



IQS399A Datasheet

An Inductive ProxFusion® sensing device with multi-level trigger UI, integrated haptics driver and the ability to recall a pre-loaded set of haptic patterns.

1 Device Overview

The IQS399A is a ProxFusion® sensing device with an integrated haptics driver capable of driving linear resonant actuator (LRA) motors. A ProxFusion channel event will trigger the haptic driver to allow effective feedback to the user. In addition the connected system can also inform the user of system related events via a set of pre-determined and configurable set of haptic patterns. The device offers an I2C mode for haptic and sensor configuration and a standalone mode with GPIO button event output.

1.1 Main Features

- > ProxFusion Channel
 - Adjustable actuation point
 - Up to 8 kHz sampling in certain modes
 - Activation hysteresis
 - Digital output (push-pull or open-drain active low)
- > I2C Interface With IRQ/RDY Signal
 - I2C interface – up to Fast Mode Plus (1 MHz)
 - Fire-and-forget interface
 - Trigger haptic via sensor event or I2C command
- > Standalone Mode
 - Convert from I2C to a standalone mode after power-on configuration
 - Sensor event triggers haptic feedback
- > Haptics
 - Internal H-bridge with H-bridge protections
 - Adjustable LRA drive frequency
 - Real-time closed loop auto-resonance tracking
 - Predefined haptic library with 12 haptic effects
 - 5 basic waveforms:
 - * Click (default), Press, Release, Buzz and Rumble
 - 7 interaction/outcome waveforms:
 - * Hover, Collide, Align, Step, Grow, Success, Error
 - 2 additional fully-configurable custom haptic effects
 - Haptic latency from command received of <5 ms
- > Ultra low power mode
- > Automatic power mode management
- > Design simplicity
 - PC software for configuration and debugging
- > Supply Voltage: 1.71 V to 3.6 V
- > QFN20 Package (3 × 3 × 0.55 mm) - 0.4 mm pitch



QFN20 Package

1.2 Applications

- > Haptic Mouse Buttons



1.3 Block Diagram

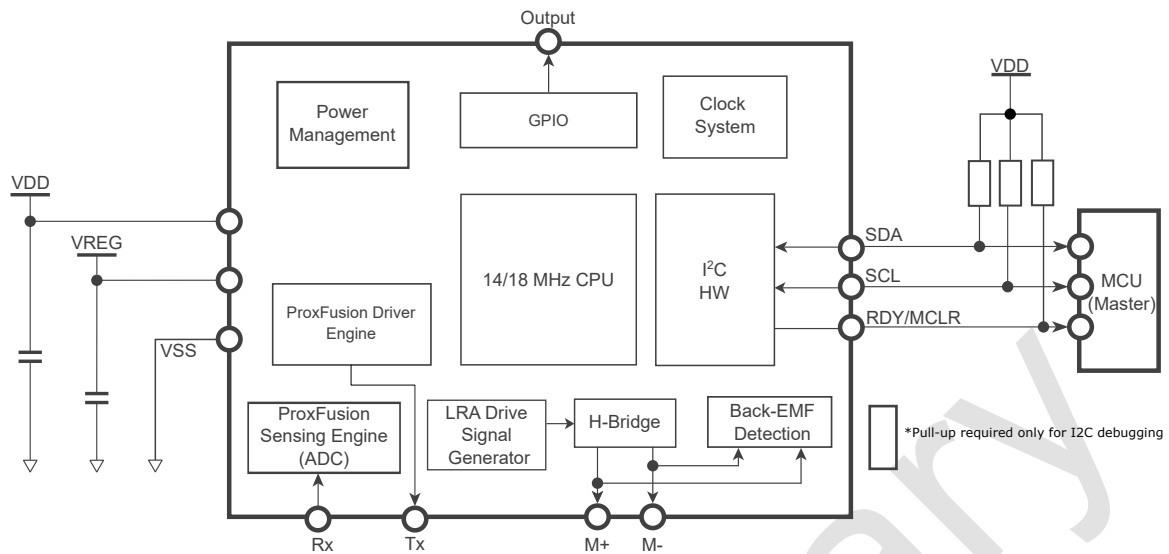


Figure 1.2: IQS399A Block Diagram

2 Usage Disclaimer

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3 Hardware Connections

3.1 QFN20 Pinout

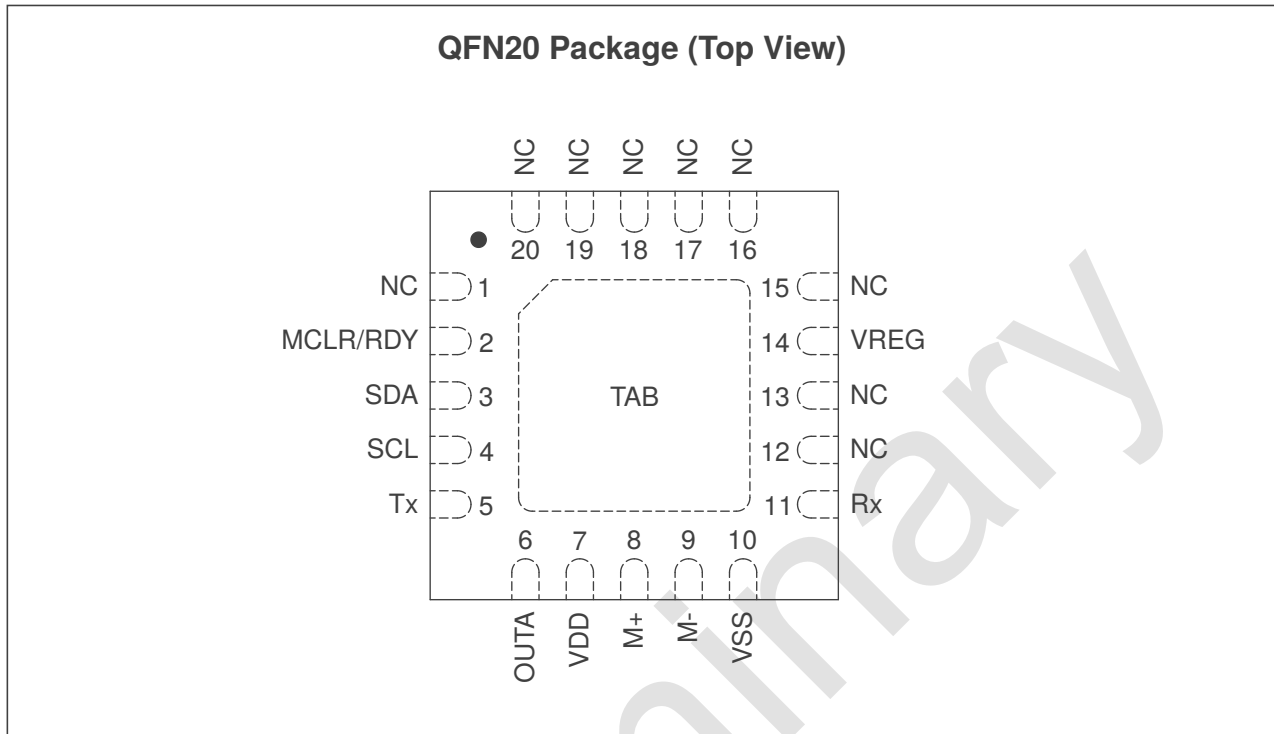


Figure 3.1: QFN20 Pinout

Table 3.1: QFN20 Pin Descriptions

Pin	Name	Type ⁱ	Function	Description
2	MCLR/RDY	I/O	GPIO	I ² C interrupt request / standalone MCLR functionality
3	SDA	I/O	I ² C	I ² C data
4	SCL	I/O	I ² C	I ² C clock
5	Tx	O	ProxFusion®	ProxFusion® inductive Tx pad
6	OUTA	O		Button state indication
7	VDD	P	Power	Power supply input voltage
8	M+	O	H-Bridge	Haptics H-Bridge
9	M-	O	H-Bridge	Haptics H-Bridge
10	VSS	P	Power	Analog/digital ground
11	Rx	I/O	ProxFusion®	ProxFusion® inductive Rx pad
14	VREG	P	Power	Internally-regulated supply voltage
*	NC	-	-	Not connected
	TAB	-	-	Thermal pad (floating). It is recommended to connect this to VSS.

ⁱ Pin Types: I = Input, O = Output, I/O = Input or Output, P = Power



3.2 Reference Schematic

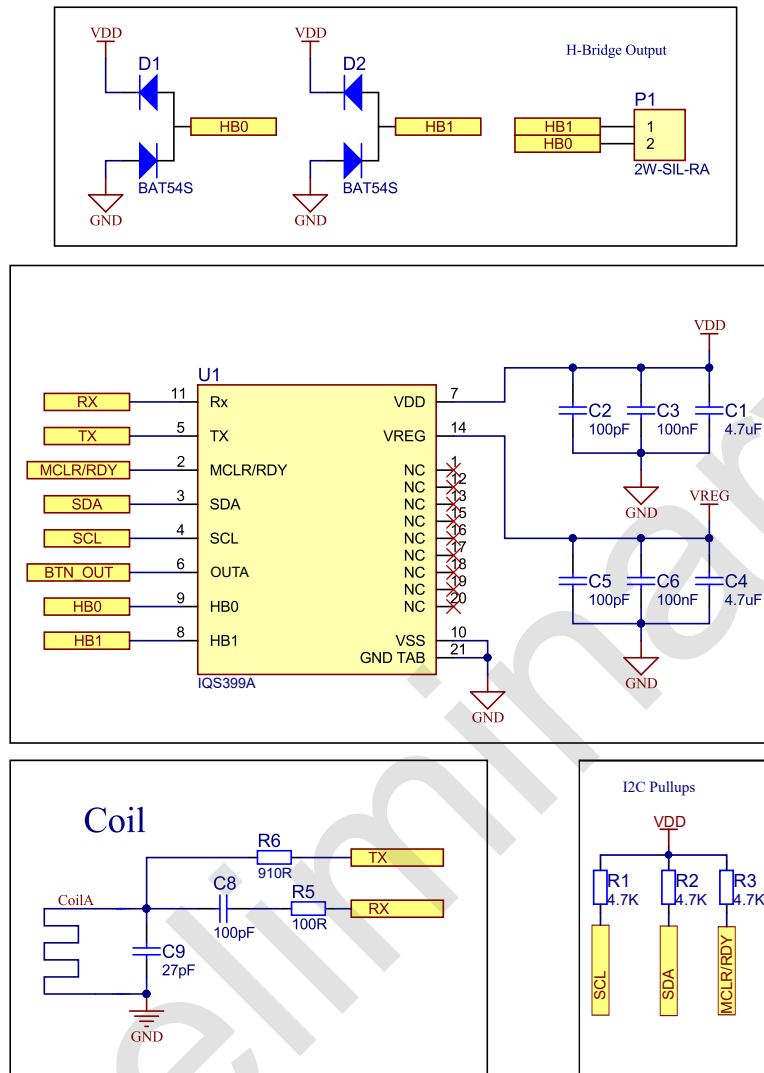


Figure 3.2: QFN20 Inductive Reference Schematic



4 Electrical Specifications

4.1 Absolute Maximum Ratings

Table 4.1: Absolute Maximum Ratings

Symbol	Rating	Min	Max	Unit
V _{DD}	Voltage applied at VDD pin (referenced to VSS)	−0.3	3.6	V
V _{IN}	Voltage applied to any ProxFusion® pin (referenced to VSS)	−0.3	V _{REG}	V
	Voltage applied to any other pin (referenced to VSS)	−0.3	V _{DD} + 0.3 (3.6 V max)	V
T _{stg}	Storage temperature	−40	85	°C

4.2 General Operating Conditions

Table 4.2: General Operating Conditions

Symbol	Parameter	Condition	Typ	Unit
f _{OSC}	Master clock frequency	f _{OSC} = 14 MHz	14	MHz
		f _{OSC} = 18 MHz	18	
f _{PROX}	ProxFusion® engine clock frequency		f _{OSC}	MHz
V _{REG}	Internally-regulated supply output	f _{OSC} = 14 MHz	1.53	V
		f _{OSC} = 18 MHz	1.8	

4.3 Recommended Operating Conditions

Table 4.3: Recommended Operating Conditions

Symbol	Parameter	Condition	Min	Rec ⁱ	Max	Unit
V _{DD}	Standard operating voltage, applied at VDD pin	f _{OSC} = 14 MHz	1.71		3.6	V
		f _{OSC} = 18 MHz	2.2			
T _A	Operating free-air temperature		−20		85	°C
C _{VDD}	Recommended capacitor at VDD		C _{VREG}	2 × C _{VREG}		μF
C _{VREG}	Recommended external buffer capacitor at VREG (ESR ≤ 200 mΩ)		2.2 ⁱⁱ	4.7	10	μF

ⁱ Recommended value

ⁱⁱ Absolute minimum allowed capacitance value is 1 μF, after taking derating, temperature, and worst-case tolerance into account. Please refer to [AZD004](#) for more information regarding capacitor derating.



4.4 ProxFusion® Electrical Characteristics

Table 4.4: Recommended Operating Conditions for ProxFusion® Pins

Symbol	Parameter	Min	Max	Unit
$C_{XSELF-VSS}$	Capacitance between ground and external electrodes, in self-capacitance mode	1	400 ⁱ	pF
$R_{Cx(SELF)}$	Series in-line resistance of self-capacitance electrodes	0	1 ⁱⁱ	kΩ

ⁱ $R_{Cx} = 0\ \Omega$

ⁱⁱ Series resistance limit is a function of f_{xfer} and the circuit time constant, RC . $R_{max} \times C_{max} = 1/(10 \times f_{xfer})$, where C is the pin capacitance to VSS.

4.5 ESD Rating

Table 4.5: ESD Rating

			Value	Unit
$V_{(ESD)}$	Electrostatic discharge voltage	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁱ	±2000	V

ⁱ JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process. Pins listed as ±2000 V may actually have higher performance.

4.6 Reset Levels

Table 4.6: Reset Levels

Parameter		Min	Max	Unit
V_{DD}	Power-up (Reset trigger) – slope > 100 V/s	1.65		V
	Power-down (Reset trigger) – slope < -100 V/s		0.9	

4.7 MCLR Pin Levels and Characteristics

Table 4.7: MCLR Pin Characteristics

Parameter		Min	Typ	Max	Unit
V_{IL}	MCLR input low level voltage	$V_{SS} - 0.3$		$0.25 \times V_{DD}$	V
V_{IH}	MCLR input high level voltage	$0.75 \times V_{DD}$		$V_{DD} + 0.3$	V
R_{PU}	MCLR pull-up equivalent resistor		210		kΩ
t_{Trig}	MCLR input pulse width – ensure trigger	250			ns

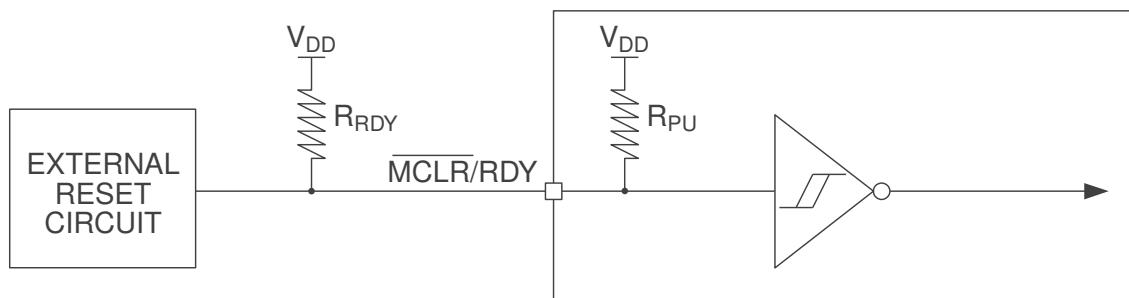


Figure 4.1: MCLR Pin Diagram

4.8 Digital I/O Characteristics

Table 4.8: Digital I/O Characteristics

Parameter		Test Conditions ⁱ	Min	Max	Unit
V _{OL}	Output low voltage of SDA and SCL pins	I _{OL} = 20 mA V _{DD} > 2 V		0.4	V
		I _{OL} = 20 mA V _{DD} ≤ 2 V		0.2 V _{DD}	
	Output low voltage of SDA and SCL pins in GPIO output mode	I _{OL} = 10 mA		0.1 V _{DD}	
	Output low voltage of MCLR/RDY	I _{OL} = 5 mA			
	Output low voltage of any other GPIO pin	I _{OL} = 10 mA			
V _{OH}	Output high voltage	I _{OH} = −5 mA	0.9 V _{DD}		V
V _{IL}	Input low voltage		V _{SS} − 0.3	0.3 V _{DD}	V
V _{IH}	Input high voltage		0.7 V _{DD}	V _{DD} + 0.3	V
C _b	SDA and SCL bus capacitance			550	pF

ⁱ Standard operating conditions:
V_{DD}: 1.8 V to 3.6 V, unless otherwise stated.
Operating temperature: -20 °C to 80 °C.



4.9 I²C Characteristics

Table 4.9: I²C Characteristics

Parameter		Min	Max	Unit
f _{SCL}	SCL clock frequency		1000	kHz
t _{HD,STA}	Hold time (repeated) START condition	0.26		μs
t _{LOW}	LOW period of the SCL clock	0.5		μs
t _{HIGH}	HIGH period of the SCL clock	0.26		μs
t _{SU,STA}	Set-up time for a repeated START condition	0.26		μs
t _{HD,DAT}	Data hold time	0		ns
t _{SU,DAT}	Data set-up time	50		ns
t _{SU,STO}	Set-up time for STOP condition	0.26		μs
t _{BUF}	Bus free time between a STOP and START condition	0.5		μs
t _{SP}	Pulse duration of spikes suppressed by input filter	0	50	ns

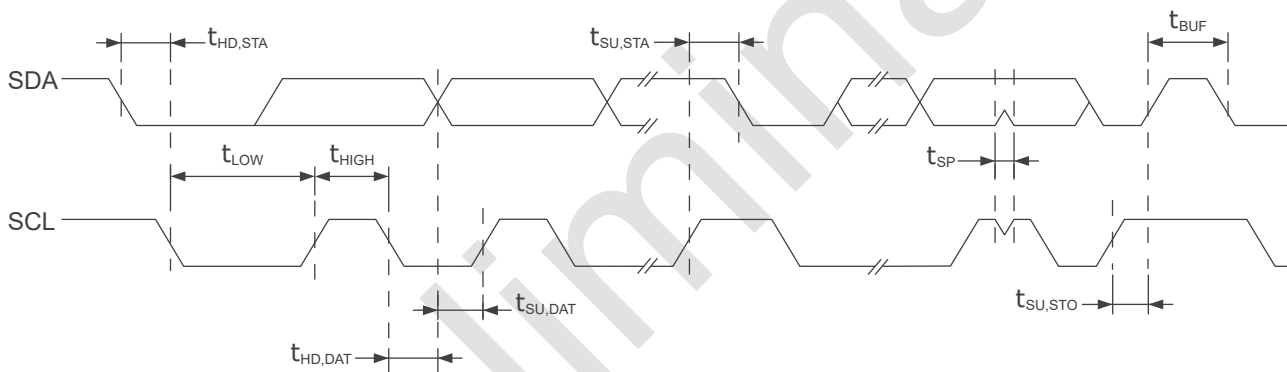


Figure 4.2: I²C Timing Diagram

4.10 H-Bridge Specifications

Table 4.10: H-Bridge Specifications

Symbol	Parameter	Min	Nominal	Max	Unit
R _L	Load resistance at V _{DD} = 3.3 V		18		Ω
I _L	Average DC load current		150	200	mA
f _{LRA}	LRA drive frequency	100		300	Hz



5 Ordering Information

5.1 Ordering Code

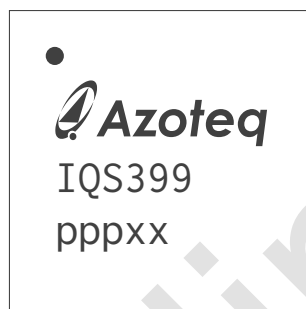
Table 5.1: Order Code Description

IQS399A zzz ppb

IC NAME			IQS399A
CONFIGURATION	zzz	=	0L1 I ² C Address: 0x22
			002 I ² C Address: 0x56
PACKAGE TYPE	pp	=	QF QFN-20 Package
BULK PACKAGING	b	=	R QFN-20 Reel (2000 pcs/reel)

Other order codes for standalone operation are available on special request – please contact Azoteq.

5.2 Top Marking



“IQS399” = Product Name

“ppp” = Product Code

“xx” = Batch Code

Figure 5.1: IQS399A-QFN20 Package Top Marking



“IQS3hd” = Product Name

“ppp” = Product Code

“xx” = Batch Code

Figure 5.2: QFN20 Generic Package Top Marking

6 Package Information

6.1 QFN20 Package Outline

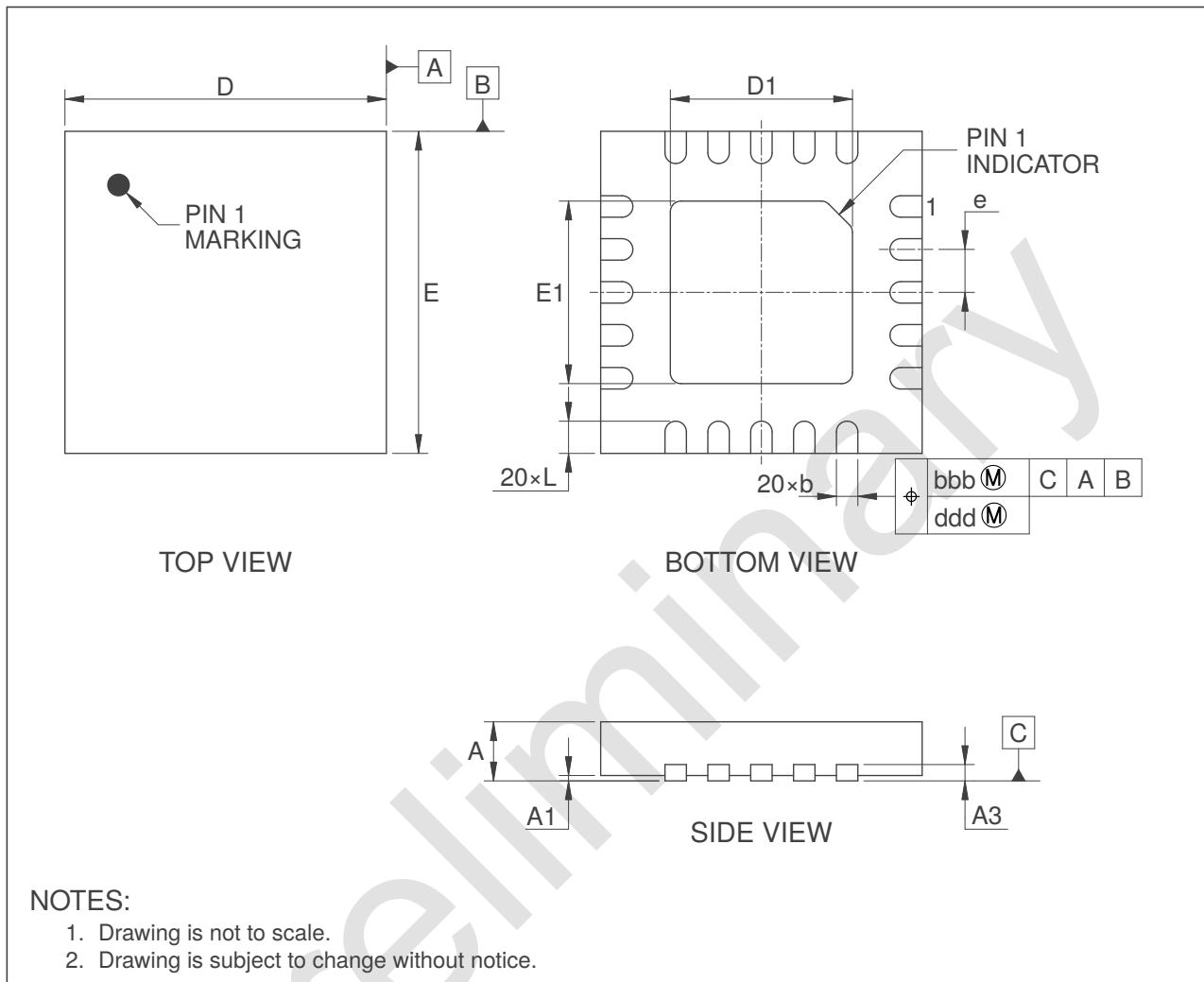


Figure 6.1: QFN20 Package Outline



Table 6.1: QFN20 Package Dimensions [mm]

Dimension	Millimeters		
	Min	Typ	Max
A	0.50	0.55	0.60
A1	0.00	0.02	0.05
A3	0.152 REF		
b	0.15	0.20	0.25
D	3.00 BSC		
E	3.00 BSC		
D1	1.60	1.70	1.80
E1	1.60	1.70	1.80
e	0.40 BSC		
L	0.25	0.30	0.35

Table 6.2: QFN20 Package Tolerances [mm]

Tolerance	Millimeters
bbb	0.07
ddd	0.05

6.2 QFN20 Recommended Footprint

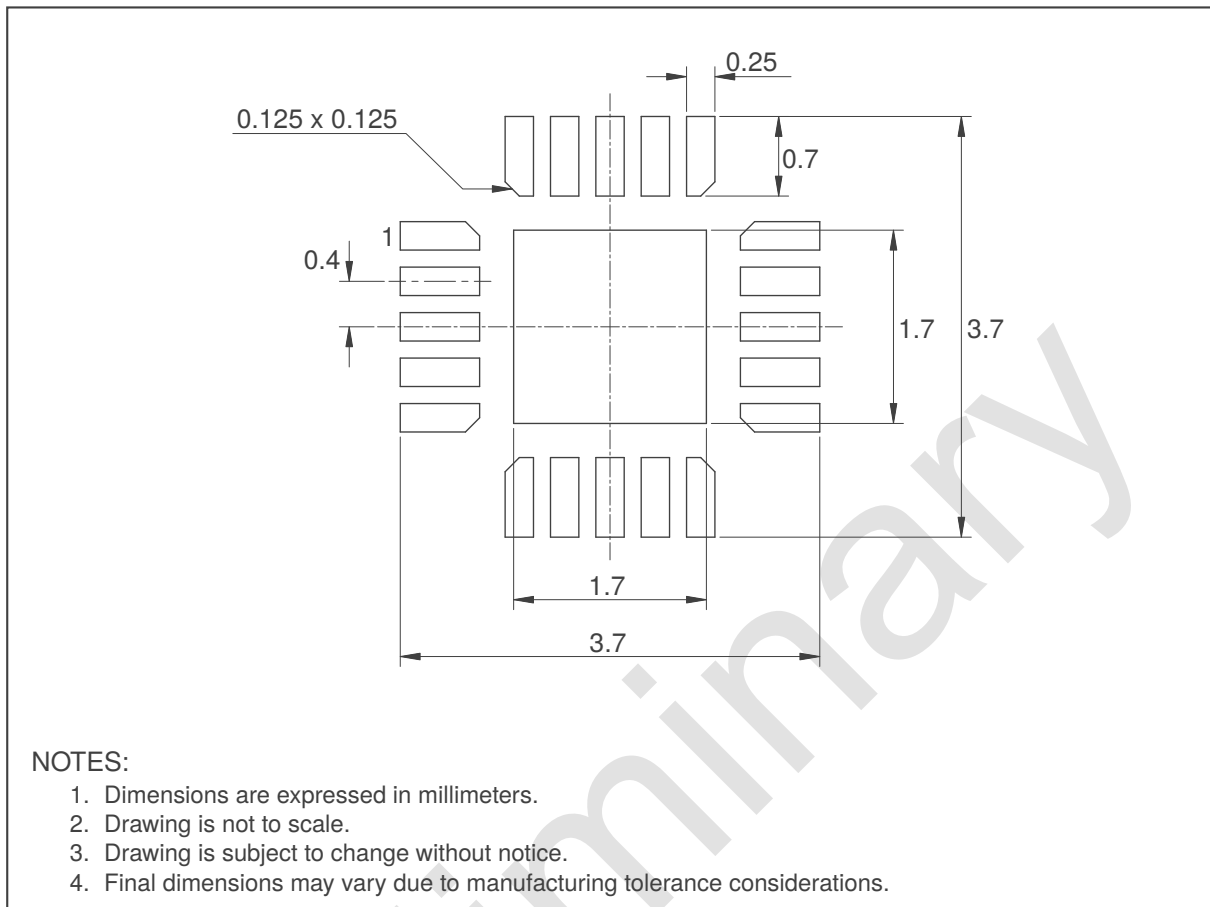


Figure 6.2: QFN20 Recommended Footprint

6.3 Tape and Reel Specifications

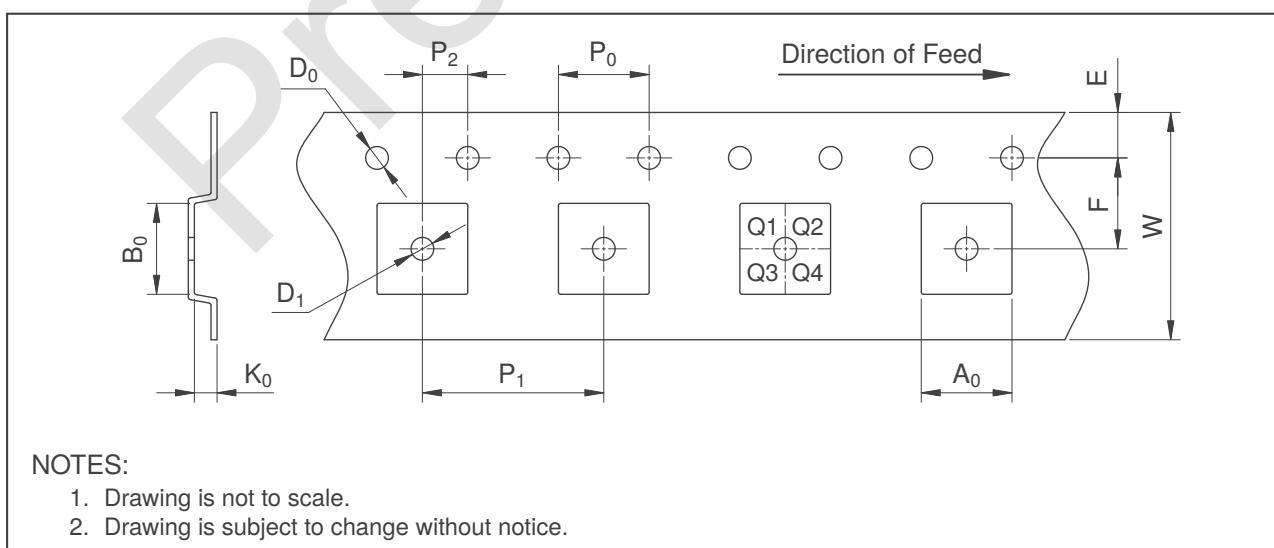


Figure 6.3: Carrier Tape Specification

Table 6.3: Carrier Tape Dimensions [mm]

Dimension	Package
	QFN20
A ₀	3.30
B ₀	3.30
K ₀	0.75
D ₀	1.50
D ₁	1.55
E	1.75
F	5.50
P ₀	4.00
P ₁	8.00
P ₂	2.00
W	12.00
Pin 1 Quadrant	Q2

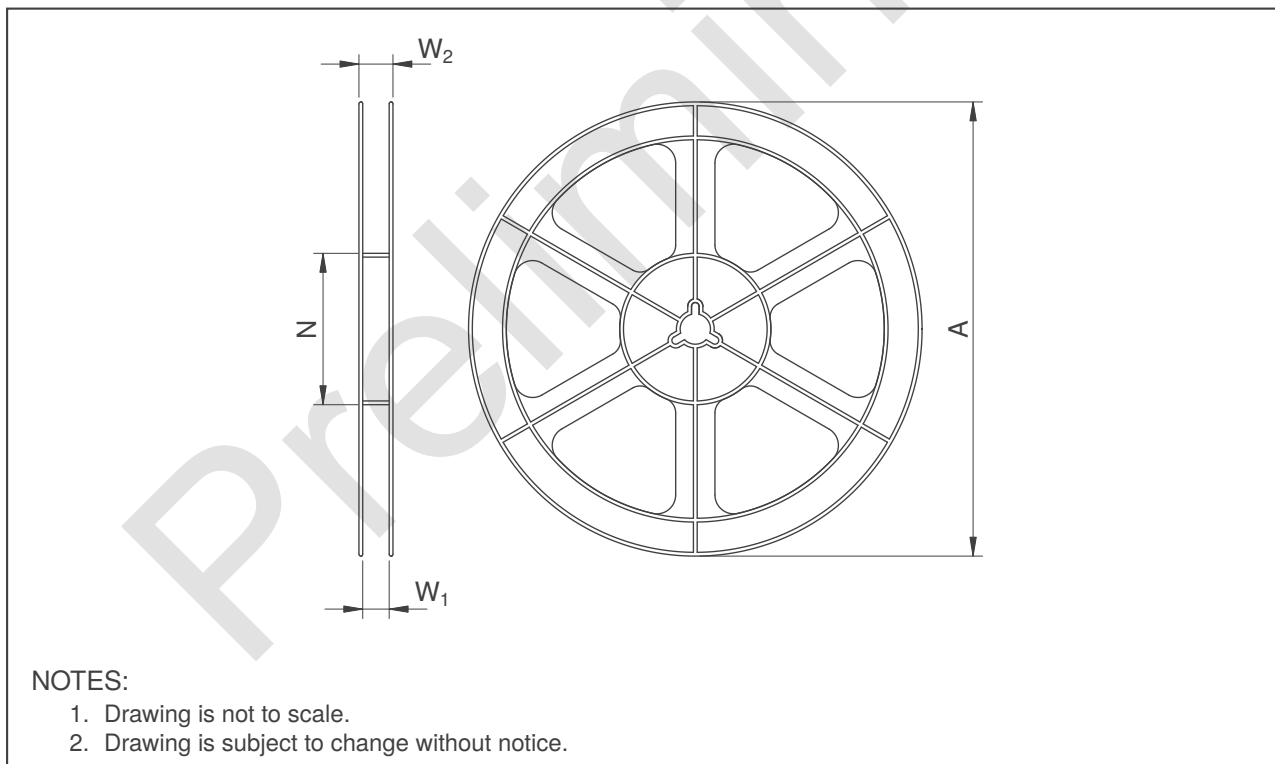


Figure 6.4: Reel Specification



Table 6.4: Reel Dimensions [mm]

Dimension	Package
	QFN20
A	178
N	60
W ₁	12.4
W ₂ (Max)	18.4

Preliminary



Contact Information

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