

Ultrasonic Measurement Analog Front End

FEATURES

- AEC-Q100 Certification
- Measurement Range: up to 4ms × Speed Velocity
- Transmit Channel: Support Single-channel and Dual-channel, Frequency Range: 31.25kHz to 4MHz, up to 31 Pulses can be Transmitted
- Receiver Channel: STOP Signal Jitter: 50ps, Built-in Low-noise Operational Amplifier and Programmable Gain Amplifier, External Filtering Circuit for Noise Filtering, Configured Comparator Threshold, Automatic Switch for Bidirectional/ Single-end TOF Measurement, Selectable Long-distance Measurement Mode or Short-distance Measurement Mode
- Temperature Measurement: RTD Resistors like PT1000/500 can be Connected
- Operating Temperature Range: -40°C to 125°C

PRODUCT DESCRIPTION

The MS1000TA is an ultrasonic measurement analog front-end chip, which can be widely applied to automotive industry and consumer electronics. And it has high flexibility. The number of transmit pulses, frequency, gain and signal threshold can be configured. At the same time, the receiver channel parameters can also be configured flexibly to suit the measurement for containers of different sizes and different liquid media.

The MS1000TA has many operating modes to reduce power dissipation largely, so it is an ideal choice for devices like low power-dissipation flow meter and distance measurement. The MS1000TA has a built-in low-noise amplifier, making it achieve ultra-low noise in low flow measurement, thus the picosecond resolution and accuracy can be guaranteed.

APPLICATIONS

- Automotive Electronics
- Container Fluid Surface Measurement, Fluid Material and Concentration Identification
- Water, Gas and Heat Flow Metering
- Short-distance Sensing

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS1000TA	TSSOP28	MS1000TA

BLOCK DIAGRAM

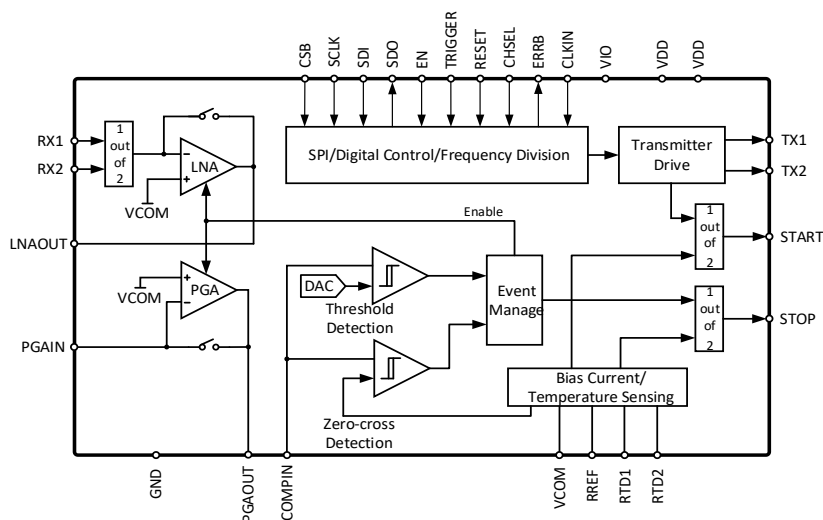
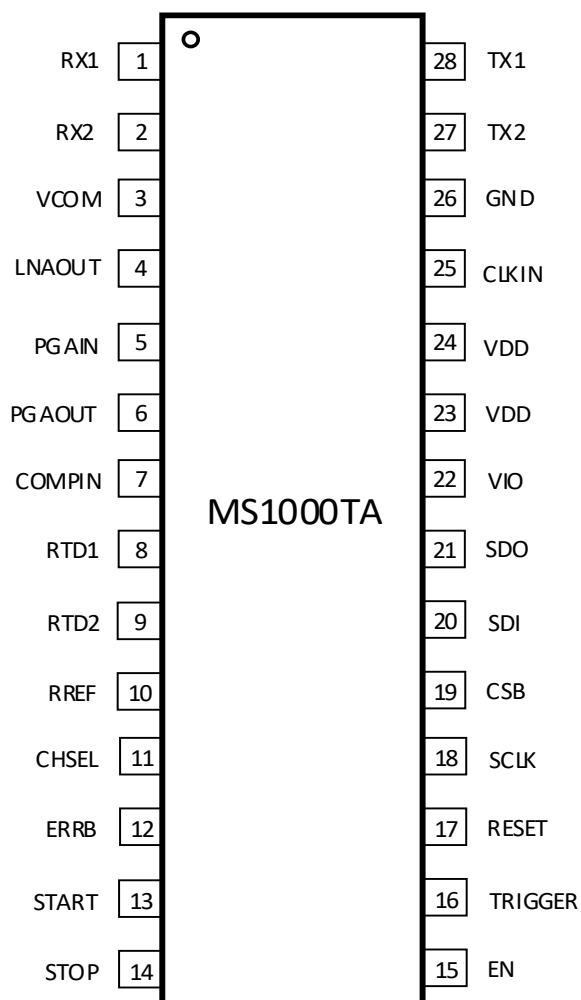


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PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Type	Description
1	RX1	I	Receiver Channel 1
2	RX2	I	Receiver Channel 2
3	VCOM	-	Output Common-mode Voltage Bias
4	LNAOUT	O	Low-noise Amplifier Output
5	PGAIN	I	Programmable Gain Amplifier Input
6	PGAOUT	O	Programmable Gain Amplifier Output
7	COMPIN	I	Echo Recognition and Zero-cross Detection Input
8	RTD1	O	Resistance Temperature Detector Channel 1
9	RTD2	O	Resistance Temperature Detector Channel 2
10	RREF	O	Reference Resistor for Temperature Measurement
11	CHSEL	I	External Channel Selection
12	ERRB	O	Error Flag (Open-drain)
13	START	O	Start Pulse Output
14	STOP	O	Stop Pulse Output
15	EN	I	Enable (Active High). When EN is low, the chip is in sleep mode.
16	TRIGGER	I	Trigger Input
17	RESET	I	Reset (Active High)
18	SCLK	I	Serial Clock for SPI Interface
19	CSB	I	Chip Select for SPI Interface (Active Low)
20	SDI	I	Serial Data Input for SPI Interface
21	SDO	O	Serial Data Output for SPI Interface
22	VIO	-	I/O Power Supply
23	VDD	-	Power Supply
24	VDD	-	Power Supply
25	CLKIN	I	Clock Input
26	GND	-	Ground
27	TX2	O	Transmit Channel 2
28	TX1	O	Transmit Channel 1

ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter	Symbol	Range	Unit
Analog Power Supply	V_{DD}	-0.3 ~ 6.0	V
Input and Output Voltage	V_{IO}	-0.3 ~ 6.0	V
Voltage on Analog Input Pins	V_I	-0.3 ~ $V_{DD}+0.3$	V
Voltage on Digital Input Pins	V_I	-0.3 ~ $V_{IO}+0.3$	V
Input Current at Pins	I_I	5	mA
Junction Temperature	T_J	-40 ~ +125	°C
Storage Temperature	T_{STG}	-65 ~ +150	°C
ESD (HBM)	V_{ESD}	±6k	V

RECOMMENDED OPERATING CONGITIONS

Parameter	Symbol	Range			Unit
		Min	Typ	Max	
Analog Power Supply	V_{DD}	2.7		5.5	V
Digital Power Supply	V_{IO}	1.8		V_{DD}	V
Voltage on Analog Input Pins	V_I	GND		V_{DD}	V
Voltage on Digital Input Pins	V_I	GND		V_{IO}	V
Operating Frequency	f_{CLKIN}	0.06		16	MHz
Junction Temperature	T_J	-40		125	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, $T_A = 25^\circ\text{C}$, $V_{DD}=V_{IO}=3.7\text{V}$, $V_{COM} = V_{CM} = V_{DD}/2$, $C_{VCOM} = 10\text{nF}$

Parameter	Symbol	Condition		Min	Typ	Max	Unit
TX Output Voltage Swing	$V_{OUT(TX)}$	$f_{OUT}=1\text{MHz}$, $R_L=75\Omega \sim V_{CM}$, $V_{DD}=3.7\text{V}$	HIGH		3.42	3.7	V
			LOW		0.3		V
TX Output Drive Current	$I_{OUT(TX)}$	$f_{OUT}=1\text{MHz}$, $R_L=75\Omega \sim V_{CM}$			45		mA_{RMS}
TX Output Frequency	$f_{OUT(TX)}$	$f_{CLKIN}=8\text{MHz}$, $f_{OUT(TX)} = f_{CLKIN}/2$			4		MHz
STOP Jitter	Δt_{STOP}	LNA Capacitive Feedback, $G_{PGA}=6\text{dB}$, $f_{IN}=1\text{MHz}$, $V_{IN}=100\text{mV}_{PP}$, $C_{VCOM}=1\mu\text{F}$			50		ps_{RMS}
LNA Gain	G_{LNA}	Capacitive Feedback, $C_{IN}=300\text{pF}$, $f_{IN}=1\text{MHz}$, $R_L=100\text{k}\Omega \sim V_{CM}$, $C_{VCOM}=1\mu\text{F}$			20		dB
LNA Input Reference Noise Density	e_{nLNA}	Capacitive Feedback, $C_{IN}=300\text{pF}$, $f=1\text{MHz}$, $V_{DD}=3.1\text{V}$, $V_{IN}=V_{CM}$, $R_L=\infty$, $C_{VCOM}=1\mu\text{F}$			3.8		$\text{nV}/\sqrt{\text{Hz}}$
LNA Input Voltage Range	$V_{IN(LNA)}$	Resistive Feedback, $R_L=1\text{k}\Omega \sim V_{CM}$, $C_{VCOM}=1\mu\text{F}$	HIGH		$V_{CM}+(V_{CM}-0.24)/(G_{LNA})$		V
			LOW		$V_{CM}-(V_{CM}-0.24)/(G_{LNA})$		V
LNA Output Voltage Range	$V_{OUT(LNA)}$	Resistive Feedback, $R_L=1\text{k}\Omega \sim V_{CM}$, $C_{VCOM}=1\mu\text{F}$, $V_{DD}=3.7\text{V}$	HIGH	$V_{DD}-0.6$	$V_{DD}-0.24$	V_{DD}	V
			LOW		$\text{GND}+0.24$	0.3	V
LNA Slew Rate	SR_{LNA}	Resistive Feedback, $R_L=1\text{k}\Omega \sim V_{CM}$, 100mV step, $C_{VCOM}=1\mu\text{F}$			15		$\text{V}/\mu\text{s}$

Parameter	Symbol	Condition		Min	Typ	Max	Unit
LNA Input Channel-to-channel Crosstalk	XTK	Capacitive Feedback, $f = 1\text{MHz}$, $R_L = 100\text{k}\Omega \sim V_{CM}$, $C_{VCOM} = 1\mu\text{F}$			-40		dB
LNA -3dB Bandwidth	BW_{LNA}	Capacitive Feedback, $C_{IN}=300\text{pF}$, $R_L=100\text{k}\Omega \sim V_{CM}$, $C_{VCOM}=1\mu\text{F}$			5		MHz
LNA Input Offset Voltage	$V_{OS(LNA)}$	Resistive Mode, $V_{IN}=V_{CM}$, $R_L = \infty$			± 200	± 500	μV
VCOM Output Error	V_{COM}	$C_{VCOM}=1\mu\text{F}$			0.5		%
PGA Input Voltage Range	$V_{IN(PGA)}$	$R_L=100\text{k}\Omega \sim V_{CM}$, $C_L=10\text{pF} \sim \text{GND}$	HIGH		$V_{CM}+(V_{CM}-0.06)/(G_{PGA})$		V
			LOW		$V_{CM}-(V_{CM}-0.06)/(G_{PGA})$		V
PGA Minimum Gain	G_{PGAMIN}	DC, $R_L = \infty$, $C_L=10\text{pF}$		-2	0	2	dB
PGA Maximum Gain	G_{PGAMAX}			19	21	23	dB
PGA Gain Step Size	ΔG_{PGA}				3		dB
PGA Gain Error	$G_{E(PGA)}$	DC, $G_{PGA}=0\text{dB}$, $R_L = \infty$, $C_L=10\text{pF}$			5		%
PGA Gain Temperature Coefficient	TCG_{PGA}	DC, $G_{PGA}=0\text{dB}$, $R_L = \infty$, $C_L=10\text{pF}$			25		ppm/ $^{\circ}\text{C}$
PGA Input Reference Noise Density	en_{PGA}	$G_{PGA}=21\text{dB}$, $f=1\text{MHz}$, $V_{DD}=3.1\text{V}$, $V_{IN}=V_{CM}$, $R_L = \infty$, $C_{VCOM}=1\mu\text{F}$			6.5		$\text{nV}/\sqrt{\text{Hz}}$
PGA Output Voltage Range	$V_{OUT(PGA)}$	$R_L=100\text{k}\Omega \sim V_{CM}$, $C_L=10\text{pF} \sim \text{GND}$, $V_{DD}=3.7\text{V}$	HIGH		$V_{DD}-0.06$	V_{DD}	V
			LOW		0.06		V
PGA -3dB Bandwidth	BW_{PGA}	$G_{PGA}=21\text{dB}$, $R_L=100\text{k}\Omega \sim V_{CM}$, $C_L=10\text{pF}$, $C_{VCOM}=1\mu\text{F}$			12		MHz
PGA Slew Rate	SR_{PGA}	$G_{PGA}=21\text{dB}$, $R_L=100\text{k}\Omega \sim V_{CM}$, $C_L=10\text{pF}$, $C_{VCOM}=1\mu\text{F}$			25		$\text{V}/\mu\text{s}$
Input Offset Voltage of Zero-cross Comparator	$V_{OS(COMP)}$	Refer to V_{COM}			± 15		μV

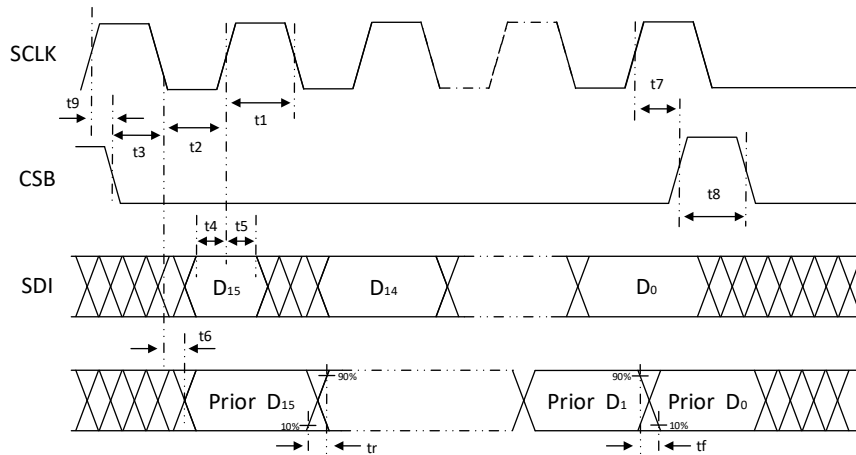
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Zero-cross Comparator Hysteresis	HYST _{COMP}	Refer to V _{COM}		-10		mV
Threshold Level of Threshold Detector	V _{THDET}	ECHO_QUAL_THLD=0h, Refer to V _{COM}		-35		mV
Threshold Level of Threshold Detector	V _{THDET}	ECHO_QUAL_THLD=7h, Refer to V _{COM}		-1.5		V
VDD Supply Current	I _{DD}	Sleep (EN=CLKIN=TRIGGER=low)	1	2	3	μA
		Continuous Receive Mode, LNA and PGA Bypass	1.6	2.3	3	mA
		Continuous Receive Mode, LNA and PGA Active	6.5	8	10	mA
		Temperature Measurement Only (PT1000 Mode)		350		μA
		Temperature Measurement Only (PT500 Mode)		450		μA
VIO Supply Sleep Current	I _{IO}	Sleep (EN=CLKIN=TRIGGER=low)		2		nA
Digital Output Logic Low Threshold	V _{OL}	SDO Pin, 100μA Current			0	V
		SDO Pin, 1.85mA Current			0.2	V
		START and STOP Pins, 100μA Current			0	V
		START and STOP Pins, 1.85mA Current			0.2	V
		ERRB Pin, 100μA Current			0	V
		ERRB Pin, 1.85mA Current			0.15	V
Digital Output Logic High Threshold	V _{OH}	SDO Pin, 100μA Current	V _{IO} -0.2			V
		SDO Pin, 1.85mA Current	V _{IO} -0.6			V
		START and STOP Pins, 100μA Current	V _{IO} -0.5			V
		START and STOP Pins, 1.85mA Current	V _{IO} -0.6			V
		ERRB Pin, 0μA Current	V _{IO} -0.2			V

Parameter	Symbol	Condition	Min	Typ	Max	Unit
High-level Input Voltage	V_{IH}		$0.8 \times V_{IO}$			V
Low-level Input Voltage	V_{IL}				$0.2 \times V_{IO}$	V

Timing Requirements

Unless otherwise noted, $T_A = 25^\circ\text{C}$, $V_{DD} = V_{IO} = 3.7\text{V}$, $f_{SCLK} = 1\text{MHz}$

Parameter	Symbol	Min	Typ	Max	Unit
Serial Clock Frequency	f_{SCLK}			26	MHz
High-level Time, SCLK	t_1	16			ns
Low-level Time, SCLK	t_2	16			ns
Set-up Time, CSB to SCLK	t_3	10			ns
Set-up Time, SDI to SCLK	t_4	12			ns
Hold Time, SCLK to SDI	t_5	12			ns
Time from SCLK Transition to SDO Valid	t_6	16			ns
Hold Time, SCLK Transition to CSB Rising Edge	t_7	10			ns
CSB Invalid Time	t_8	17			ns
Hold Time, SCLK Transition to CSB Falling Edge	t_9	10			ns
Signal Rising/Falling Time	t_r/t_f		1.8		ns



Switching Characteristics

$T_A = 25^\circ\text{C}$, $V_{DD} = V_{IO} = 3.7\text{V}$, $f_{CLKIN} = 8\text{MHz}$

Parameter	Symbol	Condition	Min	Typ	Max	Unit
START Signal Pulse Width	PW_{START}	TX_FREQ_DIV=2h, NUM_TX=1		1		μs
		TX_FREQ_DIV=2h, NUM_TX=2		2		μs
		TX_FREQ_DIV=2h, NUM_TX ≥ 3		3		μs

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Rising/Falling Time of START Signal	t_r/t_f START	20% ~ 80%, 20pF Load		0.25		ns
Rising/Falling Time of STOP Signal	t_r/t_f STOP	20%~ 80%, 20pF Load		0.25		ns
Maximum CLKIN Signal Input Frequency	f_{CLKIN}			16		MHz
Rising/Falling Time of CLKIN Signal	t_r/t_f CLKIN	20%~ 80%		10		ns
Rising/Falling Time of TRIGGER Signal	t_r/t_f TRIG	20% ~ 80%		10		ns
Enabling Trigger Waiting Time	t_{EN_TRIG}			50		ns
Resetting Trigger Waiting Time	t_{RES_TRIG}	TX_FREQ_DIV=2h		3.05		μ s

TYPICAL CHARACTERISTICS

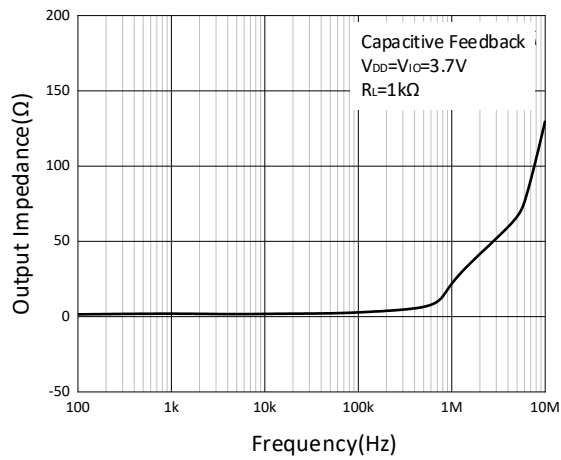


Figure 1. LNA Z_{OUT} VS. Frequency

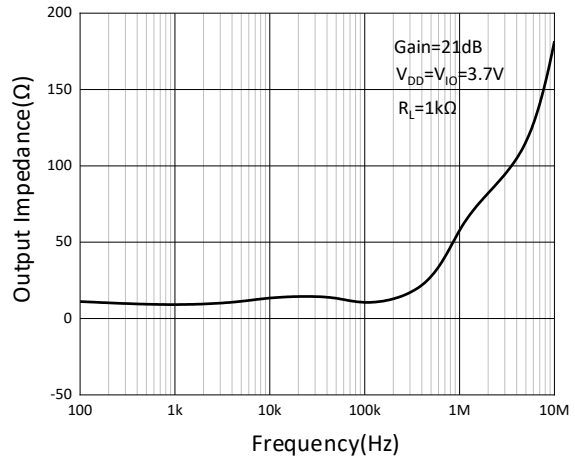


Figure 2. PGA Z_{OUT} VS. Frequency

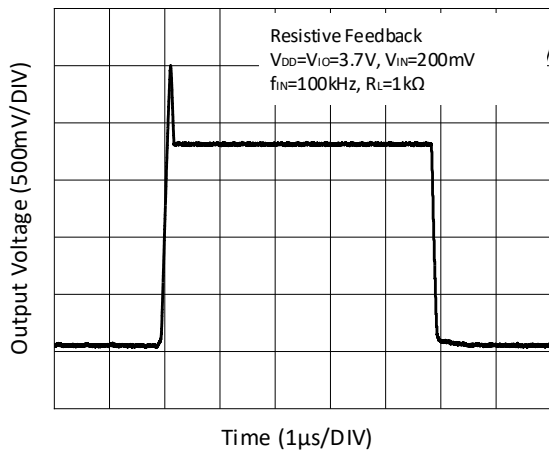


Figure 3. LNA Response

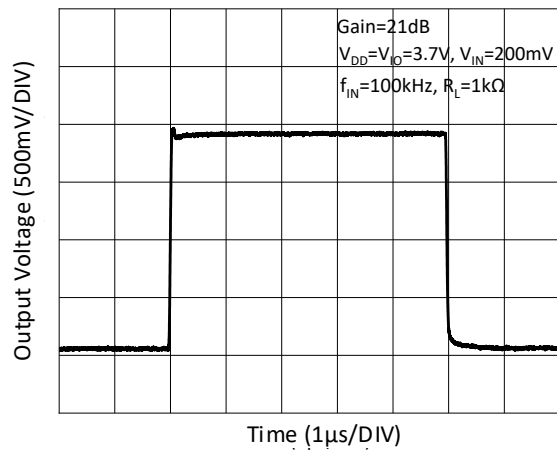


Figure 4. PGA Response

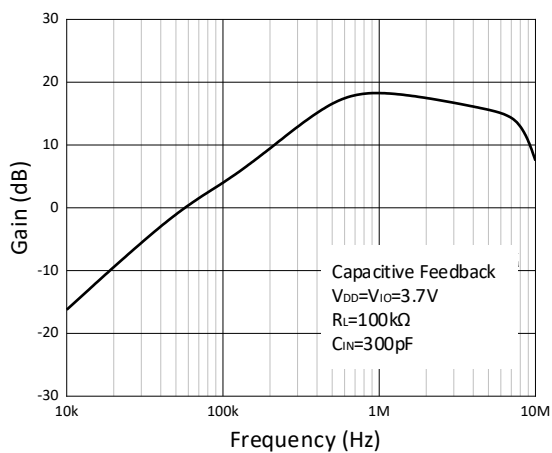


Figure 5. LNA Gain VS. Frequency

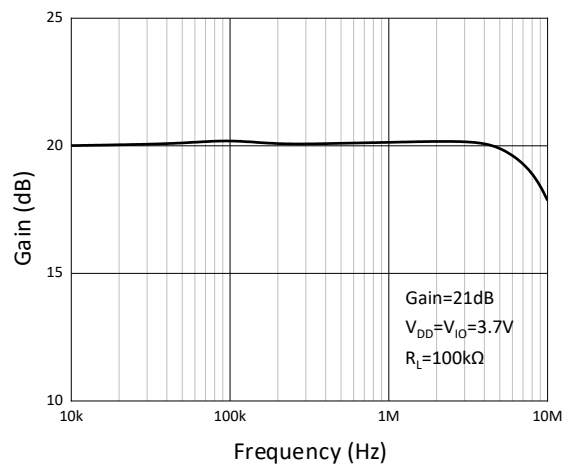
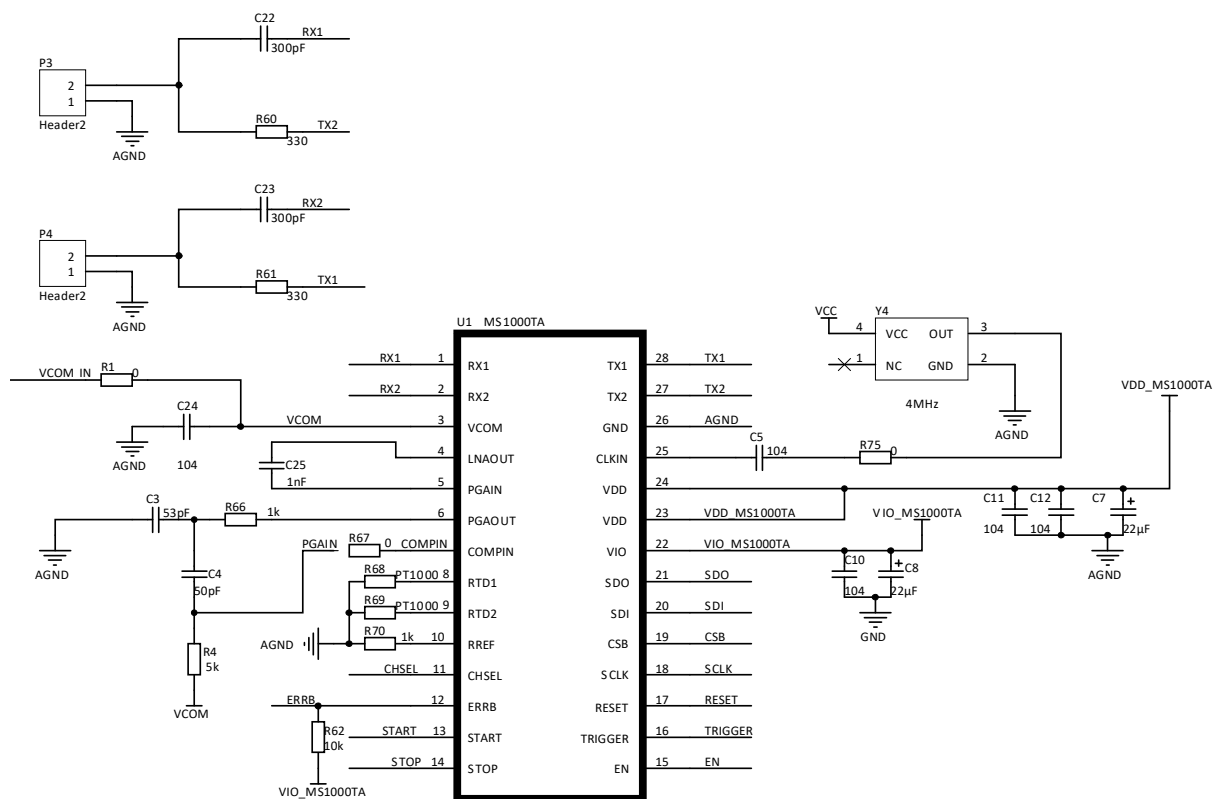


Figure 6. PGA Gain VS. Frequency

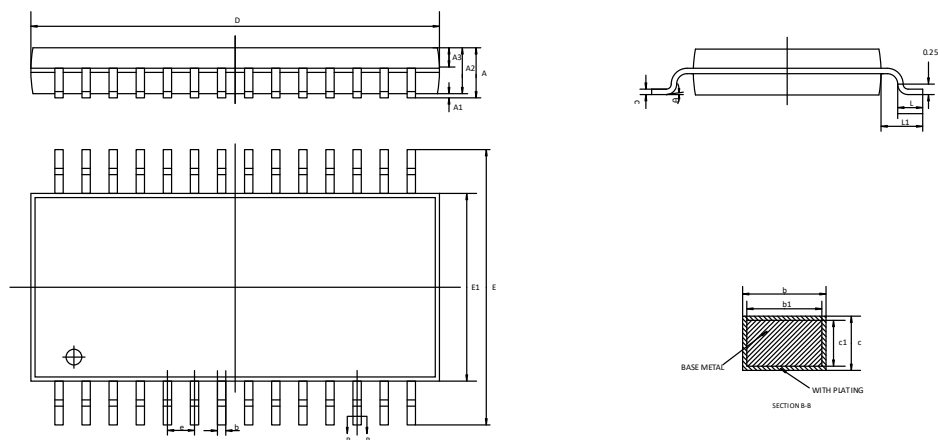
TYPICAL APPLICATION

The following figure shows the circuit for liquid level measurement and liquid identification.



PACKAGE OUTLINE DIMENSIONS

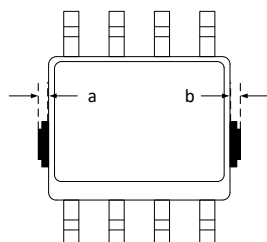
TSSOP28



Symbol	Dimensions in Millimeters		
	Min	Typ	Max
A	-	-	1.20
A1	0.05	-	0.15
A2	0.80	-	1.00
A3	0.39	0.44	0.49
b	0.20	-	0.29
b1	0.19	0.22	0.25
c	0.14	-	0.18
c1	0.12	0.13	0.14
D	9.60	9.70	9.80
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	-	8°

Note: In addition to the package size, a, b are allowed to have the maximum size of 0.15mm for waste glue simultaneously.

The diagram is as follows: taking SOP8 package as an example.



MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description



Product Name: MS1000TA

Product Code: XXXXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece/Box	Box/Carton	Piece/Carton
MS1000TA	TSSOP28	3000	1	3000	8	24000

STATEMENT

- All Revision Rights of Datasheets Reserved for Ruimeng. Don't release additional notice.
Customer should get latest version information and verify the integrity before placing order.
- When using Ruimeng products to design and produce, purchaser has the responsibility to observe safety standard and adopt corresponding precautions, in order to avoid personal injury and property loss caused by potential failure risk.
- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.

**MOS CIRCUIT OPERATION PRECAUTIONS**

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

- 1、The operator shall ground through the anti-static wristband.
- 2、The equipment shell must be grounded.
- 3、The tools used in the assembly process must be grounded.
- 4、Must use conductor packaging or anti-static materials packaging or transportation.



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