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Kind regards,

Team Nexperia

# PHP9NQ20T

## N-channel TrenchMOS standard level FET

Rev. 03 — 16 December 2010

Product data sheet

## 1. Product profile

### 1.1 General description

Standard level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product is designed and qualified for use in computing, communications, consumer and industrial applications only.

### 1.2 Features and benefits

- Higher operating power due to low thermal resistance
- Low conduction losses due to low on-state resistance
- Suitable for high frequency applications due to fast switching characteristics

### 1.3 Applications

- DC-to-DC converters
- General purpose switching
- Motor control circuits
- Off-line switched-mode power supplies
- TV and computer monitor power supplies

### 1.4 Quick reference data

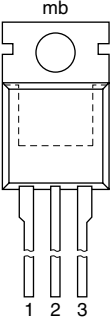
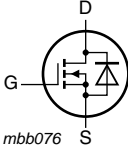
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$	-	-	200	V
$I_D$	drain current	$T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V}$	-	-	8.7	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$	-	-	88	W
<b>Static characteristics</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 4.5\text{ A}; T_j = 25\text{ °C}$	-	300	400	m $\Omega$
<b>Dynamic characteristics</b>						
$Q_{GD}$	gate-drain charge	$V_{GS} = 10\text{ V}; I_D = 9\text{ A}; V_{DS} = 160\text{ V}; T_j = 25\text{ °C}$	-	12	-	nC



## 2. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
2	D	drain		
3	S	source		
mb	D	mounting base; connected to drain		

**SOT78 (TO-220AB)**

## 3. Ordering information

Table 3. Ordering information

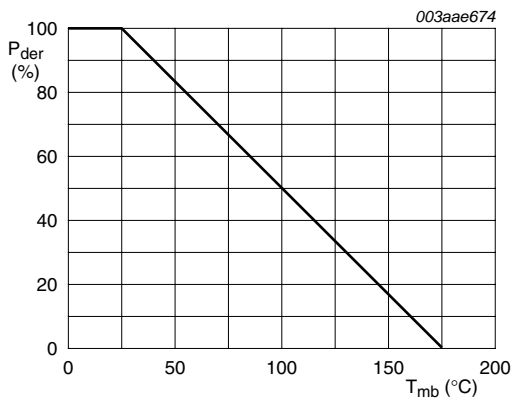
Type number	Package		
	Name	Description	Version
PHP9NQ20T	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78

## 4. Limiting values

**Table 4. Limiting values**

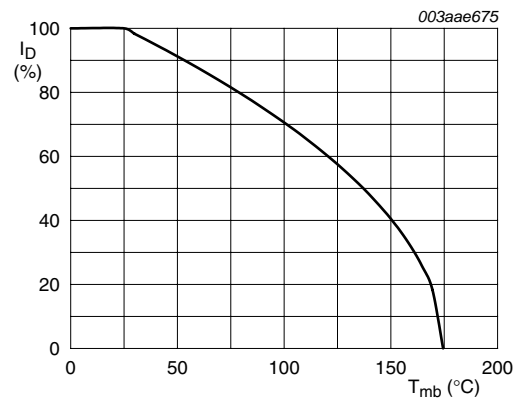
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> ≥ 25 °C; T <sub>j</sub> ≤ 175 °C	-	200	V
V <sub>DGR</sub>	drain-gate voltage	T <sub>j</sub> ≥ 25 °C; T <sub>j</sub> ≤ 175 °C; R <sub>GS</sub> = 20 kΩ	-	200	V
V <sub>GS</sub>	gate-source voltage		-30	30	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 100 °C	-	6.2	A
		V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 25 °C	-	8.7	A
I <sub>DM</sub>	peak drain current	pulsed; T <sub>mb</sub> = 25 °C	-	35	A
P <sub>tot</sub>	total power dissipation	T <sub>mb</sub> = 25 °C	-	88	W
T <sub>stg</sub>	storage temperature		-55	175	°C
T <sub>j</sub>	junction temperature		-55	175	°C
<b>Source-drain diode</b>					
I <sub>S</sub>	source current	T <sub>mb</sub> = 25 °C	-	8.7	A
I <sub>SM</sub>	peak source current	pulsed; T <sub>mb</sub> = 25 °C	-	35	A
<b>Avalanche ruggedness</b>					
E <sub>DS(AL)S</sub>	non-repetitive drain-source avalanche energy	V <sub>GS</sub> = 10 V; T <sub>j(init)</sub> = 25 °C; I <sub>D</sub> = 7.2 A; V <sub>sup</sub> ≤ 25 V; unclamped; t <sub>p</sub> = 100 μs; R <sub>GS</sub> = 50 Ω	-	93	mJ
I <sub>AS</sub>	non-repetitive avalanche current	V <sub>sup</sub> ≤ 25 V; V <sub>GS</sub> = 10 V; T <sub>j(init)</sub> = 25 °C; R <sub>GS</sub> = 50 Ω; unclamped	-	8.7	A



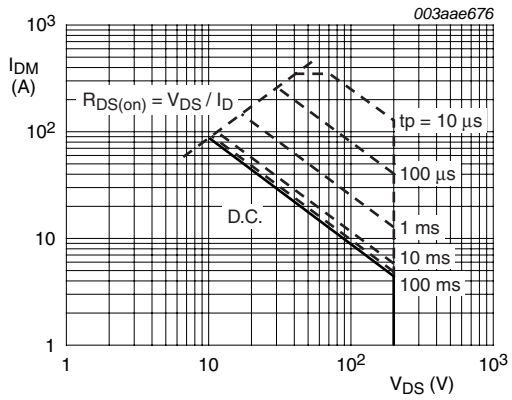
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

**Fig 1. Normalized total power dissipation as a function of mounting base temperature**



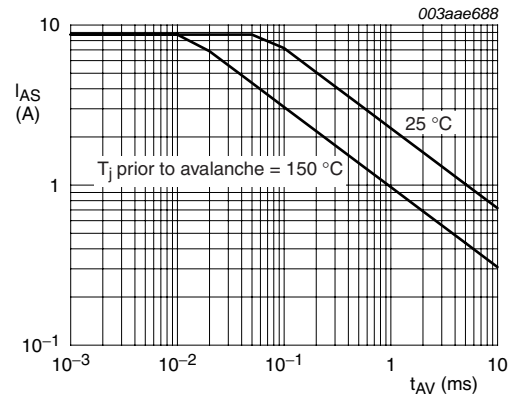
$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

**Fig 2. Normalized continuous drain current as a function of mounting base temperature**



$T_{mb} = 25 \text{ }^\circ\text{C}$ ;  $I_{DM}$  is single pulse

**Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage**



unclamped inductive load

**Fig 4. Single-shot avalanche rating; avalanche current as a function of avalanche period**

### 5. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base		-	-	1.7	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	-	60	-	K/W

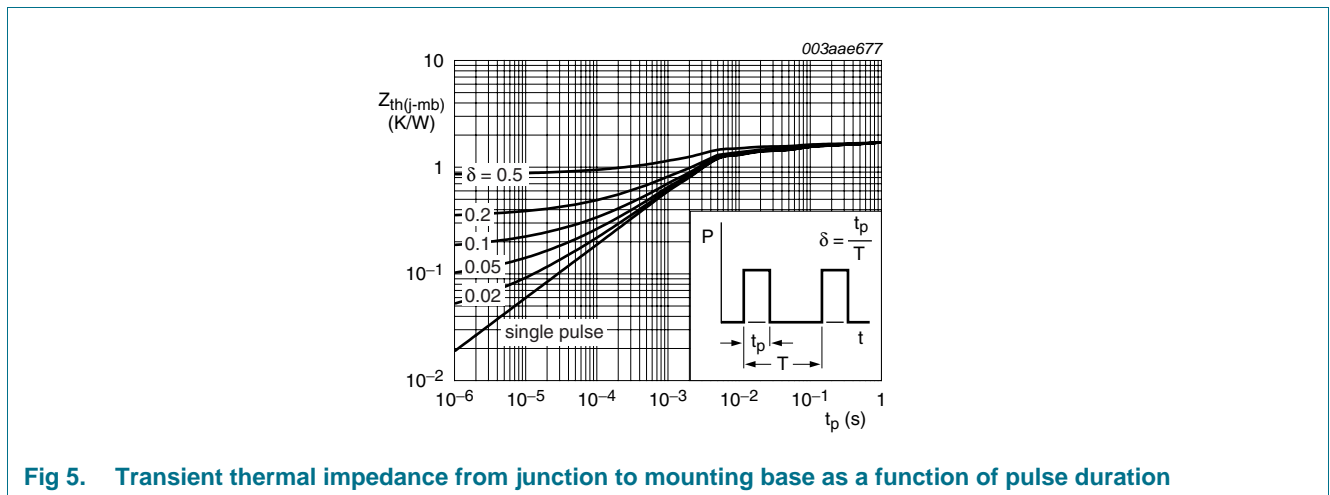


Fig 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 6. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	200	-	-	V
		$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	178	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C}$	1	-	-	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C}$	2	3	4	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C}$	-	-	6	V
$I_{DSS}$	drain leakage current	$V_{DS} = 200 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	-	500	$\mu\text{A}$
		$V_{DS} = 200 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.05	10	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	10	100	nA
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	10	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 4.5 \text{ A}; T_j = 175 \text{ }^\circ\text{C}$	-	-	1.16	$\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 4.5 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$	-	300	400	m $\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 9 \text{ A}; V_{DS} = 160 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	24	-	nC
$Q_{GS}$	gate-source charge		-	4	-	nC
$Q_{GD}$	gate-drain charge		-	12	-	nC
$C_{iss}$	input capacitance	$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}$	-	959	-	pF
$C_{oss}$	output capacitance		-	93	-	pF
$C_{rss}$	reverse transfer capacitance		-	54	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 100 \text{ V}; R_L = 10 \text{ }^\Omega; V_{GS} = 10 \text{ V}; R_{G(ext)} = 5.6 \text{ }^\Omega; T_j = 25 \text{ }^\circ\text{C}$	-	8	-	ns
$t_r$	rise time		-	19	-	ns
$t_{d(off)}$	turn-off delay time		-	25	-	ns
$t_f$	fall time		-	15	-	ns
$g_{fs}$	transfer conductance	$V_{DS} = 25 \text{ V}; I_D = 4.5 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$	3.8	6	-	S
$L_D$	internal drain inductance	from drain lead to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$	-	4.5	-	nH
		from tab to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$	-	3.5	-	nH
$L_S$	internal source inductance	from source lead to source bond pad ; $T_j = 25 \text{ }^\circ\text{C}$	-	7.5	-	nH
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 9 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.85	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 9 \text{ A}; di_S/dt = -100 \text{ A}/\mu\text{s}; V_{GS} = -10 \text{ V}; V_{DS} = 25 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	92	-	ns
$Q_r$	recovered charge		-	0.5	-	$\mu\text{C}$

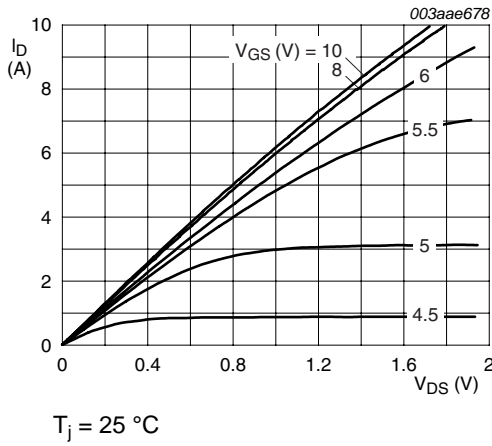


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

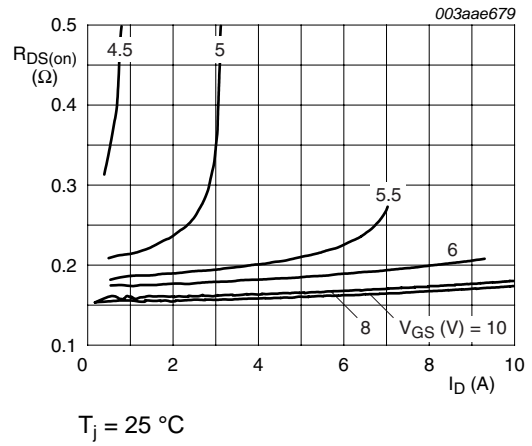


Fig 7. Drain-source on-state resistance as a function of drain current; typical values

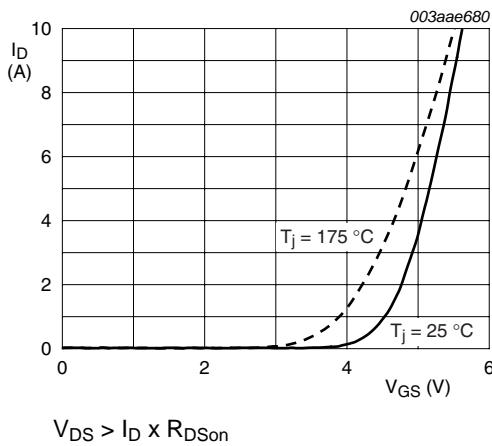


Fig 8. Transfer characteristics: drain current as a function of gate-source voltage; typical values

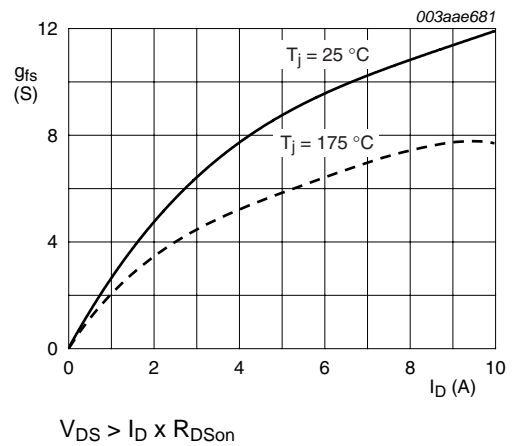
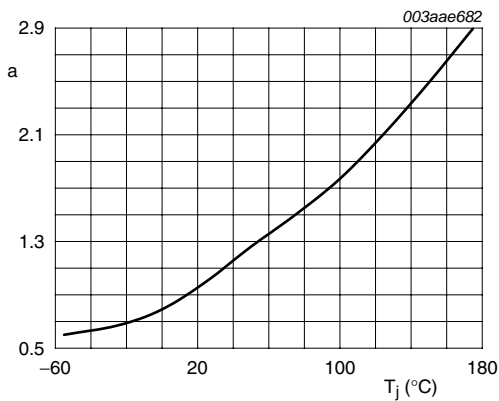


Fig 9. Forward transconductance as a function of drain current; typical values



$$a = \frac{R_{DSon}}{R_{DSon(25^{\circ}C)}}$$

Fig 10. Normalized drain-source on-state resistance factor as a function of junction temperature

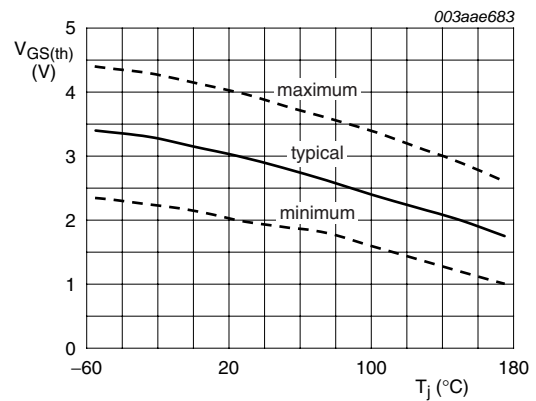
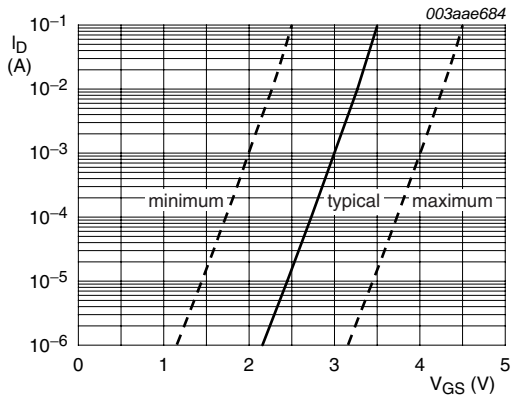


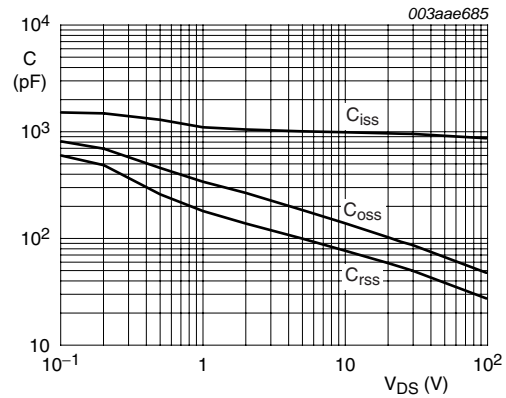
Fig 11. Gate-source threshold voltage as a function of junction temperature





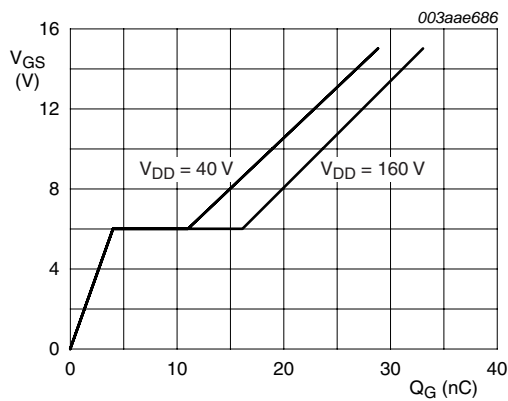
T<sub>j</sub> = 25 °C; V<sub>DS</sub> = V<sub>GS</sub>

Fig 12. Sub-threshold drain current as a function of gate-source voltage



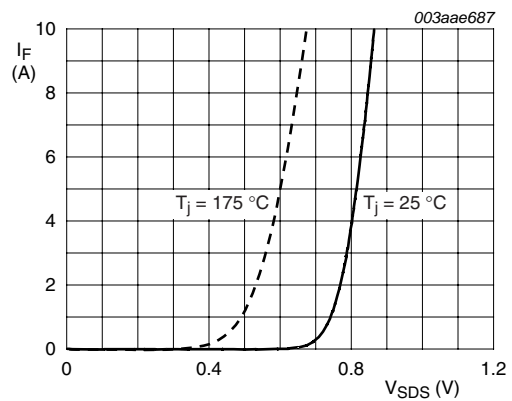
V<sub>GS</sub> = 0 V; f = 1 MHz

Fig 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



T<sub>j</sub> = 25 °C; I<sub>D</sub> = 9 A

Fig 14. Gate-source voltage as a function of gate charge; typical values



V<sub>GS</sub> = 0 V

Fig 15. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

7. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB

SOT78



Fig 16. Package outline SOT78 (TO-220AB)

## 8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PHP9NQ20T v.3	20101216	Product data sheet	-	PHB_PHD_PHP9NQ20T v.2
Modifications:				
				<ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• Type number PHP9NQ20T separated from data sheet PHB_PHD_PHP9NQ20T v.2.</li></ul>
PHB_PHD_PHP9NQ20T v.2	20001001	Product specification	-	PHB_PHD_PHP9NQ20T v.1

## 9. Legal information

### 9.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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".

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