# CAT5112

## 32-Tap Digitally Programmable Potentiometer (DPP™) with Buffered Wiper

### FEATURES

- 32-position linear taper potentiometer
- Non-volatile NVRAM wiper storage; buffered wiper
- Low power CMOS technology
- Single supply operation: 2.5V-6.0V
- Increment up/down serial interface
- Resistance values: 10kΩ, 50kΩ and 100kΩ
- Available in PDIP, SOIC, TSSOP and MSOP packages

### APPLICATIONS

- Automated product calibration
- Remote control adjustments
- Offset, gain and zero control
- Tamper-proof calibrations
- Contrast, brightness and volume controls
- Motor controls and feedback systems
- Programmable analog functions

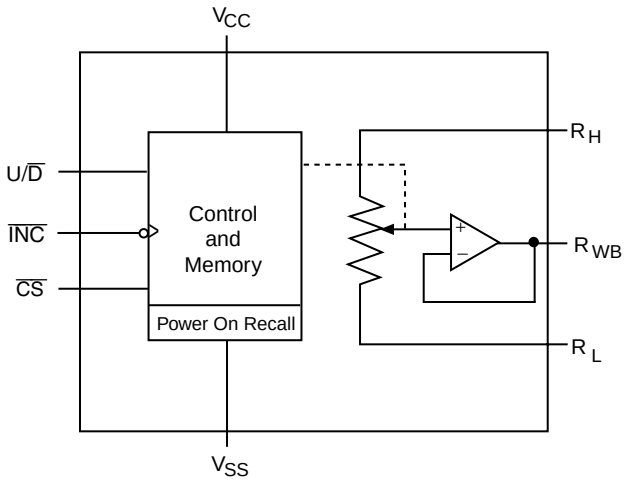
### DESCRIPTION

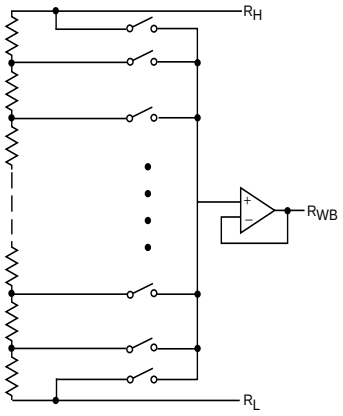
The CAT5112 is a single digitally programmable potentiometer (DPP™) designed as a electronic replacement for mechanical potentiometers and trim pots. Ideal for automated adjustments on high volume production lines, they are also well suited for applications where equipment requiring periodic adjustment is either difficult to access or located in a hazardous or remote environment.

The CAT5112 contains a 32-tap series resistor array connected between two terminals $R_H$ and $R_L$. An up/down counter and decoder that are controlled by three input pins, determines which tap is connected to the wiper, $R_{WB}$. The CAT5112 wiper is buffered by an op amp that operates rail to rail. The wiper setting, stored in non-volatile NVRAM memory, is not lost when the device is powered down and is automatically recalled when power is returned. The wiper can be adjusted to test new system values without effecting the stored setting. Wiper-control of the CAT5112 is accomplished with three input control pins, $\overline{CS}$, U/$\overline{D}$, and $\overline{INC}$. The $\overline{INC}$ input increments the wiper in the direction which is determined by the logic state of the U/$\overline{D}$ input. The $\overline{CS}$ input is used to select the device and also store the wiper position prior to power down.

The digitally programmable potentiometer can be used as a buffered voltage divider. For applications where the potentiometer is used as a 2-terminal variable resistor, please refer to the CAT5114. The buffered wiper of the CAT5112 is not compatible with that application. DPPs bring variability and programmability to a broad range of applications and are used primarily to control, regulate or adjust a characteristic or parameter of an analog circuit.

### FUNCTIONAL DIAGRAM




**Electronic Potentiometer Implementation**

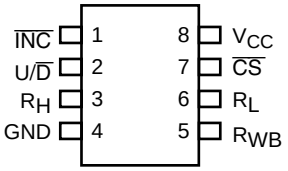
© 2004 by Catalyst Semiconductor, Inc.
Characteristics subject to change without notice



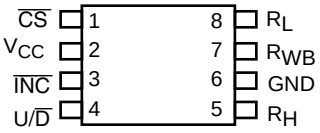
Doc. No. 2002, Rev. L

## PIN CONFIGURATION

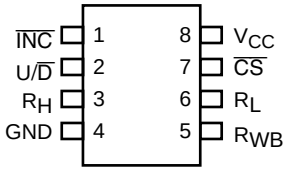
PDIP Package (P, L)



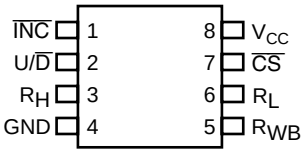

TSSOP Package (U, Y)




SOIC Package (S, V)




MSOP Package (R, Z)




## PIN FUNCTIONS

| Pin Name | Function |
|---|---|
| $\overline{INC}$ | Increment Control |
| U/$\overline{D}$ | Up/Down Control |
| $R_H$ | Potentiometer High Terminal |
| GND | Ground |
| $R_{WB}$ | Buffered Wiper Terminal |
| $R_L$ | Potentiometer Low Terminal |
| $\overline{CS}$ | Chip Select |
| $V_{CC}$ | Supply Voltage |

## PIN DESCRIPTIONS

**$\overline{INC}$**: Increment Control Input

The $\overline{INC}$ input (on the falling edge) moves the wiper in the up or down direction determined by the condition of the U/$\overline{D}$ input.

**U/$\overline{D}$**: Up/Down Control Input

The U/$\overline{D}$ input controls the direction of the wiper movement. When in a high state and $\overline{CS}$ is low, any high-to-low transition on $\overline{INC}$ will cause the wiper to move one increment toward the $R_H$ terminal. When in a low state and $\overline{CS}$ is low, any high-to-low transition on $\overline{INC}$ will cause the wiper to move one increment towards the $R_L$ terminal.

**$R_H$**: High End Potentiometer Terminal

$R_H$ is the high end terminal of the potentiometer. It is not required that this terminal be connected to a potential greater than the $R_L$ terminal. Voltage applied to the $R_H$ terminal cannot exceed the supply voltage, $V_{CC}$ or go below ground, GND.

**$R_{WB}$**: Wiper Potentiometer Terminal (Buffered)

$R_{WB}$ is the buffered wiper terminal of the potentiometer. Its position on the resistor array is controlled by the control inputs, $\overline{INC}$, U/$\overline{D}$ and $\overline{CS}$.

**$R_L$**: Low End Potentiometer Terminal

$R_L$ is the low end terminal of the potentiometer. It is not required that this terminal be connected to a potential less than the $R_H$ terminal. Voltage applied to the $R_L$ terminal cannot exceed the supply voltage, $V_{CC}$ or go below ground, GND. $R_L$ and $R_H$ are electrically interchangeable.

**$\overline{CS}$**: Chip Select

The chip select input is used to activate the control input of the CAT5112 and is active low. When in a high state, activity on the $\overline{INC}$ and U/$\overline{D}$ inputs will not affect or change the position of the wiper.

## DEVICE OPERATION

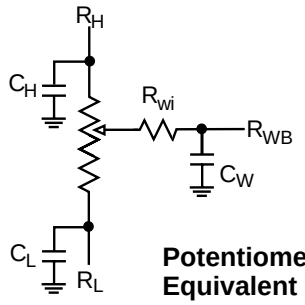
The CAT5112 operates like a digitally controlled potentiometer with $R_H$ and $R_L$ equivalent to the high and low terminals and $R_{WB}$ equivalent to the mechanical potentiometer's wiper. There are 32 available tap positions including the resistor end points, $R_H$ and $R_L$. There are 31 resistor elements connected in series between the $R_H$ and $R_L$ terminals. The wiper terminal is connected to one of the 32 taps and controlled by three inputs, $\overline{INC}$, U/$\overline{D}$ and $\overline{CS}$. These inputs control a five-bit up/down counter whose output is decoded to select the wiper position. The selected wiper position can be stored in nonvolatile memory using the $\overline{INC}$ and $\overline{CS}$ inputs.

With $\overline{CS}$ set LOW the CAT5112 is selected and will respond to the U/$\overline{D}$ and $\overline{INC}$ inputs. HIGH to LOW transitions on $\overline{INC}$ wil increment or decrement the wiper (depending on the state of the U/$\overline{D}$ input and five-bit counter). The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. The value of the counter is stored in nonvolatile memory whenever $\overline{CS}$ transitions HIGH while the $\overline{INC}$ input is also HIGH. When the CAT5112 is powered-down, the last stored wiper counter position is maintained in the nonvolatile memory. When power is restored, the contents of the memory are recalled and the counter is set to the value stored.

With $\overline{INC}$ set low, the CAT5112 may be de-selected and powered down without storing the current wiper position in nonvolatile memory. This allows the system to always power up to a preset value stored in nonvolatile memory.

## OPERATING MODES

| $\overline{INC}$ | $\overline{CS}$ | U/$\overline{D}$ | Operation |
|---|---|---|---|
| High to Low | Low | High | Wiper toward H |
| High to Low | Low | Low | Wiper toward L |
| High | Low to High | X | Store Wiper Position |
| Low | Low to High | X | No Store, Return to Standby |
| X | High | X | Standby |




**Potentiometer Equivalent Circuit**

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Supply Voltage | |
| $V_{CC}$ to GND | -0.5V to +7V |
| Inputs | |
| $\overline{CS}$ to GND | -0.5V to $V_{CC}$ +0.5V |
| $\overline{INC}$ to GND | -0.5V to $V_{CC}$ +0.5V |
| U/$\overline{D}$ to GND | -0.5V to $V_{CC}$ +0.5V |
| $R_H$ to GND | -0.5V to $V_{CC}$ +0.5V |
| $R_L$ to GND | -0.5V to $V_{CC}$ +0.5V |
| $R_{WB}$ to GND | -0.5V to $V_{CC}$ +0.5V |
| Operating Ambient Temperature | |
| Commercial ('C' or Blank suffix) | 0°C to +70°C |
| Industrial ('I' suffix) | -40°C to +85°C |
| Junction Temperature | +150°C |
| Storage Temperature | -65°C to +150°C |
| Lead Soldering (10 sec max) | +300°C |

* Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. Absolute Maximum Ratings are limited values applied individually while other parameters are within specified operating conditions, and functional operation at any of these conditions is NOT implied. Device performance and reliability may be impaired by exposure to absolute rating conditions for extended periods of time.

## RELIABILITY CHARACTERISTICS

| Symbol | Parameter | Test Method | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{ZAP}$(1) | ESD Susceptibility | MIL-STD-883, Test Method 3015 | 2000 | | | Volts |
| $I_{LTH}$(1)(2) | Latch-Up | JEDEC Standard 17 | 100 | | | mA |
| $T_{DR}$ | Data Retention | MIL-STD-883, Test Method 1008 | 100 | | | Years |
| $N_{END}$ | Endurance | MIL-STD-883, Test Method 1003 | 1,000,000 | | | Stores |

## DC Electrical Characteristics: $V_{CC}$ = +2.5V to +6.0V unless otherwise specified

### Power Supply

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Operating Voltage Range | | 2.5 | — | 6.0 | V |
| $I_{CC1}$ | Supply Current (Increment) | $V_{CC}$ = 6V, f = 1MHz, $I_W$=0 | — | — | 200 | µA |
| | | $V_{CC}$ = 6V, f = 250kHz, $I_W$=0 | — | — | 100 | |
| $I_{CC2}$ | Supply Current (Write) | Programming, $V_{CC}$ = 6V | — | — | 1 | mA |
| | | $V_{CC}$ = 3V | — | — | 500 | µA |
| $ISB_1$ (2) | Supply Current (Standby) | CS=$V_{CC}$-0.3V | — | 75 | 150 | µA |
| | | U/D, INC=$V_{CC}$-0.3V or GND | | | | |

### Logic Inputs

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $I_{IH}$ | Input Leakage Current | $V_{IN}$ = $V_{CC}$ | — | — | 10 | µA |
| $I_{IL}$ | Input Leakage Current | $V_{IN}$ = 0V | — | — | –10 | µA |
| $V_{IH1}$ | TTL High Level Input Voltage | 4.5V ≤ $V_{CC}$ ≤ 5.5V | 2 | — | $V_{CC}$ | V |
| $V_{IL1}$ | TTL Low Level Input Voltage | | 0 | — | 0.8 | V |
| $V_{IH2}$ | CMOS High Level Input Voltage | 2.5V ≤ $V_{CC}$ ≤ 6V | $V_{CC}$ x 0.7 | — | $V_{CC}$ + 0.3 | V |
| $V_{IL2}$ | CMOS Low Level Input Voltage | | -0.3 | — | $V_{CC}$ x 0.2 | V |

**NOTES:** (1) This parameter is tested initially and after a design or process change that affects the parameter.
(2) Latch-up protection is provided for stresses up to 100mA on address and data pins from –1V to $V_{CC}$ + 1V
(3) $I_W$=source or sink
(4) These parameters are periodically sampled and are not 100% tested.

**Potentiometer Parameters**

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $R_{POT}$ | Potentiometer Resistance | -10 Device | | 10 | | kΩ |
| | | -50 Device | | 50 | | |
| | | -00 Device | | 100 | | |
| | Pot Resistance Tolerance | | | | ±20 | % |
| $V_{RH}$ | Voltage on $R_H$ pin | | 0 | | $V_{CC}$ | V |
| $V_{RL}$ | Voltage on $R_L$ pin | | 0 | | $V_{CC}$ | V |
| | Resolution | | | 1 | | % |
| INL | Integral Linearity Error | $I_W \le 2\mu A$ | | 0.5 | 1 | LSB |
| DNL | Differential Linearity Error | $I_W \le 2\mu A$ | | 0.25 | 0.5 | LSB |
| $R_{OUT}$ | Buffer Output Resistance | $.05V_{CC} \le V_{WB} \le .95V_{CC}$, $V_{CC}$=5V | | | 1 | Ω |
| $I_{OUT}$ | Buffer Output Current | $.05V_{CC} \le V_{WB} \le .95V_{CC}$, $V_{CC}$=5V | | | 3 | mA |
| $TC_{RPOT}$ | TC of Pot Resistance | | | 300 | | ppm/°C |
| $TC_{RATIO}$ | Ratiometric TC | | | TBD | | ppm/°C |
| $R_{ISO}$ | Isolation Resistance | | | TBD | | Ω |
| $C_{RH}/C_{RL}/C_{RW}$ | Potentiometer Capacitances | | | 8/8/25 | | pF |
| fc | Frequency Response | Passive Attenuator, 10kΩ | | 1.7 | | MHz |
| $V_{WB(SWING)}$ | Output Voltage Range | $I_{OUT} \le 100\mu A$, $V_{CC}$=5V | $0.01V_{CC}$ | | $.99V_{CC}$ | |

### AC CONDITIONS OF TEST

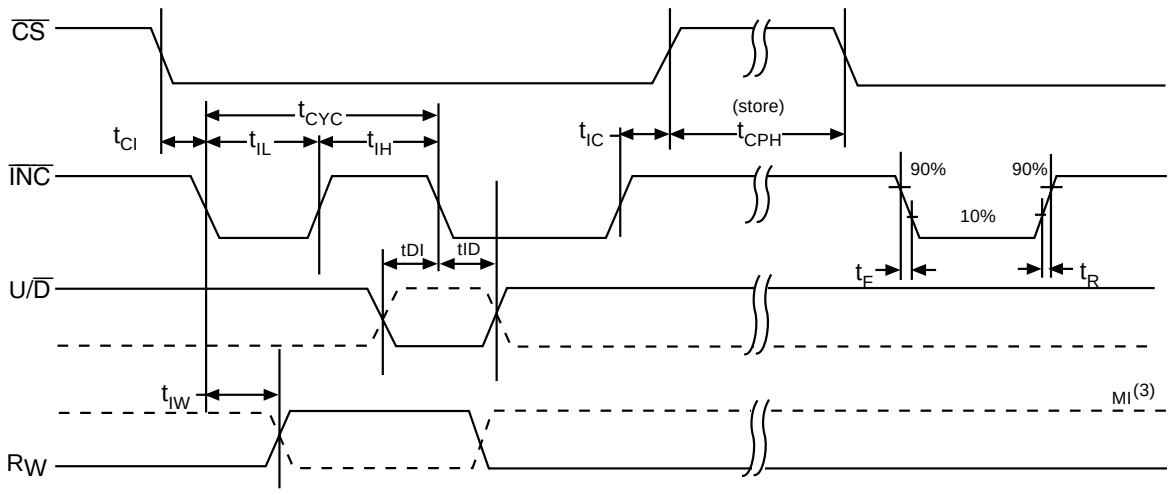
| | |
|---|---|
| $V_{CC}$ Range | $2.5V \le V_{CC} \le 6V$ |
| Input Pulse Levels | $0.2V_{CC}$ to $0.7V_{CC}$ |
| Input Rise and Fall Times | 10ns |
| Input Reference Levels | $0.5V_{CC}$ |

### AC OPERATING CHARACTERISTICS:

$V_{CC}$ = +2.5V to +6.0V, $V_H = V_{CC}$, $V_L$ = 0V, unless otherwise specified

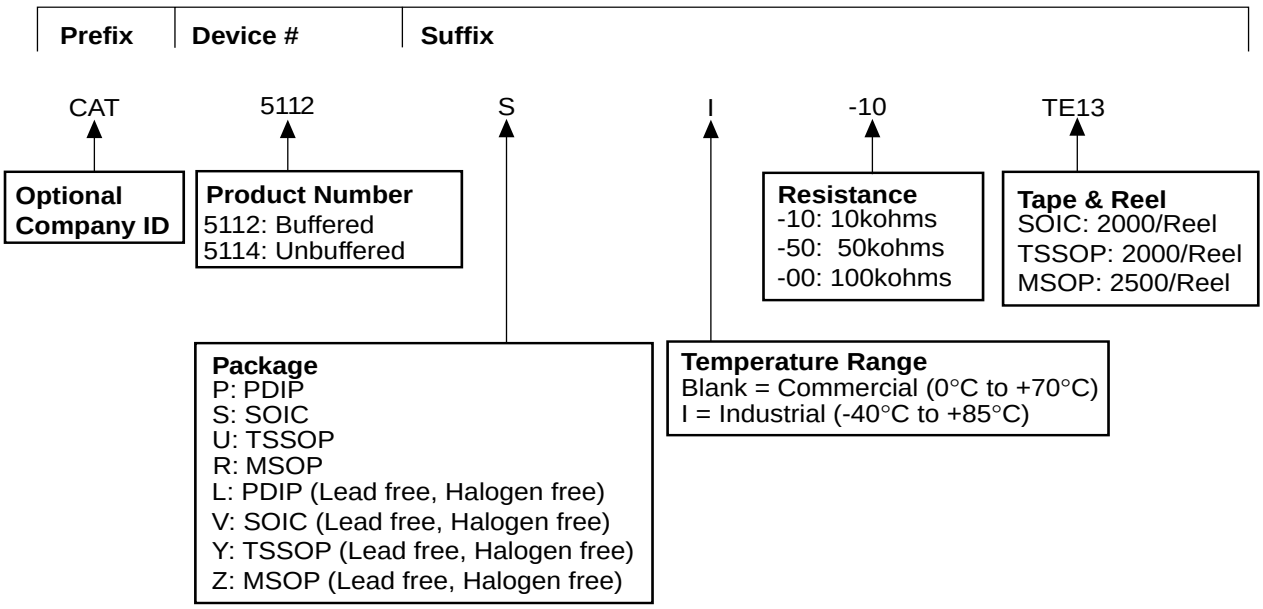
| Symbol | Parameter | Min | Typ(1) | Max | Units |
|---|---|---|---|---|---|
| $t_{CI}$ | $\overline{CS}$ to INC Setup | 100 | — | — | ns |
| $t_{DI}$ | U/$\overline{D}$ to $\overline{INC}$ Setup | 50 | — | — | ns |
| $t_{ID}$ | U/$\overline{D}$ to $\overline{INC}$ Hold | 100 | — | — | ns |
| $t_{IL}$ | $\overline{INC}$ LOW Period | 250 | — | — | ns |
| $t_{IH}$ | $\overline{INC}$ HIGH Period | 250 | — | — | ns |
| $t_{IC}$ | $\overline{INC}$ Inactive to $\overline{CS}$ Inactive | 1 | — | — | µs |
| $t_{CPH}$ | $\overline{CS}$ Deselect Time (NO STORE) | 100 | — | — | ns |
| $t_{CPH}$ | $\overline{CS}$ Deselect Time (STORE) | 10 | — | — | ms |
| $t_{IW}$ | $\overline{INC}$ to $V_{OUT}$ Change | — | 1 | 5 | µs |
| $t_{CYC}$ | $\overline{INC}$ Cycle Time | 1 | — | — | µs |
| $t_R$, $t_F$(2) | $\overline{INC}$ Input Rise and Fall Time | — | — | 500 | µs |
| $t_{PU}$(2) | Power-up to Wiper Stable | — | — | 1 | msec |
| $t_{WR}$ | Store Cycle | — | 5 | 10 | ms |

## A. C. TIMING




(1) Typical values are for $T_A$=25˚C and nominal supply voltage.
(2) This parameter is periodically sampled and not 100% tested.
(3) MI in the A.C. Timing diagram refers to the minimum incremental change in the W output due to a change in the wiper position.

## ORDERING INFORMATION



## REVISION HISTORY

| Date | Rev. | Reason |
|---|---|---|
| 3/10/2004 | J | Updated Potentiometer Parameters |
| 3/29/2004 | K | Changed Green Package marking for SOIC from W to V |
| 4/12/2004 | L | Updated Reel Ordering Information |

Notes:
(1) The device used in the above example is a CAT5112 SI-10TE13 (SOIC, 10K Ohms, Industrial Temperature, Tape & Reel)

***Copyrights, Trademarks and Patents***
Trademarks and registered trademarks of Catalyst Semiconductor include each of the following:

DPP ™ AE² ™

Catalyst Semiconductor has been issued U.S. and foreign patents and has patent applications pending that protect its products. For a complete list of patents issued to Catalyst Semiconductor contact the Company's corporate office at 408.542.1000.

*CATALYST SEMICONDUCTOR MAKES NO WARRANTY, REPRESENTATION OR GUARANTEE, EXPRESS OR IMPLIED, REGARDING THE SUITABILITY OF ITS PRODUCTS FOR ANY PARTICULAR PURPOSE, NOR THAT THE USE OF ITS PRODUCTS WILL NOT INFRINGE ITS INTELLECTUAL PROPERTY RIGHTS OR THE RIGHTS OF THIRD PARTIES WITH RESPECT TO ANY PARTICULAR USE OR APPLICATION AND SPECIFICALLY DISCLAIMS ANY AND ALL LIABILITY ARISING OUT OF ANY SUCH USE OR APPLICATION, INCLUDING BUT NOT LIMITED TO, CONSEQUENTIAL OR INCIDENTAL DAMAGES.*

Catalyst Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Catalyst Semiconductor product could create a situation where personal injury or death may occur.

Catalyst Semiconductor reserves the right to make changes to or discontinue any product or service described herein without notice. Products with data sheets labeled "Advance Information" or "Preliminary" and other products described herein may not be in production or offered for sale.

Catalyst Semiconductor advises customers to obtain the current version of the relevant product information before placing orders. Circuit diagrams illustrate typical semiconductor applications and may not be complete.

Catalyst Semiconductor, Inc.
Corporate Headquarters
1250 Borregas Avenue
Sunnyvale, CA 94089
Phone: 408.542.1000
Fax: 408.542.1200
www.catsemi.com

Publication #: 2002
Revison: L
Issue date: 4/12/04
Type: Final

Стандарт Электрон Связь

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

**Наши контакты:**

**Телефон:** +7 812 627 14 35

**Электронная почта:** sales@st-electron.ru

**Адрес:** 198099, Санкт-Петербург, Промышленная ул, дом № 19, литера Н, помещение 100-Н Офис 331