Molex (India) Private Limited
Submission for unlicensed use of 57-64 GHz Short Range Devices
Recipient: Telecom Regulatory Authority of India (TRAI)

Responding Comments on:

"Consultation Paper on Assignment of Spectrum in E&V Bands, and Spectrum for Microwave Access (MWA) & Microwave Backbone (MWB)"

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The following comments address specific V-band topics in sections of the aforementioned consultation paper:

(TRAI) Chapter V, Questions 45, 46 and 47

(TRAI) Question 45
Whether it is feasible to allow low powered indoor consumer device-to-consumer device usages on license-exempt basis in V-band (57-64 GHz), in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks? If yes, whether it should be permitted? Kindly justify your response.

(MOLEX) Response to Question 45
Yes, it should be permitted. Concurrent operation of telecom service providers with SRD and LPSRD users in the 57-64 and 57-71 GHz bands is already in harmonious operation in the major markets of the US and the EU plus many more economies, without issues. Permitting allows India to remain competitive in driving innovation, reducing e-waste and benefiting the environment. The SRD and LPSRD (57-64 and 57-71 GHz) technologies are evolving and being widely deployed globally at a rapid rate and the demand for unlicensed SRD and LPSRD spectrum use is continuously growing for various innovative uses including medical, health, safety and security. The US, European, Japanese, South Korean and many more markets are already allowing both licensed and unlicensed services to coexist in the 57-64/71 GHz band. More details are available in the Technical Considerations sections (a) and (b) below.

(TRAI) Question 46
In case it is decided to allow low powered indoor consumer device-to-consumer device usages on license-exempt basis in V-band (57-64 GHz),

(a) Whether it should be permitted in entire band or part of the band? Kindly provide detailed response including the frequency carriers, which should be considered for license exemption with justification.
(b) Whether there is a need to define such indoor use? If yes, what should be the definition for such indoor use?
(c) What technical parameters should be prescribed including EIRP limits? Suggestions may kindly be made with supporting justification and international scenario.

(MOLEX) Response to Question 46 (a)

Yes, SRD and LPSRD devices should be permitted in the entire 57-64 and 57-71 GHz bands similar to US and EU regulations. These bands are already in use for unlicensed operation of consumer devices by many developed markets. See Technical Considerations sections (c), (d), (e), and (f) below.

Using the full band (as currently allowed by the major worldwide economies), for Low Power Short Range Devices "LPSRD" will allow high data transfer rates that are in demand by emerging technologies such as IoT, AI, DSP, medical and many other technologies. As an example, throughput rates of 10 Gbps using 16-QAM modulation will require the use of the entire 7 GHz band (57-64 GHz) or the 57-71 GHz bands.

(MOLEX) Response to Question 46 (b)

Indoor and outdoor SRD and LPSRD use is essential for the SRD and LPSRD technologies and must not be restricted. Reasons include for devices when operating in medical, health or security uses, restrictions may result in unwanted adverse effects with human safety. Specifying unlicensed SRD and LPSRD use to indoor only would be unnecessarily and excessively restrictive as well as cumbersome for users to have to switch the 60 GHz band on and off especially for devices such as mobile phones, smart watches, tablets, health, fitness, and other portable and wearable devices. The LPSRDs and SRDs do not have the radiated power to interfere with licensed users of the spectrum thus, any outdoor limitations will not have any technical benefits to the terrestrial/satellite telecom network operators.

(MOLEX) Response to Question 46 (c)

Molex proposes the use of similar requirements as the USA FCC Part 15.255 regulations and, or the European ETSI EN 305 550 for Low Power Devices Short Range Devices (LPSRD) and ETSI EN 302 567 for Short Range Devices (SRD). See Technical Considerations sections (a), (c) and (f) for typical international regulations and recommendations.

(TRAI) Question 47.

Any other suggestions relevant to assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz) may kindly be made with detailed justification.

(MOLEX) Response to Question 47

Molex proposes the use of similar unlicensed requirements as the USA FCC Part 15.255 regulations and, or the European standards ETSI EN 305 550 for Low Power Devices Short Range Devices (LPSRD) and ETSI EN 302 567 for Short Range Devices (SRD). Technical Considerations section (f) contains Molex's recommendations for LPSRD and SRD operation in India.

Technical Considerations

(a) Summary of Applicable International 60 GHz Regulations

(b) Benefits to Indian Manufacturers and Consumers

(c) Key parameters for 60 GHz LPSRDs

(d) Molex 60 GHz LPSRD "Contactless" Technology:

(e) Applications of 60 GHz LPSRD Technology

(f) Molex Recommendations

(a) Summary of Applicable International 60 GHz Regulations:

There are two common categories of 60 GHz short-range devices:

- Short-Range Devices ("SRD"). These wide-band 60 GHz transmission systems (such as routers, access points and WLAN systems) typically communicate with client devices over distances typically measured up to 30 meters. Typically, SRDs operate at 100 to 500 mW conducted antenna power. SRDs generally use spectrum sharing protocols such as IEEE 802.11ad/ay to allow for harmonious operation of multiple SRDs in close proximity.

- Low-Power Short-Range Devices ("LPSRD") operate at lower power levels (typically less than 10 mW conducted antenna power), and over short distances measured in a few meters. LPSRDs are also known as "non-specific short-range devices"[1],, "extremely low-power devices (ELPD)"[2] or low interference potential device (LIPD)[3] LPSRDs are not required to employ spectrum sharing mechanisms as their radiated power is substantially below levels that may cause spectrum crowding, interference, or coexistence issues.

[1] The term "non-specific short-range devices is defined by European Union's CEPT "ERC recommendation 70-03"
[2] The term "extremely low-power devices" was introduced by Japan's JQA, a consortium for conformance testing of license-exempt 60 GHz devices operating below 10 mW.
[3] The term "low interference potential device was introduced by Australia's ACMA, Radiocommunications (Short Range Devices) Amendment Standard 2021 (No. 1)

Table 1 below provides a summary of selected parameters of the 60 GHz regulations applicable to both SRDs and LPSRDs in the European Union, USA, Canada, Japan, S. Korea, and Mexico.

Jurisdiction	Maximum Power	Operating Frequency Range(GHz)
India LPSRD[4]	100 mW eirp	61.0-61.5
European Union LPSRD (Non-Specific SRD, ETSI EN 305 550)	100 mW eirp 10 mW conducted	57-64
European Union SRD (ETSI EN 302 567)	40 dBm	57-71
USA SRD and LPSRD (47 CFR 15.255)	500 mW conducted 43 dBm peak eirp 40 dBm avg eirp	57-71
Canada SRD and LPSRD	500 mW conducted 43 dBm peak eirp 40 dBm avg eirp	57-71
Japan LPSRD ELPD	33 dBm eirp 199 – 231 µV/m @3m	57-66
Japan SRD rules (In review phase)	Up to 200 mW	57-69
S. Korea SRD and LPSRD	43 dBm eirp	57-66
Mexico SRD and LPSRD	500 mW conducted 43 dBm peak eirp 40 dBm avg eirp	57-64

Table 1. Summary of Relevant International 60 GHz Regulations

(b) Benefits to Indian Manufacturers and Consumers

We believe that a license-exempt V-Band can bring significant environmental advantages that can be achieved by leveraging LPSRD and reducing the use and production of cables and connectors in India. This shift towards more sustainable practices can have a profound impact on our environment and contribute to the nation's commitment to a greener, more sustainable future.

[4] The Gazette of India, No. 753, October 18, 2018 "Use of Low Power and Very Low Power Short Range Radio Frequency Devices (Exemption from Licensing Requirement) Rules, 2018". Normative reference: ETSI EN 305 550

Reduced E-Waste Generation: The adoption of cable-free technologies leads to a substantial reduction in the generation of electronic waste (e-waste). E-waste is a growing concern globally and in India, with the proliferation of electronic devices and accessories. Cables and connectors, often made from a variety of materials, including metals and plastics, significantly contribute to this ever-increasing problem.

According to the European Parliament, consumer electronic device cables that are thrown away make up between 11,000 and 13,000 tons of e-waste each year. It would take approximately 950,000 trees to offset the carbon emissions generated. With India's larger population and the ever-growing use of consumer electronic devices we can expect similar if not larger quantities of e-waste and carbon emissions impact to be generated in India.

Improved Air and Water Quality: E-waste is notoriously challenging to manage and dispose of safely. It contains toxic substances such as lead, mercury, and cadmium, which can leach into the soil and water supplies, posing a serious threat to public health and the environment. By reducing the production and use of cables and connectors, we can significantly curb the influx of e-waste into landfills and illegal disposal sites.

Enhanced Ecosystem Protection: Reduced e-waste and lower environmental impact translate to better protection of ecosystems, wildlife, and natural habitats. India's rich biodiversity will benefit from these conservation efforts. This reduction not only mitigates the environmental damage caused by e-waste but also lessens the burden on India's waste management infrastructure. It alleviates the strain on waste collection and disposal services, reducing the costs associated with the proper handling and recycling of electronic waste.

Furthermore, the conservation of valuable materials in cables and connectors, which would otherwise become e-waste, promotes resource sustainability. These materials can be repurposed, refurbished, or recycled to manufacture new electronic products or other goods, thereby decreasing the need for resource extraction, and reducing the energy and emissions associated with mining and processing raw materials.

Preservation of Resources: The manufacturing of cables and connectors consumes significant amounts of raw materials, including metals and plastics. By reducing their production, we can help conserve these valuable resources and lessen the environmental impact associated with resource extraction and manufacturing. Furthermore, the conservation of valuable materials in cables and connectors, which would otherwise become e-waste, promotes resource sustainability. These materials can be repurposed, refurbished, or recycled to manufacture new electronic products or other goods, thereby decreasing the need for resource extraction, and reducing the energy and emissions associated with mining and processing raw materials.

Other Benefits of Replacing Cables and Connectors with LPSRD technology:

Enhance Mobility and Portability: The elimination of cables allows for the design of more compact and portable devices. This has been a game-changer for industries like consumer electronics and healthcare, leading to the creation of smaller and more convenient products.

Convenience: Users no longer need to fumble with multiple cables and connectors, making it easier to connect and use their devices. This convenience is particularly evident in wireless charging, which has gained popularity in recent years.

Flexibility: Wireless connections provide users with the flexibility to use their devices without being tethered to a specific location. This flexibility is especially valuable in the workplace, allowing for dynamic and collaborative work environments.

Reduced Clutter: The elimination of cables and connectors reduces clutter and simplifies the user's physical environment. This is particularly beneficial in-home entertainment setups, where cable management can be a significant challenge.

Improved Safety: The removal of physical cables reduces tripping hazards, making environments safer, particularly in healthcare settings and public spaces.

Seamless Integration: Wireless technology allows for seamless integration between devices, leading to a more cohesive and efficient user experience. This is evident in the integration of smartphones with various IoT devices and smart home systems.

(c) Key parameters for 60 GHz LPSRDs:

- Maximum Power
    - The maximum 57-64 GHz band radiated and conducted power for LPSRDs vary among jurisdictions. Where LPSRDs are regulated separately from SRDs, the radiated power can range up to 47 dBm eirp depending on the combination of antenna power and antenna gain.
- Operating Frequency Range ("OFR")

  The OFR definitions for the 60 GHz band in various countries are as follows:
    - Lower band-edge:
        - In India the 60 GHz band commences at 61.0 GHz
        - EU, USA, Canada and most other countries commence the band at 57 GHz.
    - Upper band-edge:
        - In India the 60 GHz band ends at 61.5 GHz
        - USA and Canada end the band at 71 GHz.
        - EU ends the band at 64 GHz for LPSRDs (note EU ends the band at 71 GHz for SRDs)
        - Japan LPSRD/ELPD, S. Korea and several other countries end the band at 66 GHz.
        - Japan SRD end the band at 69 GHz

(d) 60 GHz LPSRD, "Contactless" Technology:

LPSRD technology replaces conventional mechanical connectors with very short-range wireless ("contactless") connectors.

Conventional mechanical connectors, both external and internal, have many limitations and have not kept pace with advancements in other key components. Connector wear and tear is a major issue for product reliability, as is damage due to water, dirt, dust and other common environmental hazards. Managing signal integrity has also become more difficult as data rates increase and RF emissions from metallic connectors interferes with Bluetooth and Wi-Fi signals. Product design is also currently limited by the necessary size, location and receptacle of an external connector.

General attributes of 60 GHz LPSRD technology:

- High data rates
- Short range (chip-to-chip $\lesssim$ 30 mm)
- Solid-state technology (non-mechanical – no wear and tear)
- Embedded under device skin – immune to environmental hazards such as water and dust.
- High signal integrity
- No EMI/RFI in the sub-6 GHz portion of the spectrum – no collisions with Bluetooth, Wi-Fi and other commonly-deployed signals internal/external to devices

LPSRD can be used, for example, to create links such as board-to-board interconnects, connections between computing devices (e.g., tablets, laptops or mobile phones) and docks, and connections between modular components in video walls. These "contactless" links replace metallic interconnects.

Molex LPSRD devices "MX60" support data rates up to 6.0 Gbps, including the 5.4 Gbps DisplayPort HBR2 mode and the 5.0 Gbps USB 3.0 SuperSpeed mode. The Molex device passes through data without modification - the data stream provided to the input of a Molex device is the same data stream delivered at the output of the Molex device.

Products incorporating MX60 links can be designed to work with one or more MX60 links. The low output power of Molex devices allows multiple Molex devices to be placed in close proximity in the same plane.

(e) Applications of 60 GHz LPSRD Technology:

Applications of 60 GHz LPSRD technology include:

- Wireless Docking
  - Phones, tablets, laptops, digital cameras, smart watches, health, fitness, and medical monitor wearables
- Modular device connection/peripheral connection
  - Modular Video Wall cabinet-to-cabinet connection
  - Second screen attach

        - Phones, tablets, laptops
    - HDTVs to external video processing device
    - Solid State Drives attach.
- Ruggedization/Sterilization
    - Medical devices: endoscopes, laparoscopes, hand-held medical devices
    - Industrial: PCs/tablets/automatic data capture devices/inventory scanners
    - Consumer devices: phones, tablets, laptops, cameras
- Wireless slip rings/articulated joint connectors/rotational connectors.
    - Robotics
    - Rotating cameras, security cameras, LiDAR systems
    - Industrial sliprings
    - Hinges on laptops, car doors, etc.
- Electrical isolation
    - Robotics
    - AI and other industrial applications
- Cable replacement
    - Phones, tablets
- Internal board-to-board connection
    - Devices with B2B connectivity
    - LED display modules to backplane/cabinets
- Wireless automated test
    - Wireless test and diagnostics of computing devices on factory production lines
        - IoT devices
        - Wearables
- AR/VR
    - Test and diagnostics
    - Fast data upload to headsets
    - Routing signals through hinges
    -

(f) Molex Recommendations:

To permit Indian manufacturers and consumers to realize the benefits described above, LPSRDs should be allowed to be manufactured, sold and operated in the 57-64 GHz band in India. Accordingly, Molex proposes that TRAI include the operating parameters of LPSRDs in the forthcoming draft regulations for the 57-64 GHz band. Specifically, Molex respectfully recommends that TRAI adopt the following intentional radiator rules for the key parameters applicable to 60 GHz LPSRDs:

- Maximum Output power:
    - 100 mW eirp at 3 meters measured in the normal operating mode of the product. This limit is the same as the current Indian limit in the 61-61.5 GHz band and the EU limit and provides flexibility for manufacturers to design products incorporating 60 GHz LPSRDs.
    - Conducted power specification (applicable for connectorized non-integral antennas). For 60 GHz LPSRDs that incorporate an integral antenna, Molex

proposes that instead of applying a conducted power limit, compliance should be determined by measuring radiated emissions (eirp). This is a common practice where integral antennas do not have connectorized access or the antenna cannot be separated from the RF output of the circuit.

- Operating Frequency Range:
  - 57 to 64 GHz and the wider 57 to 71 GHz frequency ranges. Those are the ranges that have been adopted by the US, the EU and many more top tier economies for SRDs and LPSRDs. These frequency ranges allow the highest data transfer rates demanded by current and emerging technologies.
- Spectrum access/mitigation requirements.
  - No spectrum access/mitigation requirements such as adaptive frequency agility (AFA), Listen-Before-Talk (LBT), Automatic Transmit Power Control (ATPC) or Dynamic Frequency Selection (DFS). These requirements are unnecessary for LPSRDs because of their low radiated power and low probability of interfering with other users of the 57-64/71 GHz band. To our knowledge, there have not been any interference concerns raised by users of the 57-64/71 GHz band. Imposing spectrum access and mitigation requirements will unnecessarily increase the cost, design complexity and size of LPSRDs.
    No channel requirements within the 57-64 GHz band. Channels are required for AFA and DFS. These requirements are unnecessary for 60 GHz LPSRDs because of their low radiated power and low probability of interfering with other users of the 57-64 GHz band.
- Occupied bandwidth:
  - -20 dBc[5] or 99% occupied bandwidth definition[6]. Both these OBW definitions are used for SRDs and LPSRDs internationally.
- Out-of-band emissions:
  - -20 dBm/MHz eirp for out-of-band emissions between 43 and 78 GHz. This limit is consistent with international requirements. Some jurisdictions combine out-of-band emissions limits with spurious emissions limits as shown in Table 1.
- Spurious emissions:
  - -30 dBm eirp for emissions above 1 GHz. This is a common spurious emission limit and is appropriate for LPSRDs. Some jurisdictions have variations of this limit as shown in Table 1.

[5] dBc is defined as dB below carrier peak. FCC Occupied Bandwidth measurement is specified in US ANSI C63-10-2013 standard which includes both the relative –xxdBc method as well as the 99% method.
[6] EU ETSI EN 305 550-1 v1.2.1 Section 7.3.2.