19-3379; Rev 4; 1/06

可提供评估板

双路、256抽头、非易失、I²C接口、数字电位器

概述

MAX5477/MAX5478/MAX5479非易失、双路、线性变化的数字电位器能实现机械电位器的功能，采用简单的2线数字接口取代机械调节。每个器件都具有与分立电位器或可变电阻相同的功能，提供256级抽头。

这些器件内置非易失EEPROM，用来存储滑动端的位置，以便在上电时进行初始化。器件的写保护功能可以防止对EEPROM意外重写。与快速模式I²C兼容的串行接口允许400kbps的通信速率，在多数应用中减小了电路板尺寸，并简化了布线。三个地址输入提供8个唯一地址。

MAX5477/MAX5478/MAX5479提供三种标称电阻值：10kΩ (MAX5477)、50kΩ (MAX5478)及100kΩ (MAX5479)。标称端对端电阻温度系数为70ppm/°C，比例系数为10ppm/°C。低温度系数使这些器件尤其适合于需要低温度漂移可变电阻的应用，如低失调、可编程增益放大器电路。

MAX5477/MAX5478/MAX5479采用16引脚、3mm x 3mm x 0.8mm、薄型QFN以及14引脚、4.4mm x 5mm、TSSOP封装，工作在-40°C至+85°C的扩展级温度范围内。

应用

替代机械电位器

低失调可编程增益放大器

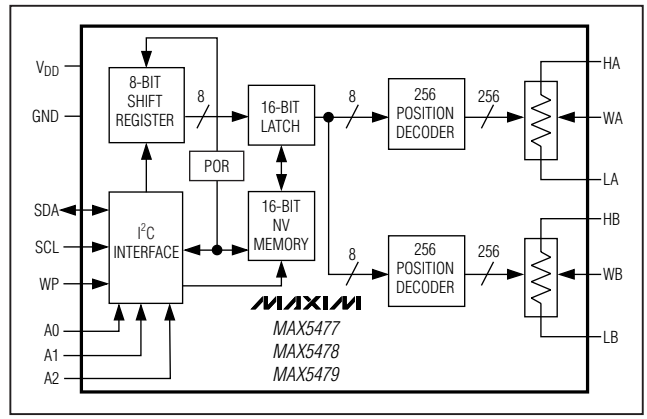
音量控制

液晶显示器(LCD)对比度控制

特性

- ♦ 上电后从非易失存储器调用滑动端位置
- ♦ EEPROM写保护
- ♦ 微型3mm x 3mm x 0.8mm、薄型QFN封装
- ♦ 端对端电阻温度系数：70ppm/°C
- ♦ 比例温度系数：10ppm/°C
- ♦ 400kbps、快速I²C*兼容串行接口
- ♦ 1µA (最大值)静态供电电流
- ♦ 单电源+2.7V到+5.25V供电
- ♦ 每个电位器256级抽头
- ♦ 分压模式下DNL：±0.5 LSB
- ♦ 分压模式下INL：±1 LSB

功能框图



*购买Maxim Integrated Products, Inc.或其从属授权公司的I²C产品，即得到了Philips I²C的专利许可、将这些产品用于符合Philips定义的I²C标准规范的系统。

定购信息/选型指南

PART	TEMP RANGE	PIN-PACKAGE	END-TO-END RESISTANCE (kΩ)	TOP MARK	PACKAGE CODE
MAX5477ETE*	-40°C to +85°C	16 Thin QFN	10	ABO	T1633F-3
MAX5477EUD	-40°C to +85°C	14 TSSOP	10	—	U14-1
MAX5478ETE*	-40°C to +85°C	16 Thin QFN	50	ABP	T1633F-3
MAX5478EUD	-40°C to +85°C	14 TSSOP	50	—	U14-1
MAX5479ETE*	-40°C to +85°C	16 Thin QFN	100	ABQ	T1633F-3
MAX5479EUD	-40°C to +85°C	14 TSSOP	100	—	U14-1

*未来产品—请与工厂联系。

引脚配置在数据资料的最后给出。

ABSOLUTE MAXIMUM RATINGS

SDA, SCL, V_{DD} to GND .....-0.3V to +6.0V
All Other Pins to GND .....-0.3V to (V_{DD} + 0.3V)
Maximum Continuous Current into H_, L_, and W_
MAX5477 .....±5.0mA
MAX5478 .....±1.3mA
MAX5479 .....±0.6mA

Continuous Power Dissipation (T_A = +70°C)
16-Pin Thin QFN (derate 17.5mW/°C above +70°C) 1399mW
14-Pin TSSOP (derate 9.1mW/°C above +70°C) 727mW
Operating Temperature Range .....-40°C to +85°C
Maximum Junction Temperature .....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

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

ELECTRICAL CHARACTERISTICS

(V_{DD} = +2.7V to +5.25V, H_ = V_{DD}, L_ = GND, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = +5V, T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DC PERFORMANCE (VOLTAGE-DIVIDER MODE)						
Resolution			256			Taps
Integral Nonlinearity	INL	(Note 2)			±1	LSB
Differential Nonlinearity	DNL	(Note 2)			±0.5	LSB
Dual Code Matching		R0 and R1 set to same code (all codes)			±1	LSB
End-to-End Resistance Temperature Coefficient	TC_R			70		ppm/°C
Ratiometric Resistance Temperature Coefficient				10		ppm/°C
Full-Scale Error		MAX5477		-4		LSB
		MAX5478		-0.6		
		MAX5479		-0.3		
Zero-Scale Error		MAX5477		4		LSB
		MAX5478		0.6		
		MAX5479		0.3		
DC PERFORMANCE (VARIABLE-RESISTOR MODE)						
Integral Nonlinearity (Note 3)	INL	V_{DD} = 3V			±3	LSB
		V_{DD} = 5V			±1.5	
Differential Nonlinearity (Note 3)	DNL	MAX5477		±1		LSB
		MAX5478			±1	
		MAX5479			±1	
Dual Code Matching		R0 and R1 set to same code (all codes), V_{DD} = 3V or 5V			±3	LSB
DC PERFORMANCE (RESISTOR CHARACTERISTICS)						
Wiper Resistance	R_W	(Note 4)		325	675	Ω
Wiper Capacitance	C_W			10		pF
End-to-End Resistance	R_{HL}	MAX5477	7.5	10	12.5	kΩ
		MAX5478	37.5	50	62.5	
		MAX5479	75	100	125	

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = +2.7V to +5.25V, H_ = V_{DD}, L_ = GND, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = +5V, T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DIGITAL INPUTS							
Input High Voltage (Note 5)	V_{IH}	V_{DD} = 3.4V to 5.25V		2.4			V
		V_{DD} < 3.4V		0.7 x V_{DD}			
Input Low Voltage	V_{IL}	(Note 5)				0.8	V
Output Low Voltage	V_{OL}	I_{SINK} = 3mA				0.4	V
WP Pullup Resistance	I_{WP}			255			kΩ
Input Leakage Current	I_{LEAK}					±1	µA
Input Capacitance					5		pF
DYNAMIC CHARACTERISTICS							
Crosstalk		HA = 1kHz (0 to V_{DD}), LA = GND, LB = GND, measure WB			-75		dB
3dB Bandwidth (Note 6)		MAX5477			400		kHz
		MAX5478			100		
		MAX5479			50		
Total Harmonic Distortion Plus Noise	THD+N	H_ = $1V_{RMS}$, f = 1kHz, L_ = GND, measure W_			0.003		%
NONVOLATILE MEMORY RELIABILITY							
Data Retention		T_A = +85°C			50		Years
Endurance		T_A = +25°C			200,000		Stores
		T_A = +85°C			50,000		
POWER SUPPLY							
Power-Supply Voltage	V_{DD}			2.70		5.25	V
Supply Current	I_{DD}	Writing to EEPROM, digital inputs at GND or V_{DD}, T_A = +25°C (Note 7)			250	400	µA
		Normal operation, digital inputs at GND or V_{DD}, T_A = +25°C	WP = GND		15	20.6	
			WP = V_{DD}		0.5	1	

TIMING CHARACTERISTICS

(V_{DD} = +2.7V to +5.25V, H_ = V_{DD}, L_ = GND, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = +5V, T_A = +25°C. See Figure 1.) (Notes 8 and 9)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ANALOG SECTION						
Wiper Settling Time (Note 10)	t_{WS}	MAX5477		325		ns
		MAX5478		500		
		MAX5479		1000		
DIGITAL SECTION						
SCL Clock Frequency	f_{SCL}				400	kHz
Setup Time for START Condition	$t_{SU:STA}$		0.6			µs
Hold Time for START Condition	$t_{HD:STA}$		0.6			µs

TIMING CHARACTERISTICS (continued)

(V_{DD} = +2.7V to +5.25V, H_ = V_{DD}, L_ = GND, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V_{DD} = +5V, T_A = +25°C. See Figure 1.) (Notes 8 and 9)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SCL High Time	t_{HIGH}		0.6			µs
SCL Low Time	t_{LOW}		1.3			µs
Data Setup Time	$t_{SU:DAT}$		100			ns
Data Hold Time	$t_{HD:DAT}$		0		0.9	µs
SDA, SCL Rise Time	t_R				300	ns
SDA, SCL Fall Time	t_F				300	ns
Setup Time for STOP Condition	$t_{SU:STO}$		0.6			µs
Bus Free Time Between STOP and START Condition	t_{BUF}	Minimum power-up rate = 0.2V/µs	1.3			µs
Pulse Width of Spike Suppressed	t_{SP}				50	ns
Capacitive Load for Each Bus Line	C_B	(Note 11)			400	pF

Note 1: All devices are production tested at T_A = +25°C and are guaranteed by design and characterization for -40°C < T_A < +85°C.

Note 2: The DNL and INL are measured with the potentiometer configured as a voltage-divider with H_ = V_{DD} and L_ = GND. The wiper terminal is unloaded and measured with a high-input-impedance voltmeter.

Note 3: The DNL and INL are measured with the potentiometer configured as a variable resistor. H_ is unconnected and L_ = GND. For V_{DD} = +5V, the wiper is driven with 400µA (MAX5477), 80µA (MAX5478), or 40µA (MAX5479). For V_{DD} = +3V, the wiper is driven with 200µA (MAX5477), 40µA (MAX5478), or 20µA (MAX5479).

Note 4: The wiper resistance is measured using the source currents given in Note 3.

Note 5: The devices draw current in excess of the specified supply current when the digital inputs are driven with voltages between (V_{DD} - 0.5V) and (GND + 0.5V). See Supply Current vs. Digital Input Voltage in the *Typical Operating Characteristics*.

Note 6: Wiper at midscale with a 10pF load (DC measurement). L_ = GND, an AC source is applied to H_, and the W_ output is measured. A 3dB bandwidth occurs when the AC W_/H_ value is 3dB lower than the DC W_/H_ value.

Note 7: The programming current exists only during power-up and EEPROM writes.

Note 8: The SCL clock period includes rise and fall times (t_R = t_F). All digital input signals are specified with t_R = t_F = 2ns and timed from a voltage level of (V_{IL} + V_{IH}) / 2.

Note 9: Digital timing is guaranteed by design and characterization, and is not production tested.

Note 10: This is measured from the STOP pulse to the time it takes the output to reach 50% of the output step size (divider mode). It is measured with a maximum external capacitive load of 10pF.

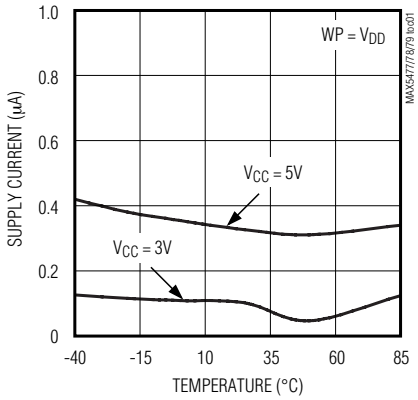
Note 11: An appropriate bus pullup resistance must be selected depending on board capacitance. Refer to the I²C-bus specification document linked to this web address: www.semiconductors.philips.com/acrobat/literature/9398/39340011.pdf

Note 12: The idle time begins from the initiation of the STOP pulse.

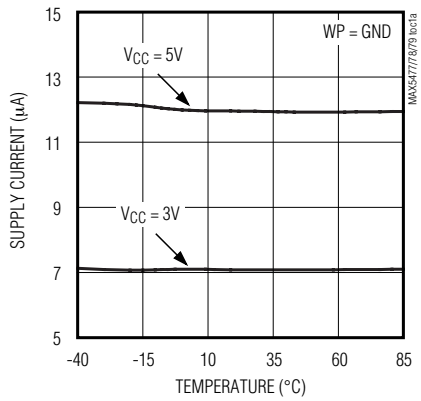
典型工作特性

(V_{DD} = +5V, H_ = V_{DD}, L_ = GND, T_A = +25°C, unless otherwise noted.)

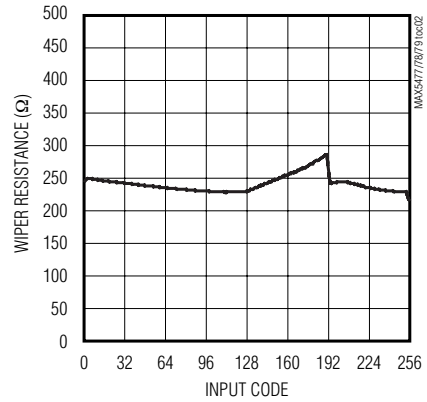
SUPPLY CURRENT vs. TEMPERATURE (MAX5477)



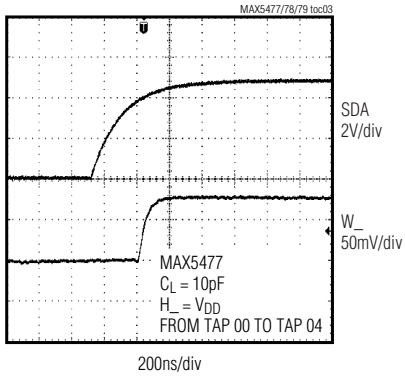
SUPPLY CURRENT vs. TEMPERATURE



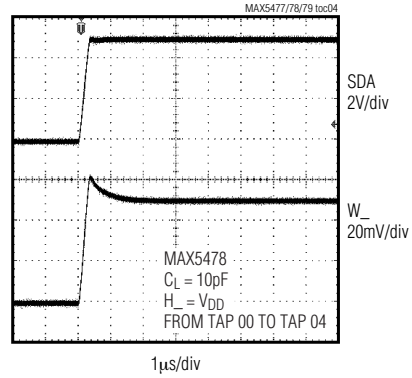
WIPER RESISTANCE vs. INPUT CODE



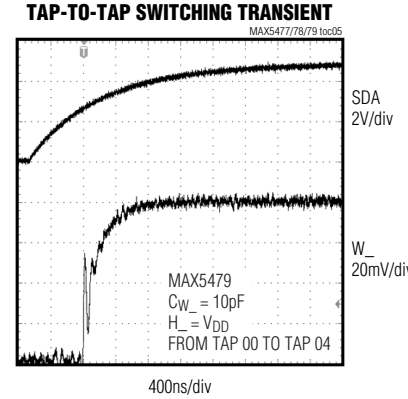
TAP-TO-TAP SWITCHING TRANSIENT



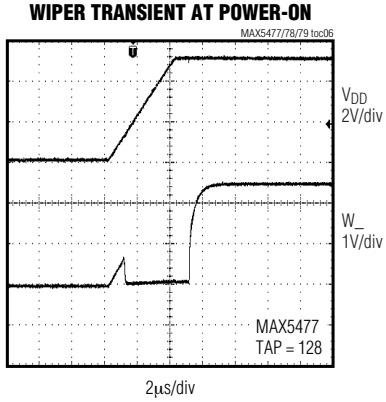
TAP-TO-TAP SWITCHING TRANSIENT



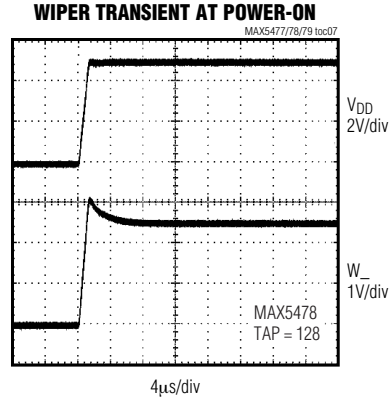
TAP-TO-TAP SWITCHING TRANSIENT



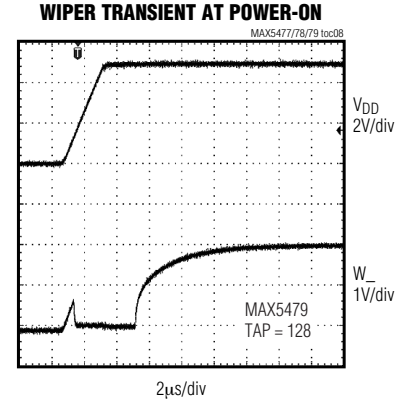
WIPER TRANSIENT AT POWER-ON



WIPER TRANSIENT AT POWER-ON



WIPER TRANSIENT AT POWER-ON

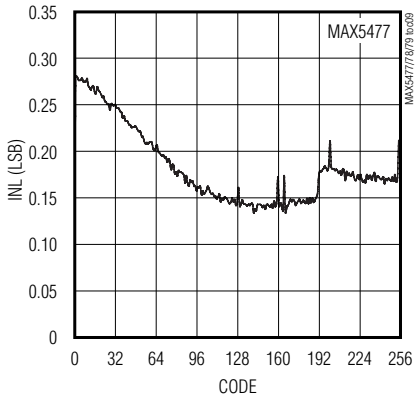


双路、256抽头、非易失、I²C接口、数字电位器

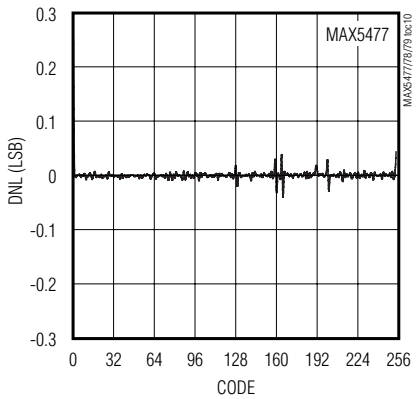
典型工作特性(续)

(V_{DD} = +5V, H_ = V_{DD}, L_ = GND, T_A = +25°C, unless otherwise noted.)

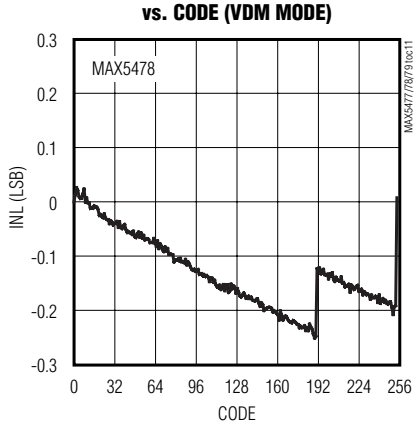
INTEGRAL NONLINEARITY vs. CODE (VDM MODE)



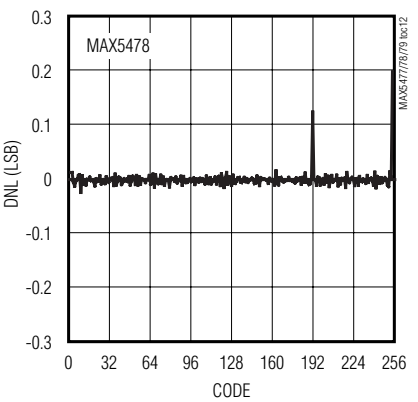
DIFFERENTIAL NONLINEARITY vs. CODE (VDM MODE)



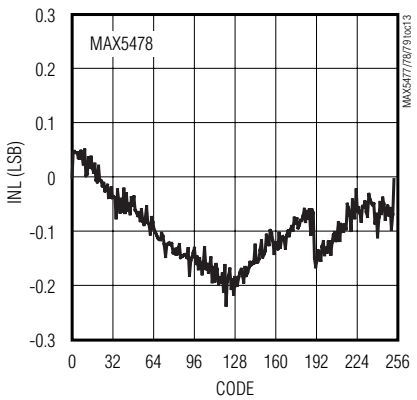
INTEGRAL NONLINEARITY vs. CODE (VDM MODE)



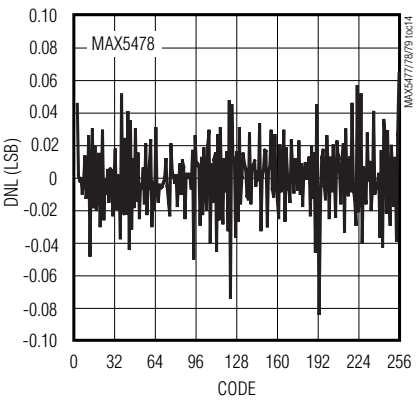
DIFFERENTIAL NONLINEARITY vs. CODE (VDM MODE)



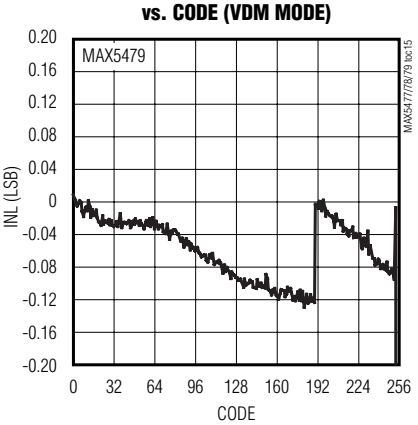
INTEGRAL NONLINEARITY vs. CODE (VRM MODE)



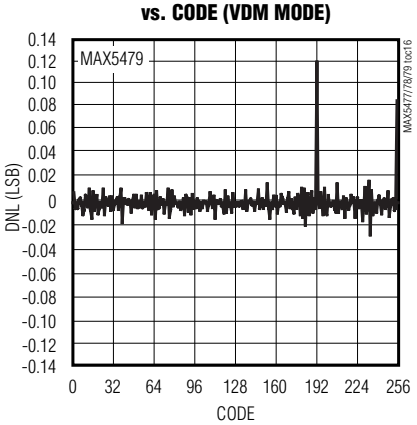
DIFFERENTIAL NONLINEARITY vs. CODE (VRM MODE)



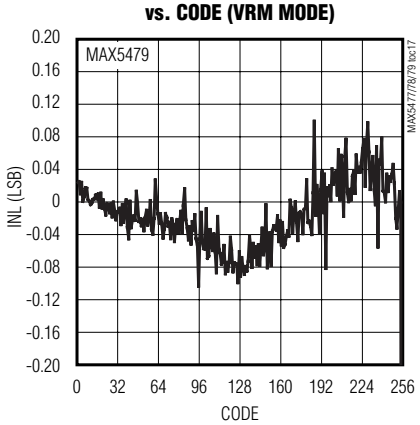
INTEGRAL NONLINEARITY vs. CODE (VDM MODE)



DIFFERENTIAL NONLINEARITY vs. CODE (VDM MODE)



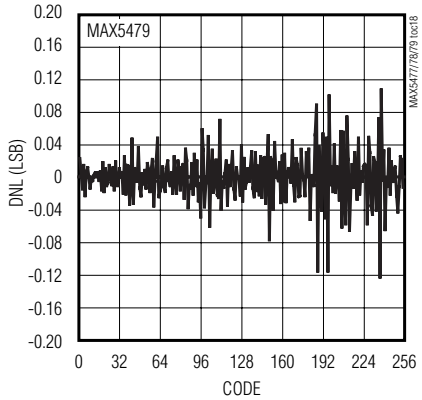
INTEGRAL NONLINEARITY vs. CODE (VRM MODE)



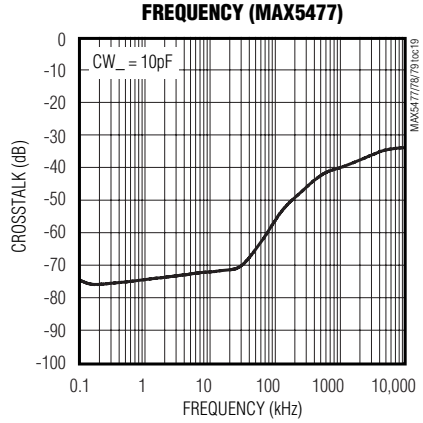
典型工作特性(续)

(V_{DD} = +5V, H_ = V_{DD}, L_ = GND, T_A = +25°C, unless otherwise noted.)

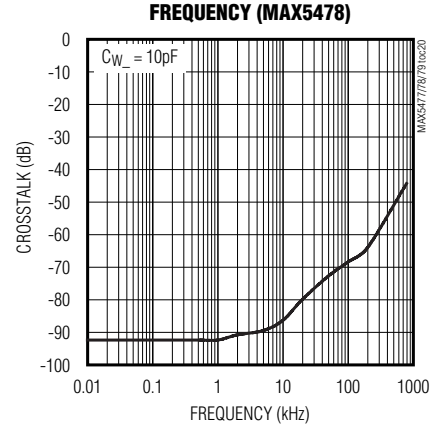
DIFFERENTIAL NONLINEARITY vs. CODE (VRM MODE)



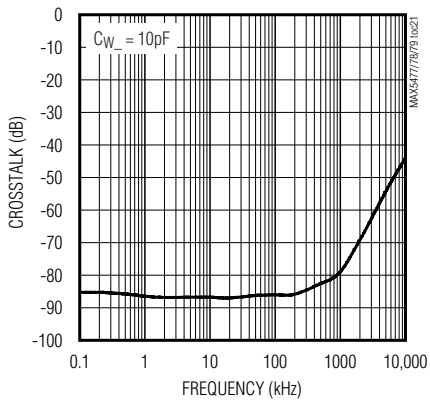
CROSSTALK vs. FREQUENCY (MAX5477)



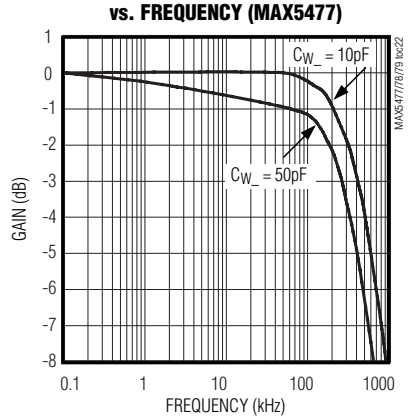
CROSSTALK vs. FREQUENCY (MAX5478)



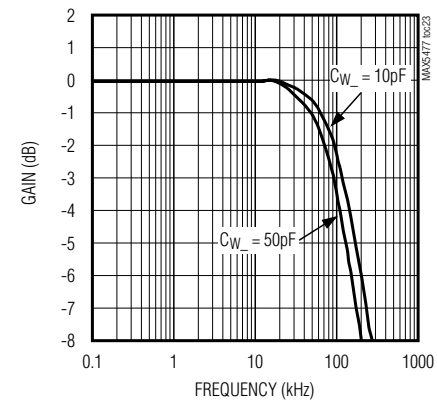
CROSSTALK vs. FREQUENCY (MAX5479)



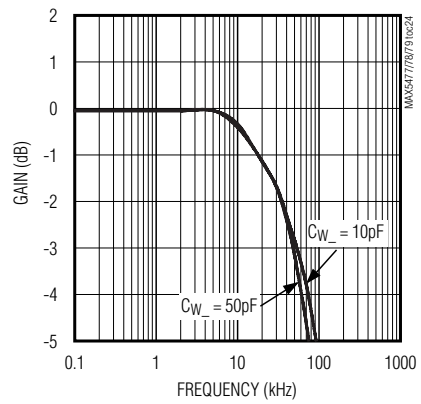
MIDSCALE WIPER RESPONSE vs. FREQUENCY (MAX5477)



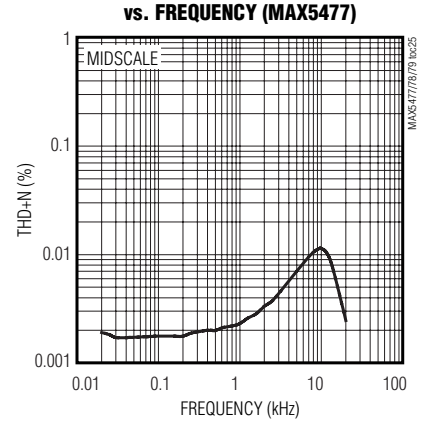
MIDSCALE WIPER RESPONSE vs. FREQUENCY (MAX5478)



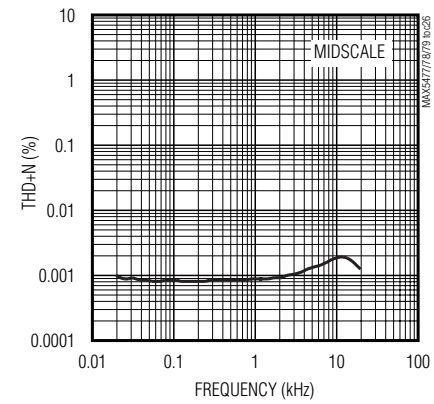
MIDSCALE WIPER RESPONSE vs. FREQUENCY (MAX5479)



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY (MAX5477)



TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY (MAX5478)

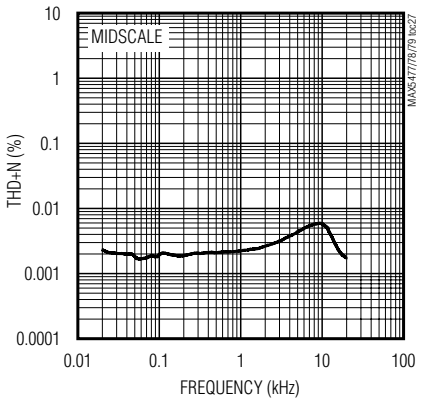


双路、256抽头、非易失、I²C接口、数字电位器

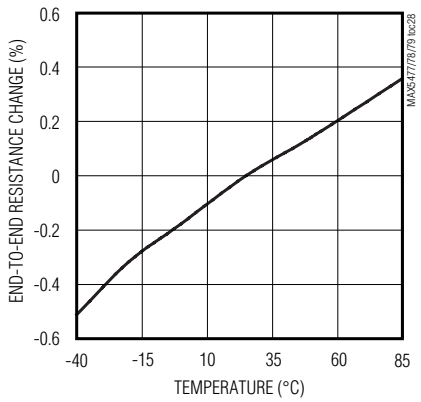
典型工作特性(续)

(V_{DD} = +5V, H_ = V_{DD}, L_ = GND, T_A = +25°C, unless otherwise noted.)

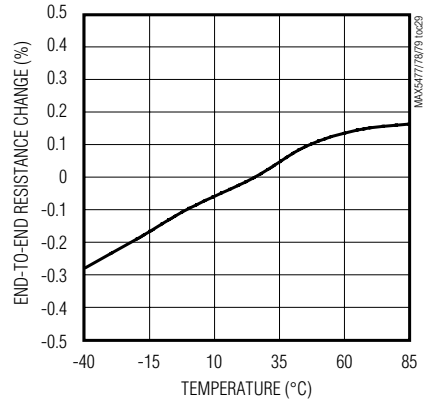
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY (MAX5479)



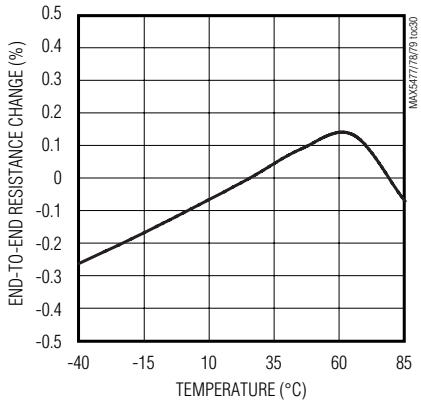
END-TO-END RESISTANCE % CHANGE vs. TEMPERATURE (MAX5477)



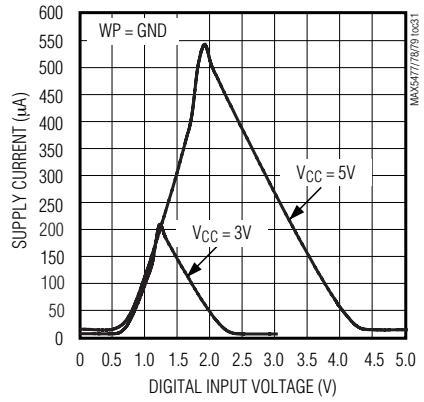
END-TO-END RESISTANCE % CHANGE vs. TEMPERATURE (MAX5478)



END-TO-END RESISTANCE % CHANGE vs. TEMPERATURE (MAX5479)



SUPPLY CURRENT vs. DIGITAL INPUT VOLTAGE



引脚说明

引脚		名称	功能
TSSOP	薄型QFN		
1	15	HA	A电位器高端。
2	14	WA	A电位器滑动端。
3	13	LA	A电位器低端。
4	12	HB	B电位器高端。
5	11	WB	B电位器滑动端。
6	10	LB	B电位器低端。
7	9	WP	写保护输入。接GND允许更改滑动端位置以及在EEPROM中的存储数据。 接V_{DD}或开路则使EEPROM处于写保护。操作说明请参考*写保护(WP)*部分。
8	7	GND	地。
9	6	A2	地址输入2。接V_{DD}或GND (见表1)。
10	5	A1	地址输入1。接V_{DD}或GND (见表1)。
11	4	A0	地址输入0。接V_{DD}或GND (见表1)。
12	3	SDA	I²C串行数据。
13	2	SCL	I²C时钟输入。
14	1	V_{DD}	电源输入。连接+2.7V到+5.25V电源至V_{DD}，并使用尽可能靠近器件的0.1µF电容旁路V_{DD}至GND。
—	8, 16	N.C.	不连接。无内部连接。
—	EP	EP	裸露焊盘。接GND或悬空。

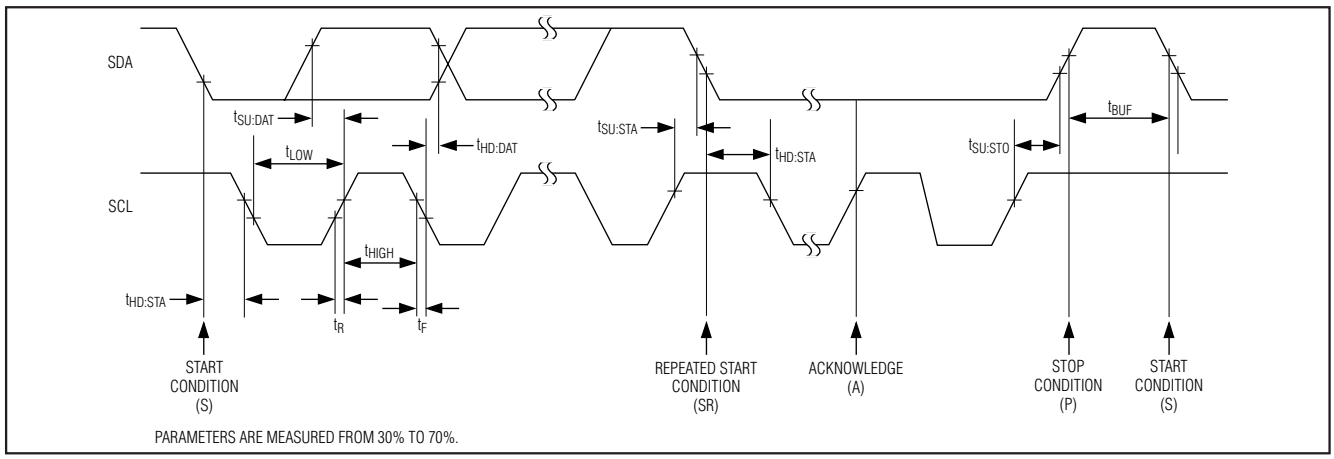


图1. I²C串行接口时序

双路、256抽头、非易失、I²C接口、数字电位器

详细说明

MAX5477/MAX5478/MAX5479内置两个电阻阵列，每个阵列包含255个电阻单元。MAX5477端到端总阻值为10kΩ，MAX5478端到端阻值为50kΩ，MAX5479端到端阻值为100kΩ。MAX5477/MAX5478/MAX5479通过连接高端、低端和滑动端可以构成标准分压器。只要保证各端电压在GND和V_{DD}之间，H_、L_和W_端可以任意配置。

简单的2线I^2C兼容串行接口可以在256级抽头间调节滑动端(图2)。非易失存储器存储滑动端位置并在上电时恢复滑动端的位置。非易失存储器能够保持数据50年、滑动端存储次数多达200,000次。

表1. 从地址

ADDRESS INPUTS			SLAVE ADDRESS
A2	A1	A0	
GND	GND	GND	0101000
GND	GND	V_{DD}	0101001
GND	V_{DD}	GND	0101010
GND	V_{DD}	V_{DD}	0101011
V_{DD}	GND	GND	0101100
V_{DD}	GND	V_{DD}	0101101
V_{DD}	V_{DD}	GND	0101110
V_{DD}	V_{DD}	V_{DD}	0101111

模拟电路

MAX5477/MAX5478/MAX5479内置两个包含255个电阻单元的电阻阵列；滑动端可连至H_和L_之间的256个抽头点。滑动端位置的选择通过I^2C接口对电位器编程实现。每个电位器通过一个地址字节，一个命令字节和8位数据设置滑动端位置。MAX5477/MAX5478/MAX5479的H_和L_端与机械电位器的两个终端相同。MAX5477/MAX5478/MAX5479内置上电复位电路，在上电时从非易失存储器自动装载滑动端位置。

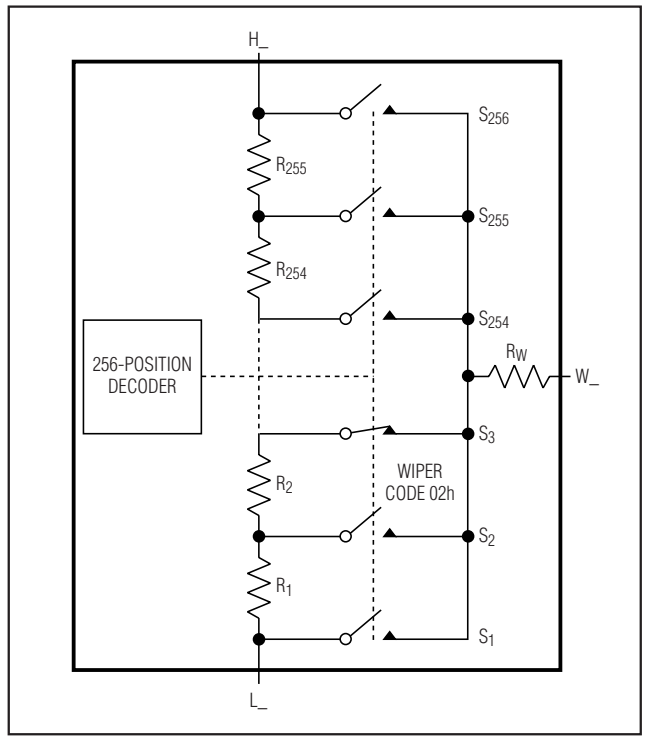


图2. 电位器配置

表2. VREG和NVREG的写保护动作

COMMAND	WP = 0	WP = 1
Write to VREG	I²C data is written to VREG. Wiper position updates with I²C data. No change to NVREG.	Copy NVREG to VREG. Wiper position updates with NVREG data. No change to NVREG.
Write to NVREG	No change to VREG or wiper position. I²C data is written to NVREG.	No change to VREG or wiper position. No change to NVREG.
Copy NVREG to VREG	Copy NVREG to VREG. Wiper position updates with NVREG data. No change to NVREG.	Copy NVREG to VREG. Wiper position updates with NVREG data. No change to NVREG.
Copy VREG to NVREG	Copy VREG to NVREG. No change to VREG or wiper position.	No change to VREG or wiper position. No change to NVREG.

表3. 命令字节

		ADDRESS BYTE									COMMAND BYTE									DATA BYTE										
SCL CYCLE NUMBER	START (S)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	STOP (P)	NOTES
		A6	A5	A4	A3	A2	A1	A0		ACK (A)		TX	NV	V	R3	R2	R1	R0	ACK (A)	D7	D6	D5	D4	D3	D2	D1	D0	ACK (A)		
VREG		0	1	0	1	A2	A1	A0	0		0	0	0	1	0	0	0	1		D7	D6	D5	D4	D3	D2	D1	D0			
NVREG		0	1	0	1	A2	A1	A0	0		0	0	1	0	0	0	0	1		D7	D6	D5	D4	D3	D2	D1	D0			WIPER A ONLY
NVREGxVREG		0	1	0	1	A2	A1	A0	0		0	1	1	0	0	0	0	1		D7	D6	D5	D4	D3	D2	D1	D0			
VREGxNVREG		0	1	0	1	A2	A1	A0	0		0	1	0	1	0	0	0	1		D7	D6	D5	D4	D3	D2	D1	D0			
VREG		0	1	0	1	A2	A1	A0	0		0	0	0	1	0	0	1	0		D7	D6	D5	D4	D3	D2	D1	D0			
NVREG		0	1	0	1	A2	A1	A0	0		0	0	1	0	0	0	1	0		D7	D6	D5	D4	D3	D2	D1	D0			WIPER B ONLY
NVREGxVREG		0	1	0	1	A2	A1	A0	0		0	1	1	0	0	0	1	0		D7	D6	D5	D4	D3	D2	D1	D0			
VREGxNVREG		0	1	0	1	A2	A1	A0	0		0	1	0	1	0	0	1	0		D7	D6	D5	D4	D3	D2	D1	D0			
VREG		0	1	0	1	A2	A1	A0	0		0	0	0	1	0	0	1	1		D7	D6	D5	D4	D3	D2	D1	D0			
NVREG		0	1	0	1	A2	A1	A0	0		0	0	1	0	0	0	1	1		D7	D6	D5	D4	D3	D2	D1	D0			WIPERS A AND B
NVREGxVREG		0	1	0	1	A2	A1	A0	0		0	1	1	0	0	0	1	1		D7	D6	D5	D4	D3	D2	D1	D0			
VREGxNVREG		0	1	0	1	A2	A1	A0	0		0	1	0	1	0	0	1	1		D7	D6	D5	D4	D3	D2	D1	D0			

数字接口

MAX5477/MAX5478/MAX5479内置非易失EEPROM，用于存储滑动端的位置，以便上电初始化。移位寄存器对控制位和地址位进行解码，并将数据写入适当的数据寄存器。数据可以写入易失存储器立即更新滑动端的位置，也可以写入非易失寄存器进行存储(见表3)。

易失寄存器在系统加电期间能够保持数据。一旦断电，易失寄存器的内容被清除。非易失寄存器在系统断电时仍能保存数据。一旦上电，上电复位电路将非易失寄存器的内容传送到易失寄存器。

写保护(WP)

写保护特性可以防止EEPROM被意外重写。WP端接V_{DD}或开路将会阻止任何对EEPROM的写操作。当WP = 1时，对易失寄存器(VREG)进行写操作，将使用储存在非易失寄存器(NVREG)内的受保护数据对抽头的位置进行更新。WP接地将会允许对EEPROM的写入，用来自EEPROM或直接来自I²C (表2)接口的数据更新滑动端位置。WP接GND会使供电电流增加19.6µA (最大)。

为确保失效保护、写保护功能，在WP上拉至高电平以前，将受保护数据写入非易失寄存器和易失寄存器。如果释放WP (WP = 0)，并发送部分指令或无效的I²C指令(例如

单字节轮询)，会将移位寄存器的数据装载到易失寄存器内，进而改变抽头位置。在从写保护(WP = 1)状态转换到非写保护(WP = 0)状态时，最好使用有效的3字节I²C命令进行正确的操作。

串行寻址

MAX5477/MAX5478/MAX5479作为从设备从I²C/SMBus™兼容的2线串行接口接收数据。该接口采用串行数据线(SDA)和串行时钟线(SCL)实现主、从设备间的双向通信。主设备，通常是微控制器，启动对MAX5477/MAX5478/MAX5479的全部数据传输，并产生SCL时钟来同步数据传输(见图1)。

MAX5477/MAX5478/MAX5479的SDA可作为输入或漏极开路输出。SDA线上需要一个典型值为4.7kΩ的上拉电阻。MAX5477/MAX5478/MAX5479的SCL只能作为输入端。若2线接口挂接有多个主机，或者单主机系统SCL输出为漏极开路，SCL线上需接典型值为4.7kΩ的上拉电阻。在混合电压系统中，无论漏极驱动能力多大，SCL和SDA都不应超过V_{DD}。

每次数据传输先由主机发送START (S)条件(图3)，然后发送MAX5477/MAX5478/MAX5479的7位从地址和NOP/$\overline{W}$位 (图4)，一个命令字节和一个数据字节，最后是STOP (P)条件 (图3)。

START和STOP条件

接口不工作时SCL和SDA均为高。主机发送START条件开始数据传输，即SCL为高电平时SDA由高变低。当主机完成与从机的通信后发送STOP条件，即在SCL为高电平时SDA由低变高。然后释放总线，进行其它的传输(图3)。

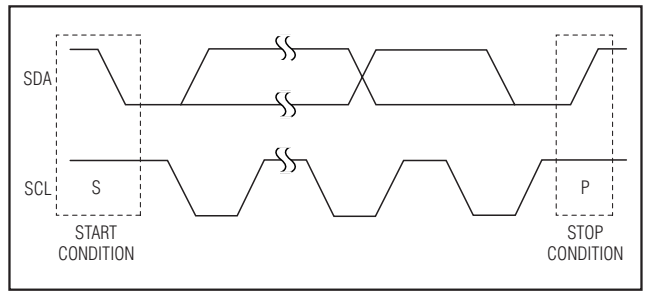


图3. START和STOP条件

位传输

每个时钟传输一个数据位。SCL为高时，SDA上的数据必须保持稳定(图5)。

应答信号

应答信号是时钟第9位，它是接收端收到每个数据字节后的握手应答信号(图6)。因此，每个字节的有效传输需要9位。主机产生第9个时钟脉冲，接收端在应答时钟脉冲内将SDA拉低，所以，在时钟脉冲为高电平期间SDA必须稳定在低电平。

从地址

MAX5477/MAX5478/MAX5479具有7位长的从地址(图4)。紧随7位从地址的第8位是NOP/$\overline{W}$位。NOP/$\overline{W}$位置低表示写操作，置高表示空操作。

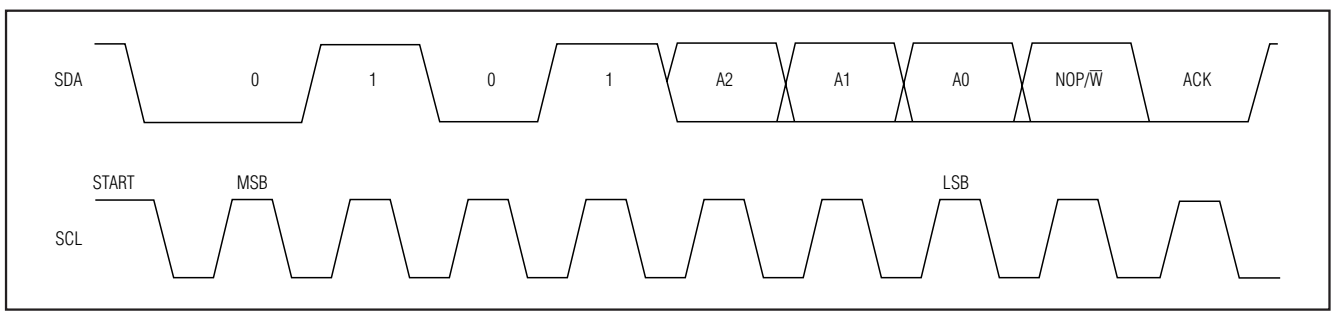


图4. 从地址

SMBus是Intel Corporation的商标。

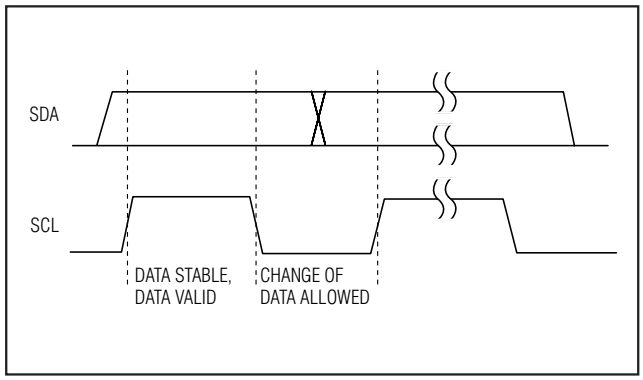


图5. 位传输

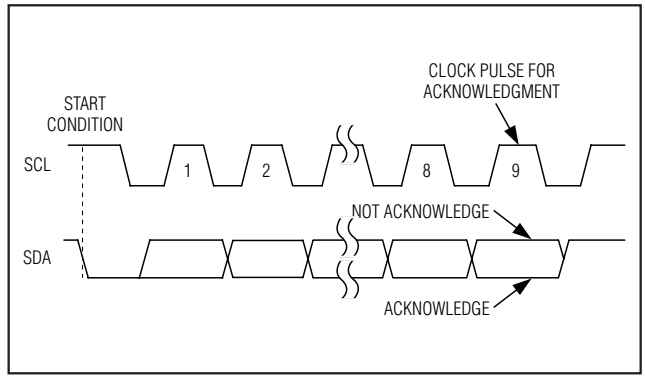


图6. 应答信号

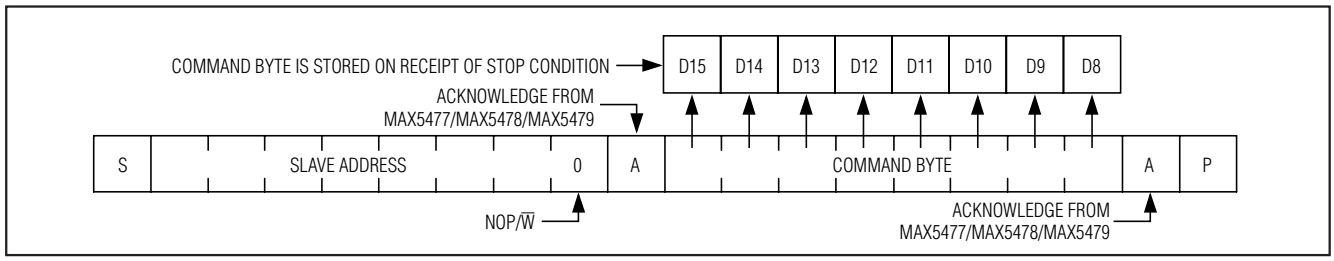


图7. 接收命令字节

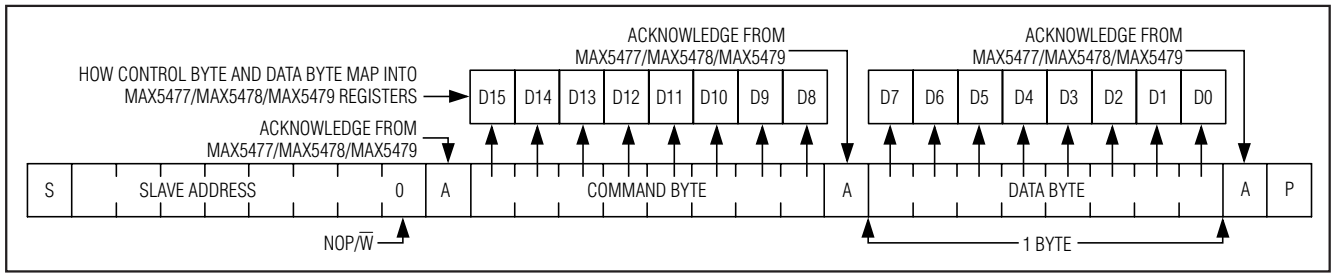


图8. 接收命令和单数据字节

MAX5477/MAX5478/MAX5479 提供三个地址输入(A0，A1和A2)，最多允许8个器件共享一个公共总线(表1)。MAX5477/MAX5478/MAX5479的从地址高4位(MSB)总是0101。A2、A1和A0设置从地址其余的3位。将每个地址输入端接V_{DD}或GND来设置这3位。每个器件必须具有唯一的地址来共享公共总线。

写数据格式

向MAX5477/MAX5478/MAX5479写入数据时，器件从地址的NOP/$\overline{W}$(第8位)置零，后面跟至少1个字节的信息(图7)。信息的第1个字节为命令字节。命令字节后面接收的是数据字节。第1个数据字节写入由命令字节选择的MAX5477/MAX5478/MAX5479的内部寄存器(图8)。

命令字节

命令字节用于选择滑动端数据的源地址和目的地址(非易失或易失存储寄存器)，或者在非易失或易失存储寄存器之间交换数据(见表3)。

命令说明

VREG: 数据字节写入易失存储寄存器，滑动端位置更新为易失存储寄存器中的数据。

NVREG: 数据字节写入非易失存储寄存器，滑动端位置保持不变。

双路、256抽头、非易失、I²C接口、数字电位器

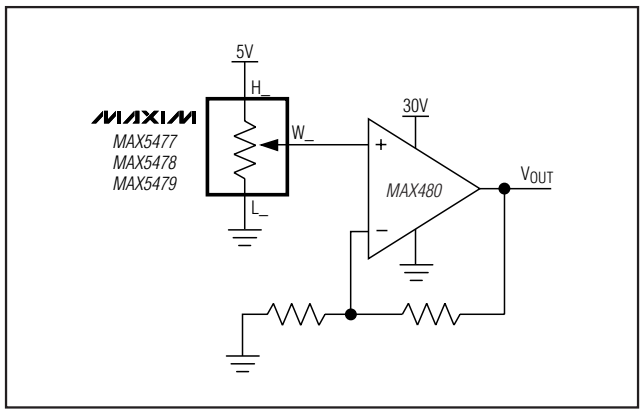


图9. 使用分压器实现正LCD偏置电压控制

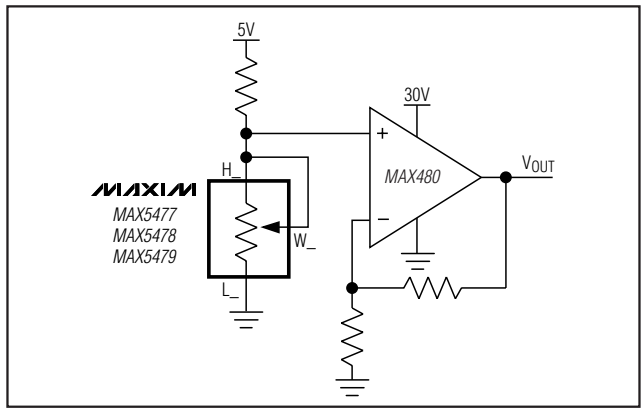


图10. 使用可变电阻实现正LCD偏置电压控制

NVREGxVREG: 数据从非易失存储寄存器传送到易失存储寄存器(滑动端位置更新)。

VREGxNVREG: 数据从易失存储寄存器传送到非易失存储寄存器(滑动端位置更新)。

非易失存储器

内置 EEPROM包含一个16位非易失寄存器，保留断电前写入的数据。非易失寄存器在工厂预置为中间值。非易失存储器确保数据维持50年，可进行200,000次滑动端位置写操作。写保护特性可以防止EEPROM的意外重写。把WP接V_{DD}或开路将使能写保护功能。滑动端寄存器只会在WP = V_{DD}时更新为EEPROM中的值。WP接GND将会允许对EEPROM的写操作，用EEPROM中的数据或直接来自I²C接口的数据更新滑动端位置。

上电

上电时，MAX5477/MAX5478/MAX5479将存储在非易失存储寄存器的数据装入易失存储寄存器，并随之更新滑动端位置。初始化周期需要10µs。

待机

MAX5477/MAX5478/MAX5479具有低功耗待机模式。器件没有编程时，进入待机模式，电流消耗值降为500nA (典型值)。

应用信息

MAX5477/MAX5478/MAX5479 适用于需要数控调节电阻的电路，如LCD对比度调节(利用偏置电压调节显示器对比度)，或用于增益和/或截止频率可调的可编程滤波器等。

LCD正偏置电压控制

图9和图10展示了一个用MAX5477/MAX5478/MAX5479提供可调节的，正LCD偏置电压的应用。运算放大器提供电阻分压电路的缓冲和放大，电阻分压电路可以由电位器单独构成(图9)，也可由一个固定电阻串联一个可变电阻构成(图10)。

可编程滤波器

图11为 MAX5477/MAX5478/MAX5479用于一阶可编程滤波器。滤波器的增益由R_2调节，截止频率通过R_3设定。利用下式计算增益(A)和-3dB截止频率(f_C)：

$$A = 1 + \frac{R_1}{R_2}$$

$$f_C = \frac{1}{2\pi \times R_3 \times C}$$

失调电压和增益调节

将MAX5477的一个电位器的高低端分别连接在MAX410的NULL输入之间，滑动端接运放正电源，可在整个工作温度范围内消除失调电压。将另一个电位器接入反馈回路来调节MAX410的增益(图12)。

可调电压基准

图13所示为MAX5477/MAX5478/MAX5479用作多级可调电压基准中的反馈电阻。改变MAX5477/MAX5478/MAX5479滑动端的位置可以在1.23V至V_{IN} - 0.2V之间独立调节MAX6160的输出电压。

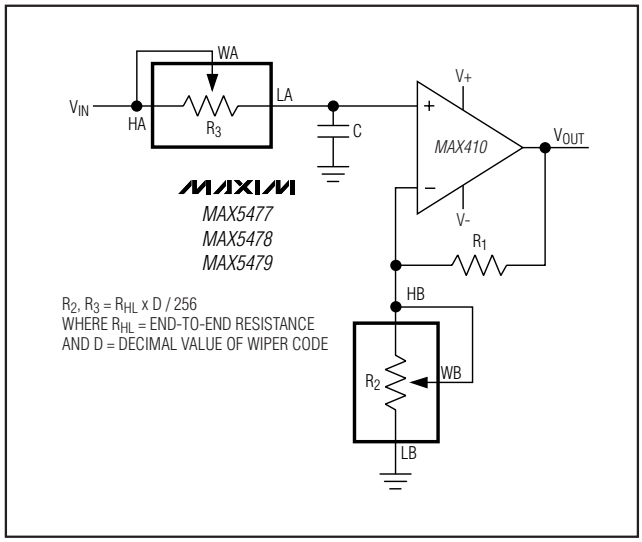


图11. 可编程滤波器

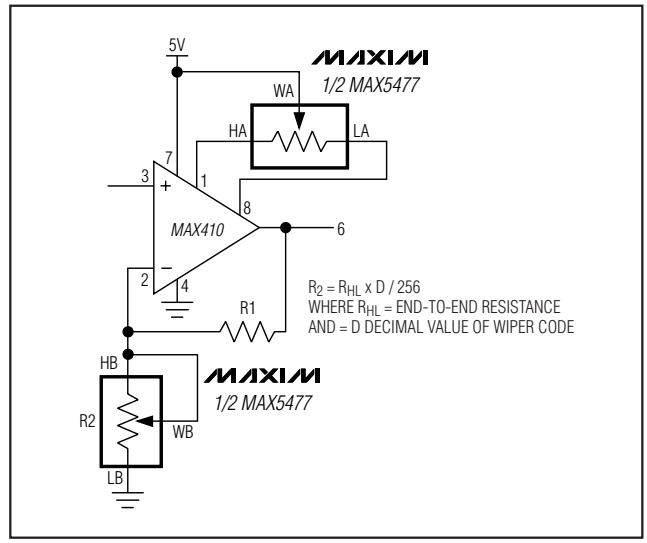


图12. 失调电压调节电路

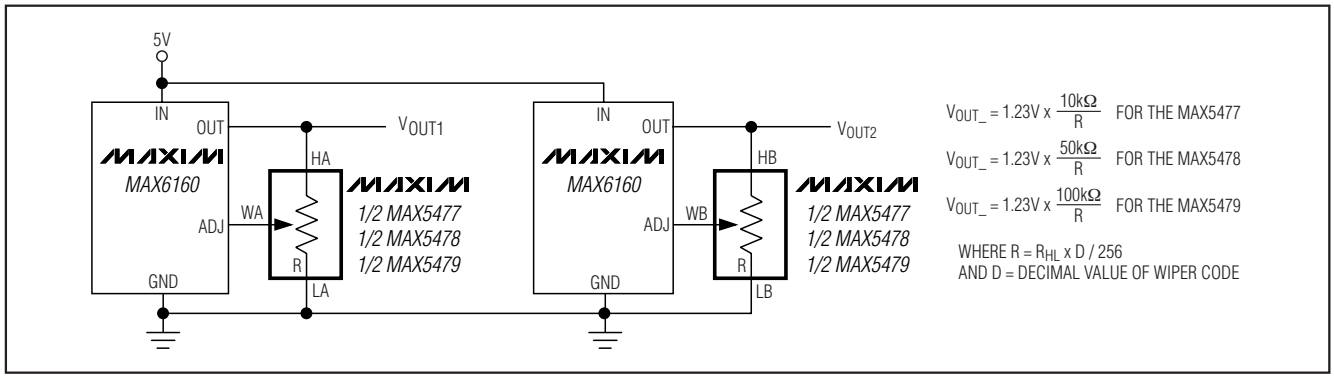


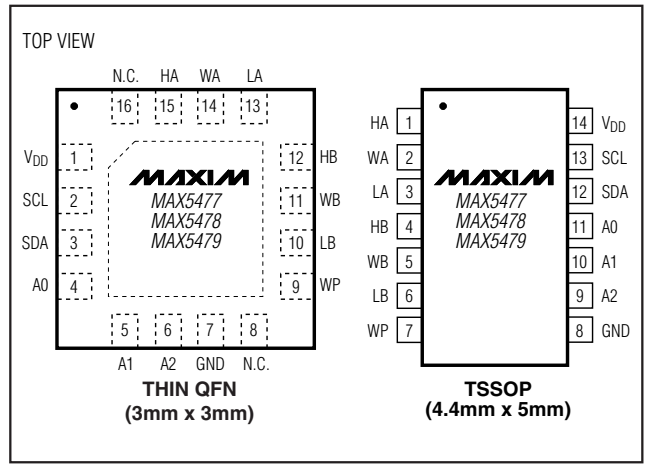
图13. 可调电压基准

芯片信息

TRANSISTOR COUNT: 12,651

PROCESS: BiCMOS

引脚配置

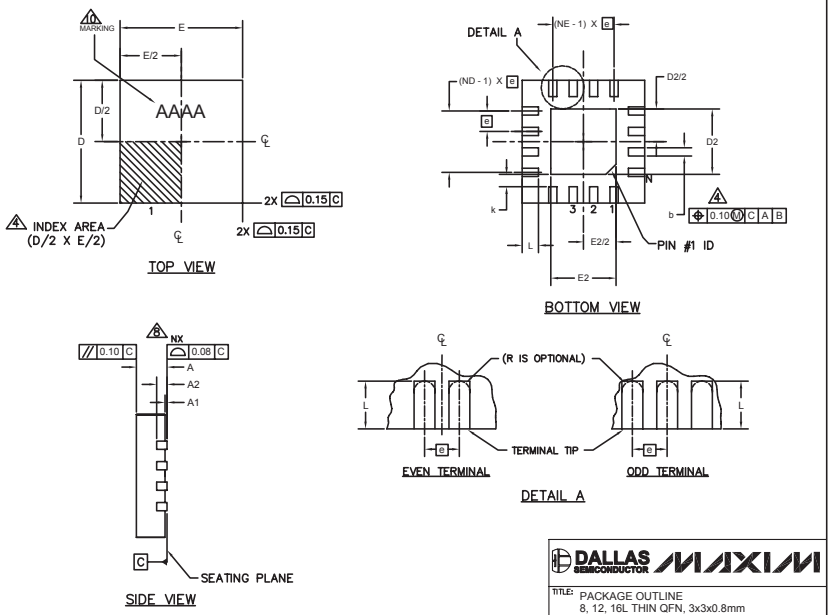


双路、256抽头、非易失、I²C接口、数字电位器

封装信息

(本数据资料提供的封装图可能不是最近的规格，如需最近的封装外型信息，请查询 **www.maxim-ic.com.cn/packages**。)

12x16L QFN THIN.EPS



–DRAWING NOT TO SCALE–

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE
8, 12, 16L THIN QFN, 3x3x0.8mm

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0136	G	1/2

PKG	8L 3x3			12L 3x3			16L 3x3		
REF.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80
b	0.25	0.30	0.35	0.20	0.25	0.30	0.20	0.25	0.30
D	2.90	3.00	3.10	2.90	3.00	3.10	2.90	3.00	3.10
E	2.90	3.00	3.10	2.90	3.00	3.10	2.90	3.00	3.10
e	0.65 BSC.			0.50 BSC.			0.50 BSC.		
L	0.35	0.55	0.75	0.45	0.55	0.65	0.30	0.40	0.50
N	8			12			16		
ND	2			3			4		
NE	2			3			4		
A1	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05
A2	0.20 REF			0.20 REF			0.20 REF		
k	0.25	-	-	0.25	-	-	0.25	-	-

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2			PIN ID	JEDEC	DOWN BONDS ALLOWED
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.			
TQ833-1	0.25	0.70	1.25	0.25	0.70	1.25	0.35 x 45°	WEEC	NO
T1233-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1	NO
T1233-3	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1	YES
T1233-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1	YES
T1633-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2	NO
T1633-2	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2	YES
T1633F-3	0.65	0.80	0.95	0.65	0.80	0.95	0.225 x 45°	WEED-2	N/A
T1633FH-3	0.65	0.80	0.95	0.65	0.80	0.95	0.225 x 45°	WEED-2	N/A
T1633-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2	NO

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.20 mm AND 0.25 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220 REVISION C.
10. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
11. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

–DRAWING NOT TO SCALE–

DALLAS SEMICONDUCTOR MAXIM

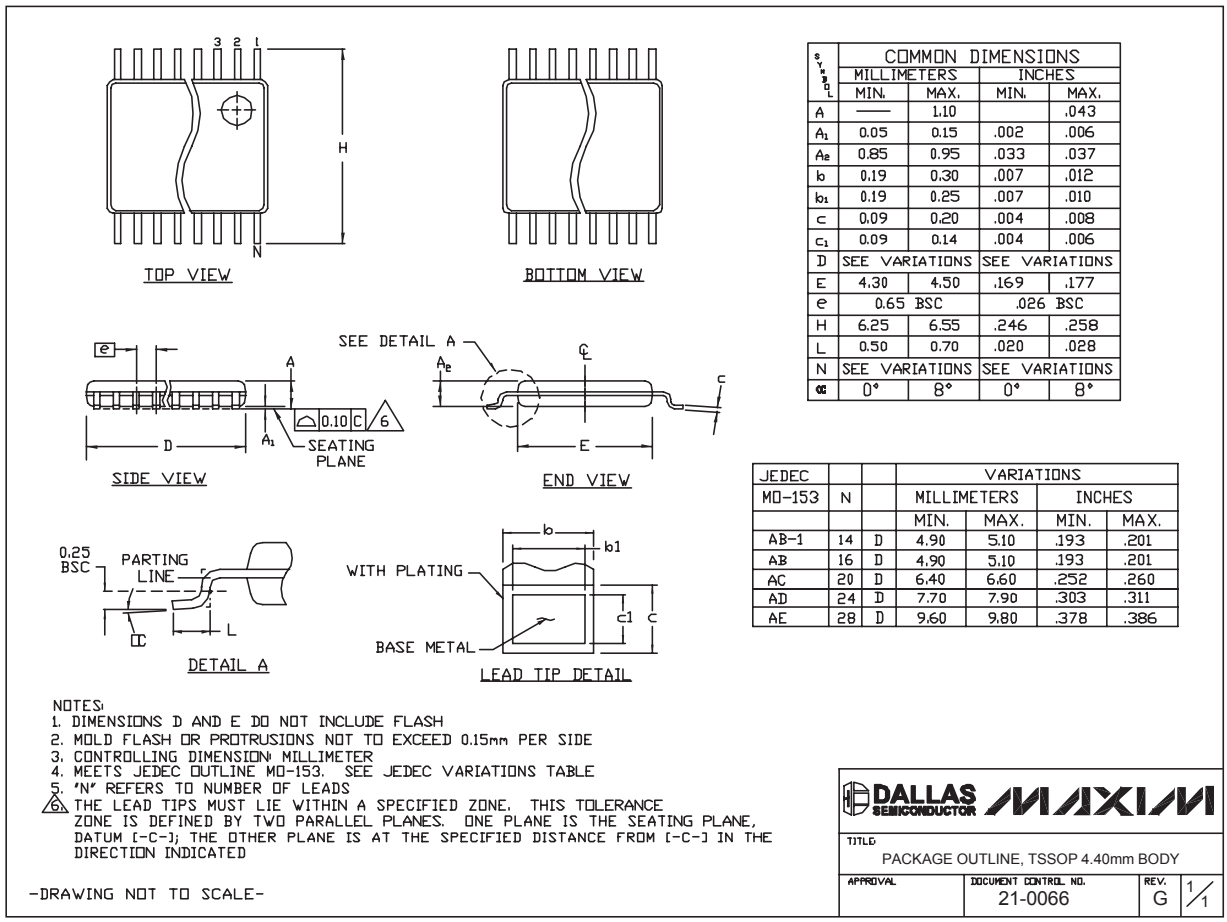
TITLE: PACKAGE OUTLINE
8, 12, 16L THIN QFN, 3x3x0.8mm

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0136	G	2/2

封装信息(续)

(本数据资料提供的封装图可能不是最近的规格，如需最近的封装外型信息，请查询 **www.maxim-ic.com.cn/packages**。)

TSSOP4.40mm.EPS



SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	——	1.10		.043
A_1	0.05	0.15	.002	.006
A_2	0.85	0.95	.033	.037
b	0.19	0.30	.007	.012
b_1	0.19	0.25	.007	.010
c	0.09	0.20	.004	.008
c_1	0.09	0.14	.004	.006
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	.169	.177
e	0.65 BSC		.026 BSC	
H	6.25	6.55	.246	.258
L	0.50	0.70	.020	.028
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°

JEDEC			VARIATIONS			
MO-153	N		MILLIMETERS		INCHES	
			MIN.	MAX.	MIN.	MAX.
AB-1	14	D	4.90	5.10	.193	.201
AB	16	D	4.90	5.10	.193	.201
AC	20	D	6.40	6.60	.252	.260
AD	24	D	7.70	7.90	.303	.311
AE	28	D	9.60	9.80	.378	.386

NOTES:
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE
5. "N" REFERS TO NUMBER OF LEADS
6. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, TSSOP 4.40mm BODY

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0066	G	1/1

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