# Arasan MIPI I3C® Total IP Solution™

A standardized sensor interface for integrated systems.

**Arasan Chip Systems, Inc.**
**2150 N First street, Ste. 240**
**San Jose, CA 95131**
**Tel. 408-641-6264**
**Website: Arasan.com**

Communications technologies are critical for connecting different local and distributed sensors with a wide range of industrial and consumer applications, which are increasingly reliant on data analytics for decision-making and system management. The worldwide sensor market was valued at $166.69 billion in 2019 and is expected to reach $345.77 billion by 2028, growing at an 8.9 percent CAGR between 2021 and 2028. Sensors are devices that detect events or changes in the environment and then provide an output. They detect physical input such as light, heat, motion, wetness, pressure, or any other entity and respond by displaying the information or transmitting it in computer form for further processing (Kundan et al., 2021).

The electronics industry has seen an explosion in the rise of embedded sensors used in high-volume applications such as smartphones, wearables, cars, and the Internet of Things in recent years (IoT). This fast expansion is being driven by the development of a wide range of small-sized, low-cost sensors that are being coupled with an ever-expanding array of new consumer applications. Today's standard smartphone, for example, contains 10 or more sensors that measure anything from light and biometric response to motion and ambient variables.

Advanced features like as activity detection, pedestrian navigation, health and fitness tracking capabilities, and others are made possible by the numerous sensors found in contemporary smartphones. Smartphones use sensor fusion and algorithms to distinguish between walking and driving, as well as to implement sophisticated power-saving features such as turning off Wi-Fi after a period of inactivity. The installation is soon becoming unmanageable as the tendency toward adding additional sensors continues. High-end smartphones feature up to 20 signal lines and up to 10 sensors. Additional sensors will necessitate more logic lines, which will increase power usage. Then there are the always-on capabilities, which allow for continuous sensor monitoring even when the gadget is turned off. The pedometer mode, as well as other activity identification capabilities, will continue to operate on a smartphone in the user's pocket or handbag. Because certain sensors are continuously on and sensor data is constantly transmitted between devices, a low-power communication interface is required.

The MIPI I3C® Standard was created particularly to solve connection problem between sensors and a host processor in mobile, wearable, and IoT applications to meet these market demands.

Arasan's Total IP Solution™ for MIPI I3C® (previously called SenseWire) comprises of the I3C Host Controller, the I3C Device Controller, the I3C and a low-level software driver (to be defined after MIPI's HCI definition for I3C has been finalized).

The Arasan I3C Host Controller IP implements Host Controller functionality as defined by the MIPI Alliance's I3C® Specification. The I3C bus is used for various sensors in the mobile/automotive system where the Host Controller transfers data and control between itself and various sensor devices. The I3C Host Controller IP Core provides a 32-bit AHB bus as the application interface to configure and control the I3C Host Controller IP Core. The I3C Host Controller IP can be easily integrated into an SOC to provide the required I3C functionality.

Also, the I3C Host Controller IP provides direct signaling to connect to the IO Buffers (SCL and SDA). Please note that the user needs to provide appropriate IO buffers to meet the I3C specification.

The I3C Host Controller implements support for legacy I2C Device Controllers, Clock frequency scaling, Open-drain and Push-pull operation of I3C Interface, and Dynamic Addressing support. The I3C Host Controller supports the required SDR mode with Clock frequency of up to 12.5 MHz and also the HDR modes as defined by the I3C Specification. The included FIFO (Configurable) is used to handle data transfers between IP and the external Device Controllers.

Arasan's MIPI I3C® host controller is compliant with MIPI I3C Specification v1.1, Compliant with MIPI I3C HCI Specification v1.1/v2.0, Supports up to 12.5 MHz operation using Push-Pull, Open-Drain and Push-pull type transactions (as required), Supports legacy I2C devices, Dynamic addressing while supporting Static addressing for Legacy I2C devices, Legacy I2C messaging, I2C-like Single Data Rate messaging (SDR), Optional High Data Rate messaging modes (HDR), Reception of In-band Interrupt support from the I3C Device Controllers, Reception of Hot-Join from newly added I3C Device Controllers, Support for Slave reset, Support for Multilane Data Transfer, Support for Group Addressing.

The Arasan I3C Device Controller IP Implements Device Controller functionality as defined by the MIPI Alliance's I3C® Specification. The I3C bus is used for various sensors in the mobile/automotive system where an I3C Host Controller transfers data and control information between itself and various sensor devices. The I3C Device Controller IP can be easily integrated into the Sensor/Device Controllers with minimal gate count.

The I3C Device Controller is highly configurable (synthesis time) to provide an optimal solution based on the Device's requirements. This includes, acting as a legacy I2C device, Support for Dynamic Address Assignment, HDR, and a configurable FIFO for data transfers.

In addition, Optional I3C Device Controller functions like Interrupt generation, Hot-Join request generation and advanced Device Controller with secondary master capabilities can be configured for more complex device controllers. The I3C Device Controller IP provides direct signaling to connect to the IO Buffers (SCL and SDA). Please note that the user needs to provide appropriate IO buffers to meet the I3C specification.

Arasan's MIPI I3C® device controller is compliant with MIPI I3C Specification Rev 1.1,Supports up to 12.5 MHz operation using Push-Pull, Open-Drain and Push-pull type transactions (as required),Acts as a legacy I2C Device Controller while supporting legacy I2C Messaging and protocol, Participates in Dynamic Addressing while supporting Static Addressing for Legacy I2C mode, I2C-like Single Data Rate Messaging (SDR), Supports High Data Rate Messaging Modes (HDR) (Synthesis time configuration), Supports Transmission of In-band Interrupt, Supports Hot-Join Request Generation, Supports Multilane Data Transfer, Supports Group Addressing, Supports Device to Device Tunneling, Supports HDR Bulk Transport mode, Supports Slave Reset, Direct FIFO Data Transfer support for simple applications.

Arasan's MIPI 13C® phy IO comprises of a host PHY IO and device PHY IO. The PHY IO is compliant with the MIPI specification for I3C v1.2 and supports 1.8V +/-10% supply for IOs and 0.8V +/-10% supply for core.

In mobile and consumer electronics such as smartphones, tablets, and wearables, Arasan's MIPI I3C® offers significant benefits. It's also useful for various sensor-based use cases, such as IoT devices and apps for medical, industrial, and automotive applications, among others. Arasan's MIPI I3C® Total IP Solution™ has a lot of promise and it can be extended to additional non-sensor devices including touch sensing, always-on, and low-resolution cameras ,higher-resolution cameras and displays such as Arasan's MIPI CSI℠ Total IP Solution™ (Camera interface) , Arasan's MIPI DSI℠ Total IP Solutions™ (Display Interface) and the Arasan's MIPI PHY IOs such as C-PHY℠ and D-PHY℠.