In Brief . . .

Motorola’s Neuron Chip processors are sophisticated VLSI devices that make it possible to implement low–cost Local Operating Network applications. The unique combination of hardware and firmware provides all the key functions necessary to process inputs from sensors and control devices intelligently, and propagate control information across a variety of network media.

Used in conjunction with the LonBuilder® Developer’s Workbench or the NodeBuilder™ Development Tool, the Neuron Chips make available to a system designer an object–oriented, high–level environment providing for the easy implementation of distributed sense and control networks, flexible reconfiguration capability after network installation, and management of LonTalk® protocol messages on the network.

Applications include distributed sense and control systems, instrumentation, machine automation, processor control, diagnostic equipment, environmental monitoring and control, power distribution and control, production control, lighting control, building automation and control, security systems, data collection/acquisition, robotics, home automation, consumer electronics, and automotive electronics.
Neuron Chips

The Motorola MC143150 and MC143120 Neuron Chips are sophisticated VLSI devices that make it possible to implement low-cost local operating network applications. Through a unique combination of hardware and firmware, they provide all the key functions necessary to process inputs from sensors and control devices intelligently, and propagate control information across a variety of network media. The MC143150 and MC143120, with the LonBuilder Developer’s Workbench or the NodeBuilder Development Tool, offer the system designer:

- Easy implementation of distributed sense and control networks
- Flexible reconfiguration capability after network installation
- Management of LonTalk protocol messages on the network
- An object-oriented high level environment for system development

![Figure 1. MC143150 Neuron Chip Simplified Block Diagram]
The MC143150 is designed for sense and control systems that require large application programs. An external memory interface allows the system designer to use 42K of the available 64K of address space for application program storage. The MC143150 has no ROM on the device. The communications protocol, developer’s operating system, and I/O device driver object code are provided with Echelon’s LonBuilder Developer’s Workbench and NodeBuilder Development Tool. The protocol and application object code can be stored in external ROM, flash, or other non-volatile memory.

The Neuron Chip is available in multiple versions. See Table 1 for the 3150® and 3120® Neuron Chip family. See Appendix G of LonWorks Technology Device Data, DL159, Rev. 2, if using MC143120B1DW (version 4 firmware) with LonBuilder 2.2 or newer.

Throughout this section, the device numbers “MC143120” and “MC143150” refer to the Motorola 3120 and 3150 families of Neuron Chips. Only if Toshiba is being referenced will the data be applied to the particular Toshiba Neuron Chip.

The FU device can be operated at different voltage ranges to achieve specific performance goals. This will optimize the overall system cost with the associated external memories. Refer to Table 2.

The MC143150 is designed for input clock operation up to and at 10 MHz clock rate over – 40 to + 85°C with writes to internal EEPROM guaranteed. Both the MC143120B1DW and MC143150B1FU versions will allow internal EEPROM writes over the full temperature range (– 40 to + 85°C).
### Table 1. Neuron IC Family

<table>
<thead>
<tr>
<th>Device</th>
<th>Alternate Source</th>
<th>Feature Size (Nominal)</th>
<th>RAM (Bytes)</th>
<th>EEPROM (Bytes)</th>
<th>Firmware Version</th>
<th>Model No.</th>
<th>Intro</th>
</tr>
</thead>
<tbody>
<tr>
<td>3150 Neuron Chip</td>
<td>TMPN3150B1F</td>
<td>0.8µ</td>
<td>2K</td>
<td>512</td>
<td>N/A</td>
<td>0</td>
<td>5/96</td>
</tr>
<tr>
<td>MC143150B1FU1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3120 Neuron Chip</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Internal ROM = 10,240 bytes)</td>
<td>TMPN3150B1F</td>
<td>0.8µ</td>
<td>1K</td>
<td>512</td>
<td>4</td>
<td>8</td>
<td>10/94</td>
</tr>
<tr>
<td>MC143120B1DW</td>
<td>TMPN3120B1M</td>
<td>0.8µ</td>
<td>1K</td>
<td>512</td>
<td>4</td>
<td>8</td>
<td>10/94</td>
</tr>
<tr>
<td>MC143120E2DW</td>
<td>TMPN3120E1M</td>
<td>0.8µ</td>
<td>1K</td>
<td>512</td>
<td>4</td>
<td>8</td>
<td>10/94</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Not recommended for applications using SRAM, NVRAM, or memory map logic. Relaxed address and read/write hold time specifications.
2. Motorola parts that are marked with the prefix “XC” are pre–release ICs.
3. \( t_{CE} = t_{CYC} - t_{AD} max - t_{DSR} min - t_{CE} decode max \)

### Table 2. Neuron IC Specifications

<table>
<thead>
<tr>
<th>Device</th>
<th>Alternate Source</th>
<th>Max Clock Rate</th>
<th>Neuron Chip Access Time</th>
<th>Supply Voltage Range</th>
<th>EEPROM Programming Temperature Range</th>
<th>Typical IDD</th>
<th>Typical Sleep Mode IDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>3150 Neuron Chip</td>
<td>TMPN3150B1F</td>
<td>10 MHz</td>
<td>130 ns</td>
<td>4.5 – 5.5 V</td>
<td>– 40 to + 85°C</td>
<td>15 mA</td>
<td>15 mA</td>
</tr>
<tr>
<td>MC143150B1FU1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3120 Neuron Chip</td>
<td>TMPN3150B1F</td>
<td>10 MHz</td>
<td>—</td>
<td>4.5 – 5.5 V</td>
<td>– 40 to + 85°C</td>
<td>14 mA</td>
<td>9 µA</td>
</tr>
<tr>
<td>MC143120B1DW</td>
<td>TMPN3120B1M</td>
<td>10 MHz</td>
<td>—</td>
<td>4.5 – 5.5 V</td>
<td>– 40 to + 85°C</td>
<td>14 mA</td>
<td>9 µA</td>
</tr>
<tr>
<td>MC143120E2DW</td>
<td>TMPN3120E1M</td>
<td>10 MHz</td>
<td>—</td>
<td>4.5 – 5.5 V</td>
<td>– 40 to + 85°C</td>
<td>14 mA</td>
<td>9 µA</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Not recommended for applications using SRAM, NVRAM, or memory map logic. Relaxed address and read/write hold time specifications.
2. Motorola parts that are marked with the prefix “XC” are pre–release ICs.
3. \( t_{CE} = t_{CYC} - t_{AD} max - t_{DSR} min - t_{CE} decode max \)

**.8µ** 3120 devices may require re–linking before being reprogrammed with a network manager or device programmer. Refer to Table 1–3 and Table 1–4 for details regarding which firmware versions are supported by the LonBuilder Developer’s Workbench or NodeBuilder Development Tool.

### Table 3. LonBuilder Firmware Supported

<table>
<thead>
<tr>
<th>LonBuilder Software Version</th>
<th>3150 Firmware Supported</th>
<th>3120 Firmware Supported</th>
<th>3120 E1/E2 Firmware Supported</th>
<th>Other Firmware Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.01</td>
<td>3–7</td>
<td>3, 4</td>
<td>6</td>
<td>LTM–10</td>
</tr>
<tr>
<td>3.0</td>
<td>3–6</td>
<td>3, 4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>2–4</td>
<td>2, 3, (4)¹</td>
<td>Not Supported</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>2,3</td>
<td>2,3</td>
<td>Not Supported</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
1. Version 4 support available through a patch on Echelon’s Website.
Table 4. NodeBuilder Firmware Supported

<table>
<thead>
<tr>
<th>Node Builder</th>
<th>3150 Firmware Supported</th>
<th>3120 Firmware Supported</th>
<th>3120 E1/E2 Firmware Supported</th>
<th>Other Firmware Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Version</td>
<td>1.0</td>
<td>3–6</td>
<td>3, 4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>3–6</td>
<td>3, 4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>LTM–10</td>
<td>LTM–10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Both parts have an eleven pin I/O interface with integrated hardware and firmware for connecting to motors, valves, display drivers, A/D converters, pressure sensors, thermistors, switches, relays, triacs, tachometers, other microprocessors, modems, etc. They each have three processors, of which two interact with a communication subsystem to make the transfer of information from node to node in a distributed control system an automatic process. These devices make it possible to rapidly implement many applications. These include distributed sense and control systems, instrumentation, machine automation, process control, diagnostic equipment, environmental monitoring and control, power distribution and control, production control, lighting control, building automation and control, security systems, data collection/acquisition, robotics, home automation, consumer electronics, and automotive electronics.

The Neuron Chips can send and receive information on either the 5-pin communications port or the 11-pin applications I/O port.

Features

- Three 8-Bit Pipelined Processors
  - Selectable Input Clock Rates: 625 kHz, 1.25 kHz, 2.5 MHz, 5 MHz, 10 MHz
- On-Chip Memory
  - 2 Kbytes Static RAM (MC143150 and MC143120E2)
  - 1 Kbyte Static RAM (MC143120B1DW)
  - 512 bytes EEPROM (MC143150 and MC143120B1DW)
  - 2 Kbytes EEPROM (MC143120E2)
  - 1 Kbytes EEPROM (TMPN3120E1)
  - 10 Kbytes ROM (MC143120)
- 11 Programmable I/O Pins
  - 34 Selectable Modes of Operation
    - Programmable Pull-Ups (IO4 – IO7)
    - 20 mA Current Sink (IO0 – IO3)
- Two 16-Bit Timer/Counters for Frequency and Timer I/O
- Up to 15 Software Timers
- Sleep Mode for Reduced Current Consumption While Retaining Operating State
- Network Communications Port
  - Single-Ended Mode
  - Differential Mode
  - Selectable Transmission Rates: 0.6 kbit/s to 1.25 Mbit/s
  - 40 mA Current Output for Differentially Driving Twisted-Pair Networks
  - Optional Collision Detect Input
  - Relay no Longer Needed for Differential Communications
- Firmware
  - LonTalk Protocol Conforming to 7-Layer OSI Reference Model
  - I/O Drivers
  - Event-Driven Task Scheduler
- Service Pin for Remote Identification and Diagnostics
- Unique 48-Bit Internal Neuron ID Stored Redundantly in Every Device
- Channel Capacity: 560 Packets/s Throughput Sustained; 700 Packets/s Peak at 10 MHz
- Built-In Low-Voltage Detection for Added EEPROM Protection (B1, E2 Parts Only)
### Table 5. MC143150 Neuron IC Progressions/Alerts

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC143150FU1</td>
<td>5 MHz&lt;br&gt;EEPROM writes down to −40°C&lt;br&gt;Requires a power down relay for differential twisted pair communications&lt;br&gt;Quadrature may have random missing of counts&lt;br&gt;1.2µ technology</td>
</tr>
<tr>
<td>DISCONTINUED</td>
<td></td>
</tr>
<tr>
<td>MC143150FU</td>
<td>10 MHz&lt;br&gt;EEPROM writes down to −20°C&lt;br&gt;90 ns external memory&lt;br&gt;Quadrature may have random missing of counts&lt;br&gt;1.2µ technology</td>
</tr>
<tr>
<td>DISCONTINUED</td>
<td></td>
</tr>
<tr>
<td>MC143150B1FB</td>
<td>Sold as SC143150FU and equivalent to TMPN3150B1F</td>
</tr>
<tr>
<td>DISCONTINUED</td>
<td></td>
</tr>
<tr>
<td>MC143150B1FU</td>
<td>Consumes less current than MC143150FU&lt;br&gt;EEPROM writes down to −40°C&lt;br&gt;120 ns external memory&lt;br&gt;0.8µ technology&lt;br&gt;Does not require a power down relay for differential communications&lt;br&gt;Successor to MC143150FU&lt;br&gt;External LVI required for reset&lt;br&gt;Not recommended for applications using SRAM, NVRAM, or memory map logic.&lt;br&gt;Relaxed address and read/write hold time specifications.</td>
</tr>
<tr>
<td>sold as SC143150B1FU</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>MC143150B1FU1</td>
<td>10 MHz operation&lt;br&gt;0.8µ technology&lt;br&gt;Longer address hold time than MC143150B1FU (10 ns minimum)&lt;br&gt;120 ns external memory&lt;br&gt;Successor to MC143150B1FU</td>
</tr>
</tbody>
</table>

### Table 6. MC143120 Neuron IC Progressions/Alerts

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC143120DW</td>
<td>1.2µ technology&lt;br&gt;24 I/O models masked in internal ROM&lt;br&gt;EEPROM writes from −20°C to +85°C&lt;br&gt;Requires a power down relay for differential communications&lt;br&gt;Quadrature may have random missing of counts&lt;br&gt;Requires LonBuilder release 2.0 and later</td>
</tr>
<tr>
<td>DISCONTINUED</td>
<td></td>
</tr>
<tr>
<td>MC143120B1DW</td>
<td>Consumes less current than MC143120DW&lt;br&gt;24 I/O models masked in internal ROM&lt;br&gt;0.8µ technology&lt;br&gt;EEPROM writes from −20°C to +85°C&lt;br&gt;Does not require a power down relay for differential communications&lt;br&gt;Successor to MC143120DW&lt;br&gt;Requires an external LVI for reset&lt;br&gt;Requires LonBuilder release 3.0, or release 2.2 with patch</td>
</tr>
<tr>
<td>MC143120E2DW</td>
<td>2K RAM, 2K EEPROM&lt;br&gt;21 I/O models masked in internal ROM&lt;br&gt;Does not require a power down relay for differential communications&lt;br&gt;.71µ technology&lt;br&gt;External LVI not needed&lt;br&gt;Requires LonBuilder release 3.0 or greater</td>
</tr>
</tbody>
</table>

**Motorola LonWorks Application Support:** (512) 934–8713
**LonWORKS Technology Overview and Architecture**

LonWORKS technology is a complete platform for implementing control network systems. These networks consist of intelligent devices or nodes that interact with their environment, and communicate with one another over a variety of communications media using a common, message-based control protocol.

LonWORKS technology includes all of the elements required to design, deploy, and support control networks, specifically the following components:

- MC143150 and MC143120 Neuron Chips
- LonTalk Protocol
- LonWORKS Transceivers
- LonBuilder and NodeBuilder Development Tools

The Motorola Neuron Chip is a VLSI component that performs the network and application-specific processing within a node. A node typically consists of a Neuron Chip, a power source, a transceiver for communicating over the network medium, and circuitry for interfacing to the device being controlled or monitored. The specific circuitry will depend on the networking medium and application. See Figures 3 and 4.

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**Figure 3. Typical Node Block Diagram**

- Sense or Control Devices: e.g. Motors, Valves, Encoders, Switches
- Crystal
- Power Source
- +5 V
- MC143150/20 Neuron Chip
- 16K – 58K EPROM/ROM for MC143150 ONLY
- I/O Circuitry
- LonWORKS Transceiver
- Networking Medium (Twisted Pair, RF, Power Line, etc.)
Figure 4. The MC143150 or MC143120 in a LONWORKS Network
LonWORKS Support Tools

Motorola’s LonBuilder Support tools offer the user a quick and flexible means to demonstrate or test a LonWORKS–based product which has been developed and debugged on the LonBuilder Developer’s Workbench. The family of tools consists of Neuron Chip–based development boards, I/O application boards, a Differential Direct–Connect Transceiver board (for the LonBuilder Developer’s Workbench), and a Neuron Chip Test/Programming board. These tools offer the unique advantages of:

- Capability to Test Products Over a Wide Range of Media and Data Rates
- Boards All Have RJ–45 Connectors Allowing Ease of Connectivity
- Neuron Chip Boards Contain a 5 V Regulator Allowing for a Wider Range of Power Supply Voltages
- Common 2 x 10 Connector for Interface to the Neuron Chip I/O Pins
- Library of Application Functions Is Available from Motorola
- Inexpensive Means of Demonstrating LonWORKS–Based Products

This document covers a brief detail on each of the boards. For further information, contact Motorola’s LonWORKS applications support team in Austin, TX, at 512–934–8713 or fax 512–934–7991.

The family consists of the following:

- M143120EVK Neuron Evaluation/Programming Kit With 3120 Socket
- M143150EVK Neuron Evaluation/Programming Kit With 3150 Socket
- M143204EVK LonBuilder Emulator Boards Direct Drive Transceiver
- M143206EVK Neuron I/O Application Kit, 5 LEDs, A/D, D/A, Clock
- M143207EVK Neuron I/O Application Kit, 6–Digit LCD, Clock, Keyboard
- M143208EVK I/O Test Board, 11 LEDs and 11 Switches
- M143213EVK5 450 MHz, 2 Watt, RF Radio with Neuron IC and (RS–232) USA
- M143213EVK6 450 MHz, 2 Watt, RF Radio with Neuron IC and (RS–232) EUR
- M143214EVK5 450 MHz, 2 Watt, RF Radio with Neuron IC and (I/O) USA
- M143214EVK6 450 MHz, 2 Watt, RF Radio with Neuron IC and (I/O) EUR
- M143215EVK5 450 MHz, 2 Watt, RF Radio for Interface to (Router) USA
- M143215EVK6 450 MHz, 2 Watt, RF Radio for Interface to (Router) EUR
- M143221EVK RS–232 EVK Interface Board for M143120EVK/M143150EVK
- M143222EVK Neuron Intelligent Card (Pack Five Cards)
- M143223EVK Neuron Intelligent Card Reader Board
- M143226EVK Gateway–TP78 to UART Interface with Neuron, 32K Flash, 32K SRAM
- M143229EVK Radio Interface Cable, 15 to 15 Pins
- M143230EVK Radio Interface Cable, 15 to 9 Pins
- M143232EVK Voice Development Kit, to Interface to LonBuilder or Neuron Board
- M143234EVK Neuron IC Evaluation Kit with MC143120E2, TP78 Transceiver, Full 11 I/O Access, Two Isolated Input/Output Ports

All the boards are available from Motorola and our franchised distributors.
Echelon Support Tools

LonBuilder Developer’s Workbench

Thanks to Echelon’s LonBuilder and NodeBuilder tools, as well as Motorola’s extensive technical support network, both system and device manufacturers can now develop control networks quickly and inexpensively. These tools provide developers with everything needed to begin building LonWorks nodes.

The LonBuilder Developer’s Workbench combines three development tools — a multi-node development system, a network manager, and a protocol analyzer — into an integrated hardware and software development environment. This development system provides the tools to create software applications and prototype hardware on a network ranging from two to hundreds of nodes. The network manager installs and configures nodes during development, making them easy to connect, define, and build. The protocol analyzer monitors the network and interprets its activity.

Transceivers

- FTT–10A Free Topology Twisted–Pair Transceiver Model 50051, 50051–1, 50050–01 (78 kbps)
- LPT–10 Link Power Twisted–Pair Transceiver Model 50040 (78 kbps)
- TPT/XF Twisted–Pair Transceiver Models 50010–10 (78 kbps) and 50020–10 (1.25 Mbps)
- PLT–10A Power Line Transceiver Model 50080 (10 kbps)
- PLT–21 Power Line Transceiver Model 50090–01 (5 kbps)
- PLT–30 Power Line Transceiver Model 50100–01 (2 kbps)
- PLA–21 Amplifier Model 53001–01

Control Modules

- Twisted–Pair Control Modules Models Flash Control Modules
  - 55010–00 (TP/XF–78), 55020–01 (TP/FT–10), and 55030–00 (TP/XF–1250)
- PLC–10 Power Line Control Module Models 56010–00 and 56010–01
- LPI–10 Link Power Interface Module and Developer’s Kit Model 56210–01 and 58020–01
- PLCA Power Line Communications Analyzers Models 57010, 57010–01, and 57010–03

Router Products

- RTR–10 Router Core Module Model 61000–100
- LonWorks Router Model 71000–11

Network Interface Products

- LonBuilder MIP/P20 and MIP/P50 Developer’s Kit Model 23201, 23205
- LonBuilder MIP/DPS Developer’s Kit Model 23211, 23215
- LTS–10 SLTA Core Module Model 65200–100
- PSG–10 Serial Gateway Core Module and Evaluation Kit Model 65200–200
- SLTA/2 Serial LonTalk Adapter Model 73000–1
- PSG/2 Programmable Serial Gateway Model 73000–3
- PCLTA PC LonTalk Adapter Model 73100–1, 73401
- SLTA/2 and Router Accessories Model 73000–1
- PCC–10 PCMCIA Card Model 73200, 7830x, 7840x
- PCLTA–10 Network Interface

Network Services Products

- LonManager LonMaker Starter Kit Model 32100–00, 32200–0x, 32205
- LonManager LonMaker Installation Tool Model 32100–00, 32200–0x, 32205
- LonManager DDE Server Model 33000, 33000–01, 33005
- LonManager ISA–Bus and PCC Protocol Analyzer Model 33100–00, 33100–10
- LonManager NSS–10 Module Model 35000–100
Network Services Products (Continued)

LonManager PCNSS Card Model 34100
LonManager PCNSI Card Model 35100
LonManager LNS for Microcontrollers and NSS–10 Upgrade Model 34001–00x, 34001–005
LonManager LNS for Windows Model 34303
LonManager LNS FASTART Package Model 34304–00x

Development Tools

LonBuilder Starter Kit Model 20311
LonBuilder Control Processor Model 21200
LonBuilder Development Station Enclosure Model 21400
LonBuilder Neuron 3120 Programmer Model 21700
LonBuilder 3120 and 3150 Application Interface Pods Models 21820 and 21850
LonBuilder Neuron Emulator Model 25000
LonBuilder Router Model 25400
LonBuilder SMX Adapter Model 27100
LonBuilder I/O Evaluation Board Model 27800
LonBuilder Application Interface Kit Model 27810
LonBuilder Gizmo 3 Kit Model 28001
NodeBuilder Development Tools Model 10010
LonBuilder Application Interface Cable Model 21800
LonBuilder Module Application Interface Model 21860

SMX Transceivers

LONWORKS SMX Transceivers Models 77010, 77030, 77040, 77090, 77160, and 77180
Power Line Coupler Model 78200

Customer Support and Training Programs

LONWORKS Technology Intelligent Distributed Control Training Course (4 days)
LonSupport Program for LonBuilder Kits and NodeBuilder Tools
LNS Network Tools Development Course
Host–Based Node Development Course
Figure 5. Evaluation and I/O Interface Boards