

# Proposal for adding swing control to the start-up protocol

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# Introduction

- The concept of adding swing control to the training protocol was initially presented in the ad hoc presentation [ran\\_3dj\\_elec\\_01\\_240208](#).
  - Brief summary of the problem statement: changing the swing is often a desirable part of training, but achieving it using the existing coefficient control requests is difficult.
- Having swing control can simplify training algorithms and enable more optimized performance, which can result in faster system start-up and shorter development times.
  - Time is money!

# Proposed change to the training message format

- Allocate one of the reserved values of the **coefficient select** field to “swing control”.
  - Suggested value is **011** (corresponding to value +3; c(+3) is not expected to be useful)
- When coefficient select is set to “swing control”:
  - “Increment” and “Decrement” in the **coefficient request** field mean: change the output swing without changing the equalization.
  - “No equalization” means: use the default output swing (not necessarily the maximum).
  - The response to these requests can be either “updated” or “coefficient at limit”.
  - Other than that, the protocol is identical to individual coefficient control (coefficient select echo, state diagrams, timing, etc.)
- When training is (re)started, and when an initial condition request that selects a “preset” setting is processed, the swing shall be reset to its initial value.
- **All the above are to be added in Annex 176A.**

# Suggested changes to the control field

## Current control field structure (clause 162)

9:8	Modulation and precoding request	9 8 1 1 = PAM4 with precoding 1 0 = PAM4 0 1 = Reserved 0 0 = PAM2
7:5	Reserved	Transmit as 0, ignore on receipt
4:2	Coefficient select	4 3 2 1 0 0 = Reserved 1 0 1 = c(-3) 1 1 0 = c(-2) 1 1 1 = c(-1) 0 0 0 = c(0) 0 0 1 = c(1) 0 1 x = Reserved

## Proposed change

9:7	Pattern request	9 8 7 1 1 1 = PAM4 free-running PRBS31 with precoding 1 0 1 = Reserved 0 1 1 = PAM4 free-running PRBS31 1 1 0 = PAM4 PRBS13 with precoding 1 0 0 = PAM4 PRBS13 0 1 0 = PAM4 free-running PRBS13 0 0 0 = PAM2 PRBS13
6:5	Reserved	Transmit as 0, ignore on receipt
4:2	Coefficient select	4 3 2 1 0 0 = Reserved 1 0 1 = c(-3) 1 1 0 = c(-2) 1 1 1 = c(-1) 0 0 0 = c(0) 0 0 1 = c(1) 0 1 0 = Reserved 0 1 1 = Swing control

Bit 7 can be interpreted as "PRBS31 enable", and PRBS31 is always free-running.

Bits 9:8 retain their current meaning, except for the currently reserved combination "0 1" that becomes "PAM4 free-running" (with PRBS13).

Subject of a separate proposal

# Proposed changes to electrical specifications

- The effect of an increment or decrement of swing is to be added to the “Coefficient step size” subclause (179.10.4.1.4 and possibly other ones for AUIs).
- Possible text:

## **179.10.4.1.4 Coefficient step size**

Denoting the value measured prior to the assertion of the “increment” or “decrement” request (i.e., `coef_req` is “Hold”) as  $c_{before}$ , and the value upon the assertion of a coefficient status of “updated” as  $c_{after}$ , the change in the normalized transmit equalizer coefficient is defined as  $c_{after} - c_{before}$ , and the relative change is defined to as the ratio  $c_{after}/c_{before}$ .

For values of `coef_sel` other than +3, the change in the normalized transmit equalizer coefficient  $c(\text{coef\_sel})$  shall be between 0.005 and 0.025 for a request to “increment”, and between  $-0.025$  and  $-0.005$  for a request to “decrement”. It is recommended that the same step size is used for all coefficients. The coefficients other than  $c(\text{coef\_sel})$  are not expected to change. The absolute change in any coefficient other than  $c(\text{coef\_sel})$  shall be less than 0.005.

When `coef_sel` is +3 (swing control), the entire set of coefficients is expected to be multiplied by approximately the same factor. The relative change in the normalized transmit equalizer coefficient  $c(0)$  shall be between 1.03 and 1.12 for a request to “increment”, and between 0.89 and 0.97 for a request to “decrement”. The  $c_{after}$  value of each of the transmit equalizer coefficients other than  $c(0)$  shall be within  $\pm 0.025$  of the value corresponding to multiplying its  $c_{before}$  value by the relative change in  $c(0)$ .

# Proposed changes to electrical specifications (cont.)

- The range of swing is to be added to the “Coefficient range” subclause (179.10.4.1.5 and possibly other ones for AUIs).
  - Possible text:

For coef\_sel values other than +3, when sufficient “increment” or “decrement” requests have been received for a coefficient, the coefficient reaches a lower or upper bound based on the range of that coefficient or the combination of coefficients.

<list of coefficient ranges>

For coef\_sel value of +3 (swing control), when sufficient “increment” or “decrement” requests have been received, the swing reaches a maximum or minimum, respectively, which results in a coefficient status value COEFFICIENT AT LIMIT. The swing control range is defined as the ratio between the values of c(0) in maximum swing and minimum swing conditions. The swing control range shall be greater than or equal to 1.5.

# Thanks!