



Signal and Noise Generator

Signal and Noise Generator User's Guide

Preface

Signal and Noise Generator is an extension board for the Xplained Pro evaluation platform. It is designed to generate an analog signal with or without noise.

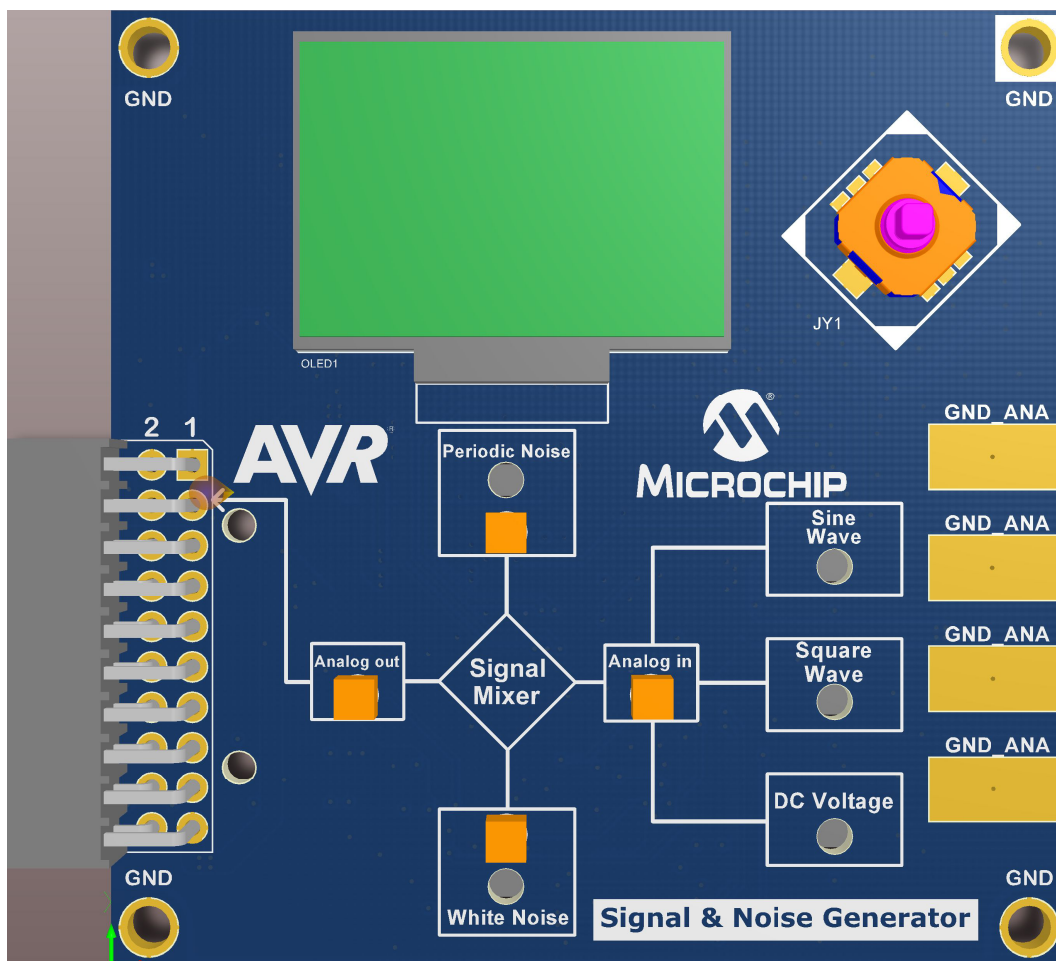


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1. Introduction

1.1 Features

- Xplained Pro Extension Features:
 - Follow existing latest version of Xplained Pro platform specification
 - PCB dimension: 60 mm x 60 mm (not including the connector)
 - One female standard 20-pin extension connector
 - ID chip
 - Four mounting holes with GND
 - Two test jig holes
 - Four rubber feet
 - Power measurement
- Power from Xplained Pro Standard Ext Header:
 - Boost to 5.25V for powering on-board microcontrollers (MCUs) and analog circuit
 - LDO to 3V for powering OLED
 - Level converter for I²C interface to the external host MCU
 - Level converter for clock sync signal between external MCU and on-board MCUs
- Microcontrollers:
 - On-board ATtiny1617 to act as the board controller, signal generator and periodic noise generator
 - On board ATtiny416 to act as the white noise generator
- Analog Features:
 - 1-channel analog signal that can be switched between:
 - Sine Wave: 1 - 150 Hz frequency, 0.05 - 2.5V V_{PP}, 0 - 2.5V offset
 - Square Wave: 0.5 - 150 Hz frequency, 0.05 - 2.5V V_{PP}, 0 - 2.5V offset
 - DC Voltage: 0.05 - 2.5V
 - FSK: 5 - 150 kHz frequency, 0.05 - 2.5V V_{PP}, 0 - 2.5V offset
 - 1-channel periodic noise:
 - Periodic noise: 45 - 140 kHz, 0.05 - 2.5V V_{PP}
 - 1-channel white noise:
 - White noise: ~ 1 MHz bandwidth, 0.05 - 2V V_{PP}
 - One 4-channel electronic potentiometer used for signal or noise attenuation
 - Op amps for signal conditioning
 - Offset circuit
- One OLED Display 128x64
- User Interface:
 - Five status LEDs controlled by a board controller
 - 5-way joystick
 - Probe points for scope connections
- Programming and Debugging:
 - Two UPDI headers for the two MCUs respectively

1.2 Kit Overview

The Signal and Noise Generator is an extension board that generates signal with or without noise for the Xplained Pro platform. The kit can be connected to any extension header on the Xplained Pro MCU Board.

Figure 1-1. Signal and Noise Generator Front

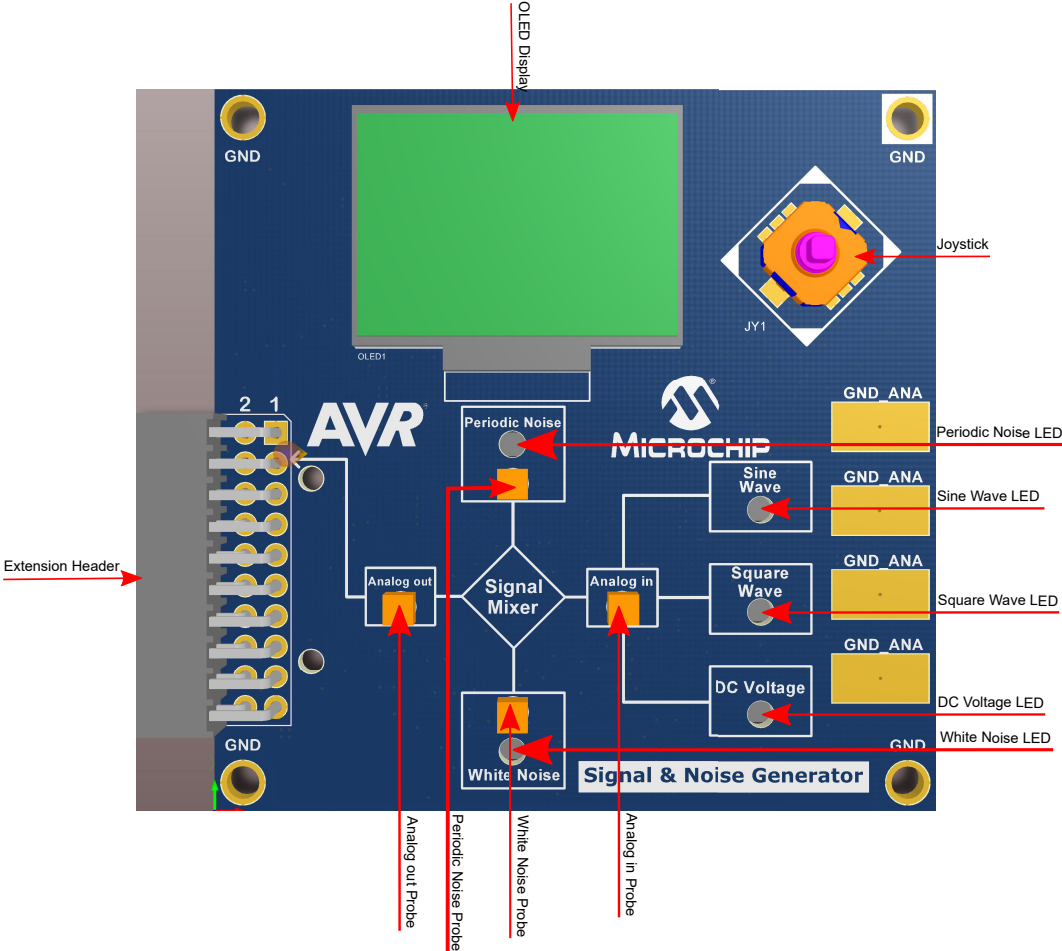
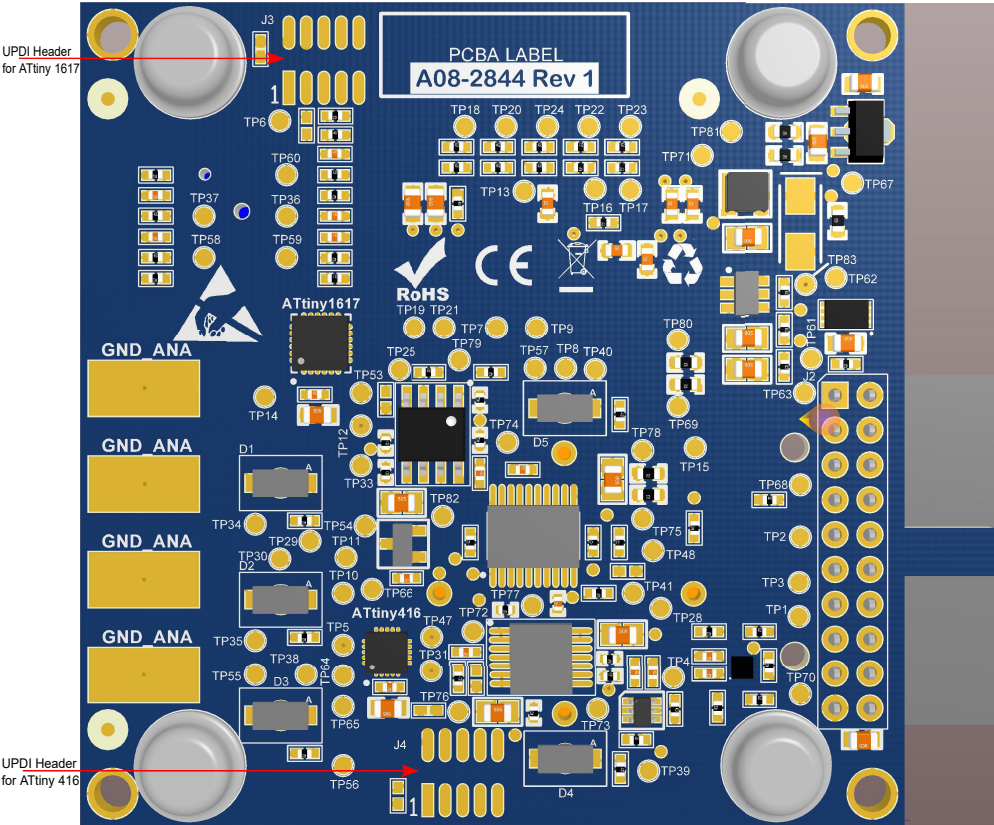


Figure 1-2. Signal and Noise Generator Back



2. Getting Started

2.1 Xplained Pro Quick Start

Steps to start exploring the Xplained Pro platform:

1. Download and install Atmel Studio.
2. Launch Atmel Studio.

When the Xplained Pro MCU kit is connected to the computer for the first time, the operating system installs the driver software automatically. This driver supports 32-bit and 64-bit versions of Microsoft® Windows® XP, Windows Vista®, Windows 7, Windows 8, Windows 10, and Windows Server 2012.

When the Xplained Pro MCU board is powered, the power LED (green) glows and the Atmel Studio automatically detects the specific Xplained Pro MCU and extension board(s) that are connected. The landing page of the kit in the Atmel Studio has an option to launch the Atmel Software Framework (ASF) and the Atmel START example application codes for the kit. The target device is programmed and debugged by the on-board embedded debugger and therefore no external programmer or debugger tool is required.

2.2 Design Documentation and Relevant Links

The following list contains links to the most relevant documents and software for the Signal and Noise Generator.

- [Xplained products](#) – Xplained evaluation kits are a series of easy-to-use evaluation kits for microcontrollers and other products. For low pin-count devices, the Xplained Nano series provides a minimalistic solution with access to all I/O pins of the target microcontroller. Xplained Mini kits are for medium pin-count devices and adds Arduino Uno compatible header footprint and a prototyping area. Xplained Pro kits are for medium to high pin-count devices, and feature advanced debugging and standardized extensions for peripheral functions. All these kits have on board programmers/ debuggers which creates a set of low-cost boards for evaluation and demonstration of features and capabilities of different products.
- [Atmel Studio](#) – Atmel Studio presents Free Atmel IDE for development of C/C++ and assembler code for microcontrollers and relevant documentation.
- [Microchip sample store](#) – Microchip sample store where you can order samples of devices.
- [EDBG User Guide](#) – User guide with more information about the on-board Embedded Debugger.
- [IAR Embedded Workbench® for ARM®](#) – This is a commercial C/C++ compiler available for ARM®. On their website there is also a 30-day evaluation version, available as a code-size limited kick-start version. The code-size limit is 16 KB for devices with M0, M0+, and M1 cores and 32 KB for devices with other cores.
- [Data Visualizer](#) – Data Visualizer is a program used for processing and visualizing data. Data Visualizer can receive data from various sources such as the Embedded Debugger Data Gateway Interface found on Xplained Pro boards and COM ports.

3. Xplained Pro

Xplained Pro is an evaluation platform which contains a series of microcontroller boards (evaluation kits) and extension boards. Atmel Studio is used to program and debug the microcontrollers on these boards. Atmel Studio includes Advanced Software Framework (ASF) and Atmel START, which has drivers and demo code, and Data Visualizer, which supports data streaming and advanced debugging. Xplained Pro evaluation kits can be connected to a wide range of Xplained Pro extension boards through standardized headers and connectors. Xplained Pro extension boards have identification (ID) chips to uniquely identify which boards are connected to the Xplained Pro evaluation kits.

3.1 Hardware Identification System

All Xplained Pro extension boards come with an identification chip (ATSHA204A CryptoAuthentication™ chip) to uniquely identify the boards that are connected to the Xplained Pro evaluation kit. This chip contains information that identifies the extension with its name and some extra data. When an Xplained Pro extension is connected to an Xplained Pro evaluation kit, the information is read and sent to the Atmel Studio. The following table shows the data fields stored in the ID chip with example content.

Table 3-1. Xplained Pro ID Chip Content

Data Field	Data Type	Example Content
Manufacturer	ASCII string	Microchip\0'
Product name	ASCII string	Segment LCD1 Xplained Pro\0'
Product revision	ASCII string	02\0'
Product serial number	ASCII string	1774020200000010\0'
Minimum voltage [mV]	uint16_t	3000
Maximum voltage [mV]	uint16_t	3600
Maximum current [mA]	uint16_t	30

3.2 Xplained Pro Headers and Connectors

3.2.1 Xplained Pro Standard Extension Header

All Xplained Pro kits have many dual-row, 20-pin, 100-mil extension headers. The Xplained Pro MCU boards have male headers, while the Xplained Pro extensions have their female counterparts. The following table provides the pin description of all the connected pins.



Info: Not all pins are always connected on all extension headers.

The extension headers can be used to connect a variety of Xplained Pro extensions to Xplained Pro MCU boards or to access the pins of the target microcontroller on the Xplained Pro boards.

Table 3-2. Xplained Pro Standard Extension Header

Pin Number	Pin Name	Description
1	ID	Pin to communicate with the ID chip on an extension board.
2	GND	Ground
3	ADC(+)	Analog-to-Digital Converter; alternatively, a pin for the positive terminal of a differential ADC.
4	ADC(-)	Analog-to-Digital Converter; alternatively, a pin for the negative terminal of a differential ADC.
5	GPIO1	General purpose I/O pin.
6	GPIO2	General purpose I/O pin.
7	PWM(+)	Pulse width modulation; alternatively, a pin for the positive part of a differential PWM.
8	PWM(-)	Pulse width modulation; alternatively, a pin for the negative part of a differential PWM.
9	IRQ/GPIO	Interrupt request pin and/or general purpose I/O pin.
10	SPI_SS_B/ GPIO	Slave select pin for Serial Peripheral Interface (SPI) and/or general purpose I/O pin.
11	I ² C_SDA	Data pin for I ² C interface. Always connected, bus type.
12	I ² C_SCL	Clock pin for I ² C interface. Always connected, bus type.
13	UART_RX	Receiver pin of target device UART.
14	UART_TX	Transmitter pin of target device UART.
15	SPI_SS_A	Slave select for SPI. This pin should preferably not be connected to anything else.
16	SPI_MOSI	SPI master out slave in pin. Always connected, bus type.
17	SPI_MISO	SPI master in slave out pin. Always connected, bus type.
18	SPI_SCK	SPI clock pin. Always connected, bus type.
19	GND	Ground pin for extension boards.
20	VCC	Power pin for extension boards.

4. Hardware Users Guide

4.1 ID Chip Content

Signal and Noise Generator can be connected to several Xplained Pro MCU boards. An Xplained Pro MCU board that does not have 3.3V as primary target voltage will read all ID devices on connected extensions to check if they support the target voltage before enabling it to the extension headers. The table below shows the static content written in the ID chip.

Table 4-1. Signal and Noise Generator ID Chip Content

Data Field	Content
Product name	Signal and Noise Generator
Minimum operation voltage	3.1V
Maximum operation voltage	5.25V
Maximum current	150 mA

Related Links

[3.1 Hardware Identification System](#)

4.2 Headers

4.2.1 Extension Header

Signal and Noise Generator implements one Xplained Pro Standard Extension Header. This header makes it possible to connect the board to an Xplained Pro MCU board. The pin-out definition for the extension header can be seen in the table below.

Table 4-2. Signal and Noise Generator Extension Header

Pin on EXT1	Function	Description
1	ID	Communication line to the ID chip
2	GND	Ground
3	Analog_out	Output of the analog signal mixed with noise
4	Analog_signal	Output of the original analog signal
5	NC	Not Connected
6	NC	Not Connected
7	Sync_clock	Clock sync signal
8	NC	Not Connected
9	NC	Not Connected
10	NC	Not Connected
11	TWI_SDA	I ² C SDA

Pin on EXT1	Function	Description
12	TWI_SCL	I ² C SCL
13	NC	Not Connected
14	NC	Not Connected
15	NC	Not Connected
16	NC	Not Connected
17	NC	Not Connected
18	NC	Not Connected
19	GND	Ground
20	VCC	Target supply voltage

Related Links

[3.2.1 Xplained Pro Standard Extension Header](#)

4.2.2 Current Measurement

The 0Ω resistor *R69* can be removed to measure the current consumed by Signal and Noise Generator by soldering in wires for an ammeter. The 0Ω resistors *R60*, *R62* and *R67* can be removed to measure the current consumed by individual power rails *VCC_MCU_P5V0*, *VCC_ANA_P5V0* and *VCC_OLED_P3V0* respectively by soldering in wires for an ammeter.

4.2.3 Programming and Debugging Headers

Two UPDI headers (J3 and J4) are used for programming and debugging the two on-board MCUs (ATtiny1617 and ATtiny416), which are not mounted on the board.

Table 4-3. UPDI header for ATtiny1617 (J3)

Pin on UPDI header	Pin on ATtiny1617-MNR	Function
1	-	Not Connected
2	3	GND
3	23	UPDI
4	4	VCC
5	-	Not Connected
6	-	Not Connected
7	-	Not Connected
8	-	Not Connected
9	-	Not Connected
10	-	Not Connected

Table 4-4. UPDI header for ATtiny416 (J4)

Pin on UPDI header	Pin on ATtiny416-MNR	Function
1	-	Not Connected
2	3	GND
3	19	UPDI
4	4	VCC
5	-	Not Connected
6	-	Not Connected
7	-	Not Connected
8	-	Not Connected
9	-	Not Connected
10	-	Not Connected

4.3 Functional Description

The Signal and Noise Generator can be configured to generate various analog signals such as DC, sine waves, square waves and FSK. It can also be configured to add both white and periodic noise to the generated analog signal output. The extension board is illustrated in [Figure 1-1](#) and [Figure 1-2](#).

4.3.1 LEDs

There are five LEDs on this board:

- D1 ON indicates the current generated signal is sine wave.
- D2 ON indicates the current generated signal is square wave.
- D3 ON indicates the current generated signal is DC voltage.
- D1, D2 and D3 all OFF indicates the current generated signal is FSK.
- D4 ON indicates white noise is mixed to the current signal.
- D5 ON indicates periodic noise is mixed to the current signal.

4.3.2 Joystick

The joystick *JY1* is used to navigate the menu system and have 5 operations:

- ↑
- ↓
- →
- ←
- Push down

4.3.3 OLED Display

The OLED display will show a menu for signal and noise configuration. This menu can be accessed to enable the available signal and noise sources, and adjust properties such as frequency, attenuation and signal level.

4.3.4 Signal & Noise Generator Oscilloscope Probe Points

The board has four oscilloscope probe points for measuring the original analog signal, white noise, periodic noise and the analog signal mixed with noise.

4.4 Usage

4.4.1 Power Supply

The Signal and Noise Generator can be powered up by connecting it to a Xplained Pro board.

4.4.2 Signal and Noise Generator Operation

After the kit is powered up, the joystick can be operated to generate signal and noise according to the menu system displayed on the OLED. There are three types of menu options in the menu system and the effect of joystick operation on the different menu options will be described as below:

One menu option starts with :

- \updownarrow selects between the different menu options.
- \leftarrow returns from current menu.
- **Push down** \rightarrow enables a signal /noise.

One menu option starts with $>$:

- \updownarrow selects between the different menu options.
- \leftarrow returns from current menu.
- **Push down** \rightarrow enters a menu.

One menu option includes a slider:

- $\uparrow\rightarrow$ increases Amplitude/Frequency/Offset of a signal/noise or DC level of DC signal.
- $\downarrow\leftarrow$ decreases Amplitude/Frequency/Offset of a signal/noise or DC level of DC signal.
- **Push down** returns from current menu.

The top menu will be displayed after powering up. The top menu options are $>$ **Signal Sources** and $>$ **Noise Sources**. All of the menu options are described as below:

- $>$ Signal Sources
 - Sine Enable
 - Square Wave Enable
 - DC Enable
 - FSK Enable
 - $>$ Sine Wave
 - $>$ Sine Amplitude
 - Sine Amplitude Slider
 - $>$ Sine Frequency
 - Sine Frequency Slider
 - $>$ Sine Offset
 - Sine Offset Slider
 - $>$ Square Wave
 - $>$ Square Amplitude
 - Square Amplitude Slider

- > Square Frequency
 - Square Frequency Slider
- > Square Offset
 - Square Offset Slider
- > DC
 - > DC Level
 - DC Level Slider
- > FSK
 - > FSK Amplitude
 - FSK Amplitude Slider
 - > FSK Sample Frequency
 - FSK Sample Frequency Slider
 - > FSK Offset
 - FSK Offset Slider
- > Noise Sources
 - Periodic Noise Enable
 - Random Noise Enable
 - > Periodic Noise
 - > Periodic Noise Amplitude
 - Periodic Noise Amplitude slider
 - > Periodic Noise Frequency
 - Periodic Noise Frequency Slider
 - > Random Noise
 - > Random Noise Amplitude
 - Random Noise Amplitude Slider

According to the joystick operations and menu system described above, the signal or noise will be easily generated.

5. Hardware Revision History and Known Issues

5.1 Identifying Product ID and Revision

The revision and product identifier of the Xplained Pro boards can be found in two ways: either through Atmel Studio or by looking at the sticker on the bottom side of the PCB.

When an Xplained Pro MCU board is connected to a computer with Atmel Studio running, an information window with the serial number is shown. The first six digits of the serial number contain the product identifier and revision. Information about connected Xplained Pro extension boards is also shown in the window.

The same information can be found on the sticker on the bottom side of the PCB. Most kits have stickers that have the identifier and revision printed in plain text as A09-nnnn/rr, where nnnn is the identifier and rr is the revision. Boards with limited space have a sticker with only a data matrix code, which contains a serial number string.

The serial number string has the following format:

```
"nnnnrrssssssss"  
n = product identifier  
r = revision  
s = serial number
```

The product identifier for the Signal and Noise Generator is A09-3090.

5.2 Hardware Revision

Revision 2 is the initially released revision for the market.

5.3 Known Issues

No known issues.

6. Document Revision History

Doc. rev.	Date	Comment
A	05/2018	Initial document release.

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