RV1S9356A

R08DS0316EJ0100
Rev. 1.00
Feb. 06, 2025

20MHz internal Clock High SNR ΔΣ modulator (Manchester code output)

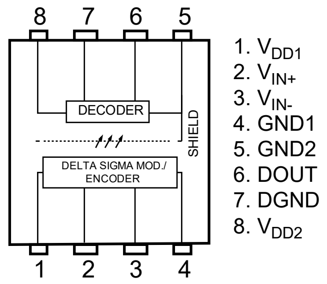
DESCRIPTION

The RV1S9356A is an optically isolated Delta − Sigma Modulator that includes high-Accuracy A/D converter with 20 MHz internal clock and converts an analog voltage input into one-bit data stream. The RV1S9356A provides an Effective Number of Bit (ENOB) is 14 bits (TYP.) with a Sinc^3 digital filter. The RV1S9356A is designed specifically for high common mode transient immunity (CMTI), high SNR and high linearity (Low nonlinearity). The RV1S9356A is suitable for the motor current sensing of the industrial instrument and enables high-precision measurement in the harsh noise environment.

FEATURES

- IEEE 802.3 compliant Manchester code output
- High SNR (88 dB TYP.)
- Gain Error (GE = ± 0.5 % @25 °C)
- Operating ambient temperature (T_A = −40 to 125 °C)
- Non-linearity (INL = ±15 LSB)
- Input offset voltage (V_{OS} = ±1 mV)
- Input offset voltage drift vs. temperature ($|dV_{OS}/dT_A|$ = 1.0 μV/°C MAX.)
- Manchester Code Clock Frequency (f_{MANCLK} = 20 MHz TYP.)
- High common mode transient immunity (CMTI = 50 kV/μs MIN.)
- Long creepage distance (8 mm MIN.)
- Embossed tape product: RV1S9356ACCSP-120x#KC0: 2 000 pcs/reel
- Pb-free product
- Safety standards
  - •UL approved: No. UL1577, Double protection
  - •VDE approved: DIN EN IEC 60747-5-5, DIN EN IEC 62368-1, Reinforced insulation (Option)

PIN CONNECTION
(Top View)



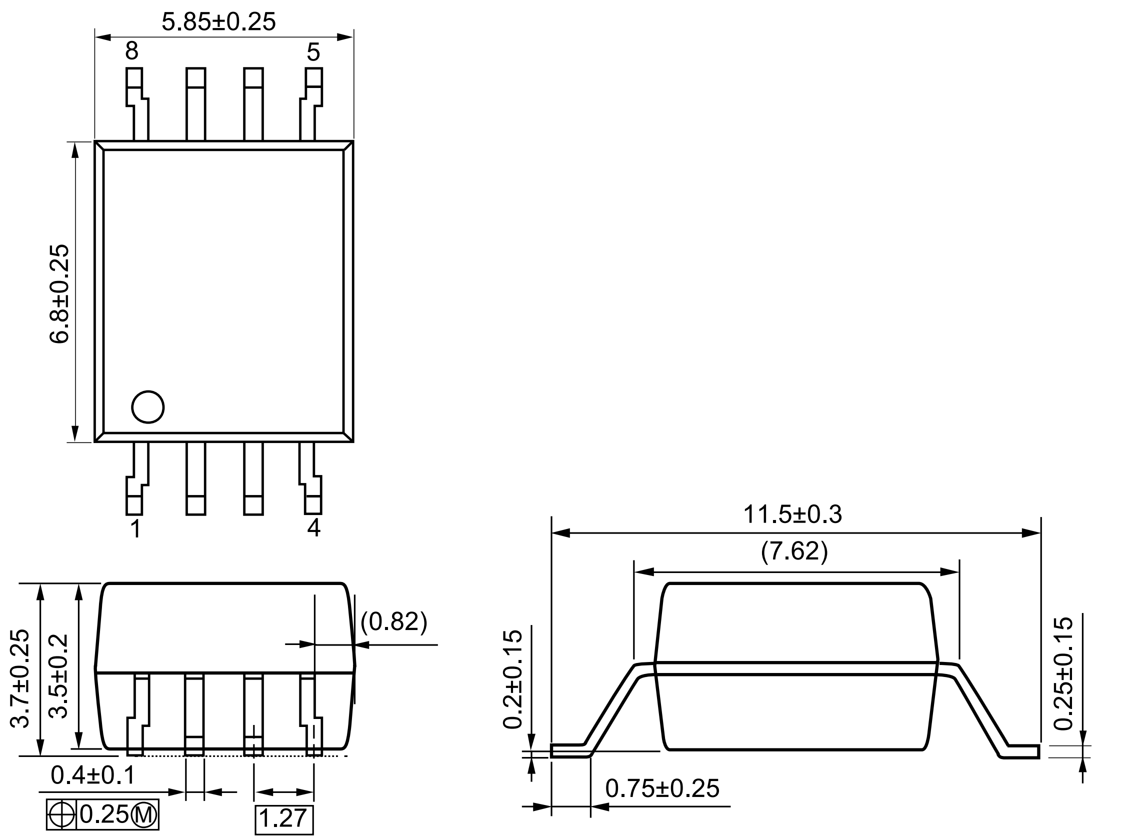
APPLICATIONS

- AC Servo, inverter
- Solar inverter
- Measurement equipment

Start of mass production
Dec. 2024

PACKAGE DIMENSIONS (UNIT: mm)

Lead Bending Type (Gull-wing) For Long Creepage Distance (Surface Mount)

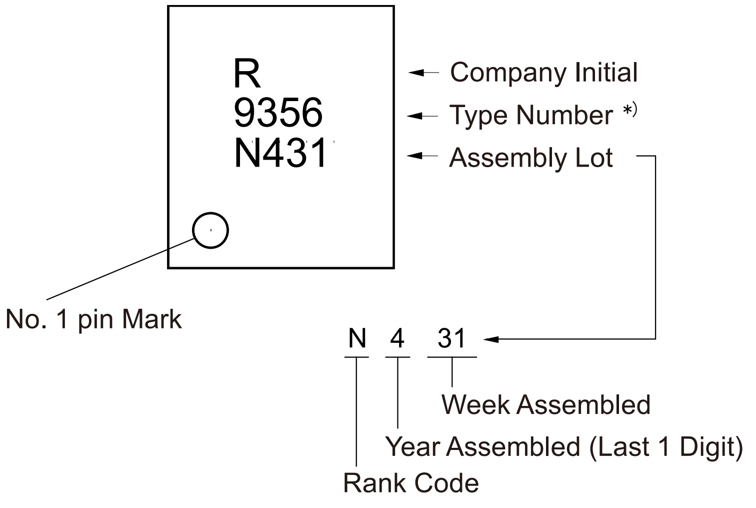


Weight : 0.316 g (TYP.)

PHOTOCOUPLER CONSTRUCTION

Parameter	MIN.
Air Distance	8 mm
Creepage Distance	8 mm
Isolation Distance	0.4 mm

MARKING EXAMPLE



*Applicable type numbers are listed below.

RV1S 9356 ACCSP-120x

Marking type number. “RV1S” and “ACCSP-120x” are omitted from original type number.

ORDERING INFORMATION

Part Number	Order Number	Solder Plating Specification	Packing Style	Safety Standard Approval	Application Part Number *1
RV1S9356ACCSP -120C	RV1S9356ACCSP -120C#SC0	Pb-Free (Ni/Pd/Au)	Embossed Tape 20 pcs	UL Approved	RV1S9356A
	RV1S9356ACCSP -120C#KC0		Embossed Tape 2 000 pcs/reel		
RV1S9356ACCSP -120V	RV1S9356ACCSP -120V#SC0		Embossed Tape 20 pcs	UL, VDE Approved	
	RV1S9356ACCSP -120V#KC0		Embossed Tape 2 000 pcs/reel		

Notes : *1. For the application of the safety standard, the following part number should be used.

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise specified)

Parameter	Symbol	Ratings	Unit
Operating Ambient Temperature	T_A	−40 to +125	°C
Storage Temperature	T_{stg}	−55 to +150	°C
Supply Voltage	V_{DD1}, V_{DD2}	−0.5 to +6.0	V
Input Voltage *1	V_{IN+}, V_{IN-}	−2 to V_{DD1} +0.5	V
Instantaneous Input Voltage *1, 2	V_{IN+}, V_{IN-}	−6 to V_{DD1} +0.5	V
Output Voltage *3	DOUT	−0.5 to V_{DD2} +0.5	V
Isolation Voltage *4	BV	5 000	Vr.m.s.

Notes : *1. The input voltage of V_{IN+} and V_{IN-} terminals is less than 6 V.

*2. Duration of time is within 2 seconds.

*3. The input voltage of DOUT terminals is less than 6 V.

*4. AC voltage for 1 minute at T_A = 25 °C, RH = 60 % between input and output.
Pins 1-4 shorted together, 5-8 shorted together.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Operating Ambient Temperature	T_A	−40		125	°C
Supply Voltage	V_{DD1}	4.5		5.5	V
Supply Voltage	V_{DD2}	3.0		5.5	V
Input Voltage (Accurate and Linear) *1	V_{IN+}, V_{IN-}	−250		250	mV

Notes : ***1**. Avoid using V_{IN-} of 2.5 V or more, because the internal test mode is activated when the voltage V_{IN-} reaches more than 2.5 V.

ELECTRICAL CHARACTERISTICS

(TYP.: T_A = 25 °C, V_{IN+} = −250 to +250 mV, V_{IN-} = 0 V, V_{DD1} = 5 V, V_{DD2} = 3.3 V,
MIN., MAX.: refer to RECOMMENDED OPERATING CONDITIONS, unless otherwise specified)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Primary-side Supply Current *1	I_{DD1}	V_{IN+} = −320 to +320 mV		12	15	mA
Secondary-side Supply Current *1	I_{DD2}	V_{DD2} = 3.0 to 3.6 V		6	8	mA
		V_{DD2} = 4.5 to 5.5 V		7.5	9	mA
Input Bias Current *1	I_{IN}	V_{IN+} = 0 V		−30		μA
Equivalent Input Resistance	R_{IN}	V_{IN+} = −250 to +250 mV		13		kΩ
Low Level Saturated Output Voltage	V_{OL}	I_{OUT} = +4 mA			0.5	V
High Level Saturated Output Voltage	V_{OH}	V_{DD2} = 3.3 V, I_{OUT} = −4 mA	V_{DD2} − 0.5	V_{DD2} − 0.1		V
		V_{DD2} = 5 V, I_{OUT} = −4 mA				
Manchester Code Clock Frequency	f_{MANCLK}		19	20	21	MHz
Isolation Capacitance	C_{I-O}	f = 1 MHz		0.7		pF
RisingTime	t_r	C_L = 15 pF		2		ns
FallingTime	t_f			2		ns
Start Up Time *2	t_{START}			1	10	μs
Common Mode Transient Immunity *3	CMTI	V_{CM} = 1.0 kV, T_A = 25 °C	50	100		kV/μs

Notes :

*1. The polarity of the current flowing from the external circuit to the RV1S9356A is positive.

*2. The start-up time is from the time V_{DD1} is applied with V_{DD2} applied to the output of normal signals (DOUT).

*3. Common-mode transient immunity CMTI measurements apply steep rise/fall time voltage steps between GND1 (4-pin) on the input side and GND2 (5-pin) on the output side. The determination is performed after 1 μsec after the voltage step is applied.

ELECTRICAL CHARACTERISTICS

(TYP.: T_A = 25 °C, V_{IN+} = −250 to +250 mV, V_{IN-} = 0 V, V_{DD1} = 5 V, V_{DD2} = 3.3 V,
MIN., MAX.: refer to RECOMMENDED OPERATING CONDITIONS, unless otherwise specified)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Integral Non-Linearity *4	INL+	T_A = −40 to 125 °C, V_{IN+} = −250 to +250 mV		3	15	LSB
	INL−		−15	−3		
Differential Non-Linearity *5	DNL	T_A = −40 to 125 °C, V_{IN+} = −250 to +250 mV	−0.9		0.9	LSB
Input Offset Voltage *6	V_{OS}	T_A = −40 to 125 °C, V_{IN+} = V_{IN-} = 0 V	−1	0	1	mV
Input Offset Voltage Drift vs. Temperature	$\lvert dV_{OS}/dT_A \rvert$	V_{DD1} = 5V		0	1	µV/°C
Input Offset Voltage Drift vs. Supply Voltage	$\lvert dV_{OS}/dV_{DD1} \rvert$			40		µV/V
Gain Error *7	GE	T_A = 25 °C, V_{IN+} = −250 to +250 mV, V_{IN-} = 0 V	−0.5		0.5	%
		T_A = −40 to 125 °C, V_{IN+} = −250 to +250 mV, V_{IN-} = 0 V	−1.0		1.0	
Gain Error Drift vs. Temperature *8	$\lvert dGE/dT_A \rvert$			20	40	ppm/°C
Gain Error Drift vs. Supply Voltage *9	$\lvert dGE/dV_{DD1} \rvert$			410		ppm/V
Common-Mode Rejection Ratio *10	$CMRR_{IN}$	V_{IN} = ±250 mV, Diff-G/Com-G		90		dB

*4. INL (Integral Non-Linearity) is the maximum deviation on the positive side (INL+) and the maximum deviation on the negative side (INL−) of the actual conversion value relative to the best-fit straight line obtained by the least squares method from the actual conversion value output for the differential input voltage ($V_{IN+} - V_{IN-}$: V_{IN+} = −250 mV to 250 mV, V_{IN-} = 0 V) in LSB. Since 16 bits (2^{16} = 65536) are assigned to the full scale of 640 mV (−320 to 320 mV), the minimum resolution of 1 LSB (Least Significant Bit) is 9.76 µV in voltage.

*5. DNL (Differential Non-Linearity) is the difference between a measured code width and ideal 1 LSB in the ADC transfer curve.

*6. Vos means the difference between the ideal mid-scale code (32,768 at the 16-bit level) when the input voltage is 0 V (V_{IN+} = V_{IN-} = 0 V). This LSB difference is converted to a voltage and expressed.

*7. GE (Gain Error) is the deviation between the slope of the best-fit line of the measured digital code output within the input voltage range (V_{IN+} = −250 to +250 mV) and the slope of the ideal conversion line.

*8. | dGE/dT_A | is calculated as the maximum temperature range change {(Gain @125 °C − Gain @25 °C) / Gain @25 °C} / (125 °C − 25 °C) and the minimum temperature range change {(Gain @ −40 °C − Gain @25 °C) / Gain @ 25 °C} / {(−40 °C) −25 °C} based on 25 °C. The unit is ppm/°C. The maximum and minimum temperature changes are compared and the larger change is used as the maximum value. The GE change based on 25 °C will not exceed this maximum value as long as it is within the maximum and minimum temperature range.

*9. | dGE/dV_{DD1} | is calculated by the maximum voltage range change amount {(Gain @5.5 V − Gain @5.0 V) / Gain @5.0 V} / (5.5 V − 5.0 V) and the minimum voltage range change amount {(Gain @4.5 V − Gain @5.0 V) / Gain @5.0 V} / (4.5 V − 5.0 V) based on 5.0 V. The unit is ppm/V.

*10. $CMRR_{IN}$ (Common-Mode Rejection Ratio) is the Gain ratio between the differential input (V_{IN+} = −250 mV to 250 mV, V_{IN-} = 0 V) and the common-mode input (V_{IN}+ = V_{IN}- = −250 mV to 250 mV: both input pins connected).
Expressed in dB, it is defined by the following formula: $CMRR_{IN}$ [dB] = 20 log (Gdo/Gco)
Gdo = Differential Input Gain
Gco = Common-mode input gain

ELECTRICAL CHARACTERISTICS (Tested with $Sinc^3$ filter, 256 decimation ratio.)

(TYP.: T_A = 25 °C, V_{IN+} = −250 to +250 mV, V_{IN-} = 0 V, V_{DD1} = 5 V, V_{DD2} = 3.3 V,
MIN., MAX.: refer to RECOMMENDED OPERATING CONDITIONS, unless otherwise specified)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Signal-to-Noise Ratio	SNR	V_{IN+} = 35 Hz, 500 mVpp sine wave	83	88		dB
Signal-to-(Noise + Distortion) Ratio	SNDR		78	84		dB
Effective Number of Bit	ENOB		13.5	14.0		bits
Total Harmonics Distortion	THD			−92		dB

AD CONVERSION TABLE

Analog Input	Input Voltage mV	ADC Code 16-bit Unsigned Decimation
+Full scale	+320	65,535
+ side Recommended input signal	+250	58,367
Input 0	0	32,768
− side Recommended input signal	−250	7,167
− Full scale	−320	0

TEST CIRCUIT

Fig.1 IDD1 Test Circuit

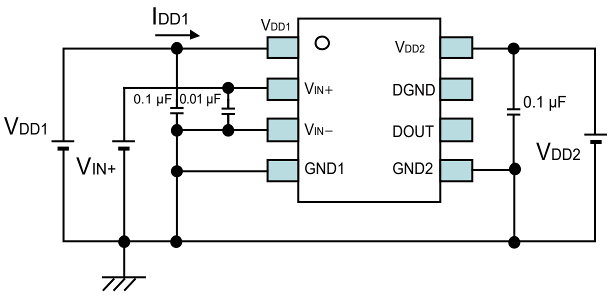


Fig.2 IDD2 Test Circuit

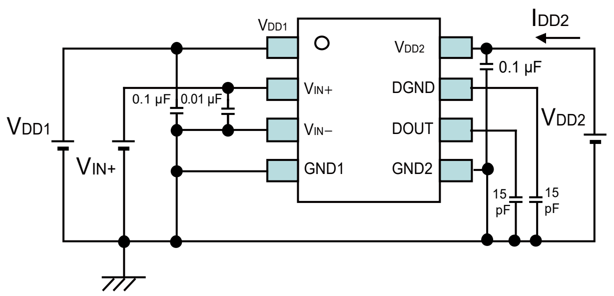


Fig.3 IIN Test Circuit

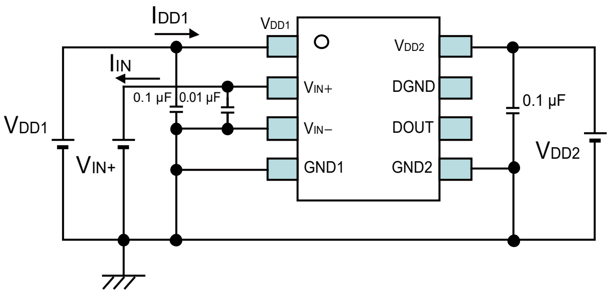
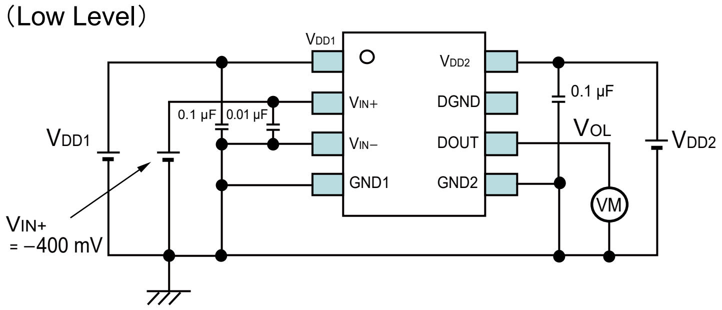


Fig.4 VOUT Test Circuit

(Low Level)



(High Level)

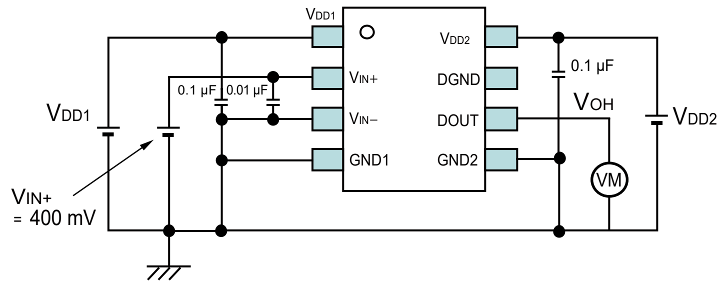


Fig.5 RisingTime,FallingTime Test Circuit

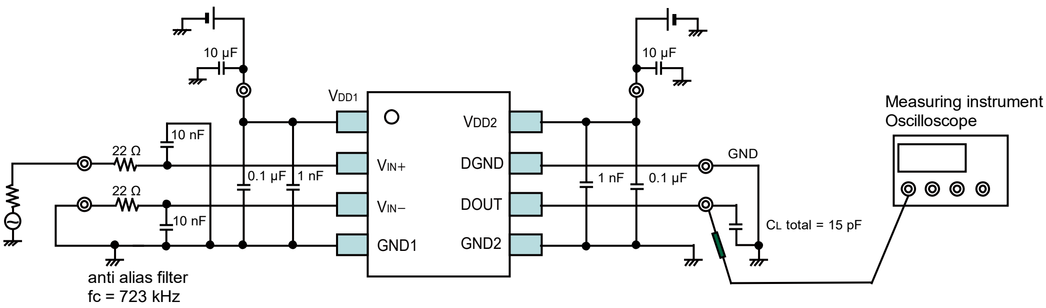


Fig.6 CMTI Test Circuit

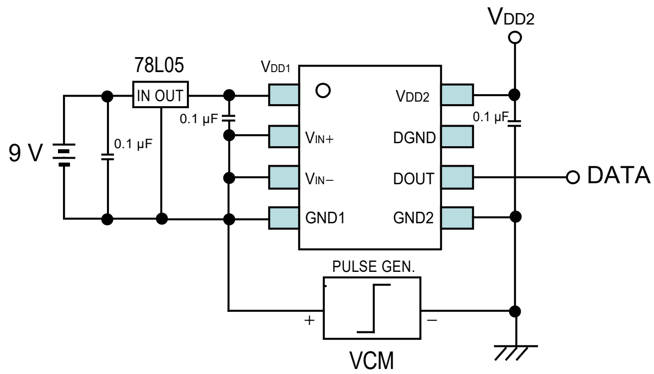


Fig.7 Vos Test Circuit

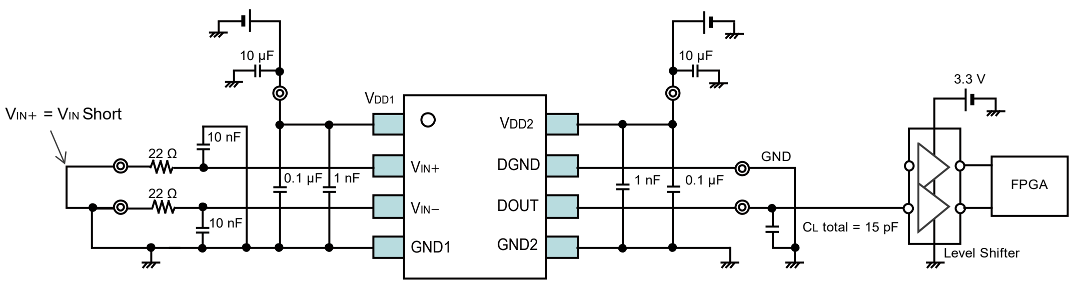


Fig.8 GE, INL, DNL Test Circuit

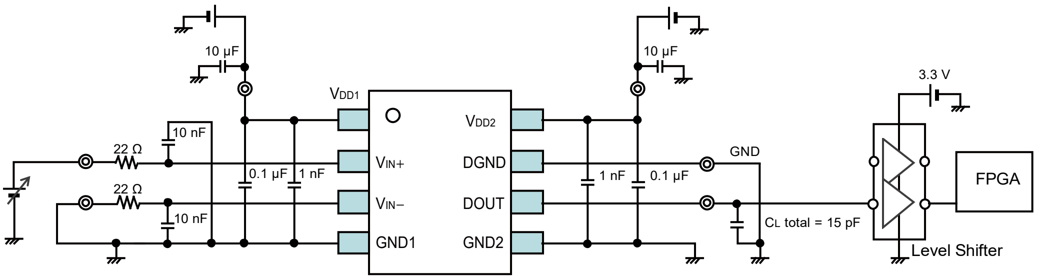
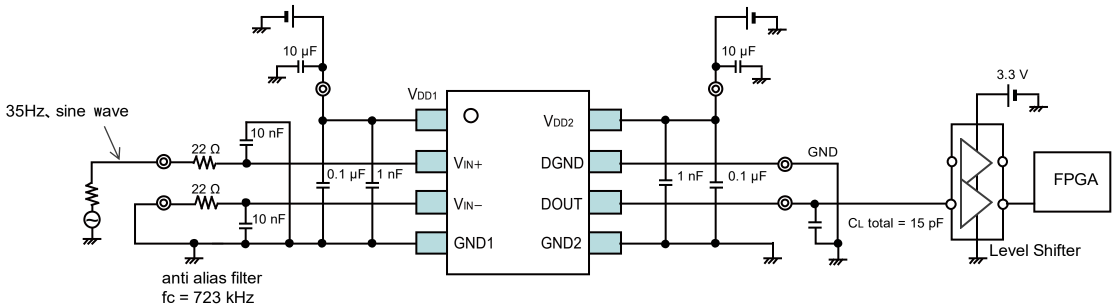


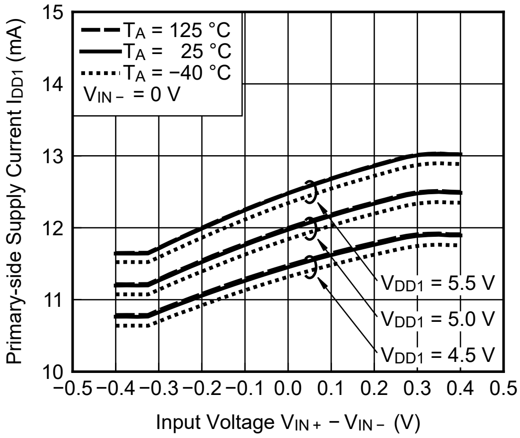
Fig.9 SNR, SNDR Test Circuit



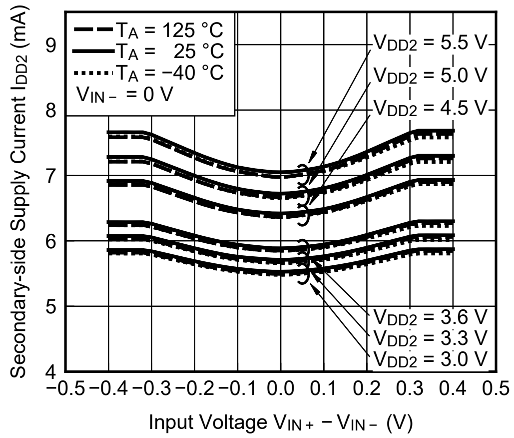
TYPICAL CHARACTERISTICS

(T_A = 25 °C, V_{IN+} = V_{IN-} = 0 V, V_{DD1} = V_{DD2} = 5 V, unless otherwise specified)

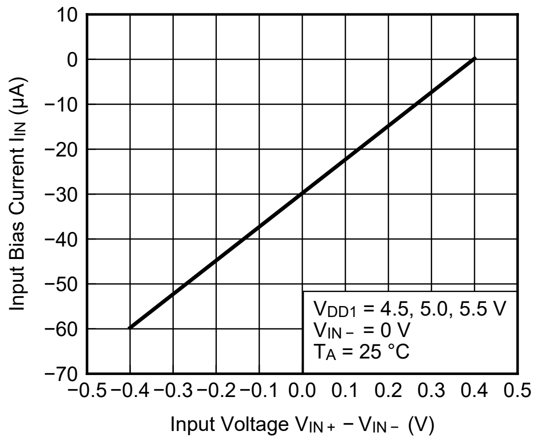
PRIMARY-SIDE SUPPLY CURRENT vs. INPUT VOLTAGE



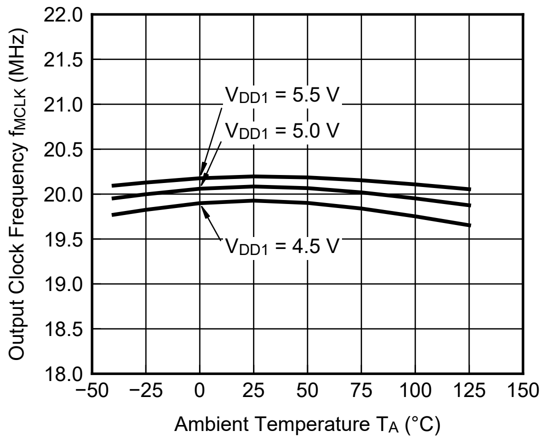
SECONDARY-SIDE SUPPLY CURRENT vs. INPUT VOLTAGE



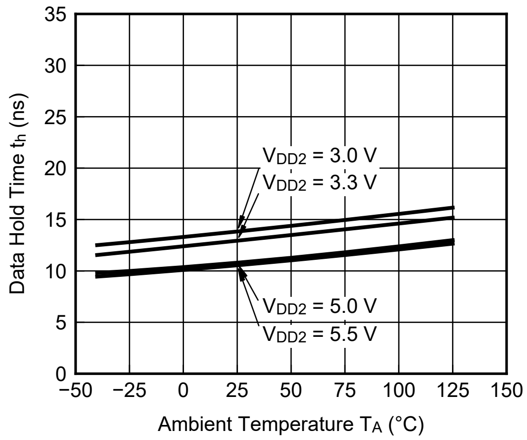
INPUT BIAS CURRENT vs. INPUT VOLTAGE



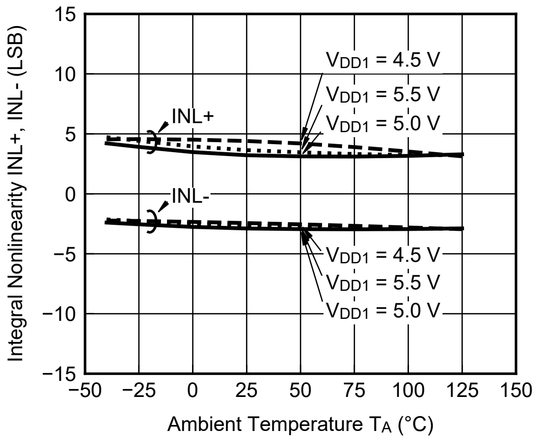
OUTPUT CLOCK FREQUENCY vs. AMBIENT TEMPERATURE



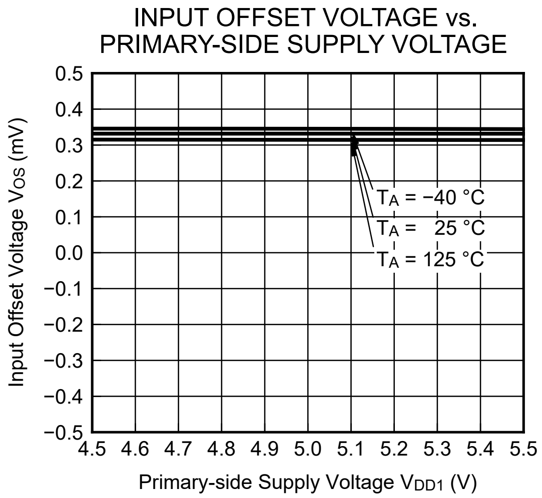
DATA HOLD TIME vs. AMBIENT TEMPERATURE

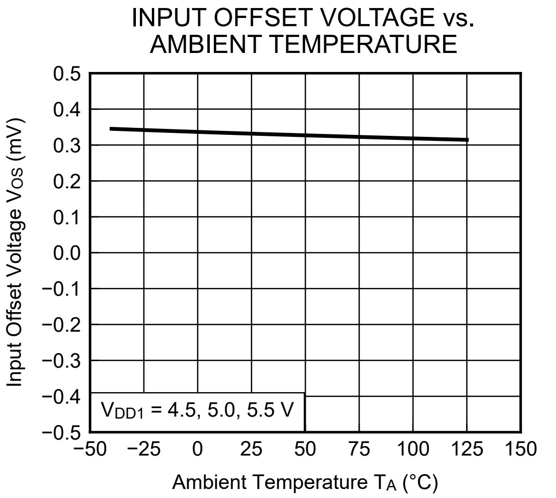


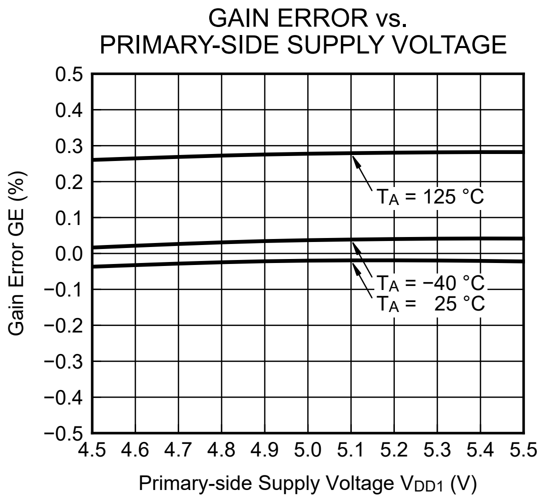
INTEGRAL NONLINEARITY vs. AMBIENT TEMPERATURE

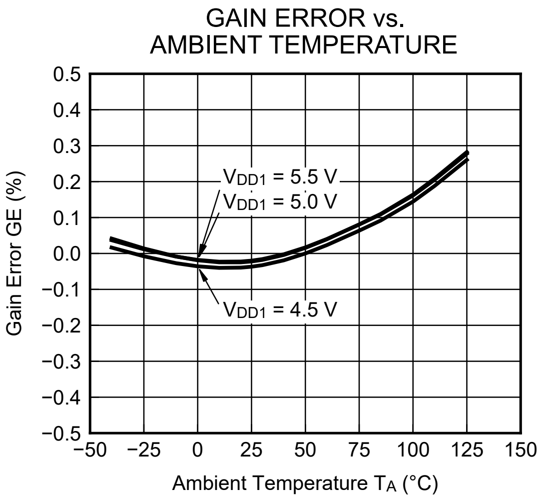


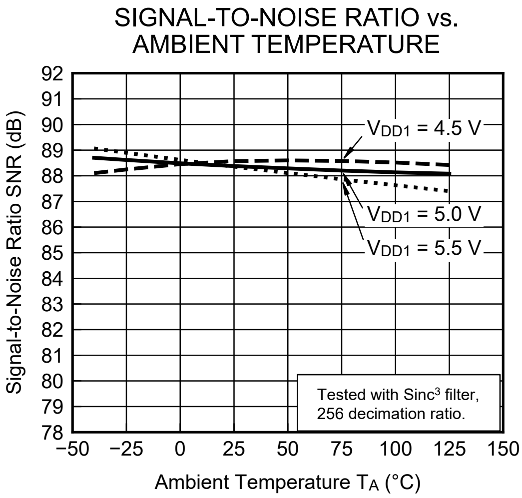
Remark The graphs indicate nominal characteristics.

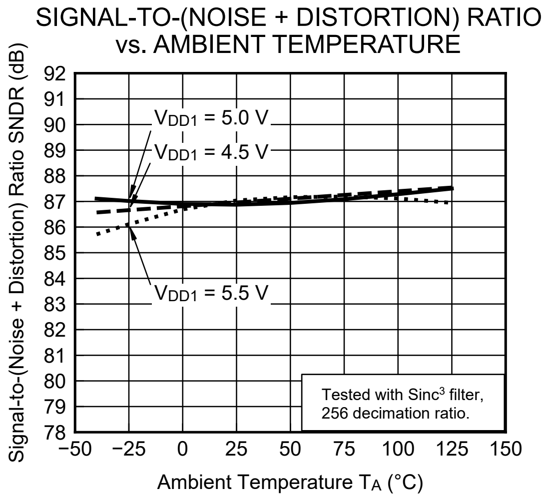








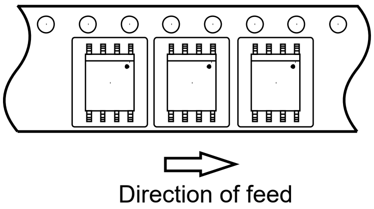




Remark The graphs indicate nominal characteristics.

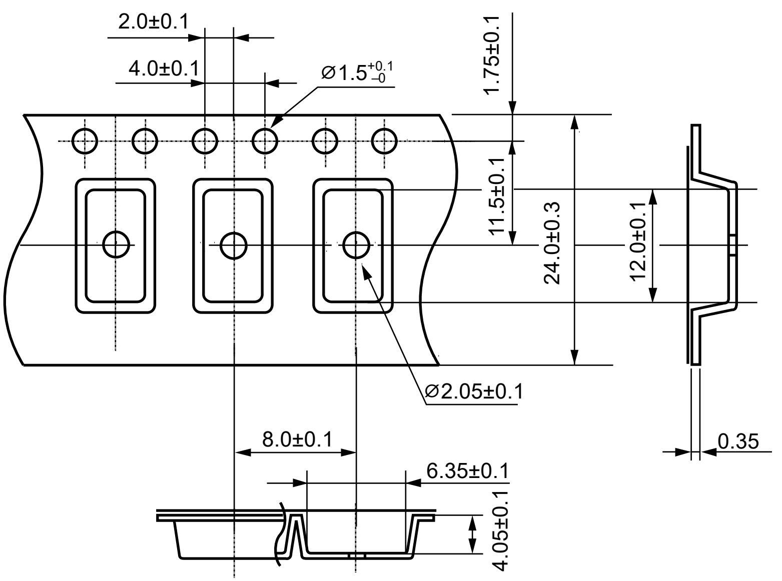
TAPING SPECIFICATIONS (UNIT: mm)

Taping Direction



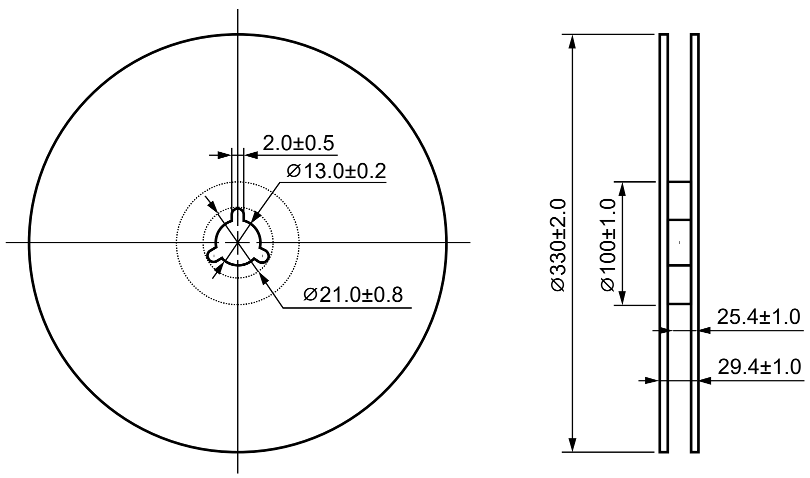
Outline and Dimensions (Tape)

Unit:mm



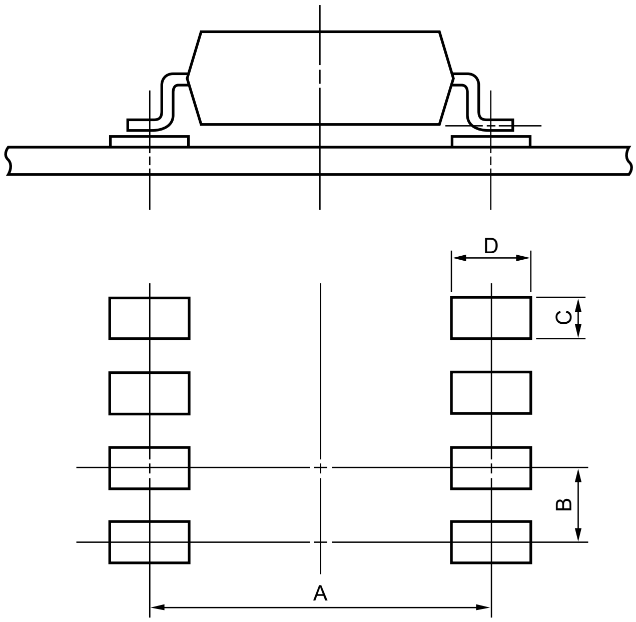
Outline and Demensions (Reel)

Unit:mm



Packing : 2 000 pcs/reel

RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)



Part Number	Lead Bending	A	B	C	D
RV1S9356A	lead bending type (Gull-wing) for long creepage distance (surface mount)	10.2	1.27	0.8	2.2

Remark All dimensions in this figure must be evaluated before use.

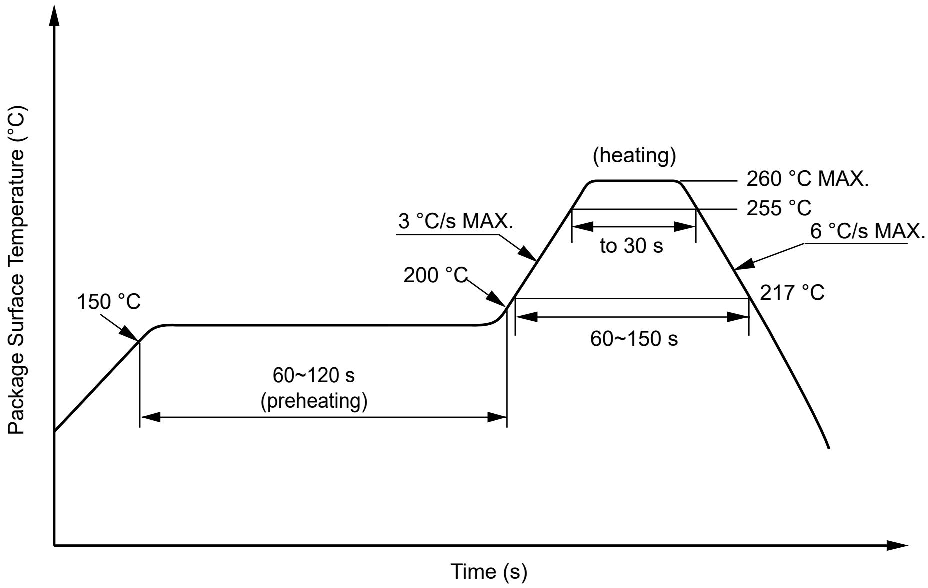
NOTES ON HANDLING

1. Recommended soldering conditions

(1) Infrared reflow soldering

- Peak reflow temperature: 260 °C or below (package surface temperature)
- Time of peak reflow temperature −5 °C (255 °C): 30 seconds or less
- Time of temperature higher than 217 °C: 60 to 150 seconds
- Time to preheat temperature from 150 to 200 °C: 60 to 120 seconds
- Number of reflows: Three
- Flux: Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

Recommended Temperature Profile of Infrared Reflow



JEDEC J-STD-020E compliant soldering conditions

(2) Wave soldering

- Temperature: 260 °C or below (molten solder temperature)
- Time: 10 seconds or less
- Preheating conditions: 120 °C or below (package surface temperature)
- Number of times: One (Allowed to be dipped in solder including plastic mold portion.)
- Flux: Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

(3) Soldering by Soldering Iron

- Peak temperature (lead part temperature): 350 °C or below
- Time (per one side): 3 s or less
- Flux: Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt % is recommended.)
- Place: 1.5 to 2.0 mm or more away from the root of the lead

(4) Cautions

- Flux cleaning: Avoid cleaning with Freon- or halogen-based (chlorinated etc.) solvents.
- Fixing/Coating: Do not use fixing agents or coatings containing halogen-based substances.

2. Cautions regarding noise
   Be aware that when voltage is applied suddenly between the photocoupler's input and output at startup, the output transistor may enter the on state, even if the voltage is within the absolute maximum ratings.

USAGE CAUTIONS

1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. Board designing
   (1) By-pass capacitor of more than 0.1 μF is used between V_{DD} and GND near device. Also, ensure that the distance between the leads of the photocoupler and capacitor is no more than 10 mm.
   (2) Keep the pattern connected the input (V_{IN+}, V_{IN-}) and the output (DOUT), respectively, as short as possible. DOUT are digital signal, but when the lines between the photocoupler and a digital filter are long, the digital filter might not read the data.
   When using long lines, use a line driver between the photocoupler and the digital filter, and keep the pattern between the output (DOUT) and the line driver as short as possible.
   (3) When the primary power supply (V_{DD1}) is off and only the secondary power supply (V_{DD2}) is being applied (V_{DD1} = 0 V and V_{DD2} = 5 V), DOUT output a high level (DOUT = 5.0 V typ.), regardless of the input voltages (V_{IN+} and V_{IN-}).

   (4) The Manchester encoding function is IEEE 802.3 compliant.

   (5) When V_{DD1} is lower than 4.5 V that is the outside of the recommended operating condition, the output (DOUT) of this product is unstable, and this might produce undesirable operation. Be sure to check the operation of an IC that is connected to this product during Power-up and Power-down process. And we recommend to use a disable function (shutdown function) of the connected IC or a reset IC to avoid this undesirable operation.

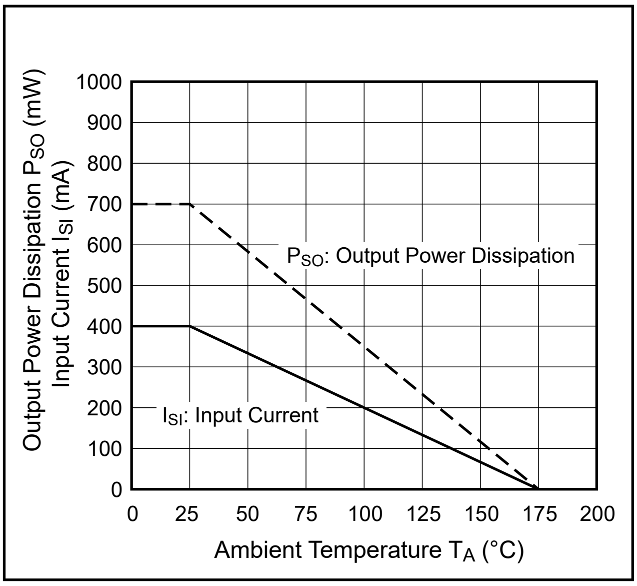
   (6) When using this product, connect GND2 and DGND to GND.

3. Avoid storage at a high temperature and high humidity.

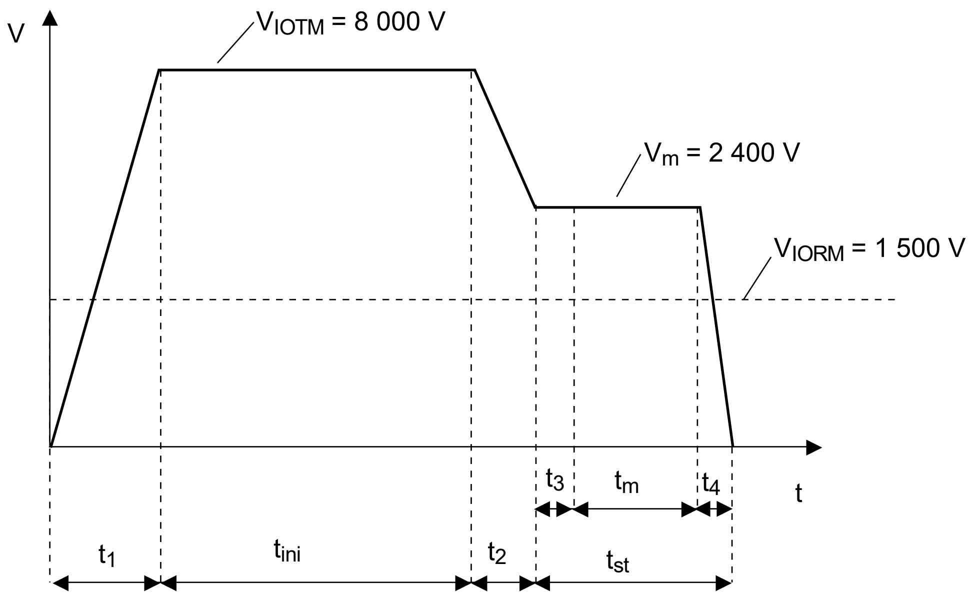
SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

Parameter	Symbol	Rating	Unit
Climatic test class (IEC 60068-1/DIN EN 60068-1)		40/125/21	
Dielectric strength maximum operating isolation voltage Test voltage (partial discharge test, procedure a for type test and random test) $V_m = 1.6 \times V_{IORM}$., $q_{pd} < 5$ pC	 V_{IORM} V_m	 1 500 2 400	 V_{peak} V_{peak}
Test voltage (partial discharge test, procedure b for all devices) $V_m = 1.875 \times V_{IORM}$., $q_{pd} < 5$ pC	V_m	2 813	V_{peak}
Highest permissible overvoltage	V_{IOTM}	8 000	V_{peak}
Degree of pollution (IEC 60664-1/DIN EN 60664-1 (VDE 0110-1))		2	
Comparative tracking index (IEC 60112/DIN EN 60112 (VDE 0303-11))	CTI	175	
Material group (IEC 60664-1/DIN EN 60664-1 (VDE 0110-1))		III a	
Storage temperature range	T_{stg}	−55 to +150	°C
Operating temperature range	T_A	−40 to +125	°C
Isolation resistance, minimum value V_{I-O} = 500 V dc, T_A = 25 °C V_{I-O} = 500 V dc, T_A = maximum temperature of rating, at least 100 °C	 R_{I-O} MIN. R_{I-O} MIN.	 10^{12} 10^{11}	 Ω Ω
Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve) Maximum ambient temperature Maximum input current Maximum output power dissipation Isolation resistance, minimum value at V_{I-O} = 500 V dc, $T_A = T_S$	 T_S I_{SI} P_{SO} R_{I-O} MIN.	 175 400 700 10^9	 °C mA mW Ω

Dependence of maximum safety ratings on ambient temperature

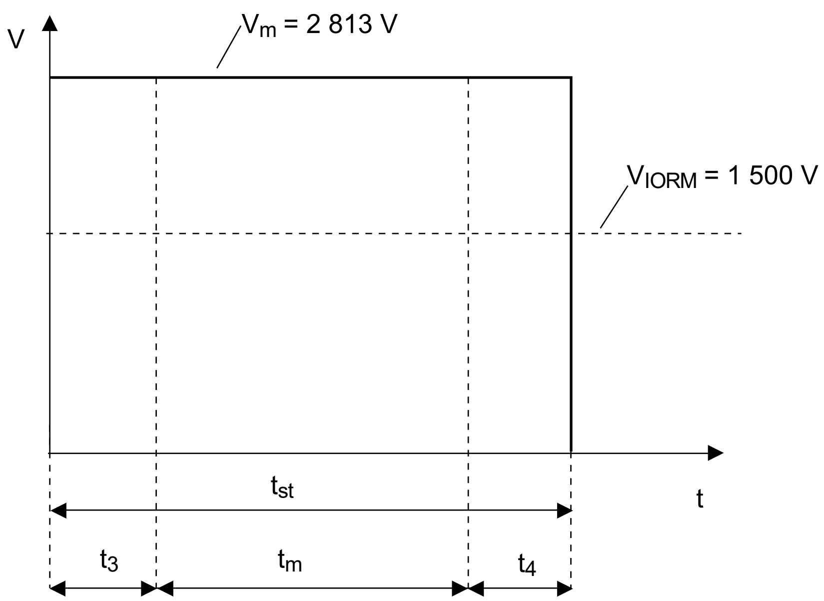


Method a) Destructive Test, Type and Sample Test



t_1, t_2 = 1 to 10 sec
t_3, t_4 = 1 sec
t_m = 10 sec
t_{st} = 12 sec
t_{ini} = 60 sec

Method b) Non-destructive Test, 100% Production Test



t_3, t_4 = 0.1 sec
t_m = 1.0 sec
t_{st} = 1.2 sec

Caution GaAs Products	This product uses gallium arsenide (GaAs). GaAs vapor and powder are hazardous to human health if inhaled or ingested, so please observe the following points. • Follow related laws and ordinances when disposing of the product. If there are no applicable laws and/or ordinances, dispose of the product as recommended below. 1. Commission a disposal company able to (with a license to) collect, transport and dispose of materials that contain arsenic and other such industrial waste materials. 2. Exclude the product from general industrial waste and household garbage, and ensure that the product is controlled (as industrial waste subject to special control) up until final disposal. • Do not burn, destroy, cut, crush, or chemically dissolve the product. • Do not lick the product or in any way allow it to enter the mouth.

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Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit: www.renesas.com/contact/.