**Features**

- Built-in LON, LON/IP, BACnet/IP, and BACnet MS/TP stacks provide compatibility with millions of LON and BACnet devices and enabling IP access to every FT 6050 based device.
- Built-in free topology (FT) transceiver provides the most cost-effective, easy-to-install, and easy-to-use interface for communication with twisted-pair cables with support for polarity-insensitive free topology star, daisy chain, bus, loop, or mixed topology wiring and very high noise immunity.
- Integrated quad core processor supports applications up to 256KB for a 5x increase over previous generations.
- Supports up to 254 network variables (NVs), 127 aliases, and 254 address table entries (16x increase).
- Neuron core supports easy migration of existing applications written for previous generation Neuron Chips and Smart Transceivers.
- Up to 80MHz system clock provides up to a 16x performance improvement over previous generations.
- On-chip 64KB RAM and 16KB ROM.
- 3.3V operation.
- User-programmable interrupts, hardware USART, and 12 GPIO pins with 35 configurable I/O drivers.
- Compatible with low-cost surface mount FT-X3 Communications Transformer.
- Low-cost and royalty-free IzoT® FT 6000 EVK available for rapid application development and testing.
- Free and royalty-free IzoT SDKs available for simple integration with other processors.
- Supports a rich set of LonMark® and IoT standard profiles and data types to reduce application development time.
- Flash file system for data logging and other applications requiring persistent storage.
- Unique 48-bit IEEE MAC ID.
- 7mm x 7mm 48-pin QFN package.
- -40°C to 85°C industrial temperature range.
**Build Free Topology Wired Devices for the Industrial IoT**

The FT 6050 Smart Transceiver is a system-on-chip for modernizing and consolidating smart control networks. It is a key product in Echelon’s IzoT® platform — the most comprehensive and open control networking platform for the Industrial Internet of Things (IIoT). It offers compatibility with the large installed base of LON FT and BACnet MS/TP devices while adding support for LON/IP and BACnet/IP communication over the reliable and proven Free Topology (FT) channel. It is designed to bring unprecedented flexibility and openness while lowering development and device costs.

The FT 6050 Smart Transceiver integrates a high-performance Neuron® core with an FT twisted-pair transceiver. Combined with the proven FT-X3 Communication Transformer and inexpensive flash memory, the FT 6050 Smart Transceivers provide a very flexible, low-cost, feature-enhanced LON FT, BACnet MS/TP, LON/IP, and BACnet/IP solution all within the same device with a single application.

A rich set of LonMark and IoT standard profiles and data types is included that you can use to further reduce application development time.

The FT 6050 Smart Transceiver includes four independent 8-bit logical processors to manage the physical MAC layer, the communication protocol stacks, the user application, and interrupts (see Figure 1). The FT 6050 Smart Transceiver supports polarity-insensitive cabling using a star, bus, daisy-chain, loop, or combination topology (see Figure 2). Installers don’t have to follow a strict set of wiring rules imposed by other networking technologies. Instead, they can install wiring in the fastest and most cost-effective manner, thereby saving time and money. FT wiring also simplifies network expansion by eliminating restrictions on wire routing, splicing, and device placement. The FT 6050 extends all the benefits of FT wiring to IP devices, allowing an efficient multi-drop IP capability where multiple IP devices can be very simply connected in any topology without the need for switches or hubs.

**Multi-Protocol Operation**

The FT 6050 simultaneously supports up to four different communication protocols, as shown in Figure 3, allowing device makers unprecedented flexibility in creating control devices for a wide variety of applications using one application. Backward compatibility and future proofing can both be met using a common platform based on the FT 6050 Smart Transceiver.

For LON FT communication, the FT 6050 implements the complete LON stack as defined by ISO/IEC 14908-1 and is fully backward compatible with devices running the LON stack, including devices based on the Neuron 3120, Neuron 3150, or the FT 3120, FT 3150, or FT 5000 Smart Transceiver.

For LON/IP communication, the FT 6050 implements layers 4 through 7 of the ISO/IEC 14908-1 LON stack running on top of layers 2 and 3 of a UDP/IP stack. This allows the implementation of devices that are fully compatible with classic LON applications while supporting native IP addressing at the device level. This allows LON compatible applications to run unmodified over FT wiring while gaining IP addressing at the device level.

For BACnet/IP communication, the FT 6050 implements a BACnet/IP standard stack running on top of layers 2 and 3 of a UDP/IP stack. This enables BACnet/IP-compliant applications to run on the easy-to-use and easy-to-install FT channel, pushing BACnet/IP all the way down to the simplest of devices, while leveraging the ease-of-installation provided by LON commissioning tools. Devices thus provisioned are fully compatible and discoverable using industry standard, BTL certified, BACnet management clients.

For BACnet MS/TP communication, the FT 6050 implements a BACnet MS/TP stack that uses one of the FT 6050 USARTS to communicate with an external RS-485 transceiver using the BACnet MS/ TP stack.
TP protocol. This enables BACnet MS/TP-compliant applications to be implemented in parallel with LON, LON/IP, and BACnet/IP applications running on the FT 6050. For other IP applications, the FT 6050 implements a UDP/IP stack that an application can use to create any type of IP interface that communicates with the easy-to-use and easy-to-install FT channel.

### Compatibility
The FT 6050 series Smart Transceiver is fully compliant with LON devices implementing the ISO/IEC 14908-1 protocol on the FT channel type defined by ISO/IEC 14908-2 and can communicate with devices that use Echelon’s FFT-T0 or FFT-T0A transceivers, FT 3120 or FT 3150 Smart Transceivers, LPT-10 or LPT-11 Link Power Transceivers, or other ISO/IEC 14908-2 compliant transceivers.

The Neuron core in the FT 6050 Smart Transceiver uses the same instruction set and architecture as the previous-generation Neuron core, including instructions for hardware multiplication and division. The FT 6050 Neuron core is source code compatible with applications written for the Series 5000 and 3100 Neuron core.

### Enhanced Performance
#### Neuron Core Speed
The internal system clock for the FT 6050 Smart Transceiver can be user-configured to run from 5MHz to 80MHz. The required external crystal provides a 10MHz clock frequency, and an internal PLL boosts the frequency to a maximum of 80MHz as the internal system clock speed. The Neuron core in the FT 6050 Smart Transceiver running with an 80MHz internal system clock is thus 16 times faster than a 10MHz Neuron 3120 or Neuron 3150 core.

The Neuron core inside the FT 6050 Smart Transceiver includes a built-in hardware multiplier and divider to increase the performance of arithmetic operations.

#### Higher Protocol Limits
The FT 6050 Smart Transceiver supports up to 254 network variables per application, up to 127 aliases, and up to 254 address table entries. This is a significant increase over the previous limits of 62 network variables, 62 aliases, and 15 address table entries which simplifies network installation and supports more complex applications.

### Interrupts
The FT 6050 Smart Transceiver lets developers define application interrupts to handle asynchronous events triggered by selected state changes on any of the 12 GPIO pins, by on-chip hardware timer-counter units, or by an on-chip high-performance hardware system timer.

### MAC Layer Enhancements
The FT 6050 has an enhanced MAC layer that allows frame sizes up to 1280 bytes. This allows large IP frames to be carried over the FT channel without fragmenting the packet to provide better bandwidth utilization of the FT channel.

The dedicated processor cores for the MAC and network protocol support allows the application to have the same performance independent of the network traffic. Traditional uni-processor designs running popular transceivers such as RS-485 must be interrupted repeatedly to receive every packet on the network, even when the packet turns out to not be addressed to the device. This increases the demands on the application processor and makes the amount of processing available to the application difficult to predict as it becomes a function of the network load.

### JTAG Interface
The FT 6050 Smart Transceiver provides an interface for the Institute of Electrical and Electronics Engineers (IEEE) Standard Test Access Port and Boundary-Scan Architecture (IEEE 1149.1-1990) of the Joint Test Action Group (JTAG) to allow an FT 6050 chip to be included in the boundary-scan chain for device production tests.

### GPIO
The FT 6050 Smart Transceiver provides 12 bidirectional GPIO pins that are 5V-tolerant and can be configured to operate in one or more of 35 predefined standard input/output modes. The chip also has two 16-bit timer/counters and a hardware USART that reduce the need for external logic and software development.

### Memory Architecture
The FT 6050 Smart Transceiver eliminates the need for external serial EEPROM that the previous generation FT 5000 required and instead relies only on inexpensive external flash memories for non-volatile application and data storage, and for Neuron firmware upgrades. It has 16KB of ROM and 64KB (44KB user-accessible) of RAM on the chip. Each chip contains a unique identifier (IEEE MAC ID) in an on-chip, non-volatile, read-only memory. Typical external flash memory configuration is 1MB of which 256KB is available for application code. This is a five-fold increase in application size that can be hosted on the FT 6050 compared to previous generations.

The application code and configuration data are stored in the external non-volatile memory (NVM) and copied into the internal RAM during device reset; the instructions then execute from internal RAM. Writes to NVM are shadowed in the internal RAM and pushed out to external NVM by the Neuron firmware.

The FT 6050 Smart Transceiver supports serial peripheral interface (SPI) for accessing off-chip, non-volatile memory.

The FT 6050 Smart Transceiver supports a variety of flash devices from different manufacturers. Echelon has qualified the following SPI flash memory devices for use with the FT 6050 Smart Transceiver:

- Winbond W25X40CL 4-Mbit SPI Serial Flash Memory.

### Noise Immunity
A LON device based on the FT 6050 Smart Transceiver is composed of two components: the FT 6050 Series Smart Transceiver and an external communications transformer such as the FT-X3 communications transformer. The transformer enables operation in the presence of high frequency common-mode noise on unshielded twisted-pair networks. Properly designed devices can meet the rigorous Level 3 requirements of EN 61000-4-6 without the need for a network isolation choke. The transformer also offers outstanding immunity from magnetic noise, eliminating the need for protective magnetic shields in most applications.

### 6K Chip Design Information
#### 6K IC Pin Configuration

![6K IC Pin Configuration](image-url)
6K Pad Layout

Figure 5: Recommended 6K Pad Layout

6K IC Mechanical Specifications

Figure 6: 6K IC Dimensions

Notes
1. All dimensions are in millimeters.
3. Package warpage max. 0.08 mm.
4. Package corners unless otherwise specified are R0.175±0.025 mm.

FT-X3 Design Information

FT-X3 Pin Configuration

FT-X3 Pad Layout

Figure 7: FT-X3 Pin-out

Figure 8: FT-X3 Transformer Pin Assignments

Tape and Reel

6K Tape and Reel

6K ICs are uniformly loaded in the carrier tape such that pin one is oriented in quadrant 1 toward the side of the tape having round sprocket holes. Figure 11 illustrates the pin-one location.

Figure 10: FT-X3 Dimensions

Figure 11: 6K Tape and Reel Orientation

6K Transformer Pad Layout (just outside of the SMT pad rectangles) to provide additional mechanical support for the transformer
Figure 12 illustrates the outline dimensions of the carrier tape.

\[ K_0 = 1.10 \]

**Notes**

1. All dimensions are in millimeters.
2. Tolerances unless noted: 1PL + 0.2, 2PL + 0.1
3. 10 Sprocket hole pitch cumulative tolerance +0.2
4. Camber in compliance with EIA 481
5. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

For more information, refer to EIA-481-B, Taping of Surface Mount Components for Automatic Placement.

Figure 13 illustrates the 6K 7” reel and hub dimensions.

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**Figure 13: 6K 7” Reel and Hub**

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**Figure 14: FT-X3 Carrier Tape Placement**

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**Figure 15: FT-X3 Reel and Hub**

**Notes**

1. All dimensions are in millimeters.
2. Tolerances unless noted: 1PL + 0.2, 2PL + 0.1, 3PL + 0.1, ANG + 0.5, FRACT +

Figure 16 illustrates the FT-X3 carrier tape dimensions.

**Notes**

1. Material: black conductive polystyrene PS
2. Inspect per EIA-481-3 standard.
3. Tape thickness: 0.5 ±0.05 mm
4. 10 Sprocket hole pitch cumulative tolerance ±0.20
5. Carrier chamber is within 1 mm in 100 mm
6. Packing length per 22” reel: 10.2 meters
7. Packing length per 13” reel: 3.4 meters
8. Component load per 13” reel: 100 PCS
9. Compression strength: 1.5 kgf min.
10. Environment-related substance must meet DELTA’s general spec no. 10000-0162

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**Application Development**

A typical FT 6050 Smart Transceiver-based device requires a power source, crystal, external memory, and an I/O interface to the device being controlled (see Figure 17 for a typical FT 6050 Smart Transceiver-based device).

Echelon provides all of the building blocks required to successfully design and field cost-effective, robust products based on the FT 6050 Smart Transceiver. Echelon’s end-to-end solutions include a comprehensive set of development tools, network interfaces, routers, and network tools. In addition, pre-production design review services, training, and worldwide technical support (including onsite support) are available through Echelon’s Support technical assistance program.

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**Figure 16: FT-X3 Carrier Tape Packing**

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**Figure 17: Typical FT 6050-based Device**
The following development tools are available for developing applications for the FT 6050 Smart Transceiver:

- **IzoT FT 6000 EVK** — a complete hardware and software platform for creating or evaluating LON, LON/IP, BACnet/IP, and BACnet MS/TP devices based on the FT 6050 Smart Transceiver. Using the FT 6000 EVK, developers can create applications that run on the FT 6050 Smart Transceiver using the highly productive Neuron C programming language.

- **IzoT SDK Premium Edition** — a software development kit that enables developers to build communicating devices using any processor that runs Linux for the application and Layers 3 through 7 of the LonTalk/IP and LON protocol stacks. The IzoT SDK Premium Edition includes royalty-free firmware for the FT 6050 Smart Transceiver that enables the FT 6050 to be used as a PHY chip to interface to an FT channel.

- **IzoT ShortStack SDK** — a free software development kit that enables developers to build communicating devices using any processor that can run the application plus a tiny IzoT ShortStack driver. The IzoT ShortStack SDK includes royalty-free firmware for the FT 6050 Smart Transceiver that enables the FT 6050 to be used as a Layer 2 to 6 LON and LON/IP protocol processor with integrated PHY interface to an FT channel.

### Specifications

**Data Communications Type**

Differential Manchester encoding

**Network Polarity**

Polarity insensitive

**Isolation between Network and FT 6050 IC**

0-60Hz, 60 seconds: 1000Vrms; 0-60Hz, continuous: 277Vrms

**EMI**

Compliant with FCC Part 15 Subpart B and EN55022 Level B

**ESD**

Compliant with EN 61000-4-2, Level 4

**Radiated Electromagnetic Susceptibility**

Compliant with EN 61000-4-3, Level 3

**Fast Transient/Burst Immunity**

Compliant with EN 61000-4-4, Level 4

**Surge Immunity**

Compliant with EN 61000-4-5, Level 3

**Conducted RF Immunity**

Compliant with EN 61000-4-6, Level 3

**Transmission Speed**

78 kilobits per second

**Number of Transceivers per Segment**

Up to 64

**Network Wiring**

24 to 16AWG twisted pair; see Series 6000 Chip Data Book or Junction Box and Wiring Guidelines engineering bulletin for qualified cable types

**Network Length in Free Topology**

500m (1640 feet) maximum total wire with no repeaters.

500m (1640 feet) maximum device-to-device distance

**Network Length in Doubly-terminated Bus Topology**

2700m (8,850 feet) with no repeaters

**Maximum Stub Length in Doubly-terminated Bus Topology**

3m (9.8 feet)

**Network Termination**

One terminator in free topology; two terminators in bus topology (more details in Series 6000 Chip Data Book).

**Power-down Network Protection**

High impedance when unpowered.

**Operating Temperature**

-40 to 85°C

**Operating Humidity**

25-90% RH @50°C, non-condensing (FT-X3 Communications Transformer)

**Non-operating Humidity**

95% RH @ 50°C, non-condensing (FT-X3 Communications Transformer)

**Vibration**

1.5g peak-to-peak, 8Hz-2kHz (FT-X3 Communications Transformer)

**Mechanical Shock**

100g (peak) (FT-X3 Communications Transformer)

**Reflow Soldering Temperature Profile**

Refer to Joint Industry Standard document IPC/JEDEC J-STD-020D.1 (March 2008)

**Peak Reflow Soldering Temperature**

260°C (FT 6050 Smart Transceiver).

245°C (FT-X3 Communications Transformer)

**Co-planarity**

0.12 mm (FT-X3 Communications Transformer)

**Mass**

6g (FT-X3 Communications Transformer)

### Ordering Information

**Components**

- 14450R-500 FT 6050 Smart Transceiver
- 14255R-100 FT-X3 Communications Transformer

**Development Tools**

- 10070R-43-54 IzoT FT 6000 EVK
- 23360-10 IzoT SDK Premium Edition
- 23400-FV IzoT ShortStack SDK