

PJ91921 Datasheet

Piezo Haptic Driver with Digital Front End

Version: Rev.1.0

Release Date: 2026-01-09

MetaWells Co., Ltd.

www.MetaWells.com

General Description

The PJ91921 is a single-chip piezo actuator driver with energy recovery. It can drive actuators with waveforms up to 190 Vpk-pk while operating from a 2.3 to 5.5 V supply voltage. Its low power and small size make it ideal for applications requiring minimal power consumption. The PJ91921 features high-resolution piezo sensing capabilities allowing haptic feedback to be automatically played when detection conditions are met.

The PJ91921 differential driver achieves low distortion waveforms and quiet actuator operation. All settings are adjustable through the digital front end to reduce the BOM. Data and configuration parameters are easily communicated to the PJ91921 through its two wire I²C interface. A flexible deep FIFO enables the streaming of digital waveform data for playback or the transmission of burst data for more bandwidth efficiency. The PJ91921 also integrates 1.5 kB of RAM waveform memory to generate waveforms with minimal communication bandwidth.

A dedicated SYNC pin can synchronize multiple PJ91921 controllers to simultaneously drive multiple actuators within 2 μ s. In addition to SYNC synchronization, PJ91921 can also support CLK_SYNC synchronization. This function synchronizes the clock, and multiple chips share the same clock.

With a typical start-up time of less than 200 μ s, the PJ91921 latency is negligible in most systems. Various safety systems protect the PJ91921 from damage in case of a fault.

Features

- ◆ **High-Voltage Low Power Piezo Driver**
 - Drive 10nF at 190VPP and 200Hz with 64mW
 - Drives Capacitive Loads up to 100nF
 - Energy Recovery
 - Differential Output
 - Small Solution Footprint, QFN & CSP
- ◆ **Low Quiescent Current: SHUTDOWN; SLEEP; IDLE; IDLE mode Current only 90uA**
- ◆ **Multiple operating modes: AUTOPLAY; SENSEPLAY; DIRECTPLAY; FIFOPLAY; SRAMPLAY**
- ◆ **Wide Supply Voltage Range of 2.3V to 5.5V**
- ◆ **Advanced Piezo Sensing Capabilities**
 - 8.8 mV Sensing Resolution
 - Interrupt Generation
 - Automatic Triggering of Haptic Feedback
- ◆ **Integrated Digital Front End with I²C**
 - 1024 sample Internal FIFO Interface
 - 1.8 V Digital I/O Supply
 - Supports Continuous Waveforms Playback
 - State Retention in SLEEP Mode
- ◆ **Fast Start Up Time less than 200 μ s**
- ◆ **Multi-Actuator Synchronization; address selection; Power-on-Reset**
- ◆ **ESD verification pass, latch up verification pass**

Applications

- ◆ **Electronic Cooling**
- ◆ **Portable Computers, Keyboards and Mice**
- ◆ **Gaming Controllers, Wearables**

Ordering Information

Ordering Information

Order number	Marking ID	Package	Description
PJ91921QW	91921 YMDNN	QFN4X4-24	Halogen free RoHS compliant in T/R, 3,000 pcs/Reel
PJ91921WS	A1 W	CSP 2.1mmx1.7mm-20	Halogen free RoHS compliant in T/R, 3,000 pcs/Reel

Note:

(1) MetaWells can meet RoHS 2.0/REACH requirement. So most package types MetaWells offers only states halogen free, instead of lead free.

Marking Information

Marking	Package	Definition
91921 YMDNN	QFN4X4-24	91921 : Product code YMDNN : Y : Year code M : Month code D : Day code NN : Serial Number
A1 W	CSP 2.1mmx1.7mm-20	A1 : Product code W : Week code

Typical Application

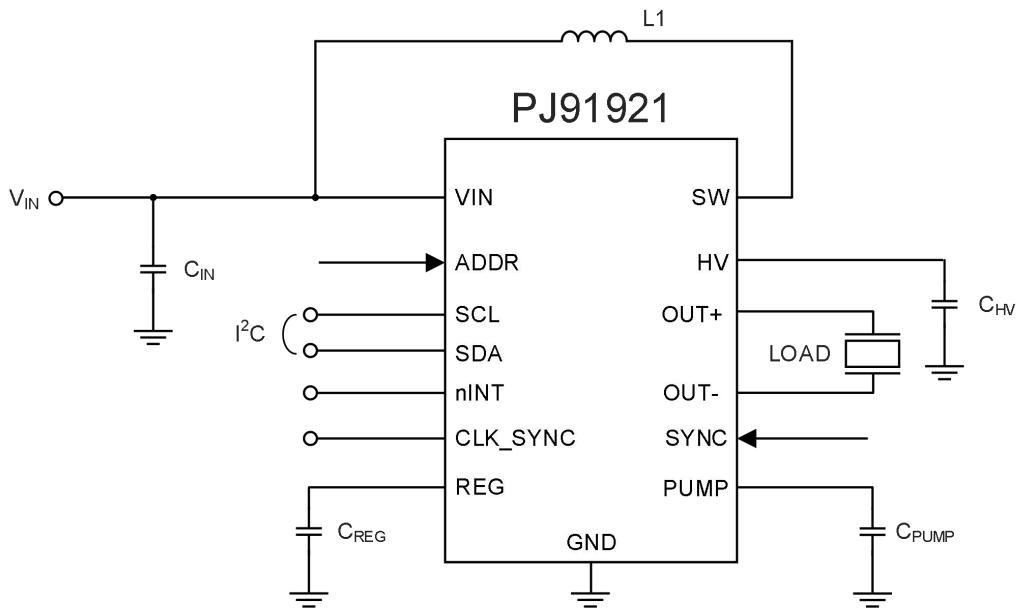


Figure 1. Typical Application Circuit

Pin Configuration

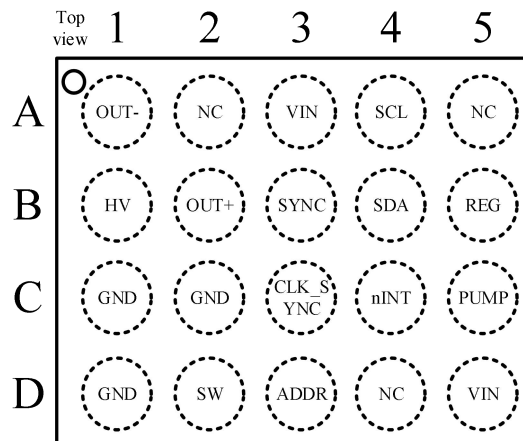


Figure 2. CSP 2.1mm*1.7mm 20 package (TOP VIEW; NOT TO SCALE)

Pin Description

Table 1. CSP 20 Pin Function Descriptions

Pin No.	Pin Name	Type ⁽¹⁾	Description
A1	OUT-	O	Negative Differential Output
A2	NC	-	No connect
A3	VIN	P	Main Power Supply
A4	SCL	I	I ² C clock
A5	NC	-	No connect
B1	HV	P	High-Voltage Output
B2	OUT+	O	Positive Differential Output
B3	SYNC	I/O	1.Synchronization pin; 2.Positive Input of ATOA(I/O)
B4	SDA	I/O	I ² C data
B5	REG	P	Internal 1.8 V Regulator Output
C1	GND	P	Ground
C2	GND	P	Ground
C3	CLK_SYNC	I/O	CLK Synchronization Pin, Can Be Set to Either Master or Slave Mode
C4	nINT	O	1.Interrupt or Alarm Out Pin; 2.Negative Input of ATOA(O)
C5	PUMP	P	Internal 2.2 V Regulator Output Analog Power
D1	GND	P	Ground
D2	SW	P	Internal Power Converter Switch Pin
D3	ADDR	I	IIC Slave Address.
D4	NC	-	No connect
D5	VIN	P	Main Power Supply

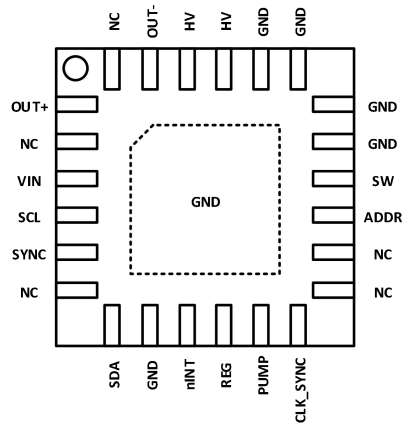


Figure 3. QFN4X4-24 package with exposed thermal pad (TOP VIEW; NOT TO SCALE)

Table 2. QFN4X4-24 Pin Function Descriptions

Pin No.	Pin Name	Type ⁽¹⁾	Description
1	OUT+	O	Positive Differential Output(O)
2	NC	-	No connect
3	VIN	P	Main Power Supply (=VIN)
4	SCL	I	I ² C clock
5	SYNC	I/O	1.Synchronization pin Open Drain; 2.Positive Input of ATOA(I/O)
6	NC	-	No connect
7	SDA	I/O	I ² C data
8	GND	P	Supply Ground
9	nINT	O	1.Interrupt or Alarm Out Pin; 2.Negative Input of ATOA(O)
10	REG	P	Internal 1.8 V Regulator Output
11	PUMP	P	Internal 2.2 V Regulator Output Analog Power
12	CLK_SYNC	I/O	CLK Synchronization Pin, Can Be Set to Either Master or Slave Mode(I/O)
13	NC	-	No connect
14	NC	-	No connect
15	ADDR	I	IIC Slave Address: Pull Down:7'b1000100; Pull Up:7'b1000101; No connect:7'b1000110
16	SW	P	Internal Power Converter Switch Pin
17	GND	P	Supply Ground
18	GND	P	Supply Ground
19	GND	P	Supply Ground
20	GND	P	Supply Ground
21	HV	P	High-Voltage Output
22	HV	P	High-Voltage Output
23	OUT-	P	Negative Differential Output
24	NC	-	No connect
25	GND	P	Supply Ground

(1) Legend: A = Analog Pin; P = Power Pin; D = Digital Pin; I = Input Pin; O = Output Pin.

Absolute Maximum Ratings

Parameter	Min	Max	Units
Voltage at pins HV, OUT+, OUT-, SW	-0.3	110	V
Voltage at pins REG, CLK_SYNC	-0.3	3.6	V
Voltage at all other pins	-0.3	7	V
Junction temperature	-40	150	°C
Storage temperature	-65	150	°C

(1) Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Operating Temperature	-40		125	°C
Continuous Supply Voltage (V_{IN})	2.3		5.5	V
Load Capacitance			100	nF
Inductance	10	47	68	μ H
Output frequency	1		1000	Hz
Junction Temperature (T_J)	-40		125	°C

Electrostatic Discharge (ESD)

Parameter	Description	Rating	Units
HBM	Human Body Model ANSI/ESDA/JEDEC JS-001-2014 Classification, Class: 2	\pm 2000	V
CDM	Charged Device Mode ANSI/ESDA/JEDEC JS-002-2014 Classification, Class: C0b	\pm 500	V
Latch-Up	JEDEC STANDARD NO.78E APRIL 2016 Temperature Classification, Class: I	\pm 200	mA

Thermal Resistance

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Close attention to PCB thermal design is required.

Item ^{(1) (2)}	Description	Value		Unit
		QFN4X4-24	CSP_20	
θ_{JA}	Junction-to-ambient thermal resistance	35.5	51.6	°C/W
θ_{JC_Top}	Junction-to-case (top) thermal resistance	24.7	0.3	°C/W

(1) The package thermal impedance is calculated in accordance to JESD 51-7.

(2) Thermal Resistances were simulated on a 4-layer, JEDEC board.

Electrical Characteristics

$V_{IN} = 3.6\text{ V}$, $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$ for minimum and maximum specifications, and $T_J = 25^\circ\text{C}$ of PJ91921 for typical specifications, unless otherwise noted.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
Voltage at REG pin	V_{REG}		1.62		1.98	V
Digital low-level input voltage	V_{IL}	SDA, SCL, NINT & SYNC pins			0.5	V
Digital high-level input voltage	V_{IH}		1.26			V
Digital low-level output voltage	V_{OL}				0.4	V
Digital high-level output voltage	V_{OH}		1.26			V
Full-scale output voltage	$V_{OUT(FS)}$		QFN4X4-24	185	190	195
		CSP_20	186	190	194	
VIN Quiescent current	I_{Q_VIN}	SHUTDOWN Mode		1.3	2.7	μA
		SLEEP Mode, QFN4X4-24		5	120	μA
		SLEEP Mode, CSP_20		5	50	μA
		IDLE Mode		90	200	μA
Maximum Inductor Current ⁽¹⁾	I_{L_MAX}			330		mA
Average VIN supply current during operation ⁽²⁾	$I_{VIN,AVG}$	$V_{IN} = 5\text{ V}$ $f_{OUT} = \text{DC}$ $V_{OUT} = 95\text{ V}$ $C_{LOAD} = 100\text{ nF}$		14		mA
		$f_{OUT} = 200\text{ Hz}$ $V_{OUT} = 190\text{ Vpk-pk}$ $C_{LOAD} = 10\text{ nF}$		17.8		mA
Total Harmonic Distortion + Noise	THD+N	$f_{OUT} = 250\text{ Hz}$ $V_{OUT} = 190\text{ Vpk-pk}$ $C_{LOAD} = 10\text{ nF}$		0.25		%
Programmable FIFO playback rate ⁽¹⁾	fs-FIFO	PLAY_SRATE[15:0]=0x0000	970	1024	1080	ksps
		PLAY_SRATE[15:0]=0xFFFF		0.015		ksps
Piezo Sensing Resolution ⁽³⁾	PSR	CONFIG.GAINS=0x1		8.8		mV
		CONFIG.GAINS=0x0		46		mV
Start-up Time	tstart	Time from SLEEP mode to haptic waveform playback			200	μs
Sensing Detection to Haptic Feedback Latency ⁽³⁾	DHL	Time from sensing detection event to automatic playback		30		μs
Full scale input range of ADC ⁽¹⁾		ADC_Gain=0	-0.35		18	V
		ADC_Gain=1	-0.35		100	V
ADC Offset error	ADC V_{OS}		-4		4	lsb
ADC Gain error	ADC GE	QFN4X4-24	-2		2	%
ADC Gain error	ADC GE	CSP_20	-1		1	%
ADC Sampling Frequency ⁽³⁾	f_{SMPL}			10		kSps
Differential nonlinearity ⁽³⁾	ADC DNL		-1.5		1.5	lsb
Integral nonlinearity ⁽³⁾	ADC INL		-2		2	lsb
Effective number of bits ⁽³⁾	ADC ENOB			10		bit
DAC Offset error	DAC V_{OS}		-1		1	lsb

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
DAC Gain error	DAC GE	OUT Vpk=190, QFN_24	-2.5		2.5	%
		OUT Vpk=190, CSP_20	-2		2	
Differential nonlinearity ⁽³⁾	DAC DNL		-1.5		1.5	lsb
Integral nonlinearity ⁽³⁾	DAC INL		-2.0		2.0	lsb

(1) This parameter is related to the device part. See Ordering Information for more details.

(2) This parameter is strongly correlated to the DCR of the inductor, which was tested on PA4342.473ANLT.

(3) These characteristics is guaranteed by design.

Typical Performance Characteristics

Typical performance characteristics for the following conditions: $T_A = 25^\circ\text{C}$, $V_{IN} = 3.6\text{ V}$, $C_L = 10\text{ nF}$, $V_{OUT} = 190\text{ Vpk-pk}$ and $f_{OUT} = 200\text{ Hz}$ (unless otherwise noted).

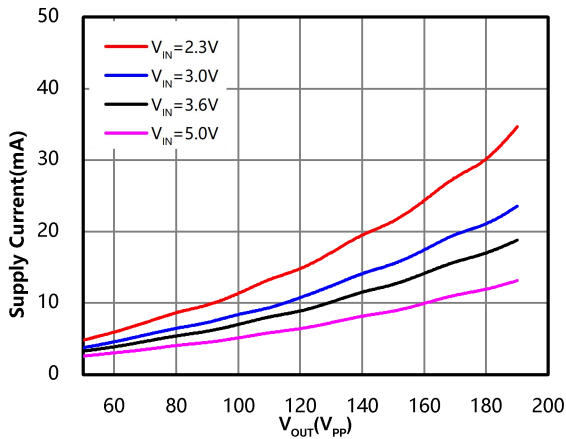


Figure 4. Supply Current vs Output Voltage

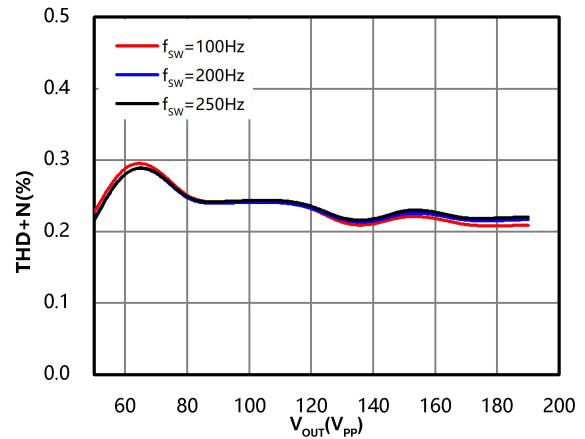


Figure 7. Total Harmonic Distortion + Noise vs Output Voltage

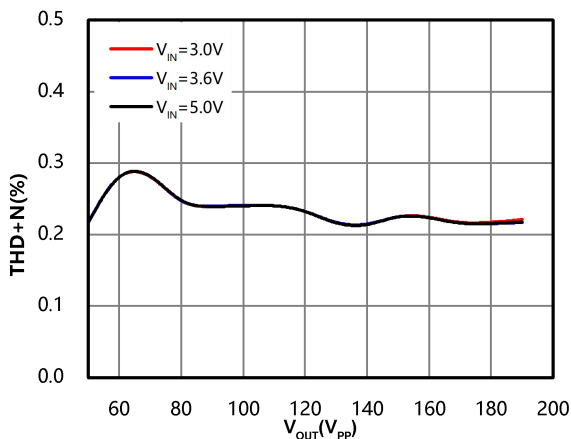


Figure 5. Total Harmonic Distortion + Noise vs Output Voltage

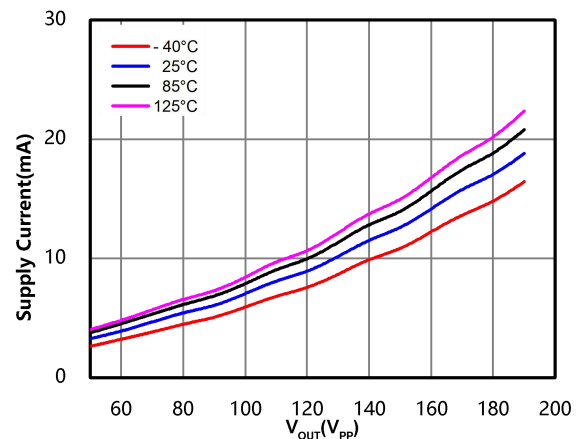


Figure 8. Supply Current vs Output Voltage

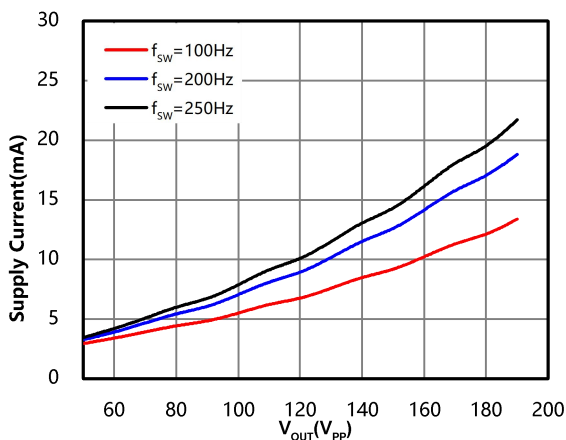


Figure 6. Supply Current vs Output Voltage

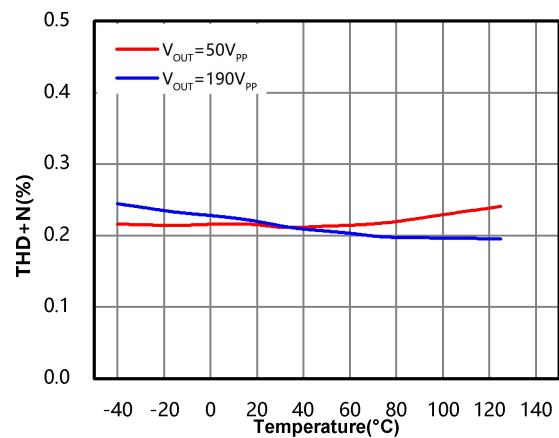


Figure 9. Total Harmonic Distortion + Noise vs Temperature

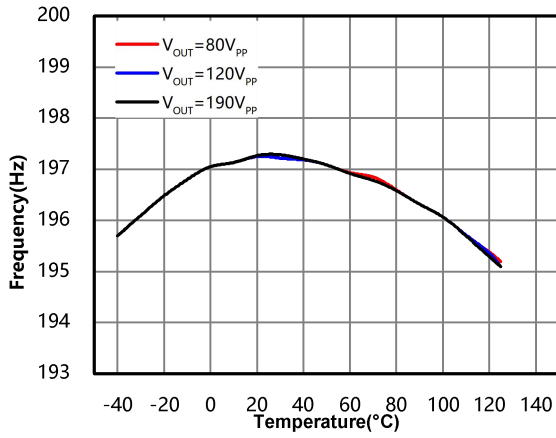


Figure 10. Output Frequency vs Temperature

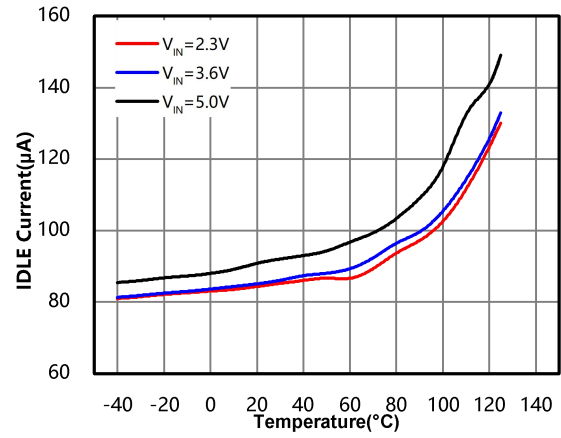
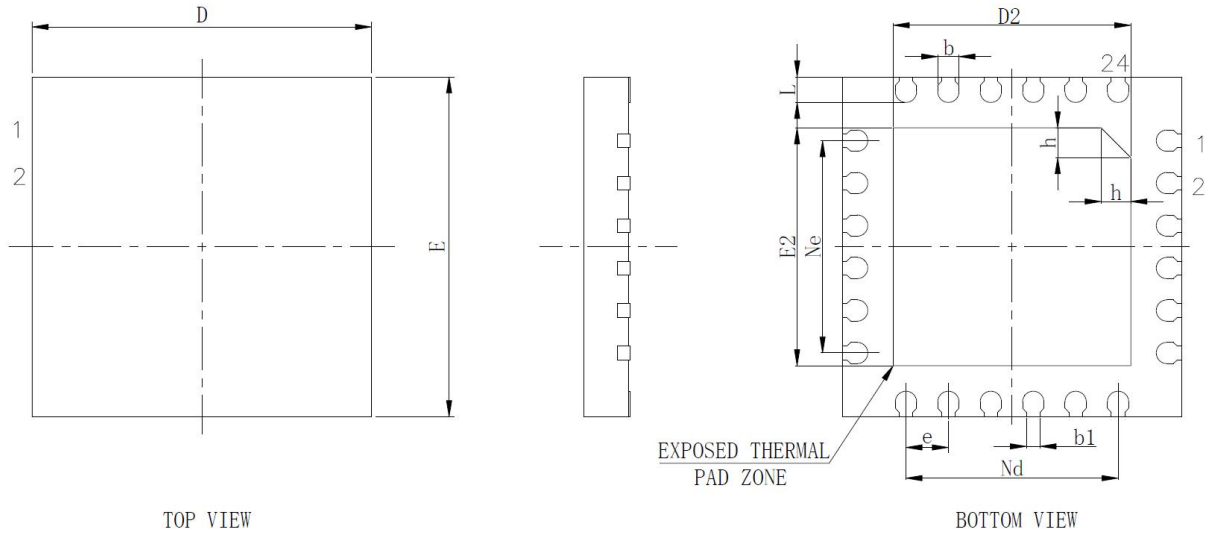


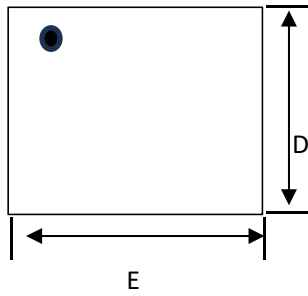
Figure 11. Quiescent Current in IDLE Mode vs Temperature

Package Outline Dimension-QFN4X4-24

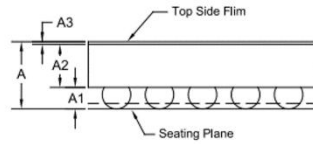


Symbol	Millimeter		
	Min.	Nom.	Max.
A	0.50	0.55	0.60
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1	0.16REF		
c	0.10	0.15	0.20
D	3.90	4.00	4.10
D2	2.70	2.80	2.90
e	0.50BSC		
Ne	2.50BSC		
Nd	2.50BSC		
E	3.90	4.00	4.10
E2	2.70	2.80	2.90
L	0.25	0.30	0.35
h	0.30	0.35	0.40

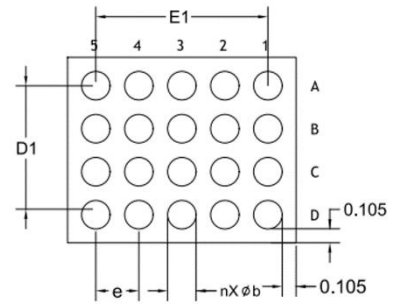
Package Outline Dimension-CSP 20



TOP VIEW



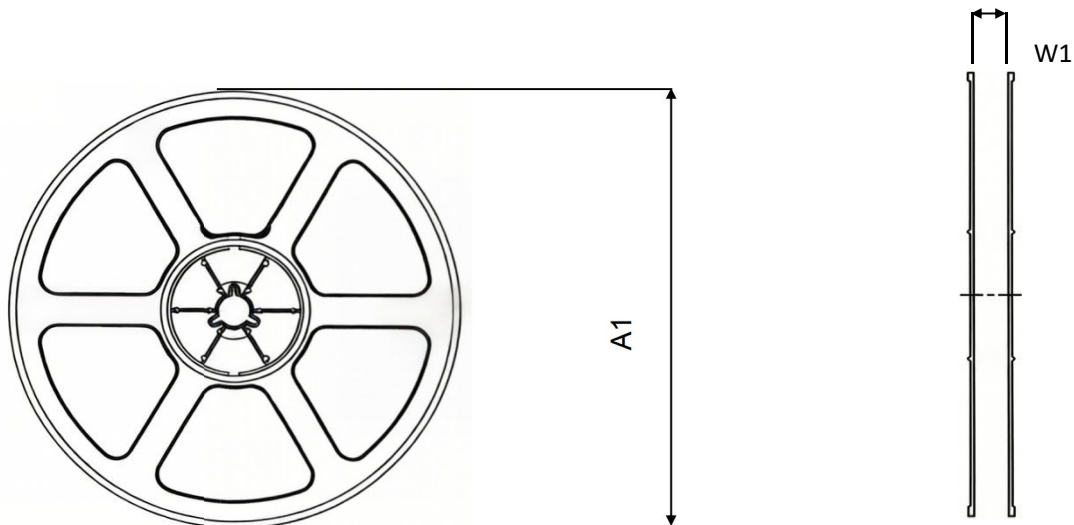
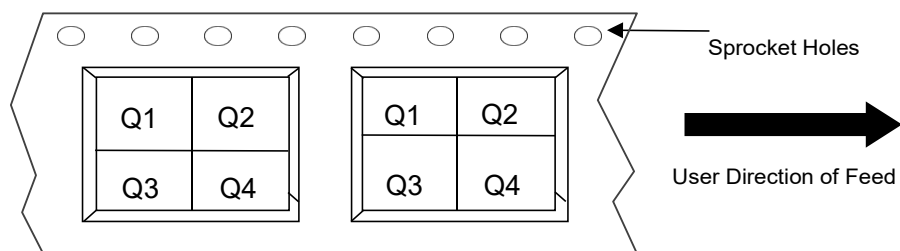
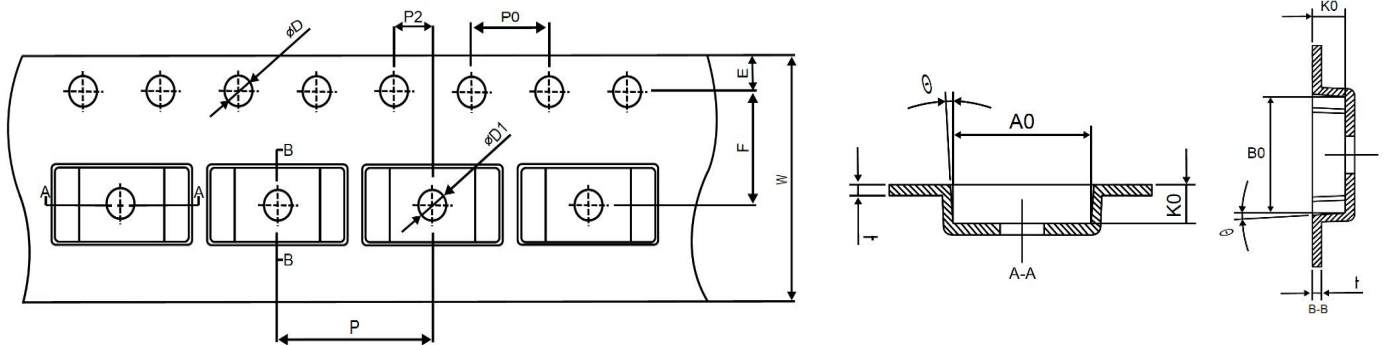
SIDE VIEW



BOTTOM VIEW

Symbol	Millimeter		
	Min.	Nom.	Max.
A	0.595	0.625	0.655
A1	0.180	0.200	0.220
A2	0.387	0.400	0.413
A3	0.20	0.25	0.30
D1	1.1	1.2	1.3
E1	1.5	1.6	1.7
b	0.245	0.265	0.285
D	1.75	1.77	1.79
E	2.15	2.17	2.19
e	0.4BSC		

Packing information



Package Type	E (mm)	F (mm)	P2 (mm)	D (mm)	D1 (mm)	P0 (mm)	W (mm)	W1 (mm)	P (mm)	A0 (mm)	A1 (mm)	B0 (mm)	K0 (mm)	t (mm)	Pin1 Quadrant	Quantity
QFN4X4-24	1.75	5.50	2.00	1.55	1.50	4.00	12.00	12.80	8.00	4.25	329	4.25	0.95	0.30	Q1	3000
CSP 20 2.1mm x 1.7mm	1.75	3.50	2.00	1.55	0.50	4.00	8.00	9.50	4.00	1.95	178	2.30	0.75	0.20	Q2	3000

(1) All dimensions are nominal.

Version History

Version	Date	Changes
Rev.1.0	2026-01-09	Initial release

Disclaimer

MetaWells Co., Ltd. and all other MetaWells Co., Ltd. trademarks are the exclusive property of MetaWells Co., Ltd.. Any mention of additional trademarks or registered trademarks in this document is made in acknowledgment of their respective owners.

Without the consent of MetaWells Co., Ltd. , any modification to any part or subsection of the company's product specifications and datasheets is strictly prohibited in any form or manner. MetaWells Co., Ltd. reserves the rights to make changes of the content herein the document follow PCN procedure. Please refer to our website for latest document. It is recommended that customers obtain the latest version of relevant information and verify its timeliness and completeness before placing an order. All products are sold in accordance with the terms and conditions provided in the sales contract at the time of order confirmation, which includes warranty scope, intellectual property rights, and liability limitations.

During the sales period, MetaWells Co., Ltd. guarantees that the performance of the products will be in accordance with the company's standard warranty. The company utilizes testing and other quality control techniques to ensure the necessity to maintain this warranty. Except for government-mandated requirements, there is no need for special testing of measurement tables or other instruments.

Customers must acknowledge that our products are not intended or manufactured for use in life support systems or other high-risk activities or environments. The utilization of our products in such applications may lead to severe consequences, including personal injury, loss of life, property damage, or environmental harm. Our products are explicitly not warranted for deployment in high-risk activities, and we shall bear no responsibility towards customers or third parties for such usage.

MetaWells Co., Ltd. commits to providing technical support, assistance, advice, and information, in line with our current capabilities, including guidance related to the design, development, or debugging of purchased boards or other applications. However, we hereby disclaim all warranties concerning technical support, merchantability, or fitness for a particular purpose. We do not guarantee the error-free operation of boards or applications in conjunction with our support services, and we shall not be held liable for any consequences arising from the utilization of our support services.

Copyright© MetaWells Co., Ltd.

Website : www.MetaWells.com