EnOcean

TCM 330 Product Integration

1. INTRODUCTION

The EnOcean TCM 330 is designed as a *place and play* module for integrating EnOcean wireless self-powered sensors and switches. The TCM 330 is an application specific member of the TCM 300 family hardware with specific firmware functionality developed to control 0-10 and PWM control interfaces. This includes applications in LED lighting, legacy dimmable lighting, fan control and more. The TCM 330 eliminates the need to undergo embedded software development and provides a quick to market solution when coupled with EnOcean Alliance compatible wireless sensors and commissioning tools.

1.1 Table of contents

1.2 References

Familiarity with the following will be useful for utilizing this application note

[1.] EnOcean Equipment Profiles (EEP)

[2.] Remote Management Specification

[3.] Remote Commissioning Specification

[4.] EnOcean Radio Protocol

[5.] TCM 3xx User Manual

[6.] Dolphin Core Description

[7.] TCM 330 Install Guide

[8.] AN502 Dolphin In-Circuit Programming

Useful Web sites:

[9.] EnOcean website **http://www.enocean.com**

[10.]   EnOcean Alliance website **http://www.enocean-alliance.org**

1.3 Purpose

The TCM 330 is a low cost solution for EnOcean integration. This application note will discuss the functionality provided by the TCM 330, hardware interfaces for PWM and 0-10V DC systems, and best design in practices. This application note will focus on the integration of a TCM 330 into a LED driver in order to provide advanced dimming functionality related to day light harvesting, occupancy control, demand response, scheduling, and manual user dimming.

1.4 Operational System Overview Diagram

Depending on the application the overall system may contain different functional blocks.
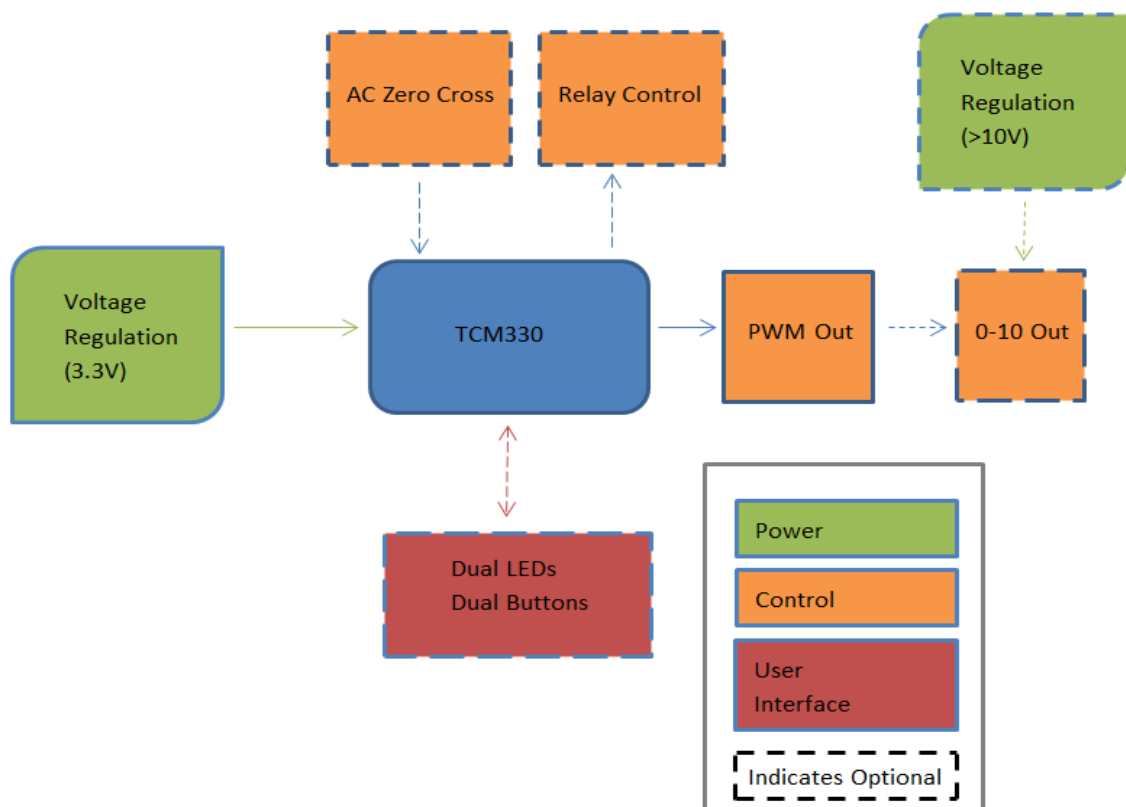

Figure 1

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Not shown above is the configuration interfaces consisting of the hardware configuration interface accessed by Dolphin Studio and the application configuration interface accessed by Navigan.

1.5 Application Control Functionality Provided by the TCM 330

The included firmware provides translation from various EnOcean (EO) energy harvesting sensors to usable interface signals. The supported sensor types include switches, occupancy sensors, light level sensors, and central controllers. Based on the sensor inputs the TCM 330 will output a variable duty cycle PWM waveform. This can be converted to an analog signal of any minimum and maximum with additional components.

The TCM 330 also is remotely configurable over the air (OTA) via the EnOcean Alliances Remote Configuration Protocol. The TCM 330 implements the EnOcean Alliances Remote Commissioning Specification which enables configuration with software tools, and does not require physical access to the device to be commissioned. For details of each device and relevant parameters please see the TCM 330 Installation Guide.

The TCM 330 supports linking with the following sensors and EEPs:

Device	EEP(s)		
Rocker Switch	F6-02-02		
Occupancy Sensors	A5-07-01	A5-07-02	A5-07-03
Light Level Sensors	A5-06-02	A5-06-03	
Central Gateway	A5-38-08		

Figure 2

Rocker Switches

EnOcean switches maximize ease of install and allow for optimal placement for a user instead of being confined to existing wiring or junction boxes. The TCM 330 supports linking with both single and double rocker EnOcean switches. Rocker switches enable manual on, off and output level control.

Occupancy Sensors

Occupancy sensors can be utilized to save energy by disabling or setting back controlled systems when a space is unoccupied. Occupancy sensors can also be enabled to support auto on scenarios.

Light Level Sensors

Light level sensors allow the output to vary based on measured light levels. A Light level sensor must be linked with another supported sensor. Two operation modes exist, a bi-level output mode with hysteresis, and a custom output based on 5 anchor points in the xy input output relationship graph.

Central Controllers

Central controllers can provide exact output based on more complex logic or inputs outside of the linked EnOcean sensors. This may include manual control, remote overrides, demand response signals, or time based scheduling. The TCM 330 supports the dim command from linked central controllers.

1.6 Hardware Integration of the TCM 330

The TCM 330 is designed to be integrated into host PCBs. The TCM 330 is not self-sufficient, it requires additional circuitry to provide power, storage memory, and any application specific hardware. There is additional optional circuitry available for a local user interface.

Mandatory TCM 330 Hardware Interfaces:

- Power Supply
- I2C EEPROM
- Antenna
- Reset Control

Optional TCM 330 Hardware Interfaces:

- LED Interface
- Two inputs for physical buttons
- Relay Control Pins with Overdrive option
- Zero Cross Detection for Relay Switching
- Programming and Configuration Interface

TCM 330 Pin Functions

TCM 330 Pin Name [Number]	TCM 330 Function	Mandatory to Implement
VDD [2]	VDD	Yes
GND[1,5,7,17,24,26,28,31]	GND	Yes
IOVDD[23]	VDD	Yes
Reset[27]	Hardware Reset – Externally Control	Yes
RF WHIP[4]	Wire Antenna Output	Yes (If not custom antenna)
RF 50 OHM[6]	Custom Antenna Output	Yes (If not standard antenna)
ADIO0[9]	I2C – SCL	Yes
ADIO5[14]	I2C – SDA	Yes
ADIO4[13]	PWM Output	Yes
ADIO3[12]	Primary Relay Control	No
ADIO2[11]	Relay Over Drive Control	No
ADIO1[10]	Zero Cross Detect	No
PROG_EN [18]	Enter Program Mode	Yes, for relay parameter configuration
WXIDIO [29]*	Clear Button	No

WXODIO [30]*	Learn Button	No
WSDADIO2 [21]	LED 1	No
RSDADIO3 [22]	LED 2	No

Figure 3

* Max voltage on WXIDIO and WXODIO is 1.8 V as these are supplied by UVDD and not DVDD. See the Dolphin Core Description for more information.

TCM 330 Programming and Configuration Interface Pins

Name	TCM 330 Pin or Net	Info
GND	Common Ground	
VDD_PROG	VDD [2]	Power Supplied by Programmer
Reset	Reset [27]	
PROG_EN	PROG_EN [18]	Enable Prog/Config mode
RSDADIO3	RSDADIO3 [22]	
WSDADIO2	WSDADIO2 [21]	
SCLKDIO1	SCLKDIO1[20]	
SCSEDIO0	SCSEDIO0 [19]	
ADIO7	ADIO7 [16]	

Figure 4

1.6.1 Power Supply

The TCM 330 requires a power supply voltage between 3.0 V and 3.3 V. The ripple should be under 10 mVpp for optimal RF performance. Care should be taken to avoid emitted and conducted emissions. See app note Power Supply Layout [AN101] and the TCM 300 user manual.

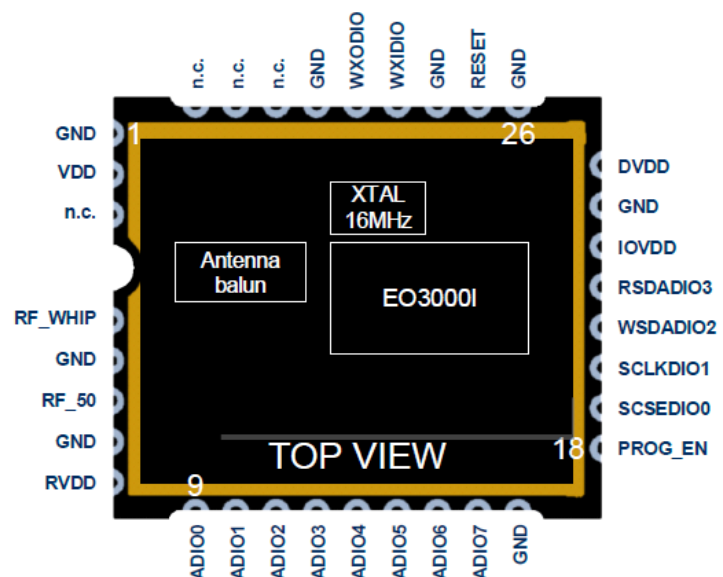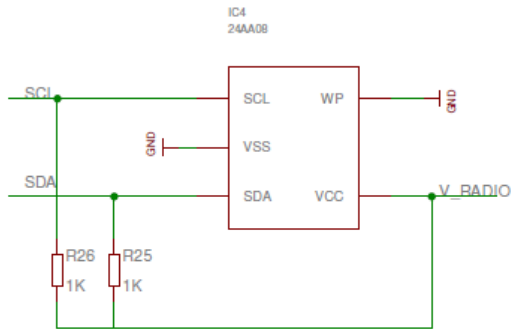**Figure 5**

1.6.2 I2C EEPROM

The TCM 330 is made to interface with I2C EEPROM. It is used for storing configuration and links. The recommended module is Microchips 24AA08. In addition, the SCL and SDA lines require 1 k pull up resistors on them.

Figure 6

1.6.3 Antenna Options

The TCM 330 offers three modular FCC approved antenna options. A wire whip, a helical or a surface mount chip antenna. A 50 Ohm impedance RF output for custom antenna solutions. Please see the TCM 300 user guide for more info.

Antenna placement is critical to a successful product design. The antenna must not be placed near metal nor near conducted or emitted noise generators. Please see Antenna Basics [AN102] and the TCM 300 user manual.

1.6.4 Reset Control

A Reset pin exists and can be utilized to perform hardware resets via a physical button, or external control signal. If the reset control pin is not required it should be directly connected to GND. Note the reset line is also used in the programming interface. See the TCM 300 user manual for details.

1.6.5 LED Interface

Some products may include a local user interface. For feedback a bicolour or two discrete LEDs may be used. These LEDs will be utilized to denote successful learn in, sending of a teach telegram, and several other functions. The LED interface should include appropriate current limiting resistors and maximum source and sinking currents must be observed. This is +-2 mA for a 3.3 V supply; electrical details are described in the Dolphin Core Description Document.
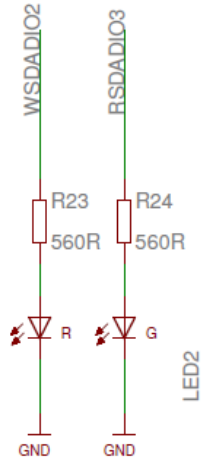
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Figure 7

1.6.6 Dual Button Physical User Interface

If a physical interface exists a dual button interface is utilized to perform teach in of sensors, transmit teach telegrams, and test the output. While designed for a physical interface this could also be controlled digitally. See the TCM 330 install guide for details. An example physical button interface is below, CLR interfaces to WXIDIO and LRN interfaces to WXODIO*:
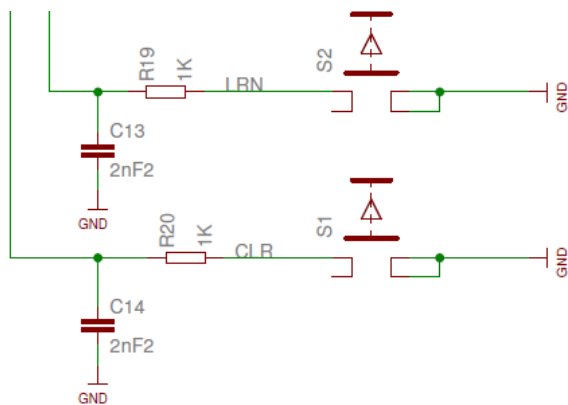

Figure 8

*The CLR and LRN pins max voltage is 1.8 V and not VDD!

1.6.7 Relay Control, including Overdrive

In some designs a relay will be utilized to fully shut off power flow to some components. This relay can be a DC or AC relay depending on the application requirements. The primary relay control pin is ADIO3. A relay overdrive pin also exists to provide additional current to the relay at switch on time. This can be utilized to reduce standby current of the relay. Note that the Relay Over-Drive Time is configurable via Dolphin Studio. The default Relay Over-Drive Time is 110 milliseconds.

Both the Relay Control and Relay Overdrive outputs are active high, when a relay should be switched closed these pins will become a logical one.

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1.6.8 AC Zero Cross Detection

Zero Cross Detect is done via a digital interface. Additional circuitry is required to create digital pulses on an AC waveforms zero voltage crossings. When a pulse is encountered the TCM 330 will switch the relay at a future zero cross if it is able to calculate the frequency of the AC voltage. This calculation is based on the two parameters, Relay Switch On Time and Relay Switch Off Time. Both of these parameters are only configurable via the Programming and Configuration interface. They are settable in 50 µs steps; the default Relay Switch On Time is 4.6 milliseconds and the default Relay Switch Off Time is 1.5 milliseconds.

AC Zero Cross detection is optional. Should this not be included, the relay will be switched with a random relationship relative to the AC input signal.

1.6.9 Programming and Configuration Interface

The Programming and Configuration interface is optional and enables two functions:

1. Enables TCM 330 to be programmed with updated or custom firmware
2. Enables setting of relay switching parameters: Relay Switch On, Relay Switch Off, and Relay Overdrive Time.

This interface is recommended to be implemented. The interface header pin out can be customized to meet size constraints. An Example header is show below, with supporting circuitry.
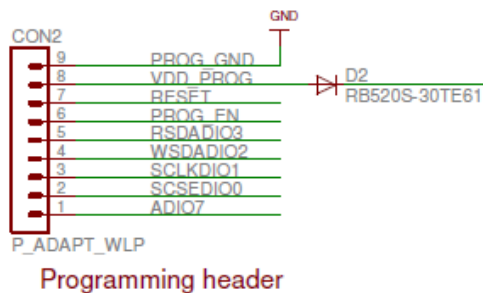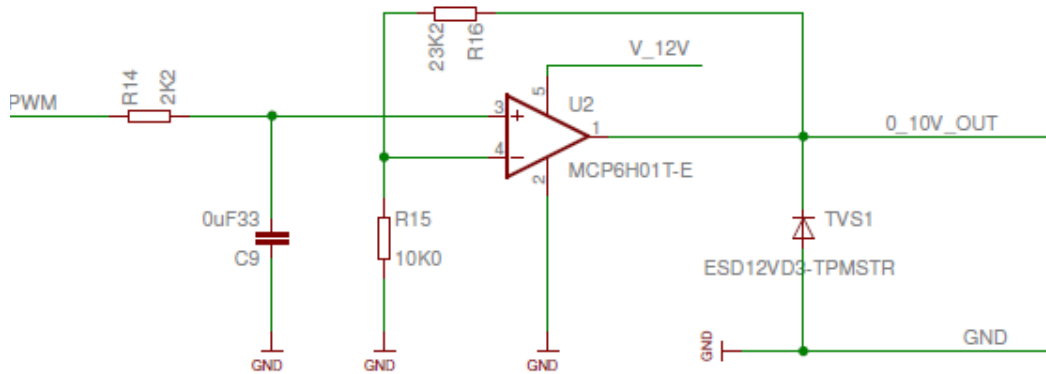

Figure 9

See [8.], AN502 for details.

1.7 Using the TCM 330 to Generate 0-10 V Output

The TCM 330 generates a PWM signal as the output. This PWM signal can be easily converted to a 0-10 V signal with a few additional components.

The TCM 330 generates a variable duty cycle PWM signal at 80 kHz. With a passive RC filter and gain amplifier this signal can be converted to a 0-10 V signal. An example circuit is below.

Figure 10

In additional to the PWM filter and gain circuit a power supply to provide the 12 V rail will be required. This may come from an external source, e.g. an external 12 V supply, or as an on-board supply.

1.8 RF Design Validation

In order to have reliable communication with a satisfactory range the TCM 330 based device's design should undergo RF validation. At minimum this is verifying the final designs radio's receive sensitivity. AN008, RF Receiver Sensitivity – Performing Validation along with special firmware for the receiver, AN008SW, can be used to determine the RX sensitivity of a design.

1.9 Production Time Configuration of Relay Control Parameters

For TCM 330 designs that utilize external relays the relay control parameters should be modified to match the relay used as well as the drive circuitry implemented. The relay control parameters are not accessible OTA and are settable only via the programming and configuration interface of the TCM 330. The requirements for utilizing this are:

- Dolphin Studio Software
- A cable interface on the TCM 330 device and the interface cable
- An EnOcean programmer board, EOP 3x0 with USB cable

Depending on the devices design an external power supply may be need to be provided for successful configuration.

Relay Parameters

Name	Default Value	Note
Relay Utilized	True	
Relay Switch On Time	4.6 milliseconds	50 µs steps
Relay Switch Off Time	1.5 milliseconds	50 µs steps
Relay Overdrive Active Time	110 milliseconds	Active only on off to on transition

Figure 11

1.10 Production Test and Validation

TCM 330 modules are electrically tested. Once integrated onto a host PCB functional testing should occur to ensure proper hardware functionally of all external components and the RF interface. The full test procedure will depend on the implemented hardware.

An USB 300, when combined with Dolphin View Advanced, can be used to set the output to various levels and switch the relay on demand. This is accomplished by linking the USB 300 as a Central Control Gateway (EEP: A5-38-08) and sending the dimming command with the appropriate dim level. See the EnOcean Equipment Profiles specification for more details.

1.11 Remote Application Configuration via Navigan

The TCM 330 supports EnOcean Alliance's Remote Commissioning specification. This enables linking and parameter configuration to be done over the air with software tools. EnOcean offers Navigan Wireless Commissioner (NWC 300) as one such tool to aid installers in configuring TCM 330 based devices to meet their application needs. The NWC 300 Tool consists of PC based software and an EnOcean wireless NWC 300 stick.