AS7211: User Guide

Smart Lighting Technology for Network-Enabled Daylighting Applications

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Revision History

Revision	Date	Owner	Description
1.1	7.16.2014		Initial NDA version
1.2	11.24.2014	KH/TG	Content updates

1 Introducing the AS7211 Smart Lighting Manager

1.1 Smart Lighting Manager at a Glance

The **ams** AS7211 Smart Lighting Manager is part of the ams family of intelligent ambient light-sensing managers. It offers low-cost, robust solutions for local and network control of LED and fluorescent lights for today's energy conscious world. The **ams** Cognitive Lighting™ family of products enables lights to adapt to their surroundings automatically to meet human lighting and energy conservation needs. With this technology, it is quick and easy for designers of luminaires and replacement lamps/bulbs to add "intelligence" to practically any lighting product. Smart Lighting Manager enabled intelligence can dim or turnoff the light as there is sufficient daylight entering the space to offset the need for electric light (called "Daylight Harvesting" or simply "Daylighting"), and operate the light features based on a schedule.

Applications include commercial, industrial, retail and residential lighting controls, networked managed lighting, and building automation control of lighting systems.

1.2 AS7211 Smart Lighting Manager Enabled Intelligence

- Daylight harvesting: Automatically reduce electric light levels when daylight is available, enabling manufacturers' compliance with the latest government regulations for energy reduction, including California's Title 24 Building Efficiency Code, and other standards worldwide.
- Eliminates the LED-binning penalty: No VF or luminous binning necessary, significantly reducing the cost of lighting systems.
- Simple configuration: The AS7211 Smart Lighting Manager provides a text-based serial command interface borrowed from the "AT Command" model used in early Hayes modems, called the Smart Lighting Command Set. For example:
    - ATSDIM=50 Set the illumination to half intensity
    - ATSLUX=375 Set the desired target illumination of the space to 375 lux

The complete Smart Lighting Command Set (SLCS) and associated operations are covered in detail in the Smart Lighting Command Set user guide. A complete USB-to-serial interface dashboard and cable are available as part of the standard AS7211 Smart Lighting Integration Kit.

2 How the AS7211 Smart Lighting Manager Works

2.1 Inside the Smart Lighting Manager

For the luminaire designer, the strength of the Smart Lighting Manage derives from its ability to provide “drop-in” intelligence. A designer can readily incorporate intelligent functionality such as daylight harvesting into virtually any luminaire or lamp. Internal sensors support photopic ambient light and optional proximity sensing capabilities. Expandability to connect to additional external sensors is provided via an I²C sensor port that automatically recognizes any ams sensor. A block diagram of the AS7211 is shown in **Figure 1**.

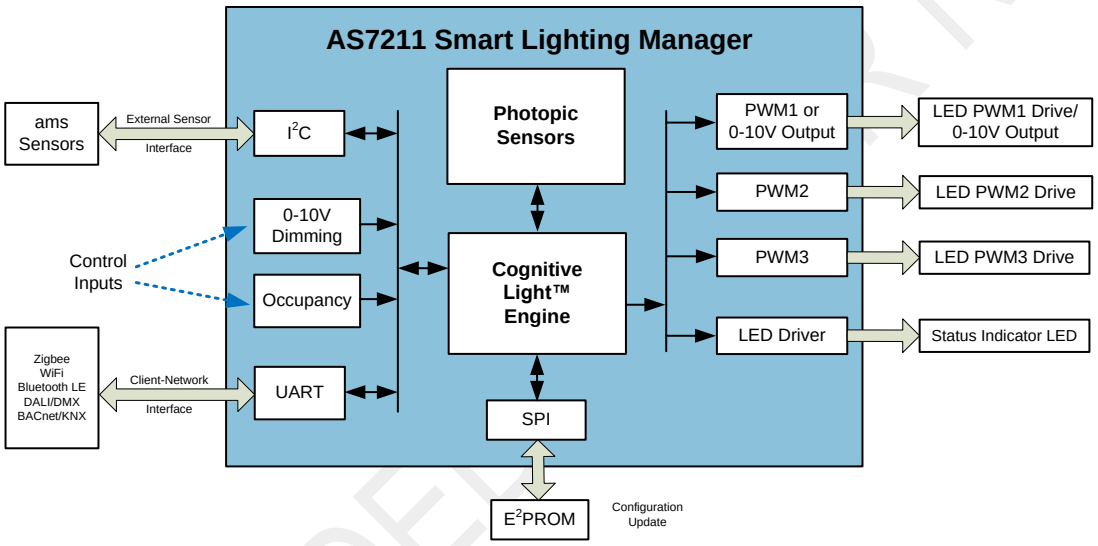

Figure 1: AS7211 Block Diagram

2.2 Cognitive Light™ Engine

The Cognitive Light™ Engine (CLE) at the heart of the Smart Lighting Manager is robust and optimized for the luminaires, light sources, and environmental conditions found in modern lighting. The CLE is where the Smart Lighting Manager gets its “smarts,” determining what the light should do based on input information from a variety of sources, including: the **integrated photopic sensors** for ambient light, local controls, connected sensors, and control networks. Depending upon the embedded and connected sensors, the AS7211 can track the time of day, the natural light conditions in its vicinity, the performance and nature of the electric light sources it manages, the presence and actions of nearby individuals, and a host of additional information sources to adapt lighting to the benefit of those who use it while minimizing power consumption and costs.

Interface Ports:

External Sensor Port: The Smart Lighting Manager can receive signals from external sensors via the 2-wire I^2C master sensor interface.

Local Controls Inputs: The Smart Lighting Manager receives signals from standard local controls such as dimmers and occupancy.

PWM Outputs: The Smart Lighting Manager supports up to 3 PWM outputs that can modulate drivers to control multiple LED strings. For fluorescent daylighting applications, PWM1 can be alternately configured to support a 0-10V output to directly drive the 0-10V input of standard dimming ballasts.

Configuration Port: SPI interface to EEPROM/SD Card. The AS7211 can run the configuration from the external EEPROM. Alternately it can detect and load its external configuration EEPROM from an SD Card using the SPI port.

Network Port: Using a standard UART network access port, the Smart Lighting Manager provides connections to wireless networks such as Bluetooth Low Energy (BLE), Wi-Fi, and ZigBee. This port enables simple high-level Lighting Commands for configuring and adjusting the lights, with no need for drivers or additional protocol stacks.

3 Interfacing with the AS7211 Smart Lighting Manager

3.1 Smart Lighting Manager Connections

The AS7211 Smart Lighting Manager has four main types of interfaces to the external world. These are the Local Control Interface, External Sensor Port, Lighting PWM Outputs, and Network Port.

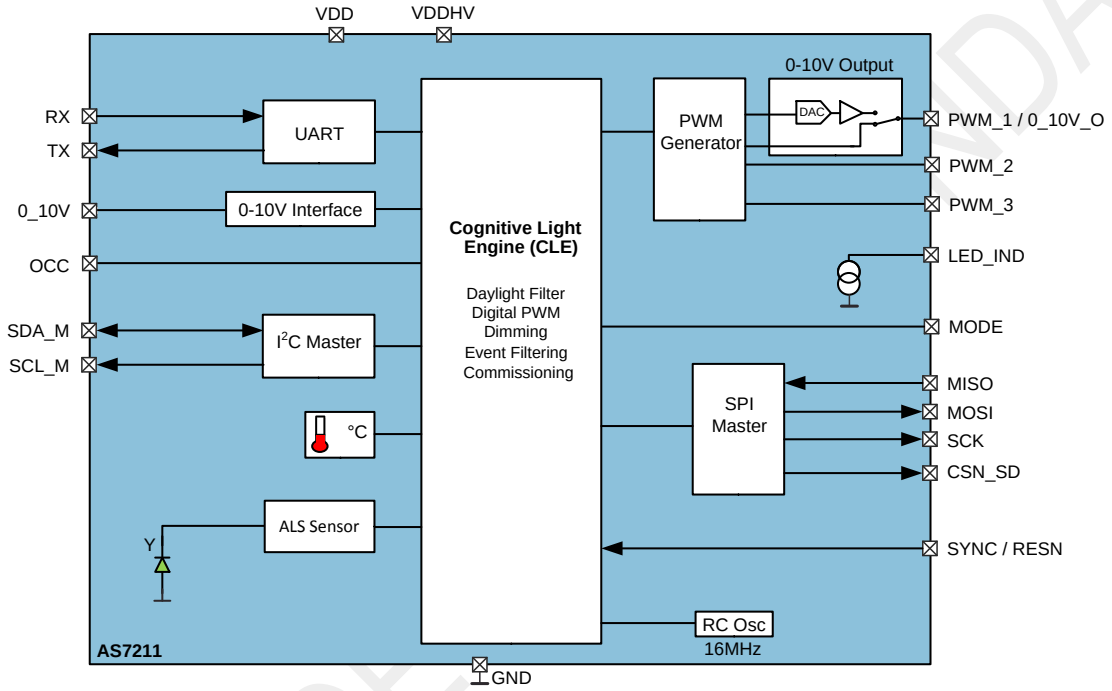

Figure 2: AS7211 Input, Output and Power pin connections

3.2 Local Control Interface

The AS7211 can be configured for a variety of local control types, including push-button operation and dimmer knobs or slide controls:

0-10V Analog Dimmer Input (0_10V)

This input can be used to evaluate signals provided by, for example, electronic dimmers. The 0-10V input signal must be scaled down by either an internal voltage divider or an external voltage divider, depending on power supply configuration, and then the scaled signal is converted to a 10 bit digital value in the AS7211.

To use the internal voltage divider, the voltage VDDHV has to be 12V ±10%. If a second supply is not available, VDD and VDDHV are tied together and the scaling has to be done by an external resistor

divider. See **Figure 3**. In addition, if VDDHV is 3.6-10V the 0_10V input scaling again has to be done by an external resistor network with the same scaling ratio as shown in **Figure 3**.

If the Dimming function is not to be used, tie the 0-10V input pin to VDDHV.

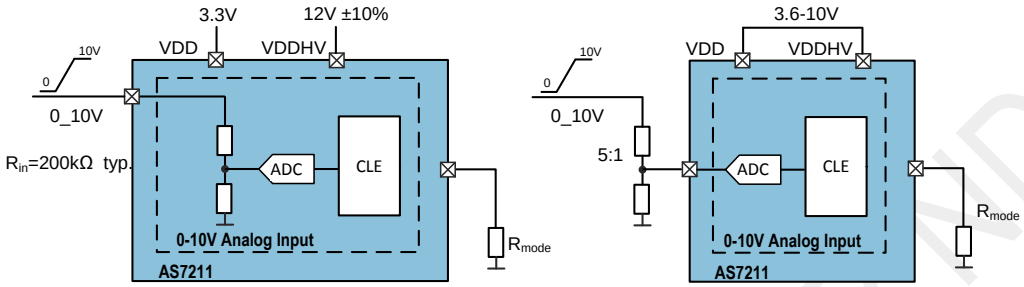

Figure 3: Input circuit options for a 0-10V analog control interface

Occupancy Sensor Input (OCC)

The occupancy sensor input is a digital control (active Low) that if used allows occupant detection control of the luminaire. Occupancy is declared active by the AS7211 after a continuous 500ms Low signal at the OCC pin, and, is declared inactive after 10 minutes of continuous High signal at the OCC pin.

Usage of the occupancy sensor input is not required for the other control inputs (IR or 0-10V dimming) to properly operate. If not required for luminaire operation, tie the OCC pin to VDD.

3.3 External Sensor Port (I^2C)

In addition to the built-in sensors, the AS7211 provides connections for additional external sensors.

There are no “pin connections” for internal sensors (Photopic, Temperature) because they are managed by the AS7211 itself. Additional external sensors may be needed in cases such as when the AS7211 needs to respond to other environmental information due to luminaire location or design.

Some examples of external sensors that can be connected to the AS7211 are:

- Daylight Sensors (TSL4531)
- Presence/Occupancy Sensor
- Temperature, humidity sensor
- CO/CO_2, smoke/fire sensors etc.

The AS7211 auto-detects I^2C based sensors that are registered at ams and automatically enables apps to support these functions.

3.4 PWM Outputs

The Smart Lighting Manager provides two different types of output signals to control the light, intended for fluorescent and LED lighting applications.

0-10V Output

When PWM1 is configured as a 0-10V, the analog output is buffered and is intended primarily for driving dimmable fluorescent/LED light AC ballasts with 0-10V dimming inputs. Ballast manufacturers such as GE, Philips, Universal, Metrolight, and Sylvania offer the 0-10V lighting control standard for commercial and industrial lighting products. 0-10V dimming is limited to 10-100% or OFF.

Digital PWM Outputs

The brightness of an LED light can best be controlled using pulse width modulation. PWM provides a full, continuous range of control, from zero to full brightness (1 to 100% dimming), Using PWM control, the LED is actually flashing on and off very rapidly, as long as the frequency is high enough (typically above 100-Hz for 50-Hz AC or 120-Hz for 60-Hz AC), this “flashing” is not perceptible to the human eye.

The duty cycle, or ratio of on-time to off-time, characterizes the PWM signal. At a 90% duty cycle the LED will be on for 90% of the time. At 50% duty cycle the LED will be on for half the time, and so on. At 0% the light is completely off, and at 100% it is completely on, relative to its rated lumen output. The frequency of the PWM output is set to approximately 5Khz.

All digital PWM outputs are phase delayed from each other for improved external power switching performance (EMI, etc.). In addition the internal AS7211 PWM time base can be externally synchronized using the SYNC pin.

PWM Output Configuration

The AS7211 supports three PWM outputs. For PWM_1, the voltage level at pin VDDHV and resistor RMODE value at pin MODE will select either a 0-VDD (or 0-VDDHV) digital PWM_1 or 0-10V voltage for the output pin PWM_1/0_10V_O. Refer to Figure 4 and Figure 5 for PWM_1/0-10V_O configuration options. PWM 2 and PWM3 always are digital PWM outputs between VDD and GND.

Figure 4: PWM_1/0-10V_O Dimming Output selection

AS7211 MODE	AS7211 VDDHV	PWM_1/0-10V_O Pin	Type of Ballast
0	VDD	Digital PWM (0-VDD)	Voltage Ballast or Current Ballast (with PWM input)
0	3.6-15V	HV Digital PWM (0-VDDHV)	HV FET driver or Japanese PWM Specification
1	3.6-10V	HV Digital PWM (0-VDDHV)	HV FET driver
1	12V±10%	Analog 0-10V	Current Ballast (with 0-10V input)

Figure 5: AS7211 MODE settings

AS7211 MODE	Mode Pin Resistor Value
0	R=100Ω
1	R=560Ω

3.5 Network Port

The TX/RX pins use digital signal levels to interface an internal UART. The AS7211 Smart Lighting Command Set provides flexible command/control interfacing of the UART to external wired and wireless networks. Additional documentation is available from ams on the Smart Lighting Command Set.

3.6 Configuration Port (SPI)

AS2711 external SD Card and direct SPI configuration

The AS7211 is fully configured at startup from an external pre-configured EEPROM via the SPI (Serial Peripheral Interface) that can be loaded by the customer, or it may be loaded as part of the lamp/luminaire manufacturing process. There are 3 methods used to configure the EEPROM with configuration data provided by ams.

Direct SPI Operation

For flexible manufacturing processes, the AS7211 EEPROM can also be directly configured via the SPI interface. In this procedure the RESN pin is pulled down for a minimum of 100ms, enabling direct connection via the SPI interface to the external EEPROM.

Refer to **Figure 6**.

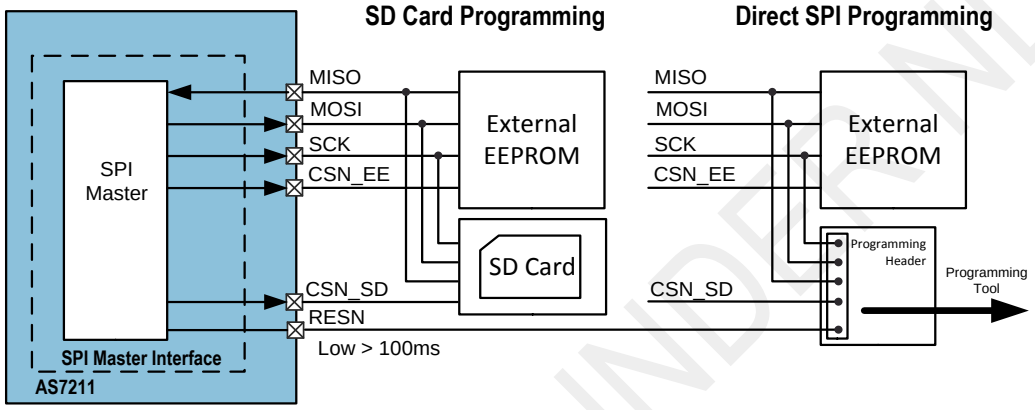

Figure 6: SD Card and direct SPI Operation

SD Card Update Operation

Simplified loading of a configuration update can be accommodated and the AS7211 will detect the presence of a standard SPI port memory card. When the SD card is detected the content of the card is copied to the external EEPROM. This configuration procedure is indicated by fast flashing (10ms pulses) of the indicator LED. When the configuration being loaded into the EEPROM is complete, the indicator LED is switched off. After this operation the SD card should be removed. A wide range of memory card types may be used in conjunction with AS7211's SPI port including MMC, SD, miniSD, and microSD cards. Note that updates do require an initial pre-configuration of the EEPROM, either before assembly or through the direct SPI operation described above.

Over the Air Operation

Using the Smart Lighting Command Set the configuration can be updated over the air via the UART Network Port. When available, the operation for this function is described in Smart Lighting Command Set documentation.

4 AS7211 Application Design Overview

4.1 Daylight Harvesting Energy Saving Light Control

The AS7211 Smart Lighting Manager continuously manages Luminaire Light Control

- How bright is the ambient light level? The AS7211 continuously measures the level using internal sensors.
- Is anyone in the room? The AS7211 continuously monitors the occupancy sensor input.
- At what level is the dimmer set? The AS7211 continuously monitors the external dimmer control input.
- If a remote control override is needed, the network port delivers control commands to the AS7211 that can dim lights, set specific lux level targets or execute stored scenes.

The block diagram below (**Figure 7**) shows a daylighting system with the AS7211 inputs on the left being used (along with the AS7211 internal daylight sensor) to control an ams LED driver, providing luminaire dimming control. This pulse width modulated output interfaces directly with the ams AS3834 LED Driver which is capable of supplying the high currents needed by bright LEDs used for room lighting. This setup enables a maximum amount of light output with minimal chip count and low BoM. An EEPROM provides the AS7211 configuration.

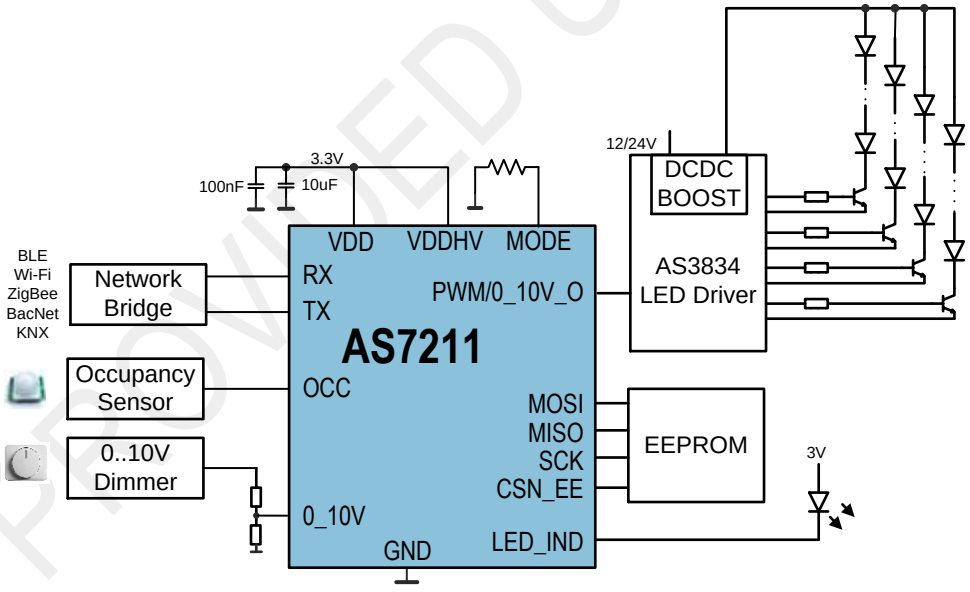

Figure 7: Sensor Drive Daylighting LED System

4.2 Fluorescent Light Control System with Automatic Daylight Harvesting

In this example, the AS7211 is used to control a dimmable fluorescent luminaire using a standard 0-10 volt analog output signal. The block diagram (**Figure 8**) is similar to the previous, except since the 0-10 volt output is used for luminaire dimming control, a second supply voltage at 12 volts is needed in addition to the AS7211's usual 3.3 volt power supply.

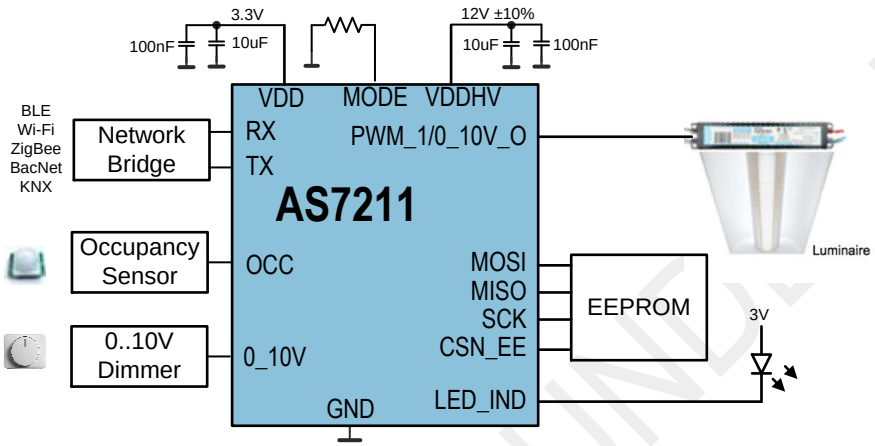

Figure 8: Sensor Driven Daylighting Fluorescent Lighting System

About ams

Austriamicrosystems (**ams**), makes intelligent optoelectronic solutions for a variety of markets covering lighting, smartphones, displays, medical and industrial applications, and offers intelligent SLC devices optimized for lighting applications. For more information, visit www.ams.com