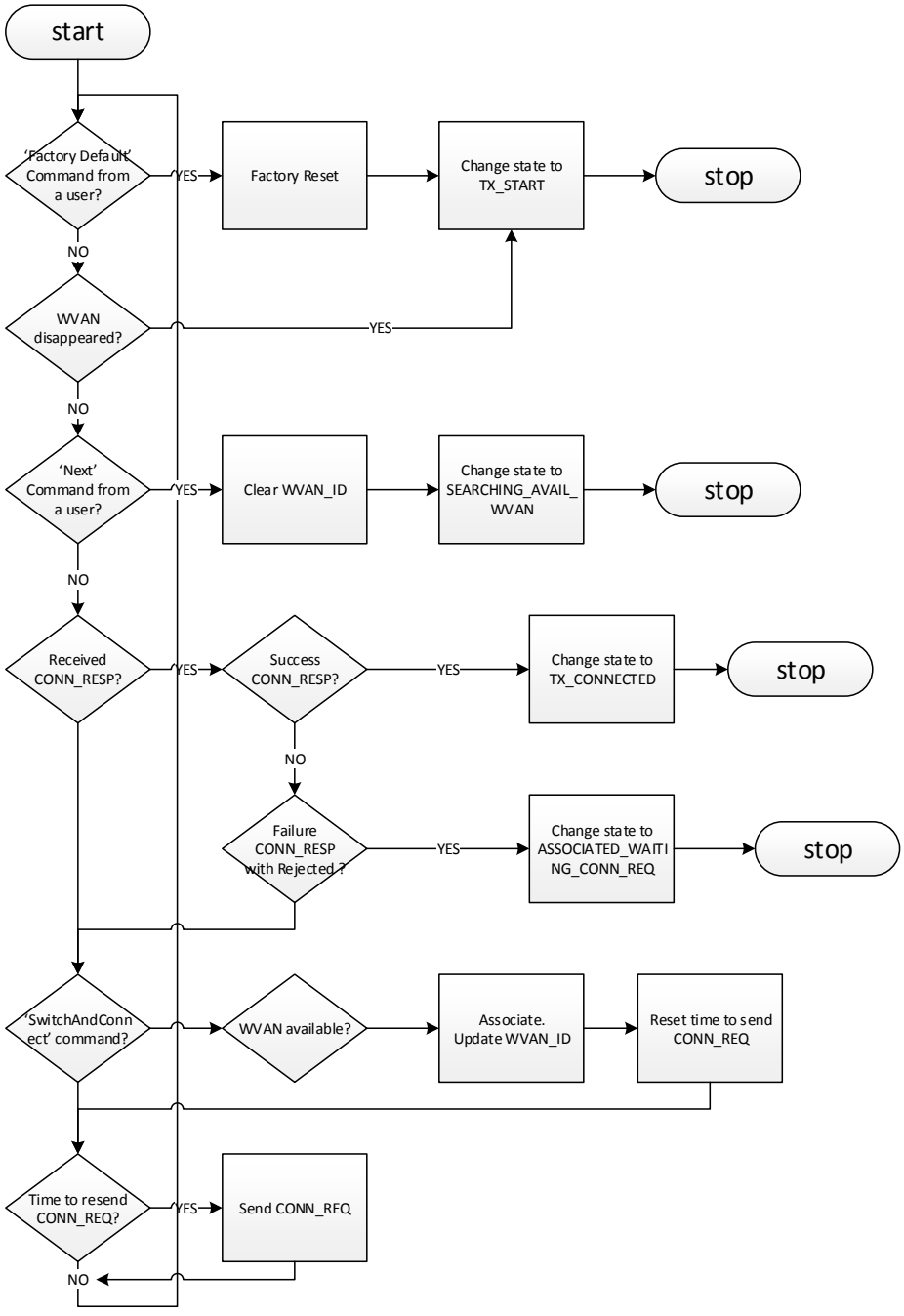


Figure A. 6. Transmitter Connect Request State Flow

A.3. Transmitter States Diagram

The following diagram (Figure A. 7) illustrates the transition between the transmitters states described above.

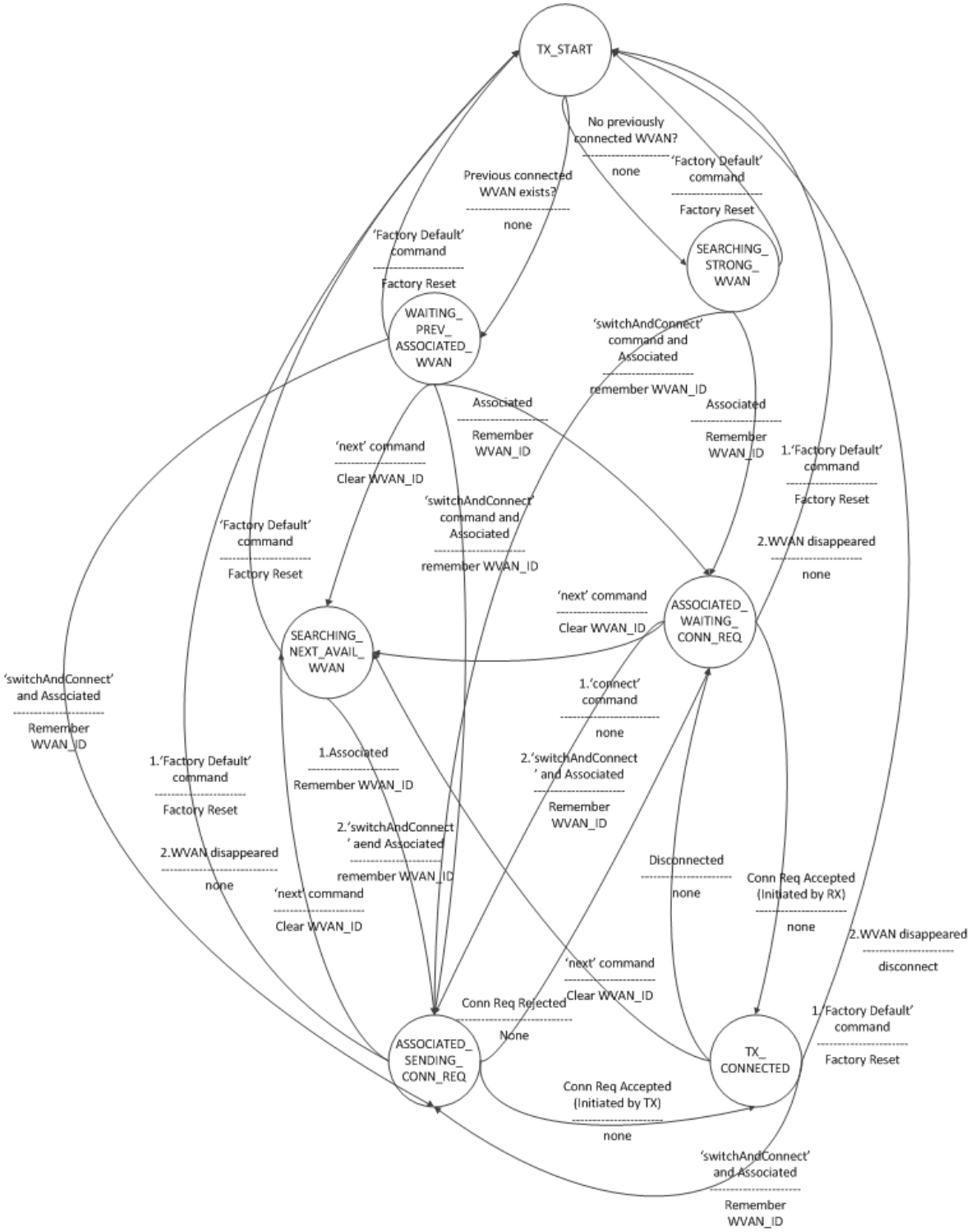


Figure A. 7. Transmitter State Diagram

A.4. Receiver State Flow Charts

Receiver in Start State

When it starts, the receiver has two possible behaviors:

- If it has already been connected to a network, it tries to find its last transmitter and quickly move to a connection with it.
  This has the following implication:
  The receiver does not try to connect to any transmitter within range. It tries to reestablish the previous connection.
  The decision to go from one transmitter to another is user-driven by triggering Next_Source command.
- If it has never been connected to a transmitter since the last reset to default, it associates to the first receiver found in range.

In this state, the decision flow is as follows.

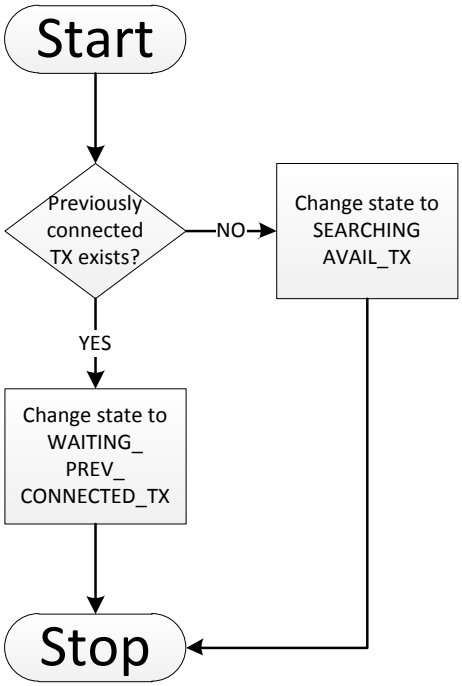


Figure A. 8. Receiver Module Start State Flow

Receiver Searching for Transmitters State

In this state, the receiver is trying to find its target transmitter in the network such that it could reestablish an A/V connection.

In this state, the decision flow is as follows.

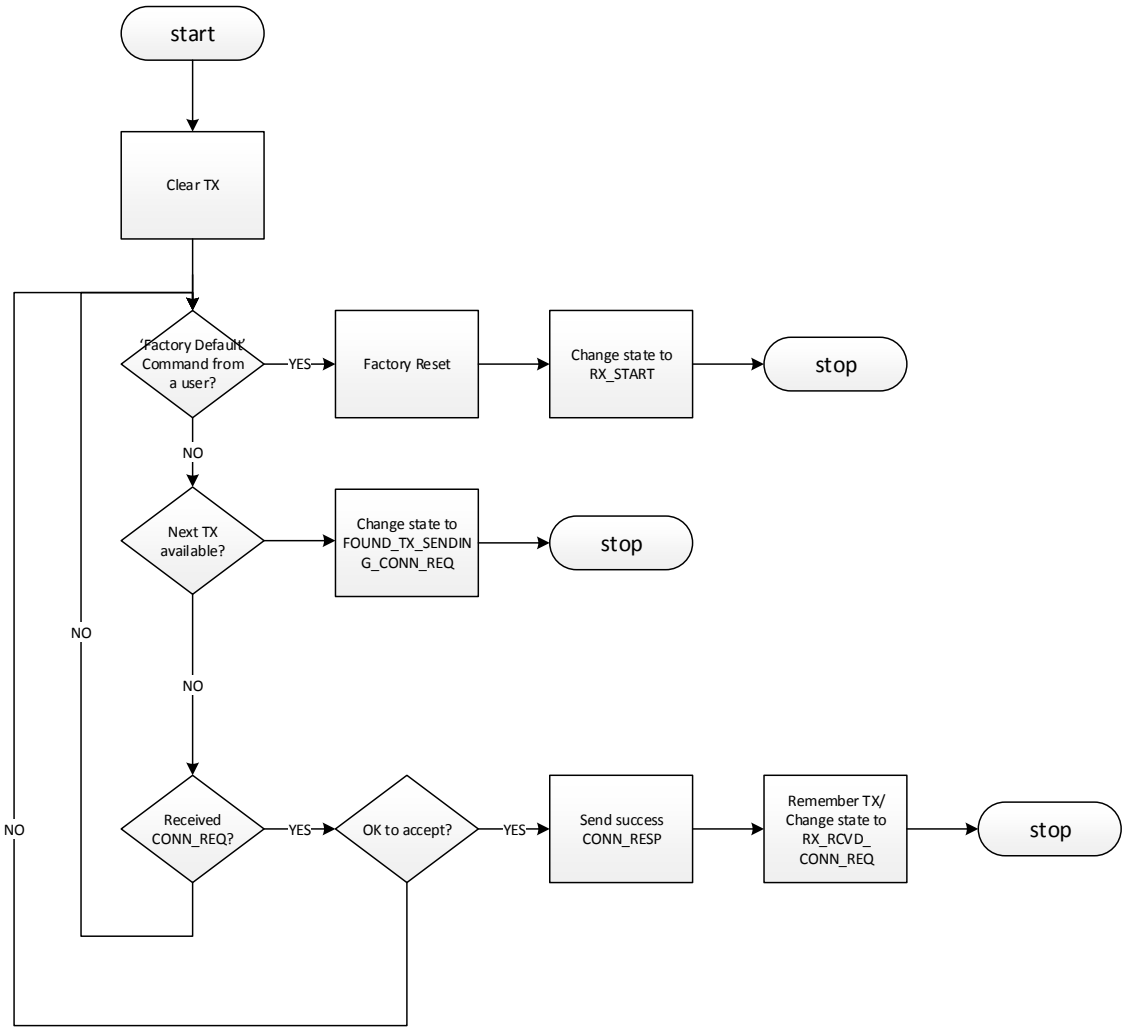


Figure A. 9. Receiver Module Searching for Transmitter State Flow

Receiver Waiting for Transmitter State

In this state, the receiver is waiting for its last connected transmitter to be available in the network. It does not try to connect to any transmitter in the network. It continues to wait for the reestablishment of the previous connection

In this state, the decision flow is as follows.

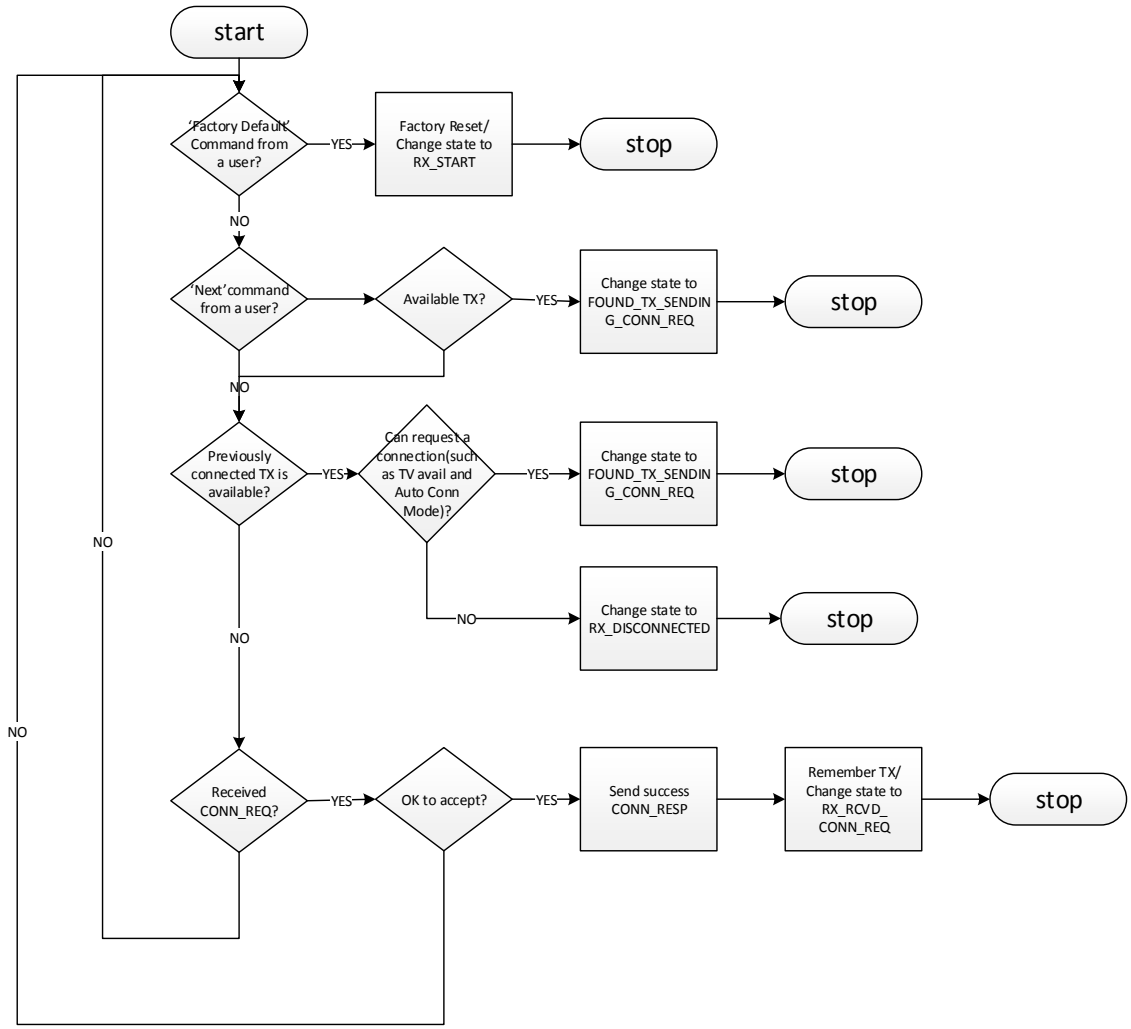


Figure A. 10. Receiver Module Waiting for Transmitter State Flow

Receiver Requests a Connection State

In this state, the receiver has selected a transmitter to which it should establish an A/V connection.

In this state, the decision flow is as follows.

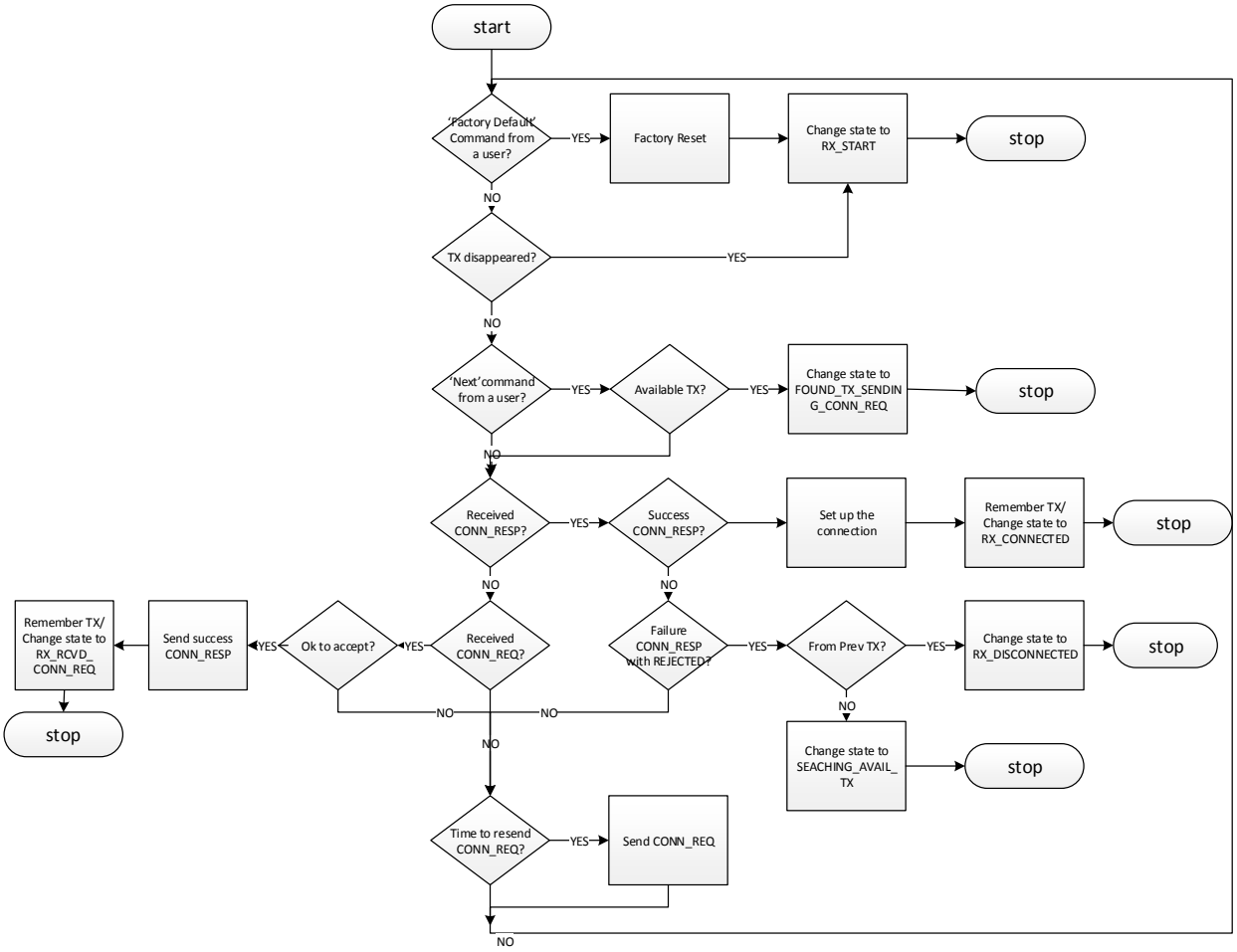


Figure A. 11. Receiver Requests a Connection State Flow

Receiver Receives a Connection Request State

In this state, the receiver is receiving a connection request from a transmitter who wants to establish an A/V connection.

In this state, the decision flow is as follows.

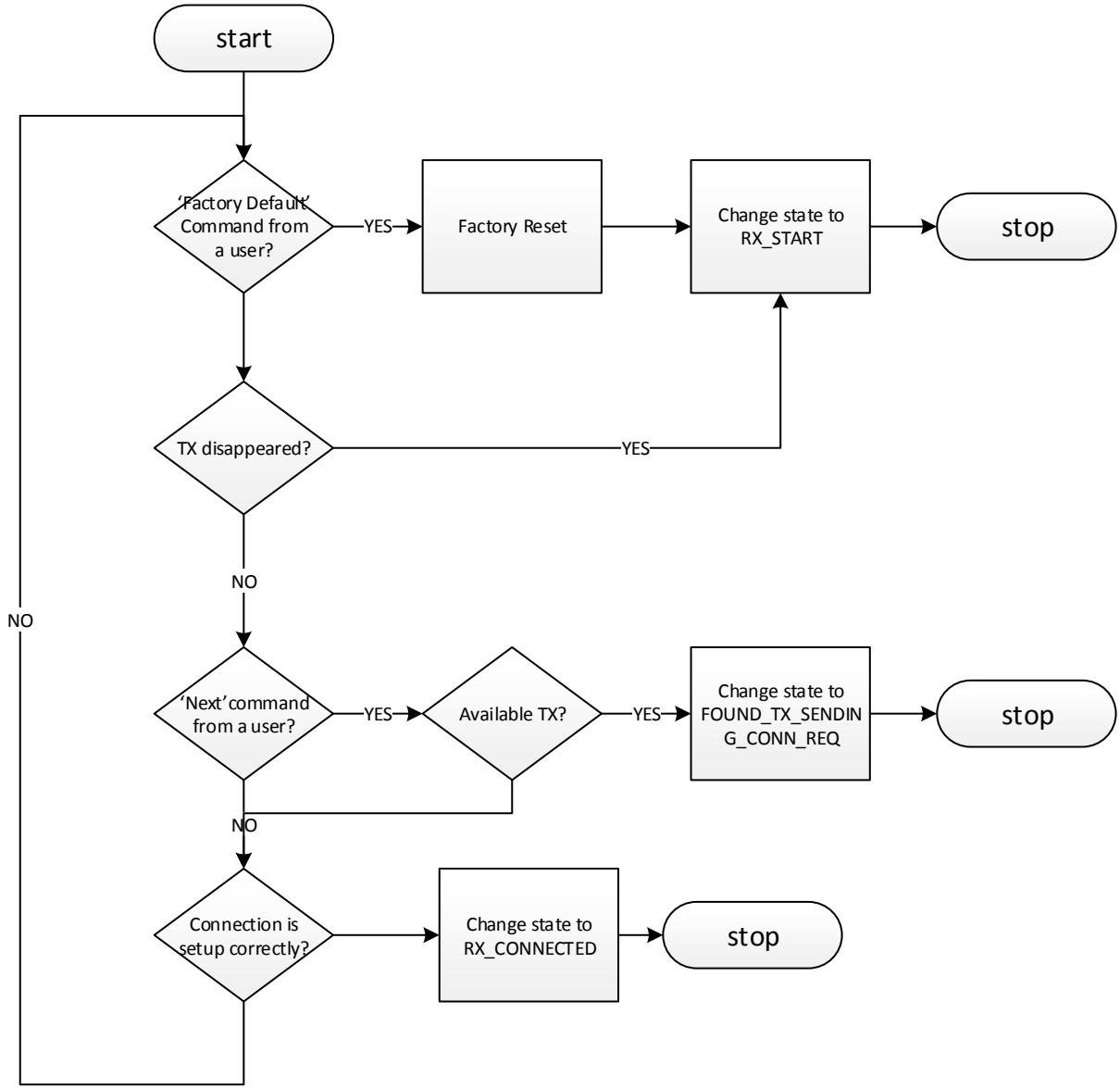


Figure A. 12. Receiver Receives Connection Request State Flow

Receiver Connected State

In this state, the receiver is connected to a transmitter and streaming A/V.

In this state, the decision flow is as follows.

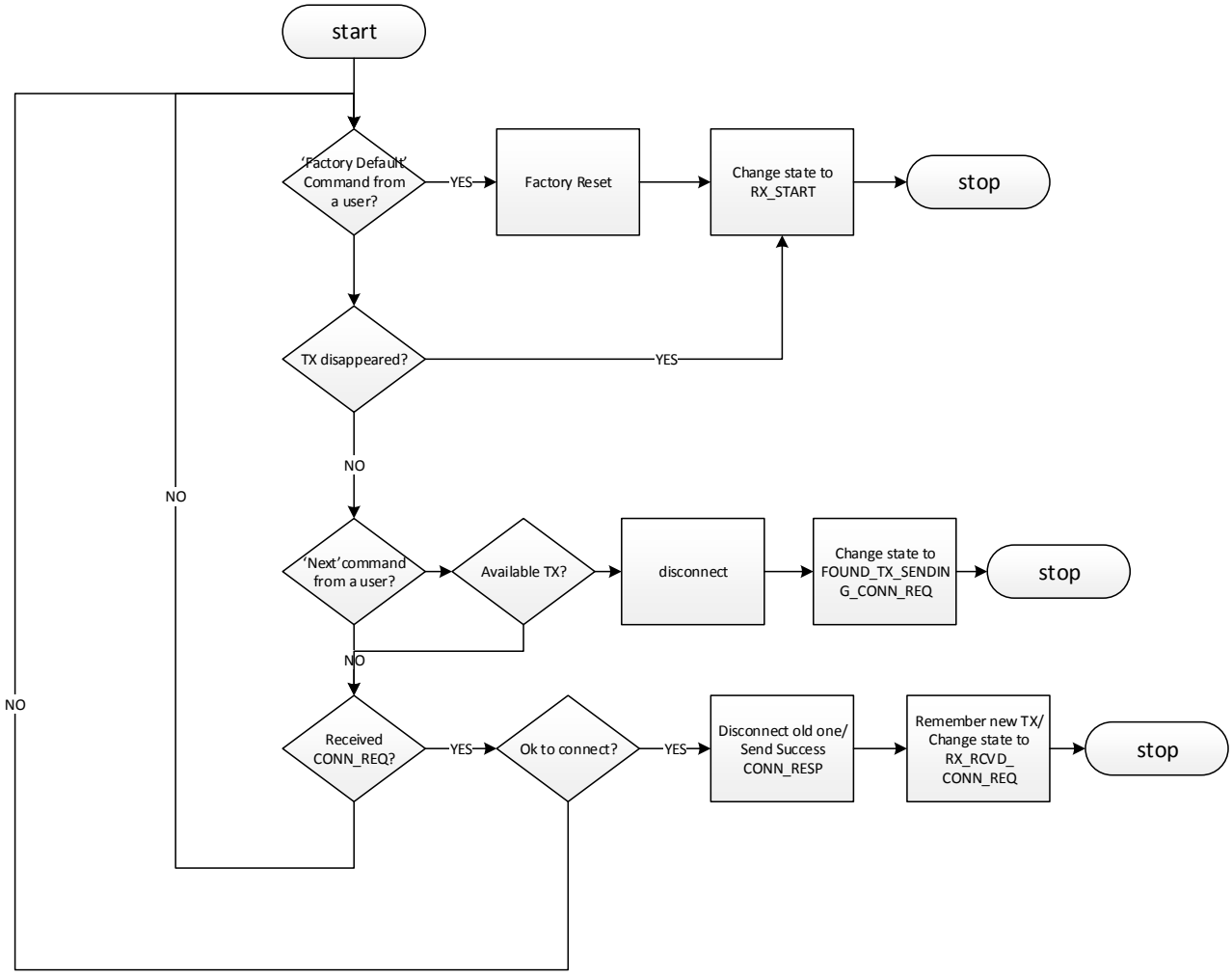


Figure A. 13. Receiver Module Connected State Flow

Receiver Disconnected State

In this state, the receiver has the Audio Video link disconnected. This happens because an explicit disconnect request has been received or because the conditions for connection are not met.

In this state, the decision flow is as follows.

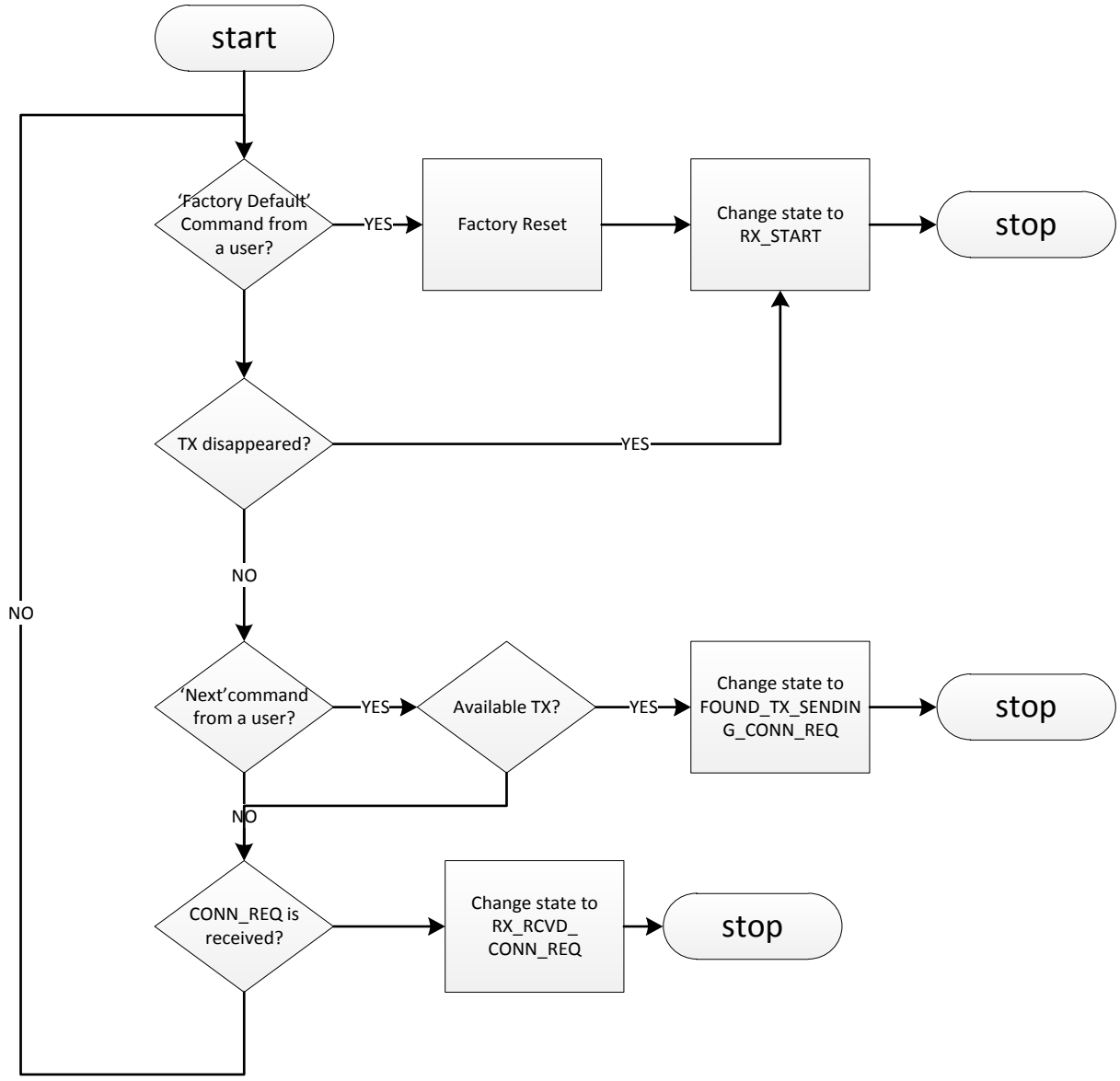


Figure A. 14. Receiver Module Disconnected State Flow

A.5. Receiver States Diagram

The following diagram (Figure A. 15) illustrates the transition between the receivers states described above.

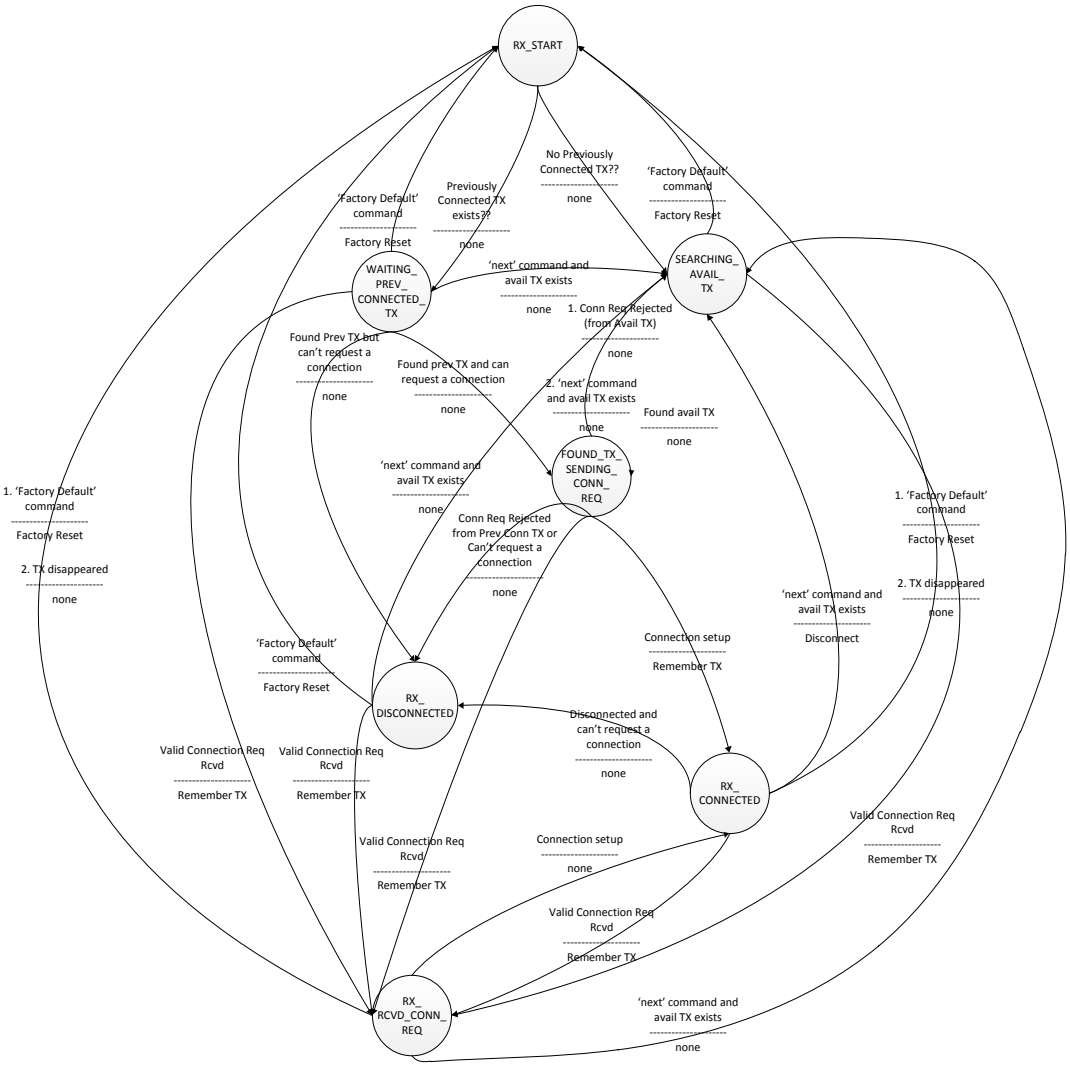


Figure A. 15. Receiver State Diagram

A.6. Transmitter-receiver Sequences

The following diagrams (Figure A. 16, Figure A. 17, Figure A. 18, Figure A. 19, Figure A. 20, and Figure A. 21) illustrate the sequence of protocol exchange between transmitters and receivers in different common user cases.

Transmitter-receiver Basic Connection Flow

This describes the connection/disconnection flow sequence when one transmitter and one receiver are available, which is the most common case.

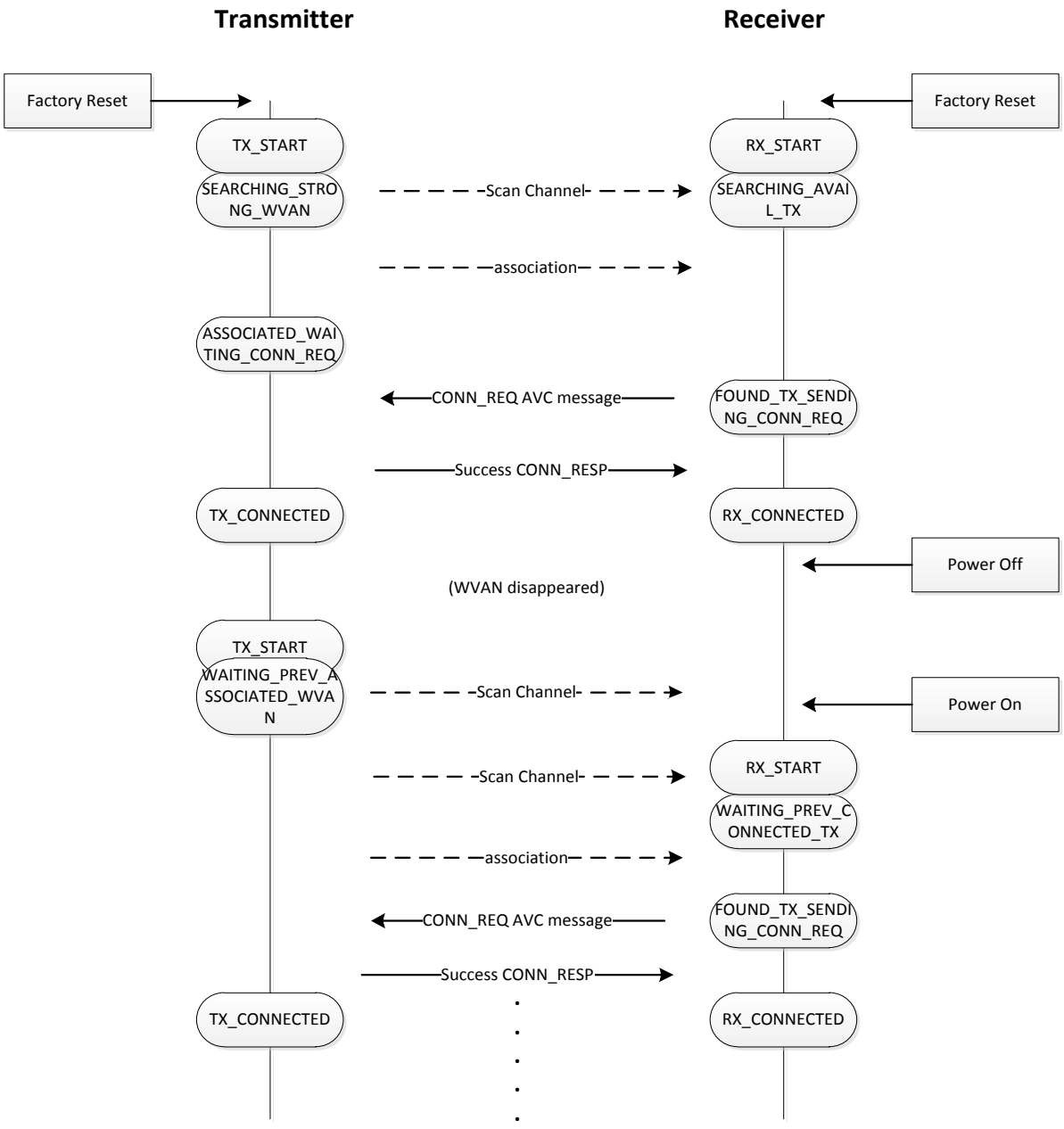


Figure A. 16. Basic Connection Sequence

Transmitter Switches Network Flow

This section describes the case when a transmitter switches between one network and the other.

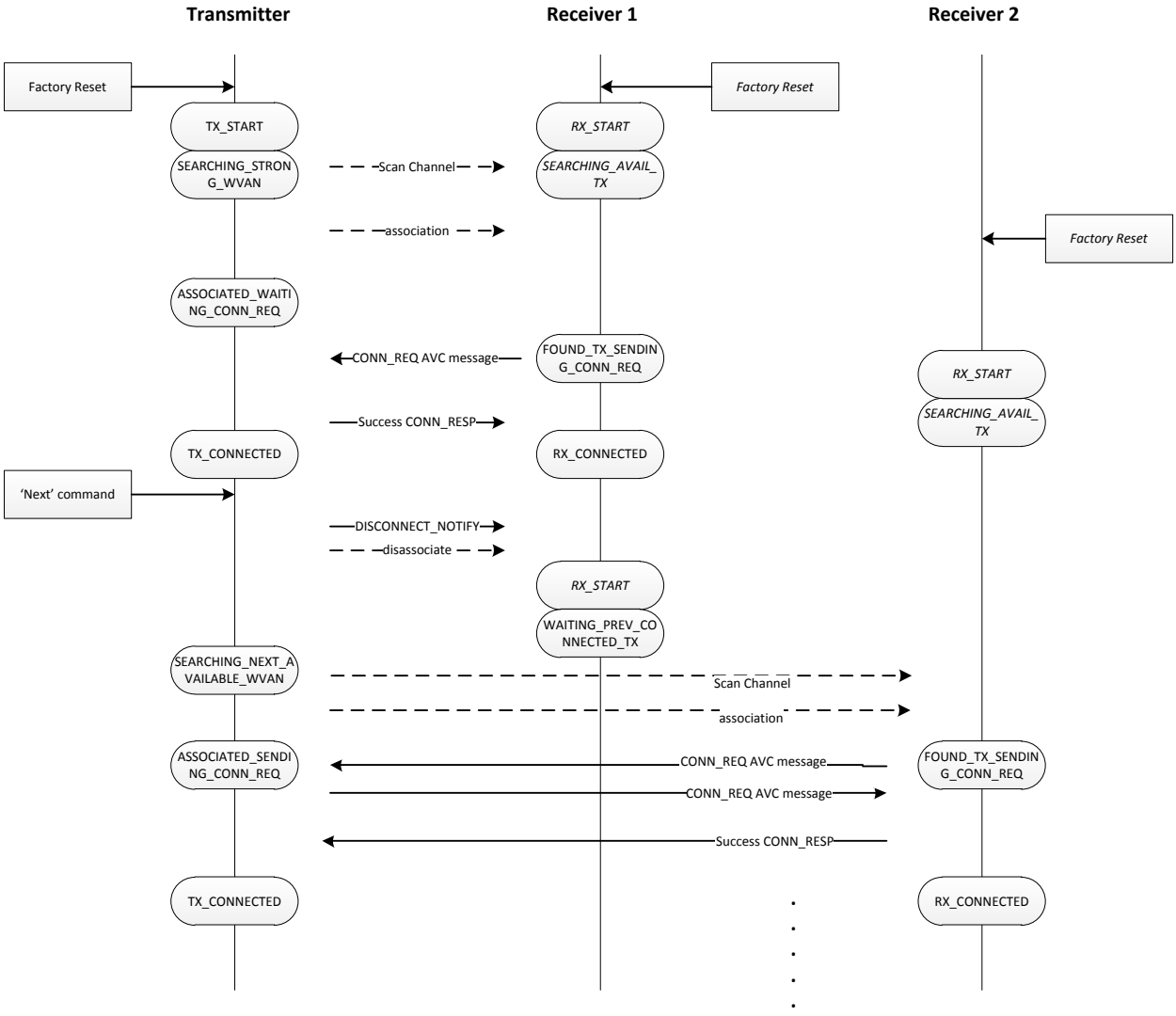


Figure A. 17. Transmitter Switches Network Sequence

Receiver Switches Transmitter

This section describes the case when a receiver switches its connection from one transmitter to another.

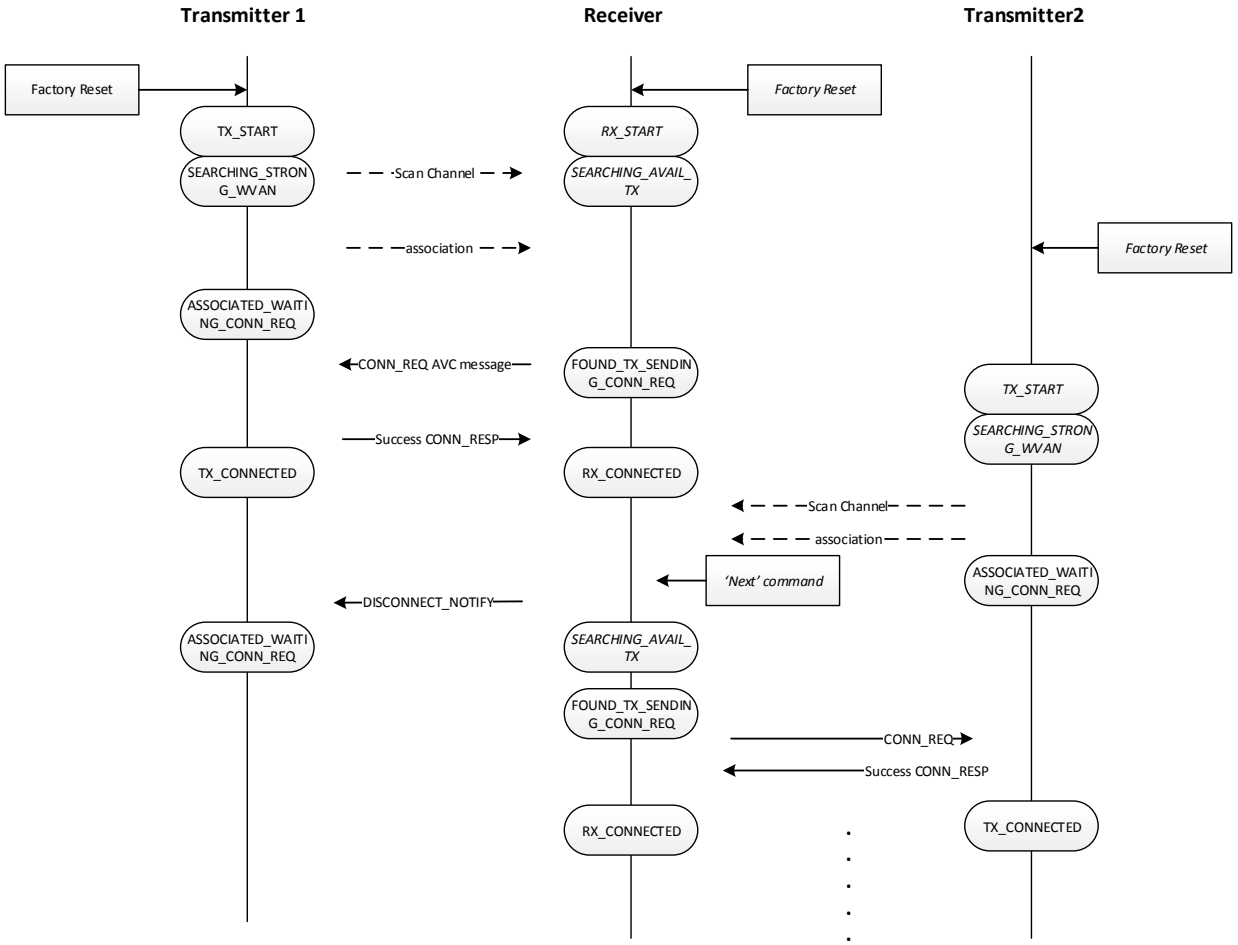


Figure A. 18. Receiver Switches Transmitter Sequence

Transmitter Connection Preemption

This section describes the case when there is an established connection and the user establishes a new connection. This cancels the existing connection and creates a new one.

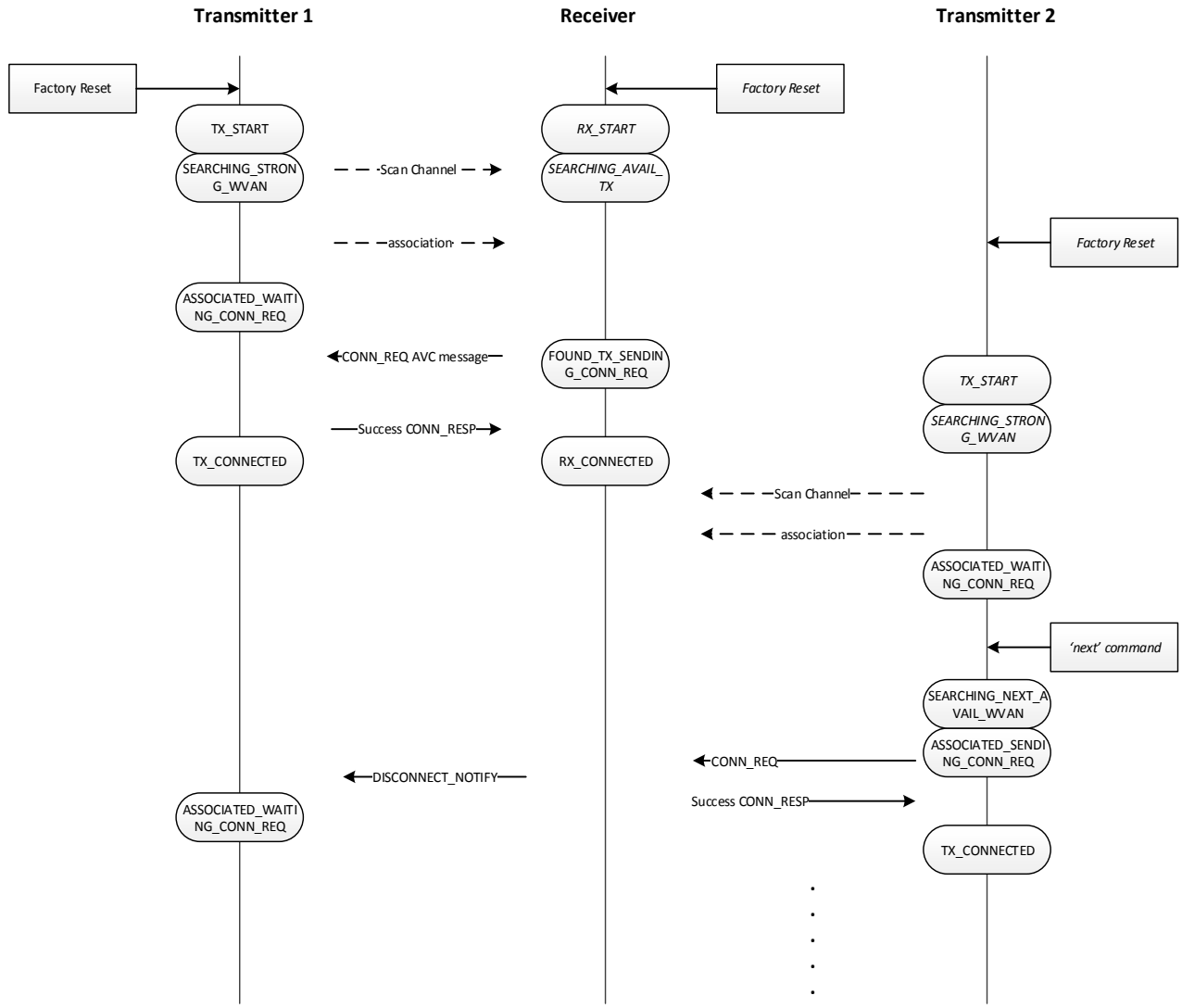


Figure A. 19. Transmitter Connection Preemption

Portable Transmitter Connection

Portable devices behave differently than stationary transmitters. A portable transmitter rejects automatic connection issued by receivers, but it can issue a connection request from the portable device manually.

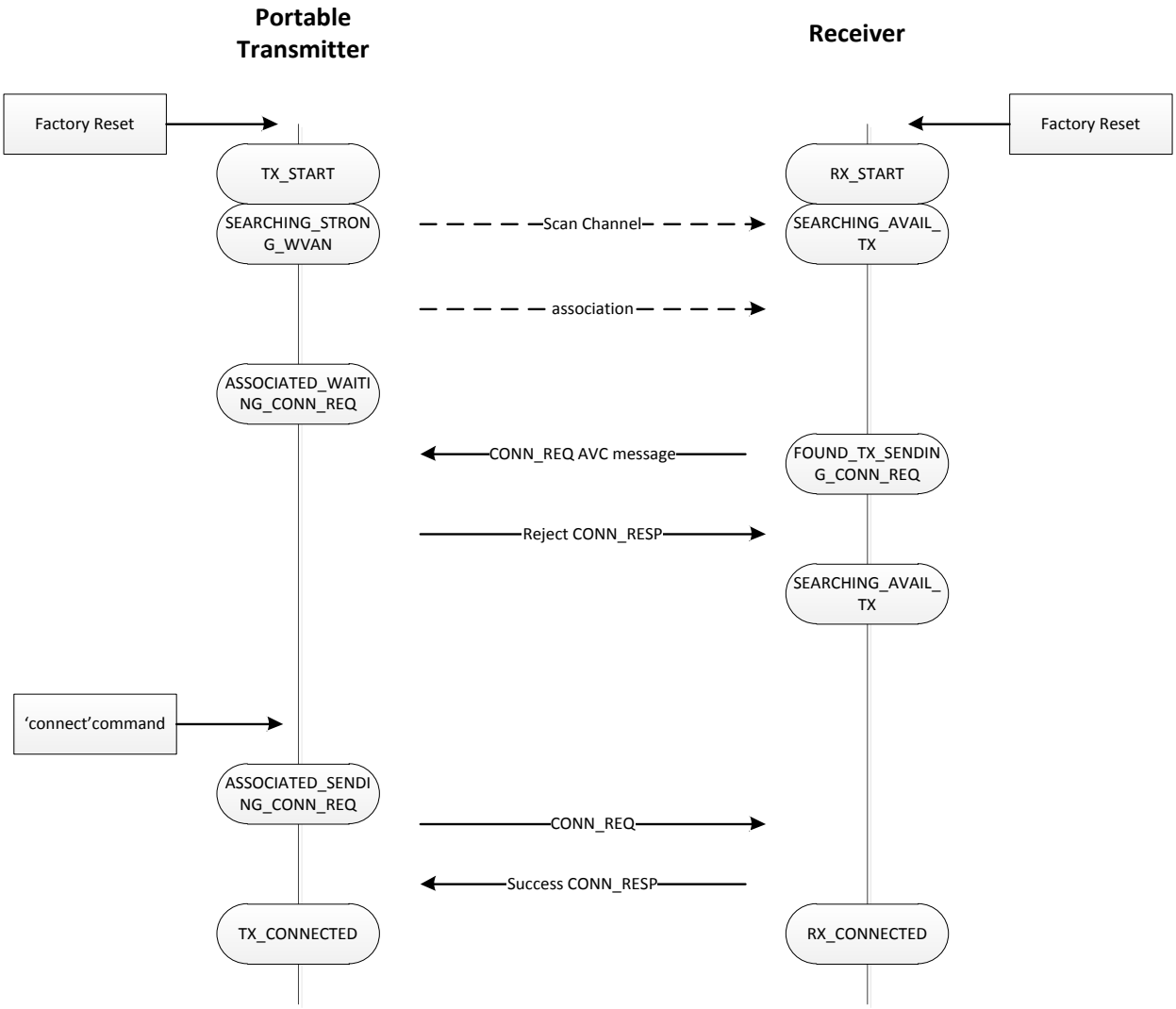


Figure A. 20. Portable Transmitter Connection

Portable Transmitter Network Switch

Portable devices behave differently than stationary transmitter. Portable transmitters can manually select the network which they are associated to the network.

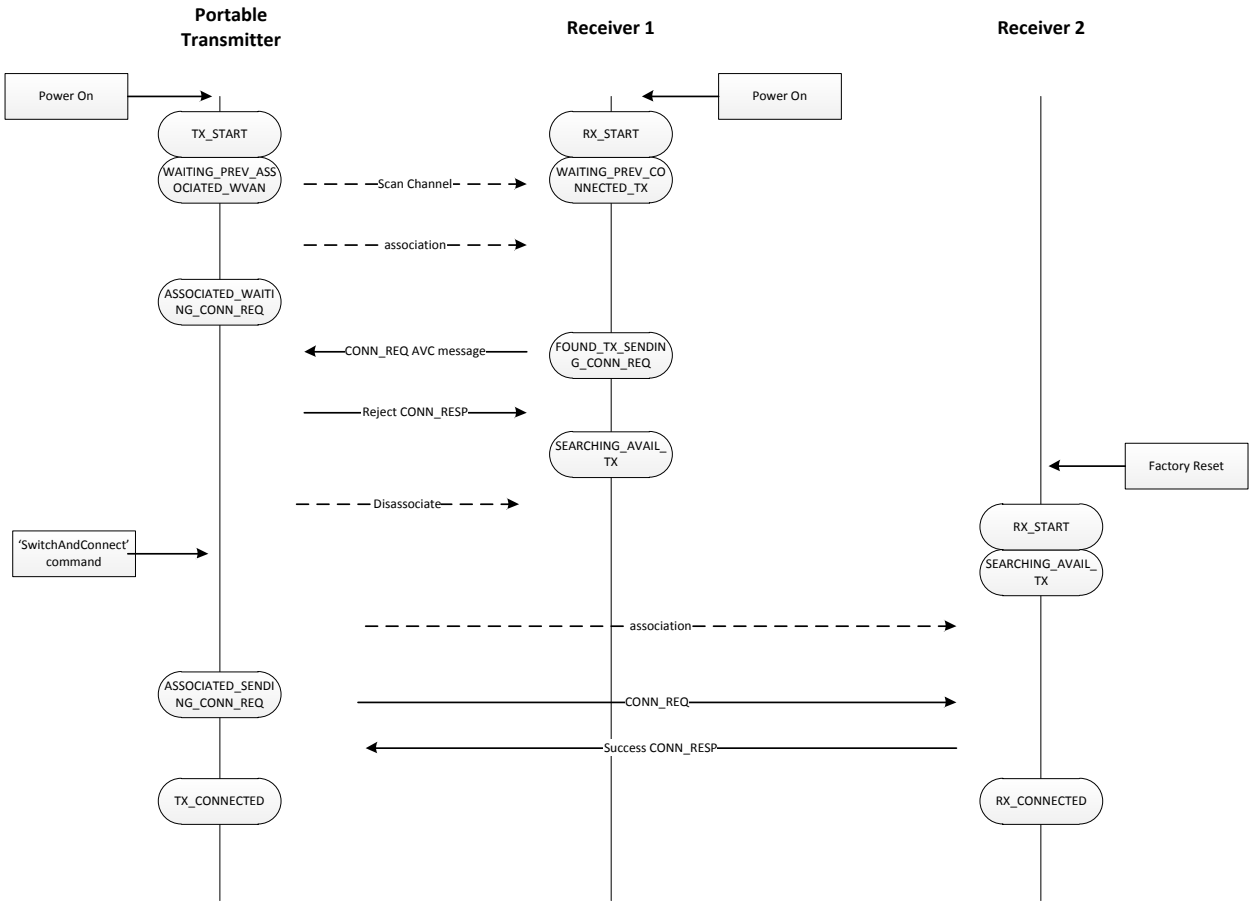


Figure A. 21. Portable Transmitter Network Switch

Appendix B. OEM Installation for SII-SK63101/63102

B.1. Interference Statement

USA - Federal Communications Commission (FCC)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, it may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

1. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
2. This product does not contain any user serviceable components. Any unauthorized product changes or modifications will invalidate warranty and all applicable regulatory certifications and approvals.
3. Caution: Exposure to Radio Frequency Radiation: The installer of this radio equipment must place the module inside the enclosure of a stationary system intended to operate 20cm away from the end user body in typical operation. This implies that this module shall not be integrated in battery operated devices, handheld devices, wearable accessories for example.
4. The antenna(s) used for this transmitter must not be collocated or operating in conjunction with any other antenna or transmitter within a host device, except in accordance with FCC multi-transmitter product procedures. Other antennas shall be installed with a minimum 20 cm separation from the 60 GHz device antenna present in this module.
5. Caution: User is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
6. FCC rule 15.255(a) prohibits the use of this device on aircrafts or satellites.
7. This module is intended for the OEM integrator.

Additional note to System Integrator/OEM:

The regulatory label on the final system must include the exact statement:

“Contains FCC ID: UK2-SII-SK63102” on the transmitter side enclosure

“Contains FCC ID: UK2-SII-SK63101” on receiver side enclosure.

Canada - Industry Canada (IC)

This device complies with RSS 210 of Industry Canada. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of this device. "

L ' utilisation de ce dispositif est autorisée seulement aux conditions suivantes : (1) il ne doit pas produire de brouillage et (2) l' utilisateur du dispositif doit étre prêt à accepter tout brouillage radio électrique reçu, même si ce brouillage est susceptible de compromettre le fonctionnement du dispositif.

The term "IC" before the equipment certification number only signifies that the Industry Canada technical specifications were met. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication. To prevent radio interference to the licensed service, this device is intended to be operated indoors and away from windows to provide maximum shielding. Equipment (or its transmit antenna) that is installed outdoors is subject to licensing.

Pour empecher que cet appareil cause du brouillage au service faisant l'objet d'une licence, il doit etre utilize a l'interieur et devrait etre place loin des fenetres afin de fournir un ecran de blindage maximal. Si le materiel (ou son antenne d'emission) est installe a l'exterieur, il doit faire l'objet d'une licence.

Caution: Exposure to Radio Frequency Radiation.

1. The installer of this radio equipment must place the module inside the enclosure of a stationary system intended to operate 20cm away from the end user body in typical operation. This implies that this module shall not be integrated in battery operated devices, handheld devices, wearable accessories for example.
2. The antenna(s) used for this transmitter must not be collocated or operating in conjunction with any other antenna or transmitter within a host device, except in accordance with FCC multi-transmitter product procedures. Other antennas shall be installed with a minimum 20 cm separation from the 60 GHz device antenna present in this module.

The regulatory label on the final system must include the exact statement:

“Contains IC: 6705A- SIISK63102” on the transmitter side enclosure

“Contains IC: 6705A- SIISK63101” on the receiver side enclosure

Europe - EU Declaration of Conformity and Restrictions

This equipment complies with the essential requirements and other relevant provisions of Directive 2014/53/EC.

This equipment is marked with the CE symbol.

This indicates compliance with the Radio Equipment Directive 2014/53/EC and meets the relevant parts of following technical specifications:

Draft EN 301 567 v2.0.24: Broadband Radio Access Networks (BRAN); 60 GHz Multiple-Gigabit WAS/RLAN Systems; Harmonized EN covering the essential requirements of article 3.2 of the Radio Equipment Directive.

Final Draft EN 301 489-3 v2.1.1: Electromagnetic compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 28: Specific conditions for wireless digital video links.

Draft EN 301 489-1 V2.2.0: ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU

EN 60950: Safety of Information Technology Equipment.

EN 62311: 2008: Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)

Marking by the symbol  on product packaging indicates that usage restrictions apply as indicated by Article 10(10) in the link below.

http://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-224238_en

The usage restriction in the EU applies to this device such that it is not permitted to be used for fixed outdoor deployments. The symbol shall be accompanied by names of countries affected as shown below.

		BE	BG	CZ	DK
		DE	EE	IE	EL
ES	FR	HR	IT	CY	LV
LT	LU	HU	MT	NL	AT
PL	PT	RO	SI	SK	FI
SE	UK				

CE RF Radiation Exposure Statement:

1. Caution this equipment complies with European RF radiation exposure limits and is meant to be used as an Indoor device.
2. The installer of this radio equipment must place the module inside the enclosure of a stationary system intended to operate 20cm away from the end user body in typical operation. This implies that this module shall not be integrated in battery operated devices, handheld devices, wearable accessories for example.

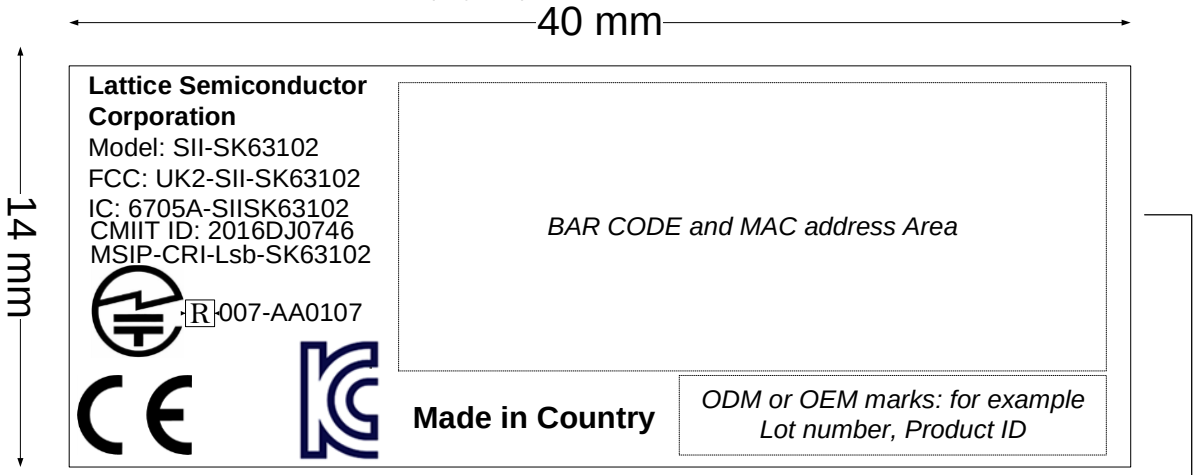
Note for system integrators:
- The module is tested to comply with the requirement of the Radio Equipment Directive. System integrators are responsible for compliance of the final device with the Radio Equipment Directive.
- Packaging: CE Marking must also be on the outer packaging of the product. The outer packaging must also provide an indication as to where the device is intended to be used and/or conversely, where there may be restrictions for use.

B.2. Label and Location

Label for Transmitter and Receiver Module

The module you receive from your vendor should have the following label attached to it:

Label Color: White
Text Color: Black
Material: adhesive and Time Resistant (Polyester)



Transmitter Side

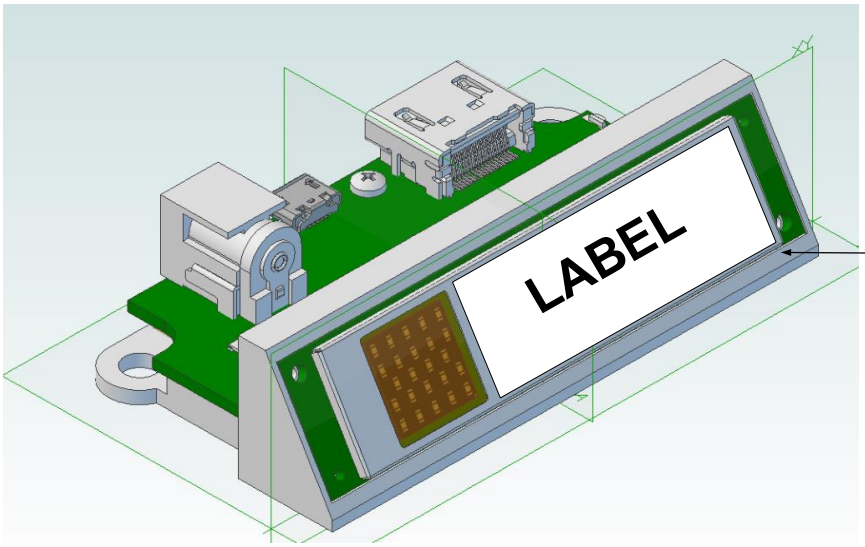
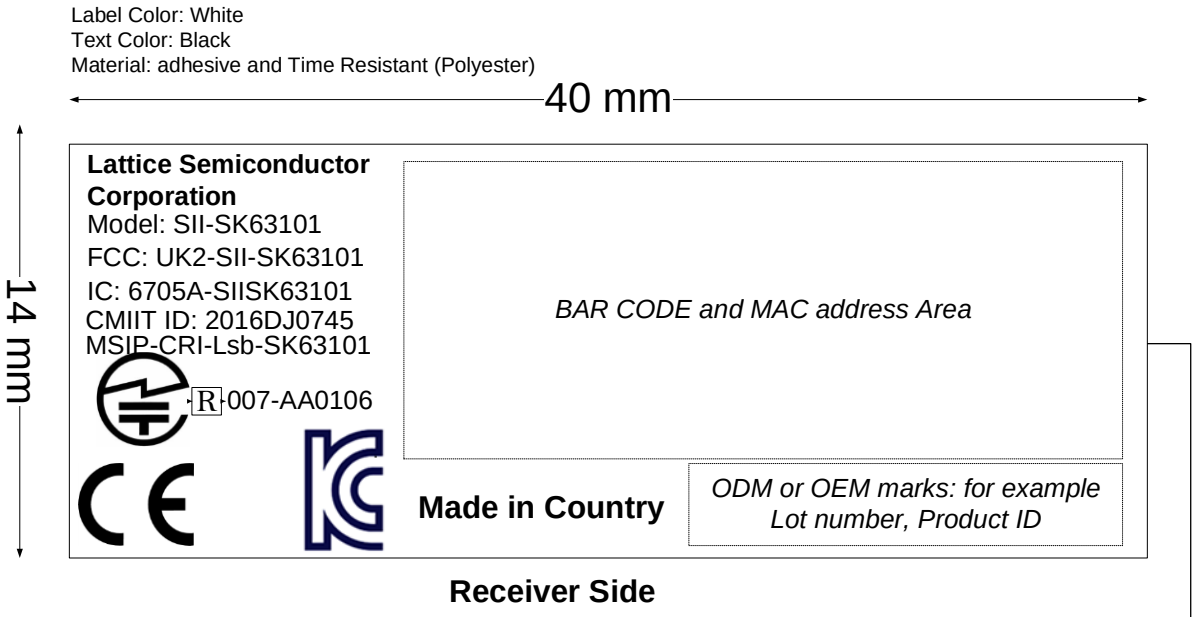


Figure B. 1. Label for SK63102 Transmitter Module



Receiver Side

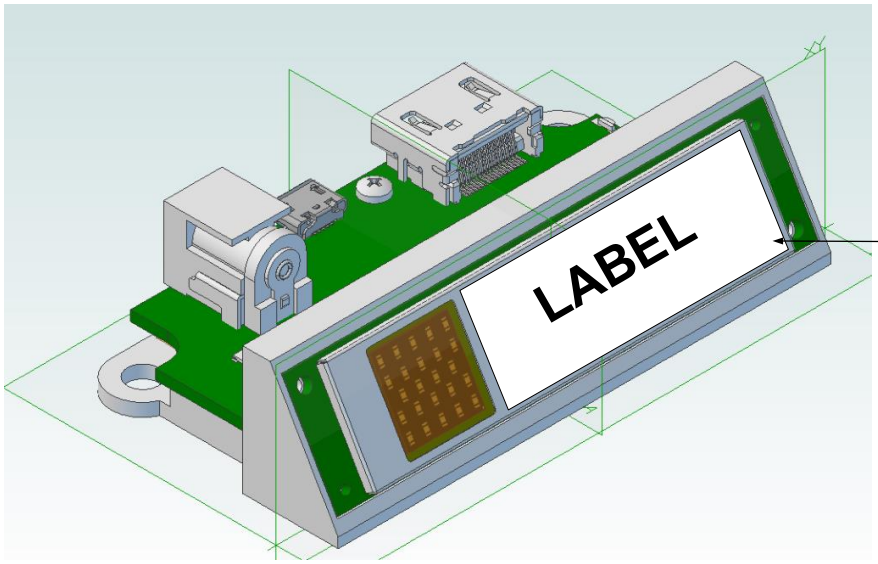


Figure B. 2. Label for SK63101 Receiver Module

B.3. Proposed Label and Location for Host Device

On Transmitter side:

On Receiver side:

Affix this label on the bottom of the host device enclosure, such that it is clearly readable by end user.

References

Standards Documents

This is a list of the abbreviations used in this document.

Abbreviation	Standards publication, organization, and date
WiHD	*WirelessHD Specification,* Version 1.1, WirelessHD, LLC, May 2010
HDMI	*High Definition Multimedia Interface*, Revision 1.4a, HDMI Consortium, March 2010
HCTS	*HDMI Compliance Test Specification,* Revision 1.4a, HDMI Consortium, March 2010
HDCP-1.4	*High-bandwidth Digital Content Protection,* Revision 1.4, Digital Content Protection, LLC, July 2009
HDCP-2.0	*HDCP To WirelessHD Specification Rev. 2.0*, Digital Content Protection, LLC, January 2010
DVI	*Digital Visual Interface*, Revision 1.0, Digital Display Working Group, April 1999
E-EDID	*Enhanced Extended Display Identification Data Standard,* Release A Revision 1, VESA; Feb. 2000
CEA-861-D	*A DMONITOR Profile For Uncompressed High Speed Digital Interfaces*, EIA/CEA, July 2006
EDDC	*Enhanced Display Data Channel Standard,* Version 1, VESA, September 1999

For information on the specifications that apply to this document, contact the responsible standards groups listed on this list.

Standards Group	Web URL	E-mail	Phone
WirelessHD	http://www.wirelessHD.org	info@WirelessHD.org	—
ANSI/EIA/CEA	http://global.ihs.com	global@ihs.com	800-854-7179
VESA	http://www.vesa.org	—	408-957-9270
DVI	http://www.ddwg.org	ddwg.if@intel.com	—
HDCP	http://www.digital-cp.com	info@digital-cp.com	—
HDMI	http://www.hdmi.org	admin@hdmi.org	—

Revision History

Revision F, April 2018

Updated to latest template.

Revision E, January 2018

Added support of MOD6320-4K-T module to the General Description, Features, Module Specifications, and Ordering Information sections.

Revision D, August 2017

- Updated the Grants and Labeling section in response to 2014/53/EU.
- Updated the Europe – EU Declaration of Conformity and Restrictions and Label and Location sections in response to 2014/53/EU.
- Updated Table 15.1. Module Specifications and Table 15.2. Video Format Supported.

Revision C, October 2016

Added KCC (Korea) to the Grants and Labeling section.

Revision B, March 2016

- Updated the Grants and Labeling section and Figure 12.5. Regulatory Label Example.
- Updated Figure B. 1. Label for SK63102 Transmitter Module and Figure B. 2. Label for SK63101 Receiver Module.
- Updated the Proposed Label and Location for Host Device section.

Revision A, August 2015

First product release.

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