SMART7: the next generation of smart switches

PROFET™+2 12V
SPOC™+2

IFAG ATV BP IPD PM BA
Q4 2019

www.infineon.com/profet+2
www.infineon.com/spoc+2

Agenda

1. General overview, features & benefits
2. PROFET™+2 12V portfolio
   - Collaterals and design-in support material
3. PROFET™+2 12V Grade0 for extended temperature and lifetime
4. SPOC™+2 portfolio
   - Collaterals and design-in support material

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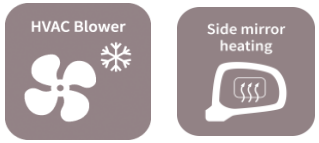
Infineon offers an entire High-Side Switch portfolio to address all kind of body applications

Infineon Technologies – SMART High-Side switches portfolio

- **PROFET™** (PROtected MosFET) is the market's leading and **widest portfolio** of smart protected High-Side Switches.
- Three main families to address all **body applications**.

High-Side w/SPI 4/6ch	**High-Side** 1/2/4ch
Multichannel SPI	Integrated

SPOC™+2 [0.5A–15A]	**PROFET™+2 12V** [0A–20A]	**Power PROFET™** [20A–40A]



Advanced Automotive TECHNOLOGIES

SMART7	**RCB1**

High-Side = High-Side Switch; PROFET™ = protected High-Side Switch; SPOC™ = SPI Power Controller

For over 25 years Infineon has been leading with innovation in smart High-Side switches

System performance & productivity

1993

MSMART

1st protected “Smart” Hi-Side in the market

PROFET™

1997

SSMART

› Introduction of the current sense for improved diagnostics

2003

SMART5

1st Integrated High-Side Driver w/ SPI

SPOC™

2010

SMART6

Full Modularity

Short Circuit robustness

Sense accuracy

SPOC™+

PROFET™+

2017

SMART7

Energy Efficiency

Miniaturization

SPOC™+2

PROFET™+2 12V

2019

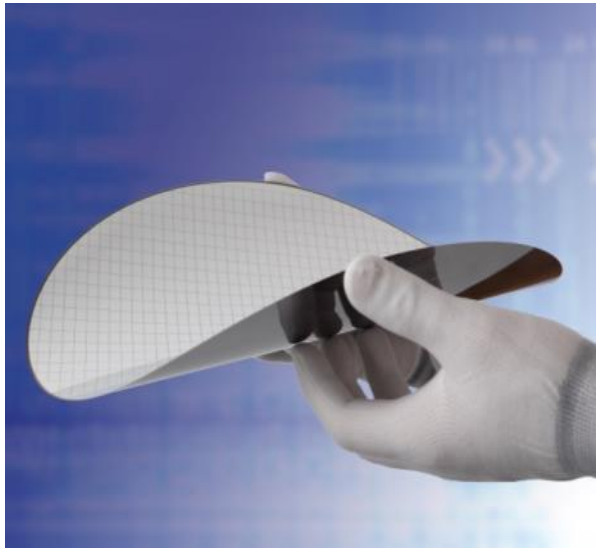
SMART7

PROFET™+2 12V k_{ILIS} improvement

PROFET™+2 12V

Grade0 Family

SMART7 PROFET™+2 12V and SPOC™+2 is produced in a 300mm volume production



300 millimeter thin-wafer manufacturing technology for power semiconductors is state of the art

- When fully loaded, frontend manufacturing cost per unit will be significantly lower than on 200 millimeter
- Capital intensity is up to 30% lower compared to 200 millimeter

Dresden, Germany

- 300 millimeter high-volume site in mass production – steeply ramping
- Fully ramped by approximately 2020/21
- Transfer of Automation and digitalization expertise to Villach

Villach, Austria

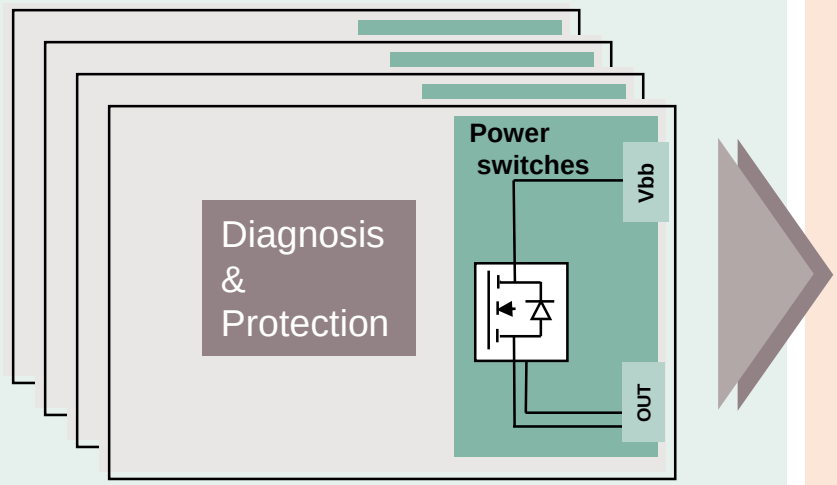
- 300 millimeter pilot line in mass production
- **NEW additional 300mm high-volume fab decided → ramps 2021**
- Innovation: Power discrete development on 300mm thin wafer & SiC & GaN development on 150mm

SMART7 concept offers design flexibility between discrete PROFET™+2 12V and integrated SPOC™+2

PROFET™+2 12V

High-Side switch
1/2/4ch

1/2/4 channel discrete devices

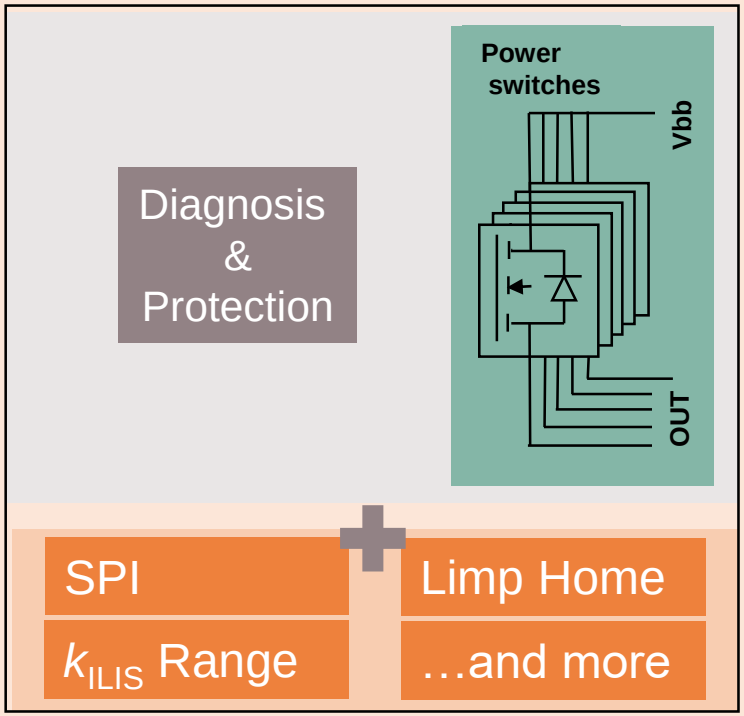


TSDSO-14

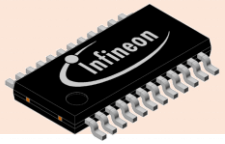
SPOC™+2

High-Side switch
4/6ch w/ SPI

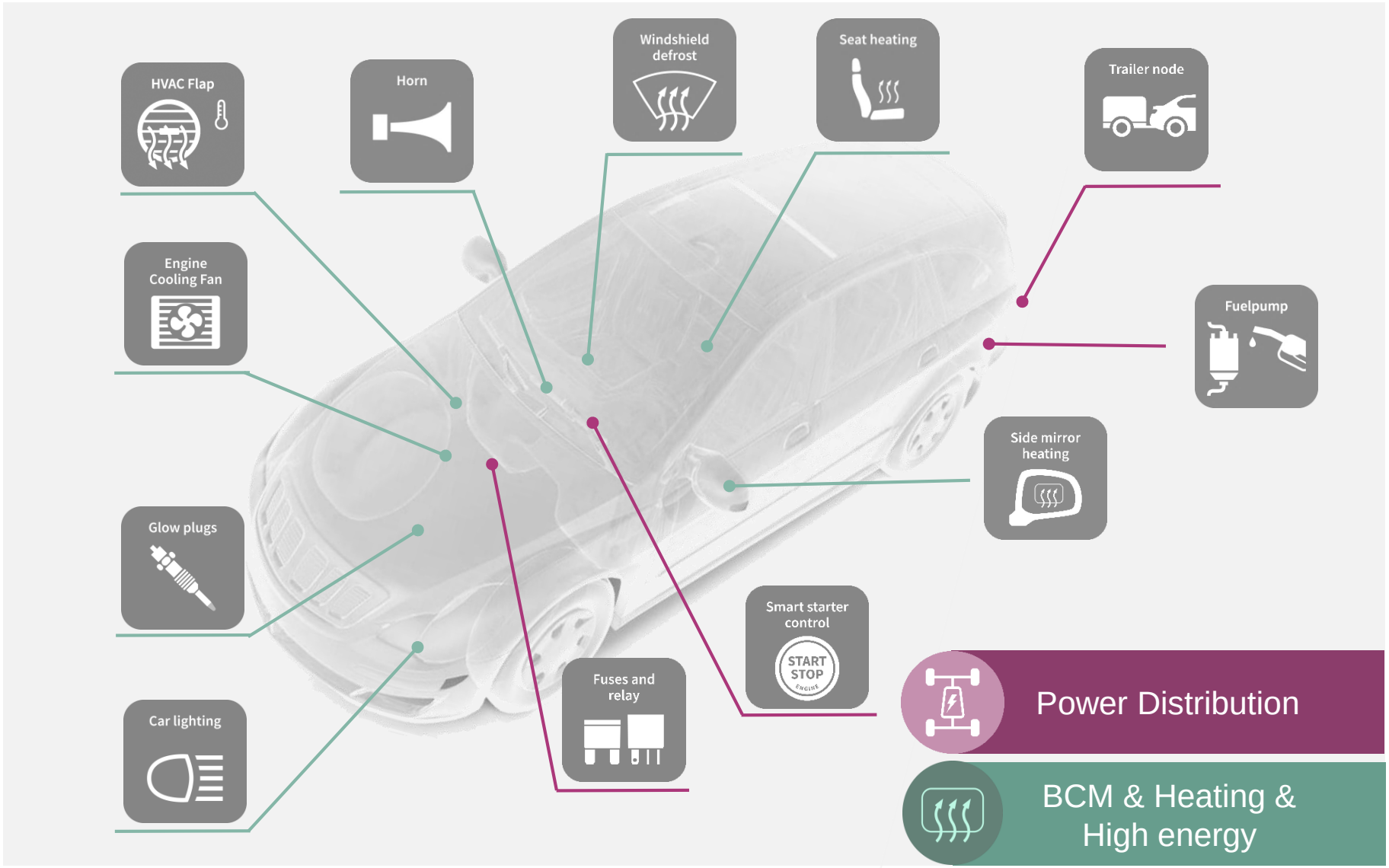
4 and 6 channel integrated SPI devices



TSDSO-24

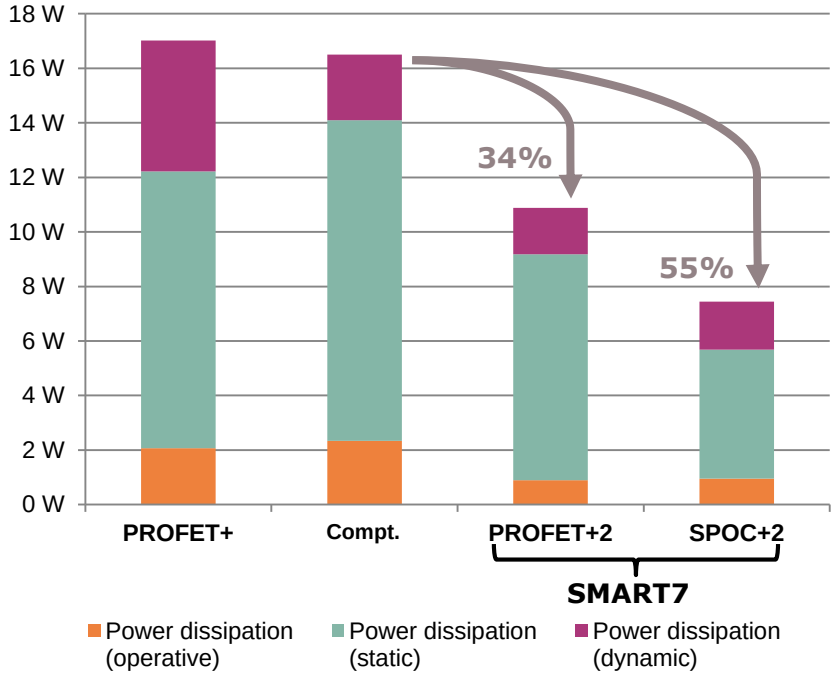


PROFET™+2 12V and SPOC™+2 universal to drive resistive, inductive and capacitive loads

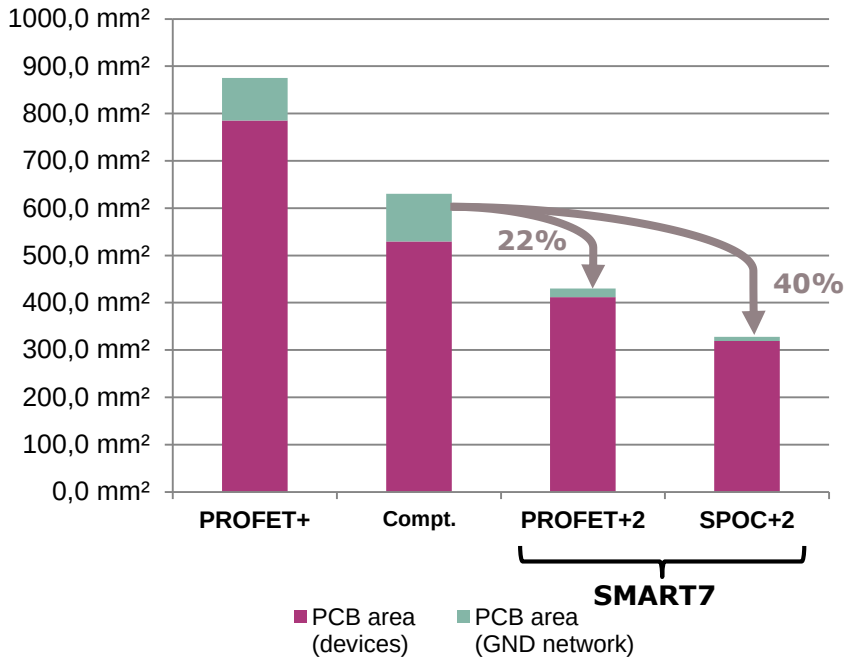


Power dissipation of SMART7 devices is up to 55% lower and PCB space is 40% smaller than competition

Standard reference partitioning:



Standard reference partitioning:



UNIQUE SELLING POINT:

For the same BCM function: Reduction of the PCB size due to less power dissipation with the SMART7 portfolio

At the same PCB size: Implementation of more functions possible

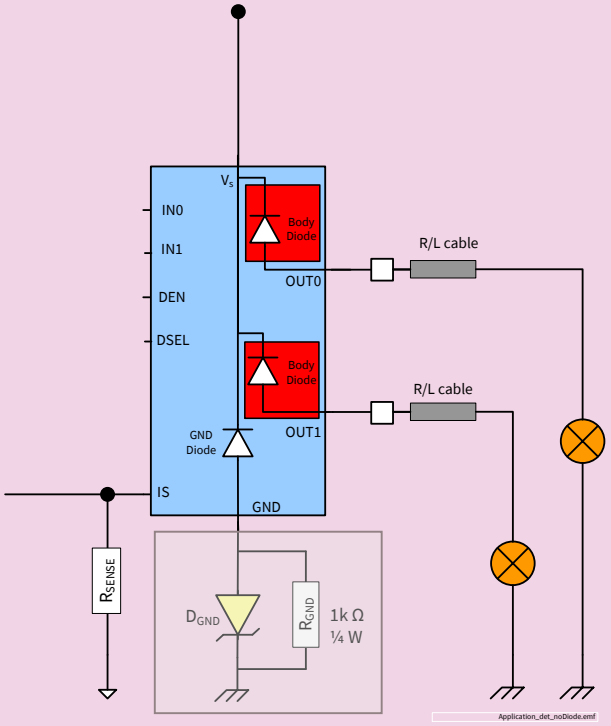
UNIQUE SELLING POINT:

Smaller PCB area
saves space at the ECU to implement further loads

The size of the ECU for the existing loads can significantly reduced

SMART7 common ground network with integrated diode leads to 12% system cost savings

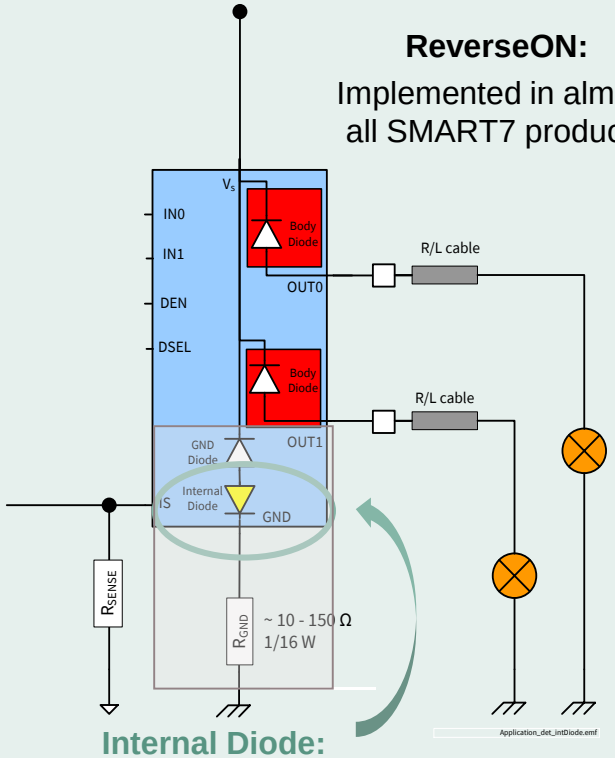
SMART6 application schematic



External Diode:
Recommended for all SMART6 products

SMART7 application schematic

ReverseON:
Implemented in almost all SMART7 products



Internal Diode:
Necessary to implement ReverseON

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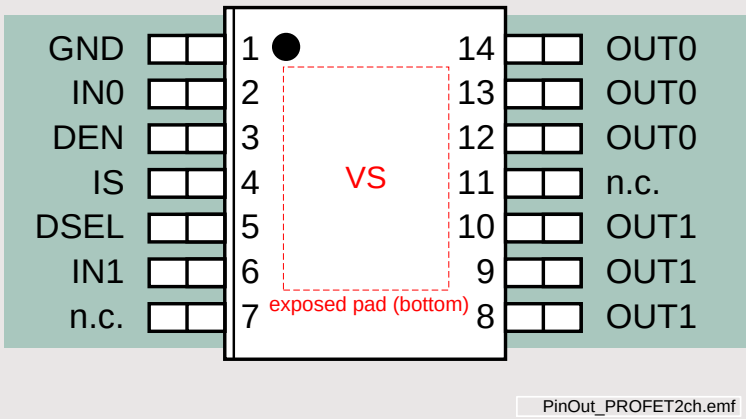
PROFET™+2 12V
One package fits all - from 1A to 21A nominal current

Features	PROFET™+ 12V	Competitor	PROFET™+2 12V	Customer benefit
Package & Pinout	DSO8 (1ch) DSO14 (2ch)	HPAK PWSSO 36 PowerSSO-16 SO-8	**TSDSO-14**	1 package for all 1ch and 2ch products

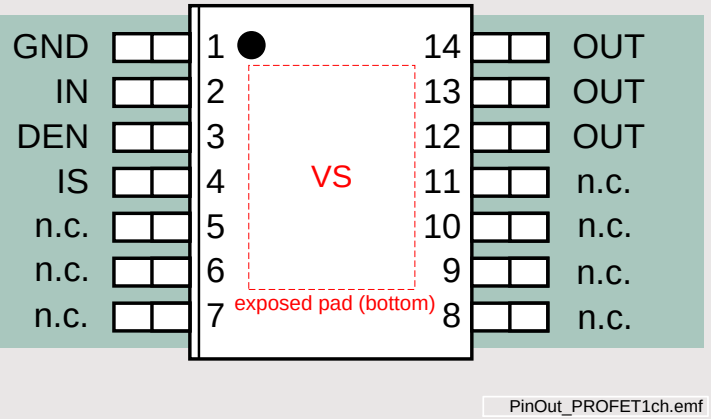
One package for single and dual channels:

*PROFET™+2 12V **dual channel** package layout*



PinOut_PROFET2ch.emf

*PROFET™+2 12V **single channel** package layout*



PinOut_PROFET1ch.emf

Highest design in flexibility with one pin-to-pin compatible TSDSO-14 package for the whole PROFET™+2 12V family

PROFET™+2 12V
Best in class Smart High-Side Switches

Beside the high design-in flexibility the PROFET™+2 12V offers four further benefits:

Features	PROFET™+ 12V	Competitor	PROFET™+2 12V	Customer benefit
Operating Range	4.1 V – 28 V	4 V – 28 V	**3.1 V – 28 V**	Extended operating range operation during cranking
Current consumption	~5 mA/ch.	~5 mA/ch.	**< 2 mA/ch.**	Significant decreased operative current consumption
Overcurrent Protection	Limitation	Limitation	**Tripping**	Optimized overcurrent detection to support bulb & module supply inrush

PROFET™+2 12V - flexibility & efficiency to drive loads with protection and diagnosis

Load current	Single Channel	Load current	Dual Channel
21A	BTS7002-1EPP		
15A	BTS7004-1EPP		
	BTS7004-1EPZ		
13A	BTS7006-1EPP		
	BTS7006-1EPZ		
10–11 A	BTS7008-1EPP		
10–11 A	BTS7008-1EPA	7–7.5 A	BTS7008-2EPA
	BTS7008-1EPZ		BTS7008-2EPZ
8–9 A	BTS7010-1EPA	6–6.5 A	BTS7010-2EPA
8–9 A	BTS7012-1EPA	6–6.5 A	BTS7012-2EPA
		5–5.5 A	BTS7020-2EPA
		4–4.5 A	BTS7030-2EPA
4–4.5 A	BTS7040-1EPA	3–3.5 A	BTS7040-2EPA
	BTS7040-1EPZ		
		3–3.5 A	BTS7080-2EPA
			BTS7080-2EPZ
		2-2.5 A	BTS7120-2EPA
		1-1.5 A	BTS7200-2EPA BTS7200-2EPC
		1-1.5 A	BTS7200-4EPA

Key applications: Heating and Power Distribution

- Nominal load currents up to 20A.
- Current trip with latch.
- Over temperature protection.
- ReverseON and inverse mode capability.
- Current sense diagnosis with failure signal up to I_{TRIP} level.
- Optimized turn-on and turn-off slew rates for high currents.

Key applications: Powertrain & “under the hood”

- Based on EPA or EPP variant.
- Same characteristic as the base variant.
- With extended junction temperature range up to 175°c.
- k_{ILIS} optimized for power distribution applications.

Key application: Lighting and Body

- Current trip with intelligent restart control.
- Low-mid currents (0,5-10A).
- Over temperature protection.
- Partially with ReverseON.
- Current sense diagnostics up to $2xI_{NOM}$.

Difference between PROFET™+2 12V -EPP and -EPA

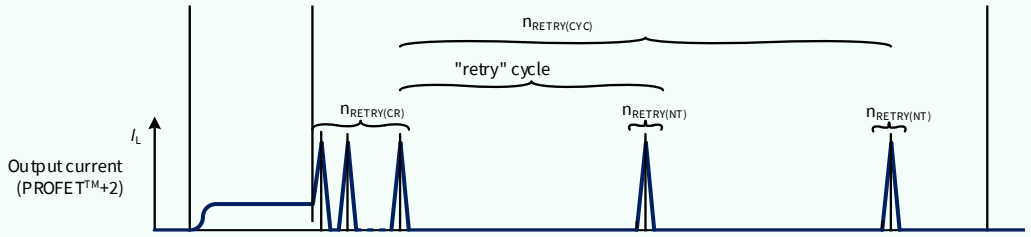
	PROFET™+2 12V family	
Features	-EPA	-EPP
Slew rate	Fast (0.6 V/µs)	Slow (0.3 V/µs)
Pinout 1ch devices	3 OUTx pins per channel	6 OUTx pins per channel
Protection	Intelligent Restart Control	Latch
Diagnosis focus	Open Load @ ON k_{ILIS}	Full output current range
ON resistance	From 8 to 200 mΩ	From 2 to 8 mΩ
Max senseable I_{OUT}	1.2-2x $I_{L(NOM)}$	$I_{L(OVL),min}$
ReverSave	Only low ohmic products	Whole family

Intelligent short circuit protection strategy for PROFET™+2 12V – EPA and –EPP

PROFET™+2 12V – EPA

Intelligent Restart Control for PROFET™+2 12V -EPA:

After short circuit the PROFET™+2 12V device tries 5 times to restart (w/o MC) if short circuit event is still in place, then the device waits two times for 70ms (retry cycle) before it latches off and needs to be reset by the MC.

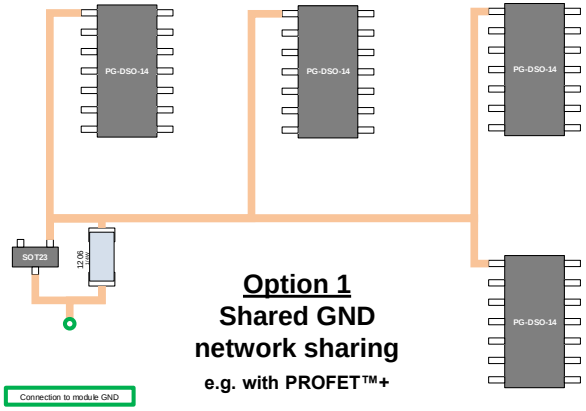


PROFET™+2 12V – EPP

Intelligent Latch for PROFET™+2 12V -EPP:

At normal condition, when IN is set to “high”, the channel is switched ON. In case of fault condition the output stage latches OFF and needs to be reset by the MC.

PROFET™+2 12V offers higher functional safety at lower system cost

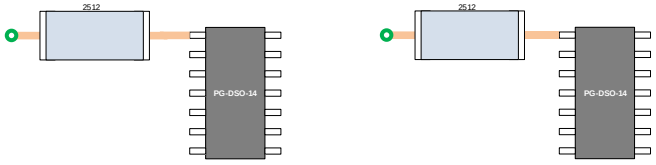


Option 1
Shared GND network sharing
e.g. with PROFET™+

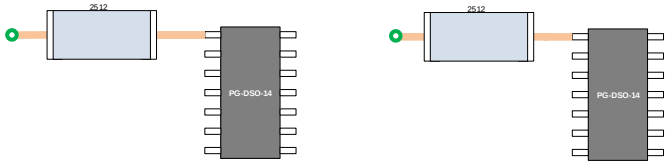
12%

cheaper system cost with 4 devices shared

How to build up a ground network with state of the art High-Side-switches



Option 2:
Individual GND network for added safety e.g. with PROFET™+

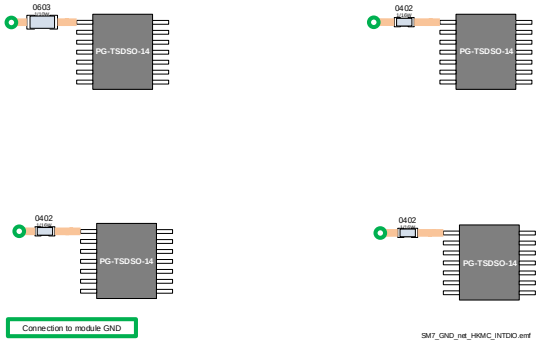


85%

cheaper system cost with 4 devices

PROFET™+2 12V

include Integrated ground diode for the whole PROFET™+2 12V portfolio
➔ Ground network needs no additional diode and requires only small resistor

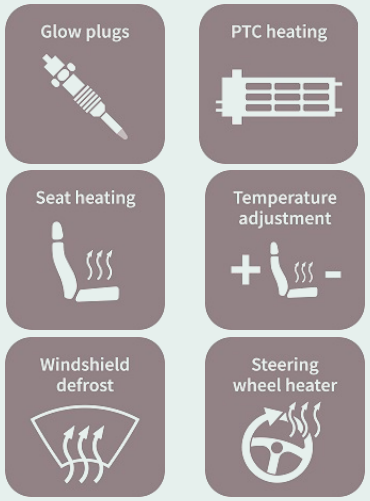
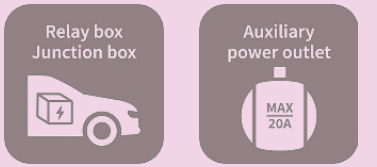
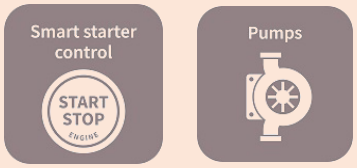


*All drawings to scale

PROFET™+2 12V - EPP

for Heating
Power Distribution,
High Energy

PROFET™+2 12V examples for high current applications (10-21A)

Heating		› Glow plug › PTC Heater › Seat heater (front, rear) › SCR › Steering wheel heater › Wiper heater › Rear defogger › Air scarf › Heating others..
Power Distribution		› Auxiliary power outlet › Switchable power feed › KL15 relay › Trailer node › BCM
High Energy Application		› Horn › Starter relay › Fuel pump (with external protection circuitry, e.g. freewheeling diode)

PROFET™+2 12V offers less power dissipation, a small package and cost optimization

Application example	PowerPROFET™ (High Energy Capability)	PROFET™+2 12V
PTC heater  Example I_{LOAD}= 17 A (DC)	BTS50055-1TMA *(TO-263, 5.5mΩ)*  DC Power losses at Ta= 85°C P(L) ~ **2.3 W** (typical)	**BTS7002-1EPP** *(TSDSO-14, 2mΩ)*  ΔP(L) ~-1.1 W DC Power losses at T_A = 85°C P(L)~ **1.2 W** (typical)
Glow plug  Example I_{LOAD} = 14 A (DC)	BTS50060-1TEA *(TO-252, 6.0mΩ)*  DC Power losses at Ta= 85°C P(L) ~ **2.3 W** (typical)	**BTS7004-1EPP** *(TSDSO-14, 4mΩ)*  ΔP(L) ~-0.9 W DC Power losses at T_A = 85°C P(L) ~ **1.4 W** (typical)

PROFET™+2 12V combines very low $R_{DS(ON)}$ with smallest footprint for reduced power losses on small PCB area

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What‘s new?

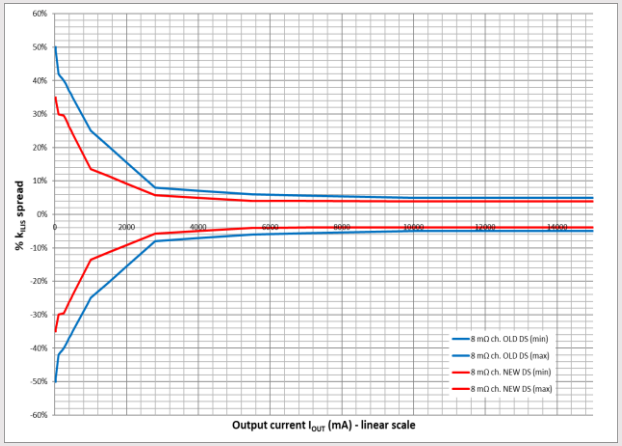
PROFET™+2 12V
Tighter k_{ILIS} specification

NEW: Tighter k_{ILIS} specification for PROFET™+2 12V

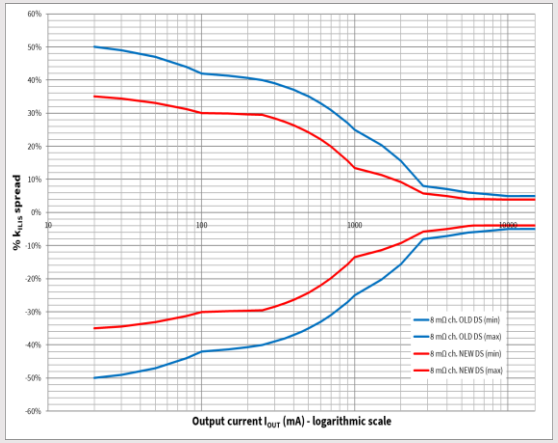
Portfolio with improved k_{ILIS}	Current	Single Channel	Current	Dual Channel
	10–11 A	BTS7008-1EPA	7–7.5 A	BTS7008-2EPA
	8–9 A	BTS7010-1EPA	6–6.5 A	BTS7010-2EPA
	8–9 A	BTS7012-1EPA	6–6.5 A	BTS7012-2EPA
			5–5.5 A	BTS7020-2EPA
			4–4.5 A	BTS7030-2EPA
	4–4.5 A	BTS7040-1EPA	3–3.5 A	BTS7040-2EPA
			3–3.5 A	BTS7080-2EPA
			2-2.5 A	BTS7120-2EPA
			1-1.5 A	BTS7200-2EPA BTS7200-2EPC
			1-1.5 A	BTS7200-4EPA

- ✓ **Tight k_{ILIS} accuracy** is needed **to fulfill OEM requirements** e.g. Open Load in ON detection.
- ✓ The updated k_{ILIS} performances **may enable the removal of calibration process** during End of Line testing at module / application manufacturer.
- ✓ k_{ILIS} accuracy can be found under chapter 9.6 in the PROFET+2 12Vdatasheets.

Example: Comparison of **old** k_{ILIS} tolerance vs. **new** k_{ILIS} tolerance for BTS7008-2EPA



Linear Scale



Logarithmic Scale (zoom in low current)

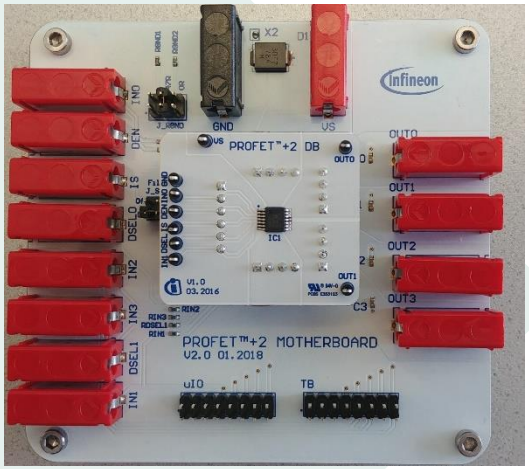
BTS7008-xEPA	OLD DS		NEW DS	
A	TYP	[%]	TYP	[%]
0.02	5500	50.0%	5400	35.0%
0.1	5500	42.0%	5400	30.0%
0.25	5500	40.0%	5400	29.5%
1	5500	25.0%	5400	13.5%
2.8	5500	8.0%	5400	5.8%
5.5	5500	6.0%	5400	4.0%
10	5500	5.0%	5400	3.9%

Collaterals, technical material and demoboards will support the design-in process

Collaterals and Videos	**Product Brief:** PROFET™+2 12V Product Brief
	Video: Feel the power of PROFET™+2 12V
	Video: PROFET™+2 12V – New High-Side switches for energy efficiency
Technical Material	**AppNote:** Thermal behaviour of PROFET™+2 12V in PG-TSDSO-14 package
	Data sheets: available for all products within the PROFET™+2 12V family e.g. BTS7008-2EPA Data Sheet
	PSPICE Model: avaialble for all products within the PROFET™+2 12V family e.g. BTS7008-2EPA orCAD Pspice Models
	PCB Design Data: available for all products within the PROFET™+2 12V family supported for Altium/Cadence/Eagle/Mentor
Evalboards	PROFET™+2 12V Evalboards + Arduino Shields available

PROFET™+2 12V evalboards

Target Application	› Body Acutation › Lighting
Use Cases	› To control and protect outputs or a 12V supply › For turning ON/OFF loads › To measure the load current
MyIFX Order Info	https://www.infineon.com/profet-plus2-moth-brd
	https://www.infineon.com/bts7008-1epa-daugh-brd https://www.infineon.com/bts7010-1epa-daugh-brd https://www.infineon.com/bts7012-1epa-daugh-brd https://www.infineon.com/bts7040-1epa-daugh-brd https://www.infineon.com/bts7008-2epa-daugh-brd https://www.infineon.com/bts7010-2epa-daugh-brd https://www.infineon.com/bts7012-2epa-daugh-brd https://www.infineon.com/bts7020-2epa-daugh-brd https://www.infineon.com/bts7030-2epa-daugh-brd https://www.infineon.com/bts7040-2epa-daugh-brd https://www.infineon.com/bts7080-2epa-daugh-brd https://www.infineon.com/bts7120-2epa-daugh-brd https://www.infineon.com/bts7200-2epa-daugh-brd https://www.infineon.com/bts7200-4epa-daugh-brd https://www.infineon.com/bts7200-2epc-daugh-brd

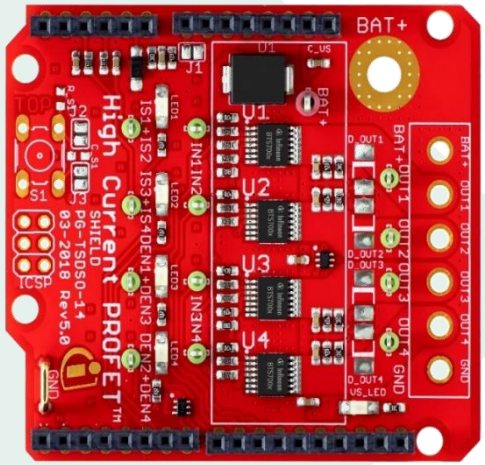


User Manual available at Infineon.com

PROFET™+2 12V Arduino Shield already available in ISaR

Target Application	› Heating › Power Distribution
Use Cases	› For demonstrating relay and fuse replacement › To control and protect outputs or a 12V supply › For turning ON/OFF loads › To measure the load current › To detect no-load condition
Board Set-up	Equipped with 4 High-Side switches: 1. 4x BTS7002-1EPP 2. 4x BTS7004-1EPP 3. 4x BTS7006-1EPP 4. 4x BTS7008-1EPP
MyIFX Order Info	See table below

Board-Name	SP-Number
https://www.infineon.com/shield_bts7002-1epp	SP005122308
https://www.infineon.com/shield_bts7004-1epp	SP005122316
https://www.infineon.com/shield_bts7006-1epp	SP005122324
https://www.infineon.com/shield_bts7008-1epp	SP005122328



User Manual available infineon.com

Agenda

1. General overview, features & benefits
2. PROFET™+2 12V portfolio
   - Collaterals and design-in support material
3. PROFET™+2 12V Grade0 for extended temperature and lifetime
4. SPOC™+2 portfolio
   - Collaterals and design-in support material

PROFET™+2 12V - flexibility & efficiency to drive loads with protection and diagnosis

Load current	Single Channel	Load current	Dual Channel
21A	BTS7002-1EPP		
15A	BTS7004-1EPP		
	BTS7004-1EPZ		
13A	BTS7006-1EPP		
	BTS7006-1EPZ		
10–11 A	BTS7008-1EPP		
10–11 A	BTS7008-1EPA	7–7.5 A	BTS7008-2EPA
	BTS7008-1EPZ		BTS7008-2EPZ
8–9 A	BTS7010-1EPA	6–6.5 A	BTS7010-2EPA
8–9 A	BTS7012-1EPA	6–6.5 A	BTS7012-2EPA
		5–5.5 A	BTS7020-2EPA
		4–4.5 A	BTS7030-2EPA
4–4.5 A	BTS7040-1EPA	3–3.5 A	BTS7040-2EPA
	BTS7040-1EPZ		
		3–3.5 A	BTS7080-2EPA
			BTS7080-2EPZ
		2-2.5 A	BTS7120-2EPA
		1-1.5 A	BTS7200-2EPA BTS7200-2EPC
		1-1.5 A	BTS7200-4EPA

Key applications: Heating and Power Distribution

- Nominal load currents up to 20A.
- Current trip with latch.
- Over temperature protection.
- ReverseON and inverse mode capability.
- Current sense diagnosis with failure signal up to I_{TRIP} level.
- Optimized turn-on and turn-off slew rates for high currents.

Key applications: Powertrain & “under the hood”

- Based on EPA or EPP variant.
- Same characteristic as the base variant.
- With extended junction temperature range up to 175°c.
- k_{ILIS} optimized for power distribution applications.

Key application: Lighting and Body

- Current trip with intelligent restart control.
- Low-mid currents (0,5-10A).
- Over temperature protection.
- Partially with ReverseON.
- Current sense diagnostics up to $2xI_{NOM}$.

The concept behind PROFET™+2 12V Grade 0

Concept	PROFET™+2 12V Grade 0 products offer an extended junction temperature range up to **175°C**

Grade Classification	Junction Operating Temperature Range	
	MIN	MAX
Grade 0	-40°C	175°C
Grade 1	-40°C	150°C

Customer Benefits

1. **Partitioning** at high ambient temperatures with **higher ohmic parts**
2. **Family concept** of **PROFET™+2 12V**
3. **Extended lifetime** at elevated temperatures
4. **Higher k_{ILIS}** enables the diagnostic of power distribution applications

PROFET™+2 12V Grade0 products offer an extended junction temperature range up to 175°C

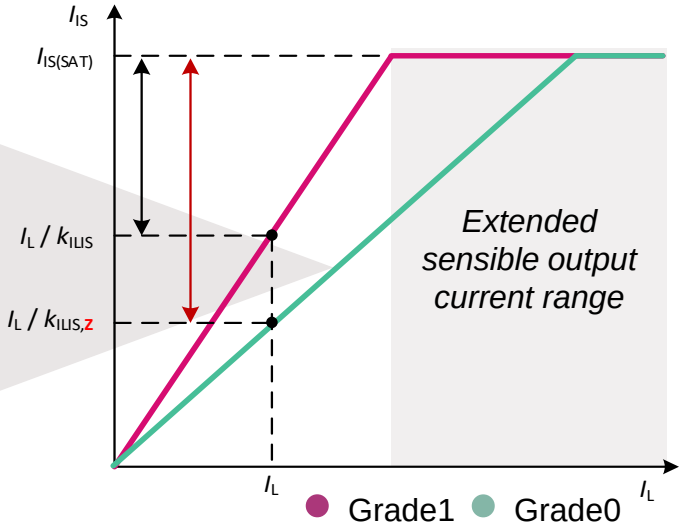
Why is a Grade0 development important?

Offering cost optimization:
Addressing loads with higher ohmic devices to support **relay replacement**

Addressing new applications:
Targeting **transmission ECUs** with high ambient temperature and **under the hood** modules

Grade0 Diagnosis concept

Diagnosis concept for Grade0 devices is tailored to address power distribution applications



Benefits

- Higher k_{ILIS} allows the sensing of an output current extended range
- Compared to the Grade1 part. circa 2x higher current can be sensed without hitting the SENSE saturation current

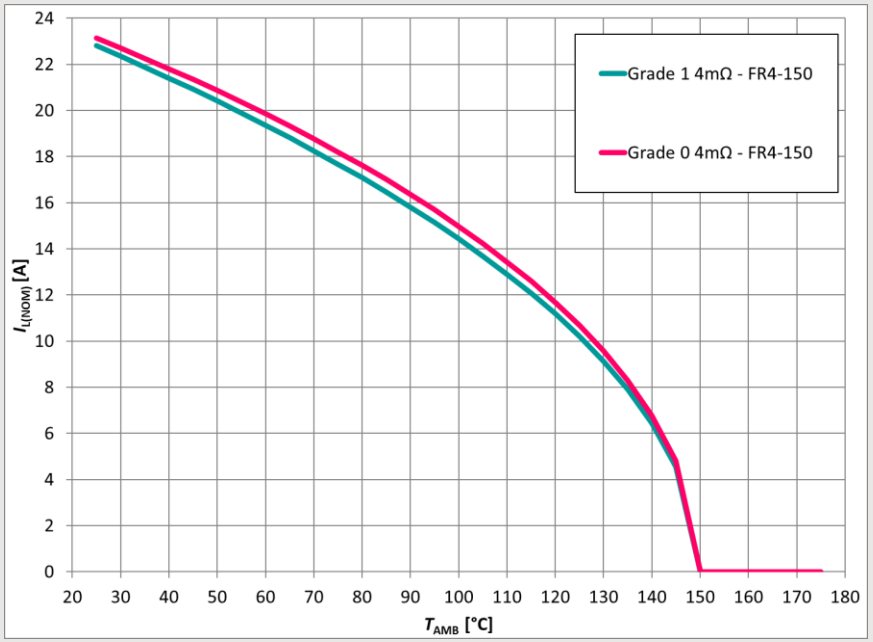
Thanks to the extended junction temperature Grade0 enables application at high ambient temperature

Standard Temperature Scenario:

FR4-150 PCB $T_{PCB,max}$ = 150°C

Grade 1
OT_{min} = 150°C

Grade0
OT_{min} = 175°C



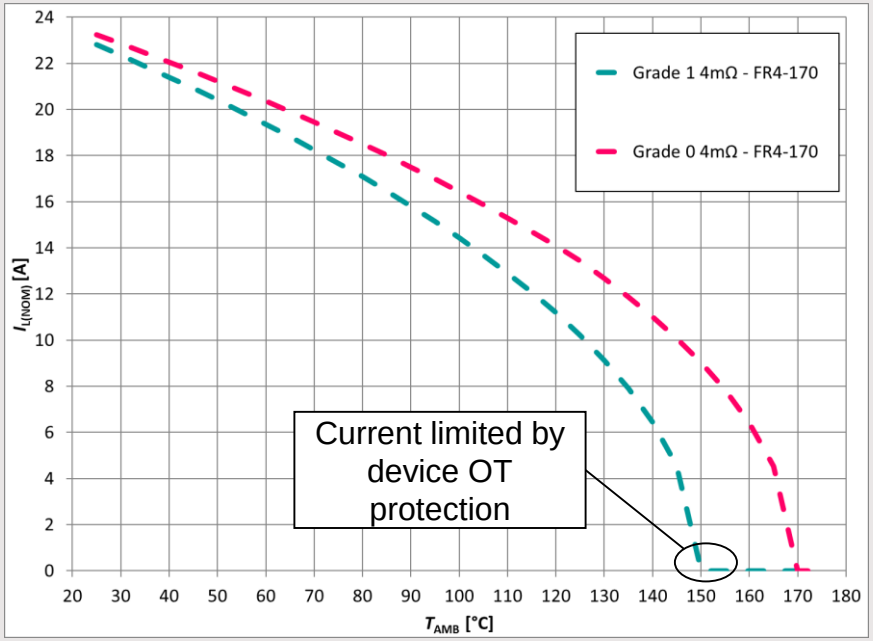
In the „standard“ temperature scenario the Grade 1 and Grade0 load current capabilities are both limited by the maximum T_{PCB}

High Temperature Scenario:

FR4-170 PCB $T_{PCB,max}$ = 170°C

Grade 1
OT_{min} = 150°C

Grade0
OT_{min} = 175°C



In the „high“ temperature scenario the Grade 1 load current capability is limited by its OT protection

Powertrain systems require Grade0 qualified switches due to increased ambient temperature

Electronic within the transmission system operates at T_A = ~ 150°C

- Grade 1 devices cannot be used if the ambient temperature is 150°C **due to its over temperature shutdown**
- Grade0 offers **PCB layout flexibility** due to temperature limitation of Grade 1 devices in PCB hot-spot areas
- Grade 1 devices may **not fulfill lifetime mission profiles**
- At high temperature **very low $R_{DS(ON)}$** needs to be used to compensate the low thermal Budget (ΔT)

The increased thermal budget enables partitionings with higher ohmic parts for under the hood modules

T_A under the hood is often defined @ T_A =105°C and the temperature within the T_{ECU} = ~120°C due to self heating

With a Grade0 device the maximum T_J is extended, therefore the thermal budget will increase:

FR4 PCB $T_{PCB,max}$ = 150°C

Grade 1: $\boldsymbol{T_{J,max}}$ **=** OT_{min} = 150°C
Grade0: $\boldsymbol{T_{J,max}}$ **=** OT_{min} = 175°C

$$T_J - T_{PCB,max} = \underbrace{P_D * R_{thJC}}$$

Δ_T = Thermal Budget

The increased thermal budget enables higher ohmic parts in these applications

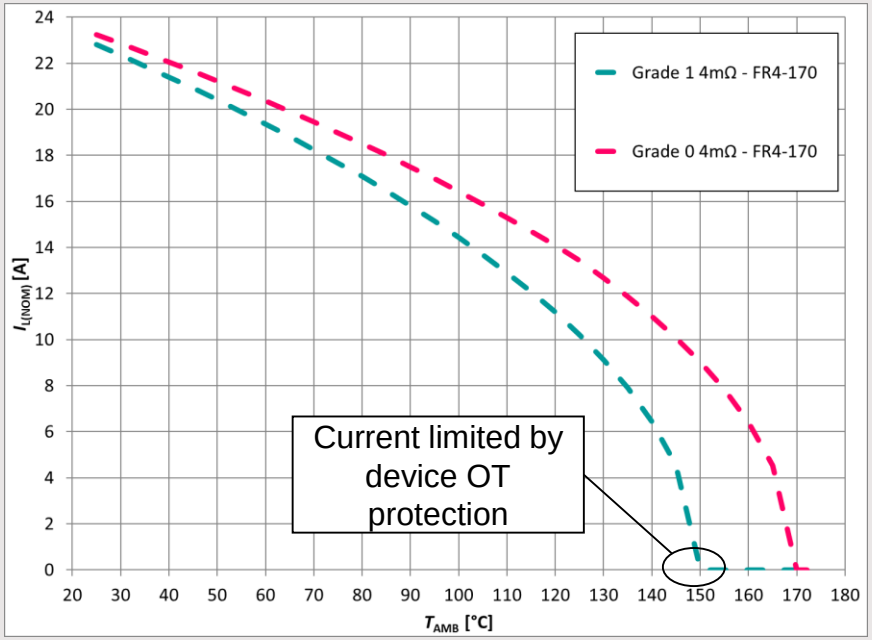
Grade0 enables higher ohmic parts at high ambient temperatures

High Temperature Scenario:

FR4-170 PCB $T_{PCB,max}$ = 170°C

Grade 1
OT_{min} = 150°C

Grade0
OT_{min} = 175°C



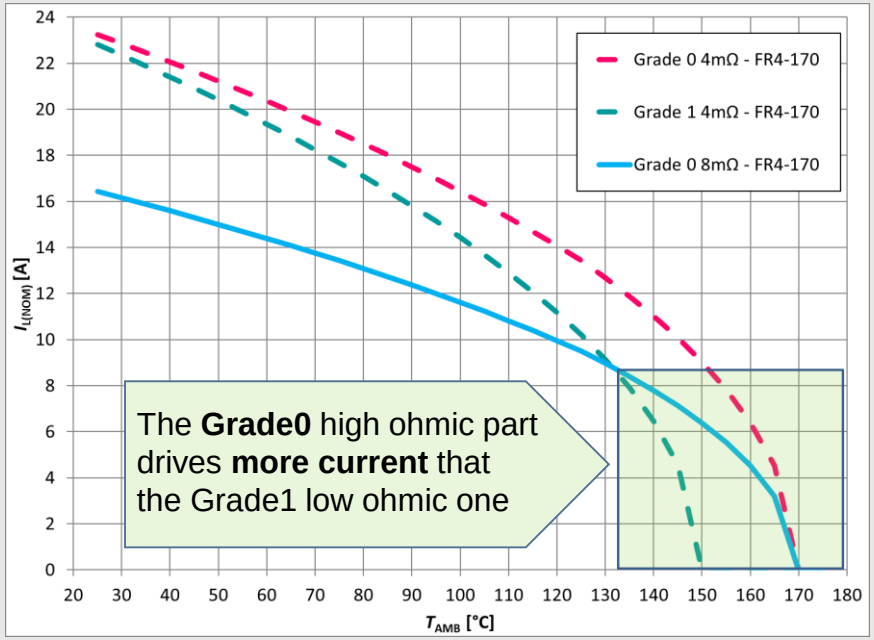
In the „high“ temperature scenario the Grade 1 load current capability is limited by its OT protection

High Temperature Scenario:

FR4-170 PCB $T_{PCB,max}$ = 170°C

Grade 1
OT_{min} = 150°C

Grade0
OT_{min} = 175°C



Thanks to the extended thermal budget Grade0 devices are conducting higher current at higher PCB temperature

PROFET™+2 12V Grade 0 portfolio consists of six different devices

Product	$R_{DS(ON)}$ typ @ 25°C	$R_{DS(ON)}$ max @ 175°C	Target Load Current*	Protection and Diagnosis
BTS7004-1EPZ	1 x 4.4mΩ	1 x 8.8mΩ	15A	**Intelligent Latch** Same as BTS7004-1EPP k_{ILIS}: 20000
BTS7006-1EPZ	1 x 6.6mΩ	1 x 13mΩ	13A	**Intelligent Latch** Same as BTS7006-1EPP k_{ILIS}: 17700
BTS7008-1EPZ	1 x 9mΩ	1 x 18mΩ	10A	**Intelligent Restart Control** k_{ILIS}: 9500 *(BTS7008-1EPA → k_{ILIS} : 5500)*
BTS7008-2EPZ	2 x 9mΩ	2 x 18mΩ	8A	**Intelligent Restart Control** k_{ILIS}: 9500 *(BTS7008-2EPA → k_{ILIS} : 5500)*
BTS7040-1EPZ	1 x 19mΩ	1 x 39mΩ	5A	**Intelligent Restart Control** k_{ILIS}: 3000 *(BTS7040-1EPA → k_{ILIS} : 1800)*
BTS7080-2EPZ	2 x 20.9mΩ	2 x 43mΩ	3A	**Intelligent Restart Control** k_{ILIS}: 3000 *(BTS7080-2EPA → k_{ILIS} : 1800)*

› *Nominal Current T_A = 85°C and T_J < 150°C

Overview of additional requirements for qualification tests of AEC-Q100 Grade0 classified devices

		Additional Requirements	Grade 1	Grade0
Ambient Operating Temperature Range			-40°C to +125°C	-40°C to +150°C
Stress Test	**TC**	PC before TC for surface mount devices.	AEC-Q100: -55°C to +150°C for 1000 cycles	**AEC-Q100:** -55ºC to +150ºC for 2000 cycles
				Infineon: -55°C to +150°C for 3000 cycles
	HTOL	For devices containing NVM, endurance preconditioning must be performed before HTOL per Q100-005.	AEC-Q100: +125°C Ta for 1000 hours	**AEC-Q100:** +150°C Ta for 1000 hours
				Infineon: +150°C Ta for 2000 hours

Grade 1 qualifications do not always fulfill all lifetime requirements reflected in today's mission profiles

*Internal estimation

OEM	GM
Application	Powertrain
Platform	Transmission „T96“
Mission Profile*	

Ambient Temperature T_a [°C]	Self-heating DT_S [°C]	Junction Temperature T_j [°C]	Operating hours [%]	Operating hours [h]
125	25	**150**	1880	25%
100	25	125	3730	50%
50	25	75	1880	25%
SUM			7490	

Translation of the mission profile into AEC-Q100 stress test:

Stress Test	Qualification required	
TC	Assumption: 2 cold starts per day for 15 years, Coffin Manson = 4 **Grade1**: 1780 cycles	Assumption: 2 cold starts per day for 15 years, Coffin Manson = 4 **Grade0**: 1780 cycles
HTOL	**Grade1**: 3027 hours	**Grade0**: 1038 hours

Additional qualification of PROFET™+2 12V Grade0 can fulfill the extended mission profile

Stress Test	Additional Requirements	Grade 1	Grade0
TC	PC before TC for surface mount devices.	**AEC-Q100**: -55°C to +150°C for 1000 cycles	**AEC-Q100**: -55ºC to +150ºC for 2000 cycles **Infineon**: -55°C to +150°C for 3000 cycles
HTOL	For devices containing NVM, endurance preconditioning must be performed before HTOL per Q100-005.	**AEC-Q100**: +125°C Ta for 1000 hours	**AEC-Q100**: +150°C Ta for 1000 hours **Infineon**: +150°C Ta for 2000 hours

Stress Test	Qualification required		IFX Grade 1 portfolio	IFX Grade0 portfolio
TC	Assumption: 2 cold starts per day for 15 years, Coffin Manson = 4 **Grade1**: 1780 cycles	Assumption: 2 cold starts per day for 15 years, Coffin Manson = 4 **Grade0**: 1780 cycles	X	✓
HTOL	**Grade1**: 3027 hours	**Grade0**: 1038 hours	X	✓

Samples of PROFET™+2 12V Grade0 ready to order

	EES	ES	QS	Productive
BTS7008-1EPZ	Available	Available	Available	Mar.20
BTS7040-1EPZ	Available	Available	Available	Mar.20
BTS7080-2EPZ	Available	Available	Available	Apr.20
BTS7004-1EPZ	Available	Available	Jan.20	Jul.20
BTS7006-1EPZ	Available	Available	Mar.20	Sept.20
BTS7008-2EPZ	Available	Available	Jan.20	Jul.20

Demoboards will be available in Dec‘19

PROFET™+2 12V Grade 0 are a perfect fit for Powertrain and Under the hood applications

PROFET™+2 12V family approach	High design flexibility on reduced PCB area with low power losses and high accuracy
Partitioning at high ambient temperatures with **higher ohmic parts**	Thanks to the **extended thermal budget** Grade 0 devices are conducting **higher current at higher PCB temperature**
Extended lifetime at elevated temperatures	Thanks to **additional qualification** PROFET™+2 12V Grade 0 can fulfill the extended mission profile
Diagnosis concept tailored to address power distribution applications thanks to **high k_{ILIS}**	**Best fit for PD applications:** Possibility to distinguish between the nominal and the fault current

Benefit

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3. PROFET™+2 12V Grade0 for extended temperature and lifetime
4. SPOC™+2 portfolio
   - Collaterals and design-in support material

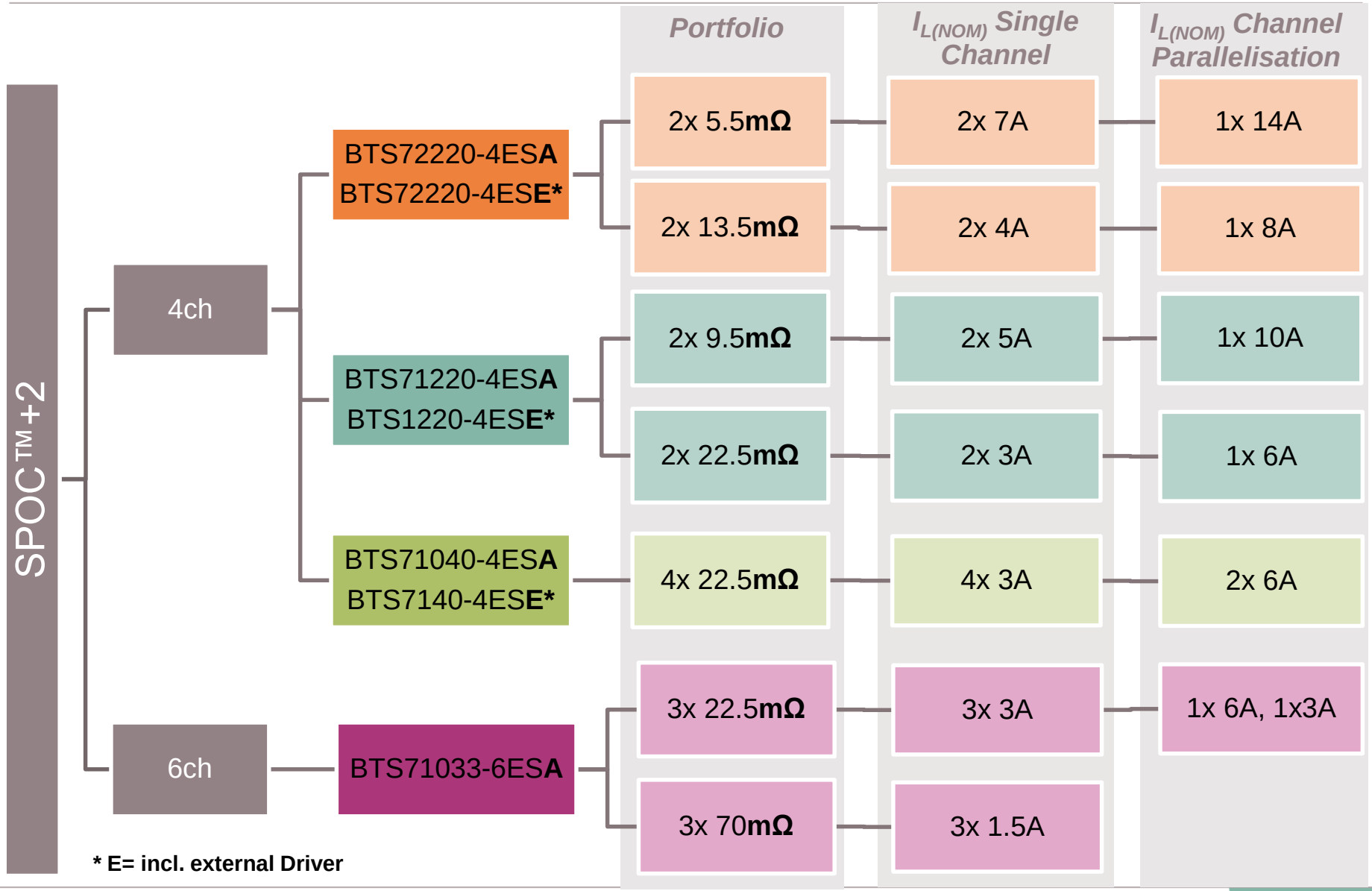
Proven solution in the automotive market, SPOC™ already convinced more than 20 OEMS!

Worldwide leader for SPI Smart Power Switches

>450 Mio units SPOC™ sold

>100 Mio units/anno from 2019 onwards

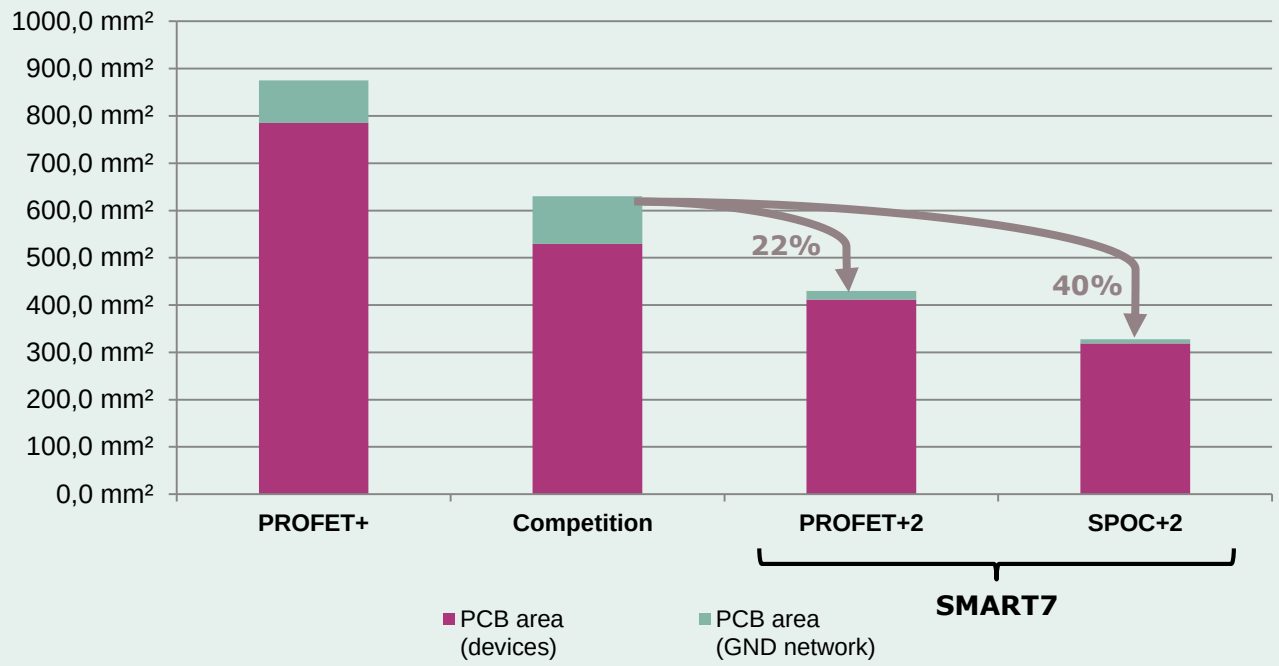
SPOC+2 Portfolio Overview



*** E= incl. external Driver**

By choosing SPOC™+2 PCB area can be saved

Standard Reference Partioning:

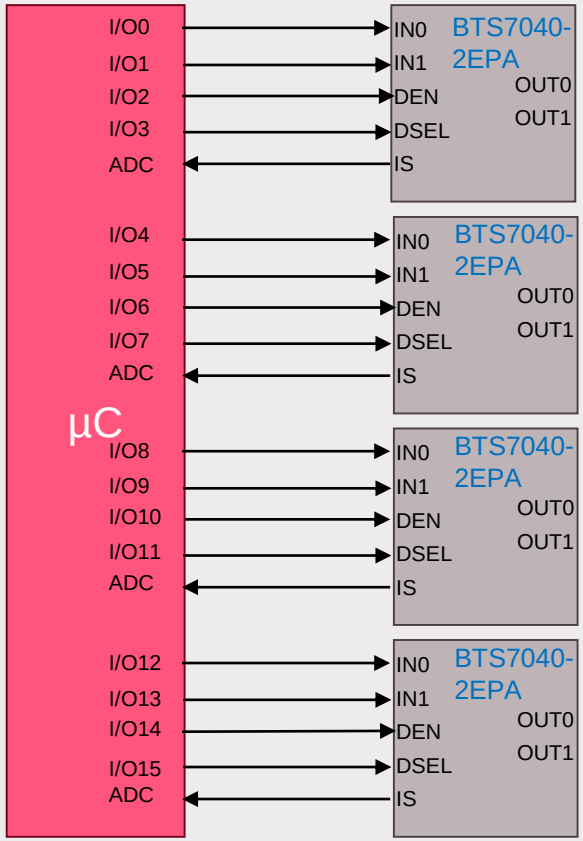


Thanks to SPI and the multichannel integration 40% PCB area can be saved compared to competition:

- ✓ Less traces on PCB, due to SPI
- ✓ Less external components, due to multichannel integration

Save ICUs by effective µC management and optimize PCB layout with SPOC™+2 in Daisy Chain Application

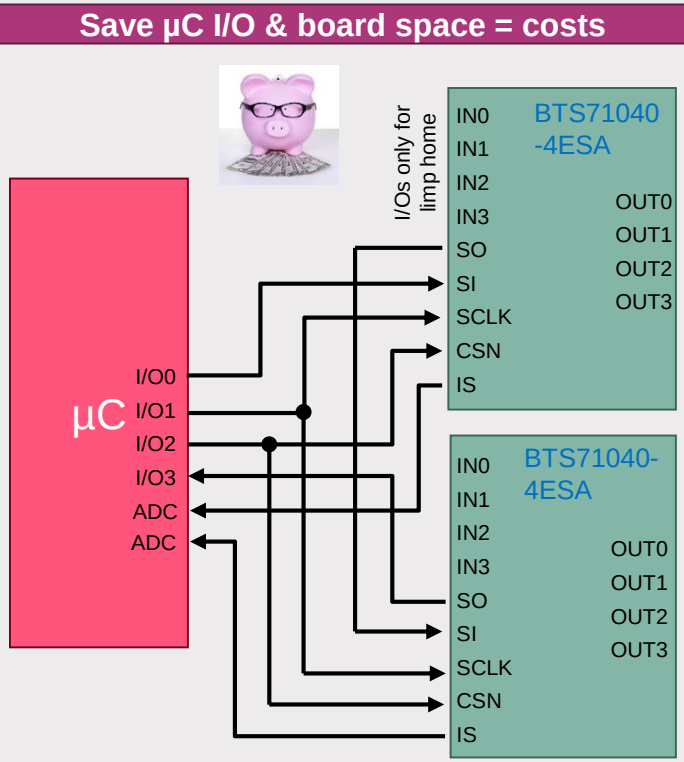
Discrete Solution w/o multiplexing



16 GPIOs: 8 channel control +
8 diagnostic enable/select + 4 ADC-pins

SPOC™+2 Solution

Save µC I/O & board space = costs

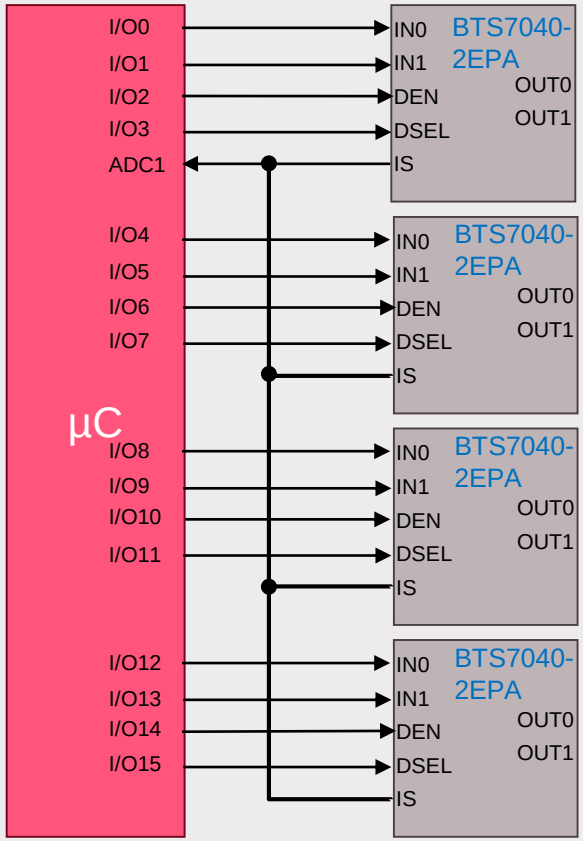


in daisy chain application

SPOC™+2 solution
4 GPIOs for SPI and 2 ADC-pin

Save ICUs by effective µC management and optimize PCB layout with SPOC™+2 in Daisy Chain Application

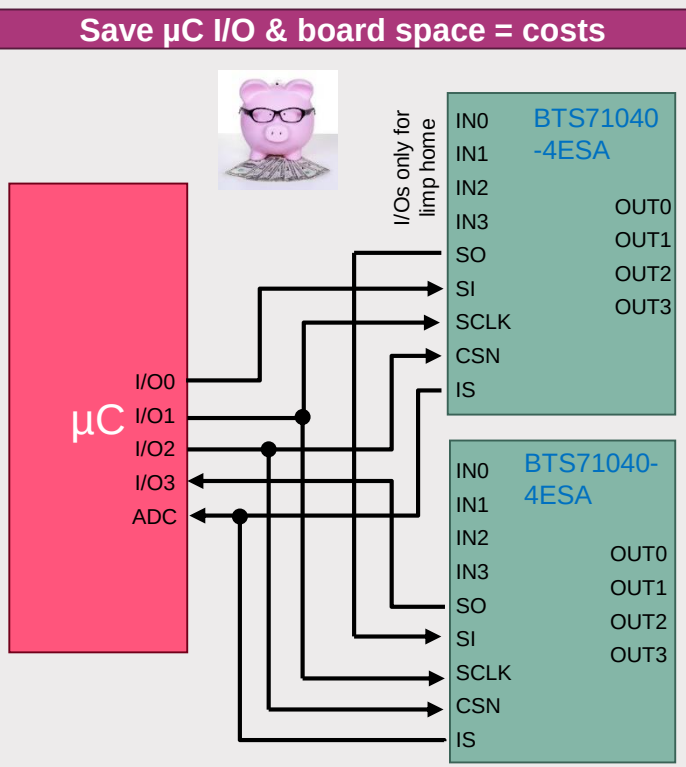
Discrete Solution with multiplexing



16 GPIOs: 8 channel control +
8 diagnostic enable/select + 1 ADC-pins

SPOC™+2 Solution

Save µC I/O & board space = costs

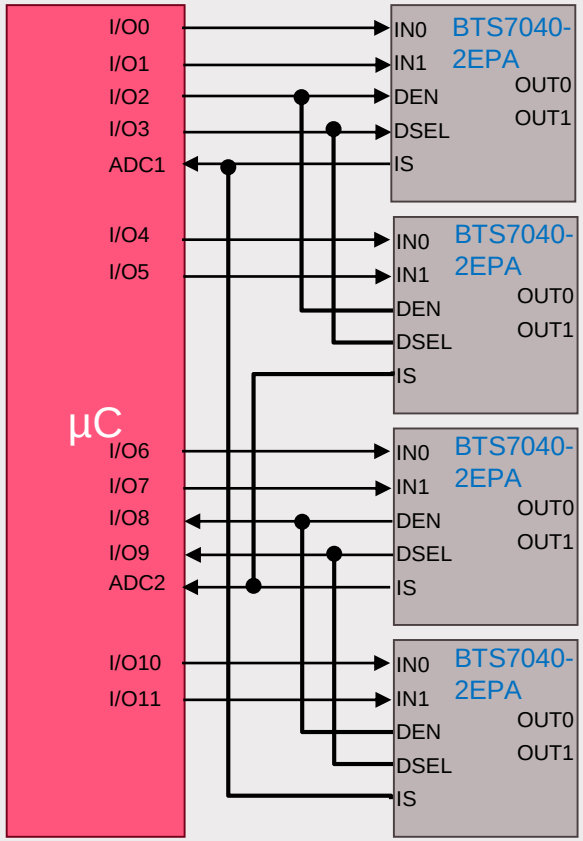


in daisy chain application

SPOC™+2 solution
4 GPIOs for SPI and 1 ADC-pin

Save ICUs by effective µC management and optimize PCB layout with SPOC™+2 in Daisy Chain Application

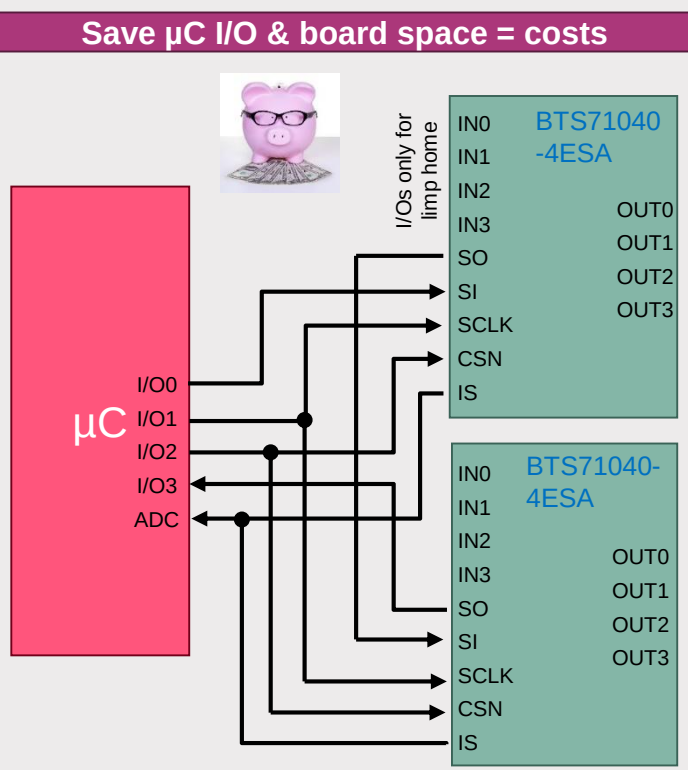
Discrete Solution with multiplexing DEN / DSEL shared



12 GPIOs: 8 channel control +
4 diagnostic enable/select + 2 ADC-pins

SPOC™+2 Solution

Save µC I/O & board space = costs



in daisy chain application

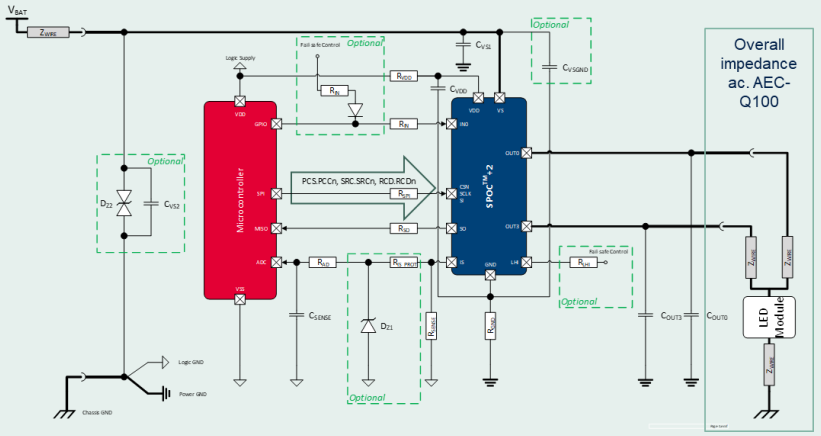
SPOC™+2 solution
4 GPIOs for SPI and 1 ADC-pin

SPOC™+2 advanced functions support the future trend of intelligent power distribution!

	PROFET™+2 12V [0A–20A]	SPOC™+2 [0.5A–15A]
Diagnosis	› Overload detection › Open load detection	› **Digital Diagnosis feedback over SPI** › Overload detection › Open load detection
Protection	› Overload protection › Thermal shutdown › Over voltage protection incl. load-dump › Under voltage shutdown › Loss of ground and loss of battery (VS) protection › Reverse battery protection ReverseON	› **Configurable restart or latch protection** › **Configurable Overload threshold** › Overload protection › Thermal shutdown › Over voltage protection incl. load-dump › Under voltage shutdown › Loss of ground and loss of battery (VS) protection › Reverse battery protection ReverseON
Advanced Features	› Open load (ON/OFF) & short to VS detection	› Input and limp-home status monitoring with automatic diagnose (via SPI) › Current sense verification mode to µC/ADC › Configuration register checksum verification → saves SW efforts on µC › Transmission error via standard diagnose with SPI 1.8V › VS monitoring (cranking at 3.1V) › Sense verification mode › SPI configuration of k_{ILIS} range, › Slew rate reduces EMC/emission to allow switching of higher capacitive loads › PWM optimization with SPI (PWMoverSPI) › Channel parallelization to optimize partitioning › Control of external smart power switches (in E-version) → savings from GPIOs (connect logic pins to SPOC™ instead of µC) › Open load (ON/OFF) & short to VS detection

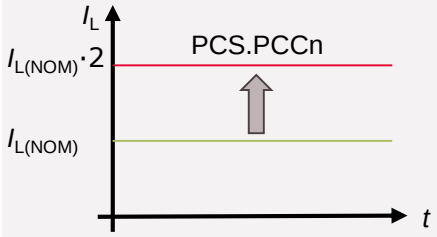
Advanced functions from SPOC™+2 do support the future trend into intelligent power distribution!

- SPOC™+2 offers **high flexibility** with **configurable features** to support the trend of **intelligent power distribution**

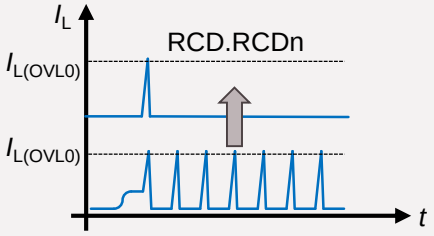


Switching modules is now supported thanks to the following features

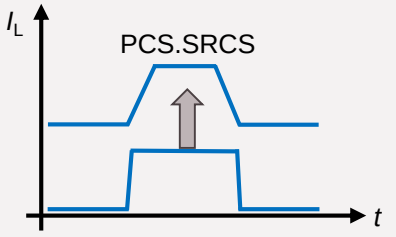
Parallel Channel Configuration



Restart Strategy for Channel n



Slew Rate control for Channel n

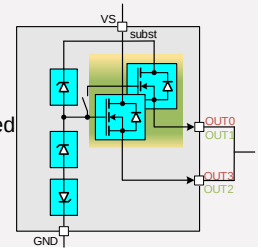


Lower power dissipation → $R_{DS(ON)}/2$

- OUT0//OUT3
- OUT1//OUT2

→ $R_{DS(ON)}$ reduced

→ Lower power dissipation



Enhanced diagnosis supporting ISO26262: SPOC™+2 checks the entire path from µC to load and back

INST
Verifies the path from uC to the INx pin

LHI
Verifies if Limp Home input work properly

1

TER
Indicates transmission error and lower Vs

SPI Checks um
Identify unintended changes or content of configuration registers

2

Current Sense Verification
Verifies the path from IS pin to uC-GPIO

3

VSMON
Verifies if V_S is lower than $V_{S(UV)}$

4

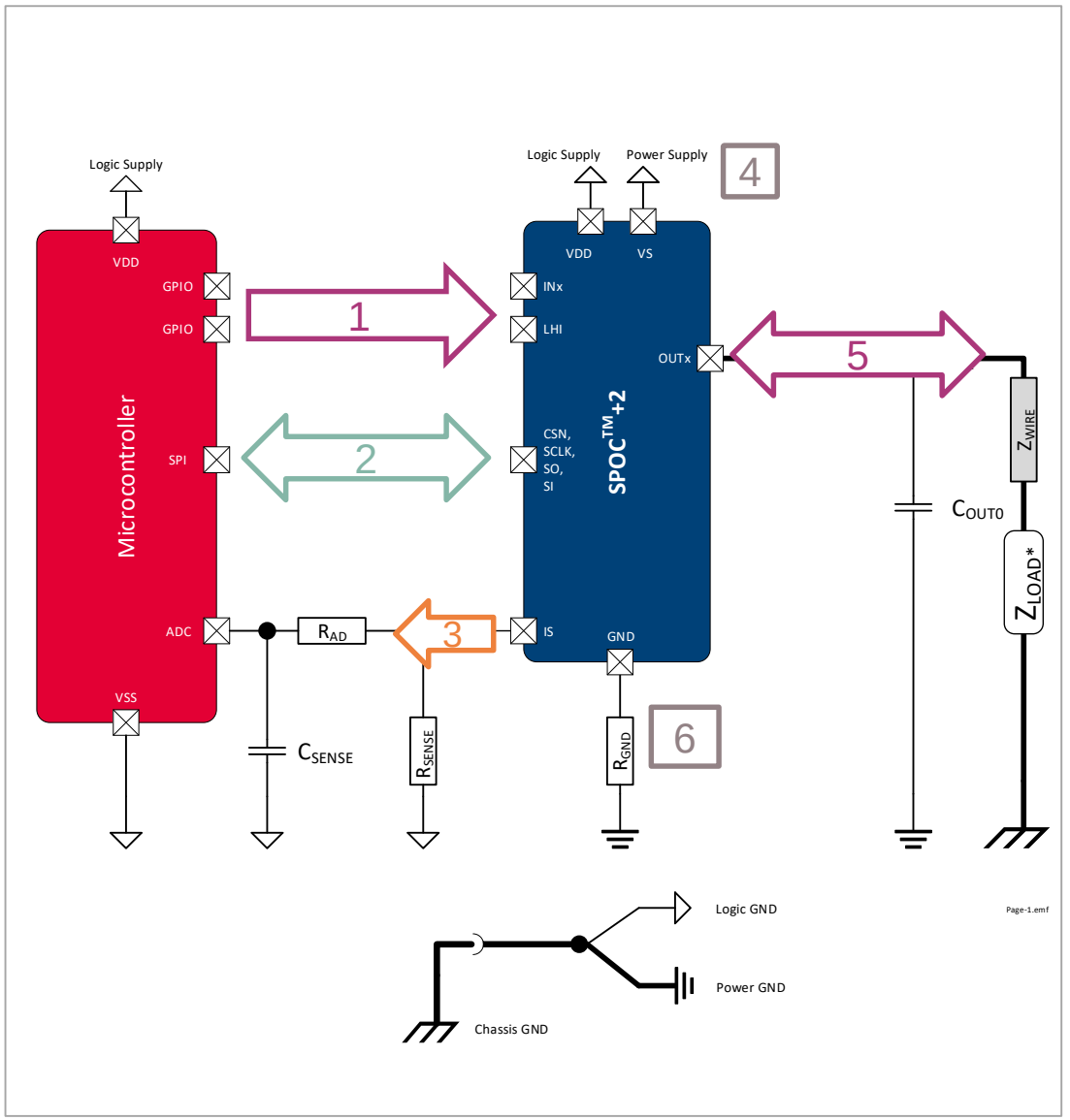
Switch Bypass Monitor
Indicates:
- SC from V_S to OUT
- OL@OFF (with resistor)

Open Load
Indicates OL@ON by current sense

5

Loss of GND
DMOS will be turned OFF or remained OFF when loss of ground

6



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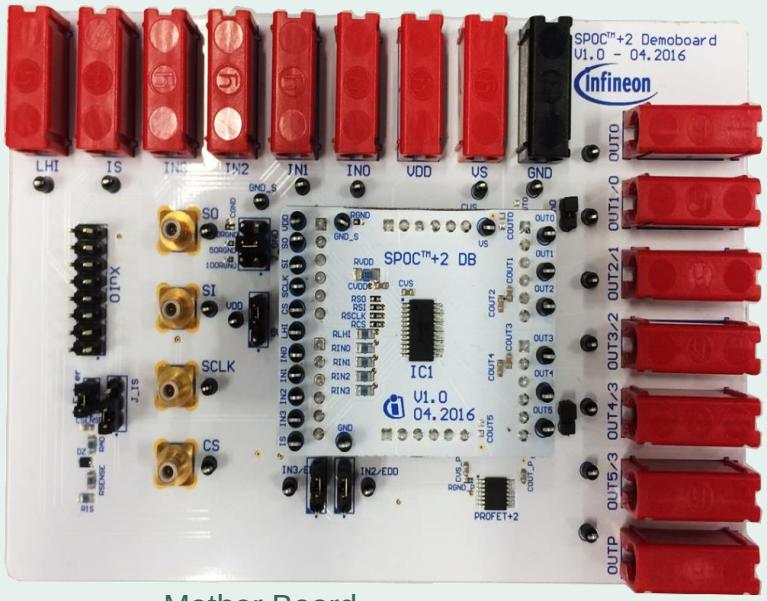
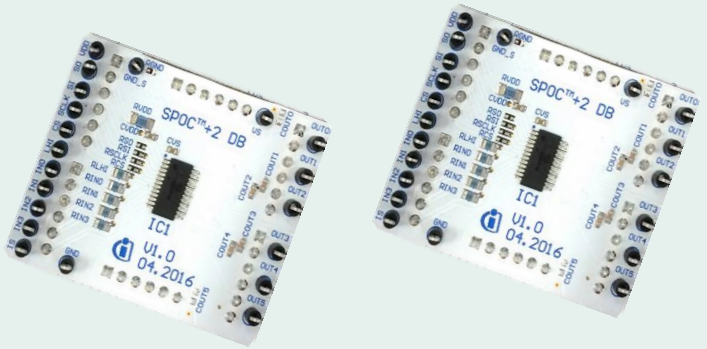
   - Collaterals and design-in support material

Complete SPOC™+2 evaluation kit available: Mother Board and Daughter Boards

- The MB is designed to handle all devices within the SPOC™+2 family
- 4 or 6-channel SPOC™+2 devices can be plugged onto the MB using the DBs
- It is suitable for evaluation of resistive, capacitive and/or inductive loads



Mother Board



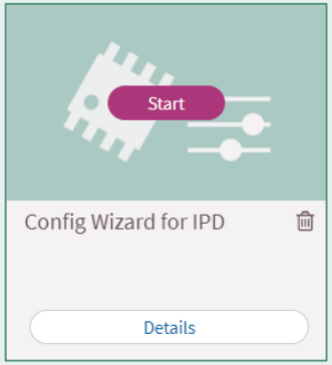
Daughter Boards

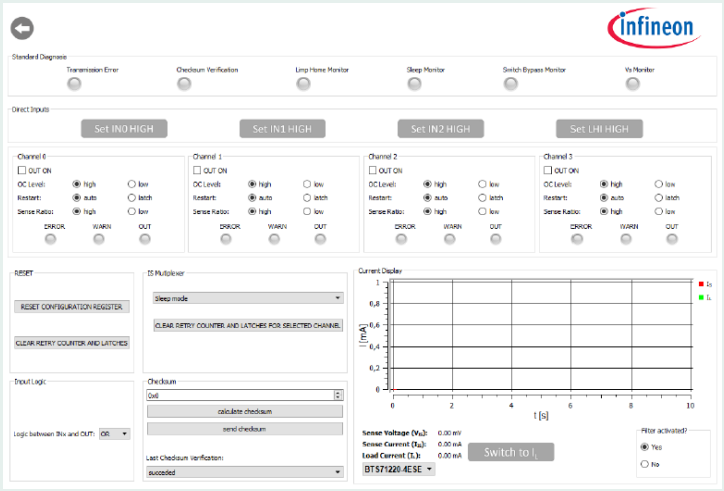
SPOC™+2 Mother and Daughter Boards can be ordered here

Config Wizard for IPD is designed to configure SPOC™+2 demoboard easily

- The SPOC™+2 MB can be used with the *Config Wizard for IPD* to control it via SPI
- The access to the software is the Infineon Toolbox, which can be downloaded here
- uIO-Stick is needed to connect the *Config Wizard*

uIO-Stick for SPI





GPIO-Control View from Config Wizard for IPD

uIO-Stick can be ordered here

Part of your life. Part of tomorrow.