OVERVIEW
The 5055A series are miniature crystal oscillator module ICs supported 20MHz to 40MHz fundamental oscillation. The oscillator circuit stage has voltage regulator drive, significantly reducing current consumption and crystal drive current, compared with existing devices, and significantly reducing the oscillator characteristics supply voltage dependency. The lowest current consumption class in the industry* is realized as the crystal oscillation modules IC of CMOS output. The pad layout is arranged for flip chip mounting, these devices are ideal for miniature crystal oscillators for the applications such as portable equipment requested small size and low consumption current.

FEATURES

- The lowest current consumption class in the industry* (typ)
- Regulated voltage drive oscillator circuit for reduced power consumption and crystal drive current
- 0.45mA@40MHz, VDD=1.8V, no load
- 0.65mA@40MHz, VDD=2.5V, no load
- 1.1mA@40MHz, VDD=3.3V, no load
- Wide range of operating supply voltage: 1.60 to 3.63V
- Recommended oscillation frequency range (fundamental oscillator): 20 to 40MHz
- Optimized low crystal drive current oscillation for miniature crystal units
- Frequency divider built-in
- Selectable by version: fosc, fosc/2, fosc/4

- Wide output frequency range by multi-stage frequency divider: 5 to 40MHz
- Pad layout optimized for flip chip mounting
- -40 to 85°C operating temperature range
- Standby function
- High impedance in standby mode, oscillator stops
- Power-saving pull-up resistor built-in
- 50±5% output duty (1/2VDD)
- ±3mA output drive capability
- 15pF output load capacitance
- Wafer form (WF5055Ax)
- Wide range of operating supply voltage: 1.60 to 3.63V
- ±3mA output drive capability
- 15pF output load capacitance
- Wafer form (WF5055Ax)

- According to our own research as at Nov, 2012

APPLICATIONS

- 3.2mm×2.5mm, 2.5mm×2.0mm, 2.0mm×1.6mm, 1.6mm×1.2mm size miniature crystal oscillator modules

SERIES CONFIGURATION

<table>
<thead>
<tr>
<th>Version name</th>
<th>Operating supply voltage range [V]</th>
<th>Recommended oscillation frequency range (fundamental) [MHz]</th>
<th>Built-in oscillation capacitance [pf]</th>
<th>Output current [mA]</th>
<th>Output frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>5055A1</td>
<td>1.60 to 3.63</td>
<td>20 to 40</td>
<td>2</td>
<td>±3</td>
<td>fosc</td>
</tr>
<tr>
<td>5055A2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fosc/2</td>
</tr>
<tr>
<td>5055A3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fosc/4</td>
</tr>
</tbody>
</table>

*1. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

*2. The built-in oscillation capacitors do not contain parasitic capacitance.

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Version name</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF5055Ax-4</td>
<td>Wafer form</td>
<td>WF5055Ax□-4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Version name</th>
<th>Frequency divider function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: fosc</td>
<td></td>
</tr>
<tr>
<td>2: fosc/2</td>
<td></td>
</tr>
<tr>
<td>3: fosc/4</td>
<td></td>
</tr>
</tbody>
</table>
PAD LAYOUT
(Unit: μm)

Chip size: 0.60×0.57mm
Wafer thickness: 130μm
PAD size: 80μm
Chip base: VSS level

PIN DESCRIPTION and PAD COORDINATES

<table>
<thead>
<tr>
<th>No.</th>
<th>Pin</th>
<th>I/O*1</th>
<th>Description</th>
<th>PAD coordinate [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>XT</td>
<td>I</td>
<td>Crystal connection pins</td>
<td>X: -145.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y: -193.5</td>
</tr>
<tr>
<td>2</td>
<td>XTN</td>
<td>O</td>
<td>Crystal is connected between XT and XTN.</td>
<td>X: 145.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y: -193.5</td>
</tr>
<tr>
<td>3</td>
<td>VDD</td>
<td>-</td>
<td>(+) supply voltage</td>
<td>X: 208.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y: -1.1</td>
</tr>
<tr>
<td>4</td>
<td>Q</td>
<td>O</td>
<td>Output one of fOSC, fOSC/2, fOSC/4</td>
<td>X: 208.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y: 193.5</td>
</tr>
<tr>
<td>5</td>
<td>VSS</td>
<td>-</td>
<td>(-) ground</td>
<td>X: -208.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y: 193.5</td>
</tr>
<tr>
<td>6</td>
<td>INHN</td>
<td>I</td>
<td>Input pin controlled output state (oscillator stops when LOW), power-saving pull-up resistor built-in</td>
<td>X: -208.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y: -1.1</td>
</tr>
</tbody>
</table>

*1. I: Input pin   O: Output pin

BLOCK DIAGRAM
SPECIFICATIONS

Absolute Maximum Ratings

\( V_{SS}=0V \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage range*1</td>
<td>( V_{DD} )</td>
<td>Between VDD and VSS</td>
<td>-0.3 to +4.0</td>
<td>V</td>
</tr>
<tr>
<td>Input voltage range<em>1</em>2</td>
<td>( V_{IN} )</td>
<td>Input pins</td>
<td>-0.3 to ( V_{DD} +0.3 )</td>
<td>V</td>
</tr>
<tr>
<td>Output voltage range<em>1</em>2</td>
<td>( V_{OUT} )</td>
<td>Output pins</td>
<td>-0.3 to ( V_{DD} +0.3 )</td>
<td>V</td>
</tr>
<tr>
<td>Output current*3</td>
<td>( I_{OUT} )</td>
<td>Q pin</td>
<td>( \pm 20 )</td>
<td>mA</td>
</tr>
<tr>
<td>Junction temperature*3</td>
<td>( T_{J} )</td>
<td></td>
<td>125</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature range*4</td>
<td>( T_{STG} )</td>
<td>Wafer form</td>
<td>-65 to +125</td>
<td>°C</td>
</tr>
</tbody>
</table>

*1. This parameter rating is the values that must never exceed even for a moment. This product may suffer breakdown if this parameter rating is exceeded.

*2. Operation and characteristics are guaranteed only when the product is operated at recommended operating conditions.

*3. Do not exceed the absolute maximum ratings. If they are exceeded, a characteristic and reliability will be degraded.

*4. When stored in nitrogen or vacuum atmosphere applied to IC itself only (excluding packaging materials).

Recommended Operating Conditions

\( V_{SS}=0V \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillator frequency*1</td>
<td>( f_{OSC} )</td>
<td>( V_{DD}=1.60 ) to ( 3.63V )</td>
<td>20</td>
<td>MHz</td>
</tr>
<tr>
<td>Operating frequency</td>
<td>( f_{OUT} )</td>
<td>( V_{DD}=1.60 ) to ( 3.63V ), ( C_{LOAD} \leq 15pF )</td>
<td>5</td>
<td>MHz</td>
</tr>
<tr>
<td>Operating supply voltage</td>
<td>( V_{DD} )</td>
<td>Between VDD and VSS*2</td>
<td>1.60</td>
<td>V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>( T_{a} )</td>
<td>Input pins</td>
<td>0</td>
<td>°C</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>( T_{a} )</td>
<td>Q output</td>
<td>+85</td>
<td>°C</td>
</tr>
<tr>
<td>Output load capacitance</td>
<td>( C_{LOAD} )</td>
<td>Q output</td>
<td>15</td>
<td>pF</td>
</tr>
</tbody>
</table>

*1. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

*2. Mount a ceramic chip capacitor that is larger than 0.01μF proximal to IC (within approximately 3mm) between VDD and VSS in order to obtain stable operation of 5055A series. In addition, the wiring pattern between IC and capacitor should be as wide as possible.

Note. Since it may influence the reliability if it is used out of range of recommended operating conditions, this product should be used within this range.
### Electrical Characteristics

#### DC Characteristics

$V_{DD}=1.60$ to $3.63V$, $V_{SS}=0V$, $T_a=-40$ to $+85^\circ C$ unless otherwise noted.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q pin</strong></td>
<td>$V_{OH}$</td>
<td>measurement circuit 3, $I_{OH}=-3mA$</td>
<td>$V_{DD}=0.4$</td>
<td>$V_{DD}$</td>
</tr>
<tr>
<td><strong>Q pin</strong></td>
<td>$V_{OL}$</td>
<td>measurement circuit 3, $I_{OL}=3mA$</td>
<td>$0$</td>
<td>$0.4$</td>
</tr>
<tr>
<td><strong>INHN pin</strong></td>
<td>$V_{IH}$</td>
<td>measurement circuit 4</td>
<td>$0.7V_{DD}$</td>
<td>$V_{DD}$</td>
</tr>
<tr>
<td><strong>INHN pin</strong></td>
<td>$V_{IL}$</td>
<td>measurement circuit 4</td>
<td>$0.3V_{DD}$</td>
<td>$V_{DD}$</td>
</tr>
<tr>
<td><strong>Q pin</strong></td>
<td>$I_Z$</td>
<td>measurement circuit 5, $I_Z$</td>
<td>$Q=V_{DD}$</td>
<td>$10 \mu A$</td>
</tr>
<tr>
<td><strong>Q pin</strong></td>
<td>$I_Z$</td>
<td>measurement circuit 5, $I_Z$</td>
<td>$Q=V_{SS}$</td>
<td>$-10 \mu A$</td>
</tr>
<tr>
<td><strong>Current consumption</strong></td>
<td>$I_{DD}$</td>
<td>$5055A1(f_{OSC})$, measurement circuit 1, no load, INHN=“OPEN”, $f_{OSC}=40MHz$, $f_{OUT}=40MHz$</td>
<td>$V_{DD}=3.3V$</td>
<td>$1.1 \text{ mA}$</td>
</tr>
<tr>
<td><strong>Current consumption</strong></td>
<td>$I_{DD}$</td>
<td>$5055A2(f_{OSC}/2)$, measurement circuit 1, no load, INHN=“OPEN”, $f_{OSC}=40MHz$, $f_{OUT}=20MHz$</td>
<td>$V_{DD}=2.5V$</td>
<td>$0.65 \text{ mA}$</td>
</tr>
<tr>
<td><strong>Current consumption</strong></td>
<td>$I_{DD}$</td>
<td>$5055A3(f_{OSC}/4)$, measurement circuit 1, no load, INHN=“OPEN”, $f_{OSC}=40MHz$, $f_{OUT}=10MHz$</td>
<td>$V_{DD}=1.8V$</td>
<td>$0.45 \text{ mA}$</td>
</tr>
<tr>
<td><strong>Standby current</strong></td>
<td>$I_{ST}$</td>
<td>measurement circuit 1, INHN=“Low”</td>
<td>$V_{DD}=3.3V$</td>
<td>$0.8 \mu A$</td>
</tr>
<tr>
<td><strong>INHN pin pull-up resistance</strong></td>
<td>$R_{PU1}$</td>
<td>measurement circuit 6</td>
<td>$V_{DD}=2.5V$</td>
<td>$3 \text{ k\Omega}$</td>
</tr>
<tr>
<td><strong>Oscillator feedback resistance</strong></td>
<td>$R_f$</td>
<td>measurement circuit 6</td>
<td>$V_{DD}=1.8V$</td>
<td>$30 \text{ k\Omega}$</td>
</tr>
<tr>
<td><strong>Oscillator capacitance</strong></td>
<td>$C_D$</td>
<td>Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.</td>
<td>$V_{DD}=3.3V$</td>
<td>$1.6 \text{ pF}$</td>
</tr>
<tr>
<td><strong>Oscillator capacitance</strong></td>
<td>$C_D$</td>
<td>Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.</td>
<td>$V_{DD}=2.5V$</td>
<td>$2 \text{ pF}$</td>
</tr>
<tr>
<td><strong>Oscillator capacitance</strong></td>
<td>$C_D$</td>
<td>Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.</td>
<td>$V_{DD}=1.8V$</td>
<td>$2.4 \text{ pF}$</td>
</tr>
</tbody>
</table>

*1. The consumption current $I_{DD}(C_{OUT})$ with a load capacitance $C_{OUT}$ connected to the Q pin is given by the following equation, where $I_{DD}$ is the no load consumption current and $f_{OUT}$ is the output frequency.

$$I_{DD}(C_{OUT})(\text{mA}) = I_{DD}(\text{mA}) + C_{OUT}(\text{pF}) \times V_{DD}(\text{V}) \times f_{OUT}(\text{MHz}) \times 10^{-3}$$
AC Characteristics

\( V_{DD} = 1.60 \text{ to } 3.63 \text{V}, V_{SS} = 0 \text{V}, T_a = -40 \text{ to } +85\text{°C} \) unless otherwise noted

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q pin Output rise time</td>
<td>( t_1 )</td>
<td>measurement circuit 1, ( C_{LOUT}=15\text{pF} ), ( 0.1V_{DD} \rightarrow 0.9V_{DD} ), ( V_{DD}=2.25 \text{ to } 3.63\text{V} )</td>
<td>2.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>( t_2 )</td>
<td>measurement circuit 1, ( C_{LOUT}=15\text{pF} ), ( 0.1V_{DD} \rightarrow 0.9V_{DD} ), ( V_{DD}=1.60 \text{ to } 2.25\text{V} )</td>
<td>3.0</td>
<td>ns</td>
</tr>
<tr>
<td>Q pin Output fall time</td>
<td>( t_1 )</td>
<td>measurement circuit 1, ( C_{LOUT}=15\text{pF} ), ( 0.9V_{DD} \rightarrow 0.1V_{DD} ), ( V_{DD}=2.25 \text{ to } 3.63\text{V} )</td>
<td>2.0</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>( t_2 )</td>
<td>measurement circuit 1, ( C_{LOUT}=15\text{pF} ), ( 0.9V_{DD} \rightarrow 0.1V_{DD} ), ( V_{DD}=1.60 \text{ to } 2.25\text{V} )</td>
<td>3.0</td>
<td>ns</td>
</tr>
<tr>
<td>Q pin Output duty cycle</td>
<td>DUTY</td>
<td>measurement circuit 1, ( T_a=25\text{°C} ), ( C_{LOUT}=15\text{pF} )</td>
<td>45</td>
<td>%</td>
</tr>
<tr>
<td>Q pin Output disable delay</td>
<td>( t_{OD} )</td>
<td>measurement circuit 2, ( T_a=25\text{°C} ), ( C_{LOUT} \leq 15\text{pF} )</td>
<td>200</td>
<td>ns</td>
</tr>
</tbody>
</table>

Timing chart

![Timing chart diagram](image)

Figure 1. Output switching waveform

When INHN goes HIGH to LOW, the Q output becomes high impedance.
When INHN goes LOW to HIGH, the Q output goes LOW once and then becomes normal output operation after having detected oscillation signals.

Figure 2. Output disable and oscillation start timing chart
FUNCTIONAL DESCRIPTION

INHN Function
Q output is stopped and becomes high impedance.

<table>
<thead>
<tr>
<th>INHN</th>
<th>Q</th>
<th>Oscillator</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH or Open</td>
<td>$f_{OUT}$</td>
<td>Operating</td>
</tr>
<tr>
<td>LOW</td>
<td>Hi-Z</td>
<td>Stopped</td>
</tr>
</tbody>
</table>

Power Saving Pull-up Resistor
The INHN pin pull-up resistance changes its value to $R_{PU1}$ or $R_{PU2}$ in response to the input level (HIGH or LOW).
When INHN is tied to LOW level, the pull-up resistance becomes large ($R_{PU1}$), thus reducing the current consumed by the resistance.
When INHN is left open circuit or tied to HIGH level, the pull-up resistance becomes small ($R_{PU2}$), thus internal circuit of INHN becomes HIGH level.
Consequently, the IC is less susceptible to the effects of noise, helping to avoid problems such as the output stopping suddenly.

Oscillation Detection Function
The 5055A series have an oscillation detection circuit.
The oscillation detection circuit disables the output until crystal oscillation becomes stable when oscillation circuit starts up. This function avoids the abnormal oscillation in the initial power up and in a reactivation by INHN.
MEASUREMENT CIRCUITS

MEASUREMENT CIRCUIT 1
Measurement Parameter: \( I_{DD}, I_{ST}, DUTY \ t_r, t_f \)

\[ \begin{align*}
X'tal & \quad XT \\
XTN & \quad INHN \\
VDD & \quad Q \\
Q & \quad C_{\text{OUT}} \quad \text{(including probe capacitance)} \\
\end{align*} \]

*AC characteristics observed on the Q pin using an oscilloscope.

Parameter table:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SW1</th>
<th>SW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{DD} )</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>( I_{ST} )</td>
<td>ON or OFF</td>
<td>ON</td>
</tr>
<tr>
<td>DUTY, ( t_r, t_f )</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

MEASUREMENT CIRCUIT 2
Measurement Parameter: \( t_{OD} \)

Input signal: 1Vp-p, sine wave

\[ \begin{align*}
\text{Input signal:} & \quad V_{\text{REF}} \rightarrow V_{\text{OUT}} \\
\end{align*} \]

Function Generator

MEASUREMENT CIRCUIT 3
Measurement Parameter: \( V_{OH}, V_{OL} \)

Input signal: 1Vp-p, sine wave

\[ \begin{align*}
\text{Input signal:} & \quad 1Vp-p, \text{sine wave} \\
\end{align*} \]

Diagram showing the circuit diagram for each measurement parameter.
**MEASUREMENT CIRCUIT 4**
Measurement Parameter: $V_{IH}, V_{IL}$.

![Measurement Circuit 4 Diagram]

- $V_{IH}$: $V_{SS} \rightarrow V_{DD}$ voltage that changes enable output state
- $V_{IL}$: $V_{DD} \rightarrow V_{SS}$ voltage that changes disable output state

**MEASUREMENT CIRCUIT 5**
Measurement Parameter: $I_z$

![Measurement Circuit 5 Diagram]

**MEASUREMENT CIRCUIT 6**
Measurement Parameter: $R_{P11}, R_{P12}$

![Measurement Circuit 6 Diagram]

$$R_{UT1} = \frac{V_{DD}}{I_{LU}} (V_{IN} = 0V)$$

$$R_{UT2} = \frac{V_{DD} - 0.7V_{DD}}{I_{LU}} (V_{IN} = 0.7V_{DD})$$
REFERENCE DATA
The following characteristics are measured using the crystal below. Note that the characteristics will vary with the crystal used.

<table>
<thead>
<tr>
<th>Crystal used for measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>C&lt;sub&gt;0&lt;/sub&gt;(pF)</td>
</tr>
<tr>
<td>R&lt;sub&gt;1&lt;/sub&gt;(Ω)</td>
</tr>
</tbody>
</table>

Current Consumption

5055A1, f<sub>OSC</sub>=40MHz, T<sub>a</sub>: Room temperature, C<sub>OUT</sub>: none

5055Ax, T<sub>a</sub>: Room temperature, C<sub>OUT</sub>: none

Negative Resistance

5055A1, V<sub>DD</sub>=3.3V, T<sub>a</sub>: Room temperature
Measurement equipment: Agilent Impedance analyzer 4396B

5055A1, T<sub>a</sub>: Room temperature, C<sub>0</sub>: none

The figures show the measurement result of the crystal equivalent circuit C<sub>0</sub> capacitance, connected between the XT and XTN pins. They were performed with Agilent 4396B using the NPC test jig. They may vary in a measurement jig, and measurement environment.
Frequency Deviation by Voltage

```
-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6
```

VDD [V]

```
⊿f/f [ppm]
```

```
5055A1, f_{osc}=40MHz, T_{a}: Room temperature, 3.0V std
```

Drive Level

```
5055A1, f_{osc}=40MHz, T_{a}: Room temperature
```

Phase Noise

```
-60
-80
-100
-120
-140
-160
-180
```

```
10 100 1k 10k 100k 1M 10M
```

Offset Frequency [Hz]

```
PhaseNoise [dBc/Hz]
```

```
5055A1, f_{osc}=40MHz, V_{DD}=3.3V, T_{a}: Room temperature
```

```
Measurement equipment: Signal Source Analyzer Agilent E5052B
```

Output Waveform

```
```

```
5055A1, f_{osc}=40MHz, V_{DD}=3.3V, f_{OUT}=40MHz, C_{OUT}=15pF, T_{a}: Room temperature
```

```
Measurement equipment: Oscilloscope Agilent DSO80604B
```

SEIKO NPC CORPORATION - 10
Please pay your attention to the following points at time of using the products shown in this document.

1. The products shown in this document (hereinafter “Products”) are designed and manufactured to the generally accepted standards of reliability as expected for use in general electronic and electrical equipment, such as personal equipment, machine tools and measurement equipment. The Products are not designed and manufactured to be used in any other special equipment requiring extremely high level of reliability and safety, such as aerospace equipment, nuclear power control equipment, medical equipment, transportation equipment, disaster prevention equipment, security equipment. The Products are not designed and manufactured to be used for the apparatus that exerts harmful influence on the human lives due to the defects, failure or malfunction of the Products. If you wish to use the Products in that apparatus, please contact our sales section in advance.

In the event that the Products are used in such apparatus without our prior approval, we assume no responsibility whatsoever for any damages resulting from the use of that apparatus.

2. NPC reserves the right to change the specifications of the Products in order to improve the characteristics or reliability thereof.

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4. The constant of each circuit shown in this document is described as an example, and it is not guaranteed about its value of the mass production products.

5. In the case of that the Products in this document falls under the foreign exchange and foreign trade control law or other applicable laws and regulations, approval of the export to be based on those laws and regulations are necessary. Customers are requested appropriately take steps to obtain required permissions or approvals from appropriate government agencies.