MediaTek
MT6169V
RF Transceiver

Partial Circuit Analysis of the Input Circuits

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About Chipworks

Introduction

The MediaTek MT6169V is a radio frequency (RF) transceiver integrated circuit accompanying the MT6290 LTE modem. It supports up to eight primary RF inputs (three high bands, two mid bands, and three low bands), plus another eight RF inputs for diversity gains. The RF chip supports more than 30 3GPP bands and is configurable to meet the RF band needs of mobile operators globally [1].

The MT6169V houses the AM10263B die with a date marking of October 30, 2013. The die measures 2.44 mm x 3.88 mm. It was manufactured in a 40 nm CMOS process. Chipworks bases this estimate on the minimum contacted gate pitch, minimum metal 1 pitch, and minimum transistor gate length measurements.

This partial Circuit Analysis report presents the first stage of one of the two inphase/quadrature TX input circuits from the input pins. The report includes the following major functional sub-blocks/sub-circuits:

- Input Impedance Control (Schematic 2.0.0)
- Control Logic (Schematic 3.0.0)
- Variable Resistor 1 (Schematic 4.0.0)
- Variable Resistor 2 (Schematic 5.0.0)
- Amplifier (Schematic 6.0.0)
- Feedback Resistor (Schematic 7.0.0)
- Variable Capacitor 1 (Schematic 8.0.0)
- Variable Capacitor 2 (Schematic 9.0.0)
- Output Resistor (Schematic 10.0.0)

Brief Design Overview

The TX input circuits of the MT6169V includes two identical lowpass filtering amplifiers for the two pairs of inphase and quadrature signals from four pads. Schematic 2.0.0 shows the simple ESD and programmable resistor circuits. The resistors are likely used for input impedance control and as a part of the gain control along with the programmable feedback resistors (Schematic 7.0.0). There are also two resistors (Schematics 4.0.0 and 5.0.0) tapped on the input of the TX input stage and connect to an analog block adjacent to the TX phase-locked loop (PLL). The amplifier shown in Schematic 6.0.0 includes a mid-voltage clamp circuit to ensure the mid-voltages of the two paired output signals, VOP/VON, are at the reference voltage VMRF.

Component Descriptions

The MT6169V is fabricated in a low power RF CMOS process and features a variety of active and passive components. The active components are MOS devices. Planar views of all devices at all layers of the process can be viewed within the ICWorks Browser.

NMOS, NMOS4, PMOS, and PMOS4

Standard MOS transistors (N-type and P-type). These devices have the following parameters associated with them in the schematics:

- Instance name (e.g., N15255 in Schematic 2.0.0)
- Gate width/gate length in µm of the unit device
- The number of unit devices (m) making up the total device

RPOLY

Resistors formed using the polysilicon layer with silicide exclusion. These devices have the following parameters associated with them in the schematics:

- Instance name (e.g., R17644 in Schematic 2.0.0)
- Type of resistor (RPOLY)
- The total number of squares in the resistor (sq)

More information is available for each resistor in the ICWorks Browser by selecting an instance and using the query (q) function. There, the following parameters are available:

r – The total number of squares in the resistor
m – The number of identical resistor segments in parallel making up the total resistor
s – The number of identical resistor segments in series making up the total resistor
w – The width of each resistor segment
l – The length of each resistor segment

This report contains the following information:

- a full set of schematics with device size measurements, organized in a hierarchical manner
- package, X-ray, die markings, and die photographs
- device summary

Accompanying this report are the full hierarchical schematics in the ICWorks Browser. This schematic viewing tool allows you to interactively view all the schematics. You can select instances, wires, or areas (left mouse button), highlight nets (b), and query devices (q). You can easily browse down (Shift-E) and up (Ctrl-E) the schematic hierarchy. You can cross-probe from devices, groups of devices, or blocks in the schematics to the annotated images (function key F7). All annotations and layer images are visible at very high resolution, and can be viewed by using the - and + keys. You can use the ruler to measure any feature in the image. Cross-probing also works in the reverse direction, from annotated images to schematics (F7). The ICWorks Browser can write many formats of netlists including SPICE, Verilog, VHDL, and EDIF200. The “help” pull-down menu in the tool includes a bindkey reference and short tutorial to help you get started. Chipworks highly recommends that these schematics be viewed with the ICWorks Browser.

Click here to launch **ICWorks Browser**.

All of the information in this report was derived by Chipworks from high magnification photographs and microscopy observations of the following sample:

MediaTek MT6169V

Device Type:	RF transceiver
Date Code:	1427
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013

Device Summary

Part Identification

Manufacturer	**MediaTek**
Part number	**MT6169V**
Type	**RF Transceiver**
Die markings	**<MediaTek logo> AM10263B OCT_30_2013**
Date code	**1427-AMAH**
Package	**Ball grid array (BGA)**

Functional Information

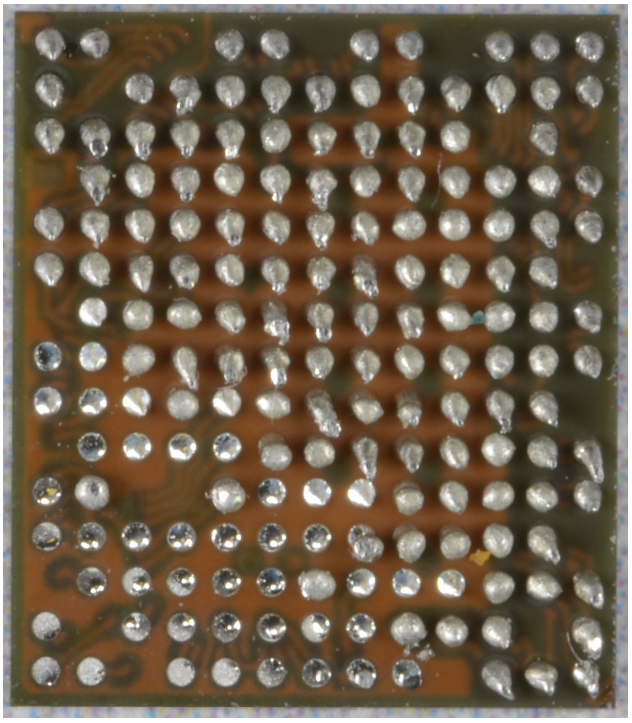
Process	**40 nm**
Technology	**Low power RF CMOS**
Metal interconnect layers	**7**
Poly interconnect layers	**1**

Peripheral Feature Sizes

PMOS/NMOS gate lengths	**40 nm/40 nm**
Metal 1 pitch	**130 nm**
Contacted gate pitch	**160 nm**
Technology node	**45 nm/40 nm**

References

[1] "MediaTek Announces the Availability of Multimode LTE Modem Chipset," http://www.mediatek.com/en/news-events/mediatek-news/mediatek-announces-the-availability-of-multimode-lte-modem-chipset/



0.1.1 Package Markings

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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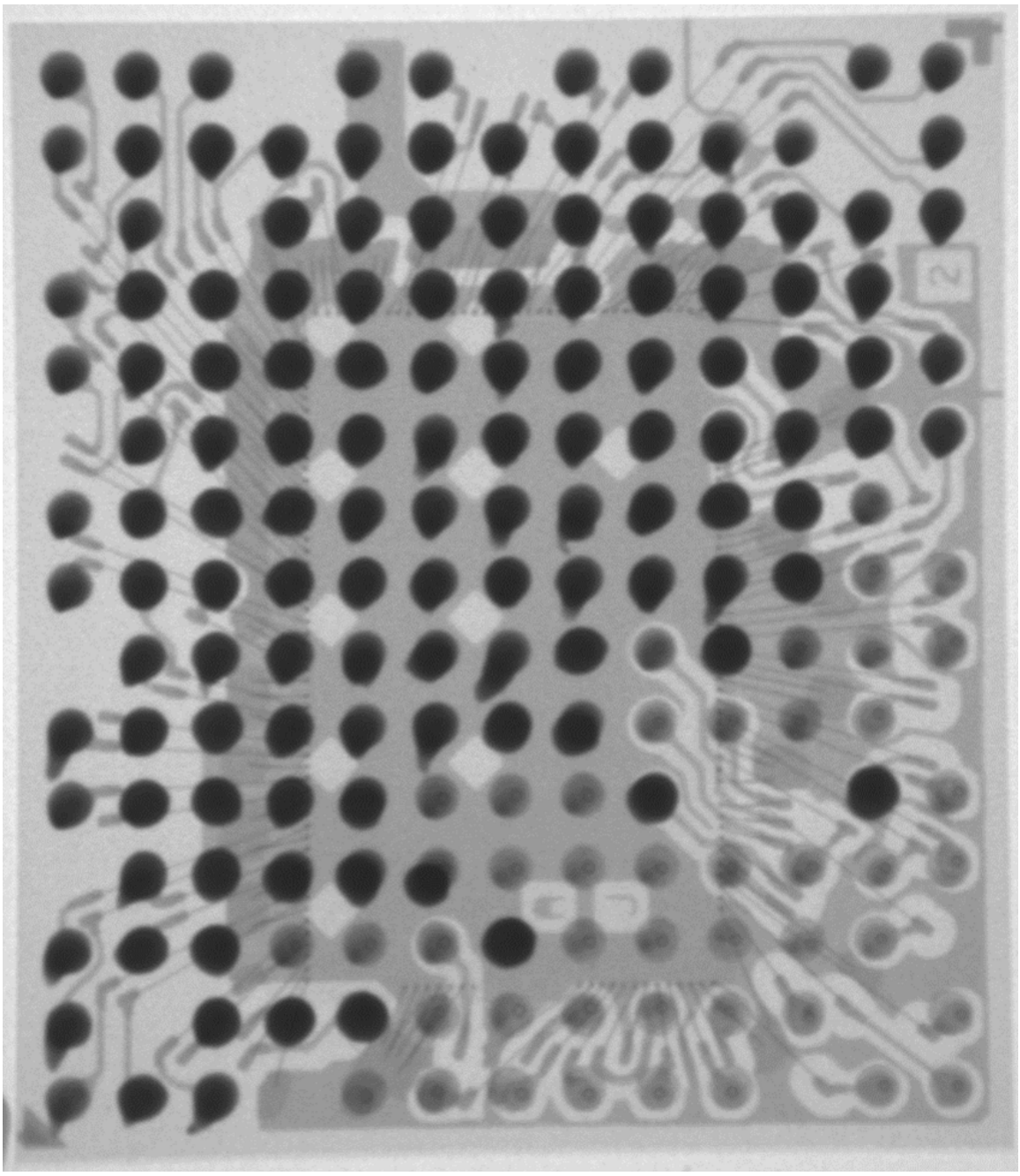
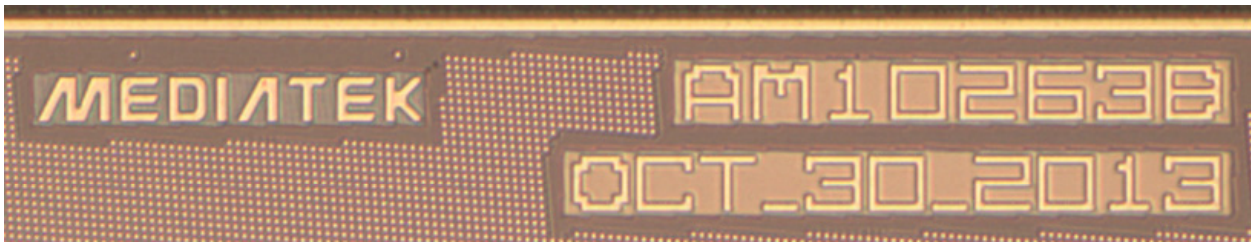


0.1.2 Package X-Ray

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427



0.1.3 Die Markings

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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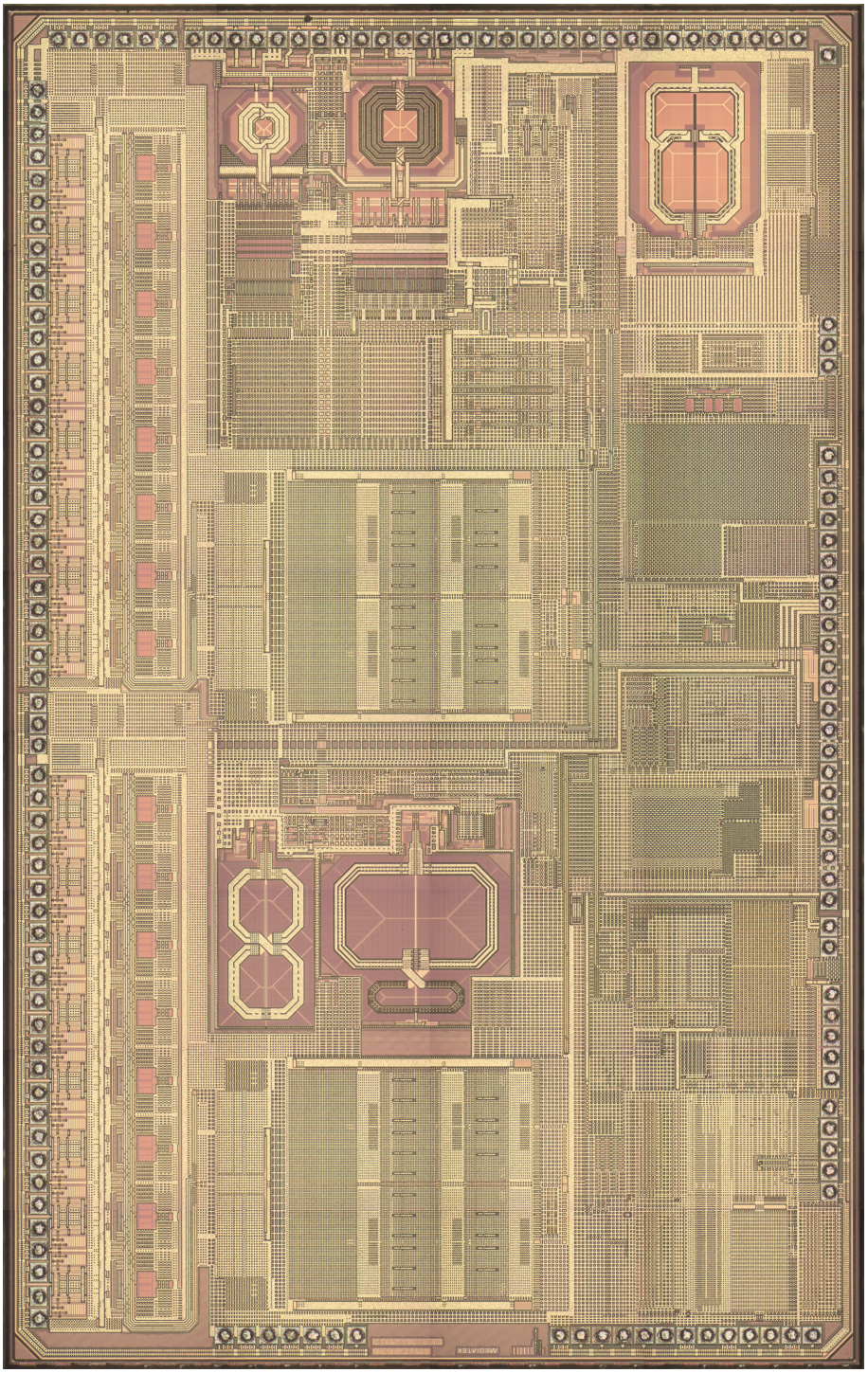

0.2.1 Die Photograph

Die Size: 2.44 mm x 3.88 mm = 9.5 mm^2

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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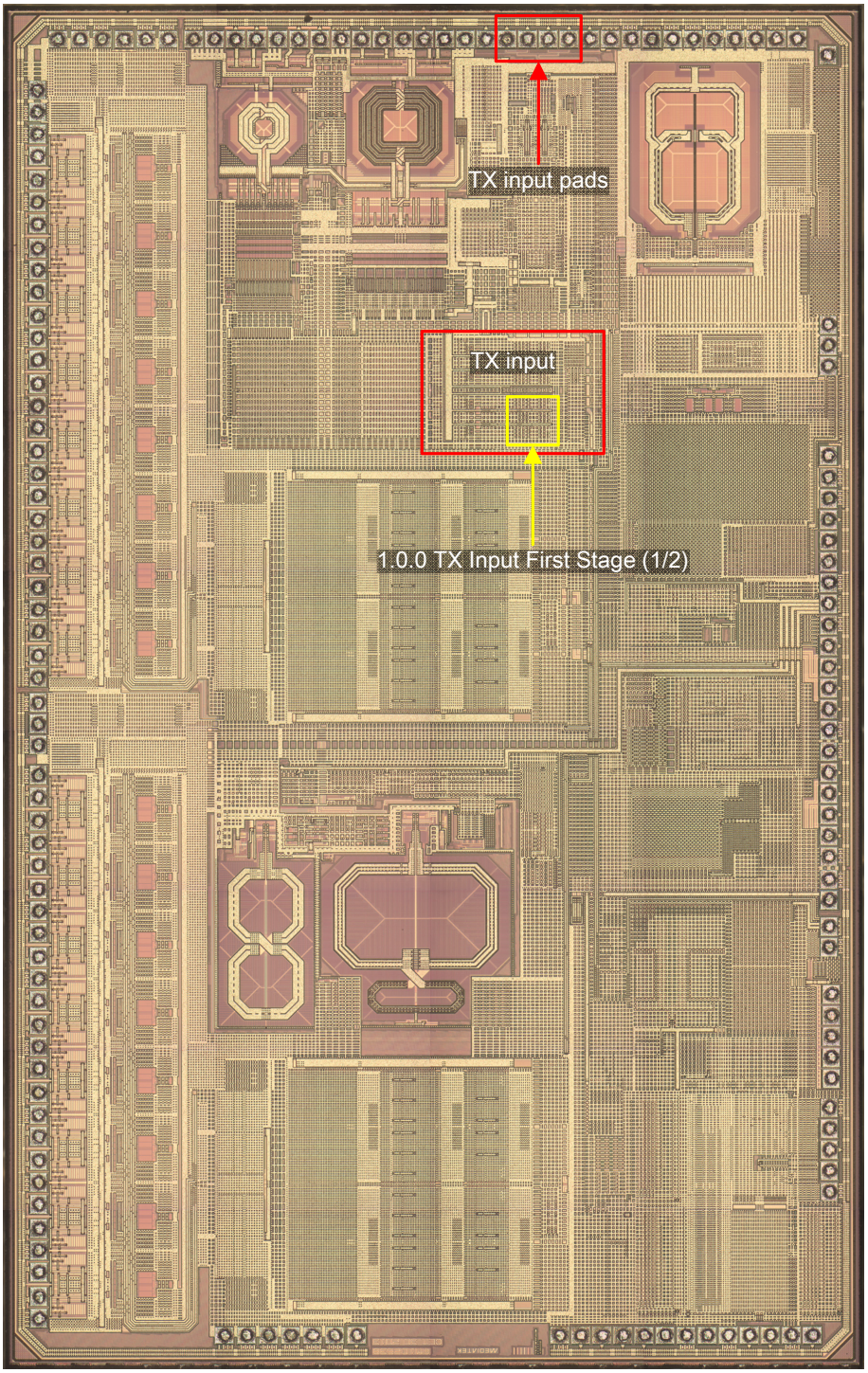
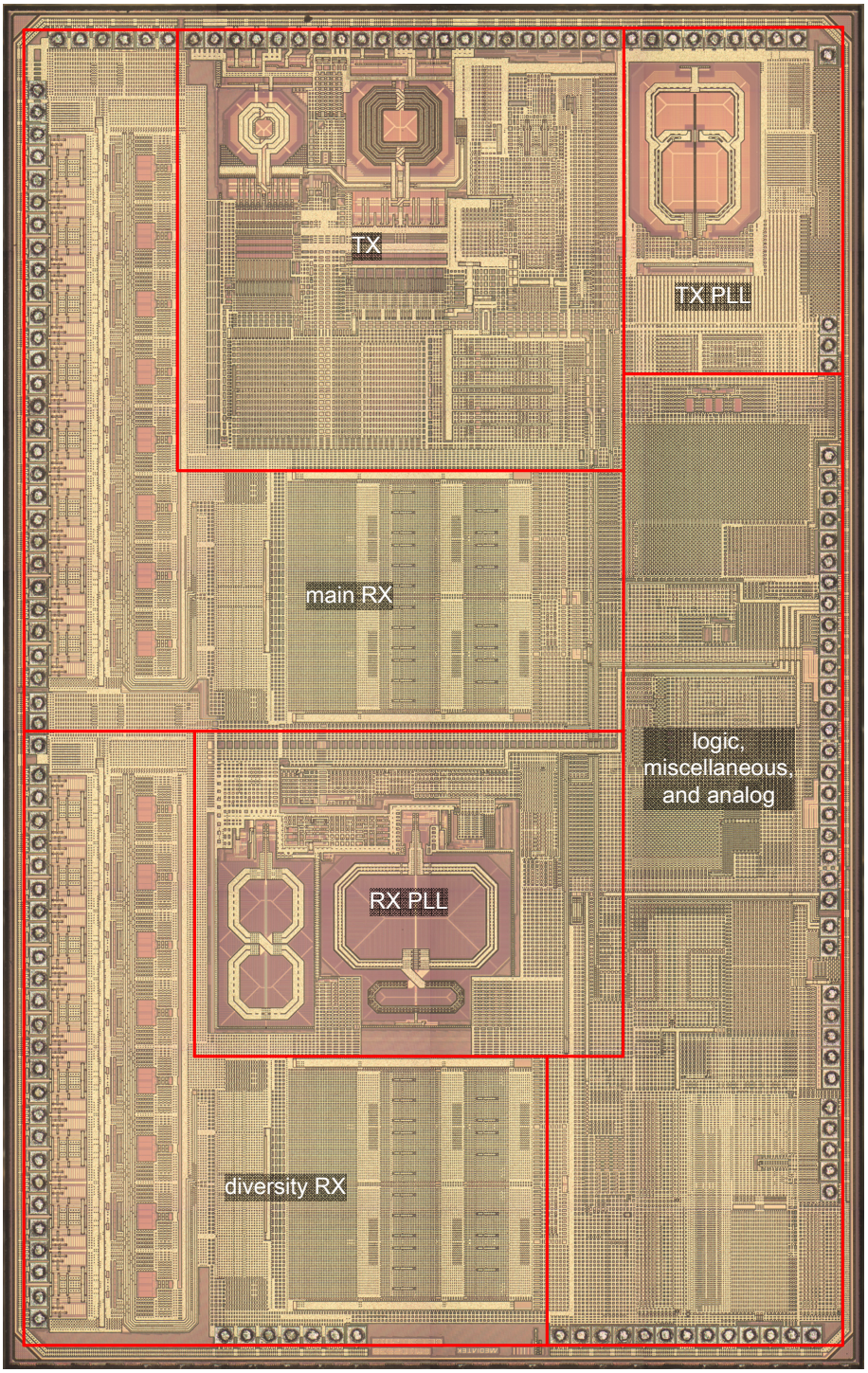


0.2.2 Annotated Die Photograph

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427



0.2.3 Die Architecture

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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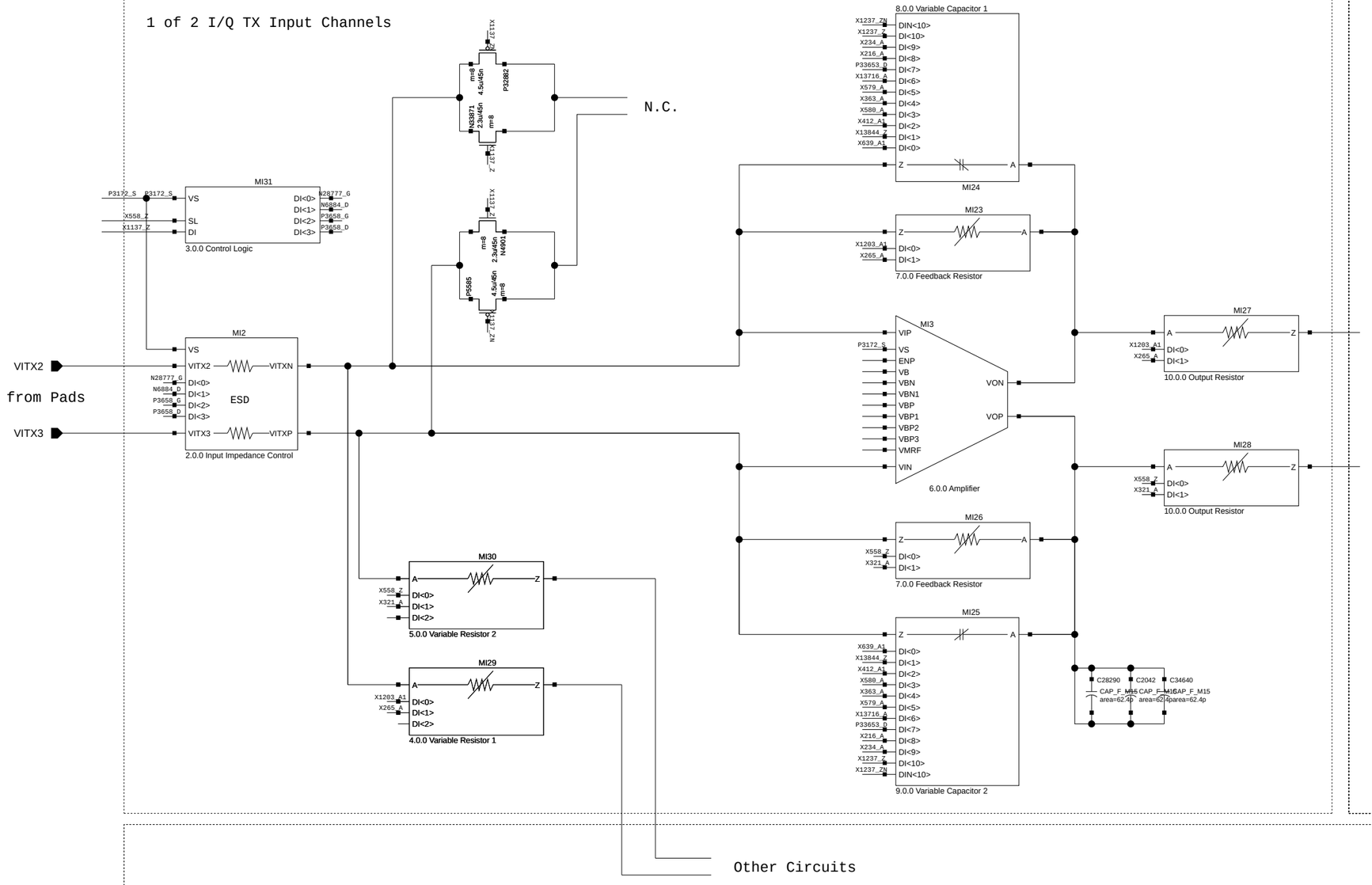
2 of 2 I/Q TX Input Channels

1 of 2 I/Q TX Input Channels



1.0.0 TX Input First Stage

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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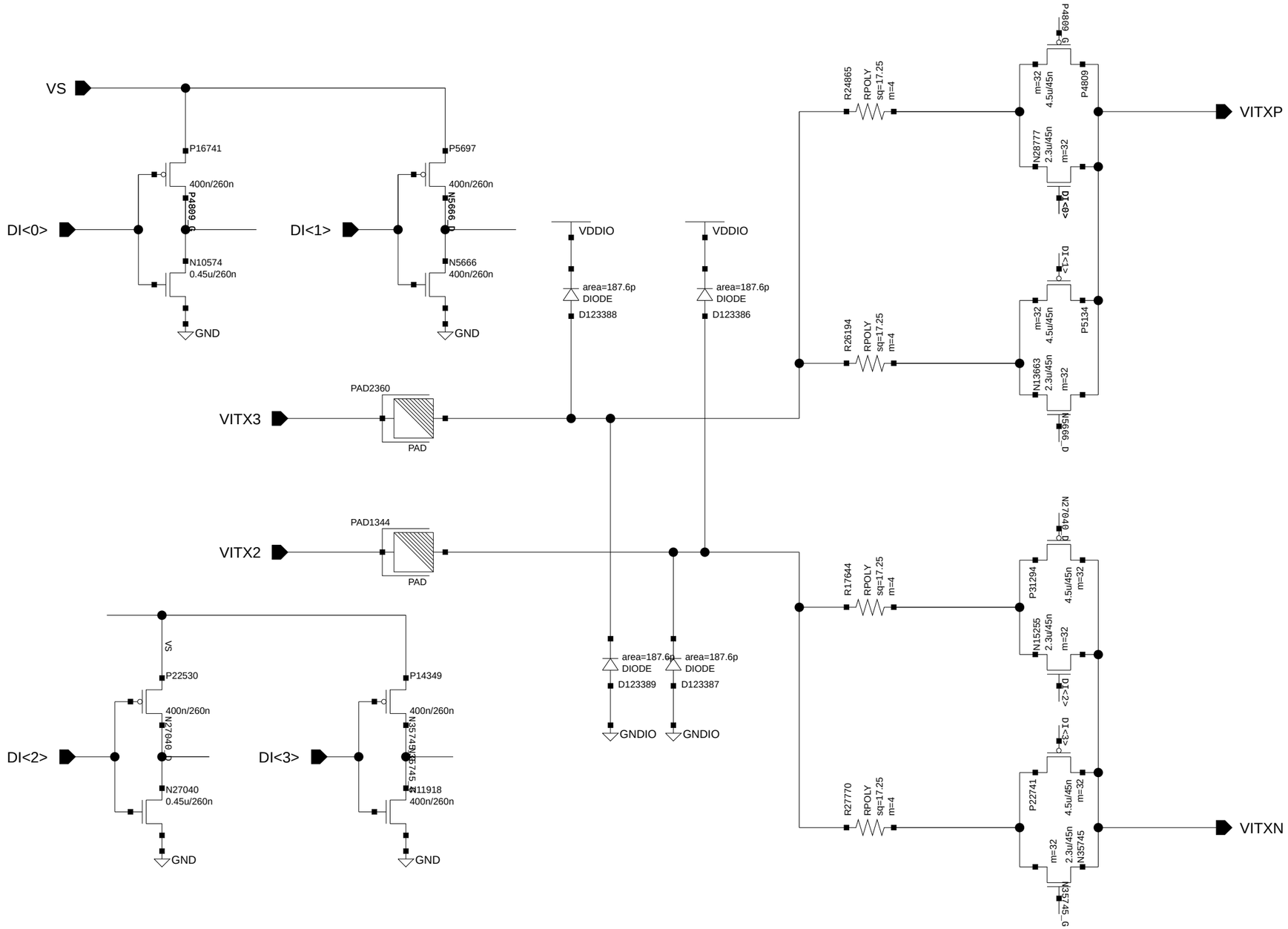

2.0.0 Input Impedance Control

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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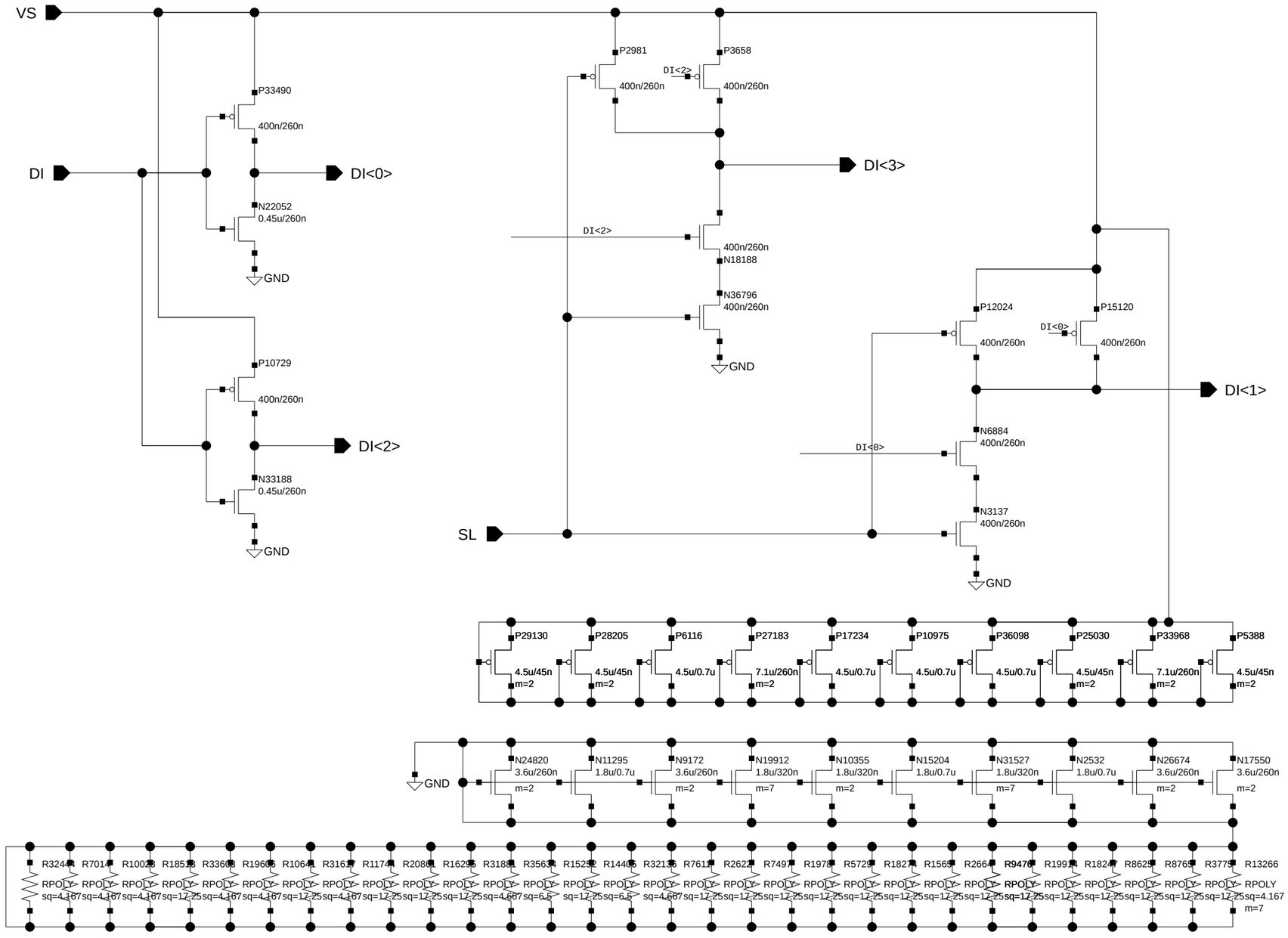

3.0.0 Control Logic

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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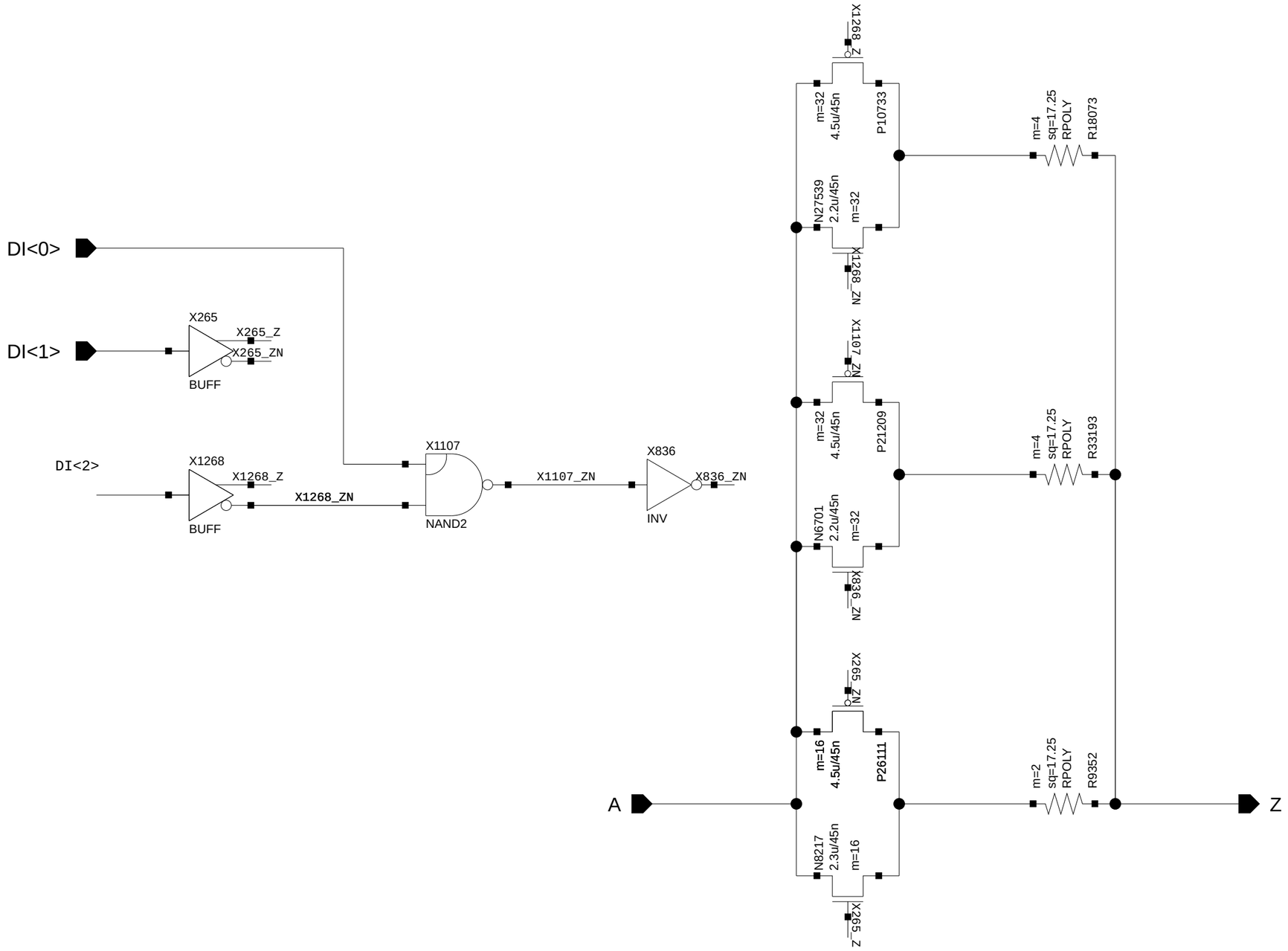

4.0.0 Variable Resistor 1

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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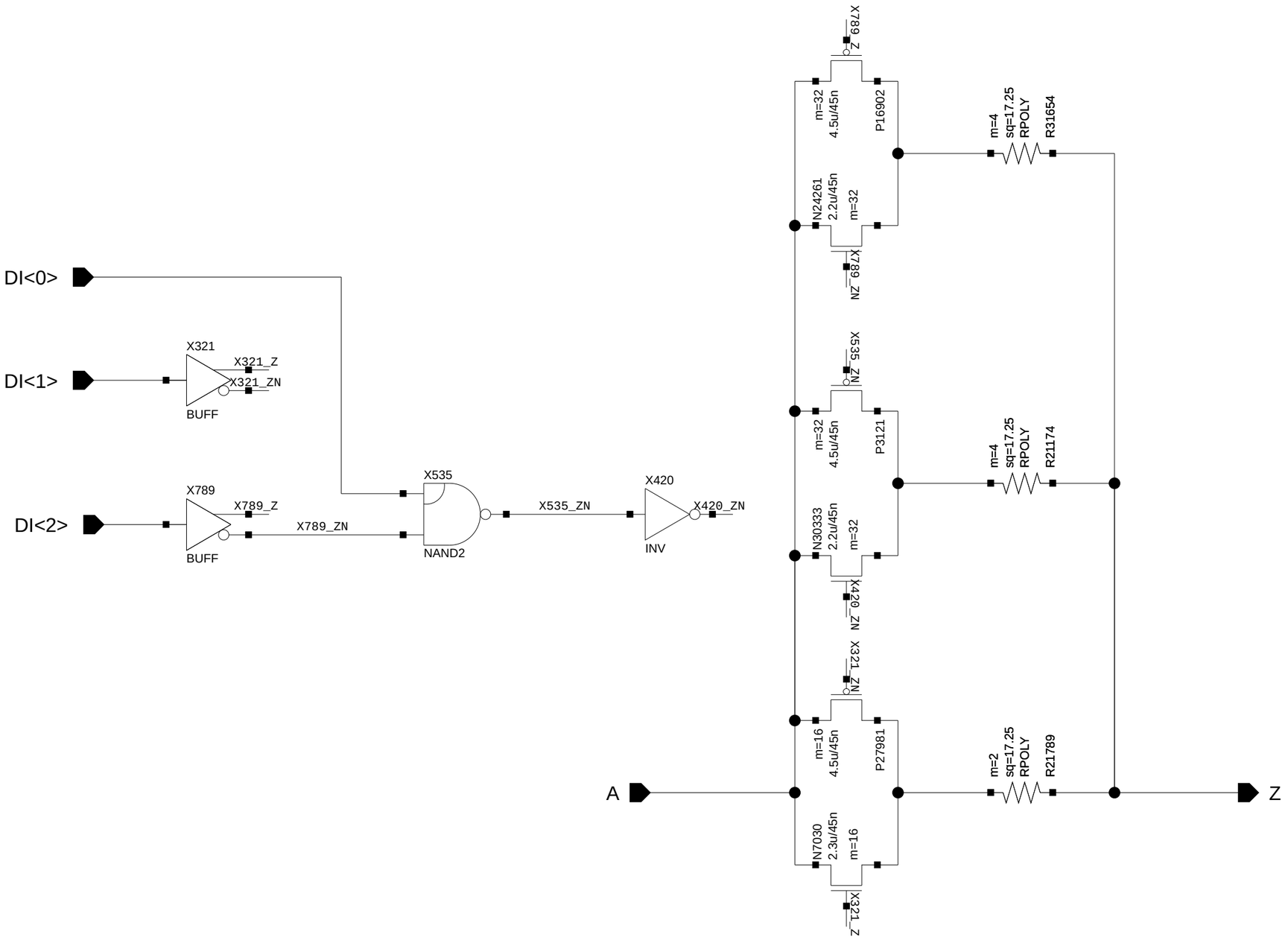

5.0.0 Variable Resistor 2

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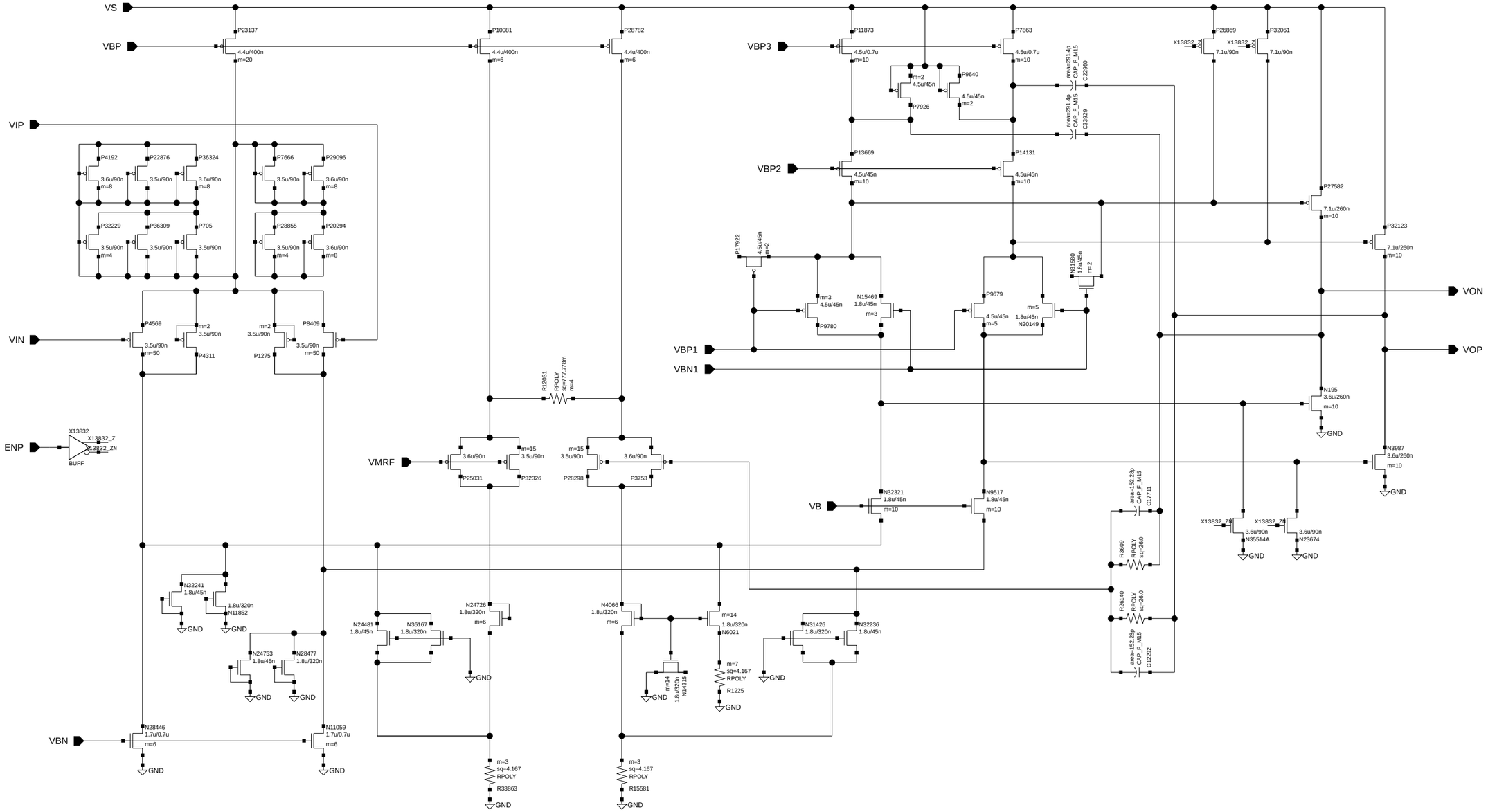
Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

chipworks



6.0.0 Amplifier

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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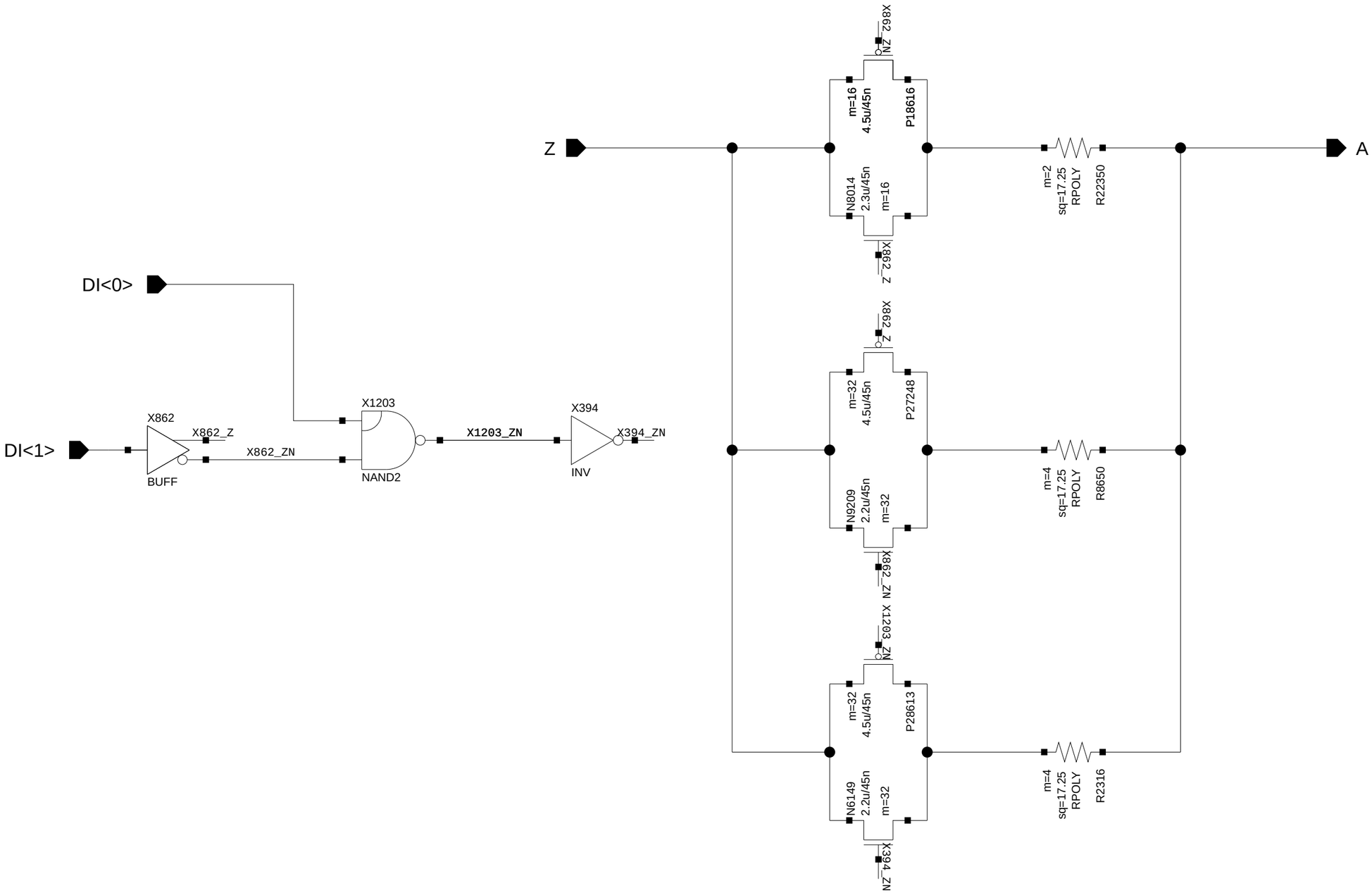
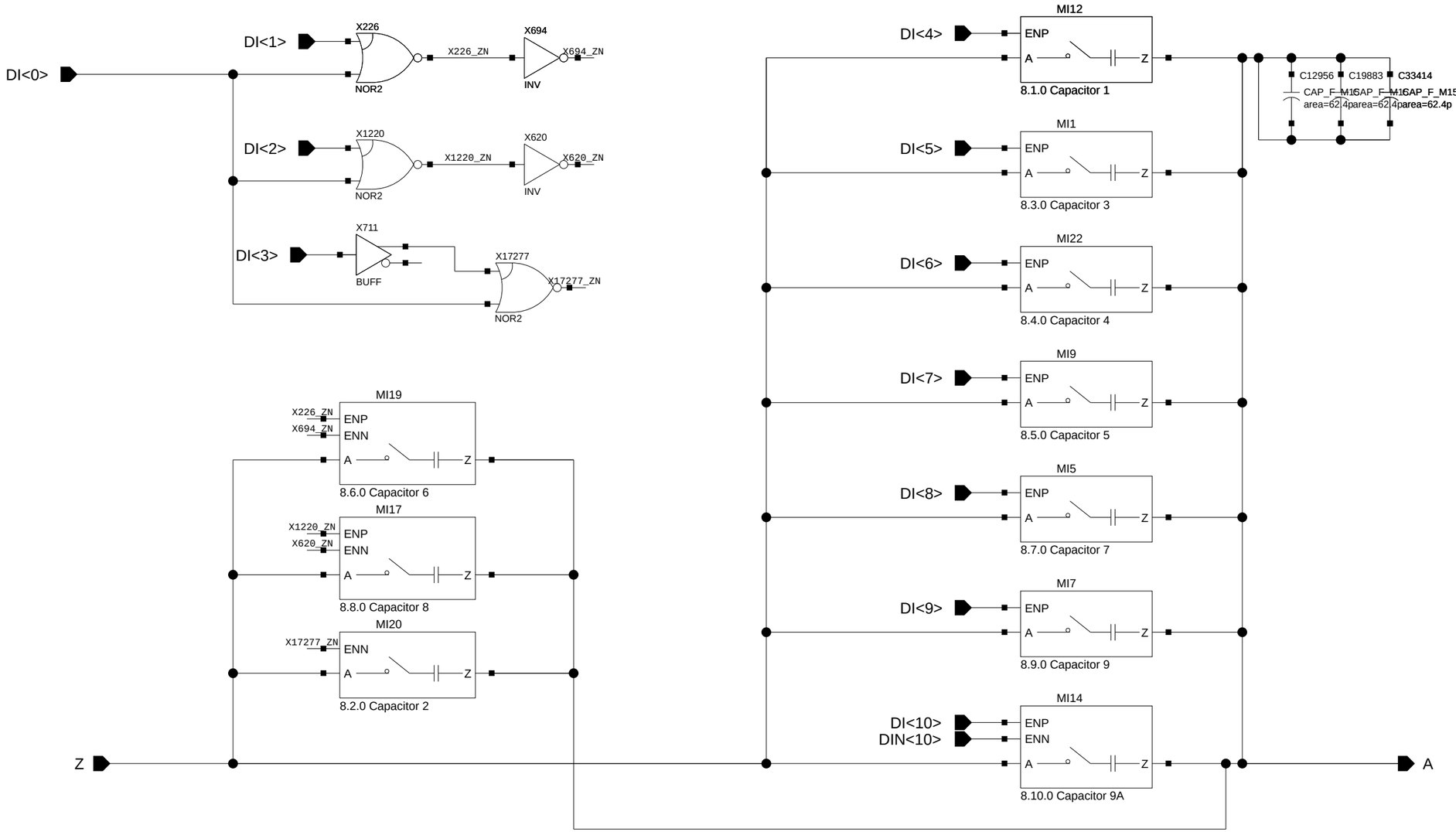


7.0.0 Feedback Resistor

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

chipworks

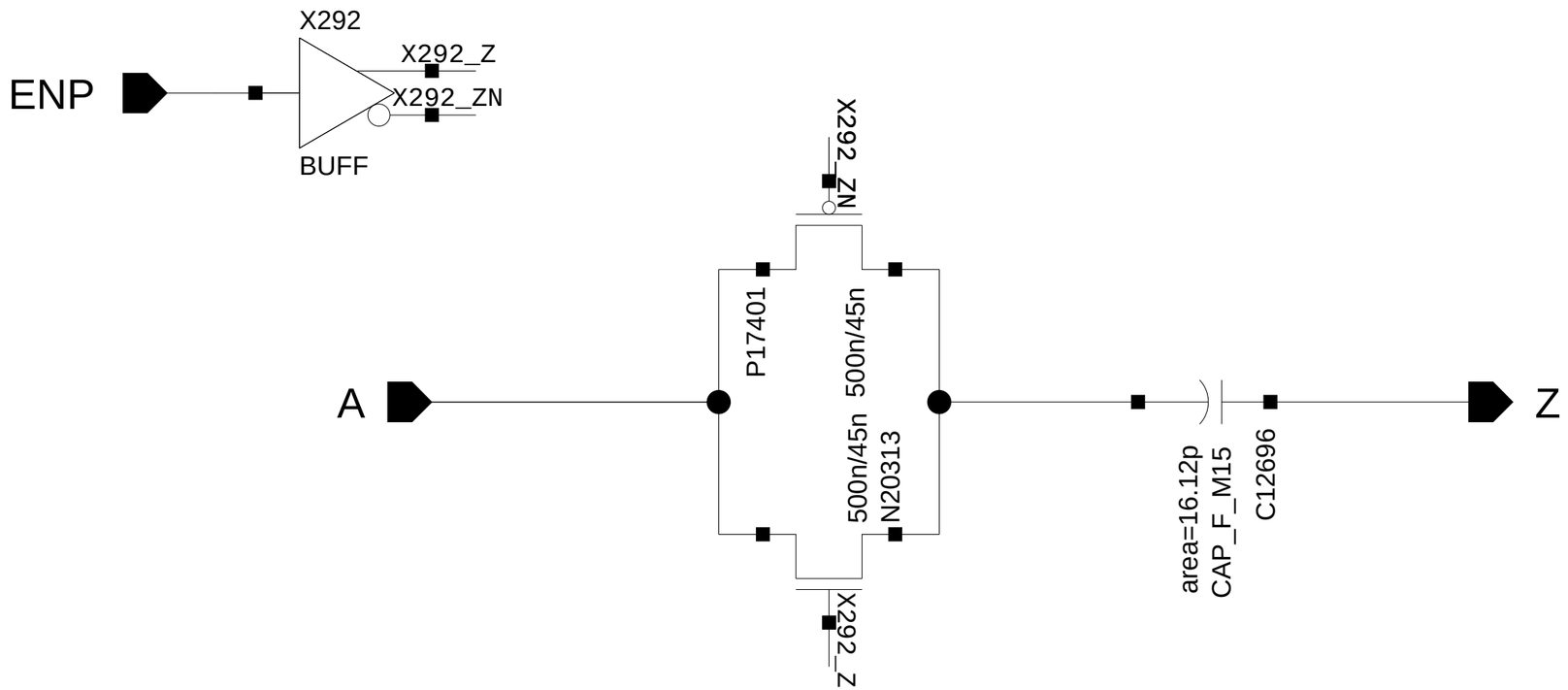


8.0.0 Variable Capacitor 1

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

chipworks

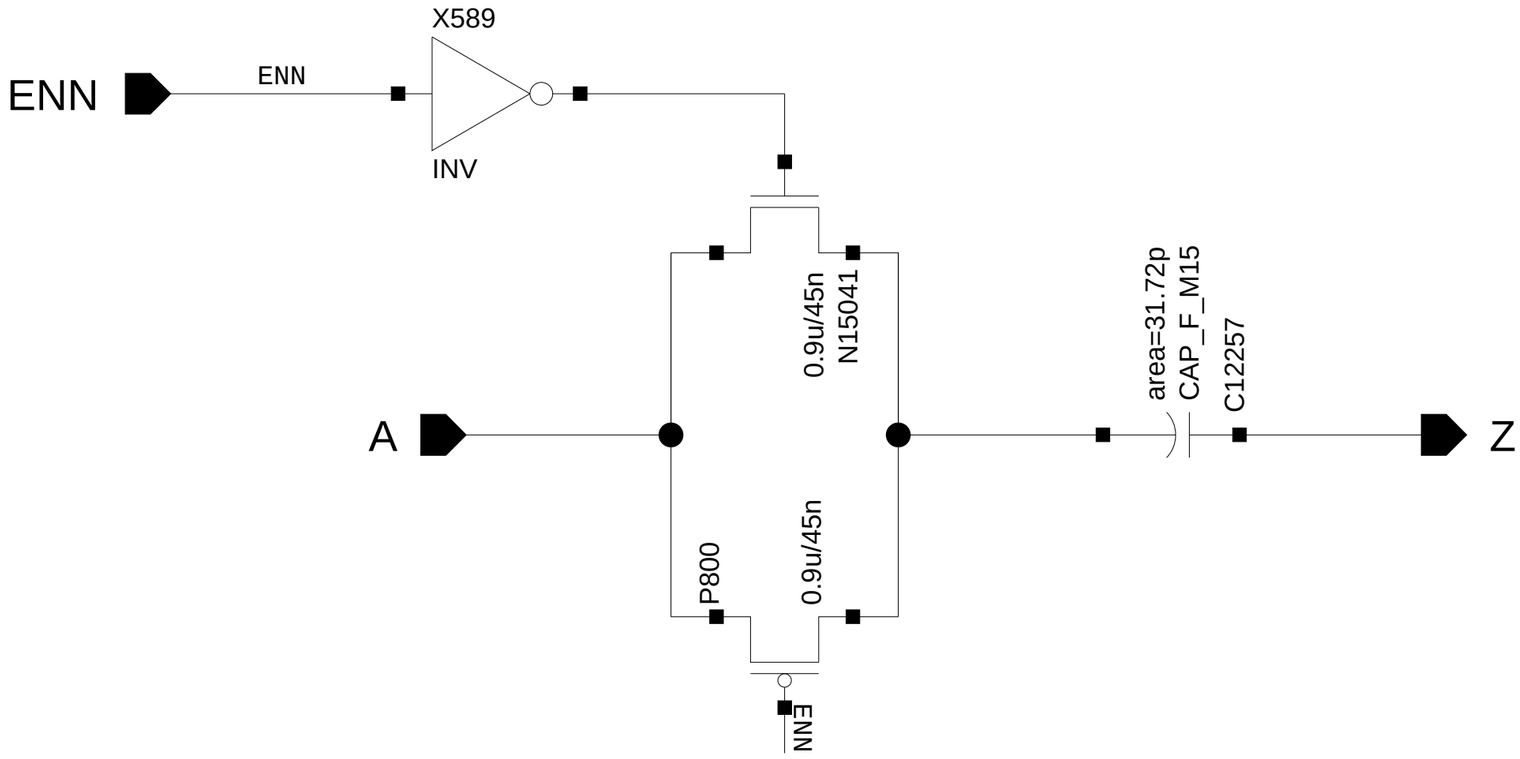


8.1.0 Capacitor 1

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B
	OCT_30_2013
Date Code:	1427

chipworks



8.2.0 Capacitor 2

MediaTek MT6169V

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Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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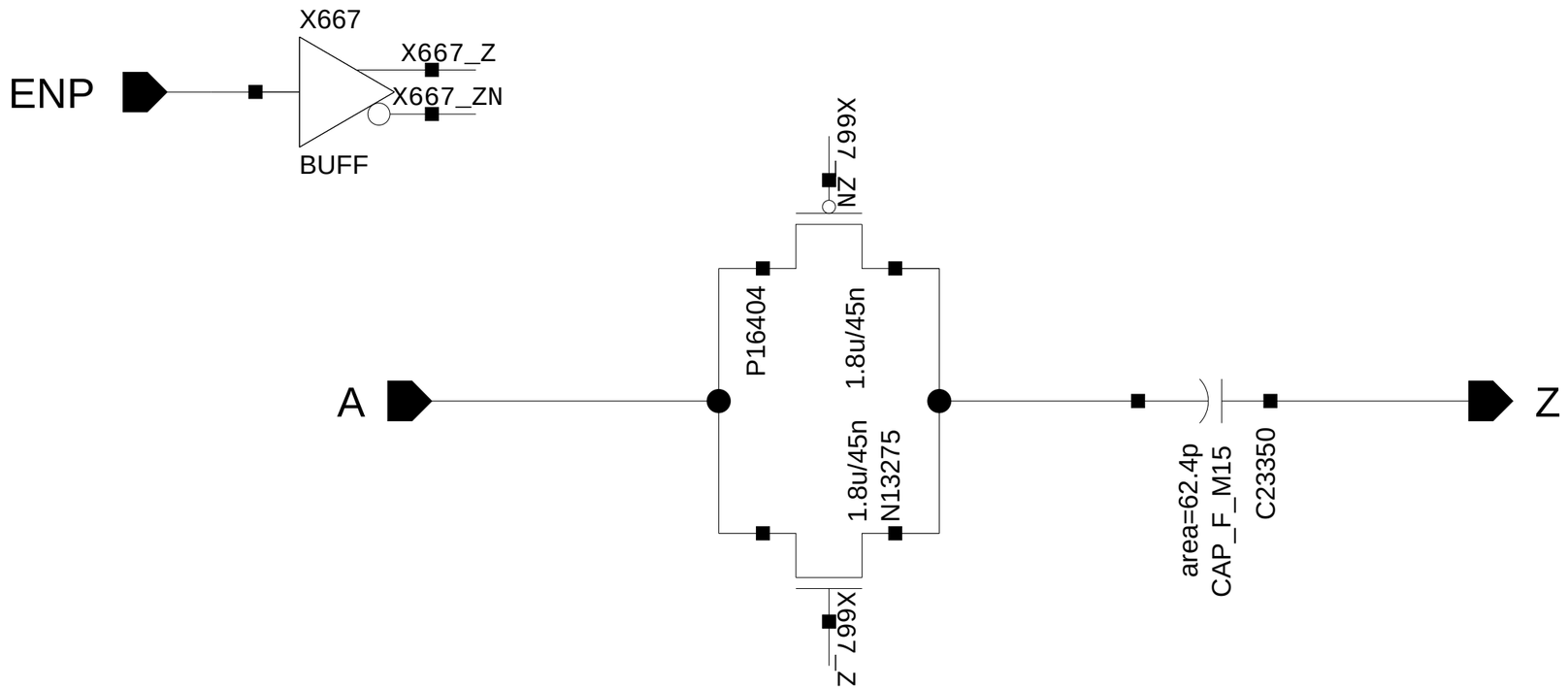

8.3.0 Capacitor 3

MediaTek MT6169V

Device Type: RF Transceiver
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OCT_30_2013
Date Code: 1427

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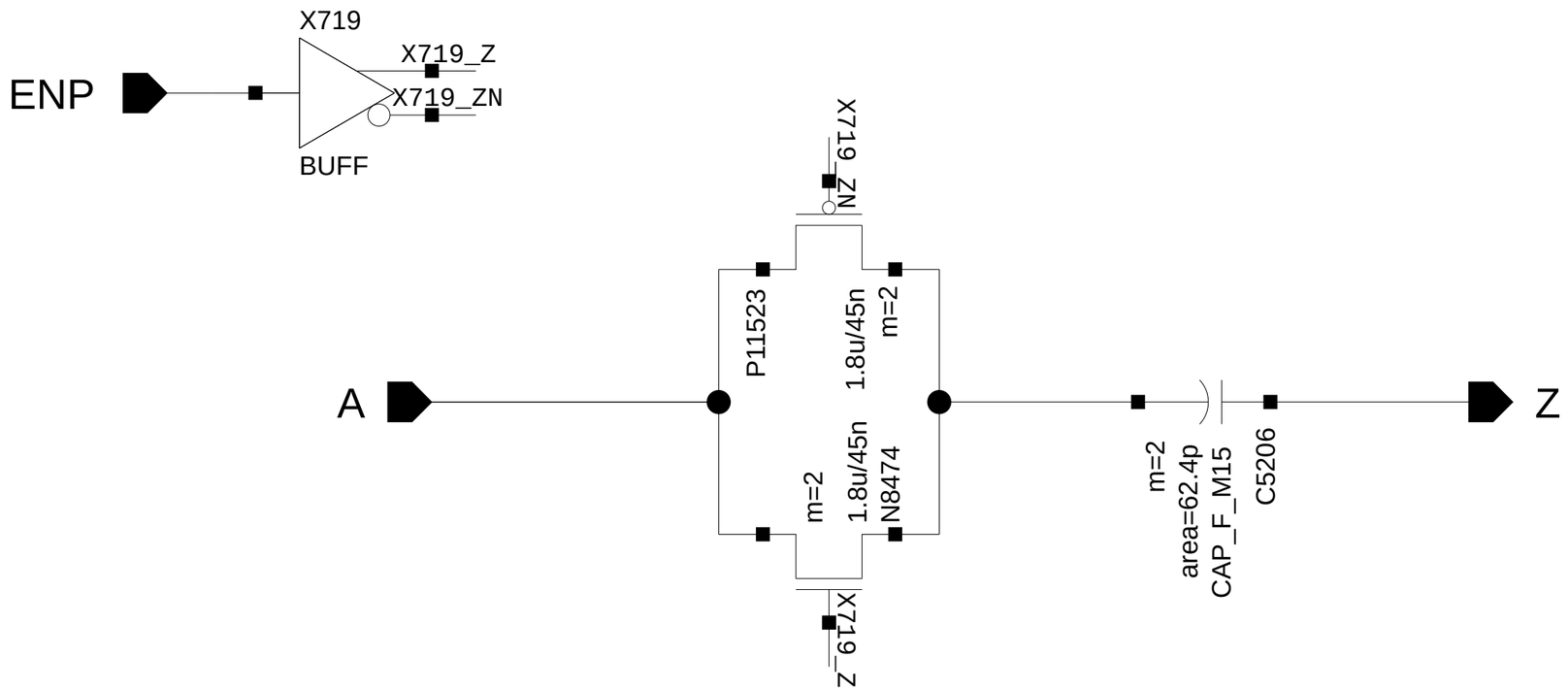

8.4.0 Capacitor 4

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B
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Date Code:	1427

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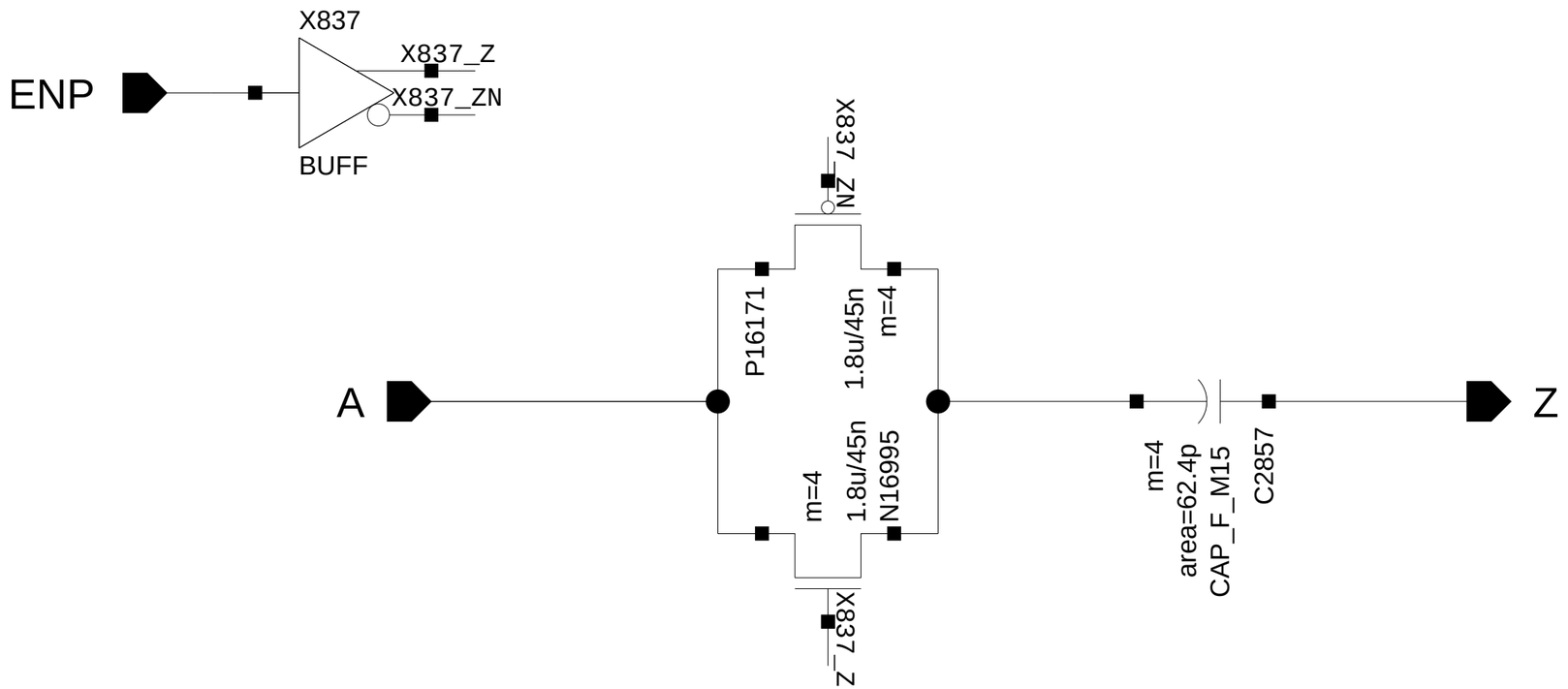

8.5.0 Capacitor 5

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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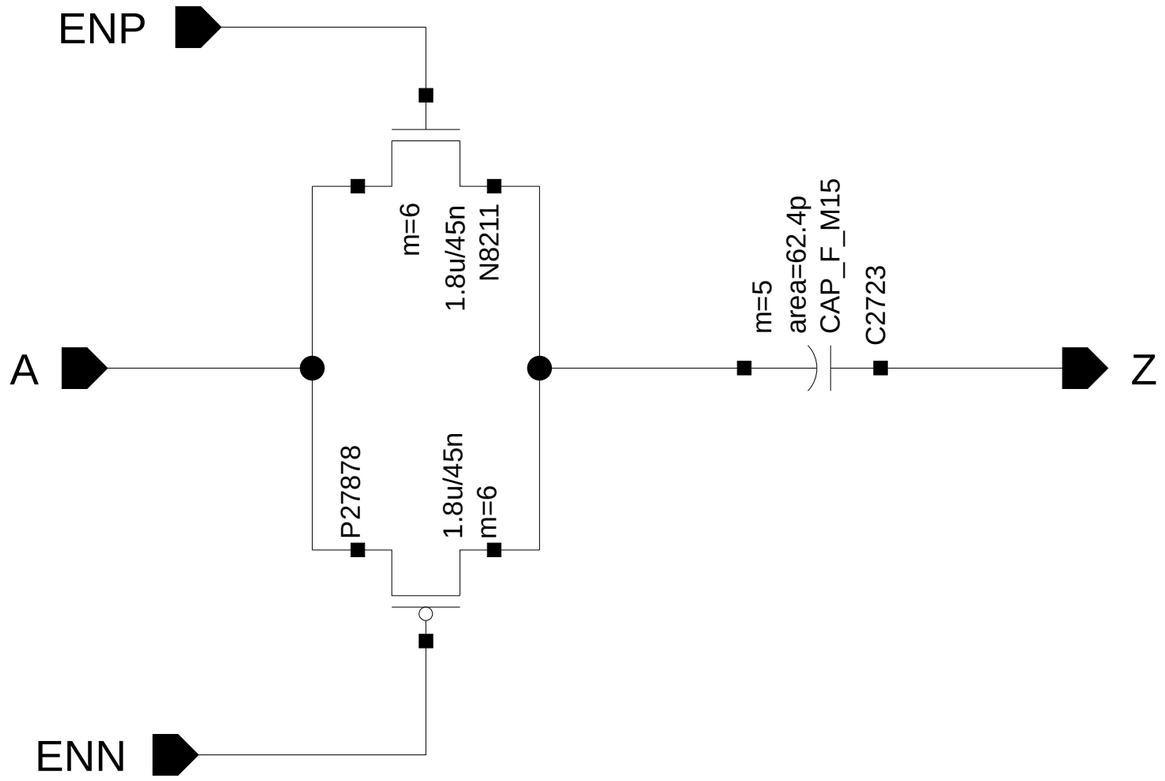

8.6.0 Capacitor 6

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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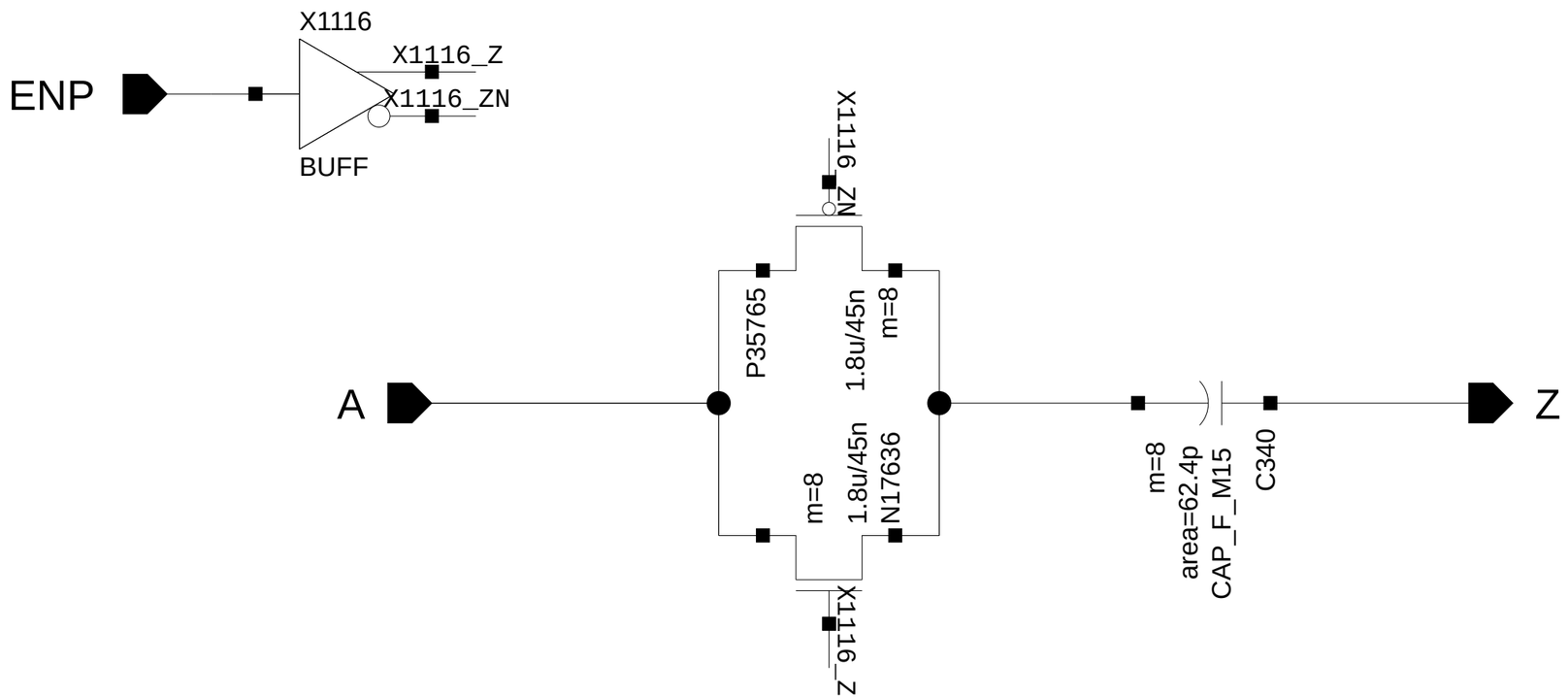

8.7.0 Capacitor 7

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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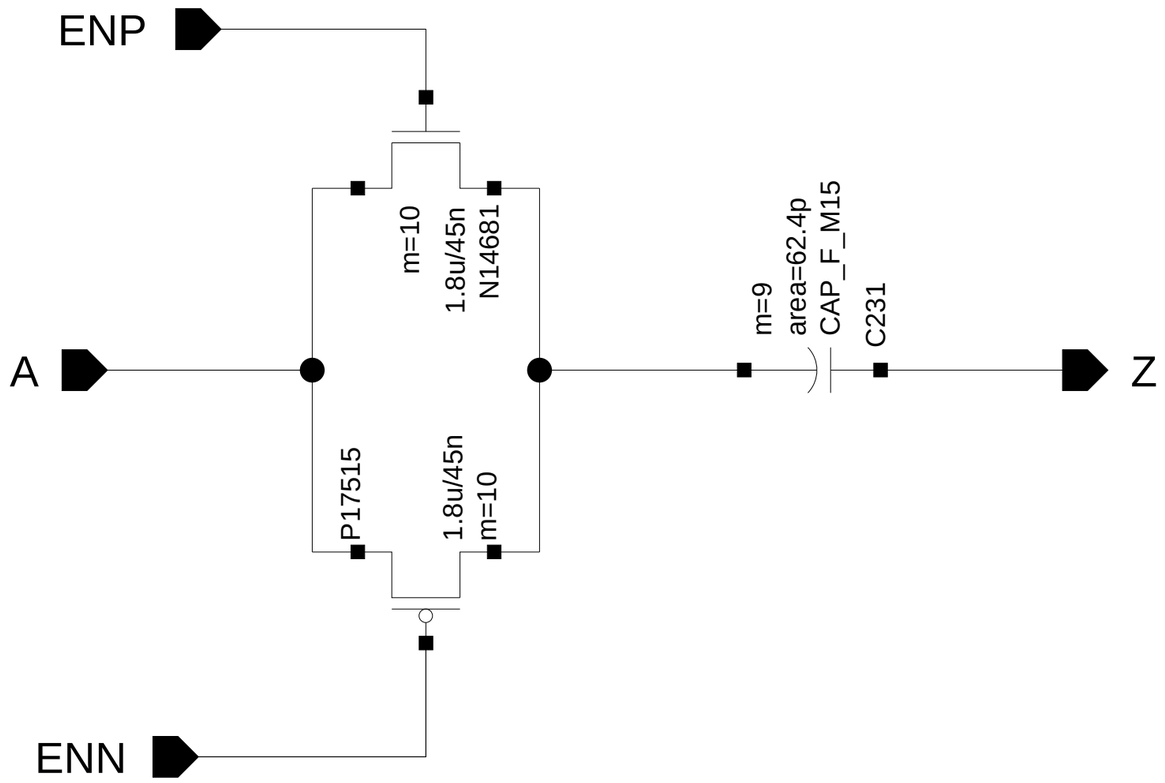

8.8.0 Capacitor 8

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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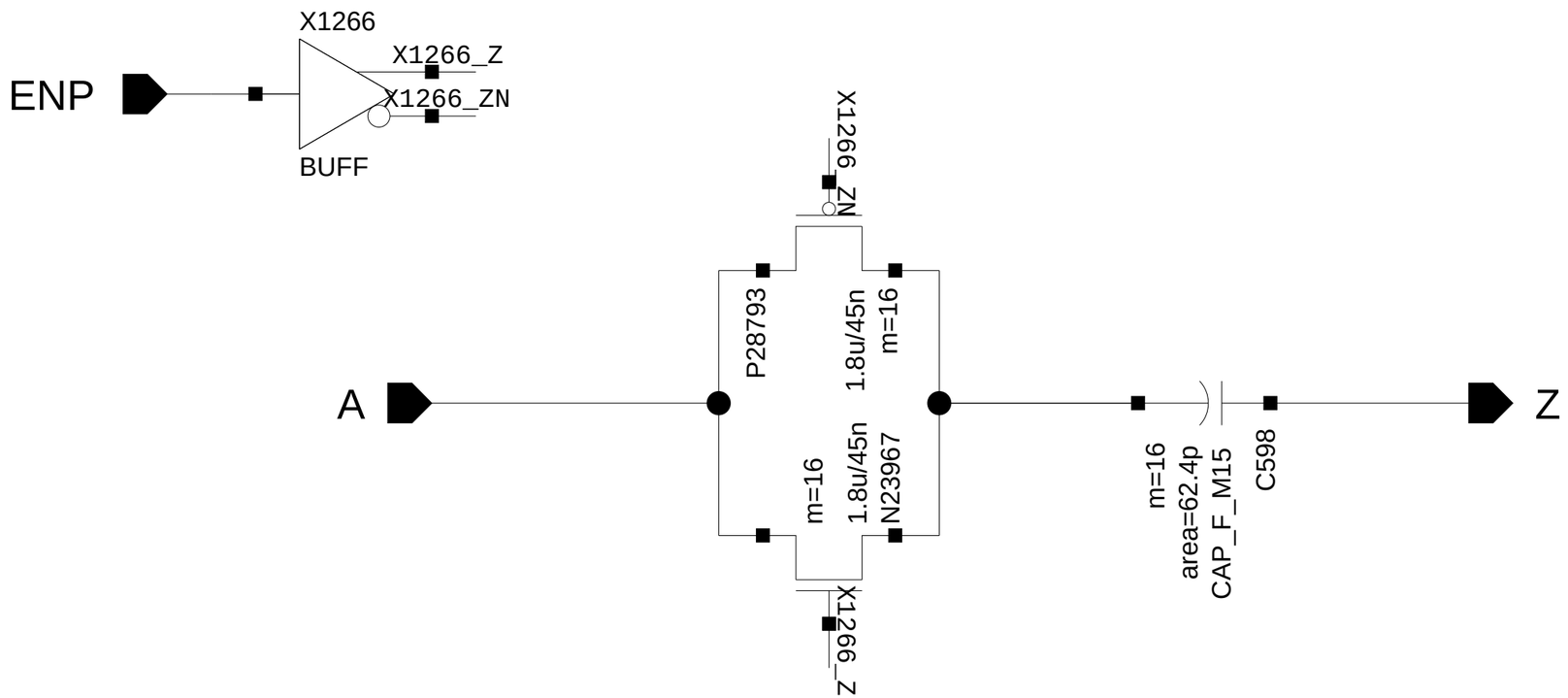

8.9.0 Capacitor 9

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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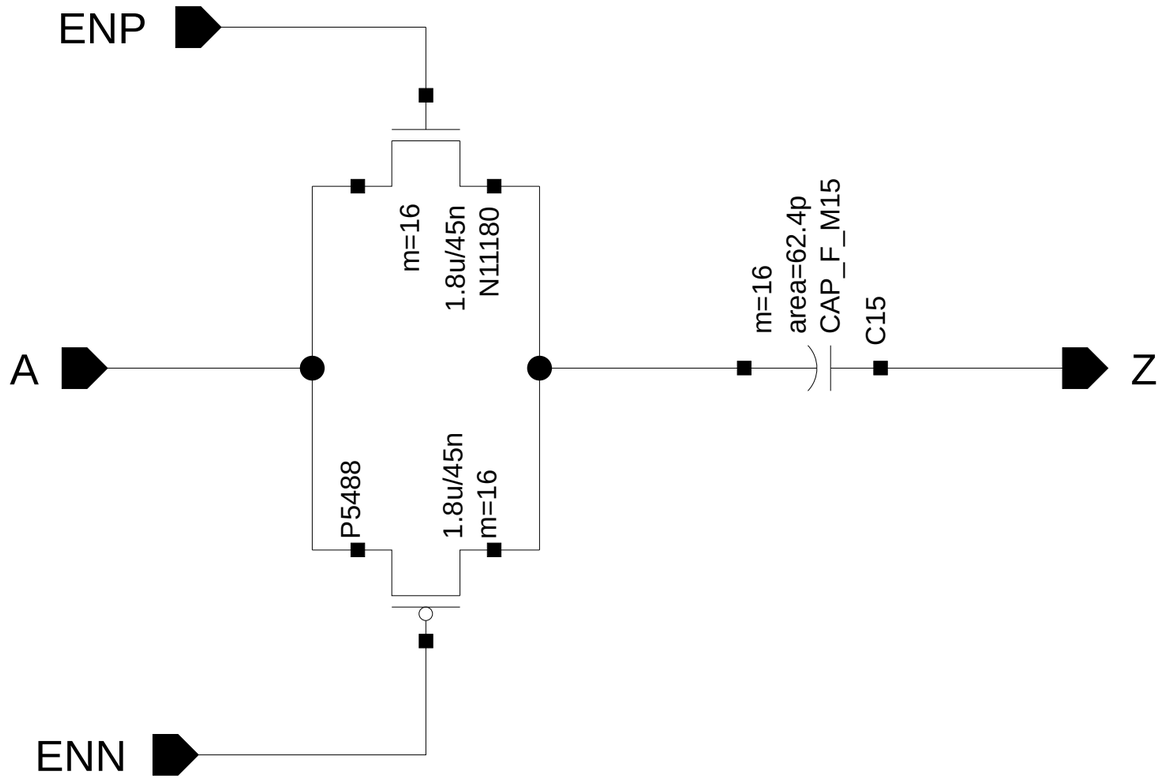

8.10.0 Capacitor 9A

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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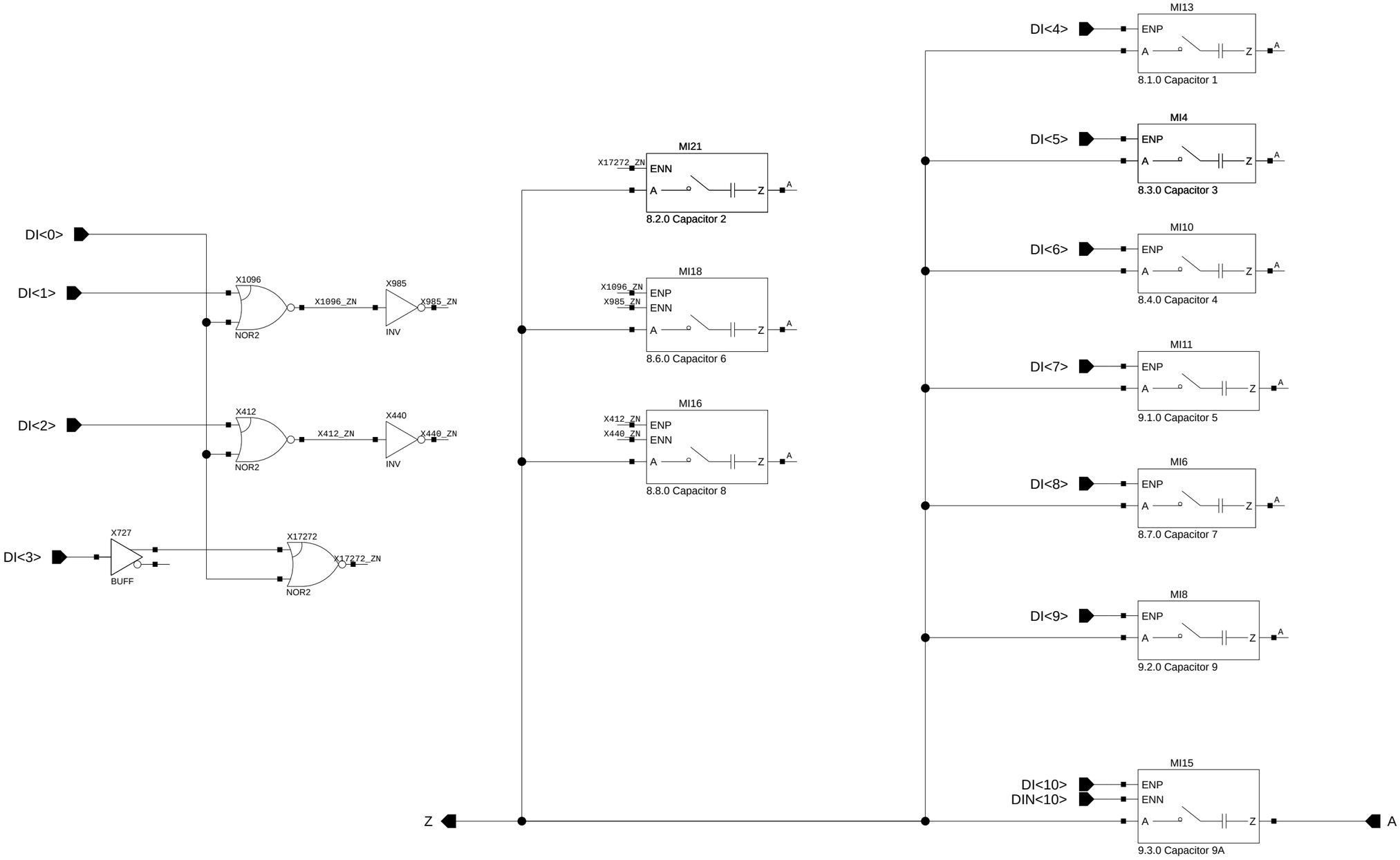

9.0.0 Variable Capacitor 2

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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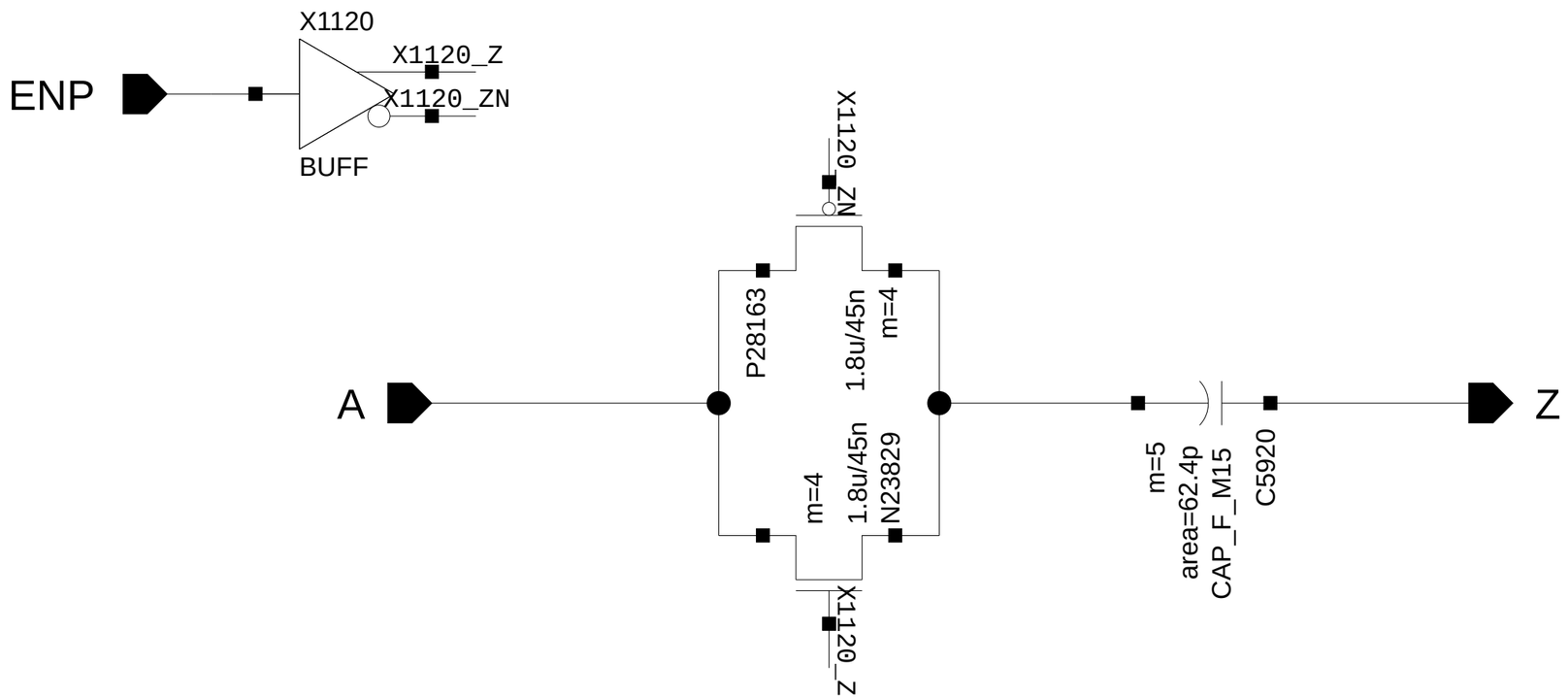
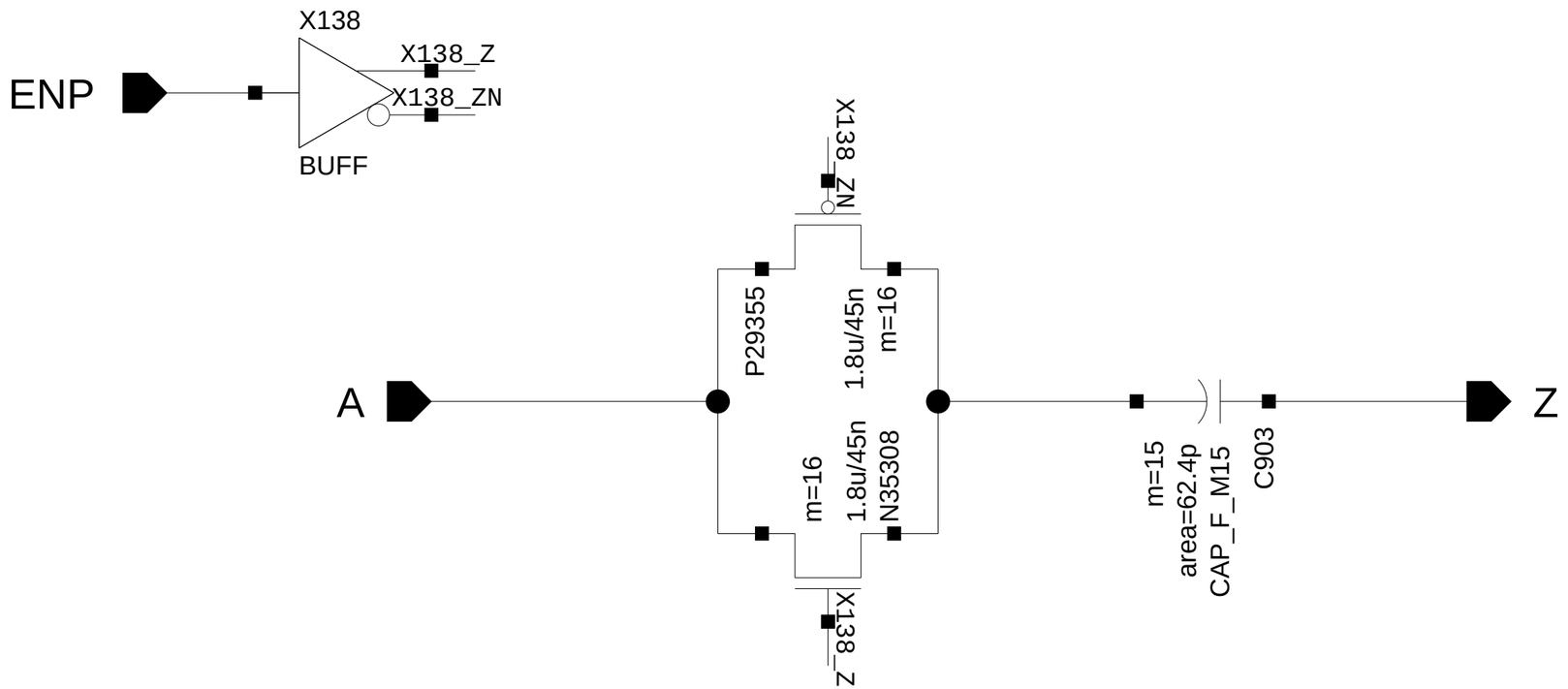


9.1.0 Capacitor 5

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

chipworks

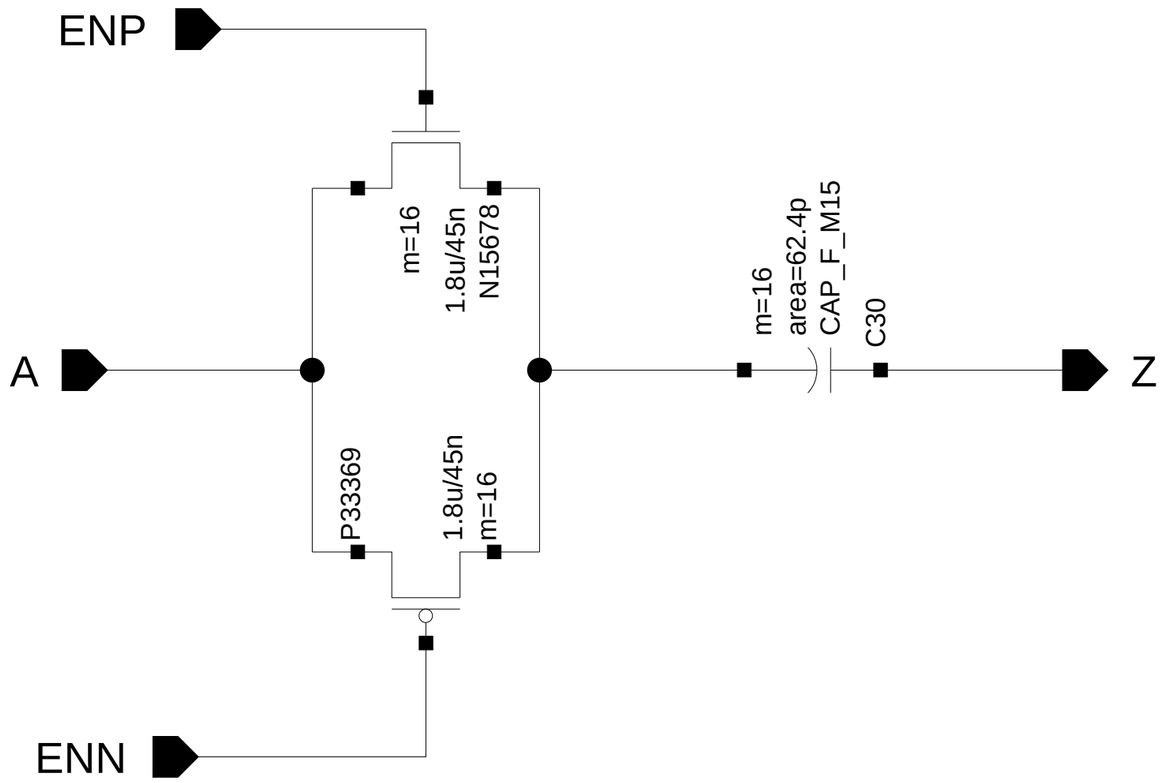


9.2.0 Capacitor 9

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

chipworks



9.3.0 Capacitor 9A

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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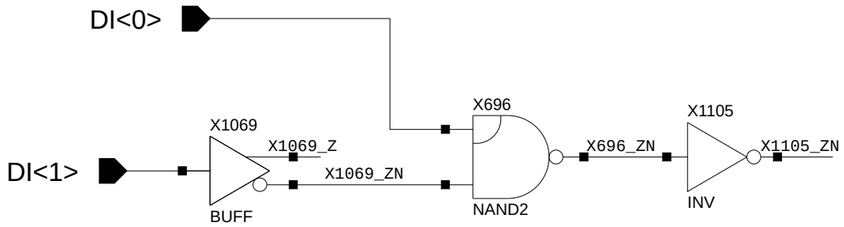

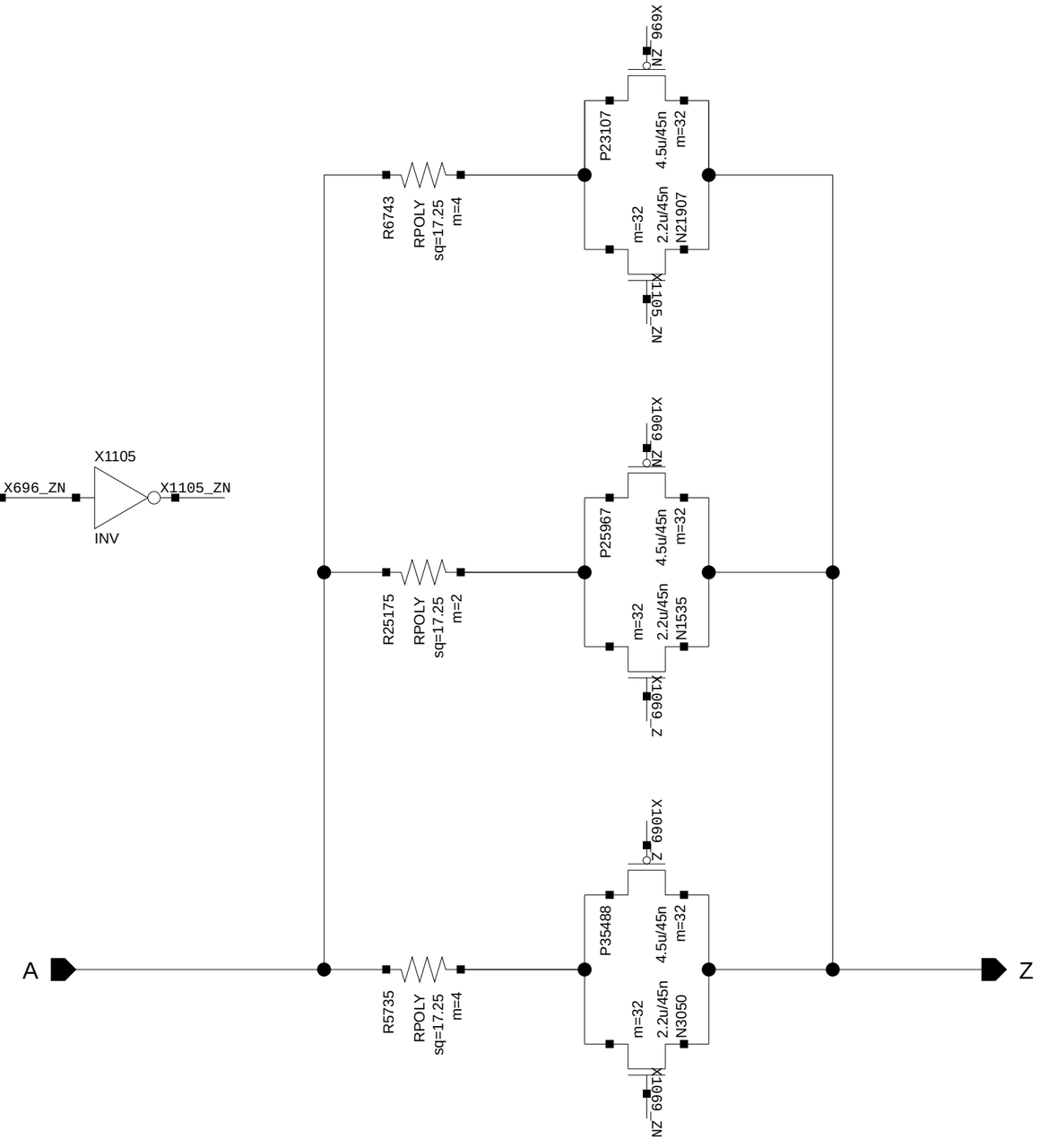

10.0.0 Output Resistor

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B OCT_30_2013
Date Code:	1427

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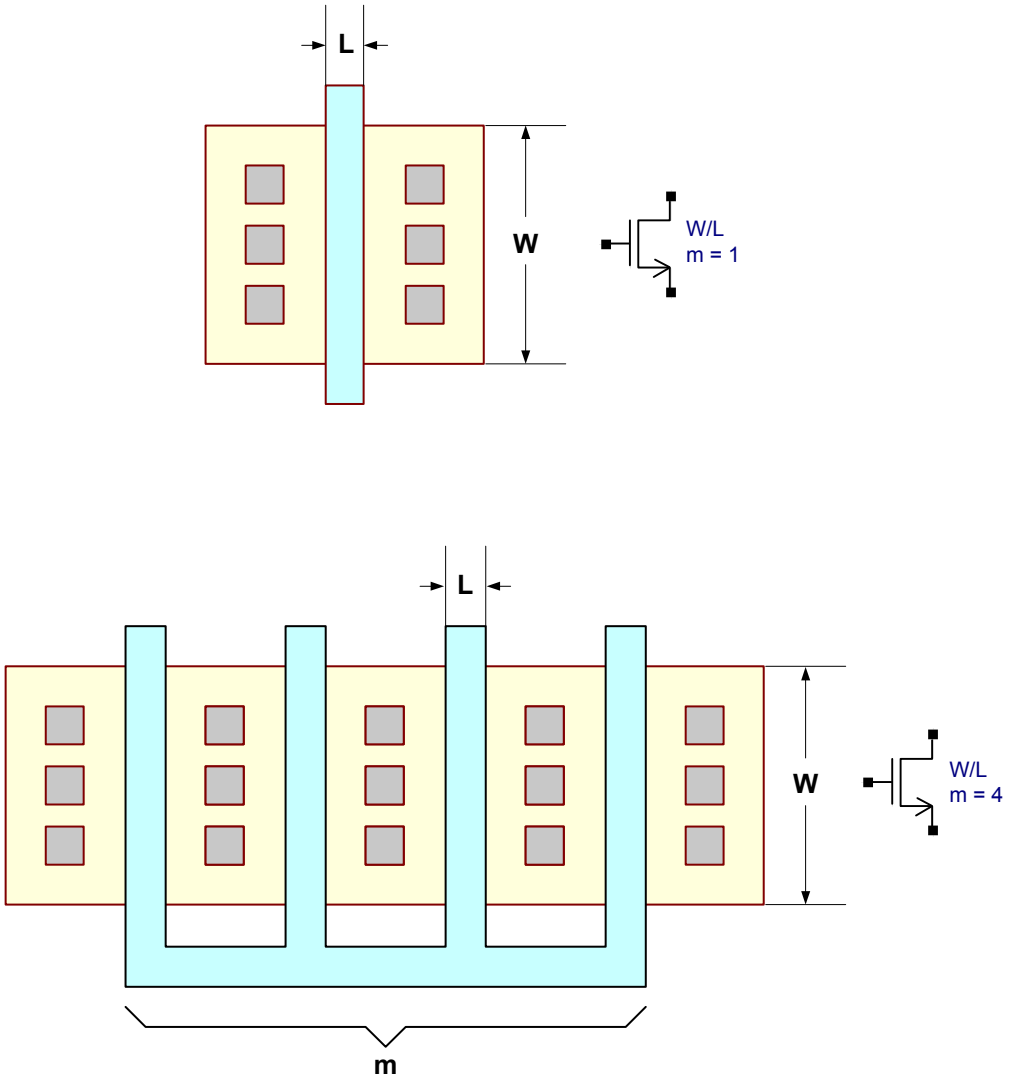

Transistor Size Notation

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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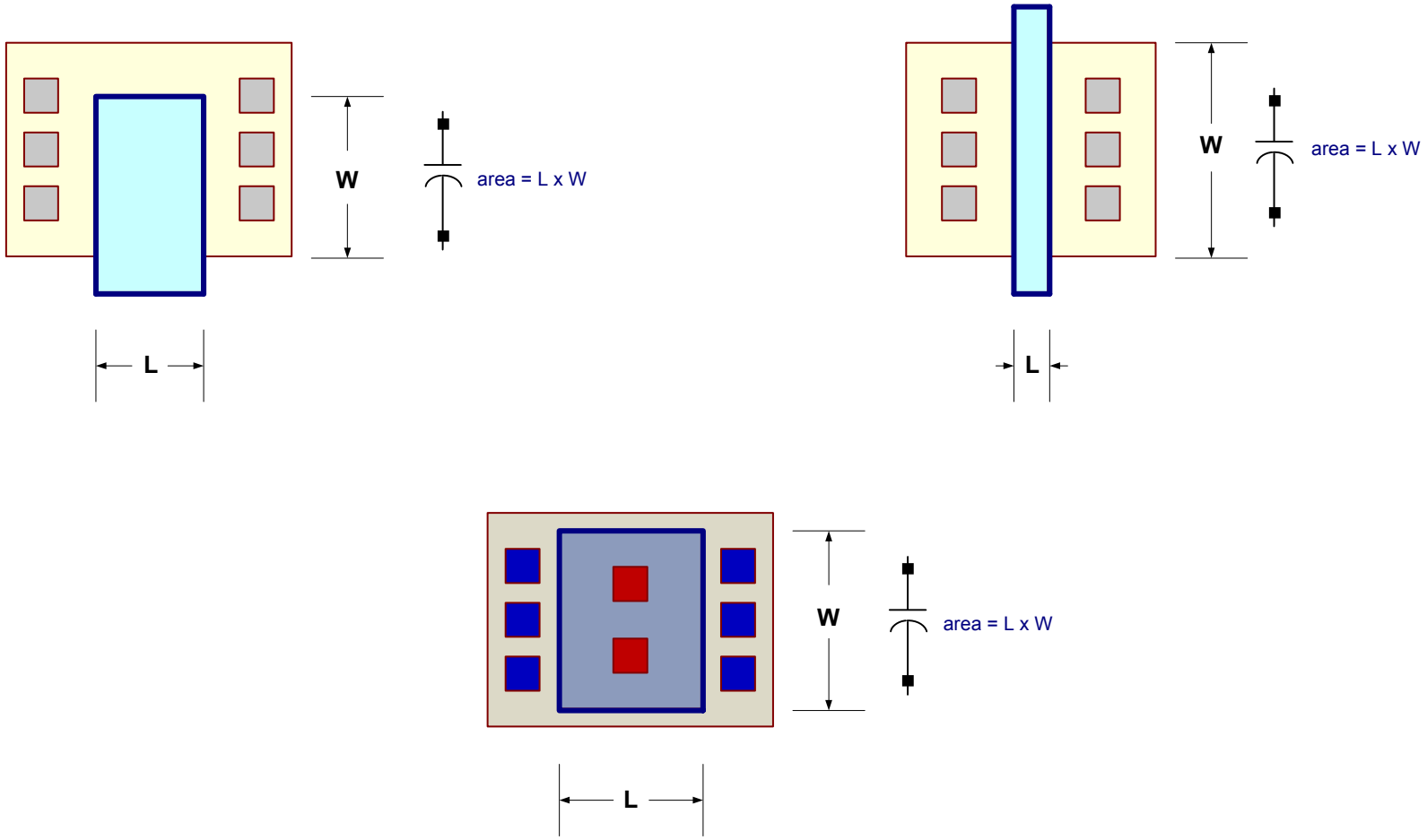

Other types of capacitors may be defined in the first chapter of the report.

Capacitor Size Notation

MediaTek MT6169V

Device Type:	RF Transceiver
Die Markings:	<MediaTek logo> AM10263B
	OCT_30_2013
Date Code:	1427

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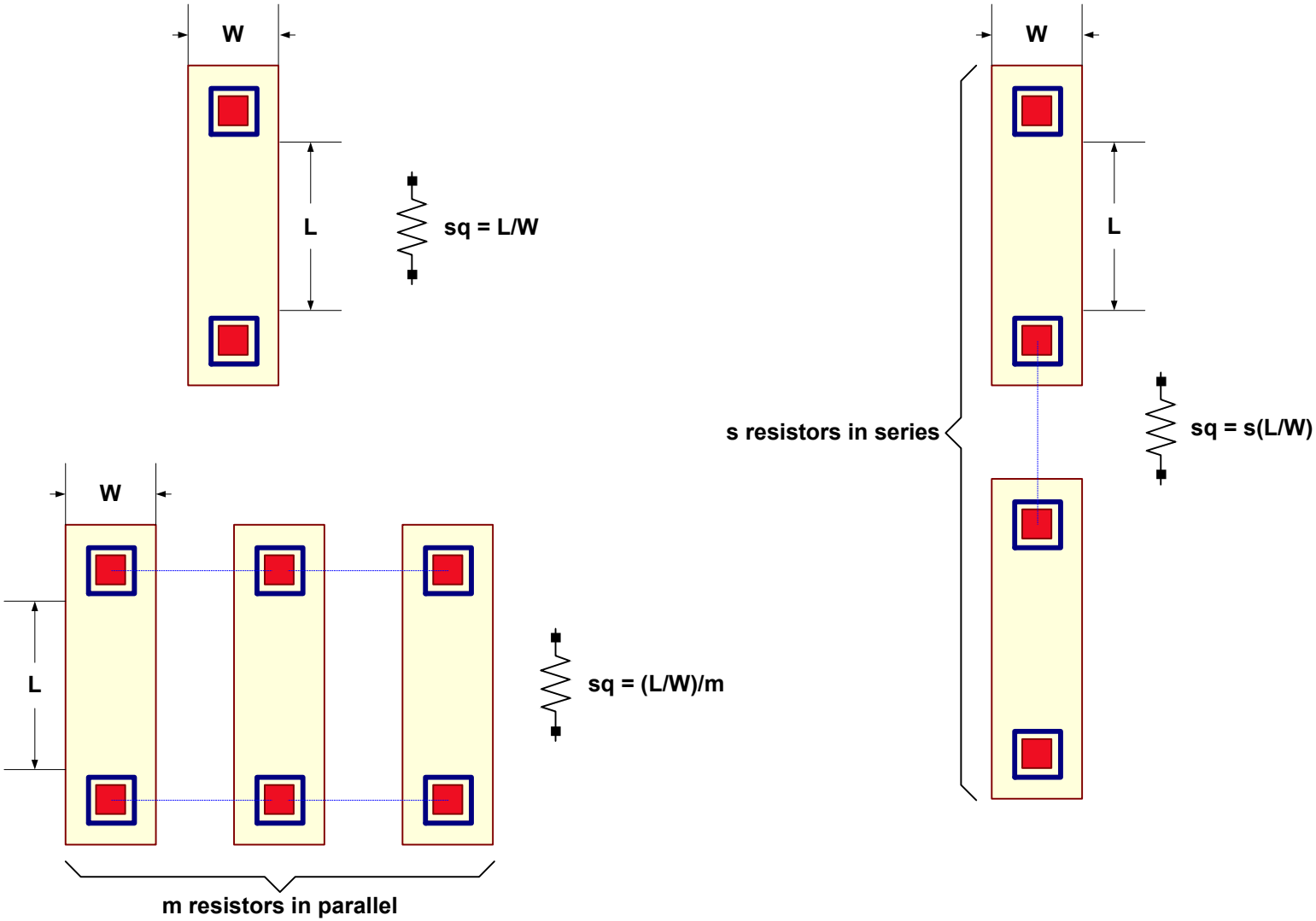

Resistor Size Notation

MediaTek MT6169V

Device Type: RF Transceiver
Die Markings: <MediaTek logo> AM10263B
OCT_30_2013
Date Code: 1427

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