

HEF4094B-Q100

8-stage shift-and-store register

Rev. 5 — 8 July 2021

Product data sheet

1. General description

The HEF4094B-Q100 is an 8-bit serial-in/serial or parallel-out shift register with a storage register and 3-state outputs. Both the shift and storage register have separate clocks. The device features a serial input (D) and two serial outputs (QS1 and QS2) to enable cascading. Data is shifted on the LOW-to-HIGH transitions of the CP input. Data is available at QS1 on the LOW-to-HIGH transitions of the CP input to allow cascading when clock edges are fast. The same data is available at QS2 on the next HIGH-to-LOW transition of the CP input to allow cascading when clock edges are slow. The data in the shift register is transferred to the storage register when the STR input is HIGH. Data in the storage register appears at the outputs whenever the output enable input (OE) is HIGH. A LOW on OE causes the outputs to assume a high-impedance OFF-state. Operation of the OE input does not affect the state of the registers. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{DD} .

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - Specified from -40 °C to +85 °C and -40 °C to +125 °C
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Wide supply voltage range from 3.0 to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Standardized symmetrical output characteristics
- ESD protection:
 - MIL-STD-883, method 3015 exceeds 2000 V
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V (C = 200 pF; R = 0 Ω)
- Complies with JEDEC standard JESD 13-B

3. Ordering information

Table 1. Ordering information

All types operate from -40 °C to +125 °C.

Type number	Package		
	Name	Description	Version
HEF4094BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
HEF4094BTT-Q100	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

4. Functional diagram

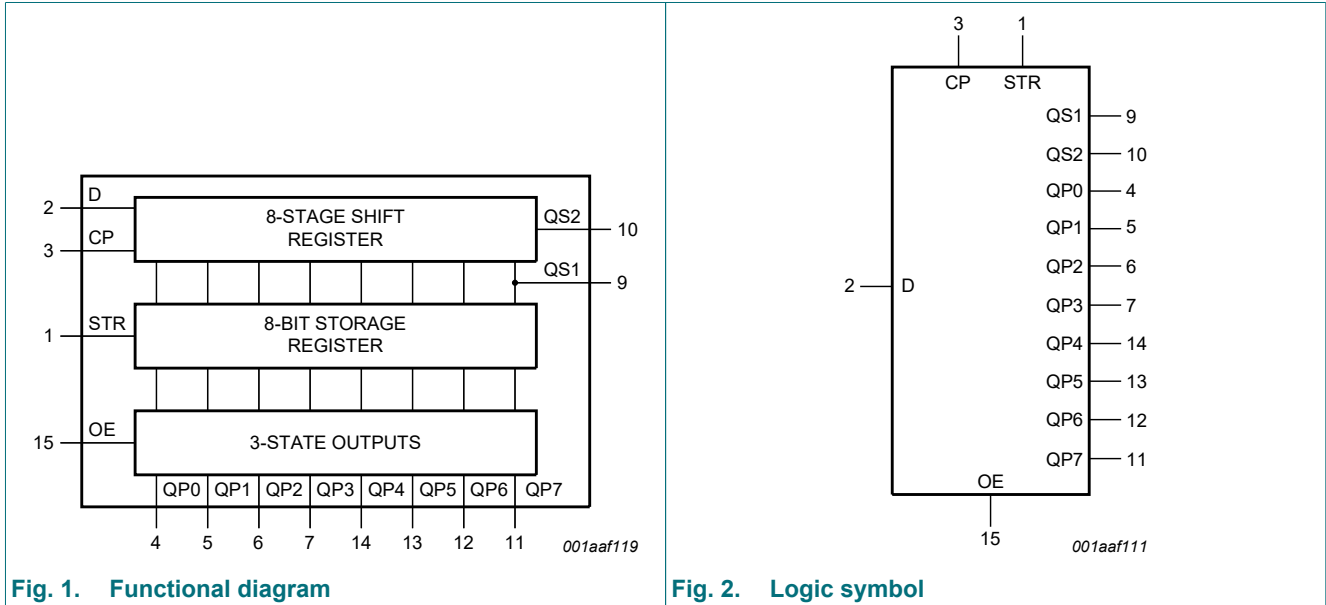


Fig. 1. Functional diagram

Fig. 2. Logic symbol

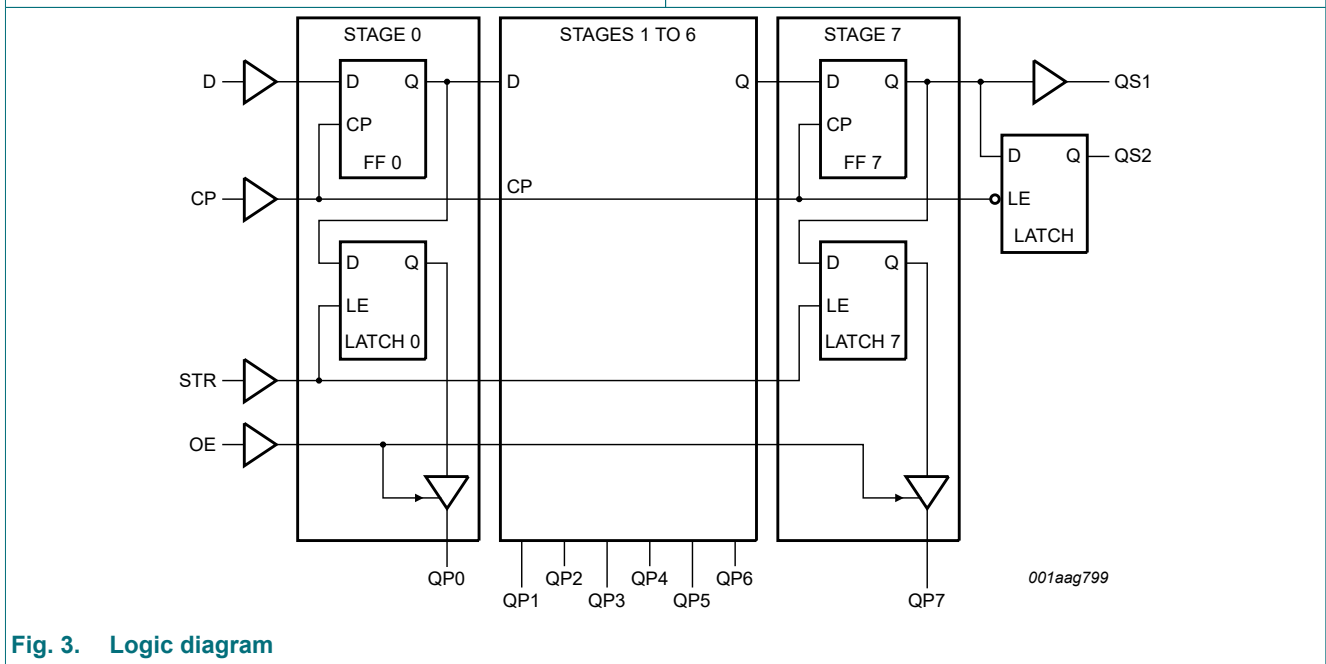


Fig. 3. Logic diagram

5. Pinning information

5.1. Pinning

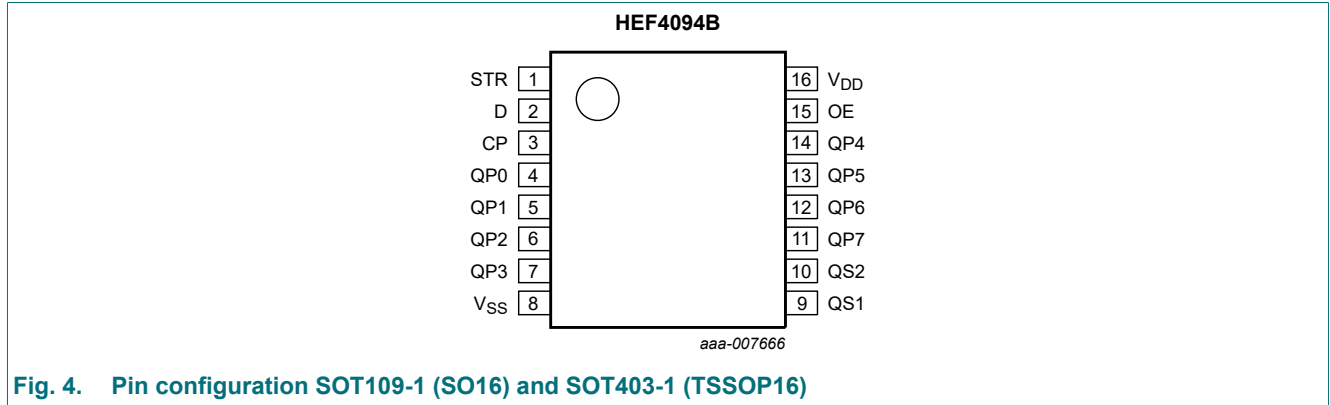


Fig. 4. Pin configuration SOT109-1 (SO16) and SOT403-1 (TSSOP16)

5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
STR	1	strobe input
D	2	data input
CP	3	clock input
QP0 to QP7	4, 5, 6, 7, 14, 13, 12, 11	parallel output
V _{SS}	8	ground supply voltage
QS1	9	serial output
QS2	10	serial output
OE	15	output enable input
V _{DD}	16	supply voltage

6. Functional description

Table 3. Function table

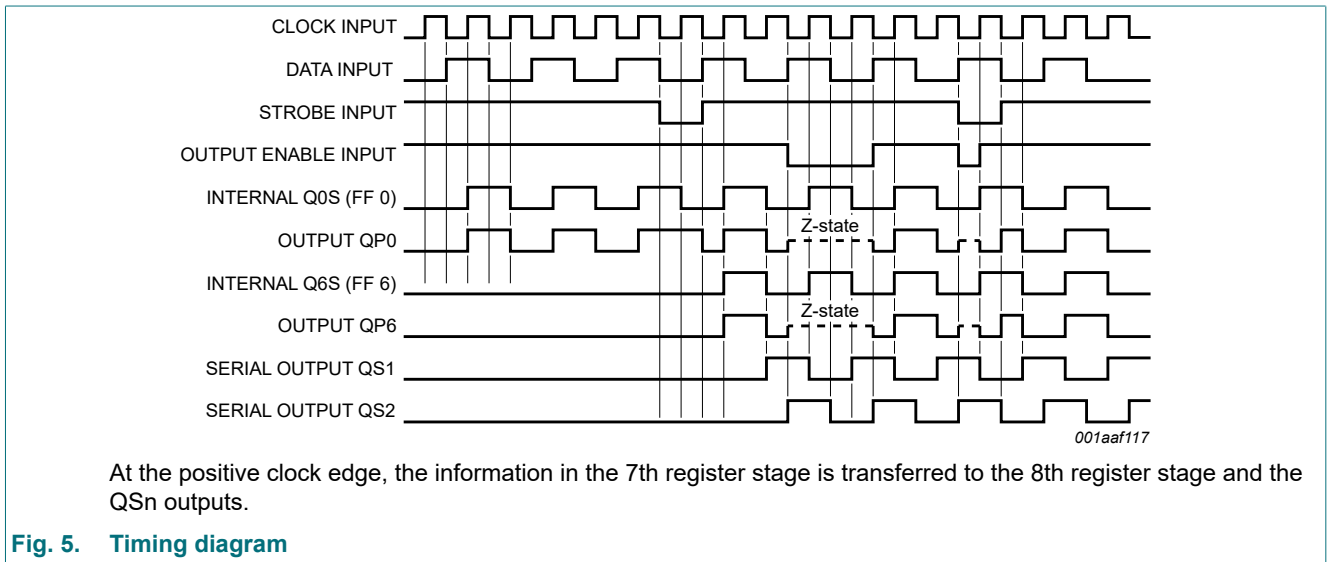
H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = HIGH-impedance OFF-state; NC = no change;

↑ = positive-going transition; ↓ = negative-going transition;

Q6S = the data in register stage 6 before the LOW to HIGH clock transition;

Q7S = the data in register stage 7 before the HIGH to LOW clock transition.

Inputs				Parallel outputs		Serial outputs	
CP	OE	STR	D	QP0	QPn	QS1	QS2
↑	L	X	X	Z	Z	Q6S	NC
↓	L	X	X	Z	Z	NC	Q7S
↑	H	L	X	NC	NC	Q6S	NC
↑	H	H	L	L	QPn - 1	Q6S	NC
↑	H	H	H	H	QPn - 1	Q6S	NC
↓	H	H	H	NC	NC	NC	Q7S



7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to $V_{SS} = 0$ V (ground).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	supply voltage		-0.5	+18	V
I_{IK}	input clamping current	$V_I < -0.5$ V or $V_I > V_{DD} + 0.5$ V	-	± 10	mA
V_I	input voltage		-0.5	$V_{DD} + 0.5$	V
I_{OK}	output clamping current	$V_O < -0.5$ V or $V_O > V_{DD} + 0.5$ V	-	± 10	mA
$I_{I/O}$	input/output current		-	± 10	mA
I_{DD}	supply current		-	50	mA
T_{stg}	storage temperature		-65	+150	°C
T_{amb}	ambient temperature		-40	+125	°C
P_{tot}	total power dissipation	[1]	-	500	mW
P	power dissipation	per output	-	100	mW

- [1] For SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C.
For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	supply voltage		3	-	15	V
V_I	input voltage		0	-	V_{DD}	V
T_{amb}	ambient temperature	in free air	-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5$ V	-	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10$ V	-	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15$ V	-	-	0.08	$\mu\text{s/V}$

9. Static characteristics

Table 6. Static characteristics

$V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} ; unless otherwise specified.

Symbol	Parameter	Conditions	V _{DD}	T _{amb} = -40 °C		T _{amb} = +25 °C		T _{amb} = +85 °C		T _{amb} = +125 °C		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
V _{IH}	HIGH-level input voltage	I _O < 1 μA	5 V	3.5	-	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	11.0	-	11.0	-	11.0	-	V
V _{IL}	LOW-level input voltage	I _O < 1 μA	5 V	-	1.5	-	1.5	-	1.5	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	-	4.0	V
V _{OH}	HIGH-level output voltage	I _O < 1 μA	5 V	4.95	-	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	14.95	-	V
V _{OL}	LOW-level output voltage	I _O < 1 μA	5 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	-	0.05	V
I _{OH}	HIGH-level output current	V _O = 2.5 V	5 V	-	-1.7	-	-1.4	-	-1.1	-	-1.1	mA
		V _O = 4.6 V	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
		V _O = 9.5 V	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
		V _O = 13.5 V	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mA
I _{OL}	LOW-level output current	V _O = 0.4 V	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		V _O = 0.5 V	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		V _O = 1.5 V	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I _{OZ}	OFF-state output current	QPN output is HIGH; V _O = 15 V	15 V	-	0.4	-	0.4	-	12	-	12	μA
I _I	input leakage current		15 V	-	±0.1	-	±0.1	-	±1.0	-	±1.0	μA
I _{DD}	supply current	all valid input combinations; I _O = 0 A	5 V	-	5	-	5	-	150	-	150	μA
			10 V	-	10	-	10	-	300	-	300	μA
			15 V	-	20	-	20	-	600	-	600	μA
C _I	input capacitance			-	-	-	7.5	-	-	-	pF	

10. Dynamic characteristics

Table 7. Dynamic characteristics

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; for test circuit see Fig. 10; unless otherwise specified.

Symbol	Parameter	Conditions	V _{DD}	Extrapolation formula	Min	Typ	Max	Unit
t _{PHL}	HIGH to LOW propagation delay	CP to QS1; see Fig. 6	5 V [1]	108 ns + (0.55 ns/pF)C _L	-	135	270	ns
			10 V	54 ns + (0.23 ns/pF)C _L	-	65	130	ns
			15 V	42 ns + (0.16 ns/pF)C _L	-	50	100	ns
		CP to QS2; see Fig. 6	5 V	78 ns + (0.55 ns/pF)C _L	-	105	210	ns
			10 V	39 ns + (0.23 ns/pF)C _L	-	50	100	ns
			15 V	32 ns + (0.16 ns/pF)C _L	-	40	80	ns
		CP to QPn; see Fig. 6	5 V	138 ns + (0.55 ns/pF)C _L	-	165	330	ns
			10 V	64 ns + (0.23 ns/pF)C _L	-	75	150	ns
			15 V	47 ns + (0.16 ns/pF)C _L	-	55	110	ns
		STR to QPn; see Fig. 7	5 V	83 ns + (0.55 ns/pF)C _L	-	110	220	ns
			10 V	39 ns + (0.23 ns/pF)C _L	-	50	100	ns
			15 V	27 ns + (0.16 ns/pF)C _L	-	35	70	ns
t _{PLH}	LOW to HIGH propagation delay,	CP to QS1; see Fig. 6	5 V [1]	78 ns + (0.55 ns/pF)C _L	-	105	210	ns
			10 V	39 ns + (0.23 ns/pF)C _L	-	50	100	ns
			15 V	32 ns + (0.16 ns/pF)C _L	-	40	80	ns
		CP to QS2; see Fig. 6	5 V	78 ns + (0.55 ns/pF)C _L	-	105	210	ns
			10 V	39 ns + (0.23 ns/pF)C _L	-	50	100	ns
			15 V	32 ns + (0.16 ns/pF)C _L	-	40	80	ns
		CP to QPn; see Fig. 6	5 V	123 ns + (0.55 ns/pF)C _L	-	150	300	ns
			10 V	59 ns + (0.23 ns/pF)C _L	-	70	140	ns
			15 V	47 ns + (0.16 ns/pF)C _L	-	55	110	ns
		STR to QPn; see Fig. 7	5 V	73 ns + (0.55 ns/pF)C _L	-	100	200	ns
			10 V	34 ns + (0.23 ns/pF)C _L	-	45	90	ns
			15 V	27 ns + (0.16 ns/pF)C _L	-	35	70	ns
t _t	transition time		5 V [1]	10 ns + (1.00 ns/pF)C _L	-	60	120	ns
			10 V	9 ns + (0.42 ns/pF)C _L	-	30	60	ns
			15 V	6 ns + (0.28 ns/pF)C _L	-	20	40	ns
t _{PZH}	OFF-state to HIGH propagation delay	OE to QPn; see Fig. 8	5 V		-	40	80	ns
			10 V		-	25	50	ns
			15 V		-	20	40	ns
t _{PZL}	OFF-state to LOW propagation delay	OE to QPn; see Fig. 8	5 V		-	40	80	ns
			10 V		-	25	50	ns
			15 V		-	20	40	ns
t _{PHZ}	HIGH to OFF-state propagation delay	OE to QPn; see Fig. 8	5 V		-	75	150	ns
			10 V		-	40	80	ns
			15 V		-	30	60	ns
t _{PLZ}	LOW to OFF-state propagation delay	OE to QPn; see Fig. 8	5 V		-	80	160	ns
			10 V		-	40	80	ns
			15 V		-	30	60	ns

Symbol	Parameter	Conditions	V _{DD}	Extrapolation formula	Min	Typ	Max	Unit
t _{su}	set-up time	D to CP; see Fig. 9	5 V		60	30	-	ns
			10 V		20	10	-	ns
			15 V		15	5	-	ns
t _h	hold time	D to CP; see Fig. 9	5 V		+5	-15	-	ns
			10 V		20	5	-	ns
			15 V		20	5	-	ns
t _w	pulse width	minimum LOW clock pulse; see Fig. 6	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
		minimum HIGH strobe pulse; see Fig. 7	5 V		40	20	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
f _{max}	maximum frequency	see Fig. 6	5 V		5	10	-	MHz
			10 V		11	22	-	MHz
			15 V		14	28	-	MHz

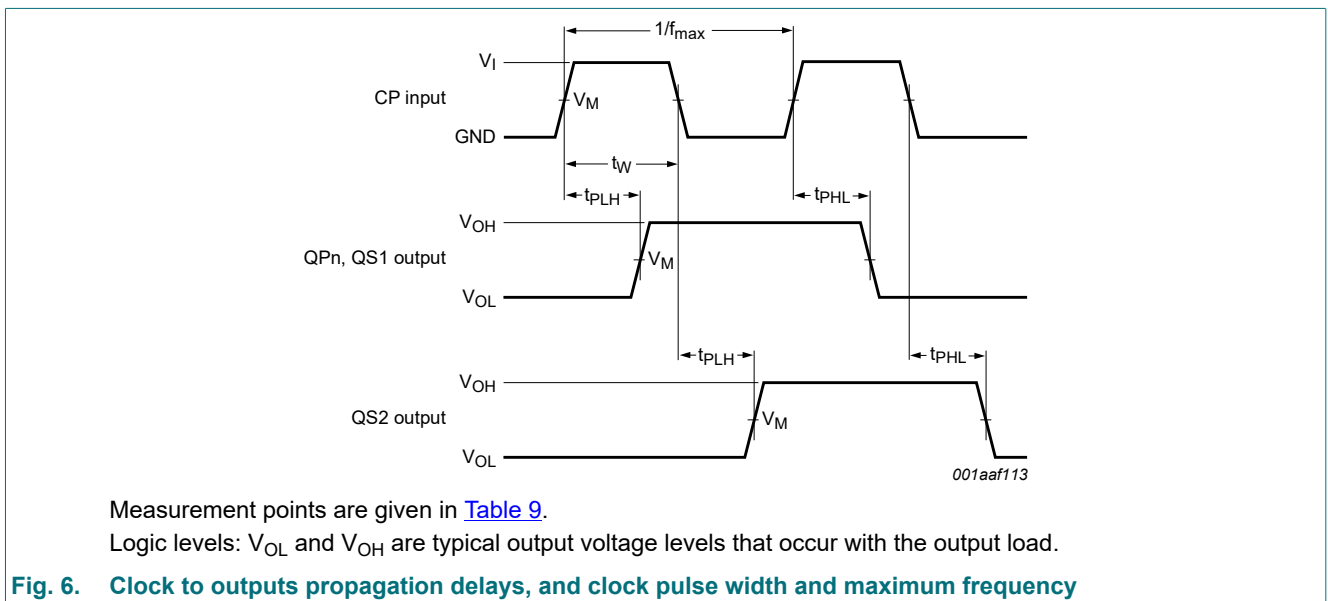
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

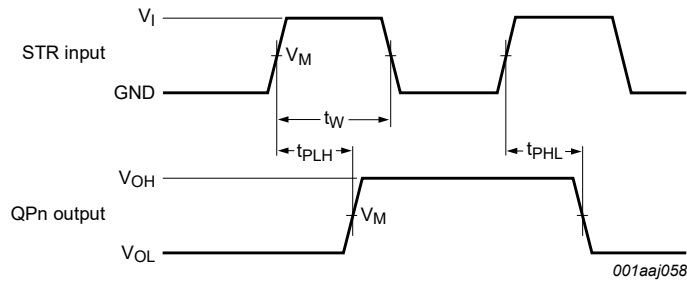
Table 8. Dynamic power dissipation

V_{SS} = 0 V; t_r = t_f ≤ 20 ns; T_{amb} = 25 °C.

Symbol	Parameter	V _{DD}	Typical formula for P _D (μW)	where:
P _D	dynamic power dissipation	5 V	$P_D = 2100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f _i = input frequency in MHz, f _o = output frequency in MHz, C _L = output load capacitance in pF, V _{DD} = supply voltage in V, Σ(f _o × C _L) = sum of the outputs.
		10 V	$P_D = 9700 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 26000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

10.1. Waveforms and test circuit

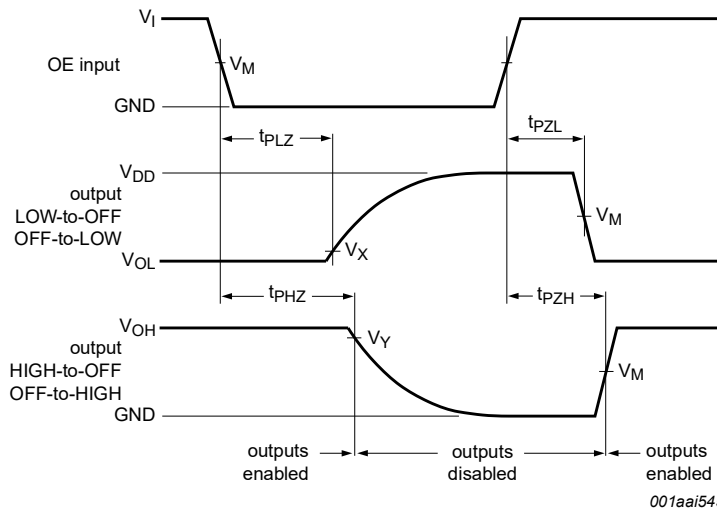




Measurement points are given in [Table 9](#).

Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

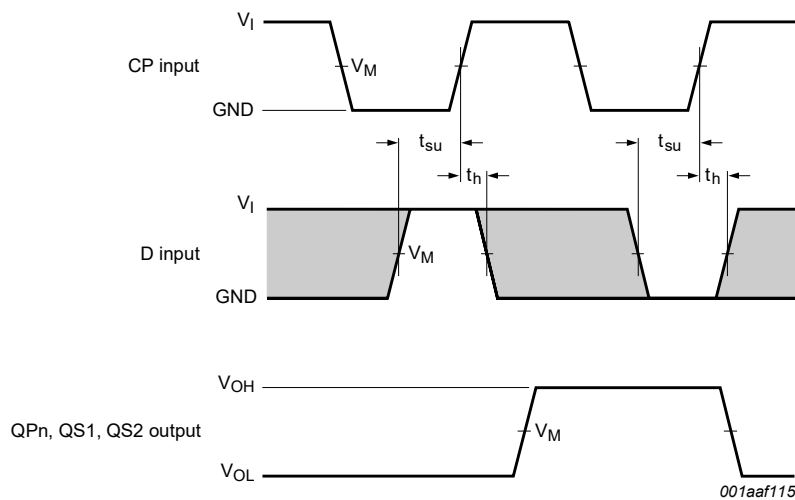
Fig. 7. Strobe to output propagation delays, and strobe pulse width, set up and hold times



Measurement points are given in [Table 9](#).

Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig. 8. 3-state output enable and disable times for OE input



Measurement points are given in [Table 9](#).

Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig. 9. Data input data set up and hold times

Table 9. Measurement points

Supply voltage	Input	Output		
V_{DD}	V_M	V_M	V_X	V_Y
5 V to 15 V	$0.5V_{DD}$	$0.5V_{DD}$	$0.1V_{DD}$	$0.9V_{DD}$

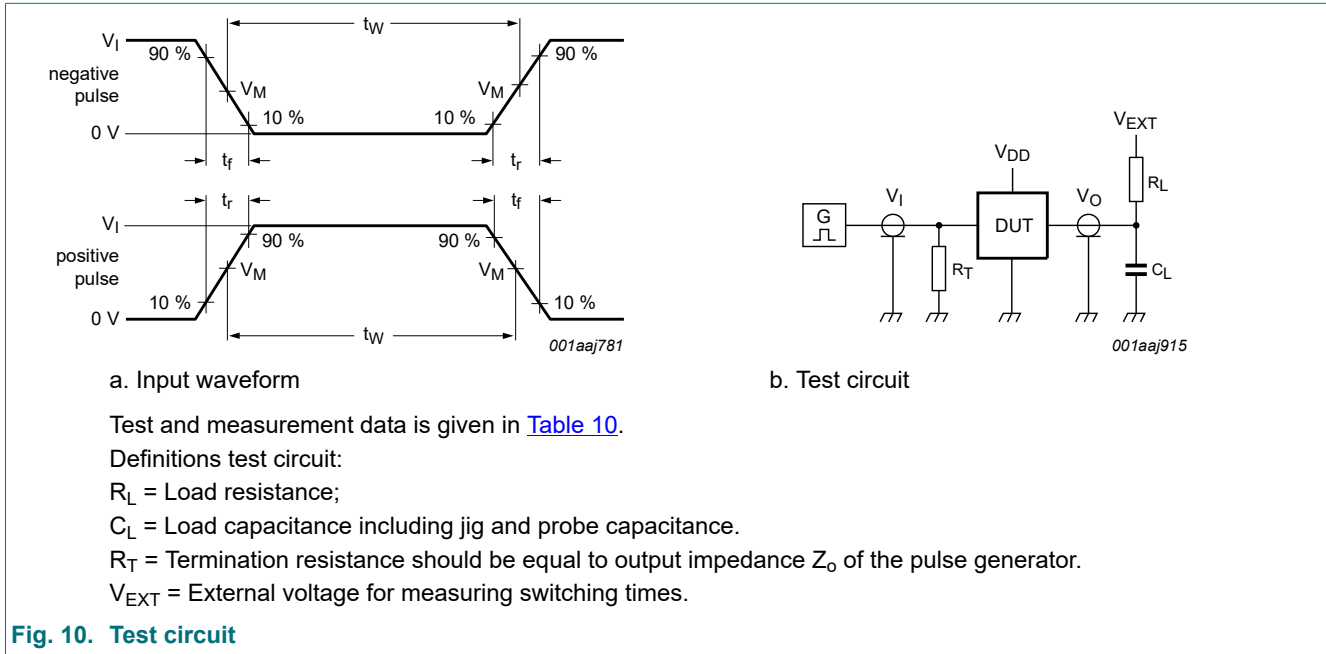


Fig. 10. Test circuit

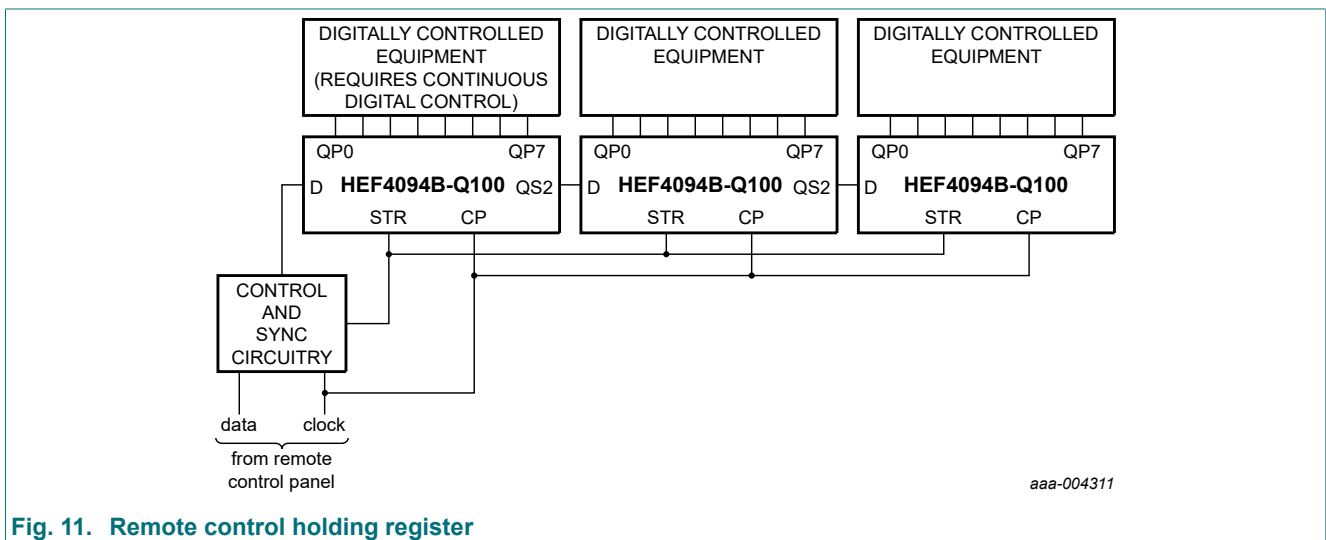
Table 10. Test data

Supply voltage	Input		V_{EXT}			Load	
V_{DD}	V_I	t_r, t_f	t_{PHL}, t_{PLH}	t_{PHZ}, t_{PZH}	t_{PLZ}, t_{PZL}	C_L	R_L
5 V to 15 V	V_{SS} or V_{DD}	≤ 20 ns	open	V_{SS}	V_{DD}	50 pF	1 k Ω

11. Application information

Some examples of applications for the HEF4094B-Q100 are:

- Serial-to-parallel data conversion
- Remote control holding register



12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

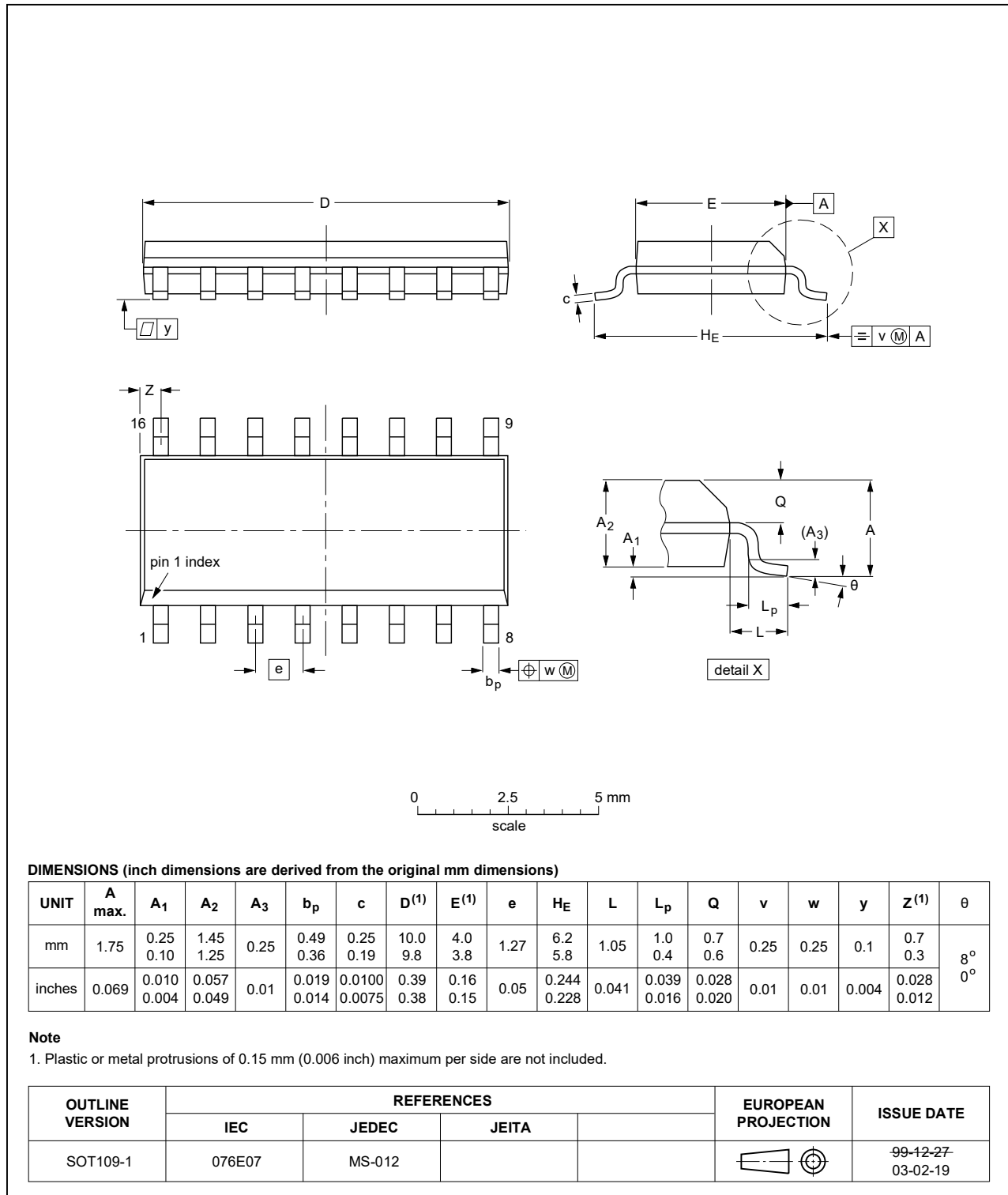


Fig. 12. Package outline SOT109-1 (SO16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

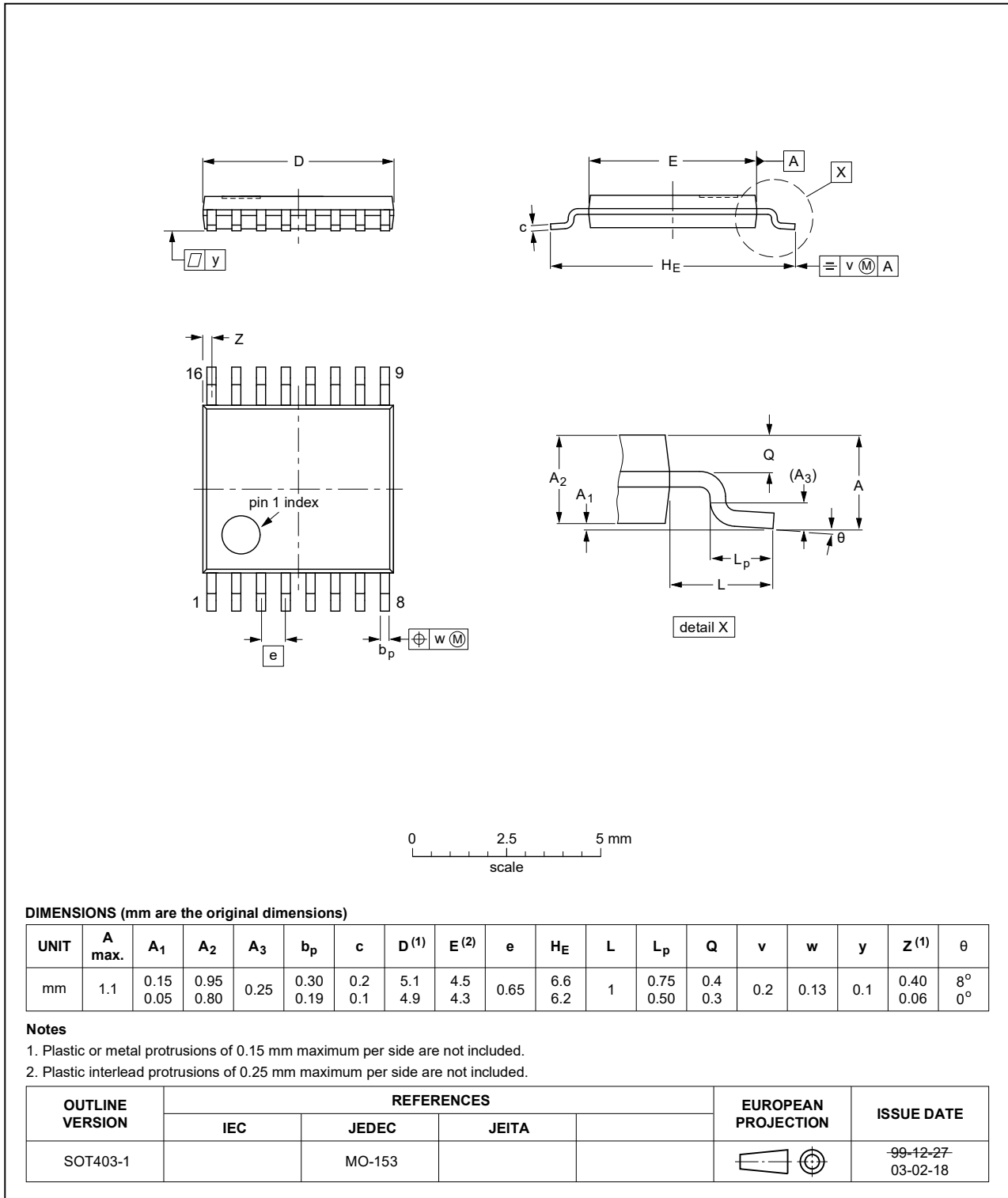


Fig. 13. Package outline SOT403-1 (TSSOP16)

13. Abbreviations

Table 11. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model

14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4094B_Q100 v.5	20210708	Product data sheet	-	HEF4094B_Q100 v.4
Modifications:	<ul style="list-style-type: none"> • Section 1 and Section 2 updated. • Section 7: Derating values for P_{tot} total power dissipation updated. 			
HEF4094B_Q100 v.4	20181114	Product data sheet	-	HEF4094B_Q100 v.3
Modifications:	<ul style="list-style-type: none"> • The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. • Legal texts have been adapted to the new company name where appropriate. • Fig. 5 corrected. 			
HEF4094B_Q100 v.3	20130704	Product data sheet	-	HEF4094B_Q100 v.2
Modifications:	<ul style="list-style-type: none"> • Fig. 3 corrected (errata). 			
HEF4094B_Q100 v.2	20130606	Product data sheet	-	HEF4094B_Q100 v.1
Modifications:	<ul style="list-style-type: none"> • added type number HEF4094BTT-Q100. 			
HEF4094B_Q100 v.1	20120807	Product data sheet	-	-

15. Legal information

Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Nexperia does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local Nexperia sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

Product specification — The information and data provided in a Product data sheet shall define the specification of the product as agreed between Nexperia and its customer, unless Nexperia and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the Nexperia product is deemed to offer functions and qualities beyond those described in the Product data sheet.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, Nexperia does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. Nexperia takes no responsibility for the content in this document if provided by an information source outside of Nexperia.

In no event shall Nexperia be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, Nexperia's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of Nexperia.

Right to make changes — Nexperia reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use in automotive applications — This Nexperia product has been qualified for use in automotive applications. Unless otherwise agreed in writing, the product is not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or

equipment, nor in applications where failure or malfunction of an Nexperia product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Nexperia and its suppliers accept no liability for inclusion and/or use of Nexperia products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Quick reference data — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. Nexperia makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using Nexperia products, and Nexperia accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Nexperia product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

Nexperia does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Nexperia products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Nexperia does not accept any liability in this respect.

Limiting values — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and conditions of commercial sale — Nexperia products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nexperia.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Nexperia hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of Nexperia products by customer.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.