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**FT 6000 Key Features**

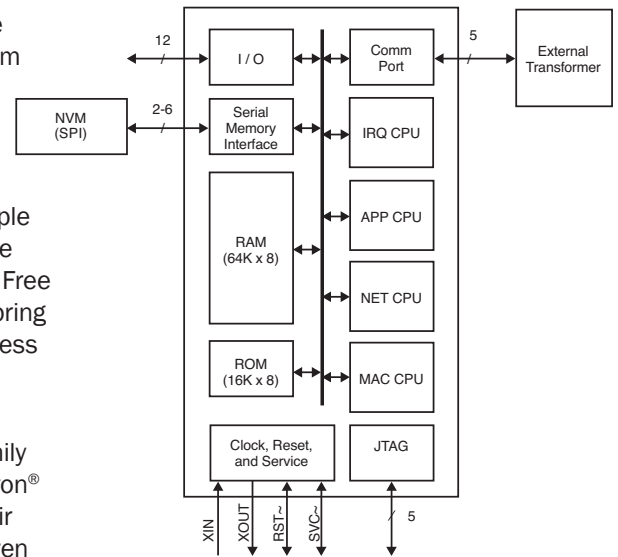
- 3.3V operation. 80MHz system clock, 64KB RAM and 16KB ROM on-chip memories
- Support for larger external flash memories, up to 256KB applications
- Supports up to 254 Network Variables (NVs) and 127 aliases. up to 254 address table entries (16-fold increase)
- Low-cost surface mount FT-X3 Communications Transformer.
- Supports polarity-insensitive free topology star, daisy chain, bus, loop, or mixed topology wiring. Very high common-mode noise immunity.
- User-programmable interrupts , hardware UART, 12 I/O pins with 35 programmable standard I/O models
- Flash file system for data logging and other applications requiring persistent storage
- Unique 48-bit IEEE MAC ID
- 7 mm x 7 mm 48-pin QFN package, -40°C to +85°C.

The FT 6000 family of Smart Transceivers is the next-generation system-on-chips 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 options for backward compatibility with LONWORKS® while adding native IP addressing at the device level and consolidating multiple control protocols on the same device carried over the reliable and proven Free Topology channel. It is designed to bring unprecedented flexibility and openness while lowering development and device costs.

The FT 6000 Smart Transceiver family integrates a high-performance Neuron® core with a free topology twisted-pair transceiver. Combined with the proven FT-X3 Communications Transformer and inexpensive flash memory, the FT 6000 Smart Transceivers provide a very flexible, low-cost, feature enhanced LONWORKS or IzoT/IP or BACnet/IP solution all within the same device.

The FT6000 series Smart Transceiver includes three independent 8-bit logical processors to manage the physical MAC layer, the network, and the user application. These are called the Media-Access Control (MAC) processor, the network (NET) processor, and the

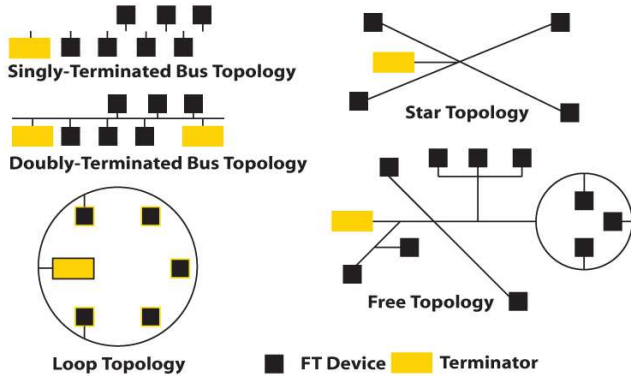
application (APP) processor, respectively (see Figure 1). At higher system clock rates, a fourth processor called the IRQ CPU can be used to handle interrupts.



**Figure 1: FT 6000 Smart Transceiver Chip**

The FT 6000 Smart Transceiver supports polarity-insensitive cabling using a star, bus, daisy-chain, loop, or combination topology (see Figure 2). Thus, 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. Free topology wiring also simplifies network expansion by eliminating restrictions on wire routing, splicing, and device placement. The FT 6000 extends all the benefits of Free Topology 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.



**Figure 2: FT Free Topology Network Configurations**

The FT-X3 Communications Transformer is a surface mount communications transformer that is compatible with both the FT 6000 Smart Transceiver and the previous-generation FT 5000/FT 3120/FT 3150 Smart Transceivers. The FT-X3 Communications Transformer provides equivalent noise immunity to both the FT-X1 and FT-X2 Communication Transformers, the previous-generation communication transformers. However, the FT-X3 Communications Transformer is not pin-compatible with the FT-X2 Communication Transformer (which is also a surface mount transformer). The FT 6000 Smart Transceiver can also be used with the FT-X1 and FT-X2 Communication Transformers.

**Multi-protocol Operation, Future Proofing and Backward Compatibility**

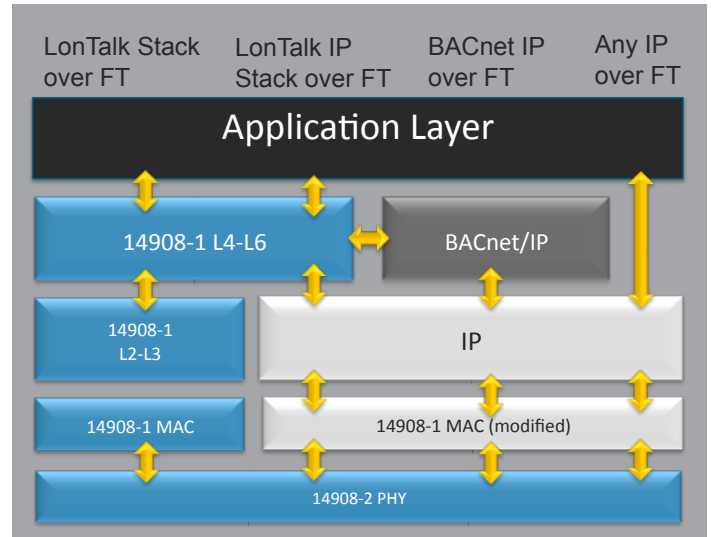
The FT 6000 supports up to four different modes of operation, as shown in Figure 3, allowing device makers unprecedented flexibility in creating control devices for a wide variety of applications using one common development effort. Backward compatibility and future proofing can both be met using a common platform based on the FT 6000 family.

The FT 6000 series Smart Transceiver is fully compliant with the TP/FT-10 channel and can communicate with devices that use Echelon’s FTT-10/FTT-10A Transceivers, FT 3120/FT 3150 Smart Transceivers, or LPT-10/LPT-11 Link Power Transceivers.

The Neuron core in the FT 6000 series Smart Transceiver uses the same instruction set and architecture as the previous-generation Neuron core, including instructions for hardware multiplication and division. The Series 6000 Neuron core is source code compatible with applications written for the Series 5000 and 3100 Neuron core. Applications written for the Series 5000 and 3100 Neuron Core must be recompiled with

the IzoT NodeBuilder Software before they can be used with the FT 6000 Smart Transceiver.

The FT 6000 series Smart Transceiver uses Neuron firmware version 21 or later. Firmware versions prior to version 21 are not compatible with the FT 6000 Smart Transceiver. The Neuron firmware is loaded into RAM from off-chip flash. The FT 6000 Smart Transceiver firmware can be upgraded over the network.



**Figure 3: FT 6000 Modes of Operation**

In the “LonTalk Stack over FT” mode, the FT 6000 runs the complete LonTalk stack and is fully backward compatible with devices running the LonTalk stack, including devices based on the Neuron 3120, Neuron 3150 or FT 3120/3150/5000 Smart Transceiver.

In the “LonTalk IP stack over FT” mode, the FT 6000 preserves the services offered by LonTalk layers 4-7, replacing layers 2-3 with UDP/IP. This allows the creation of devices that are fully compatible with LonTalk applications while supporting native IP addressing at the device level. In this mode, the network layer has been enhanced to support translation between LonTalk addresses and IP addresses in a manner that is transparent to both the LonTalk application above and the FT network below. This allows LonTalk compatible applications to run unmodified over Free Topology wiring while gaining IP addressing at the device level.

In the “BACnet/IP over FT” mode, LonTalk layers 4-6 services are used to create BACnet/IP devices borrowing from a rich set of LONMARK® services and profiles. LONMARK compatible applications can now run unmodified over a very reliable Free Topology channel, and present their LONMARK interfaces as native BACnet Objects thus pushing BACnet/IP all the way down to the simplest of devices. Provisioning and commissioning of BACnet/IP devices is now possible with available and powerful LonWORKS commissioning tools. Devices thus provisioned are fully compatible and discoverable using industry standard, BTL certified, BACnet management clients.

And finally, in the “Any IP over FT” mode, the FT 6000 allows any control protocol to be modernized with IP addressing transported over the proven Free Topology channel.

### Enhanced Performance

**Fast system clock.** The internal system clock for the FT 6000 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 fast clock is the same as what is available with the FT 5000; however, the Neuron 3120/3150 core divided the external oscillator frequency by two to create the internal system clock. An FT 6000 (or FT 5000) Smart Transceiver running with an 80MHz internal system clock is thus 16 times faster than a 10MHz Neuron 3120/3150 core.

The 5MHz internal system clock mode in the FT 6000 Smart Transceiver provides backward compatibility to support timing-critical applications designed for the 10MHz FT 3150 or FT 3120 Smart Transceiver.

The Neuron core inside the FT 6000 Smart Transceiver includes a built-in hardware multiplier and divider to increase the performance of arithmetic operations.

### Support for large number of network variables.

**Interrupts.** The FT 6000 Smart Transceiver lets developers define application interrupts to handle asynchronous events triggered by selected state changes on any of the 12 I/O pins, by on-chip hardware timer-counter units, or by an on-chip high-performance hardware system timer. An application uses the Neuron C **interrupt()** clause to define the interrupt condition and the interrupt task that handles the condition. The Neuron C program runs the interrupt task whenever the interrupt condition is met. See the Neuron C Programmer’s Guide for more information about writing interrupt tasks and handling interrupts.

### Enhancements for processing IP packets:

The FT 6000 has an enhanced MAC layer that allows frame sizes, up to 1280 bytes that allows large IP frames to be carried over the FT channel without fragmenting the packet which provides better bandwidth utilization of the FT channel. Having dedicated processor contexts 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 node. 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.** The FT 6000 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 a Series 6000 chip to be included in the boundary-scan chain for device production tests.

### I/O Pins and Counters

The FT 6000 Smart Transceiver provides 12 bidirectional I/O pins that are 5V-tolerant and can be configured to operate in one or more of 35 predefined standard input/output models. The chip also has two 16-bit timer/counters that reduce the need for external logic and software development.

### Memory Architecture

The FT 6000 series 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. It has no on-chip non-volatile memory for application use. Each chip, however, contains its unique identifier (IEEE MAC ID) in an on-chip, non-volatile, read-only memory. Typical external flash memory configuration is 512KB of which 128KB is available for application code. This is a three-fold increase in application size that can be hosted on the FT 6000 compared to previous generations. Larger application sizes are possible with larger flashes. For example, a 256KB application is possible on a 1 MB flash part.

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 application does not manage NVM directly.

**External memories supported.** The FT 6000 Smart Transceiver supports serial peripheral interface (SPI) for accessing off-chip, non-volatile memory.

The FT 6000 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 6000 Smart Transceiver:

Winbond W25X40CL 4-Mbit SPI Serial Flash Memory.

**Memory map.** The FT 6000 maps the Neuron firmware, application code, application data, and system data to an on-chip 64 KB RAM. The Neuron firmware, application code, persistent data are loaded from an external serial flash memory. The application code and persistent data can be up to 256 KB, and is automatically swapped into and out of the on-chip RAM by the Neuron firmware.

**Programming memory devices.** Because the FT 6000 Series Smart Transceiver does not have any on-chip user-accessible NVM, only the external flash devices need to be programmed with the application and configuration data. The memory devices can be programmed in any of the following ways:

- In-circuit programming on the board.
- Over the network.
- Pre-programming before soldering on the board.



## Noise Immunity

A LONWORKS device based on the FT 6000 Series Smart Transceiver is composed of two components: the FT 6000 Series Smart Transceiver and an external communications transformer (the FT-X3). 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.

The FT 6000 Series Smart Transceiver and the FT-X3 Communications Transformer are designed to be used as a pair, and therefore must be implemented together in all designs. No transformer other than the FT-X3 (or FT-X1 or FT-X2) communications transformer may be used with the FT 6000 Smart Transceiver or the smart transceiver warranty will be void.

## Migration Considerations

A typical FT 6000 Smart Transceiver-based device requires a power source, crystal, external memory, and an I/O interface to the device being controlled (see Figure 4 for a typical FT 6000 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 6000 Smart Transceivers. Our 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.

Please contact your local Echelon representative for further details.

## Ordering Information

The FT 6000 is a family of transceivers: FT 6050 and FT 6010.

**14450R-500** FT 6050 Smart Transceiver: Supports all four operating modes LonTalk Stack over FT, LonTalk/IP Stack over FT, BACnet/IP over FT and Any IP over FT

**14410R-500** FT 6010 Smart Transceiver: Supports three operating modes: LonTalk/IP Stack over FT, BACnet/IP over FT and Any IP over FT

**14255R-100** FT-X3 Communications Transformer

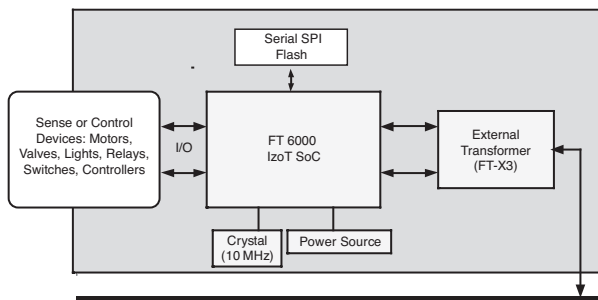


Figure 4: Typical LONWORKS based device

Preliminary