# GestIC® Design Guide

**Note the following details of the code protection feature on Microchip devices:**

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.



*Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.*

**QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV**

**== ISO/TS 16949 ==**

**Trademarks**



ISBN: 978-1-5224-0477-4

# Table of Contents

# Preface

## NOTICE TO CUSTOMERS

**All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.**

**Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXA”, where “XXXXX” is the document number and “A” is the revision level of the document.**

**For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.**

## INTRODUCTION

This chapter contains general information that will be useful to know before using the GestIC® Design Guide. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- Recommended Reading
- The Microchip Website
- Development Systems Customer Change Notification Service
- Customer Support
- Revision History

## DOCUMENT LAYOUT

This document describes how to use the GestIC® Design Guide as a development tool to emulate and debug firmware on a target board, as well as how to program devices. The document is organized as follows:

- **Chapter 1. "GestIC® Design-In"** – Describes the recommended design-in process got GestIC® sensors.
- **Chapter 2. "GestIC® Sensor"** – Introduces GestIC® sensor designs, expected performance and characteristic values.
- **Chapter 3. "GestIC® Standard Electrode Design"** – Describes the rules to design GestIC® standard electrodes.
- **Chapter 4. "Electrode Design for Battery-Operated Systems"** – Describes the rules to design electrodes for battery-operated systems.
- **Chapter 5. "Boosted Electrode Design"** – Describes the rules to design boosted GestIC® systems.
- **Chapter 6. "Sensor Integration and Common Mistakes"** – Presents tips for sensor integration and a list of common mistakes.
- **Appendix A. "GestIC® Design-In Checklist"** – Describes the GestIC® design-in checklist – worksheet for customers.
- **Appendix B. "Reference Circuitry for MGC3130"** – Provides reference circuitry for MGC3130.
- **Appendix C. "Reference Circuitry for MGC3030"** – Provides reference circuitry for MGC3030.
- **Appendix D. "Reference Circuitry for MGC3130 Boosted"** – Provides reference circuitry for MGC3130 boosted.
- **Appendix E. "GestIC® Equivalent Circuitry and Capacitance Design Goals"** – Provides the GestIC® equivalent circuitry and capacitance design goals.
- **Appendix F. "GestIC® Performance Evaluation"** – Provides details about performance evaluation and reference values.
- **Appendix G. "GestIC® Hardware References"** – Provides details on the GestIC® hardware references package which contains design sources for electrodes and demos.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

<table>
<tr><th>Description</th><th>Represents</th><th>Examples</th></tr>
<tr><td colspan="3">Arial font:</td></tr>
<tr><td rowspan="2">Italic characters</td><td>Referenced books</td><td>MPLAB® IDE User’s Guide</td></tr>
<tr><td>Emphasized text</td><td>...is the only compiler...</td></tr>
<tr><td rowspan="3">Initial caps</td><td>A window</td><td>the Output window</td></tr>
<tr><td>A dialog</td><td>the Settings dialog</td></tr>
<tr><td>A menu selection</td><td>select Enable Programmer</td></tr>
<tr><td>Quotes</td><td>A field name in a window or dialog</td><td>“Save project before build”</td></tr>
<tr><td>Underlined, italic text with right angle bracket</td><td>A menu path</td><td><u>File>Save</u></td></tr>
<tr><td rowspan="2">Bold characters</td><td>A dialog button</td><td>Click OK</td></tr>
<tr><td>A tab</td><td>Click the Power tab</td></tr>
<tr><td>N‘Rnnnn</td><td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td><td>4‘b0010, 2‘hF1</td></tr>
<tr><td>Text in angle brackets < ></td><td>A key on the keyboard</td><td>Press <Enter>, <F1></td></tr>
<tr><td colspan="3">Courier New font:</td></tr>
<tr><td rowspan="7">Plain Courier New</td><td>Sample source code</td><td><code>#define START</code></td></tr>
<tr><td>Filenames</td><td><code>autoexec.bat</code></td></tr>
<tr><td>File paths</td><td><code>c:\mcc18\h</code></td></tr>
<tr><td>Keywords</td><td><code>_asm, _endasm, static</code></td></tr>
<tr><td>Command-line options</td><td><code>-Opa+, -Opa-</code></td></tr>
<tr><td>Bit values</td><td><code>0, 1</code></td></tr>
<tr><td>Constants</td><td><code>0xFF, ‘A’</code></td></tr>
<tr><td>Italic Courier New</td><td>A variable argument</td><td><code>file.o</code>, where <code>file</code> can be any valid filename</td></tr>
<tr><td>Square brackets [ ]</td><td>Optional arguments</td><td><code>mcc18 [options] file [options]</code></td></tr>
<tr><td>Curly brackets and pipe character: { | }</td><td>Choice of mutually exclusive arguments; an OR selection</td><td><code>errorlevel {0|1}</code></td></tr>
<tr><td rowspan="2">Ellipses...</td><td>Replaces repeated text</td><td><code>var_name [, var_name...]</code></td></tr>
<tr><td>Represents code supplied by user</td><td><code>void main (void)<br>{ ...<br>}</code></td></tr>
</table>

## WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip website.

## RECOMMENDED READING

This user's guide describes how to design a GestIC® sensor. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

**MGC 3030/3130 3D Gesture Controller Data Sheet (DS40001667)**

This data sheet provides information about the MGC3030/3130 3D Gesture Controller.

**GestIC® Hardware References**

This is a collection of reference designs for electrodes and demonstrators to be used for hardware integration.

**MGC3030/3130 GestIC® Library Interface Description (DS40001718)**

This document is the interface description of the MGC3XXX and provides a description and the complete reference of $I^2C$ messages.

**MGC3030/3130 Software Development Kit (SDK)**

The Software development kit contains GestIC API and C reference code for applications for Windows, Linux, and Embedded controllers.

**MGC3030/3130 PIC18 Host Reference Code**

The PIC18 reference code contains an easy example for MGC3XXX message decoding on PIC18F14K50 (Hillstar $I^2C$ to USB bridge)

**Aurea Graphical User Interface User's Guide (DS40001681)**

**Aurea Software Package**

The Aurea package contains all relevant system software and documentation to operate and parameterize MGC3XXX devices. An integrated online help give the details about MGC3XXX parameterization.

## THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user’s guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

## DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip’s customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip website at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers, assemblers, linkers and other language tools. These include all MPLAB C compilers; all MPLAB assemblers (including MPASM™ assembler); all MPLAB linkers (including MPLINK™ object linker); and all MPLAB librarians (including MPLIB™ object librarian).
- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB REAL ICE™ and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICkit™ 3 debug express.
- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART® Plus and PICkit 2 and 3.

## CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the website at:

http://www.microchip.com/support.

## REVISION HISTORY

### Revision A (August 2013)

This is the initial release of this document.

### Revision B (January 2015)

Changed document title; Added note and updated titles in the Recommended Reading section; Other minor corrections.

### Revision C (April 2016)

Added latest design rules for GestIC standard designs; Added battery operated systems information; Added boosted systems information. Updated the Recommended Reading section; Other corrections.

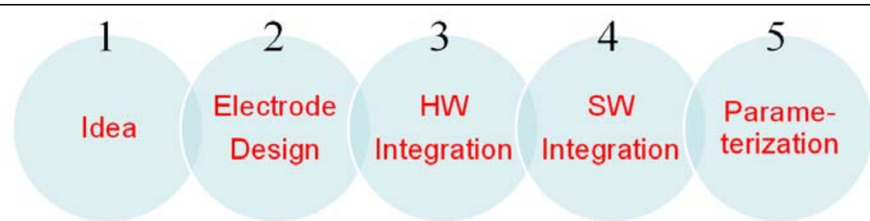
# Chapter 1. GestIC® Design-In

## 1.1 INTRODUCTION

The MGC3XXX gesture controllers based on Microchip's GestIC® technology offer a fully integrated 3D gesture solution for numerous commercial, industrial, medical and automotive applications. This design guide explains the GestIC electrode design rules, provides examples for good sensor designs and deals with potential pitfalls.

The design-in process of a GestIC system has five steps, as shown as an overview in Figure 1-1.

**FIGURE 1-1: GESTIC® DESIGN-IN PROCESS**




1. Step 1 reviews the entire 3D application before starting the design. The following points should be known:
   - Use cases of the input device
   - Sensor range expectation
   - Required 3D sensor features
   - Available space for the sensor
   - Battery operation
   - Combination with Microchip 2D (touch controller) or 1D (buttons) solutions

When this information is available, a first electrode design can be drawn.

2. Step 2 is the electrode design within the given application boundaries. At this point the following information is required:
   - Mechanical construction of the device (dimensions, placement of building blocks, metal/conductive parts)
   - Electrical circuitry (block diagram, power supply, host controller, peripherals, interconnection)
   - Connection to ground (GND)
   - Possible noise sources within the system
3. Steps 3 and 4 are integration steps for the sensor into the application's hardware and software structure, based on the information provided at step 2. Details such as schematics and software architecture of the complete system may be required.
4. After these steps, it is recommended to build a sensor prototype and parameterize it for the target application.
5. Step 5 handles the tuning of GestIC firmware parameters.

This Electrode Design Guide covers the GestIC electrode design (steps 1 and 2) and the basics of hardware integration (steps 3 and 4).

**TABLE 1-1: DESIGN-IN REFERENCE DOCUMENTATION**

| Design-In Step | Reference Documentation |
|---|---|
| 1. Idea<br>2. Electrode Design<br>3. Hardware Integration | *MGC 3030/3130 3D Gesture Controller Data Sheet* (DS40001667)<br>*GestIC® Design Guide* (DS40001716)<br>GestIC® Hardware References (Collection of reference designs for electrodes and demonstrators) |
| 4. Software Integration | *MGC3030/3130 GestIC® Library Interface Description* (DS40001718)<br>*MGC3030/3130 Software Development Kit* (SDK)<br>*MGC3030/3130 PIC18 Host Reference Code* |
| 5. Parameterization | *Aurea Graphical User Interface User's Guide* (DS40001681)<br>*Aurea Software Package* |

**Note:** All referenced guides, reference designs, and drivers can be downloaded from http://www.microchip.com/gesticresources.

The GestIC design-in checklist in **Appendix A. "GestIC® Design-In Checklist"** will help the designer to collect the needed information for the sensor design.

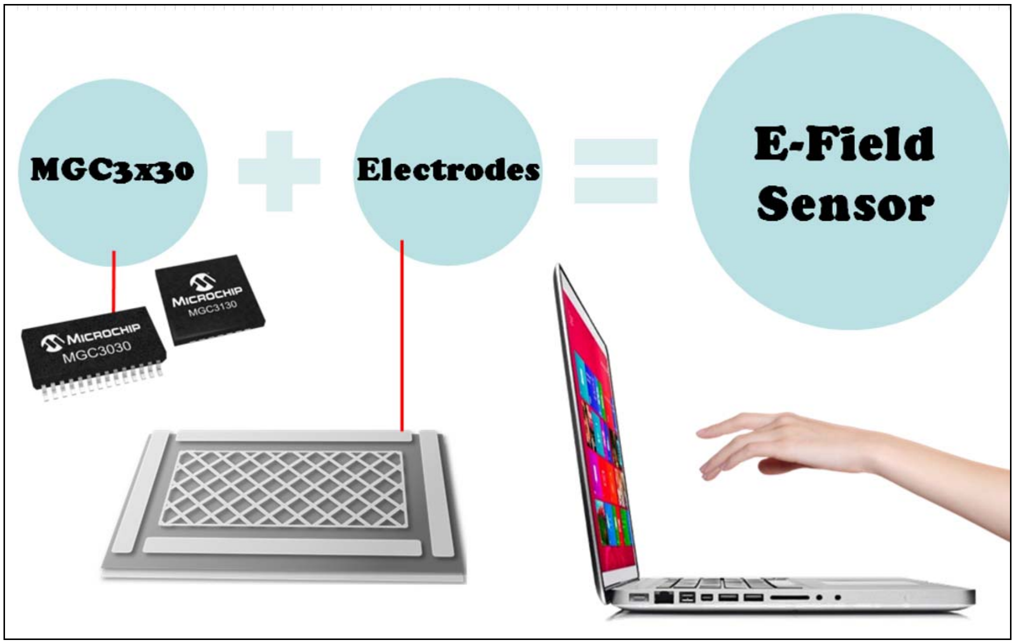
 

# Chapter 2. GestIC® Sensor

## 2.1 INTRODUCTION

A 3D GestIC® sensor is the combination of a gesture controller (MGC3XXX) and a set of sensor electrodes.

**FIGURE 2-1: GESTIC® SENSOR**




MGC3XXX communicates with a host controller via $I^2C$ or by gesture mapping to I/O pins (GesturePort). For details, refer to the *MGC3030/3130 3D Tracking and Gesture Controller Data Sheet* (DS40001667). It is possible to combine a 3D GestIC sensor with Microchip's 1D and 2D solutions, sharing the same electrode structures. This is supported by MGC3130 and MGC3140.

The GestIC electrodes consist of:

- 4 or 5 Receive electrodes (Rx) connected to Rx 0-4 pins of MGC3XXX
- 1 Transmit electrode (Tx) connected to the Tx pin of MGC3XXX
- Isolation between Rx and Tx

Rx and Tx are made of any conductive material such as copper, metal mesh, indium tin oxide (ITO) or similar. The isolation between the electrodes can be any material which is non-conductive (PCB, glass, PET, etc.). An optional cover layer on top of the electrode must be non-conductive as well.

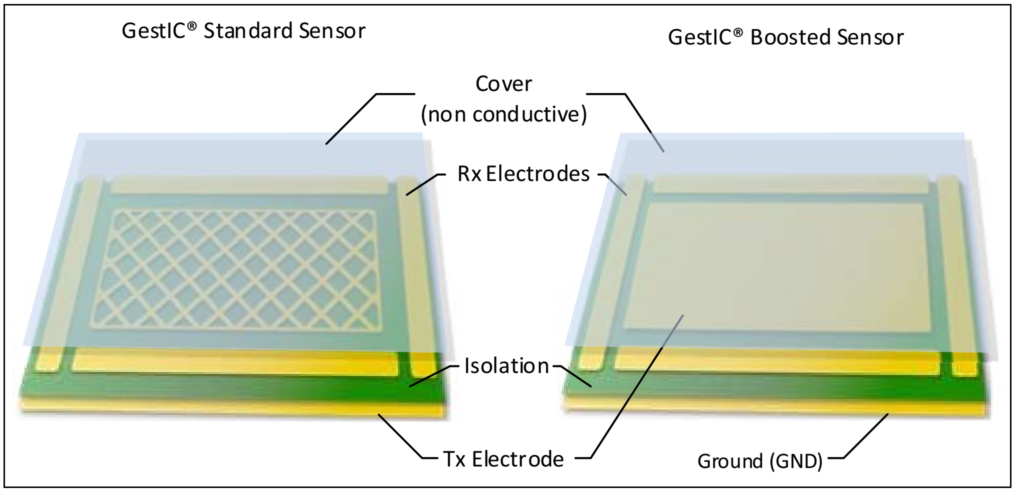
There are two different sensor designs supported:

1. The **Standard sensor** (Tx amplitude = 2.85V) is used in small or medium-sized devices and it is mandatory for devices having a weak connection to earth ground (battery operated).

2. **Boosted sensors** (Tx amplitude = 5-18V) allow larger sensor sizes and recognition ranges. That is necessary in particular in combination with 2D touch sensors.

Figure 2-2 shows the structure of the two sensor designs.

**FIGURE 2-2: GestIC® ELECTRODE**




The reference circuitry for each design is shown in **Appendix B. "Reference Circuitry for MGC3130"**.

## 2.2 DECISION FOR A SENSOR DESIGN

The decision for a sensor design depends on the application, on the available space in the customer's system, and on the sensor environment. Devices which are connected to ground and have a certain size may prefer a boosted electrode. Non-grounded sensor systems (battery operated) are based on standard electrodes.

Figure 2-3 shows an overview of expected gesture recognition ranges of GestIC sensors, Figure 2-4 provides a decision matrix which helps to choose the right design for a given application.

**FIGURE 2-3: EXPECTED GESTURE RECOGNITION RANGE VS. SENSOR SIZE AND TYPE**

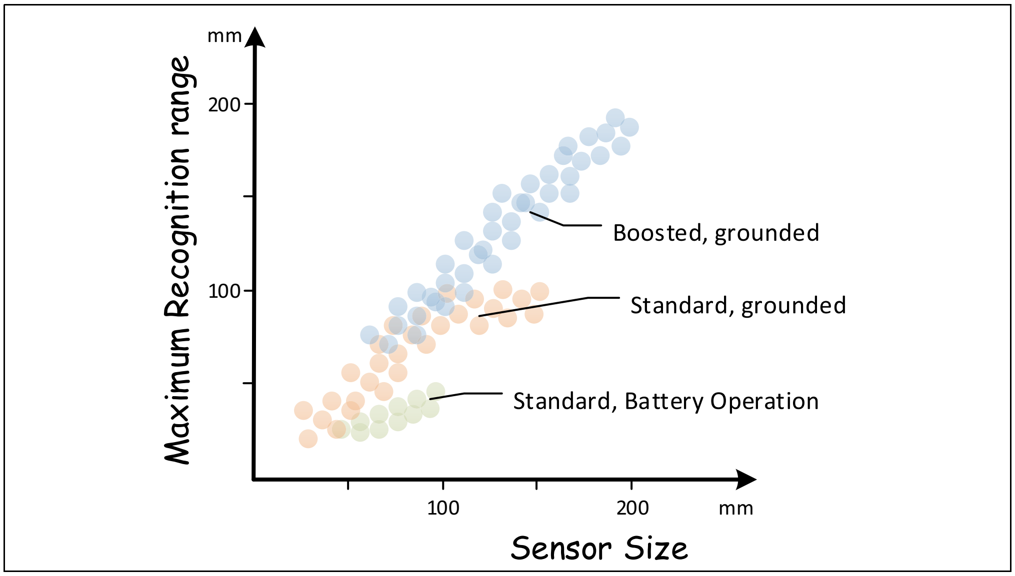
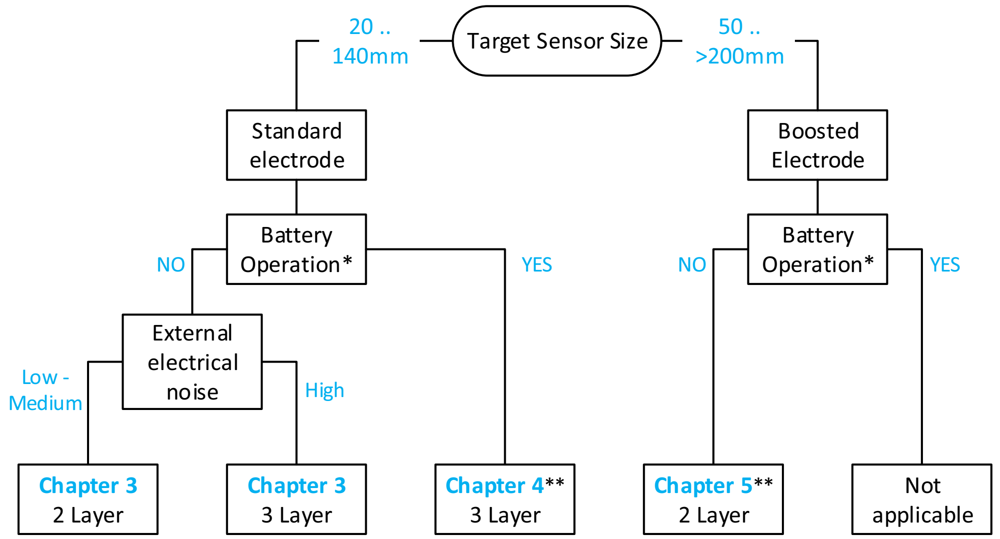


**FIGURE 2-4: DECISION MATRIX**




**Note 1:** Battery operation refers to systems which are battery-driven and have a weak connection to ground. Details in Chapter 4.

**2:** The general design rules for GestIC® electrodes are explained in Chapter 3 and are valid for battery-optimized and boosted electrodes as well.

## 2.3 GESTIC SENSOR CHARACTERISTICS

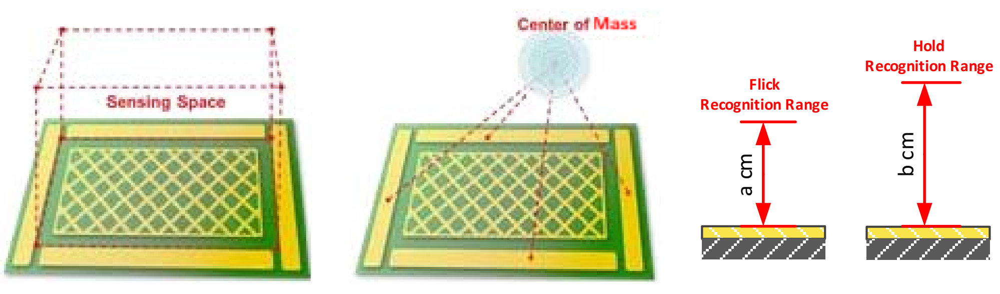
A number of definitions are used to describe and characterize a GestIC sensor, as shown in Figure 2-5.

The Sensing Space is the space above the sensor area where it's sensitive to the human hand. The sensor area is measured between the inner edges of the Rx electrodes. The height of the sensing space is determined by the maximum recognition range of the sensor.

GestIC technology utilizes the electrical field to track hand movements. The detection method recognizes the electrical center of mass of the human hand, and it is able to track a single point inside the sensing space of a GestIC sensor over time.

The Sensor Recognition Range is defined as the maximum distance of the human hand from the sensor surface, which allows to track the position and to recognize gestures. Depending on the feature, different recognition ranges can be defined.

**FIGURE 2-5: GESTIC® SENSOR DEFINITIONS**



**NOTES:**

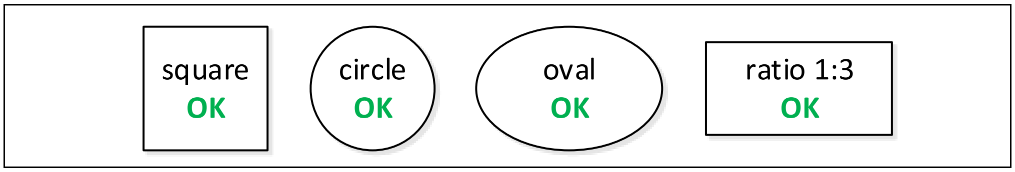
# Chapter 3. GestIC® Standard Electrode Design

## 3.1 GENERAL DESIGN RULES

### 3.1.1 Sensor Outline

GestIC® technology can work with a wide range of sensor sizes and shapes. The sensor outline follows the available space in the product. The sensor shape can be square, rectangular, circular or oval, but it should not exceed a 1:3 ratio, as shown in Figure 3-1.

**FIGURE 3-1: SENSOR OUTLINE**




GestIC standard electrodes work within the following recommended dimensions:

- Maximum size = 140 x 140 mm/diameter 140 mm
- Minimum size = 20 x 20 mm/diameter 20 mm

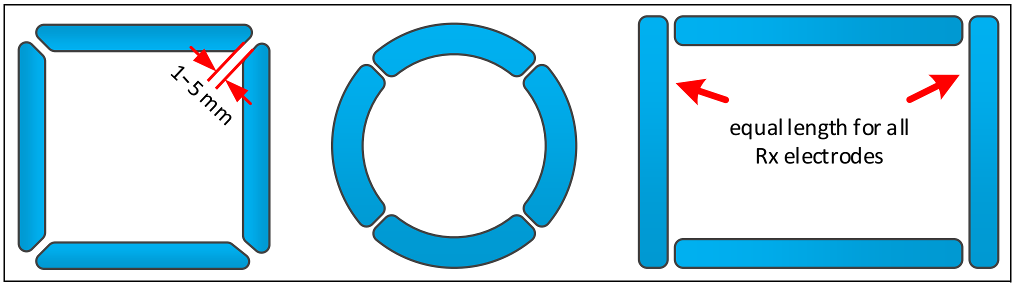
Using the Tx Boosted sensor, the maximum size increases to 200 x 200 mm and higher. Refer to **Chapter 5. “Boosted Electrode Design”**.

### 3.1.2 Rx Electrodes

Rx electrodes are placed inside the top layer of the sensor. The minimum GestIC system consists of four Rx electrodes aligned as a rectangular frame along the edges of a sensor board. They are named after the four cardinal directions: North, West, South, and East.

Their length should be laid out as long as the device size allows. It is good practice to balance the length of the two vertical and the two horizontal electrodes. If the recognition range should be symmetrical in both directions, the electrode design should be symmetrical. The recommended distance between the Rx electrodes is 1.5 mm, as indicated in Figure 3-2.

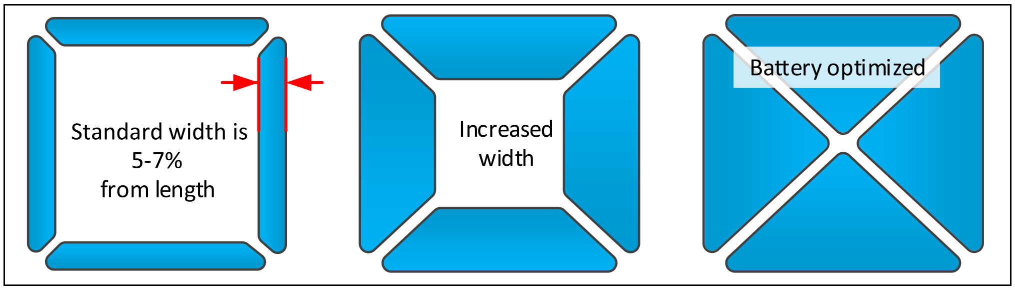
**FIGURE 3-2: ELECTRODE SHAPE**



The Rx electrodes' width is 4 to 7% of their length. Wider electrodes have a better exposure to the human hand and should be preferred.

It is also possible to further increase the Rx electrodes' area. That will limit the gesture recognition range, but the higher capacitance to the hand brings advantages in weakly grounded systems. Thus, such an extension has been consequently applied for battery powered systems. For further details, refer to **Chapter 4. "Electrode Design for Battery-Operated Systems"**.

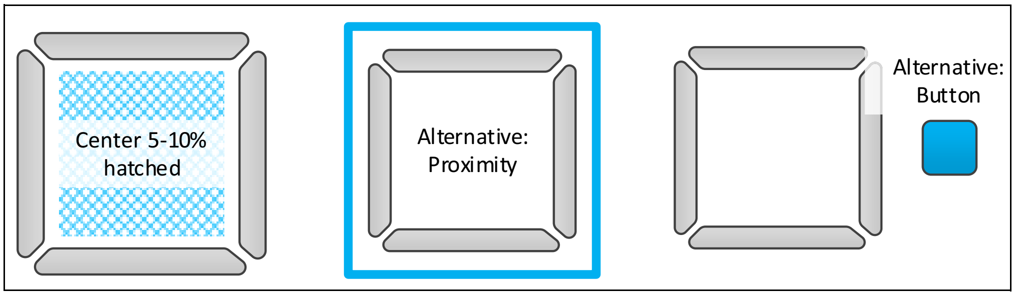
**FIGURE 3-3: RX ELECTRODE WIDTH**




The Microchip gesture controllers support a fifth electrode, as shown in Figure 3-4. It functions either as a center electrode to establish a center touch, or as a structure to build a sensor ring for approach/proximity detection, or an additional touch button.

A center electrode is usually stretched over the area inside the frame electrodes, and it is recommended to be cross-hatched (5-10% hatching, not smaller than the finger pitch). Alternative structures can be placed outside the sensor area, but need to be laid out over a Tx area. For further information on the rules for Tx, refer to **Section 3.1.3 "Tx Electrodes"**.

**FIGURE 3-4: USAGE OF FIFTH ELECTRODE**



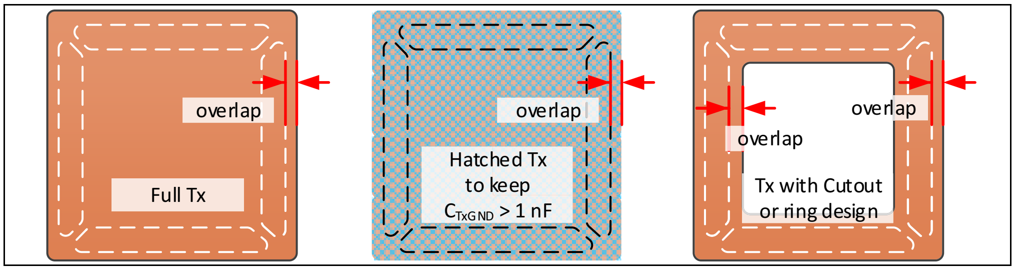

### 3.1.3 Tx Electrodes

The GestIC Tx electrode emits an electrical field and it is located below the Rx electrodes. It shields Rx electrodes and feeding lines from the human body and from electrical disturbers on the back of the sensor.

In order to improve shielding, it is recommended to overlap all Rx structures with Tx. 1-2 mm is the minimum overlapping value, and the optimum value is 50-100% of the Rx electrodes width. The same rule applies when the electrode layout has cutouts, holes, or if the center area is completely cut out (GestIC Ring Sensor).

**FIGURE 3-5: TX ELECTRODE**




When the capacitive load of Tx ($C_{TxGND}$) exceeds MGC3XXX's driving capability of 1 nF, the Tx electrode may be cross-hatched. If that is not sufficient, the Tx driving strength can be increased using an external operational amplifier, such as a voltage follower. Refer to **Section 3.1.5 "Layer Stack"** for more details.

For best performance and stability it is preferred that the Tx electrode covers the complete area of the sensor. A ring design, as shown in Figure 3-5, is prone to external noise. If the design includes a larger GND area inside the ring, recognition range will decrease. That includes a possible GestIC sensor design around a TFT display. If GestIC should be combined with a display, it is recommended to design transparent electrodes and place them on top of the display. Refer to **Chapter 5. "Boosted Electrode Design"** for more information.

### 3.1.4 Chip Placement and Rx Feeding Lines

The MGC3XXX device has to be placed as close as possible to the GestIC electrodes. A good way to do this is to integrate the chip directly on the sensor board, e.g., on the back side. The MGC3XXX circuitry should be away from the user's common approach direction.

The connection between Rx electrodes and the input pins of the gesture controller must be handled with great care, as the Rx feeding lines are sensitive to the human hand and to environmental noise in the same way Rx electrodes are. That's why they should be routed as short as possible and kept away from all external influences.

The following requirements should be met:

- Keep as thin and short as possible (width 0.1-0.15 mm)
- Route inside the sensor area
- Keep away from analog and digital sources
- Keep ground away from Rx electrodes and feeding lines
- Shield with Tx (distance to Tx > 0.15 mm)

| | |
|---|---|
| **Note:** | Rx feeding lines ought to be routed to the nearest Rx pin of MGC3XXX and should not cross each other. The logical assignment between electrode and Rx pin can be done later during the AFE parameterization. |

Figure 3-6 shows three possible layouts for Rx feeding lines. In the first two examples, the feeding lines are routed in the Tx layer, while the third example shows a possibility to route them in the top layer, e.g., if the center area is transparent.

**FIGURE 3-6: CHIP PLACEMENT AND RX FEEDING LINES – TOP VIEW**

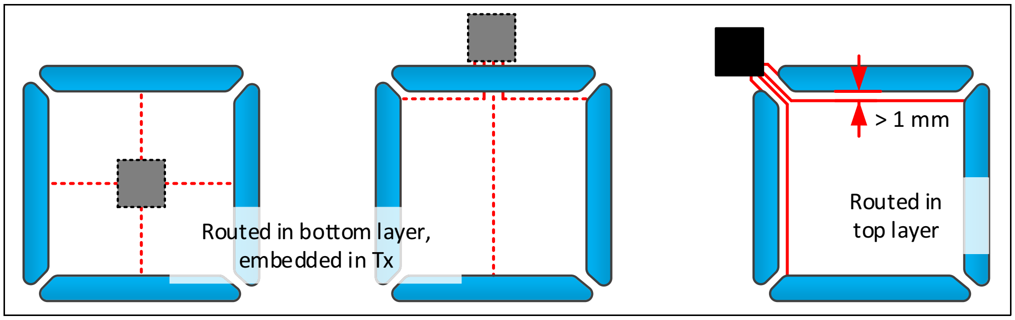
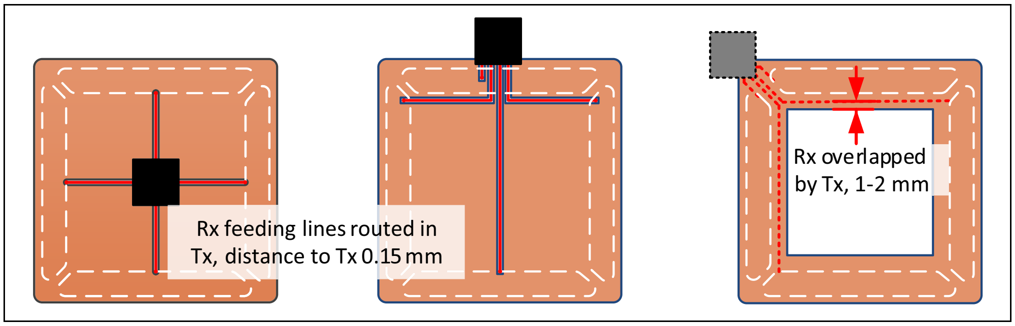



Figure 3-7 represents the rear side view of the three examples.

**FIGURE 3-7: CHIP PLACEMENT AND RX FEEDING LINES – BOTTOM VIEW**




As seen in these examples, the gesture controller is recommended to be placed on the same board as the sensor. It is, however, possible to connect the Rx electrodes via connector to the MGC3XXX device on a different PCB. In this case, the connection must be mechanically fixed and any moving of the feeding lines during sensor operation has to be avoided. The connection via board-to-board connector is recommended as opposed to using cables or flexible structures, unless they are directly glued onto the PCBs and shielded by Tx.

### 3.1.5 Layer Stack

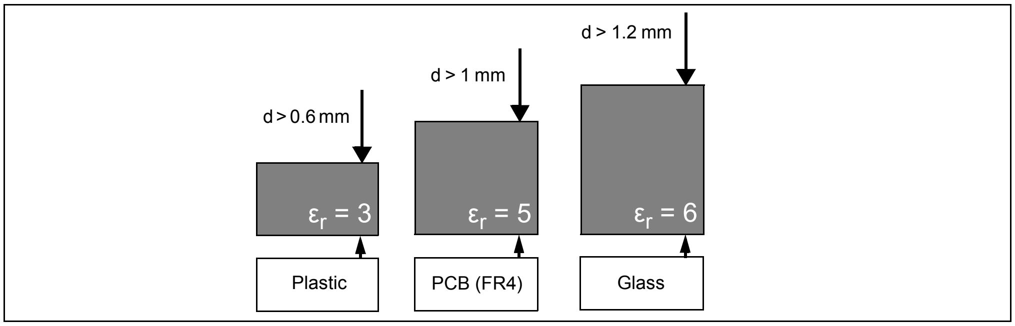
The GestIC sensor is built in a two layer stack, Rx on top and Tx underneath Rx. The optimum distance between Rx and Tx (d) depends from the relative permeability of the isolation material between the two layers, as shown in Equation 3-1.

**EQUATION 3-1: THICKNESS CALCULATION**

$$d > \frac{\varepsilon_r}{5}$$

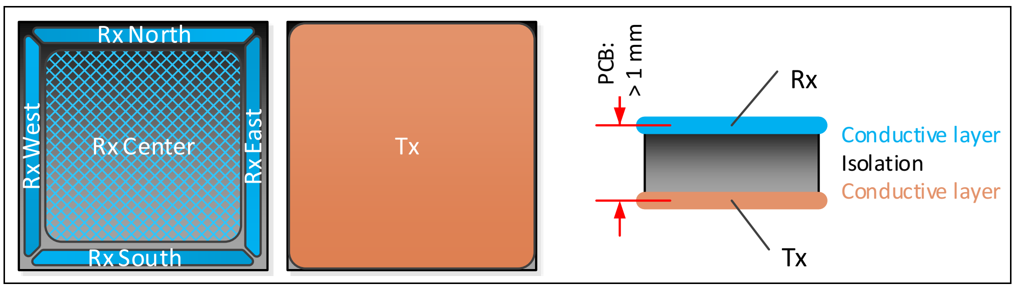
For the PCB material FR4 ($\varepsilon r = 5$), the thickness is d > 1 mm.The sensor signals will increase when the thickness increases: 1.5-2 mm will significantly improve the performance. A thickness beyond 2 mm is seen as not practical and is the object of future development. If the thickness is lower than 1 mm, the performance will drop. Examples for different materials are given in Figure 3-8.

**FIGURE 3-8: LAYER STACK**



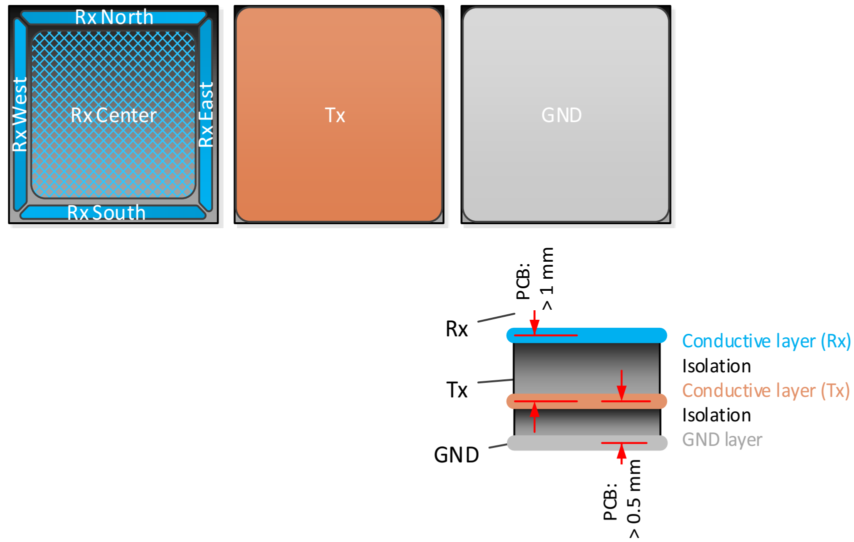

The design of a two-layer electrode is simple, as shown in Figure 3-9. It is recommended to lay out the top layer according to the rules in **Section 3.1.2 "Rx Electrodes"**, and add the Tx layer as a full copper area. The overlapping rules from **Section 3.1.3 "Tx Electrodes"** and the thickness rules mentioned before apply.

**FIGURE 3-9: ELECTRODE LAYER STACK – TWO LAYERS**



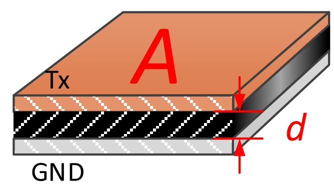

An additional GND layer can be added to the layer stack. In battery-operated devices this is mandatory (refer to **Chapter 4. "Electrode Design for Battery-Operated Systems"**). In earth grounded systems it is optional and it depends on the environment. The GND layer adds stability, noise robustness, and shield sensitivity from the backside of the sensor at the cost of 10-20% lower range. The layer stack is shown in Figure 3-10.

**FIGURE 3-10: ELECTRODE LAYER STACK – THREE LAYERS**




One additional requirement must be fulfilled: the capacitance between Tx and GND must not exceed the MGC3XXX's Tx driving capability of 1 nF, which is indicated in Figure 3-11. An estimate of the capacitance can be done using the formula of the plate capacitor, shown in Equation 3-2.

**FIGURE 3-11: ELECTRODE LAYER STACK – CAPACITANCE TX-GND**




**EQUATION 3-2: CAPACITANCE ESTIMATION**

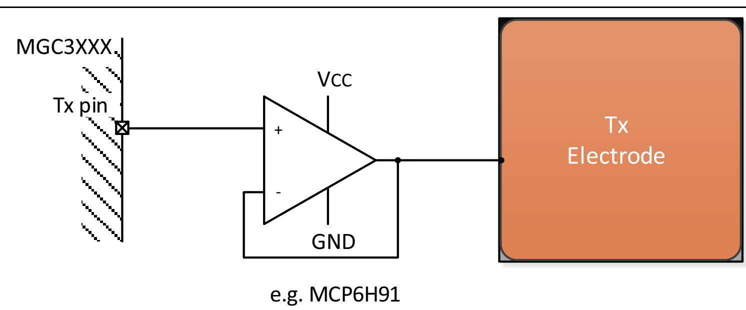
$$C = \varepsilon_0 \cdot \varepsilon_r \cdot \frac{A}{d}$$

If the calculated capacitance is in the range of 1 nF or higher, special measures must be taken to reduce it. The following options are recommended:

- Increase distance between Tx and GND
- Decrease relative permeability of the isolation layer (choose different material)
- Cross-hatch the Tx area – a good value is to cover of 50-60% with copper

If this is not possible, an external Tx driver (voltage follower) can be used. The circuitry is shown in Figure 3-12.

**FIGURE 3-12: TX DRIVER**



# Chapter 4. Electrode Design for Battery-Operated Systems

## 4.1 WHAT IS BATTERY OPERATION?

If the gesture-controlled electric device is battery-operated, it is often not sufficiently connected to ground to maintain the loop to the human hand.

Two main effects can be observed:

- Low sensor signals
- Signals decrease when the hand approaches instead of increasing

The severity of these effects depend on the actual capacitance of the sensor to earth ground and the sensor design and size. The result can be a low sensor performance and requires adaptations of the electrode design which are described below.

The following figures illustrate the dependency from the ground capacitance. Figure 4-1 shows a sensor in three different grounding conditions: grounded via USB, battery-operated with a short wire connected to system ground, and just battery-operated without any wire or connection to GND. The performance of this sensor was tested on a wooden table. Figure 4-2 shows the corresponding flick recognition ranges.

**FIGURE 4-1: TEST CASES FOR EARTH GROUND COUPLING**

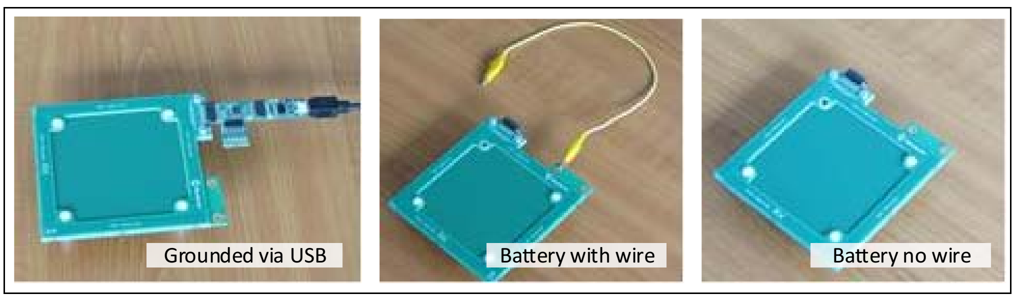
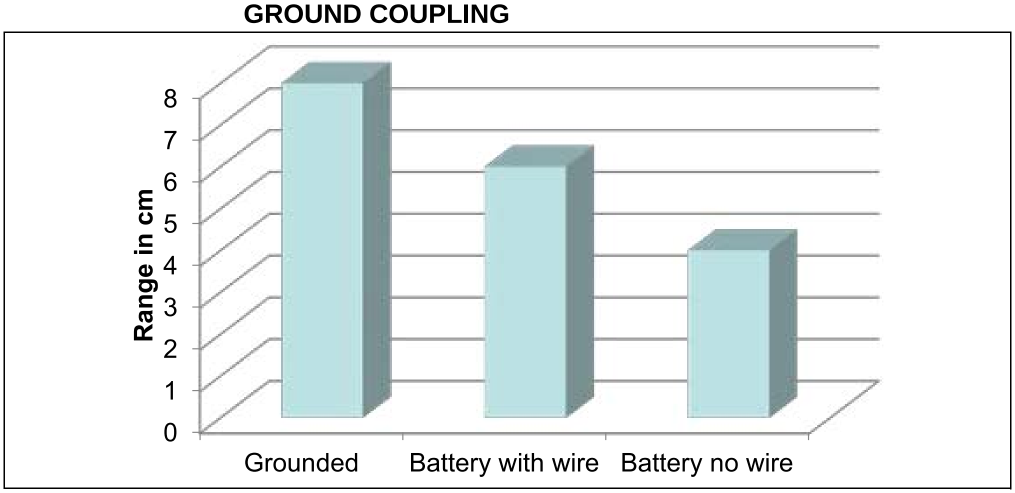



**FIGURE 4-2: FLICK RECOGNITION RANGE DEPENDING ON EARTH GROUND COUPLING**



The tests show that the flick recognition range is reduced to 50% if the sensor does not have any connection to earth ground. It becomes obvious that the first countermeasure is to increase the coupling of the device to earth ground. Just a wire connected to the system ground results in a much higher range.

Applications with metallic parts and internal wiring (chassis, loudspeakers) benefit from that effect. If the presence of metal in a device is large enough (e.g., laptops), it can be considered as 'grounded', and design rules in **Chapter 3. "GestIC® Standard Electrode Design"** and **Chapter 5. "Boosted Electrode Design"** apply.

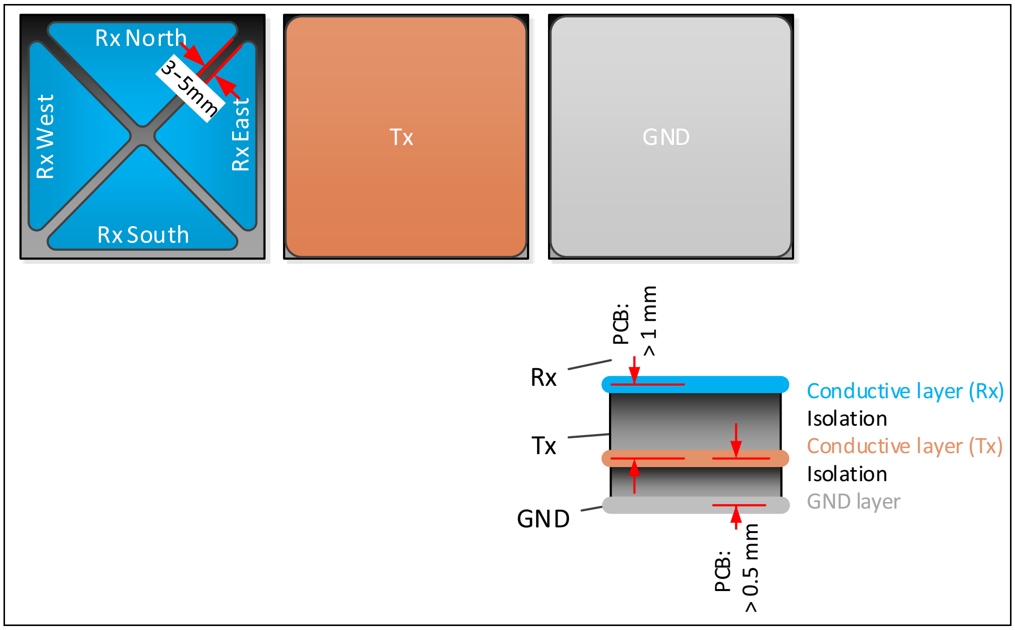
For small battery-driven devices with a few metallic parts, such as remote controls, Bluetooth® speakers, or light controls, the following additional design rules apply:

1. Increase Rx electrode area: better exposure to hand
2. Hide Tx behind Rx: do not expose Tx to hand/avoid transmission
3. Increase coupling to earth ground: maximize system ground (4-layer design mandatory)
4. Electrodes > 8-10 cm: increase coupling between Rx electrodes to compensate decreasing sensor signals

### 4.1.1 Electrode Design

These additional rules result in designs with increased Rx area as shown in Figure 4-3. The principle sensor design is the same as introduced in **3.1 "General Design Rules"**, only the Rx electrode is changed to meet the additional design rules. Requirements for layer stack-up, Tx electrode, chip placement and feeding lines remain the same.

**FIGURE 4-3: BATTERY-OPTIMIZED SENSOR DESIGN**



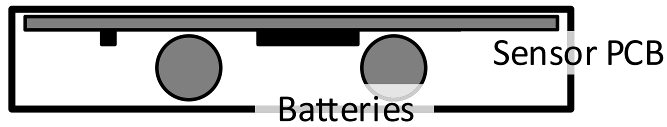

Compared to standard electrode design, battery-optimized electrodes achieve a lower flick recognition range (compare with Figure 2-3).

Depending on electrode size and system architecture, the following variants of Rx electrode layout are recommended:

1. Setup A

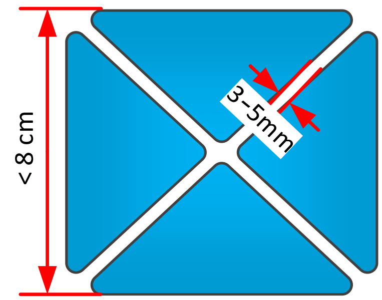
Setup A, shown in Figure 4-4, is represented by small devices which consist of a single PCB and have a size of < 8 cm. This includes battery-driven light switches or remote controls.

**FIGURE 4-4: TYPICAL SETUP A DEVICE**




Setup A devices need to be optimized for a maximum signal deviation and do not have a significant decrease of their sensor signals when a hand approaches. Thus, the optimization is to increase the Rx electrode area as shown in Figure 4-5.

**FIGURE 4-5: SENSOR DESIGN FOR SETUP A DEVICES**




A 3-layer design is mandatory, for the rest of the design the general rules of **Chapter 3. "GestIC® Standard Electrode Design"** apply.

> **Note:** It is recommended that the capacitance between Tx and GND ($C_{TxGND}$) is smaller than 1 nF. For details, refer to **Section 3.1.5 "Layer Stack"**.

2. Setup B

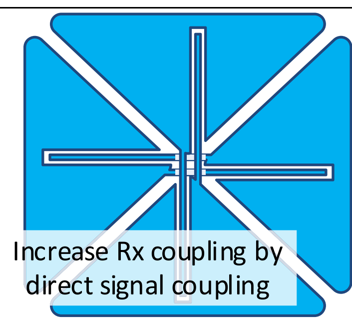
Setup B is represented by devices which consist of a single PCB and a size between 8 and 14 cm.

These devices can be table top devices for home automation or wireless control units for home appliances.

Setup B devices need to be optimized for a maximum signal deviation, but due to their size, they have a significant decrease of their sensor signals when a hand approaches. Thus, the optimization includes increased Rx electrodes and a higher coupling between opposite Rx electrodes.

A recommended way is to add extensions to the electrodes which go inside the opposite electrodes, as shown in Figure 4-6.

**FIGURE 4-6: SENSOR DESIGN FOR SETUP B DEVICES**



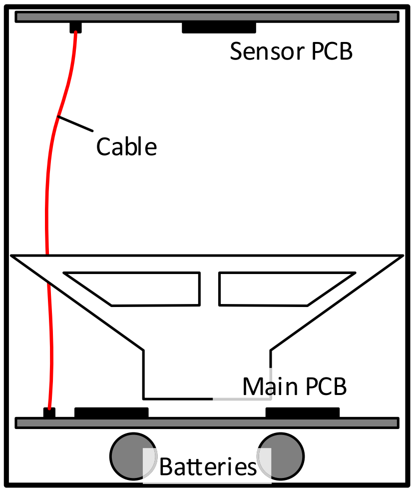
If such design is required, contact Microchip.

3. Setup C

Setup C is represented by devices which include two or more modules that are distributed in a certain volume and are interconnected via cables. The actual GestIC® sensor size is not crucial for such systems because the system ground is distributed over the complete volume and establishes a minimum connection to earth ground.

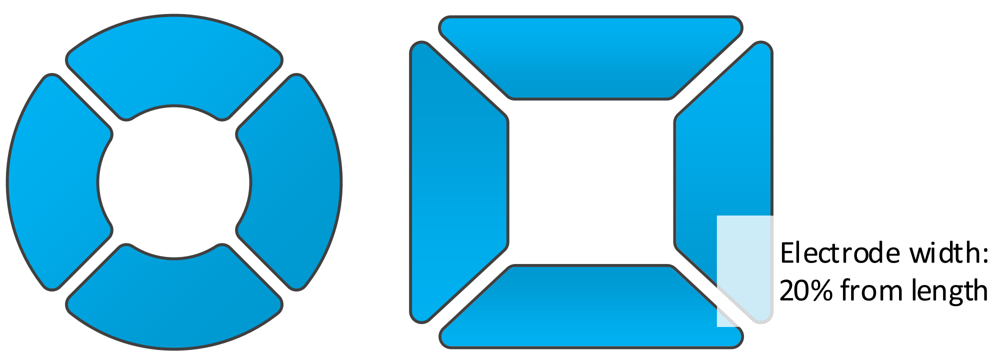
Typical Setup C devices, shown in Figure 4-7, are Bluetooth speakers (sensor PCB, main PCB, speaker), and toys (sensor PCB, main PCB, motors).

**FIGURE 4-7: TYPICAL SETUP C DEVICES**




Setup C sensors need care for a maximum signal deviation only. Thus, the optimization is to increase the Rx electrode area only as shown in Figure 4-8.

**FIGURE 4-8: SENSOR DESIGN FOR SETUP C DEVICES**




A 3-layer design is recommended, for the rest of the design the general rules of **Section 3.1 "General Design Rules"** apply.

4. Setup D

Setup D devices have a good connection to earth ground because of their size and construction. They can be treated like grounded devices.

Setup D devices consist of multiple modules, large metallic parts like chassis or metallic housing and usually have dimensions of 20cm and more. Typical examples are Laptops, large table top devices or appliances.

The electrode design follows the rules described in **Chapter 3. “GestIC® Standard Electrode Design”** (Standard Electrodes) and **Chapter 5. “Boosted Electrode Design”** (Boosted Electrodes).

### 4.1.2 Parameterization

The parameterization of battery optimized designs should be done in the non-grounded condition. The resulting parameter set is valid for the grounded case, too.

Performance validation and parameterization require a wireless connection to the PC running Aurea, e.g., IR or Bluetooth. For further details, contact Microchip.

**NOTES:**

# Chapter 5. Boosted Electrode Design

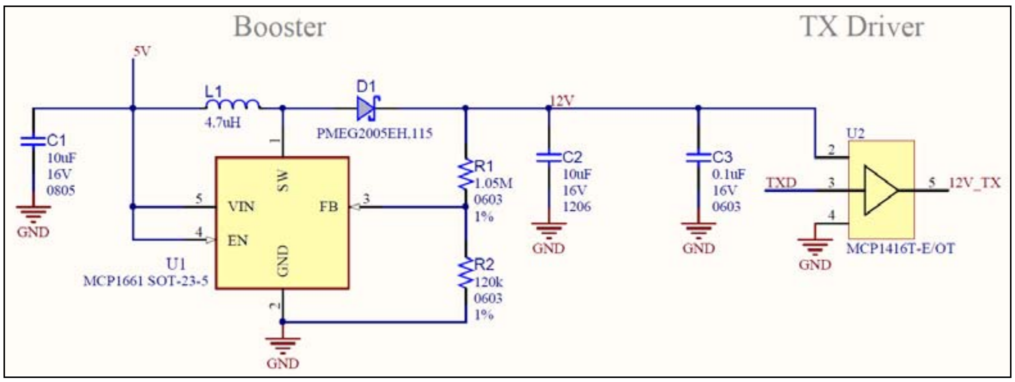
## 5.1 CIRCUITRY FOR TX BOOST

GestIC® standard electrode design is applicable up to a maximum electrode size and within the detection range. An enhanced electrode design allows to boost the Tx voltage to overcome these limits.

This approach requires a Tx level shifter like MCP1416, which allows increasing the Tx amplitude to values of up to 18V. It is recommended to provide its DC input voltage from an available voltage in the customer’s system. If not available, it can be generated by a step-up controller like MCP1661.

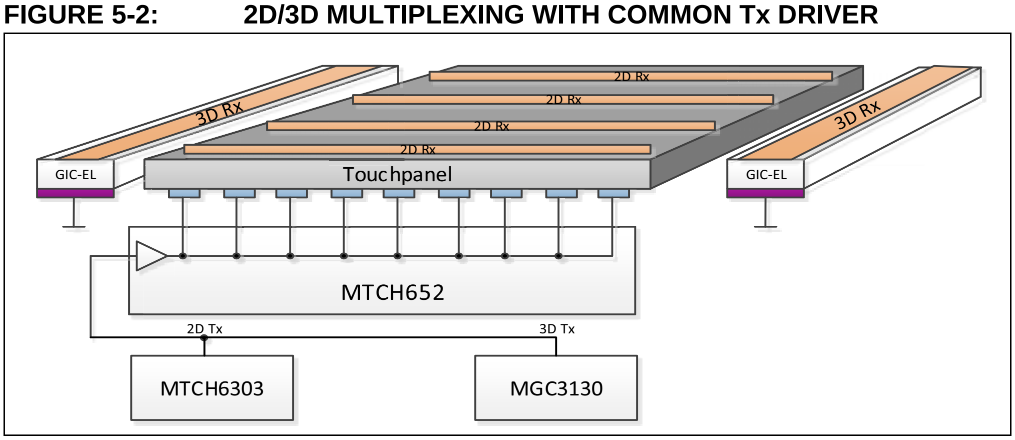
If a step-up other than MCP1661 is used, it is recommended that the switching frequencies and noise are above MGC3XXX operating frequencies (44-250 kHz). The whole circuitry is shown in Figure 5-1.

**FIGURE 5-1: TX BOOST CIRCUITRY**




MGC3XXX can be used as well in combination with the high-performance MTCH6303 2D Touch Controller and the MTCH652 Line Driver with boost functionality to create a unique 2D/3D sensing solution. The line driver MTCH652 can drive up to 19 Tx channels with up to 18V. The MTCH652 Line Driver will be shared for 2D and 3D operation. The control will be automatically handled in the firmware of MTCH6303 and MGC31XX. A block diagram is shown in Figure 5-2. For further details, contact Microchip.

**FIGURE 5-2: 2D/3D MULTIPLEXING WITH COMMON Tx DRIVER**



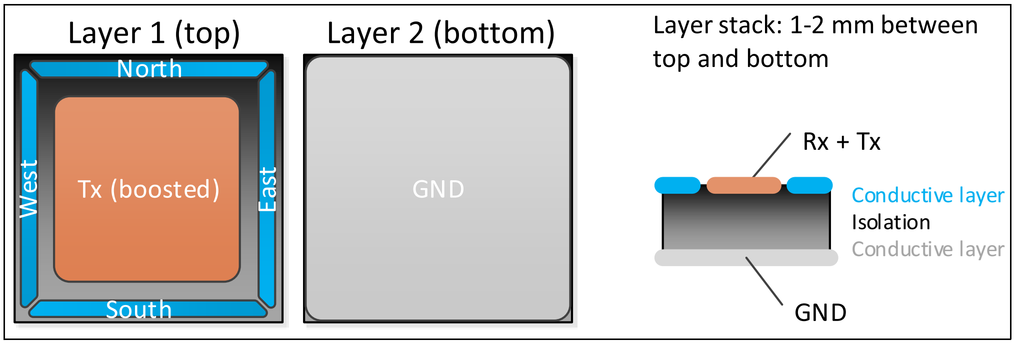

 

## 5.2 ELECTRODE DESIGN FOR 3D ONLY SYSTEMS

In order to keep a stable working point and protect the MGC3XXX inputs from signal overload, it is mandatory to separate the physical Tx electrode area from the Rx input electrodes. Boosted Tx electrodes are not placed underneath the Rx electrodes as typical for standard GestIC systems (refer to **Chapter 3. "GestIC® Standard Electrode Design"**). Instead, they are laid out in the same layer as the Rx electrodes.

It is recommended to place a GND layer underneath the GestIC electrode arrangement. Figure 5-3 shows a typical sensor design for boosted systems.

**FIGURE 5-3: BOOSTED ELECTRODE DESIGN**




The design rules for boosted systems are different from those for standard electrodes and they are summarized below:

### 5.2.1 Rx electrodes

Rx electrodes are designed as a frame like standard electrodes as described in **Section 3.1.2 "Rx Electrodes"**.

The width of the electrodes depends on the sensor size:

- < 140 mm: 4-7% of the electrode's length
- > 140 mm: 5-7 mm is recommended, smaller values (e.g., 2 mm) are in characterization

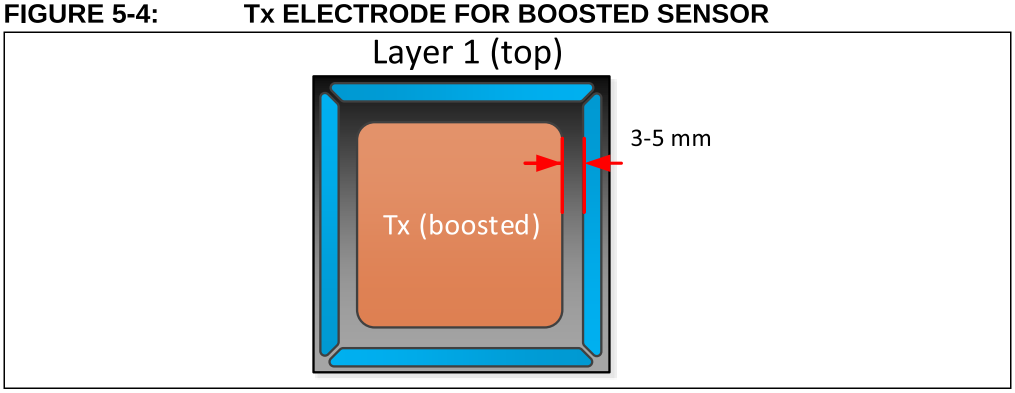
The center area is used for boosted Tx and thus, no center electrode is supported.

### 5.2.2 Tx electrodes

The boosted Tx electrode is placed in the center of the Rx frame. In order to limit the noise coupling between boosted Tx and Rx, it is mandatory to keep a 3-5 mm distance between the Rx and Tx electrodes.

Holes and cutouts in the Tx electrodes are allowed, but it is recommended that the Tx electrode covers 70-80% of the electrode area.

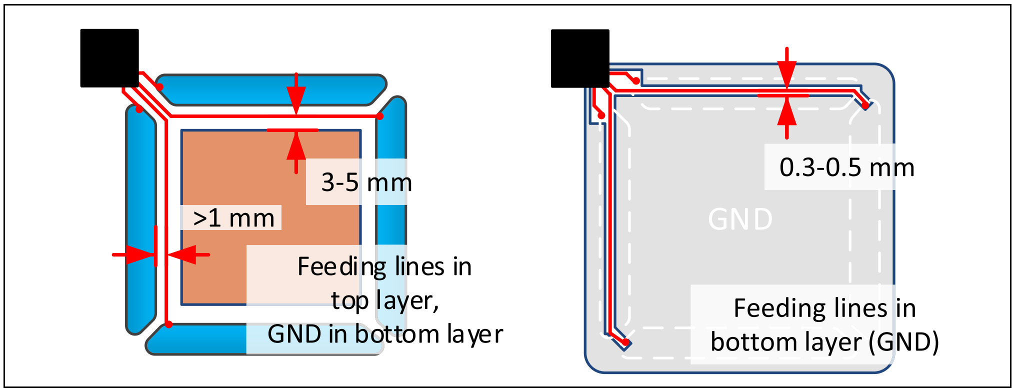
**FIGURE 5-4: Tx ELECTRODE FOR BOOSTED SENSOR**



### 5.2.3 Rx Feeding Lines

Unlike proposed for standard sensor designs, Rx feeding lines should be kept apart from the boosted Tx structures. It is recommended to route them next to the Rx electrodes or inside the GND layer. It is recommended to leave a 0.3-0.5 mm space between feeding lines and GND.

**FIGURE 5-5: Rx FEEDING LINES FOR BOOSTED SENSOR**




### 5.2.4 Chip Placement

The MGC3XXX device should be placed outside of the sensor frame and kept away from boosted Tx structures.

### 5.2.5 Layer Stack

A 2-layer stack consisting of GestIC electrodes in the top layer and GND in the bottom layer is recommended. The distance between the layers is 1-2 mm for PCB material ($\varepsilon r = 5$) and it goes down to 0.5 mm for plastic material ($\varepsilon r < 3$).

Single layer designs are, in general, possible but object of further investigation.

Boosted electrode designs have been verified up to a 300 mm x 300 mm dimension and a maximum Tx amplitude of 18V.

### 5.2.6 Optimization of Rx-Tx Coupling

The boosted GestIC system uses mutual effects between Rx and Tx to measure the presence of the human hand. Sensor signals increase with the hand's approach. In very close proximity (< 1 mm), or if the hand touches the electrodes, however, the signals may decrease with the hand's approach due to transmission effects.

For that reason, it is recommended to design boosted GestIC sensors with a 1-2 mm thick cover on top of the sensor.

Furthermore, it is recommended to add capacitances between Rx and (non-boosted) Tx pins of the MGC3XXX. 10 pF give an optimum between performance reduction and transmission effects.

The capacitors are included in the boosted reference circuitry in **Appendix D. "Reference Circuitry for MGC3130 Boosted"**.

**NOTES:**

# Chapter 6. Sensor Integration and Common Mistakes

## 6.1 GestIC® AND GROUND

Special attention must be given to the ground (GND) around the GestIC® sensor. GND has a shielding function, but at the same time it takes sensitivity from the GestIC sensor.

Different rules apply for GestIC standard designs and boosted designs.

The following rules apply for **standard designs**:

1. Keep GND away from Rx electrodes

A distance of 3-5 mm should be kept as a minimum. Especially inside the sensor area, it is recommended to avoid GND areas.

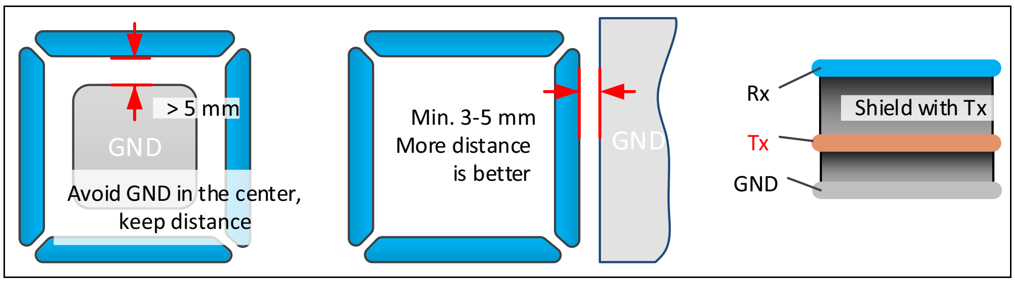
2. Keep GND away from Rx feeding lines

The same rules apply as for the Rx electrodes. In particular, the Rx feeding lines should not be routed inside a GND plane.

3. Shield with Tx

A good GND connection is necessary for the signal integrity of the digital circuitry of MGC3XXX and connected parts. If these parts are assembled on the same board as the GestIC sensor, it is recommended to shield the GND area with a Tx layer (refer to **Section 3.1.5 “Layer Stack”**).

**FIGURE 6-1: GestIC® AND GND**




The following rules apply for **boosted designs**:

1. Shield Rx electrodes with GND

A GND layer behind the Rx electrodes adds stability to the whole system and limits noise coupling from the boosted Tx layer. A minimum distance of approximately 1 mm should be kept between Rx and GND.

2. Shield Rx feeding lines with GND

Rx feeding lines must be shielded from boosted Tx and that can be done with GND. It is recommended to route feeding lines inside the GND layer. A distance of 0.3-0.5 mm should be kept between Rx feeding lines and GND.

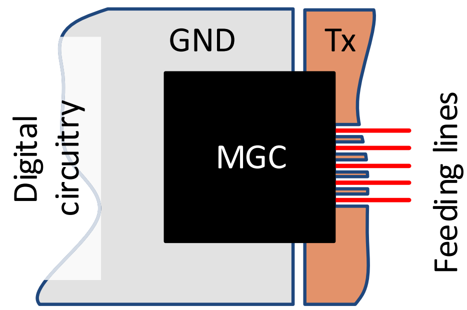
## 6.2 SENSOR LAYOUT ON A PCB

A lot of applications have the GestIC sensor built on a 2 or a 4-layer PCB (Printed Circuit Board), and in many cases it is combined with the gesture controller and even with other circuitry. These combinations require a strict separation between the circuitry and the GestIC electrode structures. If the additional components are placed in the center of the sensor board, a 4-layer PCB is recommended to allow an electrode shielding with a Tx layer.

Some additional tips on how to integrate the GestIC sensor on a PCB layout are provided below:

1. Separate digital and analog domains on the MGC3XXX gesture controller.
   - low-impedance GND connection is required for digital signals
   - keep area around Rx pads and feeding lines clear from GND, as indicated in Figure 6-2 (if necessary, apply Tx for shielding)

**FIGURE 6-2: SEPARATION OF Rx PADS, FEEDING LINES AND GND**

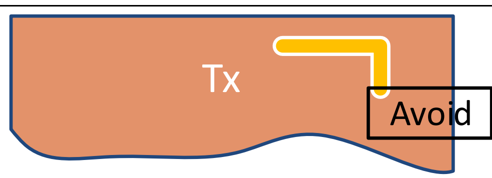



2. Do not place vias inside the Rx electrodes and do not place routes in the Rx layer, as shown in Figure 6-3.

**FIGURE 6-3: Rx LAYER**

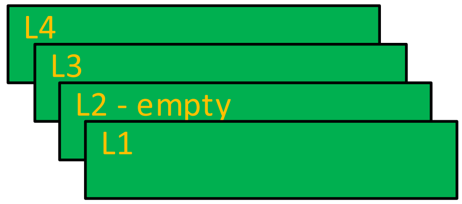

3. Avoid to place routes in the Tx layer, as indicated in Figure 6-4.

**FIGURE 6-4: Tx LAYER**



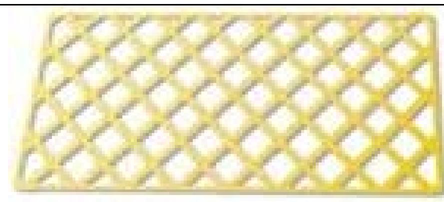
4. Empty layers should not be filled with copper (Figure 6-5). Some PCB manufacturers misinterpret empty layers as “full copper”. Add text or small structures into the empty layers.

**FIGURE 6-5: EMPTY LAYERS**




5. Check with PCB manufacturer if required hatching structures can be manufactured, as shown in Figure 6-6. Some PCB manufacturers may interpret hatched areas as “full copper”.

**FIGURE 6-6: HATCHING STRUCTURES**



## 6.3 COMMON MISTAKES OF GestIC ELECTRODE DESIGN

Table 6-1 lists the most common mistakes of a GestIC sensor design and offers suggestions for possible countermeasures.

**TABLE 6-1: COMMON MISTAKES IN GestIC® SENSOR DESIGN**

| Observation | Mistake | Countermeasure |
|---|---|---|
| **Recognition range is low** | Electrode size is too small | Extend available space for GestIC® sensor (**Section 3.1.1 “Sensor Outline”**) |
| **Recognition range is low** | Electrode layer stack is not optimal | Increase distance between Rx and Tx (**Section 3.1.5 “Layer Stack”**) |
| **Recognition range is low** | Rx electrodes are too close to GND areas | Increase distance between Rx and GND (**Section 3.1.5 “Layer Stack”**) |
| **Recognition range in one direction is lower than in the other** | Sensor outline is asymmetric | Increase symmetry – use a square or circular design (**Section 3.1.5 “Layer Stack”**) |
| **Rx signals are noisy** | Rx electrodes or Rx feeding lines are routed too close to digital signals | Increase the distance to digital lines and shield feeding lines with Tx (ch. **Section 3.1.2 “Rx Electrodes”** to **Section 3.1.4 “Chip Placement and Rx Feeding Lines”**) |
| **Rx signals are jumping or drifting** | Feeding lines are mechanically instable | Care for mechanically stable conditions (ch. **Section 3.1.4 “Chip Placement and Rx Feeding Lines”**) |
| **Rx signals are noisy** | Capacitance between Tx and GND is too high | Improve layer stack, change to a cross-hatched Tx layer (**Section 3.1.5 “Layer Stack”**) |

NOTES:

# Appendix A. GestIC® Design-In Checklist

**FIGURE A-1: GestIC® DESIGN-IN CHECKLIST**

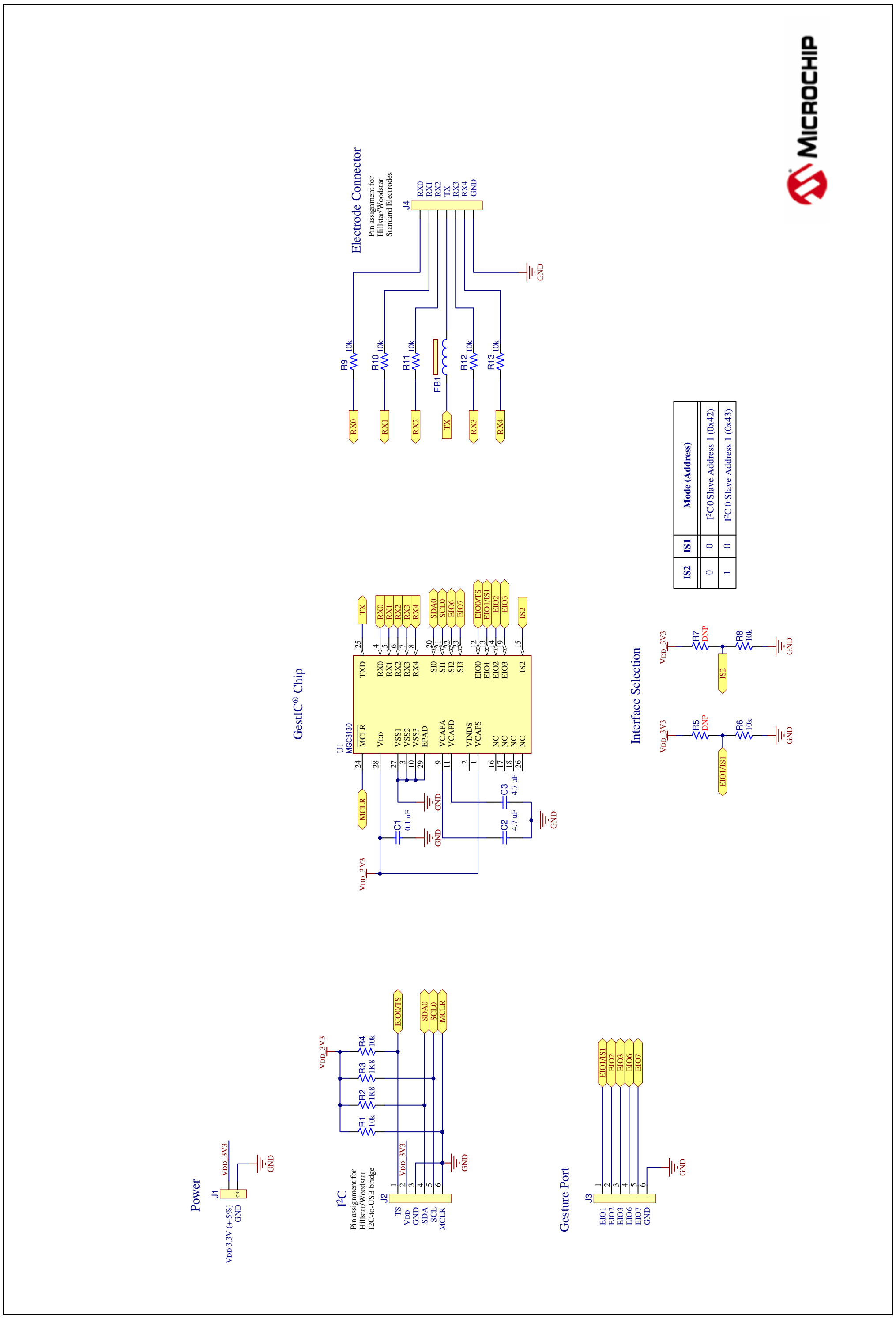
**Project:** **Date:**

| Check | Item | Details |
|---|---|---|
| **Application** | | |
| ☐ | Use Case | |
| ☐ | Sensor range expectation | |
| ☐ | Sensor features | |
| ☐ | Available space for the sensor | |
| **Mechanical construction of the device** | | |
| ☐ | Drawing | |
| ☐ | Dimensions | |
| ☐ | Placement of building blocks | |
| ☐ | Metallic/conductive parts | |
| **Electrical circuitry** | | |
| ☐ | Block diagram | |
| ☐ | Power supply | |
| ☐ | Host controller | |
| ☐ | Peripherals | |
| ☐ | Interconnection | |
| **Ground and Noise** | | |
| ☐ | Connection to Earth Ground | |
| ☐ | Possible noise sources within the system | |

**NOTES:**

# Appendix B. Reference Circuitry for MGC3130

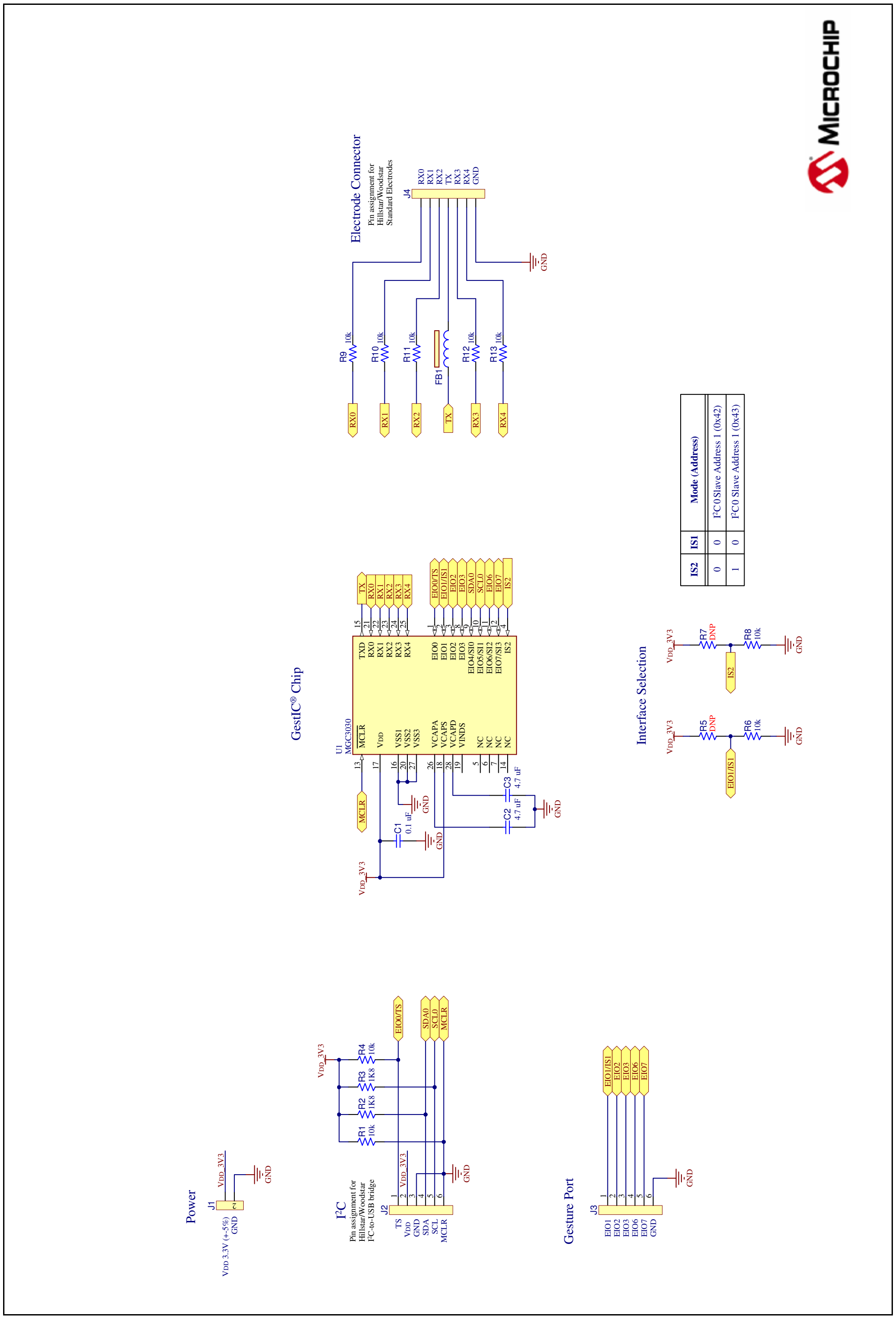
**FIGURE B-1: REFERENCE CIRCUITRY FOR MGC3130**



**NOTES:**

# Appendix C. Reference Circuitry for MGC3030

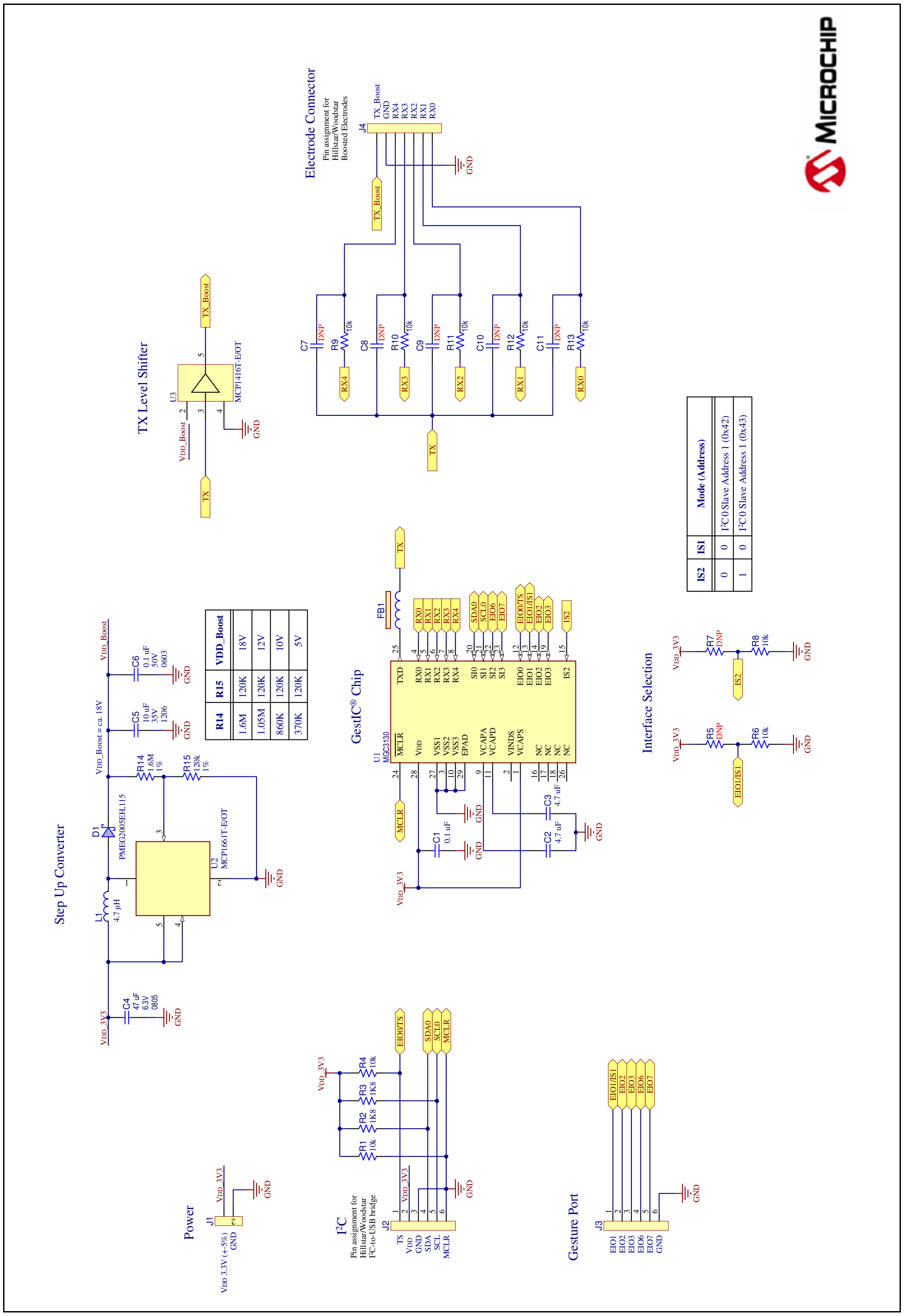
**FIGURE C-1: REFERENCE CIRCUITRY FOR MGC3030**



**NOTES:**

# Appendix D. Reference Circuitry for MGC3130 Boosted

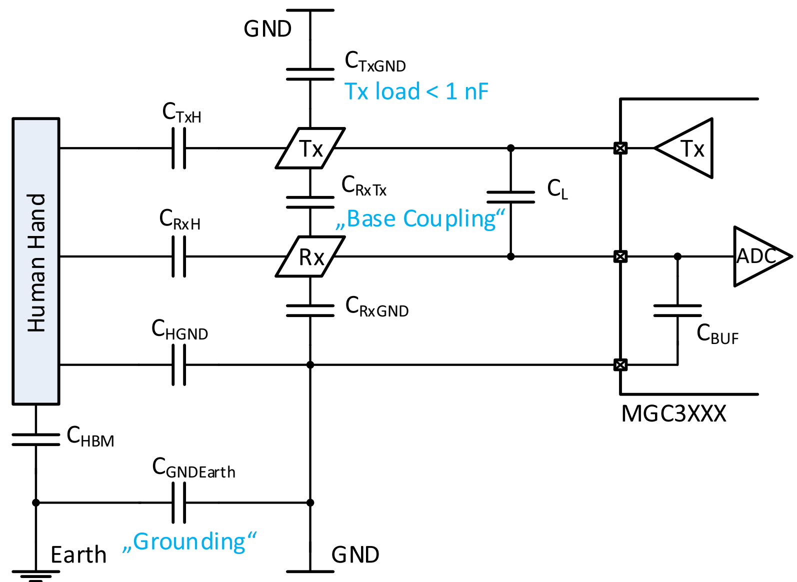
**FIGURE D-1: REFERENCE CIRCUITRY FOR MGC3130 BOOSTED**



**NOTES:**

# Appendix E. GestIC® Equivalent Circuitry and Capacitance Design Goals

**FIGURE E-1: GestIC® EQUIVALENT CIRCUITRY AND CAPACITANCE DESIGN GOALS**




**Where,**

| | |
|---|---|
| Tx, Rx | Tx and Rx electrodes of the GestIC® sensor |
| $C_{RxTx}$ | Capacitance between Rx and Tx electrode (base coupling) |
| $C_{RxGND}$ | Capacitance between Rx electrode and system ground |
| $C_{TxGND}$ | Capacitance between Tx electrode and system ground (capacitive load of the GestIC system) |
| $C_{HGND}$, $C_{RxH}$, $C_{TxH}$ | Capacitances between human hand and GestIC sensor |
| $C_{HBM}$ | Capacitance between human body and earth ground (“Human Body Model”) |
| $C_{GNDEarth}$ | Capacitance between earth ground and GestIC system ground (actual “grounding”) |
| $C_{BUF}$ | Input Capacitance of the MGC3XXX Rx pin (approximately 5 pF) |
| $C_L$ | Capacitance of the Rx feeding lines |

**TABLE E-1: CAPACITANCE DESIGN GOALS**

| Capacitance | Standard Electrode | Standard Electrode Battery operation | Boosted Electrode |
|---|---|---|---|
| $C_{RxTx}$ | 5-20 pF | 5-20 pF | < 5 pF |
| $C_{RxGND}$ | 5-20 pF | 5-20 pF | 5-20 pF |
| $C_{TxGND}$ | < 1 nF | < 1 nF | it depends from booster driving capabilities |
| $C_{TxH}$ | 0.1 pF | 0.1pF | 0.1pF |
| $C_{RxH}$ | 0.1 pF | 0.1pF | 0.1pF |
| $C_{HGND}$ | 0.1 pF | 0.1pF | 0.1pF |
| $C_{HBM}$ | >> $C_{HGND}$, $C_{RxH}$, $C_{TxH}$ | >> $C_{HGND}$, $C_{RxH}$, $C_{TxH}$ | >> $C_{HGND}$, $C_{RxH}$, $C_{TxH}$ |
| $C_{GNDEARTH}$ | >> $C_{HGND}$, $C_{RxH}$, $C_{TxH}$ | n.a. | >> $C_{HGND}$, $C_{RxH}$, $C_{TxH}$ |

**Note 1:** Rule for Standard Electrode best operation: $C_{RxGND} + C_{BUF} = C_{RxTx} + C_L$

**2:** Rule for Boosted Electrode best operation: $C_{RxGND} + C_{BUF} >= C_{RxTx} + C_L$

# Appendix F. GestIC® Performance Evaluation

## F.1 ANALOG FRONT END (AFE)

AFE parameters are tuned according to the electrode capacitances and indicate a good or bad electrode design.

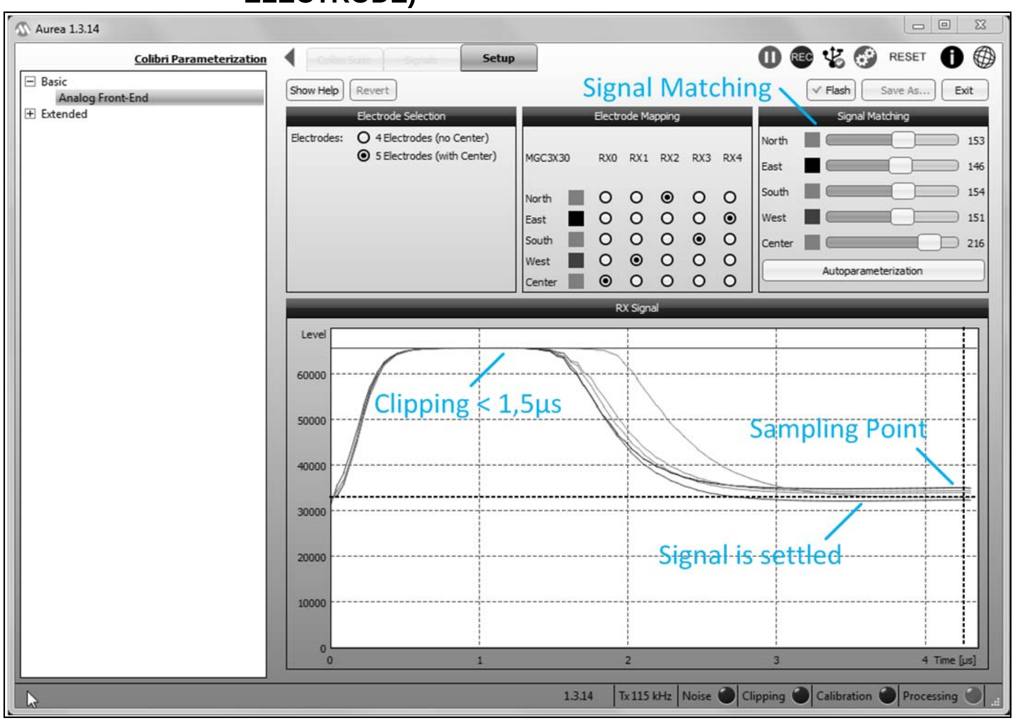
Signal Matching values represent the status of the capacitive voltage divider ($C_{RxGND}$) + $C_{BUF}$ | $C_{RxTx}$ + $C_L$). They are good between 10-180 counts. Higher values are an indication for a high capacitance between Rx and GND ($C_{RxGND}$), and will cause a lower sensor performance.

The Rx signal represents a half cycle of the ADC input signal. In an optimal electrode design, the following conditions will apply:

- Rx signal goes through the sampling point (+/-20%)
- Rx signal is settled at sampling time
- Rx signal has a maximum clipping of 2 ms

If these conditions are not met, the Tx signal cannot be driven ($C_{TxGND}$ too high) and an increased noise level must be expected.

**FIGURE F-1: AFE PARAMETERIZATION (HILLSTAR STANDARD ELECTRODE)**



## F.2 SIGNAL DEVIATION

Signal deviation (SD) is the signal change when the hand approaches. It is measured with an artificial hand 3 cm above the center of an electrode. The following minimum values are required:

- SD at near end (directly above the electrode): > 200 counts
- SD at far end (measured at the opposite electrode): > 12 counts

Aurea supports SD measurement in the Extended Parameterization.

**FIGURE F-2: SD MEASUREMENT WITH AUREA HELP**

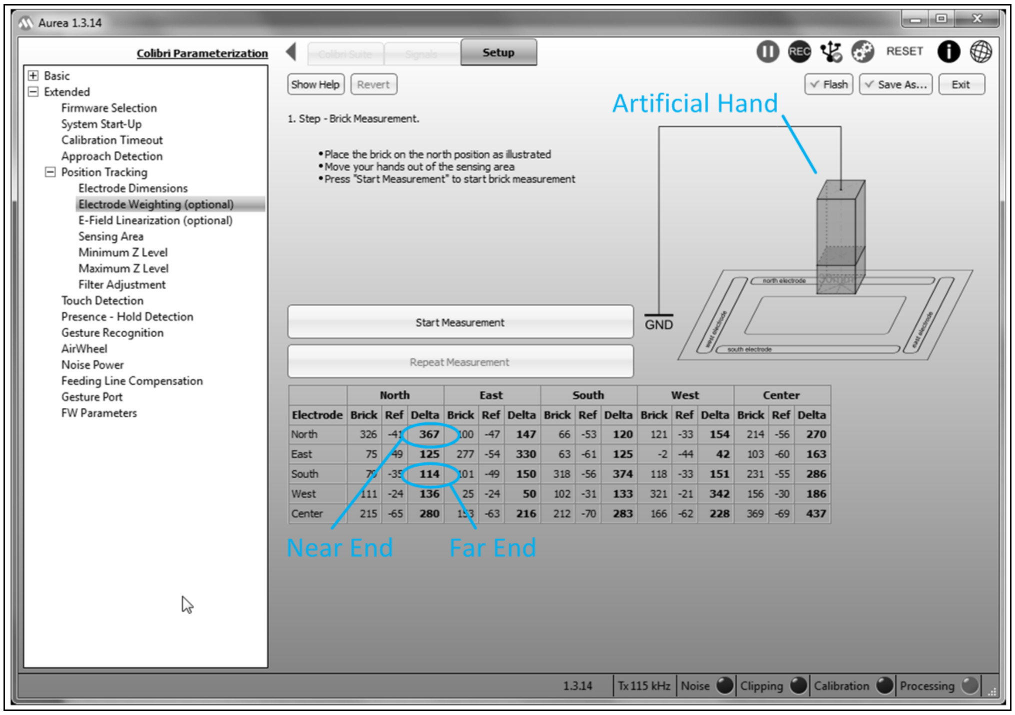



**TABLE F-1: SIGNAL DEVIATION TYPICAL VALUES**

| Standard Electrode – (Hillstar 95x60 mm) | S | W | N | E | C |
|---|---|---|---|---|---|
| Near End | 374 | 342 | 367 | 350 | 437 |
| Far End | 120 | 42 | 115 | 50 | n/a |

| Standard Electrode – Battery Operation | S | W | N | E | C |
|---|---|---|---|---|---|
| Near End | 290 | 301 | 301 | 208 | 0 |
| Far End | 119 | 124 | 96 | 103 | n/a |

| Boosted Electrode | S | W | N | E | C |
|---|---|---|---|---|---|
| Near End | 1409 | 1620 | 1613 | 1229 | 0 |
| Far End | 186 | 85 | 245 | 54 | n/a |

## F.3 NOISE VALUES

Several methods are used to characterize the noise of a GestIC system.

1. Aurea Noise Level:

100s average of CIC signal standard deviation, measures internal and external noise floor (select in Aurea **Signals** tab)

2. Noise variance:

Value for the external noise floor, measured between 200-1000 Hz (shown with CIC values in Aurea **Signals** tab, available via $I^2C$ messages)

3. CIC STD:

Standard deviation of CIC values over 1024 samples

4. CIC PP:

Peak-to-Peak values of CIC values over 1024 samples

Typical values are listed in the table below.

**TABLE F-2: GestIC® NOISE TYPICAL VALUES (Tx = 103 kHz)**

| Standard Electrode – (Hillstar 95x60) | S | W | N | E | C |
|---|---|---|---|---|---|
| Aurea Noise Level | 2,0 | 2,3 | 2,3 | 2,0 | 2,9 |
| CIC STD | 2,2 | 2,0 | 2,8 | 1,7 | 2,5 |
| CIC PP | 12,7 | 10,6 | 15,0 | 13,0 | 12,8 |
| Noise Variance | 0,0016 | | | | |

| Standard Electrode – Battery Operation | S | W | N | E | C |
|---|---|---|---|---|---|
| Aurea Noise Level | 3,7 | 2,9 | 2,7 | 2,3 | 0,0 |
| CIC STD | 3,2 | 3,9 | 2,6 | 2,7 | 0,0 |
| CIC PP | 17,6 | 18,6 | 18,6 | 16,9 | 0,3 |
| Noise Variance | 0,0039 | | | | |

| Boosted Electrode | S | W | N | E | C |
|---|---|---|---|---|---|
| Aurea Noise Level | 2,5 | 2,3 | 3,0 | 2,1 | 0,0 |
| CIC STD | 3,3 | 3,5 | 3,8 | 2,5 | 0,0 |
| CIC PP | 17,8 | 19,6 | 21,2 | 15,8 | 0,1 |
| Noise Variance | 0,0040 | | | | |

**Note 1:** Noise values should be close to the typical values, higher noise will degrade GestIC® performance.

**2:** All 4-frame electrodes (NESW) should have noise values in the same range, if one or more electrodes have higher noise, check signal integrity (crosstalk) of your system.

**3:** Different noise values will be measured at different GestIC Tx frequencies, it is recommended to check all.

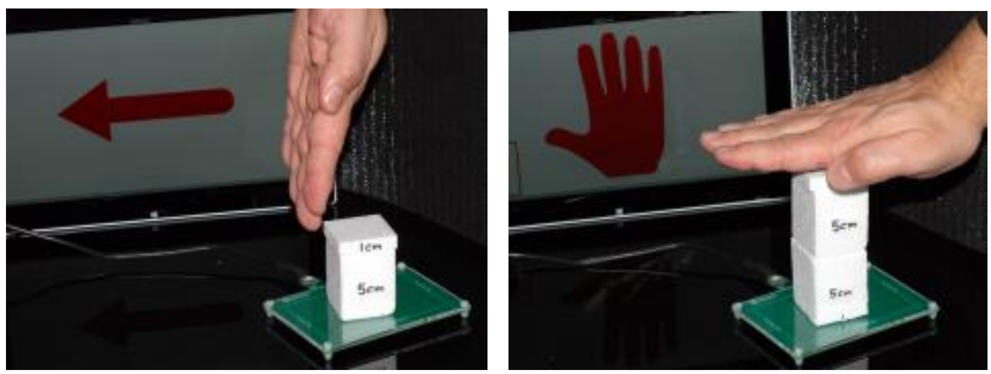
## F.4 RECOGNITION RANGE

The Sensor Recognition Range is defined as the maximum distance of the human hand from the sensor surface to track the position and to recognize gestures. Depending on the feature, different recognition ranges can be defined.

**TABLE F-3: GESTURE RECOGNITION RANGE TYPICAL VALUES**

| | Standard Electrode – (Hillstar 95x60) | Battery Operation – Setup A (70 x 70 mm) | Boosted Electrode 8” (210 x 135 mm) |
|---|---|---|---|
| **Flick Recognition N-S** | 60 mm | 40 mm | 140 mm |
| **Flick Recognition E-W** | 50 mm | 40 mm | 130 mm |
| **Proximity Range** | 140 mm | 100 mm | 320 mm |

**FIGURE F-3: MEASUREMENT OF GESTURE RECOGNITION RANGE**



# Appendix G. GestIC® Hardware References

## G.1 GESTIC® HARDWARE REFERENCES

The GestIC® Hardware References package contains the PCB layouts (Gerber files) for the MGC3XXX development kits (Hillstar, Woodstar) and a collection of electrode reference designs fitting both kits. In addition, the package includes designs, parameter files and host code of various demonstrators which represent complete systems for embedded or PC-based applications.

New designs will be added to the package once they are available. The GestIC Hardware Reference package can be downloaded from the Microchip website at http://www.microchip.com/gesticresources.

**NOTES:**

# Worldwide Sales and Service

## AMERICAS

**Corporate Office**
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

**Atlanta**
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

**Austin, TX**
Tel: 512-257-3370

**Boston**
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

**Chicago**
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

**Cleveland**
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

**Dallas**
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

**Detroit**
Novi, MI
Tel: 248-848-4000

**Houston, TX**
Tel: 281-894-5983

**Indianapolis**
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

**Los Angeles**
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

**New York, NY**
Tel: 631-435-6000

**San Jose, CA**
Tel: 408-735-9110

**Canada - Toronto**
Tel: 905-673-0699
Fax: 905-673-6509

## ASIA/PACIFIC

**Asia Pacific Office**
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

**Hong Kong**
Tel: 852-2943-5100
Fax: 852-2401-3431

**Australia - Sydney**
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

**China - Beijing**
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

**China - Chengdu**
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

**China - Chongqing**
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

**China - Dongguan**
Tel: 86-769-8702-9880

**China - Hangzhou**
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

**China - Hong Kong SAR**
Tel: 852-2943-5100
Fax: 852-2401-3431

**China - Nanjing**
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

**China - Qingdao**
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

**China - Shanghai**
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

**China - Shenyang**
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

**China - Shenzhen**
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

**China - Wuhan**
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

**China - Xian**
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

## ASIA/PACIFIC

**China - Xiamen**
Tel: 86-592-2388138
Fax: 86-592-2388130

**China - Zhuhai**
Tel: 86-756-3210040
Fax: 86-756-3210049

**India - Bangalore**
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

**India - New Delhi**
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

**India - Pune**
Tel: 91-20-3019-1500

**Japan - Osaka**
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

**Japan - Tokyo**
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

**Korea - Daegu**
Tel: 82-53-744-4301
Fax: 82-53-744-4302

**Korea - Seoul**
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

**Malaysia - Kuala Lumpur**
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

**Malaysia - Penang**
Tel: 60-4-227-8870
Fax: 60-4-227-4068

**Philippines - Manila**
Tel: 63-2-634-9065
Fax: 63-2-634-9069

**Singapore**
Tel: 65-6334-8870
Fax: 65-6334-8850

**Taiwan - Hsin Chu**
Tel: 886-3-5778-366
Fax: 886-3-5770-955

**Taiwan - Kaohsiung**
Tel: 886-7-213-7828

**Taiwan - Taipei**
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

**Thailand - Bangkok**
Tel: 66-2-694-1351
Fax: 66-2-694-1350

## EUROPE

**Austria - Wels**
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

**Denmark - Copenhagen**
Tel: 45-4450-2828
Fax: 45-4485-2829

**France - Paris**
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

**Germany - Dusseldorf**
Tel: 49-2129-3766400

**Germany - Karlsruhe**
Tel: 49-721-625370

**Germany - Munich**
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

**Italy - Milan**
Tel: 39-0331-742611
Fax: 39-0331-466781

**Italy - Venice**
Tel: 39-049-7625286

**Netherlands - Drunen**
Tel: 31-416-690399
Fax: 31-416-690340

**Poland - Warsaw**
Tel: 48-22-3325737

**Spain - Madrid**
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

**Sweden - Stockholm**
Tel: 46-8-5090-4654

**UK - Wokingham**
Tel: 44-118-921-5800
Fax: 44-118-921-5820

07/14/15