**LinearDimensions**
SEMICONDUCTOR

MEMsiics ™
with nanoPower Technology

## LND1114
## Programmable Fourteen (14) Channel
## High Voltage Precision Voltage Reference

## GENERAL DESCRIPTION

The LND1114-1, -2, -3 are the smallest fourteen (14) channel voltage references available. The LND1114-1, -2, -3 combine extremely high accuracy with high voltage capability. Each reference voltage may be independently programmed or factory pre-set to any voltage from 100mV to 9V. The LND1114-1 offers 5mV accuracy, the LND1114-2 offers 1mV accuracy, LND1114-3 offers 0.5mV accuracy.

The LND1114 uses Linear Dimensions proprietary floating gate technology to produce a flat response over temperature, eliminating the curved temperature profile normally associated with bandgap based silicon references and dramatically improves accuracy. The technology has been proven to maintain a +/-2% worst case accuracy **over 10 years at 70C.**

The LND1114 can be operated from an input voltage of 2.7V to 12V. The LND1114 draws only 39uA/channel and can drive up to +/- 1.5mA from each reference output.

The LND1114 is packaged in a compact 2.2x3mm, 18 lead QFN package.

## APPLICATIONS

- Instrumentation
- Precision DAC Replacement
- Sensor Calibration
- Transceivers & Interfaces
- Optical Laser Drivers
- Precision Portable Instrumentation
- TV Gamma Correction

## FEATURES

- Fourteen (14) Precision Voltage References
- Wide Input Voltage Range: 2.7V to 12V
- Each Voltage Reference May be Independently Programmed from 0.1V to 9V
- Available Pre-Programmed
- Quiescent Current: 39uA/Channel
- Buffered Outputs: +/-1.5mA Per Channel
- High Precision:
  - Eliminates Silicon Bandgap Curvature
  - Initial Accuracy of 5mV, 1mV or 0.5mV (LND1114-1, LND1114-2, LND1114-3)
- Super Flat Response
- +/-2% Variation @ 70C **Over 10 Years**
- Super Small 2.2x3mm QFN Package

## PINOUT
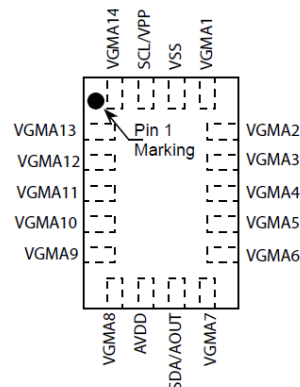


## BLOCK DIAGRAM
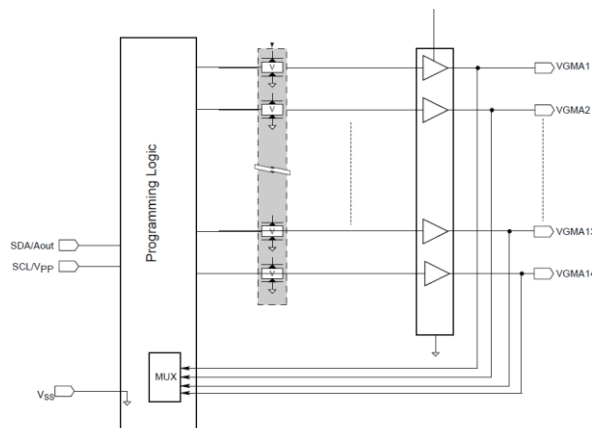
## ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range unless otherwise specified [1]

| PARAMETER | Max | Unit |
|---|---|---|
| Analog Supply, $A_{VDD}$ [2] | 13 | V |
| Programming Supply $V_{PP}$ | 14 | V |
| Maximum Junction Temperature, $T_J$ | 150 | ºC |
| Storage Temperature, $T_{STG}$ | -65 to 150 | ºC |

- Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

- All voltage values are with respect to $V_{SS}$.

## DISSIPATION RATING TABLE

| PACKAGE TYPE | PACKAGE DESIGNATOR | $\Theta_{JA}$ |
|---|---|---|
| QFN 18 | Q | 59ºC/W |

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| $T_A$ | Operating Free air Temperature | -5 | | 85 | $^oC$ |
| $A_{VDD}$ | Analog Supply Voltage (2) | 2.7 | | 12 | V |
| $V_{PP}$ | Programming Supply Voltage (2) | 9 | | 14 | V |

## ELECTRICAL CHARACTERISTICS

Operating temperature range -5 to 85ºC, $V_{PP}$ = 9V to 14V, $A_{VDD}$ = 9V unless otherwise specified.

| SUPPLIES | | | | | | |
|---|---|---|---|---|---|---|
| Symbol | Parameter | Test Condition | Min | Typ | Max | Units |
| $I_{AVDD}$ | Analog Supply Current | $A_{VDD}$ = 3.3V | | 545 | | uA |
| $I_{AVDD}$ | Analog Supply Current | $A_{VDD}$ = 5.0V | | 600 | | uA |
| $I_{AVDD}$ | Analog Supply Current | $A_{VDD}$ = 9V | | 650 | | uA |
| **ANALOG CHARACTERISTICS** | | | | | | |
| Symbol | Parameter | Test Condition | Min | Typ | Max | Units |
| $V_{PROG}$ | Voltage Operating Range | | 2.7 | | 9 | V |
| $V_{PROG}$ | $V_{REF}$ Programming Precision | LD1114-1 | | ±5 | | mV |

| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{PROG}$ | $V_{REF}$ Programming Precision | LD1114-2 | | ±1 | | mV |
| $V_{PROG}$ | $V_{REF}$ Programming Precision | LD1114-3 | | ±0.5 | | mV |
| $OL_{DRIFT}$ | Operating Life $V_{REF}$ Drift | 10 Years @ 70ºC, Vo=5V | -0.2 | | +0.2 | % |
| $I_{OUT}$ | Current Per $V_{REF}$ Output | $A_{VDD}$ = 5.0V | -1.5 | | +1.5 | mA |
| $V_{OL}$ | $V_{REF1}$ & $V_{REF2}$ Output Swing Low | I Sink 50 uA | $V_{SS}$+0.1 | | | V |
| $V_{OH}$ | $V_{REF13}$ & $V_{REF14}$ Output Swing High | I source 50 uA | | | $A_{VDD}$-0.1 | V |
| $V_{TEMP}$ | Output voltage Variation with temperature | $\Delta V_{REF}$ for temperature from -5 to 85 deg. C | -0.2 | | +0.1 | % |
| PSRR | Power Supply Rejection Ratio | $\Delta V_{REF}$ for 6V $\leq$ AVDD $\leq$ 9V | 45 | 60 | | dB |

| Digital OPERATING CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Parameter** | **Test Condition** | **Min** | **Typ** | **Max** | **Units** |
| $V_{IL}$ | SDA, Input Low Voltage | | | | $V_{CC}$x.20 | V |
| $V_{IH}$ | SDA, Input High Voltage | | $V_{CC}$x.80 | | | V |
| $V_{OL}$ | SDA, Low voltage Output | | | | 2 | V |

Note: Detailed programming information is available from Linear Dimensions in the LND1114 Addendum.
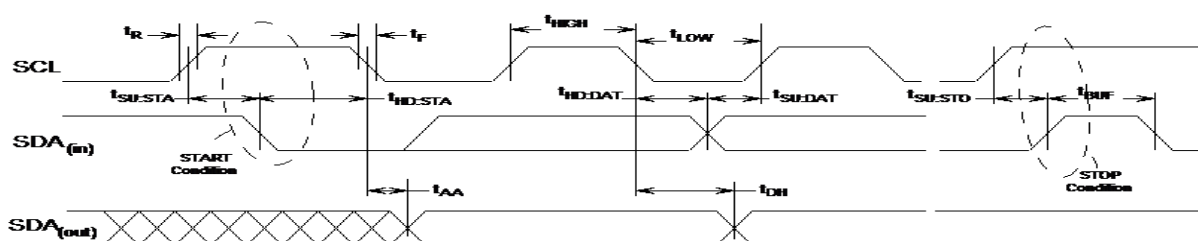


Serial Interface Timing Diagram

| (Over recommended operating conditions, unless otherwise noted. All voltages are relative to $V_{SS}$.) | | | | | |
|---|---|---|---|---|---|
| **Symbol** | **Description** | **Min.** | **Typ.** | **Max.** | **Units** |
| $f_{SCL}$ | **SCL Clock Frequency** | **0** | | **100** | **KHz** |
| $t_{LOW}$ | **Clock Low Period** | **4.7** | | | **μS** |
| $t_{HIGH}$ | **Clock High Period** | **4.0** | | | **μS** |
| $t_{BUF}$ | **Bus Free Time** | **4.7** | | | **μS** |
| $t_{SU:STA}$ | **Start Condition Setup Time** | **4.7** | | | **μS** |

| | | | | | | |
|---|---|---|---|---|---|---|
| $t_{HD:STA}$ | Start Condition Hold Time | 4.0 | | | µs |
| $t_{SU:STO}$ | Stop Condition Setup Time | 4.7 | | | µs |
| $t_{AA}$ | Clock Edge to Data Valid | 0.1 | | 4.5 | µs |
| $t_{DH}$ | Data Output Hold Time | 100 | | | nsec |
| $t_R$ | SCL and SDA Rise Time | | | 1 | µs |
| $t_F$ | SCL and SDA Fall Time | | | 300 | nsec |
| $t_{SU:DAT}$ | Data In Setup Time | 200 | | | nsec |
| $t_{HD:DAT}$ | Data In Hold Time | 0 | | | nsec |
| TI | Noise Filter SCL and SDA | | | 100 | nsec |

## FUNCTIONAL DESCRIPTION

The **LND1114** is a programmable voltage reference device.

The **LND1114** has 14 voltage reference outputs (VREF1-VREF14). Each voltage is programmed as a difference between two analog nonvolatile memory cells. Storing the voltage in a pseudo-differential manner provides excellent temperature stability as well as supply rejection.

**SDA/ $A_{OUT}$** is a dual function Pin**.**

**SDA** is the serial data input pin used to input instructions and data into the LND1114.

**$A_{OUT}$** is an un-buffered analog output that reflects the $V_{REF}$ voltage of the output being programmed.

**SCL/$V_{PP}$** is a dual function pin.

**SCL** is the serial clock that is used to clock data into or out of the device on the Serial Data line.

**$V_{PP}$** is a high voltage input which is used top program gamma voltages to their desired values.

## VOLTAGE PROGRAMMING

Programming the voltage reference voltages is generally done utilizing the AP100 programmer, however, in circuit programming is also possible. Programming of the references utilizes the SDA pin as a command/data input, used to select the function to perform and to select the gamma output ($V_{REF1}$ – $V_{REF14}$) to be programmed. The SDA pin also outputs the actual voltage on the output pin of the reference voltage being programmed. The SCL/VPP input provides the clock for inputting data and the programming voltage for the non-volatile analog storage cells.

Programming details are available from Linear Dimensions for those wishing to perform in circuit programming, however, factory presets are recommended and can be defined during the ordering process.
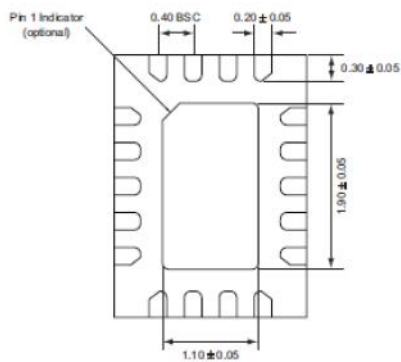
## PACKAGE

The LND1114 is packaged in a 2.2x3mm TQFN package offering minimal footprint and headroom for size challenged applications.  It is the only fourteen (14) channel voltage reference in such a small package.
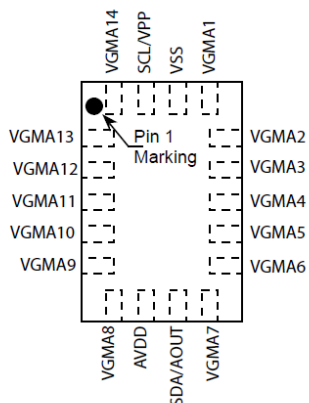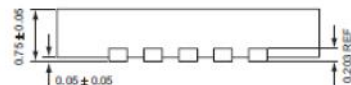


TQFN3x2.2-18³
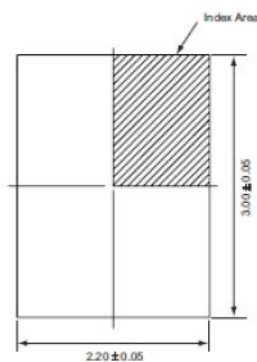


Top View

Bottom View

Side View

All dimensions in millimeters.

## PINOUT

| INPUT / OUTPUT FUNCTION DESCRIPTION | | | |
|---|---|---|---|
| **Name** | **Description** | **Value Range** | **Function** |
| $V_{SS}$ | Ground | | Ground for both analog and digital circuitry |
| $A_{VDD}$ | Analog Supply | 2.7V-12V | Analog Input Voltage |
| $V_{REF1}$-$V_{REF14}$ | Analog Outputs | $V_{SS}$+0.1 to $A_{VDD}$-0.1 | Voltage references |
| SDA/Aout | Serial I/O | $V_{IL}$ to $V_{IH}$ | Serial data interface used during the programming of the LND1114<br><br>**Programming:** During voltage reference programming, the $A_{OUT}$ signal provides a closed loop measurement of the voltage reference voltage being programmed. |
| SCL/VPP | Serial clock Input | $V_{IL}$ to $V_{IH}$ | Serial clock interface used during the programming of the LND1114<br><br>**Programming:** Input for VPP pulses for adjusting the VREF output values and VPP for Programming memory cells. |
| | Programming Voltage | 9V to 14V | |