



ALPHA & OMEGA
SEMICONDUCTOR

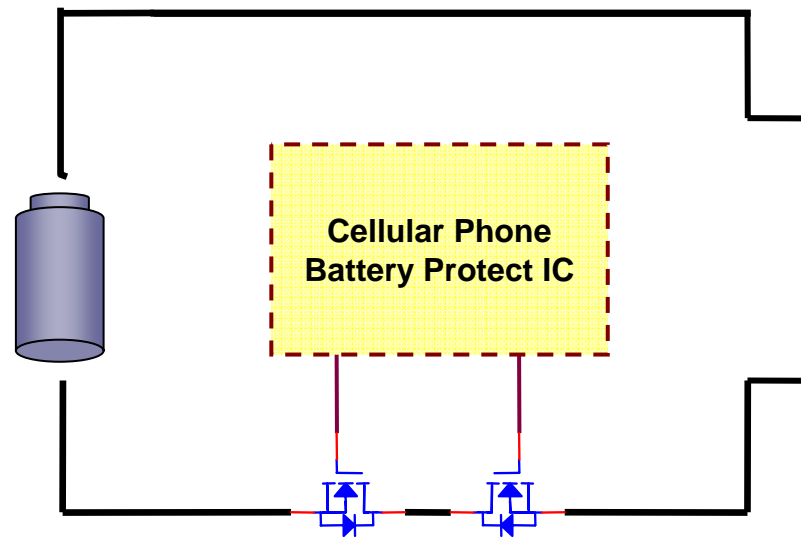
AOS MOSFET PCM Solution

Application Structure



SPIRIT OF NO. 1

- I_D under 2A
- OCP = 4A to 8A
- Total resistance $120m\Omega$ to $150m\Omega$
- Reverse voltage protection option
- Support 2-Cell series
- ESD



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PCM solution



SPIRIT OF NO. 1

- **TSSOP 8 serial**
- **DFN 2x5 serial**
- **DFN 3x3 serial (Future product to beat ECH8 series)**
- **CSP (WLP / Chip Scale Package)**
- **One-chip serial**

TSSOP-8 solution



SPIRIT OF NO. 1

Battery	Control IC	MOSFET Competitor	AOS Part
One Cell	S8211 S8241 S8261 R5426	uPA1870	AO8814
		uPA1872	AO8804
		NTDQ6986	AO8806
		FDW2501	AO8814
		FDW2503	AO8820
		TPC8204	AO8814
		TPC8212	AO8806
Two Cell	S8232 S8242 S8253	FDW2601	AO8818
		Si6876EBDQ	AO8818

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DFN 2x5 solution



SPIRIT OF NO. 1

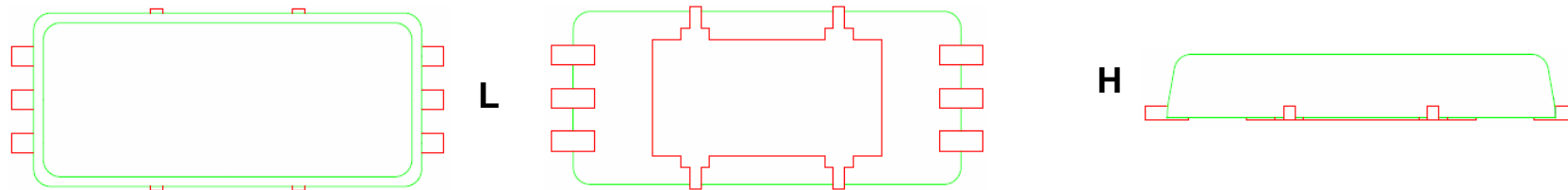
Battery	Control IC	MOSFET Competitor	AOS Part
One Cell	S8211 S8241 S8261 R5426	SiF902EDZ	AON5810 AON5812
		uPA2450B	AON5810 AON5812
		uPA2451B	AON5810 AON5812
Two Cell	S8232 S8242 S8253	SiF912EDZ	AON5812
		uPA2451B	AON5812
		uPA2452B	AON5812
		FDM2452	AON5812

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DFN2x5 new package (Future Product)



SPIRIT OF NO. 1



W

L

H

TOP View

Bottom View

Side View

Dimension:

L=2mm / W=5mm / H=0.75mm

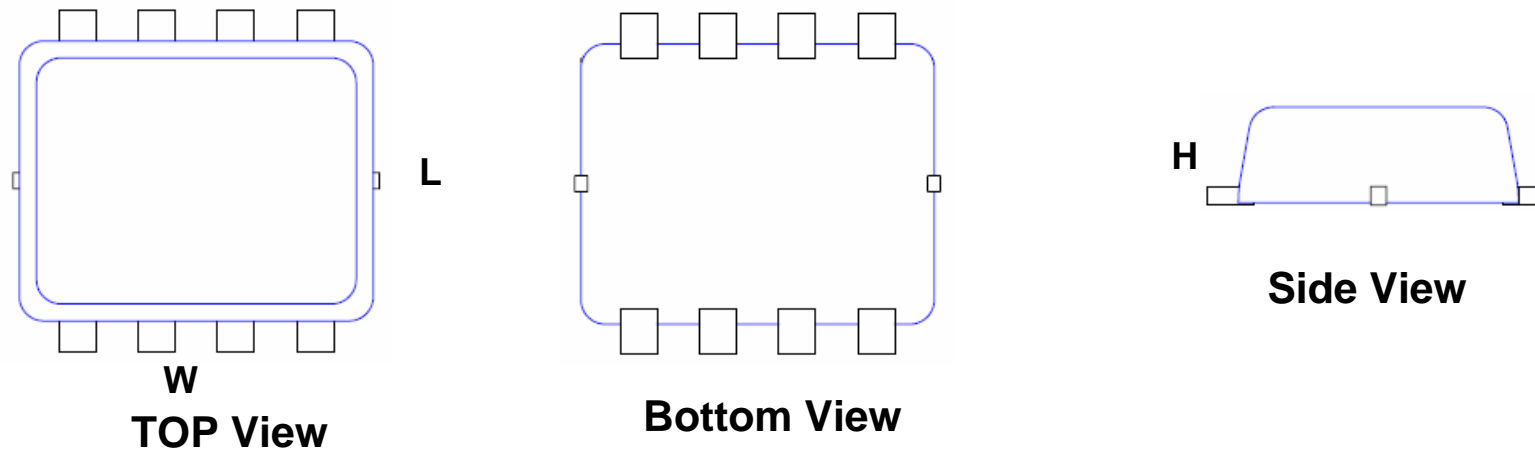
Battery	Control IC	AOS Part
One Cell	S8211 S8241	AON5810
Two Cell	S8261 R5426	AON5812

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DFN3x3 Solution (Future Product)



SPIRIT OF NO. 1



Dimension:

L=2.9mm / W=2.8mm / H=0.8mm

Battery	Control IC	MOSFET Competitor	AOS Part
One Cell	S8211 S8241 S8261 R5426	ECH8601 ECH8601-R	AON3806 AON3814
		TPCP8202	AON3806

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CSP type (Wafer Sell)



SPIRIT OF NO. 1

- Provide the die by 8” wafer
- Offering die sort service
- Offer following wafer spec
- Advantage
 - Reduce Cost: without package cost
 - Reduce layout space
 - Provide reverse voltage protection for two Cell – AO23802 (30V VDS)

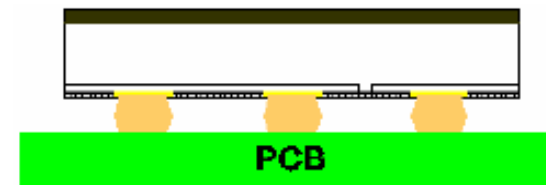
Part number	Description	VDS	VGS (+/-)	Rds(on)/max				VGS(th) MAX	Ciss / pF	Qg / nC
				10V	4.5V	2.5V	1.8V			
AO23800	Dual-N CD with ESD	20	12	16	20	27		0.8	1330	13.1
AO23802	Dual-N CD with ESD	30	12	17	20	30		1.5	890	10.7
AO23804	Dual-N CD with ESD	30	12	17	20	30		1.5		

CSP Solution



SPIRIT OF NO. 1

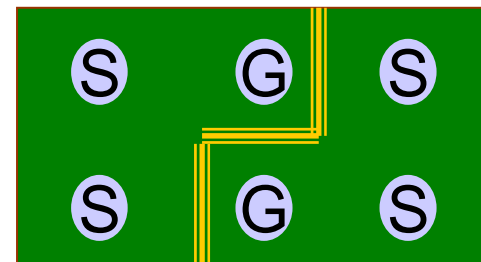
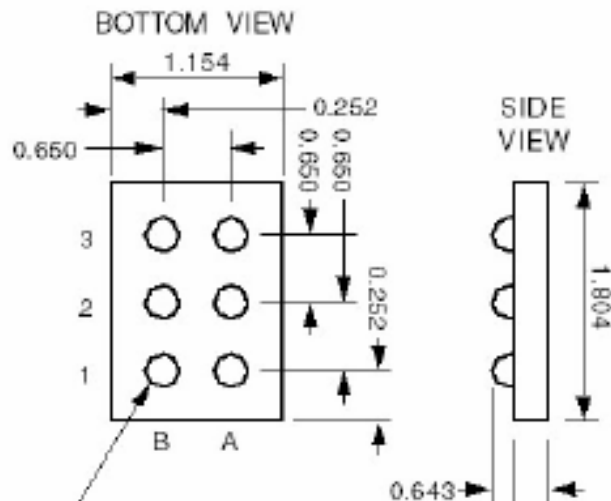
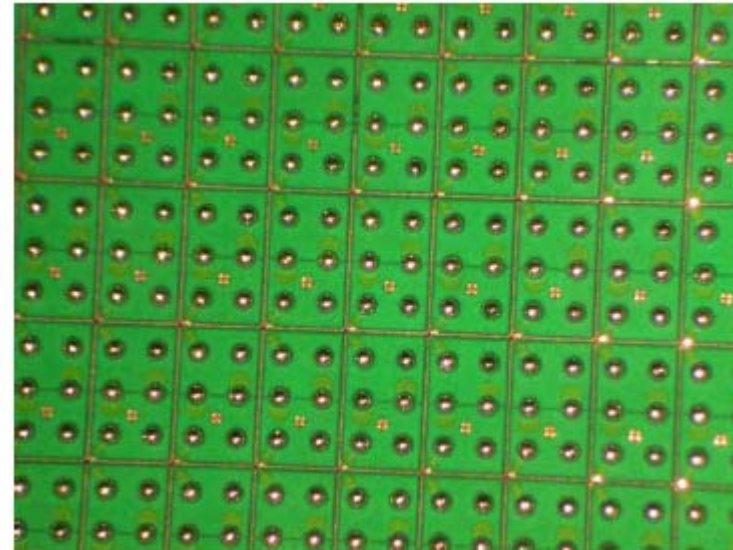
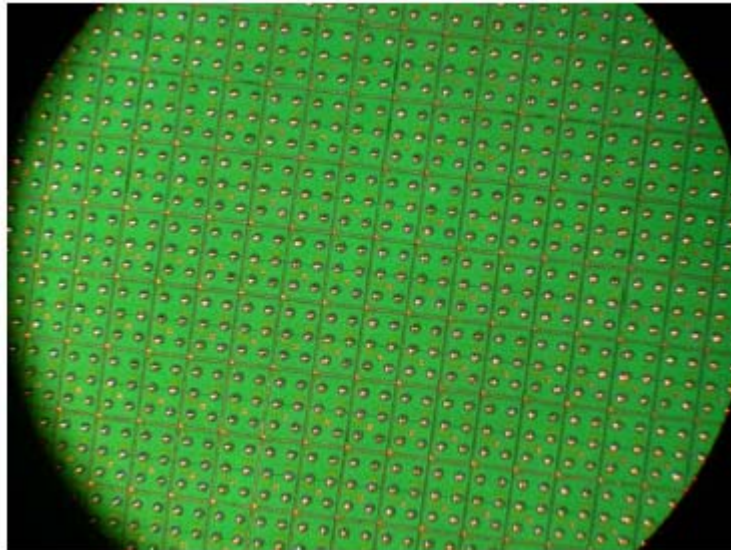
- Golden ball connection.
- Without wire bonding, save production cost
- Small size (1.5mm X 2.5mm 6pin) and (1.6mm X 1.6mm 4pin)
- Without molding
- SMT type, easy to mount.



CSP Solution



SPIRIT OF NO. 1



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AOZ9004B Features/Benefits



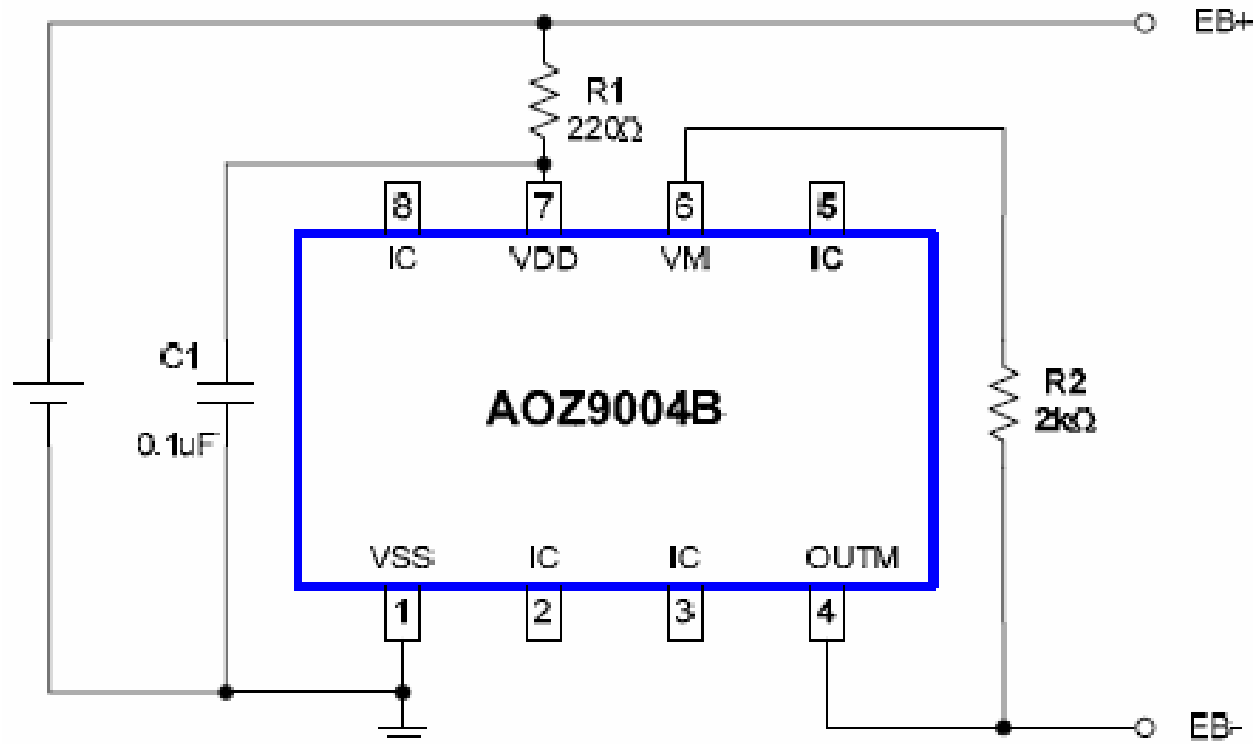
SPIRIT OF NO. 1

- AOZ9004 is a single IC combining one dual N Channel MOSFET (AOS AON5802 series MOSFET) and one Battery Protect IC (Seiko S8211 series) for PCM application.
- Advantage
 - Reduce layout space
 - AOZ9004B build 1 protect IC and 1 dual N Channel MOSFET on single TSSOP-8 package.
 - **Saves 1 SOT23-5 or SOT23-6 or SON6 package space.**
 - Reduce total cost
 - Combination solution only need 1 MOSFET wafer, 1 Protect IC and 1 TSSOP-8 package cost.
 - **Saves Battery Protect IC package cost.**

AOZ9004B Diagram



SPIRIT OF NO. 1

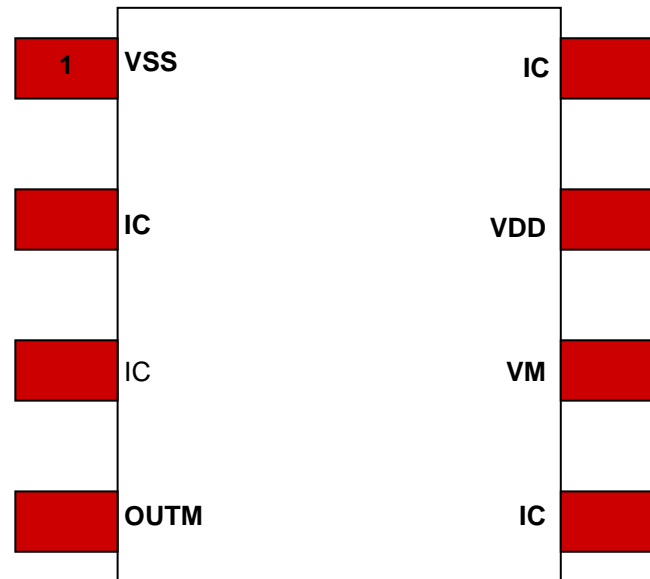


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AOZ9004B Pin Definition



SPIRIT OF NO. 1



AOZ9004B Series Option Specification Summary



SPIRIT OF NO. 1

Part Number	Overcharge Detection Voltage (V_{cu})	Overcharge Release Voltage (V_{cr})	Over-discharge Detection Voltage (V_{dl})	Over-discharge Release Voltage (V_{dro})	Discharge Over-current Threshold (I_{dio})	Charge Over-current Threshold (I_{cio})	0 V Battery Charge Function	Shutdown Function
AOZ9004BI	4.250V	4.05V	2.6V	2.9V	2.5A	N/A	No	No
AOZ9004BI-01	4.275V	4.175V	2.3V	2.4V	2A	2A	Yes	Yes
AOZ9004BI-02	4.325V	4.075V	2.5V	2.9V	3A	2A	No	Yes
AOZ9004BI-03	4.280V	4.130V	2.8V	3.1V	2A	2A	Yes	Yes
AOZ9004BI-04	4.275V	4.075V	2.3V	2.3V	3A	2A	Yes	Yes

Delay Time Combination	Overcharge Detection Delay Time t_{cu}	Over-discharge Detection Delay Time t_{dl}	Discharge Over-current Detection Delay Time t_{dio}	Charge Over-current Detection Delay Time t_{cio}	Load Short-circuiting Detection Delay Time t_{short}
1	1.2s	150ms	9ms	9ms	560 μ s
2 ⁽²⁾	1.2s	150ms	9ms	9ms	300 μ s
3	142ms	38ms	18ms	9ms	300 μ s
4	1.2s	150ms	18ms	9ms	300 μ s
5 ⁽³⁾	1.2s	38ms	9ms	9ms	300 μ s

Delay Time	Symbol	Selection Range		
Overcharge detection delay time	t_{cu}	143 ms	573 ms	1.2 s
Over-discharge detection delay time	t_{dl}	38 ms	150 ms	300 ms
Discharge over-current detection delay time	t_{dio}	4.5 ms	9 ms	18 ms
Charge over-current detection delay time	t_{cio}	4.5 ms	9 ms	18 ms
Load short-circuiting detection delay time	t_{short}	-	300μs	560 μ s

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MOSFET Option Specification Summary



SPIRIT OF NO. 1

- Offer following wafer spec

–AOSN511

- $V_{DS}=20V$, $V_{GS}=12V$, ESD=2.5KV

- $R_{DS(ON)}=19m@V_{GS}=4.5V$ / $R_{DS(ON)}=26m@V_{GS}=2.5V$

–AOSN651

- $V_{DS}=30V$, $V_{GS}=12V$, ESD=2.5KV

- $R_{DS(ON)}=19m@V_{GS}=4.5V$ / $R_{DS(ON)}=26m@V_{GS}=2.5V$

Advantage of AOZ9004D



SPIRIT OF NO. 1

For small package, we also has DFN2x5 package solution AOZ9004D. Suitable for PCB width small than 3mm application.

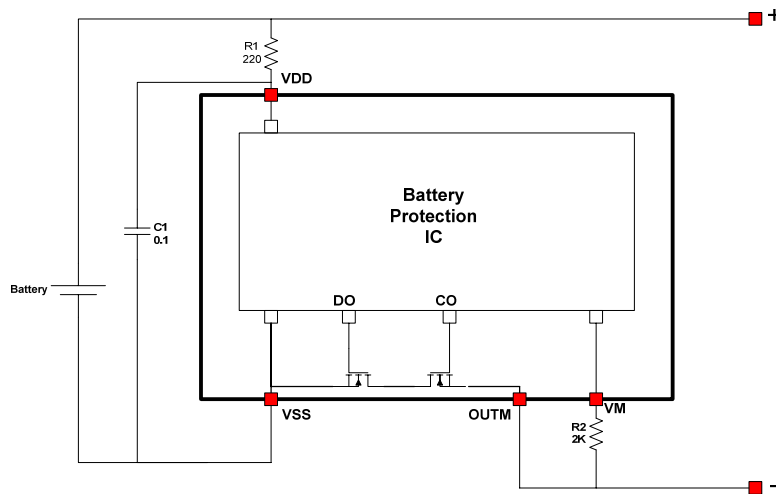
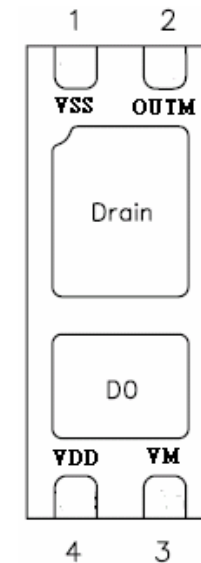


Diagram of AOZ9004D



2x5 DFN Pin-out

AOZ9004B vs AOZ9004D



SPIRIT OF NO. 1

Product	$R_{DS}(typ/max)$	Voltage (MOSFET V_{DS})	Package
AOZ9004B	40m Ω /48m Ω	30V	TSSOP-8
<i>AOZ9004D</i>	<i>48mΩ/60mΩ</i>	<i>30V</i>	<i>2x5 DFN</i>
<i>AOZ9005D</i>	<i>40mΩ/48mΩ</i>	<i>25V</i>	<i>2x5 DFN</i>

Battery Protect Product Roadmap



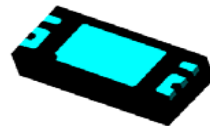
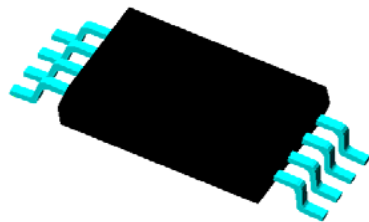
SPIRIT OF NO. 1

Mar 2006

Aug 2006

TSSOP-8

2x5 DFN



19.84 mm²

10 mm²

*~50% reduction in size
compared to TSSOP-8*

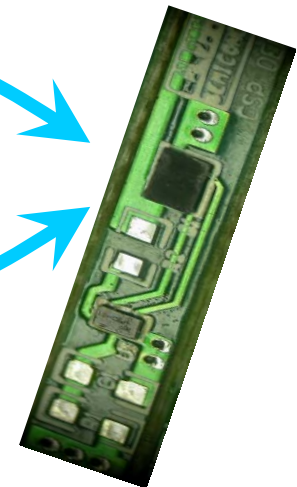
*Wafer Level
Chip Scale¹*

*Flip-Chip on
Board*

PCM IC



PCM MOSFET



AOS Offers Complete Solutions.....

1) Wafer bumping available by customer request

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Direction Item



SPIRIT OF NO. 1

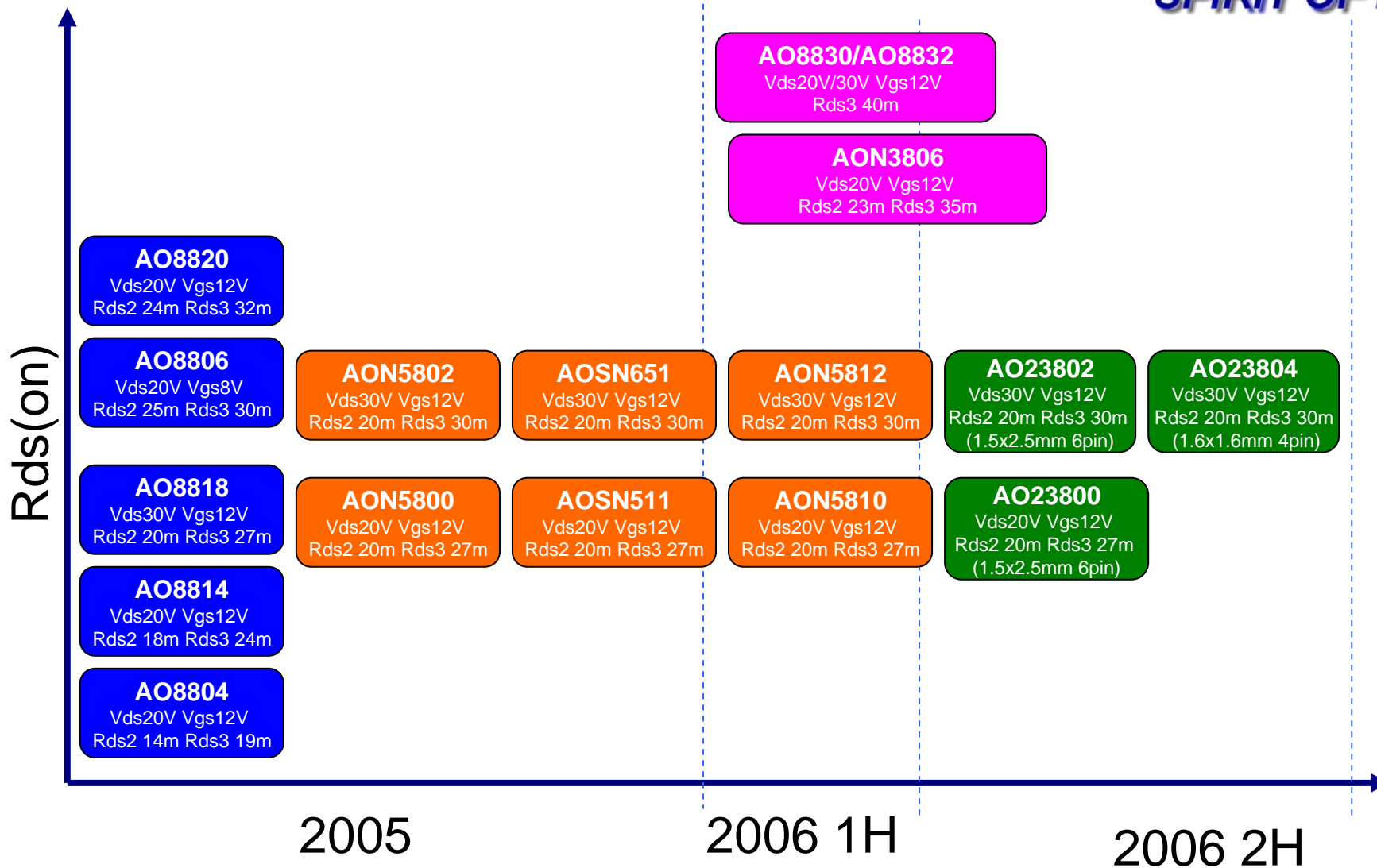
Package	Competitor solution	Topology	AOS Solution 1 (Direction Item)	AOS Solution 2 (High Performance)	AOS Solution 3 (Low cost)
TSSOP-8 Dual-P	FDW2504 FDW2506 FDW2508	Battery Protection	AO8803		AO8801
TSSOP-8 Dual-N	uPA1872 uPA1870 TPCS8204 TPCS8212 FDW2503NZ NTDQ6968		AO8814	AO8804	AO8820 (AO8822)
TSSOP-8 Dual-N + IC			AOZ9004B		
DFN3x3	ECH8601		AON3806		
DFN2x5	uPA2450 uPA2451 uPA2452 FDM2452		AON5800 AON5802		

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New product Road-Map



SPIRIT OF NO. 1



Parameter Cross Reference



SPIRIT OF NO. 1

AOS Solution	Topology	Part number	Description	VDS	VGS (+/-)	IDS	PD	Rds(on)/max				VGS(th) Max	Ciss / pF	Qg / nC
						25°C	25°C	10 V	4.5 V	2.5 V	1.8 V			
TSSOP-8														
Direction Item	One Cell	AO8814	Dual-N CD with ESD	20	12	7.5	1.5	16	18	24	34	1	1390	15.4
High Performance		AO8804	Dual-N CD with ESD	20	12	8	1.5	13	14	19	27	1	1810	17.9
Low Cost		AO8820	Dual-N CD with ESD	20	12	7	1.5	21	24	32	50	1	800	12
Direction Item	Two Cell	AO8818	Dual-N CD with ESD	30	12	7	1.5	18	20	27		1.5	1060	14
DFN2x5														
Direction Item	One Cell	AON5800	Dual-N CD with ESD	20	12	8	1.6	16	20	27	45	0.8	1330	13.1
Direction Item	Two Cell	AON5802	Dual-N CD with ESD	30	12	8	1.7	17	20	30		1.5	869	107
DFN3x3														
Direction Item	One Cell	AON3806	Dual-N CD with ESD	20	12	6			23	35				
CSP														
Direction Item	One Cell	AO23800	Dual-N CD with ESD	20	12	8	1.6	16	20	27	45	0.8	1330	13.1
Direction Item	Two Cell	AO23802	Dual-N CD with ESD	30	12	8	1.7	17	20	30		1.5	869	107

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SPIRIT OF NO. 1

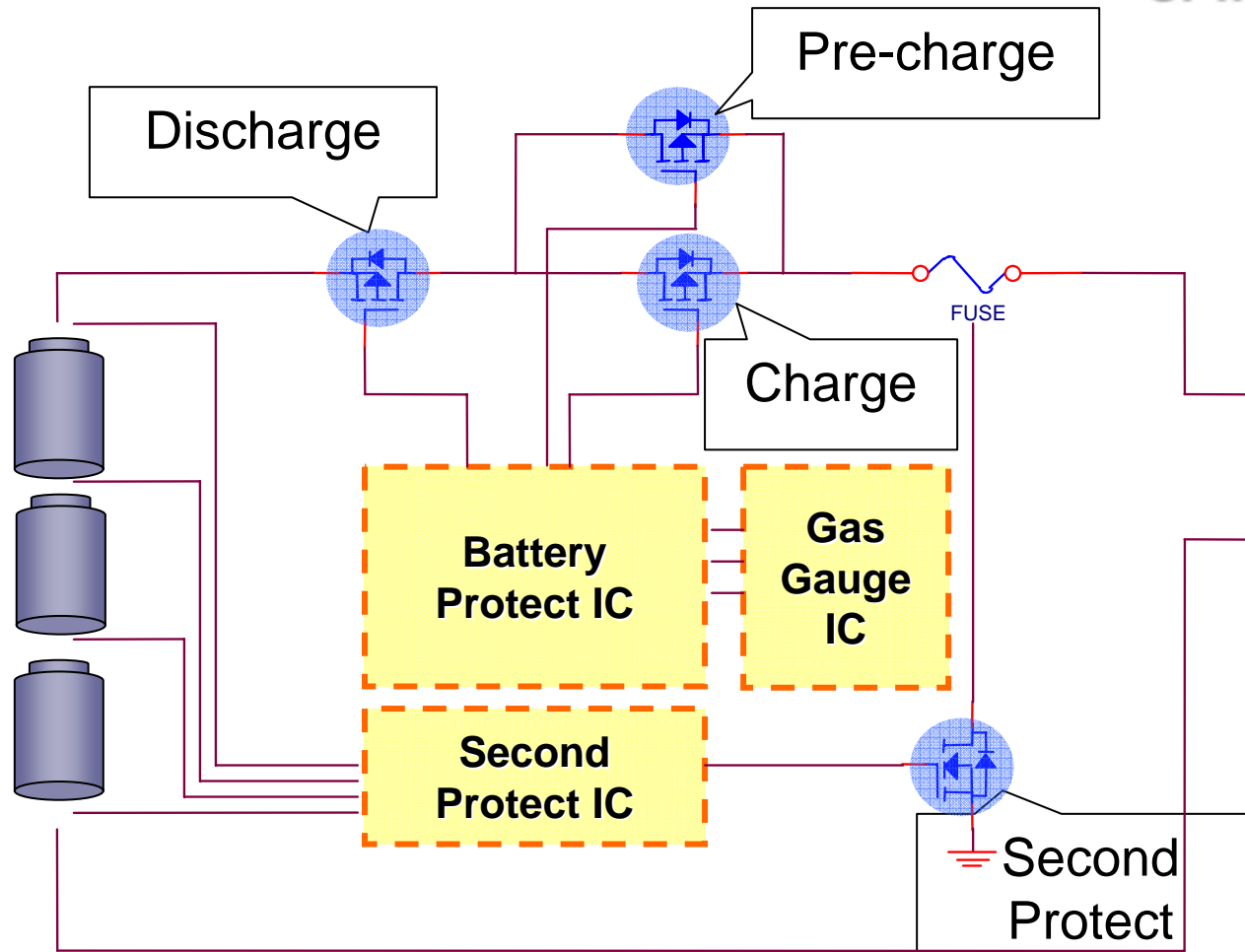
AOS MOSFET NB Battery Pack Solution

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Application Structure



SPIRIT OF NO. 1



Application requirement



SPIRIT OF NO. 1

● Discharge/Charge

- $V_{BAT} = 12.6V$ to $16.8V$ (3S or 4S)
- $V_{GS} \geq 20V$, $V_{DS} \geq 30V$
- $I_D \geq 4A$
- OCP = 40A to 60A
- $R_{DS@10V}$ under $15m\Omega$
- ESD
- Reverse voltage protection option

● Pre-charge

- $V_{GS} \geq 20V$, $V_{DS} \geq 30V$
- $I_D \geq 200mA$
- $V_{GS(th)} \geq 1.5V$

● Second protect

- $V_{GS} \geq 20V$, $V_{DS} \geq 30V$
- $I_D \geq 500mA$

Reason to win



SPIRIT OF NO. 1

- **Discharge/Charge**
 - **AO4429**
 - SO-8 package, Single-P
 - Low voltage drop
 - For discharge Current under 8A application
 - Beat main competitor TPC8107
 - **AO4447 (Future Product)**
 - Sample release : 5E/2006
 - SO-8 package, Single-P
 - $V_{DS} = 35V, V_{GS} = 25V, R_{DS@10V} = 7m\Omega$
 - Low voltage drop
 - For discharge Current under 8A application
 - For Reverse voltage protection
 - Beat main competitor TPC8107

Reason to win



SPIRIT OF NO. 1

- **Discharge/Charge**

- **AOL1407 (Future Product)**

- Ultra SO-8 package, Single-P
 - Good thermal resistance and $R_{DS(ON)}$
 - Higher current rating
 - For Reverse voltage protection
 - Beat main competitor TPC8107
 - For space limit or huge power (80W above) battery pack – AOL1403

- **AO4460 (Future Product)**

- Sample release : 2M/2006
 - SO-8 package, Single-N
 - $V_{DS} = 30V$, $V_{GS} = 20V$, $R_{DS@10V} = 7.5m\Omega$
 - The cost of N-channel is lower than P-channel MOSFET
 - TI has new protect IC using N-Channel MOSFET for some Japan customer
 - Beat main competitor TPC8017- H

Reason to win



SPIRIT OF NO. 1

- **Pre-Charge**

- **AO3421**

- SOT-23 package, Single-P
 - $I_D \leq 200\text{mA}$
 - $V_{GS(th)} \geq 1.5\text{V}$
 - Beat main competitor 2SJ204

- **AO4419**

- SO-8 package, Single-P
 - $V_{GS} = 20\text{V}$ (For $V_{GS} = 25\text{V}$ requirement – AO4415)
 - $R_{DS@10V} = 35\text{m}\Omega$
 - $V_{GS(th)} \geq 1.5\text{V}$

- **2nd-Protection**

- **AO3406**

- SOT-23 package, Single-N
 - $V_{GS} = 20\text{V}$
 - $I_D \leq 500\text{mA}$
 - Beat main competitor NDS351

Direction Item



SPIRIT OF NO. 1

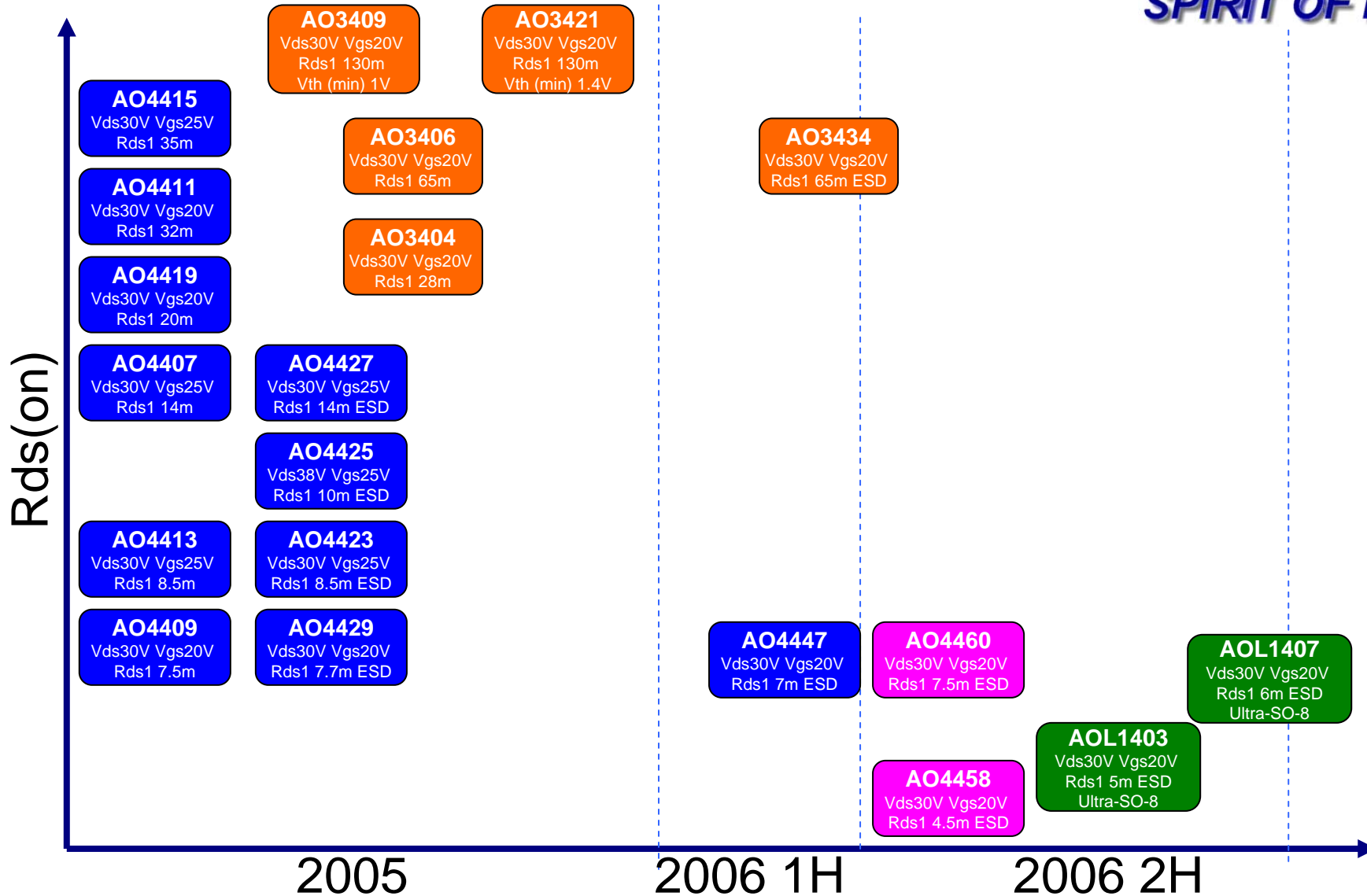
Package	Competitor solution	Topology	AOS Solution 1 (Direction Item)	AOS Solution 2 (High Performance)	AOS Solution3 (Low cost)
SO-8 Single-P	TPC8107 TPC8111 TPC8114	Charge/ Discharge	AO4429	AO4447	AO4427
Ultra SO-8 Single-P	TPCA8103		AOL14xx	AOL1403	AOL1401
SO-8 Single-N	TPC8017H		AO4460	AO4458	
SO-8 Single-P	SI4435	Pre-Charge	AO4419 AO4415		AO4411
SOT-23	2SJ204		AO3421		
SOT-23	NDS351 CPH3414 SSM3K14T	2nd Protection	AO3406	AO3404	

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New product Road-Map



SPIRIT OF NO. 1



Parameter Cross Reference



SPIRIT OF NO. 1

Application	Part number	Package	Description	VDS	Vgs (+/-)	Ids		Rds(on) m ohm/max		Vgs(th) / max	Ciss /pF	Qg /nC
						25'C	70'C	10V	4.5V			
						Charge & Discharge	TPC8111	SO-8	Single-P			
TPC8107	SO-8	Single-P	-30	20	-13			7	15	-2	5880	130
TPC8114	SO-8	Single-P	-30	20	-18			4.5	6.8	-2	7480	180
TPCA8103	POWER PAK	Single-P	-30	20	-40			4.2	6.8	-2	7880	184
TPC8017	SO-8	Single-N	30	20	15			6.6	9.5	2.3	1465	25
AO4447	SO-8	Single-P	-35	25				7				
AO4429	SO-8	Single-P	-30	20	15		12.8	7.7	12	-2.7	5355	91
AO4460	SO-8	Single-N	30	20				7.5				
Pre-charge	SI4435DY	SO-8	Single-P	-30	-20	-8	-6.4	20	35	-1	min	47
	2SJ204	SOT-23	Single-P	-30	20	0.2		8k	13k		27	
	AO4419	SO-8	Single-P	-30	-20	-9.7	-8.1	20	35	-2.7	1573	26.4
	AO4415	SO-8	Single-P	-30	-25	-15			35	-3.5	893	16.6
	AO3421	SOT-23	Single-P	-30	-20	-2.6	-2.2	130	200	-3	302	6.8
2nd protection	NDS351N	SOT-23	Single-N	30	20	1.1		160	250	2	140	2
	AO3406	SOT-23	Single-N	30	20	3.6	2.9	65	100	3	288	6.5