Discrete Components versus Miniaturization – A contradiction?

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Discrete vs. Miniaturization

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Infineon High Reliability (HiRel) Miniaturization

Miniaturization in commercial world works mostly by integration (ASICs)

Hybrid Module (with discrete chips)
- Advantages:
  - Up to 70% less in size compared to PCB
  - Flexible in design
  - Reasonable prize
- Disadvantages
  - Development efforts
  - Components in die from necessary

However Space World is different!

ASICS (Integrated solution)
- Advantages:
  - Very small size

- Disadvantages
  - High Price due to low demand
  - Less robustness
  - Development cost

PCB Module (with packaged discretes)
- Advantages:
  - Well established technology
  - Low cost
  - Reasonable low cost
  - Easy and flexible
  - Low development effort

- Disadvantages
  - Size

Miniaturization in commercial world works mostly by integration (ASICs)

Robustness
Availability
Initial cost
Component cost
Development effort
Size

Infineon High Reliability (HiRel) Miniaturization
Infineon High Reliability (HiRel) Miniaturization

Hybrid Module (with discrete chips)

- Advantages:
  - Up to 70% less in size compared to PCB
  - Flexible in design
  - Reasonable prize

- Disadvantages
  - Development efforts
  - Components in die from necessary

Infineon can support both solutions, packaged and bare die to contribute on the Miniaturization on Space Applications
Infineon (former Siemens Semiconductor) has an excellent reputation in the space community for over 40 years!

The space heritage covers major European and WW satellite programs some examples:

- Artemis
- Alphasat
- Meteosat SG
- Intelsat
- Iridium
- Iridium Next
- Galileo IOV
- Sentinel
Infineon HiRel
Portfolio Overview

Silicon Diodes
Small Signal-, Schottky-, PIN-, and General Purpose switching Diodes

Silicon Microwave Transistors
Various devices with supply voltage rating from 4V to 12V
Transition Frequency from 8GHz up to 42GHz
Output power from 20mA to 100mA
For High Frequency applications like LNA or oscillator circuits

Radiation Hard PowerMOS Transistors
250V in SMD and TO Packages
150V Technology under development

All Products completely made by Infineon!
(Frontend Wafer Fab as well as Backend packaging and screening)

More detailed product information is available on the Infineon web-side under:
www.infineon.com/space
Infineon HiRel
Micro-Wave Transistors for communication

- BFY640 Micro-Wave low noise transistor with space heritage (Galileo).
- BFY650B Micro-Wave high-end power transistor
- BFY740B Next Generation Micro-Wave high-end low noise transistors
- Generated out of Infineon standard device which are widely used eg. in smartphones
- Devices also available as FM qualified bare dies

Technical Features BFY640:
- Maximum stable gain: \( > 24 \text{dB} @ 1,8 \text{ GHz} \)
- Very low noise figure: \( < 0,8 \text{dB} @ 1,8 \text{ GHz} \)
- \( f_T \text{ typ:} \ > 40 \text{ GHz} \)

Technical Features BFY650B:
- IC max: \( 150\text{mA} \)
- \( f_T \text{ typ:} \ > 42 \text{ GHz} \)

Technical Features BFY740B:
- Maximum stable gain: \( > 17 \text{ dB} @ 6,0 \text{ GHz} \)
- Ultralow noise figure: \( < 1,15 \text{ dB} @ 6,0 \text{ GHz} \)
- \( f_T \text{ typ:} \ > 42 \text{ GHz} \)
Infineon HiRel
Radiation Hard PowerMOS Transistors

Target applications (drop in for existing products):
- DC/DC or switch mode converters
- Motor control (H-Bridge)

Radiation-hardened:
- TID up to 100 krad (300 krad on request)
- SEE up to LET 55@90µm (Xe)
  NASA tested up to LET 85@118µm (Au)

Datasheet available at:
WWW.Infineon.com/RadHardMOS

Devices also available as FM qualified bare die (chip)

<table>
<thead>
<tr>
<th>Type</th>
<th>ESCC Reference</th>
<th>RDSon max@25°C</th>
<th>IDC</th>
<th>Umax</th>
<th>Package</th>
<th>ESA QPL</th>
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<tbody>
<tr>
<td>BUY25CS12J-01</td>
<td>5205/026</td>
<td>130mOhm</td>
<td>12A</td>
<td>250V</td>
<td>SMD0.5</td>
<td>yes</td>
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<tr>
<td>BUY10CS12J-01</td>
<td>5205/028</td>
<td>130mOhm</td>
<td>12A</td>
<td>100V</td>
<td>SMD0.5</td>
<td>yes</td>
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<td>BUY25CS54A-01</td>
<td>5205/027</td>
<td>30mOhm</td>
<td>54A</td>
<td>250V</td>
<td>SMD2</td>
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<td>BUY25CS12K-01</td>
<td>TBD</td>
<td>130mOhm</td>
<td>12A</td>
<td>250V</td>
<td>TO257AA</td>
<td>beg. 2015</td>
</tr>
<tr>
<td>BUY25CS45B-01</td>
<td>TBD</td>
<td>50mOhm</td>
<td>45A</td>
<td>250V</td>
<td>TO254AA</td>
<td>beg. 2015</td>
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</tbody>
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# Infineon HiRel
## Technical overview

### HiRel Rad-Hard PowerMOS Transistors

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Package</th>
<th>V DS (max)</th>
<th>RDS(ON) (typ)</th>
<th>Qg max</th>
<th>ID (max)</th>
<th>Idpuls (max)</th>
<th>Ptot (max)</th>
<th>V GS (max)</th>
<th>ESA QPL</th>
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</thead>
<tbody>
<tr>
<td>BUY25CS54A-01 (ql)</td>
<td>SMD2</td>
<td>250V</td>
<td>25mOhm</td>
<td>180nC</td>
<td>54A</td>
<td>214.0A</td>
<td>250 W</td>
<td>+/- 20 V</td>
<td>Yes</td>
</tr>
<tr>
<td>BUY25CS12J-01 (ql)</td>
<td>SMD0.5</td>
<td>250V</td>
<td>110mOhm</td>
<td>42nC</td>
<td>12.4A</td>
<td>50.0A</td>
<td>75 W</td>
<td>+/- 20 V</td>
<td>Yes</td>
</tr>
<tr>
<td>BUY10CS12J-01 (ql)</td>
<td>SMD0.5</td>
<td>100V</td>
<td>110mOhm</td>
<td>42nC</td>
<td>12.4A</td>
<td>50.0A</td>
<td>75 W</td>
<td>+/- 20 V</td>
<td>Yes</td>
</tr>
<tr>
<td>BUY25CS45B-01 (ql)</td>
<td>TO254AA</td>
<td>250V</td>
<td>45mOhm</td>
<td>100nC</td>
<td>45A</td>
<td>180.0A</td>
<td>208 W</td>
<td>+/- 20 V</td>
<td>ongoing</td>
</tr>
<tr>
<td>BUY25CS12K-01 (ql)</td>
<td>TO257AA (DSG)</td>
<td>250V</td>
<td>120mOhm</td>
<td>42nC</td>
<td>12.4A</td>
<td>50.0A</td>
<td>75 W</td>
<td>+/- 20 V</td>
<td>ongoing</td>
</tr>
<tr>
<td>BUY25CS12K-11 (ql)</td>
<td>TO257AA (GDS)</td>
<td>250V</td>
<td>120mOhm</td>
<td>42nC</td>
<td>12.4A</td>
<td>50.0A</td>
<td>75 W</td>
<td>+/- 20 V</td>
<td>ongoing</td>
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<tr>
<td>L5491 (ql)</td>
<td>Chip for BUY25CS54A</td>
<td>-</td>
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<td>-</td>
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### HiRel Silicon Diodes

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Package</th>
<th>VBR (min)</th>
<th>IF (max)</th>
<th>rF (typ)</th>
<th>τ (typ)</th>
<th>CT (max)</th>
<th>ESA QPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS40-T1 (ql)</td>
<td>T1</td>
<td>40.0 V</td>
<td>120 mA</td>
<td>10.0 Ohm</td>
<td>-</td>
<td>5.0 pF</td>
<td>Yes</td>
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<tr>
<td>BAS70-T1 (ql)</td>
<td>T1</td>
<td>70.0 V</td>
<td>120 mA</td>
<td>9.0 Ohm</td>
<td>-</td>
<td>1.5 pF</td>
<td>Yes</td>
</tr>
<tr>
<td>BAY6642 (ql)</td>
<td>HSL2</td>
<td>100.0 V</td>
<td>500 mA</td>
<td>-</td>
<td>3.7 ns</td>
<td>2.5 pF</td>
<td>Yes</td>
</tr>
<tr>
<td>BXY42-T1 (ql)</td>
<td>T1</td>
<td>50.0 V</td>
<td>5000 mA</td>
<td>1.0 Ohm</td>
<td>50 ns</td>
<td>0.24 pF</td>
<td>Yes</td>
</tr>
<tr>
<td>BXY43-T1 (ql)</td>
<td>T1</td>
<td>150.0 V</td>
<td>400 mA</td>
<td>0.9 Ohm</td>
<td>600 ns</td>
<td>0.3 pF</td>
<td>Yes</td>
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<tr>
<td>D309 (ql)</td>
<td>Chip for (BXY43)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.a.</td>
</tr>
</tbody>
</table>
# Infineon HiRel Technical overview

## HiRel Silicon Bipolar Transistors

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Package</th>
<th>VCEO (max)</th>
<th>IC (max)</th>
<th>Ptot (max)</th>
<th>fT (typ)</th>
<th>NF (typ) [dB]</th>
<th>ESA QPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BFY181 (ql)</td>
<td>Micro-X</td>
<td>12.0 V</td>
<td>20.0 mA</td>
<td>175.0 mW</td>
<td>8.0 GHz</td>
<td>2.5 @ 2.0 GHz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY182 (ql)</td>
<td>Micro-X</td>
<td>12.0 V</td>
<td>35.0 mA</td>
<td>250.0 mW</td>
<td>8.0 GHz</td>
<td>2.5 @ 2.0 GHz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY183 (ql)</td>
<td>Micro-X</td>
<td>12.0 V</td>
<td>65.0 mA</td>
<td>450.0 mW</td>
<td>8.0 GHz</td>
<td>2.5 @ 2.0 GHz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY193C (ql)</td>
<td>Micro-X</td>
<td>12.0 V</td>
<td>80.0 mA</td>
<td>580.0 mW</td>
<td>8.0 GHz</td>
<td>2.5 @ 2.0 GHz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY196 (ql)</td>
<td>Micro-X</td>
<td>12.0 V</td>
<td>100.0 mA</td>
<td>700.0 mW</td>
<td>6.5 GHz</td>
<td>3.2 @ 2.0 GHz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY405 (ql)</td>
<td>Micro-X</td>
<td>4.5 V</td>
<td>12.0 mA</td>
<td>55.0 mW</td>
<td>22 GHz</td>
<td>1.2 @ 1.8 Ghz</td>
<td>Yes</td>
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<tr>
<td>BFY420 (ql)</td>
<td>Micro-X</td>
<td>4.5 V</td>
<td>35.0 mA</td>
<td>160.0 mW</td>
<td>22 GHz</td>
<td>1.2 @ 1.8 Ghz</td>
<td>Yes</td>
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<tr>
<td>BFY450 (ql)</td>
<td>Micro-X</td>
<td>4.5 V</td>
<td>100.0 mA</td>
<td>450.0 mW</td>
<td>22 GHz</td>
<td>1.4 @ 1.8 Ghz</td>
<td>Yes</td>
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<tr>
<td>BFY640-04 (ql)</td>
<td>Micro-X</td>
<td>4.0 V</td>
<td>50.0 mA</td>
<td>200.0 mW</td>
<td>40 GHz</td>
<td>0.7 @ 1.8 Ghz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY650B-11 (ql)</td>
<td>Micro-X</td>
<td>4.0 V</td>
<td>150 mA</td>
<td>600.0 mW</td>
<td>40 GHz</td>
<td>0.9 @ 1.8 Ghz</td>
<td>Yes</td>
</tr>
<tr>
<td>BFY740B-01 (ql)</td>
<td>Micro-X</td>
<td>4.0 V</td>
<td>30.0 mA</td>
<td>120.0 mW</td>
<td>42 GHz</td>
<td>0.9 @ 6.0 Ghz</td>
<td>Yes</td>
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<tr>
<td>T359C (ql)</td>
<td>Chip for (BFY193C)</td>
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<tr>
<td>T395 (ql)</td>
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<td>T502 (ql)</td>
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<td>T503 (ql)</td>
<td>Chip for (BFY450)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

ql = quality levels

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**Standard lead-times:**

- **FLIGHT PARTS:** 16 to 18 Weeks
- **ENG. PARTS:** 6 to 8 Weeks
Infineon HiRel

Conclusion

✓ Infineon has been well known and has excellent experience in the space community for over 40 years

✓ Infineon has already contributed for JAXA projects from Europe

✓ Infineon can support both solutions, packaged and die to contribute on the HiRel miniaturization

✓ Infineon has a broad portfolio
  • RF Silicon Diodes & Transistors
  • Rad Hard PowerMOS Transistors

✓ Infineon has enough capability to work in Japanese Space Business
ENERGY EFFICIENCY
MOBILITY
SECURITY

Innovative semiconductor solutions for energy efficiency, mobility and security.