

1MHz, Rail-to-Rail I/O CMOS Operational Amplifiers

FEATURES

- Rail-to-Rail Input/Output
- High Slew Rate: 1V/μs
- Low I_B: 1pA at 25°C (TYP)
- High Gain: 110dB (TYP)
- Low Offset Voltage: 1mV (TYP)
- Low Power Consumption: 90μA at 5V (Per Amplifier)
- Low Supply Voltage: 2.5V to 5.5V
- Extended Temperature: -40°C to +125°C

APPLICATIONS

- Battery-Powered Applications
- Portable Devices
- Signal Conditioning
- Active Filtering
- Current Sensor Amplifier
- Weight Scale Sensor
- Medical/Industrial Instrumentation
- Instrumentation

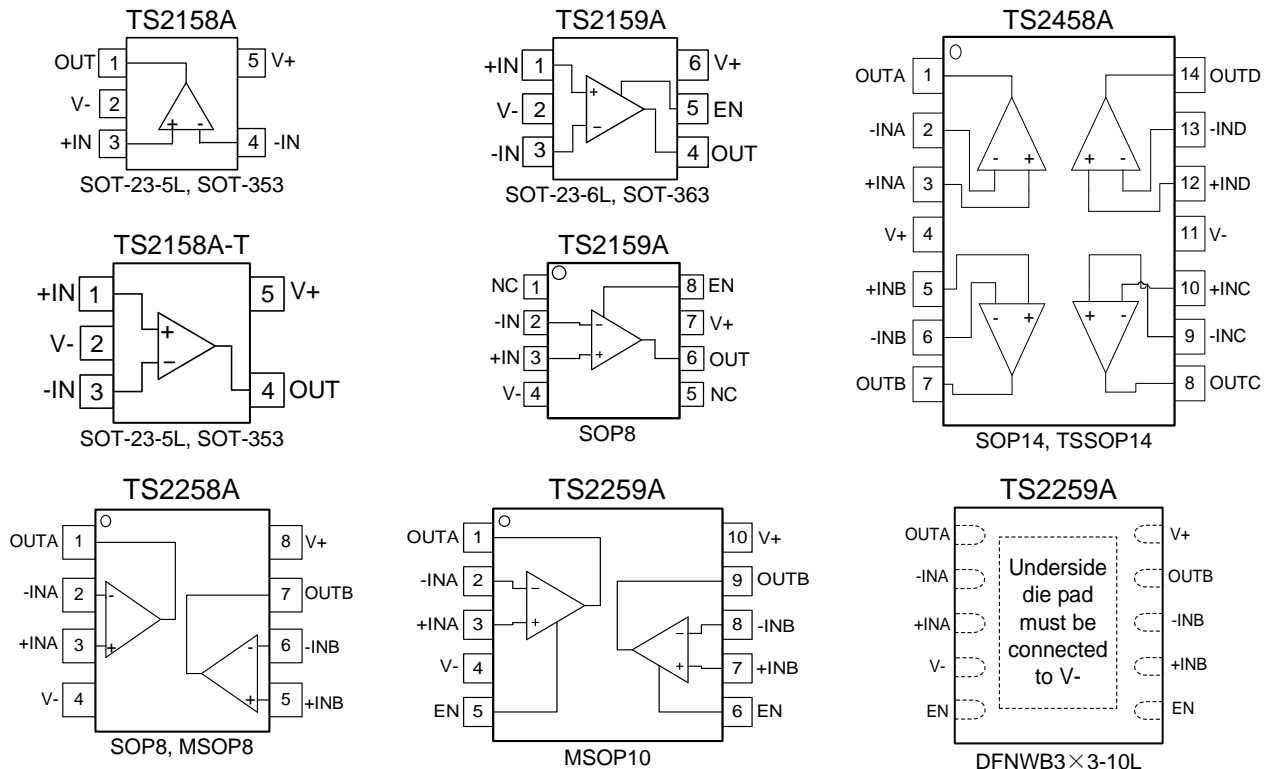
PRODUCT DESCRIPTION

TS2158A/TS2159A are the most cost-effective amplifiers for low voltage, low power consumption and low-cost applications. The device specifies rail-to-rail input and output, and the inputs exceeding power supply range make the TS2158A series easy to use for very low voltage supply applications.

Low I_B feature of these amplifiers allows the parts to be ideal for many sensor applications. 1MHz GBW and 1V/μs slew rate under low power supply voltage can meet almost all sensor requirement.

TS2158A/TS2159A families of operational amplifiers are specified at the full temperature range of -40°C to +125°C under single or dual power supplies of 2.7V to 5.5V, however these products will operate under an extended supply range from 2.5V to 5.5V at a reduced temperatures range.

PIN ASSIGNMENTS



ORDERING INFORMATION

Model	Part Number	Eco Plan	Package	AMP	Shutdown	Container, Pack Qty
TS2158A	TS2158ASOT235LR	RoHS	SOT-23-5L	1	NO	Reel, 3000
TS2158A	TS2158ASOT353R	RoHS	SOT-353 ⁽¹⁾	1	NO	Reel, 3000
TS2158A-T	TS2158ATSOT235LR	RoHS	SOT-23-5L	1	NO	Reel, 3000
TS2158A-T	TS2158ATSOT353R	RoHS	SOT-353	1	NO	Reel, 3000
TS2159A	TS2159ASOT236LR	RoHS	SOT-23-6L	1	YES	Reel, 3000
TS2159A	TS2159ASOT363R	RoHS	SOT-363 ⁽²⁾	1	YES	Reel, 3000
TS2159A	TS2159ASOP8R	RoHS	SOP8	1	YES	Reel, 2500
TS2258A	TS2258ASOP8R	RoHS	SOP8	2	NO	Reel, 2500
TS2258A	TS2258AMSOP8R	RoHS	MSOP8	2	NO	Reel, 3000
TS2259A	TS2259AMSOP10R	RoHS	MSOP10	2	YES	Reel, 3000
TS2259A	TS2259ADFNWB3310LR	RoHS	DFNWB3×3-10L	2	YES	Reel, 5000
TS2458A	TS2458ASOP14R	RoHS	SOP14	4	NO	Reel, 2500
TS2458A	TS2458ATSSOP14R	RoHS	TSSOP14	4	NO	Reel, 3000

(1) SC70-5 renamed to SOT-353.

(2) SC70-6 renamed to SOT-363.

ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range (unless otherwise noted) ⁽³⁾

Parameter	Min	Max	Unit
Supply Voltage		7.0	V
Signal Input Terminal Voltage	(V-) - 0.5	(V+) + 0.5	V
Operating Temperature	-40	150	°C
Junction Temperature		150	°C
Storage Temperature	-65	150	°C
Lead Temperature (Soldering, 10s)		260	°C
ESD HBM		±3000	V
ESD MM		±400	V
ESC CDM		±1000	V

(3) Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION



ESD (Electrostatic Discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjects to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

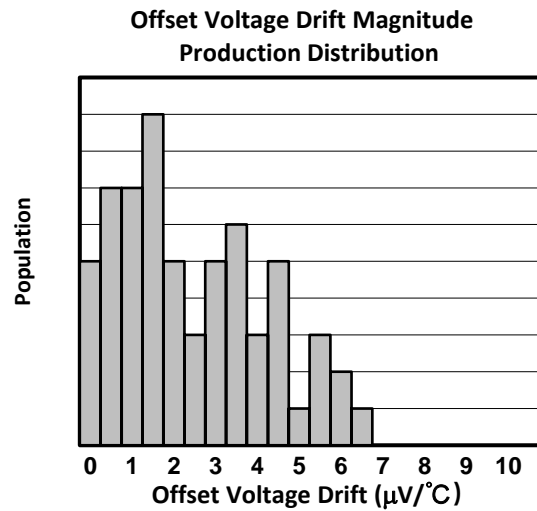
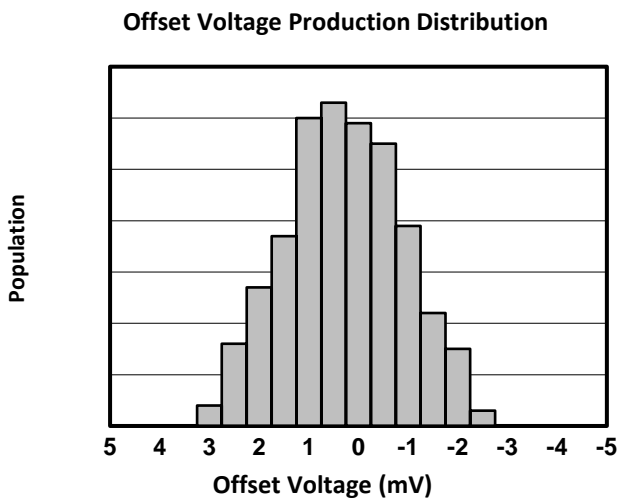
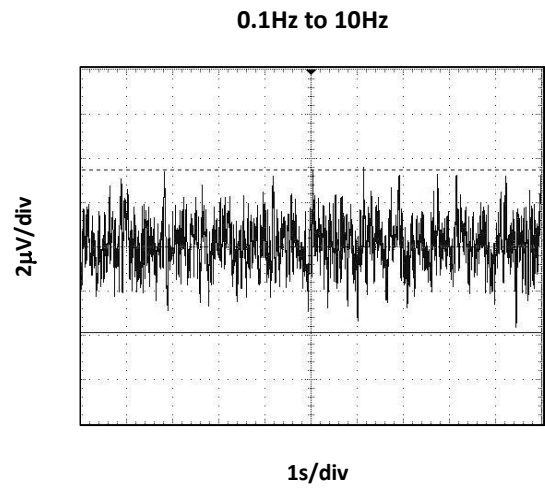
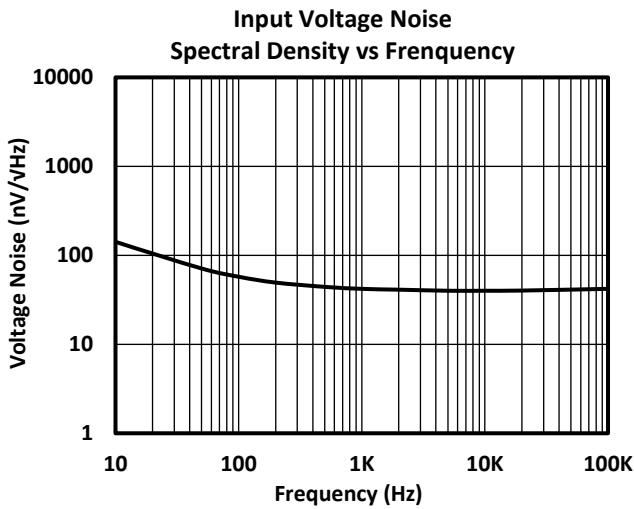
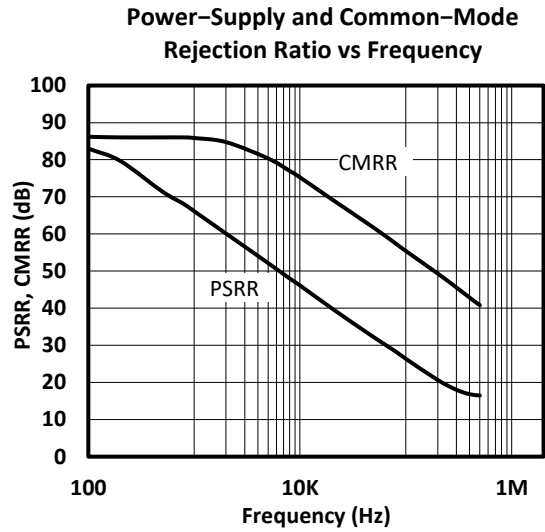
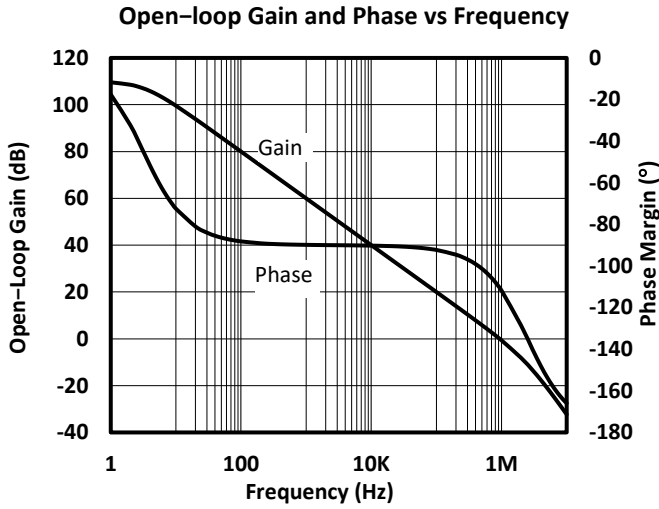
ELECTRICAL CHARACTERISTICS

Boldface limits apply over the specified temperature range, $V_S = +2.7V$ to $+5.5V$, $T_A = -40^\circ C$ to $+125^\circ C$
At $T_A = +25^\circ C$, $R_L = 100k\Omega$ connected to $V_S / 2$ and $V_{OUT} = V_S / 2$ (unless otherwise noted)

Parameter	Operating Conditions	Min	Typ	Max	Unit
V_S Power Supply Voltage		2.5		5.5	V
I_S Supply Current	$I_O = 0, V_S = 5V$		90	132	μA
PSRR Power Supply Rejection Ratio	$V_S = 2.7V$ to $5.5V, V_{CM} < (V+) - 2V$ $T_A = -40^\circ C$ to $+125^\circ C$	75 68	90		dB dB
Input Characteristics					
V_{OS} Input Offset Voltage	$V_S = 5V$		1	3.5	mV
dV_{OS}/dT Drift			3		$\mu V/^\circ C$
I_B Input Bias Current			1		μA
I_{OS} Input Offset Current			1		μA
CMRR Common Mode Rejection Ratio	$(V-) - 0.2V < V_{CM} < (V+) - 2V$ $T_A = -40^\circ C$ to $+125^\circ C$	73 65	87		dB dB
	$V_S = 5.5V, (V-) - 0.2V < V_{CM} < (V+) + 0.2V$ $T_A = -40^\circ C$ to $+125^\circ C$	60 56	72		dB dB
A_{OL} Open-Loop Gain	$V_S = 5V, R_L = 5k\Omega, 0.125V < V_O < 4.875V$ $T_A = -40^\circ C$ to $+125^\circ C$	96 70	102		dB dB
	$V_S = 5V, R_L = 100k\Omega, 0.025V < V_O < 4.975V$ $T_A = -40^\circ C$ to $+125^\circ C$	101 76	110		dB dB
Output Characteristics					
V_{OUT} Output Voltage Swing from Rail	$R_L = 100k\Omega$		10		mV
R_{OUT} Open-Loop Output Impedance	$f = 1MHz, I_O = 0$		280		Ω
Frequency Domain Response					
GBW Gain Bandwidth Product			1		MHz
t_s Settling Time to 0.1% Overload Recovery Time	$V_{OUT} = 2V$ step, $G = +1$ $V_{in} * Gain > V_S$		3		μs
			1		μs
SR Slew Rate	$G = +1$		1		V/ μs
Distortion/Noise Response					
e_n Input Voltage Noise Density	$f = 10kHz$		40		nV/\sqrt{Hz}
V_{NOISE} Input Voltage Noise	$f = 0.1Hz$ to $10Hz$		6.5		μV_{pp}
THD+N Total Harmonic Distortion+ Noise	$V_S = 5V, V_O = 3V_{pp}, G = +1, f = 1kHz$		TBD		%
Temperature Range					
θ_{JA} Thermal Resistance	Specified Range SOT-23-5L, SOT-353, SOT-363, SOT-23-6L MSOP8, SOP8, SOP14, TSSOP14, MSOP10, DFNWB3 \times 3-10L	-40		125	$^\circ C$
			150		$^\circ C/W$

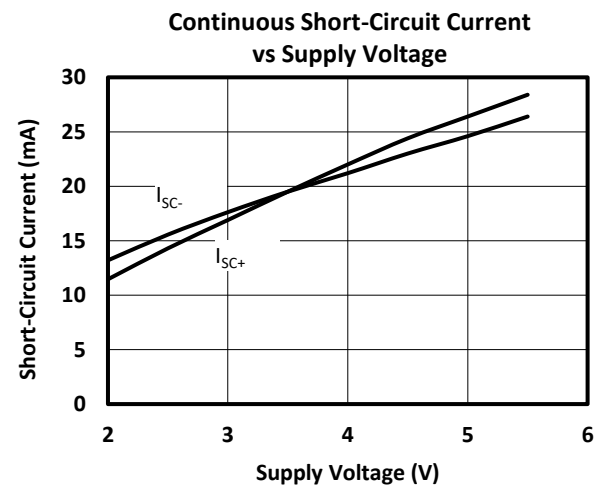
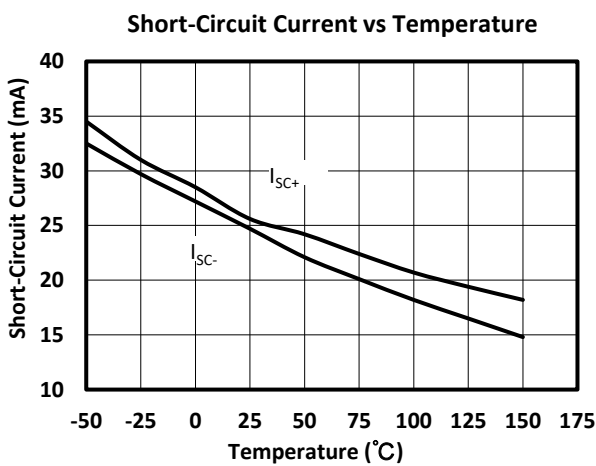
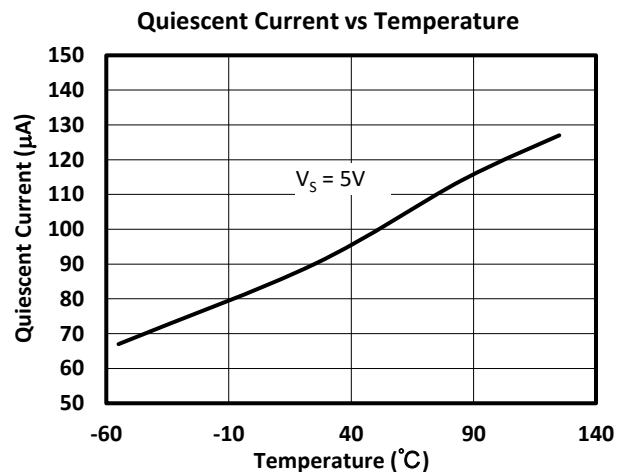
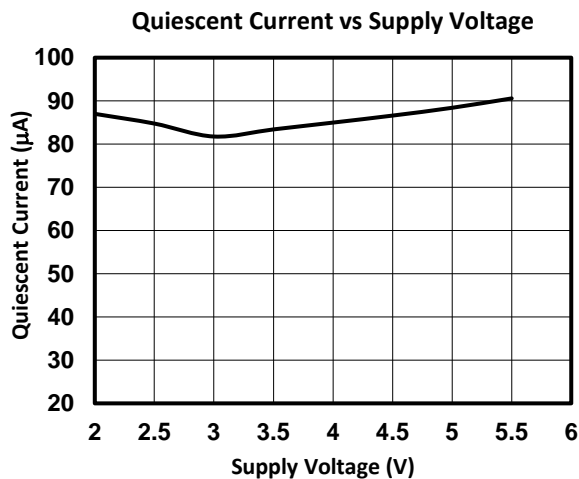
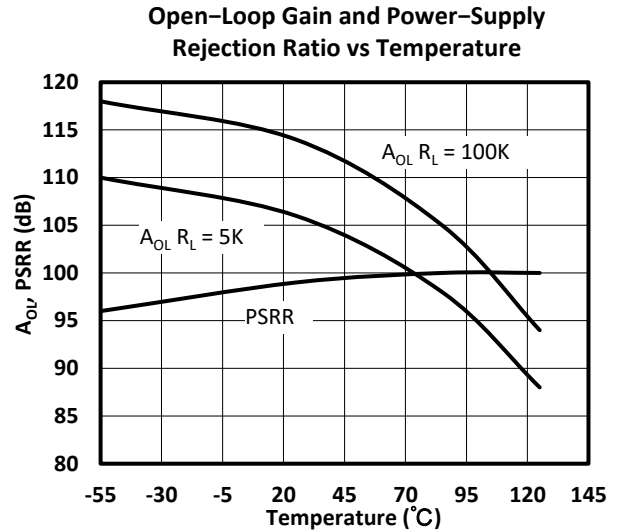
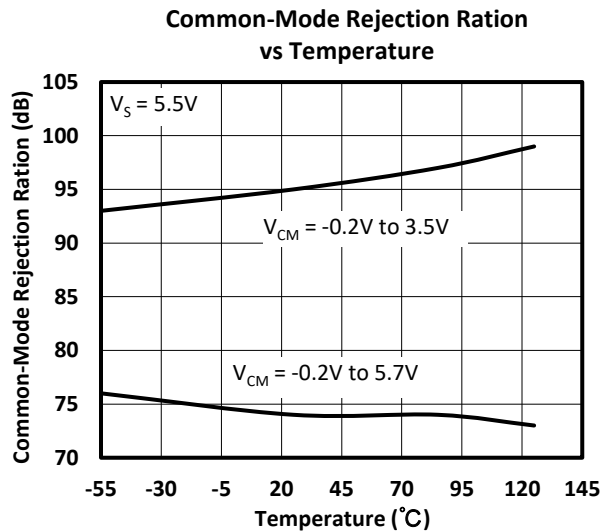
TYPICAL CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $R_L = 10\text{k}\Omega$ connected to $V_S / 2$, and $V_{OUT} = V_S / 2$ (unless otherwise noted)



TYPICAL CHARACTERISTICS (CONTINUE)

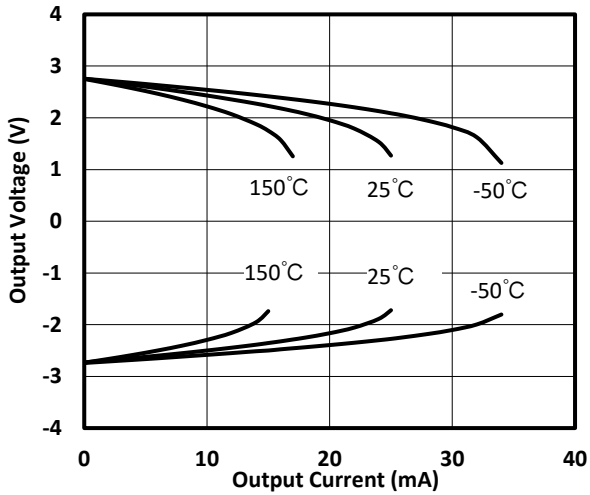
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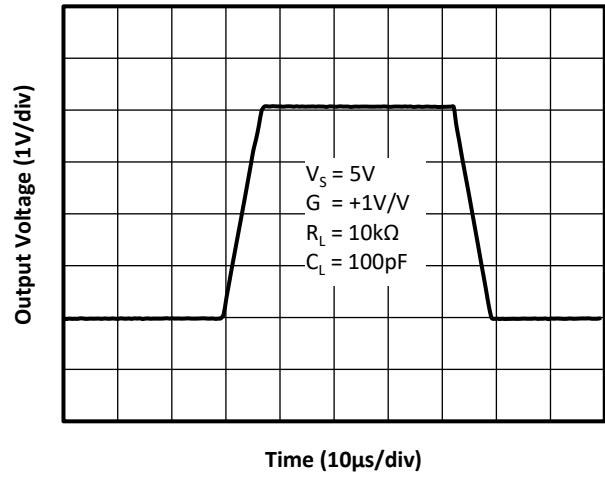
TYPICAL CHARACTERISTICS (CONTINUE)

At $T_A = +25^\circ\text{C}$, $R_L = 10\text{k}\Omega$ connected to $V_S / 2$, and $V_{OUT} = V_S / 2$ (unless otherwise noted)

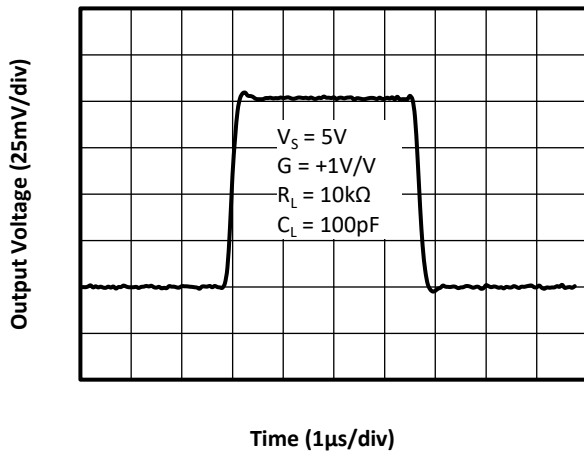
Output Voltage Swing vs Output Current



Large Signal Non-Inverting Pulse Response

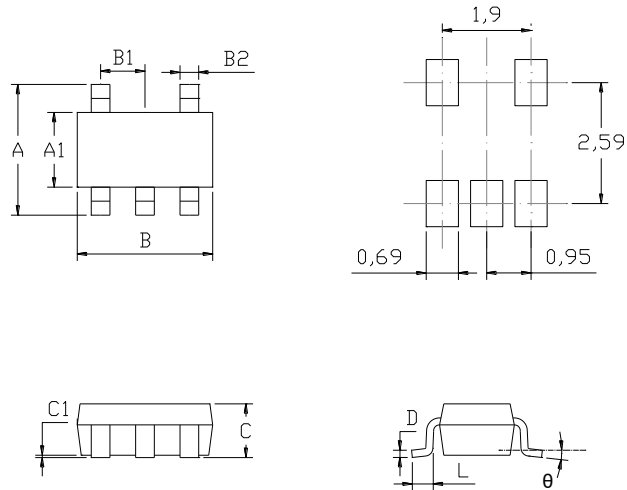


Small Signal Non-Inverting Pulse Response



MECHANICAL DIMENSIONS

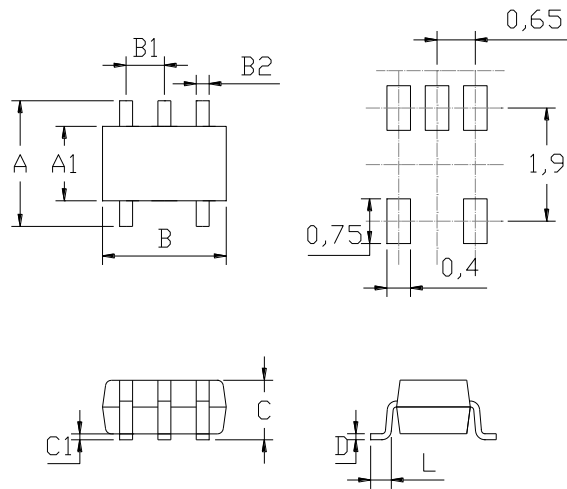
SOT-23-5L PACKAGE MECHANICAL DRAWING



SOT-23-5L PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	2.650	2.950	0.104	0.116
A1	1.500	1.700	0.059	0.067
B	2.820	3.020	0.111	0.119
B1	0.950		0.0374	
B2	0.300	0.500	0.012	0.020
C	1.050	1.250	0.041	0.049
C1	0	0.100	0	0.004
L	0.300	0.600	0.012	0.024
D	0.100	0.200	0.004	0.008
θ	0°	8°	0°	8°

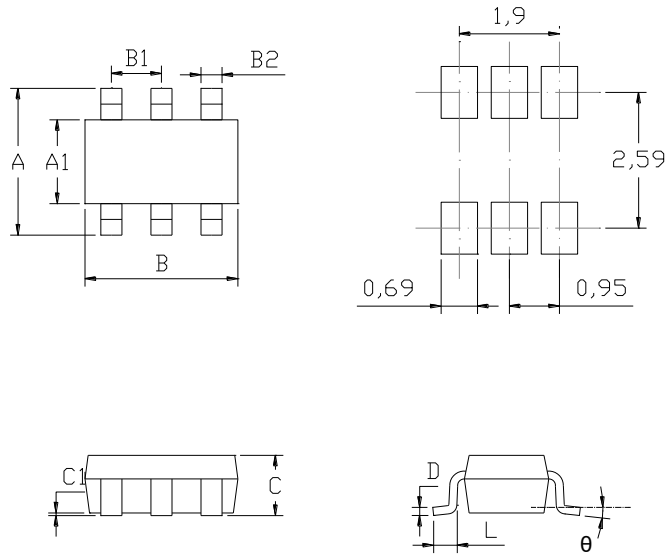
SOT-353 PACKAGE MECHANICAL DRAWING



SOT-353 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	2.150	2.450	0.085	0.096
A1	1.150	1.350	0.045	0.053
B	2.000	2.200	0.079	0.087
B1	0.650		0.026	
B2	0.150	0.350	0.006	0.014
C	0.900	1.000	0.035	0.039
C1	0	0.100	0	0.004
L	0.260	0.460	0.010	0.018
D	0.080	0.150	0.003	0.006
θ	0°	8°	0°	8°

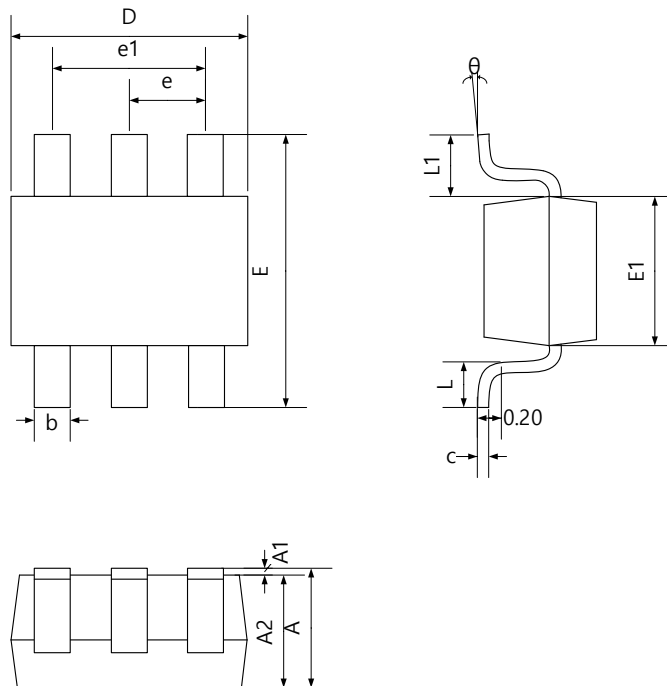
SOT-23-6L PACKAGE MECHANICAL DRAWING



SOT-23-6L PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	2.650	2.950	0.104	0.116
A1	1.500	1.700	0.059	0.067
B	2.820	3.020	0.111	0.119
B1	0.950		0.037	
B2	0.300	0.500	0.012	0.020
C	1.050	1.250	0.041	0.049
C1	0	0.100	0	0.004
L	0.300	0.600	0.012	0.024
D	0.100	0.200	0.004	0.008
theta	0°	8°	0°	8°

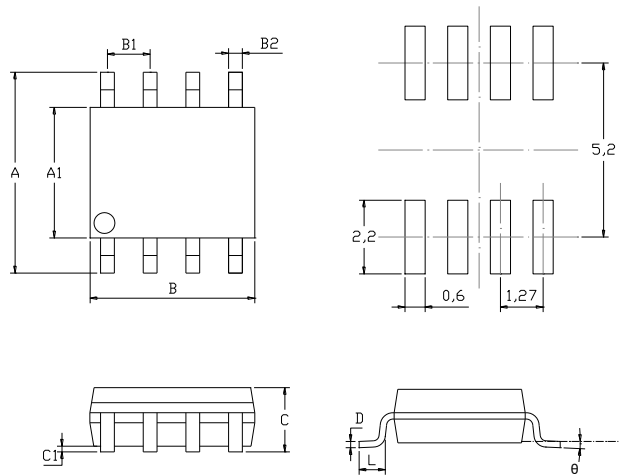
SOT-363 PACKAGE MECHANICAL DRAWING



SOT-363 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	0.900	1.100	0.035	0.043
A1	0	0.100	0	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.090	0.150	0.004	0.006
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.084	0.096
E1	1.150	1.350	0.045	0.053
e	0.650		0.026	
e1	1.200	1.400	0.047	0.055
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

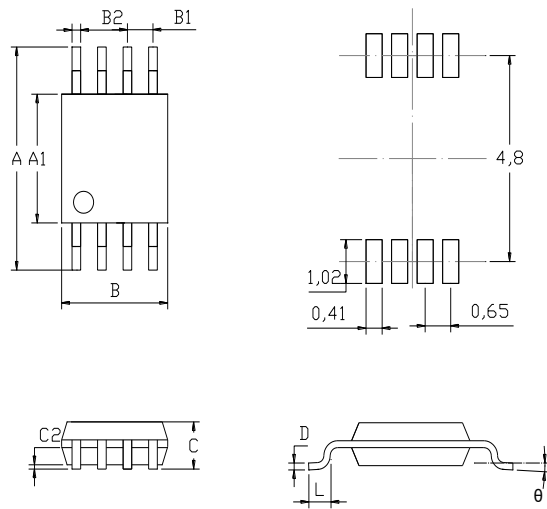
SOP8 PACKAGE MECHANICAL DRAWING



SOP8 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	5.800	6.200	0.228	0.244
A1	3.800	4.000	0.150	0.157
B	4.700	5.100	0.185	0.201
B1	1.270		0.050	
B2	0.330	0.510	0.013	0.020
C	1.450	1.750	0.057	0.069
C1	0.100	0.250	0.004	0.010
L	0.400	1.270	0.016	0.050
D	0.170	0.250	0.007	0.010
θ	0°	8°	0°	8°

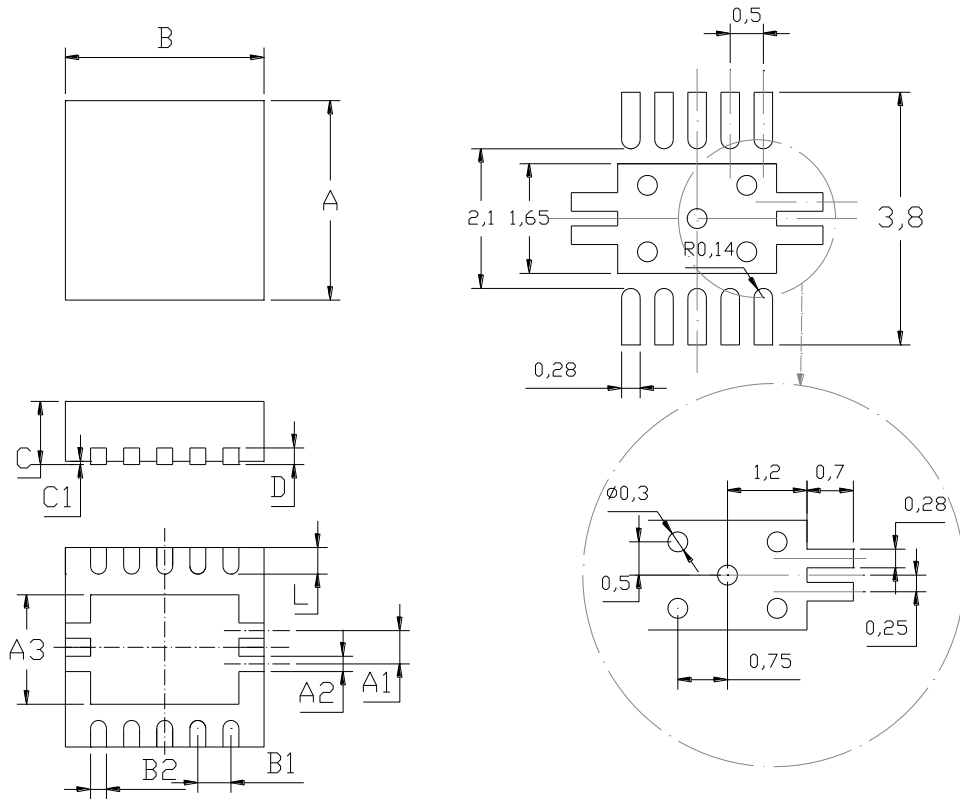
MSOP8 PACKAGE MECHANICAL DRAWING



MSOP8 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	4.750	5.050	0.187	0.199
A1	2.900	3.100	0.114	0.122
B	2.900	3.100	0.114	0.122
B1	0.650		0.026	
B2	0.250	0.380	0.010	0.015
C	0.820	1.100	0.032	0.043
C2	0.020	0.150	0.001	0.006
L	0.400	0.800	0.016	0.031
D	0.090	0.230	0.004	0.009
θ	0°	6°	0°	6°

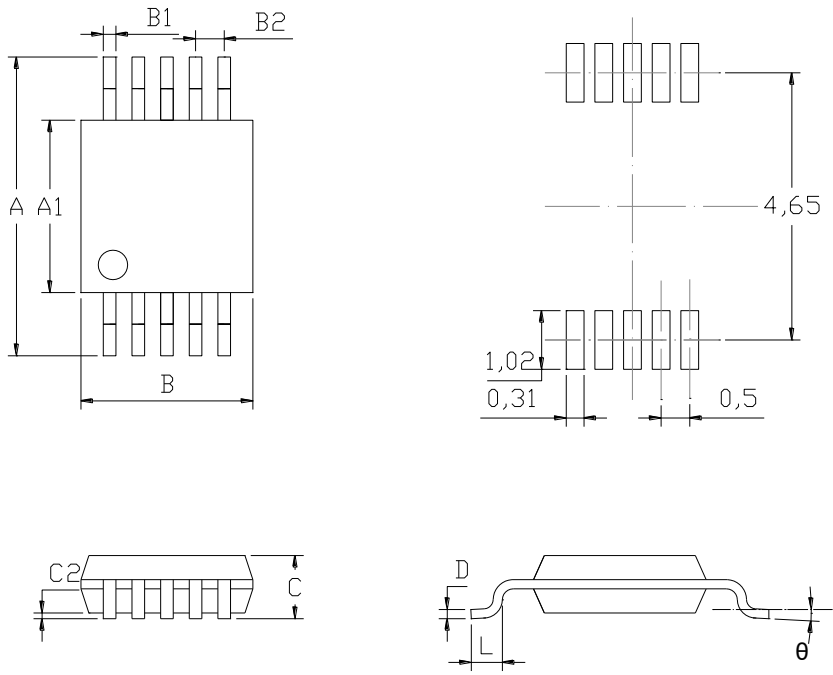
DFNWB3×3-10L PACKAGE MECHANICAL DRAWING



DFNWB3x3-10L PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	2.924	3.076	0.115	0.121
A1	0.500		0.020	
A2	0.200	0.300	0.008	0.012
A3	1.550	1.750	0.061	0.069
B	2.924	3.076	0.115	0.121
B1	0.500		0.020	
B2	0.200	0.300	0.008	0.012
C	0.700	0.900	0.028	0.035
C1	0	0.050	0	0.002
L	0.324	0.476	0.013	0.019
D	0.203		0.008	

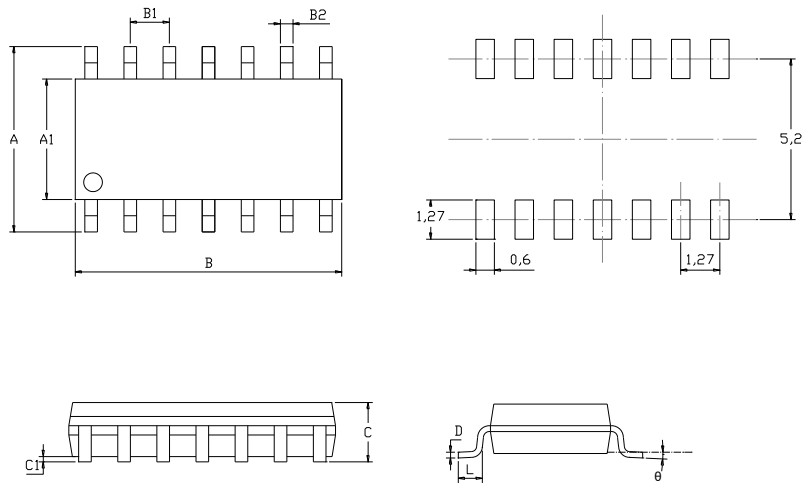
MSOP10 PACKAGE MECHANICAL DRAWING



MSOP10 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	4.750	5.050	0.187	0.199
A1	2.900	3.100	0.114	0.122
B	2.900	3.100	0.114	0.122
B2	0.500		0.020	
B1	0.180	0.280	0.007	0.011
C	0.820	1.100	0.032	0.043
C2	0.020	0.150	0.001	0.006
L	0.400	0.800	0.016	0.031
D	0.090	0.230	0.004	0.009
θ	0°	6°	0°	6°

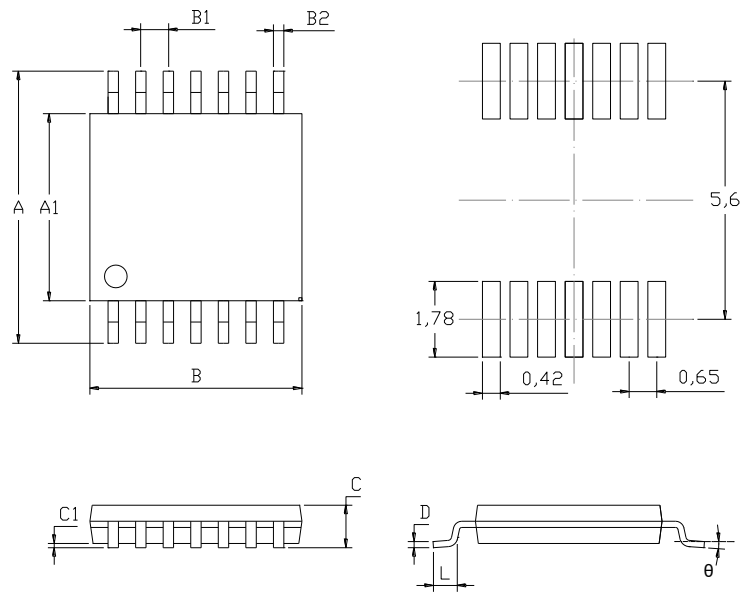
SOP14 PACKAGE MECHANICAL DRAWING



SOP14 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	5.800	6.200	0.228	0.244
A1	3.800	4.000	0.150	0.157
B	8.450	8.850	0.333	0.348
B1	1.27		0.050	
B2	0.310	0.510	0.012	0.020
C		1.750		0.069
C1	0.100	0.250	0.004	0.010
L	0.400	1.270	0.016	0.050
D	0.100	0.250	0.004	0.010
θ	0°	8°	0°	8°

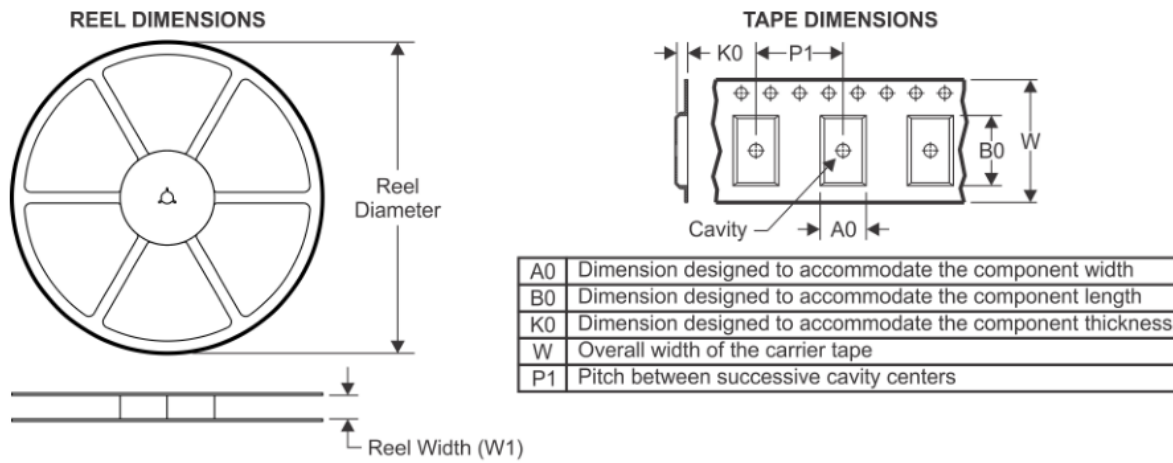
TSSOP14 PACKAGE MECHANICAL DRAWING



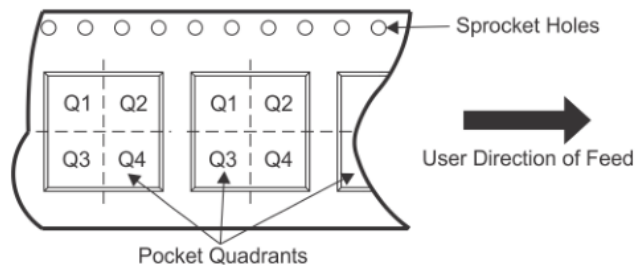
TSSOP14 PACKAGE MECHANICAL DATA

symbol	dimensions			
	millimeters		inches	
	min	max	min	max
A	6.250	6.550	0.246	0.258
A1	4.300	4.500	0.169	0.177
B	4.900	5.100	0.193	0.201
B1	0.650		0.026	
B2	0.190	0.300	0.007	0.012
C		1.200		0.047
C1	0.050	0.150	0.002	0.006
L	0.500	0.70	0.020	0.028
D	0.090	0.200	0.004	0.008
θ	1°	7°	1°	7°

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS2158ASOT235R	SOT-23-5L	5	3000	180.0	9.0	3.2	3.3	1.4	4.0	8.0	Q3
TS2158ASOT353R	SOT-353	5	3000	180.0	9.0	3.2	3.3	1.4	4.0	8.0	Q3
TS2158ATSOT235R	SOT-23-5L	5	3000	180.0	9.0	3.2	3.3	1.4	4.0	8.0	Q3
TS2158ATSOT353R	SOT-353	5	3000	180.0	9.0	3.2	3.3	1.4	4.0	8.0	Q3
TS2159ASOT236L	SOT-23-6L	6	3000	180.0	9.0	3.2	3.3	1.4	4.0	8.0	Q3
TS2159ASOT363R	SOT-363	6	3000	180.0	9.0	3.2	3.3	1.4	4.0	8.0	Q3
TS2159ASOP8R	SOP8	8	2500	330.0	12.4	6.4	5.4	2.1	8.0	12.0	Q1
TS2258ASOP8R	SOP8	8	2500	330.0	12.4	6.4	5.4	2.1	8.0	12.0	Q1
TS2258AMSOP8R	MSOP8	8	3000	330.0	12.4	5.2	3.3	1.5	8.0	12.0	Q1
TS2259AMSOP10R	MSOP10	10	3000	330.0	12.4	5.2	3.3	1.5	8.0	12.0	Q1
TS2259ADFNWB3310LR	DFNWB3x3-10L	10	5000	330.0	12.4	6.4	5.4	2.1	8.0	12.0	Q1
TS2458ASOP14R	SOP14	14	2500	330.0	12.4	6.5	9.0	2.1	8.0	16.0	Q1
TS2458ATSSOP14R	TSSOP14	14	3000	330.0	12.4	6.8	5.4	1.2	8.0	12.0	Q1

REVISION HISTORY

NOTE: Page numbers for previous revisions may be different from that of the current version.

2020/6/17 — REV KY1.0.8A to REV KY1.0.9A

Added ESD CAUTION.....	2
Updated ELECTRICAL CHARACTERISTICS (Test Conditions)	4

2020/8/13 — REV KY1.0.9A to REV KY1.1.9A

Added package information of TS2159A and TS2259A.....	2
Updated TYPICAL CHARACTERISTICS	6

2020/9/16 — REV KY1.1.9A to REV KY1.1.10A

Changed SC70-5 to SOT-353 and changed SC70-6 to SOT-363.....	2
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2021/07/12 — REV KY1.1.10A to REV KY1.2.10A

Updated MSOP8,MSOP10,TSSOP14 and SOT-353 SPQ.....	2,17
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