


# Infineon Product and Solution Offerings For E2E3 Wheelers

Foon Wee Hin & Gao Lei



# Infineon product and solutions for electric 2 and 3 wheeler

- Market Driver
- Infineon complete product offering
- LV/MV MOSFET portfolio for BMS and Motor Drive
- Partner's Turnkey solution

## 1200W Off Board charger

- HV MOSFET portfolio for Charger
- Key charger specification
- Topology and Graphic User Interface
- Charger performance and Measurements


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# The Key Market Drivers Are …

**Environmental**

Saving the environment by reducing CO2 Emission

**Government Incentives**

Regional based standards push for quicker adoption of electric 2 wheelers, e.g. India FAME-II and adaptation of AC Charging point throughout India

**Commercial**

Traditional OEMs (local and foreign) and startups (many founded by existing industry giant) all want to take part in this largely untapped market

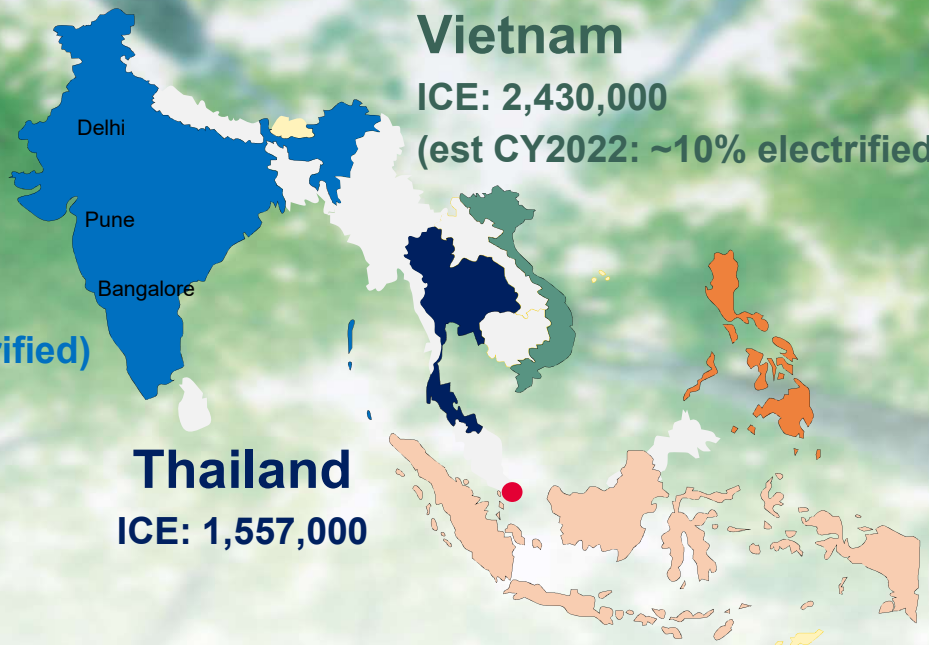



**Technical**

Increased use of Li-ion batteries → improved power density and longer lifespan over sealed lead-acid batteries (SLA)


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# Best estimate 2022 – ICE Scooter
# ~ 32 million (SEA:12M, INDIA:20M)




## India
**ICE: 20,000,000**
**(est CY2022: ~3.5% electrified)**

## Vietnam
**ICE: 2,430,000**
**(est CY2022: ~10% electrified)**

## Thailand
**ICE: 1,557,000**

## Philippines
**ICE: 1,494,000**

## Indonesia
ICE: 5,850,000

Data source: Motorcycles.com & Market sources


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# Broad product portfolio for innovation and differentiation

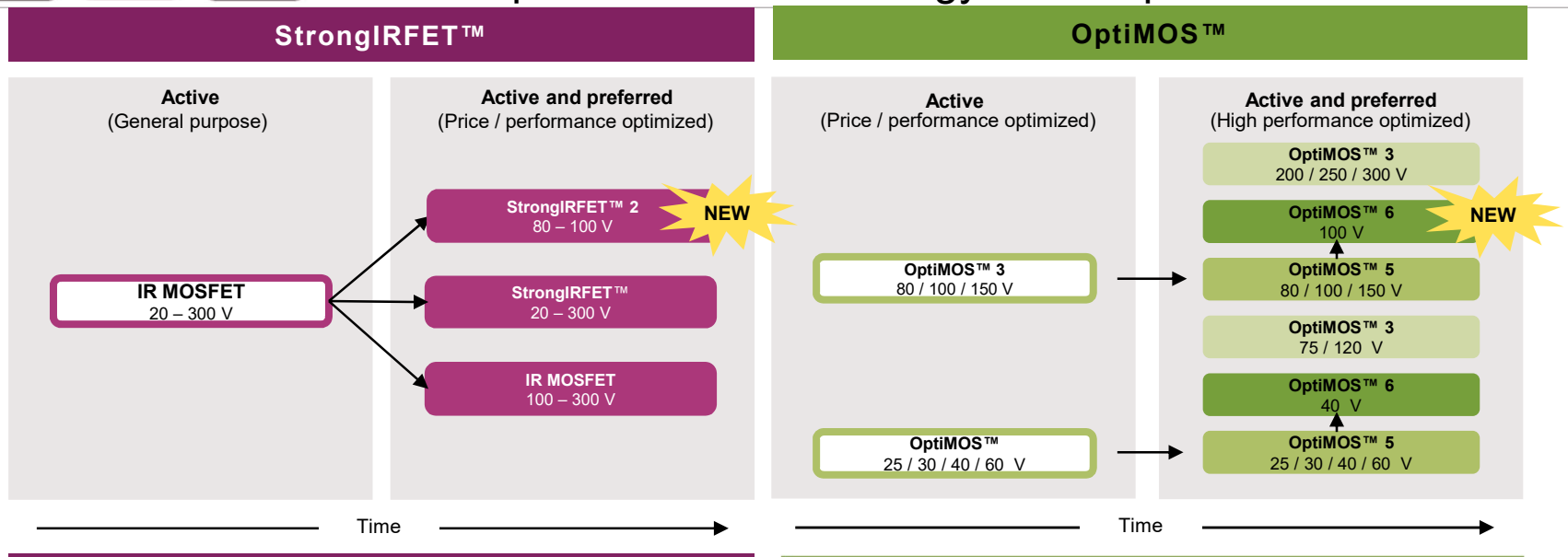
| | | |
|---|---|---|
| **AC Charger** | Charger | OptiMOS™ and StrongIRFET™ · CoolMOS™ · Gate Driver ICs · CoolSET™ PWM PFC/FB controller |
| **Battery Management** | BMS | OptiMOS™ and StrongIRFET™ · Gate Driver ICs · Small Signal · Authentication · Cell Balancing |
| **Security** | Security | OPTIGA™ TPM · Authenticate IDoT · OPTIGA™ Trust M · OPTIGA™ Connect |
| **Motor Inverter & DCDC** | Motor drivers | OptiMOS™ and StrongIRFET™ · Gate Driver ICs · Magnetic/Current sensor |
| **Sensor & Peripherals** | Sensing | LIN/CAN Transceivers · LED Drivers · LNA · XENSIV™ sensors<br>Barometric pressure sensors<br>24/60/77 GHz radar<br>MEMS microphone<br>ToF Sensor |
| **Interface** | HMI | USB Type C · CapSense |
| **Connectivity** | Connectivity | WiFi + BT combo · eSIM OPTIGA™ Connect |
| **Microcontroller** | Micro-controller | XMC™ · PSoC™ · AURIX™ · Traveo™ |


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# OptiMOS™ and StrongIRFET™

## Product portfolio and technology roadmap




**StrongIRFET™**

Robust and excellent price/performance ratio

Right fit products for a broad range of application

Easy of design and flexible use

**OptiMOS™**

Best-in-class technology

Designed for high performance applications

Industry´s best figure of merit

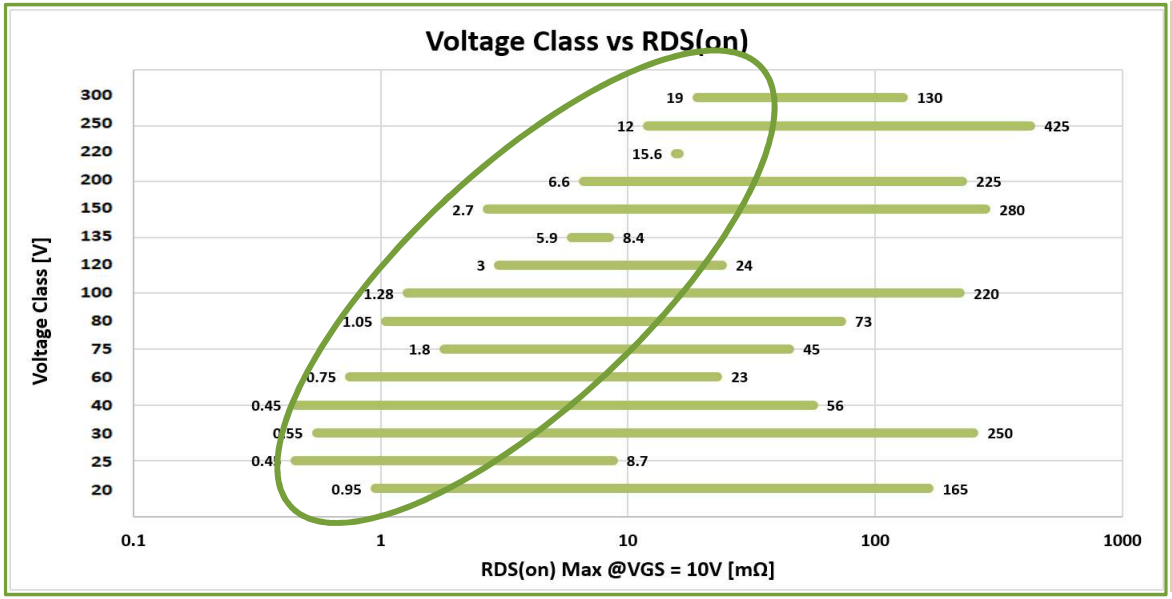
High efficiency, power density and current capability

**Industrial & Standard Grade qualified under JESD47, *more OptiMOS and StrongIRFET are available for your selection***


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# Power discretes MOSFET value proposition




## Value proposition

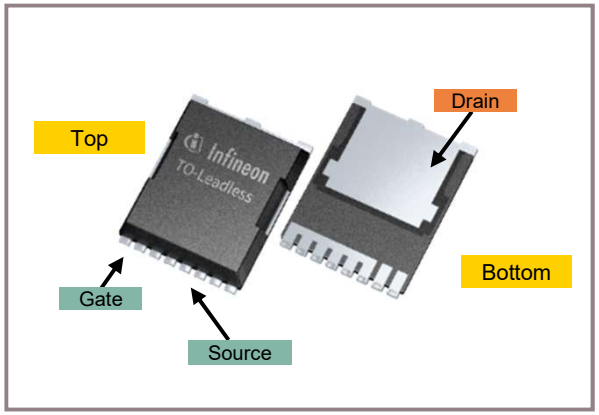
- Infineon leads the industry with respect to breath of portfolio.
- Infineon offers both best in-class silicon technology including our latest 100 V **OptiMOS™ 6**, and drive optimized devices which includes the new 80-100 V **StrongIRFET™ 2** devices.
- Infineon has a broad range of high performance power packages to suit the majority of our customer needs.
  - The newest packages include **sTOLL, TOLG, TOLT, SuperSO8 Super Cool, and PQFN 3.3x3.3 Source Down.**

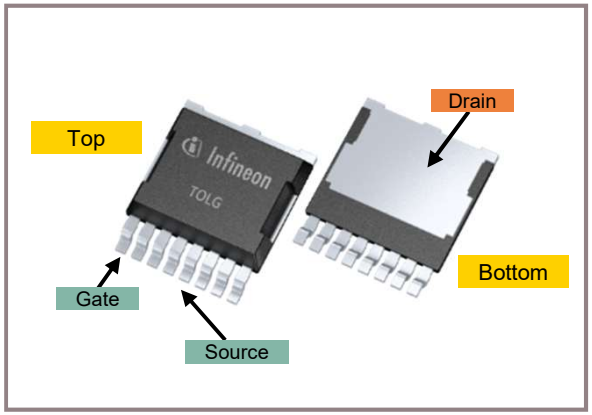


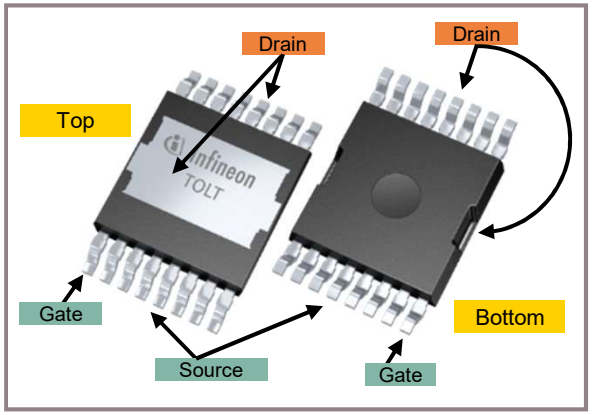

**Usage trending up** | **New package types**


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# TOLT vs TOLL and TOLG




| TOLL | TOLG | TOLT |
|---|---|---|
| **TO-Leadless** | TO-Leadless with **Gullwing leads** | TO-Leadless **Top Side Cooling** |
| Optimized for high power applications | Optimized for better TCoB robustness | Optimized for superior thermal performance |
| 60% board space reduction compared to D²PAK 7-pin leading to higher power density | High power density and superior thermal cycling on board (TCoB) performance | Top-side cooling negative stand-off leading to minimized thermal resistance to heat-sink |

Enable High Power Density, High Peak-Current handling and Superior Thermal Performance

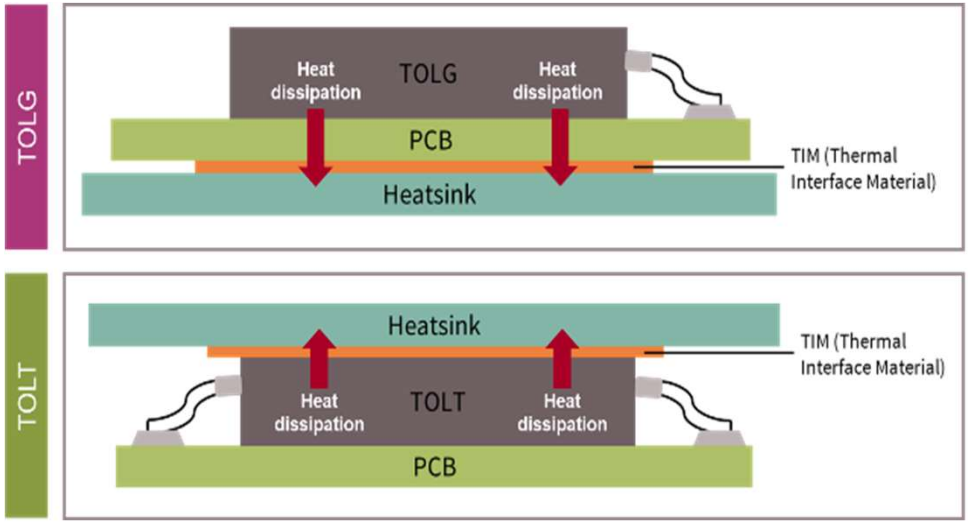

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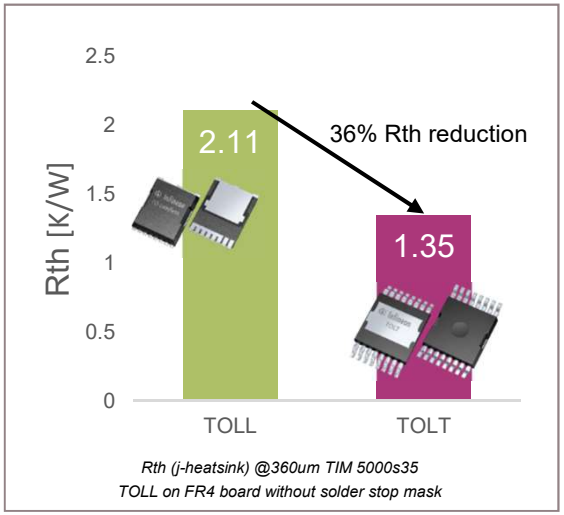
# OptiMOS™ 5 in TOLT – Top side cooling



## Value proposition

- BiC performance (very low $R_{DS(on)}$ and high current capability)
- Heat dissipation promoted directly to the heatsink ➔ 20% better $R_{thJA}$ compared to bottom side cooling packages
- TOLT reduces thermal resistance to heatsink by up to 50% compared to TOLL package
- Only 5% of the heat is getting dissipated through the PCB

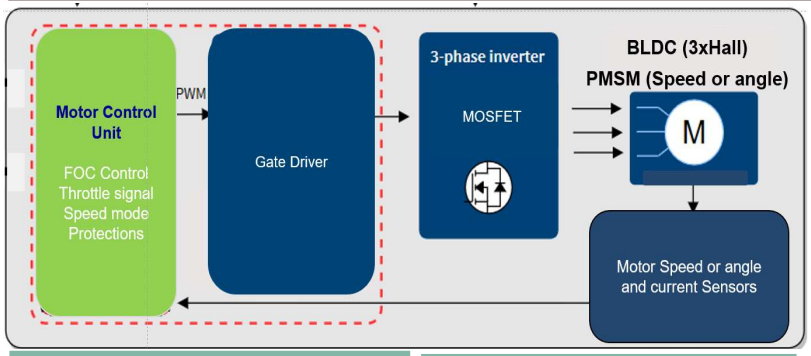




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# Motor Inverter – MOSFET, Gate Driver, Sensor, Microcontroller




| Current Sensor |
|---|
| TLI4971 |
| **Angle Sensor** |
| TLE5012B |
| **Gate Driver** |
| 2ED2181S06F |
| 2EDL8024G |
| TLE9180D-3xQK |
| AUIRS2181STR |

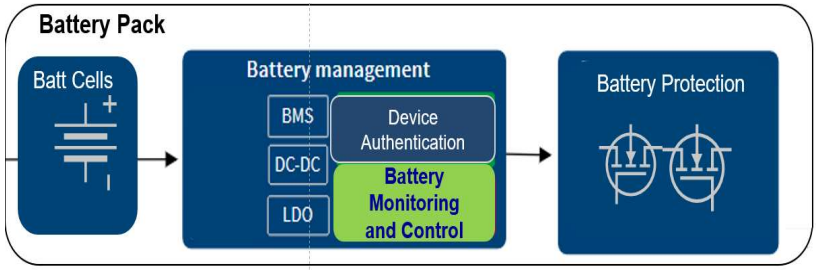
| Microcontroller - XMC |
|---|
| XMC1300/1400 |
| XMC4200/4400 |
| **Microcontroller - AURIX™** |
| SAK-TC21x/SAK-TC22xS |
| SAK-TC32x |
| **Microcontroller - Traveo™** |
| TVII-B-512K |
| TVII-B-1M |

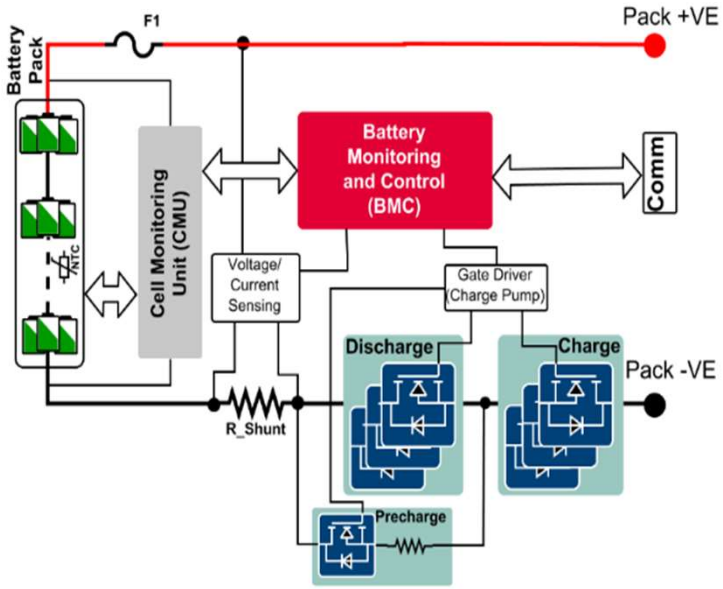
| Battery Voltage | MOSFET* | Voltage | $R_{DS(on)}$ max. [mΩ] | $I_D$ max [A] | Package | Remark |
|---|---|---|---|---|---|---|
| 48 V | IPT012N08N5 | 80 | 1.2 | 400 | TOLL | Industrial |
| | IPTC012N08NM5 | 80 | 1.2 | 396 | TOLT | Industrial |
| | IAUT300N08S5N012 | 80 | 1.2 | 300 | TOLL | Automotive |
| | IAUS300N08S5N012 | 80 | 1.2 | 300 | TOLG | Automotive |
| | IAUS300N08S5N012T | 80 | 1.2 | 300 | TOLT | Automotive |
| | IPTC014N08NM5 | 80 | 1.4 | 330 | TOLT | Industrial |
| | IAUA250N08S5N018 | 80 | 1.8 | 250 | sTOLL | Automotive |
| | IPB019N08N3 | 80 | 1.9 | 180 | D2PAK 7 pins | Industrial |
| | BSC021N08NS5 | 80 | 2.1 | 226 | Super SO8 | Industrial |
| | IPTG014N10NM5 | 100 | 1.4 | 366 | TOLG | Industrial |
| | IAUT300N10S5N014 | 100 | 1.4 | 300 | TOLL | Automotive |
| | IAUS300N10S5N014 | 100 | 1.4 | 300 | TOLG | Automotive |
| | IPTC015N10NM5 | 100 | 1.5 | 354 | TOLT | Industrial |
| | IPT015N10N5 | 100 | 1.5 | 300 | TOLL | Industrial |
| | IAUS300N10S5N015T | 100 | 1.5 | 300 | TOLT | Automotive |
| | IPB017N10N5 | 100 | 1.7 | 273 | D2PAK | Industrial |
| | IAUA210N10S5N024 | 100 | 2.4 | 212 | sTOLL | Automotive |
| | BSC027N10NS5 | 100 | 2.7 | 194 | D2PAK | Industrial |
| 72 – 96 V | IPT030N12N3 | 120 | 3.0 | 237 | TOLL | Industrial |
| | IPB038N12N3 | 120 | 3.8 | 120 | D2PAK | Industrial |
| | IPP041N12N3 G | 120 | 4.1 | 120 | PG-TO-220-3 | Industrial |
| | IPP100N12S3-05 | 120 | 4.8 | 100 | PG-TO-220-3 | Automotive |
| | IPB100N12S3-05 | 120 | 5.1 | 100 | PG-TO-263-3 | Automotive |
| | BSC077N12NS3 | 120 | 7.7 | 98 | Super SO8 | Industrial |
| | IPB048N15N5 | 150 | 4.8 | 120 | D2PAK | Industrial |
| | IPT059N15N3 | 150 | 5.9 | 155 | TOLL | Industrial |
| | AUIRFP4568 | 150 | 5.9 | 171 | PG-TO-247-3 | Automotive |
| | IPTG111N20NM3FD | 200 | 11.1 | 108 | TOLG | Industrial |
| | IPB117N20NFD | 200 | 11.7 | 84 | D2PAK | Industrial |
| | AUIRFS4127 | 200 | 22.0 | 72 | PG-TO-263-3 | Automotive |

Newest TOLx offerings; www.Infineon.com/tolx


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# Battery Management System



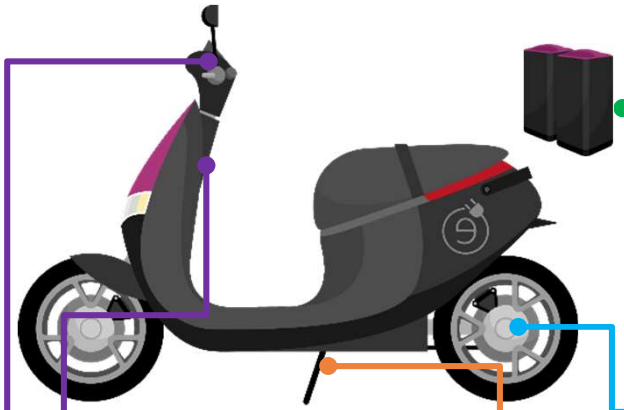

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| | IAUS300N10S5N014 | 100 | 1.4 | 300 | TOLG | Automotive |
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| | IPT015N10N5 | 100 | 1.5 | 300 | TOLL | Industrial |
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| | IPP041N12N3 G | 120 | 4.1 | 120 | PG-TO-220-3 | Industrial |
| | IPP100N12S3-05 | 120 | 4.8 | 100 | PG-TO-220-3 | Automotive |
| | IPB100N12S3-05 | 120 | 5.1 | 100 | PG-TO-263-3 | Automotive |
| | BSC077N12NS3 | 120 | 7.7 | 98 | Super SO8 | Industrial |
| | IPB048N15N5 | 150 | 4.8 | 120 | D2PAK | Industrial |
| | IPT059N15N3 | 150 | 5.9 | 155 | TOLL | Industrial |
| | AUIRFP4568 | 150 | 5.9 | 171 | PG-TO-247-3 | Automotive |
| | IPTG111N20NM3FD | 200 | 11.1 | 108 | TOLG | Industrial |
| | IPB117N20NFD | 200 | 11.7 | 84 | D2PAK | Industrial |
| | AUIRFS4127 | 200 | 22.0 | 72 | PG-TO-263-3 | Automotive |

Newest TOLx offerings; www.Infineon.com/tolx


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# Offerings for Complete System





## Charging

CoolMOS™ & OptiMOS™
EICEDRIVER™ 2EDS,
OPTIGA™ TPM

**Accessory Wireless Charging**
XMC™ -SC,OPTIGA™ Trust Charge

## BMS

**Protection FET**
OptiMOS™ 3/5

**Monitoring & Balancing IC**
TLE9012DQU

**Battery Authentication**
OPTIGA™
Authenticate IDoT

## HMI & Control unit

**Handle Bar Control**
XENSIV™ TLE4964, TLE493D
Controls (horn, turn indicator, light)
XENSIV™ TLE4997/98 (throttle)

**CapSense Capacitive-sensing**
PSoC 4000 - entry-level
PSoC 4100 - more touch buttons
PSoC 4700 - inductive sensing

## Connectivity & Security

**Wi-Fi + Bluetooth**
CYW4373/CYW43012
CYW54590/CYW54591

**eSIM**
OPTIGA™ Connect

**Security**
OPTIGA™ TPM

## Sensor Systems

**Distance & Presence Sensing**
XENSIV™ 24 GHz/60 GHz/77 GHz Radar & ToF 3D Imager

**Safety Sensing** XENSIV™ TLE4964 – Side stand position

## Motor Drive

**Power MOSFET**
OptiMOS™ 3/5 & StrongIRFET

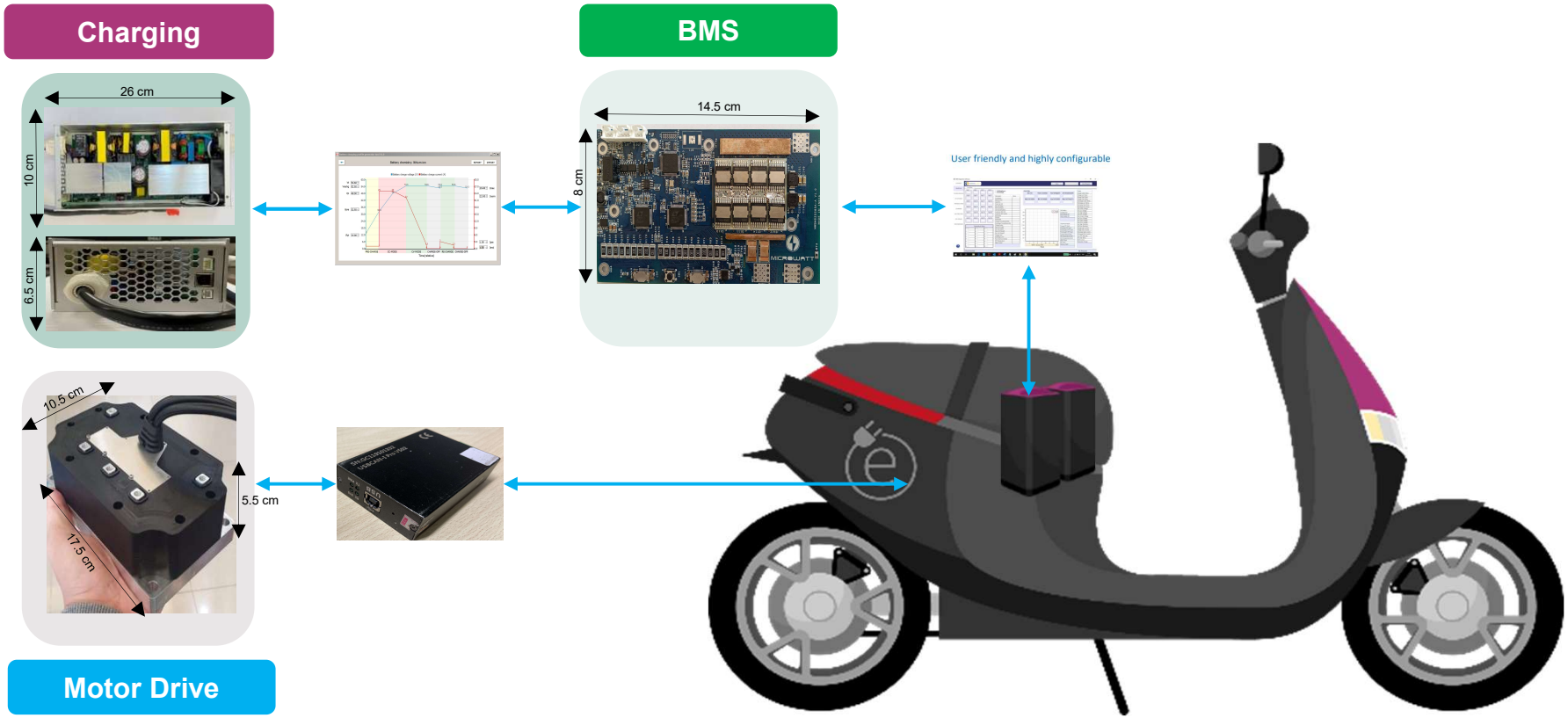
**Gate Driver**
EiceDRIVER™ 200V HB Driver

**Magnetic Position Sensors**
XENSIV™ TLE4961, TLE5012B, TLE5501 - for motor commutation

**Microcontroller**
XMC™13xx/14xx & AURIX™


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# IDH's 1.2KW Charger, 2-10KW Motor Inverter and BMS Turnkey Solutions





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# Test setup at Singapore System Competency Laboratory

› Test setup

Oscilloscope

Dynamometer controller

E-load

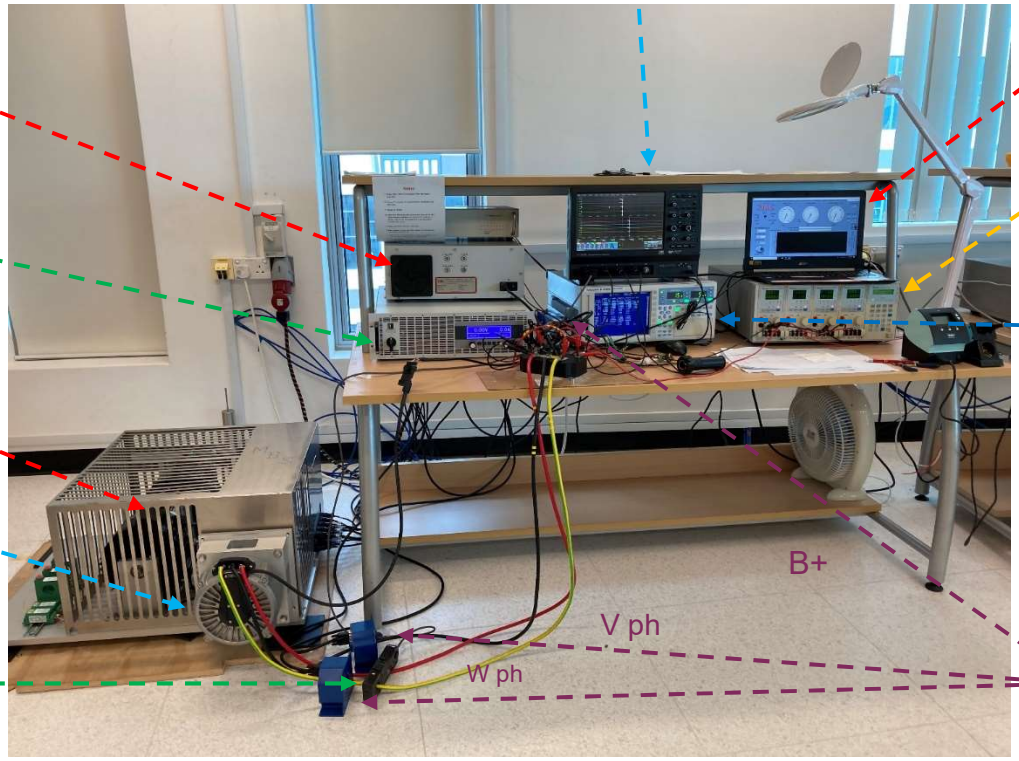
Dynamometer controller

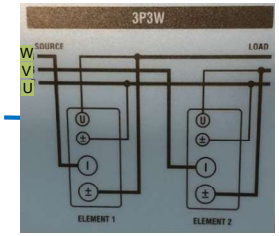
10kw Dc source 200V/140Amax

Dynamometer 9.8kw_cont

Ashwood motor IP65

High current probe 150Arms




power meter
Motor 3ph connection




400A current transducer


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# 1.2KW Off Board Charger


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# 600 V CoolMOS™ P7
## Product portfolio

### 600 V CoolMOS P7 SJ MOSFETs

| | $R_{DS(on)}$ [mΩ] | DPAK | D²PAK | ThinPAK 8x8 | TO220 FullPAK | TO220 | TO220 FP NL | TO220 FP WC | TO247 | TO247-4 | SOT223 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ind. Grade | 600 | IPD60R600P7 | | | IPA60R600P7 | IPP60R600P7 | | | | | |
| | 360/365 | IPD60R360P7 | IPB60R360P7 | IPL60R365P7 | IPA60R360P7 | IPP60R360P7 | | | | | |
| | 280/285 | IPD60R280P7 | IPB60R280P7 | IPL60R285P7 | IPA60R280P7 | IPP60R280P7 | | | | | |
| | 180/185 | IPD60R180P7 | IPB60R180P7 | IPL60R185P7 | IPA60R180P7 | IPP60R180P7 | | | IPW60R180P7 | IPZA60R180P7 | |
| | 160 | | | | IPA60R160P7 | IPP60R160P7 | | | | | |
| | 120/125 | | IPB60R120P7 | IPL60R125P7 | IPA60R120P7 | IPP60R120P7 | | | IPW60R120P7 | IPZA60R120P7 | |
| | 99/105 | | IPB60R099P7 | IPL60R105P7 | IPA60R099P7 | IPP60R099P7 | | | IPW60R099P7 | IPZA60R099P7 | |
| | 80 | | IPB60R080P7 | IPL60R085P7 | IPA60R080P7 | IPP60R080P7 | | | IPW60R080P7 | IPZA60R080P7 | |
| | 60/65 | | IPB60R060P7 | IPL60R065P7 | IPA60R060P7 | IPP60R060P7 | | | IPW60R060P7 | IPZA60R060P7 | |
| | 45 | | IPB60R045P7 | | | | | | IPW60R045P7 | IPZA60R045P7 | |
| | 37 | | | | | | | | IPW60R037P7 | IPZA60R037P7 | |
| | 24 | | | | | | | | IPW60R024P7 | IPZA60R024P7 | |
| Std. Grade | 600 | IPD60R600P7S | | | IPA60R600P7S | | IPAN60R600P7S | IPAW60R600P7S | | | IPN60R600P7S |
| | 360 | IPD60R360P7S | | | IPA60R360P7S | | IPAN60R360P7S | IPAW60R360P7S | | | IPN60R360P7S |
| | 280 | IPD60R280P7S | | | IPA60R280P7S | | IPAN60R280P7S | IPAW60R280P7S | | | |
| | 180 | IPD60R180P7S | | | IPA60R180P7S | | IPAN60R180P7S | IPAW60R180P7S | | | |

ESD ruggedness: HBM class 2 (>2kV)

Infineon's $R_{DSon}$ recommendation for LEV
Packages vary based on application / form factor





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# 600 V CoolMOS™ CFD7
## Product portfolio

### 600 V CoolMOS™ CFD7 SJ MOSFETs

| $R_{DS(ON)}$ [mΩ] | TO-263 D²PAK | TO-252 D-PAK | ThinPAK 8x8* | TO-220 | TO-220 FullPAK | TO-247 | TOLL | DDPAK | QDPAK |
|---|---|---|---|---|---|---|---|---|---|
| 360 | IPB60R360CFD7 | IPD60R360CFD7 | | IPP60R360CFD7 | IPA60R360CFD7 | | | | |
| 280 | IPB60R280CFD7 | IPD60R280CFD7 | | IPP60R280CFD7 | IPA60R280CFD7 | | | | |
| 210/215 | IPB60R210CFD7 | IPD60R210CFD7 | IPL60R225CFD7 | IPP60R210CFD7 | IPA60R210CFD7 | | | | |
| 170/185 | IPB60R170CFD7 | IPD60R170CFD7 | IPL60R185CFD7 | IPP60R170CFD7 | IPA60R170CFD7 | IPW60R170CFD7 | | IPDD60R170CFD7 | |
| 145/160 | IPB60R145CFD7 | IPD60R145CFD7 | IPL60R160CFD7 | IPP60R145CFD7 | IPA60R145CFD7 | IPW60R145CFD7 | IPT60R145CFD7 | IPDD60R145CFD7 | |
| 125/140 | IPB60R125CFD7 | | IPL60R140CFD7 | IPP60R125CFD7 | IPA60R125CFD7 | IPW60R125CFD7 | IPT60R125CFD7 | IPDD60R125CFD7 | |
| 105/115 | IPB60R105CFD7 | | IPL60R115CFD7 | IPP60R105CFD7 | | IPW60R105CFD7 | IPT60R105CFD7 | IPDD60R105CFD7 | |
| 90/95 | IPB60R090CFD7 | | IPL60R095CFD7 | IPP60R090CFD7 | | IPW60R090CFD7 | IPT60R090CFD7 | IPDD60R090CFD7 | |
| 70/75 | IPB60R070CFD7 | | IPL60R075CFD7 | IPP60R070CFD7 | | IPW60R070CFD7 | IPT60R075CFD7 | IPDD60R075CFD7 | IPDQ60R075CFD7 |
| 55/60 | IPB60R055CFD7 | | IPL60R060CFD7 | | | IPW60R055CFD7 | IPT60R055CFD7 | IPDD60R055CFD7 | IPDQ60R055CFD7 |
| 40/45 | IPB60R040CFD7 | | | | | IPW60R040CFD7 | IPT60R045CFD7 | IPDD60R045CFD7 | IPDQ60R045CFD7 |
| 31/35 | | | | | | IPW60R031CFD7 | IPT60R035CFD7 | | IPDQ60R035CFD7 |
| 24/25 | | | | | | IPW60R024CFD7 | | | IPDQ60R025CFD7 |
| 18/20 | | | | | | IPW60R018CFD7 | | | IPDQ60R020CFD7 |
| 15 | | | | | | | | | IPDQ60R015CFD7 |

Infineon's $R_{DSon}$ recommendation for LEV
Packages vary based on application / form factor




Released | TBD


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# 650 V CoolMOS™ CFD7
## Product portfolio

| 650 V CoolMOS™ CFD7 SJ MOSFETs | | | | | | | |
|---|---|---|---|---|---|---|---|
| $R_{DS(on)}$ [Ω] |  TO-220 |  TO-247 |  TO247-4 |  TO-263 D²PAK |  ThinPAK 8x8 |  TOLL |  QDPAK TSC |
| 190/200 | IPP65R190CFD7 | | | | IPL65R200CFD7 | IPT65R190CFD7 | |
| 155/160 | IPP65R155CFD7 | IPW65R155CFD7 | | IPB65R155CFD7 | IPL65R160CFD7 | IPT65R155CFD7 | |
| 125/130 | | IPW65R125CFD7 | | IPB65R125CFD7 | IPL65R130CFD7 | IPT65R125CFD7 | IPDQ65R125CFD7 |
| 110/115 | IPP65R110CFD7 | IPW65R110CFD7 | | IPB65R110CFD7 | IPL65R115CFD7 | | |
| 90/95/99 | IPP65R090CFD7 | IPW65R090CFD7 | | IPB65R090CFD7 | IPL65R095CFD7 | IPT65R099CFD7 | IPDQ65R099CFD7 |
| 80 | | | | | | IPT65R080CFD7 | IPDQ65R080CFD7 |
| 60/65 | IPP65R060CFD7 | IPW65R060CFD7 | | | IPL65R065CFD7 | IPT65R060CFD7 | IPDQ65R060CFD7 |
| 40 / 41 | IPP65R041CFD7 | IPW65R041CFD7 | | IPB65R041CFD7 | | IPT65R040CFD7 | IPDQ65R040CFD7 |
| 29 | | IPW65R029CFD7 | IPZA65R029CFD7 | | | | IPDQ65R029CFD7 |
| 17 / 18 | | IPW65R018CFD7 | IPZA65R018CFD7 | | | | IPDQ65R017CFD7 |

Infineon's $R_{DSon}$ recommendation for LEV
Packages vary based on application / form factor




Released | Coming Soon | TBD

Solution to address soft-switching applications in high power SMPS


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# 650 V CoolMOS™ CFD7A
## Product portfolio

### Automotive 650V CoolMOS™ CFD7A SJ MOSFET

| Min. board space | 150 mm² | 150 mm² | 45 mm² | 80 mm² | 80 mm² | 315 mm² | 315 mm² |
|---|---|---|---|---|---|---|---|
| $R_{DS(ON)}$ max. [mΩ] |  TO-263 D²PAK |  TO-263-7 D²PAK 7 pin |  TO-220 |  TO-247-3 |  TO-247-3 short leads |  QDPAK TSC |  QDPAK BSC |
| **230** | IPB65R230CFD7A | IPBE65R230CFD7A | | | | | |
| **190** | IPB65R190CFD7A | IPBE65R190CFD7A | IPP65R190CFD7A | IPW65R190CFD7A | | | |
| **145** | IPB65R145CFD7A | IPBE65R145CFD7A | IPP65R145CFD7A | IPW65R145CFD7A | | | |
| **115/125** | IPB65R115CFD7A | IPBE65R115CFD7A | IPP65R115CFD7A | IPW65R115CFD7A | | IPDQ65R125CFD7A | IPQC65R125CFD7A |
| **99** | IPB65R099CFD7A | IPBE65R099CFD7A | IPP65R099CFD7A | IPW65R099CFD7A | | IPDQ65R099CFD7A* | IPQC65R099CFD7A |
| **75/80** | IPB65R075CFD7A | IPBE65R075CFD7A | IPP65R075CFD7A | IPW65R075CFD7A | IPWS65R075CFD7A | IPDQ65R080CFD7A* | IPQC65R080CFD7A |
| **50/60** | IPB65R050CFD7A | IPBE65R050CFD7A | IPP65R050CFD7A | IPW65R050CFD7A | IPWS65R050CFD7A | IPDQ65R060CFD7A* | IPQC65R060CFD7A |
| **35/40** | | | | IPW65R035CFD7A | IPWS65R035CFD7A | IPDQ65R040CFD7A | IPQC65R040CFD7A |
| **22/29** | | | | IPW65R022CFD7A | IPWS65R022CFD7A | IPDQ65R029CFD7A | IPQC65R029CFD7A |
| **17** | | | | | | IPDQ65R017CFD7A | IPQC65R017CFD7A |

SOP April 2021

SOP Q4 CY2021
ES Q3 CY2021

SOP Q4 CY2021
ES available

SOP Q4 CY2022
EES available
*EES coming soon
ES Q3 CY2021

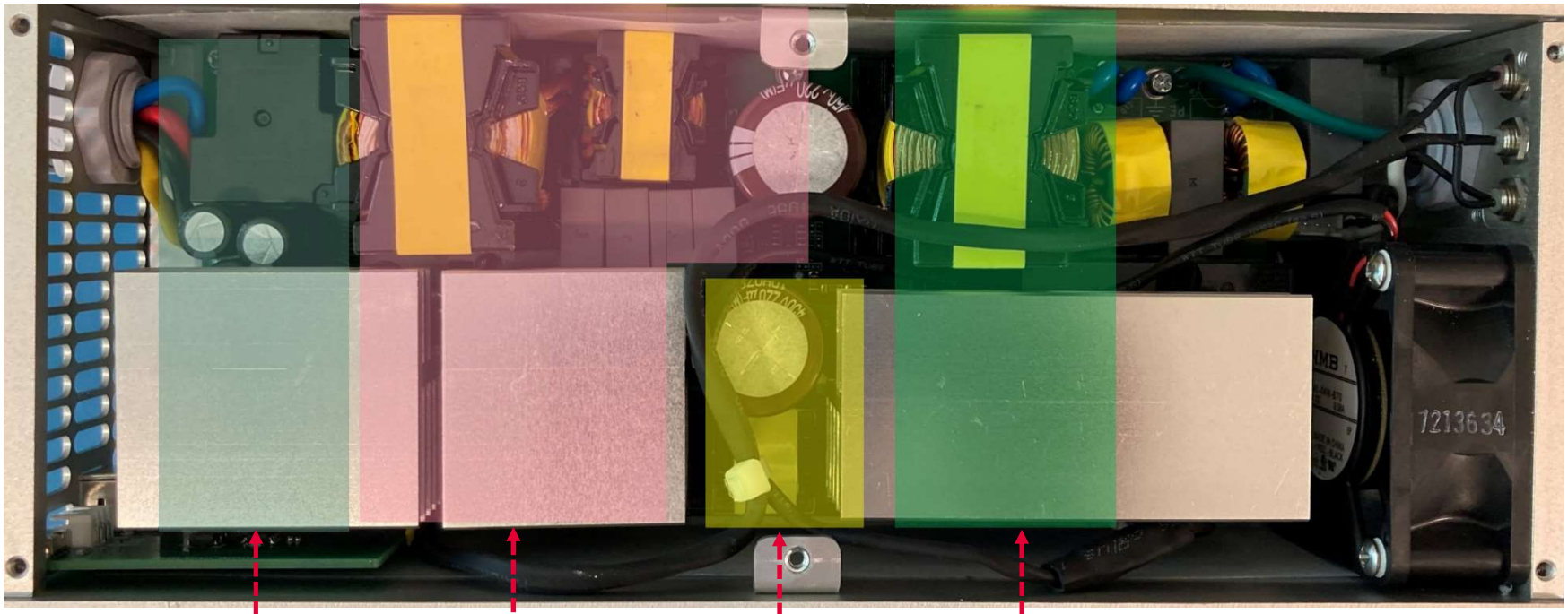
SOP Q4 CY2022
EES Q3 CY2021
ES Q4 CY2021

SOP CY2023

**DISCLAIMERS**
**Dates** in the roadmap **are subject to change** before the SOP date.
**RDS(on)** (and hence the product names) **are subject to change** before the SOP (start of production) date.
Customers cannot use this roadmap as a base for planning the start of production or taking other tactical decisions, but they are welcome to use it to sync their product strategies with the ones of Infineon.


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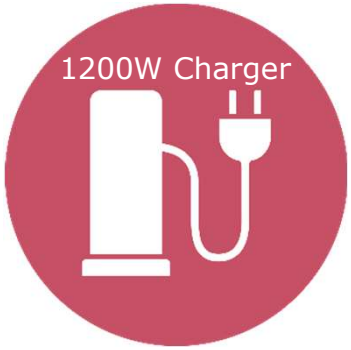
# Overview of 1.2KW LEV Battery Charger





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# Key features




## Features & Benefits

- Wide range input operation 110 $V_{AC}$ – 265 $V_{AC}$
- Capable of charging lead-acid, Li-ion, LiFeO4 batteries
- Battery capacity selection 20 Ah – 100 Ah
- Comprehensive protection features
- Easy battery charging profile configuration via GUI
- Can work with Solar panel as input (optional)
- Booster function to charge battery faster
- Silent mode when charging over night -> better customer experience

## Protections

- Non destructed Input protection up to 315 $V_{AC}$
- Over temperature protection
- Output short circuit protection
- Output overload protection

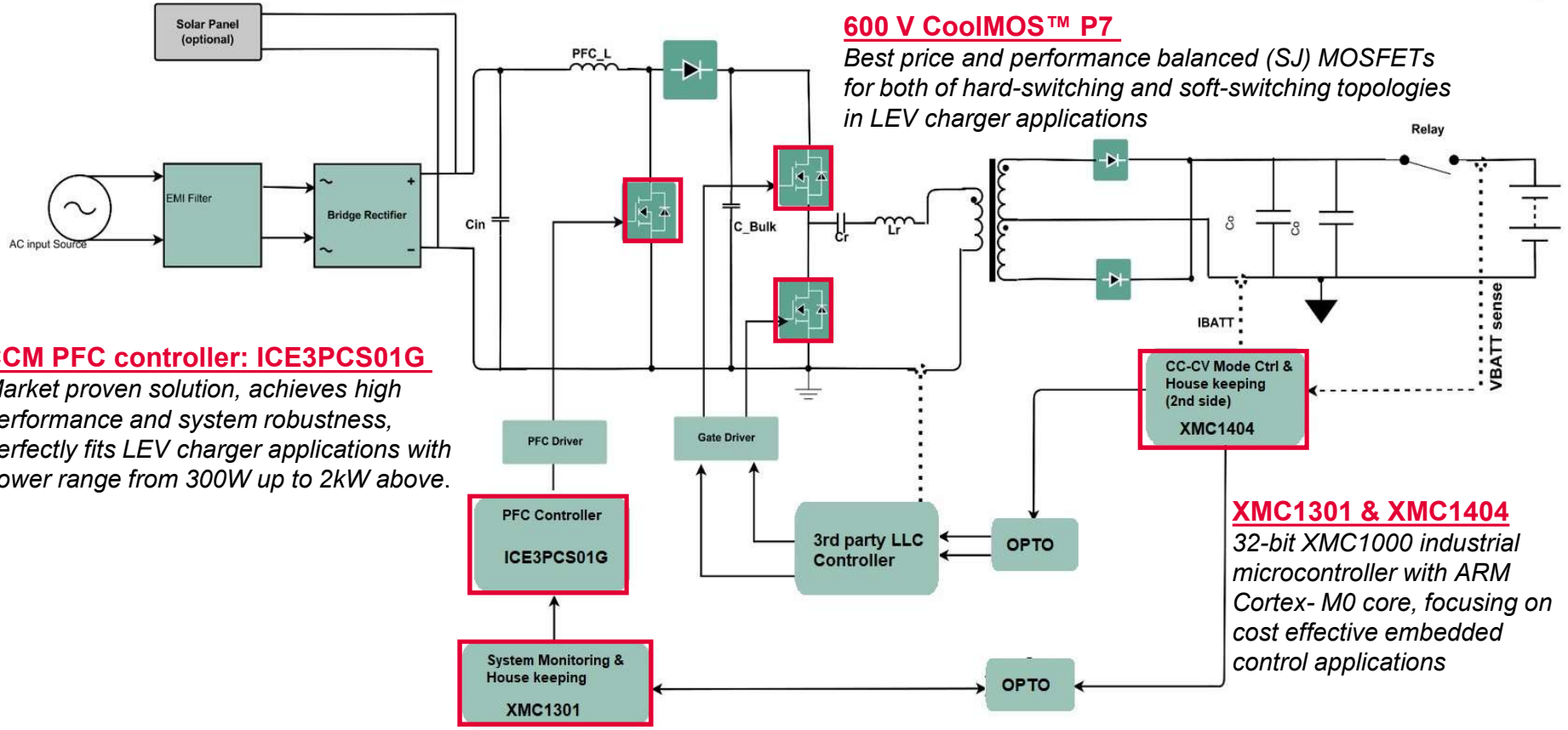

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# Key specifications

| Key Specifications of 1.2KW LEV Off-board Charger | |
|---|---|
| **Input voltage range**<br>- Full output power<br>- Power derating | 110 - 265 $V_{AC}$<br>-185 – 265 $V_{AC}$<br>-110 – 185 $V_{AC}$ |
| **Maximum AC input current** | 6A @ full load, 230$V_{AC}$ input. |
| **Line Frequency** | 50 to 60 Hz |
| **Optimal battery cells in series** | 13 to 14 cell Lithium Ion<br>or 14 to 18 cell Lithium iron phosphate (LiFePO4/LFP)<br>or lead acid battery |
| **Battery voltage** | Default 48 V (60V and 72V optional with minor HW modifications) |
| **Output voltage range** | 40 - 60V |
| **Rated output current** | Max 25A |
| **Max output power** | 1200W ( 48V/ 25A ) |
| **Conversion efficient** | ≥ 92% at full load, $_C$; ≥90% from 25% of rated load upwards with 230$V_{Ac}$ |
| Power factor | ≥ 0.95 at full load, 230$V_{AC}$ |
| Total current harmonic distortion | ≤ 5% at full load, 230$V_{AC}$ |
| Operation Temperature | 0˚C ~ +55˚C |
| **Protections** | LOVP, BO, UVP, OLP, SCP, OTP Reverse polarity protection (optional) |
| **Control interface** | CAN bus 2.0 default (Mobus / Wifi / BLE optional) |
| **Cooling** | **Fan with dual speed control** |
| **Dimension (L x W x H)** | 270mm X 105mm X 65mm |
| **Weight** | 1.6 kg |


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# Infineon Key Components




**600 V CoolMOS™ P7**

*Best price and performance balanced (SJ) MOSFETs for both of hard-switching and soft-switching topologies in LEV charger applications*

**CCM PFC controller: ICE3PCS01G**

*Market proven solution, achieves high performance and system robustness, perfectly fits LEV charger applications with power range from 300W up to 2kW above.*

**XMC1301 & XMC1404**

*32-bit XMC1000 industrial microcontroller with ARM Cortex- M0 core, focusing on cost effective embedded control applications*

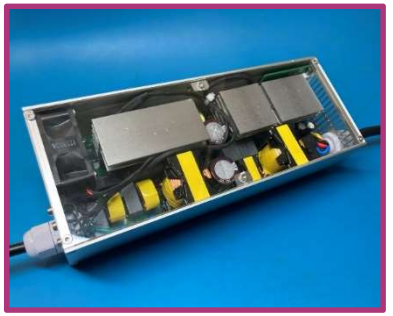

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# Test setup in Singapore System Competency Laboratory

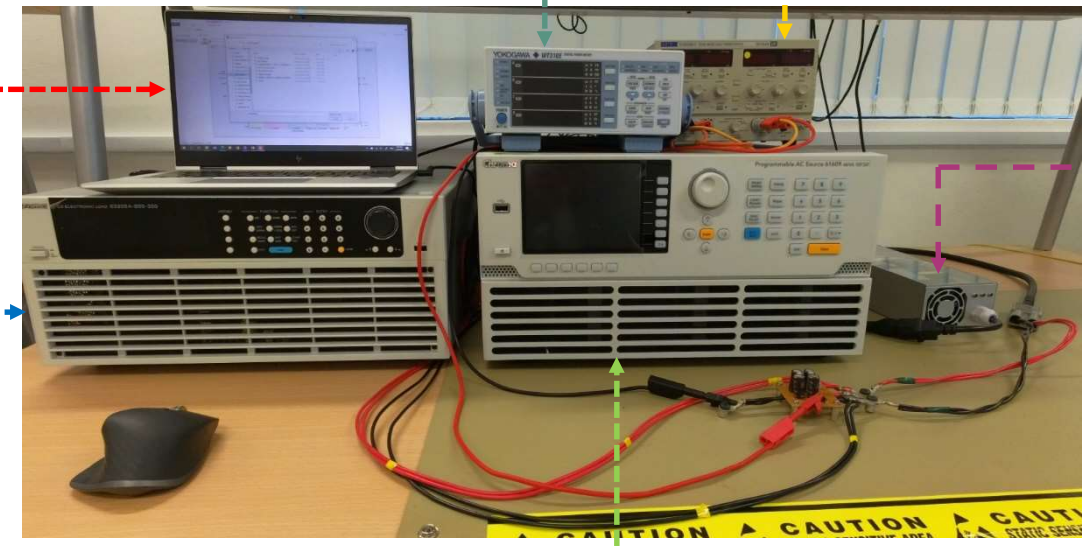
Digital power meter
Model: WT310

DC Power source
Model: PL303QMD

DUT
1.2KW Charger



Software
Battery Charger Management & Profile Generator



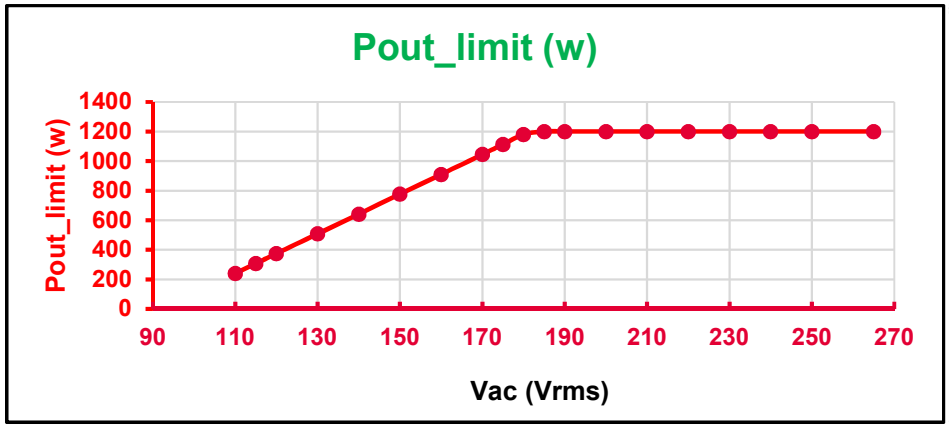

DC Electronic load
Model: 63205A

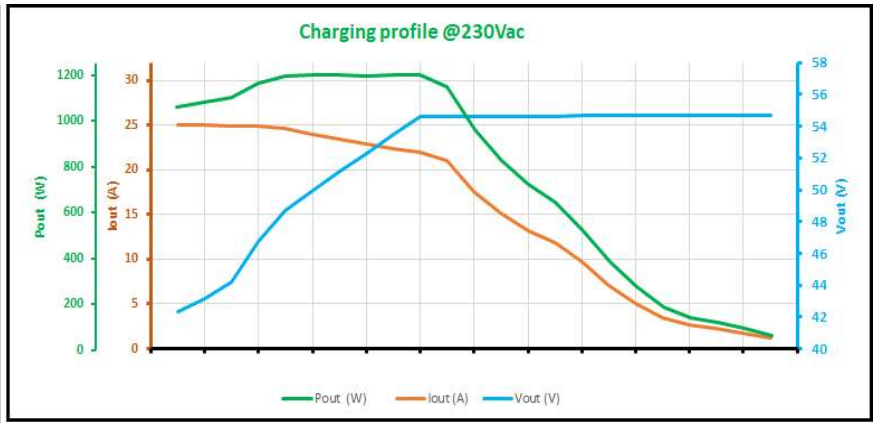
Programmable AC Source
Model: 61608

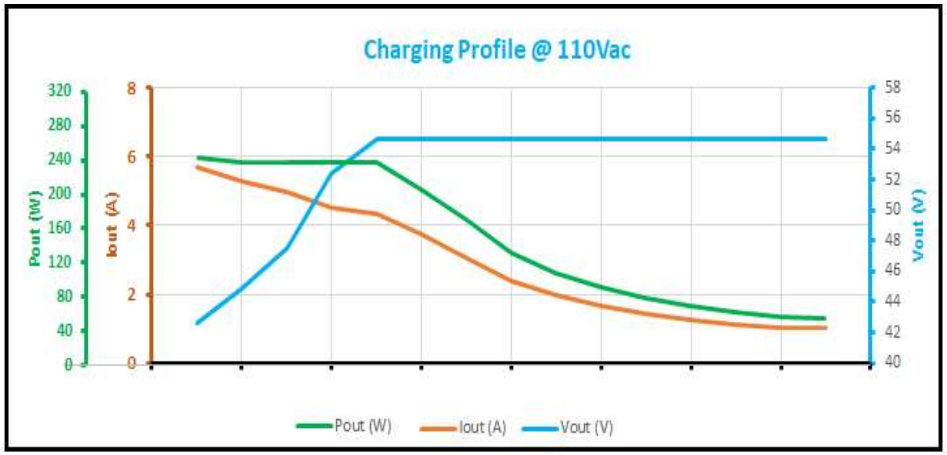

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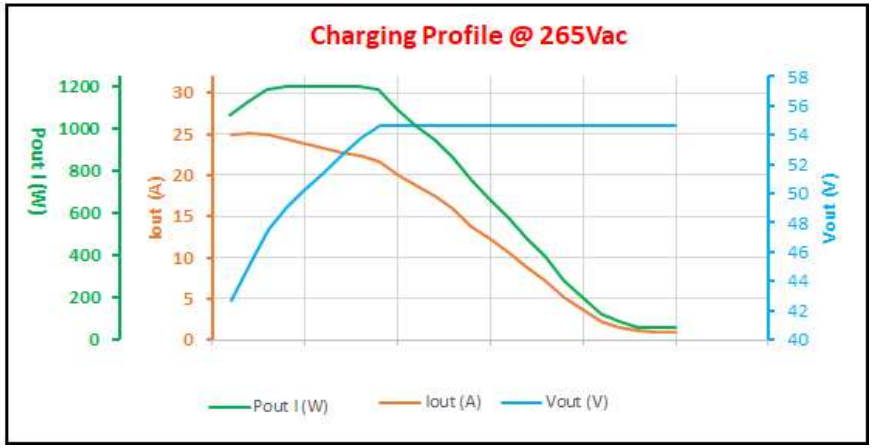
# Power limits & Charging profiles

@ 230Vac, 110Vac and 265Vac



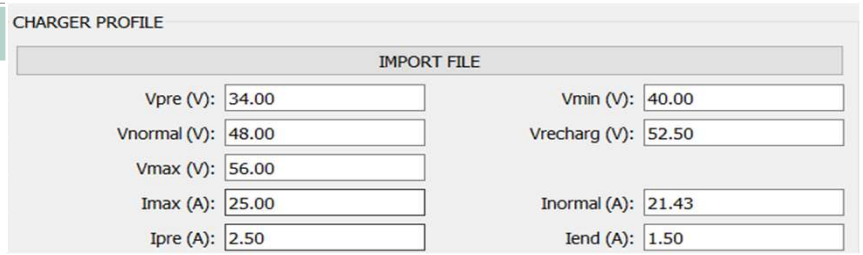





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# Charger performance
@ 230Vac

| Test Equipment/Tool | |
|---|---|
| Test Software | Battery Charger Management/Monitor |
| Programmable AC Source | Chroma 61608 |
| DC Electronic Load | Chroma 63205A, in CR mode |
| Digital Power meter | Yokogawa WT310 |
| DC Power Source | TME PL303QMD |

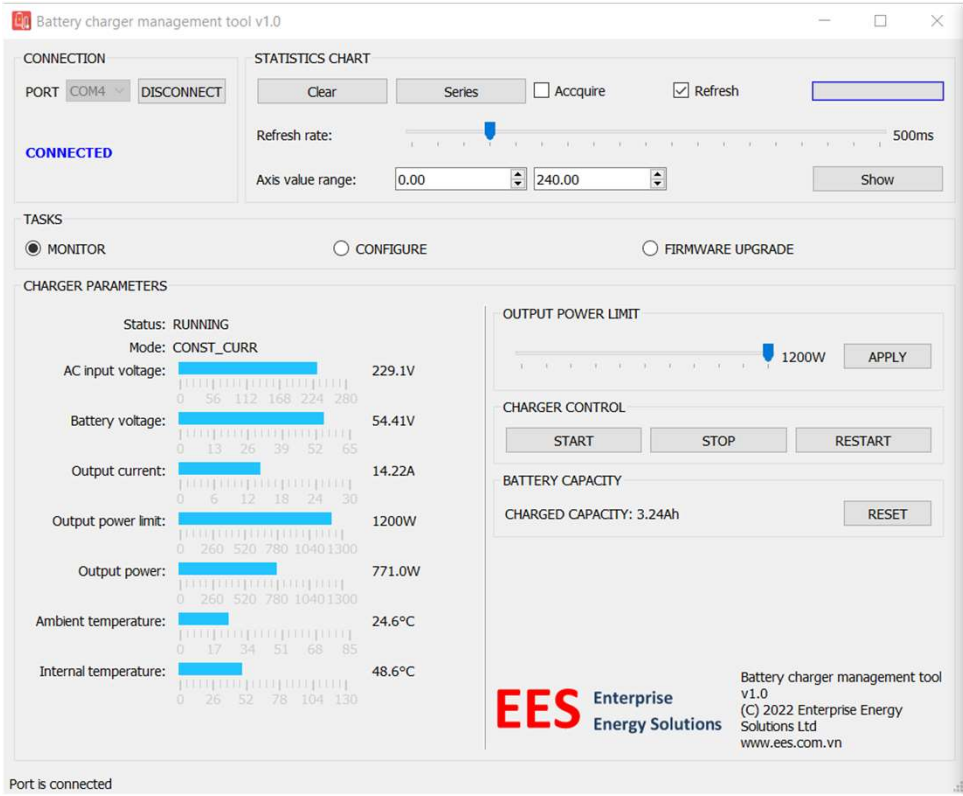



| Op. Mode | % of Load | $P_{in}$ (w) | $I_{in}$ (A) | PF | THD_A (%) | $V_{out}$ (V) | $I_{out}$ (A) | η (%) | $P_O$ (W) |
|---|---|---|---|---|---|---|---|---|---|
| Pre-charg. | 7.39% | 105.07 | 0.620 | 0.7362 | 17.8% | 34.36 | 2.58 | 84.38% | 89 |
| | 8.12% | 112.91 | 0.654 | 0.7494 | 19.0% | 39.95 | 2.44 | 86.44% | 97 |
| CC Charg. | 83.95% | 1,108.70 | 4.860 | 0.991 | 3.6% | 40.2 | 25.06 | 91.30% | 1007 |
| | 88.26% | 1,162.00 | 5.090 | 0.9918 | 3.7% | 42.5 | 24.92 | 91.57% | 1059 |
| | 93.56% | 1,227.50 | 5.380 | 0.992 | 3.9% | 45 | 24.95 | 91.83% | 1123 |
| | 96.23% | 1,260.00 | 5.520 | 0.993 | 3.8% | 46.3 | 24.94 | 91.99% | 1155 |
| CP Charg. | 99.72% | 1,305.50 | 5.725 | 0.992 | 3.3% | 48.41 | 24.72 | 91.94% | 1197 |
| | 99.98% | 1,301.50 | 5.706 | 0.9919 | 3.0% | 52.69 | 22.77 | 92.49% | 1200 |
| | 99.88% | 1,299.80 | 5.698 | 0.992 | 3.0% | 53.82 | 22.27 | 92.52% | 1199 |
| | 99.87% | 1,300.10 | 5.699 | 0.992 | 3.0% | 54.95 | 21.81 | 92.49% | 1198 |
| CV Charg. | 99.78% | 1,299.70 | 5.698 | 0.992 | 3.0% | 56.03 | 21.37 | 92.42% | 1197 |
| | 71.94% | 933.80 | 4.118 | 0.9859 | 2.9% | 56.06 | 15.4 | 92.66% | 863 |
| | 49.72% | 646.6 | 2.888 | 0.9734 | 2.7% | 56.07 | 10.64 | 92.39% | 597 |
| | 24.39% | 323 | 1.547 | 0.9077 | 11.7% | 56.08 | 5.22 | 90.68% | 293 |
| | 9.82% | 138.6 | 0.790 | 0.7626 | 18.2% | 56.09 | 2.1 | 84.97% | 118 |
| End Charg. | 7.06% | 103.25 | 0.636 | 0.7054 | 18.3% | 56.09 | 1.51 | 82.02% | 85 |

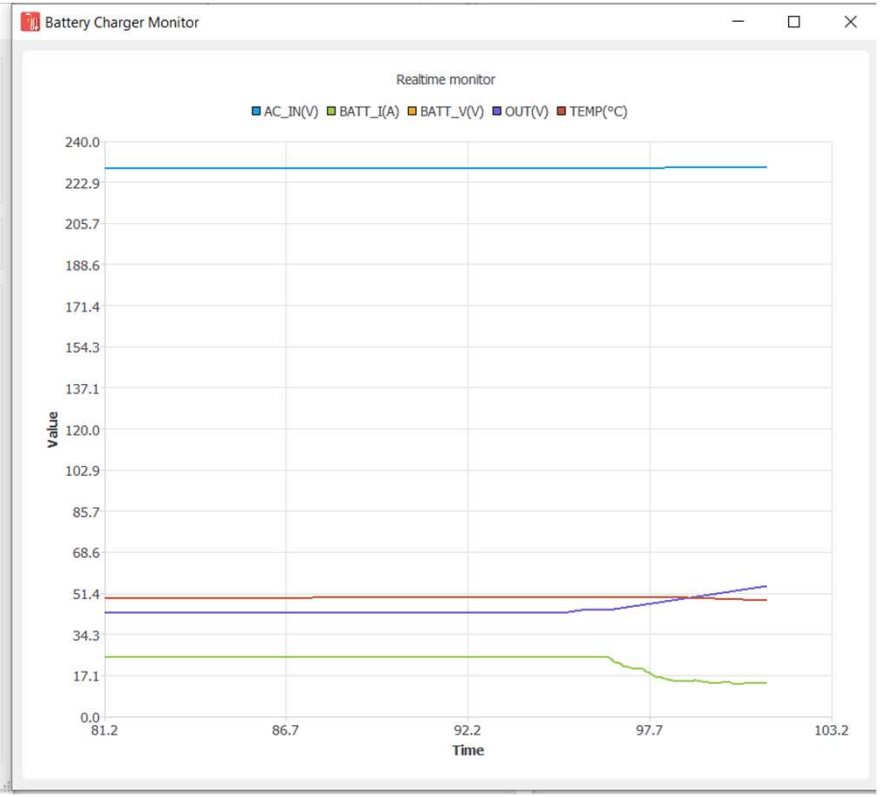

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# Battery Charger Management Tool

- **Battery Charger Management tool**




- **Realtime Charger Monitor**



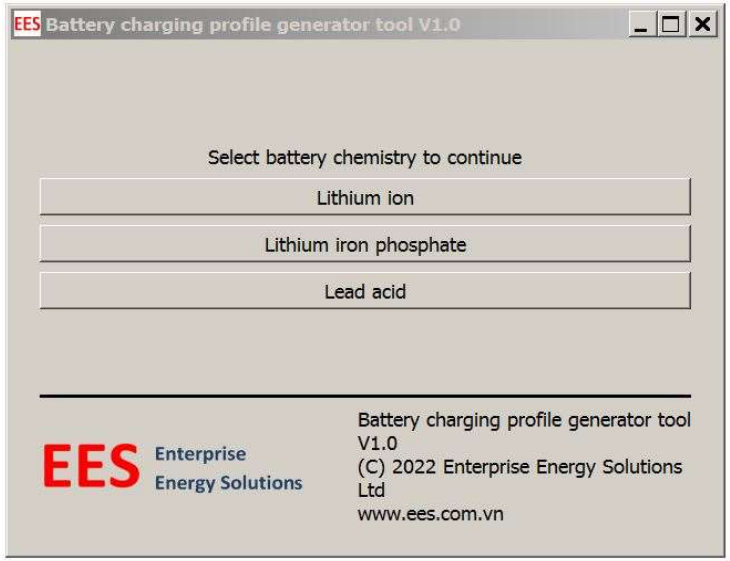


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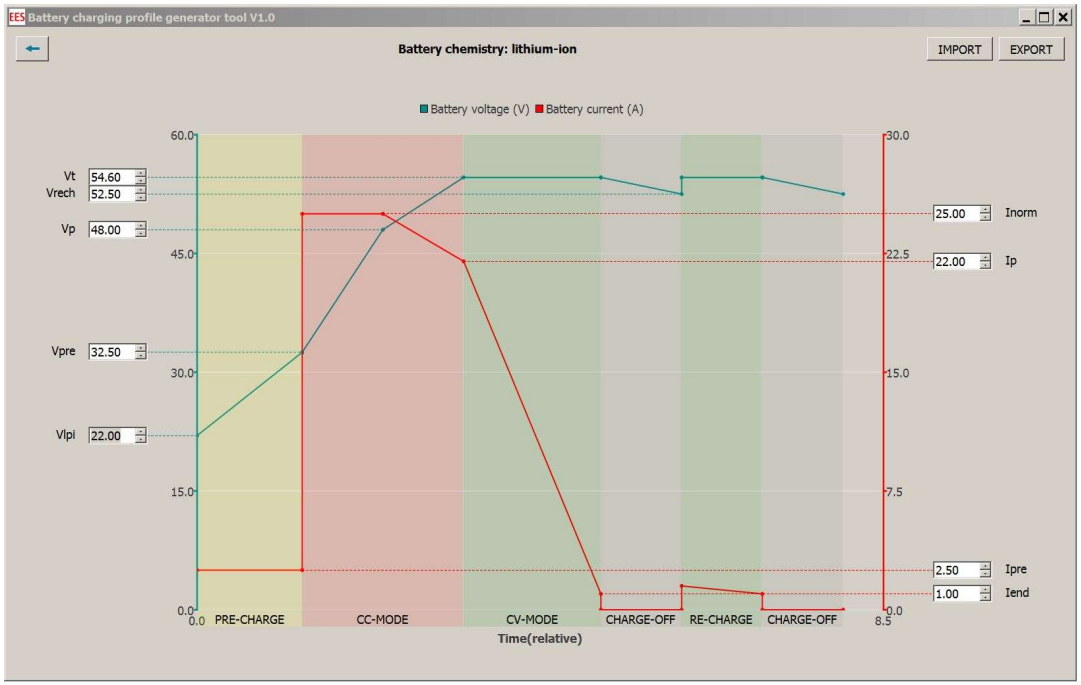
# Charging Profile Generator

--Configure battery charging profile

- **Select the battery chemistry**




- **Customize charging profile**




## Procedures

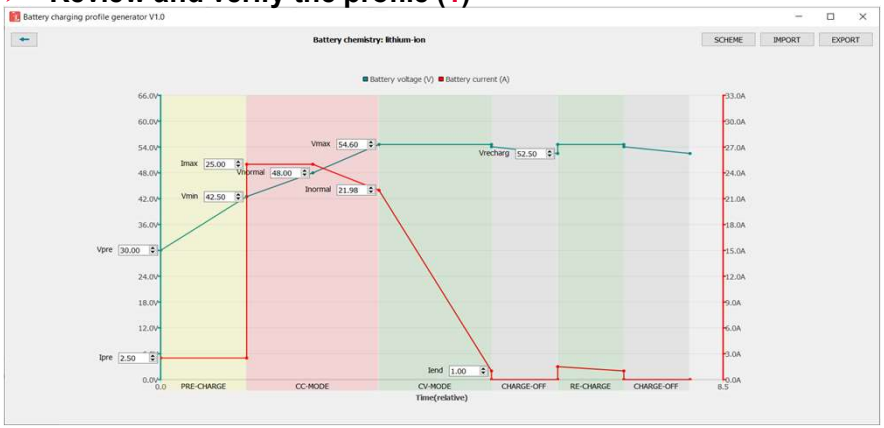
- ❑ Select battery chemistry
- ❑ Customize the charging profile by setting
  - Entry levels of each charging mode
  - The max current and power limits in high speed charging modes
  - Battery UVP, OVP and end charging cut-off current


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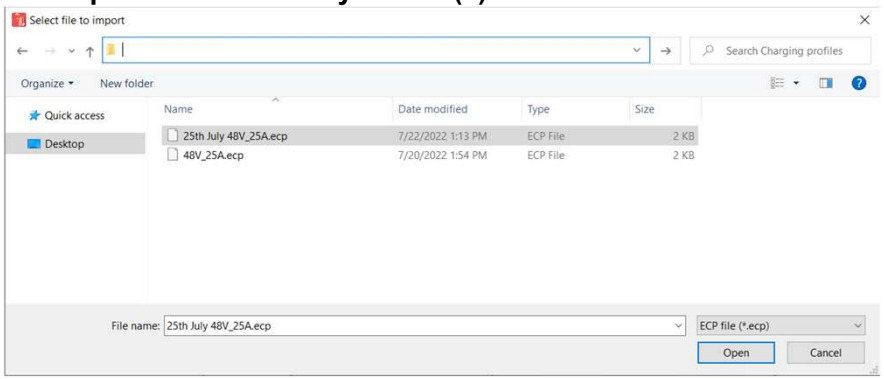
# Charging Profile Generator

-- Review; Export & Save; Load the new charging profile

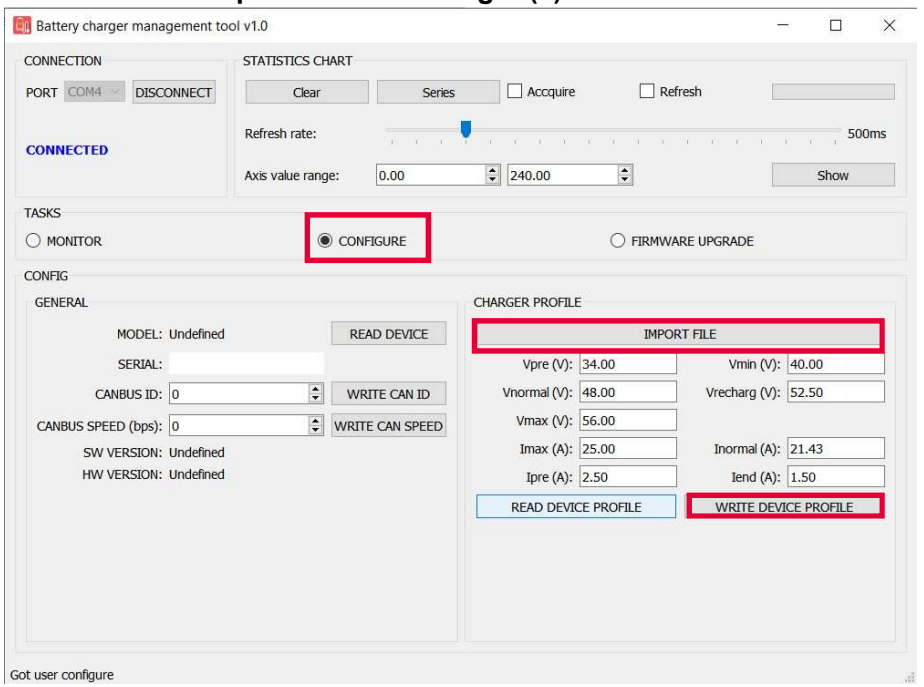
➢ **Review and verify the profile (1)**




➢ **Export and save it to your PC (2)**




➢ **Load the new profile to the Charger (3)**




**Configure:**

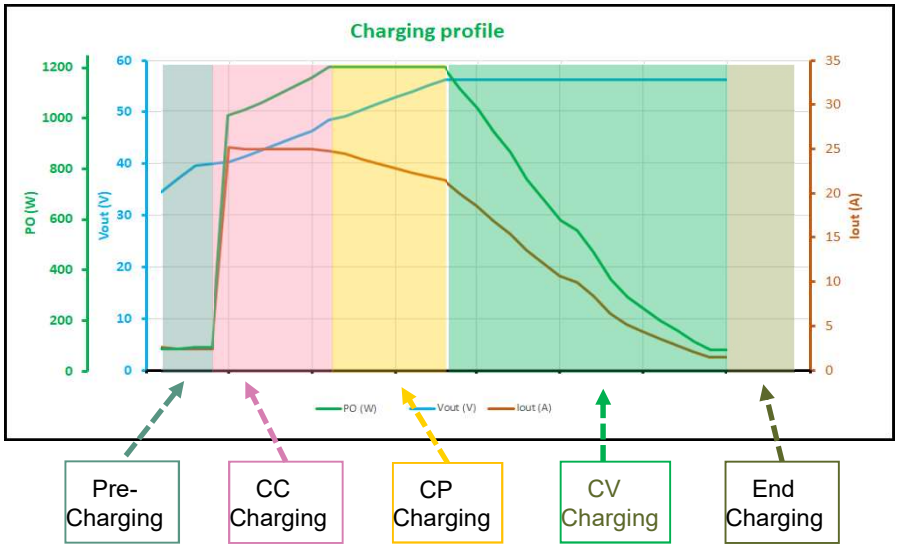
Import profile → Write to device → Restart the charger w new profile


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# Real data plot vs. New Profile

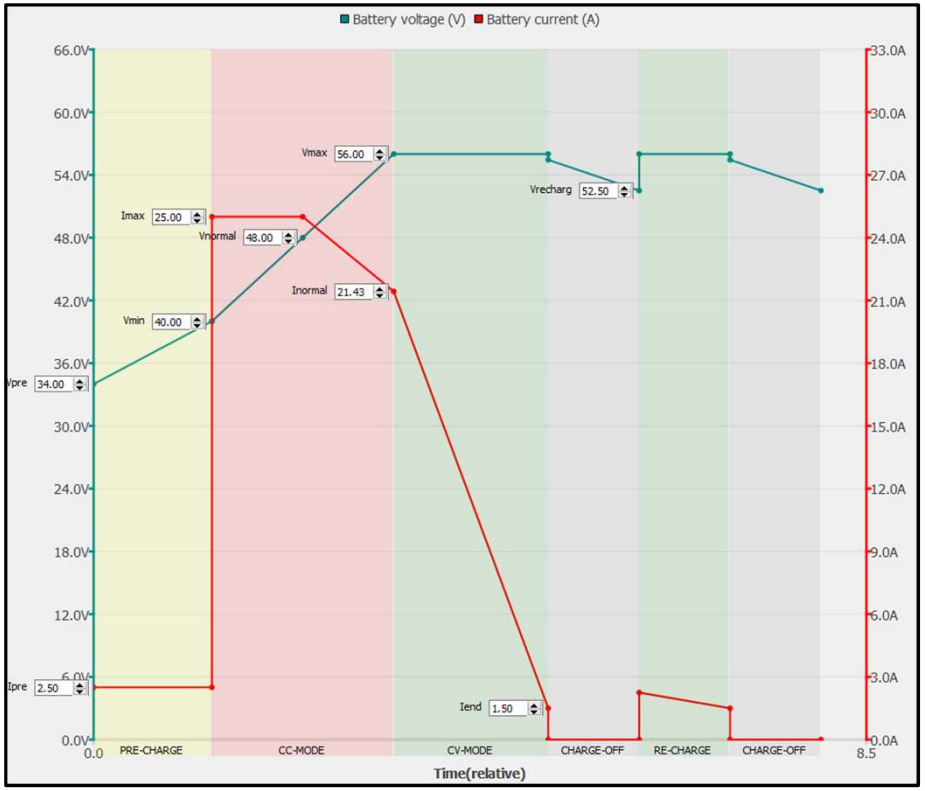
-- Full charging profile plot and verification

## › Real data plot




- **Test data plot well matched its charging profile**
- **Established 4 Charging Modes**
  - Pre-charging
  - Constant Current (CC) charging
  - Constant Power (CP) charging
  - Constant Voltage (CV) charging

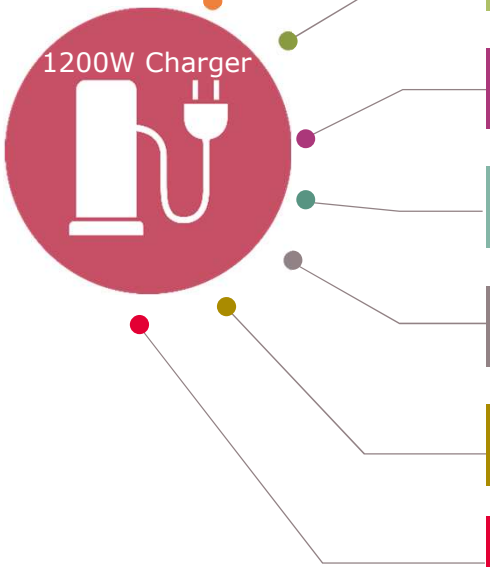
## › New Profile





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# Summary




- Wide input range of 110 $V_{AC}$ – 265 $V_{AC}$
- Capable of charging Multi-Chemistry Battery
- Programmable charging profile via GUI
- Compact and portable design with fan cooling
- Flexible cost and performance for each customer
- Boost/Silent mode enable/disable via CAN Bus
- Optional for working with solar panels


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