

TPA6404-Q1 45-W, 2-MHz Analog Input -Channel Automotive Class-D Audio Amplifier With Load Dump Protection and I²C Diagnostics

1 Features

- Advanced Load Diagnostics
 - AC Diagnostic for Tweeter Detection with Impedance and Phase Response
 - Integrated sine wave Generator
- Easy to meet CISPR25-L5 EMC specification
- AEC-Q100 Qualified With the Following Results for Automotive Applications:
 - Device Temperature Grade 1: –40°C to 125°C Ambient Operating Temperature Range
 - Device HBM ESD Classification Level: 3A
 - Device CDM ESD Classification Level: C4B
- Audio Inputs
 - 4 Channel Differential Analog Input
 - Four I²C-Controlled Gain Options
 - High Input Impedance for Low Value AC-coupling Capacitor
- Audio Outputs
 - Four-Channel Bridge-Tied Load (BTL), with Option of Parallel BTL (PBTL)
 - Up to 2.1 MHz Output Switching Frequency
 - 27 W, 10% THD into 4 Ω at 14.4 V
 - 45 W, 10% THD into 2 Ω at 14.4 V
 - 85 W, 10% THD into 1 Ω at 14.4 V PBTL
- Audio Performance into 4 Ω at 14.4 V, 1 kHz
 - THD+N < 0.01%
 - 42 μ V_{RMS} Output Noise
 - -90 dB Crosstalk
- Load Diagnostics
 - Output Open and Shorted Load
 - Output-to-Battery or Ground Shorts
 - Line Output Detection Up to 6 k Ω
 - Runs without Input Clocks
- Protection
 - Output Current Limiting
 - Output Short Protection
 - 40 V Load Dump
 - Fortuitous Open Ground and Power Tolerant
 - DC Offset
 - Over Temperature
 - Undervoltage and Overvoltage
- General Operation
 - 4.5 V to 18 V supply voltage

- I²C Control With 4 Address Options
- Clip Detection and Thermal Foldback

2 Applications

- Automotive Head Units
- Automotive External Amplifier Modules

3 Description

The TPA6404-Q1 device is a four-channel analog-input Class-D audio amplifier that implements a 2.1 MHz PWM switching frequency that enables a cost optimized solution in a very small 4.5 cm² PCB size, full operation down to 4.5 V for start/stop events, and exceptional sound quality with up to 100 kHz audio bandwidth.

The TPA6404-Q1 Class-D audio amplifier has an optimal design for use in entry level automotive head units that provide analog audio input signals as part of their system design.

The Class-D topology dramatically improves efficiency over traditional linear amplifier solutions.

The output switching frequency operates above the AM band, which eliminates the AM band interference and reduces the output filter size and cost.

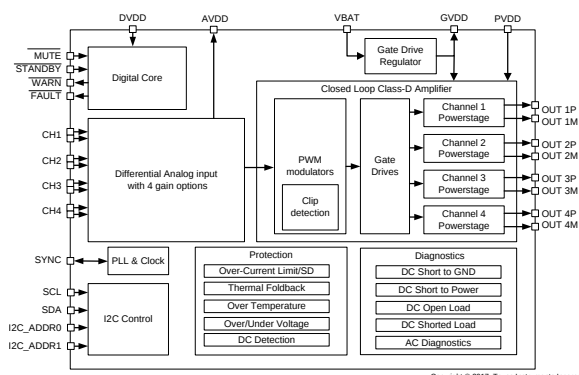
The device is offered in a 56 pin HSSOP package with the exposed thermal pad up.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPA6404-Q1	HSSOP (56)	18.41 mm × 7.49 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Block Diagram



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (October 2017) to Revision A	Page
• Released data sheet as Production Data.....	1

5 Device and Documentation Support

5.1 Documentation Support

5.1.1 Related Documentation

For related documentation see the following:

[PurePath™ Console 3](#) Graphical Development Suite

5.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

5.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

E2E Audio Amplifier Forum *TI's Engineer-to-Engineer (E2E) Community for Audio Amplifiers*. Created to foster collaboration among engineers. Ask questions and receive answers in real-time.

5.4 Trademarks

PurePath, E2E are trademarks of Texas Instruments.

5.5 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

5.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

6 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPA6404QDKQRQ1	ACTIVE	HSSOP	DKQ	56	1000	Green (RoHS & no Sb/Br)	NIPDAU	Level-3-260C-168 HR	-40 to 125	TPA6404	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

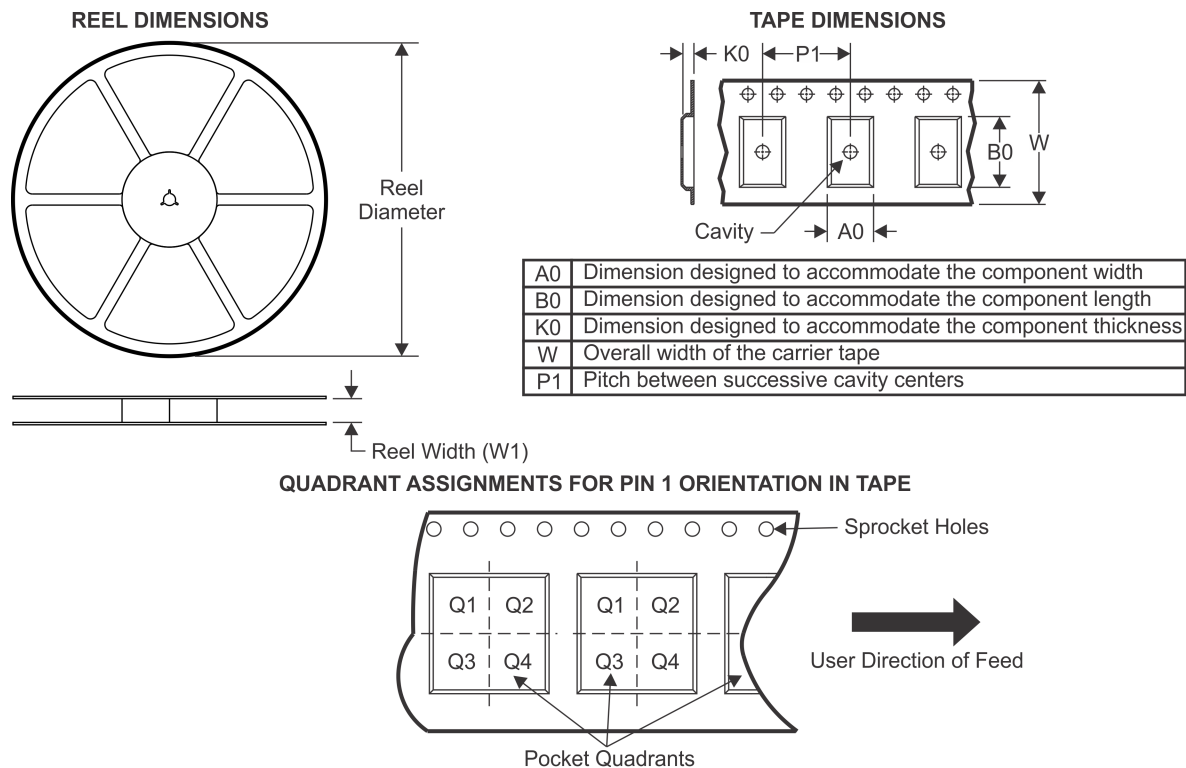
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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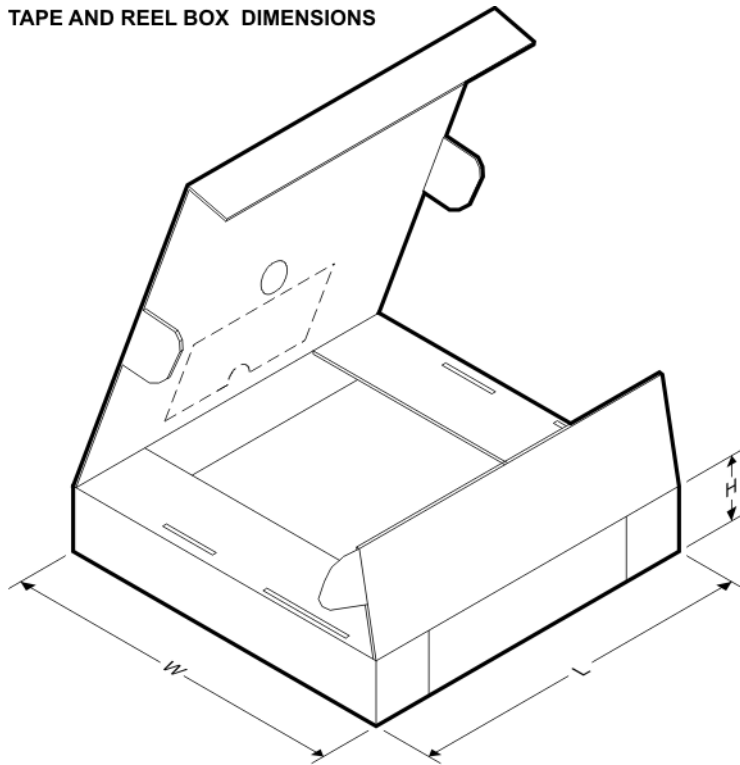
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION


*All dimensions are nominal

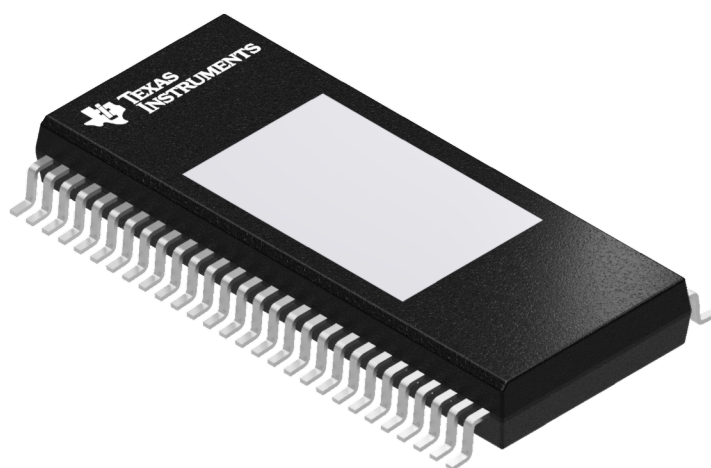
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPA6404QDKQRQ1	HSSOP	DKQ	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

TAPE AND REEL BOX DIMENSIONS



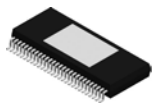
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPA6404QDKQRQ1	HSSOP	DKQ	56	1000	367.0	367.0	55.0



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

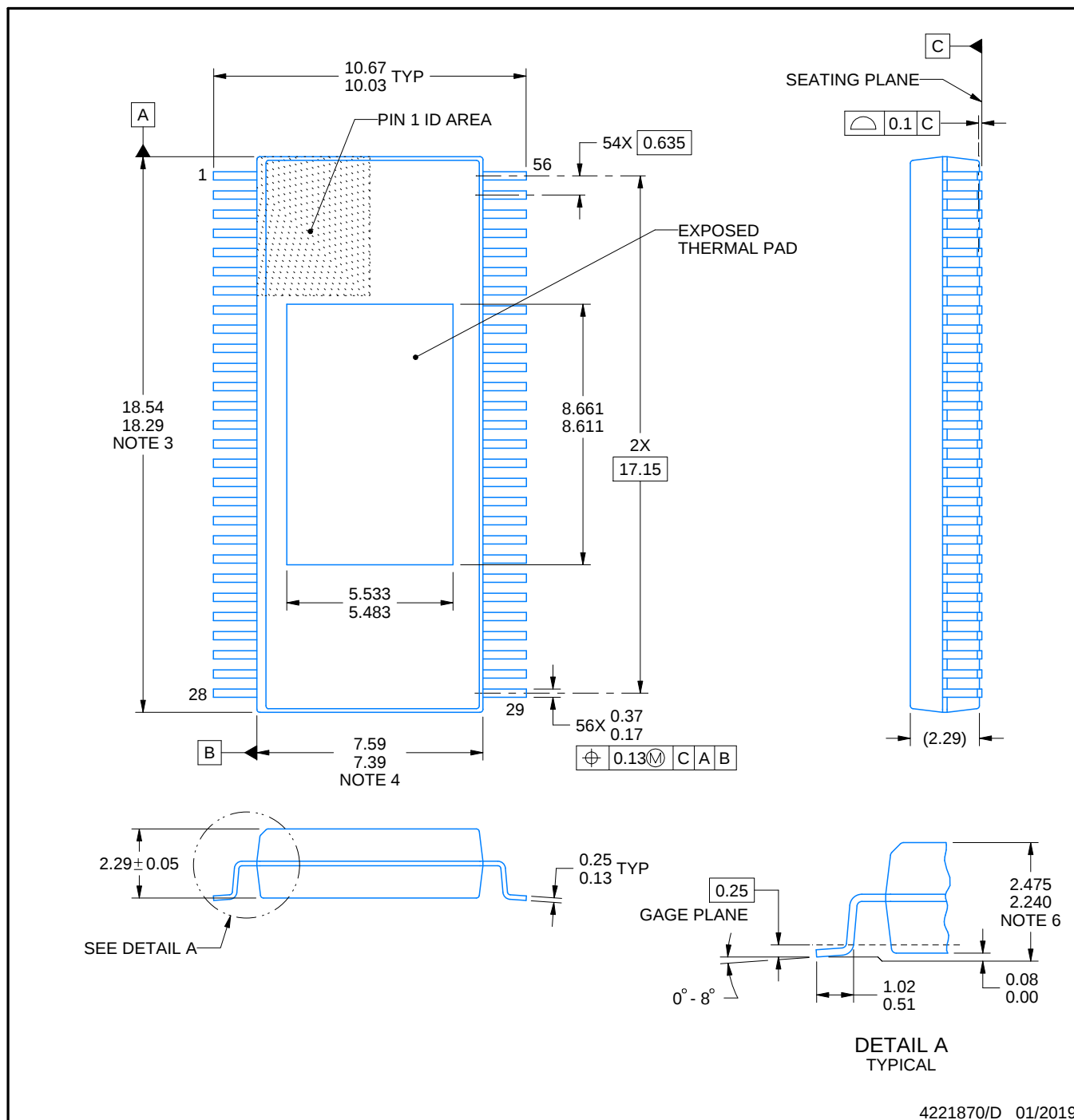
DKQ0056A



PowerPAD™ HSSOP - 2.475 mm max height

PACKAGE OUTLINE

PLASTIC SMALL OUTLINE



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NOTES:

PowerPAD is a trademark of Texas Instruments.

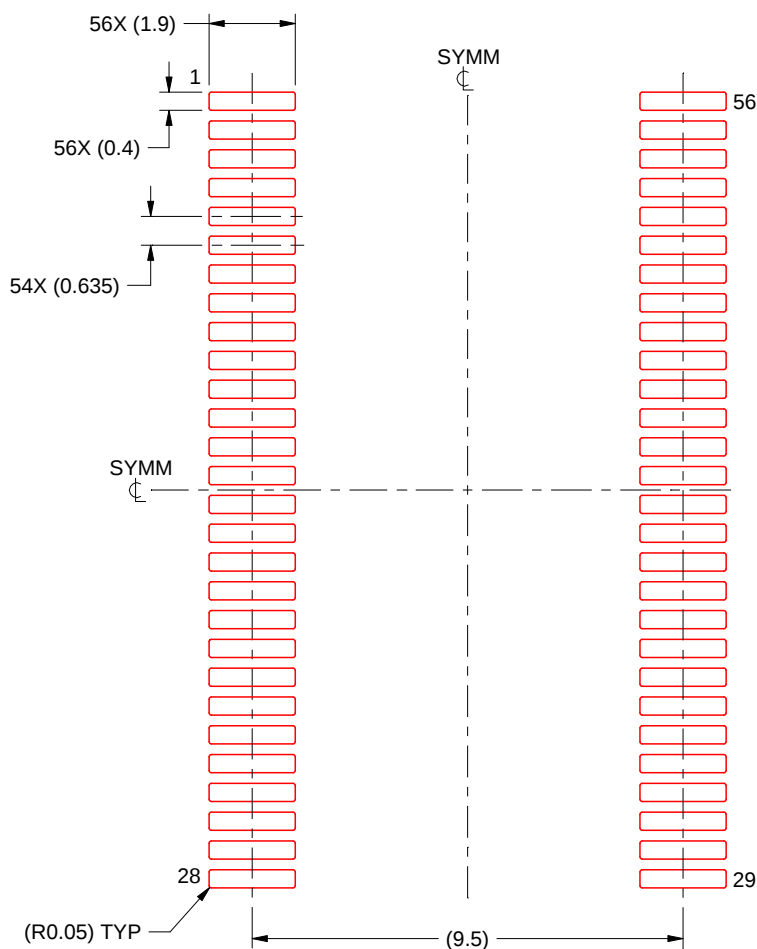
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. The exposed thermal pad is designed to be attached to an external heatsink.
6. For clamped heatsink design, refer to overall package height above the seating plane as 2.325 +/- 0.075 and molded body thickness dimension.

EXAMPLE STENCIL DESIGN

DKQ0056A

PowerPAD™ HSSOP - 2.475 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE:6X

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NOTES: (continued)

10. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
11. Board assembly site may have different recommendations for stencil design.

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