# R300 SMT True Random Number Generator Module R300

## GENERAL DESCRIPTION

The R300 True Random Number Generator is a low power – high reliability source of random numbers. The R300 is made for SMT mounting. The R300 is driven by a 3.0V-5.0V supply. Six standard pads are provided for power and communication on the module. In addition the device has four test pads that enable easy evaluation and hardware testing. The random numbers are transferred from the module by the digital serial SPI-slave interface. The physically generated random numbers is thoroughly processed and tested for anomalies and bias, before they are transferred to the digital output part of the module.

## FEATURES

- 3.0V to 5.0V Power supply
- SMT machine mountable
- Output random numbers pass any statistical test
- SPI Slave unit for easy integration
- On line testing of random numbers
- Error Detect pad
- 50 kbit output rate
- Special test pads enable in circuit validation
- Fail-safe internal reset circuit guarantee sustained operation
- Metal EMI/RFI shielding
- 26.5mm x 14.5mm x 3.0mm size

## APPLICATIONS

*Crypto applications:* PKI accelerators, Key distribution, Session key, and initialisation vector generation.

*Gaming applications:* Gaming machines, Lottery machines, Lotto number generators.

*Security:* Link encryption modules, Encrypted Radio, Virtual Private Network, Telecom applications.

## ABSOLUTE MAXIMUM RATINGS

| | MINIMUM | MAXIMUM | UNIT |
|---|---|---|---|
| ESD Tolerance (HBM) | 1.5 | | kV |
| Ambient Temperature with power applied | -40 | 95 | °C |
| Storage temperature | -65 | 100 | °C |
| Supply voltage on Vcc relative to GND | -0.4 | +5.6 | V |
| DC input voltage (input pad) | -0.4 | Vcc +0.4 | V |
| Maximum current on Vcc pad | -1 | 30 | mA |
| Maximum current on any (other) pad | -10 | 10 | mA |
| Convection Reflow Soldering (20 sec) | | 235 | °C |


## PINOUT AND CONNECTION DIAGRAM

SMT PADS

| PAD NO | NAME | CONNECTION | FUNCTION |
|---|---|---|---|
| 1 | GND | IN | Ground connection |
| 2 | CLK | IN | Input serial clock |
| 3 | DO | OUT | Data Out |
| 4 | ERR | IN/OUT | Device Error Signal |
| 5 | CMD | IN/OUT | Device Command |
| 6 | Vcc | IN | Power Supply |

TEST PADS

| NAME | DIR | FUNCTION |
|---|---|---|
| PRG_DATA | IN/OUT | Reserved for special purpose |
| RESET | IN/OUT | Reset detect or control pad |
| HEARTBEAT | OUT | Heartbeat signal from digital block |
| ANALOG | OUT | Analog noise signal |
| DIGITEST | OUT | Raw digital stream after sampling |
| PRG_CLK | Reserved | Reserved |

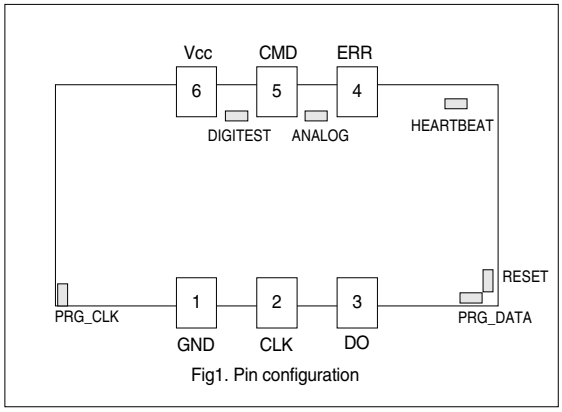


Fig1. Pin configuration

## POWER SUPPLY

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Minimum supply voltage | | 2.50 | | V | 20 degrees °C |
| Supply Current | | | 30 | mA | |
| | | | | | |
| Supply Voltage 3.3 Volts | 3.0 | 3.3 | | V | |
| Supply Current 2.5 Volts | | 8.8 | | mA | Operating at 20 degrees °C |
| Supply Current 3.0 Volts | | 11.5 | | mA | |
| Supply Current 3.3 Volts | | 12.7 | | mA | |
| Supply Current 3.5 Volts | | 13.3 | | mA | |
| Supply Current 3.3 Volts | | 2.1 | | mA | Device held in reset |
| Supply Current 3.3 Volts | | 1.5 | | mA | Device in low power mode |
| | | | | | |
| Supply Voltage 5.0 Volts | | 5.0 | 5.5 | V | |
| Supply Current 4.5 Volts | | 15.3 | | mA | |
| Supply Current 5.0 Volts | | 16.5 | | mA | |
| Supply Current 5.5 Volts | | 18.1 | | mA | |
| Supply Current 5.0 Volts | | 3.8 | | mA | Device held in reset |
| Supply Current 5.0 Volts | | 1.7 | | mA | Device in low power mode |
| | | | | | |
| Ambient Temperature | -40 | | +70 | °C | 3.3 V supply |
| Ambient Temperature | -40 | | +85 | °C | 5.0 V supply |

Supply current will increase if a communication pad draw or sink current into the device. Due to a silicon problem, the R300A may occasionally reset if the $V_{CC}$ is in the 3.9V-4.3V range. The problem has been fixed and the note applies to evaluation modules only. At high ambient temperature and low supply voltage the unit will report an error if the analog noise source fail.

AC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Supply maximum drive impedance | | 2 | 50 | Ω | |
| Ripple from R300 on $V_{CC}$ pad | | 1.6 | | mA | Amplitude (0Hz-500MHz) Communication pads open |

R300 $V_{CC}$ min harmonic ripple rejection for $V_{CC}$ =3.3V:

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Supply voltage ripple rejection | 300 | | | mV | Narrow band harmonic disturbance 0Hz-200Hz. |
| Supply voltage ripple rejection | 100 | | | mV | Narrow band harmonic disturbance 200Hz-1.0MHz. |

The R300 have a 100nF capacitor on the $V_{CC}$ internally. This will be sufficient $V_{CC}$ decoupling for most application areas.

## COMMUNICATION SPI-S PADS

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Digital input low voltage | -0.4 | 0.0 | 0.8 | V | |
| Digital input high voltage | 2.2 | $V_{CC}$ | $V_{CC}$+0.4V | V | |
| Digital output low voltage | | | 0.5 | V | Sink 10 mA |
| Digital output high voltage | $V_{CC}$-1.1 | | | V | Source 10 mA |
| Digital output low sink current | | | 10 | mA | May sink 25 mA at 0.75V if modest operating temperature |
| Digital output high source | | | 10 | mA | May source 10 mA max |

A digital zero is encoded as a low voltage and a digital one as a high voltage. The input DC specification is 5.0V TTL compatible and 3.3V + 5.0V CMOS compatible. At $V_{CC}$=3.3V the inputs are **not** 5.0V tolerant. Digital output buffer type is CMOS output driver with high/low drive. The digital output pads are "DO" and "DIGITEST". A typical digital input pad is the "CLK" clock input pad.

AC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Digital input hysteresis voltage | | 60 | | mV | |
| Digital CLK input low time | 50 | | Infinite | ns | |
| Digital CLK input high time | 50 | | Infinite | ns | |
| Random number generation | 20 | 50 | 60 | kbits/s | Continuous output supported |
| Output from internal buffer | | 450 | | kbits/s | 240 bits may be read at high speed |
| Output SPI-S data rate | 0 | | 10000 | kbits/s | 8 bits or less may be read at high speed |
| R300 start up time | 1.5 | 2 | 5 | s | Power on->running unit |

The SPI-S support a high data rate of 10Mbits/s. The R300 cannot produce random number of this speed or update status bits as CMD and ERR pads. An application may, however, safely run the SPI-S at 10Mbits/s for one byte (8 bits), and then allow sufficient time for the R300 to reload the SPI-S with a new byte of random numbers and to update CMD and ERR pads. If the application overrun the R300 the SPI-S will be filled with zeroes and the ERR pad will go low. A synchronisation problem may exist if the R300 and the application do not agree on which clock flank represent the first bit of a byte, producing a one-time error.

The R300 have a 29 bytes internal buffer that can serve the application at 450 kbits/s. If the 8-bit byte rate remain below this rate individual bytes may still be transferred at 10Mb/s. If the buffer go empty the R300 will signal an error by driving the ERR pad low.

The DO pad is updated (changed) on the rising flank of the clock (CLK pad). The CLK idle state is low. Data is sent MSB bit first and LSB bit last. The normal output is a byte in range 0 to 255 (decimal) 0x00 to 0xFF (hex) with flat distribution; with all 256 values equally probable.

If the R300 runs with a slow clock care should be taken so that not a series of high-frequency glitches overrun the SPI-S so that a zero bit is read. An NP0 capacitor may be mounted between CLK and GND close to the R300, to reduce the AC ripple voltage on the CLK pad. The SPI-S may clock on a pulse as short as 20 ns.

In case of an error (ERR pad driven low) the SPI-S will output zeroes (low voltage) on the DO pad. Depending on the application it may be wise to check that the random output contain both ones and zeroes. As an example: If the application need a 64 bit random number the value of all zeroes 00....000....000 may be rejected in the application as an R300 error. The application may, for test purposes, obtain extra bits of randomness, and check for the all zeroes error, in case the requested block is short.

## COMMUNICATION CONTROL AND ERROR PADS: "CMD" "ERR"

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Input low voltage | -0.4 | 0.0 | 0.8 | V | |
| Input high voltage | 2.2 | Vcc | Vcc+0.4V | V | |
| Output low voltage | | | 0.5 | V | Sink 10 mA |
| Output high impedance | 4 | 5.6 | 8 | kΩ | Drive resistance connected to Vcc |
| Output low sink current | | | 10 | mA | May sink 25 mA at 0.75V if modest operating temperature |
| Output high source | Vcc/8 | Vcc/5.6 | Vcc/4 | mA | Output signal grounded to 0V |
| Output high source | 0.12 | 0.17 | | mA | Output signal at Vcc-1.0V |
| ERR (when pull-down output) sink | 0.06 | 0.08 | | mA | Output signal at 0.5V |

The CMD and ERR pads are configured with a strong drive-low and a pull-up 5.6k resistor. This enables bi-directional communication on the pads. The normal voltage for CMD and ERR is high. If ERR is low the output (DO pad) may be faulty or have been so for a short while. When the ERR pad is detected low the application shall stop the CLK clock.

During some error conditions the ERR pad will be a pull-down pad (with 5.6 (Typ) kΩ resistance). Therefore should the application connect to the ERR pad using a sufficiently high impedance so that ERR == low is detected at all times. An example of a condition when ERR pad is a pull-down pad is when the R300 is in reset or when Vcc is below the operating range.

## R300 LOW POWER MODE

Holding ERR low will put the R300 in a low-power mode. Access to the low power mode is available for R300 operating modes where the ERR pad is high. Should the ERR pad be low due to an error or a command, an external "low" on the ERR pad cannot be detected. The low power mode can also be entered by a command.

When in low-power mode the pull-up resistor of ERR will be turned off. Some other pads will also be set to high impedance. The application is responsible for keeping the ERR pad low, and not to confuse the low power mode with an operating device.

The application must lift the ERR pad to high to resume normal operation. The R300 should be expected to immediately drive the ERR pad low upon restart. It is recommended to install a current limiting resistor between the application and the R300 should the application lack resistor pull-up capability. Floating the ERR pad will normally not be sufficient to exit the low power mode.

The CMD pad will be high when in the low power mode. If the low power mode was entered by a command, driving the CMD pad low will exit the low power mode. This can normally be accomplished by sending a few bytes to the CMD pad.

When the R300 exit the low power mode, it will perform a hardware reset, and then restart.

## R300 COMMAND PAD: CMD

The CMD pad allows communication with the R300 using UART-style serial communication. The CMD pad communicates with 9.600 bit/s. The CMD pad may be of value during evaluation, testing, and debugging of the application.

- Hardware and software version and revision codes
- Clear text error messages, identifying the source of the error
- Access to the raw random number stream for test purposes
- Periodic status messages
- Easy software access to low power mode and hardware boot/reset
- Alternative random number output
- Interface for future upgrades of device
- Customer and application specific operating modes

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| CMD pad bit rate | 9100 | 9600 | 10100 | bit/s | Temperature dependent |

| STATE | R300A Voltage | PC computer serial port voltage |
|---|---|---|
| CMD Idle | High: Vcc voltage | Low: -10 volts |
| CMD start bit | Low: 0 volts | High: +10 volts |
| CMD data "0" | Low: 0 volts | High: +10 volts |
| CMD data "1" | High: Vcc voltage | Low: -10 volts |

The table above give the UART serial port voltages. A start bit is followed by 8 data bits and one stop bit. The LSB bit of the byte is transmitted first. The stop bit is "CMD idle". Note that the voltages correspond to an inverted PC computer serial port.

The CMD pad is generally used for entering commands to the R300 unit. As the CMD pad is double directional, the application may have to monitor the CMD pad to find an empty slot to enter the command.

The bit rate of the CMD pad depends on the temperature. To guarantee successful communication with the R300 the application may have to adapt to the R300 bit rate. Otherwise may the R300 misread the command bytes.

The format of the commands is one digit (0-9) followed by optional uppercase letter (A-Z). "0" commands are for power and boot control, "1" commands are test commands, "3" commands are variants of normal operation.

| COMMAND CODE | ERR PAD | FUNCTION |
|---|---|---|
| 0 | Go low | The R300 will enter a null command mode. |
| 0L | High-Z | The R300 will enter the low power mode. Transmit a few 0x00 bytes to exit. |
| 0X | | The R300 will perform a soft reset, and then load the 3R command. |
| 0B | | The R300 will perform a hardware reset, and then load the 3R command. |
| 1T | Go low | The R300 will transmit a 192 bytes sample of raw input noise and then go idle (RAW<>). The output format is binary data 0x00-0xFF. |
| 1X | Go low | The R300 will transmit a 192 bytes sample of raw input noise and then go idle (RAWX<>). The output format is hex data "00"-"FF". |
| 3R | Low->High | The default R300 command loaded after reset. |
| 3T | Low->High | The 3R command with additional binary CMD pad output of R300 random numbers (RN<>). The output format is binary data 0x00-0xFF. |
| 3X | Low->High | The 3R command with additional binary CMD pad output of R300 random numbers (RNX<>). The output format is hex data "00"-"FF". |

In response to issued commands, results of internal tests, and error conditions the R300 output messages on the CMD pad:

| STRING | INTERPRETATION | NOTES |
|---|---|---|
| CR-LF"R300A-0321"CR-LF | The R300 was booted. 3R command follow. | The "A" in "R300A" is the hardware revision code. The "03" is the year and the "21" the week software revision. Revision codes intended for device errata. |
| "CMD_z."CR-LF<br>"CMD_zz."CR-LF | CMD pad command received. | The code "z" ("zz") represent an one- or two bytes command code received by the R300. For the 0X, 0B commands will the reset/reboot be delayed until this string is printed. |
| "STAT_ERROR_xxxx"CR-LF | The R300 detect a statistical error. ERR->low | A statistical error was detected. The "xxxx" code correspond to a too low test value, printed as four hex characters (0-F). |
| "STAT_OK_xxxx"CR-LF | ERR->High | The previous error condition (statistical error) is lifted. The "xxxx" code correspond to a test value, printed as four hex characters (0-F). |
| "OKxxxx"CR-LF | Statistical test performed, result is OK. | The "xxxx" code correspond to a test value, printed as four hex characters (0-F). This message is to be expected regularly during normal operation (3R, 3T, 3X commands). |
| "OVERRUN"CR-LF | SPI-S overrun. ERR->low | The 8 bit SPI-S of the R300 was overrun. At least one zero bit was output, that is not a random bit. |
| "BUFFER_EMPTY"CR-LF | Buffer empty. ERR->low | The R300 buffer was empty. The CLK data rate was to high for too long time, causing the buffer to go low. |
| "LOWPOWER MODE"CR-LF | R300 in low power mode | The R300 go to low power mode in response to the "0L" command, or the application is driving the ERR pad low during operation (3R, 3T, 3X commands). |
| "RAW<data>"CR-LF | Test data output, binary | The R300 output 192 bytes of raw noise bytes (unprocessed data). "data" is 192 bytes. |
| "RAWX<data>"CR-LF | Test data output, hex | The R300 output 192 bytes of raw noise bytes (unprocessed data). "data" is 384 bytes of "0"-"9" "A"-"F" characters. |
| "RN<data>"CR-LF | Random number output, binary. | The R300 output a string of true random bytes. Transmission of "data" will go on until another message is due for printing. As the "data" is binary the application may check for the ">" end mark only by parsing the output. |
| "RNX<data>"CR-LF | Random number output, hex. | The R300 output a string of true random bytes. Transmission of "data" will go on until another message is due for printing. |

In the table the text CR-LF refer to ASCII carriage return and line feed characters (0x0D,0x0A), and the quotes are not printed. The "0" and the "1" commands normally set the ERR pad low, to signal to the application that the R300 is performing a test command. 3R, 3T, 3X commands start up with the statistical error set (and ERR pad low). This is intentional, and not an R300 malfunction. When the statistical test go OK the message "STAT_OK_xxxx"CR-LF is printed, ERR pad go high, and the application may start using the R300.

The 3T, 3X commands will schedule a printing of random data, as long as no other printing is in progress. This will block the CMD port for input. To stop the 3T, 3X commands the CMD pad may be held low until the RN<data> or RNX<data> string terminates. The R300 will then detect that the CMD pad is low, and temporarily abort the output. The application may then send a new command.

The application shall turn off the CLK clock in response to an error. In some cases the CMD pad will output errors until the error condition is cleared.

## PRG_DATA TEST PAD

The PRG_DATA pad is reserved for future use, depending on the customers application. The pad is reserved for use by customers, not for use by Protego Information. The pad may be an input pad or an output pad or both.

## RESET TEST PAD

The RESET pad connects between the R300 fail-safe reset circuit and the internal reset pad. The reset is a hard reset, and will reset the R300 as a power cycling would have done.

The fail-safe device is an analog switch circuit that continuously send reset pulses to the R300 until the power is turned off or the R300 starts operating. The reset is an active high reset; during normal operation, the RESET pad is normally low.

The fail-safe reset circuit connects to the RESET pad by a 2k resistor. An external application (or operator) may reset the R300 at any time by pulling the RESET pad high to $V_{CC}$. An external application can also (for test purposes) hold the RESET low to GND. This will disable the fail-safe reset generator.

An external application may monitor the reset of the R300 by connecting to the RESET pad using a high-impedance connection (100kΩ (Min)) such as an oscilloscope probe.

When the R300 is in RESET all pads will be of "pull-down" type. In particular ERR will be low to indicate an error. Also note that if the R300 "locks" it may take 200 (Typ) ms before the ERR goes to pull-down due to a reset.

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Probe resistance | 100 | | | kΩ | To monitor the pad |
| Reset drive resistance | | | 0.1 | kΩ | To take over reset control of the device |
| Fail-safe circuit operating voltage | 0.8 | | 6.0 | V | |

AC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Reset pulse "high" from fail-safe circuit | | 200 | 350 | ms | |
| Reset pulse "low" timeout by fail-safe circuit | 100 | 200 | 400 | ms | When HEARTBEAT stops |
| External reset pulse to reset | 1 | | Infinite | µs | The outcome of a shorter pulse is undefined |
| Holding RESET low | | | Infinite | ms | Disabling the fail-safe circuit |

## HEARTBEAT TEST PAD

The heartbeat signal is generated by an operating R300 device to inhibit the fail-safe reset circuit. This signal is enabled only during special well-controlled operating conditions. Should an unknown operating state be encountered, either because of a hardware event such as a power glitch or a disturbance by an ionising ray, or due to a software event such as issuing an undocumented software command or similar, the heartbeat signal will stop and a hard reset will follow. The output is analog and intended for oscilloscope probes only.

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Connected external probe resistance | 500 | | | kΩ | |
| Connected external probe capacitance | | | 1000 | pF | |
| Pad "high" level | Vcc-0.3 | Vcc | | V | |
| Pad "low" level | | 0 | 0.3 | V | |

AC specification

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Pulse frequency during normal operation | 29 | 32 | 34 | Hz | Accuracy further reduced in low power mode |

## ANALOG TEST PAD

The analog test pad gives access to the internal analog noise source. The ANALOG testpad is buffered by a dedicated analog driver to prevent external signals disturbing the analog noise signal before sampling. The typical use of this pad is when investigating if an external electrical (or other) disturbance have influence on the analog noise source.

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| DC signal level | | Vcc/2 | | V | |
| DC analog->digital sample level | | Vcc/2 | | V | May depend on module revision code |
| Output driver resistance | | 0.001 | | kΩ | |
| High output voltage swing | Vcc/2+1.3 | | | V | 50Ω load to Vcc/2 (not recommended) |
| Low output voltage swing | | | Vcc/2-1.3 | V | 50Ω load to Vcc/2 (not recommended) |
| External connected probe resistance | 1.0 | 10 | | kΩ | To any DC voltage between GND and Vcc |

AC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Output signal amplitude | | 2.0 | | V | |
| Analog amplification from noise source | | 100 | | dB | Noise source->ANALOG pad |
| Acceptable AC disturbance | 200 | | | µs | Signal may be high/low occasionally during this time |
| Analog bandwidth noise signal | | 100 | | kHz | |
| Analog output buffer bandwith | | 2.8 | | MHz | |
| Non-random ripple signal | | 7.35 | | kHz | Ripple frequency (non-random signal) |
| Non-random ripple signal | | | 0.5 | V | Ripple amplitude (non-random signal) |

## DIGITEST TEST PAD

The digital test pad gives access to the analog noise signal after the signal has been sampled into digital form. This pad is of use when investigating the effect of external disturbances. The pad also enable access to the raw bit stream should this be needed or be of value for the application.

Internally is this bit stream read in 8 bit bytes. The bytes is then checked for non-random events which may render the bytes invalid or may trigger an error event (ERR==low). An accepted byte stream is encrypted using the patented hCIA method before the byte stream is made available to the application on the DO pad. One or several raw input bytes may be needed to produce a single output byte on the DO pad.

If the CLK pad is held idle, so no bytes are read from the DO pad, the input raw random number stream will continuously update the next available byte to be transmitted on the DO pad.

DC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Digital output low voltage | | | 0.5 | V | Sink 10 mA |
| Digital output high voltage | Vcc-1.1 | | | V | Source 10 mA |
| Digital output low sink current | | | 10 | mA | May sink 25 mA at 0.75V if modest operating temperature |
| Digital output high source | | | 10 | mA | May source 10 mA max |

AC SPECIFICATION

| PARAMETER | MIN | TYP | MAX | UNIT | NOTES/CONDITIONS |
|---|---|---|---|---|---|
| Output data rate | 50 | 80 | 100 | kbits/s | May depend on model and operating conditions |
| Sample->Output delay time | | 8 | | bits | Time=8*(sample bit time) |

## PRG_CLK TEST PAD

Reserved, Do not connect. A disturbance on this pad may influence the analog noise signal.

## APPLICATION INFORMATION

### INTERFACE

An application shall normally interface to the R300 module using the CLK, DO, and ERR pads. If the application cannot interface to the ERR pad it is possible to build an interface based upon the CLK and DO pads only. In that case may the application detect errors by running a test on the output random numbers. When the ERR pin is low the DO pad will output zeroes.

An application may also interface using the CMD pin. For some applications an interface using a single bidirectional pad may be preferable. For an application with an software interface this may be preferred despite interface problems such as fluctuations in the bit rate and that the R300 output must be parsed.

In case that the application don't use the CMD pin we recommend that some connection to the CMD pin is arranged for test, debugging, or repair purposes.

### DEBUGGING & TESTING

By sending commands to the R300, various error conditions can easily be simulated, that may not occur at all or with a very low frequency in an actual application. If the "0" command is given the R300 will set the ERR pad low, and hold it there, until the test operator give a new command. Sending a "0B" command, that hard-boot the R300, could be used as a simulation of an ESD or other environmental event.

### EVALUATION MODULE

An R300 evaluation module is available. The module give access to the six R300 pads using a contact or a cable. A simple RC-style oscillator is provided as CLK input. The ERR pad have an attached red LED for visual inspection. An opto-coupler, an amplifier, and a cable enable the evaluation module to be plugged into a PC using a standard 10V serial port. A supplied battery eliminator that lack a DC connection to the mains ground enable the use of the evaluation module as a communication amplifier between an application with a mounted R300 and a PC computer. Test software with source code is provided with the evaluation module.

### APPLICATION SPECIFFIC MODIFICATIONS

The command structure of the R300 is intended to provide a framework for application and customer specific additions and modifications. In case the intended application would benefit from some modification in the output, the module pinout, or in the output format, please contact Protego Information.

### R300 RANDOMNESS SOURCE

The R300 use Johnson noise as the physical noise source. The noise originates in a combination of resistor noise, in an external resistor, and in resistance in the input stage of the first amplifier. Johnson noise has a frequency distribution shaped according to the pass band of the amplifier; the noise is bandwidth-limited by the amplifier's bandwidth. Johnson noise is also well known to have very low amplitude. A very high gain, disturbance free, amplification is needed. The R300 use six stages of analog amplification.

### SOFTWARE ACCESS

To lower production costs a customer may contact Protego Information for obtaining information about a **licence agreement**. Under a license contract the customer may mount the components inside the R300 unit directly on the customer's PCB. Protego Information also have several other random number circuits, that may be cost effective in the customers application as a function of the intended production volume.

Complete software access to the R300 unit require a licence agreement or other agreement with Protego Information. Customers ordering 300+ units may request partial (algorithmic) software access in response to a signed NDA.

### HCIA PROCESSING

The processing of random numbers inside the R300 unit is performed using the HCIA method (patent and patent pending). The R300 use the same processing as the R200-USB units, sold by Protego Information. A detailed description of the HCIA method and technology, including a description on how the technology was adopted to the R200-USB units and source code, can be found on Protego Information's webbsite http://www.protego.se/pdf/hcia.pdf.

### SOFTWARE & DOCUMENTATION UPDATES

The R300 datasheet revision history:

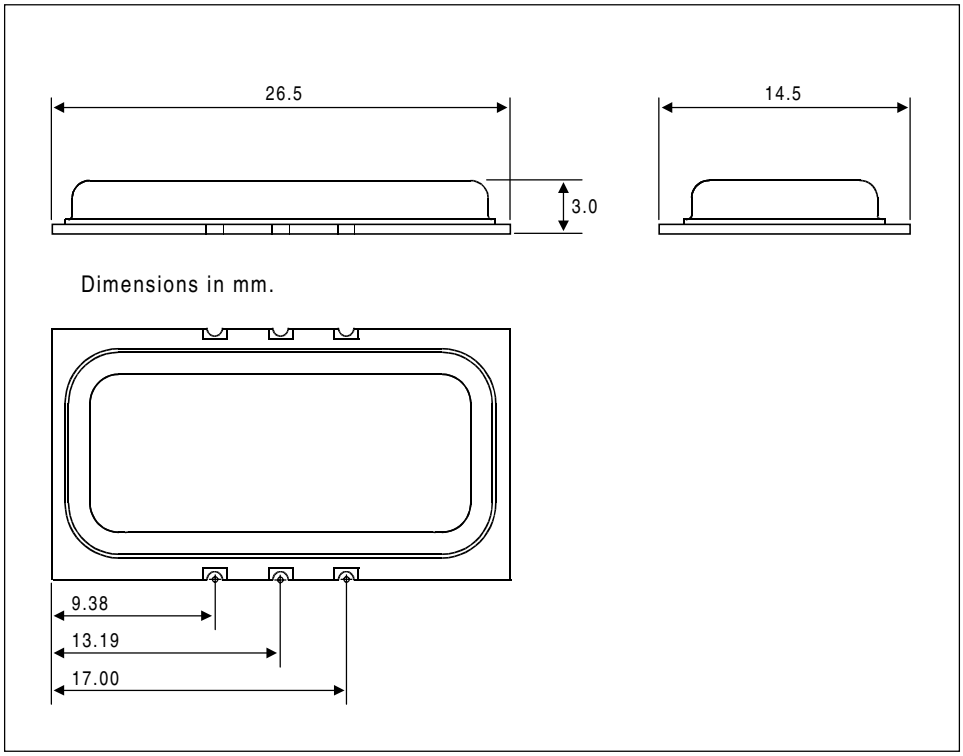
| VERSION | NOTES |
|---|---|
| February 2003 | First version |
| October 2003 | Included CMD pad format and timing. Included the CMD pad command list. |

The R300 hardware revision history:

| VERSION | NOTES |
|---|---|
| R300A | First version |

The R300 software revision history is included in the R300 evaluation module documentation.

## PACKAGE OUTLINES




## LANDING PATTERN LAYOUT

An example landing pattern in Gerber format is available on Protego Information's webbsite.

http://www.protego.se/doc/r300a_gerber.zip

## DEFINITIONS

OBJECTIVE PRODUCT SPECIFICATION

This datasheet target specifications for product development

PRELIMINARY PRODUCT SPECIFICATION

This datasheet contains preliminary data; supplementary data may be published from Protego Information later.

PRODUCT SPECIFICATION

This datasheet contains final product specifications. Protego Information reserves the right to make changes at any time without notice in order to improve design and supply the best possible result.

ABSOLUTE MAXIMUM RATINGS

Stress above one or more of the limiting values may cause permanent and terminal damage to the device. These are stress ratings only and operation of the device at these or other conditions above those given in the "Absolute Maximum Ratings" section of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

APPLICATION INFORMATION

When application information is given, it is advisory and does not form a part of the specification.

## LIFE SUPPORT POLICY

A hardware random number generator is normally used in demanding situations where the failure or the correct operation of the device may be of critical importance for the success or failure of the application. Nevertheless, we wish to be informed if the device is used in a life support application or generally in a critical application. This to be able to enforce that best practices are followed when the R300 is integrated into the application.

*Protego Information's products are not authorised for use as critical components in life support devices or systems without the express written approval of the president and general counsel of Protego Information corporation. As used herein:*

*1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labelling, can reasonably expected to result in a significant injury to the user.*

*2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.*

## PRICING AND AVAILABILITY

The R300A True Random Number Generator Module is available in sampling quantities. For information on product pricing and availability, call +46 (0) 46 286 36 34. For additional product information visit the Protego Information web site at http://www.protego.se or send email to sales@protego.se.

## PACKAGING AND ORDER INFORMATION

| ORDER CODE | PACKAGE SIZE | IN PRODUCTION | NOTES |
|---|---|---|---|
| R300A-EVM | 1 package | | One R300A unit included |
| R300A-B | 1 unit | | Bulk |
| R300A-S | 10 units | | Strip of 10 units on 44 mm tape with 9 empty header slots |
| R300A-Q | 100 units | | Reel of 100 units on 44 mm tape |
| R300A-W | 300 units | | Reel of 300 units on 44 mm tape |

http://www.protego.se
Protego Information AB
Ideon Gamma Science Park
SE - 223 70 Lund
SWEDEN
E-mail/sales: sales@protego.se