# iMOTION™ IMC100

## High performance motor control IC series

**IMC100**
**Quality Requirement Category: Industry**

## Feature list

- Motion Control Engine (MCE) as ready-to-use solution for variable speed drives
- Field oriented control (FOC) for permanent magnet synchronous motor (PMSM)
- Space vector PWM with sinusoidal commutation and integrated protection features
- Current sensing via single or leg shunt
- Sensorless operation
- Optional support for hall sensors (analog or digital)
- Optional boost or totem pole PFC control integrated
- Flexible host interface options for motor control commands: UART, PWM or analog input signal
- Support for IEC/UL 60335 (‘Class B’)
- Integrated scripting engine for application flexibility
- Multiple package options

## Applications

- Refrigerators
- Home appliances
- Pumps, fans
- ...any other PMSM drive

### Ordering Information

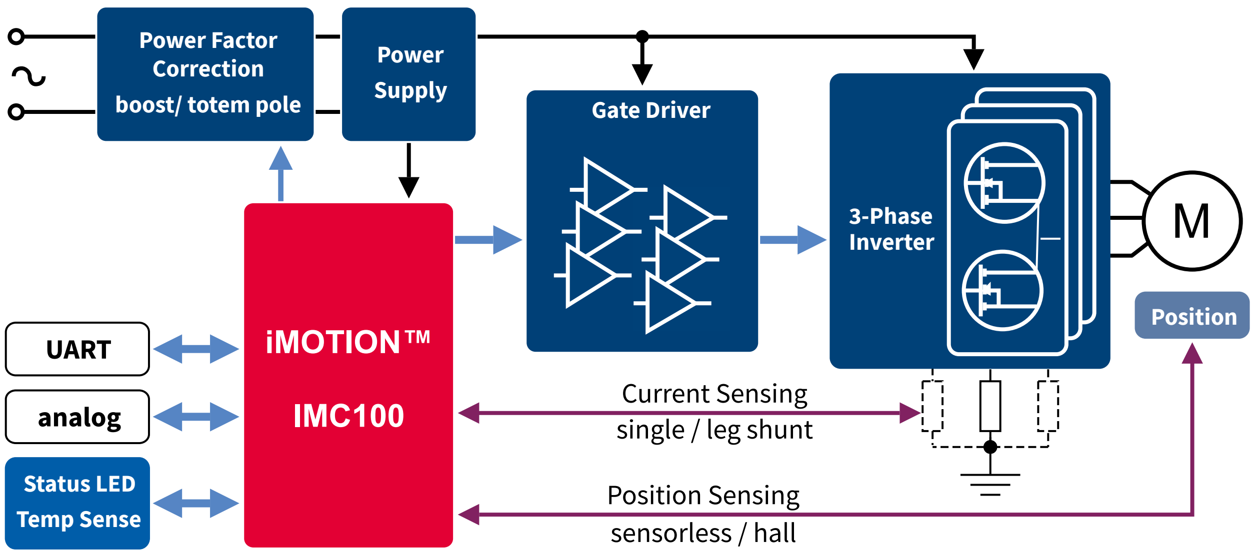
| Product Type | Application | Package |
|---|---|---|
| IMC099T-T038 | single motor, no scripting, no class B | TSSOP-38 |
| IMC101T-T038 | single motor | TSSOP-38 |
| IMC101T-Q048 | | QFN-48 |
| IMC101T-F048 | | LQFP-48 |
| IMC101T-F064 | | LQFP-64 |
| IMC102T-F048 | single motor + PFC (boost, totem pole) | LQFP-48 |
| IMC102T-F064 | | LQFP-64 |

*Note: Variants in LQFP-48 package under development.*

# Description

iMOTION™ IMC100 is a family of highly integrated ICs for the control of variable speed drives. By integrating both the required hardware and software to perform control of a permanent magnet synchronous motor (PMSM) they provide the shortest time to market for any motor system at the lowest system and development cost.

The integrated script engine allows to add application flexibility without interfering with the motor and PFC control algorithm.



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# About this document

### Scope and purpose

This Datasheet describes the mechanical, electrical and functional characteristics of the iMOTION™ IMC100 series of motor control ICs. If no specific device is given the characteristics are valid for all devices within the iMOTION™ IMC100 series.

For a detailed description of the functionality and configuration options please refer to the reference manual of the Motion Control Engine.

### Intended audience

The Datasheet is targeting developers implementing a variable speed drive.

# 1 Block Diagram Reference

The block diagram below gives an overview on the available functional units in the iMOTION™ IMC100 family. Not all units are required in all applications and some modules might share pins in smaller packages. Please refer to the pin configuration for the individual packages and the application schematic examples given.

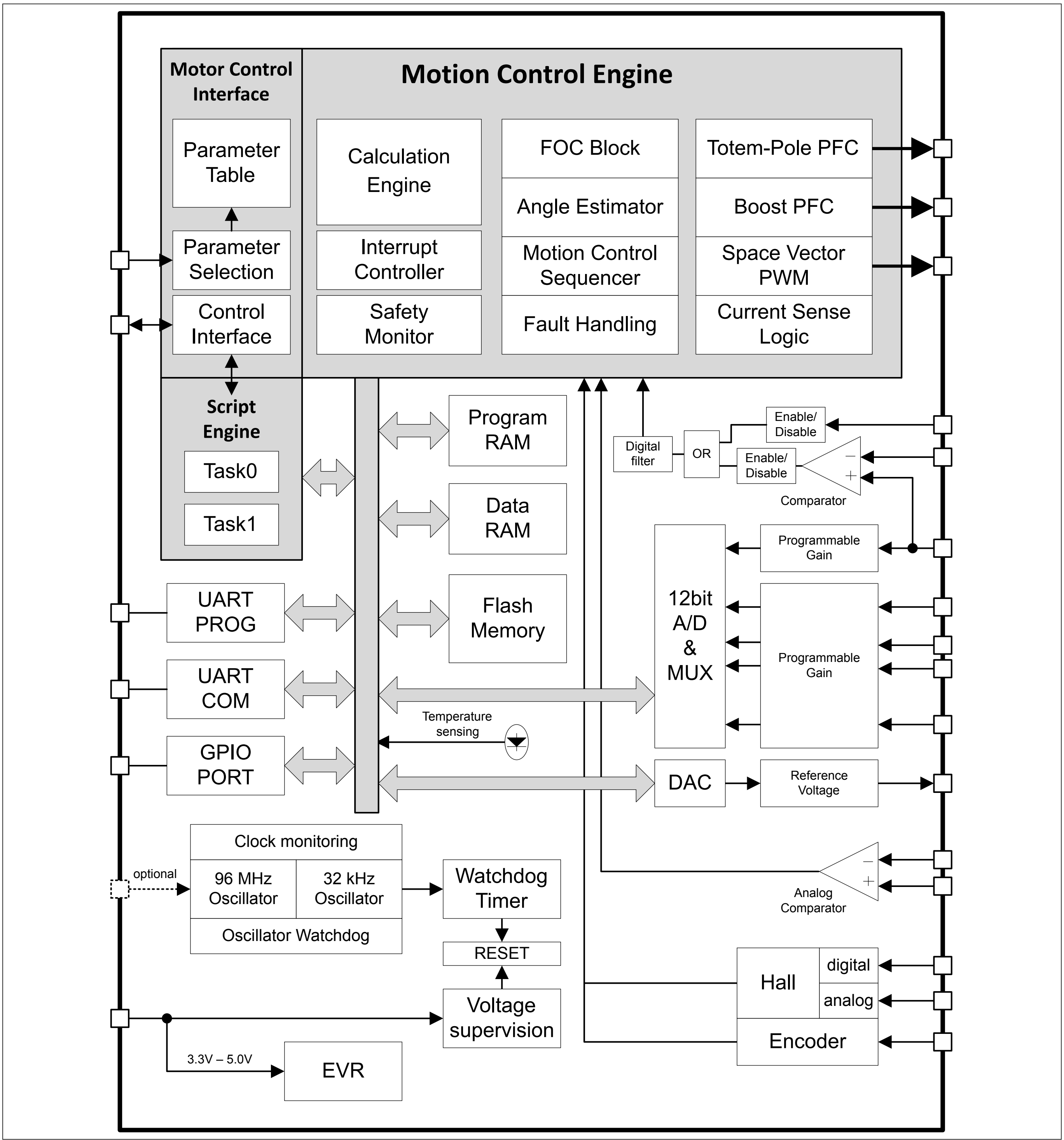


**Figure 1** **Block diagram**

# 2 Pin Configuration

The following tables give the pin configurations of the individual devices of the IMC100 series in the available packages.

The pin type is specified as follows:

- I - digital input
- O - digital output
- AIN - analog input

The pin function given below refers to the standard software configuration. Different software might configure pins differently. Some of the input pins can be configured to have pull up or pull down resistor and some output pins can be configured to push-pull or open drain. This is described in the reference manual of the respective software.

Pins can serve multiple functions and have to be configured accordingly. Please also refer to the respective pin configuration drawings in this data sheet and the description in the MCE software manual.

Pins that do not have any signal assigned are reserved for future use. These pins should be left unconnected and neither be connected to ground nor to the positive supply.

*Note: All required reference voltages are generated by an internal DAC, therefor the pins like REFU, REFV, REFW and PFCREF only require a blocking capacitor.*

## 2.1 Pin Configuration IMC099T/ IMC101T

*Note: IMC099T-T038 does not support scripting. Therefore the scripting pins given below for the TSSOP-38 package only apply to the IMC101T-T038.*

**Table 1 Pin list**

| Signal | Type | LQFP-64 | VQFN-48 | LQFP-48 | TSSOP-38 | Description |
|---|---|---|---|---|---|---|
| Supply | | | | | | |
| VDD | Power | 2, 24, 25, 35, 50 | 18, 19, 27, 38 | | 10, 26 | Supply Voltage |
| VSS | Power | 1, 23, 49 | 17, 37 | | 9, 25 | Ground |
| Motor control | | | | | | |
| PWMUL | O | 29 | 21 | | 11 | PWM output phase U low side |
| PWMUH | O | 30 | 22 | | 12 | PWM output phase U high side |
| PWMVL | O | 31 | 23 | | 13 | PWM output phase V low side |
| PWMVH | O | 32 | 24 | | 14 | PWM output phase V high side |
| PWMWL | O | 33 | 25 | | 15 | PWM output phase W low side |
| PWMWH | O | 34 | 26 | | 16 | PWM output phase W high side |
| GK | I | 36 | 28 | | 18 | Motor gate kill input |
| VDC | AIN | 14 | 8 | | 2 | DC bus sensing input |
| ISS/IU | AIN | 18 | 12 | | 6 | Current sense input single shunt / phase U |
| IV | AIN | 15 | 9 | | 3 | Current sense input phase V / analog input |

**Table 1 Pin list (continued)**

| Signal | Type | LQFP-64 | VQFN-48 | LQFP-48 | TSSOP-38 | Description |
|---|---|---|---|---|---|---|
| IW | AIN | 11 | 5 | | 37 | Current sense input phase W / analog input |
| REFU | AIN | 17 | 11 | | 5 | Itrip phase U reference / analog input |
| REFV | AIN | 16 | 10 | | 4 | Itrip phase V reference / analog input |
| REFW | AIN | 10 | 4 | | 36 | Itrip phase W reference / analog input |
| Hall sensor inputs | | | | | | |
| AHALL1+ | AIN | 12 | 6 | | 38 | Analog hall 1 positive input |
| AHALL1- | AIN | 19 | 13 | | 1 | Analog hall 1 negative input |
| AHALL2+ | AIN | 20 | 14 | | 8 | Analog hall 2 positive input |
| AHALL2- | AIN | 9 | 3 | | 35 | Analog hall 2 negative input |
| AHALL3+ | AIN | 16 | 10 | | 4 | Analog hall 3 positive input |
| AHALL3- | AIN | 10 | 4 | | 36 | Analog hall 3 negative input |
| HALL1 | I | 26 | 6 | | 38 | Digital hall input 1 |
| HALL2 | I | 27 | 13 | | 1 | Digital hall input 2 |
| HALL3 | I | 28 | 14 | | 8 | Digital hall input 3 |
| Interface | | | | | | |
| DIR | I | 52 | 40 | | 28 | Direction input |
| DUTYFREQ | I | 55 | 43 | | 31 | Duty/Frequency input |
| VSP | AIN | 9 | 3 | | 35 | Analog speed reference input |
| PGOUT | O | 42 | 30 | | 21 | Pulse output |
| PARAM | AIN | 20 | 14 | | 8 | Parameter table selection, analog |
| PAR0 | I | 3 | 33 | | 22 | Parameter page select 0 |
| PAR1 | I | 4 | 34 | | 23 | Parameter page select 1 |
| PAR2 | I | 5 | 35 | | 24 | Parameter page select 2 |
| PAR3 | I | 6 | 36 | | 27 | Parameter page select 3 |
| NTC | AIN | 13 | 7 | | 7 | External thermistor input |
| LED | O | 41 | 29 | | 17 | Status LED |
| Communication | | | | | | |
| RX0 | I | 57 | 45 | | 33 | Serial port 0, device programming, receive input |
| TX0 | O | 58 | 46 | | 34 | Serial port 0, device programming, transmit output |
| RX1 | I | 63 | 47 | | 20 | Serial port 1, user communication, receive input |
| TX1 | O | 64 | 48 | | 19 | Serial port 1, user communication, transmit output |
| Scripting | | | | | | |
| AIN0 | AIN | 9 | 3 | | 35 | Analog input 0 |

**Table 1 Pin list (continued)**

| Signal | Type | LQFP-64 | VQFN-48 | LQFP-48 | TSSOP-38 | Description |
|---|---|---|---|---|---|---|
| AIN1 | AIN | 10 | 4 | | 36 | Analog input 1 |
| AIN2 | AIN | 11 | 5 | | 37 | Analog input 2 |
| AIN3 | AIN | 12 | 6 | | 38 | Analog input 3 |
| AIN4 | AIN | 13 | 7 | | 1 | Analog input 4 |
| AIN7 | AIN | 16 | 10 | | 4 | Analog input 7 |
| AIN8 | AIN | 17 | 11 | | 5 | Analog input 8 |
| AIN10 | AIN | 19 | 13 | | 7 | Analog input 5 |
| AIN11 | AIN | 20 | 14 | | 8 | Analog input 6 |
| GPIO2 | IO | 3 | 33 | | 22 | Digital input/output 2 |
| GPIO3 | IO | 4 | 34 | | 23 | Digital input/output 3 |
| GPIO4 | IO | 5 | 35 | | 24 | Digital input/output 4 |
| GPIO5 | IO | 6 | 36 | | 27 | Digital input/output 5 |
| GPIO6 | IO | 52 | 40 | | 28 | Digital input/output 6 |
| GPIO7 | IO | 7 | 1 | | 29 | Digital input/output 7 |
| GPIO8 | IO | 8 | 2 | | 30 | Digital input/output 8 |
| GPIO9 | IO | 26 | 20 | | 32 | Digital input/output 9 |
| GPIO10 | IO | 27 | 31 | | | Digital input/output 10 |
| GPIO11 | IO | 28 | 32 | | | Digital input/output 11 |
| GPIO12 | IO | 37 | 39 | | | Digital input/output 12 |
| GPIO13 | IO | 38 | 41 | | | Digital input/output 13 |
| GPIO14 | IO | 39 | 42 | | | Digital input/output 14 |
| GPIO15 | IO | 40 | 44 | | | Digital input/output 15 |
| GPIO16 | IO | 43 | | | | Digital input/output 16 |
| GPIO17 | IO | 44 | | | | Digital input/output 17 |
| GPIO18 | IO | 45 | | | | Digital input/output 18 |
| GPIO19 | IO | 46 | | | | Digital input/output 19 |
| GPIO20 | IO | 47 | | | | Digital input/output 20 |
| GPIO21 | IO | 48 | | | | Digital input/output 21 |
| GPIO22 | IO | 51 | | | | Digital input/output 22 |
| GPIO23 | IO | 53 | | | | Digital input/output 23 |
| GPIO24 | IO | 54 | | | | Digital input/output 24 |
| GPIO25 | IO | 56 | | | | Digital input/output 25 |
| GPIO26 | IO | 59 | | | | Digital input/output 26 |
| GPIO27 | IO | 60 | | | | Digital input/output 27 |
| GPIO28 | IO | 61 | | | | Digital input/output 28 |
| GPIO29 | IO | 62 | | | | Digital input/output 29 |

## 2.2 Pin Configuration Drawing IMC099T/ IMC101T

The following drawings give the position of the functional pins for the available packages.

*Note: IMC099T-T038 does not support scripting. Therefore the scripting pins given in the drawing below for the TSSOP-38 package only apply to the IMC101T-T038.*

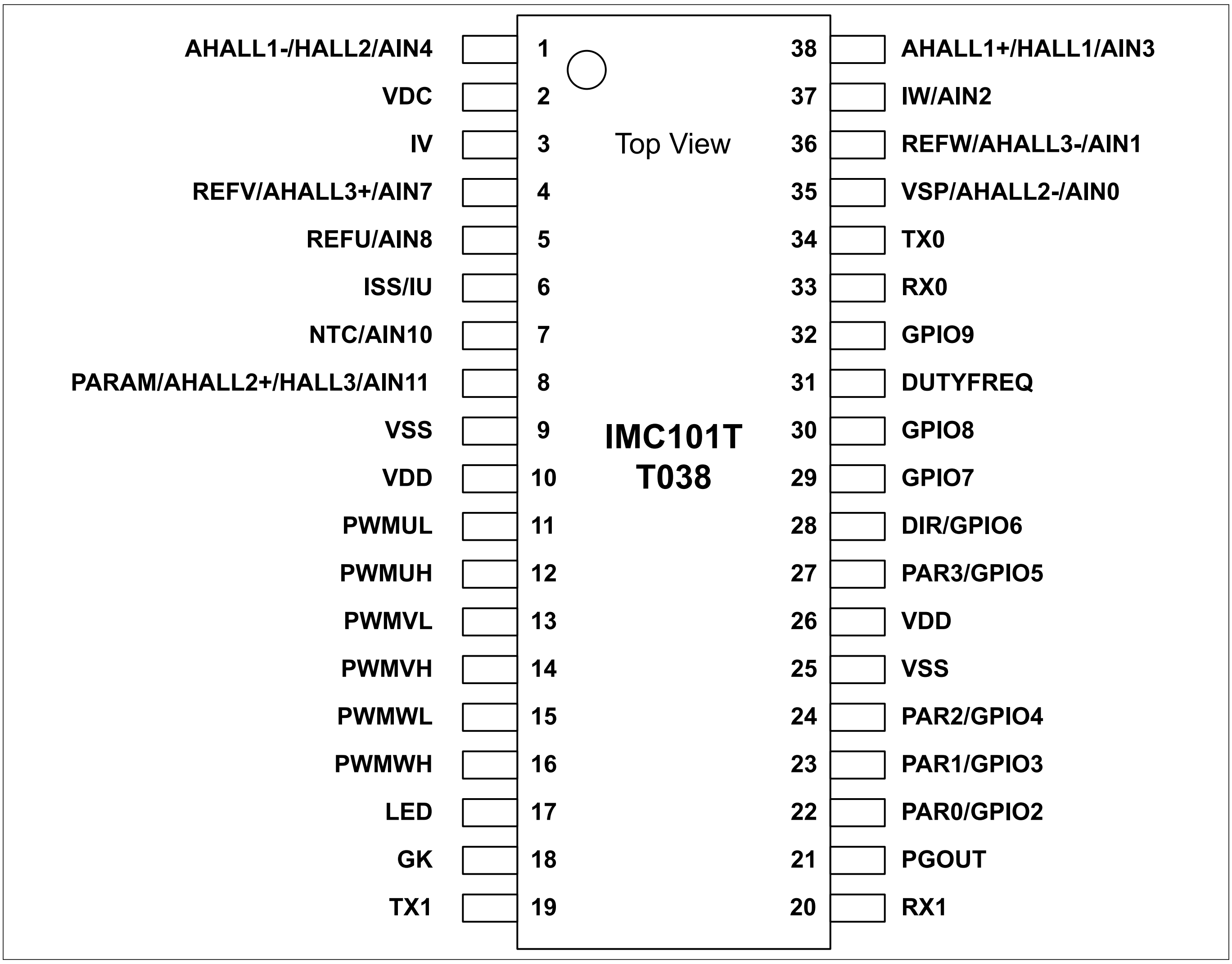


**Figure 2** **IMC099T-T038, IMC101T-T038**

Pins that do not have any signal assigned are reserved for future use. These pins should be left unconnected and neither be connected to ground nor to the positive supply.

**Pin Configuration**

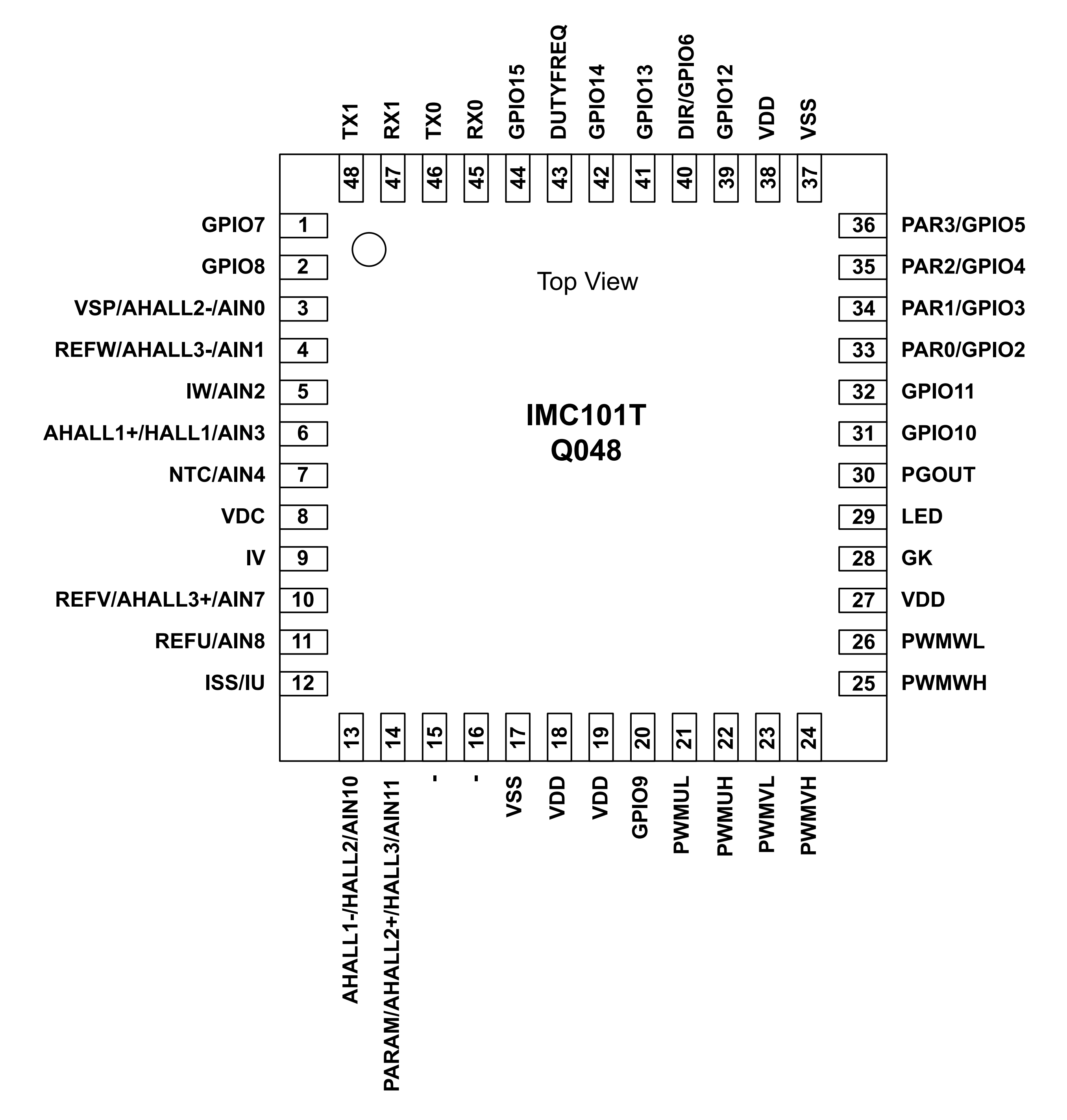


**Figure 3** IMC101T-Q048

Pins that do not have any signal assigned are reserved for future use. These pins should be left unconnected and neither be connected to ground nor to the positive supply.

## Pin Configuration

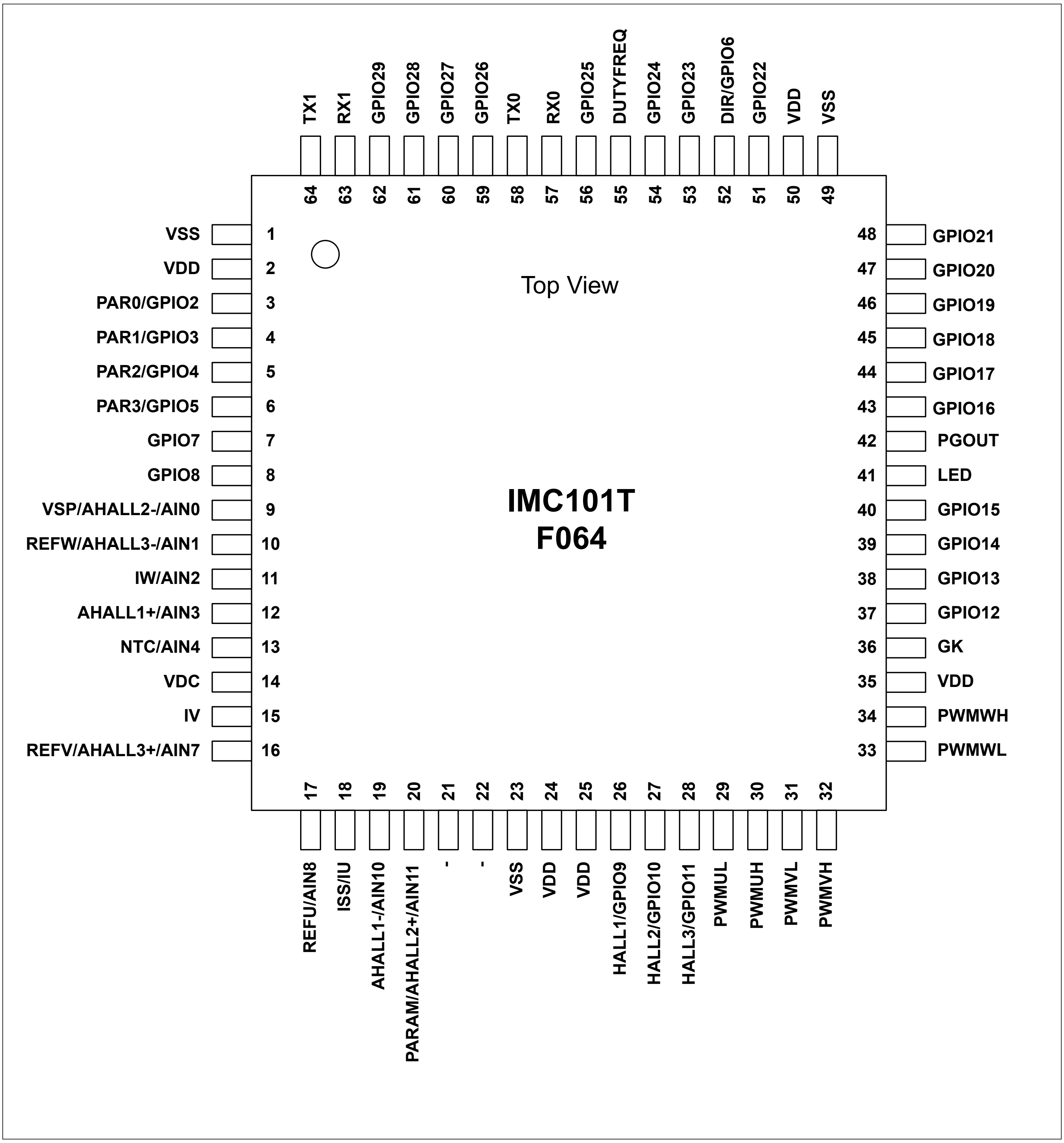


**Figure 4** IMC101T-F064

Pins that do not have any signal assigned are reserved for future use. These pins should be left unconnected and neither be connected to ground nor to the positive supply.

## 2.3 Pin Configuration IMC102T

**Table 2 Pin list Motion Control Engine**

| Signal | Type | LQFP-64 | LQFP-48 | Description |
|---|---|---|---|---|
| Supply | | | | |
| VDD | Power | 2, 24, 25, 35, 50 | | Supply Voltage |
| VSS | Power | 1, 23, 49 | | Ground |
| Motor control | | | | |
| PWMUL | O | 29 | | PWM output phase U low side |
| PWMUH | O | 30 | | PWM output phase U high side |
| PWMVL | O | 31 | | PWM output phase V low side |
| PWMVH | O | 32 | | PWM output phase V high side |
| PWMWL | O | 33 | | PWM output phase W low side |
| PWMWH | O | 34 | | PWM output phase W high side |
| GK | I | 36 | | Motor gate kill input |
| VDC | AIN | 14 | | DC bus sensing input |
| ISS/IU | AIN | 18 | | Current sense input single shunt / phase U |
| IV | AIN | 15 | | Current sense input phase V / analog input |
| IW | AIN | 11 | | Current sense input phase W / analog input |
| REFU | AIN | 17 | | Itrip phase U reference / analog input |
| REFV | AIN | 16 | | Itrip phase V reference / analog input |
| REFW | AIN | 10 | | Itrip phase W reference / analog input |
| Power factor correction | | | | |
| PFCG0 | O | 44 | | PFC gate drive 0 |
| PFCG1 | O | 43 | | PFC gate drive 1 (totem pole only - high side switch) |
| PFCI | AIN | 12 | | PFC current sensing |
| PFCREF | AIN | 21 | | Itrip PFC reference input |
| PFCITRIP | AIN | 22 | | Itrip PFC input |
| VAC1 | AIN | 20 | | VAC sense input line 1 |
| VAC2 | AIN | 19 | | VAC sense input line 2 |
| Interface | | | | |
| DIR | I | 52 | | Direction input |
| DUTYFREQ | I | 55 | | Duty/Frequency input |
| VSP | AIN | 9 | | Analog speed reference input |
| PGOUT | O | 42 | | Pulse output |
| PAR0 | I | 3 | | Parameter page select 0 |
| PAR1 | I | 4 | | Parameter page select 1 |

**Table 2 Pin list Motion Control Engine (continued)**

| Signal | Type | LQFP-64 | LQFP-48 | Description |
|---|---|---|---|---|
| PAR2 | I | 5 | | Parameter page select 2 |
| PAR3 | I | 6 | | Parameter page select 3 |
| NTC | AIN | 13 | | External thermistor input |
| LED | O | 41 | | Status LED |
| Communication | | | | |
| RX0 | I | 57 | | Serial port 0, device programming, receive input |
| TX0 | O | 58 | | Serial port 0, device programming, transmit output |
| RX1 | I | 63 | | Serial port 1, user communication, receive input |
| TX1 | O | 64 | | Serial port 1, user communication, transmit output |
| Scripting pins | | | | |
| AIN0 | AIN | 9 | | Analog input 0 |
| AIN1 | AIN | 10 | | Analog input 1 |
| AIN2 | AIN | 11 | | Analog input 2 |
| AIN4 | AIN | 13 | | Analog input 4 |
| AIN7 | AIN | 16 | | Analog input 7 |
| AIN8 | AIN | 17 | | Analog input 8 |
| GPIO2 | IO | 3 | | Digital input/output 2 |
| GPIO3 | IO | 4 | | Digital input/output 3 |
| GPIO4 | IO | 5 | | Digital input/output 4 |
| GPIO5 | IO | 6 | | Digital input/output 5 |
| GPIO6 | IO | 52 | | Digital input/output 6 |
| GPIO7 | IO | 7 | | Digital input/output 7 |
| GPIO8 | IO | 8 | | Digital input/output 8 |
| GPIO9 | IO | 26 | | Digital input/output 9 |
| GPIO10 | IO | 27 | | Digital input/output 10 |
| GPIO11 | IO | 28 | | Digital input/output 11 |
| GPIO12 | IO | 37 | | Digital input/output 12 |
| GPIO13 | IO | 38 | | Digital input/output 13 |
| GPIO14 | IO | 39 | | Digital input/output 14 |
| GPIO15 | IO | 40 | | Digital input/output 15 |
| GPIO18 | IO | 45 | | Digital input/output 18 |
| GPIO19 | IO | 46 | | Digital input/output 19 |
| GPIO20 | IO | 47 | | Digital input/output 20 |
| GPIO21 | IO | 48 | | Digital input/output 21 |
| GPIO22 | IO | 51 | | Digital input/output 22 |
| GPIO23 | IO | 53 | | Digital input/output 23 |

**Table 2 Pin list Motion Control Engine (continued)**

| Signal | Type | LQFP-64 | LQFP-48 | Description |
|---|---|---|---|---|
| GPIO24 | IO | 54 | | Digital input/output 24 |
| GPIO25 | IO | 56 | | Digital input/output 25 |
| GPIO26 | IO | 59 | | Digital input/output 26 |
| GPIO27 | IO | 60 | | Digital input/output 27 |
| GPIO28 | IO | 61 | | Digital input/output 28 |
| GPIO29 | IO | 62 | | Digital input/output 29 |

## 2.4 Pin Configuration Drawing IMC102T

The following drawings give the position of the functional pins for the available packages.

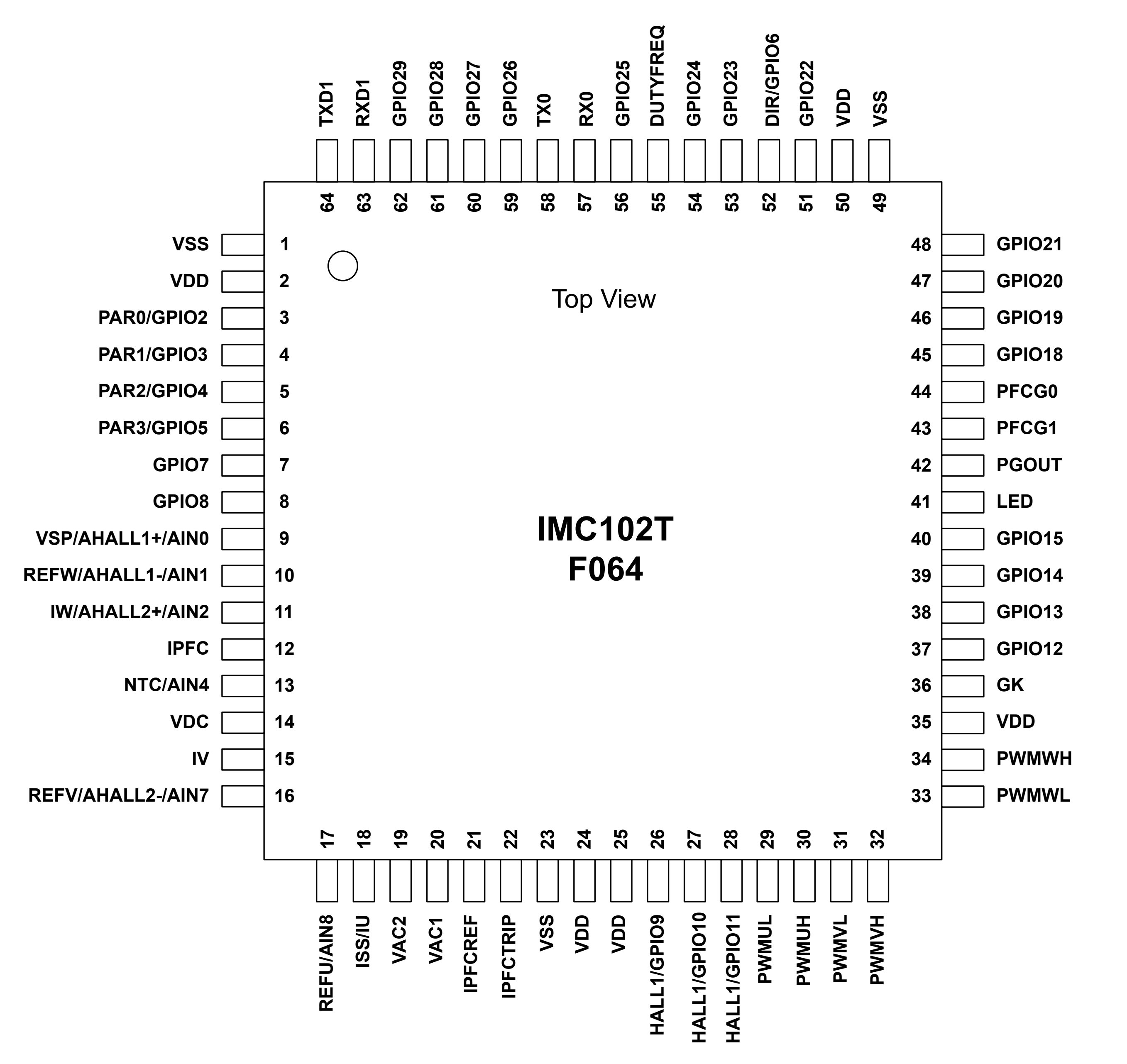


**Figure 5** **IMC102T-F064**

Pins that do not have any signal assigned are reserved for future use. These pins should be left unconnected and neither be connected to ground nor to the positive supply.

# 3 Functional description

iMOTION™ IMC100 is a series of highly integrated ICs for the control of a Permanent Magnet Synchronous Motor (PMSM). IMC101 devices provide control of a single motor while the IMC102 devices control the motor and additionally a boost or totem pole power factor correction (PFC).

The IMC100 series is based on Infineon's Motion Control Engine (MCE) and integrate all hardware and software functions required to implement a closed loop sensorless or optionally sensor based control algorithm for permanent magnet motors. IMC100 devices do not require any software programming and can be configured for a wide range of motor control inverters.

The IMC100 series takes advantage of a new hardware platform that is based on a comprehensive set of innovative analog and motor control peripherals. The high level of integration both in terms of hardware modules and software algorithms results in a minimum number of external components required for the implementation of the inverter control.

Infineon's patented and field proven Motion Control Engine (MCE) implements field oriented control (FOC) using single or leg shunt current feedback and uses space vector pulse width modulation (PWM) with sinusoidal signals to achieve highest energy efficiency. In addition to the motor control algorithm it also integrates multiple configurable protection features like over- and under-voltage, over current, rotor lock etc. to protect both the power stage as well as the motor during application tuning or in case of malfunction.

The second generation of the MCE further improves the performance of the sensorless control algorithm and adds functionality like optional sensor support for applications that require accurate rotor positioning, two types of ready-to-use PFC algorithms as well as more and flexible and faster host interface options.

The IMC100 series is offered in several device and package variants for applications from single motor control to motor control plus PFC. All devices can be used in applications requiring functional safety according to IEC 60335 ('Class B').

There are multiple versions of the MCE software offered by Infineon and made available for download from the Infineon web site.

By using a special secure boot loader algorithm in combination with type specific chip IDs it is assured that these MCE software versions can only be installed onto the matching hardware derivatives, i.e. IMC100 variants for which the software has been tested and released for. Infineon as well as third parties provides tools to program these software images. For details please refer to the iMOTION™ programming manual.

The MCE integrates a script engine providing additional flexibility. The script engine can make use of analog and digital IOs for reading sensors or driving signals. The respective IOs are given in the pin lists referencing the name in the script to the physical pin of the package.

This data sheet provides all electrical, mechanical, thermal and quality parameters. A detailed description of the features, functionality and configuration of the Motion Control Engine (MCE) including scripting can be found in the respective reference manual of the MCE.

The application schematics in the following chapters show some examples of different use cases for the IMC100 devices. The combination of the different configuration options like leg vs. single shunt, sensorless or sensored operation, boost or totem pole PFC etc. is not limited to the examples shown here but can be chosen according to the individual application requirements.

## 3.1 Application schematic motor control single shunt

*Figure 6* gives the schematic diagram for a motor control system using the IMC101 in sensorless operation and single shunt mode. As an option analog hall elements can be used to improve low speed performance.

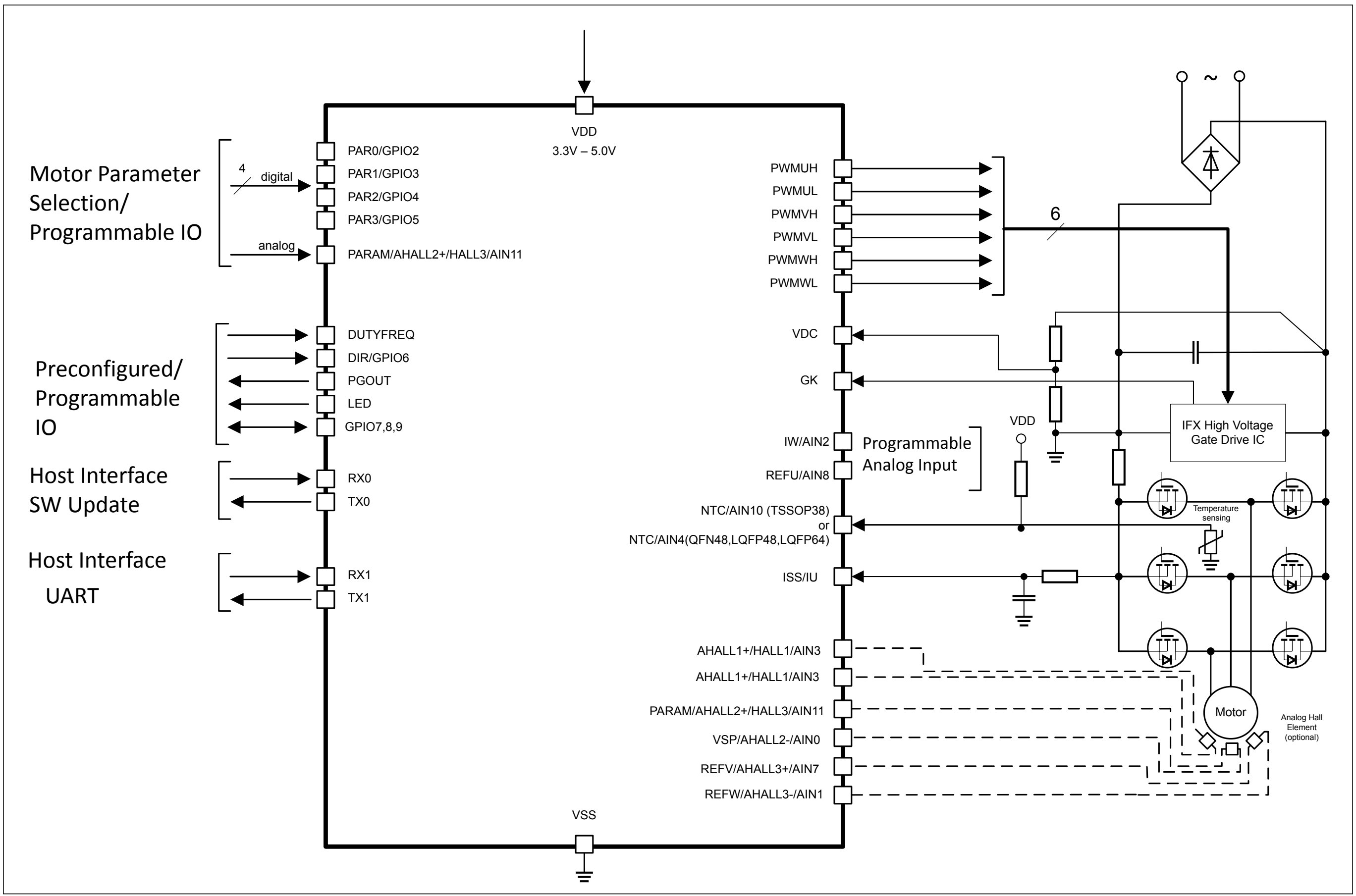


**Figure 6** IMC101 in single shunt configuration

## 3.2 Application schematic motor control leg shunt

*Figure 7* gives the schematic diagram for a motor control system using the IMC101 in sensorless operation and leg shunt mode. An NTC can be used for temperature sensing at the power stage.

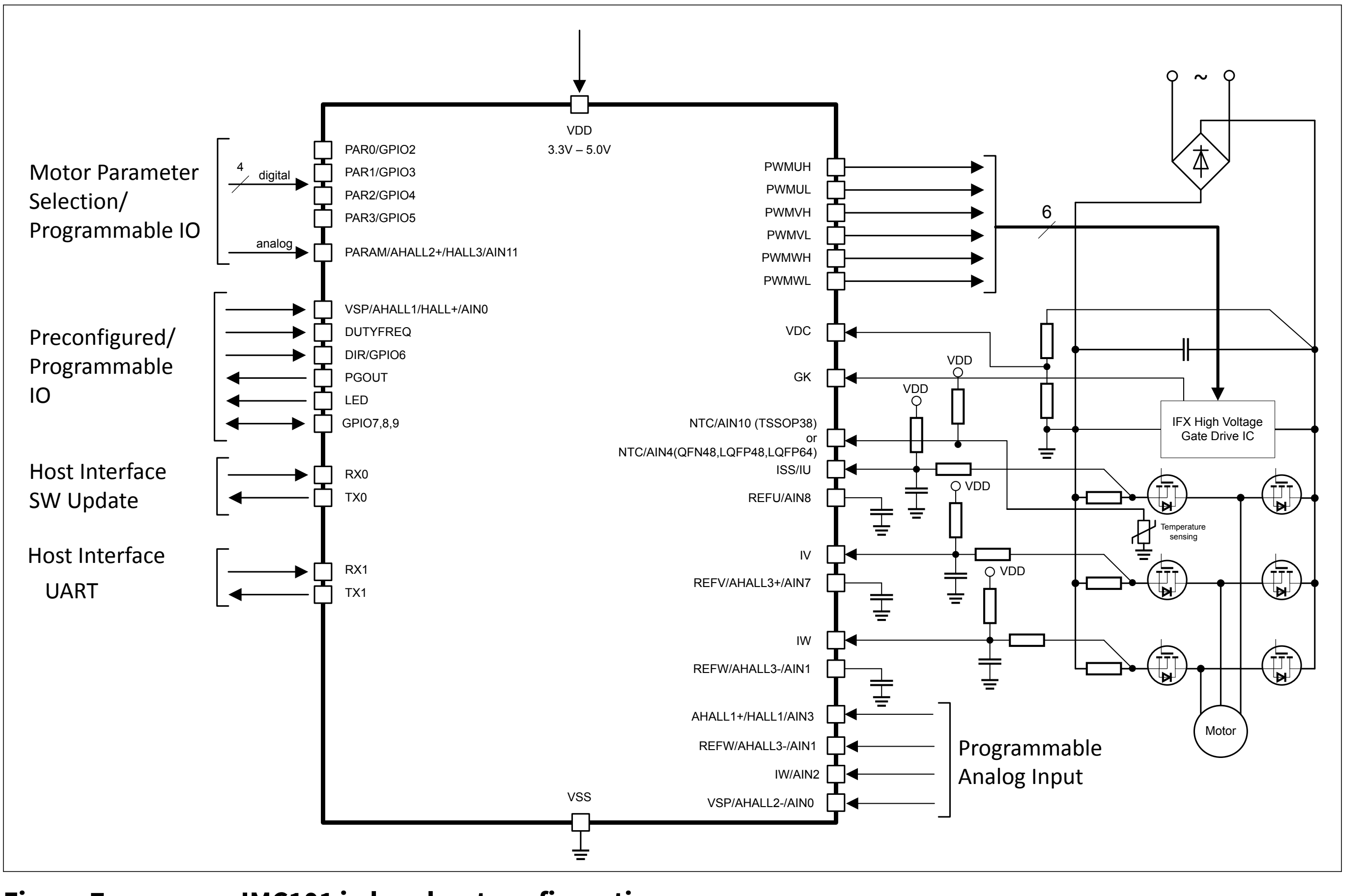


**Figure 7** IMC101 in leg shunt configuration

## 3.3 Application schematic motor control plus boost PFC

*Figure 8* gives the schematic diagram for a motor control system with boost PFC using the IMC102 in sensorless operation and single shunt mode. An NTC can be used for temperature sensing at the power stage.

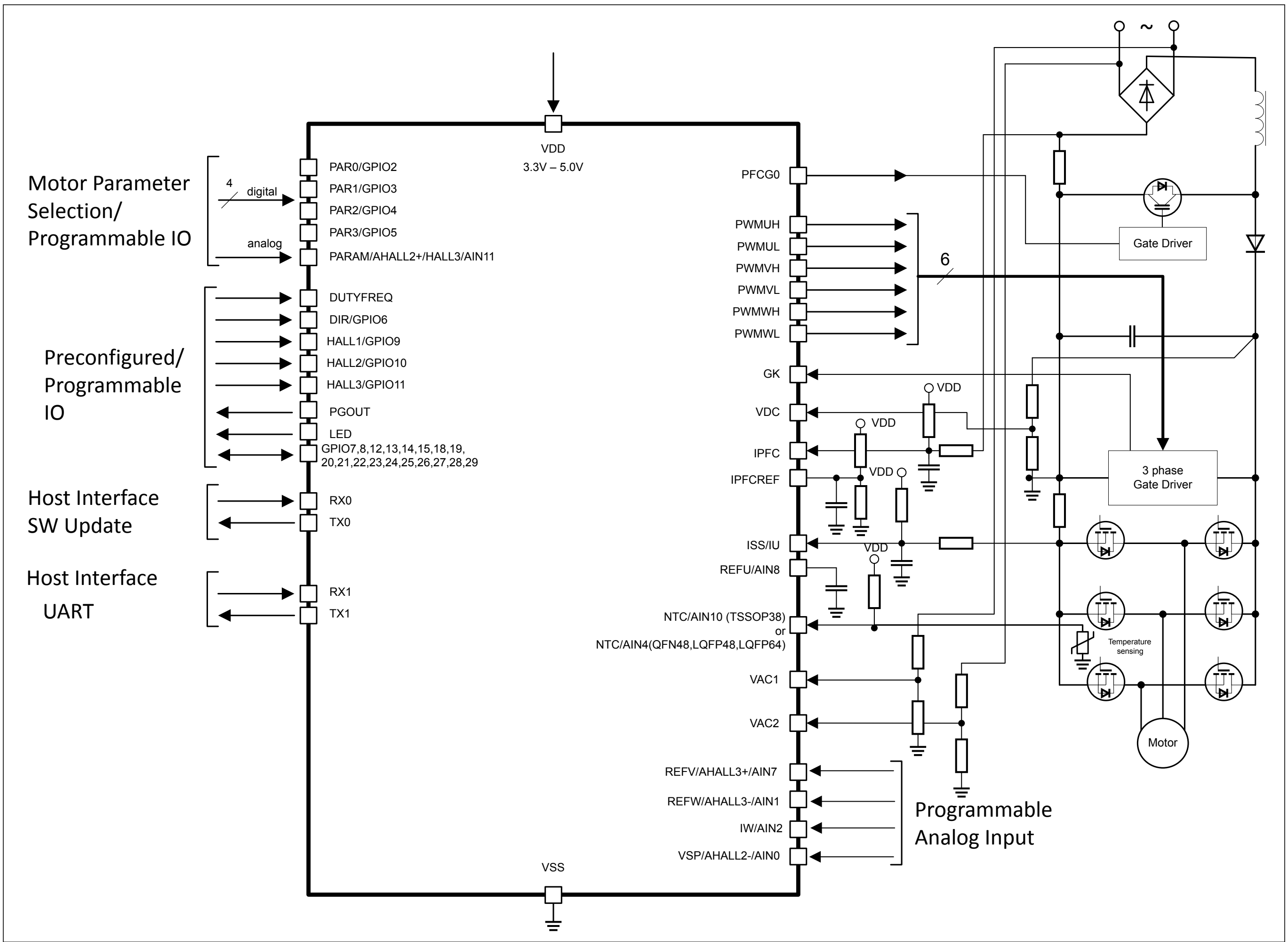


**Figure 8** IMC102 in single shunt configuration with boost PFC control

## 3.4 Application schematic motor control plus totem pole PFC

*Figure 9* gives the schematic diagram for a motor control system with totem pole PFC using the IMC102 in sensorless operation and single shunt mode.

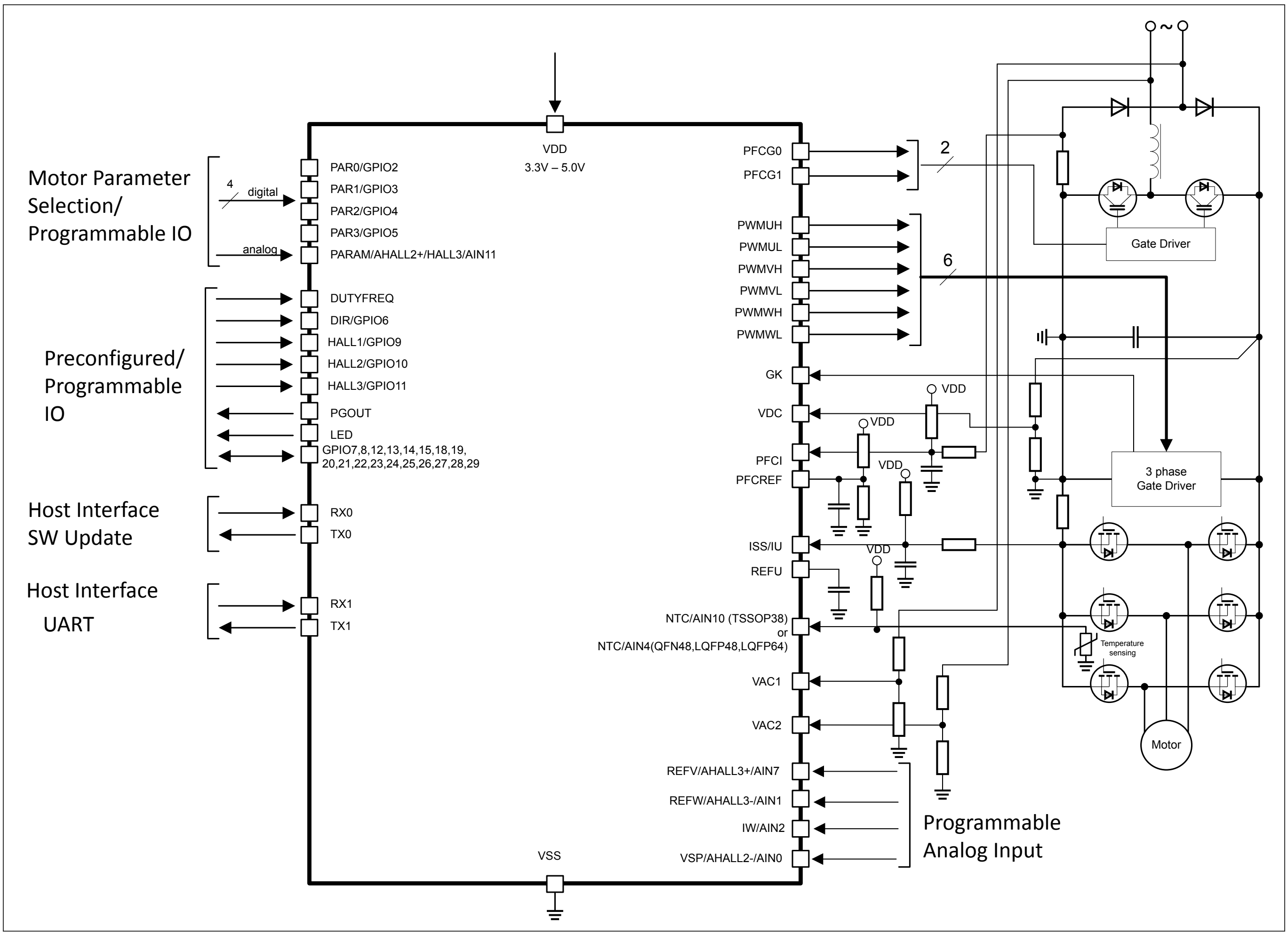


**Figure 9** **IMC102 in single shunt configuration with totem pole PFC**

# 4 Electrical characteristics and parameters

## 4.1 General Parameters

### 4.1.1 Parameter Interpretation

The parameters listed in this section represent partly the characteristics of the IMC100 and partly its requirements on the system. To aid interpreting the parameters easily when evaluating them for a design, they are indicated by the abbreviations in the “Symbol” column:

- **CC**
  Such parameters indicate **C**ontroller **C**haracteristics, which are distinctive feature of the IMC100 and must be regarded for a system design.
- **SR**
  Such parameters indicate **S**ystem **R**equirements, which must be provided by the application system in which the IMC100 is designed in.

### 4.1.2 Absolute Maximum Ratings

Stresses above the values listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Table 3 Absolute Maximum Rating Parameters**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Ambient temperature | $T_A$ SR | -40 | – | 105 | °C | – |
| Junction temperature | $T_J$ SR | -40 | – | 115 | °C | – |
| Storage temperature | $T_{ST}$ SR | -55 | – | 125 | °C | – |
| Voltage on power supply pin with respect to $V_{SSP}$ | $V_{DDP}$ *SR* | -0.3 | – | 6 | V | – |
| Voltage on digital pins with respect to $V_{SSP}$ | $V_{IN}$ SR | -0.3 | – | $V_{DDP}$ + 0.3 or max. 6 | V | whichever is lower |
| Voltage on analog input pins with respect to $V_{SSP}$ | $V_{AIN}$ $V_{AREF}$ SR | -0.5 | – | $V_{DDP}$ + 0.5 or max. 6 | V | whichever is lower |
| Input current on any pin during overload condition | $I_{IN}$ *SR* | -10 | – | 10 | mA | – |
| Absolute maximum sum of all input currents during overload condition | $\Sigma I_{IN}$ *SR* | -50 | – | +50 | mA | – |

### 4.1.3 Pin Reliability in Overload

When receiving signals from higher voltage devices, low-voltage devices experience overload currents and voltages that go beyond their own IO power supplies specification.

***Table 4*** defines overload conditions that will not cause any negative reliability impact if all the following conditions are met:

- full operation life-time is not exceeded
- ***Operating Conditions*** are met for
  - pad supply levels ($V_{DDP}$)
  - temperature

If a pin current is outside of the ***Operating Conditions*** but within the overload conditions, then the parameters of this pin as stated in the Operating Conditions can no longer be guaranteed. Operation is still possible in most cases but with relaxed parameters.

*Note: An overload condition on one or more pins does not require a reset.*

*Note: A series resistor at the pin to limit the current to the maximum permitted overload current is sufficient to handle failure situations like short to battery.*

**Table 4 Overload Parameters**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input current on analog port pins during overload condition | $I_{OVA}$ SR | -3 | – | 3 | mA | |
| Input current on any port pin during overload condition | $I_{OV}$ SR | -5 | – | 5 | mA | |
| Absolute sum of all input circuit currents during overload condition | $I_{OVS}$ SR | – | – | 25 | mA | |

*Figure 10* shows the path of the input currents during overload via the ESD protection structures. The diodes against $V_{DDP}$ and ground are a simplified representation of these ESD protection structures.

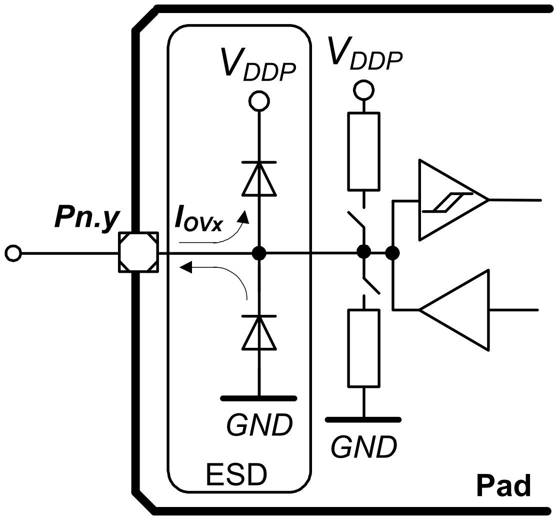


**Figure 10** **Input Overload Current via ESD structures**

*Table 5* and *Table 6* list input voltages that can be reached under overload conditions. Note that the absolute maximum input voltages as defined in the *Absolute Maximum Ratings* must not be exceeded during overload.

**Table 5** **PN-Junction Characterisitics for positive Overload**

| Pad Type | $I_{OV}$ = 5 mA |
|---|---|
| Standard, High-current, AN/DIG_IN | $V_{IN} = V_{DDP}$ +(0.3 ... 0.5) V<br>$V_{AIN} = V_{DDP}$ + 0.5 V<br>$V_{AREF} = V_{DDP}$ + 0.5 V |

**Table 6** **PN-Junction Characterisitics for negative Overload**

| Pad Type | $I_{OV}$ = 5 mA |
|---|---|
| Standard, High-current, AN/DIG_IN | $V_{IN} = V_{SS}$ - (0.3 ... 0.5) V<br>$V_{AIN} = V_{SS}$ - 0.5 V<br>$V_{AREF} = V_{SS}$ - 0.5 V |

### 4.1.4 Operating Conditions

The following operating conditions must not be exceeded in order to ensure correct operation and reliability of the IMC100. All parameters specified in the following tables refer to these operating conditions, unless noted otherwise.

**Table 7 Operating Conditions Parameters**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Ambient Temperature | $T_A$ SR | -40 | – | 105 | °C | |
| Junction temperature | $T_J$ SR | -40 | – | 115 | °C | |
| Digital supply voltage[1] | $V_{DDP}$ SR | 3.0 | 3.3 | 5.5 | V | |
| Short circuit current of digital outputs[2] | $I_{SC}$ SR | -5 | – | 5 | mA | |
| Absolute sum of short circuit currents of the device[3] | $\Sigma I_{SC\_D}$ SR | – | – | 25 | mA | |

1 See also the Supply Monitoring thresholds ***Power-Up and Supply Threshold Characteristics***.
2 Applicable for digital outputs.
3 See also section "Pin Reliability in Overload" for overload current definitions.

## 4.2 DC Parameters

### 4.2.1 Input/Output Characteristics

The table below provides the characteristics of the input/output pins of the IMC100.

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

*Note: Unless otherwise stated, input DC and AC characteristics, including peripheral timings, assume that the input pads operate with the standard hysteresis.*

**Table 8 Input/Output Characteristics (Operating Conditions apply)**

| Parameter | Symbol | | Limit Values | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | | Min. | Max. | | |
| Input low voltage on port pins (Standard Hysteresis) | $V_{ILPS}$ | SR | – | 0.19 × $V_{DDP}$ | V | CMOS Mode |
| Input high voltage on port pins (Standard Hysteresis) | $V_{IHPS}$ | SR | 0.7 × $V_{DDP}$ | – | V | CMOS Mode |
| Input low voltage on port pins (Large Hysteresis, scripting pins only) | $V_{ILPL}$ | SR | – | 0.08 × $V_{DDP}$ | V | CMOS Mode |
| Input high voltage on port pins (Large Hysteresis, scripting pins only) | $V_{IHPL}$ | SR | 0.85 × $V_{DDP}$ | – | V | CMOS Mode |
| Output low voltage on port pins | $V_{OLP}$ | CC | – | 1.0 | V | $I_{OL}$ = 11 mA (5 V)<br>$I_{OL}$ = 7 mA (3.3 V) |
| | | | – | 0.4 | V | $I_{OL}$ = 5 mA (5 V)<br>$I_{OL}$ = 3.5 mA (3.3 V) |
| Output low voltage on PWM outputs | $V_{OLP1}$ | CC | – | 1.0 | V | $I_{OL}$ = 50 mA (5 V)<br>$I_{OL}$ = 25 mA (3.3 V) |
| | | | – | 0.32 | V | $I_{OL}$ = 10 mA (5 V) |
| | | | – | 0.4 | V | $I_{OL}$ = 5 mA (3.3 V) |
| Output high voltage on port pins | $V_{OHP}$ | CC | $V_{DDP}$ - 1.0 | – | V | $I_{OH}$ = -10 mA (5 V)<br>$I_{OH}$ = -7 mA (3.3 V) |
| | | | $V_{DDP}$ - 0.4 | – | V | $I_{OH}$ = -4.5 mA (5 V)<br>$I_{OH}$ = -2.5 mA (3.3 V) |
| Output high voltage on PWM outputs | $V_{OHP1}$ | CC | $V_{DDP}$ - 0.32 | – | V | $I_{OH}$ = -6 mA (5 V) |
| | | | $V_{DDP}$ - 1.0 | – | V | $I_{OH}$ = -8 mA (3.3 V) |
| | | | $V_{DDP}$ - 0.4 | – | V | $I_{OH}$ = -4 mA (3.3 V) |

**Table 8 Input/Output Characteristics (Operating Conditions apply) (continued)**

| Parameter | Symbol | | Limit Values | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | | Min. | Max. | | |
| Rise/fall time on PWM outputs[4] | $t_{HCPR}$, $t_{HCPF}$ | CC | – | 9 | ns | 50 pF @ 5 V |
| | | | – | 12 | ns | 50 pF @ 3.3 V |
| Rise/fall time on standard pad | $t_R$, $t_F$ | CC | – | 12 | ns | 50 pF @ 5 V |
| | | | – | 15 | ns | 50 pF @ 3.3 V. |
| Pin capacitance (digital inputs/outputs) | $C_{IO}$ | CC | – | 10 | pF | |
| Pull-up/-down resistor on port pins (if enabled in software) | $R_{PUP}$ | CC | 20 | 50 | kΩ | $V_{IN} = V_{SSP}$ |
| Input leakage current [5] | $I_{OZP}$ | CC | -1 | 1 | µA | $0 < V_{IN} < V_{DDP}$, $T_A$ 105°C |
| Maximum current per pin standard pin | $I_{MP}$ | SR | -10 | 11 | mA | – |
| Maximum current per PWM outputs pins | $I_{MP1A}$ | SR | -10 | 50 | mA | – |
| Maximum current into $V_{DDP}$ / out of $V_{SS}$ | $I_{MVDD}$ / $I_{MVSS}$ | SR | – | 260 | mA | |

4 Rise/Fall time parameters are taken with 10% - 90% of supply.
5 An additional error current ($I_{INJ}$) will flow if an overload current flows through an adjacent pin.

### 4.2.2 Analog to Digital Converter (ADC)

The following table shows the Analog to Digital Converter (ADC) characteristics. This specification applies to all analog input including the analog Hall sensor interface input (AHALLx+/AHALLx-, where x=1,2,3) as given in the pin configuration list.

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

**Table 9 ADC Characteristics (Operating Conditions apply)[6]**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage range | $V_{DD}$ SR | 3.0 | – | 5.5 | V | |
| Analog input voltage range | $V_{AIN}$ SR | $V_{SSP}$- 0.05 | – | $V_{DDP}$+ 0.05 | V | |
| Conversion time | $t_{C12}$ CC | – | 1.0 | 1.6 | µs | |
| Total capacitance of an analog input | $C_{AINT}$ CC | – | – | 10 | pF | |
| Total capacitance of the reference input | $C_{AREFT}$ CC | – | – | 10 | pF | |
| Sample time | $t_{sample}$ CC | – | 200 | – | ns | |
| RMS noise | $EN_{RMS}$ CC | – | 1.5 | – | LSB12 | |
| DNL error | $EA_{DNL}$ CC | – | ±2.0 | – | LSB12 | |
| INL error | $EA_{INL}$ CC | – | ±4.0 | – | LSB12 | |
| Gain error | $EA_{GAIN}$ CC | – | ±0.5 | – | % | $V_{DD}$ = 3.3V |
| Offset error | $EA_{OFF}$ CC | – | ±8.0 | – | mV | |

6 All parameters are defined for the full supply range if not stated otherwise.

### 4.2.3 Power Supply Current

The total power supply current defined below consists of a leakage and a switching component.

Application relevant values are typically lower than those given in the following tables, and depend on the customer's system operating conditions (e.g. thermal connection or used application configurations).

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

**Table 10 Power Supply parameter table; $V_{DDP}$ = 5V**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Active mode current motor control only | $I_{DDPWM}$ CC | – | 10 | 20 | mA | |
| Active mode current motor control plus PFC | $I_{DDPFC}$ CC | – | 14 | 20 | mA | IMC102 only |
| Deep Sleep mode current[7] | $I_{DDPDS}$ CC | – | 0.27 | – | mA | |
| Wake-up time from Sleep to Active mode | $t_{SSA}$ CC | – | 6 | – | cycles | |
| Wake-up time from Deep Sleep to Active mode | $t_{DSA}$ CC | – | 290 | – | µsec | |

### 4.2.4 Flash Memory Parameters

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

**Table 11 Flash Memory Parameters**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Data Retention Time | $t_{RET}$ CC | 10 | | | years | Max. 100 erase / program cycles |
| Erase Cycles[8] | $N_{ECYC}$ CC | | | $5*10^4$ | cycles | Sum of page and sector erase cycles |
| Total Erase Cycles | $N_{TECYC}$ CC | | | $2*10^6$ | cycles | |

7 CPU in sleep, peripherals clock disabled, Flash is powered down and code executed from RAM after wake-up.

8 Sum of page erase and sector erase cycles a page sees.

## 4.3 AC Parameters

### 4.3.1 Testing Waveforms

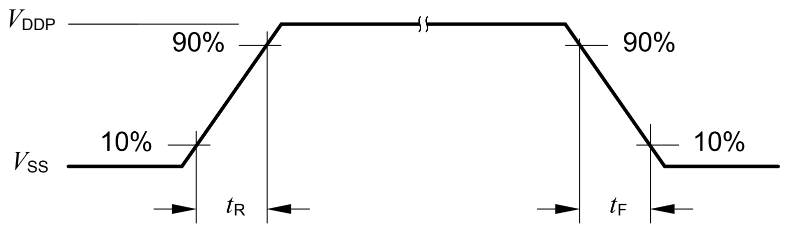


**Figure 11** **Rise/Fall Time Parameters**

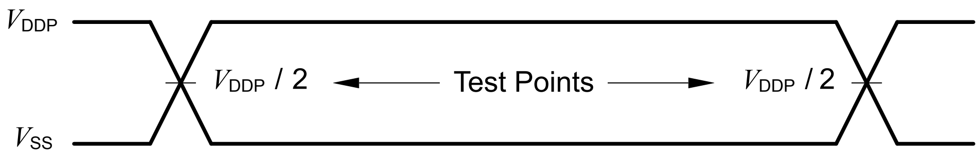


**Figure 12** **Testing Waveform, Output Delay**

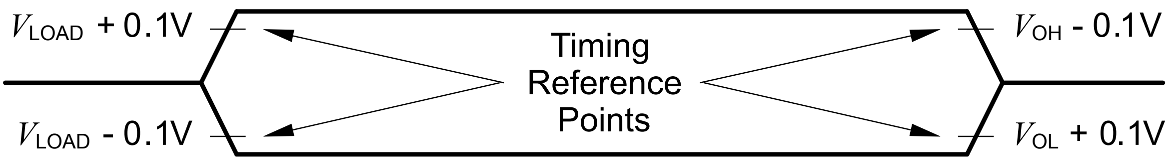


**Figure 13** **Testing Waveform, Output High Impedance**

### 4.3.2 Power-Up and Supply Threshold Characteristics

This chapter provides the characteristics of the supply threshold in IMC100.

The guard band between the lowest valid operating voltage and the brownout reset threshold provides a margin for noise immunity and hysteresis. The electrical parameters may be violated while $V_{DDP}$ is outside its operating range.

The brownout detection triggers a reset within the defined range. The prewarning detection can be used to trigger an early warning and issue corrective and/or fail-safe actions in case of a critical supply voltage drop.

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

*Note: Operating Conditions apply.*

**Table 12 Power-Up and Supply Threshold Parameters**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| $V_{DDP}$ ramp-up time | $t_{RAMPUP}$ SR | $V_{DDP}$/ $S_{VDDPrise}$ | – | $10^7$ | µs | |
| $V_{DDP}$ slew rate | $S_{VDDPOP}$ SR | 0 | – | 0.1 | V/µs | Slope during normal operation |
| | $S_{VDDP10}$ SR | 0 | – | 10 | V/µs | Slope during fast transient within +/-10% of $V_{DDP}$ |
| | $S_{VDDPrise}$ SR | 0 | – | 10 | V/µs | Slope during power-on or restart after brownout event |
| | $S_{VDDPfall}$[9] SR | 0 | – | 0.25 | V/µs | Slope during supply falling out of the +/-10% limits[10] |
| $V_{DDP}$ prewarning voltage | $V_{DDPPW}$ CC | 2.1 | 2.25 | 2.4 | V | ANAVDEL.VDEL_SELECT = $00_B$ |
| | | 2.85 | 3 | 3.15 | V | ANAVDEL.VDEL_SELECT = $01_B$ |
| | | 4.2 | 4.4 | 4.6 | V | ANAVDEL.VDEL_SELECT = $10_B$ |
| $V_{DDP}$ brownout reset voltage | $V_{DDPBO}$ CC | 1.55 | 1.62 | 1.75 | V | calibrated, before user code starts running |
| $V_{DDP}$ voltage to ensure defined pad states | $V_{DDPPA}$ CC | – | 1.0 | – | V | |

9 A capacitor of at least 100 nF has to be added between VDDP and VSSP to fulfill the requirement as stated for this parameter.

10 Valid for a 100 nF buffer capacitor connected to supply pin where current from capacitor is forwarded only to the chip. A larger capacitor value has to be chosen if the power source sink a current.

**Table 12 Power-Up and Supply Threshold Parameters (continued)**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Start-up time from power-on reset | $t_{SSW}$ CC | – | 260 | – | µs | Time to the first user code instruction[11)] |
| Start-up time to PWM on | $t_{PWMON}$ CC | 5.2 | - | 360 | ms | Time to PWM enabled |

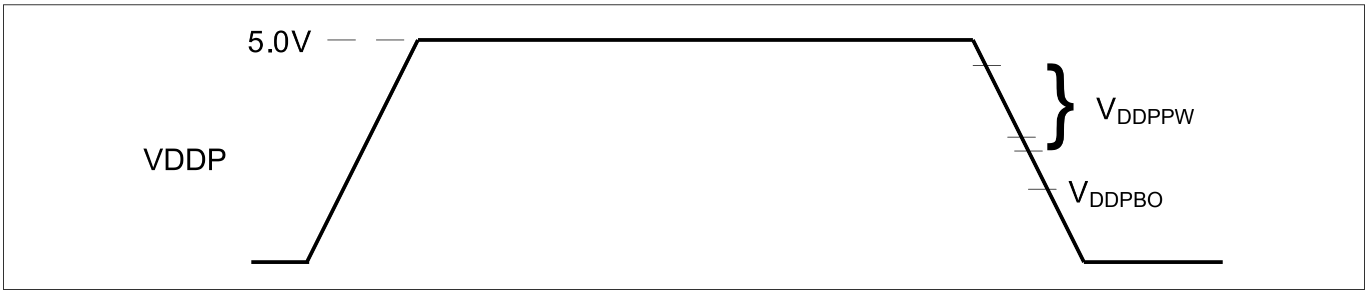


**Figure 14 Supply Threshold Parameters**

11 This values does not include the ramp-up time. During startup firmware execution, MCLK is running at 48 MHz and the clocks to peripheral as specified in register CGATSTAT0 are gated.

### 4.3.3 On-Chip Oscillator Characteristics

*Table 13* provides the characteristics of the 96 MHz digital controlled oscillator DCO1. The DCO1 is used as the time base during normal operation.

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

**Table 13 96 MHz DCO1 Characteristics**

| Parameter | Symbol | Limit Values | | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Nominal frequency | $f_{NOM}$ CC | 95.7 | 96 | 96.3 | MHz | under nominal conditions[12) after trimming |
| Short term frequency deviation (over $V_{DDC}$) | $\Delta f_{ST}$ CC | -1 | – | 1 | % | with respect to $f_{NOM}$ (typ), at 25°C |
| Accuracy | $\Delta f_{LT}$ CC | -1.7 | – | 3.4 | % | with respect to $f_{NOM}$(typ), over temperature (0°C to 85°C) |
| | | -3.9 | – | 4.0 | % | with respect to $f_{NOM}$(typ), over temperature (-40°C to 105°C) |

*Table 14* provides the characteristics of the 32 kHz digital controlled oscillator DCO2. The DCO2 is only used internally as a secondary clock source for the internal watchdog and as a fallback in case of failure of DCO1.

**Table 14 32 kHz DCO2 Characteristics**

| Parameter | Symbol | Limit Values | | | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Nominal frequency | $f_{NOM}$ CC | 32.5 | 32.75 | 33 | kHz | under nominal conditions[13) after trimming |
| Short term frequency deviation (over $V_{DDC}$) | $\Delta f_{ST}$ CC | -1 | – | 1 | % | with respect to $f_{NOM}$(typ), at 25°C |
| Accuracy | $\Delta f_{LT}$ CC | -1.7 | – | 3.4 | % | with respect to $f_{NOM}$(typ), over temperature (0°C to 85°C) |
| | | -3.9 | – | 4.0 | % | with respect to $f_{NOM}$(typ), over temperature (-40°C to 105°C) |

12 The deviation is relative to the factory trimmed frequency at nominal $V_{DDC}$ and $T_A$ = + 25°C.
13 The deviation is relative to the factory trimmed frequency at nominal $V_{DDC}$ and $T_A$ = + 25°C.

## 4.4 Motor Control Parameters

The following parameters are defined in the iMOTION™ motion control engine (MCE) software.

### 4.4.1 PWM Characteristics

**Table 15 Electrical characteristics**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Motor PWM Frequency | $f_{PWM}$ | 5 | 16 | 20 | kHz | |

### 4.4.2 Current Sensing

**Table 16 Motor Current Sensing**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input range | $I_{PWM}$ | $V_{SS}$-0.05 | - | $V_{DD}$+0.05 | V | |
| Configurable analog gain | | - | 1/ 3/ 6/ 12 | - | | |
| Itrip input range | $I_{PWMTRIP}$ | $V_{SS}$-0.05 | - | $V_{DD}$+0.05 | V | |
| Itrip offset | | - | ±8 | - | mV | |
| Input capacitance | $C_{REF}$ | - | - | 10 | pF | REFU, REFV, REFW capacitor |

## 4.4.3 Fault Timing

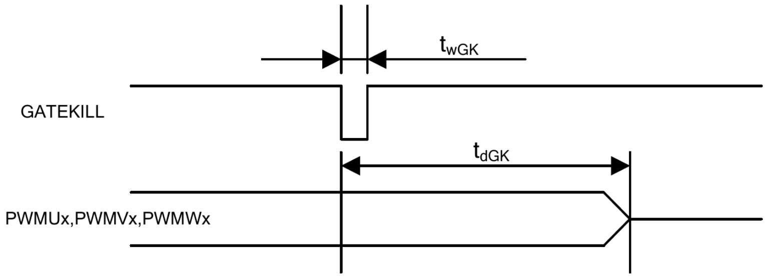


**Figure 15 Fault timing**

**Table 17 Gatekill timing**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| GK pulse width | $t_{wGK}$ | 1 | - | - | µs | |
| GK input to PWM shutoff | $t_{GK}$ | - | 1.3 | - | µs | |
| Motor Fault reset timing | $t_{RESET}$ | - | 1.84 | - | ms | fault reset command via UART to PWM reactivation |
| Itrip to PWM shutoff | $t_{PWMOFF}$ | - | 1.0 | - | µs | single shunt |
| Itrip to PWM shutoff | $t_{PWMOFF}$ | - | 1.0 | - | µs | leg shunt |

## 4.5 Power Factor Correction (PFC) parameters

The parameters specified for the power factor correction only refer to the IMC102 with integrated PFC control algorithms.

### 4.5.1 Boost PFC characteristics

**Table 18 Electrical characteristics**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| PFC frequency | $f_{PFC}$ | - | 20 | 50 | kHz | Motor PWM frequency within specified range |

### 4.5.2 Totem Pole PFC characteristics

**Table 19 Electrical characteristics**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| PFC frequency | $f_{PFC}$ | - | 20 | 50 | kHz | Motor PWM frequency within specified range |

### 4.5.3 PFC Current Sensing

The current sensing specification applies to both PFC algorithms, boost mode and totem pole.

**Table 20 PFC Current Sensing**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input range | $I_{PFC}$ | $V_{SS}$- 0.05 | - | $V_{DD}$+ 0.05 | V | $V_{DD}$= 3.3 or 5.0 V |
| Configurable analog gain | | - | 1/ 3/ 6/ 12 | - | | |
| PFC Itrip input range | $I_{PFCTRIP}$ | $V_{SS}$-0.05 | - | $V_{DD}$+ 0.05 | V | $V_{DD}$= 3.3 or 5.0 V |
| Itrip offset | | - | ± 3 | - | mV | Input voltage difference > 200mV |
| Input capacitance | $C_{REF}$ | - | - | 10 | pF | PFCREF capacitor |

### 4.5.4 PFC Fault Timing

**Table 21 PFC Fault timing**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Itrip to PFC PWM shutoff | $t_{PFCOFF}$ | - | 1.18 | - | µs | |
| PFC fault reset timing | $t_{RESET}$ | - | 1.0 | - | ms | fault reset command via UART to PWM reactivation |

## 4.6 Control Interface Parameters

The following tables specify the interfaces that can be used to control the motor drive in the application.

### 4.6.1 Serial Interface Parameters

The IMC100 series provides the following communication interfaces.

*Note: These parameters are not subject to production test, but verified by design and/or characterization.*

#### 4.6.1.1 UART Interface

The UART interface is configured as given below.

*Note: Operating Conditions apply.*

**Table 22 Electrical characteristics**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| UART baud rate | | 1200 | 57600 | - | Bps | |
| UART mode | | - | 8-N-1 | - | | data-parity-stop bit |
| UART sampling filter period [14] | $T_{UARTFIL}$ | - | 1/16 | - | $T_{BAUD}$ | |

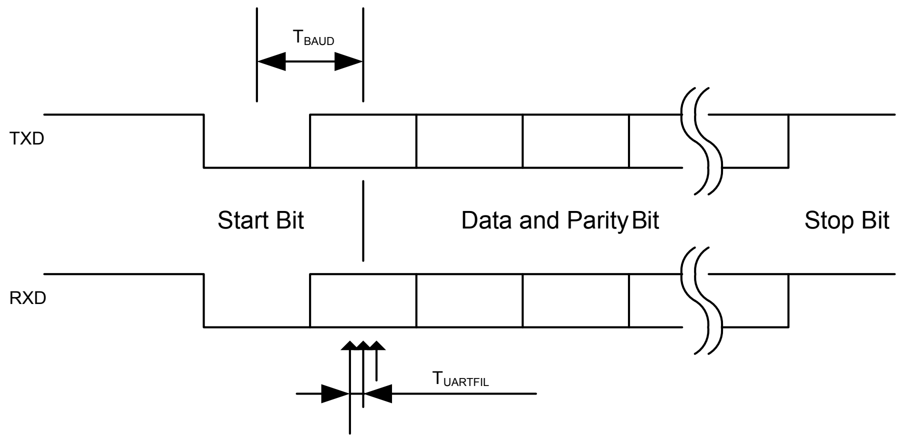


**Figure 16 UART timing**

14 Each bit including start and stop bit is sampled three times at center of a bit at an interval of 1/16 $T_{BAUD}$. If three sampled values do not agree, then UART noise error is generated.

### 4.6.2 Analog Speed Input

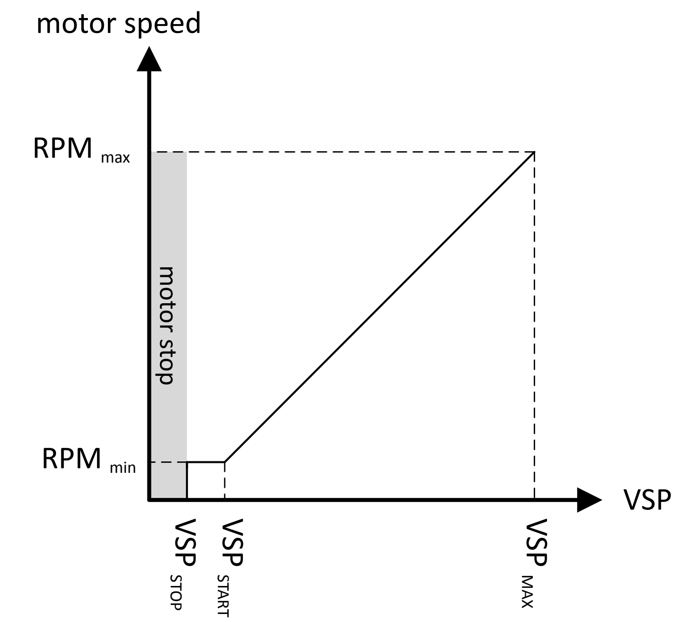


**Figure 17** **VSP analog control mode**

**Table 23** **Analog Speed Control Voltage (VSP)**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Motor start voltage | $VSP_{START}$ | - | 1.2 | - | V | Configured $VSP_{START}$=1.0V |
| Motor stop voltage | $VSP_{STOP}$ | - | 1.0 | - | V | Configured $VSP_{STOP}$=1.0V |
| Motor max voltage | $VSP_{MAX}$ | - | 4.9 | 4.95 | V | $V_{DD}$=5.0V |
| VSP active to PWM start | $t_{START}$ | - | 44 | - | ms | |
| VSP inactive to PWM stop | $t_{STOP}$ | - | 16 | - | ms | |

### 4.6.3 Frequency Input

In frequency input control mode, the motor operations like motor start, motor stop and speed change are controlled by applying a square wave frequency signal on a digital input pin.

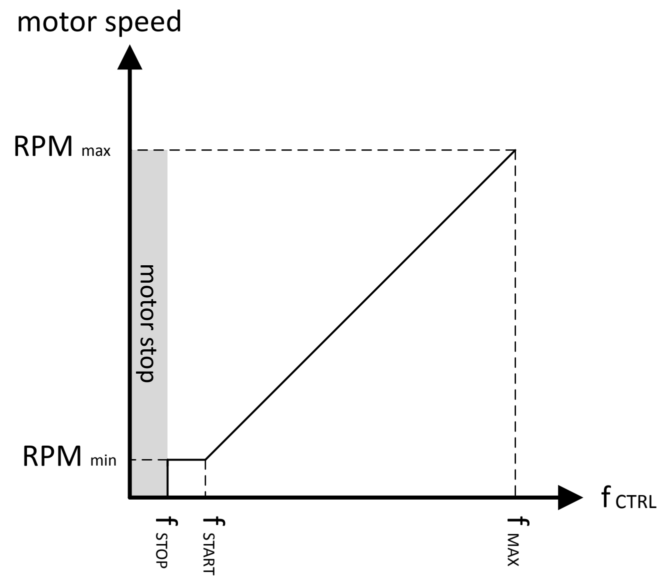


**Figure 18** Frequency input control mode

**Table 24** Frequency Control Mode

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Motor start frequency | $f_{START}$ | - | 100 | 360 | Hz | $f_{START} > f_{STOP}$ |
| Motor stop frequency | $f_{STOP}$ | - | 50 | - | Hz | |
| Motor max speed frequency | $f_{MAX}$ | - | - | 1000 | Hz | |
| Frequency input duty cycle | $T_{DUTY}$ | 10 | - | 90 | % | |

### 4.6.4 Duty Cycle Input

In duty cycle input control mode, the motor operations like motor start, stop and speed change are controlled by varying the duty cycle of a rectangular wave signal on a digital input pin.

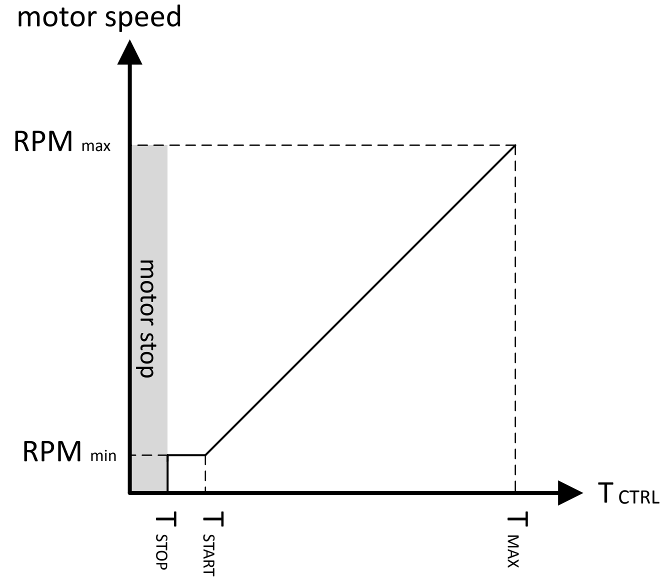


**Figure 19** Duty cycle input control mode

**Table 25** Duty Cycle Control Mode

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input signal frequency | $f_{DUTY}$ | 5 | 1000 | 20000 | Hz | |
| Motor start duty cycle | $T_{START}$ | - | 10 | - | % | $T_{START} > T_{STOP}$ |
| Motor stop duty cycle | $T_{STOP}$ | - | 5 | - | % | |
| Motor max duty cycle | $T_{MAX}$ | - | 95 | - | % | |

### 4.6.5 Over Temperature Input

The over temperature input can be used to continuously monitor an external temperature sensor like an NTC.

**Table 26 Over Temperature Input**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Over Temperature Input Threshold | $V_{OT}$ | 0.1 | 1.0 | 3.0 | V | $V_{DD}$=3.3V, Configurable parameter e.g. via MCEDesigner, default=1.0V |
| Over Temperature to PWM shutdown | $t_{OT}$ | | 1.0 | 2.1 | ms | |

### 4.6.6 Pulse Output

The IMC100 series can generate a square wave pulse output in sync with the motor rotation which can be used to monitor the motor speed. The number of pulses to be generated for a full rotation can be configured.

**Table 27 Pulse Output**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pulses per Rotation | *PPR* | 4 | - | 24 | | |
| Pulse duty cycle | $t_{PPR}$ | - | 50 | - | % | |

### 4.6.7 LED Output

The IMC100 series provides an output that can be connected to an LED to give a visual indication of the status of the motor drive.

**Table 28 LED Output**

| Parameter | Symbol | Values | | | Unit | Note or test condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Fault to LED delay | $t_{LEDFAULT}$ | - | 53 | - | ms | |
| Fault reset to LED delay | $t_{LEDRESET}$ | - | 1.84 | - | ms | |
| LED blinking frequency | $f_{LED}$ | 1 | | 1000 | Hz | |
| LED blinking duty cycle | $t_{LED}$ | 5 | | 95 | % | |

## 4.7 Quality Declaration

*Table 29* shows the characteristics of the quality parameters in the IMC100.

**Table 29 Quality Parameters**

| Parameter | Symbol | Limit Values | | Unit | Notes |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| ESD susceptibility according to Human Body Model (HBM) | $V_{HBM}$ SR | – | 2000 | V | Conforming to EIA/ JESD22-A114-B |
| ESD susceptibility according to Charged Device Model (CDM) pins | $V_{CDM}$ SR | – | 500 | V | Conforming to JESD22-C101-C |
| Moisture sensitivity level | MSL CC | – | 3 | – | JEDEC J-STD-020C |
| Soldering temperature | $T_{SDR}$ SR | – | 260 | °C | Profile according to JEDEC J-STD-020D |

# 5 Device and Package specification

## 5.1 SBSL and Chip-IDs

The table below gives the IDs for the individual devices in the IMC100 family. Depending upon the mode either the SBSL-ID (secure boot loader) or the Chip-ID should be used to identify the device. For details refer to the Reference Manual or the iMOTION™ Programming Manual.

**Table 30 SBSL-IDs and Chip-IDs**

| Product Type | Package | Chip-ID | SBSL-ID |
|---|---|---|---|
| IMC099T-T038 | TSSOP-38 | 0x10990005 | 02af86dbe4df1c3471cd41bfae101928 |
| IMC101T-T038 | TSSOP-38 | 0x11010005 | 02270f1fccdf57c333d31abd78f960b0 |
| IMC101T-Q048 | QFN-48 | 0x11010008 | 0244e4486f613c04e6539585aec5d311 |
| IMC101T-F048 | LQFP-48 | 0x11010006 | tbd |
| IMC101T-F064 | LQFP-64 | 0x1101000B | 02a5cdc6d93bbfba0e3617fd7be5df07 |
| IMC102T-F048 | LQFP-48 | 0x11020006 | tbd |
| IMC102T-F064 | LQFP-64 | 0x1102000B | 0289426daa14293ab31828d8341ad4ef |

## 5.2 Package Outlines

All dimensions in mm.

You can find complete information about Infineon packages, packing and marking in our Infineon Internet Page "Packages": ***www.infineon.com/packages***

### 5.2.1 Package Outline PG-TSSOP-38-9

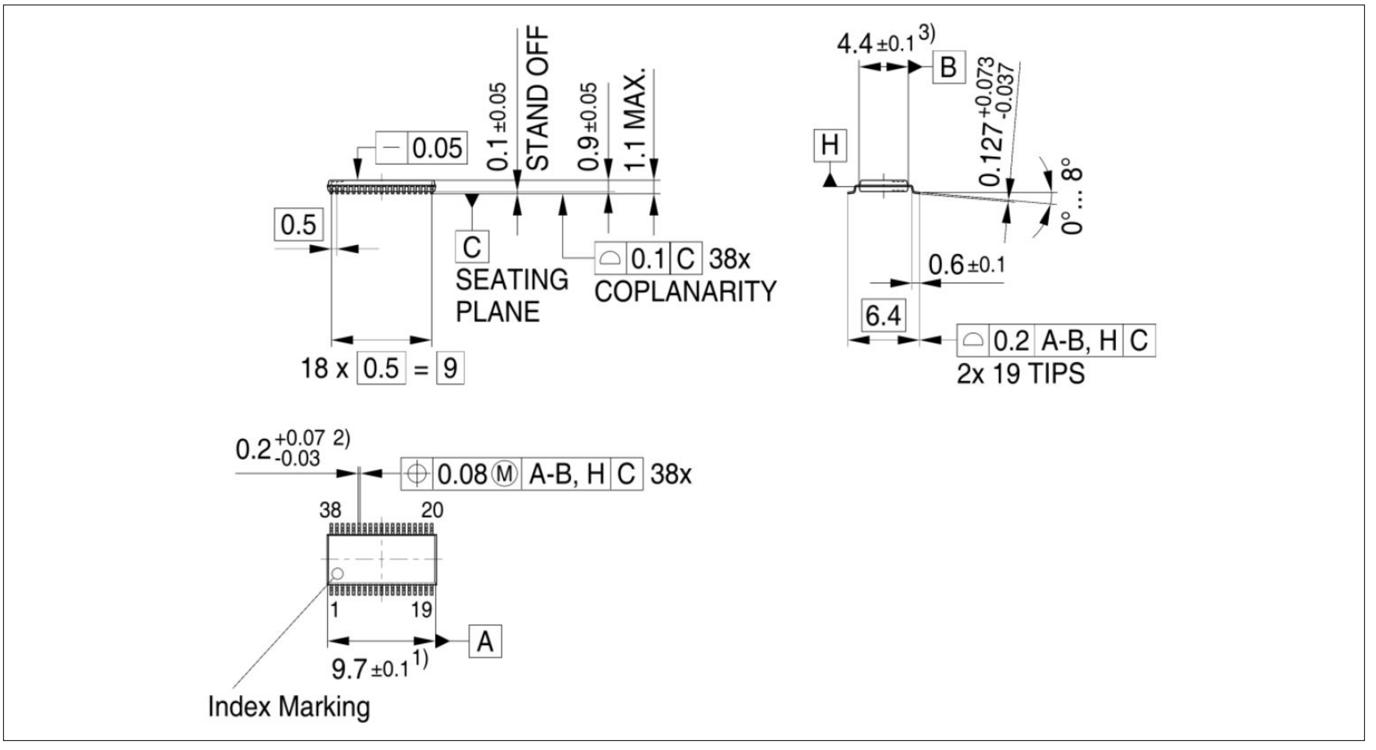


**Figure 20** **PG-TSSOP-38-9**

### 5.2.2 Package Outline PG-VQFN-48-73

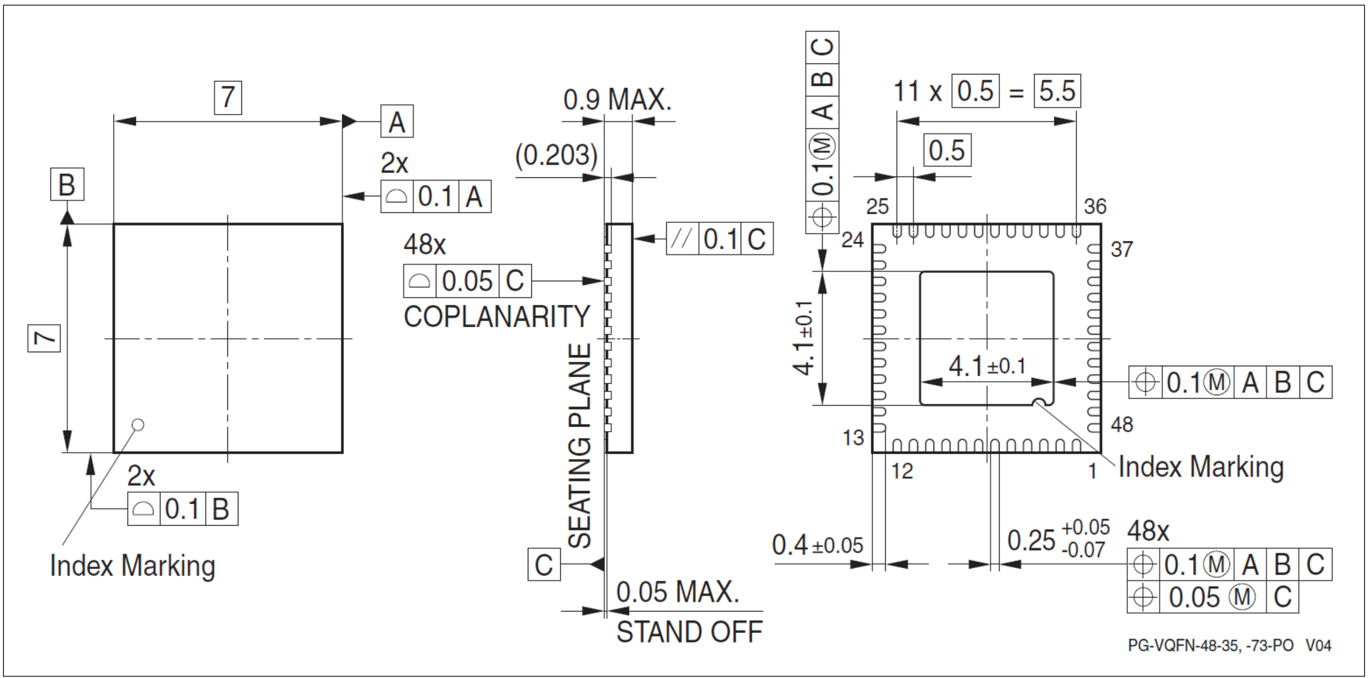


**Figure 21** PG-VQFN-48-73

### 5.2.3 Package Outline PG-LQFP-48-10

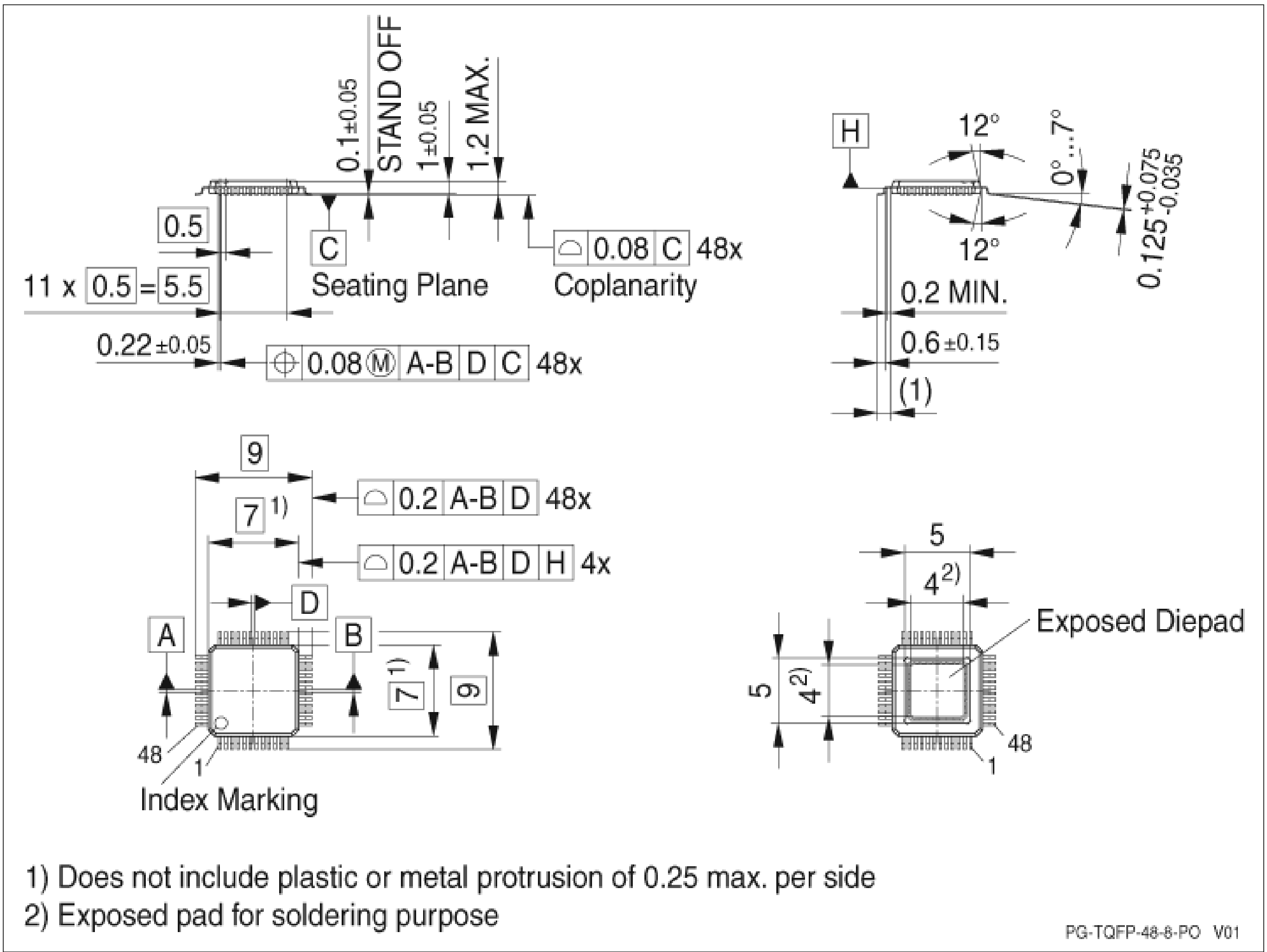


**Figure 22** PG-LQFP-48-10

### 5.2.4 Package Outline PG-LQFP-64-26

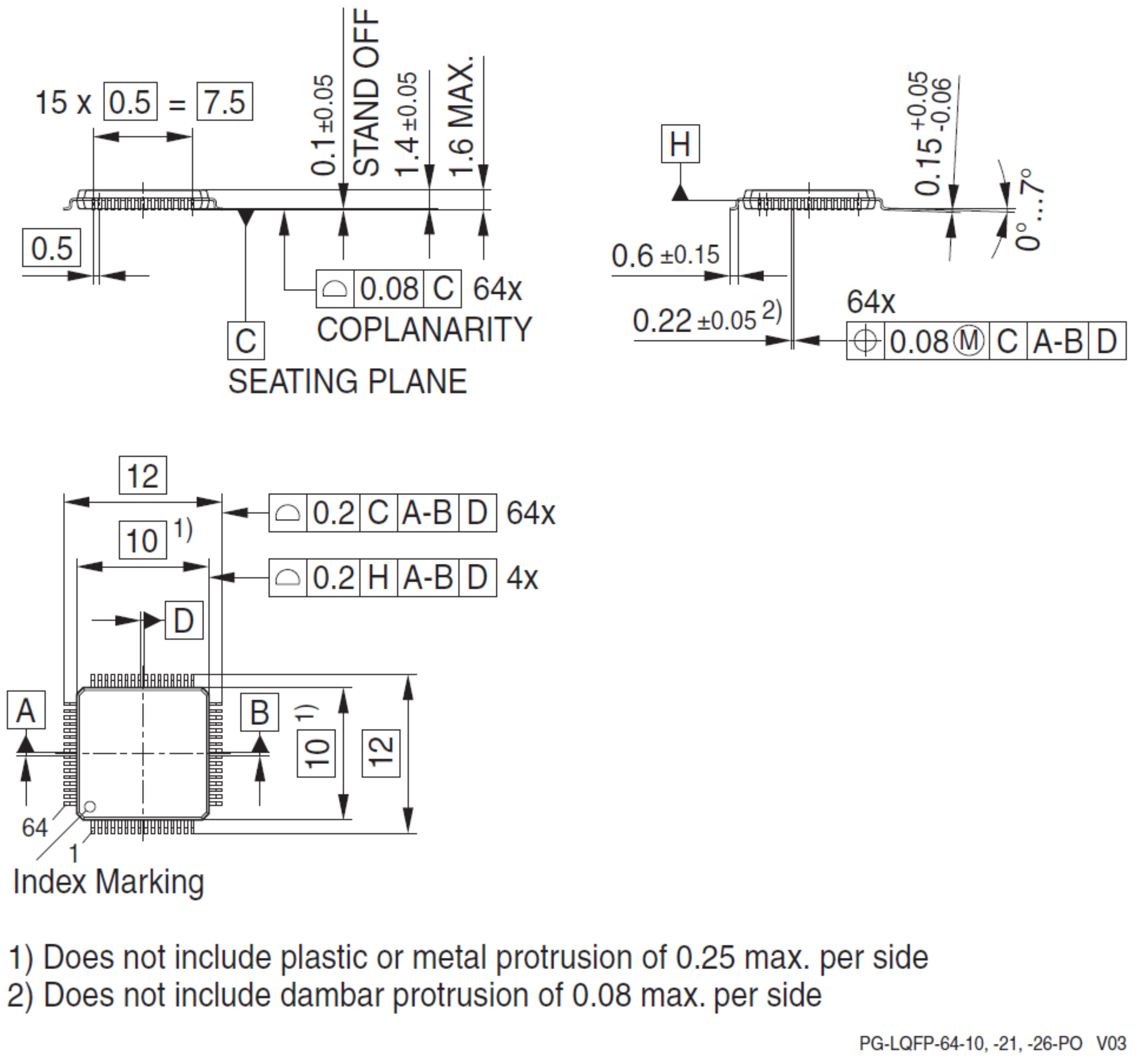


**Figure 23** **PG-LQFP-64-26**

## 5.3 Thermal Considerations

**Table 31 Thermal Characteristics of the Packages**

| Parameter | Symbol | Limit Values | | Unit | Package Types |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Exposed Die Pad Dimensions | Ex × Ey CC | - | 4.2 × 4.2 | mm | PG-VQFN-48-73 |
| Thermal resistance Junction-Ambient[15] | $R_{\Theta JA}$ CC | - | 86.0 | K/W | PG-TSSOP-38-9 |
| | | - | 44.9 | K/W | PG-VQFN-48-73 |
| | | - | t.b.d. | K/W | PG-LQFP-48-10 |
| | | | 66.7 | K/W | PG-LQFP-64-26 |

Note: *For electrical reasons, it is required to connect the exposed pad to the board ground $V_{SSP}$, independent of EMC and thermal requirements.*

When operating the IMC100 in a system, the total heat generated in the chip must be dissipated to the ambient environment to prevent overheating and the resulting thermal damage.

The maximum heat that can be dissipated depends on the package and its integration into the target board. The “Thermal resistance $R_{\Theta JA}$” quantifies these parameters. The power dissipation must be limited so that the average junction temperature does not exceed 115°C.

The difference between junction temperature and ambient temperature is determined by

$\Delta T = (P_{INT} + P_{IOSTAT} + P_{IODYN}) \times R_{\Theta JA}$

The internal power consumption is defined as

$P_{INT} = V_{DDP} \times I_{DDP}$ (switching current and leakage current).

The static external power consumption caused by the output drivers is defined as

$P_{IOSTAT} = \Sigma((V_{DDP} - V_{OH}) \times I_{OH}) + \Sigma(V_{OL} I_{OL})$

The dynamic external power consumption caused by the output drivers ($P_{IODYN}$) depends on the capacitive load connected to the respective pins and their switching frequencies.

If the total power dissipation for a given system configuration exceeds the defined limit, countermeasures must be taken to ensure proper system operation:

- Reduce $V_{DDP}$, if possible in the system
- Reduce the system frequency
- Reduce the number of output pins
- Reduce the load on active output drivers

15 Device mounted on a 4-layer JEDEC board (JESD 51-5); exposed pad of VQFN soldered.

## 5.4 Part marking

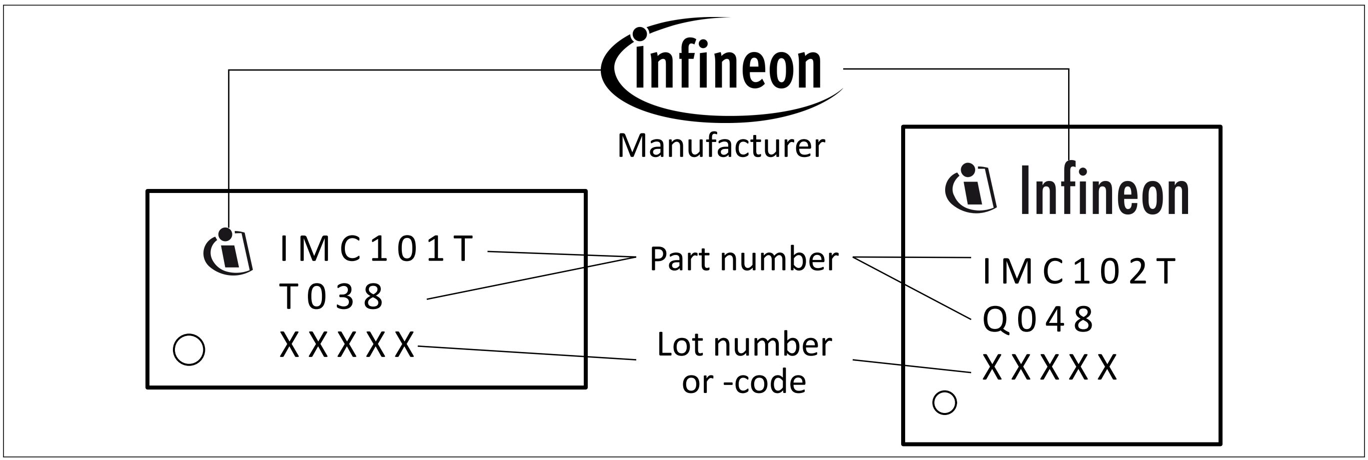


**Figure 24 Part marking**

# 6 References

## Revision history

| Document version | Date of release | Description of changes |
|---|---|---|
| 1.0 | 2018-02-09 | • Initial version |
| 1.1 | 2018-02-20 | • corrected RX1, TX1 in QFN-48, QFP-48 and LQFP-64 |
| 1.2 | 2018-07-24 | • added pins for scripting engine<br>• added SBSL-IDs and Chip-IDs<br>• added input voltage specification<br>• several minor corrections |
| 1.3 | 2019-02-14 | • added the IMC099T-T038 |

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