Application Note

Rain Light Sensor system with MLX75310

Melexis
INSPIRED ENGINEERING

Contents

1. Scope

This application note explains how to design a state of the art automatic Rain Light Sensor system using the Melexis MLX75310 Rain Light Sensor interface chip.

2. Introduction

The Rain Light Sensor module detects two driving conditions. One is the accumulation of moisture on the windscreen of a car. The second is the ambient light level ahead and above the car. The module provides data to adjust the wipe rate based on the rain or moisture and the driver's wiper sensitivity settings. The ambient light level is used to control the vehicle headlamps at nightfall or when entering tunnels and parking structures.

The Rain Light Sensor system started out as a comfort function. The driver of a car equipped with such a system is freed from the need to manually control the headlights or the wipers. Increasingly it is recognized as a safety system. Automatic wiper and light control maximizes driver visibility at all times by ensuring the headlights are on when there is insufficient ambient light and that the windshield is rain free.

As shown in Figure 1, the Rain Light Sensor module consists of three main components. The Rain Light Sensor interface chip, the MLX75310, is the heart of the module. It interfaces with all optical components and provides the rain and light data to the ECU. The ECU is the decision maker. It uses the data received from the Rain Light Sensor interface chip to decide whether it is necessary to turn on the wipers or headlights. The LIN system basis chip connects the Rain Light Sensor module to the car's LIN network and regulates the battery voltage to supply the microcontroller, the MLX75310 and the other components on the module.

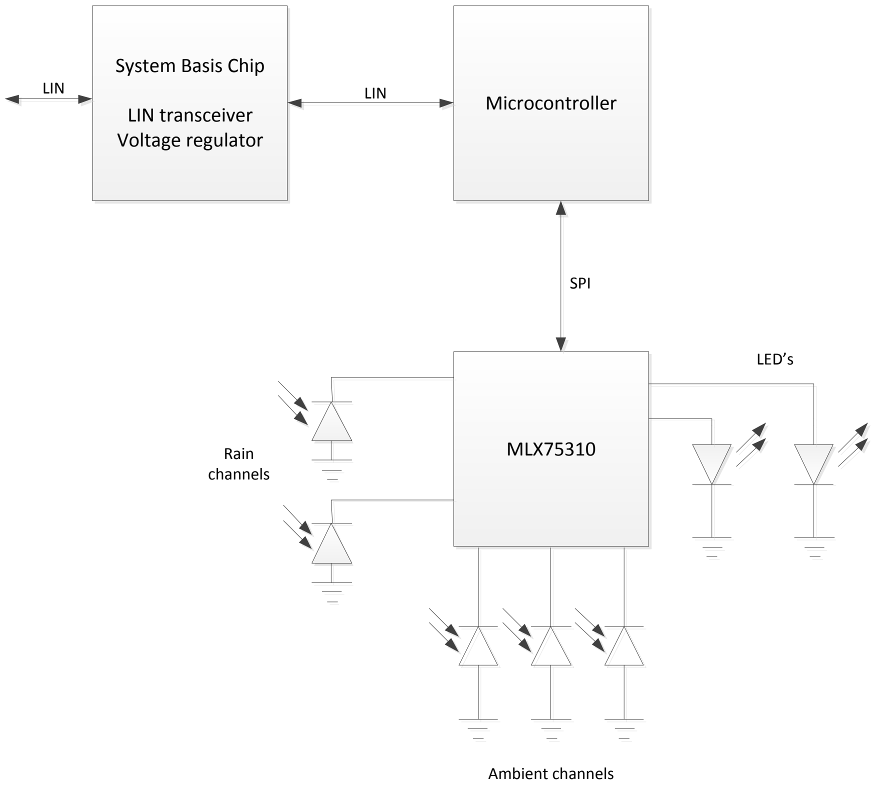

Figure 1: Rain Light Sensor system component overview

3. Working principle of a Rain Light Sensor module

Figure 2 shows the working principle of a Rain Light Sensor module. A near-infrared LED sends a high energy light pulse to the windshield. Dedicated optics within the module ensures total internal reflection of the transmitted light signal. This reflected light generates a current in the receiving photodiode. When there is rain on the windshield, some of the transmitted pulse is lost and the photodiode receives less light. Rain intensity can then be calculated from the difference in the amount of reflected light.
One of the functions of the MLX75310 is to control the LEDs and convert the photodiode current into a digital form. This data is sent to the microcontroller which uses it to decide whether it is raining and how fast the wiper speed should be.

One of the biggest challenges for a Rain Light Sensor system is that the photodiode receives not just LED light, but sunlight too, which also induces a current. Changes in sunlight can be interpreted as a sudden burst of rain on the windshield, resulting in annoying false wipes. It is very difficult in a discrete solution to split the two types of stimulus. Special optics or a mechanical solution can be used to remove the sunlight variable. As the sunlight signal is much stronger than the rain signal, only a little bit of sunlight is enough to completely corrupt the analog signal. Complicated software can attempt to correct this. However, once there is a sun component in the rain signal, it is almost impossible for the two to be split.

The MLX75310 rejects sunlight from the rain signal in two highly effective ways. First, the MLX75310 suppresses the sun signal in the rain signal, resulting in a very precise rain signal. Secondly, the chip is capable of measuring the rain signal and the sun signal and presenting that information to the microcontroller as two separate values. Having these two separate signals makes the software considerably less complicated, while the sun signal data may be valuable to the automotive developer for other reasons besides rain sensing.

Low cost photodiodes have a less than perfect output characteristic. Expensive photodiodes (PDs) can perform much better than cheaper ones. The MLX75310 compensates for this imperfection, achieving good performance with less expensive photodiodes.

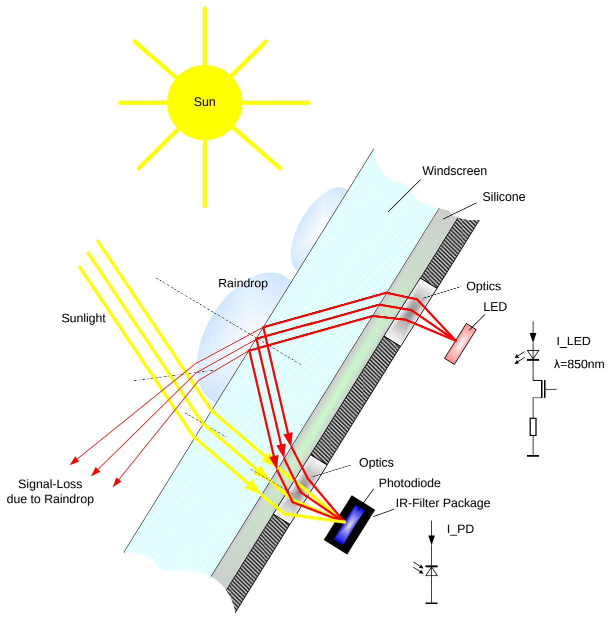

Figure 2: Windshield optics

4. MLX75310

The MLX75310 has two independent linear rain measurement channels. These can operate at the same time or separately. A typical rain current is between 1uA and 100uA, depending on the optics, windshield type, LEDs and PDs used. Normally one photodiode is connected to each channel, but more photodiodes can be connected to each channel to extend the sensing area on the windshield. Extending the sensing area improves rain detection.

Three logarithmic ambient channels are available on the sensor. A logarithmic output curve is used to cover a large dynamic range, from bright sun to dark night. Two channels have exactly the same output characteristic, while one has a lower sensitivity. In this way the user can choose between a broad range of photodiodes. In most applications two ambient channels are used for headlight control. One is directed at the sky, while the second is focused directly ahead, to detect upcoming tunnels for example. The third channel can be used to control the dash panel or head up display intensity.

Dynamic range is important when the system needs to support multiple usage scenarios. OEMs demand is for one Rain Light Sensor system that covers multiple car types with different windshield types - from dark tinted versions to crystal clear ones. Varying ageing effects, a large temperature range, changing weather conditions and a potential mechanical mismatch when the sensor is mounted; all these things add up to a challenging large dynamic range requirement for the system. The MLX75310 accommodates all these difficulties with its huge dynamic range. At its input stage the dynamic range is represented by a large programmable gain and bandwidth. The large output dynamic range is obtained by the big current range of the two integrated LED drivers. Only one of the two can be used at a time. The LED current is fed back to the chip over a shunt resistor. LED currents up to 150mA are supported.

A temperature sensor is included in the MLX75310. It can be used to protect the LEDs. It will not measure the absolute temperature of the LEDs itself, but is a good indication of the temperature inside the module. If the temperature gets too high, the output can be reduced to lower the LED current and prevent LED damage. When the temperature gets excessively high, the output current can be shut down to avoid destroying the LEDs.
When the temperature changes, so does the sensitivity of the photodiodes, resulting in an absolute measurement value change. The microcontroller can use the temperature to check if a change in the absolute value is related to a temperature change and take this into account.

The MLX75310 has also the capability to measure the voltage of the LED drivers. The microcontroller can use this measurement to detect spikes or voltage drops on the LED driver supply. The MLX75310 can also measure the temperature of the LEDs when they are fired. This is a very useful measurement to detect over-temperature of one of the LED caused by too much current through the LED or caused by a big increase in ambient temperature.

The MLX75310 acts as a digital SPI slave. The microcontroller sends a command to begin measurements. Once the command is received, the MLX75310 will start its measurement cycle and perform the necessary analog to digital conversion. At completion, it will set its device ready pin high to inform the microcontroller data is available. The microcontroller can now read out the digital value of the requested measurements. Figure 3 shows a typical measurement cycle. The big advantage of working with this digital slave principle is that the microcontroller can perform other tasks while waiting on the MLX75310 to perform the measurements. In addition, as a digital value is sent to the microcontroller, no extra analog to digital conversion is required of the microcontroller, leaving it more time to run the software.

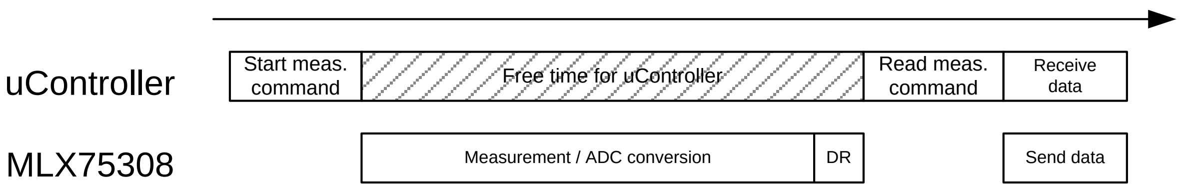

Figure 3: Measurement cycle

Very few components are needed to integrate the MLX75310 in a Rain Light Sensor system. Photodiodes are required for the rain measurements. A wide range of photodiodes with wavelengths from 500nm to 1000nm can be used with the MLX75310. Photodiodes sensitive to a narrow wavelength between 800 and 1000nm are typically used to suppress the sun as much as possible. The LEDs should match the photodiode's wavelength.

The photodiodes used for the ambient channels are sensitive to the complete visible spectrum. The intention of these photodiodes is to see what the human eye sees. For HUD and ambient light detection, a V-Lambda photodiode is a good choice. It corresponds more closely to the human eye's spectral response curve. For tunnel detection this is less important.

The MLX75310 has integrated FET's to drive the LED's. This makes the use of external FET's superfluous and thus results in a lower BOM and space saving on the PCB. A current range between 1mA and 150mA can be supplied to the LED's.

5. Application information

The following paragraph describes the components needed to create a Rain Light Sensor module using the MLX75310. First, there is the LIN transceiver/voltage regulator. This connects the Rain Light Sensor module to the LIN bus and converts the battery supply into 3.3V for the MLX75310 and microcontroller. A suitable LIN system basis IC can be used, Melexis offers several appropriate components. A second part is the microcontroller that takes care of the software. It needs to communicate with the MLX75310 and the LIN transceiver. Communication with the MLX75310 is realized through SPI. No special requirements are needed for the microcontroller, typical 16 bit automotive grade devices should be suitable. The MLX75310 controls the LED's and the PD's. The selection of the LED's and rain photodiodes depends on many factors. The MLX75310 has a specification called Optical Transfer Ratio. $OTR = \frac{I_{LED}}{I_{RainPD}}$. The MLX75310 supports an OTR of 30 to 12000. It depends on the clarity of the windshield, the optics used to focus the LED light, the sensitivity of the PD, the radiant intensity of the LED and more. It is hard to give a list of PD's and LED's that should be used since the OTR is dependent on the windshield and optics used.

Table 1 lists components that are tested with the MLX75310. However, the MLX75310 is very flexible and can work with many different components.

Ambient detector	Rain detector	LED
SFH2270	BPW34FA	SFH4232
SFH3410	VBPW34FA	SFH4250
SFH3710	VBP104FAS	SFH4253
SFH5711	SFH2400FA	SFH4257
SFH2430	SFH2701	VSMY1850X01
BP104S		VSMY3850
TEMD6010FX01		VSMB3940
TEMD6200FX02		
TEMT6000X01		
TEMT6200FX01		

Table 1: Components list

6. MLX75310 SPI interface

The MLX75310 is controlled through SPI. It is an SPI slave.

Symbol	Command Description	Control1 Byte	Control2 Byte	Control3 Byte
NOP	Idle Command	0000 0000	0000 0000	N/A
CR	Chip Reset	1111 0000	0000 0000	N/A
WDT	Watchdog Trigger	1001 0011	0000 0000	N/A
RSLP	Request Sleep	1110 0001	0000 0000	N/A
CSLP	Confirm Sleep	1010 0011	0000 0000	N/A
RSTBY	Request Standby	1110 0010	0000 0000	N/A
CSTBY	Confirm Standby	1010 0110	0000 0000	N/A
NRM	Normal Running Mode	1110 0100	0000 0000	N/A
SM	Start Measurement	1101 00R0T	M6..M3 M2M1M0P	N/A
SD	Start Diagnostics	1011 0000	0000 0000	N/A
RO	Start Read-Out	1100 0011	0000 0000	N/A
WR	Write Register	1000 0111	D7..D0	A3..A0 P1P000
RR	Read Register	1000 1110	A3..A0 0000	0000 0000

Table 2 gives an overview of all available commands. It is not the intention of the application note to go into detail on all the possible commands. It will focus on the commands needed to get the Rain Light Sensor system running. Please refer to the datasheet for in depth information of all the commands and the SPI protocol. The following commands are used for performing rain and light measurements.

- Start Measurement
- Start Read-Out
- Write Register
- Read register

Symbol	Command Description	Control1 Byte	Control2 Byte	Control3 Byte
NOP	Idle Command	0000 0000	0000 0000	N/A
CR	Chip Reset	1111 0000	0000 0000	N/A
WDT	Watchdog Trigger	1001 0011	0000 0000	N/A
RSLP	Request Sleep	1110 0001	0000 0000	N/A
CSLP	Confirm Sleep	1010 0011	0000 0000	N/A
RSTBY	Request Standby	1110 0010	0000 0000	N/A
CSTBY	Confirm Standby	1010 0110	0000 0000	N/A
NRM	Normal Running Mode	1110 0100	0000 0000	N/A
SM	Start Measurement	1101 00R_0T	$M_6..M_3$ $M_2M_1M_0$P	N/A
SD	Start Diagnostics	1011 0000	0000 0000	N/A
RO	Start Read-Out	1100 0011	0000 0000	N/A
WR	Write Register	1000 0111	$D_7..D_0$	$A_3..A_0$ $P_1P_0$00
RR	Read Register	1000 1110	$A_3..A_0$ 0000	0000 0000

Table 2: MLX75310 instruction set

CS	Chip Select pin
DR	Device Ready pin
MISO	Master In Slave Out SPI pin
MOSI	Master Out Slave In SPI pin

Table 3: List of pin abbreviations

6.1. SM - Start Measurement

The SM command is used to start up measurement cycles. Two different Measurement Sequences can be selected with option bit M_6:

- setting M_6 high enables the Measurement Sequence 1, wherein the three Ambient Light Channels, the die temperature and the voltage on the *VSUP* pin are measured
- setting M_6 low enables the Measurement Sequence 2, wherein the DC Light, the Rain, the LED Temperature and the voltage on the *VSUP* pin during the Rain pulse are measured. When M_6 is set low, 4 other option bits are available in order to select the LED that needs to be fired and to select the Rain Channel that needs to be read out:
  - M_3: setting this bit high fires LEDA and measures the temperature of LEDA
  - M_2: setting this bit high fires LEDB and measures the temperature of LEDB
  - M_1: setting this bit high enables the rain measurement in channel A
  - M_0: setting this bit high enables the rain measurement in channel B

The table below gives the overview of available options bits in the SM command.

Control2 Bits	Measurement Sequence 1	Measurement Sequence 2
M_6	Set to 1	Set to 0
M_5	Set to 0	Set to 0
M_4	Set to 0	Set to 0
M_3	Set to 0	1 = Fire + Measure Temperature of LED A 0 = Don't fire + Measure Temperature of LED A
M_2	Set to 0	1 = Fire + Measure Temperature of LED B 0 = Don't fire + Measure Temperature of LED B
M_1	Set to 0	1 = Measure Rain on Channel A 0 = Don't measure Rain on Channel A
M_0	Set to 0	1 = Measure Rain on Channel B 0 = Don't measure Rain on Channel B
Available Measurements	Die Temperature Ambient Light Channel C Ambient Light Channel D Ambient Light Channel E Battery Voltage	DC Light before Rain pulse Battery Voltage during Rain Pulse Rain measurements Temperature of LED

Table 4: Available option bits in SM Command

After uploading the SM command, the measurement cycle is started as soon as the *CS* pin is set high. The ADC starts converting all the needed analog voltages and stores the digital values in registers.
A time t_{cs_dr} after *CS* is set high, the state of the *DR* pin goes low. A time t_{dr} after *DR* was set low, the state of the *DR* pin becomes high, indicating that all measurements are completed and that the resulted data is available for read-out (read-back of the stored data in the registers). This time can be up to 239us, if an internal auto-zeroing process is under execution and needs to be finished.

Note that the *DR* pin can be used as an interrupt for the master device as it indicates when a read-out cycle can be started.

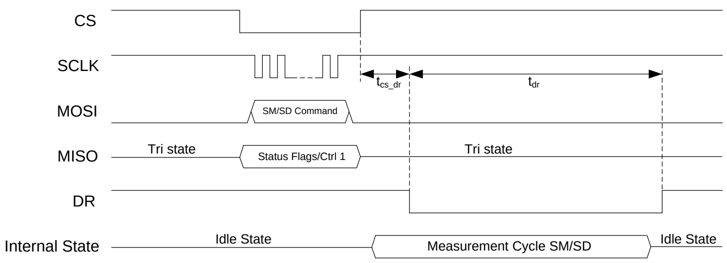

Figure 4: Timing diagram of a measurement cycle

6.2. RO- Read-Out

When the state of the *DR* pin changed into a high state, the measurement data is available for read-out. The RO command shall be uploaded to start a read-out cycle and to start reading out the data that was stored in the internal registers.

To make sure that no memory effects can occur, all data registers are cleared at the end of each read-out cycle.

A typical timing diagram is given in Figure 5 below:

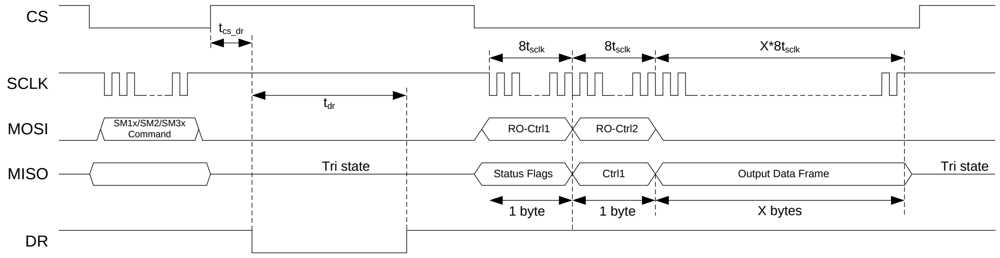

Figure 5: Timing diagram for Read-Out

Note that the RO command is not available in Standby and Sleep Mode.

The data that appears on the *MISO* pin depends on the type of measurement that was done (i.e. it depends on the command that was uploaded: SM/SD and the selected option bits $M_6..M_0$).

The table below shows the Output Data Frame when Measurement Sequence 1 is selected:

Data Byte Number	Output Data Frame Contents - Measurement Sequence 1	Comments
Byte 3	Die Temperature Measurement (8 MSB)	Depends on EN_TEMP
Byte 4	Die Temperature Measurement (8 LSB)	Depends on EN_TEMP
Byte 5	Ambient light channel C measurement (8 MSB)	Depends on EN_CH_C
Byte 6	Ambient light channel C measurement (8 LSB)	Depends on EN_CH_C
Byte 7	Ambient light channel D measurement (8 MSB)	Depends on EN_CH_D
Byte 8	Ambient light channel D measurement (8 LSB)	Depends on EN_CH_D
Byte 9	Ambient light channel E measurement (8 MSB)	Depends on EN_CH_E
Byte 10	Ambient light channel E measurement (8 LSB)	Depends on EN_CH_E
Byte 11	Battery Voltage Measurement (8 MSB)	Depends on EN_VSUPMON
Byte 12	Battery Voltage Measurement (8 LSB)	Depends on EN_VSUPMON
Byte 13	CRC (8 bit)	Output always

Table 5: SM Output Data Frame - Measurement Sequence 1

The table below shows the Output Data Frame when Measurement Sequence 2 is selected:

Data Byte Number	Output Data Frame Contents - Measurement Sequence 2	Comments
Byte 3	DC measurement of IR channel A (8 MSB)	Depends on M_1 + on EN_CH_A
Byte 4	DC measurement of IR channel A (8 LSB)	Depends on M_1 + on EN_CH_A
Byte 5	DC measurement of IR channel B (8 MSB)	Depends on M_0 + on EN_CH_B
Byte 6	DC measurement of IR channel B (8 LSB)	Depends on M_0 + on EN_CH_B
Byte 7	Battery Voltage Measurement during rain pulse (8 MSB)	Depends on EN_VSUPMON
Byte 8	Battery Voltage Measurement during rain pulse (8 LSB)	Depends on EN_VSUPMON

Byte 9	Rain measurement of IR channel A (8 MSB)	Depends on M_1 + on EN_CH_A + LED selection depends on M_3/M_2
Byte 10	Rain measurement of IR channel A (8 LSB)	Depends on M_1 + on EN_CH_A + LED selection depends on M_3/M_2
Byte 11	Rain measurement of IR channel B (8 MSB)	Depends on M0 + on EN_CH_B + LED selection depends on M_3/M_2
Byte 12	Rain measurement of IR channel B (8 LSB)	Depends on M0 + on EN_CH_B + LED selection depends on M_3/M_2
Byte 13	Temperature of LED that was fired (8 MSB)	Depends on EN_LEDSENS + LED selection depends on M_3/M_2
Byte 14	Temperature of LED that was fired (8 LSB)	Depends on EN_LEDSENS + LED selection depends on M_3/M_2
Byte 15	CRC (8 bit)	Output always

Table 6: SM Output Data Frame - Measurement Sequence 2

When certain measurement blocks are disabled, the corresponding data bytes are omitted from the Output Data Frame.

Cyclic Redundancy Check Calculation
In all Output Data Frames, a CRC byte is included as last byte. This byte provides a way to detect transmission errors between slave and master. An easy method to check if there were no transmission errors is to calculate the CRC of the whole read-out frame as defined in previous tables. When the calculated CRC results in 0x00, the transmission was error free. If the resulting CRC is not equal to zero, then an error occurred in the transmission and all the data should be ignored.
For more information regarding the CRC calculation, please refer to the datasheet.

6.3. WR/RR - Write Register / Read Register

The MLX75310 contains several user registers that can be read and written by the master. The WR and RR commands are used for that.

The WR command writes the contents of an 8-bit register addressed by bits $A_{3..0}$ with data $D_{7..0}$. Data is sent to the device over the *MOSI* pin. Control2 Byte contains the 8 bit data that shall be written into the target register. Control3 Byte contains the address of the target register.
The WR command is defined in the table below:

Control1 Byte	Control2 Byte	Control3 Byte
1000 0111	$D_7D_6D_5D_4$ $D_3D_2D_1D_0$	$A_3A_2A_1A_0$ $P_1P_0$00
$D_7D_6D_5D_4$ $D_3D_2D_1D_0$ $A_3A_2A_1A_0$ P_1P_0	Data contents of register to be written Address of target register Parity bits (P_1 = odd parity bit, P_0 = even parity bit)	

Data1 Byte	Data2 Byte	Data3 Byte
Status Flag Byte	1000 0111	0000 0000

Table 7: Write Register command

In order to detect some transmission errors while writing data towards the slave device, the micro-controller has to compute an odd and an even parity bit of the Control2 and the 4 MSB's of the Control3 byte and send these parity bits to the slave. The slave will check if the parity bits are valid. The data will only be written into the registers if the parity bits are correct. If the parity bits are not correct, bit 7 of the internal Status Flag Byte will be set high, indicating that the command was invalid. This can be seen when uploading a NOP command (when one is only interested in reading back the internal status flags) or during upload of the next command.
In case the parity bits were not correct, the data of the registers will not be changed.

The parity bits calculation is based on the data $D_7..D_0$ and $A_3..A_0$. If the number of ones in the given data set [$D_7..D_0$, $A_3..A_0$] is odd, the even parity bit P_0 shall be set to 1, making the total number of ones in the set [$D_7..D_0$, $A_3..A_0$, P_0] even.
Similar: if the number of ones in the given data set [$D_7..D_0$, $A_3..A_0$] is even, the odd parity bit P_1 shall be set to 1, making the total number of ones in the set [$D_7..D_0$, $A_3..A_0$, P_1] odd.

Note that the parity bits can be generated with XOR instructions: P_1 = XNOR($D_7..D_0$, $A_3..A_0$) and P_0 = XOR($D_7..D_0$, $A_3..A_0$). The odd parity bit P_1 should always be the inverse of the even parity bit P_0.

The RR command returns the contents of an 8-bit register addressed by bits $A_{3..0}$. Data is read back over the *MISO* pin. The Data1 Byte contains the Internal Status Flag byte. Data2 Byte contains the copy of the Control1 Byte. Data3 Byte contains the 8 bits of the target register.
The RR command is defined in the table below:

Control1 Byte	Control2 Byte	Control3 Byte
1000 1110	$A_3A_2A_1A_0$ 0000	0000 0000
$A_3A_2A_1A_0$	Address of target register	
Data1 Byte	**Data2 Byte**	**Data3 Byte**
Status Flag Byte	1000 1110	$D_7D_6D_5D_4$ $D_3D_2D_1D_0$
$D_{7..0}$	Data contents of register read	

Table 8: Read Register command

Note that the WR and RR commands are commands that require 3 bytes instead of 2 bytes.

An overview of the registers that can be read and written are given in Table 9. Please refer to the datasheet for an in depth explanation of these registers.

Table 9: MLX75310 register map

Name	Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SetAna	0x0	VSUPLOW1	VSUPLOW0	-	-	-	Tdc_pulse1	Tdc_pulse0	Unity_Gain
SetAH	0x1	DACA7	DACA6	DACA5	DACA4	DACA3	DACA2	DACA1	DACA0
SetAL	0x2	GAIN_ADJ _A2	GAIN_ADJ _A1	GAIN_ADJ _A0	-	BW_ADJ _A1	BW_ADJ _A0	-	-
SetBH	0x3	DACB7	DACB6	DACB5	DACB4	DACB3	DACB2	DACB1	DACB0
SetBL	0x4	GAIN_ADJ _B2	GAIN_ADJ _B1	GAIN_ADJ _B0	-	BW_ADJ _B1	BW_ADJ _B0	-	-
SetTP	0x5	-	-	EN_ LEDSENS	EN_ VSUPMON	EN_ PDCOMP	TP2	TP1	TP0
Err	0x6	Err_ VsupH	Err_ TIA	Err_ Drv	Err_ Vref	Err_ Amb	Err_ RCO	-	Err_ VsupL
Rst	0x7	PD_COMP_ IC13	PD_COMP_ IC12	PD_COMP_ IC11	PD_COMP_ IC10	TrimOk	DieChip	TO	POR
Version	0x8	Ver3	Ver2	Ver1	Ver0	PD_COMP_ IC23	PD_COMP_ IC22	PD_COMP_ IC21	PD_COMP_ IC20
PDComp	0x9	PD_COMP_ IC33	PD_COMP_ IC32	PD_COMP_ IC31	PD_COMP_ IC30	PD_COMP_ IC43	PD_COMP_ IC42	PD_COMP_ IC41	PD_COMP_ IC40
GainBuf	0xA	-	-	-	GAIN_BUF4	GAIN_BUF3	GAIN_BUF2	GAIN_BUF1	GAIN_BUF0
Calib1	0xB	TRIM_ T_SLOPE4	TRIM_ T_SLOPE3	TRIM_ T_SLOPE2	TRIM_ T_SLOPE1	TRIM_ T_SLOPE0	-	-	-
Calib2	0xC	-	-	TRIM_ TEMP5	TRIM_ TEMP4	TRIM_ TEMP3	TRIM_ TEMP2	TRIM_ TEMP1	TRIM_ TEMP0
EnChan	0xD	EN_TEMP	EN_DIAG_A	EN_DIAG_B	EN_CH_A	EN_CH_B	EN_CH_C	EN_CH_D	EN_CH_E
Tamb	0xE	PD_COMP_ IC53	PD_COMP_ IC52	PD_COMP_ IC51	PD_COMP_ IC50	-	-	Tamb1	Tamb0
SetPLS	0xF	OS_ADJ_ LED1	OS_ADJ_ LED0	G_ADJ_ LED1	G_ADJ_ LED0	-	-	Rise1	Rise0

7. Basic system configuration

Only a few steps and registers are needed to get a Rain Light Sensor system with the MLX75310 running. The MLX75310 is a very flexible chip. There are more registers that can be used to optimize the system for specific preferences. The main register used is the DACA/DACB register. It sets the output driver strength.

The strength of the light pulse must be set to configure the rain signal to be in the proper ADC range. The output DAC registers (DACA and DACB) control the strength of the pulse. The ADC range is between 0 and 65535LSB. Lower values correspond to less received light in the photodiode. 55000LSB without rain on the windshield is a value one should aim to get. It is not too close to saturation and has a good resolution to detect small amounts of rain. The rain output value will decrease when there is rain on the windshield.

8. Advantages of the MLX75310

The MLX75310 is the best choise for use in a fully digital Rain Light Sensor system with extreme optical performance and a high integration. The main advantages of the MLX75310 over other Rain Light Sensor interface chips or discrete circuits are:

- The MLX75310 is designed specifically to interface to the highly demanding Rain Light Sensor module.
- The MLX75310 has a large and programmable dynamic range, allowing the part to cater to a wide range of input signals (variation of windshield shades, variation of external light influences, variation of LED & PD performances due to mechanical setup, ageing effects).
- The MLX75310 has a flexible and versatile digital SPI interface with large programmability and easy to use 16bit ADC readout.
- The MLX75310 has internal compensation for both large sunlight effects (static & dynamic) and for parasitic 2nd order effects of low-cost PD's. Both rain and sun signals are measured and compensated for at a 16bit level, allowing the user of the MLX75310 to create a Rain Light Sensor system with the highest possible performance in rain detection.
- The MLX75310 has an internal pre-driver to facilitate a large dynamic range, and the external FET's allow for intense current peaks to maximize SNR and allow for the use of low cost PD's.
- The MLX75310 has several diagnostic and internal watchdog features that enable system designers to design a fail-safe Rain Light Sensor system.
- The MLX75310 comes with 2 versatile rain channels and 3 versatile ambient channels, allowing the Rain Light Sensor system architect to connect to any PD required for best system performance or lowest cost.
- With the 3.3V power supply, sleep and standby modes, the MLX75310 offers a Rain Light Sensor system maximum flexibility, with low-power modes for different car-models.
- The MLX75310 comes in a small QFN4x4 leadless package with minimal footprint, external components and ECU overhead for a Rain Light Sensor application.

9. Disclaimer

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