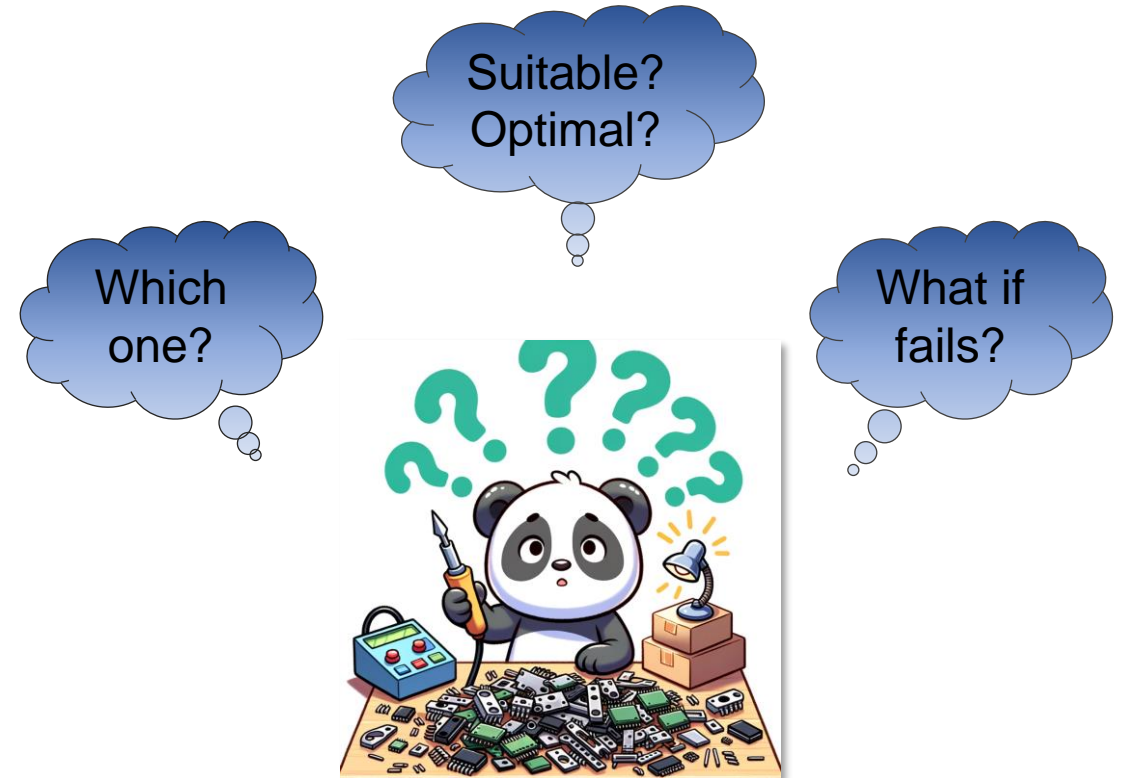
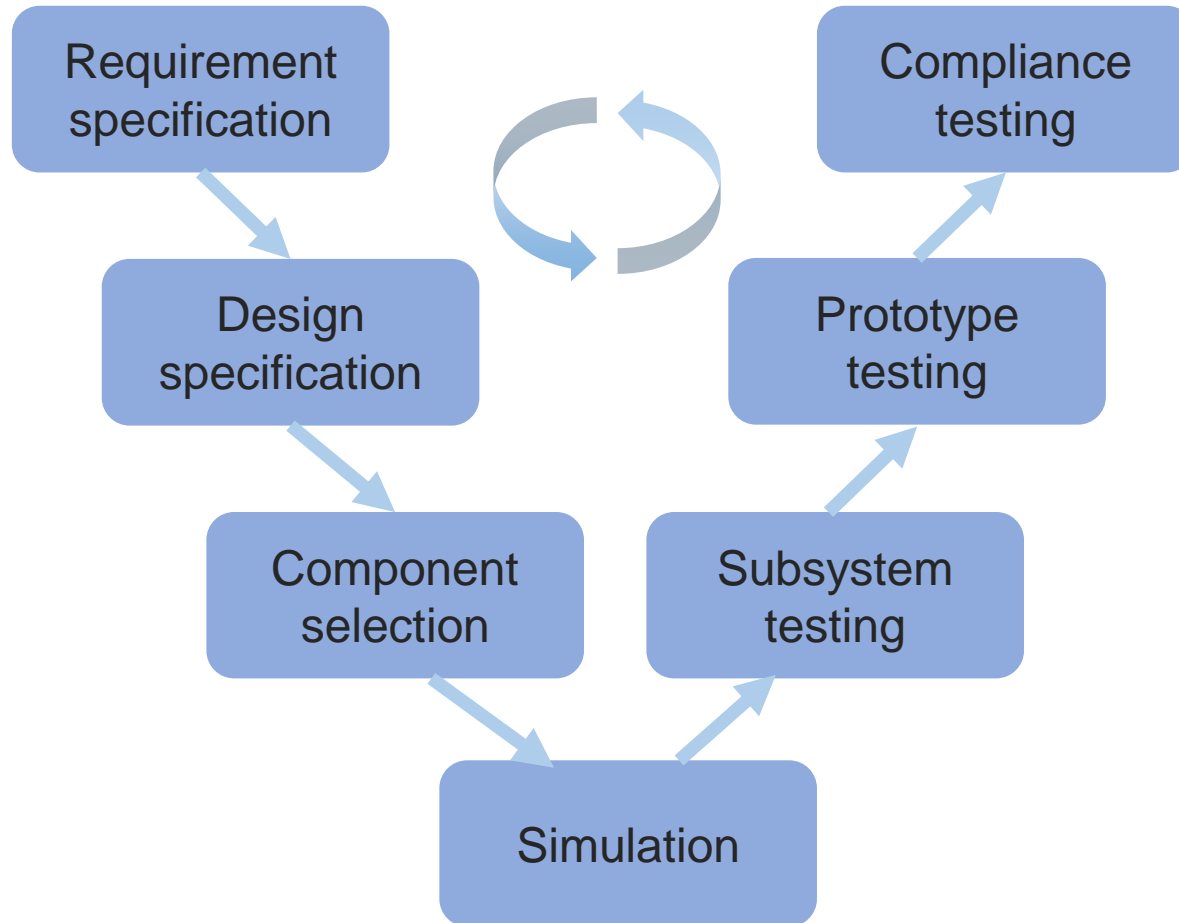


PowerBrain: An automatic data extraction tool for semiconductor datasheets

Fanghao Tian, KU Leuven - EnergyVille

Choosing a component is complex

A general design flow of power electronics



Our Market is flooded with Available Choices

The screenshot shows the DigiKey website interface for searching MOSFETs. The search bar contains 'mosfet' and shows 41,442 results. The results are filtered by 'Stacked' and 'Scrolling' options. The filters are categorized into Technology, Drain to Source Voltage (V_{ds}), Current - Continuous Drain (I_d) @ 25°C, Drive Voltage (Max R_{ds On}, Min R_{ds On}), R_{ds On} (Max) @ I_d, V_{gs}, and V_{gs(th)} (Max) @ I_d. The 'Drain to Source Voltage (V_{ds})' filter is set to 450 V. The 'Current - Continuous Drain (I_d) @ 25°C' filter is set to 30mA (Tj). The 'Drive Voltage (Max R_{ds On}, Min R_{ds On})' filter is set to 1.5V. The 'R_{ds On} (Max) @ I_d, V_{gs}' filter is set to 0.45mOhm @ 30A, 10V. The 'V_{gs(th)} (Max) @ I_d' filter is set to 600mV @ 1.2mA (...). The 'Apply All' button is highlighted, and the results are shown as 2,414 of 41,442 results. The 'Feedback' and 'Need Help?' buttons are also visible.

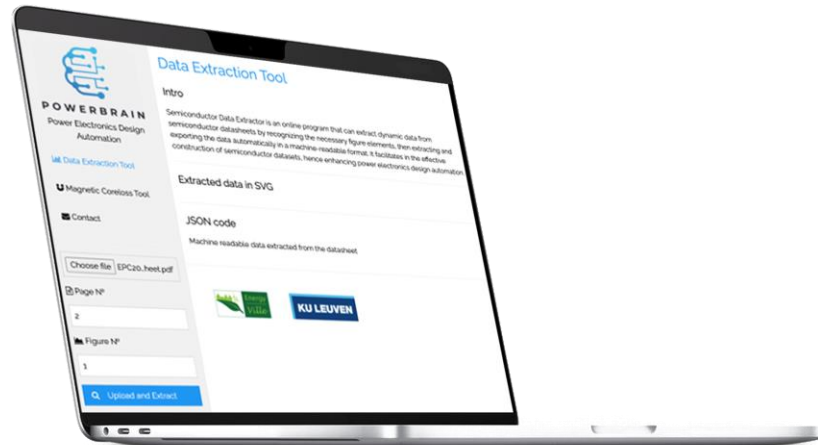
PowerBrain can collect data in mins




POWERBRAIN

**DON'T LET
DATASHEETS
SLOW YOU DOWN!**

1. Upload Your Datasheet
2. Select the Figure
3. Get Machine Readable Data



Demonstration of a case



POWERBRAIN

Power Electronics Design
Automation

- [Data Extraction Tool](#)
- Magnetic Coreloss Tool
- Heatsink Design
- Converter Design
- Feedback
- Documentation
- Contact

Manufacturer

EPC

Data Extraction Tool

Intro

Don't let datasheets slow down your design. Check out our automatic data extraction tool, an intelligent solution automates the tedious, time-consuming process of data extraction from MOSFET datasheets, turning hours of work into just a matter of minutes.

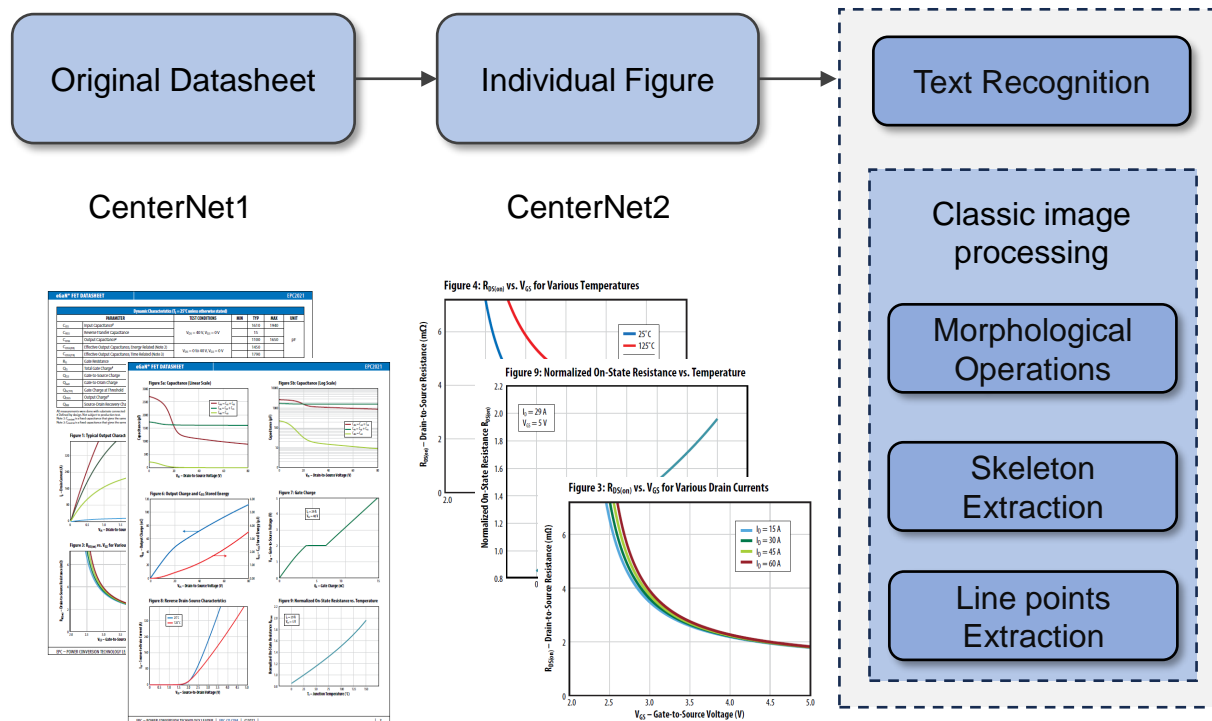
All you need to do is to follow 3 steps:

1. Upload your datasheet;
2. Select the figure;
3. Get the machine-readable data!

Version v0.0.4 All right reserved
2024

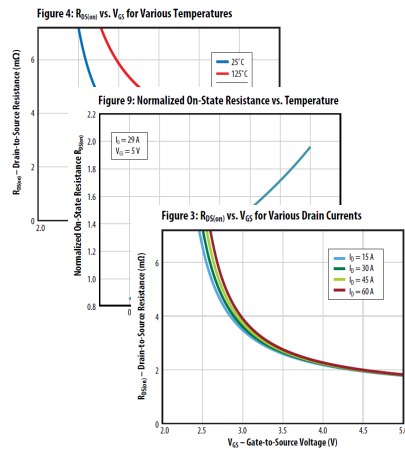
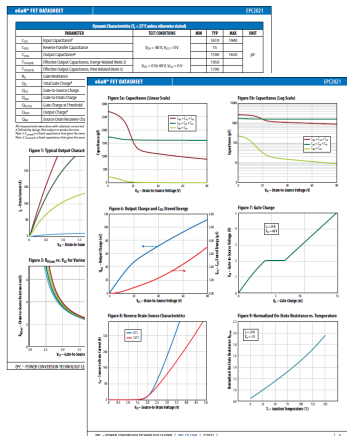


The overview of PowerBrain



CenterNet1

CenterNet2

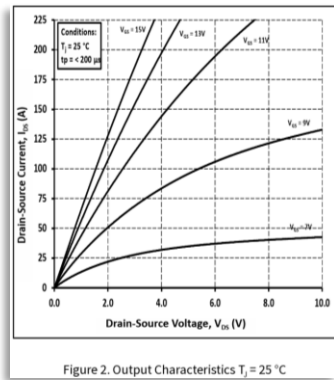


Task1: Detect figures from original datasheet page

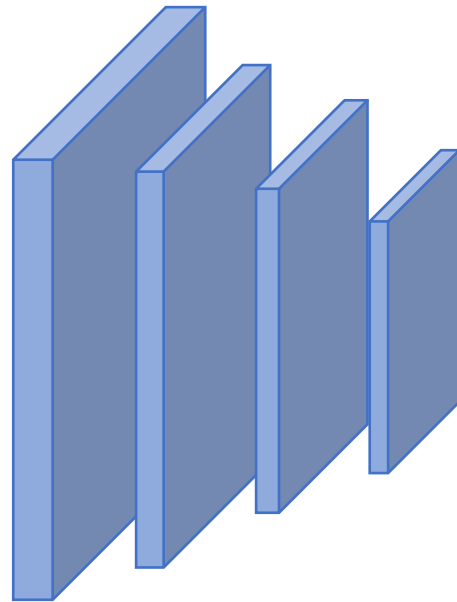
Task2: Extract data from individual Line Chart

- Object detection: detect key elements: title, legend, label, value, corner, and others
- Text recognition: Recognize texts & numbers
- Data extraction: Extract line pixels and align it with coordination

Structure of CenterNet - Object Detection



(512,512,3)



(16,16,2048)

Backbone-(ResNet50)

Transposed
Convolution



High-resolution
feature maps

(128,128,64)

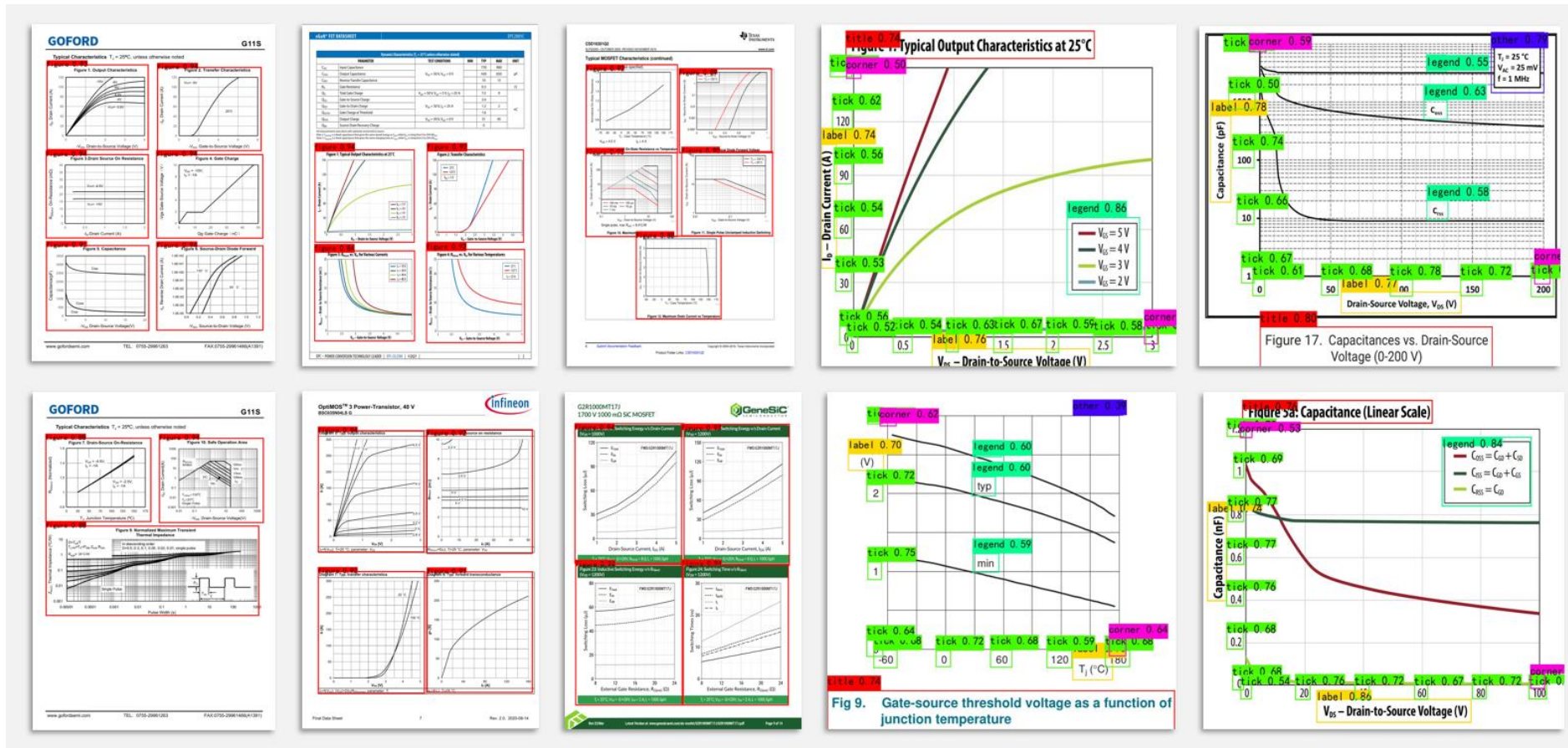
Category

Center
Position

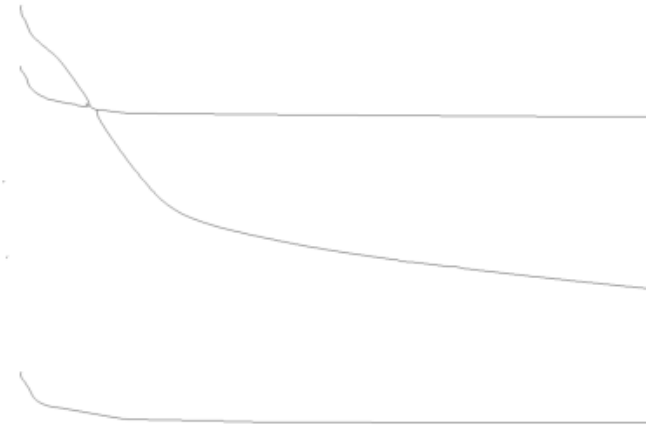
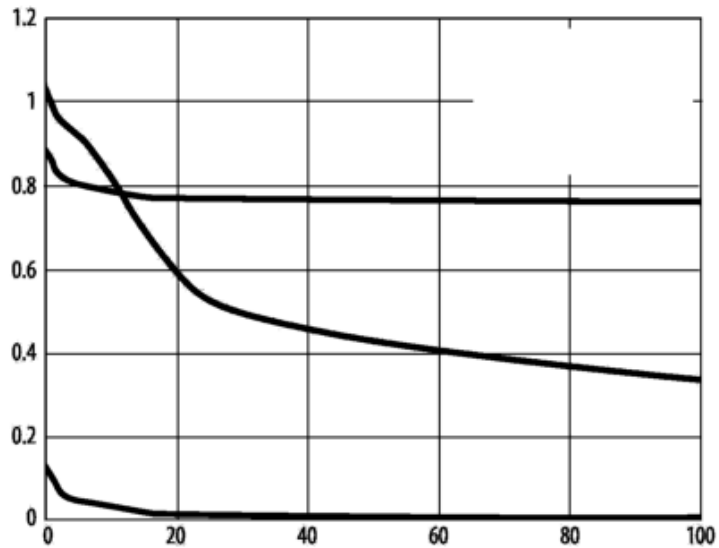
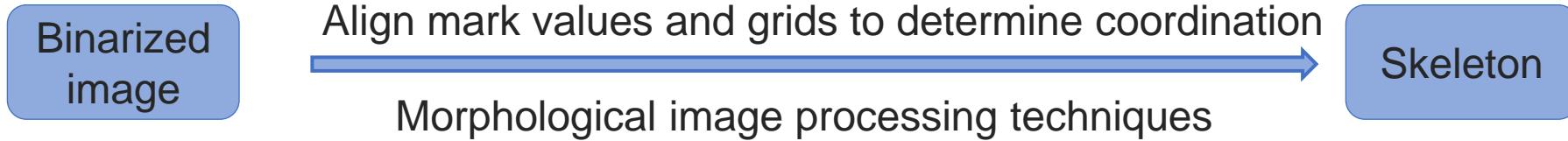
Width &
Length

Results of CenterNet

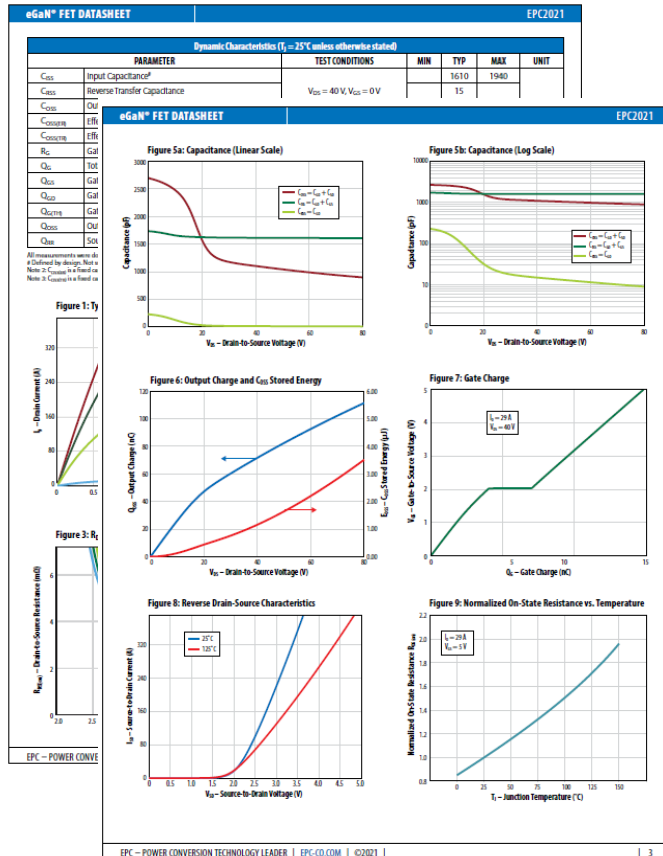
CenterNet based object detection algorithm applied to detect the key elements from the datasheet



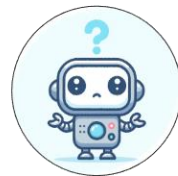
Automatic Data Extraction – Line Data Extraction



PowerBrain Interpret the Datasheet to Machine-Readable



Original Datasheet



POWERBRAIN

Figure 1: Typical Output Characteristics at 25 °C

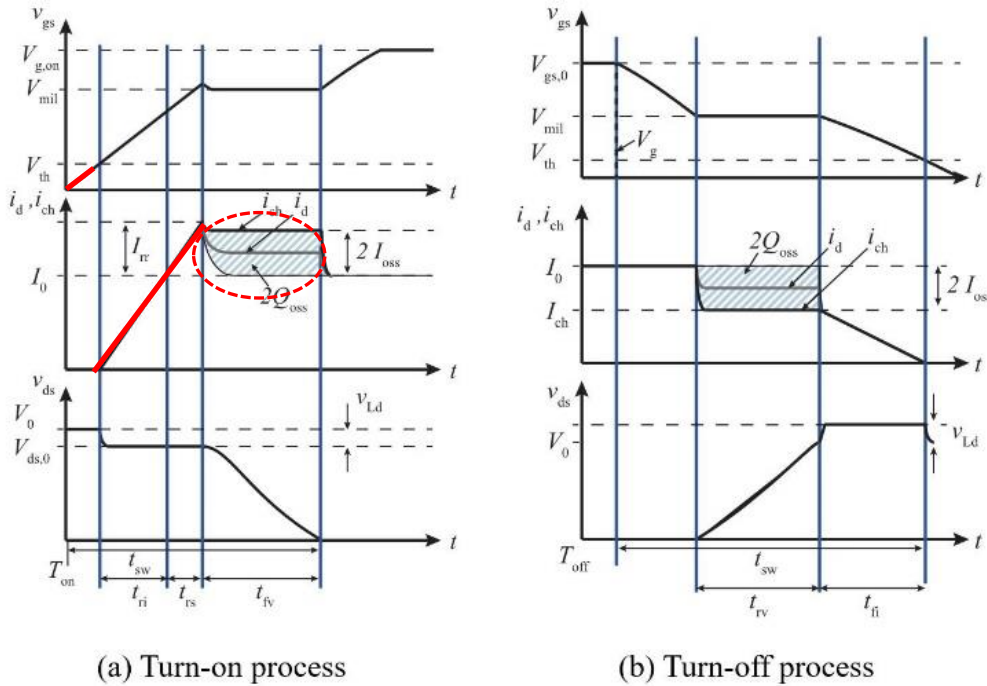


Machine Readable Data



Data needed for Power Loss Model

Switching Process of SiC MOSFET



$$E_{Ton} = \frac{1}{2} t_{ri} V_{ds} I_o + \frac{1}{2} t_{fv} V_{ds} (I_o - 2I_{oss}) + t_{rs} V_{ds} I_o + E_{rr}$$

$$t_{fi} = -\ln\left(\frac{V_{th} + V_g}{V_{mil} + V_g}\right) (C_{gs} R_g + L_s g_m)$$

$$t_{ri} = -\ln\left(1 - \frac{I_o}{g_m (V_g - V_{th})}\right) (C_{gs} R_g + L_s g_m)$$

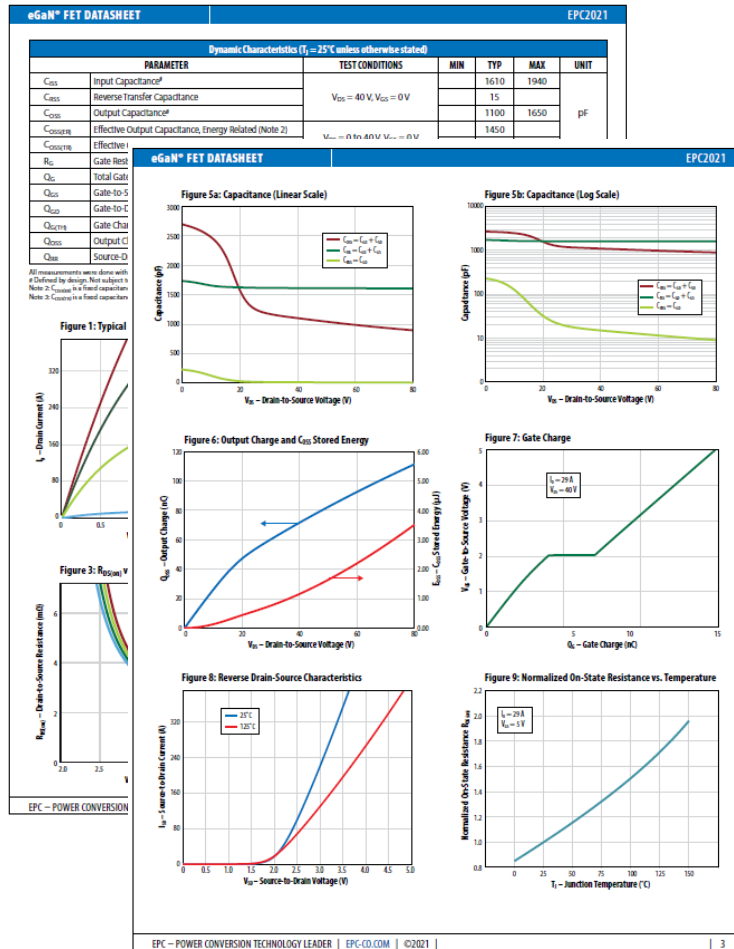
$$E_{Toff} = \frac{1}{2} t_{rv} V_o (I_o - 2I_{oss}) + \frac{1}{2} t_{fi} (V_o + V_{Ld}) (I_o - 2I_{oss})$$

$$t_{rv} = \frac{Q_{coss, discharge}}{I_{coss, discharge}}$$

$$t_{fv} = -\frac{Q_{coss, charge}}{I_{coss, charge}}$$

$$E_{cond} = I_{ds(rms)}^2 R_{ds(on)} T$$

Conduction Loss



Conduction Loss

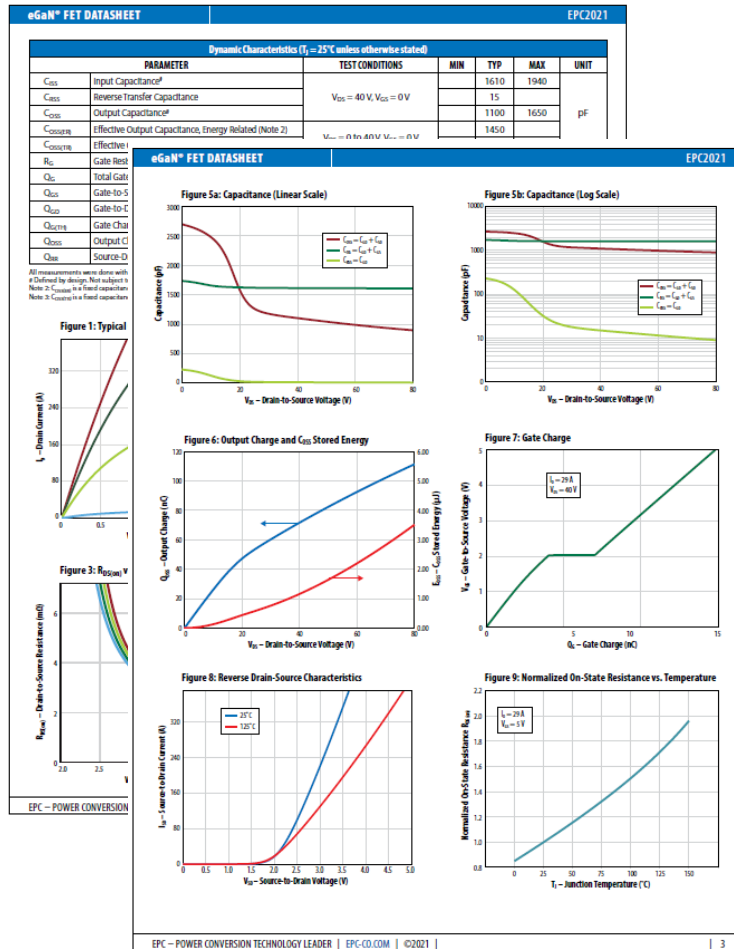


Figure 4: R_{DS(on)} vs. V_{GS} for Various Temperatures



Figure 9: Normalized On-State Resistance vs. Temperature

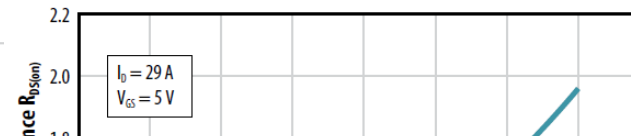
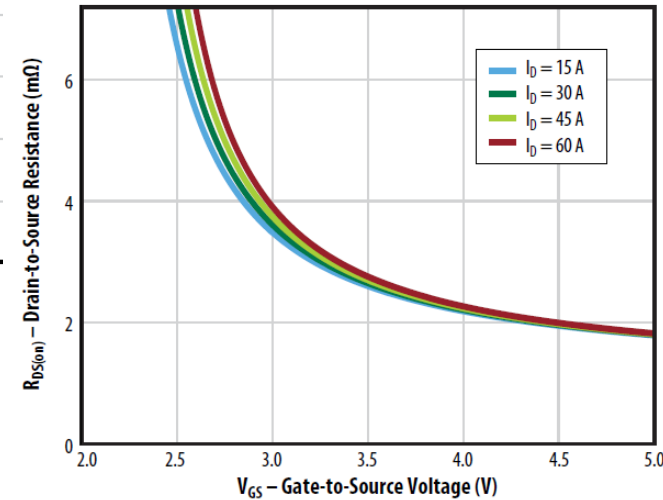


Figure 3: R_{DS(on)} vs. V_{GS} for Various Drain Currents



Conduction Loss

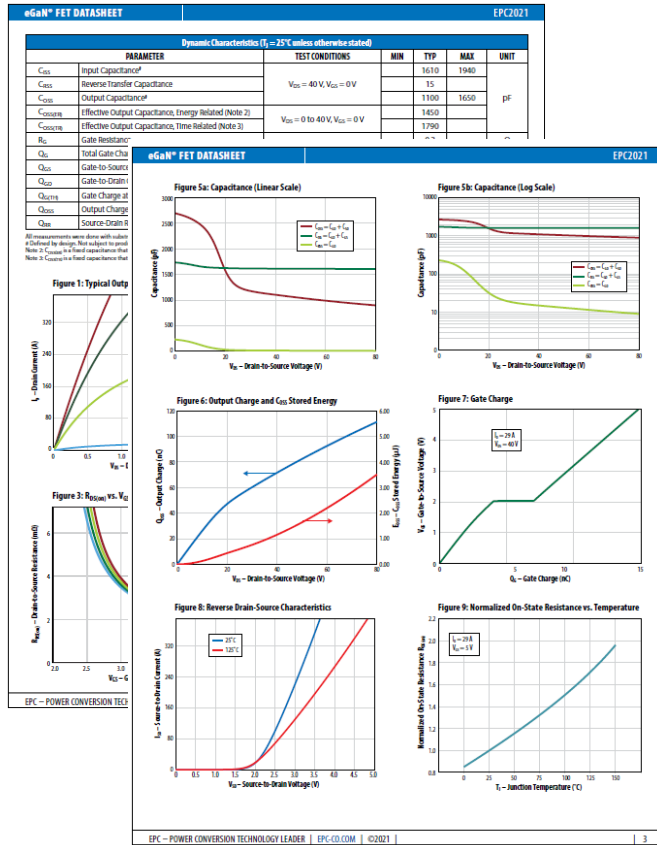


Figure 4: R_{DS(on)} vs. V_{GS} for Various Temperatures

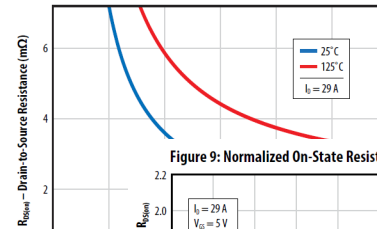
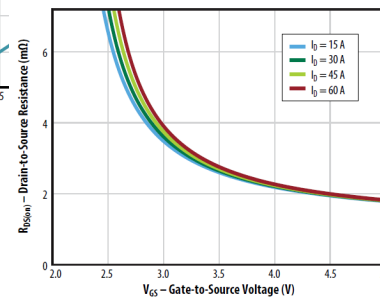
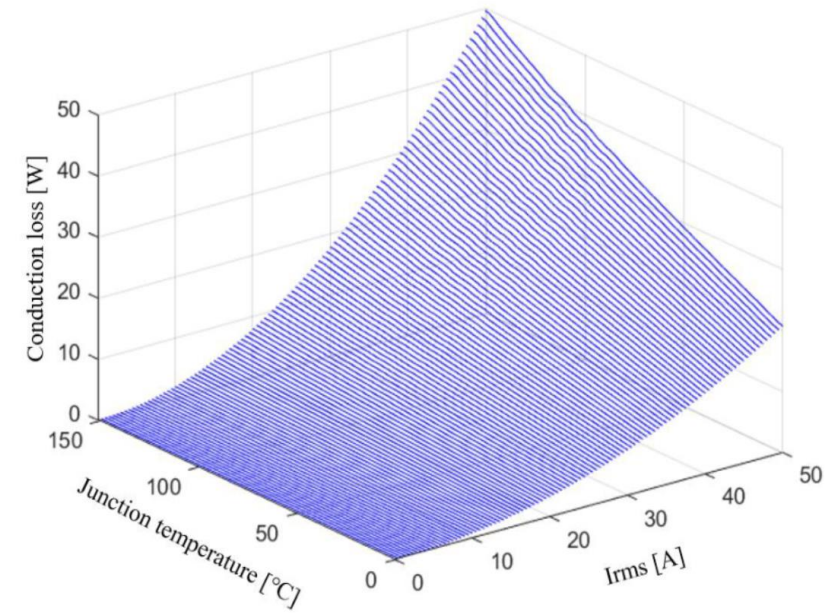


Figure 9: Normalized On-State Resistance vs. Temperature

Figure 3: R_{DS(on)} vs. V_{GS} for Various Drain Currents



Conduction loss vs. current and temperature



Conduction loss vs. RMS current and junction temperature.

Switching Loss



C3M0015065D

Silicon Carbide Power MOSFET
C3M™ MOSFET Technology
N-Channel Enhancement Mode

Features

- 3rd Generation SiC MOS
- High blocking voltage
- High speed switching
- Fast intrinsic diode with
- Halogen free, RoHS compliant

Benefits

- Higher system efficiency
- Reduced cooling requirement
- Increased power density
- Increased system switch
- Easy to parallel and sin
- Enable new hard switch

Applications

- EV charging
- Solar PV Inverters
- UPS
- SMPS
- DC/DC converters

Maximum Ratings (T_{case})

Symbol	Parameter
V _{DSmax}	Drain - Source
V _{GSmax}	Gate - Source
I _D	Continuous
I _{DM}	Continuous
I _{DM,peak}	Pulsed Drain
P _D	Power Dissip
T _J , T _{stg}	Operating J _s
T _s	Solder Temp
M ₂	Mounting To

Note (1): Recommended for
Note (2): Package limited to 12

Rev. 7, March 2022

Typical Performance

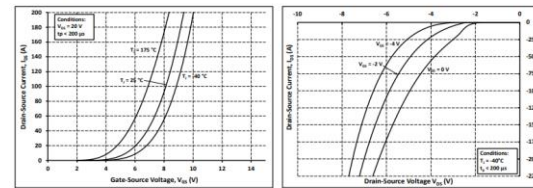


Figure 7. Transfer Characteristic for Various Junction Temperatures

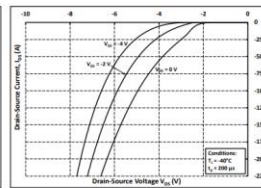


Figure 8. Body Diode Characteristic at -40 °C

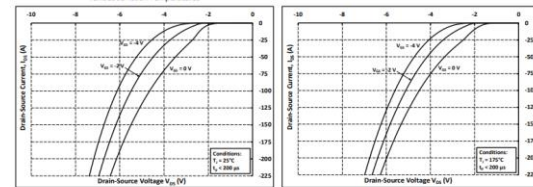


Figure 9. Body Diode Characteristic at 25 °C

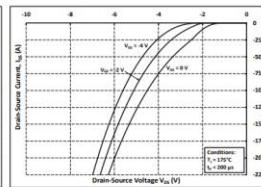


Figure 10. Body Diode Characteristic at 175 °C

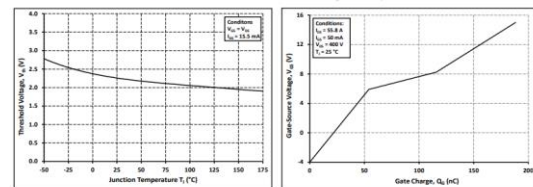


Figure 11. Threshold Voltage vs. Temperature

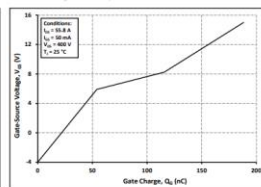
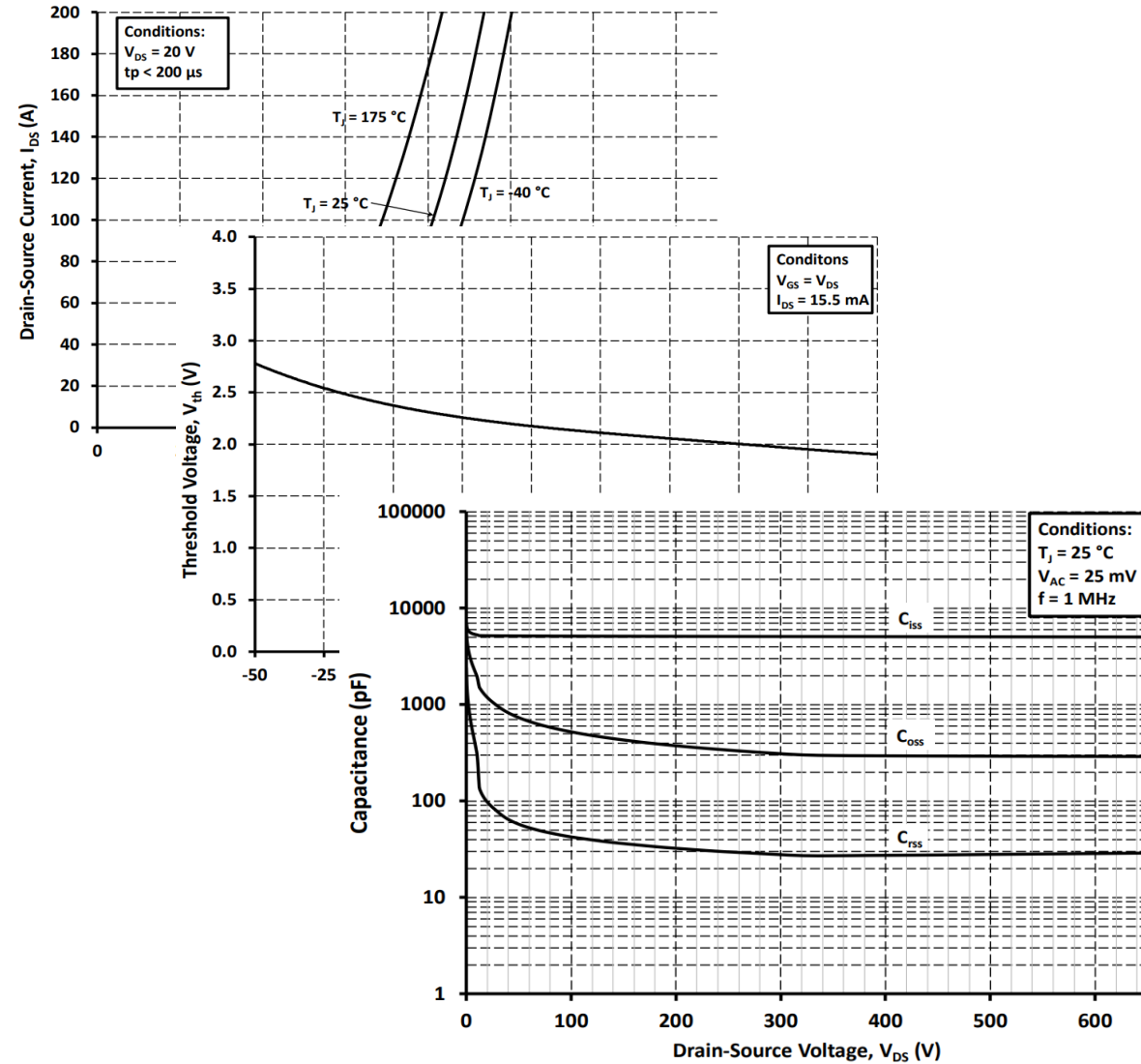


Figure 12. Gate Charge Characteristics

Rev. 7, March 2022

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Switching Loss

Wolfspeed

C3M0015065D
Silicon Carbide Power MOSFET
C3M™ MOSFET Technology
N-Channel Enhancement Mode

Features

- 3rd-Generation SiC MOSFET technology
- High blocking voltage with low on-resistance
- High speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Qrr)
- Halogen free, RoHS compliant

Benefits

- Higher system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching
- Easy to parallel and simple
- Enable new hard switching

Applications

- EV charging
- Solar PV inverters
- UPS
- SMPS
- DC/DC converters

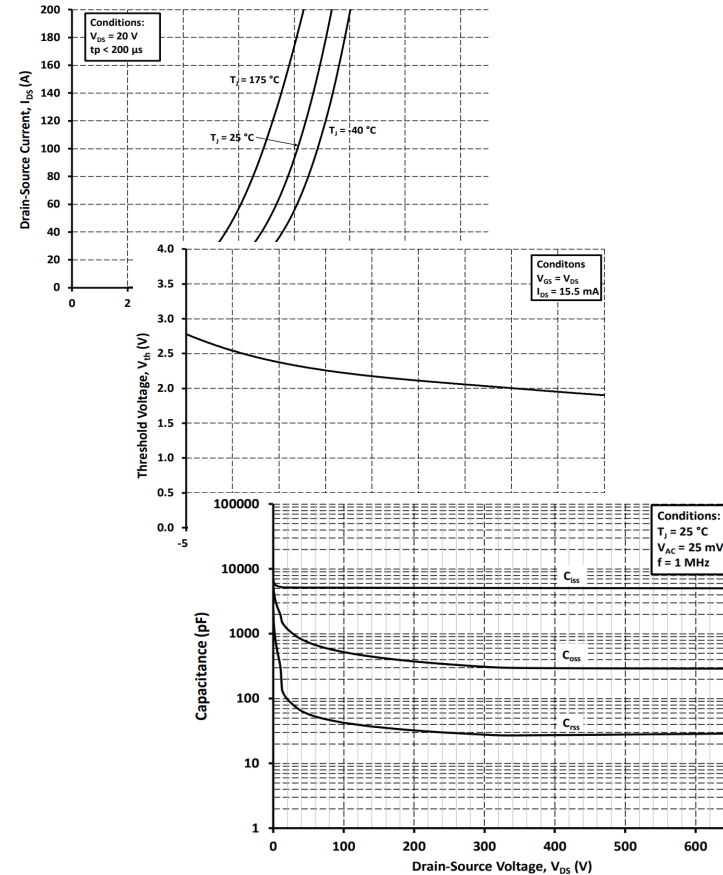
Maximum Ratings (T_j=25°C)

Symbol	Drain - Source Volt
V _{DS}	Gate - Source Volt
V _{GS}	Gate - Source Volt
V _{GSmax}	Continuous Drain
I _D	Continuous Drain
I _{D(switch)}	Pulsed Drain Cur
P _{tot}	Power Dissipation
T _j , T _{stg}	Operating Junction
T _s	Solder Temperatu
M _t	Mounting Torque

Note (1): Recommended turn of heat (2): Package limited by I_{DM}

Rev. 7, March 2022

Typical Performance



Dynamic Parasitic Capacitance:

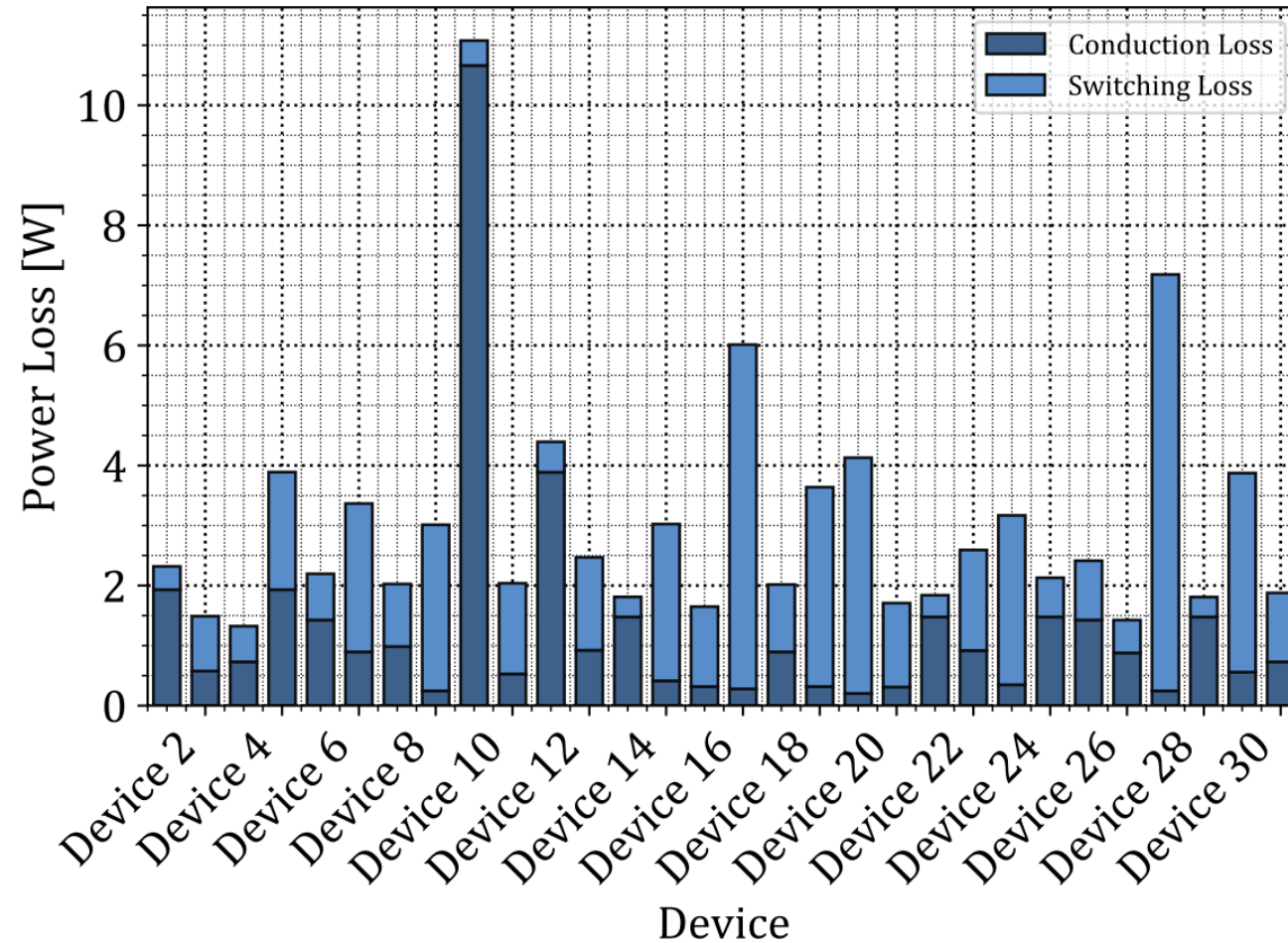
$$C_{x,eq} = \frac{1}{V_o} \int_0^{V_o} C_x(v) dv, x = iss, oss, rss$$

Curve fitting transconductance:

$$i_{ch} = g_m(i_{ch})(v_{gs} - V_{th})$$

Case study: a comparison of multiple devices

Operating Condition (half bridge)
V=50V
I=5A
f=50kHz
D=0.5



Fast MOSFET Selection, Faster and better design



Thanks for Listening

Fanghao Tian, KU Leuven - EnergyVille