

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

1. INTRODUCTION

EnOcean 'J' family of devices for the Japanese market operates in the license-free 928 MHz band (http://www.enocean.com/en/enocean_modules_928mhz/) and uses the ERP2 (EnOcean Advanced Radio Protocol, FSK Modulation). It is full ARIB STD-T108 compliant.

This document mainly addresses engineering management who intend to migrate previous standard EnOcean products to enter into the 928 MHz Japanese market and need to establish a level of effort requirement. It provides a high-level overview of motivation, important common aspects but also differences, new tools and additional / updated documentation required as consequence to take advantage of EnOcean's new products and developments even for newcomers.

2. ADDITIONAL (AND UPDATED) USEFUL REFERENCES AND RESOURCES

- [1] ESP3 (EnOcean Serial Protocol 3): <http://www.enocean.com/esp>
- [2] ERP2 (EnOcean Radio Protocol 2): <http://www.enocean.com/erp2/>
- [3] EEP (EnOcean Equipment Profiles, updated with new profiles according new ERP2): <http://www.enocean-alliance.org/eep/>
- [4] Dolphin Core V4 description: <http://www.enocean.com/dolphin-v4-core-description/>
- [5] Dolphin V4 API (Dolphin V4 Application Programming Interface): <http://www.enocean.com/en/download/>
- [6] Dolphin V4 API User manual: <http://www.enocean.com/fileadmin/redaktion/support/dolphinv4-api/index.html>
- [7] DolphinSuite Tool Chain Graphical User Interface for easy configuration, programming: <http://www.enocean.com/en/download/>
- [8] DolphinSuite User Manual: http://www.enocean.com/fileadmin/redaktion/support/dolphin-suite/DolphinV4_Suite.html
- [9] DolphinView Advanced: <http://www.enocean.com/en/download/>
- [10] Remote Management Description: <http://www.enocean.com/remote-management>
- [11] Smart Acknowledgement Bi-directional Communication Protocol: <http://www.enocean.com/smart-acknowledgement>
- [12] Generic Profiles, Abstract: http://www.enocean.com/fileadmin/redaktion/enocean_alliance/pdf/GenericProfiles_V1_Extract.pdf
- [13] EDK 400J (EnOcean Development Kit for 928 MHz, Dolphin V4 modules): http://www.enocean.com/en/enocean_modules_928mhz/edk-400j/
- [14] EnOcean Link updated (support of all EnOcean Protocols): <http://www.enocean.com/en/enocean-software/enocean-link/>

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

3. SPECIFIC IMPLEMENTATION/MIGRATION ASPECTS (OVERVIEW DOLPHIN V4 VS. DOLPHIN)

Background: almost all new EnOcean 928 MHz ('J') modules are Dolphin V4 core based. Exceptions thereof are the 'J' radio switches (e.g. PTM 210J / PTM 430J).

EnOcean Dolphin V4 core is the generic HW name for the special 928 MHz version of the original Dolphin V1 core.

Firmware Dolphin V4 based Modules

The core software functionality of 'J' Dolphin V4 modules lies in the Dolphin V4 API, while the device 'customer functionality' remains roughly the same as for the standard Dolphin V1 core based modules (similar Tool chain, based now on Dolphin V4 API).

<http://www.enocean.com/fileadmin/redaktion/support/dolphinv4-api/index.html>

Hardware Dolphin V4 based Modules

928 MHz TCM / STM 4xxJ Dolphin V4 based modules are all HW pin-to-pin compatible with all other existing Dolphin based versions and will operate on same already existing PCB layouts (the Dolphin V4 core has however some enhanced HW features vs. Dolphin V1 core)

TCM / STM 4xxJ (Dolphin V4 based)	No changes	No changes
Footprint vs. Dolphin V1 based versions	868 MHz	902 MHz 'U'

ERP2 and 928 MHz Band considerations

Why 928 MHz?

1. Shorter antenna, easier to integrate
2. Generally, the higher the frequency the less interference noise from near typical electrical appliances like e.g. electronic ballasts/HVAC.
3. Optimal certification conditions for the specific Japan market.

Why FSK?

For better sensitivity and higher noise immunity vs. ASK (Amplitude Shift Keying).

Background: ASK as opposed to FSK is more dependent on the matching of the specific antenna and is more sensitive to interfering signals independent of the used frequency.

Why ERP2?

1. More suitable for FSK – longer payload telegrams up to 255 bytes, (currently used 44) vs. max. 21 bytes possible with ERP1 (ASK). Drawback: FSK radio requires more energy.
2. 48-bit source ID – required for ARIB STD-T108 compliance, requires longer telegrams!
3. New Market, means there were no legacy (e.g. ASK) products in field.

Background: EnOcean FSK radio requires EnOcean Radio Protocol 2 (ERP2). ASK radio requires less energy and stays historically for the first EnOcean Radio Protocol, ERP1.

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

Overview EnOcean Dolphin V4 vs. their Dolphin pendants and specific differences:

E.g. TCM 410J vs. TCM 310 (both having same 'GatewayController' functionality):

TCM 410J as opposed to TCM 310 is reprogrammable, however no default actuator FW for TCM 4xxJ (e.g. like for TCM 300) is currently available, default GatewayController functionality only (means no 'TCM 400J' pendant for current 'TCM 300' default versions available).

DOLPHIN V4		DOLPHIN (V1)	
HW NAME	CORE / FW (NAME)	HW NAME	CORE / FW (NAME)
USB 400J	Dolphin V4 / GatewayController	USB 300(U)	Dolphin / GatewayController
TCM 410J	Dolphin V4 / GatewayController (reprogrammable!)	TCM 310(U)	Dolphin / GatewayController
STM 431J	Dolphin V4 / TRH	STM 33x(U)	Dolphin / TRH
STM 429J	Dolphin V4 / MAG	STM 32x(U)	Dolphin / MAG
STM 400J	Dolphin V4 / USN	STM 300(U)	Dolphin / USN
PTM 430J	N/A	PTM 330(U) (obsolete)	Dolphin / RPS

Dolphin V4 based Product Overview & specific differences vs. Dolphin (V1) based

The following products can be programmed / configured by customer with custom specific SW:

- STM 400J, STM 431J (Source code and FW available), TCM 410J
- TCM 410J (Firmware available) STM 40xJ modules will also have Generic Profiles as an option by Teach-In and up to 35 bytes payload in telegrams.

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

Enhanced Security Modules Overview, current status

DOLPHIN V4	
HW NAME	CORE / FW (NAME)
STM 435J (HW + EEPROM on board)	Dolphin V4 / TRH S
STM 425J (HW + EEPROM on board)	Dolphin V4 / MAG S
STM 405J (STM 400J HW + EEPROM on customer board) ¹	Dolphin V4 / USN S
TCM 415J (TCM410J HW + EEPROM on customer board) ¹	Dolphin V4 GatewayController Secured
USB 405J (USB 400J HW + EEPROM on board)	Dolphin V4 GatewayController Secured

¹ Additional appropriate EEPROM must be therefore provided on the customer board.

Some of the enhanced features Dolphin V4 (928 MHz) vs. Dolphin core (V1)²:

- V4 core has lower overall consumption:

Dolphin V4 – 928 MHz

Symbol	Parameter	Conditions / Notes	Typ	Max	Units
IDD _{OFF}	Current Consumption "OFF Mode"	@ VDD=1 V @27 °C	75		nA
IDD _{DS}	Current Consumption "Deep Sleep Mode"	@27 °C	100	130	nA
		@85 °C	350	1000	nA
IDD _{FS}	Current Consumption "Flywheel Sleep Mode"	@27 °C	720	880	nA
		@85 °C	1000	2000	nA
IDD _{SS}	Current Consumption "Short Term Sleep Mode"	@27 °C	4	5	µA
		@85 °C	15	20	µA
IDD _{SB}	Current Consumption "Standby Mode"	Ultra low power blocks, voltage regulators and XTAL oscillator running @27 °C @85 °C	1.0 1.2	1.2 1.8	mA
IDD _{CPU}	Current Consumption "CPU Mode"	Voltage regulators, XTAL, and CPU 8051 at 16.385 MHz	3.9	4.8	mA
IDD _{TX}	Current Consumption TX	@928.35 MHz, 125 kbps FSK, 0 dBm TX power, CPU stopped	23.1	25.9	mA
IDD _{RX}	Current Consumption RX	@928.35 MHz, CPU stopped	26.5	29.8	mA

Dolphin

Symbol	Parameter	Conditions / Notes	Min	Typ	Max	Units
IDD _{OFF}	Current Consumption "OFF Mode"	@ VDD=V _{OFF} @ VDD=1 V @27 °C		200 75		nA nA
IDD _{DS}	Current Consumption "Deep Sleep Mode"	@27 °C		220	360	nA
		@85 °C		2000	3100	nA
IDD _{FS}	Current Consumption "Flywheel Sleep Mode"	@27 °C		720	1000	nA
		@85 °C		2300	4000	nA
IDD _{SS}	Current Consumption "Short Term Sleep Mode"	@27 °C		8	10	µA
		@85 °C		25	35	µA
IDD _{SB}	Current Consumption "Standby Mode"	Ultra low power blocks, voltage regulators and XTAL oscillator running		1.4	1.8	mA
IDD _{CPU}	Current Consumption "CPU Mode"	Voltage regulators, XTAL, and CPU 8051 at 16 MHz		3.7	5.1	mA
IDD _{TX}	Current Consumption TX	@868 MHz and +6 dBm TX power during transmission of "H". CPU stopped		23.4	30	mA
IDD _{RX}	Current Consumption RX	@868 MHz CPU stopped		27.4	40	mA

- V4 core is 4 times faster
- V4 Radio settings stored separately by EnOcean
- V4 core ADC now with Rail-to-Rail measurement.
- V4 core 64 kb and 2 RAM (both 2 times larger vs. Dolphin V1 core)

Consequences

Updated EnOcean Specifications & Protocols (especially ERP2, ESP3 and EEP), provided new specific Development Tools (API V4 core related similar to the Dolphin API ones).

² More details see [4].

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

Required Software Tools

1. **Dolphin V4 API** for 928 MHz has similar interfaces to 868 MHz / 902 MHz (V1). Porting existing custom application on the V4 platform is possible.
Overview changes/differences to Dolphin API:

<http://www.enocean.com/fileadmin/redaktion/support/dolphinv4-api/changes13page.html>

2. **Dolphin V4 Suite:**

1. Instead of DolphinStudio, a new **Dolphin V4 Suite** Tool Chain is provided. Unlike DolphinStudio, Dolphin V4 Suite has separate, V4 core specific SW toolsets:

- Programmer
- API Configurator
- Module Configurator
- Calibration

- 2.

3. **DolphinView Tool:** remains the same, shows the 928 MHz ERP2 Telegrams too.

Further V4 / ERP2 related specific behavior:

- 48 bit ID instead of 32 bit: 'J' Modules must have 48 bit IDs. The 48-bit ID is however not used in all radio telegrams – e.g. a Teach-In telegram with 48 ID bit is enough.
- Maturity time parameters:

The TX period defines the maximum sending time for a packet containing maximum three redundant sub-telegrams.

(The same applies for repeater, only 1 level supported at 928 MHz, for ARIB compliance).

Description	Parameter
TX maturity time	25 ms
RX maturity time	100 ms

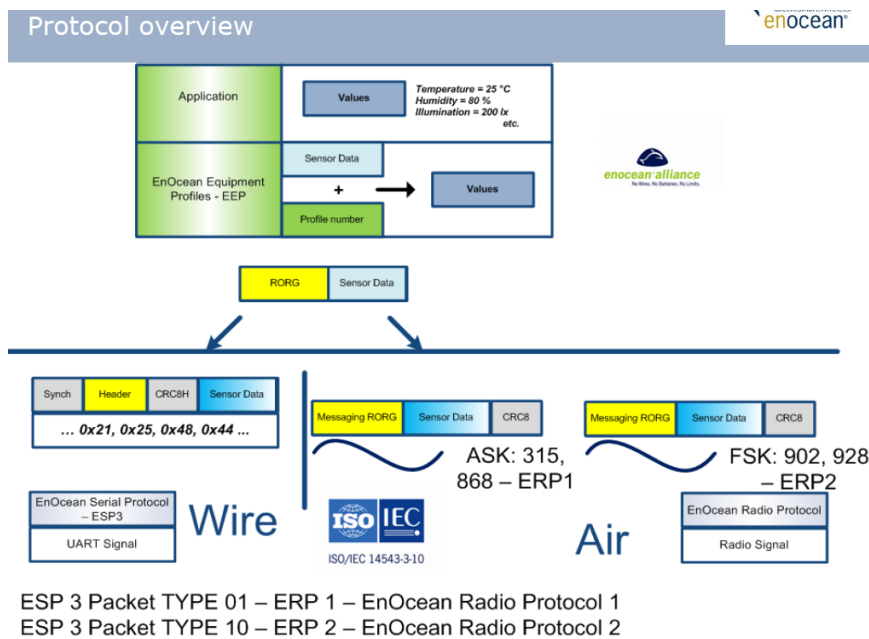
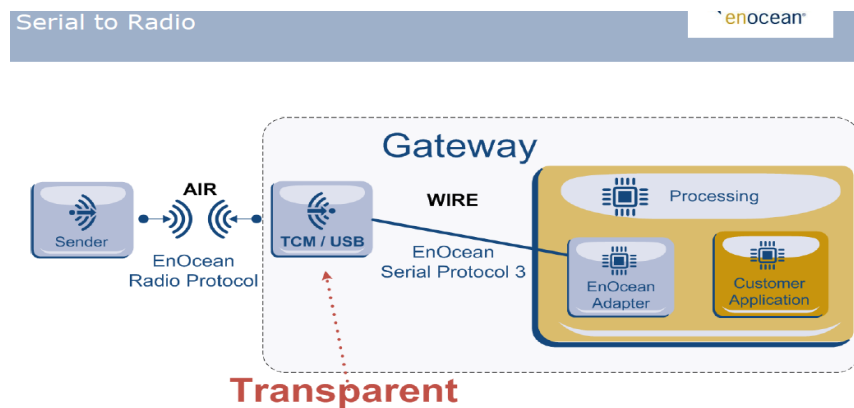
Backgrounds therefore see ERP2 specification, e.g. limitations for Japan compliance:

'Redundant transmissions (means including possible repeated sub-telegrams) shall be finished within 50 milliseconds. After the last transmission, no further transmission allowed for the next 50 milliseconds'.

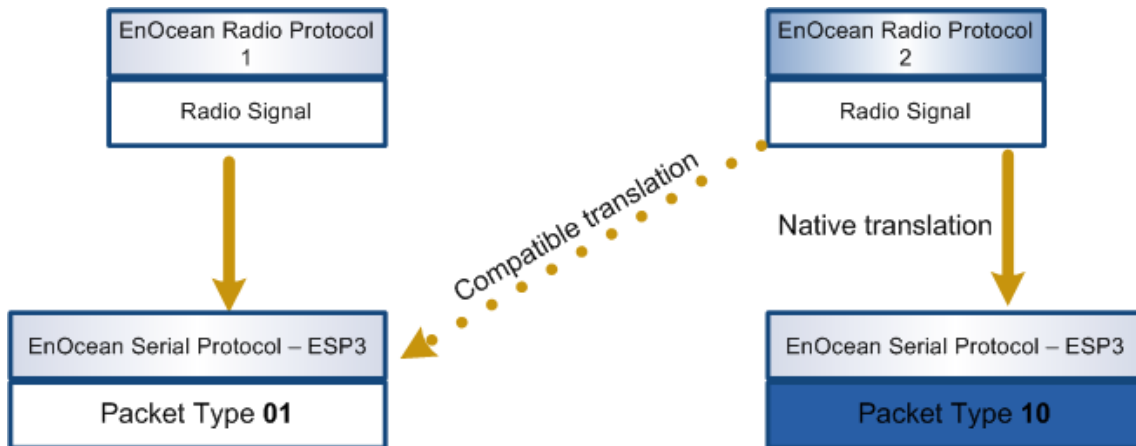
- EEP new F6-RPS profiles coding for ERP2, also see EEP [3]
- Security: security concept for EnOcean 'J' devices is the same as for all other frequencies.

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

4. IMPORTANT ASPECTS REGARDING FW MIGRATION FROM DOLPHIN PLATFORMS TO DOLPHIN V4 (GATEWAY, RADIO / SERIAL TRANSLATION):



EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

ERP Overview:**Ways to change the gateway serial communication mode (e.g. for TCM 410J):**

1. Through serial command, (see ESP3, volatile change, non-permanent):

Code 28: CO_WR_MODE

Function: Sets the gateway transceiver mode. There are two modes available:

- Compatible mode - ERP1 - gateway uses Packet Type 1 to transmit and receive radio telegrams – for ASK products
- Advanced mode - ERP2 - gateway uses Packet Type 10 to transmit and receive radio telegrams – for FSK products with advanced protocol

Group	Offset	Size	Field	Value hex	Description
-	0	1	Sync. Byte	0x55	
Header	1	2	Data Length	0x0002	2 bytes
	3	1	Optional Length	0x00	0 byte
	4	1	Packet Type	0x05	COMMON_COMMAND = 5
-	5	1	CRC8H	0xnn	
Data	6	1	COMMAND Code	0x1C	CO_WR_MODE = 28
	6	1	Mode	0xnn	0x00 – Compatible mode (default) - ERP1 0x01 – Advanced mode - ERP2
-	7	1	CRC8D	0xnn	

2. Through Dolphin V4 Suite / Module Configurator (configuration, permanent change)

General configuration

Functionality	ESP3 + RemoteMan + SmartAcl	Configure the functionality of the gateway firmware
Gateway mode	ESP3 Packet Type 0x0A (ERP2)	Specify ESP3 packet type used for forwarding radio communication to serial
Baudrate	ESP3 Packet Type 0x01 (ERP1) ESP3 Packet Type 0x0A (ERP2)	The default baudrate for ESP3 is 57600 baud

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

Backgrounds to the different Telegram Packet Types used, also see [1]**Serial Packet Types:**

Type No.	Value hex	Name	Description
0	0x00	---	Reserved
1	0x01	RADIO	Radio telegram (ERP1)
2	0x02	RESPONSE	Response to any packet
3	0x03	RADIO_SUB_TEL	Radio sub-telegram
4	0x04	EVENT	Event message
5	0x05	COMMON_COMMAND	Common command
6	0x06	SMART_ACK_COMMAND	Smart-Acknowledgement command
7	0x07	REMOTE_MAN_COMMAND	Remote management command
8	0x08	---	Reserved for EnOcean
9	0x09	RADIO_MESSAGE	Radio message
10	0x0A	RADIO_ADVANCED	Advanced radio protocol telegram (ERP2)
11 ... 127	0x08 ... 7F	---	Reserved for EnOcean
128...255	0x80 ... FF	available	Manufacturer specific commands and messages

Background: ARIB STD-T108 compliance requires 48-bit (instead of 32) device ID, means the shorter, previous used ERP1 Packet Type 1 has to be replaced by Packet Type 10.

EEP updated: Special Note regarding all F6-RPS profiles by ERP2 migration:

Previous ERP1 defined EEPs can be used like before for ERP2 with one exception, the RPS profiles. The ERP2 does not use the same RPS telegram coding anymore which ERP1 does.

The biggest difference regards the Status Field of ERP1. The Status Field in ERP2 changes to Repeater Count Field (also its position in the data packet.) Other functionalities and fields, e.g. T21 / NU are no longer needed either; therefore, new encoding was developed.

Background: EEP describes an equipment – device – application. The meaning of the payload data did not change, only it's coding. The logic and semantic of the application remains the same. Therefore, it is defined that RPS profiles on ERP2 have different coding of the actual telegram data, but the logic remains the same on ERP1 and ERP2. The new RPS coding for ERP2 is published as new profiles in the EEP specification. This was required to keep the same interfaces on the EEP processing (e.g. existing gateways / IP gateways – additional information like which radio protocol was used – ERP1 / ERP2 is not relevant for the end application).

The new specific RPS profiles added according ERP2 (RPS new coding) are currently:

F6-02-04 - Light and Blind Control ERP2 (pendant for ERP1: F6-02-01)

F6-04-02 - Key Card Activated Switch ERP2 (pendant for ERP1: F6-04-01)

F6-10-01 - Window Handle ERP2 (pendant for ERP1: F6-10-00)

EnOcean 928 MHz (Dolphin V4 Platform) - Migration Overview

Conclusions

In TCM 4XXJ and USB 4XXJ, the ERP2 radio telegrams put on the serial interface ESP3 can be 'translated' to Packet Type 01 (RADIO ERP1) for compatibility to an existing application. However, the native Packet Type for 'J' devices is always Type 10 (ERP2).

We recommend therefore using Packet Type 10 in all new product developments.

('Compatible mode' Type 1 limits the types of the handled telegrams due to limited data length and is available only to easy porting of already existing product variants to 928 MHz, not recommended for new developments.)

The EOP (PCB board itself) as well as the DolphinView Tool (FW) are device independent and unique, both used for all Dolphin V1 / Dolphin V4 core based frequency variants.

The Dolphin V4 core based single 'J' devices (customer functionality, security options, radio and serial communication packet type) are quite similar but in deeper detail however, ERP, ESP, EEP (see RPS profiles), Frequency, Application and Compliancy requirement specific.

This overview tries to point out the most important aspects and bundle the relevant documentation sources as well as to explain the specific difference reasons and motivations. It is intended as a first reference source for an easier device design start and / or migration.

If you have further questions or support queries, please visit the EnOcean website, especially the support area at <http://www.enocean.com/en/support/> or contact the application engineering team at EnOcean: support@enocean.com

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