Precision, Zero-Drift, Zero-Crossover, True Rail-to-Rail Input/Output Operational Amplifiers

General Description

The ET85522M precision operational amplifiers are ultra-low noise, fast-settling, zero-drift, zero-crossover devices that provide rail-to-rail input and output operation.

These features and excellent ac performance, combined with only 0.5 μV of offset and 0.005 μV/°C of drift over temperature, makes the ET85522M a great choice for driving high-precision, analog-to-digital converters (ADCs) or buffering the output of high-resolution, digital-to-analog converters (DACs). This design results in excellent performance when driving analog-to-digital converters (ADCs) without degradation of linearity.

The ET85522M is specified over the industrial temperature range of -40°C to +125°C. It is offered in the SOP8 packages.

Features

- Ultra-low offset voltage: ±0.5 μV (typical)
- Zero drift: ±0.005 μV/°C (typical)
- Zero crossover: 140 dB CMRR true RRIO (typical)
- Low noise: 7.0 nV/√Hz at 1kHz
- No 1/f noise: 140 nV_{PP} (0.1 Hz to 10 Hz)
- Fast settling: 2 μs (1 V to 0.01%)
- Gain bandwidth: 10 MHz
- Single supply: 2.5 V to 5.5 V
- Dual supply: ±1.25 V to ±2.75 V
- True rail-to-rail input and output
- EMI/RFI filtered inputs

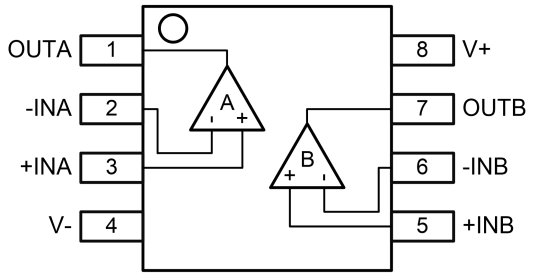
Applications

- Merchant network and server PSU
- Notebook PC power adapter design
- Weighing scale
- Lab and field instrumentation
- Battery testing
- Electronic thermometer
- Temperature transmitter

Device Information

Part No.	Package	Packing Option	MSL
ET85522M	SOP8	Tape and Reel, 4K	3

Pin Configuration



Top View

Pin Function

Pin Number	Symbol	Descriptions
1,7	OUT	Output
4	V-	Negative supply
3,5	+IN	Non-inverting input
2,6	-IN	Inverting input
8	V+	Positive supply

Functional Description

Overview

The ET85522M zero-drift amplifiers are engineered with the unique combination of a precision auto-calibration technique paired with a low-noise, low-ripple, input charge pump. The amplifier offers ultra-low input offset voltage and drift and achieve excellent input and output dynamic linearity. The ET85522M operates from 2.5 V to 5.5 V, is unity-gain stable, and is designed for a wide range of general-purpose and precision applications. The integrated, low-noise charge pump allows true rail-to-rail input common-mode operation without distortion associated with complementary rail-to-rail input topologies (input crossover distortion). The ET85522M strengths also include 10 MHz bandwidth, 7 nV/√Hz noise spectral density, and no 1/f noise, making the ET85522M optimal for interfacing with sensor modules and buffering high-fidelity, digital-to-analog converters (DACs).

Functional Block Diagram

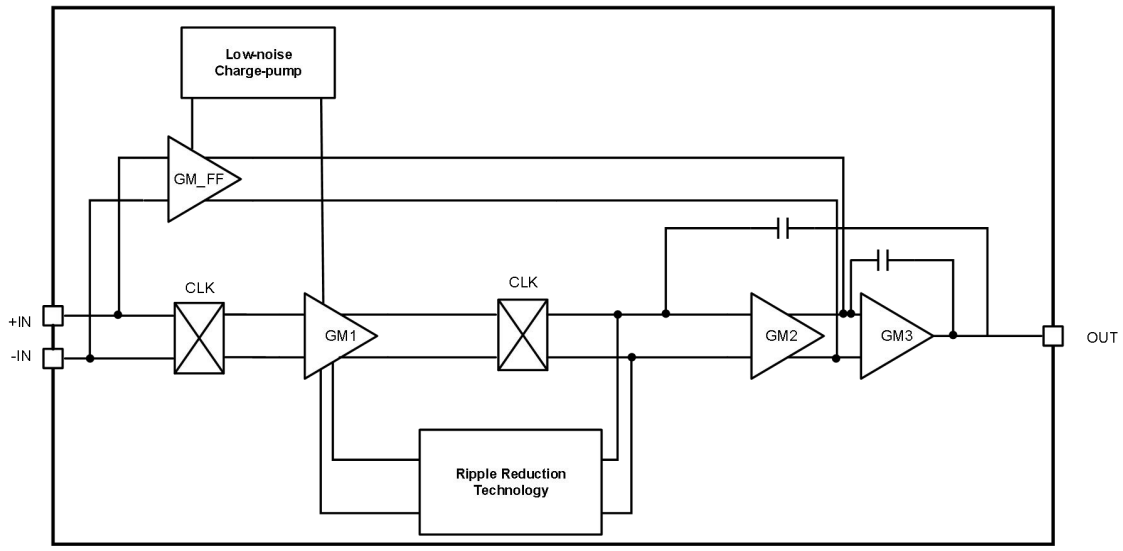


Figure 1. Functional Block Diagram

Operating Voltage

The ET85522M operational amplifiers can be used with single or dual supplies from an operating range of VS = 2.5 V (±1.25 V) up to 5.5 V (±2.75 V). Supply voltages greater than 6 V can permanently damage the device (see the Absolute Maximum Ratings table).

Internal Offset Correction

The ET85522M operational amplifiers uses an auto-calibration technique with a time-continuous, 200 kHz operational amplifier in the signal path. This amplifier is zero-corrected every 5 µs using a precision auto-calibration technique. At power-up, the amplifier requires approximately 1 ms to achieve the specified V_{OS} accuracy. This design has no aliasing or flicker noise.

EMI Susceptibility and Input Filtering

Operational amplifiers vary in susceptibility to EMI. If conducted EMI enters the operational amplifier, the dc

offset at the amplifier output can shift from its nominal value when EMI is present. This shift is a result of signal rectification associated with the internal semiconductor junctions. Although all operational amplifier pin functions can be affected by EMI, the input pins are likely to be the most susceptible. The ET85522M operational amplifier incorporates an internal input low-pass filter that reduces the amplifier response to EMI. Both common-mode and differential-mode filtering are provided by the input filter. The filter is designed for a cutoff frequency of approximately 20 MHz (-3 dB), with a roll-off of 20 dB per decade.

Device Functional Modes

The ET85522M has a single functional mode and is operational when the power-supply voltage is greater than 2.5 V (±1.25 V). The maximum specified power-supply voltage for the ET85522M is 5.5 V (±2.75 V).

Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are only stress ratings, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions are not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

Symbol	Parameter		Value	Unit
V_S	Supply Voltage		0 ~ 6	V
V_{IN}	Signal input terminals Voltage	Common-mode	(V-) - 0.5 ~ (V+) + 0.5	V
		Differential	(V+) - (V-) + 0.2	
I_{IN}	Signal input terminals Current		-10 ~ +10	mA
$T_{J(MAX)}$	Maximum Junction Temperature		+150	°C
T_{STG}	Storage Temperature		-65 ~ +150	°C
V_{ESD}	Human body model (HBM)(1)		±4000	V
	Charged device model (CDM)(1)		±1000	V

Note1:This device series incorporates ESD protection and is tested by the following methods:

ESD Human Body Model tested per ESDA/JEDEC JS-001-2024.

CDM tested per ESDA/JEDEC JS-002-2022.

Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V_S	Supply Voltage: (V+) - (V-)	2.5(±1.25) ~ 5.5(±2.75)	V
T_A	Operating Temperature Range	-40 ~ +125	°C

Electrical Characteristics

V_S = 2.5 to 5.5 V(±1.25 V to ±2.75 V), V_{CM} = V_{OUT} = V_S/2, and R_L = 10 kΩ connected to V_S/2, T_A = 25°C

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
OFFSET VOLTAGE						
V_{OS}	Input Offset Voltage			±0.5	±5	μV
		T_A = -40°C to +125°C			±8	μV
$\Delta V_{OS}/\Delta T$	V_{OS} vs Temperature	T_A = -40°C to +125°C		±0.005	±0.05	μV/°C
PSRR	Power Supply Rejection Ratio	T_A = -40°C to +125°C		±0.1	±1	μV/V
INPUT BIAS CURRENT						
I_B	Input Bias Current			±30	±300	pA
		T_A = -40°C to +125°C			±500	
I_{OS}	Input Offset Current				±500	
		T_A = -40°C to +125°C			±600	
NOISE						
E_n	Input Voltage Noise	f = 0.1 Hz to 10 Hz		0.14		μV_{PP}
e_n	Input Voltage Noise Density	f = 100 Hz		7		nV/√Hz
		f = 1 kHz		7		
		f = 10 kHz		7		
I_N	Input Current Noise Density[(2)]	f = 1 kHz		100		fA/√Hz
INPUT VOLTAGE						
V_{CM}	Common-mode Voltage Range		(V-) - 0.1		(V+) + 0.1	V
CMRR	Common-mode Rejection Ratio	V_S = ±1.25 V, (V-)-0.1V< V_{CM} <(V+)+0.1V	120	138		dB
		V_S = ±2.75 V, (V-)-0.1V< V_{CM} <(V+)+0.1V	120	140		
INPUT IMPEDANCE						
Z_{ID}	Differential Input Impedance[(2)]			100 || 3		MΩ||pF
Z_{IC}	Common-mode Input Impedance[(2)]			60 || 6		TΩ||pF
OPEN-LOOP GAIN						
A_{OL}	Open-loop Voltage Gain	R_L = 10kΩ, (V-)+0.15V<V_O<(V+)-0.15V	126	148		dB
		R_L = 2kΩ, (V-)+0.25V<V_O<(V+)-0.25V	126	148		

Electrical Characteristics (Continued)

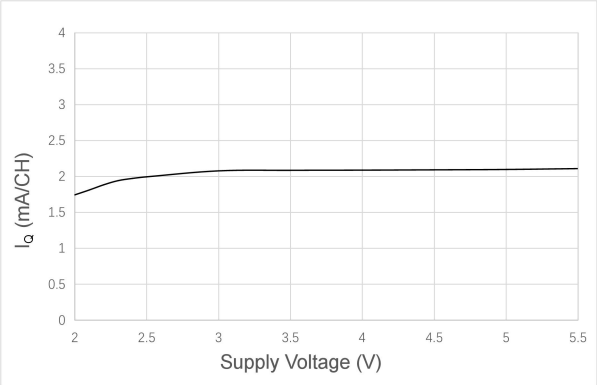
V_S = 2.5 to 5.5 V(±1.25 V to ±2.75 V), V_{CM} = V_{OUT} = V_S/2, and R_L = 10 kΩ connected to V_S/2, T_A = 25°C (unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
FREQUENCY RESPONSE							
GBP	Gain Bandwidth Product				10		MHz
SR	Slew Rate	G = 1, 4V step			5		V/μs
THD+N	Total Harmonic Distortion + Noise	G = 1, f = 1 kHz,V_O = 1 V_{RMS}			0.0005		%
t_S	Settling Time[2]	V_S = ±2.5 V, G = 1, 1V step	To 0.1%		0.75		μs
			To 0.01%		2		μs
t_{OR}	Overload Recovery Time	V_{IN} × G = V_S			1.5		μs
OUTPUT							
V_O	Voltage Output Swing From Rail	Positive rail	No load		2	15	mV
			R_L = 10kΩ		5	20	
			R_L = 2kΩ		20	50	
		Negative rail	No load		1	10	
			R_L = 10kΩ		10	20	
			R_L = 2kΩ		40	60	
		R_L =10kΩ, T_A = -40°C to +125°C			10	25	
I_{SC}	Short-circuit Current	V_S = 5.5V			±80		mA
		V_S = 2.5V			±30		mA
Z_O	Open-loop Output Resistance[2]	f = 1 MHz, I_O = 0 A			100		Ω
POWER SUPPLY							
I_Q	Quiescent Current per Amplifier	V_S = 2.5V			2	2.7	mA
		V_S = 2.5V, T_A = -40°C to +125°C			2	2.7	mA
		V_S = 5.5V			2.1	2.8	mA
		V_S = 5.5V, T_A = -40°C to +125°C			2.1	2.8	mA

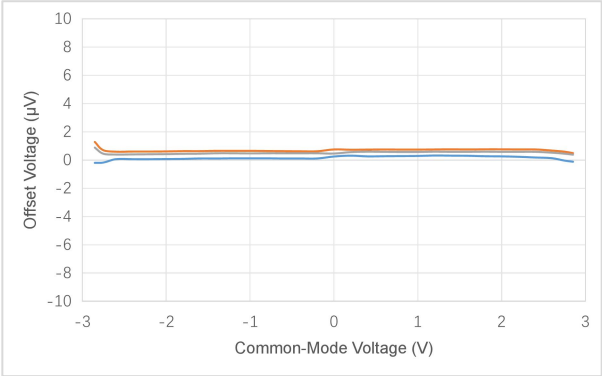
Note2: Guaranteed by design.

Typical Characteristics

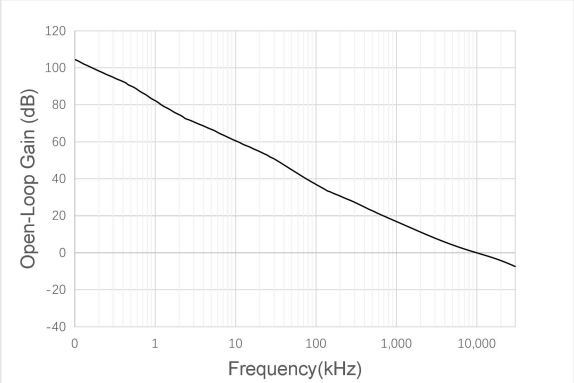
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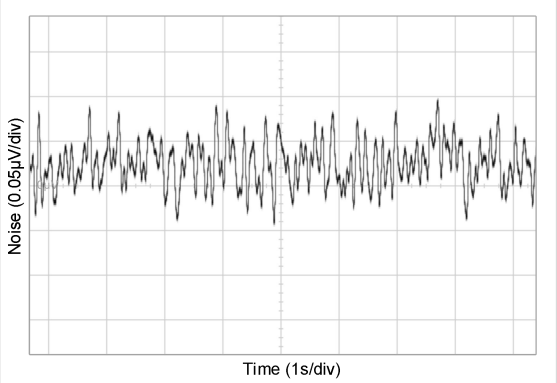
Quiescent Current vs Supply Voltage



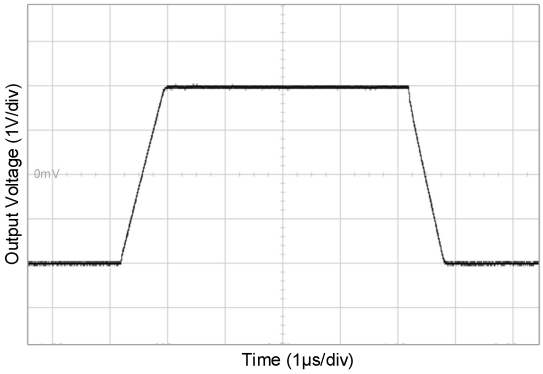
Offset Voltage vs Common-Mode Voltage (V_S = 5.5V)



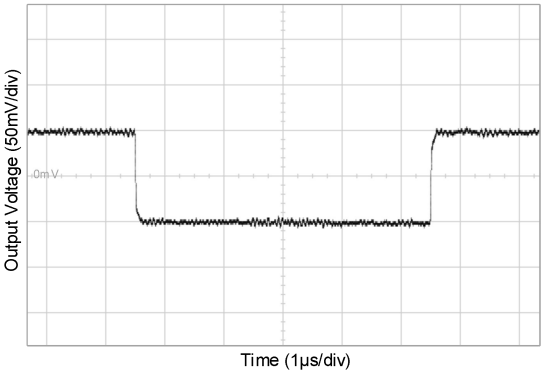
Open-Loop Gain vs Frequency



0.1 Hz to 10 Hz Noise



Large-Signal Step Response



Small-Signal Step Response (100 mV)

Application Notes

The ET85522M is a unity-gain stable, precision operational amplifier free from unexpected output and phase reversal. The use of proprietary zero-drift circuitry gives the benefit of low input offset voltage over time and temperature, as well as lowering the 1/f noise component. As a result of the high PSRR, these devices work well in applications that run directly from battery power without regulation. The ET85522M is optimized for full rail-to-rail input, allowing for low-voltage, single-supply operation or split-supply use. These miniature, high-precision, low-noise amplifiers offer high-impedance inputs that have a common-mode range 100 mV beyond the supplies without input crossover distortion and a rail-to-rail output that swings within 5 mV of the supplies under normal test conditions. The ET85522M precision amplifiers are designed for upstream analog signal chain applications in low or high gains, as well as downstream signal chain functions such as DAC buffering.

Layout Guidelines

For best operational performance of the devices, good printed circuit board (PCB) layout practices are recommended. Low-loss, 0.1 µF bypass capacitors must be connected between each supply pin and ground, placed as close to the devices as possible. A single bypass capacitor from V+ to ground is applicable to single-supply applications.

Typical Applications

This single-supply, low-side, bidirectional current-sensing solution detects load currents from -1 A to +1 A. The single-ended output spans from 110 mV to 3.19 V. This design uses the ET85522M because of its low offset voltage and rail-to-rail input and output. One of the amplifiers is configured as a difference amplifier and the other amplifier provides the reference voltage.

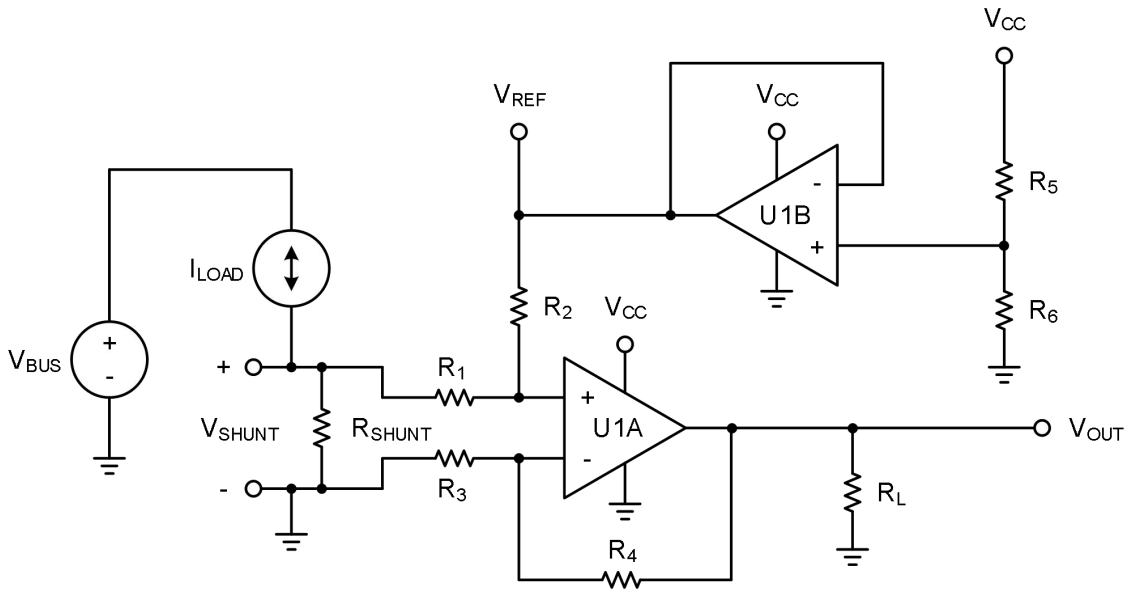
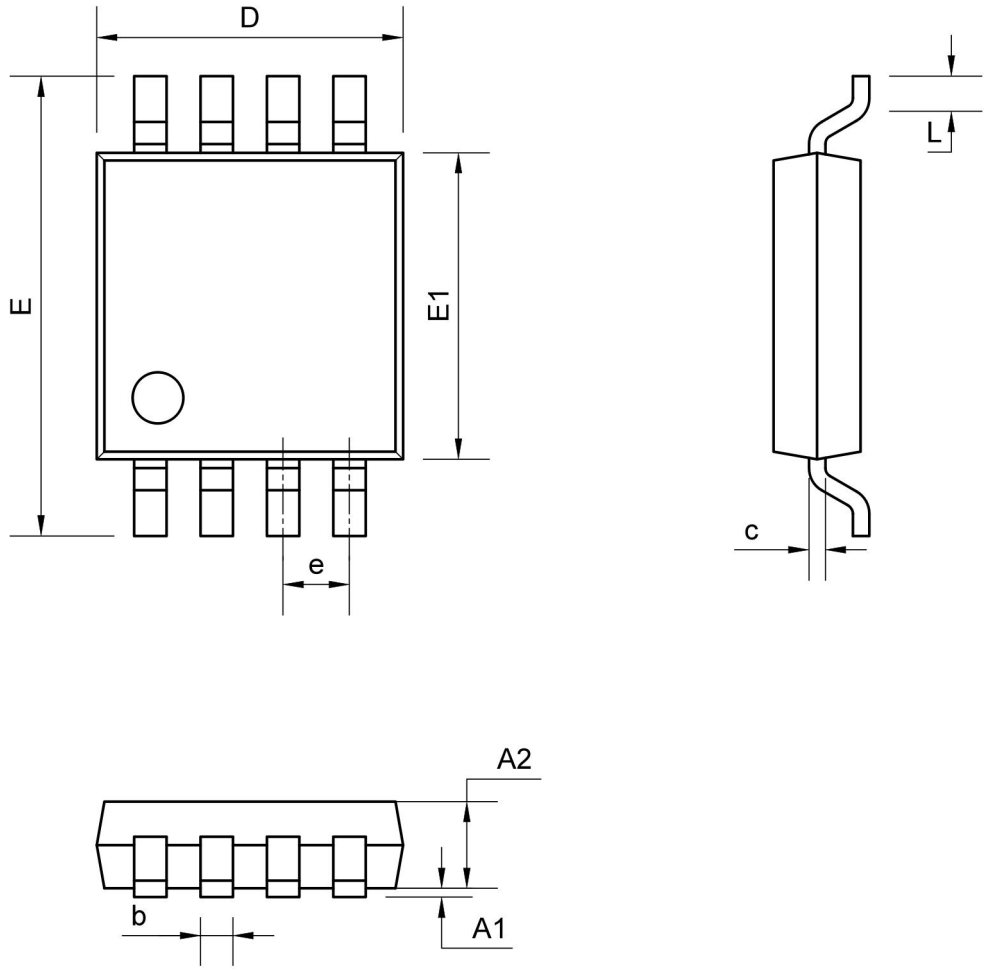


Figure 2. Bidirectional Current-Sensing Schematic

Package Dimension

SOP8

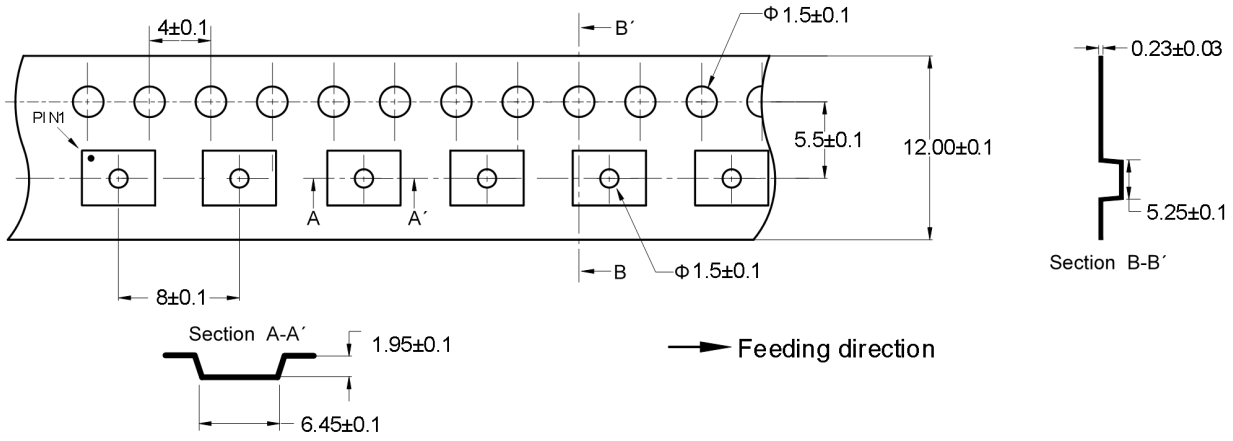


COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A1	0.15	—	0.22
A2	1.40	1.45	1.50
b		0.40 BSC	
c	0.20	—	0.25
D	4.85	4.90	4.95
E	5.99	6.04	6.09
E1	3.85	3.90	3.95
e		1.27 BSC	
L	0.50	0.60	0.70

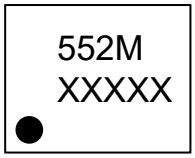
Tape Information

SOP8



Marking Information

SOP8



552M - Part Number

XXXXX - Tracking Number

***Note*:** X (Tracking Number) is variable, according to the wafer lot number.

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0.0	2024-10-22	Preliminary Version	Jiangqp	Wanggp	Liujy
0.1	2025-01-23	Preliminary Version	Wangxx	Wanggp	Liujy
1.0	2026-02-06	Official Version	Jiangqp	Wanggp	Liujy