

**MAS6012****Stepper Motor Driver IC**

This is preliminary information on a new product under development. Micro Analog Systems Oy reserves the right to make any changes without notice.

**Preliminary**

- **Supports Microstepping Movement**
- **Capable to Drive One to Four Motors**
- **Low Operating Voltage**

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**DESCRIPTION**

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MAS6012 is a miniature stepper motor driver IC to drive up to four stepper motors. Applications include motorcycle and car dashboards and miniature stepper motor appliances. MAS6012 features a microstepping function to allow smooth movement of the motor shaft. Full rotor revolution consists of 24 microsteps each having 15 degree angular rotation. With gear reduction of 180 the microstep

corresponds to an angular rotation of 1/12 degree of the motor shaft. The actual precision of the position is affected by the gear play of the motor.

The microstepping movement of the motor shaft is achieved by converting a pulse sequence into a current level sequence sent to the stepper motor coils.

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**FEATURES**

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- Bipolar Stepper Motor Driver Outputs
- Drives One to Four Stepper Motors
- Microstepping Function
- Glitch Filters at All Inputs
- Low Operating Voltage
- TSSOP-28 Package

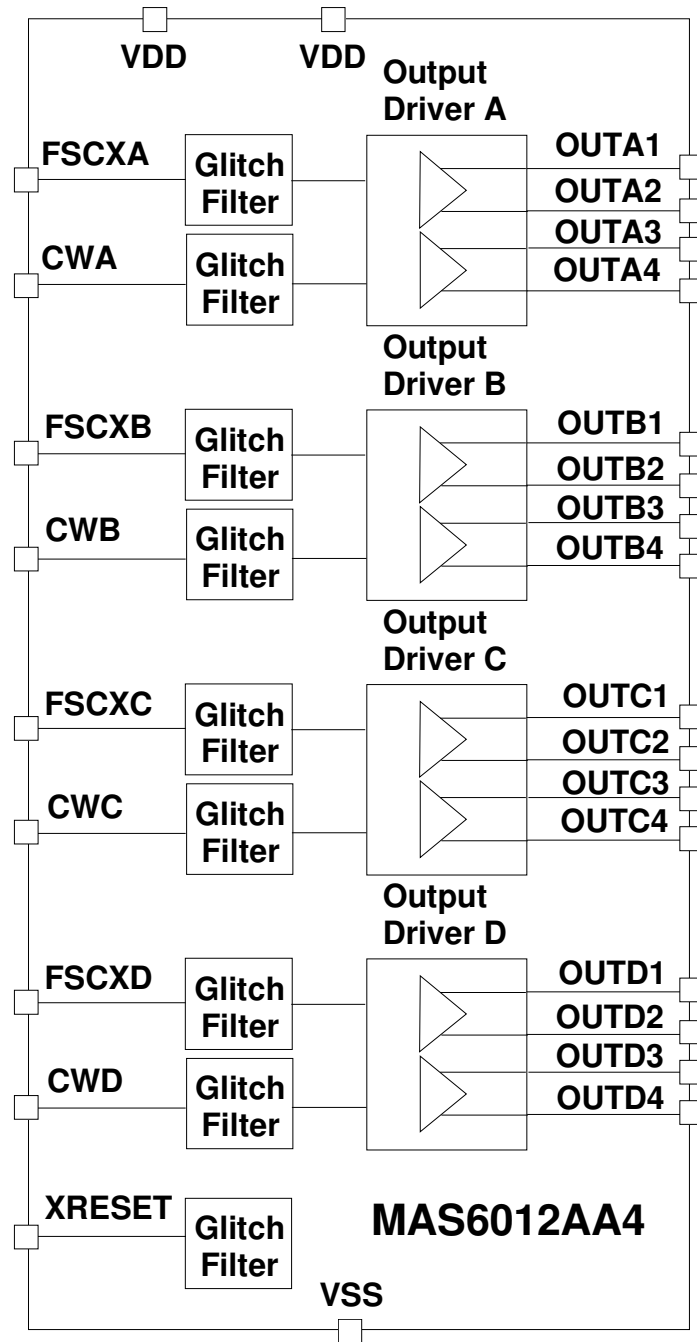
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**APPLICATIONS**

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- Motorcycle Dashboards
- Car Dashboards
- Nautical Instrumentation
- Miniature Stepper Motors in Appliances

**BLOCK DIAGRAMS**



**Figure 1.** Block diagram quad output stepper motor driver IC MAS6012AA4

## OPERATION DESCRIPTION

MAS6012 is a stepper motor driver IC specifically designed to drive bipolar stepper motors of pointers in a car and motorcycle dashboard and in the other similar applications.

The IC is operated from single 5V supply. Each stepper motor output is controlled by two digital control signal inputs, FSCX and CW. Each rising edge of FSCX stepping clock input causes stepper motor to step one microstep (15 degree angular rotation of rotor) ahead. Rotation direction is determined by CW rotation direction selection signal. High CW selects clockwise direction and low CW selects counterclockwise direction. Each of the four stepper motor drivers (A, B, C, D) have their own FSCX and CW control inputs.

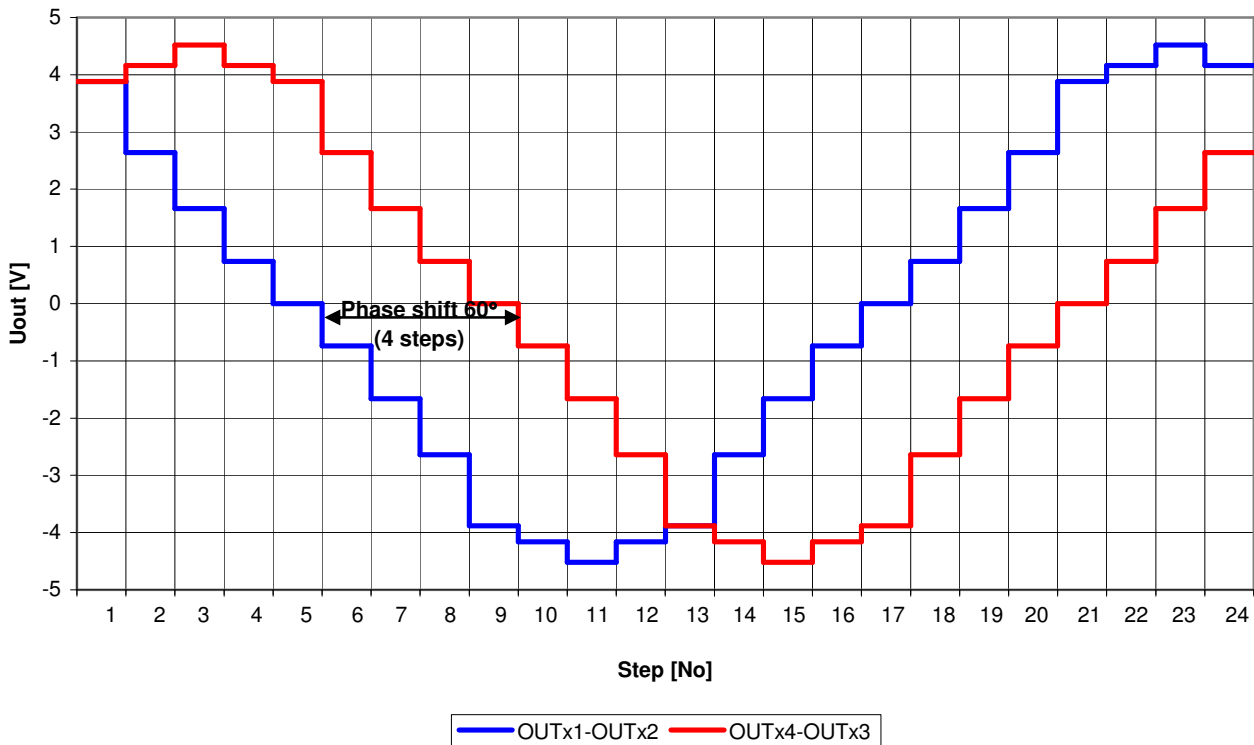
For each of the motors there are four outputs. Outputs OUTx1 and OUTx2 are for driving first

motor coil and outputs OUTx3 and OUTx4 are for driving second motor coil where x is one of the four motor drivers A, B, C or D. The output signal waveforms consist of digitized sine waves which have 60° phase shift (see figure 2).

The device has common XRESET master reset control input for resetting stepper motor outputs to initial state. The initial state corresponds to step number 1 state (see figure 2). XRESET is active low. Each digital input has a glitch filter for eliminating effects of electrical disturbances at the control inputs.

It is recommended to keep XRESET signal low (active) during power up until the supply voltage VDD has risen up.

**MAS6012 Microstepping Output Waveform**



**Figure 2.** MAS6012 Microstepping Output Waveform (x=A, B, C or D)

## ABSOLUTE MAXIMUM RATINGS

All voltages with respect to ground

Parameter	Symbol	Conditions	Min	Max	Unit
Supply Voltage	$V_{IN}$		-0.3	5.8	V
Voltage Range for All Pins			-0.3	$V_{IN} + 0.3$	V
ESD Rating		Human Body model (HBM)	$\pm 2$		kV
Junction Temperature	$T_{Jmax}$			+175 (limited)	$^{\circ}C$
Storage Temperature	$T_S$		-50	+125	$^{\circ}C$

Stresses beyond those listed may cause permanent damage to the device. The device may not operate under these conditions, but it will not be destroyed.

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating Supply Voltage	$V_{DD}$		4.5	5.0	5.5	V
Operating Ambient Temperature	$T_A$		-40		+85	$^{\circ}C$

## ELECTRICAL CHARACTERISTICS

### ◆ Load Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Coil resistance	$R_{COIL}$	$T_A = 25^{\circ}C$	190	290	340	Ohm
Phase inductance	$L_{COIL}$	$T_A = 25^{\circ}C$		0.4		H

### ◆ Current Parameters

 $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , typical values at  $T_A = +25^{\circ}C$ ,  $R_{COIL} = 290 \Omega$ ,  $V_{DD} = 5.0 V$ , unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Quiescent current	$I_{CC}$	All inputs at VDD or VSS, no load			300	$\mu A$
Typical supply current consumption	$I_C$	One motor Two motors Three motors Four motors		18 36 53 71		mA
Output drive capability	$I_{OUT}$	For each output pin, $R_{COIL} = 190 \Omega$			29	mA

## ELECTRICAL CHARACTERISTICS...

### ◆ Digital Inputs

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , typical values at  $T_A = +25^\circ\text{C}$ ,  $V_{DD}=5.0\text{ V}$ , unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input High Voltage	$V_{IH}$	$V_{DD} = 4.5\dots5.5\text{V}$	80% VDD		100% VDD	V
Input Low Voltage	$V_{IL}$	$V_{DD} = 4.5\dots5.5\text{V}$	0% VDD		20% VDD	V
Input Leakage	$I_{ILEAK}$	Input VDD or VSS	-2.5		+2.5	$\mu\text{A}$
Input frequency	$f_{IN}$	Driver speed limited Motor speed limited. Note 1.		7.2	TBD	kHz

Note 1. Depends on the stepper motor.  
TBD = To Be Defined

### ◆ Power Dissipation

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , typical values at  $T_A = +25^\circ\text{C}$ ,  $V_{DD}=5.0\text{ V}$ , unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Junction to Ambient Thermal Resistance	$R_{JA}$	typical PC board mounting, still air, TSSOP package		100.4		$^\circ\text{C}/\text{W}$
Maximum Power Dissipation	$P_d$	any ambient temperature, TSSOP package	$P_{dMAX} = \frac{T_{J(MAX)} - T_A}{R_{JA}}$ Note 1			W

**Note 1:**  $T_{J(MAX)}$  denotes maximum operating junction temperature ( $+125^\circ\text{C}$ ),  $T_A$  ambient temperature, and  $R_{JA}$  junction-to-air thermal resistance ( $+144^\circ\text{C}/\text{W}$ ).

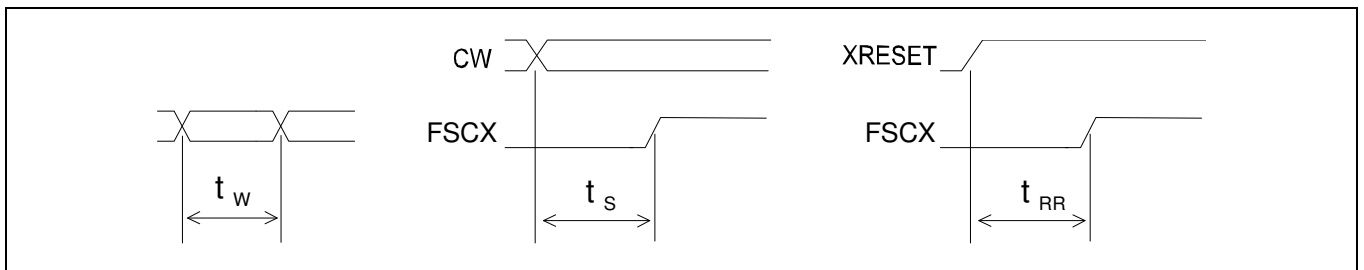
### ◆ Timing Characteristics

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $V_{DD} = 5.0\text{ V}$ , unless otherwise specified

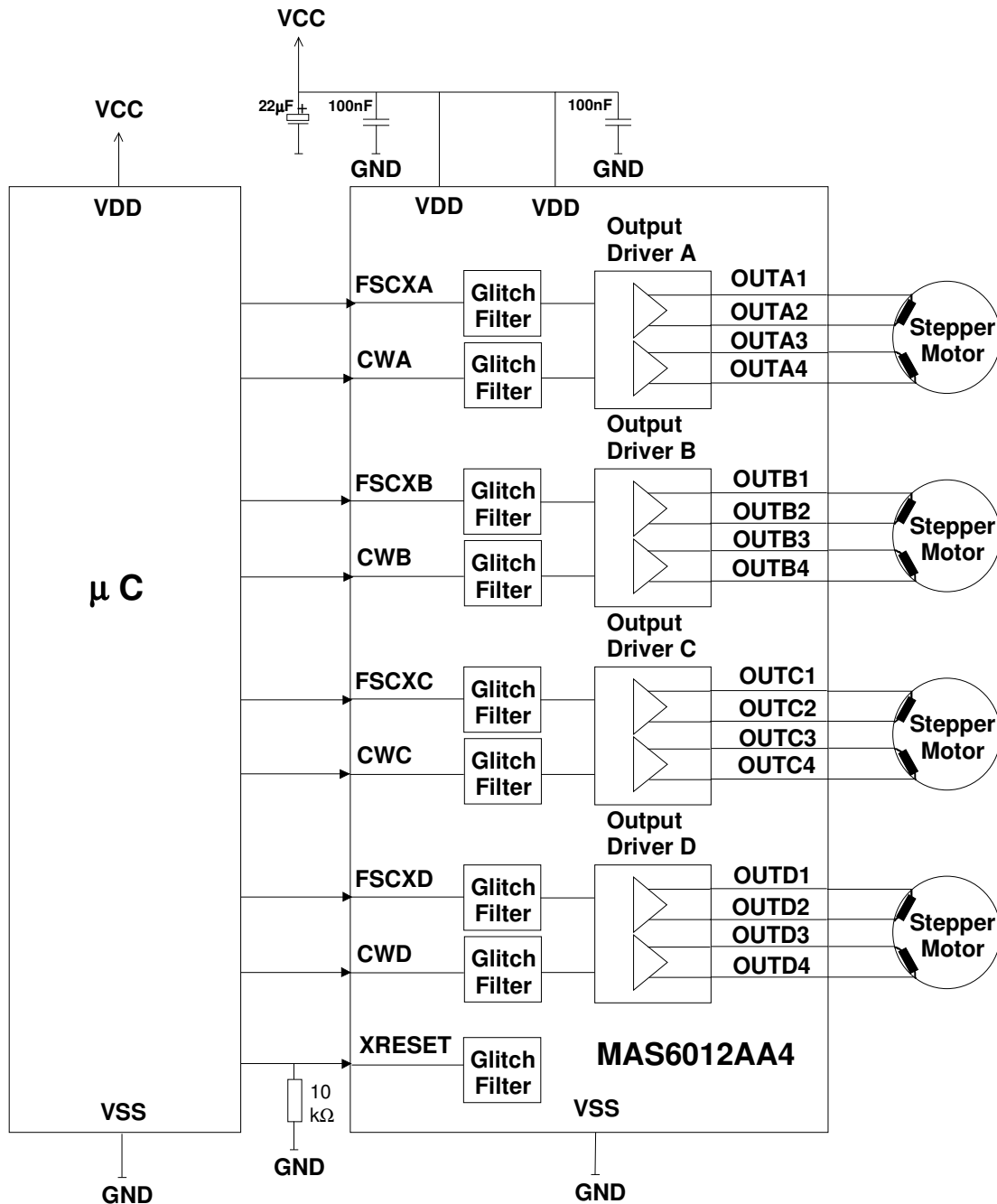
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Signal pulse width	$t_w$	High or low	TBD			ns
Setup time to f(SCX)	$t_s$	High or low	TBD			ns
XRESET release time to f(SCX)	$t_{RR}$		TBD			ns

TBD = To Be Defined

### ◆ Delay Timing Waveforms



**APPLICATION INFORMATION**

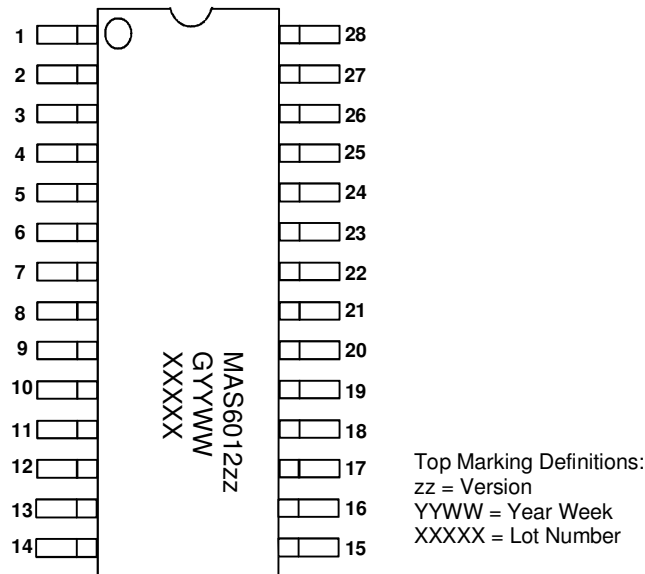


**Figure 3.** Typical MAS6012AA4 quad stepper motor driver application circuit

For filtering fast voltage transients it is recommended to connect two 100nF ceramic capacitors close to power supply pins of the IC (see figure 3). Additionally there should be 5µF capacitance per motor connected for latch-up protection. Thus for four motors there should be additional 22µF filtering capacitor connected to the supplies.

For proper power up it is recommended to keep the XRESET pin low during supplies rising. Depending on used microcontroller an external pull-down resistor might be needed to stay at reset during power up (see figure 3 external pull down resistor connected to XRESET pin).

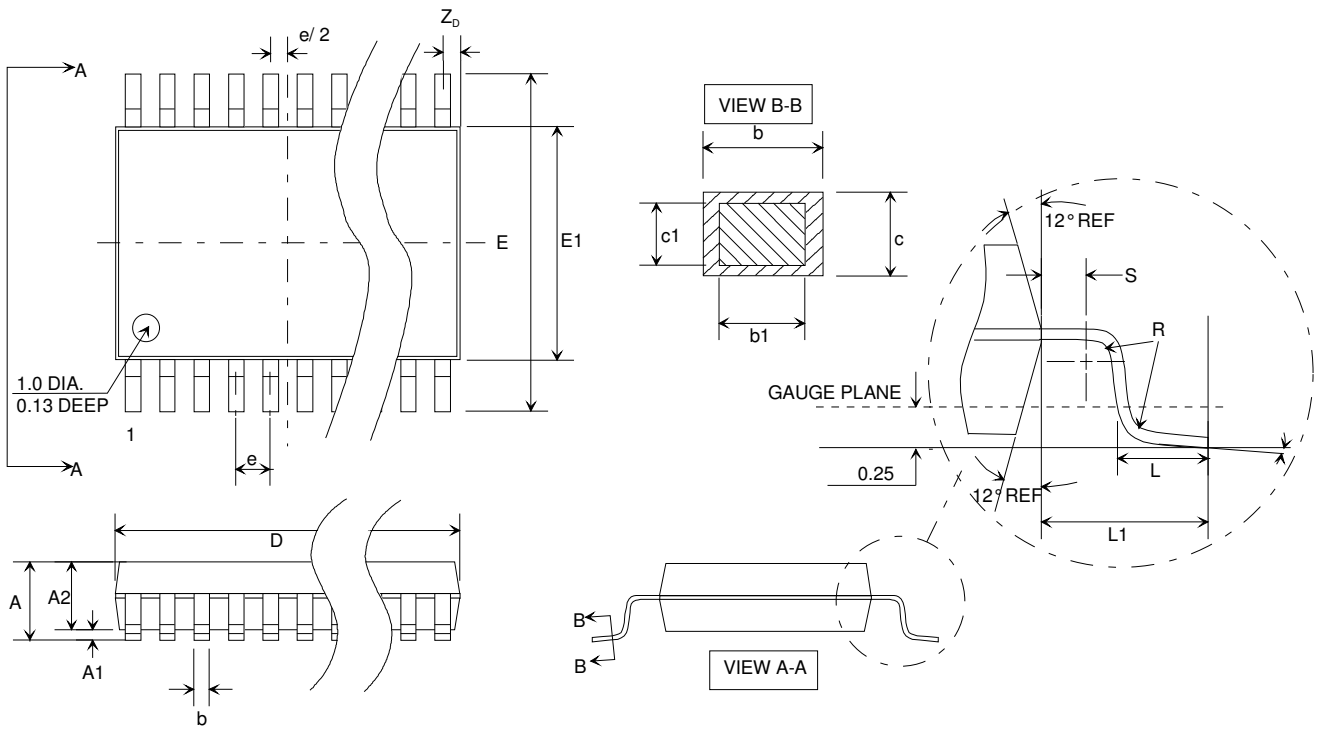
## MAS6012AA4 QUAD OUTPUT DRIVER PIN CONFIGURATION IN PLASTIC TSSOP-28



### PIN DESCRIPTION

Pin Name	Pin	Type	Function
VDD	1	P	Positive Power Supply
CWB	2	DI	Rotation Direction Selection for Driver B, high = Clockwise
FSCXB	3	DI	Stepping Clock Input for Driver B
OUTA3	4	AO	Stepper Motor Driver A Coil Output 3
OUTA4	5	AO	Stepper Motor Driver A Coil Output 4
OUTA2	6	AO	Stepper Motor Driver A Coil Output 2
OUTA1	7	AO	Stepper Motor Driver A Coil Output 1
OUTD1	8	AO	Stepper Motor Driver D Coil Output 1
OUTD2	9	AO	Stepper Motor Driver D Coil Output 2
OUTD4	10	AO	Stepper Motor Driver D Coil Output 4
OUTD3	11	AO	Stepper Motor Driver D Coil Output 3
VSS	12	G	Power Supply Ground
CWC	13	DI	Rotation Direction Selection for Driver C, high = Clockwise
FSCXC	14	DI	Stepping Clock Input for Driver C
VDD	15	P	Positive Power Supply
CWD	16	DI	Rotation Direction Selection for Driver D, high = Clockwise
FSCXD	17	DI	Stepping Clock Input for Driver D
OUTC3	18	AO	Stepper Motor Driver C Coil Output 3
OUTC4	19	AO	Stepper Motor Driver C Coil Output 4
OUTC2	20	AO	Stepper Motor Driver C Coil Output 2
OUTC1	21	AO	Stepper Motor Driver C Coil Output 1
OUTB1	22	AO	Stepper Motor Driver B Coil Output 1
OUTB2	23	AO	Stepper Motor Driver B Coil Output 2
OUTB4	24	AO	Stepper Motor Driver B Coil Output 4
OUTB3	25	AO	Stepper Motor Driver B Coil Output 3
XRESET	26	DI	Master Reset, active low
CWA	27	DI	Rotation Direction Selection for Driver A, high = Clockwise
FSCXA	28	DI	Stepping Clock Input for Driver A

A = Analog, D = Digital, P = Power, G = Ground, I = Input, O = Output

**PACKAGE (TSSOP-28) OUTLINES**


Dimension	Min	Max	Unit
A		1.20	mm
A1	0.05	0.10	mm
A2		0.90	mm
D		9.70 ± 0.05	mm
E		6.10 ± 0.10	mm
E1		4.40 ± 0.10	mm
L		0.60 + 0.15 / - 0.10	mm
L1		1.00	mm
e		0.65	mm
b		0.22 ± 0.05	mm
c	0.13	0.20	mm
Z <sub>0</sub>		0.625	mm

Dimensions do not include mold flash, protrusions, or gate burrs.  
 All dimensions are in accordance with JEDEC standard MO-153.

## SOLDERING INFORMATION

◆ For Pb-Free, RoHS Compliant TSSOP-28

Resistance to Soldering Heat	According to RSH test IEC 68-2-58/20
Maximum Temperature	260°C
Maximum Number of Reflow Cycles	3
Reflow profile	Thermal profile parameters stated in IPC/JEDEC J-STD-020 should not be exceeded. <a href="http://www.jedec.org">http://www.jedec.org</a>
Seating Plane Co-planarity	max 0.08 mm
Lead Finish	Solder plate 7.62 - 25.4 µm, material Matte Tin

## ORDERING INFORMATION

Product Code	Product	Package	Comments
MAS6012AA1ST206	Single Output Stepper Motor Driver IC	TSSOP-16	Note
MAS6012AA2ST206	Dual Output Stepper Motor Driver IC	TSSOP-16	Note
MAS6012AA3ST206	Three Output Stepper Motor Driver IC	TSSOP-28	Note
MAS6012AA4ST206	Quad Output Stepper Motor Driver IC	TSSOP-28	Tape and Reel

**Note:** Contact Micro Analog Systems Oy for one to three output stepper motor driver IC version options.

## LOCAL DISTRIBUTOR

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