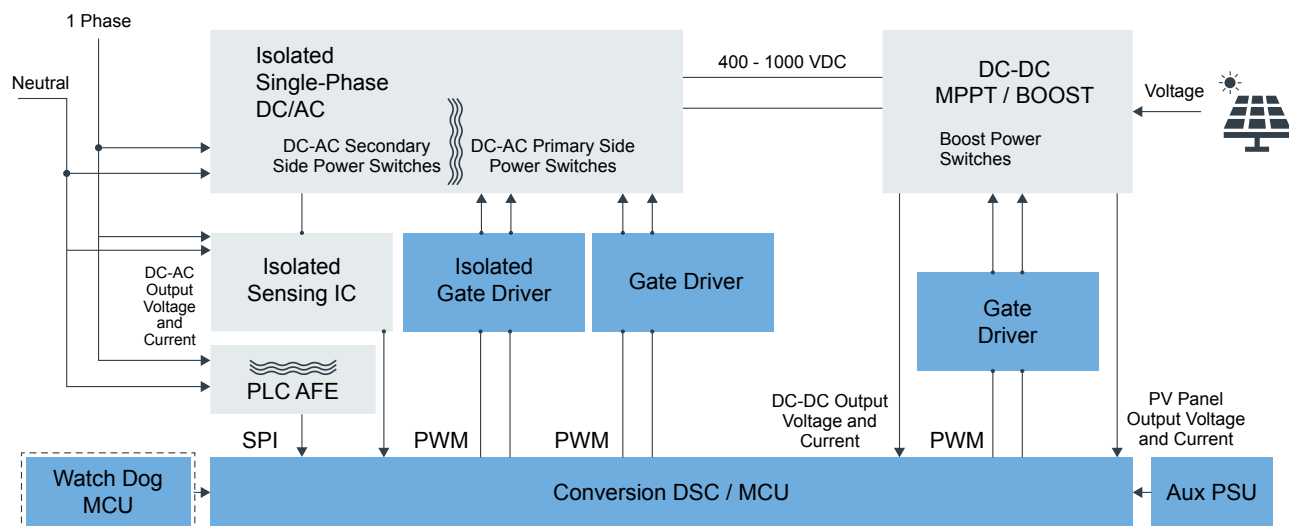# Solar Photovoltaic (PV) Energy Generation

Last Updated: May 16, 2024

NXP offers an array of products for several solar power generation system solutions such as photovoltaic inverters for residential, commercial and utility power generation systems that supply AC power to the grid. NXP solutions enable grid-tied systems (the most common types of photovoltaic systems today) and off-grid solar power systems. Where battery energy storage is desired, the PV inverters could be designed with bi-directional conversion and excess power can also be output to the grid.

Microcontrollers, gate drivers, power management devices and various types of wireless and wired connectivity devices are recommended for string and micro inverters (AC power output) as well as optimizer inverters (DC power output).

Micro Inverter Block Diagram

1 Phase

Neutral

Isolated
Single-Phase
DC/AC

DC-AC Secondary
Side Power Switches

DC-AC Primary Side
Power Switches

400 - 1000 VDC

DC-DC
MPPT / BOOST

Boost Power
Switches

Voltage

DC-AC
Output
Voltage
and
Current

Isolated
Sensing IC

Isolated
Gate Driver

Gate Driver

Gate
Driver

PLC AFE

DC-DC Output
Voltage and
Current

PV Panel
Output Voltage
and Current

SPI   **PWM**   **PWM**   **PWM**

Watch Dog
MCU

Conversion DSC / MCU

Aux PSU

■ NXP Technology   ■ Non NXP Technology   ⬚ Optional Technology

Recommended Products for Micro Inverter	
Conversion DSC / MCU	• MCX-A14X-A15X: MCX A14x/15x MCUs with Arm® Cortex® M33, Scalable Device Options, Low Power and Intelligent Peripherals • MCX-N94X-N54X: MCX N94x/54x Highly Integrated Multicore MCUs with On-Chip Accelerators, Intelligent Peripherals and Advanced Security • KV4x: Kinetis KV4x-168 MHz, High Performance Motor / Power Conversion MCUs based on Arm® Cortex®-M4 • MC56F83xxx: Performance Level Digital Signal Controllers, USB FS OTG, CAN FD
Basic System MCU	• LPC550x: LPC550x/S0x: Baseline Arm® Cortex®-M33-Based Microcontroller Family • i.MX-RT1170: i.MX RT1170: 1 GHz Crossover MCU with Arm® Cortex® Cores
Isolated Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs

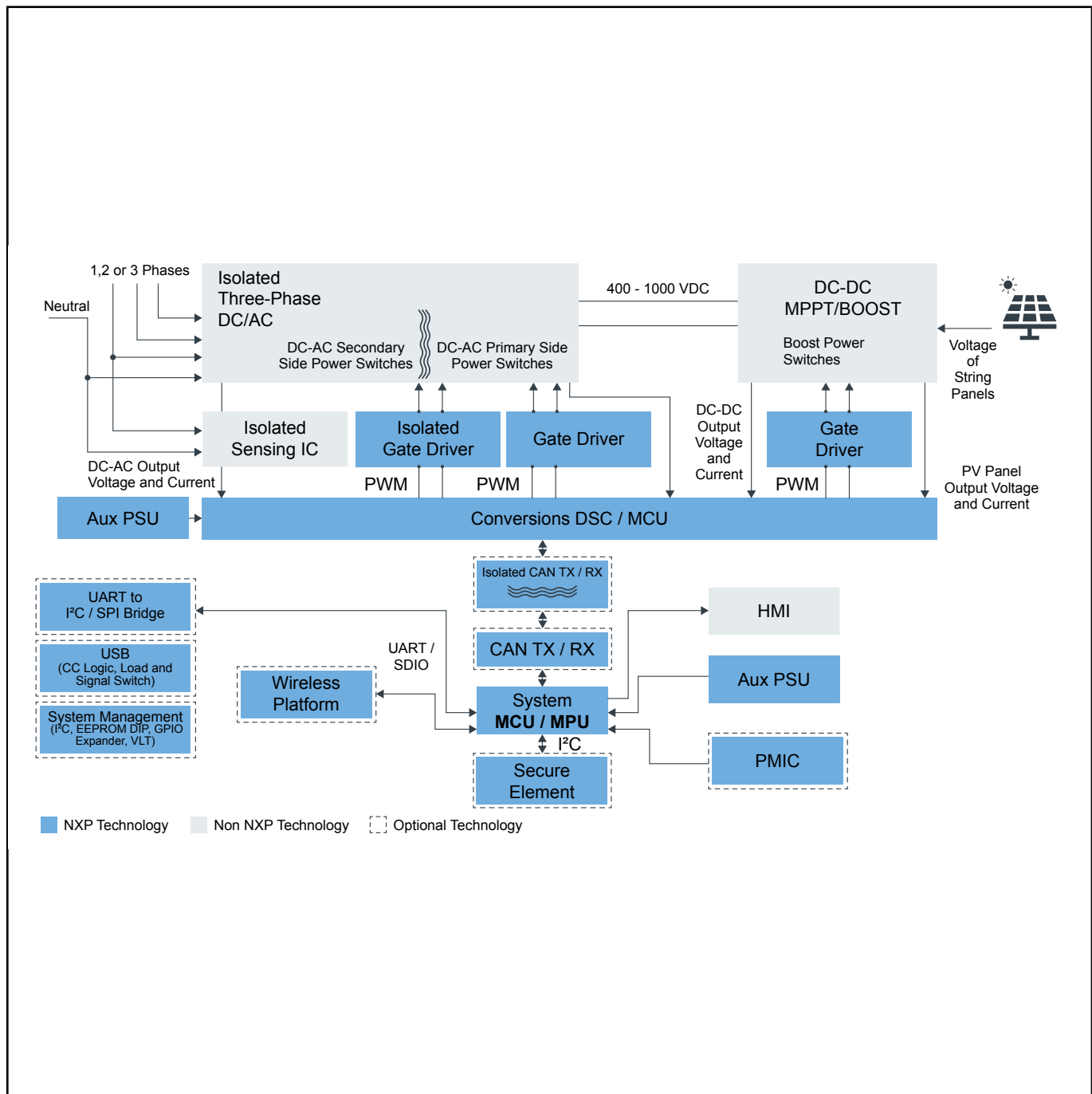| Aux PSU	• TEA1833LTS: GreenChip SMPS Control IC
Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
Watch Dog MCU	• LPC8N04: Low-Cost Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core

String Inverter Block Diagram
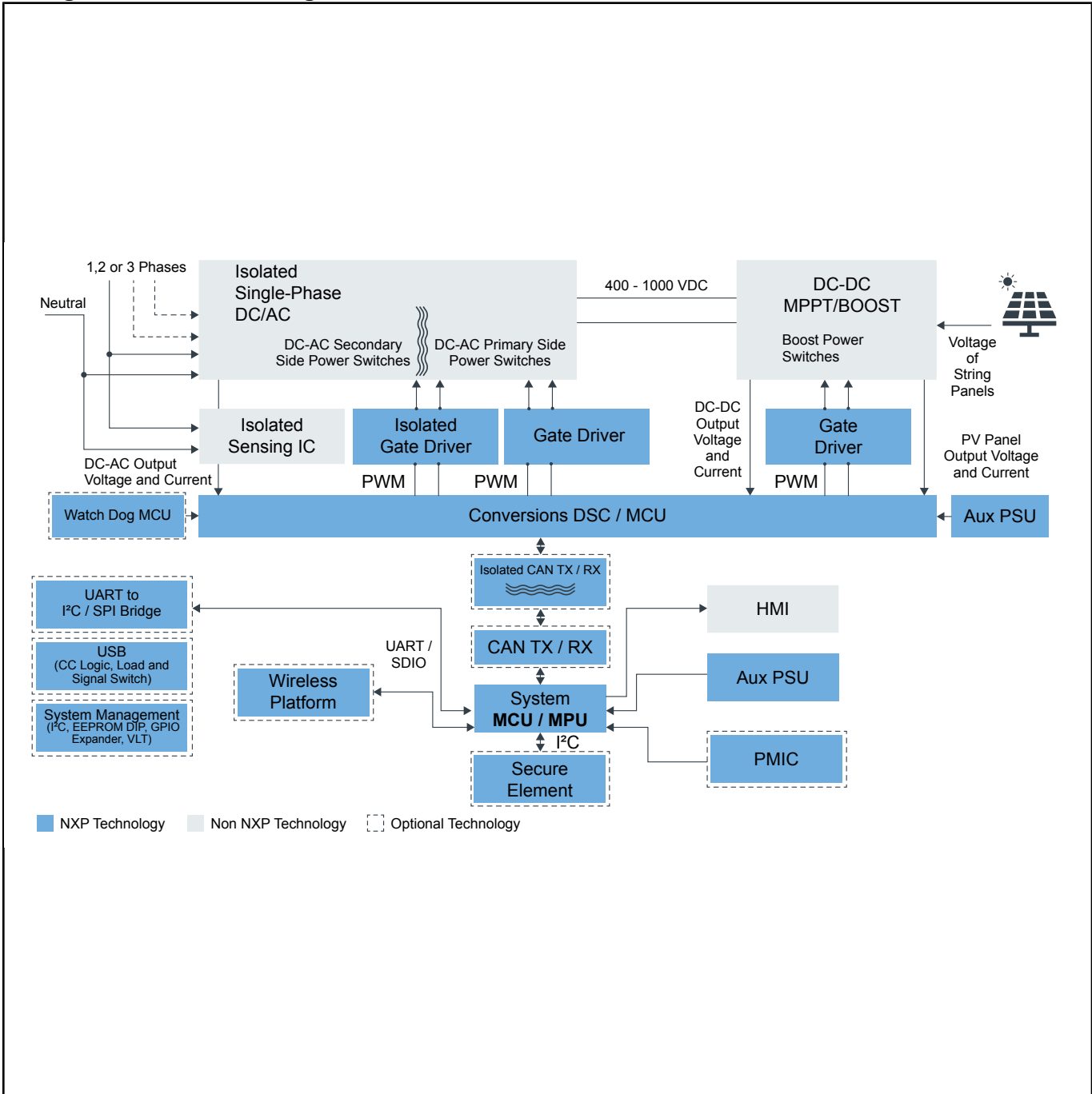
Recommended Products for String Inverter	
Conversion DSC / MCU	• MCX-A14X-A15X: MCX A14x/15x MCUs with Arm® Cortex® M33, Scalable Device Options, Low Power and Intelligent Peripherals

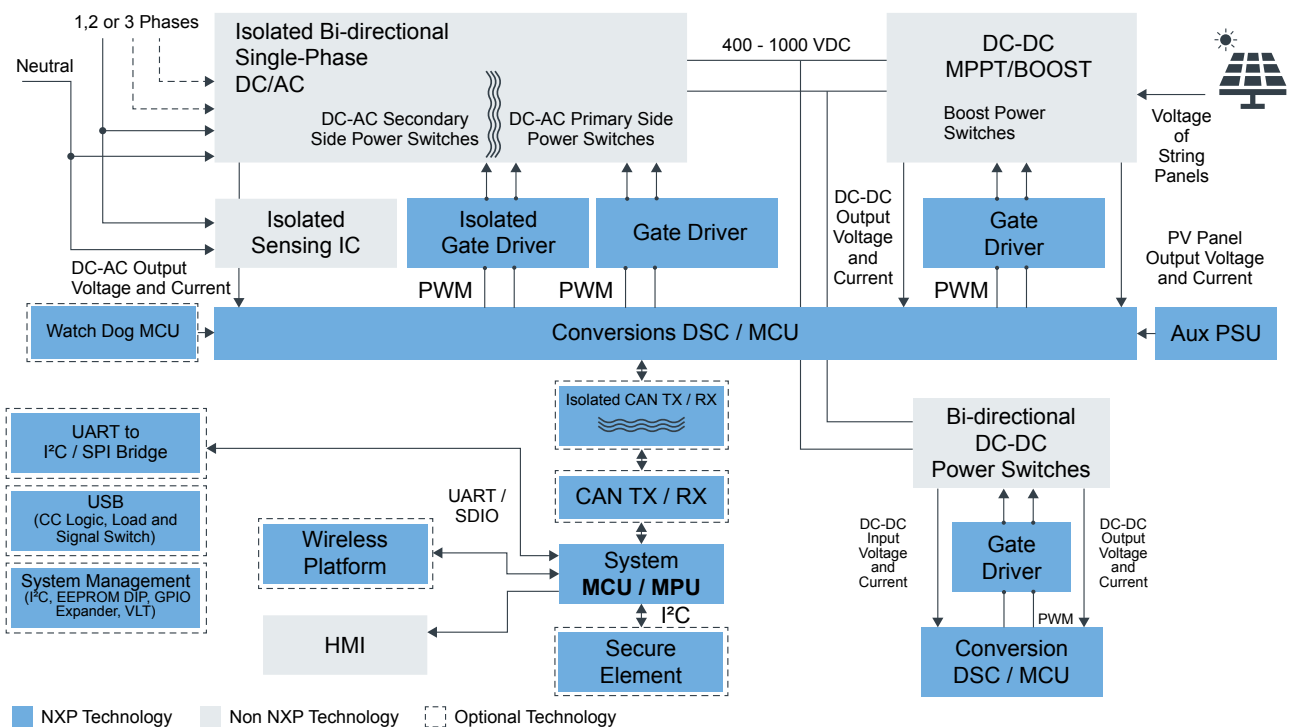|	
	• **MCX-N94X-N54X**: MCX N94x/54x Highly Integrated Multicore MCUs with On-Chip Accelerators, Intelligent Peripherals and Advanced Security • **KV4x**: Kinetis KV4x-168 MHz, High Performance Motor / Power Conversion MCUs based on Arm® Cortex®-M4 • **MC56F83xxx**: Performance Level Digital Signal Controllers, USB FS OTG, CAN FD
System MCU / MPU	• **i.MX-RT1020**: i.MX RT1020: Crossover MCU with Arm® Cortex®-M7 • **i.MX-RT1060**: i.MX RT1060: Crossover MCU with Arm® Cortex®-M7 • **i.MX-RT1170**: i.MX RT1170: 1 GHz Crossover MCU with Arm® Cortex® Cores • **i.MX8**: i.MX 8 Family – Arm® Cortex®-A53, Cortex-A72, Virtualization, Vision, 3D Graphics, 4K Video
Isolated Gate Driver	• **GD3100**: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
Wireless Platform	• **K32W041AM-A**: K32W041AM/A: High Performance, Secure and Low-Power MCU for Zigbee®, Thread™ and Bluetooth® LE 5.0 with High Tx Power Option • **K32W061_41**: K32W061/41: High-Performance, Secure and Ultra-Low-Power MCU for Zigbee®,Thread™, and Bluetooth® LE 5.0 with Built-In NFC Option • **IW416**: 2.4/5 GHz Dual-Band 1x1 Wi-Fi® 4 (802.11n) + Bluetooth® 5.2 Solution • **OL2385AHN**: Low-Power Multi-Channel UHF RF Wireless Platform
PMIC	• **PF5020**: Multi-Channel (5) PMIC for Automotive Applications – 4 High Power and 1 Low Power, Fit for ASIL B Safety Level
Secure Element	• **SE050**: EdgeLock® SE050: Plug and Trust Secure Element Family – Enhanced IoT security with high flexibility
Aux PSU	• **TEA1833LTS**: GreenChip SMPS Control IC
Watch Dog MCU	• **KL0x**: Kinetis® KL0x-48 MHz, Entry-Level Ultra-Low Power Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core • **LPC8N04**: Low-Cost Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core
Gate Driver	• **GD3100**: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
UART to I2C /SPI Bridge	• **SC18IM704**: UART to I²C-Bus Bridge • **SC18IS606**: I²C-Bus to SPI Bridge • **SC18IS604**: SPI to I²C-Bus Bridge
USB (CC Logic, Load and Signal Switch)	• **NX5P3090UK**: USB PD and Type-C Current-Limited Power Switch • **NX3P1108UK**: Logic-Controlled High-Side Power Switch • **NX20P0477**: USB Type-C CC Smart Protection • **NX3DV221**: High-Speed USB 2.0 Switch with Enable • **NX3DV642GU**: Three-Lane High-Speed MIPI-Compatible Switch • **NX5L2750CGU**: Analog Switch with Negative Swing Audio Capability • **PTN5150**: CC Logic for USB Type-C Applications
System Management	• **PCA9555A**: Low-Voltage 16-Bit I²C-Bus I/O Port with Interrupt and Weak Pull-Up • **PCAL6408A**: Low-Voltage Translating, 8-Bit I²C-Bus/SMBus I/O Expander • **PCAL6416A**: Low-Voltage Translating 16-Bit I²C-Bus/SMBus I/O Expander • **NTS0104**: Dual-Supply Translating Transceiver (Open-Drain, Auto-Direction Sensing) • **NTB0104**: Dual-Supply Translating Transceiver (Auto-Direction Sensing, Three-State) • **PCA9306**: Dual Bidirectional I²C-Bus and SMBus Voltage-Level Translator • **PCA9561**: Quad 6-Bit Multiplexed I²C-Bus EEPROM DIP Switch
CAN TX/RX	• **TJA1152**: Secure HS-CAN Transceiver with Standby Mode

Central inverter Block Diagram

Legend:
- NXP Technology
- Non NXP Technology
- Optional Technology

Diagram labels:
- 1,2 or 3 Phases
- Neutral
- Isolated Three-Phase DC/AC
- DC-AC Secondary Side Power Switches
- DC-AC Primary Side Power Switches
- 400 - 1000 VDC
- DC-DC MPPT/BOOST
- Boost Power Switches
- Voltage of String Panels
- Isolated Sensing IC
- Isolated Gate Driver
- Gate Driver
- DC-DC Output Voltage and Current
- Gate Driver
- DC-AC Output Voltage and Current
- PWM
- PWM
- PWM
- PV Panel Output Voltage and Current
- Aux PSU
- Conversions DSC / MCU
- UART to I²C / SPI Bridge
- USB (CC Logic, Load and Signal Switch)
- System Management (I²C, EEPROM DIP, GPIO Expander, VLT)
- Isolated CAN TX / RX
- HMI
- CAN TX / RX
- Aux PSU
- UART / SDIO
- Wireless Platform
- System MCU / MPU
- I²C
- PMIC
- Secure Element

Recommended Products for Central inverter	
Conversion DSC / MCU	• MCX-A14X-A15X: MCX A14x/15x MCUs with Arm® Cortex® M33, Scalable Device Options, Low Power and Intelligent Peripherals • MCX-N94X-N54X: MCX N94x/54x Highly Integrated Multicore MCUs with On-Chip Accelerators, Intelligent Peripherals and Advanced Security • KV4x: Kinetis KV4x-168 MHz, High Performance Motor / Power Conversion MCUs based on Arm® Cortex®-M4 • MC56F83xxx: Performance Level Digital Signal Controllers, USB FS OTG, CAN FD
System MCU / MPU	• i.MX-RT1020: i.MX RT1020: Crossover MCU with Arm® Cortex®-M7 • i.MX-RT1060: i.MX RT1060: Crossover MCU with Arm® Cortex®-M7 • i.MX-RT1170: i.MX RT1170: 1 GHz Crossover MCU with Arm® Cortex® Cores • i.MX8: i.MX 8 Family – Arm® Cortex®-A53, Cortex-A72, Virtualization, Vision, 3D Graphics, 4K Video

Isolated Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
Wireless Platform	• K32W041AM-A: K32W041AM/A: High Performance, Secure and Low-Power MCU for Zigbee®, Thread™ and Bluetooth® LE 5.0 with High Tx Power Option • K32W061_41: K32W061/41: High-Performance, Secure and Ultra-Low-Power MCU for Zigbee®,Thread™, and Bluetooth® LE 5.0 with Built-In NFC Option • IW416: 2.4/5 GHz Dual-Band 1x1 Wi-Fi® 4 (802.11n) + Bluetooth® 5.2 Solution • OL2385AHN: Low-Power Multi-Channel UHF RF Wireless Platform
PMIC	• PF5020: Multi-Channel (5) PMIC for Automotive Applications – 4 High Power and 1 Low Power, Fit for ASIL B Safety Level
Secure Element	• SE050: EdgeLock® SE050: Plug and Trust Secure Element Family – Enhanced IoT security with high flexibility
Aux PSU	• TEA1833LTS: GreenChip SMPS Control IC
UART to I2C/SPI Bridge	• SC18IM704: UART to I²C-Bus Bridge • SC18IS606: I²C-Bus to SPI Bridge • SC18IS604: SPI to I²C-Bus Bridge
USB	• NX5P3090UK: USB PD and Type-C Current-Limited Power Switch • NX3P1108UK: Logic-Controlled High-Side Power Switch • NX20P0477: USB Type-C CC Smart Protection • NX3DV221: High-Speed USB 2.0 Switch with Enable • NX3DV642GU: Three-Lane High-Speed MIPI-Compatible Switch • NX5L2750CGU: Analog Switch with Negative Swing Audio Capability • PTN5150: CC Logic for USB Type-C Applications
System Management	• PCA9555A: Low-Voltage 16-Bit I²C-Bus I/O Port with Interrupt and Weak Pull-Up • PCAL6408A: Low-Voltage Translating, 8-Bit I²C-Bus/SMBus I/O Expander • PCAL6416A: Low-Voltage Translating 16-Bit I²C-Bus/SMBus I/O Expander • NTS0104: Dual-Supply Translating Transceiver (Open-Drain, Auto-Direction Sensing) • NTB0104: Dual-Supply Translating Transceiver (Auto-Direction Sensing, Three-State) • PCA9306: Dual Bidirectional I²C-Bus and SMBus Voltage-Level Translator • PCA9561: Quad 6-Bit Multiplexed I²C-Bus EEPROM DIP Switch
Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs

Hybrid String Inverter Block Diagram

Isolated Bi-directional Single-Phase DC/AC

1,2 or 3 Phases

Neutral

400 - 1000 VDC

DC-DC MPPT/BOOST

Boost Power Switches

Voltage of String Panels

DC-AC Secondary Side Power Switches

DC-AC Primary Side Power Switches

Isolated Sensing IC

Isolated Gate Driver

Gate Driver

DC-DC Output Voltage and Current

Gate Driver

PV Panel Output Voltage and Current

DC-AC Output Voltage and Current

PWM

PWM

PWM

Watch Dog MCU

Conversions DSC / MCU

Aux PSU

UART to I²C / SPI Bridge

Isolated CAN TX / RX

Bi-directional DC-DC Power Switches

USB (CC Logic, Load and Signal Switch)

CAN TX / RX

DC-DC Input Voltage and Current

Gate Driver

DC-DC Output Voltage and Current

System Management (I²C, EEPROM DIP, GPIO Expander, VLT)

UART / SDIO

Wireless Platform

System MCU / MPU

I²C

PWM

HMI

Secure Element

Conversion DSC / MCU

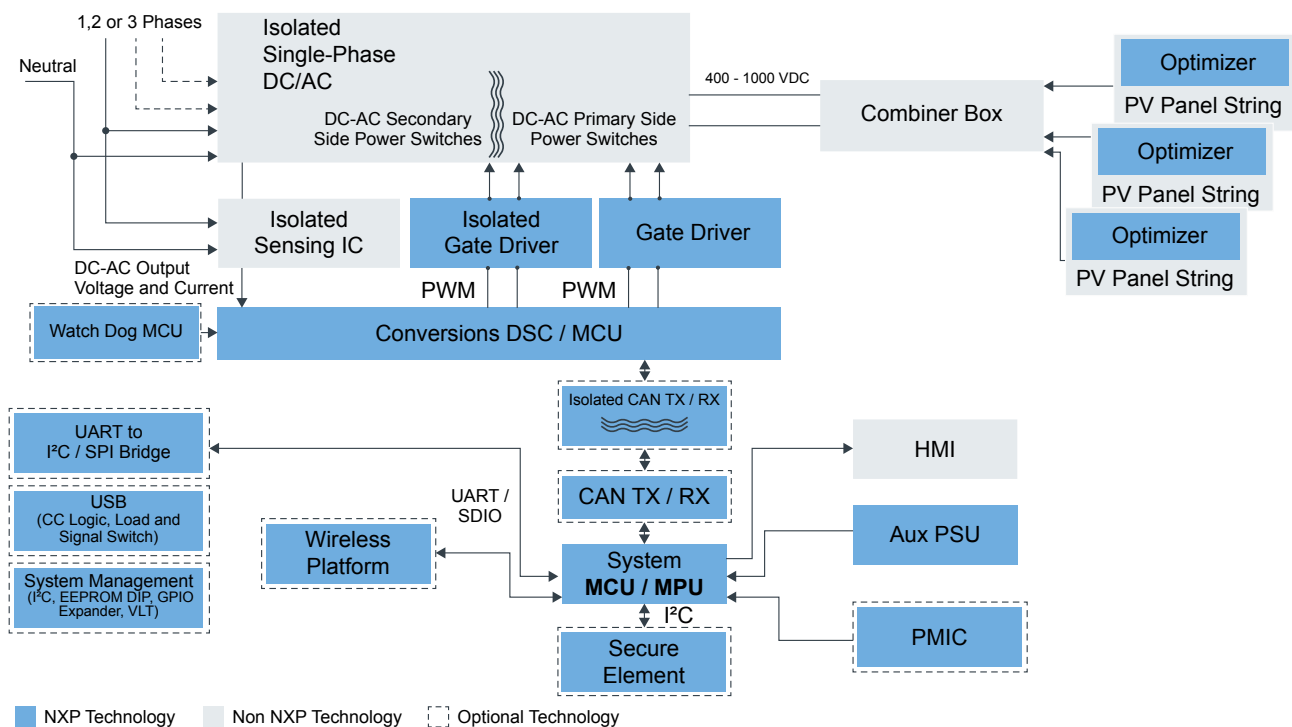■ NXP Technology   ■ Non NXP Technology   ⬚ Optional Technology

Recommended Products for Hybrid String Inverter

Conversion DSC / MCU	• MCX-A14X-A15X: MCX A14x/15x MCUs with Arm® Cortex® M33, Scalable Device Options, Low Power and Intelligent Peripherals
	• MCX-N94X-N54X: MCX N94x/54x Highly Integrated Multicore MCUs with On-Chip Accelerators, Intelligent Peripherals and Advanced Security
	• KV4x: Kinetis KV4x-168 MHz, High Performance Motor / Power Conversion MCUs based on Arm® Cortex®-M4
	• MC56F83xxx: Performance Level Digital Signal Controllers, USB FS OTG, CAN FD
System MCU / MPU	• i.MX-RT1020: i.MX RT1020: Crossover MCU with Arm® Cortex®-M7
	• i.MX-RT1060: i.MX RT1060: Crossover MCU with Arm® Cortex®-M7
	• i.MX-RT1170: i.MX RT1170: 1 GHz Crossover MCU with Arm® Cortex® Cores
	• i.MX8: i.MX 8 Family – Arm® Cortex®-A53, Cortex-A72, Virtualization, Vision, 3D Graphics, 4K Video

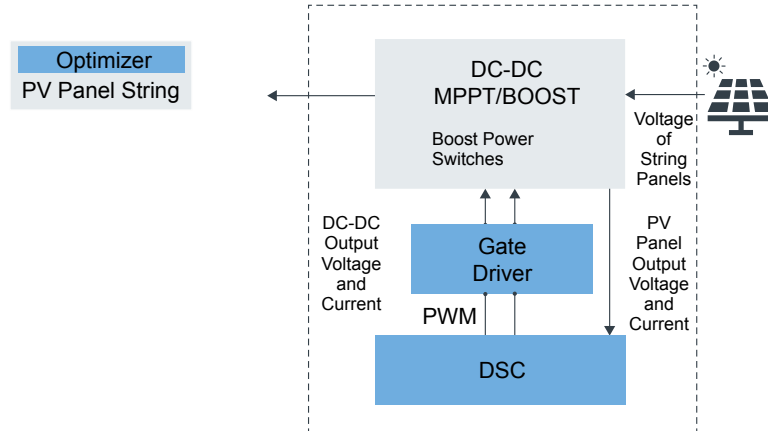|	
Isolated Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
Wireless Platform	• K32W041AM-A: K32W041AM/A: High Performance, Secure and Low-Power MCU for Zigbee®, Thread™ and Bluetooth® LE 5.0 with High Tx Power Option • K32W061_41: K32W061/41: High-Performance, Secure and Ultra-Low-Power MCU for Zigbee®,Thread™, and Bluetooth® LE 5.0 with Built-In NFC Option • IW416: 2.4/5 GHz Dual-Band 1x1 Wi-Fi® 4 (802.11n) + Bluetooth® 5.2 Solution • OL2385AHN: Low-Power Multi-Channel UHF RF Wireless Platform
PMIC	• PF5020: Multi-Channel (5) PMIC for Automotive Applications – 4 High Power and 1 Low Power, Fit for ASIL B Safety Level
Secure Element	• SE050: EdgeLock® SE050: Plug and Trust Secure Element Family – Enhanced IoT security with high flexibility
Aux PSU	• TEA1833LTS: GreenChip SMPS Control IC
Watch Dog MCU	• KL0x: Kinetis® KL0x-48 MHz, Entry-Level Ultra-Low Power Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core • LPC8N04: Low-Cost Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core
UART to I2C/SPI Bridge	• SC18IM704: UART to I²C-Bus Bridge • SC18IS606: I²C-Bus to SPI Bridge • SC18IS604: SPI to I²C-Bus Bridge
USB	• NX5P3090UK: USB PD and Type-C Current-Limited Power Switch • NX3P1108UK: Logic-Controlled High-Side Power Switch • NX20P0477: USB Type-C CC Smart Protection • NX3DV221: High-Speed USB 2.0 Switch with Enable • NX3DV642GU: Three-Lane High-Speed MIPI-Compatible Switch • NX5L2750CGU: Analog Switch with Negative Swing Audio Capability • PTN5150: CC Logic for USB Type-C Applications
System Management	• PCA9555A: Low-Voltage 16-Bit I²C-Bus I/O Port with Interrupt and Weak Pull-Up • PCAL6408A: Low-Voltage Translating, 8-Bit I²C-Bus/SMBus I/O Expander • PCAL6416A: Low-Voltage Translating 16-Bit I²C-Bus/SMBus I/O Expander • NTS0104: Dual-Supply Translating Transceiver (Open-Drain, Auto-Direction Sensing) • NTB0104: Dual-Supply Translating Transceiver (Auto-Direction Sensing, Three-State) • PCA9306: Dual Bidirectional I^{2}C-Bus and SMBus Voltage-Level Translator • PCA9561: Quad 6-Bit Multiplexed I²C-Bus EEPROM DIP Switch
Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs

Distributed String Inverter Block Diagram

1,2 or 3 Phases

Neutral

Isolated Single-Phase DC/AC

DC-AC Secondary Side Power Switches | DC-AC Primary Side Power Switches

400 - 1000 VDC

Combiner Box

Optimizer
PV Panel String

Optimizer
PV Panel String

Optimizer
PV Panel String

DC-AC Output Voltage and Current

Isolated Sensing IC

Isolated Gate Driver

Gate Driver

PWM | PWM

Watch Dog MCU

Conversions DSC / MCU

Isolated CAN TX / RX

UART to I²C / SPI Bridge

USB (CC Logic, Load and Signal Switch)

System Management (I²C, EEPROM DIP, GPIO Expander, VLT)

UART / SDIO

CAN TX / RX

HMI

Wireless Platform

System MCU / MPU

Aux PSU

I²C

PMIC

Secure Element

■ NXP Technology   ■ Non NXP Technology   ⌐ ¬ Optional Technology

Recommended Products for Distributed String Inverter	
Conversion DSC / MCU	• MCX-A14X-A15X: MCX A14x/15x MCUs with Arm® Cortex® M33, Scalable Device Options, Low Power and Intelligent Peripherals • MCX-N94X-N54X: MCX N94x/54x Highly Integrated Multicore MCUs with On-Chip Accelerators, Intelligent Peripherals and Advanced Security • i.MX-RT1170: i.MX RT1170: 1 GHz Crossover MCU with Arm® Cortex® Cores
Optimizer DCS	• MC56F80xxx: DSCs with Integrated FPU and Trigonometric Math Engine with OPAMP and Quadrature Decoder • LPC8N04: Low-Cost Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core
System MCU/MPU	• i.MX8: i.MX 8 Family – Arm® Cortex®-A53, Cortex-A72, Virtualization, Vision, 3D Graphics, 4K Video • i.MX93: i.MX 93 Applications Processor Family – Arm® Cortex®-A55, ML Acceleration, Power Efficient MPU • i.MX-RT1170: i.MX RT1170: 1 GHz Crossover MCU with Arm® Cortex® Cores • i.MX-RT1060: i.MX RT1060: Crossover MCU with Arm® Cortex®-M7

	• i.MX-RT1020: i.MX RT1020: Crossover MCU with Arm® Cortex®-M7
Isolated Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
Wireless Platform	• OL2385AHN: Low-Power Multi-Channel UHF RF Wireless Platform • IW416: 2.4/5 GHz Dual-Band 1x1 Wi-Fi® 4 (802.11n) + Bluetooth® 5.2 Solution • K32W061_41: K32W061/41: High-Performance, Secure and Ultra-Low-Power MCU for Zigbee®,Thread™, and Bluetooth® LE 5.0 with Built-In NFC Option • K32W041AM-A: K32W041AM/A: High Performance, Secure and Low-Power MCU for Zigbee®, Thread™ and Bluetooth® LE 5.0 with High Tx Power Option
PMIC	• PF5020: Multi-Channel (5) PMIC for Automotive Applications – 4 High Power and 1 Low Power, Fit for ASIL B Safety Level
Secure Element	• SE050: EdgeLock® SE050: Plug and Trust Secure Element Family – Enhanced IoT security with high flexibility • EDGELOCK-A5000: EdgeLock® A5000 Plug and Trust Secure Authenticator: Authentication Made Secure, Scalable and Easy
Watch Dog MCU	• KL0x: Kinetis® KL0x-48 MHz, Entry-Level Ultra-Low Power Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core • LPC8N04: Low-Cost Microcontrollers (MCUs) based on Arm® Cortex®-M0+ Core
UART to I2C/SPI Bridge	• SC18IM704: UART to I²C-Bus Bridge • SC18IS606: I²C-Bus to SPI Bridge • SC18IS604: SPI to I²C-Bus Bridge
USB (CC Logic, Load and Signal Switch)	• NX5P3090UK: USB PD and Type-C Current-Limited Power Switch • NX3P1108UK: Logic-Controlled High-Side Power Switch • NX20P0477: USB Type-C CC Smart Protection • NX3DV221: High-Speed USB 2.0 Switch with Enable • NX3DV642GU: Three-Lane High-Speed MIPI-Compatible Switch • NX5L2750CGU: Analog Switch with Negative Swing Audio Capability • PTN5150: CC Logic for USB Type-C Applications
System Management	• PCA9555A: Low-Voltage 16-Bit I²C-Bus I/O Port with Interrupt and Weak Pull-Up • PCAL6408A: Low-Voltage Translating, 8-Bit I²C-Bus/SMBus I/O Expander • PCAL6416A: Low-Voltage Translating 16-Bit I²C-Bus/SMBus I/O Expander • NTS0104: Dual-Supply Translating Transceiver (Open-Drain, Auto-Direction Sensing) • NTB0104: Dual-Supply Translating Transceiver (Auto-Direction Sensing, Three-State) • PCA9306: Dual Bidirectional I^{2}C-Bus and SMBus Voltage-Level Translator • PCA9561: Quad 6-Bit Multiplexed I²C-Bus EEPROM DIP Switch
Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs
Aux PSU	• TEA2208T: Full Wave Active Bridge Rectifier Controller • TEA2209T: Active Bridge Rectifier Controller • TEA2206T: Active Bridge Rectifier Controller • TEA1708T: GreenChip X Capacitor Discharge IC • TEA19361T: GreenChip SMPS Primary Side Control IC with QR/DCM Operation • TEA19362T: GreenChip SMPS Primary Side Control IC with Fixed Frequency Operation • TEA19363LT: GreenChip SMPS Primary Side Control IC with QR/DCM Operation and Active x-Capacitor Discharge • TEA19363T: GreenChip SMPS Primary Side Control IC with QR/DCM Operation and X-Capacitor Discharge
Isolated CAN TX/RX	• TJA1052IT: Galvanically-Isolated High-Speed CAN Transceiver • TJF1052IT: Galvanically-Isolated High-Speed CAN Transceiver
CAN TX/RX	• TJA1052IT: Galvanically-Isolated High-Speed CAN Transceiver

	• TJF1052IT: Galvanically-Isolated High-Speed CAN Transceiver

Optimizer Block Diagram

Recommended Products for Optimizer	
Optimizer DCS	• MC56F80xxx: DSCs with Integrated FPU and Trigonometric Math Engine with OPAMP and Quadrature Decoder • LPC8N04: Low-Cost Microcontrollers (MCUs) based on Arm$^®$ Cortex$^®$-M0+ Core
Gate Driver	• GD3100: Advanced High Voltage Isolated Gate Driver for IGBT and SiC MOSFETs

View our complete solution for Solar Photovoltaic (PV) Energy Generation.

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www.nxp.com