UMW TSV6390/6391

Micropower (60 μA), wide bandwidth (2.4 MHz) CMOS operational amplifiers

1.Description

The UMW TSV6390, TSV6391, and their "A" versions are single operational amplifiers (op amps) offering low voltage, low power operation, and rail-to-rail input and output.With a very low input bias current and low offset voltage (500 μV maximum for the A version), the UMW TSV6390 and UMW TSV6391 are ideal for applications requiring precision. The devices can operate at power supplies ranging from 1.5 to 5.5 V, and are therefore ideal for battery-powered devices, extending battery life.

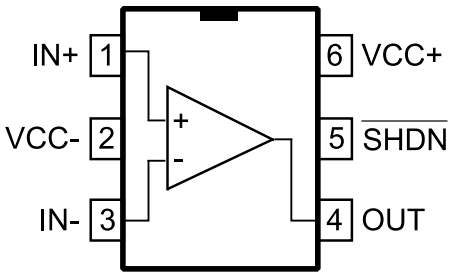
2.Features

- Low offset voltage: 500μV max (A version)
- Low power consumption: 60μA typ at 5V
- Low supply voltage: 1.5V - 5.5V
- Gain bandwidth product: 2.4 MHz typical
- Stable in gain configuration (-3 or 4)
- Low power shutdown mode: 5nA typical
- High output current: 63mA at V_{CC}=5V
- Low input bias current: 1pA typical
- Rail-to-rail input and output
- Extended temperature range: -40°C to 125°C
- 4 kV human body model

3.Applications

- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

4.Pinning information



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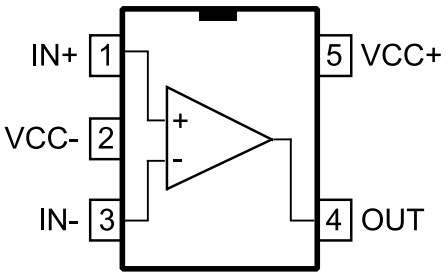

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5.Absolute Maximum Ratings

Parameter		Symbol	Value	Units
Supply voltage (1)		V_{CC}	6	V
Differential input voltage (2)		V_{id}	$\pm V_{CC}$	V
Input voltage (3)		V_{in}	(V_{CC-})-0.2 to (V_{CC+})+0.2	V
Input current (4)		I_{in}	10	mA
Shutdown voltage (3)		SHDN	(V_{CC-})-0.2 to (V_{CC+})+0.2	V
Storage temperature		T_{STG}	-65 to 150	°C
Maximum junction temperature		T_J	150	°C
Thermal resistance junction-to-ambient (5)(6)	SC70-6	R_{thja}	232	°C/W
	SOT23-6		240	°C/W
	SC70-5		205	°C/W
	SOT23-5		250	°C/W
HBM: human body model (7)		ESD	4	kV
MM: machine model (8)			300	V
CDM: charged device model (9)			1.5	kV
Latch-up immunity			200	mA

Notes:

(1) All voltage values, except differential voltage, are with respect to network ground terminal.

(2) Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.

(3) V_{CC} - V_{in} must not exceed 6 V, V_{in} must not exceed 6 V.

(4) Input current must be limited by a resistor in series with the inputs.

(5) Short-circuits can cause excessive heating and destructive dissipation.

(6) Rth are typical values.

(7) Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.

(8) Machine mode: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating.

(9) Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

6.Operating conditions

Parameter	Symbol	Rating	Units
Supply voltage	V_{CC}	1.5 to 5.5	V
Common mode input voltage range	V_{icm}	(V_{CC-})-0.1 to (V_{CC+})+0.1	V
Operating free air temperature range	T_{oper}	40 to +125	°C

7.1 DC Electrical Characteristics

(V_{CC+})=1.8V with (V_{CC-})=0V, V_{icm}=V_{CC}/2, T_{amb}=25°C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Offset voltage	V_{io}	UMW TSV6390 and TSV6391			3	mV
		UMW TSV6390A and TSV6391A			0.5	mV
		T_{min}<T_{op}<T_{max} UMW TSV6390 and TSV6391			4.5	mV
		T_{min}<T_{op}<T_{max} UMW TSV6390A and TSV6391A			2	mV
Input offset voltage drift	$\Delta V_{io}/\Delta T$			2		µV/°C
Input offset current, V_{out}=V_{CC}/2	I_{io}			1	10	pA
		T_{min}<T_{op}<T_{max}		1	100	pA
Input bias current, V_{out}=V_{CC}/2	I_{ib}			1	10	pA
		T_{min}<T_{op}<T_{max}		1	100	pA
Common mode rejection ratio, 20 log ($\Delta V_{ic}/\Delta V_{io}$)	CMR	0V to 1.8V, V_{out}=0.9V	53	74		dB
		T_{min}<T_{op}<T_{max}	51			dB
Large signal voltage gain	A_{vd}	R_L=10kΩ, V_{out}=0.5V to 1.3V	85	95		dB
		T_{min}<T_{op}<T_{max}	80			dB
High-level output voltage (V_{OH}=V_{CC}-V_{OUT})	V_{OH}	R_L=10kΩ		5	35	mV
		T_{min}<T_{op}<T_{max}			50	mV
Low-level output voltage	V_{OL}	R_L=10kΩ		4	35	mV
		T_{min}<T_{op}<T_{max}			50	mV
I_{sink}	I_{OUT}	V_{out}=1.8V	6	12		mA
		T_{min}<T_{op}<T_{max}	4			mA
I_{source}		V_{out}=0V	6	10		mA
		T_{min}<T_{op}<T_{max}	4			mA
Supply current $\overline{SHDN}$=V_{CC}	I_{CC}	No load, V_{out}=V_{CC}/2	40	50	60	µA
		T_{min}<T_{op}<T_{max}			62	µA

Parameter	Symbol	Conditions	Min	Typ	Max	Units
AC performance						
Gain bandwidth product	GBP	R_L=10kΩ, C_L=100pF		2		MHz
Minimum gain for stability	Gain	Phase margin=60°, R_f=10kΩ		4		V/V
		R_L=10kΩ, C_L=20pF		-3		V/V
Slew rate	SR	R_L=10kΩ,C_L=100pF,V_{out}=0.5V to 1.3V		0.7		V/μs
Equivalent input noise voltage	e_n	f=1kHz		60		nV/√Hz
		f=10kHz		33		nV/√Hz

7.2 DC Electrical Characteristics

Shutdown characteristics V_{CC}=1.8V

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply current in shutdown mode (all operators)	I_{CC}	$\overline{SHDN}$=V_{CC-}		2.5	50	nA
		T_{min}<T_{op}<85°C			200	nA
		T_{min}<T_{op}<125°C			1.5	μA
Amplifier turn-on time	t_{on}	R_L=2kΩ, V_{out}=V_{CC-} to V_{CC-} + 0.2V		300		ns
Amplifier turn-off time	t_{off}	R_L=2kΩ,V_{out}=V_{CC+} -0.5V to V_{CC+} -0.7V		20		ns
$\overline{SHDN}$ logic high	V_{IH}		1.3			V
$\overline{SHDN}$ logic low	V_{IL}				0.5	V
$\overline{SHDN}$ current high	I_{IH}	$\overline{SHDN}$=V_{CC+}		10		pA
$\overline{SHDN}$ current low	I_{IL}	$\overline{SHDN}$=V_{CC-}		10		pA
Output leakage in shutdown mode	I_{OLeak}	$\overline{SHDN}$=V_{CC-}		50		pA
		T_{min}<T_{op}<T_{max}		1		nA

7.3 DC Electrical Characteristics

(V_{CC+})=3.3V with (V_{CC-})=0V, V_{icm}=V_{CC}/2, T_{amb}=25°C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Offset voltage	V_{io}	UMW TSV6390 and TSV6391			3	mV
		UMW TSV6390A and TSV6391A			0.5	mV
		T_{min}<T_{op}<T_{max} UMW TSV6390 and TSV6391			4.5	mV
		T_{min}<T_{op}<T_{max} UMW TSV6390A and TSV6391A			2	mV
Input offset voltage drift	$\Delta V_{io}/\Delta T$			2		µV/°C
Input offset current	I_{io}			1	10	pA
		T_{min}<T_{op}<T_{max}		1	100	pA
Input bias current	I_{ib}			1	10	pA
		T_{min}<T_{op}<T_{max}		1	100	pA
Common mode rejection ratio, 20 log ($\Delta V_{ic}/\Delta V_{io}$)	CMR	0V to 3.3V, V_{out}=1.65V	57	79		dB
		T_{min}<T_{op}<T_{max}	53			dB
Large signal voltage gain	A_{vd}	R_L=10kΩ, V_{out}=0.5V to 2.8V	88	98		dB
		T_{min}<T_{op}<T_{max}	83			dB
High-level output voltage (V_{OH}=V_{CC}-V_{OUT})	V_{OH}	R_L=10kΩ		6	35	mV
		T_{min}<T_{op}<T_{max}			50	mV
Low-level output voltage	V_{OL}	R_L=10kΩ		7	35	mV
		T_{min}<T_{op}<T_{max}			50	mV
I_{sink}	I_{OUT}	V_{out}=3.3V	23	45		mA
		T_{min}<T_{op}<T_{max}	20	42		mA
I_{source}		V_{out}=0V	23	38		mA
		T_{min}<T_{op}<T_{max}	20			mA
Supply current $\overline{SHDN}$=V_{CC}	I_{CC}	No load, V_{out}=V_{CC}/2	43	55	64	µA
		T_{min}<T_{op}<T_{max}			66	µA

Parameter	Symbol	Conditions	Min	Typ	Max	Units
AC performance						
Gain bandwidth product	GBP	R_L=10kΩ, C_L=100pF		2.2		MHz
Minimum gain for stability	Gain	Phase margin=60°, R_f=10kΩ		4		V/V
		R_L=10kΩ, C_L=20pF		-3		V/V
Slew rate	SR	R_L=10kΩ,C_L=100pF,V_{out}=0.5V to 2.8V		0.9		V/µs
Equivalent input noise voltage	e_n	f=1kHz		65		nV/√Hz

7.4 DC Electrical Characteristics

(V_{CC+})=5V with (V_{CC-})=0V, V_{icm}=V_{CC}/2, T_{amb}=25°C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Offset voltage	V_{io}	UMW TSV6390 and TSV6391			3	mV
		UMW TSV6390A and TSV6391A			0.5	mV
		T_{min}<T_{op}<T_{max} UMW TSV6390 and TSV6391			4.5	mV
		T_{min}<T_{op}<T_{max} UMW TSV6390A and TSV6391A			2	mV
Input offset voltage drift	$\Delta V_{io}/\Delta T$			2		µV/°C
Input offset current, V_{out}=V_{CC}/2	I_{io}			1	10	pA
		T_{min}<T_{op}<T_{max}		1	100	pA
Input bias current, V_{out}=V_{CC}/2	I_{ib}			1	10	pA
		T_{min}<T_{op}<T_{max}		1	100	pA
Common mode rejection ratio, 20 log ($\Delta V_{ic}/\Delta V_{io}$)	CMR	0V to 5V, V_{out}=2.5V	60	80		dB
		T_{min}<T_{op}<T_{max}	55			dB
Supply voltage rejection ratio 20 log ($\Delta V_{CC}/\Delta V_{io}$)	SVR	V_{CC}=1.8 to 5V	75	93		dB
		T_{min}<T_{op}<T_{max}	73			dB
Large signal voltage gain	A_{vd}	R_L=10kΩ, V_{out}=0.5V to 4.5V	89	98		dB
		T_{min}<T_{op}<T_{max}	84			dB
Low-level output voltage (V_{OH}=V_{CC}-V_{OUT})	V_{OH}	R_L=10kΩ		7	35	mV
		T_{min}<T_{op}<T_{max}			50	mV
Low-level output voltage	V_{OL}	R_L=10kΩ		6	35	mV
		T_{min}<T_{op}<T_{max}			50	mV

Parameter	Symbol	Conditions	Min	Typ	Max	Units
I_{sink}	I_{OUT}	V_O=5V	40	65		mA
		T_{min}<T_{op}<T_{max}	35			mA
I_{source}		V_O=0V	40	72		mA
		T_{min}<T_{op}<T_{max}	35			mA
Supply current, $\overline{SHDN}$=V_{CC}	I_{CC}	No load, V_{out}=V_{CC}/2	50	60	69	µA
		T_{min}<T_{op}<T_{max}			72	µA
AC performance						
Gain bandwidth product	GBP	R_L=10kΩ, C_L=100pF		2.4		MHz
Minimum gain for stability	Gain	Phase margin=60°, R_f=10kΩ		4		V/V
		R_L=10kΩ, C_L=20pF		-3		V/V
Slew rate	SR	R_L=10kΩ,C_L=100pF		1.1		V/µs
Equivalent input noise voltage	e_n	f=1kHz		60		nV/√Hz
		f=10kHz		33		nV/√Hz
Total harmonic distortion + noise	THD+N	A_V=-10, f_{in}=1kHz, R=100kΩ, V_{icm}=V_{CC}/2, V_{in}=40mV_{pp}		0.11		%

7.5 DC Electrical Characteristics

Shutdown characteristics V_{CC}=5V

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply current in shutdown mode (all operators)	I_{CC}	$\overline{SHDN}$=V_{CC}		5	50	nA
		T_{min}<T_{op}<85°C			200	nA
		T_{min}<T_{op}<125°C			1.5	μA
Amplifier turn-on time	t_{on}	R_L=2kΩ, V_{out}=V_{CC-} to V_{CC-} + 0.2V		300		ns
Amplifier turn-off time	t_{off}	R_L=2kΩ,V_{out}=V_{CC+} -0.5V to V_{CC+} -0.7V		30		ns
$\overline{SHDN}$ logic high	V_{IH}		4.5			V
$\overline{SHDN}$ logic low	V_{IL}				0.5	V
$\overline{SHDN}$ current high	I_{IH}	$\overline{SHDN}$=V_{CC+}		10		pA
$\overline{SHDN}$ current low	I_{IL}	SHDN=V_{CC-}		10		pA
Output leakage in shutdown mode	I_{OLeak}	SHDN=V_{CC-}		50		pA
		T_{min}<T_{op}<T_{max}		1		nA

8.1 Typical characteristic

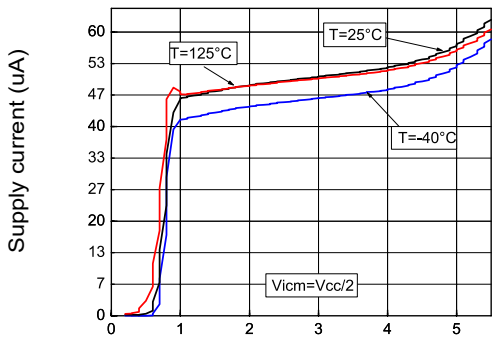


Figure 1: Supply current vs. supply voltage at V_{icm}= V_{CC}/2

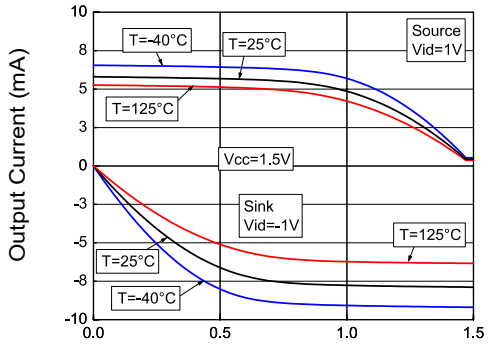


Figure 2: Output current vs. output voltage at V_{CC}=1.5V

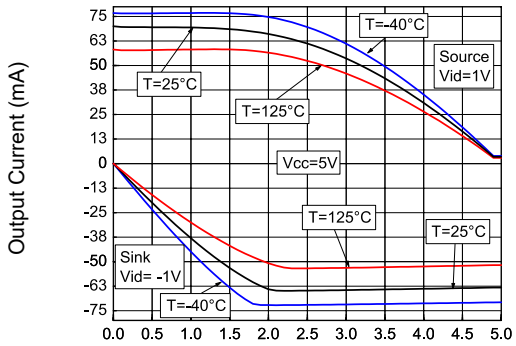


Figure 3: Output current vs. output voltage at V_{CC}=5V

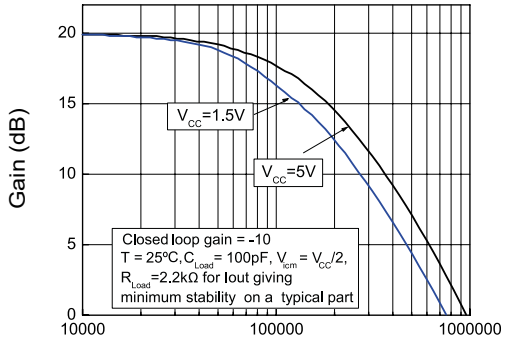


Figure 4: Peaking at closed loop gain = -10

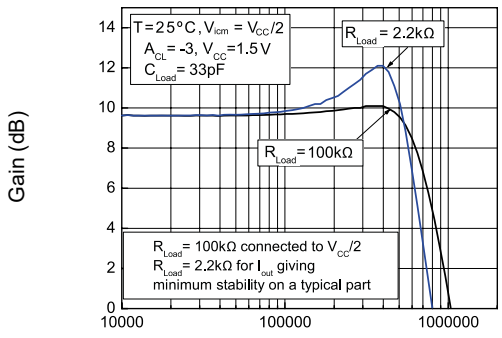


Figure 5: Peaking at closed loop gain =-3, V_{CC}=1.5V

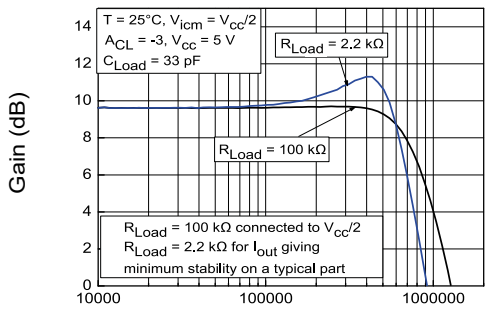


Figure 6: Peaking at closed loop gain = -3, V_{CC}=5V

8.2 Typical characteristic

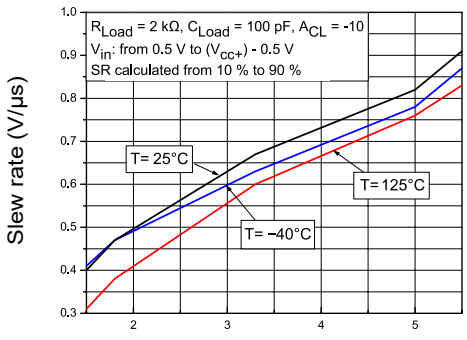


Figure 7: Positive slew rate vs. supply voltage

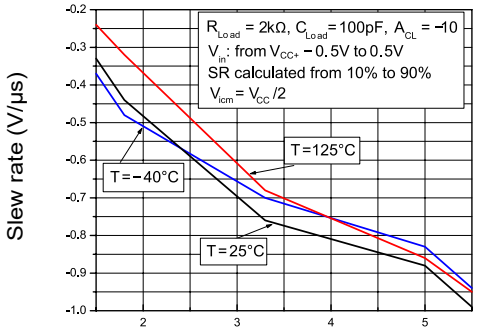


Figure 8: Negative slew rate vs. supply voltage

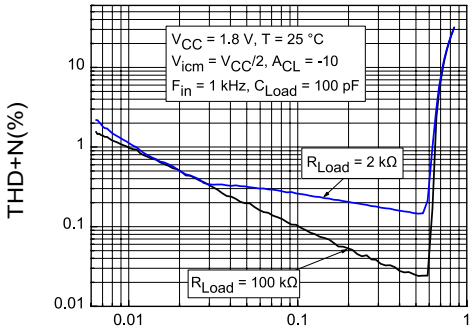


Figure 9: Distortion + noise vs. output voltage at V_{CC}=1.8V

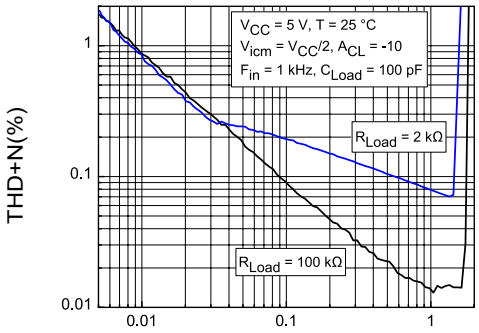


Figure 10: Distortion + noise vs. output voltage at V_{CC}=5V

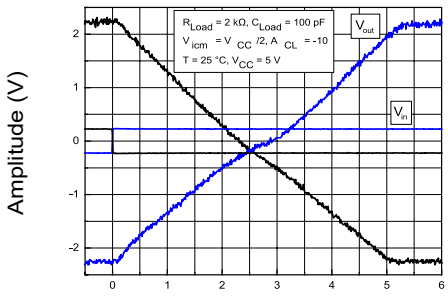


Figure 11: Slew rate timing

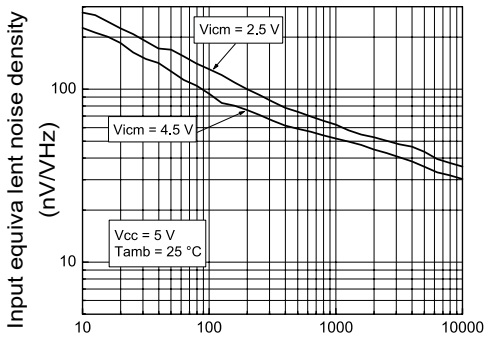


Figure 12: Noise vs. frequency at V_{CC}=5V

8.3 Typical characteristic

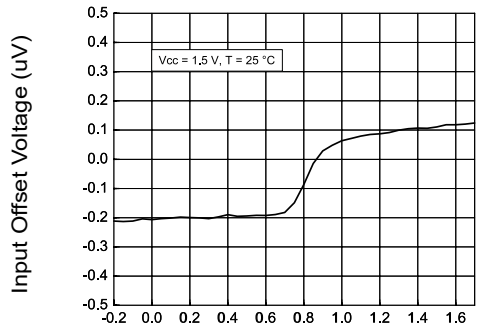


Figure 18: Input offset voltage vs input common mode at V_{CC}=1.5V

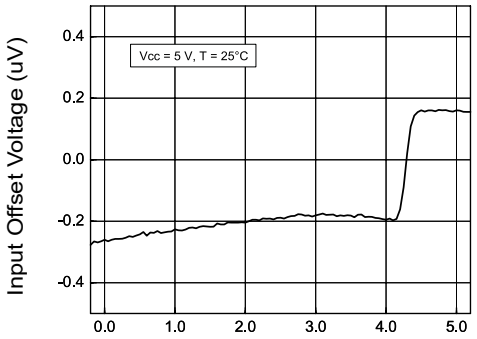


Figure 19: Input offset voltage vs input common mode at V_{CC}=5V

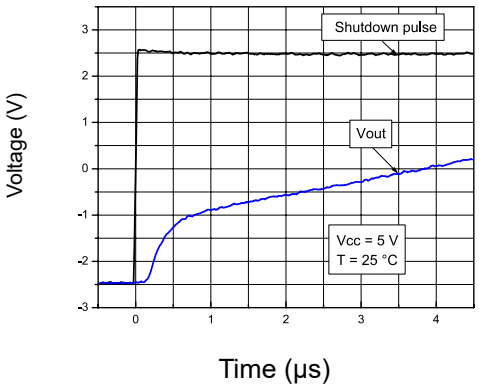


Figure 20: Turn-on time, V_{CC}=5V, Vout pulled down, T=25°C

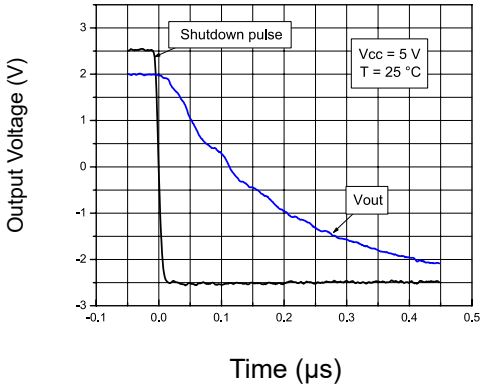


Figure 21: Turn-off time, V_{CC}=5V, Vout pulled down, T=25°C

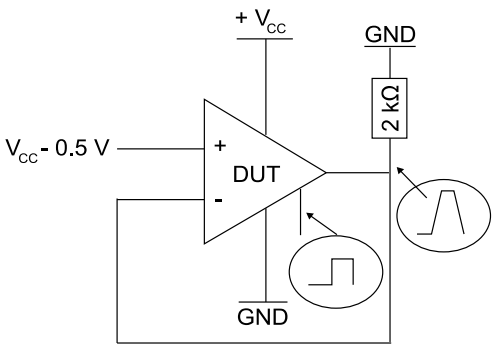


Figure 21: Test configuration for turn-on time (Vout pulled down)

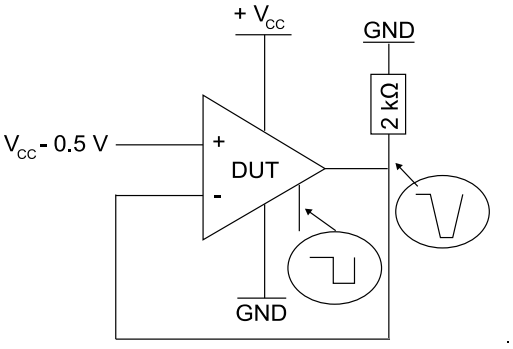
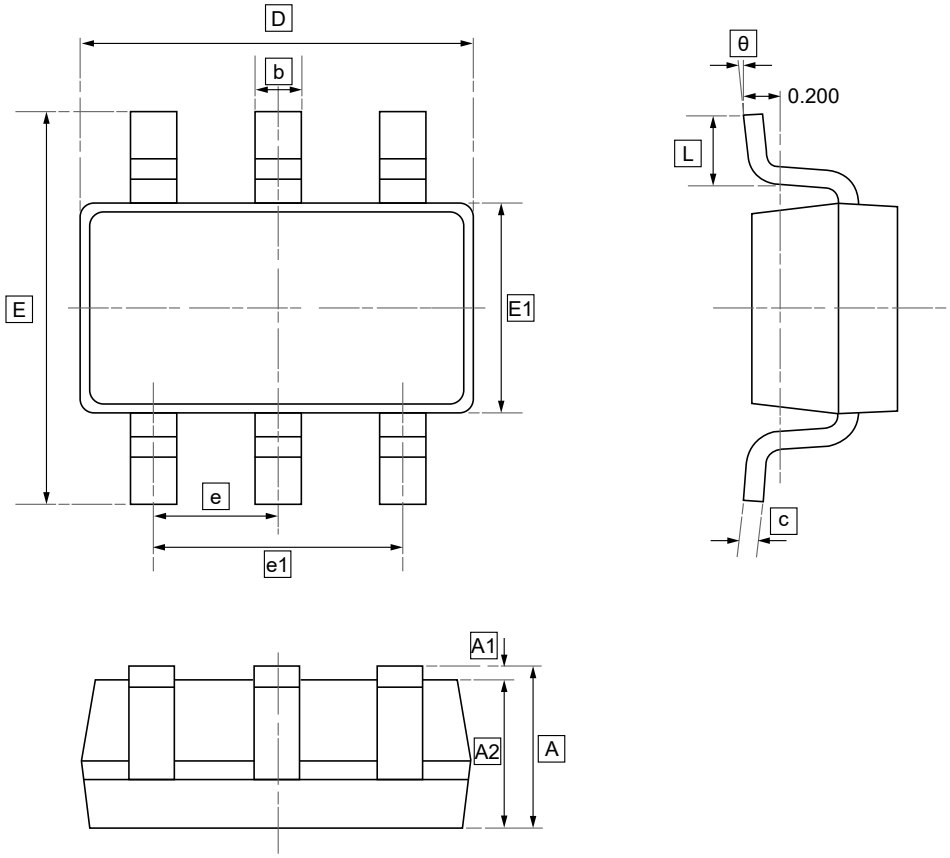


Figure 21: Test configuration for turn-off time (Vout pulled down)

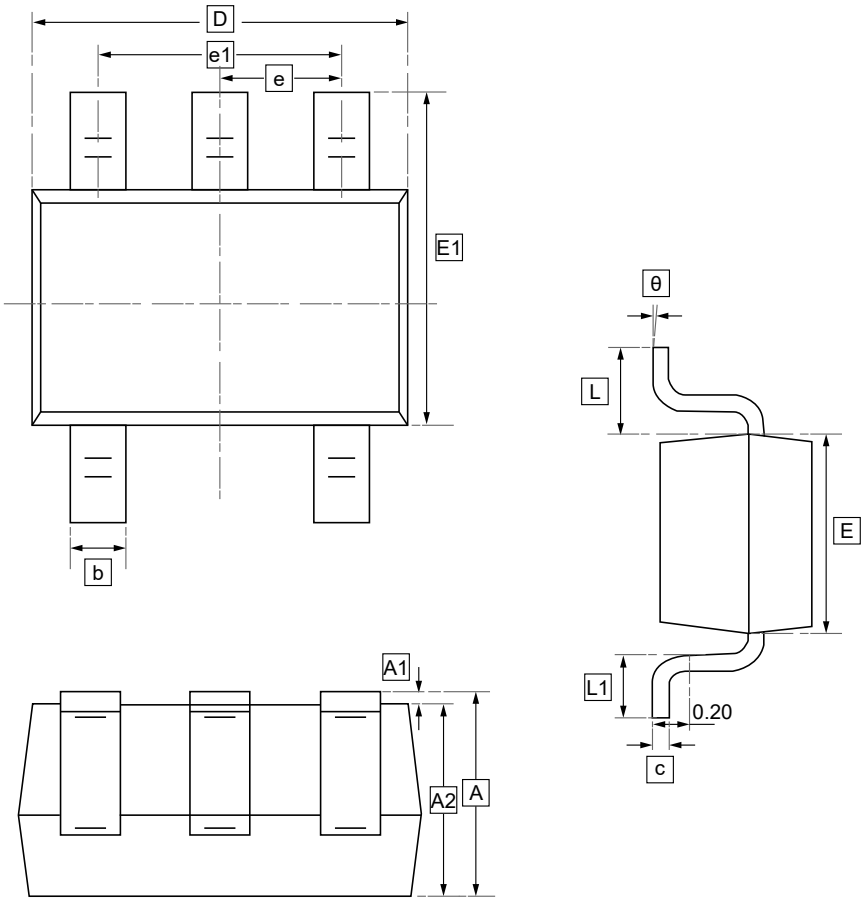
9.1 SOT23-6 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	c	D	E1	E	e	e1	L	θ
Min	1.050	0.000	1.050	0.300	0.100	2.820	1.500	2.650	0.950	1.800	0.300	0°
Max	1.250	0.100	1.150	0.500	0.200	3.020	1.700	2.950	BSC	2.000	0.600	8°

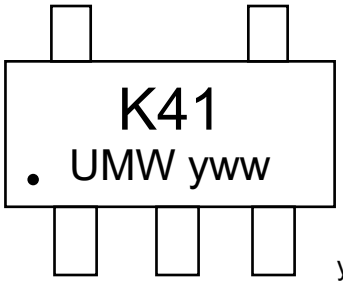
9.2 SC70-5 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	c	D	E	E1	e	e1	L	θ
Min	0.90	0.00	0.90	0.15	0.08	2.05	1.15	2.15	0.65	1.20	0.26	7°
Max	1.10	0.10	1.00	0.35	0.15	2.25	1.35	2.45	TYP	1.40	0.46	REF.

10.Ordering information



yww: Batch Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW TSV6391ICT	K20	SC70-5	3000	Tape and reel
UMW TSV6391AICT	K41	SC70-5	3000	Tape and reel
UMW TSV6390ILT	K19	SOT23-6	3000	Tape and reel
UMW TSV6390AILT	K42	SOT23-6	3000	Tape and reel

11.Disclaimer

UMW reserves the right to make changes to all products, specifications. Customers should obtain the latest version of product documentation and verify the completeness and currency of the information before placing an order.

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