广告位

安防监控摄像头购买/电气智能化工程安装可联系-超低价

无线AP覆盖/音响安装/智慧门禁/车牌识别

（电子与智能化二级资质）

廉价版智能沙盘/展厅移动机器人可联系

山西本地特种车辆租赁/混凝土/买车买房/抵押贷款需要可联系

办理各类企业/工程师人工智能工信部证书可联系（包过一条龙）

高光谱相机/100kg大型吊装无人机购买可联系

山西本地无人机高空清洗作业可联系/数字人视频生成

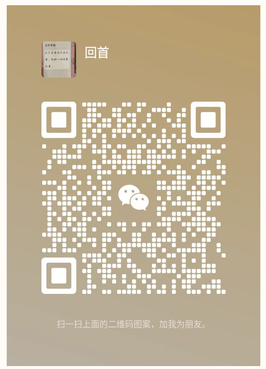
ERP沙盘模拟赛可dd/高校实验室装修/化工电子类实验设备

项目科技查新/双软评估/科小认证等包过一条龙可联系

企业代理记账/知识产权代缴/企业科技项目申报可联系

中国创翼创业创新大赛等各类企业创赛可代做（PPT/申报书/知识产权一条龙）

有以上需要均可dd我，介绍人来给提成！



办证

认证企业	方向	周期/方式	证书实物图
英伟达NVIDIA认证	人工智能计算证书	一周内全包下证	
腾讯云	交付工程师	一周内全包下证	
	云计算技能认证 区块链从业认证		
	腾讯高级工程师-数据库产品认证		
华为云	鲲鹏/华为云 技能认证	一周内全包下证	
	开发者工作级认证		
	大数据技能认证 hicp证书		
	openGauss数据库开发者证书		

	A	B
1	项目类别	认证专业
2	商务管理类	人力资源管理师
3		风险管理师
4		项目管理师
5		物联网管理师
6		新媒体运营师
7		大数据分析师
8		互联网营销师
9		数字经济管理师
10		电子商务师
11		电子政务师
12		社会工作师
13	医疗防疫公共卫生类	消毒员
14		公共场所卫生管理员
15	美学艺术类	化妆品测评师
16		新媒体主播
17		美业培训师
18		美容院管理师
19		摄影摄像与后期制作
20	经贸管理类	酒店经营管理师
21		理财规划制师
22		连锁经营管理师
23		双碳管理师
24		财务税务管理师
25		工商企业管理师
26		公共关系管理师
27		微商经营管理师
28		市场营销师
29	计算机与软件	劳动关系协调师
30		计算机信息技术
31		企业培训师
32		管理会计师
33		中式京调师
34		中式面点师

序号	专业名称	级别
1	广告艺术设计师	高级
2	网络工程师	高级
3	电子商务师	高级
4	室内设计师	高级
5	平面设计师	高级
6	ERP财务应用师	高级
7	JAVA软件工程师	高级
8	计算机辅助设计师	高级
9	软件技术开发工程师	高级
10	软件开发工程师	高级
11	物联网技术应用工程师	高级
12	数据库管理工程师	高级
13	软件设计师	高级
14	网络安全架构师	高级
15	渗透测试工程师	高级
16	提示工程师	高级
17	大模型开发工程师	高级
18	数字技术应用工程师	高级
19	大数据治理工程师	高级
20	数据安全工程师	高级
21	程序设计工程师	高级
22	AIGC应用工程师	高级
23	大模型应用工程师	高级
24	大数据采集工程师	高级
25	商务数棍分析师	高级
26	移动安全工程师	高级
27	安全运维工程师	高级
28	软件工程师	高级
29	数据库工程师	高级
30	音响工程	高级
31	舞台灯光	高级
32	通信工程师	高级
33	软件测试工程师	高级
34	新能源应用工程师	高级
35	新材料检测工程师	高级
36	新材料研发工程师	高级
37	新材料技术与应用工程师	高级
38	固体废物资源综合利用技术工程师	高级
39	现场管理工程师	高级
40	网络信息与安全工程师	高级
41	机器学习工程师	高级
42	python技术应用工程师	高级

企业认证证书 | 工信部职业 | 工信部人才交流中心测评证书 | 工

A	B	C
类别	编号	测评科目
计算机与软件	CPOO1	Office办公软件
	CPOO2	信息化办公
	CPOO3	计算机硬件维护
	CPOO4	系统管理
	CPOO9	网站管理
	CPO10	物流管理
	CPO11	网络营销
	CPO12	局域网组建
	CPO13	网络工程师
	CPO15	信息安全与管理
	CPO17	电子商务师
	CPO19	跨境电子商务师
	CPO20	数据管理
	CPO21	数据库应用技术
	CPO22	C语言编程高阶
	CPO24	.NET开发工程师
	CPO25	Android软件开发工程师
	CPO26	Java软件开发工程师
	CPO27	J2EE软件开发工程师
	CPO31	Web前端开发工程师
	CPO42	软件测试工程师
	CPO206	财务信息化管理
	CPO45	平面设计师
	CPO47	网页设计师
	CPO48	二维动画设计师
	CPO49	三维设计师

企业认证证书 | 工信部职业 | 工信部人才交流中心测评证书 | 工信部信创证书 | 中国未来研究会 | 人力

以下说明来源为数据手册内容

MCP4728性能参数

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise indicated, all parameters apply at V_{DD} = +2.7V to 5.5V, V_{SS} = 0V, R_L = 5 kΩ, C_L = 100 pF, G_N = 1, T_A = -40°C to +125°C. Typical values are at +25°C, V_{IH} = V_{DD}, V_{IL} = V_{SS}.

Parameter	Symbol	Min	Typical	Max	Units	Conditions
Analog Output (Output Amplifier)						
Output Voltage Swing	V_{OUT}	—	FSR	—	V	**Note 7**
Full Scale Range (**Note 7**)	FSR	—	V_{DD}	—	V	V_{REF} = V_{DD}, FSR = from 0.0V to V_{DD}
		—	V_{REF}	—	V	V_{REF} = Internal, G_N = 1, FSR = from 0.0 V to V_{REF}
		—	2 * V_{REF}	—	V	V_{REF} = Internal, G_N = 2, FSR = from 0.0V to 2 * V_{REF}
Output Voltage Settling Time	$T_{SETTLING}$	—	6	—	µs	**Note 8**
Analog Output Time Delay from Power-Down Mode	T_{DePO}	—	4.5	—	µs	V_{DD} = 5V. **Note 4, Note 9**
Time delay to settle to new reference (**Note 4, Note 6**)	T_{DEF}	—	26	—	µs	From External to Internal Reference
		—	44	—	µs	From Internal to External Reference
Power Supply Rejection	PSRR	—	-57	—	dB	V_{DD} = 5V ±10%, V_{REF} = Internal
Capacitive Load Stability	C_L	—	—	1000	pF	R_L = 5 kΩ. No oscillation. **Note 4**
Slew Rate	SR	—	0.55	—	V/µs	
Phase Margin	P_M	—	66	—	Degrees (°)	G_N = 400 pF, R_L = ∞
Short Circuit Current	I_{SC}	—	15	24	mA	V_{DD} = 5V. All V_{OUT} Pins = Grounded. Tested at room temperature.
Short Circuit Current Duration	T_{SC_DUR}	—	Infinite	—	hours	**Note 4**
DC Output Impedance (**Note 4**)	R_{OUT}	—	1	—	Ω	Normal mode
		—	1	—	kΩ	Power-Down mode 1 (PD1:PD0 = 0:1). V_{OUT} to V_{SS}
		—	100	—	kΩ	Power-Down mode 2 (PD1:PD0 = 1:0). V_{OUT} to V_{SS}
		—	500	—	kΩ	Power-Down mode 3 (PD1:PD0 = 1:1). V_{OUT} to V_{SS}

Note 1: All digital input pins (SDA, SCL, LDAC) are tied to "High". Output pins are unloaded, code = 0 x 000.
2: The power-up ramp rate measures the rise of V_{DD} over time.
3: This parameter is ensured by design and not 100% tested.
4: This parameter is ensured by characterization and not 100% tested.
5: Test code range: 100 - 4000 codes, V_{REF} = V_{DD}, V_{DD} = 5.5V.
6: Time delay to settle to a new reference when switching from external to internal reference or vice versa.
7: This parameter is indirectly tested by Offset and Gain error testing.
8: Within 1/2 LSB of the final value when code changes from 1/4 of to 3/4 of full scale.
9: This time delay is measured from the falling edge of ACK pulse in I²C command to the beginning of V_{OUT} This time delay is not included in the output setting time specification.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise indicated, all parameters apply at V_{DD} = +2.7V to 5.5V, V_{SS} = 0V, R_L = 5 kΩ, C_L = 100 pF, G_N = 1, T_A = -40°C to +125°C. Typical values are at +25°C, V_{IH} = V_{DD}, V_{IL} = V_{SS}

Parameter	Symbol	Min	Typical	Max	Units	Conditions
Dynamic Performance (**Note 4**)						
Major Code Transition Glitch		—	45	—	nV-s	1 LSB code change around major carry (from 7FFh to 800h)
Digital Feedthrough		—	<10	—	nV-s	
Analog Crosstalk		—	<10	—	nV-s	
DAC-to-DAC Crosstalk		—	<10	—	nV-s	
Digital Interface						
Output Low Voltage	V_{OL}	—	—	0.4	V	I_{OL} = 3 mA SDA and RDY/BSY pins
Schmitt Trigger Low Input Threshold Voltage	V_L	—	—	0.3V_{DD}	V	V_{DD} > 2.7V, SDA, SCL, LDAC pins
		—	—	0.2V_{DD}	V	V_{DD} ≤ 2.7V, SDA, SCL, LDAC pins
Schmitt Trigger High Input Threshold Voltage	V_H	0.7V_{DD}	—	—	V	SDA, SCL, LDAC pins
Input Leakage	I_{LI}	—	—	±1	µA	SCL = SDA = LDAC = V_{DD}, SCL = SDA = LDAC = V_{SS}
Pin Capacitance	C_{PIN}	—	—	3	pF	**Note 4**
EEPROM						
EEPROM Write Time	T_{WRITE}	—	25	50	ms	EEPROM write time
Data Retention		—	200	—	Years	At +25°C. **Note 3**
LDAC Input						
LDAC Low Time	T_{LDAC}	210	—	—	ns	Updates analog outputs (**Note 3**)

Note 1: All digital input pins (SDA, SCL, LDAC) are tied to "High", Output pins are unloaded, code = 0 x 000.
2: The power-up ramp rate measures the rise of V_{DD} over time.
3: This parameter is ensured by design and not 100% tested.
4: This parameter is ensured by characterization and not 100% tested.
5: Test code range: 100 - 4000 codes, V_{REF} = V_{DD}, V_{DD} = 5.5V.
6: Time delay to settle to a new reference when switching from external to internal reference or vice versa.
7: This parameter is indirectly tested by Offset and Gain error testing.
8: Within 1/2 LSB of the final value when code changes from 1/4 of to 3/4 of full scale.
9: This time delay is measured from the falling edge of ACK pulse in I²C command to the beginning of V_{OUT} This time delay is not included in the output setting time specification.

以下说明来源为数据手册内容

MCP4728性能参数

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

V_{DD} 6.5V
All inputs and outputs w.r.t V_{SS} ..... -0.3V to V_{DD}+0.3V
Current at Input Pins ..... ±2 mA
Current at Supply Pins ..... ±110 mA
Current at Output Pins ..... ±25 mA
Storage Temperature ..... -65°C to +150°C
Ambient Temp. with Power Applied ..... -55°C to +125°C
ESD protection on all pins ..... ≥ 4 kV HBM, ≥ 400V MM
Maximum Junction Temperature (T_J) ..... +150°C

† Notice: Stresses above those listed under "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 above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, all parameters apply at V_{DD} = +2.7V to 5.5V, V_{SS} = 0V, R_L = 5 kΩ, C_L = 100 pF, G_N = 1, T_A = -40°C to +125°C. Typical values are at +25°C, V_{IH} = V_{DD}, V_{IL} = V_{SS}.

Parameter	Symbol	Min	Typical	Max	Units	Conditions
Power Requirements						
Operating Voltage	V_{DD}	2.7		5.5	V	
Supply Current with External Reference (V_{REF} = V_{DD}) (**Note 1**)	I_{DD_EXT}	—	800	1400	µA	V_{REF} = V_{DD}, V_{DD} = 5.5V. All 4 channels are in Normal mode.
		—	600	—	µA	3 channels are in Normal mode, 1 channel is powered down.
		—	400	—	µA	2 channels are in Normal mode, 2 channel are powered down.
		—	200	—	µA	1 channels are in Normal mode, 3 channels are powered down.
Power-Down Current with External Reference	I_{PD_EXT}	—	40	—	nA	All 4 channels are powered down. (V_{REF} = V_{DD})
Supply Current with Internal Reference (V_{REF} = Internal) (**Note 1**)	I_{DD_INT}	—	800	1400	µA	V_{REF} = Internal Reference V_{DD} = 5.5V All 4 channels are in normal mode.
		—	600	—	µA	3 channels are in Normal mode, 1 channel is powered down.
		—	400	—	µA	2 channels are in Normal mode, 2 channels are powered down.
		—	200	—	µA	1 channel is in Normal mode, 3 channels are powered down.
Power-Down Current with Internal Reference	I_{PD_INT}	—	45	60	µA	All 4 channels are powered down. V_{REF} = Internal Reference

Note 1: All digital input pins (SDA, SCL, LDAC) are tied to "High", Output pins are unloaded, code = 0 x 000.
2: The power-up ramp rate measures the rise of V_{DD} over time.
3: This parameter is ensured by design and not 100% tested.
4: This parameter is ensured by characterization and not 100% tested.
5: Test code range: 100 - 4000 codes, V_{REF} = V_{DD}, V_{DD} = 5.5V.
6: Time delay to settle to a new reference when switching from external to internal reference or vice versa.
7: This parameter is indirectly tested by Offset and Gain error testing.
8: Within 1/2 LSB of the final value when code changes from 1/4 of to 3/4 of full scale.
9: This time delay is measured from the falling edge of ACK pulse in I²C command to the beginning of V_{OUT} This time delay is not included in the output setting time specification.

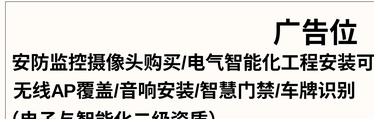
ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise indicated, all parameters apply at V_{DD} = +2.7V to 5.5V, V_{SS} = 0V, R_L = 5 kΩ, C_L = 100 pF, G_N = 1, T_A = -40°C to +125°C. Typical values are at +25°C, V_{IH} = V_{DD}, V_{IL} = V_{SS}.

Parameter	Symbol	Min	Typical	Max	Units	Conditions
Power-on Reset Threshold Voltage	V_{POR}	—	2.2	—	V	All circuits, including EEPROM, are ready to operate.
Power-Up Ramp Rate	V_{RAMP}	1	—	—	V/s	**Note 2, Note 4**
DC Accuracy						
Resolution	n	12	—	—	Bits	Code Change: 000h to FFFh
Integral Nonlinearity (INL) Error	INL	—	±2	±13	LSB	**Note 5**
DNL Error	DNL	-0.75	±0.2	±0.75	LSB	**Note 5**
Offset Error	V_{OS}	—	5	20	mV	Code = 000h See Figure 2-24
Offset Error Drift	$\Delta V_{OS}/^{\circ}C$	—	±0.16	—	ppm/°C	+85°C to +25°C
		—	±0.44	—	ppm/°C	+25°C to +125°C
Gain Error	G_E	±1.25	0.4	±1.25	% of FSR	Code = FFFh, Offset error is not included. Typical value is at room temperature. See Figure 2-25
Gain Error Drift	$\Delta G_E/^{\circ}C$	—	-3	—	ppm/°C	
Internal Voltage Reference (V_{REF}), (Note 3)						
Internal Voltage Reference	V_{REF}	2.007	2.048	2.089	V	
Temperature Coefficient	$TV_{REF}/^{\circ}C$	—	125	—	ppm/°C	-40 to 0°C
		—	0.25	—	LSB/°C	
		—	45	—	ppm/°C	0 to +125°C
		—	0.09	—	LSB/°C	
Reference Output Noise	E_{NREF}	—	290	—	μV_{P-P}	Code = FFFh, 0.1 – 10 Hz, G_N = 1
Output Noise Density	e_{NREF}	—	1.2	—	$nV/\sqrt{Hz}$	Code = FFFh, 1 kHz, G_N = 1
		—	1.0	—	$nV/\sqrt{Hz}$	Code = FFFh, 10 kHz, G_N = 1
1/f Corner Frequency	f_{CORNER}	—	400	—	Hz	

Note 1: All digital input pins (SDA, SCL, LDAC) are tied to "High", Output pins are unloaded, code = 0 x 000.
2: The power-up ramp rate measures the rise of V_{DD} over time.
3: This parameter is ensured by design and not 100% tested.
4: This parameter is ensured by characterization and not 100% tested.
5: Test code range: 100 - 4000 codes, V_{REF} = V_{DD}, V_{DD} = 5.5V.
6: Time delay to settle to a new reference when switching from external to internal reference or vice versa.
7: This parameter is indirectly tested by Offset and Gain error testing.
8: Within 1/2 LSB of the final value when code changes from 1/4 of to 3/4 of full scale.
9: This time delay is measured from the falling edge of ACK pulse in I²C command to the beginning of V_{OUT} This time delay is not included in the output setting time specification.

基于MCP4728的四通道数模转换模块-V1.0.0



公众号链接

github仓库： https://github.com/lesshong

飞书链接：Flash输入/C

Github仓库：Arduino/C

Flash输入/C

设计特点

1、本模块基于MCP4821芯片，它是 Microchip 推出的 12 位电压输出 DAC，内置非易失性 EEPROM 存储电压输出设置值，I²C 接口，供电电压 2.7V~5.5V，通信电平为+3.3V，可与 51/STM32 直接通信。

2、12 位精确输出的 4096 级输出，可选内部基准 (2.048V/4.096V) 或外部 VDD 作为基准，输出范围宽广，精度高、线性度好。

3、四路 DAC 输出（VOUTA~VOUTD）通过 DAC 输出接口（U2）引出，可同时输出四路独立且精准的、满足多通道控制需求。

4、4路模拟输出通过专用SMA接口，接口高耐压有 GND 保护引脚，有效降低共模干扰。

版本记录

V1.0.0版本-2026/03/16-零高幸：初版完成设计

以下说明来源为数据手册内容

MCP4728简介

Features

- 12-Bit Voltage Output DAC with Four Buffered Outputs
- On-Board Nonvolatile Memory (EEPROM) for DAC Codes and I²C™ Address Bits
- Internal or External Voltage Reference Selection
- Output Voltage Range:
  - Using Internal V_{REF} (2.048V):
    - 0.000V to 2.048V with Gain Setting = 1
    - 0.000V to 4.096V with Gain Setting = 2
  - Using External V_{REF} (V_{DD}):
    - 0.000V to V_{DD}
- ±0.2 Least Significant Bit (LSB) Differential Nonlinearity (DNL) (typical)
- Fast Settling Time: 6 µs (typical)
- Normal or Power-Down Mode
- Low Power Consumption
- Single-Operation: 2.7V to 5.5V
- I²C Interface:
  - Address bits: User Programmable to EEPROM
  - Standard (100 kbps), Fast (400 kbps) and High Speed (HS) Mode (3.4 Mbps)
- 10-Lead MSOP Package
- Extended Temperature Range: -40°C to +125°C

Applications

- Set Point or Offset Adjustment
- Sensor Calibration
- Closed-Loop Servo Control
- Low Power Portable Instrumentation
- PC Peripherals
- Programmable Voltage and Current Source
- Industrial Process Control
- Instrumentation
- Bias Voltage Adjustment for Power Amplifiers

Description

The MCP4728 device is a quad, 12-bit voltage output Digital-to-Analog Converter (DAC) with nonvolatile memory (EEPROM). Its on-board precision output amplifier allows it to achieve rail-to-rail analog output swing.

The DAC input codes, device configuration bits, and I²C address bits are programmable to the nonvolatile memory (EEPROM) by using I²C serial interface commands. The nonvolatile memory feature enables the DAC device to hold the DAC input codes during power-off time, allowing the DAC outputs to be available immediately after power-up with the saved settings. This feature is very useful when the DAC device is used as a supporting device for other devices in the application's network.

The MCP4728 device has a high precision internal voltage reference (V_{REF} = 2.048V). The user can select the internal reference or external reference (V_{DD}) for each channel individually.

Each channel can be operated in Normal mode or Power-Down mode individually by setting the configuration register bits. In Power-Down mode, most of the internal circuits in the powered-down channel are turned off for power savings, and the output amplifier can be configured to present a known low, medium, or high resistance output load.

The MCP4728 device includes a Power-on Reset (POR) circuit to ensure reliable power-up and an on-board charge pump for the EEPROM programming voltage.

The MCP4728 has a two-wire I²C compatible serial interface for standard (100 kHz), fast (400 kHz), or high speed (3.4 MHz) mode.

The MCP4728 DAC is an ideal device for applications requiring design simplicity with high precision, and for applications requiring the DAC device settings to be saved during power-off time.

The MCP4728 device is available in a 10-lead MSOP package and operates from a single 2.7V to 5.5V supply voltage.

MCP4728引脚说明

MCP4728
MSOP

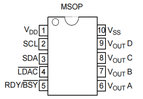


TABLE 3-1: PIN FUNCTION TABLE

Pin No.	Name	Pin Type	Function
1	V_{DD}	P	Supply Voltage
2	SCL	OI	I²C Serial Clock Input (**Note 1**)
3	SDA	OI/OO	I²C Serial Data Input and Output (**Note 1**)
4	LDAC	ST	This pin is used for two purposes: (a) Synchronization Input. It is used to transfer the contents of the DAC input registers to the output registers (V_{OUT}). (b) Select the device for reading and writing I²C address bits. (**Note 2**)
5	RDY/BSY	OO	This pin is a status indicator of EEPROM programming activity. An external pull-up resistor (about 100 kΩ) is needed from RDY/BSY pin to V_{DD} line. (**Note 1**)
6	V_{OUT} A	AO	Buffered analog voltage output of channel A. The output amplifier has rail-to-rail operation.
7	V_{OUT} B	AO	Buffered analog voltage output of channel B. The output amplifier has rail-to-rail operation.
8	V_{OUT} C	AO	Buffered analog voltage output of channel C. The output amplifier has rail-to-rail operation.
9	V_{OUT} D	AO	Buffered analog voltage output of channel D. The output amplifier has rail-to-rail operation.
10	V_{SS}	P	Ground reference.

Legend: P = Power, OI = Open-Drain Input, OO = Open-Drain Output, ST = Schmitt Trigger Input Buffer, AO = Analog Output

Note 1: This pin needs an external pull-up resistor from V_{DD} line. Leave this pin float if it is not used.
2: This pin can be driven by MCU.