OOK Protocols description

Introduction

This document summarises some findings about decoding ASK / OOK protocols, more specifically for Home Automation usage.
Most of the home automation protocols are derived from the old X10 protocol (see https://en.wikipedia.org/wiki/X10_(industry_standard)).
For light switch control a common one is known as KAKU (Klick Aan / Klick Uit or Click On Click Off) that is widely deployed in The Netherlands (see http://www.klikaanklikuit.nl/home/). Plenty of other manufactures use the same technique (Home Easy, Chacon, D.IO, Cogex, etc...).
I have currently decoded 3 variants of these protocols (hereafter referred as Kaku).

- Kaku Old
- Kaku Cogex (see http://www.superstar.com.tw)
- Kaku New

Other weather stations applications (typically referred as Oregon Scientific protocol) are using a similar method but are not covered by this document

Kaku Old

This protocol uses an OOK modulated datagram of 12 symbols.
The datagram is summarised as follow:

```
Bit order       B A 9 8 7 6 5 4 3 2 1 0
Weight          8 4 2 1 8 4 2 1 8 4 2 1
Symbols         L 1 1 0 U U U U A A A A Start

S = SYNC/Start bit
L = Level bit                0 OFF, 1 ON 1
U = Unit bits                (0)1...(15)16
A = Home Address bit         (0)1...(15)16 or (A...P)
```

Note that the lowest bit is send first.

The characteristics are the following:

- Use a limited number of hand held controller addresses (aka House address); 16, from A to P
- Use a limited number of controlled units per house address; 16 from 1 to 16
- Do not allow dimming
- Unidirectional (controller to unit)
- No encryption
- No anti-replay

Kaku Old Home Address

The home address and units are identified by rotary switches.

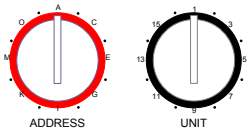

Figure 1: Kaku Old Home Address and Unit switches

Kaku Old bit pattern

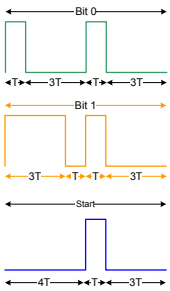

Figure 2: Kaku old bit pattern

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The datagram looks like (see OOK Poor man's monitoring tool vx.y.pdf for tracing):

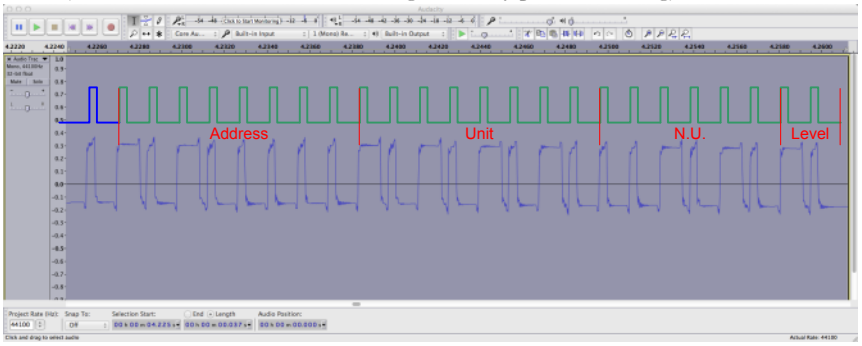

Figure 3: Kaku Old - Datagram

Kaku Old bit timing

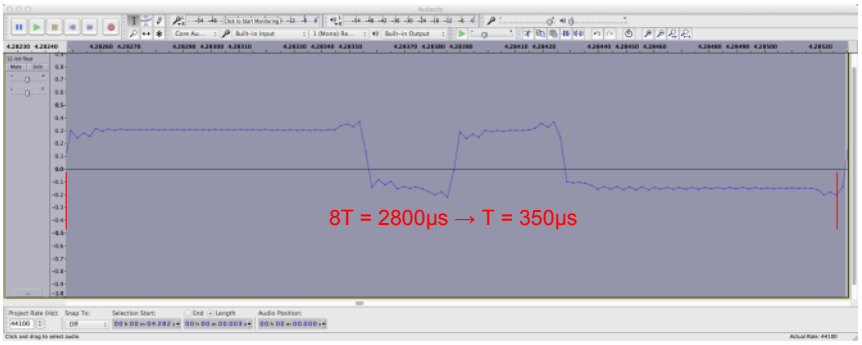

Figure 4: Kaku Old - Bit timing

Kaku Inter datagram timing

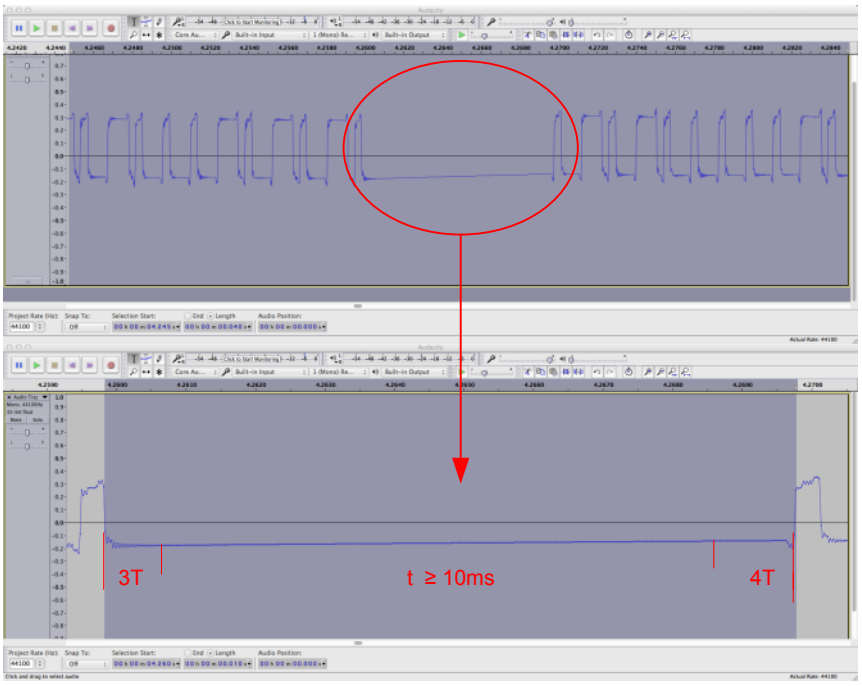

Figure 5: Kaku old -Inter datagram timing

Kaku Old Timing summary

T	300...450µs nominal 375µs
Inter datagram	>10ms

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Datagram timing

8T+12*8T = 104T or 39.000µs

Kaku Old example

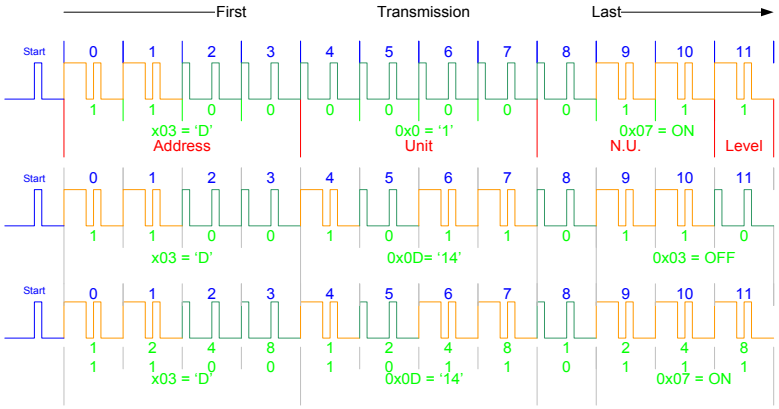

Figure 6: Kaku old timing and data pattern example

COGEX

This protocol uses an OOK modulated datagram of 12 symbols.
The datagram is summarised as follow:

```
Bit order     B A 9 8 7 6 5 4 3 2 1 0
Weight        8 4 2 1 8 4 2 1 8 4 2 1
Symbols       L 1 1 U U U U A A A A L Start

S = SYNC/start bit
L = Level                    0 OFF, 1 ON
U = Unit bits                (0)1...(15)16
A = Home Address bits        (0)1...(15)16
```

Notes:
Lowest bits are sent first
Timing is quite similar to the old KAKU however the datagram structure is quite different

The characteristics are the following:

- Use a limited number of hand held controller addresses (aka House address); 16, from 1 to 16
- Use a limited number of controlled units per house address; 16 from 1 to 16
- Do not allow dimming
- Unidirectional (controller to unit)
- No encryption
- No anti-replay

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Cogex Home Address

The home address and units are identified by hard coded jumpers.

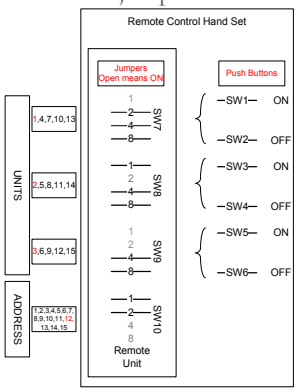

Figure 7: Cogex Home Address and Unit jumpers

Cogex bit pattern

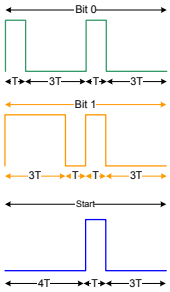

Figure 8: Cogex bit pattern

The datagram looks like (see OOK Poor man's monitoring tool vx.y.pdf for tracing):

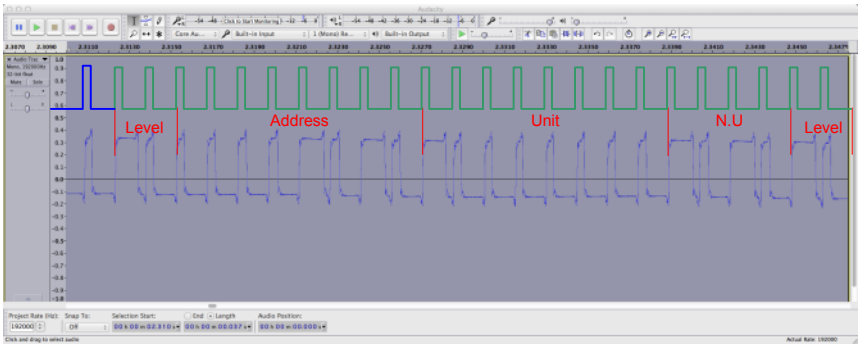

Figure 9: Cogex - Datagram

Cogex bit timing

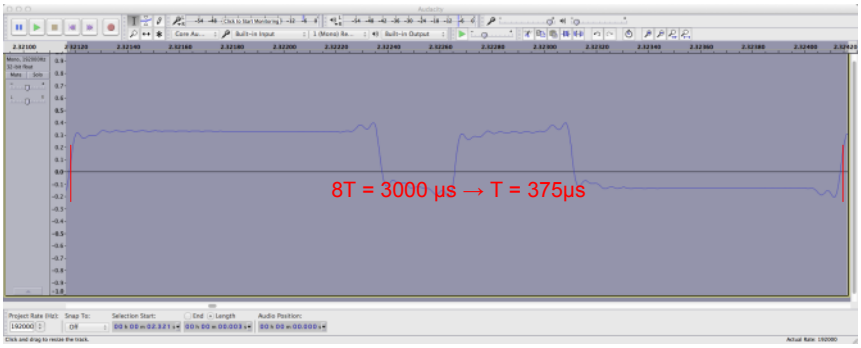

Figure 10: Cogex - Bit timing

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Cogex Inter datagram timing

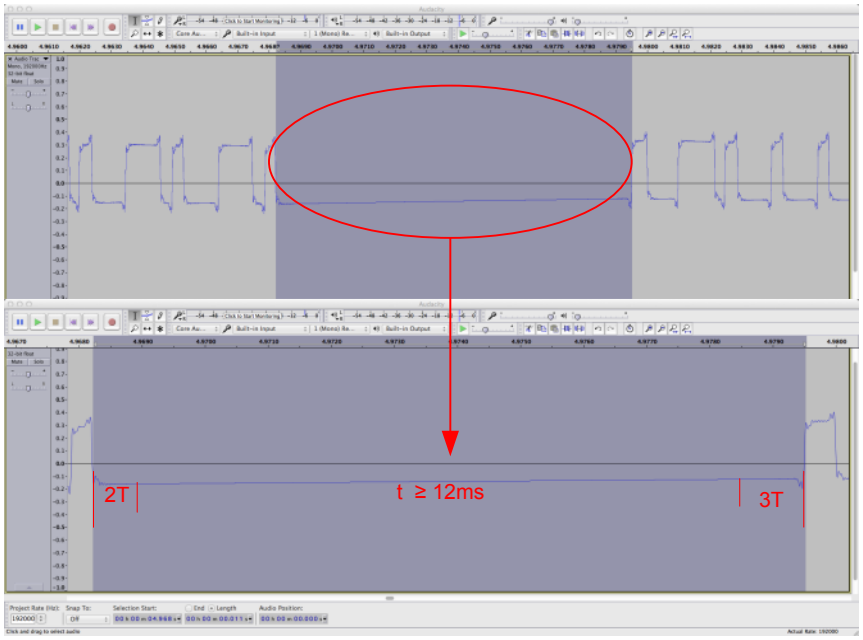

Figure 11: Cogex - Inter datagram timing

Cogex Timing summary

T	200...500µs nominal 350µs
Inter datagram	>12ms

Datagram timing

8T+12*8T = 104T or 36.400 µs

Cogex example

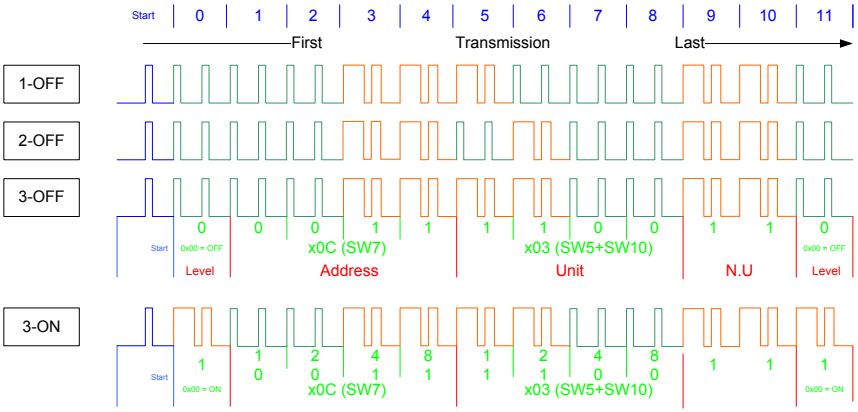

Figure 12: Cogex timing and data pattern example

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Kaku New

This protocol uses an OOK modulated datagram of 32/36 symbols.
The datagram is summarised as follow:

```
ON/OFF
======
Bit order             31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9  8  7  6  5  4  3  2  1  0
Weight                1  2  4  8        1  2  4  8  1  2  4  8  1  2  4  8  1  2  4  8  1  2  4  8  1  2  4  8  1  2
Symbols         Stop  U  U  U  U  L  G  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  Start
                   !     0     !  !  !   0 (LSB)  !     1     !     2     !     3     !     4     !     5    !6(MSB)!
DIM
===
Bit order       35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9  8  7  6  5  4  3  2  1  0
Weight          1  2  4  8  1  2  4  8        1  2  4  8  1  2  4  8  1  2  4  8  1  2  4  8  1  2  4  8  1  2  4  8  1  2
Symbols   Stop  l  l  l  l  U  U  U  U  d  G  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  Start
             !     0     !     0     !  !  !  0(LSB)    !     1     !     2     !     3     !     4     !     5     !6(MSB)!

S = SYNC/Start/Stop bit
L/d = Level (or remote switch state) bit:   ON = 1, OFF = 0 ; 'L' symbol is replaced by 'd' symbol if a Dim level is specified
U = Unit                             bits:  0...15; Practical handset values are 1...16
A = Address (or handset)             bits:  0...(2^26)67.108.863; value of handset addresses are defined by Manufacturer
G = Group bit                        bit:   Group = 1, no Group = 0
l = Dim Level for Dim option         bits:  1...15;  0 means no Dim
```

The characteristics are the following:

- Large number of hand held controller addresses (aka House address), from 1 to 67.108.863
- Use a limited number of controlled units per house address; 16 from 1 to 16 (0 to 15)
- Units supports multiple controllers (up to 4)
- Allow dimming
- Unidirectional (controller to unit)
- No encryption
- No anti-replay

Note that some units support both old and new Kaku protocols

Kaku New Home Address

Each controller should have a unique House address, which is determined by the vendor.
Locally administrated addresses are possible but care should be taken to avoid conflict with other houses!
Cloning of existing address in the same house (no anti-replay is implemented). This is convenient to simulate handset command via wireless applications.
House code addresses are 26 bits long for a decimal value comprise 1 to 67.108.863.
The easiest way to decode an exiting address for cloning is by using a RX433 receiver and the *NewRemotSwitch ShowReceivedCode* sketch (see SAW Devices and OOK vx.y.pdf and https://bitbucket.org/fuzzillogic/433mhzforarduino/wiki/Home).
A second way is to decode the trace using the "OOK Poor mans' monitor tool", see figure below.
A third way is to create your own code and force the units to learn the address via transmission (see *NewRemoteSwitch LearnCode* sketch).

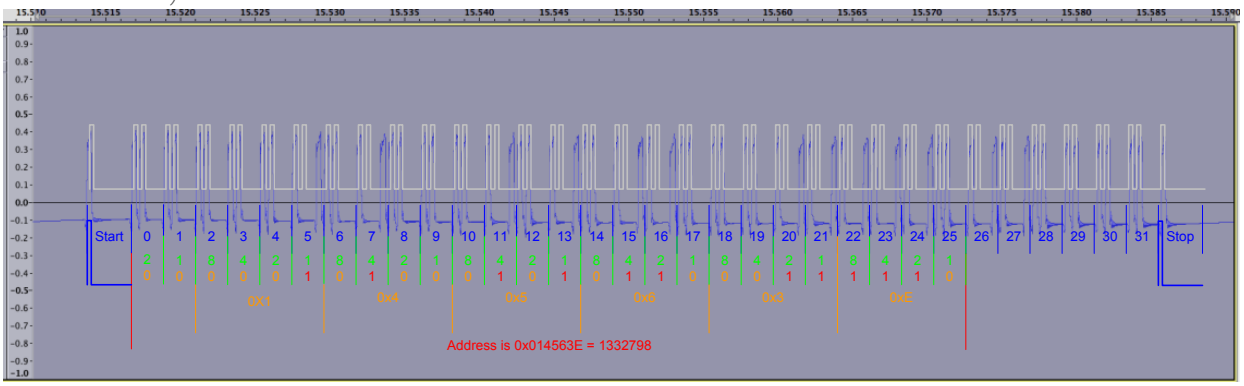

Figure 13: Kaku new - Home Address

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Kaku New bit pattern

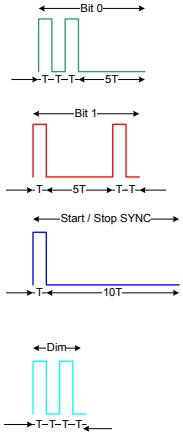

Figure 14: Kaku New bit pattern

The datagram looks like (see OOK Poor man's monitoring tool vx.y.pdf for tracing):

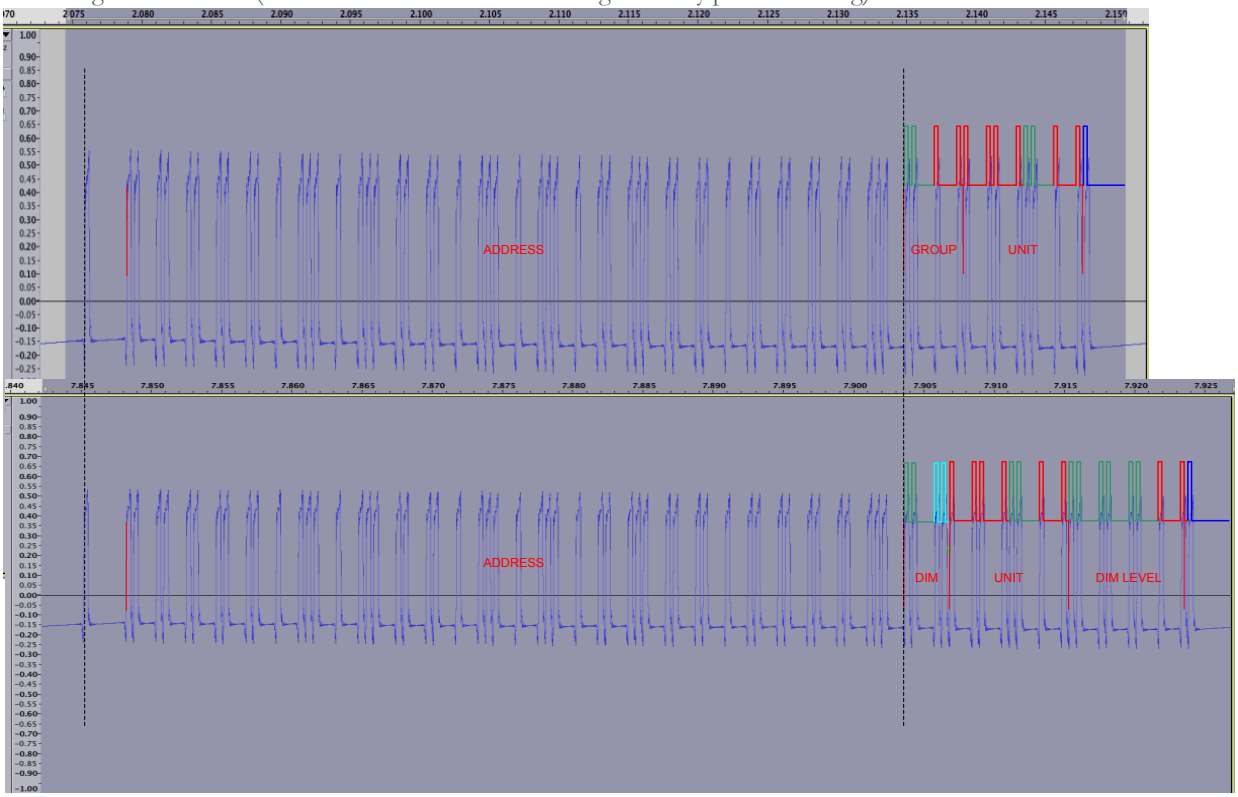

Figure 15: Kaku New – Datagram (ON/OFF) and DIMM

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Kaku New bit timing

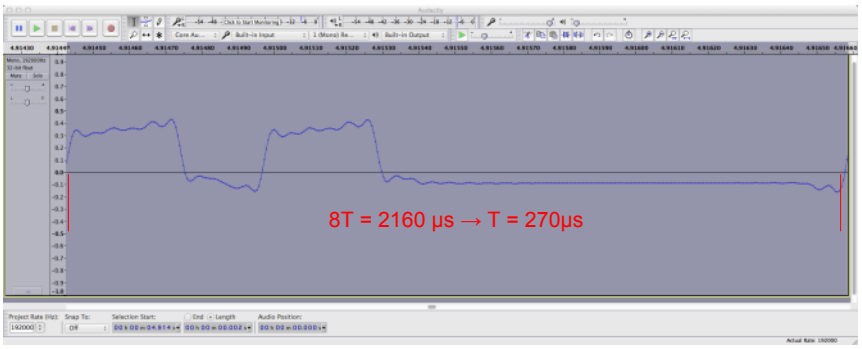

Figure 16: Kaku New - Bit timing

Kaku New Inter datagram timing

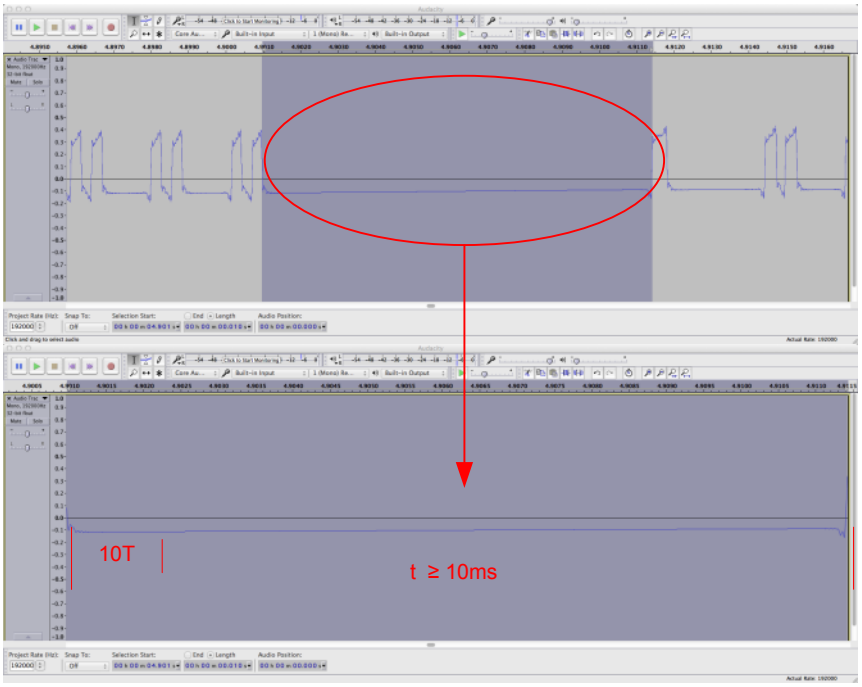

Figure 17: Kaku New - Inter datagram timing

Kaku New Timing summary

T	200...300µs nominal 250µs
Inter datagram	>10ms

Datagram timing (ON/OFF)

11T+32*8T = 267T or 66.750µs ~67ms

Datagram timing (Dimmer)

11T+36*8T = 299T or 74.750 µs ~75ms

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Kaku New example

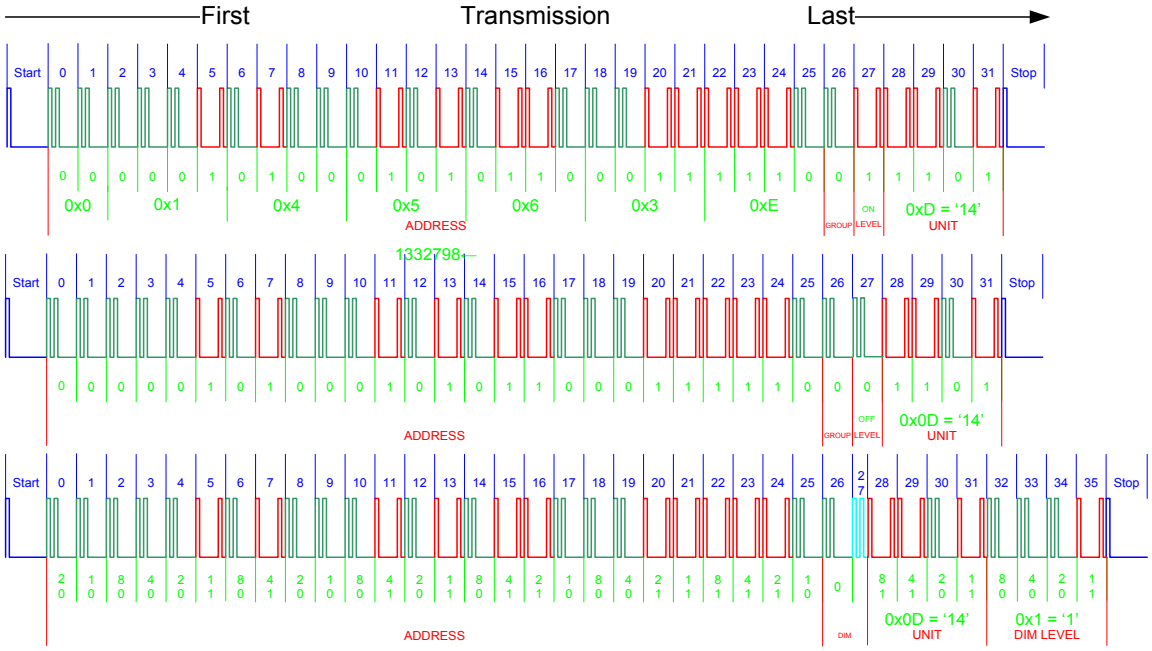

Figure 18: Kaku New timing and data pattern example

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