

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TMPN3120FE5MG

Neuron<sup>®</sup> Chip for Distributed Intelligent Control Networks (LONWORKS<sup>®</sup>)

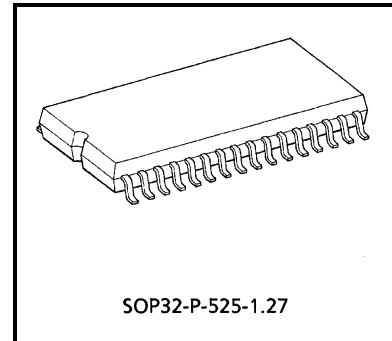
The TMPN3120FE5MG features extra single-chip memory in the form of a 3 Kbyte EEPROM, a 4 Kbyte SRAM, and a 16 Kbyte ROM.

Neuron Chips have all the built-in communications and control functions required to implement LONWORKS<sup>®</sup> nodes. These nodes may then be easily integrated into highly reliable distributed intelligent control networks.

The typical functions for this chip are described below.

## Features

- Main features of the 20 MHz Neuron Chip (compared with the TMPN3120E1M)
  - Increased communication speed
    - The maximum transmission speed has been increased twofold:  
1.25 Mbps → 2.5 Mbps (This value applies to Single-Ended Mode only.)
  - Shortened response time
    - The amount of time required from I/O input to I/O output has been greatly reduced.  
Maximum speed 7 ms → 3 to 4 ms
  - Increased I/O object speed
    - The execution time for all objects has been halved.  
Example) Serial I/O 9600 bps  
Parallel I/O 1.2 μs/byte



Weight: 1.1 g (typ.)

- I/O functions
  - Eleven programmable I/O pins
  - Two programmable 16-bit timers and counters built in
  - More than thirty different types of I/O functions to handle a wide range of input and output
  - ROM firmware image containing preprogrammed I/O drivers, greatly simplifying application programs
- Network functions
  - High-impedance communication port
  - Two CPUs for communication protocol processing built in  
The communications and application CPUs execute in parallel.
  - Equipped with a built-in LonTalk protocol supporting all seven levels of the ISO OSI reference model
  - The ROM firmware image contains a complete network operating system, greatly simplifying application programs.
  - Built-in twisted-pair wire transceiver with improved common-mode and drive current capabilities
  - Equipped with communications modes and communication speeds to support various types of external transceivers
  - Communication port transceiver modes and logical addresses are stored within the EEPROM.  
Can be amended via the network.
- Other functions
  - Application programs are also stored within the EEPROM.  
Can be updated by downloading over the network.
  - Built-in watchdog timer
  - Each chip has a unique ID number.  
Effective during the logical installation of networks
  - Low electrical consumption mode supported through a sleep mode
  - Built-in selectable reset time  
Prolongs the power-on reset time for at least 50 ms and keeps the operation stable during this time. The reset time for reset after power on, however, can be set to 3-clock delay mode by programming.
  - High-impedance communication port (CP0 to CP3)  
The communication port pins (CP0 to CP3) attain high impedance. This eliminates the need for an external relay.
  - Built-in low-voltage detection circuit  
Prevents incorrect operations and writing errors in the EEPROM during drops in power voltage.  
An external LVD must be used to assert reset at a power supply voltage below 4.5 V if the Neuron Chip is operated at 20 MHz.
  - Built-in programmable LVD (low-voltage detection) circuit  
An external LVD input pin (LVDin) is used to assert reset at a given voltage.
  - Firmware version 10
  - The package is SOP32-P-525-1.27 (lead-free type).

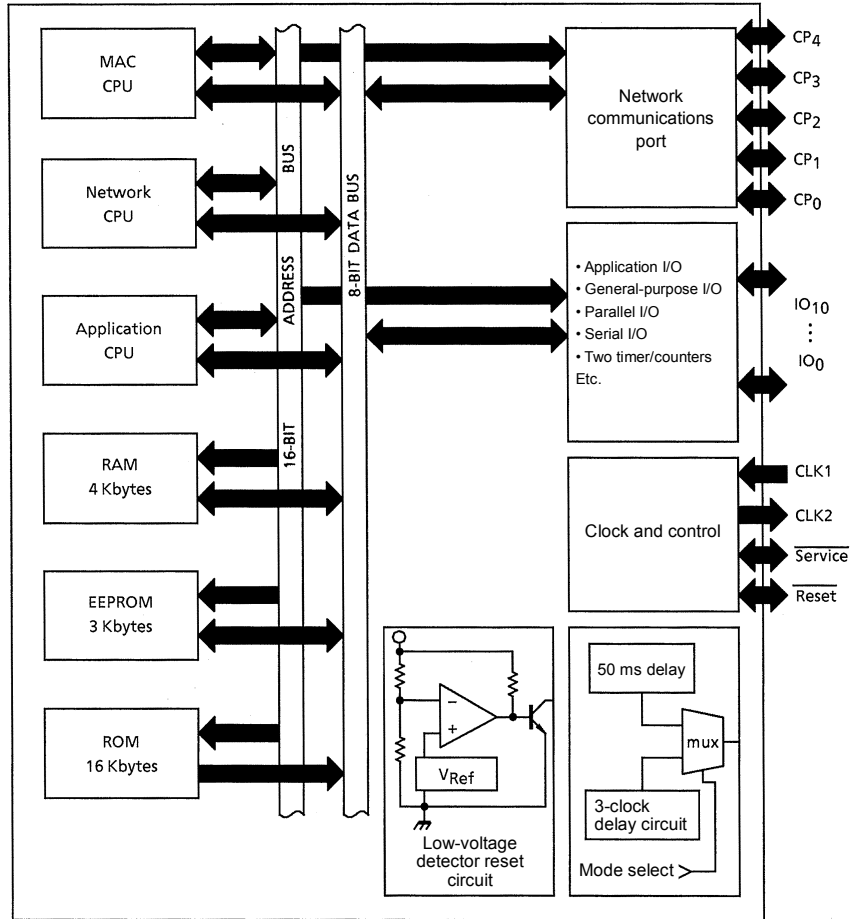
- Timing for the main I/O objects during 20 MHz Neuron Chip operations

| I/O Model           | 10 MHz Timing  | 20 MHz Timing   |
|---------------------|--|---|
| Parallel            | 2.4 $\mu$ s/byte   | 1.2 $\mu$ s/byte  |
| Bitshift            | 1, 10 or 15 kbps   | 2, 20 or 30 kbps  |
| Magcard             | Up to 8334 bps   | Up to 16668 bps   |
| Magtrack1           | Up to 7246 bps   | Up to 14492 bps   |
| Neurowire master    | 1, 10 or 20 kbps   | 2, 20 or 40 kbps  |
| Neurowire slave     | Up to 18 kbps  | Up to 36 kbps   |
| Serial              | 600, 1200, 2400 or 4800 bps                                    | 1200, 2400, 4800 or 9600 bps                                  |
| Touch               | Supported  | Not supported   |
| Frequency output    | Resolution: 0.4 to 51.2 $\mu$ s<br>Max range: 26.21 to 3355 ms | Resolution: 0.2 to 25.6 $\mu$ s<br>Max range: 13.1 to 1678 ms |
| Other timer/counter | Resolution: 0.2 to 25.6 $\mu$ s<br>Max range: 13.1 to 1678 ms  | Resolution: 0.1 to 12.8 $\mu$ s<br>Max range: 6.55 to 839 ms  |

The specifications for the main timers during 20 MHz operations are as follows:

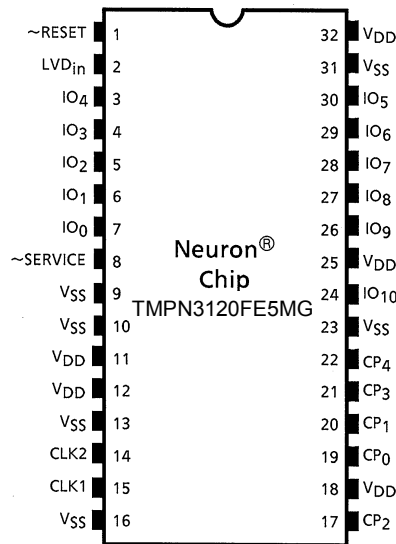
|                             |                         |
|-----------------------------|-------------------------|
| Watchdog timer              | 420 ms                  |
| Millisecond timers          | 1 to 32000 ms           |
| Second timers               | 1 to 65000 s            |
| Delay ( ) function          | 1 to 32767 counts       |
| Get_tick_count ( ) function | 409.6 $\mu$ s per count |

**Block Diagram**



| Item                      | TMPN3120FE5MG |
|---------------------------|---------------|
| CPU                       | 8-bit CPU × 3 |
| RAM                       | 4,096 bytes   |
| ROM                       | 16,384 bytes  |
| EEPROM                    | 3,072 bytes   |
| 16-bit timer/counter      | 2 channels    |
| External memory interface | Not available |
| Package                   | 32-pin SOP    |

## Pin Connections



Note: All NC pins should be open.

## Pin Functions

| Pin No.               | Pin Name                            | I/O                                    | Pin Function  |
|-----------------------|-------------------------------------|--|---|
| 15                    | CLK1                                | Input                                  | Oscillator connection, or external clock input  |
| 14                    | CLK2                                | Output                                 | Oscillator connection. Leave open when the external clock is input to CLK1.   |
| 1                     | ~RESET                              | I/O<br>(built-in pull-up)              | Reset pin (active low)  |
| 8                     | ~SERVICE                            | I/O<br>(built-in configurable pull-up) | Service pin. Indicator output during operation.   |
| 7 to 4                | IO <sub>0</sub> to IO <sub>3</sub>  | I/O                                    | Large current sink capacity (20 mA).<br>General I/O port.   |
| 3, 30 to 28           | IO <sub>4</sub> to IO <sub>7</sub>  | I/O<br>(built-in configurable pull-up) | General I/O port. One of IO <sub>4</sub> to IO <sub>7</sub> can be specified as the No.1 timer/counter input. Output signals can be output to IO <sub>0</sub> . IO <sub>4</sub> can be used as the No.2 timer/counter input with IO <sub>1</sub> as output. |
| 27, 26, 24            | IO <sub>8</sub> to IO <sub>10</sub> | I/O                                    | General I/O port. Can be used for serial communication with other devices.  |
| 11, 12, 18, 25, 32    | V <sub>DD</sub>                     | Input                                  | Power input (5.0 V typ.)  |
| 9, 10, 13, 16, 23, 31 | V <sub>SS</sub>                     | Input                                  | Power input (0 V GND)   |
| 2                     | LVD <sub>in</sub>                   | Input                                  | Input pin for programmable LVD<br>(normally connected to V <sub>DD</sub> )  |
| 19, 20, 17, 21, 22    | CP <sub>0</sub> to CP <sub>4</sub>  | I/O                                    | Bidirectional port for communications. Supports several communications protocols through specifying of mode.  |

- \* :
- The ~SERVICE and IO<sub>4</sub> to IO<sub>7</sub> terminals are programmable pull-ups.
  - All V<sub>DD</sub> terminals must be externally connected.
  - All V<sub>SS</sub> terminals must be externally connected.

## Maximum Ratings (V<sub>SS</sub> = 0 V, V<sub>SS</sub> typ.)

| Item   | Symbol              | Rating  | Unit |
|--|---------------------|---|------|
| Power supply voltage                             | V <sub>DD</sub>     | -0.3 to 7.0   | V    |
| Input voltage                                    | V <sub>IN (1)</sub> | -0.3 to V <sub>DD</sub> + 0.3 V                                       | V    |
| Input voltage CP <sub>0</sub> to CP <sub>3</sub> | V <sub>IN (2)</sub> | -0.5 to V <sub>DD</sub> + 1.3 V<br>V <sub>IN (2)</sub> ≤ 7.3 (Note 1) | V    |
| Drain current                                    | I <sub>DD</sub>     | 200   | mA   |
| Source current                                   | I <sub>SS</sub>     | 300   | mA   |
| Power dissipation                                | P <sub>D</sub>      | 800   | mW   |
| Storage temperature                              | T <sub>stg</sub>    | -65 to 150  | °C   |

Note 1: V<sub>IN (2)</sub> should not exceed 7.3 V.

## Operating Conditions

| Item  | Symbol           | Min                     | Typ. | Max                     | Unit |
|---|------------------|-------------------------|------|-------------------------|------|
| Operating voltage   | V <sub>DD</sub>  | 4.5                     | 5.0  | 5.5                     | V    |
| Input voltage (TTL)   | V <sub>IH</sub>  | 2.0                     | —    | V <sub>DD</sub>         | V    |
|   | V <sub>IL</sub>  | V <sub>SS</sub>         | —    | 0.8                     | V    |
| Input voltage (CMOS)  | V <sub>IH</sub>  | V <sub>DD</sub> - 0.8 V | —    | V <sub>DD</sub>         | V    |
|   | V <sub>IL</sub>  | V <sub>SS</sub>         | —    | 0.8                     | V    |
| Input voltage CP <sub>0</sub> to CP <sub>3</sub><br>(differential mode) | V <sub>IH</sub>  | —                       | —    | V <sub>DD</sub> + 1.0 V | V    |
|   | V <sub>IL</sub>  | -0.1                    | —    | —                       |      |
| Operating frequency   | f <sub>osc</sub> | 0.625                   | —    | 20                      | MHz  |
| Operating temperature   | T <sub>opr</sub> | -40                     | —    | 85                      | °C   |

## Electrical Characteristics

**DC characteristic** ( $V_{DD} = 5.0 \text{ V} \pm 10\%$ ,  $V_{SS} = 0 \text{ V}$ ,  $T_a = -40 \text{ to } 85^\circ\text{C}$ )

(The above operating conditions apply unless otherwise stated.)

| Item                         | Symbol               | Pins   | Test Condition                       | Min                      | Max                 | Unit          |
|------------------------------|----------------------|--|--------------------------------------|--------------------------|---------------------|---------------|
| LOW level input voltage (1)  | $V_{IL} (1)$         | IO <sub>0</sub> to IO <sub>10</sub><br>CP <sub>0</sub> , CP <sub>3</sub> , CP <sub>4</sub> ,<br>~SERVICE | —                                    | 0                        | 0.8                 | V             |
| LOW level input voltage (2)  | $V_{IL} (2)$         | ~RESET   | —                                    | 0                        | $V_{DD} \times 0.3$ | V             |
| HIGH level input voltage (1) | $V_{IH} (1)$         | IO <sub>0</sub> to IO <sub>10</sub><br>CP <sub>0</sub> , CP <sub>3</sub> , CP <sub>4</sub> ,<br>~SERVICE | —                                    | 2.0                      | $V_{DD}$            | V             |
| HIGH level input voltage (2) | $V_{IH} (2)$         | ~RESET   | —                                    | $V_{DD} - 0.7 \text{ V}$ | $V_{DD}$            | V             |
| LOW output voltage (1)       | $V_{OL} (1)$         | IO <sub>0</sub> to IO <sub>3</sub><br>~SERVICE,<br>~RESET  | $I_{OL} = 20 \text{ mA}$             | 0                        | 0.8                 | V             |
|                              |                      |  | $I_{OL} = 10 \text{ mA}$             | 0                        | 0.4                 |               |
| LOW output voltage (2)       | $V_{OL} (2)$         | CP <sub>2</sub> , CP <sub>3</sub>  | $I_{OL} = 40 \text{ mA}$             | 0                        | 1.0                 | V             |
| LOW output voltage (3)       | $V_{OL} (3)$         | Others (Note 1)  | $I_{OL} = 1.4 \text{ mA}$            | 0                        | 0.4                 | V             |
| HIGH output voltage (1)      | $V_{OH} (1)$         | IO <sub>0</sub> to IO <sub>3</sub>   | $I_{OH} = -1.4 \text{ mA}$           | $V_{DD} - 0.4 \text{ V}$ | $V_{DD}$            | V             |
| HIGH output voltage (2)      | $V_{OH} (2)$         | ~SERVICE   | $I_{OH} = -1.4 \text{ mA}$           | $V_{DD} - 0.4 \text{ V}$ | $V_{DD}$            | V             |
| HIGH output voltage (3)      | $V_{OH} (3)$         | CP <sub>2</sub> , CP <sub>3</sub>  | $I_{OH} = -40 \text{ mA}$            | $V_{DD} - 1.0 \text{ V}$ | $V_{DD}$            | V             |
| HIGH output voltage (4)      | $V_{OH} (4)$         | Others (Note 1)  | $I_{OH} = -1.4 \text{ mA}$           | $V_{DD} - 0.4 \text{ V}$ | $V_{DD}$            | V             |
| Input current                | $I_{IN}$             | (Note 2)   | $V_{IN} = V_{SS} \text{ to } V_{DD}$ | -10                      | 10                  | $\mu\text{A}$ |
| Pull-up current              | $I_{PU}$<br>(Note 3) | IO <sub>4</sub> to IO <sub>7</sub><br>~SERVICE,<br>~RESET  | $V_{IN} = 0 \text{ V}$               | -30                      | -300                | $\mu\text{A}$ |
| Low-voltage detection level  | $V_{LVD}$            | $V_{DD}$   | —                                    | 3.8                      | 4.5                 | V             |

Note 1: Output voltage characteristics exclude the CLK2 pin.

Note 2: Excludes pull-up input pins.

Note 3: The IO<sub>4</sub> to IO<sub>7</sub> and ~SERVICE pins have programmable pull-ups. ~RESET has a fixed pull-up.

| Item                               | Symbol         | Typ.            | Max | Unit          |    |
|------------------------------------|----------------|-----------------|-----|---------------|----|
| Operating mode current consumption | $I_{DD} (OP)$  | 20 MHz clock    | 34  | 55            | mA |
|                                    |                | 10 MHz clock    | 16  | 30            |    |
|                                    |                | 5 MHz clock     | 8.5 | 15            |    |
|                                    |                | 2.5 MHz clock   | 4.5 | 8             |    |
|                                    |                | 1.25 MHz clock  | 2.3 | 5             |    |
|                                    |                | 0.625 MHz clock | 1.3 | 3             |    |
| Sleep mode current consumption     | $I_{DD} (SLP)$ | 16              | 100 | $\mu\text{A}$ |    |

Note: Test conditions for current dissipation:

$V_{DD} = 5 \text{ V}$ ; all output = with no load; all input = 0.2 V or below or  $V_{DD} - 0.2 \text{ V}$ ; programmable pull-up = off; crystal oscillator clock input; differential receiver disabled.

The current value (typ.) is a typical value when  $T_a = 25^\circ\text{C}$ .

The current value (max) applies to the rated temperature range at  $V_{DD} = 5.5 \text{ V}$ .

200  $\mu\text{A}$  (typ.) to 600  $\mu\text{A}$  (max) is added to the current of the differential receiver when the receiver is enabled.

The differential receiver is enabled by either of the following conditions:

- When the Neuron Chip is in Run mode and the communication ports are in Differential mode.
- When the Neuron Chip is in Sleep mode, the communication ports are in Differential mode, and the Comm Port Wakeup is not masked.

- Echelon, Neuron, LON, LonTalk, NodeBuilder, LonWORKS, 3150 and 3120 are trademarks of Echelon Corporation ("Echelon") registered in the United States and other countries.
- The Neuron Chip is manufactured by Toshiba under license from Echelon. A licensing agreement between the customer and Echelon must be concluded before purchase of any of the Neuron Chip products.
- The Neuron Chip itself does not include the I<sup>2</sup>C object function. You need the "I<sup>2</sup>C Library" supplied by Echelon. The Neuron Chip and the I<sup>2</sup>C Library neither convey nor imply a right under any I<sup>2</sup>C patent rights of Philips Electronics N.V. ("Philips") to make, use or sell any product employing such patent rights. Please refer all questions regarding I<sup>2</sup>C patents and licenses to Philips at the following:

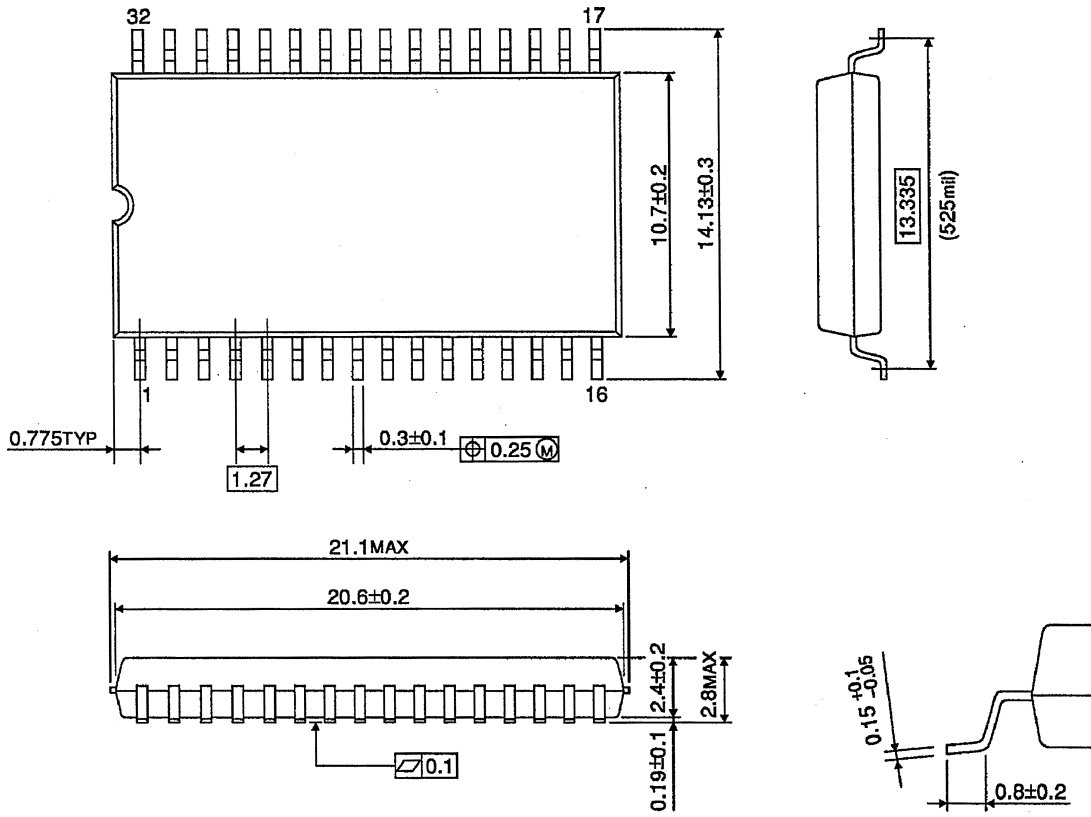
Mr. Gert-Jan Hesselmann  
Corporate Intellectual Property  
Philips International B.V.  
Prof. Holstlaan 6  
Building WAH 1-100  
P.O. Box 220  
5600 AE, Eindhoven, The Netherlands  
Phone : +31 40 274 32 61  
Fax : +31 40 274 34 89  
E-mail : Gert.Jan.Hesselmann@philips.com



## Package Dimensions

SOP32-P-525-1.27

Unit : mm



Weight : 1.1g (typ.)

Lead-free type

About solderability, following conditions were confirmed

- Solderability
  - (1) Use of Sn-63Pb solder Bath
    - solder bath temperature = 230°C
    - dipping time = 5 seconds
    - the number of times = once
    - use of R-type flux
  - (2) Use of Sn-3.0Ag-0.5Cu solder Bath
    - solder bath temperature = 245°C
    - dipping time = 5 seconds
    - the number of times = once
    - use of R-type flux

## RESTRICTIONS ON PRODUCT USE

030619EBA

- The information contained herein is subject to change without notice.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of TOSHIBA or others.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.  
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- TOSHIBA products should not be embedded to the downstream products which are prohibited to be produced and sold, under any law and regulations.