

# Rain and Light Sensor Interface with SPI

## NCV76124

The NCV76124 is an interface chip for rain and light detection in automotive applications. It measures photodiode currents that represent rain and light signals, and transfers the converted signals to a master microcontroller on request via the SPI interface.

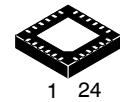
The rain measurement data can be used to control the rain wipers. The light intensity signals can be used for e.g. the brightness control of displays, the headlamp control and others. Due to the SPI programmability, one single hardware configuration can support various applications.

### Features

- Conversion of Rain and Light Sensor Photodiodes Current to a Voltage through a Programmable Gain Trans Impedance Amplifier (TIA)
- Controlled Pulse Current Amplitude for 2 External LED's
- Periodical Measurement of 4 (Optionally 5) Light Sensor Signals
- Periodical Measurement of 2 (Optionally 1) Rain Sensor Signals with Environment Light Cancellation Circuitry
- Rain Channels Environmental Light Measurement
- Die Temperature Measurement
- Power On Reset and Watchdog-functionality
- Standby and Sleep Modes with Low Current Consumption
- On-chip Oscillator for System Clock
- SPI Interface
- Diagnostics Circuitry according to ASIL-B
- Rain Channels Comply with ASIL-A
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- The device is Pb-Free and RoHS Compliant

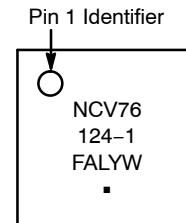
### Typical Applications

- Rain Sensor for Wipers
- Ambient Light Sensor
- Front Lighting
- Head-up Display



QFNW24  
CASE 484AA

### MARKING DIAGRAM



NCV76124-1	= Specific Device Code
F	= Fab Location
A	= Assembly Location
L	= Wafer Lot
YW	= Year/Work Week
▪	= Pb-Free Designator

### SAFETY DESIGN – ASIL B

ASIL B Product developed in compliance with ISO 26262 for which a complete safety package is available.

### ORDERING INFORMATION

See detailed ordering and shipping information on page 13 of this data sheet.

## Non-NDA Data Sheet

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## TYPICAL APPLICATION SCHEMATIC

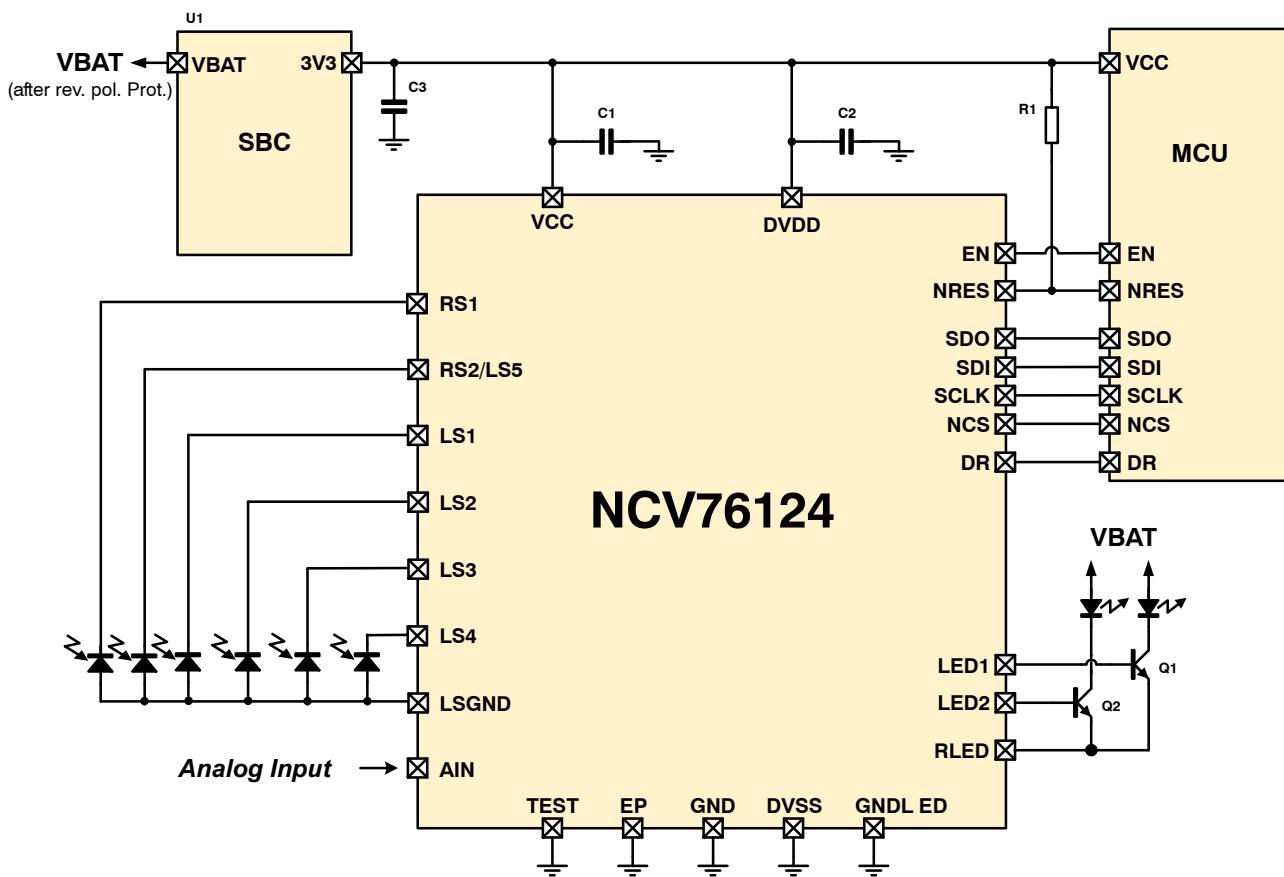


Figure 1. Typical Application Schematic

Table 1. EXTERNAL COMPONENTS

Component	Function	Typ. Value	Unit
R1	Pull-up resistor for NRES output	10	kΩ
C1	Low ESR VCC decoupling capacitor (50 mΩ) Max ripple on VCC should be kept below 20 mV peak to peak	100	nF
C2	Low ESR DVDD decoupling capacitor (50 mΩ)	100	nF
C3	3V3 Regulator Output capacitor	4.7	μF
U1	System Basis Chip with LIN	NCV7428	–
Q1, Q2	NPN transistor	NSV40501UW3 NSV60101DMT	–

## BLOCK DIAGRAM &amp; ESD SCHEMATIC

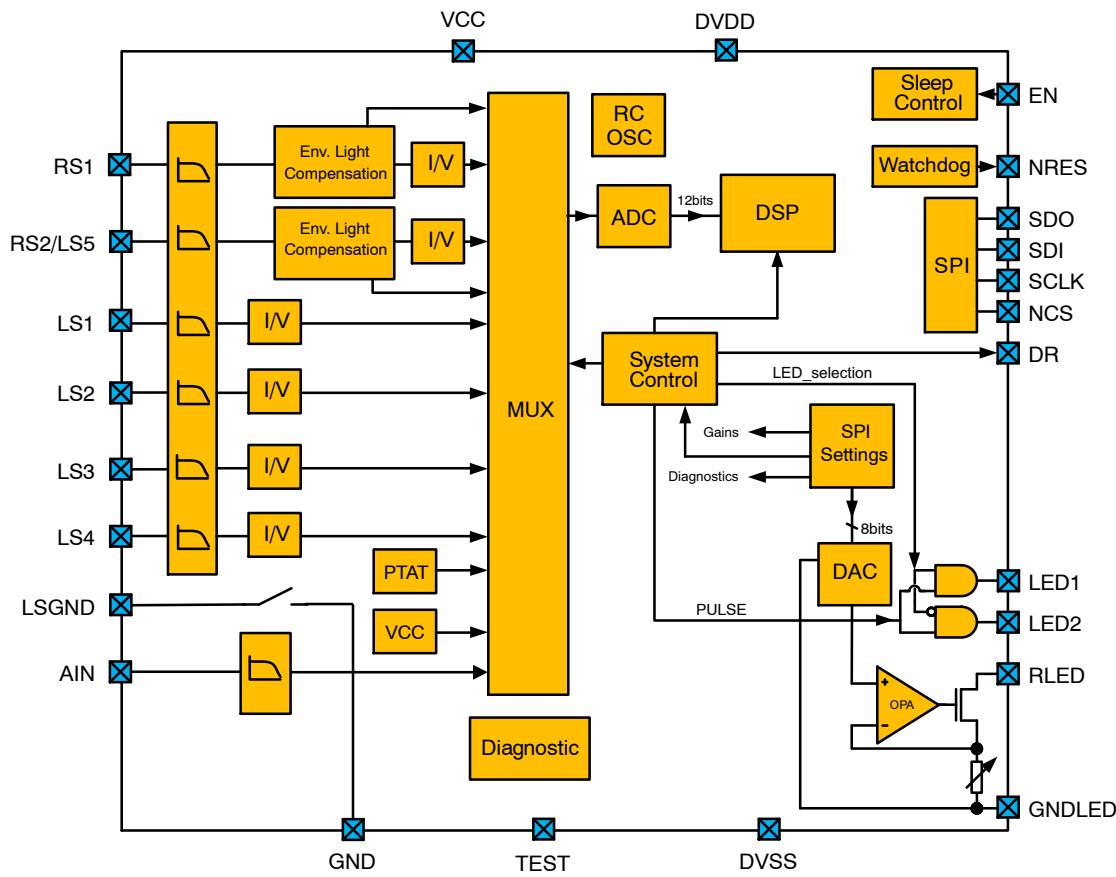


Figure 2. Block Diagram

# NCV76124

## PACKAGE AND PIN DESCRIPTION

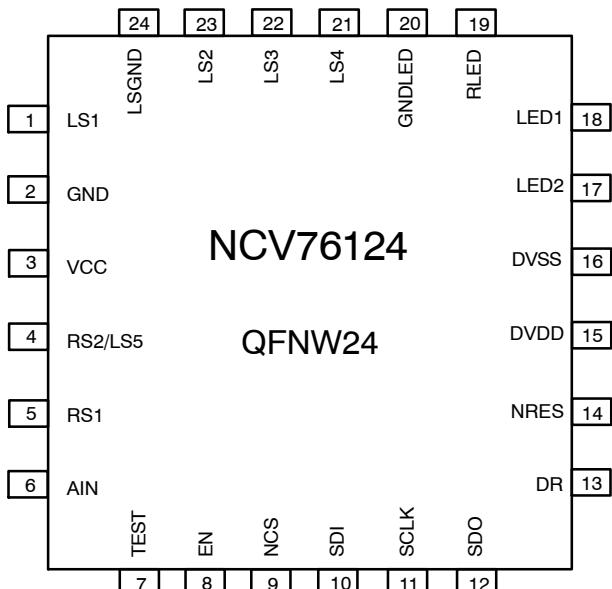


Figure 3. Pin Connections – QFNW24 4x4 0.5P (Top View)

Table 2. PIN DESCRIPTION

Pin No.	Pin Name	Description	I/O Type
1	LS1	Ambient Light Photodiode (HUD); Leave open when not used	Analog Input
2	GND	Analog Ground	Ground
3	VCC	Analog Supply	Supply
4	RS2/LS5	Input Rain Photodiode 2 or Ambient Light Photodiode (SLS); Leave open when not used	Analog Input
5	RS1	Input Rain Photodiode 1; Leave open when not used	Analog Input
6	AIN	Analog Input Channel. If not used can be kept floating (internal pull-down)	Analog Input
7	TEST	To be tied to GND	Analog Input
8	EN	Enable pin, Active High	Digital Input
9	NCS	Chip Select, Active Low	Digital Input
10	SDI	SPI Data Input	Digital Input
11	SCLK	SPI Clock	Digital Input
12	SDO	SPI Data Output (Push-Pull with Tristate)	Digital Output
13	DR	Data Ready Output (Push-Pull)	Digital Output
14	NRES	Watchdog output Reset. Active Low (Open-Drain)	Digital Output
15	DVDD	Digital Supply	Supply
16	DVSS	Digital Ground	Ground
17	LED2	LED2 Output Driver	Analog Output
18	LED1	LED1 Output Driver	Analog Output
19	RLED	R <sub>SHUNT</sub> resistor	Analog Input
20	GNDLED	LED Driver Ground	Ground
21	LS4	Ambient Light Photodiode (SLS); Leave open when not used	Analog Input
22	LS3	Ambient Light Photodiode (FLS); Leave open when not used	Analog Input
23	LS2	Ambient Light Photodiode (GLS); Leave open when not used	Analog Input

**Table 2. PIN DESCRIPTION**

Pin No.	Pin Name	Description	I/O Type
24	LSGND	Ground for Ambient Light/Rain Channel(s) Photodiodes	Ground
EP	EXPOSED PAD	To be tied to GND	

**Table 3. ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Min	Max	Unit
Analog DC Supply	VCC	-0.3	3.6	V
Digital DC Supply	DVDD	-0.3	3.6	V
Difference between DVDD and VCC	V(DVDD)-V(VCC)	-0.1	0.1	V
Ground Ambient Light/Rain Channels (Note 3)	LSGND	-0.3	0.3	V
The Exposed Pad*	EXPAD	GND - 0.3	GND + 0.3	V
LED1/LED2 Power Ground	GNDLED	-0.3	0.3	V
Rain and Light Sensor Input Voltage RS1, RS2, LS1, LS2, LS3, LS4	RS1, RS2, LS1, LS2, LS3, LS4	-0.3	3.6	V
Analog Input	AIN	-0.3	3.6	V
Digital Inputs	SDI, SCLK, NCS, EN, TEST	-0.3	3.6	V
Maximum Current Sink to RLED Pin	I <sub>RLED</sub>		900	mA
Electrostatic Discharge on Component Level Human Body Model (Note 2)	V <sub>ESD_HBM</sub>	-2	+2	kV
Electrostatic Discharge on Component Level Charge Device Model (Note 2)	V <sub>ESD_CDM</sub>	-500	+500	V

\* Designed to be met over the stated voltage and temperature operating ranges, and characterized, though may not be parametrically tested in production.

1. The exposed pad must be hard wired to GND pin in the application to ensure both electrical and thermal connection.
2. This device series incorporates ESD protection and is tested by the following methods:
  - ESD Human Body Model tested per ANSI/ESDA/JEDEC JS-001
  - ESD Charge Device Model tested per EIA-JESD22-C101
  - Latch-up Current Maximum Rating:  $\leq 100$  mA per JEDEC standard: JESD78
3. During diagnostics the LSGND is internally connected to VCC.

- Operating ranges define the limits for functional operation and parametric characteristics of the device.
- Characteristics marked with (Note \*) are designed to be met over the stated voltage and temperature operating ranges, and characterized, though may not be parametrically tested in production.
- A mission profile (Note \*\*) is a substantial part of the operation conditions; hence, the Customer must contact **onsemi** to mutually agree in writing on the allowed missions profile(s) in the application.

**Table 4. RECOMMENDED OPERATING RANGES**

Parameter	Symbol	Min	Typ	Max	Unit
Analog DC Supply	VCC	3.15	3.3	3.45	V
Digital DC Supply	DVDD	3.15	3.3	3.45	V
Battery Voltage (after reverse polarity protection) (Note 4)	V <sub>BAT</sub>	6	–	–	V
SPI CLK Frequency	f <sub>SCLK</sub>	–	–	5	MHz
Ambient Temperature (Note 4)	T <sub>A</sub>	-40	–	125	°C
Junction Temperature (Note 4)	T <sub>J</sub>	-40	–	135	°C
The Exposed Pad Connection (Note 5)	EXPOSED_PAD	GND - 0.1	GND	GND + 0.1	V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

\*\*A mission profile describes the application specific conditions such as, but not limited to, the cumulative operating conditions over lifetime, the system power dissipation, the system's environmental conditions, the thermal design of the customer's system, the modes, in which the device is operated by the customer, etc.

4. The external components like the SBC and the NPN transistors collector voltage determine the maximum Battery voltage for the application.
5. The exposed pad must be wired to the GND pin in an application to ensure both electrical and thermal connection.

**Table 5. THERMAL CHARACTERISTICS**

Parameter	Package	Symbol	Min	Typ	Max	Unit
Thermal Resistance Junction to Exposed Pad (Note 6)	QFNW24, 4x4, 0.5p	Rthjp	–	3	–	°C/W

6. Includes also typical solder thickness under the Exposed Pad (EP).

**ELECTRICAL CHARACTERISTICS**(All Min and Max parameters are guaranteed over full junction temperature ( $T_J$ ) range ( $-40^{\circ}\text{C}$ ;  $135^{\circ}\text{C}$ ), unless otherwise specified.)**Table 6. CURRENT CONSUMPTION (VCC = DVDD = 3.3 V)**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Current Consumption in Active Mode (Note 7)	$I_{\text{CONS}}$	Configuration mode of one rain channel and 5 light channels	–	9	12	mA
Sleep Current*	$I_{\text{SLEEP}}$	$T = 27^{\circ}\text{C}$	–	7	10	$\mu\text{A}$
Standby Current*	$I_{\text{STBY}}$	$T = 27^{\circ}\text{C}$	–	–	350	$\mu\text{A}$

7. Without photodiodes DC current and NPN base current or LED current.

**Table 7. LED DRIVER**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
DC GAIN of External NPN	$h_{\text{FE}}$		100	–	–	
Minimum LED Current Pulse Setting (Note 8)	$I_{\text{LED\_MIN}}$		–	–	0.3	mA
Maximum LED Current Pulse Setting	$I_{\text{LED\_MAX}}$		800	–	–	mA
Minimum LED Current Pulse Period Setting	$T_{\text{PP\_LED\_MIN}}$		–	150	–	$\mu\text{s}$
Maximum LED Current Pulse Period Setting	$T_{\text{PP\_LED\_MAX}}$		–	300	–	$\mu\text{s}$
DC LED Current Deviation from the Programmed Current	$I_{\text{LED\_DCERR}}$		–10	–	10	%
VRLED Reference Threshold Voltage	$V_{\text{DIAGLED\_REF}}$		–	1.185	–	V

8. The current setting is done by the means of 11 bits, with 3 bits MSB selecting the shunt value (6 dB logarithmic step) and 8 bits LSB selecting the code of the linear DAC. The complete current DAC setting steps of the ILED.

**Table 8. TEMPERATURE SENSOR MEASUREMENT PARAMETERS**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Temperature Range	$T_{\text{RANGE}}$		–40	–	125	$^{\circ}\text{C}$

**Table 9. VCC: POWER SUPPLY MEASUREMENT PARAMETERS**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
The Minimal Voltage Measurement Range	$V_{\text{CCRANGE\_LOW}}$		–	–	3.0	V
The Maximal Voltage Measurement Range	$V_{\text{CCRANGE\_HIGH}}$		3.65	–	–	V

**Table 10. RS1, RS2: RAIN SENSOR**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Average Reverse Voltage on Photodetector (between RSx and LSGND)	$V_{R\_RAIN}$		1	1.65	2.3	V
Total Capacitance Value Connected between Pins RSx and LSGND	$C_{IN\_RAIN}$		1	-	50	pF
Photo Input Current from environmental light (test condition for $V_{R\_RAIN}$ , $I_{AC\_RAIN\_ACC}$ ; $I_{AC\_RAIN\_noise}$ )	$I_{DC\_RAIN}$		0	-	0.6	mA
Equivalent Resistance of the Trans Conductance Amplifier	$RS_{TIA}$		-	1.75	-	k $\Omega$
Full Scale DC Current Range	$I_{DC\_ENVIRONMENT}$		0.6	-	1.248	mA

**Table 11. LS1, LS2, LS3 LIGHT SENSORS**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Average Reverse Voltage on Photo-diode (between LS and GND)	$V_{R\_LS}$		1	1.65	2.3	V
Total Capacitance Value Connected between Pins LS1, LS2, LS3 and GND	$C_{LOAD\_LS1}$		0.001	-	1	nF
	$C_{LOAD\_LS2}, C_{LOAD\_LS3}$		1	-	70	pF
Maximal Current Measurement range from LS light	$I_{LS1\_MAX}$ ,		10	-	-	$\mu$ A
	$I_{LS2\_MAX}, I_{LS3\_MAX}$ ,		50	-	-	$\mu$ A
LS1, LS2, LS3 Pin Input Leakage*	$I_{LS1\_LEAK}, I_{LS2\_LEAK}, I_{LS3\_LEAK}$	$T = -45^{\circ}C$ to $135^{\circ}C$	-2	-	2	nA
Minimal Current Measurement Range from LS Light Corresponding to 1 LSB Resolution	$I_{LS1\_MIN}, I_{LS2\_MIN}, I_{LS3\_MIN}$		-	-	20	pA

**Table 12. LS4, LS5 LIGHT SENSORS**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Average Reverse Voltage on Photo-diode (between LS and GND)	$V_{R\_LS}$		1	1.65	2.3	V
Total Capacitance Value Connected between Pins LSx and GND	$C_{LOAD\_LS4}, C_{LOAD\_LS5}$		1	-	70	pF
Maximal Current Measurement Range from LSx Light	$I_{LS4\_MAX}, I_{LS5\_MAX}$		200	-	-	$\mu$ A
LS4, LS5 Pin Input Leakage*	$I_{LS4\_LEAK}, I_{LS5\_LEAK}$	$T = -45^{\circ}C$ to $135^{\circ}C$	-2	-	2	nA
Minimal Current Measurement Range from LSx light corresponding to 1 LSB in 12 bit ADC resolution	$I_{LS4\_MIN}, I_{LS5\_MIN}$		-	-	1	nA

**Table 13. DIAGNOSTIC**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Open PD Threshold Voltage (for RSx and LSx)	$V_{DIAG\_RefL}$		GND + 0.35	–	GND + 0.45	V
Short PD Threshold Voltage (for RSx and LSx)	$V_{DIAG\_RefH}$	LSGND short to VCC by internal switch	$V_{CC} - 0.22$	–	$V_{CC} - 0.14$	V
LSGND Threshold Voltage	$V_{Ref\_GND}$		1.1	–	1.3	V

**Table 14. DIGITAL INPUTS (SCLK, NCS, SDI, EN)**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
High Level Input Voltage	$V_{IH}$		$0.7 * DVDD$	–	$DVDD$	V
Low Level Input Voltage	$V_{IL}$		0	–	$0.3 * DVDD$	V
Hysteresis on the Digital Inputs	$V_{HYS}$		–	0.25	–	V
Input Leakage for the Digital Inputs	$I_{Leak}$	No Pull-Up/Down resistor	–10	–	10	$\mu A$
Input Current due to the Pull-Up Resistor for Digital Inputs	$I_{pu}$		–120	–	–	$\mu A$
Input Current due to the Pull-Down Resistor for Digital Inputs	$I_{pd}$		–	–	120	$\mu A$
Input Capacitance for Digital Input Pins	$C_{IN}$		–	–	30	pF
Internal Pull-Up Resistor	$R_{PU}$	For SCLK, NCS	–	50	–	$k\Omega$
Internal Pull-Down	$R_{pd}$	For TEST, SDI and EN	–	50	–	$k\Omega$

**Table 15. DIGITAL OUTPUT (DR, SDO, NRES; OPEN DRAIN)**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
High Level Input Voltage	$V_{OH}$	$CL = 30 \text{ pF}$ ; and with $IOH_{max}$ ;	2.2	–	$DVDD$	V
Low Level Input Voltage	$V_{OL}$	$CL = 30 \text{ pF}$ ; and with $IOL_{max}$ ;	0	–	0.4	V
High Level Output Current	$I_{OH}$	For DR and SDO	–	–	–4	mA
Low Level Output Current	$I_{OL}$	For DR and SDO	–	–	4	mA
High Level Output Leakage Current	$I_{O\_LEAK}$	For NRES	–10	–	10	$\mu A$
Low Level Output Current	$I_{OL}$	For NRES	–	–	2	mA

**Table 16. SPI INTERFACE**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Clock Period	$T_{sck}$		200	300	1000	ns
Clock Time High	$T_{sck\_high}$		100	–	–	ns
Clock Time Low	$T_{sck\_low}$		100	–	–	ns
SCK Setup Time, NCS Low before Rising Edge SCK	$T_{sck\_setup}$		300	–	–	ns
NCS Setup Time, SCK Low before Rising Edge of NCS (Note X24)	$T_{ncs\_setup}$		1.4	–	–	$\mu s$
SDI Setup Time	$T_{sdi\_setup}$		75	–	–	ns
SDI Hold Time	$T_{sdi\_hold}$		75	–	–	ns
Input Rise Time	$T_{rise}$		–	–	100	ns

Table 16. SPI INTERFACE (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Fall Time	$T_{fall}$		–	–	100	ns
Min NCS High Time	$T_{ncs\_high}$		900	–	–	ns
Max SDO Enable Time after Falling Edge of NCS	$T_{sdo\_ena\_tri\_X}$	$CL = 30 \text{ pF}$	–	–	30	ns
Output Rise Time	$T_{sdo\_rise}$	$CL = 30 \text{ pF}$	–	–	40	ns
Output Fall Time	$T_{sdo\_fall}$	$CL = 30 \text{ pF}$	–	–	30	ns
Max SDO Disable Time after Rising Edge of NCS	$T_{sdo\_dis\_X\_tri}$	$CL = 30 \text{ pF}$	–	–	30	ns
SPI Read Command Delay Time	$T_{stby\_delay}$	Only for STBY mode	–	80	–	$\mu\text{s}$

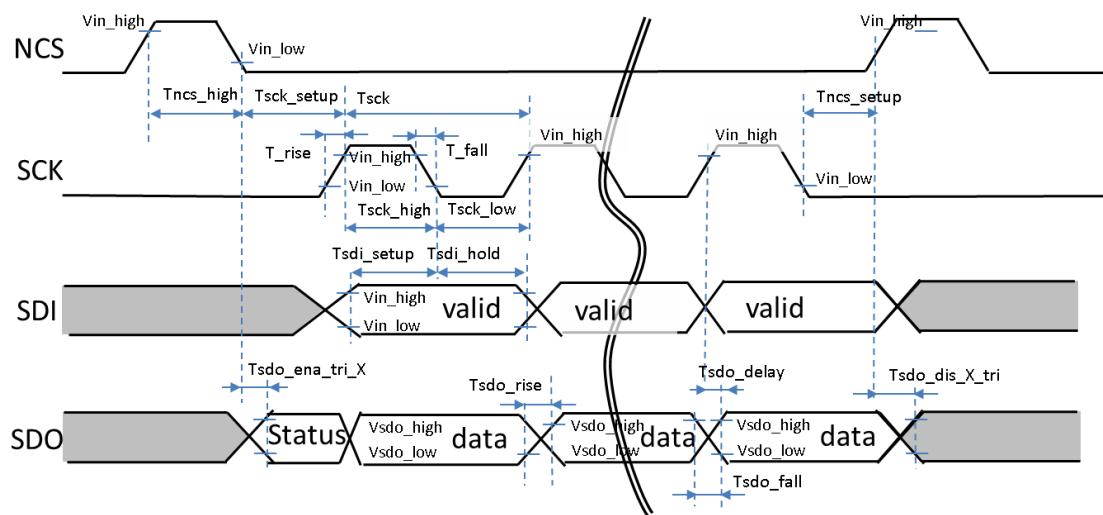


Figure 4. SPI Communication Timing

## DETAILED OPERATING DESCRIPTION

## SUPPLY CONCEPT

These supply voltages are used in NCV76124: VCC & DVDD as low voltage supply and VBAT to supply the LEDs.

## VBAT Supply

The battery voltage, after reverse polarity protection with a minimum level defined in Table 4. RECOMMENDED OPERATING RANGES is connected to LED1 and optionally to LED2.

## VCC Supply

The VCC supply voltage, which is typically 3.3 V, is used to supply the analog circuitry of the chip.

## DVDD Supply

The DVDD supply voltage, which is 3.3 V, is used to supply the digital circuits. DVDD and VCC should be connected together to the same external supply. It is important to decouple the DVDD and VCC with multi-layer chip capacitors as specified in the Application diagram component table.

The Power-On-Reset circuit (POR) monitors the DVDD voltage.

## OPERATION MODES

The NCV76124 supports 3 operating modes: ACTIVE, STANDBY and SLEEP mode.

This is presented in the state diagram shown in Figure 5.

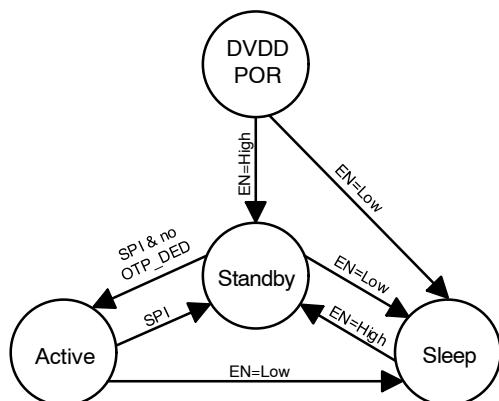


Figure 5. Operating Mode Description

## RAIN SENSOR MEASUREMENT

The NCV76124 has 2 dedicated rain measurement channels RS1 and RS2.

In combination with the LED1 or LED2 (optional) LED drivers, there are up to 4 individual rain measurement configurations possible that can be set up by SPI.

## LED Driver

The main features of the LED driver:

- The internal LED driver circuitry drives the base of an external NPN transistor with base current limitation.
- The LED current is programmable via SPI (one setting per LED channel).
- Slope control for reducing EMI.
- Base current compensation circuit.
- Synchronous operation of the LED current pulse and the rain sensor measurement.
- The LEDs are pulsed alternately in case both LED channels are used.
- The LED pulse width and period can be programmed with the ‘LED\_PULSE\_WIDTH’ and ‘NR\_LED\_PULSES’ in the “LED\_CONFIG” SPI registers.

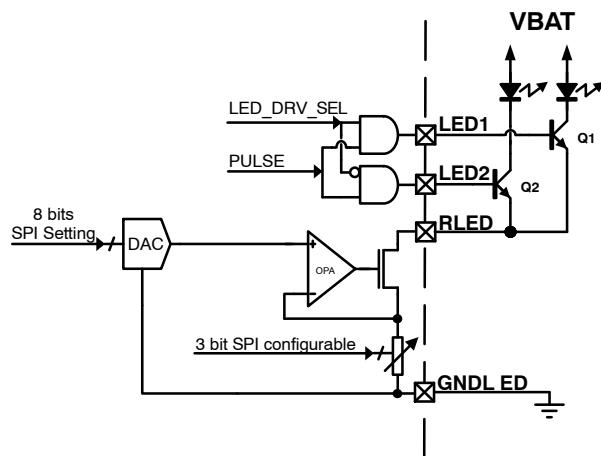


Figure 6. Block Diagram of the LED Driver

## Rain Sensor Channels

Two rain sensor channels are available and measure simultaneously. The rain sensors are used in combination with the LED pulses.

Ambient light (DC current) and rain signal (AC current) can be measured.

In case only the DC values are of interest, the rain measurement can be performed with enabled LED(s) but without pulses programmed.

When only one Rain Channel input is used, the un-used channel should be kept open.

## LIGHT SENSOR MEASUREMENT

The light measurements are used to control e.g. the front lights, dashboard brightness and HUD light intensity. In total four (5 when RS2 is not used) light channels are available. Un-used light channels should be kept open (floating).

## DIAGNOSTICS

The diagnostic cycle is 1.2 ms. It is advised to launch the diagnostic as first action in Active mode after leaving standby mode. Especially the diagnostic that is related to Photodiode, LED and the light channel measurement.

The diagnostic can be launched by the MCU via the RDIAG SPI command. Before launching the diagnostics, the MCU shall configure the diagnostics register “DIAG\_SET\_REG” to select which of the diagnostics are needed. By default all diagnostics are disabled.

## SPI INTERFACE

### General

The serial peripheral interface (SPI) is used to allow an external microcontroller (MCU) to communicate with the device. NCV76124 acts always as a slave and it cannot initiate any transmission.

The NCV76124 SPI architecture is CRC-Secured.

The SPI interface consists of four wires:

1. NCS: (Chip Select, active low). An input signal, when set to low, the reception and transmission are enabled.
2. SCLK: (Shift Clock). An input clock, driving the communication.
3. SDI (Serial Data In): The input data (MOSI), input bits are captured at falling edge of the SCLK.
4. SDO (Serial Data Out): The output data (MISO), output data is set during the rising edge of SCLK. The SDO output pin is in tri-state when NCS is high.

### SPI Transfer Format

Three types of SPI commands can be distinguished:

- “Command Instruction” 16 bit
- “Write control register” 32 bit
- “Read control or status register” 32 bit

Command Structure:

CMD	INSTRUCTION
0x	COMMAND
10	WRITE
11	READ

### SPI Command Instruction

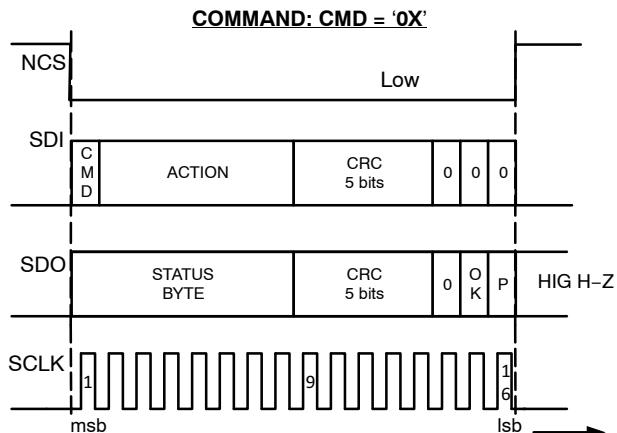


Figure 7. SPI Command Instruction Frame

Referring to the above picture, the Command Instruction frame coming from the master (into the SDI) is composed from the following fields:

Bits[15:8]	CMD bit = 0 + ACTION
Bits[7:3]	5 bits Cyclic Redundancy Check over the CMD and Action
Bits[2:0]	3 bits unused “000”

In the same time, the device replies to the master command (on the SDO):

Bit 15	Status byte	ERROR
	Status byte	DIAG_ERR
	Status byte	RDIAG-BUSY
	Status byte	Reserved
	Status byte	MEAS-AUTO
	Status byte	Reserved
	Status byte	MEAS-BUSY
	Status byte	ACTIVE
Bits[7:3]	5 bits Cyclic Redundancy Check over the Status byte	
Bits[2:0]	3 confirm bits “0”+OK+P	

## SPI Write Instruction

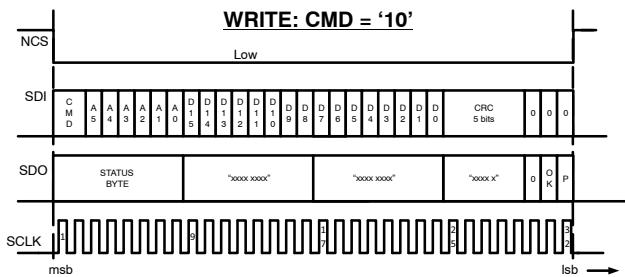


Figure 8. SPI Write Frame

Referring to above picture, the write frame coming from the master (into the SDI) contains the following fields:

Bits[31:30]	CMD bits "10" for write
Bits[29:24]	6 bits WRITE ADDRESS field
Bits[23:8]	16 bits DATA field
Bits[7:3]	5 bits Cyclic Redundancy Check over all send contents (24 bits)
Bits[2:0]	3 bits unused "000"

The device in the same time replies to the master (on the SDO):

Bit 31	Status byte	ERROR
Bit 30	Status byte	DIAG_ERR
Bit 29	Status byte	RDIAG-BUSY
Bit 28	Status byte	Reserved
Bit 27	Status byte	MEAS-AUTO
Bit 26	Status byte	Reserved
Bit 25	Status byte	MEAS-BUSY
Bit 24	Status byte	ACTIVE
Bits[23:16]	"xxxx xxxx"	
Bits[15:8]	"xxxx xxxx"	
Bits[7:3]	"xxxx x"	
Bits[2:0]	3 confirm bits "0"+OK+P	

## ORDERING INFORMATION

Device Order Number	Specific Device Marking	Package*	Shipping†
NCV76124MW0R2G	NCV76124-1	QFNW24, 4x4, 0.5p	2,500 / Tape & Reel

\*For additional information on our Pb-Free strategy and soldering details, please download the [onsemi](#) Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

If the OK bit or parity bit are wrong in the frame, the device will not perform the command.

## SPI Read Instruction

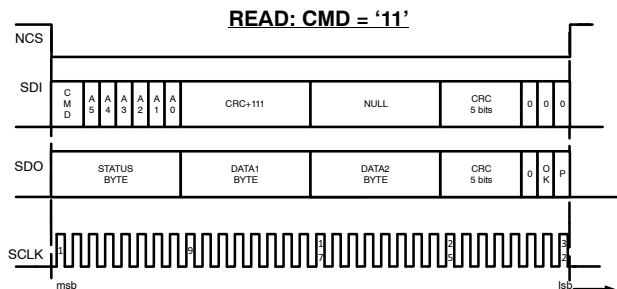


Figure 9. SPI Read Frame

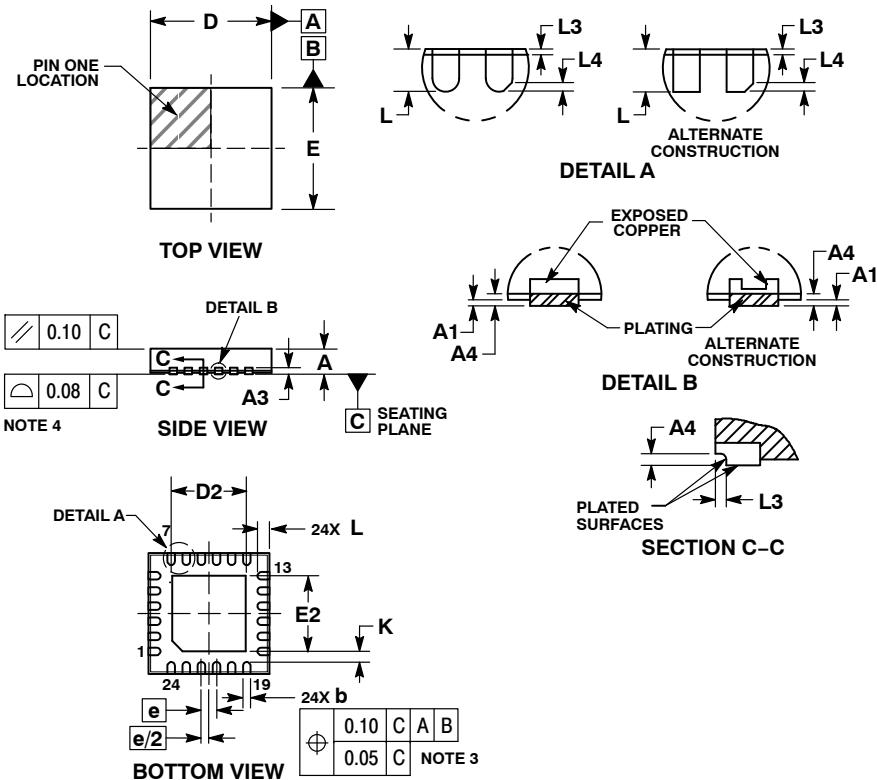
Referring to above picture, the read frame coming from the master (into the SDI) is composed from the following fields:

Bits[31:30]	CMD bits = "11" for read operation
Bits[29:24]	6 bits READ ADDRESS field
Bits[23:19]	5 bits Cyclic Redundancy Check over the command and address
Bits[18:16]	3 bits unused "111"
Bits[15:0]	Always 0x0078



**QFNW24 4x4, 0.5P**  
CASE 484AA  
ISSUE A

DATE 07 AUG 2018

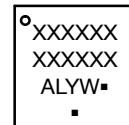


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	---	---	0.05
A3	0.20 REF		
A4	0.10	---	---
b	0.20	0.25	0.30
D	3.90	4.00	4.10
D2	2.40	2.50	2.60
E	3.90	4.00	4.10
E2	2.40	2.50	2.60
e	0.50 BSC		
K	0.25	---	---
L	0.35	0.40	0.45
L3	0.00	0.05	0.10
L4	0.05	0.10	0.15

**GENERIC  
MARKING DIAGRAM\***



XXXXXX = Specific Device Code

A = Assembly Location

L = Wafer Lot

Y = Year

W = Work Week

■ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

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