Precision Rectifier Using Mixer – PSoC® 3/PSoC 5

EP61919

Associated Part Families:CY8C38xx/CY55xx
Software: PSoC® Creator™
Related Hardware: CY8CKIT-001
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Project Objective

This project demonstrates full wave rectifier implementation using mixer component.

Overview

The sine wave is given to the input of the Multiplying mixer. The mixer operates:

- As an inverting amplifier when its local oscillator input is Low (-1).
- As a noninverting amplifier when its local oscillator input is High (+1).

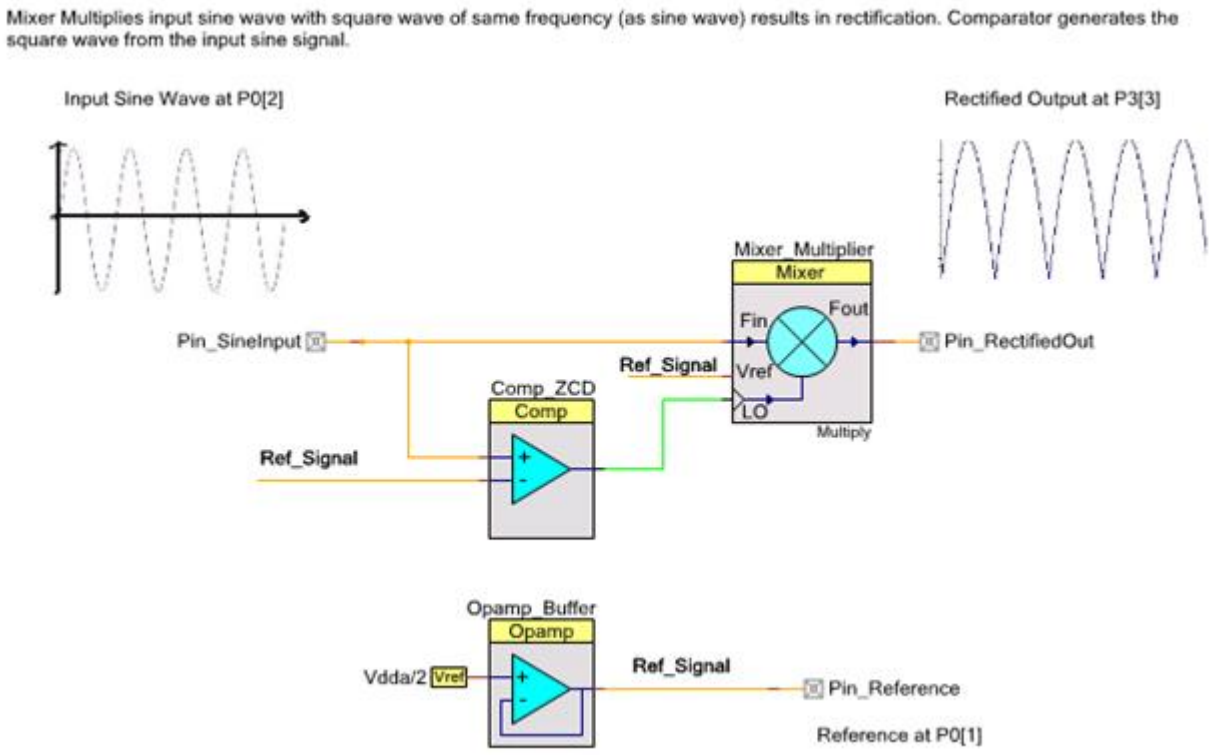
The local oscillator input of the mixer receives the square wave of the same frequency as an input sine wave. A rectified wave is thus obtained at the mixer output.

Component List

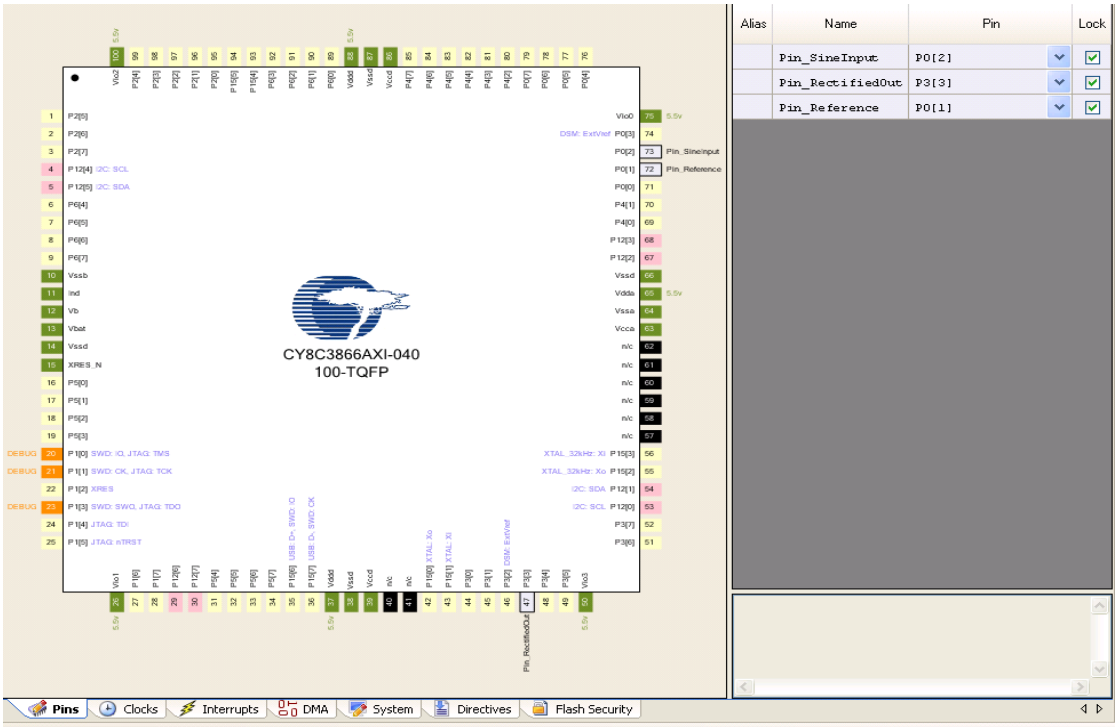
Instance Name	Component Name	Component Category	Comments
Mixer_Multiplier	Mixer	Analog	Configured as Multiplier
Comp_ZCD	Comparator	Analog	--
Opamp_Buffer	Opamp	Analog → Amplifiers	The opamp buffers the reference voltage (Vdda/2) before it is brought out on the pin
Pin_SineInput	Analog Pin	Ports and Pins	--
Pin_RectifiedOut	Analog Pin	Ports and Pins	--
Pin_Reference	Analog Pin	Ports and Pins	--
Vdda/2	VRef	System	--

Top Design

The following figure shows the components and their routing.

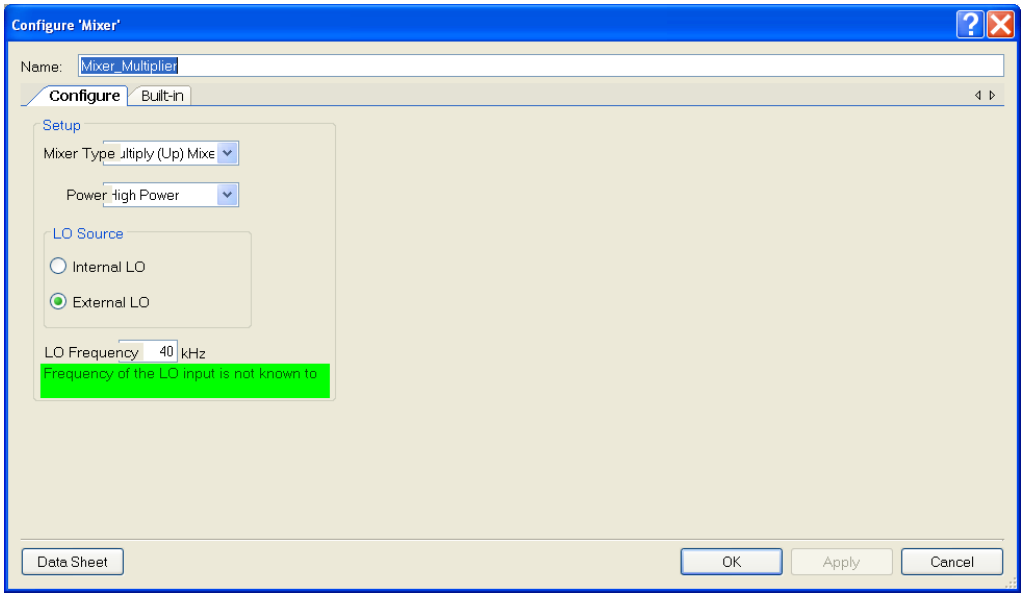


The following figure shows the pin configuration (as in .cydwr file)

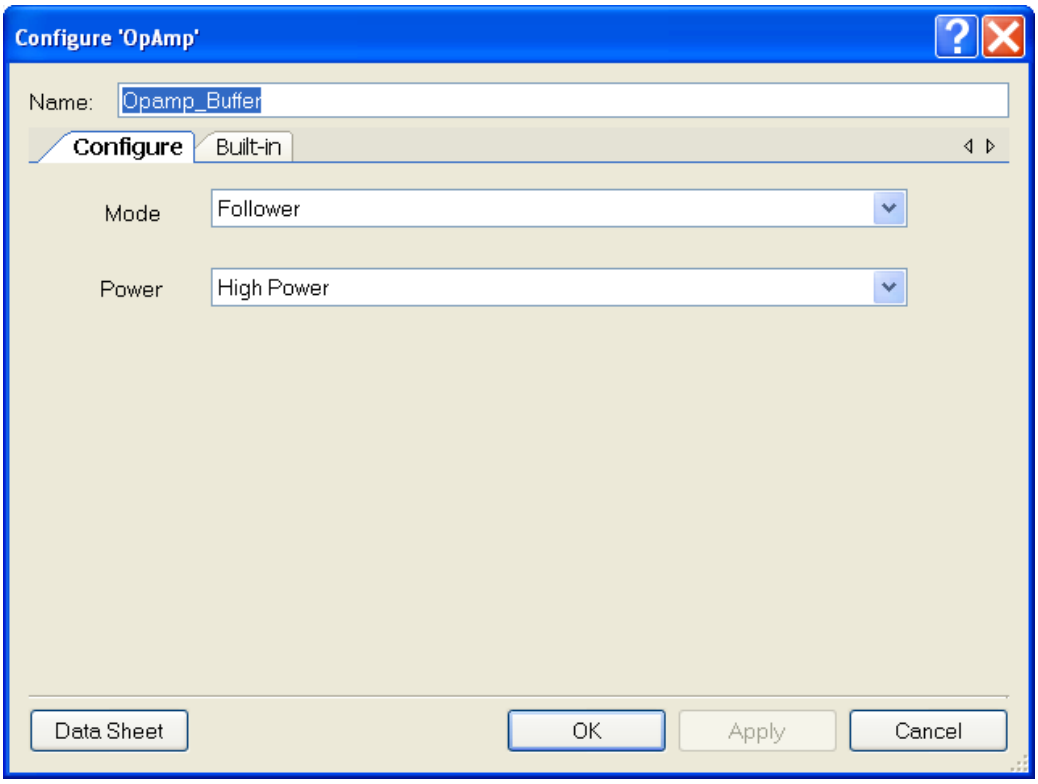


Component Configuration

Mixer_Multiplier

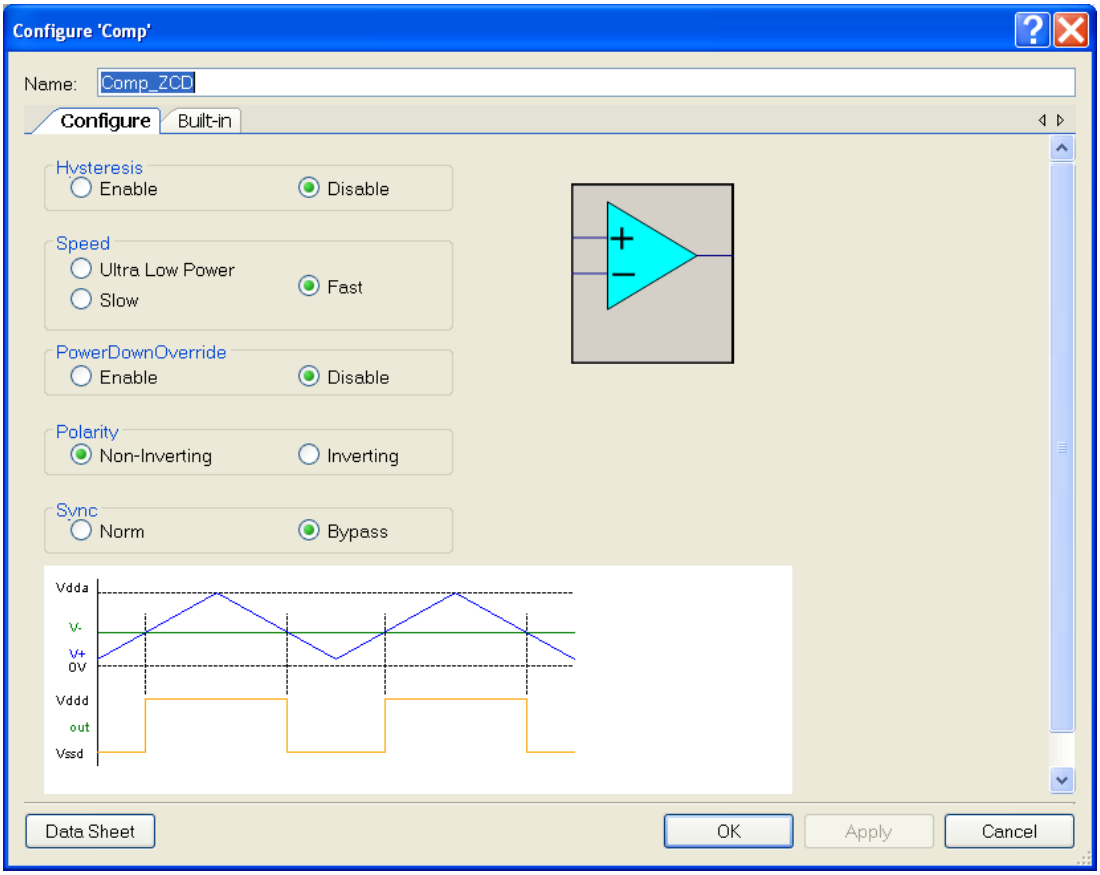


Opamp_Buffer



Note The Opamp component buffers the reference voltage (Vdda/2) before it is brought out on the pin.

Comp_ZCD



Design Wide Resources

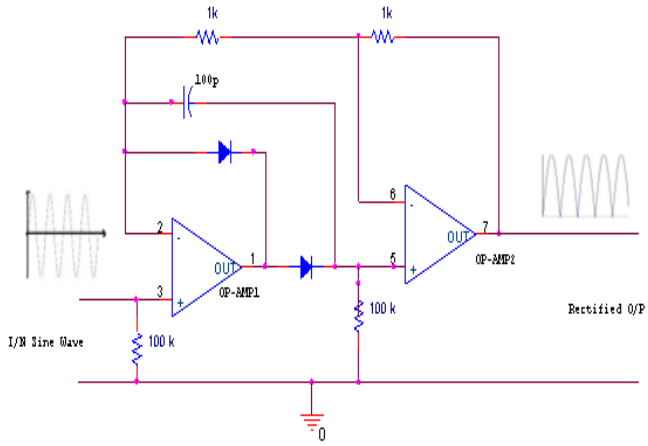
This project uses the default configuration. Refer to the .cydwr file for the default settings.

Operation

Introduction

Rectifiers are typically designed with opamps and discrete components. An example is shown in Figure 1. These rectifiers can be implemented in PSoC 3 and PSoC 5 using PSoC 3 and PSoC 5 opamps. However, PSoC's unique configurable and programmable analog peripherals allow the construction of rectifiers without using any external components.

Figure 1. Typical Implementation of a Precision Rectifier



A sine wave, when multiplied with a square wave of the same frequency and phase as the sine wave, results in rectification.

Input the sine wave to the mixer input. A square wave of the same frequency is obtained by passing the input sine wave through a comparator. Feed the output of the comparator into the local oscillator input of the mixer. The mixer takes care of the multiplication and produces a rectified output.

A multiplying mixer multiplies by acting as a unity gain amplifier, alternating its gain between +1 and -1 based on the local oscillator input level. The mixer:

- Acts as an inverting amplifier when its local oscillator input is low (-1).
- Acts as a non-inverting amplifier when its local oscillator input is high (+1).

Figure 2 shows the block diagram of the implementation and Figure 3 illustrates the timing diagram of the input signal, comparator output, and mixer output. As shown, when the sine wave goes below zero, the comparator output also goes low; this sets the gain to -1. Therefore, the negative half of the incoming sine wave is always given a gain of -1 and the positive half is given a gain of +1, leading to rectification.

Figure 2. Block Diagram of Mixer Implementation Method

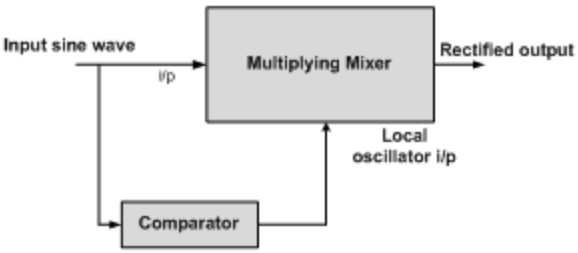
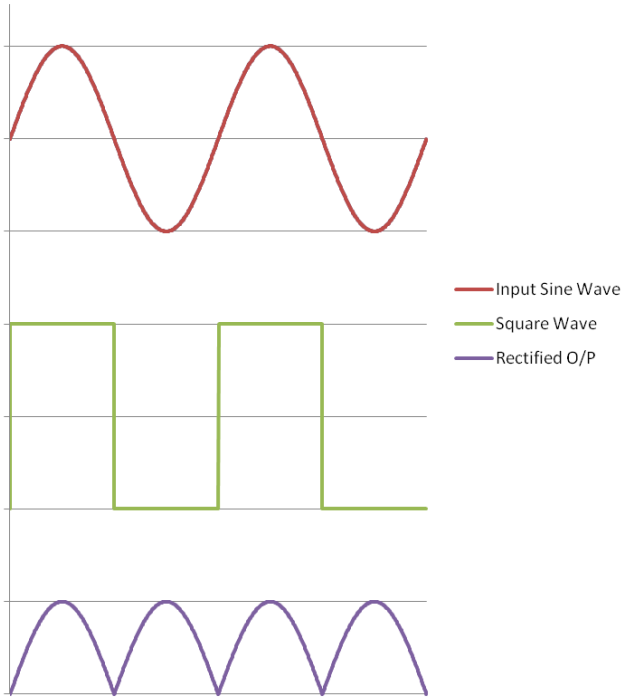


Figure 3. Timing Diagram of Mixer Implementation Method

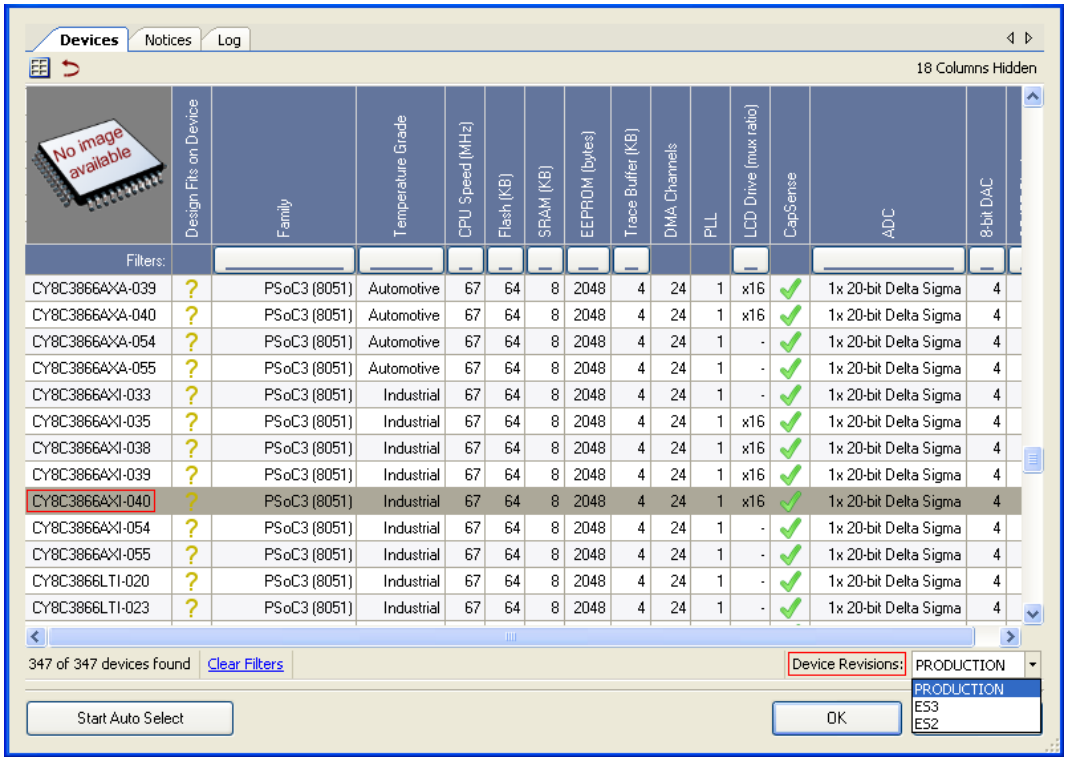


Hardware Connections

- The external sine input signal needs to be reference with respect to Vdda/2. So, apply 1-V amplitude and 1-kHz sine wave signal to Pin P0[2] with respect to Pin P0[1]. Connect the signal generator output signal to P0[2] and the signal generator ground to Pin P0[1].
- Connect pin P0[2] and P3[3] to the oscilloscope to view input signal and rectified output signal respectively.
- For rest of the basic settings of the DVK, refer to the CY8CKIT-001 PSoC Development Kit Board Guide, which is supplied with the kit.

Output

- Use the device selector window (Project->Device Selector) in PSoC Creator to select the appropriate device and device revision. If you are using a PSoC 3 device (for example, CY8C3866AXI-040) with production revision, then use the following selection.



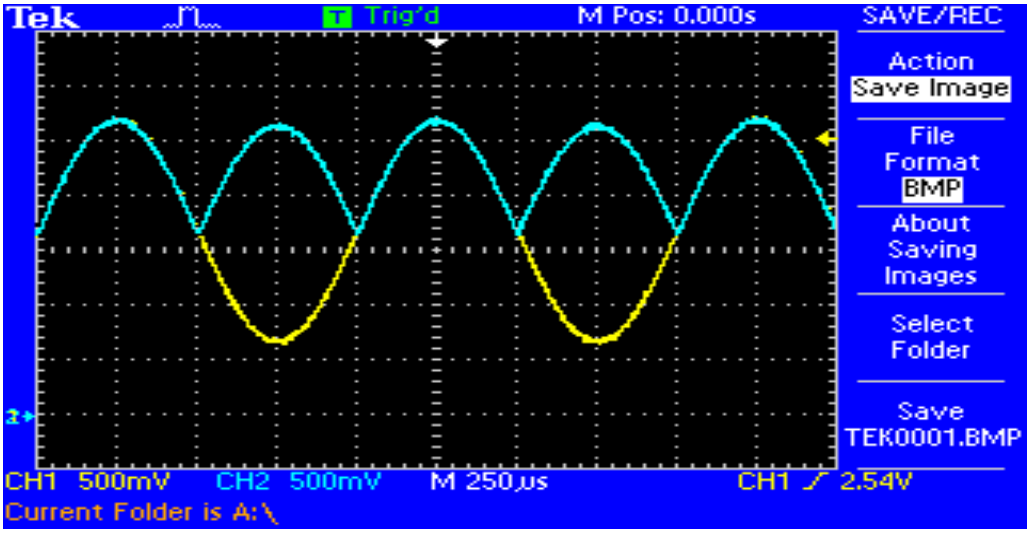
Similarly, select an appropriate device number to work with the PSoC 5 Device family (for example, CY8C5588AXI-060).

Note For engineering samples, device revision is marked on the package as part of the device number. Production silicon will not have an ES marking.

Build the Project and Program the Device

Press SW4 to reset the device. (Reset Switch)

The following figure shows the Input Signal and Rectified Output.



Document History

Document Title: Precision Rectifier Using Mixer – PSoC® 3/PSoC 5

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	2942288	PFZ	06/20/2010	New Example Project
*A	3152653	PFZ	01/24/2011	Added Introduction to Operation section.

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