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Standard for UCATT Laser Engagement Interface

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Prepared by
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Standard for UCATT Laser Engagement Interface

1 Overview

1.1 Scope

This standard applies to the optical interface primarily used to communicate a simulated weapon engagement from a weapon simulator platform to a target simulator platform. Additionally, the Laser Engagement interface has a secondary use to communicate administrative and other kind of information (i.e., umpire control-gun commands, indoor positioning and player association).In defining this interface the Reference [1] defines a number of key interfaces including capabilities typical of a live ground training system.

This standard primarily defines the optical communication of a simulated weapon engagement. That engagement comprises the period from simulated weapon actuation (firing), through the projectile or missile flight, to the target(s) engagement(s) either as a hit and/or one or several misses (flybys). The subsequent assessment of the simulated effect on the target is not part of this optical interface standard and thus it has to be separately defined. The intent is that the optical communication of a simulated weapon engagement is abstracted from the target simulated effect evaluation; i.e., direct fire optically simulated engagement may be complimented or replaced by another type of communication with the same interface requirements to maintain the coalition interoperability objectives.

This standard does not prescribe maximum simulated engagement ranges, laser transmitter safety classification or similar. The objective is however to replicate the weapon system engagement range performance using primary a Class 1 laser transmitter during optical transmission conditions defined as a standard clear day (i.e., visibility of 23.5km). The vendors and manufacturers are obliged to design the laser transmitter to comply with the weapon performance, given the customer required laser classification, optical transmission conditions and target simulator detector sensitivity specified herein to enable interoperability.

This Laser Engagement standard defines a specific direct fire laser engagement simulation methodology. It does not preclude a non-interfering parallel operation of other laser communication protocols as for example; a simulator system that requires this Laser Engagement optical interface for vehicle engagements and the MILES Communication Code (MCC) optical interface for soldier engagements.

1.2 Purpose

There is a requirement for coalition training of defense forces. Weapons effect simulation has in the past typically evolved with national training requirements resulting in proprietary protocols satisfying specific national needs. This Optical Interface Specification standard primarily details a laser simulated engagement methodology for direct fire weapon simulation used for gunnery and combat training for example. The realization of interface standards across coalition platforms enables interoperability in a live ground training environment.

This Optical Interface Specification standard is one of a number of (potential) standards used for weapon effects simulation. This standard will be complimentary to those other standards. Furthermore this optical interface also requires collective implementation of casualty and damage effects resulting from simulated engagements, defined in a separate document.

1.3 Objectives

The primary objective of this optical interface specification is to establish a standard interface for the communication of a laser based simulated weapon engagement in a training environment. The intent is to prescribe the content and engagement methodology for the simulation of a number of classes of direct fire weapon systems. Compliance with these procedures enables interoperability between simulator equipment and systems provided from different vendors and manufacturers.

1.4 Intended Audience

A typical weapon simulator is principally built up by two parts, the fire simulator and the target simulator. The weapon simulator may then simulate fire against a target and at the same time receive simulated fire from other weapon simulators.

A weapon simulator may also be made up of only the fire simulator part, as in an antitank weapon, or only the target simulator part as on a truck.

This Laser Engagement specification specifies how the different weapon simulators interact on the exercise area. All simulators on the exercise area have to follow the specification, to ensure that simulators can interoperate properly. The requirements in this specification are specifically important when different weapon simulators from different manufacturers shall interact on the exercise area.

The weapon systems have different price levels and the simulator requirements may differ as for example:

- A tank weapon system is an expensive weapon system and the hit accuracy requirements are usually important
- An antitank weapon system is comparatively less expensive but the simulator might have to consider that it shall simulate a "Fire-and-Forget" weapon system.
- A small arms weapon system is even less expensive but the simulator data transfer from the fire simulator to target simulators can be time critical.

As a consequence different optical encoding methods are used to meet the different simulator requirements.

2 References (Normative)

2.1 SISO References

#	Document Number	Title	Date (MM/DD/YYYY)
1.	SISO-GUIDE-003-2016	Guide for UCATT Live Simulation Standards and Architecture	05/09/2016
2.	SISO-REF-059-00-2015	Reference for UCATT Ammunition Table	07/29/2015

2.2 Other References

#	Document Number	Title	Date
3.	none provided		

3 Definitions, Acronyms, and Abbreviations

English words are used in accordance with their definitions in the latest edition of Webster's New Collegiate Dictionary except when special SISO Product-related technical terms are required.

3.1 Definitions

Term	Definition
none provided	

3.2 Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
ABM	Air Burst Munitions
AC	Ammunition Code (optical message item)
AmLsd	Ammunition Least Significant Digit
AmNo	Ammunition Number (optical encoded/decoded logical number)
AP	Armor Piercing
APDS	Armor-Piercing Discarding-Sabot
APFSDS	Armor-Piercing Fin-Stabilized Discarding-Sabot
CA	Cant Angle Code
DI	Distance Info Code
EI	Engagement Info Code
FlgNo	Flag Number
GC	Geographical Command Code
GIC	Geographical Identification Code
HE	High Explosive
HEAT	High Explosive Anti-Tank
HEMP	High Explosive Multi-Purpose
HP	Hit Probability Code
IC	Player Identity Code
IdNo	Player Identity Number
MCC	MILES Communication Code
NC	Null Code
PAC	Player Association Code
PC	Position Code
PI	Pulse Interval
PIU	Pulse Interval Unit
SISO	Simulation Interoperability Standards Organization
SP	Simulated Projectiles
TF	Time-to-Impact for Fire-and-Forget
UC	Umpire Command Code
UCATT	Urban Combat Advanced Training Technology
UIC	Umpire Identification Code

4 UCATT Optical Interface

4.1 Optical Physical Characteristics

This section 4.1 shall be seen as recommendations and not as requirements. The primary intent with the information in this section is to enable a fair and reasonable multinational training interoperability and is not intended to be used as contractual requirements between vendor and buyer of simulation equipment.

4.1.1 Transmitter and Detector

Wave Length

A laser transmitter is used to transmit:

- All codes with the two exception examples below.

A laser transmitter or infrared diode transmitter is used to transmit:

- Player Association Code
- Geographical Reference Code

When laser transmitter is used:

Laser pulse wave length	905 nm ± 25 nm

When infrared diode transmitter is used:

Infrared diode pulse wave length	930 nm ± 50 nm

The transmitters transmit, using an infrared diode, at the similar 905nm wavelength as the laser simulator transmitters but the allowed wavelength is 880-980nm to allow cost effective infrared diodes to be used.

Pulse Length

The pulse length (P) is measured at the half of the pulse height.

Laser transmitter	40 ns ≤ P ≤ 100 ns
Infrared diode transmitter	40 ns ≤ P ≤ 350 ns

Detector Characteristics

The light detector shall be able to receive information from transmitters simulating a weapon engagement at far distances when the light intensity or luminance is low.

Target simulator laser detector sensitivity	Vehicle	< 4 mW/m²
	Man worn	< 100 mW/m²

The light detector shall be able to receive information also from transmitters at close distances when the light intensity or luminance is high.

Maximum received light intensity (luminance)	< 2.0 kW/m²

4.1.2 Retro Reflector

4.1.2.1. **Retro Reflector Characteristics**

For example, the "Real-Time Code" the engagement methodology typically requires a laser light reflection from the target to the fire simulator (i.e., two-way simulator). A Retro Detector Unit then comprises both retro reflector(s) and detector(s). The maximum distance from the center of one retro reflector to the center of the closest detector is 0,1m. The distance between two Retro Detector Units on a target simulator shall be less than 5m.

The target retro reflector size is designed from two primary maximum range characteristics concerning the fire simulator:

- The ability to receive and detect reflected laser light.
- The ability to transmit engagement information.

To align with typical existing laser fire simulator characteristics and for simulated combat training interoperability a target retro reflector shall have a minimum effective diameter of:

- Vehicle: $d \geq 56$ mm, nominal 60mm
- Man worn: $d \geq 22$ mm

It is possible to design a target simulator replacing a single retro reflector with multiple retro reflectors. In that case the close mounted retro reflectors area sum shall exceed the area of one of the above two defined retro reflectors.

A single retro reflector shall reflect the laser light with at least an accuracy of:

- Vehicle: ± 2 arc seconds
- Man worn: ± 5 arc seconds

4.1.2.2. **Retro Reflector Usage**

Target simulator retro reflector(s) are used by the two-way fire simulator primarily for the following reasons:

- Measure the simulated projectile or missile position in relation to the target retro reflector(s).
- Measure distances to target simulator from:
  - Projectile or missile
    - To initiate transmission of engagement info like "Position Code", "Ammunition Code" and "Player Identity Code" when the simulated projectile or missile is close to a target.
    - In case of an air burst engagement the "Detonation Distance" info shall be transmitted.
  - Fire simulator
    - In case of distance dependent engagement lethality the "Engagement Distance" info shall be transmitted.

4.2 Pulse Interval Description

To establish the possibility to simulate fire and to transmit information from the laser fire simulator to the target simulator, one or more laser detectors are mounted on the target simulator. The transmitted information is built up by modulating the laser pulse intervals.

4.2.1 Encoded and Decoded Pulse Interval Item

An optical information code part is built up by pulse intervals (PI). A pulse interval has a start pulse and a stop pulse. The stop pulse can be the start pulse for the next interval.

The pulse interval encoder clock is driven by a frequency of 15 MHz with an accuracy of at least ± 70 ppm.

Two pulses are building a pulse interval (PI) measured in pulse interval units (PIU). A Pulse Interval Unit (PIU) has a resolution of 1 / (15 MHz) or 66⅔ns. The pulse interval (PI) is the optical code information carrier, used by the firing simulator to transmit information to the target simulator.

A firing laser transmitter transmits several message elements (pulse intervals) to encode each message item. There are several message items building a complete message.

4.2.1.1. **Pulse Interval Types**

There are three types of transmitted encoded pulse interval message items:

- Fixed
    - o Non-alternating
    - o Alternating
- Continuously changing

Fixed Non-alternating

This is the most fundamental method of encoding message items, when transmitting fixed values like "Ammunition Code" and "Player Identity Code". A decoded message item is illustrated below.

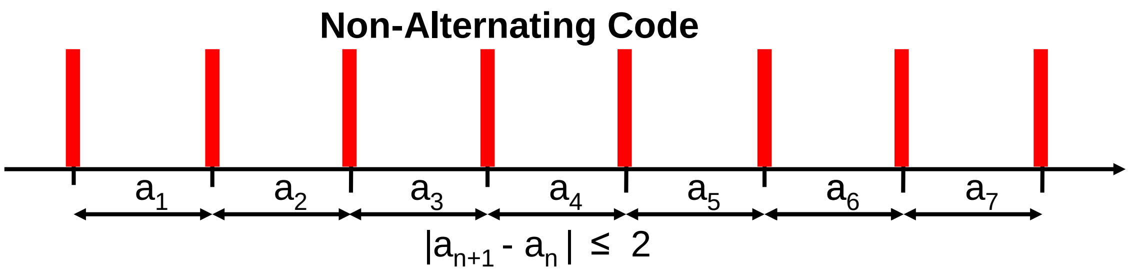

Figure 1 Pulse Interval Description, Fixed Non-alternating Code

Fixed Alternating

This is a more advanced method of encoding message items, when transmitting fixed values like "Ammunition Code" and "Player Identity Code". The pulse intervals "a" and "b" are alternating and both can carry the shortest pulse interval. In the decoded message item illustration below "a" carries the shortest pulse interval.

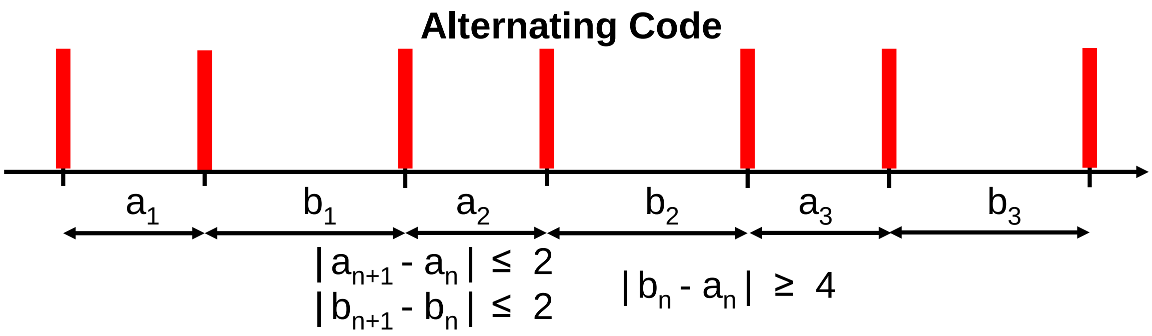

Figure 2 Pulse Interval Description, Fixed Alternating Code

As illustrated above there is a basic decoding rule for alternating pulse interval pairs "a" and "b". To ensure that a fixed alternating message item cannot be decoded and misinterpreted as a fixed non-alternating message item the encoder must use an alternating pair where the difference in encoded pulse intervals "a" and "b" is more or equal to six PIU. The consequence is that the receiver can decode a difference in "a" and "b" equal or more than four PIU and still correctly interpret the message item as alternating.

Continuously Changing

This is the method of encoding the projectile position message item. The pulse interval is continuously changing as the transmitter scans around the simulated projectile, representing a fixed position in space to be read by a single or multiple targets. A decoded message item is illustrated below.

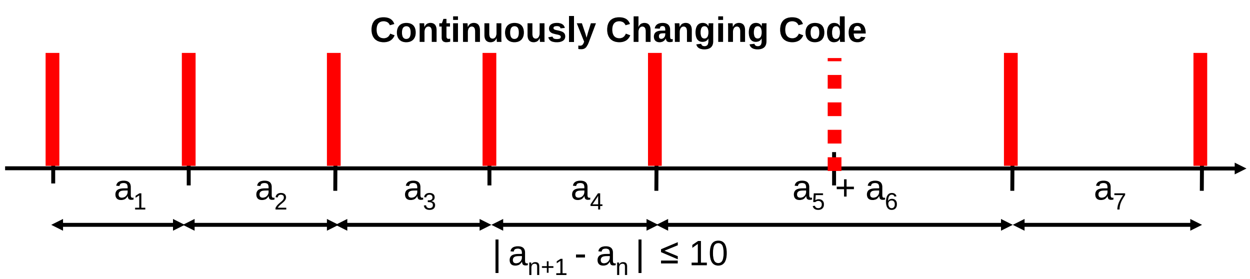

Figure 3 Pulse Interval Description, Continuously Changing Code

As illustrated above the decoded single adjacent pulse interval cannot change more than ten PIU to be decoded as belonging to the same message item. When a single adjacent pulse is missing the decoded pulse interval consequently cannot change more than twenty PIU to belong to the same message item. The consequence is that the transmitter shall not change the adjacent pulse interval more than nine PIU, to assure that the message item is correctly interpreted by the receiver.

To some extent continuously changing encoding has similar characteristics as fixed non-alternating encoding. At the decoder end they differ by the compared characteristics in the next chapter.

4.2.1.2. Basic Message Item Encoding and Decoding Rules

The following pulse interval related definitions in an encoded and decoded message item is used:

Table 1 Pulse Interval Description, Pulse Interval Related Definitions

Item Definition	Description
a_1 and b_1	First message item pulse interval measured in PIU
a_n, a_k, b_n and b_k	Any message item pulse interval measured in PIU
a_N and b_N	Last message item pulse interval measured in PIU
$1 \leq n \leq N$	Valid indexes on message item pulse intervals
$1 \leq k \leq n$	Valid indexes on message item pulse intervals

Table 2 Pulse Interval Description, Encoding Rules

Pulse Interval Type	Encoding Rules	Description
Fixed non-alternating	$a_{n+1} = a_k$	All pulse intervals are transmitted having the same nominal pulse interval.
Fixed alternating	$a_{n+1} = a_k$	All "a" pulse intervals are transmitted having the same nominal pulse interval.
	$b_{n+1} = b_k$	All "b" pulse intervals are transmitted having the same nominal pulse interval.
	$\| a_n - b_n \| \geq 6$	To ensure that a fixed alternating message item cannot be misinterpreted and decoded as a fixed non-alternating message item.
	$\| b_n - a_n \| \geq 6$	
Continuously changing	$\| a_{n+1} - a_n \| \leq 2$	Typical change between adjacent message item pulse intervals.
	$\| a_{n+1} - a_n \| \leq 9$	Maximum allowed change between adjacent message item pulse intervals.

Table 3 Pulse Interval Description, Decoding Rules

Pulse Interval Type	Decoding Rules	Description
Fixed non-alternating	$\| a_{n+1} - a_k \| \leq 2$	All received message item pulse intervals does not differ more than two PIU.
Fixed alternating	$\| a_{n+1} - a_k \| \leq 2$	All received "a" message item pulse intervals does not differ more than two PIU.
	$\| b_{n+1} - b_k \| \leq 2$	All received "b" message item pulse intervals does not differ more than two PIU.
	$\| a_n - b_n \| \geq 4$	The encoder has ensured that a fixed alternating message item cannot be misinterpreted and decoded as a fixed non-alternating message item.
	$\| b_n - a_n \| \geq 4$	
Continuously changing	$\| a_{n+1} - a_n \| \leq 2$	Typical change between adjacent message item pulse intervals.
	$\| a_{n+1} - a_n \| \leq 10$	Maximum allowed change between adjacent message item pulse intervals.

"Continuously changing" is consequently from the above illustrated similarities, sometimes also referred to as "Non-alternating".

4.2.2 Minimum Decodable Pulse Interval Item

The receiver does not need to receive all transmitted pulse intervals to decode a message item. When the fire and target simulators have a distance close to the simulator maximum range performance, more or less pulses in a transmitted sequence are expected to be decoded by the target receiver. To stretch the simulator maximum range performance, minimum decodable pulse interval items are defined. The minimum decodable pulse interval item for each type of pulse interval sequence is illustrated below.

Non-alternating Intervals

The minimum decodable pulse interval items are illustrated below.

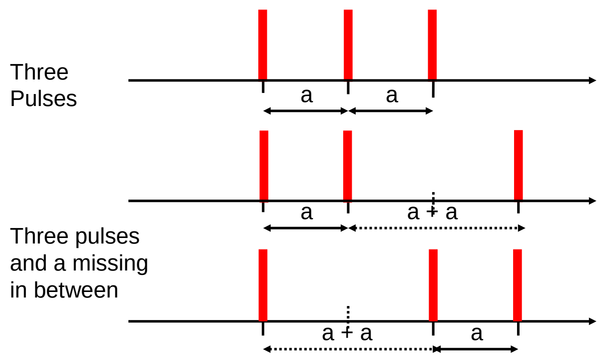

Figure 4 Pulse Interval Description, Minimum Decodable Pulse Interval Item, Non-alternating Code

Alternating Intervals

The interval "a" and "b" is alternating and can both can carry the shortest pulse interval. In the illustration below "a" carries the shortest pulse interval.

As opposed to Non-alternating Intervals, Alternating Intervals is not specified to include a missing pulse in the Minimum Decodable Pulse Interval Item definition. Despite it is not specified it is possible to implement missing pulse decoding as for example illustrated below:

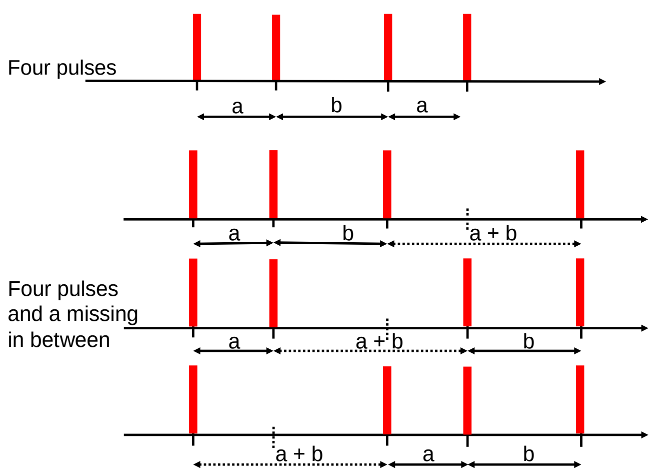

Figure 5 Pulse Interval Description, Minimum Decodable Pulse Interval Item, Alternating Code

4.2.3 Pulse Sequence Identification

When a Minimum Decodable Item is decoded there are rules to connect interval items, as belonging to the same message item. Items are connected by two reasons:

- A single missing pulse is identified, if it is not part of the definition as a minimum pulse interval item
- A "Null Code" (NC1, NC2 or NC3) is identified between the items.

The below figures illustrate how to connect interval items as belonging to the same pulse sequence.

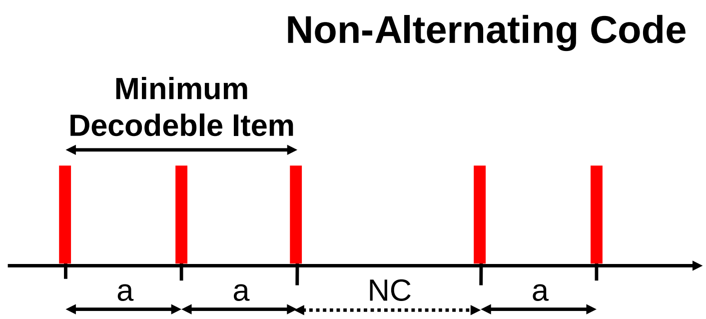

Figure 6 Pulse Interval Description, Pulse Sequence Identification, Non-alternating Code

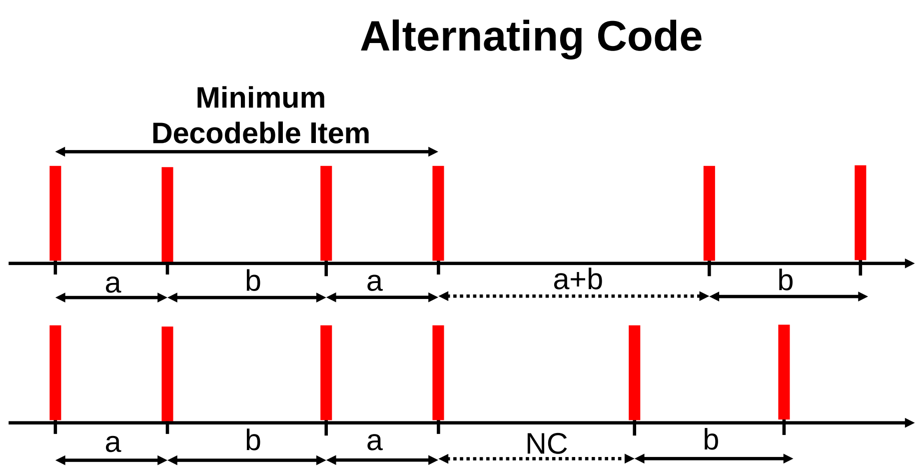

Figure 7 Pulse Interval Description, Pulse Sequence Identification, Alternating Code

4.2.4 Common Decoding Characteristics

The following conditions and abilities are common when decoding all optical code types like "Real-Time Code", "Short-Time Code", etc.

The Target Simulator shall use the following conditions when decoding pulse intervals:

- The Target Simulator does not have to decode more than 50 message elements (pulse intervals) to decode a single message item.
- When the "Ammunition Code", "Player Identity Code", "Detonation Info Code" and similar Fixed Alternating and Fixed Non-alternating Codes are transmitted, the decoded pulse interval **average value** is calculated, when two adjacent pulse intervals does not differ more than two PIU’s.
- When the Continuously Changing "Position Code" is transmitted, the decoded pulse interval **average value** is calculated using all pulse intervals, when two adjacent pulse intervals does not differ more than ten PIU’s.
- If the player identity number cannot be decoded, the identity value is set to zero. The decoding of the rest of the codes is still done.

The Target Simulator shall have the following abilities when decoding pulse intervals:

- The target simulator must be able to receive codes simultaneously and in parallel received at one single or several detectors and shall consequently be able to decode pulse interval sequences even when they are overlaid.
- The target simulator must be able to decode information when several firing simulators engage the target simulator apparently (i.e., same or multiple detector(s) receive both optical engagement codes) at the same time. As a consequence the target simulator must at least be able to decode engagement information from at least two firing simulators when they are simulating weapon fire trigger at a time distance of 50ms.
- Immunity to optical noise in the ambient environment:
  - o All functions of the target simulator must be ensured also if it receives a lot of disturbing noise pulses. The target simulator shall decode "Ammunition Code" and "Player Identity Code" correctly in a test case when a correct transmitted sequence is disturbed by noise pulses evenly distributed around 1000 pulses / second with a 1-sigma value equal to 500 Hz (2ms) and noise pulse amplitude not significantly exceeding the optical coded received pulse.

4.2.5 Encoding and Decoding Notation

In the following optical coding chapters the below mathematical notation is used when encoding and decoding the messages:

- "INT(.../...)" in the formulas means "The truncated integer part of" as a result of the division operation.
- "INT(..%..)" in the formulas means "The remainder part of" as a result of the division operation.
- "INT(...*...)" in the formulas means "The integer part of" as a result of the multiplication operation. The integer result is truncated without using rounding.
- "INT(...+...)" in the formulas means "The integer part of" as a result of the addition operation. The integer result is truncated without using rounding.

The notation is selected and aligned with how embedded computers usually handle basic mathematical operations.

Examples:

Table 4 Pulse Interval Description, Encoding and Decoding Notation Examples

INT(8/3)	=	2
INT(-8/3)	=	-2
INT(7/3)	=	2
INT(-7/3)	=	-2
INT(7%3)	=	1
INT(-7%3)	=	-1
INT(7.6*3)	=	22
INT(7.6*4)	=	30
INT(0.3+7.6)	=	7
INT(0.5+7.6)	=	8
INT(0.5+7.6*3)	=	23

Observe that Microsoft Excel does not define "INT" in the same way as in this specification!
In this specification "INT" corresponds to Microsoft Excel "TRUNC".

4.3 Optical Codes

The simulators and other kind of related laser equipment transmit coded information by using laser light that is received by target simulators.

This optical specification includes the following optical code types and each type consists of the following message items:

Table 5 Optical Codes, Message Item Names and Acronyms

Optical Code Type	Message Item Name	Acronym
Short-Time	Ammunition Code	AC3, AC9
	Player Identity Code	IC4a, IC4b, IC5a, IC5b
Real-Time	Ammunition Code	AC1, AC11, AC21
	Player Identity Code	IC1, IC2, IC3, IC11, IC12, IC21, IC22
	Projectile or Missile Position Code	PC1, PC2
	Distance Lethality Code	EI11, DI11
	Cant Angle	CA21
	Null Code	NC1, NC2, NC3, NC4
Fire-and-Forget	Ammunition Code	AC5, AC12, AC22
	Player Identity Code	IC1, IC2, IC3, IC11, IC12, IC21, IC22
	Hit Probability Code	HP1
	Time-to-Impact Code	TF1
	Distance Lethality Code	EI11, DI11
	Cant Angle	CA21
	Null Code	NC1, NC2, NC3, NC4
Short-Time Scanning	Ammunition Code	AC2, AC11, AC22
	Player Identity Code	IC4a, IC4b, IC5a, IC5b IC11, IC12, IC21, IC22
	Null Code	NC1, NC2, NC3, NC4
Umpire Control-Gun	Umpire Identification Code	UIC
	Umpire Command Code	UC1, UC2
	Player Identity Code	IC4a, IC4b, IC5a, IC5b
Geographical Reference	Geographical Identification Code	GIC
	Geographical Command Code	GC1, GC2
Player Association	Player Association Code	PAC

4.3.1 Pulse Intervals

The pulse intervals can be understood as constructed by using a 15MHz clock.

- The pulse interval is defined as the time distance between two pulses, measured at the positive flanks of the two pulses.
- Valid pulse intervals are decoded between 1205PIU (≈0,08ms) and 2397PIU (≈0,16ms). Possible future growth is between 1200-2399PIU. There are two exceptions where pulse intervals are allowed outside 1200-2399PIU:
    - "Player Association Code" (PAC)
        - Valid pulse intervals are decoded between 470-490PIU
    - "Null Code 4" (NC4)
        - Valid pulse intervals are decoded between 382-386PIU
- When a single transmitted pulse is missing when received at the target, it is assured it cannot by accident be decoded as any additional valid pulse interval.
- When a single additional (noise) erroneous pulse is received within a valid pulse interval, it is assured that it cannot by accident result in decoding any additional valid pulse interval pair.

The following decodable pulse intervals are used by each message item. The pulse intervals are also illustrated in the Pulse Intervals Map.

Table 6 Optical Codes, Decodable Pulse Intervals

Item Acronym	Message Item Description	No.		Alternating Pair	PIU	
		Low	High		Low	High
IC1	Player Identity Code Non-alternating	1	20		1505	1564
IC2		0	19		1565	1624
IC3		0	24		1625	1699
IC4a		1	50		1250	1399
IC4b		51	100		1550	1699
IC5a		0	49		1400	1549
IC5b		50	99 163 (179)		1909	2058 2250 (2298)
IC11	Player Identity Code Alternating	1	20	IC21	1505	1564
IC12		0	24	IC22	1625	1699
IC21		0	9	IC11	1235	1264
IC22		0	6 (9)	IC12	1205	1234
AC1	Ammunition Code Non-alternating	1	24		1700	1771
AC5		25	25		1772	1774
AC1		26	29		1775	1786
AC5		30	30		1787	1789
AC1		31	46		1790	1837
AC3		47	67		1838	1900
AC3		68	70		2308	2316
AC3		71	76		2371	2388
AC2		77	79		2389	2397
AC9		3	7		1211	1225
AC11	Ammunition Code Alternating	1	20	AC21 AC22	1205	1264
AC12		1	20	AC22	1625	1684
AC21		1	28	AC11	1268	1351
AC22		1	28	AC11 AC12	1355	1438
EI11	Distance Lethality Code	1	28	DI11 CA21	1268	1351
DI11		1	20	EI11 CA21	1505	1564
CA21	Cant Angle	1	30	EI11 DI11	1355	1444
PC1	Position Code	-97	+97		1911	2105
PC2		-97	+97		2107	2301
HP1	Hit Probability Code	0	100		1999	2101
TF1	Time-to-Impact Code	0	60		2133	2200
UIC	Umpire Identification Code	1	3		2359	2367
UC1	Umpire Command Code	1	64		1912	2103
UC2		1	64		2108	2299
GIC	Geographical Identification Code	1	1		2368	2370
GC1	Geographical Command Code	1	64		1912	2103

Item Acronym	Message Item Description	No.		Alternating Pair	PIU	
		Low	High		Low	High
GC2		1	64		2108	2299
NC1	Null Code	1	1		2302	2306
NC2		2	2		1902	1906
NC3		3	3		2318	2322
NC4		4	4		382	386
PAC	Player Association Code				470	490

4.3.2 Pulse Intervals Map

This pulse interval map illustrates pulse interval usage.

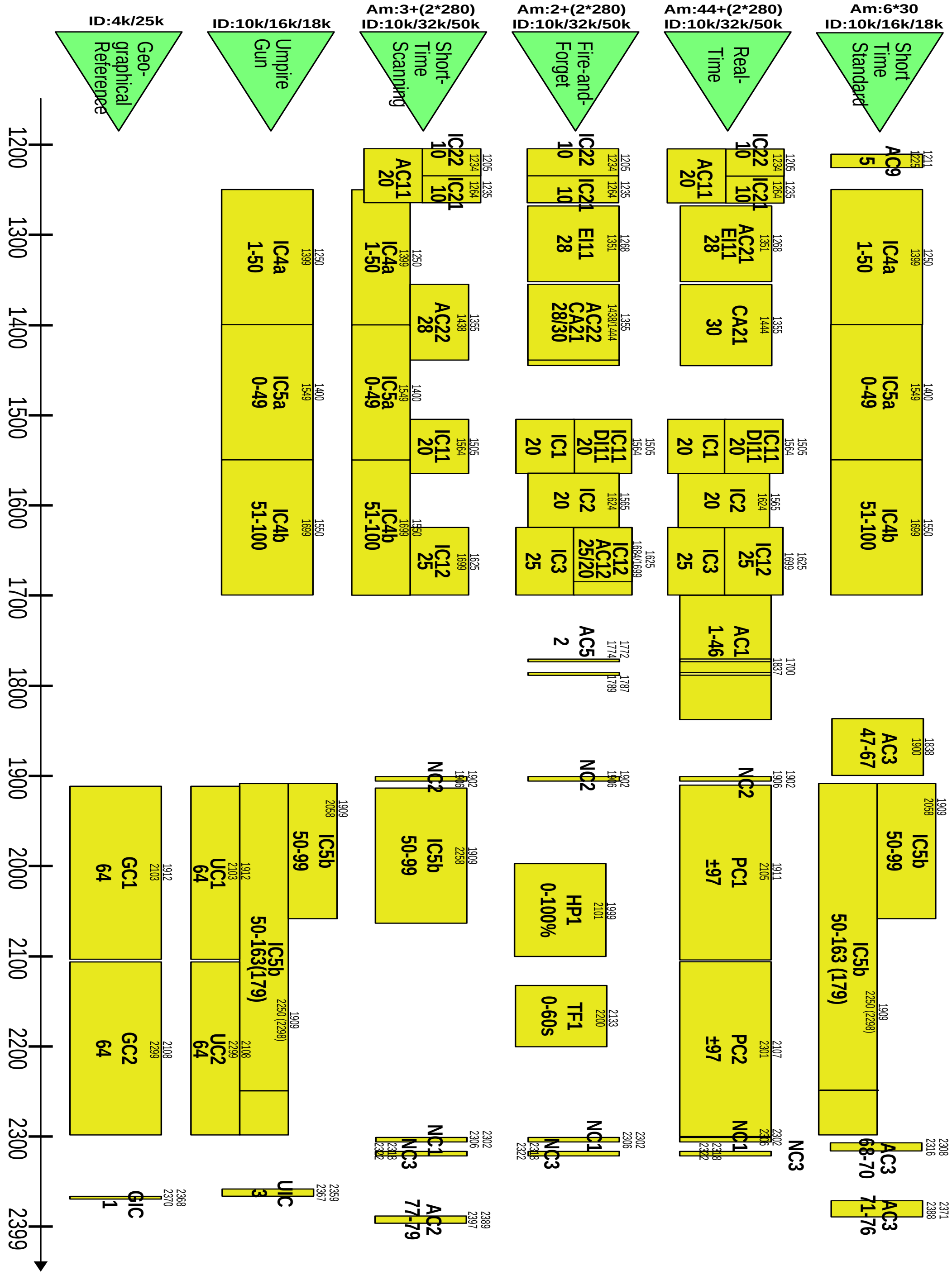

Figure 8 Optical Codes, Pulse Intervals Map

4.3.3 Code Structure

The optical code structure containing message item sequences can be arranged two groups:

- Short-Time Group Structure
- Triplet Group Structure

4.3.3.1. Short-Time Group Structure

The following optical code types are using the Short-Time Group characteristics when transmitting sequences of message items:

- Short-Time Code
- Umpire Control-Gun Code

The "Short-Time Code" use message blocks and sequences of message blocks when transmitting information.

For each simulated projectile the transmitter typically starts with a limited number of hit coded messages followed by a number of near miss coded messages. When hit coded messages are transmitted for a projectile they must precede near miss coded messages. If the receiver can only decode near miss messages, the receiver interprets the engagement as a near miss.

Typical example where the number of blocks B=12, message items I=3 and number of elements E=5:

Table 7 Optical Codes, Short-Time Group, Block Transmission Illustration 1

Block	AC3	Sequence
1-2	Hit	IC4a–IC4a–IC4a–IC4a–IC4a – AC3–AC3–AC3–AC3–AC3 – IC5a–IC5a–IC5a–IC5a–IC5a
2-12	Near Miss	IC4a–IC4a–IC4a–IC4a–IC4a – AC3–AC3–AC3–AC3–AC3 – IC5a–IC5a–IC5a–IC5a–IC5a

To transmit a child ammunition number more than three message items (I >3) are required where AC9 is then transmitted followed by AC3.

Typical example where the number of blocks B=14, message items I=4 and number of elements E=3:

Table 8 Optical Codes, Short-Time Group, Block Transmission Illustration 2

Block	AC3	Sequence
1-2	Hit	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2-14	Near Miss	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a

In the two examples above the two first blocks use AC3="Hit" to encode the hit messages and in the following blocks AC3="Near Miss" is used to encode the near miss messages.

A message block delimiter item is defined by the end of a message block and the start of the next message block as illustrated below:

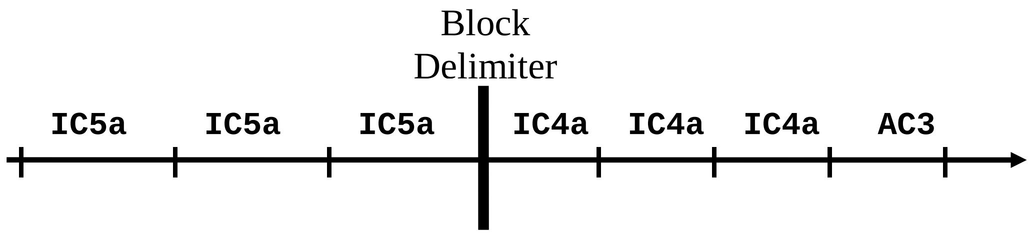

Figure 9 Optical Codes, Short-Time Group, Block Delimiter Example

Block transmission is done in two different ways depending on if IC5a or IC5b is transmitted.

- IC5a is transmitted last in block
- IC5b is transmitted first in block

The "Short-Time Code" is built with message item sequences (blocks) in several combinations with corresponding block delimiter illustrated as follows:

Table 9 Optical Codes, Short-Time Code, Block Delimiters

Valid Message Item Sequences (Blocks)	Block Delimiter
IC4a–AC3–IC5a	IC5a–IC4a
IC4a–AC9–AC3–IC5a	
IC4b–AC3–IC5a	IC5a–IC4b
IC4b–AC9–AC3–IC5a	
IC5b–AC3–IC4a	IC4a–IC5b
IC5b–AC9–AC3–IC4a	
IC5b–AC3–IC4b	IC4b–IC5b
IC5b–AC9–AC3–IC4b	

Note that each message item (IC4a, IC4b, IC5a, IC5b, AC9 and AC3) in the above table consists of three to five message elements.

4.3.3.2. Triplet Group Structure

The following optical code types are using message item triplet sequences and sequences of triplets when transmitting information:

- Real-Time Code
- Fire-and-Forget Code
- Short-Time Scanning Code

There are six message item sequences, build as triplets with acronym names as follows:

- P3ON: Position or "Hit Probability" and "Time-to-Impact". With non-alternating ammo code
- P3OA: Position or "Hit Probability" and "Time-to-Impact". With alternating message item
- I3ON: Player identity. Non-alternating
- I3OA: Player identity and ammo. Alternating
- I3SN: Player identity and ammo. Non-alternating. I3SN is not combined with any other triplet and is exclusively designed for "Short-Time Scanning" simulation.
- I3SA: Player identity and ammo. Alternating. I3SA is not combined with any other triplet and is exclusively designed for "Short-Time Scanning" simulation.

The five most typical triplets are illustrated as follows:

Table 10 Optical Codes, Most Typical Used Triplets Illustration

Optical Code Type	Triplet	Sequence			Description of Sequence No. 1 and 3	Description of Sequence No. 2
		1 or 3 No. 1	2 No. 2	1 or 3 No. 3		
Real-Time	P3ON	PC1	AC1	PC2	Projectile Position	Ammo
	I3ON	IC1	IC2	IC3	Player Identity	Player Identity
	P3OA	PC1	EI11 CA21	PC2	Projectile Position	Engagement Info Cant Angle
	I3OA	IC11 IC21	AC11 AC21	IC12 IC22	Player Identity	Ammo
Short-Time Scanning	I3SA	IC11 IC21	AC11 AC22	IC12 IC22	Player Identity	Ammo

Single and multiple triplets has to be transmitted and combined as illustrated in the below table.

Received sequences of triplets builds a minimum decodable sequence combination also illustrated in the below table.

Table 11 Optical Codes, Single and Multiple Triplet Combinations

Allowed Encoded Sequence	Minimum Decodable Sequence without firing Player Identity	Minimum Decodable Sequence with firing Player Identity
I3SN		I3SN
I3SA		I3SA
N1*P3ON – M1*I3ON	P3ON	P3ON - I3ON
N2*P3OA – M2*I3OA	Not decodable without I3OA	P3OA - I3OA

The integers N1, N2, M1 and M2 are selected by the encoder and then typically decoded as follows:

Table 12 Optical Codes, Typical Number of Triplets

N1, N2	M1,M2	Comment
N1=N2=2	M1=M2=2	Single shot and low rate burst of fire (approx. < 250 rounds/min)
N1=N2=1	M1=M2=1	High rate burst of fire (approximately ≥ 250 rounds/min)

In the simulation situations described in the below table comment column, N1, N2, M1 and M2 are extended from the above previous tabled typical values. The decoder shall consequently expect to receive sequences with the following N1, N2, M1, and M2 values:

Table 13 Optical Codes, Allowed Number of Triplets

<table>
<tr><th>N1, N2</th><th>M1, M2</th><th>Comment</th></tr>
<tr><td>1 ≤ N1 ≤ 3
1 ≤ N2 ≤ 3</td><td>1 ≤ M1 ≤ 3
1 ≤ M2 ≤ 3</td><td rowspan="2">Single shot and low rate burst of fire</td></tr>
<tr><td colspan="2">2 ≤ (N1+ M1) ≤ 6
2 ≤ (N2+ M2) ≤ 6</td></tr>
<tr><td>1 ≤ N1 ≤ 2
1 ≤ N2 ≤ 2</td><td>1 ≤ M1 ≤ 2
1 ≤ M2 ≤ 2</td><td rowspan="2">High rate burst of fire</td></tr>
<tr><td colspan="2">2 ≤ (N1+ M1) ≤ 4
2 ≤ (N2+ M2) ≤ 4</td></tr>
</table>

The triplets are illustrated as follows:

Table 14 Optical Codes, All Used Triplets Illustration

Optical Code Type	Triplet	Sequence 1 or 3 No. 1	Sequence 2 No. 2	Sequence 1 or 3 No. 3	Description of Sequence No. 1 and 3	Description of Sequence No. 2
Real-Time	I3ON	IC1	IC2	IC3	Player Identity	Player Identity
Fire-and-Forget						
Real-Time	P3ON	PC1	AC1	PC2	Projectile Position	Ammo
Fire-and-Forget	P3ON	HP1	AC5	TF1	Hit Probability Time-to-Impact	
Short-Time Scanning	I3SN	IC4a	AC2	IC5a	Player Identity	Ammo
		IC4b		IC5a		
		IC5b		IC4a		
		IC5b		IC4b		
Real-Time	I3OA	IC11 IC21	AC11 AC21	IC12 IC22	Player Identity	Ammo
Fire-and-Forget			AC12 AC22			
Short-Time Scanning	I3SA		AC11 AC22			
Real-Time	P3OA	PC1	EI11 CA21	PC2	Projectile Position	Engagement Info Cant Angle
			DI11 CA21			Detonation Info Cant Angle
			EI11 DI11			Engagement Info Detonation Info
Fire-and-Forget	P3OA	HP1	EI11 CA21	TF1	Hit Probability Time-to-Impact	Engagement Info Cant Angle
			EI11 DI11			Engagement Info Detonation Info
			DI11 CA21			Detonation Info Cant Angle

NOTE 1-

- It shall be noted that it is possible to transmit multiple P3OA's referring to the same projectile containing different "Sequence No. 2" information as for example:
    - EI11/CA21 and DI11/CA21

4.4 Ammunition Numbering Structure

The Laser Engagement ammunition table is defined in Reference [2] and includes several hundred ammo numbers.

The ammo numbers are used in two code groups:
- Short-Time Group
- Triplet Group

4.4.1 Short-Time Group Coded

The "Short-Time Group Coded" ammunition codes are typically used by non-scanning transceivers although also scanning transceivers also can use them. The "Short-Time Group Coded" ammunition codes include:
- Short-Time Code
  - 30 grandparent ammo numbers 47-76
  - 5*30 child ammo numbers

The ammo numbering is illustrated with the below table:

Table 15 Ammunition Numbering, Short-Time Group

Parent-Child Relationship	Short-Time
Grandparent	47-76
Child	1547-1576
Child	1647-1676
Child	1747-1776
Child	1847-1876
Child	1947-1976

4.4.2 Triplet Group Coded

The "Triplet Group Coded" ammunition codes are typically used by scanning transceivers although also non-scanning transceivers also can use them. The "Triplet Group Coded" ammunition codes include three types of optical coding.
1. Real-Time Code
   - Ammo numbers 1-24, 26-29 and 31-46.
   - 8*280 ammo numbers.
2. Fire-and-Forget Code
   - Ammo numbers 25 and 30.
   - 2*280 ammo numbers.
3. Short-Time Scanning Code
   - Ammo numbers 77-79.
   - 2*280 ammo numbers.

Depending on how the Real-Time Code ammunition is simulated and detonating, ammo numbers are decoded by the target simulator from detonation types optically transmitted by the fire simulator. The fire simulator encodes some of the detonation types in the "Engagement Info" (EI11) or "Detonation Info" (DI11) optical codes.
- Direct Detonation
- Burst of Fire
- Air Burst
- Unarmed

The ammo numbering is illustrated with the below table:

Table 16 Ammunition Numbering, Triplet Group

<table>
<tr><th rowspan="2">Parent-Child Relationship</th><th colspan="4">Real-Time</th></tr>
<tr><th>Direct Detonation</th><th>Burst of Fire</th><th>Air Burst</th><th>Unarmed</th></tr>
<tr><td>N.A.</td><td>1-24
26-29
31-46</td><td></td><td></td><td></td></tr>
<tr><td>Grandparent</td><td>2001-2280</td><td></td><td></td><td></td></tr>
<tr><td>Parent</td><td></td><td>4001-4280</td><td>6001-6280</td><td>8001-8280</td></tr>
<tr><td>Child</td><td>3001-3280</td><td>5001-5280</td><td>7001-7280</td><td>9001-9280</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="2">Parent-Child Relationship</td><td colspan="2">Fire-and-Forget</td><td colspan="2">Short-Time Scanning</td></tr>
<tr><td colspan="2">Direct Detonation</td><td colspan="2">Direct Detonation</td></tr>
<tr><td>N.A.</td><td colspan="2">25, 30</td><td colspan="2">77-79</td></tr>
<tr><td>Parent</td><td colspan="2">12001-12280</td><td colspan="2">22001-22280</td></tr>
<tr><td>Child</td><td colspan="2">13001-13280</td><td colspan="2">23001-23280</td></tr>
</table>

NOTE 1-There are restrictions in using "Short-Time Scanning" child ammo numbers as they also can be used as part of the "Short-Time Scanning" "Burst of Fire Engagement" simulation mechanism.

4.4.3 Grandparent-Parent-Child Relationship

Grandparent and parent ammo numbers may have one or more related child ammo numbers. Child numbers are free to use as for example for national training purposes, but can be evaluated as its grandparent or parent ammo number at multinational training. See the below Figure 10 and Figure 11 for more details. At least all grandparent ammo numbers shall have a defined lethality and engagement effect in the target simulators.

It is possible to fine tune the vulnerability data or for specific training purposes alter the grandparent or parent ammo vulnerability data using child ammo numbers. Below are described two examples:

Fine tuning example:
You want to make a difference between 20mm AP and 23mm AP ammunitions. You can then define a child ammo number for the 23mm AP. You shall then select the target simulators where you expect that the child ammo number makes a difference and update the vulnerability description in those target simulators.

Training purpose example:
Your training includes an OPFOR and a BLUEFOR both using the same type of anti-tank weapons. It is then possible to for example decrease the lethality for the OPFOR antitank weapons. You can then define child ammo numbers for the OPFOR anti-tank weapons and then select the target simulators where you expect that the child ammo numbers make a difference and update the vulnerability description in those target simulators.

Missing Child Ammo Vulnerability
When a child ammo number is not noted in a target simulator vulnerability description there is always a grandparent or parent ammo number that is used to evaluate the vulnerability for the child ammo number, as they are assumed having similar vulnerability data.

Missing Parent Ammo Vulnerability
When a parent ammo number is not noted in a target simulator vulnerability description there is always a grandparent ammo number that is used to evaluate the vulnerability for the parent ammo number, as they have associated vulnerability data. For example, in case of Air Burst or Unarmed engagement you usually cannot expect similarities in inherited vulnerability data. It is up to the target simulator application engineer to carefully define the ammo vulnerability data.

The grandparent-parent-child relationship in the Triplet Group can be illustrated as in the below figure.

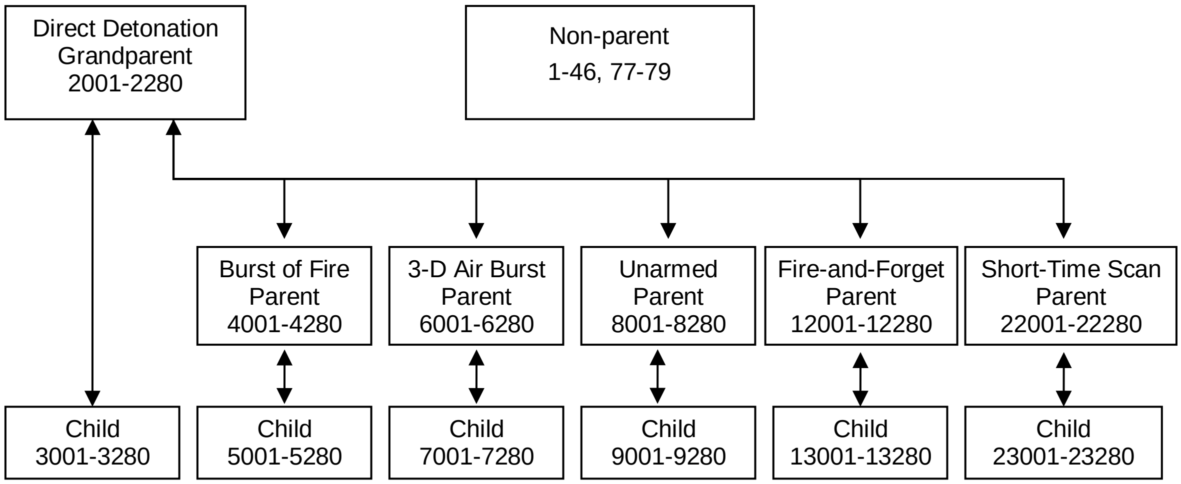

Figure 10 Ammunition Numbering, Grandparent-parent-child Relationship, Triplet Group

The grandparent-child relationship in the "Short-Time Group" can be illustrated as in the below figure.

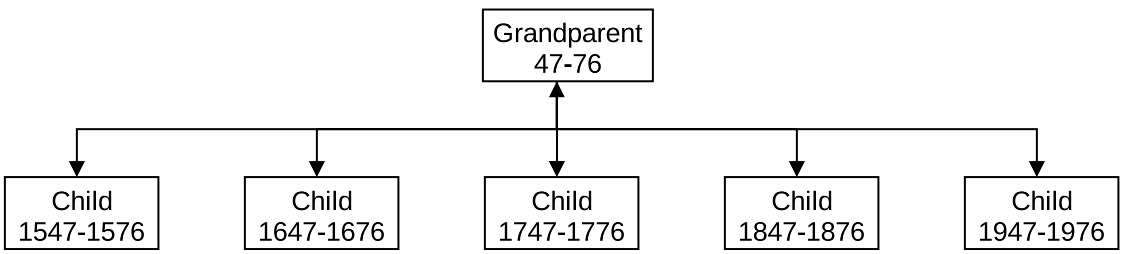

Figure 11 Ammunition Numbering, Grandparent-parent-child Relationship, Short-Time Group

The target simulator decoder and vulnerability functionality handles the grandparent-parent-child relationship as illustrated above.

4.5 Player Identity Numbering Structure

All players on the exercise area shall have a unique "Player Identity" number. The "Player Identity" is normally a permanent number assigned in advance but can in exceptional cases be altered during the exercise. The "Player Identity" number shall be transmitted optically when simulating direct fire.

The player identity numbers are used in two code groups:

- Short-Time Group Coded
- Triplet Group Coded

Observe that the “Short-Time Scanning Code” uses player identities encoded and decoded from both of the above two described groups. However, in both cases the transmission follows the Triplet Group Structure.

4.5.1 Short-Time Group Coded

The "Short-Time Group Coded" player identity codes are typically used by non-scanning transceivers although also scanning transceivers also can use them. The "Short-Time Group Coded" player identity codes include:

- Short-Time Code
- Short-Time Scanning Code
- Umpire Control-Gun Code

Recommendations for the use of "Player Identity" (ID) numbers:

Table 17 Player ID Numbering, Short-Time Group

Player ID	Usage
1-16383	Player ID numbers
16384-18000	Spare: Additional future growth Player ID numbers

4.5.2 Triplet Group Coded

The "Triplet Group Coded" player identity codes are typically used by scanning transceivers although also non-scanning transceivers also can use them. The "Triplet Group Coded" player identity codes include:

- Real-Time Code
- Fire-and-Forget Code
- Short-Time Scanning Code

When the "Player Identity Code" is transmitted alternating, Player ID numbers exceeding 10000 can be used as illustrated in the below table.

Table 18 Player ID Numbering, Triplet Group

Player ID	Use
1-10000	Non-alternating and Alternating Player ID numbers
10001-32767	Additional Alternating Player ID numbers
32768-50000	Spare: Future growth Alternating Player ID numbers

4.6 Engagement Codes

The following optical codes use the laser interface for simulated engagement functions.

- Short-Time Code
- Real-Time Code
- Fire-and-Forget Code
- Short-Time Scanning Code

4.6.1 Short-Time Code

Weapon systems that need to transmit firing data within a short time and/or do not transmit projectile or missile position data may use the "Short-Time Code". Amongst those weapon systems are rifles, guns and sector charged antitank mines. The "Short-Time Code" is also typically used for weapon effects like collateral damage from back blasting weapons, etc.

The "Short-Time Code" does not require a retro-reflection from the target, and as such it is typically referred to as a "one-way" code.

The "Short-Time Code" is identified by the decoder when the ammunition code AC3 is included.

The "Short-Time Code" is built with message item sequences (blocks) in several combinations where the number of encoded message items is I=3 or I=4:

Table 19 Short-Time Code, Valid Message Item Sequences

Valid Message Item Sequences (Blocks)	
I=3	I=4
IC4a, AC3, IC5a	IC4a, AC9, AC3, IC5a
IC4b, AC3, IC5a	IC4b, AC9, AC3, IC5a
IC5b, AC3, IC4a	IC5b, AC9, AC3, IC4a
IC5b, AC3, IC4b	IC5b, AC9, AC3, IC4b

Note that each message item (IC4a, IC4b, IC5a, IC5b, AC9, AC3) in the above table consists of 3-5 message elements.

The following optical codes are used:

- Ammunition Code AC3 and AC9
- Player Identity Code IC4a, IC4b, IC5a and IC5b

4.6.1.1. Additional Code Structure

The simulators using the "Short-Time Code" shall consider the following additional conditions when encoding and decoding pulse intervals:

- The "Short-Time Code" applies only non-alternating pulse intervals
- The "Short-Time Code" transmission rate may replicate the firing rate of the respective weapon.
- The number of different transmitted message items I (IC4a, IC5a, etc., AC3 and AC9) where I is defined as: $3 \leq I \leq 4$
- The code is transmitted using a block structure. Each block consists of at least three basic message items (I). Each item consists of a number of elements (E). The basic block consist of player identity and ammunition code and is typically transmitted as for example:
  E*IC4a, E*AC3 and E*IC5a where
  $3 \leq E \leq 5$ (Typically E=5)
  The number of elements (E) is selected depending on the simulated weapon type characteristics. You may want to use as short block transmit time as possible (E=3) when the simulator is using blank ammunition. There might be redundancy aspects to use as many elements as possible (E=5).

Block information example where the number of message items I=3 and number of elements E=3:

Table 20 Short-Time Code, Block Info Example

Block	Sequence
1	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Block information example where the number of message items I=4 and number of elements E=3:

Table 21 Short-Time Code, Block Info Example Including AC9

Block	Sequence
1	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Block transmission is typically done multiple times. The below table illustrates the timing using an example where three blocks are transmitted and where the number of message items I=3 and number of elements E=3:

Table 22 Short-Time Code, Timing Illustration

Block	I_1			Delay	I_2			Delay	I_3			Delay
B	E_1	E_2	E_3		E_1	E_2	E_3		E_1	E_2	E_3	
1	IC4a	IC4a	IC4a	t1	AC3	AC3	AC3	t1	IC5a	IC5a	IC5a	t2
2	IC4a	IC4a	IC4a	t1	AC3	AC3	AC3	t1	IC5a	IC5a	IC5a	t2
3	IC4a	IC4a	IC4a	t1	AC3	AC3	AC3	t1	IC5a	IC5a	IC5a	t3

The below first definition specification of the transmitted elements E and the time delays t1, t2 and t3 is as follows:

E = 5:

`t1 = 0 or 1µs < t1 < 300µs;` t1 is recommended to be zero, and constant.

`0.06ms < t2 < 12ms` t1 can change between blocks and inside a block

`t3 > 16ms`

The above definition shall be regarded as the most typical used and the below second definition can be used in exceptional cases to enhance the encoding performance in time critical situations.

The second definition of the transmitted elements E and the time delays t1, t2 and t3 is as follows:

$3 \leq E \leq 4$ and $B \geq 2$:

$t1 = 0$ or $1\mu s < t1 < 80\mu s;$ t1 is recommended to be zero

$t2 = 0$ or $1\mu s < t2 < 80\mu s;$ t2 is recommended to be zero

$t3 > 16ms$

The decoder shall be able to decode sequences from both of the above described definitions of E, t1, t2 and t3.

The time to transmit each element (IC4a, IC4b, AC3, AC9, IC5a and IC5b) is defined as:

$$0.08ms \leq t4 < 0.16ms$$

A complete transmission containing B blocks (B=3 in the above table example) shall take less than 30ms:

$$B*(t2 + (I-1)*t1 + E*I*t4) + t3 - t2 \leq 30ms$$

To be compatible with existing sector charged mine simulators, some additional timing rules are added. The added rules are only valid for the sector charged ammunition code. For the sector charged mine, each block can be transmitted up to 12 times within 400ms. The time distance t2 between the blocks then needs to be greater than 0.32ms. All 12 sent blocks within 400ms have the same information and are to be associated with the same round.

Sector charge ammunition code is defined in Reference [2], and the decoder shall interpret the received optical code as a single engagement.

E = 5:

$(12*(t2 + (I-1)*t1 + E*I*t4)) - t2 < 400ms$ $0.32ms < t2 < 12ms;$

Block sequence example where I=3, E=3, t2=0 and t1=0:

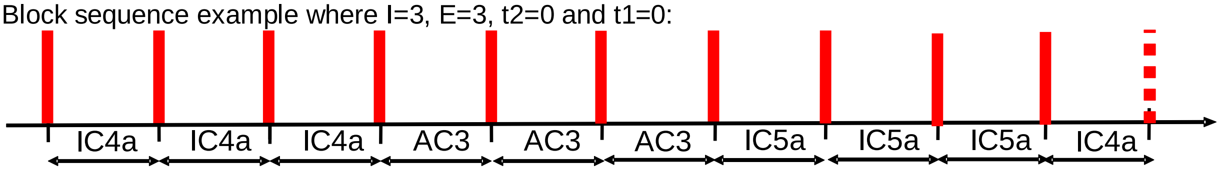

Figure 12 Short-Time Code, Block Sequence 1

Block sequence where t1 is not equal to zero is not recommended but is allowed. Example on part of a block sequence where t1 is not equal to zero and where I=3, E=5:

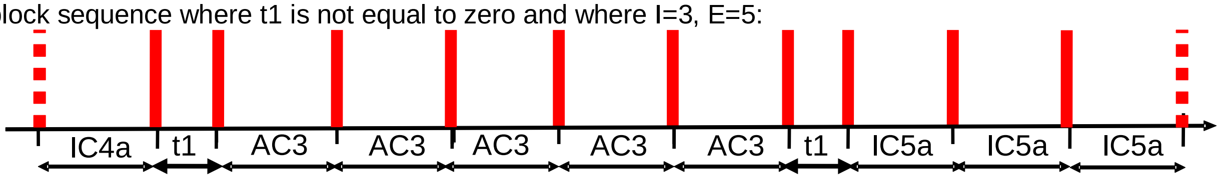

Figure 13 Short-Time Code, Block Sequence 2

Block sequence where t2 is not equal to zero is not recommended but is allowed. Example on part of a block sequence where t2 is not equal to zero and where I=3, E=3 and t1=0:

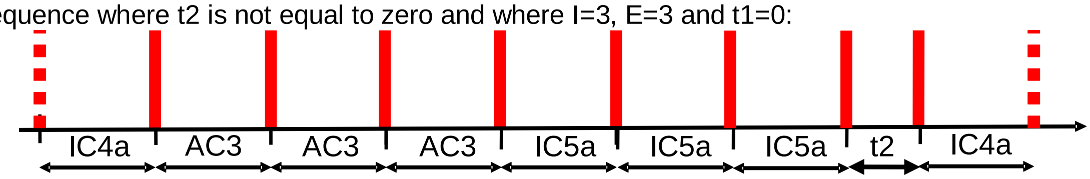

Figure 14 Short-Time Code, Block Sequence 3

4.6.1.2. Ammunition Code

The Ammo Number (AmNo) for the "Short-Time Code" is built from AC3 alone or AC3 followed by AC9. AC9 is used to encode child ammo numbers. You typically transmit ammo numbers as grandparent ammo numbers without using the ammunition code AC9. The ammunition code AC9 is used for transmitting child ammunition numbers.

Example where the number of message items I=3 and number of elements E=3:

Table 23 Short-Time Code, Block Transmission Illustration using AC3

Block	Sequence
1	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
3	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a

There is one Grandparent Ammo Number series. The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding: [AC3 and AmNo are integers]

```
AC9 not transmitted
AC3 = AmNo                       47 ≤ AmNo ≤ 76
PI3 = 1698 + (3*AC3)             47 ≤ AC3  ≤ 67
PI3 = 2105 + (3*AC3)             68 ≤ AC3  ≤ 70
PI3 = 2159 + (3*AC3)             71 ≤ AC3  ≤ 76
```

Decoding: [PI3 is an integer measured in PIU]

```
AC9 transmitted but not received and decoded or
AC9 not transmitted
AC3 = INT((PI3 – 1697) / 3)    1838 ≤ PI3  ≤ 1900
AC3 = INT((PI3 – 2104) / 3)    2308 ≤ PI3  ≤ 2316
AC3 = INT((PI3 – 2158) / 3)    2371 ≤ PI3  ≤ 2388
AmNo = AC3                       47 ≤ AC3  ≤ 76
```

Grandparent ammo number encoding examples:

Table 24 Short-Time Code, Grandparent Ammo Number Encoding Examples

AmNo	AC3	PI3
47	47	1839
67	67	1899
68	68	2309
76	76	2387

When encoding ammunition child codes you shall add AC9 followed by AC3 in the block.
Example where the number of message items I=4 and number of elements E=3:

Table 25 Short-Time Code, Block Transmission Illustration using AC9 and AC3

Block	Sequence
1	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a
3	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a

There are five Child Ammo Number series. The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding: [AC3, AC9 and AmNo are integers]

```
AC9 = INT((AmNo – 1200) / 100)        1547 ≤ AmNo ≤ 1576
AC9 = INT((AmNo – 1200) / 100)        1647 ≤ AmNo ≤ 1676
AC9 = INT((AmNo – 1200) / 100)        1747 ≤ AmNo ≤ 1776
AC9 = INT((AmNo – 1200) / 100)        1847 ≤ AmNo ≤ 1876
AC9 = INT((AmNo – 1200) / 100)        1947 ≤ AmNo ≤ 1976
PI9 = 1203 + (3*AC9)                     3 ≤ AC9  ≤ 7

AC3 = INT((AmNo – 1200) % 100)        1547 ≤ AmNo ≤ 1576
AC3 = INT((AmNo – 1200) % 100)        1647 ≤ AmNo ≤ 1676
AC3 = INT((AmNo – 1200) % 100)        1747 ≤ AmNo ≤ 1776
AC3 = INT((AmNo – 1200) % 100)        1847 ≤ AmNo ≤ 1876
AC3 = INT((AmNo – 1200) % 100)        1947 ≤ AmNo ≤ 1976
PI3 = 1698 + (3*AC3)                    47 ≤ AC3  ≤ 67
PI3 = 2105 + (3*AC3)                    68 ≤ AC3  ≤ 70
PI3 = 2159 + (3*AC3)                    71 ≤ AC3  ≤ 76
```

Decoding: [PI3 and PI9 are integers measured in PIU]

```
AC3 = INT((PI3 – 1697) / 3)           1838 ≤ PI3  ≤ 1900
AC3 = INT((PI3 – 2104) / 3)           2308 ≤ PI3  ≤ 2316
AC3 = INT((PI3 – 2158) / 3)           2371 ≤ PI3  ≤ 2388

AC9 = INT((PI9 - 1202) / 3)           1211 ≤ PI9  ≤ 1225
AmNo = 1200 + (AC9*100) + AC3           47 ≤ AC3  ≤ 76
                                         3 ≤ AC9  ≤ 7
```

Child ammo number encoding examples:

Table 26 Short-Time Code, Child Ammo Number Encoding Examples

AmNo	AC3	AC9	PI3	PI9
1547	47	3	1839	1212
1567	67	3	1899	1212
1668	68	4	2309	1215
1976	76	7	2387	1224

The total numbers of available "Short-Time Code" ammo numbers are then:

```
30*6 = 180
```

or 30 Grandparent Ammo Numbers and 5*30=150 Child Ammo Numbers

The Ammunition Table of Reference [2] defines the "Short-Time Code" "Near Miss" ammo numbers. To enhance the decoder capability to identify sequences of "Hit" and "Near Miss" blocks, knowledge about "Near Miss" ammo numbers is useful. The following ammo numbers are "Short-Time Code" "Near Miss" ammo numbers:

Table 27 Short-Time Code, Near Miss Ammo Numbers

Inheritance	Ammo Numbers
Grandparent	**57, 59, 65**
Child 1	1557, 1559, 1565
Child 2	1657, 1659, 1665
Child 3	1757, 1759, 1765
Child 4	1857, 1859, 1865
Child 5	1957, 1959, 1965

4.6.1.3. **Player Identity Code**

Each player has a unique player identity number. The player identity number for players using the "Short-Time Code" is encoded and decoded as described below.

Table 28 Short-Time Code, Player ID Numbering

Player ID	Usage
1-16383	Player ID numbers
16384-18000	Spare: Additional future growth Player ID numbers

The use of IC4a, IC4b, IC5a and IC5b can be illustrated as below:

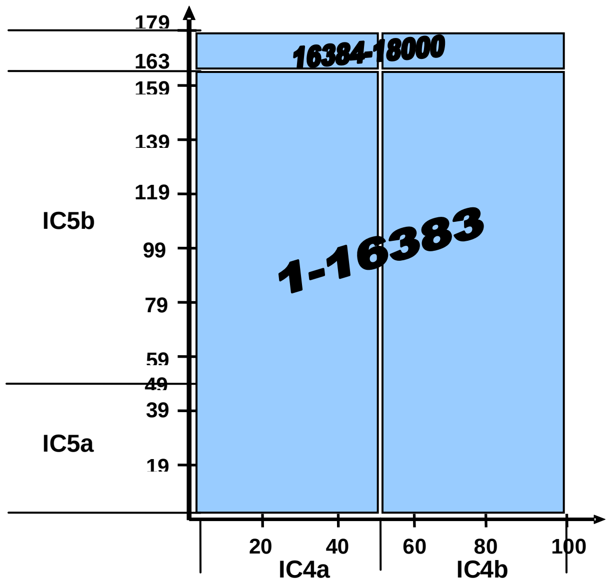

Figure 15 Short-Time Code, Player Identity Code IC4a, IC4b, IC5a and IC5b usage

Block transmission is done in two different ways depending on if IC5a or IC5b is transmitted.

- IC5a is transmitted last in block
- IC5b is transmitted first in block

Block transmission is typically done multiple times.

The below table illustrates an example where three blocks using IC5a are transmitted and where the number of message items I=3 and number of elements E=3:

Table 29 Short-Time Code, Block Transmission Illustration using IC5a

Block	Sequence
1	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
3	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a

The below table illustrates an example where three blocks using IC5b are transmitted and where the number of message items I=3 and number of elements E=3:

Table 30 Short-Time Code, Block Transmission Illustration using IC5b

Block	Sequence
1	IC5b–IC5b–IC5b – AC3–AC3–AC3 – IC4a–IC4a–IC4a
2	IC5b–IC5b–IC5b – AC3–AC3–AC3 – IC4a–IC4a–IC4a
3	IC5b–IC5b–IC5b – AC3–AC3–AC3 – IC4a–IC4a–IC4a

IC4 represents both IC4a and IC4b and IC5 represents both IC5a and IC5b in the below formulas.

The "Player Identity Number" (IdNo) is encoded and decoded as follows:

Encoding: [IdNo, IC4a, IC4b, IC5a and IC5b are integers]

```
IC5 =     INT((IdNo-1)/100)    1 ≤ IdNo ≤ 16383;(18000 future growth)
IC4 = 1 + INT((IdNo-1)%100)    1 ≤ IdNo ≤ 16383;(18000 future growth)
PI4 = 1248 + (3*IC4a)             1 ≤ IC4a ≤  50
PI4 = 1398 + (3*IC4b)            51 ≤ IC4b ≤ 100
PI5 = 1401 + (3*IC5a)             0 ≤ IC5a ≤  49
PI5 = 1760 + (3*IC5b)            50 ≤ IC5b ≤ 163;(179 future growth)
```

Decoding: [PI4 and PI5 are integers measured in PIU]

```
IC4a = INT((PI4 - 1247) / 3)   1250 ≤ PI4 ≤ 1399
IC4b = INT((PI4 - 1397) / 3)   1550 ≤ PI4 ≤ 1699
IC5a = INT((PI5 - 1400) / 3)   1400 ≤ PI5 ≤ 1549
IC5b = INT((PI5 - 1759) / 3)   1909 ≤ PI5 ≤ 2298
IdNo = IC4 + (100*IC5)         1 ≤ IC4 ≤ 100, 0 ≤ IC5 ≤ 179
```

Encoding examples:

Table 31 Short-Time Code, Player ID Encoding Examples

IdNo	IC4	IC5	PI4	PI5
1	1	0	1251	1401
202	2	2	1254	1407
10000	100	99	1698	2057
16383	83	163	1647	2249

4.6.2 Real-Time Code

Simulators using "Real-Time Code" transmits typically an accurate projectile or missile position, ammunition code and player identity code to a single target simulator or to nearby standing multiple target simulators, when the simulated projectile or missile passes (real-time) the target simulator(s).

The "Real-Time Code" does typically involve reception of retro reflection from the target, and as such it is referred to as a "two-way" code.

The "Real-Time" "Ammunition Code" AC1 or AC11 alternating with AC21 can be used by the target simulators to identify that the simulation is of "Real-Time" type.

There are two types of "Real-Time Code":

- Non-alternating AC1 is used
- Alternating AC11 alternating with AC21is used

The following non-alternating optical codes are used:

- Ammunition Code AC1
- Player Identity Code IC1, IC2, IC3
- Projectile or Missile Position Code PC1, PC2
- Null Code NC1, NC2 , NC3, NC4

The following alternating optical codes are used:

- Ammunition Code AC11, AC21

- Player Identity Code — IC11, IC12, IC21, IC22
- Projectile or Missile Position Code — PC1, PC2
- Distance Lethality Code — EI11, DI11
- Cant Angle — CA21

Messages transmitted by using a "Real-Time Code" consist of three message items building a triplet. The chapter "4.3.3.2 Triplet Group Structure" specifies the triplet encoding and decoding.

4.6.2.1. Additional Code Structure

The following additional conditions are valid for the "Real-Time" optical code type.

The Target Simulator shall use the following additional conditions to decode pulse intervals as valid pulse intervals:

- The pulse interval decoder shall, as previously described, decode continuously changing, non-alternating as well as alternating pulse intervals.
- When more than one detector at the same time (< 2ms) is receiving, then it is allowed to decode at the detector receiving the most number of position triplets.
- The position triplet can only be transmitted in the following order of occurrences:
  - `PC1–AC1-PC2 or PC2–AC1-PC1`
  - `PC1–XXX-PC2 or PC2–XXX-PC1` XXX is an alternating pair item
- The player identity triplet can only be transmitted in the following order of occurrences:
  - `IC1-IC2-IC3  or  IC3-IC2–IC1`
  - `ICa1-YYY–ICa3 or ICa3-YYY–ICa1` YYY is an alternating pair item

    ICa1 is IC11 alternating with IC21

    ICa3 is IC12 alternating with IC22
- Sometimes as for example in multiple target situations, the fire simulator may transmit a triplet consisting of a combination of info from a position triplet and info from an identity triplet. Such a triplet shall then be ignored by the pulse interval decoder if it cannot identify triplet information from all three message items. Ignored combined info triplet examples:
  - `PC1-AC1–IC3  or  IC1-AC1–PC3`
  - `PC1-XXX–ICa3 or ICa1-XXX–PC3`
- The position triplet and the identity triplet can consecutively be transmitted multiple times to a single detector.
- The player identity triplet(s) shall be transmitted following the position triplet(s), when representing a single projectile or missile position.
- The time to transmit three triplets shall not exceed 200ms; otherwise they are interpreted as belonging to multiple target engagements.
- Triplet sequences representing multiple engagements are identified as defined in chapter "4.6.2.8 Burst of Fire Simulation".
- When any of the three message items in a triplet is missing, the triplet is not decoded.
- The time between receiving message items 1-2 and 2-3 within a triplet has to be symmetric within a tolerance of ±5ms. The meaning of 1-2 and 2-3 message items in this sense are:
  - `PC1-AC1  and  AC1-PC2` AC1 is a non-alternating ammunition code item
  - `PC1-XXX  and  XXX-PC2` XXX is an alternating pair item
  - `IC1-IC2  and  IC2-IC3`
  - `ICa1-YYY and  YYY-ICa3` YYY is an alternating pair ammunition code item

    ICa1 is IC11 alternating with IC21

    ICa3 is IC12 alternating with IC22

Projectile or missile simulation is done transmitting 2- to 6-fold triplets. Below is an example of two 4-fold message item triplets.

Table 32 Real-Time Code, Timing Illustration

Triplet	Pass 1	Delay	Pass 2	Delay	Pass 3	Delay
1	PC1	t1	AC1	t1	PC2	t2a
2	PC2	t1	AC1	t1	PC1	t2b
3	IC1	t1	IC2	t1	IC3	t2a
4	IC3	t1	IC2	t1	IC1	
1	PC2	t1	AC1	t1	PC1	t2b
2	PC1	t1	AC1	t1	PC2	t2a
3	IC3	t1	IC2	t1	IC1	t2b
4	IC1	t1	IC2	t1	IC3	

Note that each message item (PC1, PC2, IC1, IC2 and IC3) in the above table consists of several (typical eight) message elements.

The length of the decoded time intervals t1, t2a and t2b from the above table:

```
t1  < 30ms
t2a < 100ms
t2b < 100ms
```

t1 within the same triplet shall not differ more than 5ms

Two triplets (when followed by at least one triplet) take:

```
4*t1 + t2a + t2b + 2*Pass1 + 2*Pass2 + 2*Pass3 = 120ms ± 10ms
```

As previously described projectile simulation is done using 2- to 6-fold triplets. The fire simulator typically selects between using 2-fold or 4 -fold triplets. Position triplets are transmitted consecutively first, followed by consecutive identity triplets. The number of consecutive position or identity triplets cannot be more than four. The target simulator has to be able to decode 2- to 6-fold triplets, representing a single projectile or missile, as for example for the following reasons:

- The 5 and 6-fold triplets are allowed to be transmitted during exceptional conditions for low velocity projectile or missile.
- The 4-fold triplet is used during most normal fire simulations.
- The 3 and 2-fold triplet is used during exceptional fire simulation conditions like high rate burst of fire simulation.

When the pulse interval decoder has received a sequence of triplets, it shall associate the preceding position triplets with identity triplets as belonging to the same round.

See chapter "4.6.2.8 Burst of Fire Simulation" for more info concerning burst of fire simulation.

4.6.2.2. **Ammunition Code**

The "Real-Time Code" ammo number is encoded and decoded in two ways:

- Non-alternating using AC1
- Alternating using AC11 and AC21

4.6.2.2.1 Non-alternating

You can transmit an ammunition code using non-alternating code.
A laser transmitter typically transmits eight message items when transmitting the "Real-Time Code".

```
AC1 - AC1 - AC1 - AC1 - AC1 - AC1 – AC1 – AC1
```

The ammo number (AmNo) is encoded and decoded as follows:

Encoding: [AmNo and AC1 are integers]

```
AC1 = AmNo                       1 ≤ AmNo ≤ 46
PI1 = 1698 + (3*AC1)
```

Decoding: [PI1 is an integer measured in PIU]

```
AC1 = INT((PI1 – 1697) / 3)      1700 ≤ PI1 ≤ 1837
AmNo = AC1                       1 ≤ AC1 ≤ 46
```

AmNo 25 and 30 are excluded and used for "Fire-and-Forget" simulation

Ammo number encoding examples:

Table 33 Real-Time Code, Non-alternating Ammo Number Encoding Examples

AmNo	AC1	PI1
1	1	1701
2	2	1704
46	46	1836

4.6.2.2.2 Alternating

You can also transmit an "Ammunition Code" using alternating codes AC11 and AC21. A simulator using "Real-Time Code" is typically transmitting four pairs of ammunition code to the target:

```
AC11 – AC21 – AC11 – AC21 – AC11 – AC21 – AC11 – AC21
```

There are grandparent, parent and child Ammo Number (AmNo) series. The ammo numbering depends on three flags (FlgNo) set in "Engagement Info" (EI11) or "Detonation Info" (DI11) as illustrated with the below table.

Table 34 Real-Time Code, Alternating Ammo Numbers

FlgNo	Direct Detonation	Burst of Fire	Air Burst	Unarmed
	2	4	6	8
Grandparent	2001-2280			
Parent		4001-4280	6001-6280	8001-8280
Child	3001-3280	5001-5280	7001-7280	9001-9280

The Ammo Number (AmNo) is encoded and decoded as follows:

Grandparent or Parent Ammo Number:

Encoding: [AC11, AC21, AmNo, AmLsd and FlgNo are integers]

```
FlgNo  = INT(AmNo / 1000)
AmLsd = 2000 + INT(AmNo % 1000)
AC11  = 1 + INT((AmLsd – 2001) % 10)      2001 ≤ AmLsd ≤ 2280
AC21  = 1 + INT((AmLsd – 2001) / 10)      2001 ≤ AmLsd ≤ 2280
PI11  = 1203 + (3*AC11)                   1 ≤ AC11 ≤ 10
PI21  = 1266 + (3*AC21)                   1 ≤ AC21 ≤ 28
```

Decoding: [PI11 and PI21 are integers measured in PIU]

```
AC11 = INT((PI11 – 1202) / 3)             1205 ≤ PI11 ≤ 1234
AC21 = INT((PI21 - 1265) / 3)             1268 ≤ PI21 ≤ 1351
AmNo = (FlgNo*1000)+((AC21-1)*10)+AC11    1 ≤ AC11 ≤ 10, 1 ≤ AC21 ≤ 28
```

Grandparent and parent ammo number encoding examples:

Table 35 Real-Time Code, Alternating Grandparent/Parent Ammo Number Encoding Examples

AmNo	FlgNo	AC11	AC21	PI11	PI21
2001	2	1	1	1206	1269
2010	2	10	1	1233	1269
2032	2	2	4	1209	1278
4280	4	10	28	1233	1350

Child Ammo Number:

Encoding: [AmNo, AmLsd and FlgNo are integers]

```
FlgNo  = (INT(AmNo / 1000)) - 1
AmLsd = 2000 + INT(AmNo % 1000)
AC11  = 11 + INT((AmLsd – 2001) % 10);  2001 ≤ AmLsd ≤ 2280
AC21  =  1 + INT((AmLsd – 2001) / 10);  2001 ≤ AmLsd ≤ 2280
PI11  = 1203 + (3*AC11)                 11 ≤ AC11 ≤ 20
PI21  = 1266 + (3*AC21)                  1 ≤ AC21 ≤ 28
```

Decoding: [PI11 and PI21 are integers measured in PIU]

```
AC11 = INT((PI11 – 1202) / 3)           1235 ≤ PI11 ≤ 1264
AC21 = INT((PI21 - 1265) / 3)           1268 ≤ PI21 ≤ 1351
AmNo =((FlgNo+1)*1000)+((AC21-1)*10)+(AC11–10);
                                       11 ≤ AC11 ≤ 20, 1 ≤ AC21 ≤ 28
```

Child ammo number encoding examples:

Table 36 Real-Time Code, Alternating Child Ammo Number Encoding Examples

AmNo	FlgNo	AC11	AC21	PI11	PI21
3001	2	11	1	1236	1269
3010	2	20	1	1263	1269
3032	2	12	4	1239	1278
5280	4	20	28	1263	1350

4.6.2.3. **Player Identity Code**

Each player has a unique player identity number. The player identity number for players using "Real-Time Code" is encoded and decoded as described below.

The "Player Identity Code" is transmitted in two different ways

- Non-alternating "Player Identity" using IC1, IC2 and IC3.
- Alternating "Player Identity" using IC11 alternating with IC21 and IC12 alternating with IC22

When the "Player Identity Code" is transmitted alternating, Player ID numbers exceeding 10000 can be used as illustrated in the below table.

Table 37 Player ID Numbering

Player ID	Use
1-10000	Non-alternating and Alternating Player ID numbers
10001-32767	Additional Alternating Player ID numbers
32768-50000	Spare: Future growth Alternating Player ID numbers

In the below encoding and decoding formulas the maximum Player ID number equal to 32767 and for future growth (50000) is used.

4.6.2.3.1 Non-alternating Player Identity

Non-alternating "Player Identity Code" transmission sequence is illustrated below:

Table 38 Real-Time Code, Non-alternating Player Identity Triplets Sequence Illustration

Triplet	Pass 1	Pass 2	Pass 3
N	IC1	IC2	IC3
N + 1	IC3	IC2	IC1

Note that each message item (IC1, IC2 and IC3) in the above table consists of several message elements.

The "Player Identity Code" is being transmitted in the order IC1 - IC2 - IC3 or IC3 - IC2 - IC1

The "Player Identity Number" (IdNo) is encoded and decoded as follows:

Encoding: [IC1, IC2, IC3 and IdNo are integers]

```
IC3 =       INT((IdNo-1)/400)           1 ≤ IdNo ≤ 10000
IC2 =   INT(INT((IdNo-1)%400)/20)       1 ≤ IdNo ≤ 10000
```

```
IC1 = 1+INT(INT((IdNo-1)%400)%20)       1 ≤ IdNo ≤ 10000
PI1 = 1503 + (3*IC1)                    1 ≤ IC1  ≤ 20
PI2 = 1566 + (3*IC2)                    0 ≤ IC2  ≤ 19
PI3 = 1626 + (3*IC3)                    0 ≤ IC3  ≤ 24
```

Decoding: [PI1, PI2, and PI3 are integers measured in PIU]

```
IC1 = INT((PI1 - 1502) / 3)          1505 ≤ PI1  ≤ 1564
IC2 = INT((PI2 - 1565) / 3)          1565 ≤ PI2  ≤ 1624
IC3 = INT((PI3 - 1625) / 3)          1625 ≤ PI3  ≤ 1699
IdNo= IC1+(20*IC2)+(400*IC3)         1 ≤ IC1 ≤ 20, 0 ≤ IC2 ≤ 19,
                                     0 ≤ IC3 ≤ 24
```

Encoding examples:

Table 39 Real-Time Code, Non-alternating Player ID Encoding Examples

IdNo	IC1	IC2	IC3	PI1	PI2	PI3
1	1	0	0	1506	1566	1626
21	1	1	0	1506	1569	1626
421	1	1	1	1506	1569	1629
10000	20	19	24	1563	1623	1698

4.6.2.3.2 Alternating Player Identity

Alternating "Player Identity Code" transmission sequence is illustrated below:

Table 40 Real-Time Code, Alternating Player Identity Triplets Sequence Illustration

Triplet	Pass 1	Pass 2	Pass 3
N	ICa3	XXX	ICa1
N+1	ICa1	XXX	ICa3

Note that each message item (ICa1 and ICa3) in the above table consists of several message element alternating pairs.

Table 41 Real-Time Code, Alternating Message Item Description

Item Acronym	Message Item Description
ICa1	Message items IC11 alternating with IC21
ICa3	Message items IC12 alternating with IC22
XXX	Other alternating item pairs

The "Player Identity Code" is being transmitted in the order: ICa1 - XXX – ICa3 or ICa3 - XXX – ICa1

The "Player Identity Number" (IdNo) is encoded and decoded as follows:
Encoding: [IC11, IC21, IC12, IC21 and IdNo are integers]

```
IC22 =       INT((IdNo-1)/5000)                1 ≤ IdNo ≤ 32767(50000)
IC12 =   INT(INT((IdNo-1)%5000)/200)           1 ≤ IdNo ≤ 32767(50000)
IC21 =   INT(INT((IdNo-1)%5000)%200)/20        1 ≤ IdNo ≤ 32767(50000)
IC11 = 1+INT(INT((IdNo-1)%5000)%200)%20        1 ≤ IdNo ≤ 32767(50000)
PI11 = 1503 + (3*IC11)                         1 ≤ IC11 ≤ 20
PI21 = 1236 + (3*IC21)                         0 ≤ IC21 ≤ 9
PI12 = 1626 + (3*IC12)                         0 ≤ IC12 ≤ 24
PI22 = 1206 + (3*IC22)                         0 ≤ IC22 ≤ 6(9)
```

Decoding: [PI11, PI21, PI12 and PI22 are integers measured in PIU]

```
IC11 = INT((PI11 - 1502) / 3)              1505 ≤ PI11 ≤ 1564
IC21 = INT((PI21 - 1235) / 3)              1235 ≤ PI21 ≤ 1264
IC12 = INT((PI12 - 1625) / 3)              1625 ≤ PI12 ≤ 1699
IC22 = INT((PI22 - 1205) / 3)              1205 ≤ PI22 ≤ 1225(1234)
IdNo = (IC11+(IC21*20)) + ((IC12+(IC22*25))*200)
                                       1 ≤ IC11 ≤ 20, 0 ≤ IC21 ≤ 9
                                       0 ≤ IC12 ≤ 24, 0 ≤ IC22 ≤ 6(9)
```

Encoding examples:

Table 42 Real-Time Code, Alternating Player ID Encoding Examples

IdNo	IC11	IC21	IC12	IC22	PI11	PI21	PI12	PI22
1	1	0	0	0	1506	1236	1626	1206
20	20	0	0	0	1563	1236	1626	1206
21	1	1	0	0	1506	1239	1626	1206
200	20	9	0	0	1563	1263	1626	1206
201	1	0	1	0	1506	1236	1629	1206
5001	1	0	0	1	1506	1236	1626	1209
32767	7	8	13	6	1524	1260	1665	1224
(50000)	20	9	24	9	1563	1263	1698	1233

4.6.2.4. **Position Code**

The "Position Code" representing the projectile or missile position is transmitted to the target simulators using two codes:

- Position Code 1 (PC1) for vector 1 is positive pointing to the lower right.
- Position Code 2 (PC2) for vector 2 is positive pointing to the lower left.

It may seem unnecessary to think about how to encode using a resolution better than 0.1m as the optical encoding does not have a resolution better than 0.1m. Several position values are transmitted and the receiver calculates an average value resulting in a received position resolution possibly better than 0.1m.

The Position Code vectors are orthogonal and rotated by 45 degrees.

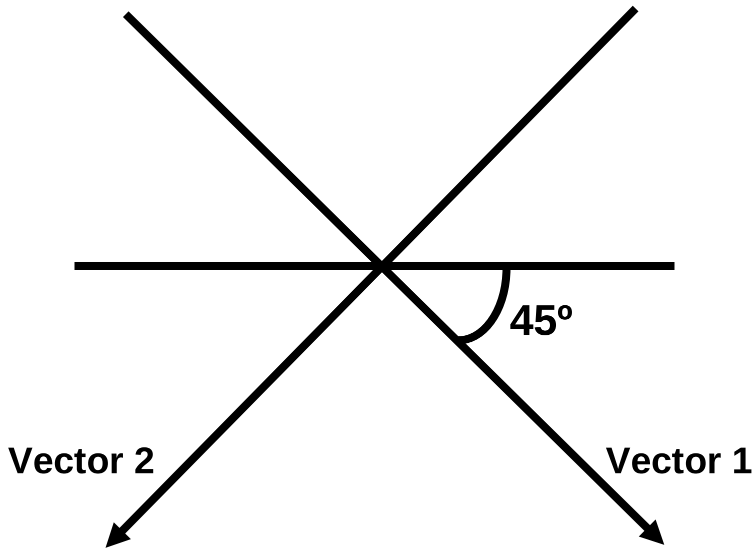

Figure 16 Real-Time Code, Position Code Vectors

The relationship between the position value, position resolution and pulse intervals are shown in the diagrams below.

The position value in the diagrams represents the projectile position relative to the target detector.

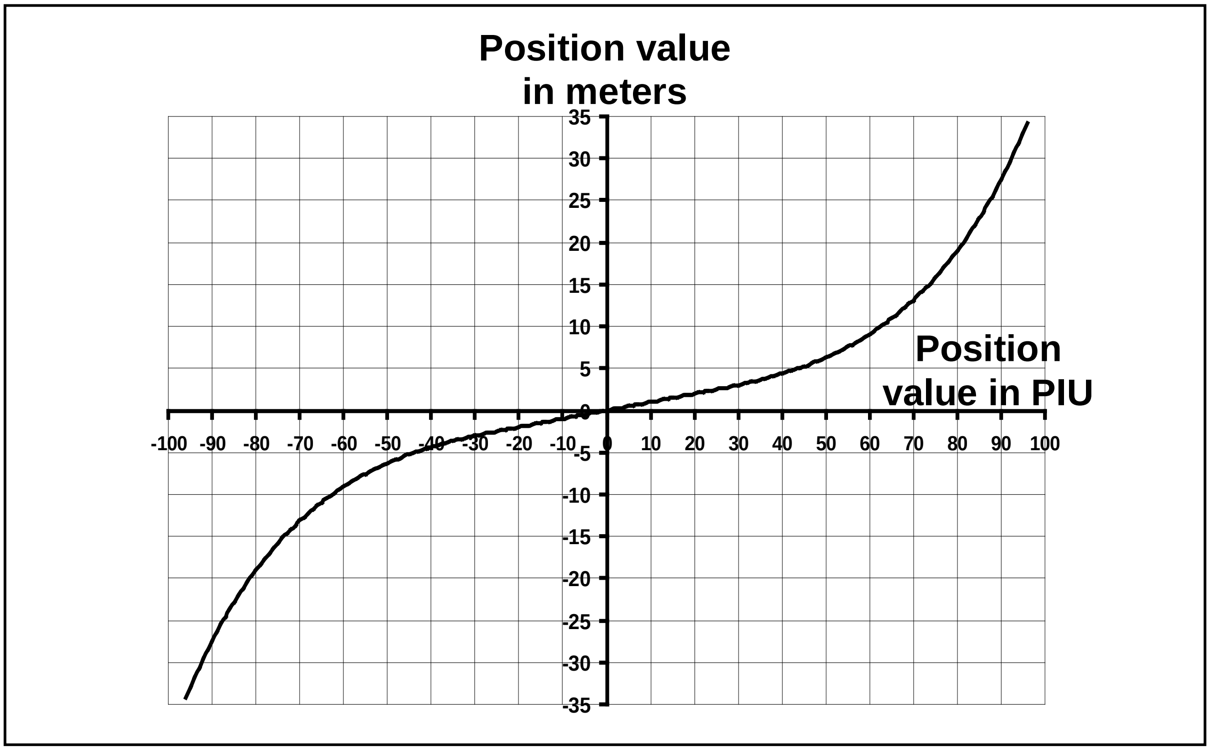

Figure 17 Real-Time Code, Position Value Encoding

The position resolution 0.1m changes for coordinates greater than 2.7 meter from the impact point centre.

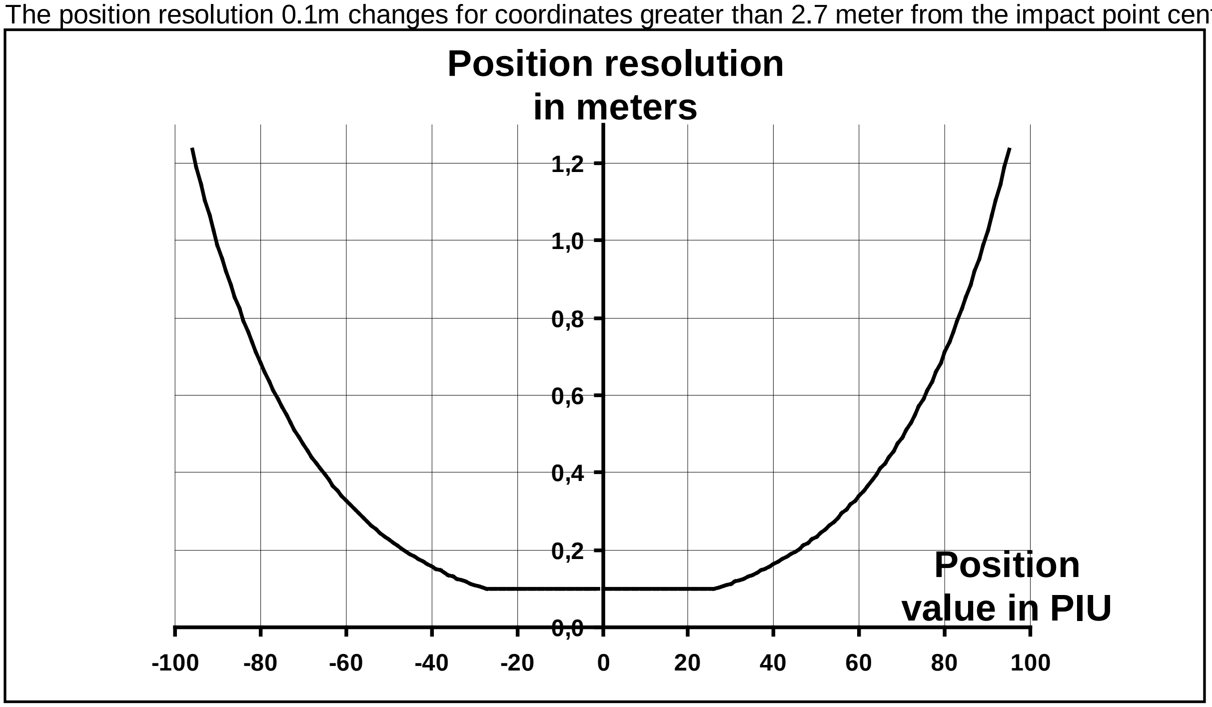

Figure 18 Real-Time Code, Position Value Resolution

The "Position Code" 1 (PC1) is decoded in the range 1911-2105 PIU whereas zero is positioned at 2008 PIU.

The "Position Code" 2 (PC2) is decoded in the range 2107-2301 PIU whereas zero is positioned at 2204 PIU.

The position is encoded from the firing simulator's perspective in relation to the pulse receiving reference module. The encoded position vectors PC1 and PC2 have allowed values between ± 96 PIU thus resulting in decoding values between ± 97 PIU.

PC represents both PC1 and PC2 in the below formulas.
X represents both X1 and X2 in the below formulas.

The decoding of the vector X1 and X2 in meters from PC1 and PC2 is based on the following formulas:

Decoding: [PC, PI2 and PI1 are integers measured in PIU]

```
PC = 2008-PI1
PC = 2204-PI2
X  = -e^(-PC / 10*e)        -97 < PC < -27
X  =  PC*0,1                -27 < PC <  27
X  =  e^( PC / 10*e)         27 < PC <  97
```

Observe that the target simulator usually is receiving and decoding multiple X values when a scanning fire simulator is engaging. The final X value is then calculated as the average value of the decoded X values.

The encoding of PI1 and PI2 from the vector length X1 and X2 in meters is based on the following formulas:
Encoding: [X is a decimal value measured in meters]

```
PC  = -10*e*ln(-X))    -34,8 ≤ X < -2,7
PC  =  10*X             -2,7 ≤ X ≤  2,7
PC  =  10*e*ln(X)        2,7 < X ≤  34,8
PI1 = 2008-PC
PI2 = 2204-PC
```

Embedded computers do not usually include logarithmic formulas or if they do they might be time consuming. A way to solve that problem is to encode and decode using tables. See Appendix B and C at the end of this document for examples on position decoding and encoding tables.

To the above basic encoding formulas is added conventional rounding mathematics:

```
INT(((10*value)+ 5)/10)
```

The resulting encoding of PI1 and PI2 from the vector length X1 and X2 in meters is then written as follows:
Encoding: [X is a decimal value measured in meters]

```
PC  = -INT(((100*e*ln(-X))+5)/10)    -34,8 ≤ X < -2,7
PC  =  INT(((100*X)+5)/10)            -2,7 ≤ X ≤  2,7
PC  =  INT(((100*e*ln( X))+5)/10)      2,7 < X ≤  34,8
PI1 = 2008-PC
PI2 = 2204-PC
```

4.6.2.5. **Null Code**

The "Null Codes" are codes that do not contain any information to be processed by the targets other than they are "Null Codes". They are only used by the fire simulator for measuring purposes when searching for targets. The "Null Codes" are the most frequent transmitted codes and have to be identified and rejected by the targets when the encoding is done.

The "Null Codes" are defined and encoded and decoded as follows:

Table 43 Real-Time Code, Null Code Encoding and Decoding

Description	Acronym	Encoded	Decoded	
		PIU	Low PIU	High PIU
Null Code 1	NC1	2304	2302	2306
Null Code 2	NC2	1904	1902	1906
Null Code 3	NC3	2320	2318	2322
Null Code 4	NC4	384	382	386

"Null Codes" may coincide (overlap) in time with other types of codes. For example, multiple fire simulators may simultaneously engage the same target simulator at the training field. The target simulator must consequently have the ability to reject Null Codes coinciding with codes and at the same time decoding such codes.

4.6.2.5.1 Null Code 4

As the Null Code 4 (NC4) is transmitted outside the normal 1200-2399PIU interval there are some additional rules needed. Compared to other Null Codes the "Null Code 4" (NC4) uses different transmitted block structure:

- Each block consists of one message item (I=1). The blocks are transmitted as:
  `E*NC4`
  where E is the number of elements for the message item and
  `E=1, E=2 or E=3`
- 3*384PIU=1152PIU, i.e., not within 1200-2399PIU.
  - o The target simulator decoder may then choose to consider the NC4 pulse interval as a result of noise pulses.
- The transmitted message item (I) repetition is limited to a maximum of 50 times/s.
  - o 4*50=200pulses/s, i.e., the NC4 pulse interval can be rejected by the decoder as part of the noise immunity capability described in section “4.2.4 Common Decoding Characteristics”.

NC4 block transmission illustration where the number of transmitted elements E=2:

Table 44 Real-Time Code, Null Code 4 Timing Illustration

Block	I		Delay
	E_1	E_2	
1	NC4	NC4	t
2	NC4	NC4	t
.	.	.	.
N	NC4	NC4	t

The timing value is specified as follows:

Table 45 Real-Time Code, Null Code 4 Timing Value

t
ms
t ≥ 20

4.6.2.6. **Distance Lethality Code**

The "Distance Lethality Code" is used to enhance the lethality description in the ammunition code sent to target simulators. The "Distance Lethality Code" is then typically transmitted alternating with "Cant Angle Code" (CA21) in a triplet together with the Projectile Position.

The "Distance Lethality Code" is built up by two main components that contain subcomponents or subfunctions:

- Engagement Info Code (EI11)
    - Engagement distance. Distance between the fire simulator and the target simulator.
    - Burst of Fire (multiple projectiles)
- Detonation Info Code (DI11)
    - Detonation distance. Distance between the ammo detonation and the target simulator.
    - Burst of Fire (multiple projectiles)
    - Unarmed

Examples on when and how EI11 and/or DI11 are transmitted:

- When simulating AP type of ammunitions, the "Engagement Info Code" (EI11) encoding engagement distance is typically transmitted alternating with "Cant Angle Code" (CA21).
- When simulating the air burst type of ammunitions, you must transmit "Detonation Distance" in the "Detonation Info" (DI11) to indicate air burst detonation to the target simulator.
- When simulating "Unarmed" ammunition hitting a target, the "Detonation Info Code" (DI11) encoding "Unarmed" engagement is typically transmitted alternating with "Engagement Distance" in (EI11).

Detonation characteristics not handled by the "Distance Lethality Code" is described by the actual ammo number. Such detonation characteristic is for example:

- Delayed Detonation.
    - The simulated warhead is detonating a short time after impact. The ammunition may for example detonate using a Point-Detonation fuse with delay. Compared to the direct at impact detonation the lethality behind the wall or inside the vehicle is considerably increased.
- Proximity Fuze.
    - The simulated warhead is detonating close to the target. The ammunition may detonate using for example short range radar to measure the target distance. Compared to air burst time fuzed detonation for large caliber High Explosive ammo (≥90mm) for example, the lethality 40mm proximity fuzed ammo may need different target vulnerability considerations.

The situations the fire simulator can identify and inform the target simulators about are illustrated in the below figure.

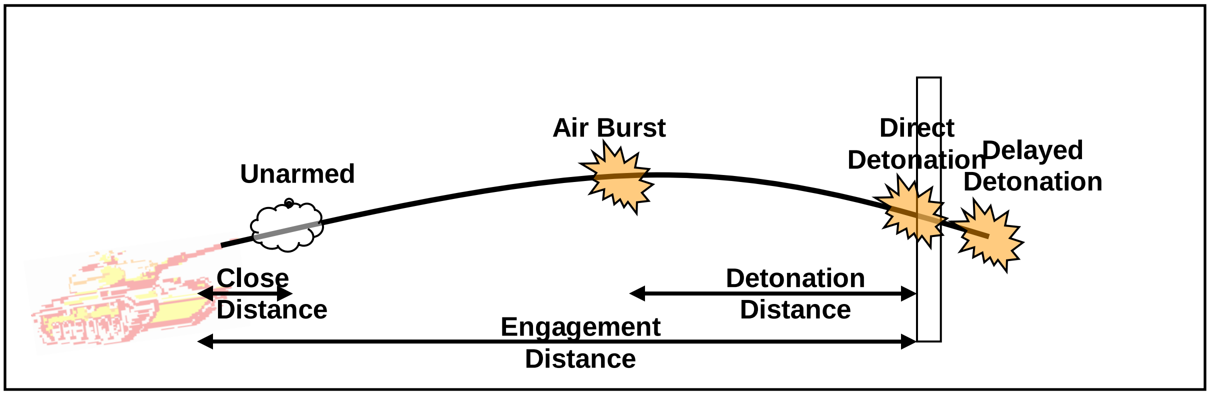

Figure 19 Real-Time Code, Distance Lethality Code Info Illustration

How the fire simulator can inform the target simulators about more details in the engagement using DI11, EI11 and CA21 is described in the following table:

Table 46 Real-Time Code, Distance Lethality Codes Details

Flag Number FlgNo		Flag Description	Typical Alternating Pair	Significant Distance Lethality Code Usage	"Distance Lethality Code" Description
Real-Time	F-and-F				
2	12	Direct Detonation	EI11/CA21	EI11 Engagement Distance	The distance between the fire simulator and the target.
4	N.A.	Burst of Fire	EI11/DI11	DI11 Burst of Fire	The transmitted projectile position comprises a lethality corresponding to more than one projectile.
6	N.A.	Air Burst	DI11/EI11 DI11/CA21	DI11 Detonation Distance	The warhead is detonating in the air. The distance between the ammo detonation and the target transmitted. Note 1 and 2
8	N.A.	Unarmed	EI11/DI11	DI11 Unarmed	Hitting without detonating. Note 3

NOTE 1 - Air burst detonation simulation is indicated by the fire simulator by transmitting "Detonation Distance" in the "Detonation Info" (DI11). Air burst detonation can be simulated for example for time fuzed or proximity fuzed type of ammo. Before the detonation the fire simulator can simulate how the projectile passes targets by transmitting an alternating pair not containing "Detonation Distance" as for example "Engagement Distance" and "Cant Angle". The target system shall be able to resolve such an engagement simulation and not decode it as a double engagement situation.

NOTE 2 - The lethality of the Air Burst Munition Kinetic Energy Time Fuze (ABM-KETF) type of ammo for example depends on both detonation distance and the engagement distance.

NOTE 3 - When for example a missile, is engaging a target before the missile is armed, the missile warhead is usually not detonating and its lethality is considerably reduced. The "Unarmed" flag is set in DI11 and is then typically transmitted alternating with the "Engagement Distance" in EI11.

When transmitting info the fire simulator must select to transmit an alternating pair of "Engagement Info", "Detonation Info" or "Cant Angle". Examples on how DI11 and EI11 can be used for each ammunition type is summarized in the below table.

Table 47 Real-Time Code, Distance Lethality Code, Usage Examples

Ammo Type	Engagement Info EI11		Detonation Info DI11			Cant Angle	Comment
	Engage-ment Distance	Burst of Fire	Detonation Distance	Burst of Fire	Unarmed		
Air Burst, Note 1 and Note 2	X					X	Fly-by Simulation
			X			X	Air Burst
	X		X				e.g., ABM-KETF
AP, APDS, APFSDS, HEAT	X					X	
	X			X			
HE, HEMP, Minor caliber Direct Detonation	X					X	
	X			X			
HE, HEMP, Large caliber Direct Detonation	X					X	
Missile	X					X	
	X				X		

NOTE 1 - Example on time fuzed ammo:
The 70mm M255A1 Flechette Warhead rocket design uses standard components such as the M439 Fuze. The M439 Fuze is remotely set from the weapon system with time (range) to the target data. The M439 Fuze initiates the expulsion of the charge at an expected point slightly before and above the target area.

NOTE 2 - Example on proximity fuzed ammo:
The 40 mm L/60 PFHE projectile has a proximity fuze, which operates on the Doppler effect principle to measure the target distance, which is used to initiate the expulsion of the charge against the target area is done.

"Air Burst" in the above table column "Ammo Type" refers to the following examples:

- High Explosive (HE) using a time fuze or proximity fuze detonating in the air.
- Air Burst Munition Kinetic Energy Time Fuze (ABM KETF for CV90)
- Air Burst Munition High Explosive Time Fuze (ABM HETF for CV90)

See Ammunition Table Reference [2] for referred Ammo Types.

4.6.2.6.2 Engagement Info

How the fire simulator can inform the target simulators about more details in the engagement using EI11 is described in the following table:

Table 48 Real-Time Code, Engagement Info

Engagement Info EI11	Description
Engagement Distance	The distance between the fire simulator and the target simulator is transmitted.
Burst of Fire	The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to more than one projectile.

The engagement info functions and distance are encoded and decoded as follows:

Encoding: [DED and EED are integers measured in meter]

```
PI = 1269                                Burst of Fire
PI = INT((EED + 50) / 100) + 1272        0m ≤ EED < 7750m
PI = 1350                                7750m ≤ EED ≤ 12000m
```

Decoding: [PI is an integer measured in PIU]

```
Burst of Fire                            1268 ≤ PI ≤ 1270
DED = 40                                 1271 ≤ PI ≤ 1272
DED = (PI – 1272)* 100                   1273 ≤ PI ≤ 1350
DED = 7800                               PI = 1351
```

Encoding and decoding engagement functions and distance examples:

Table 49 Real-Time Code, Engagement Info Encoding and Decoding Examples

Encoded (EED) Engagement Distance or function	Decoded (DED) Engagement Distance or function	PI
m	m	PIU
Not allowed	Burst of Fire	1268
Burst of Fire	Burst of Fire	1269
Not allowed	Burst of Fire	1270
Not allowed	40	1271
0-49	40	1272
50-149	100	1273
150-249	200	1274
Etc.	Etc.	Etc.
7650-7749	7700	1349
≥7750	7800	1350
not allowed	7800	1351

Observe that the target simulator may receive and decode multiple DED values when a fire simulator is engaging. The final DED value is then calculated as the average value of the decoded DED values.

4.6.2.6.3 Detonation Info

How the fire simulator can inform the target simulators about more details in the engagement using DI11 is described in the following table:

Table 50 Real-Time Code, Detonation Info

Detonation Info DI11	Description
Detonation Distance	The warhead is detonating in the air or at impact at another target or on the ground. The ammunition may for example have a time fuze or proximity fuze. The distance between the ammo detonation and the target is transmitted.
Burst of Fire	The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to more than one projectile.
Unarmed	When for example a missile is engaging a target before the preset arming distance, the missile warhead is usually not detonating and its lethality is considerably reduced.

The detonation info functions and distance is encoded and decoded as follows:

Encoding:	[DDD and EDD are integers measured in meter]
PI = 1506	Unarmed
PI = 1509	Burst of Fire
PI = 1512	Future growth
PI = 1515	EDD ≤ -155m
PI = INT((EDD - 5) / 10) + 1531	-155m < EDD ≤ -21m
PI = INT((EDD - 1) / 2) + 1539	-21 < EDD < 0m
PI = INT((EDD + 1) / 2) + 1539	0m ≤ EDD < 21m
PI = INT((EDD + 5) / 10) + 1547	21m ≤ EDD < 155m
PI = 1563	EDD ≥ 155m

Decoding:	[PI is an integer measured in PIU]
Unarmed	1505 ≤ PI ≤ 1507
Burst of Fire	1508 ≤ PI ≤ 1510
Future growth	1511 ≤ PI ≤ 1513
DDD = -20 + (PI – 1529)* 10	1514 ≤ PI ≤ 1528
DDD = (PI – 1539) * 2	1529 ≤ PI ≤ 1549
DDD = 20 + (PI – 1549)* 10	1550 ≤ PI ≤ 1564

The sign definition for the "Encoded Detonation Distance" (EDD) and the "Decoded Detonation Distance" (DDD) values is illustrated below:

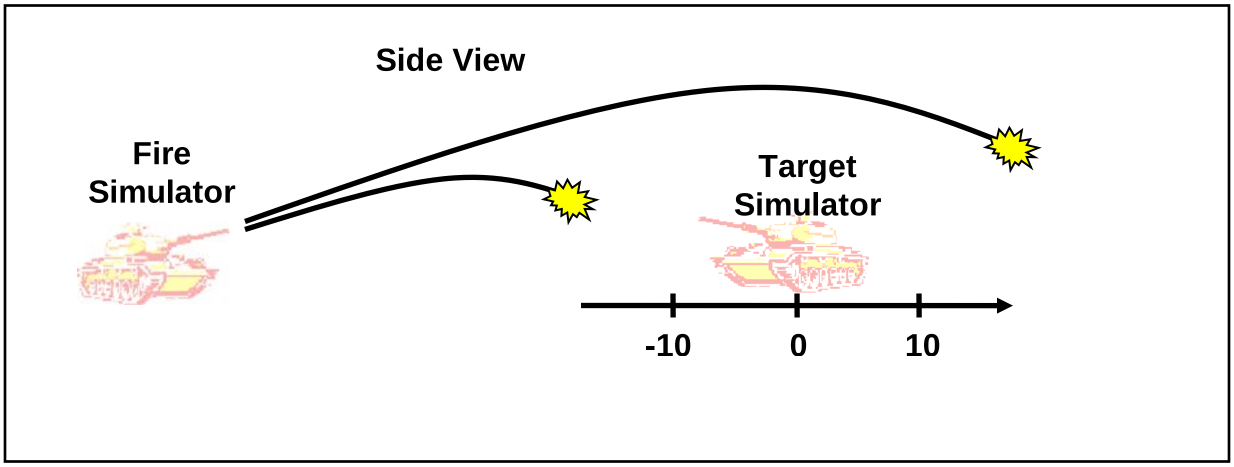

Figure 20 Real-Time Code, Detonation Distance Sign Definition

The three dimensional coordinate definition of the detonation distance and the detonation coordinates is illustrated below. Depending on the level of abstraction the X and Y-axis could have been drawn differently. They could have been drawn as the "Position Code" coordinates rotated 45 degrees relative to ground. As drawn below the X and Y-axis represents how the detonation position normally is presented to the gunner for example.

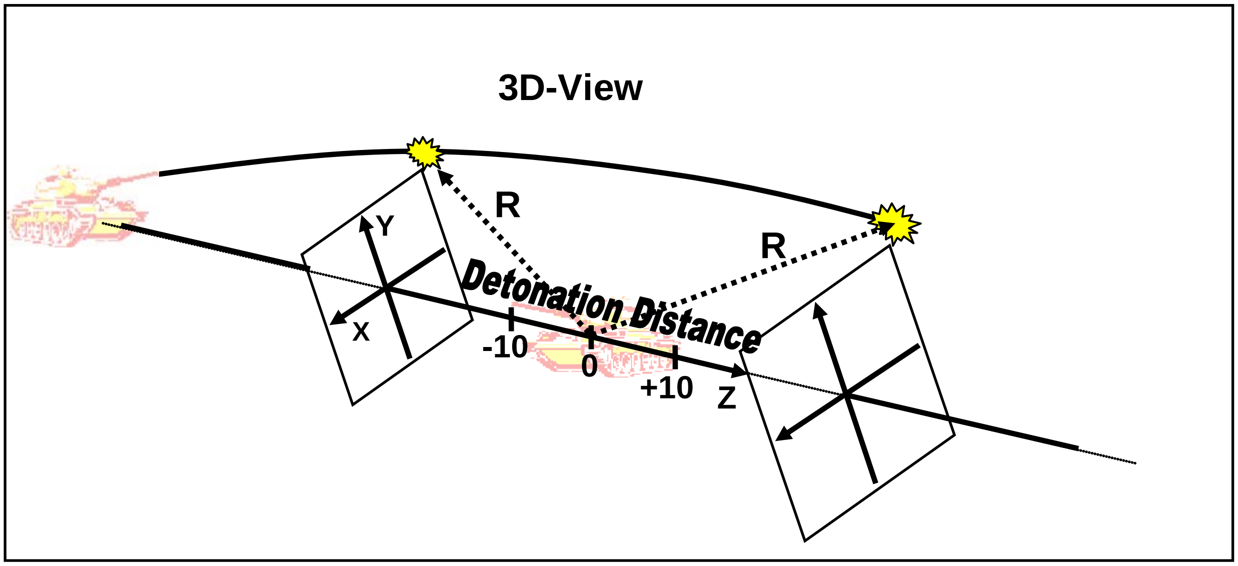

Figure 21 Real-Time Code, Detonation Distance 3D-view

The calculated radius R, dotted in the above illustration, can then be used in the vulnerability evaluation.

Encoding and decoding detonation functions and distance examples:

Table 51 Real-Time Code, Detonation Distance Info, Encoding and Decoding Examples

Encoded (EDD) Detonation Distance or function	Decoded (DDD) Detonation Distance or function	PI
m	m	PIU
Not allowed	Unarmed	1505
Unarmed	Unarmed	1506
Not allowed	Unarmed	1507
Not allowed	Burst of Fire	1508
Burst of Fire	Burst of Fire	1509
Not allowed	Burst of Fire	1510
Not allowed	Future growth	1511
Future Growth	Future growth	1512
Not allowed	Future growth	1513
Not allowed	-170	1514
≤ -155	-160	1515
-154 to -145	-150	1516
Etc.	Etc.	Etc
-34 to -25	-30	1528
-24 to -22	-20	1529
-21 to -19	-20	1529
Etc.	Etc.	Etc.
-4 to -3	-4	1537
-2 to -1	-2	1538
0	0	1539
1 to 2	2	1540
3 to 4	4	1541
Etc.	Etc.	Etc.
19-21	20	1549
22-24	20	1549
25-34	30	1550
Etc.	Etc.	Etc.
145-154	150	1562
≥155	160	1563
Not allowed	170	1564

Observe that the target simulator usually is receiving and decoding multiple DDD values when a fire simulator is engaging. The final DDD value is then calculated as the average value of the decoded DDD values.

4.6.2.7. Cant Angle Code

The Cant Angle Code (CA21) is used to inform the target simulator about how the Projectile Position coordinates are slanted in relation to ground seen from the fire simulator point of view.

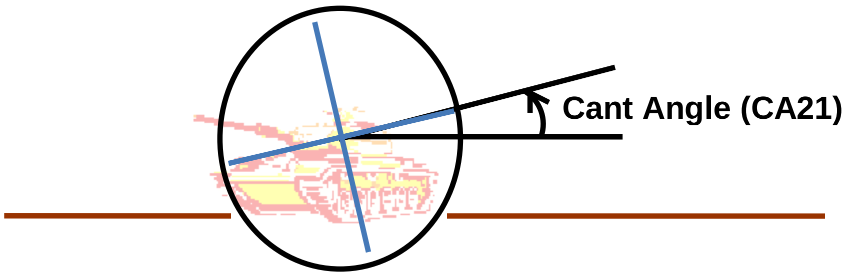

Figure 22 Real-Time Code, Cant Angle

The fire simulators can measure the Cant Angle by using simulator built in sensors or read the Cant Angle from the weapon fire computer system. The Cant Angle value is then transmitted from the fire simulator to the target simulator. The target simulator has then enhanced possibilities to adjust the Projectile Position coordinates transmitted from the fire simulator.

The Cant Angle is measured and regarded positive in the counter clockwise direction as illustrated above.

The Cant Angle is encoded and decoded in 2/64 radians increments as follows:

Encoding:	[PI is an integer measured in PIU]
`ECA = ECR * 64`	[ECR measured in radians]
`PI = 1356`	`ECA ≤ -83`
`PI = INT((ECA-1) / 2) + 1398`	`-83 < ECA ≤ -1`
`PI = 1399`	`-1 < ECA < 1`
`PI = INT((ECA+1) / 2) + 1400`	`1 ≤ ECA < 83`
`PI = 1442`	`ECA ≥ 83`
Decoding:	[DCA is an integer]
`DCA = (PI - 1398)* 2`	`1355 ≤ PI ≤ 1397`
`DCA = 0`	`1398 ≤ PI ≤ 1400`
`DCA = (PI – 1400)* 2`	`1401 ≤ PI ≤ 1443`
`DCR = DCA / 64`	[DCR measured in radians]

Encoding and decoding Cant Angle examples:

Table 52 Real-Time Code, Detonation Distance Info, Encoding and Decoding Examples

Encoded (ECA) Cant Angle	Decoded (DCA) Cant Angle	Decoded (DCR) Cant Angle	PI
radians x 64	radians x 64	degrees (approx)	PIU
not encoded	-86	-76.99	1355
ECA≤-83	-84	-75.20	1356
-83<ECA≤-81	-82	-73.41	1357
-5<ECA≤-3	-4	-3.58	1396
-3<ECA≤-1	-2	-1.79	1397
not allowed	0	0	1398
-1<ECA<1	0	0	1399
not allowed	0	0	1400
1≤ECA<3	2	1.79	1401
3≤ECA<5	4	3.58	1402
81≤ECA<83	82	73.41	1441
ECA≥83	84	75.20	1442
not encoded	86	76.99	1443

Observe that the target simulator usually is receiving and decoding multiple DCA values when a scanning fire simulator is engaging. The final DCA value is then calculated as the average value of the decoded DCA values.

4.6.2.8. **Burst of Fire Simulation**

This chapter describes only the "Real-Time" burst of fire simulation. "Short-Time Scanning" burst of fire simulation is described in the "4.6.4.5 Burst of Fire Simulation" chapter.

A laser simulator using "Real-Time Code" transmits information for typically a maximum fire rate of 250 rounds per minute. If the fire rate is greater than that, especially designed burst of fire simulation methods are applied.

1 **Individual Round Simulation.** Each individual round is simulated.
2 **Burst of Fire Simulation.** The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to more than one projectile.
  - 2.1 **"Burst of Fire" "Ammunition Code" Simulation**. There are burst of fire coded ammo numbers. This type of functionality is defined for a few non-alternating ammo numbers.
  - 2.2 **"Distance Lethality Code" "Burst of Fire Flag"**. The fire simulator sets one of the "Burst of Fire" flags in the "Distance Lethality Code".

As previously described the fire simulator typically selects between using 2-fold or 4-fold triplet sequences. The selection can be done for the following reasons:

- The 4-fold triplet is used during most normal fire simulations when the fire rate is <250 rounds per minute. When the fire simulator is selecting the 4-fold triplet the simulation principle typically includes a 2*0.06*v (two 60ms projectile position scans and v = projectile velocity) engagement distance interval where targets are engaged.
- The 2-fold triplet is used during exceptional fire simulation conditions like high fire rate burst of fire simulation when the fire rate is >250 rounds per minute. When the fire simulator is selecting the 2-fold triplet the simulation principle typically includes a 0.06*v (one 60ms projectile position scan and v = projectile velocity) engagement distance interval where targets are engaged.

From the fire simulator point of view you can simulate as follows depending on the simulated fire rate.

Table 53 Real-Time Code, Burst of Fire Simulation

Number of Transmitted Triplets	Max. Fire Rate Rounds per Minute	Burst of Fire Simulation Method	Comment
5 or 6	180	1. Individual Round Simulation	In exceptional situations, for example for low velocity projectile or missile
4	250	1. Individual Round Simulation	Typical normal simulation
2-3	500	1. Individual Round Simulation	Exceptional high fire rate simulation
2-6	>250	2. Burst of Fire Simulation	The transmitted lethality corre-sponds to more than one projec-tile.

The following triplet definitions are made for the below illustrations:

- P3: Position triplet
  - `P3ON: PC1-AC1-PC2,` Non-alternating ammunition code
  - `P3OA: PC1-XXX-PC2,` XXX is any alternating pair item
- I3: Identity triplet
  - `I3ON:  IC1-IC2-IC3` Non-alternating player identity code
  - `I3OA: ICa1-YYY-ICa3,` YYY is an alternating pair ammunition code item

  ICa1 is player identity IC11 alternating with IC21
  ICa3 is player identity IC12 alternating with IC22

A typical 4-fold triplet "Burst of Fire Simulation" including three simulated rounds can be illustrated as:
P3, P3, I3, I3, … P3, P3, I3, I3, … P3, P3, I3, I3

An exceptional 5- and 6-fold triplet "Burst of Fire Simulation" including three simulated rounds can be illustrated as:
P3, P3, P3, I3, I3, … P3, P3, I3, I3, I3, … P3, P3, P3, I3, I3, I3

Each of the above simulation sequences then comprises two or more simulated projectiles.

Burst of fire simulation triplet sequences are identified as follows:

- Main rules:
    - P3 starts the triplet sequence representing a single projectile
    - When P3ON follows a P3ON triplet, P3ON represents a triplet for **the same** simulation in the triplet sequence.
    - When P3OA follows a P3OA triplet, P3OA represents a triplet for **the same** simulation in the triplet sequence.
    - When P3ON follows an I3ON triplet, P3ON represents a triplet for **the next** simulation in the triplet sequence
    - When P3OA follows an I3OA triplet, P3OA represents a triplet for **the next** simulation in the triplet sequence
    - I3ON represents a triplet for **the same** simulation as the preceding P3ON or I3ON triplet in the triplet sequence.
    - I3OA represents a triplet for **the same** simulation as the preceding P3OA or I3OA triplet in the triplet sequence.
- Additional rules:
    - When the time between two triplets exceeds 230ms, they are not interpreted as belonging to the same simulation.
    - Change in identity code:
        - When I3 follows an I3 triplet, and a change in identity code, compared to the preceding triplet is identified, I3 is not interpreted as belonging to the same simulation.
    - Change in ammunition code
        - When I3OA follows an I3OA triplet, and a change in ammunition code compared to the preceding triplet is identified is identified, I3OA is not interpreted as belonging to the same simulation.
        - When P3ON follows a P3ON triplet, and a change in ammunition code compared to the preceding triplet is identified is identified, P3ON is not interpreted as belonging to the same simulation.

The target simulator can be informed about that the transmitted projectile position comprises a lethality corresponding to two or more projectiles. The target simulator can then use the burst of fire information in different ways to achieve a realistic engagement outcome for example:

- Vulnerability data with enhanced vulnerability
- Adjusted target template geometries

4.6.3 Fire-and-Forget Code

The "Fire-and-Forget Code" is implemented on weapon systems not following a ballistic projectile or "Real-Time" guided missile principle. Weapons systems using the "Fire-and-Forget Code" are for example Stinger, PARS LR, Javelin, SPIKE and Gill.

The "Fire-and-Forget Code" does typically involve reception of retro reflection from the target, and as such it is referred to as a "two-way" code.

The "Fire-and-Forget Code" has similar principal structure of the optical code as the "Real-Time Code". For "Fire-and-Forget-Systems", the "Hit Probability" code (HP1) and the "Time-to-Impact" code (TF1) are transmitted instead of the "Position Codes" (PC1 and PC2).

The "Fire-and-Forget" "Ammunition Code" AC5 or AC12 alternating with AC22 can be used by the target simulators to identify that the simulation is of "Fire-and-Forget" type. There are two types of "Fire-and-Forget Code"

- Non-alternating ammunition code. AC5 is used
- Alternating ammunition code. AC12 alternating with AC22is used

The following non-alternating optical codes are used:

- Ammunition Code AC5
- Player Identity Code IC1, IC2, IC3
- Hit Probability Code HP1
- Time-to-Impact Code TF1
- Null Code NC1, NC2, NC3, NC4

The following alternating optical codes are used:

- Ammunition Code AC12, AC22
- Player Identity Code IC11, IC12, IC21, IC22
- Distance Lethality Code EI11, DI11
- Cant Angle CA21

Messages transmitted by using a "Fire-and-Forget Code" consist of three message items building a triplet. The chapter "4.3.3.2 Triplet Group Structure" specifies the triplet encoding and decoding.

4.6.3.1. **Additional Code Structure**

The "Fire-and-Forget Code" follows the additional conditions also valid for the "Real-Time" optical code type as described in chapter "4.6.2.1 Additional Code Structure".

4.6.3.2. **Ammunition Code**

The "Fire-and-Forget Code" ammo number is encoded and decoded in two ways:

1. Non-alternating using AC5.
2. Alternating using AC12 and AC22

4.6.3.2.1 Non-alternating

You can transmit an ammunition code using non-alternating code.
A laser transmitter typically transmits eight message elements when transmitting the "Fire-and-Forget Code".

```
AC5 - AC5 - AC5 - AC5 - AC5 - AC5 – AC5 – AC5
```

The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding:	[AC5 and AmNo are integers]
`AC5  = AmNo`	`AmNo=25, AmNo=30`
`PI5  = 1698 + (3*AC5)`	
Decoding:	[PI5 is an integer measured in PIU]
`AC5  = INT((PI5 – 1697) / 3)`	`1772≤PI5≤1774, 1787≤PI5≤1789`
`AmNo = AC5`	`AC5=25, AC5=30`

Ammo numbers and encoding:

Table 54 Fire-and-Forget Code, Non-alternating Ammo Number Encoding

AmNo	AC5	PI5
25	25	1773
30	30	1788

4.6.3.2.2 Alternating

You can also transmit an ammunition code using alternating codes AC12 and AC22. A simulator using "Fire-and-Forget Code" is then typically transmitting four pairs of ammunition code to the target:

```
AC12 – AC22 – AC12 – AC22 – AC12 – AC22 – AC12 – AC22
```

There are both Parent Ammo Number series and Child Ammo Number series.

The decoded ammo numbering depends on three flags (FlgNo) set in "Engagement Info" (EI11) or "Detonation Info" (DI11) as illustrated with the below table:

Table 55 Fire-and-Forget Code, Alternating Ammo Numbers

	Direct Detonation
FlgNo	**12**
Parent	12001-12280
Child	13001-13280

Note. "Fire-and-Forget" "Unarmed" ammo numbers are shared with "Real-Time" "Unarmed" ammo numbers.

The Ammo Number (AmNo) is encoded and decoded as follows:

Parent Ammo Number: [PI12 and PI22 are integers measured in PIU]
Encoding: [AC12, AC22, AmLsd, AmNo and FlgNo are integers]

```
FlgNo = INT(AmNo / 1000)
AmLsd= 2000 + INT(AmNo % 1000)
AC22 = 1 + INT((AmLsd – 2001) / 10)      2001 ≤ AmLsd ≤ 2280
AC12 = 1 + INT((AmLsd – 2001) % 10)      2001 ≤ AmLsd ≤ 2280
PI12 = 1623 + (3*AC12)                      1 ≤ AC12 ≤ 10
PI22 = 1353 + (3*AC22)                      1 ≤ AC22 ≤ 28
```

Decoding:

```
AC12 = INT((PI12 – 1622) / 3)             1625 ≤ PI12 ≤ 1684
AC22 = INT((PI22 - 1352) / 3)             1355 ≤ PI22 ≤ 1438
AmNo = (FlgNo*1000)+((AC22-1)*10)+AC12;  1 ≤ AC12 ≤ 10, 1 ≤ AC22 ≤28
```

Parent ammo number encoding examples:

Table 56 Fire-and-Forget Code, Alternating Parent Ammo Number Encoding Examples

AmNo	AC12	AC22	PI12	PI22
12001	1	1	1626	1356
12010	10	1	1653	1356
12032	2	4	1629	1365
12280	10	28	1653	1437

Child Ammo Number: [PI12 and PI22 are integers measured in PIU]
Encoding: [AC12, AC22, AmNo and FlgNo are integers]

```
FlgNo = (INT(AmNo / 1000)) - 1
AmLsd= 2000 + INT(AmNo % 1000)
AC22 =  1 + INT((AmLsd – 2001) / 10)      2001 ≤ AmLsd ≤ 2280
AC12 = 11 + INT((AmLsd – 2001) % 10)      2001 ≤ AmLsd ≤ 2280
PI12 = 1623 + (3*AC12)                      11 ≤ AC12 ≤ 20
PI22 = 1353 + (3*AC22)                       1 ≤ AC22 ≤ 28
```

Decoding:

```
AC12 = INT((PI12 – 1622) / 3)            1625 ≤ PI12 ≤ 1684
AC22 = INT((PI22 - 1352) / 3)            1355 ≤ PI22 ≤ 1438
AmNo =((FlgNo+1)*1000)+((AC22-1)*10)+(AC12–10);
                                     11 ≤ AC12 ≤ 20, 1 ≤ AC22 ≤ 28
```

Child ammo number encoding examples:

Table 57 Fire-and-Forget Code, Alternating Child Ammo Number Encoding Examples

AmNo	AC12	AC22	PI12	PI22
13001	11	1	1656	1356
13010	20	1	1683	1356
13032	12	4	1659	1365
13280	20	28	1683	1437

4.6.3.3. **Player Identity Code**

"Player Identity Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.3 Player Identity Code".

4.6.3.4. **Null Code**

"Null Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.5 Null Code”

4.6.3.5. **Distance Lethality Code**

"Distance Lethality Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.6 Distance Lethality Code".

4.6.3.6. **Cant Angle Code**

Cant Angle Code encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.7 Cant Angle Code".

4.6.3.7. **Burst of Fire Simulation**

"Burst of Fire Simulation" principles identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.8 Burst of Fire Simulation".

4.6.3.8. **Hit Probability Code**

The firing simulator can estimate the probability of hit when engaging the target.
The "Hit Probability" is encoded and decoded using:

- Non-alternating using HP1

The "Hit Probability" (HP) percentage is encoded and decoded as follows:

Encoding:	[HP is an integer]
`PI = HP + 2000`	$0 \leq HP \leq 100$

The HP is encoded with a resolution of 1% starting at 0%

Decoding:	[PI is an integer measured in PIU]
`HP = 0`	`PI = 1999`
`HP = PI – 2000`	$2000 \leq PI \leq 2100$
`HP = 100`	`PI = 2101`

"Hit Probability" encoding and decoding:

Table 58 Fire-and-Forget Code, Hit Probability Code Encoding and Decoding

HP	Encoding	Decoding
	PI	PI
0%	not allowed	1999
0%	2000	2000
2%	2002	2002
N%	2000+N	2000+N
100%	2100	2100
100%	not allowed	2101

Observe that the target simulator may receive and decode multiple HP values when a "Triplet Group Coded" fire simulator is engaging. The final HP value is then calculated as the average value of the decoded HP values.

4.6.3.9. **Time-to-Impact Code**

The "Time-to-Impact" defines the time until impact in target in seconds. When the target receives the info it can wait the time received until the evaluation of the engagement is done.

The "Time-to-Impact Code" is encoded and decoded as follows:

Encoding: [K and N are integers]; [PI1 is an integer measured in PIU]

```
    PI1 = 2134 + K              TF1 = K*0.1,  0 ≤ K ≤ 4
    PI1 = 2140                  TF1 = 0.5
    PI1 = 2140 + N              TF1 = N,   1 ≤ N ≤ 59 (N Seconds)
```

Decoding: [TF1 is a decimal value measured in seconds]

```
    TF1 = 0                     PI1 = 2133
    TF1 = 0.1*(PI1 – 2134)      2134 ≤ PI1 ≤ 2139
    TF1 = 0.5                   PI1 = 2140
    TF1 = PI1 – 2140            2141 ≤ PI1 ≤ 2200
```

Observe that the target simulator may receive and decode multiple TF1 values when a fire simulator is engaging. The final TF1 value is then calculated as the average value of the decoded TF1 values.

The "Time-to-Impact Code" encoding and decoding is illustrated as follows:

Table 59 Fire-and-Forget Code, Time-to-Impact Code, Encoding and Decoding

Encode	Decode	Encode	Decode
PI1	PI1	TF1	TF1
PIU	PIU	seconds	seconds
	2133		0
2134	2134	0	0
2135	2135	0.1	0.1
2136	2136	0.2	0.2
2137	2137	0.3	0.3
2138	2138	0.4	0.4
2139	2139		0.5
2140	2140	0.5	0.5
2141	2141	1	1
2140+N	2140+N	1 ≤ N ≤ 59	1 ≤ N ≤ 59
2199	2199	59	59
	2200		60

4.6.4 Short-Time Scanning Code

Weapon fire simulators using "Real-Time Code" and "Fire-and-Forget Code" also add "Short-Time Scanning Code", to ensure realistic engagement effects primarily in man worn target simulators but also vehicle target simulators may decode the "Short-Time Scanning Code". Those target simulators may have a solution without retro reflectors or the soldier may temporarily have taken off the retro reflector equipped helmet.

The "Short-Time Scanning Code" does not require a retro-reflection from the target, and as such it is typically referred to as a "one-way" code.

The "Short-Time Scanning" "Ammunition Code" AC2 or AC11 alternating with AC22 is used by the target simulators to identify that the simulation is of "Short-Time Scanning" type. There are two types of "Short-Time Scanning Code".

- Non-alternating
    - AC2 and "Short-Time Code" "Player Identity" encoding is used.
- Alternating
    - AC11 alternating with AC22 and "Real-Time Code" "Player Identity" encoding is used.

The following non-alternating optical codes are used:

- Ammunition Code AC2
- Player Identity Code IC4a, IC4b, IC5a, IC5b
- Null Code NC1, NC2, NC3, NC4

The following alternating optical codes are used:

- Ammunition Code AC11, AC22
- Player Identity Code IC11, IC12, IC21, IC22

Messages transmitted by using a "Short-Time Scanning Code" consist of three message items building a triplet. The chapter "4.3.3.2 Triplet Group Structure" specifies the triplet encoding and decoding.

The "Short-Time Scanning Code" is typically transmitted during the real time projectile flight simulation or at an appropriate simulated engagement distance. Depending on type of weapon fire simulator the "Short-Time Scanning Code" shall be transmitted at different occasions:

- At the time when the projectile or missiles leaves the weapon platform.

- Regularly during the real time projectile flight simulation.
- Principally at the engagement distance. If the fire simulator has information about the engagement distance, it may choose to transmit when the projectile reaches the target(s).

The shape and the size of the "Short-Time Scanning" fire engagement area is drawn by the fire simulator laser transmitter. The effective area is adapted by the fire simulator depending on the simulated ammunition lethality. When simulated during the entire real time projectile flight, the effective area can typically be seen, from the gunner's perspective, to be falling with the projectile drop.

4.6.4.1. **Additional Code Structure**

The following additional conditions are valid for the "Short-Time Scanning Code". The conditions can to some extent be seen as a subset of the Additional Code Structure for the "Real-Time Code" as described in chapter "4.6.2.1 Additional Code Structure".

The Target Simulator shall use the following additional conditions to decode pulse intervals as valid pulse intervals:

- When more than one detector at the same time (< 2ms) is receiving, then it is allowed to decode at the detector receiving the most number of position triplets.
- The player identity and ammo message item triplets can only be transmitted in the following orders of occurrence:
  - `IC4a-AC2–IC5a or IC4b-AC2–IC5a`
  - `IC5b-AC2–IC4a or IC5b-AC2–IC4b`
  - `ICa1-ACa–ICa3 or ICa3-ACa–ICa1`

    ACa is AC11 alternating with AC22
    ICa1 is IC11 alternating with IC21
    ICa3 is IC12 alternating with IC22
- The triplet can consecutively be transmitted multiple times to a single detector.
- Triplet sequences representing multiple engagements are identified as defined in chapter "4.6.2.8 Burst of Fire Simulation".
- When any of the three message items in a triplet is missing, the triplet is not decoded.

A projectile or missile simulation is done transmitting at least a 1-fold triplet. Below are illustrated simulating two projectiles using a 1-fold and a 3-fold triplet:

Table 60 Short-Time Scanning Code, Timing Illustration

Triplet	Pass 1	Delay	Pass 2	Delay	Pass 3	Delay
1	ICa1	t1	ACa	t1	ICa3	t2
2	ICa3	t1	ACa	t1	ICa1	t2
3	ICa1	t1	ACa	t1	ICa3	t3
1	ICa3	t1	ACa	t1	ICa1	

Note that each message item (ACa, ICa1 and ICa3) in the above table consists of several message elements.

The length of the decoded time intervals t1 and t2 from the above table:

`t3 ≥ 6s`
`t2 < 6s`
`t1 < 30ms` t1 within the same triplet shall not differ more than 5ms

See following chapters "4.6.4.5 Burst of Fire Simulation" for more info concerning burst of fire simulation.

4.6.4.1.1 Short-Time Scanning Triplet Coded Sequences

Messages transmitted by using a "Short-Time Scanning Code" consist of three message items building a triplet. To accept the information, the target simulator has to receive a complete triplet containing "Ammunition Code" and "Player Identity". The chapter "4.3.3.2 Triplet Group Structure" describe the basics of triplet encoding and decoding. Additional "Short-Time Scanning Code" triplet decoding and encoding rules are specified below.

The following additional acronym definitions are made for the below triplet sequence illustrations:

- ICa1: IC11 alternating with IC21 as player identity item
- ICa3: IC12 alternating with IC22 as player identity item
- ACsp: "Short-Time Scanning Code" AC11 alternating with AC22 as parent ammo code item
- ACsc: "Short-Time Scanning Code" AC11 alternating with AC22 as child ammo code item
- ACs: ACsp or ACsc. "Short-Time Scanning Code" AC11 alternating with AC22
- ACr: "Real-Time Code" AC11 alternating with AC21 as ammo code item
- ACf: "Fire-and-Forget Code" AC12 alternating with AC22 as ammo code item
- Null: Transmitting "Null Code" info searching for targets
- DLY: The time between two triplets exceeds six seconds
- RTa: "Real-Time Code" alternating pair item transmitted together with position code
- FFa: "Fire-and-Forget Code" alternating pair item transmitted together with "Hit Probability" or "Time-to-Impact".

The following "Short-Time Scanning Code" triplet acronym definitions are made for the below descriptions:

- **SPa**3: "**S**hort-Time Scanning Code" **Pa**rent ammo code and player identity triplet
  - `ICa1-ACsp-ICa3`
- **SCh**3: "**S**hort-Time Scanning Code" **Ch**ild ammo code and player identity triplet
  - `ICa1-ACsc-ICa3`
- **SId**3: "**S**hort-Time Scanning Code" ammo code and player identity triplet
  - `ICa1-ACsp-ICa3`
  - `ICa1-ACsc-ICa3`
  - `IC4a-AC2-IC5a`
  - `IC4b-AC2-IC5a`
  - `IC5b-AC2-IC4a`
  - `IC5b-AC2-IC4b`

The following "Real-Time Code" triplet acronym definitions are made for the below descriptions:

- **RPo**3: "**R**eal-Time Code" **Po**sition triplet
  - `PC1-AC1-PC2` Non- alternating ammo code
  - `PC1-RTa-PC2`
- **RId**3: "**R**eal-Time Code" **Id**entity triplet
  - `IC1-IC2-IC3` Non- alternating player identity
  - `ICa1-ACr-ICa3` Alternating message items

The following "Fire-and-Forget Code" triplet acronym definitions are made for the below descriptions.

- **FPo**3: "Fire-and-Forget Code" "Hit Probability" and "Time-to-Impact" triplet
  - `HP1-AC5-TF1` Non- alternating ammo code
  - `HP1-FFa-TF1`
  - `HP1-FFa-TF11`
- **FId**3: "**F**ire-and–Forget" **Id**entity triplet
  - `IC1-IC2-IC3` Non- alternating player identity
  - `ICa1-ACf-ICa3`

There are basic similarities between the "Real-Time Code" and "Fire-and-Forget Code" triplets. In case referring to both triplet types at the same time, the following acronyms are used:

- **Po3** refers to **RPo3** and **FPo3**
- **Id3** refers to **RId3** and **FId3**

An engagement simulation triplet sequence example including one "Real-Time" fire engagement against a single target can then be illustrated as:

`SId3,Null,Null,RPo3,RPo3,RId3,RId3,SId3,Null,Null`

In the above example the fire simulator has identified that the projectile is passing the target outside the fire template as the "Short-Time Scanning Code" transmission continues after the "Real-Time Code" transmission.

An engagement simulation triplet sequence example including one "Fire-and-Forget" fire engagement against a single target can then be illustrated as:

`RPo3,RPo3,RId3,RId3,SId3,SId3`

As stated previously weapon fire simulators using "Real-Time Code" and "Fire-and-Forget Code" also use "Short-Time Scanning Code" in the majority of fire engagements. It is up to the man worn target simulators to select between the two simulation types. There are three main situations from which the man worn target simulators shall decode the triplet sequences.

- With retro-reflectors.
  - The target simulator knows that the simulator is equipped with retro-reflectors and the helmet where the retro-reflectors are mounted is taken on.
    - The **SId3** triplets are rejected as the **Po3** and **Id3** triplets probably refers to this target simulator and represents the most realistic simulation.
  - The target simulator knows that the simulator is equipped with retro-reflectors and the helmet where the retro-reflectors are mounted is taken off
    - The **Po3** and **Id3** triplets are rejected independent from the fact that they refer to this target simulator or not. The **SId3** triplets are expected to have stronger lethality, thus expected punishing players having helmet taken off.

- Without retro-reflectors.
  - The target simulator knows that the simulator does not include any retro-reflector.
    - The **Po3** and **Id3** triplets are rejected as they refer to another target simulator. The **SId3** triplets probably represent the most realistic simulation.

- With or without retro-reflectors. Retro-reflectors delivered as add-on kits, thus the simulator does not know whether or not it is currently equipped with them.
  - The target simulator does not know that the simulator is equipped with retro-reflectors.
    - The **Po3** and **Id3** triplets are rejected as they might refer to another target simulator. The **SId3** triplets probably represent the most realistic simulation.

Further explanation of triplet sequence decoding can be read in the "4.6.4.5 Burst of Fire Simulation" chapter.

4.6.4.2. **Ammunition Code**

The "Short-Time Scanning Code" ammo number is encoded and decoded in two ways:

1. Non-alternating using AC2
2. Alternating using AC11 and AC22

4.6.4.2.1 Non-alternating

The "Ammunition Code" AC2 can be used by the target simulator to identify that the simulation is of "Short-Time Scanning" type.

The laser transmitter transmits three message items each containing typically eight message elements when transmitting the Short-Time Scanning Code. The transmitted ammo code can then be illustrated as:

```
AC2 – AC2 – AC2 – AC2 – AC2 – AC2 – AC2 – AC2
```

The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding:	[AC2 and AmNo are integers]
`AC2 = AmNo`	$77 \leq AmNo \leq 79$
`PI2 = 2159 + (3*AC2)`	
Decoding:	[PI2 is an integer measured in PIU]
`AC2 = INT((PI2 – 2158) / 3)`	$2389 \leq PI2 \leq 2397$
`AmNo = AC2`	$77 \leq AC2 \leq 79$

Ammo number encoding:

Table 61 Short-Time Scanning Code, Non-alternating Ammo Number Encoding

Short-Time Scanning		
AmNo	**AC2**	**PI2**
77	77	2390
78	78	2393
79	79	2396

4.6.4.2.2 Alternating

The "Ammunition Code" AC11 alternating with AC22 can be used by the target simulator to identify that the simulation is of "Short-Time Scanning" type.

The laser transmitter transmits three message items each containing typically eight message elements when transmitting the "Short-Time Scanning Code". A simulator using the "Short-Time Scanning Code" is then typically transmitting four pairs of ammunition code to the target:

```
AC11 – AC22 – AC11 – AC22 – AC11 – AC22 – AC11 – AC22
```

There are both a Parent Ammo Number series and a Child Ammo Number series.

Table 62 Short-Time Scanning Code, Alternating Ammo Numbers

Short-Time Scanning	
Parent-Child Relationship	**AmNo**
Parent	22001-22280
Child	23001-23280

There are restrictions in using "Short-Time Scanning" child ammo codes as they also can be used as part of the "Short-Time Scanning" "Burst of Fire Simulation" mechanism. See the below "4.6.4.5 Burst of Fire Simulation" chapter for more info.

The Parent Ammo Number (AmNo) is encoded and decoded as follows:

Parent Ammo Number:
Encoding: [AC11, AC22 and AmNo are integers]

```
AC11 = 1 + INT((AmNo – 22001) % 10)   22001 ≤ AmNo ≤ 22280
AC22 = 1 + INT((AmNo – 22001) / 10)   22001 ≤ AmNo ≤ 22280
PI11 = 1203 + (3*AC11)                    1 ≤ AC11 ≤ 10
PI22 = 1353 + (3*AC22)                    1 ≤ AC22 ≤ 28
```

Decoding: [PI11 and PI22 are integers measured in PIU]

```
AC11 = INT((PI11 – 1202) / 3)          1205 ≤ PI11 ≤ 1264
AC22 = INT((PI22 - 1352) / 3)          1355 ≤ PI22 ≤ 1438
AmNo = 22000+((AC22-1)*10)+AC11       1 ≤ AC11 ≤ 10, 1 ≤ AC22 ≤ 28
```

Parent ammo number encoding examples:

Table 63 Short-Time Scanning Code, Alternating Parent Ammo Number Encoding Examples

AmNo	AC11	AC22	PI11	PI22
22001	1	1	1206	1356
22010	10	1	1233	1356
22032	2	4	1209	1365
22280	10	28	1233	1437

The Child Ammo Number (AmNo) is encoded and decoded as follows:

Child Ammo Number:
Encoding: [AmNo is an integer]

```
AC11 = 11 + INT((AmNo – 23001) % 10)   23001 ≤ AmNo ≤ 23280
AC22 =  1 + INT((AmNo – 23001) / 10)   23001 ≤ AmNo ≤ 23280
PI11 = 1203 + (3*AC11)                    11 ≤ AC11 ≤ 20
PI22 = 1353 + (3*AC22)                     1 ≤ AC22 ≤ 28
```

Decoding: [PI11 and PI22 are integers measured in PIU]

```
AC11 = INT((PI11 – 1202) / 3)           1205 ≤ PI11 ≤ 1264
AC22 = INT((PI22 - 1352) / 3)           1355 ≤ PI22 ≤ 1438
AmNo =(23000)+((AC22-1)*10)+(AC11–10)  11 ≤ AC11 ≤ 20, 1 ≤ AC22 ≤ 28
```

Child ammo number encoding examples:

Table 64 Short-Time Scanning Code, Alternating Child Ammo Number Encoding Examples

AmNo	AC11	AC22	PI11	PI22
23001	11	1	1236	1356
23010	20	1	1263	1356
23032	12	4	1239	1365
23280	20	28	1263	1437

4.6.4.3. **Player Identity Code**

Each player has a unique player identity number. The player identity number for players using "Short-Time Scanning Code" is encoded and decoded as described below.

The "Player Identity Code" is transmitted in two different ways
1. Non-alternating "Player Identity" using IC4a, IC4b, IC5a and IC5b.
2. Alternating "Player Identity" using IC11 alternating with IC21 and IC12 alternating with IC22.

4.6.4.3.1 Non-alternating

"Short-Time Scanning" "Player Identity Code" encoding and decoding algorithms identical to those of the "Short-Time Code" shall be used as described in chapter "4.6.1.3 Player Identity Code".

4.6.4.3.2 Alternating

"Short-Time Scanning" "Player Identity Code" encoding and decoding algorithms identical to those of the alternating "Player Identity Code" for "Real-Time Code" shall be used as described in chapter "4.6.2.3.2 Alternating Player Identity".

4.6.4.4. **Null Code**

"Null Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.5 Null Code”

4.6.4.5. **Burst of Fire Simulation**

The "Short-Time Scanning Code" "Burst of Fire Simulation" can be done in two ways:
- Non-alternating
- Alternating

4.6.4.5.1 Non-alternating

A fire simulator using "Short-Time Scanning Code" can use the following burst of fire simulation method:
- **Fire Timing Simulation.** The timing between two triplets is used to identify multiple fire engagements.

Read the previous chapter "4.6.4.1.1 Short-Time Scanning Triplet Coded Sequences" for the explanation of the below acronym definitions.

"Short-Time Scanning Code" simulation triplet sequences are decoded as follows:
- "Real-Time Code" triplets and "Null Code" are ignored when decoding the "Short-Time Scanning Code" triplet sequences. As for example the following triplet sequences are considered as a single continuous sequence:
  - **SId3**, Null, Null, Null, **SId3**
  - RPo3, RPo3, RId3, RId3, **SId3**, **SId3**
  - **SId3**, RPo3, RPo3, RId3, RId3, **SId3**
  - **SId3**, Null, Null, Null, RPo3, RPo3, RId3, RId3, Null, Null, Null, **SId3**
- "Fire-and-Forget Code" triplets are transmitted at time of fire and thus the "Null Code" is not involved in the same way as when using "Real-Time Code". Still for clarification the following triplet sequences are considered as a single continuous sequence:
  - **SId3**, **SId3**
  - FPo3, FPo3, FId3, FId3, **SId3**, **SId3**
  - **SId3**, FPo3, FPo3, FId3, FId3, **SId3**
- A decoded triplet is added to the triplet sequence for the same fire engagement when:

- SId3 follows a SId3 triplet with identical ammo code and player identity
- A decoded triplet is beginning the triplet sequence for the next fire engagement when:
    - SId3 follows a SId3 triplet where ammo code or player identity differs
- Additional rules:
    - When the time between two SId3 triplets exceeds six seconds, they are not interpreted as belonging to the same fire engagement.
    - When a change in ammunition code AC1 or AC5, compared to the preceding triplet is identified, the triplets are not interpreted as belonging to the same fire engagement.

The next illustrations show examples on how "Short-Time Scanning Code" typically is transmitted alone without "Real-Time Code", as the "Real-Time" simulation does not find any target simulator retro-reflectors.

Simulation sequence for a single fire engagement:
SId3,Null,Null,Null,**SId3**,Null,Null,Null,**SId3**

Simulation sequence including two fire engagements:
SId3,Null,Null,,Null,Null,**SId3**,**DLY**,**SId3**,Null,Null,,Null,Null,**SId3**

The next illustrations show examples on how "Real-Time" and "Short-Time Scanning" simulation typically is combined.

Observe that the RPo3 and RId3 triplets describe projectile coordinates referring to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation for a single fire engagement can be illustrated as:
SId3,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**,Null,Null,Null,**SId3**
The fire simulator has identified that the projectiles are passing **a target** outside the fire template as the "Short-Time Scanning Code" transmission continues after each "Real-Time Code" transmission.

Simulation sequence for a single fire engagement can be illustrated as:
SId3,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**
The fire simulator has identified that the projectile is passing **targets** as defined by the fire template as the individual projectile simulations continues after the "Real-Time Code" transmissions.

Simulation sequence for multiple fire engagements can be illustrated as:
SId3,Null,Null,RPo3,RPo3,RId3,RId3,**DLY,SId3,**Null,Null,RPo3,RPo3,RId3,RId3

The next illustrations show examples on how "Fire-and-Forget" and "Short-Time Scanning" simulation typically is combined. Observe that the FPo3 and FId3 triplets are transmitted to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation for a single fire engagement can be illustrated as:
FPo3,FPo3,FId3,FId3,**SId3**,**SId3**
Simulation sequence including two fire engagements can be illustrated as:
FPo3,FPo3,FId3,FId3,**SId3**,**SId3**,**DLY**,FPo3,FPo3,FId3,FId3,**SId3**,**SId3**

4.6.4.5.2 Alternating

A fire simulator using "Short-Time Scanning" Code can use two different burst of fire simulation methods.

1 **Fire Timing Simulation.** The timing between two triplets is used to identify multiple fire engagements. This method is used to simplify the circumstances for the fire simulators during extraordinary situations. The fire simulators do not always have to remember if a parent or a child ammo code was the latest used ammo code. For example power save and power off situations are then easier to handle for the fire simulators.

1.1 **Individual Round Simulation**. Each individual round is simulated.

1.2 **"Burst of Fire" "Ammunition Code" Simulation**. There are burst of fire coded ammo numbers. The target simulator is informed about that the transmitted ammo number comprises a lethality corresponding to more than one projectile.

2 **"Burst of Fire" Ammo Alternating Simulation**. The alternating between parent and child ammo number is used to identify multiple projectiles. This is the standard mechanism used for "Short-Time Scanning" burst of fire simulation.

2.1 **Individual Round Simulation**. Each individual round is simulated.

2.2 **"Burst of Fire" "Ammunition Code" Simulation**. There are burst of fire coded ammo numbers. The target simulator is informed about that the transmitted ammo number comprises a lethality corresponding to more than one projectile.

Read the previous chapter "4.6.4.1.1 Short-Time Scanning Triplet Coded Sequences" for the explanation of the below acronym definitions.

"Short-Time Scanning Code" simulation triplet sequences are decoded as follows:

- "Real-Time Code" triplets and "Null Code" are ignored when decoding the "Short-Time Scanning Code" triplet sequences. As for example the following triplet sequences are thus considered as a single continuous sequence where "SPa3" follows a "SPa3":
  - **SPa3**, Null, Null, Null, **SPa3**
  - RPo3, RPo3, RId3, RId3, **SPa3**, **SPa3**
  - **SPa3**, RPo3, RPo3, RId3, RId3, **SPa3**
  - **SPa3**, Null, Null, Null, RPo3, RPo3, RId3, RId3, Null, Null, Null, **SPa3**
- "Fire-and-Forget Code" triplets are transmitted at time of fire and thus the "Null Code" is not involved in the same way as when using "Real-Time Code". Still for clarification the following triplet sequences are considered as a single continuous sequence where "SPa3" follows a "SPa3":
  - **SPa3**, **SPa3**
  - FPo3, FPo3, FId3, FId3, **SPa3**, **SPa3**
  - **SPa3**, FPo3, FPo3, FId3, FId3, **SPa3**
- A decoded triplet is added to the triplet sequence for the same fire engagement when:
  - SPa3 follows a SPa3 triplet with identical ammo code and player identity
  - SCh3 follows a SCh3 triplet with identical ammo code and player identity
- A decoded triplet is beginning the triplet sequence for the next fire engagement when:
  - SPa3 follows a SCh3 triplet
  - SCh3 follows a SPa3 triplet
  - SPa3 follows a SPa3 triplet where ammo code or player identity differs
  - SCh3 follows a SCh3 triplet where ammo code or player identity differs
- Additional rules:
  - When the time between two SPa3 or two SCh3 triplets exceeds six seconds, they are not interpreted as belonging to the same fire engagement.
  - When a change in ammunition code ACr or ACf, compared to the preceding triplet is identified, the triplets are not interpreted as belonging to the same fire engagement.
  - When a change in player identity, compared to in the preceding SPa3 or SCh3 triplet is identified, the triplets are not interpreted as belonging to the same fire engagement.

The next illustrations show examples on how "Short-Time Scanning Code" typically is transmitted alone without "Real-Time Code", as the "Real-Time" simulation does not find any target simulator retro-reflectors.

Simulation sequence using parent ammo code including one fire engagement:
SPa3,Null,Null,Null,**SPa3**,Null,Null,Null,**SPa3**
Similar as above but using child ammo code:
SCh3,Null,Null,Null,**SCh3**,Null,Null,Null,**SCh3**

Fire timing simulation sequence, applied in extraordinary situations, using parent ammo code including two fire engagements:

SPa3,Null,Null,,Null,Null,**SPa3**,**DLY**,**SPa3**,Null,Null,,Null,Null,**SPa3**
Similar as above but using child ammo code:
SCh3,Null,Null,,Null,Null,**SCh3**,**DLY**,**SCh3**,Null,Null,,Null,Null,**SCh3**

Burst of fire ammo alternating simulation sequence including two fire engagements:
SPa3,Null,Null,Null,**SPa3**,Null,Null,Null,**SCh3**,Null,Null,Null,**SCh3**
The previous triplet sequence shows that there are restrictions in using "Short-Time Scanning" child ammo codes as they also can be used as part of the "Short-Time Scanning" "Burst of Fire Engagement" simulation mechanism.

The next illustrations show examples on how "Real-Time" and "Short-Time Scanning" simulation typically is combined. Observe that the RPo3 and RId3 triplets describe projectile coordinates referring to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation sequence including one fire engagement can be illustrated as:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,**SPa3**,Null,Null,Null,**SPa3**
The fire simulator has identified that the projectiles are passing **a target** outside the fire template as the "Short-Time Scanning Code" transmission continues after each "Real-Time Code" transmission.
Simulation including one fire engagement can be illustrated as:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,**SPa3**,Null,Null,RPo3,RPo3,RId3,RId3,**SPa3**
The fire simulator has identified that the projectile is passing **targets** as defined by the fire template as the individual projectile simulations continues after the "Real-Time Code" transmissions.

Burst of fire ammo alternating simulation sequence including two fire engagements can be illustrated as:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,**SCh3**,Null,Null,RPo3,RPo3,RId3,RId3

Similar as above but in a different sequence:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,RPo3,RPo3,RId3,RId3,**SCh3**
The fire simulator has identified that the projectiles are hitting a target within the fire template as the individual projectile simulations stop after the "Real-Time Code" transmissions.

The next illustrations show examples on how "Fire-and-Forget" and "Short-Time Scanning" simulation typically is combined. Observe that the FPo3 and FId3 triplets are transmitted to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation sequence including one fire engagement can be illustrated as:
FPo3,FPo3,FId3,FId3,**SPa3**,**SPa3**
Burst of fire ammo alternating simulation sequence including two fire engagements can be illustrated as:
FPo3,FPo3,FId3,FId3,**SPa3**,**SPa3**,FPo3,FPo3,FId3,FId3,**SCh3**,**SCh3**

4.7 Auxiliary Codes

The following optical codes use the laser interface for functions other than simulated engagement functions.

- Umpire Control-Gun Code
- Geographical Reference Code
- Player Association Code

4.7.1 Umpire Control-Gun Code

The exercise area umpire, observer/controller or other personnel may have an umpire control-gun transmitter to distantly interfere against the players on the exercise area.

The Umpire Control-Gun Code has similar code structure as defined by the "Short-Time Code".

The Umpire Control-Gun Code is identified by the decoder when the "Umpire Identification Code" UIC is included.

The number of encoded message items in each message is three (I=3) as for example:

- `UC1,  UIC, UC2`

To decode the information, the target simulator has to receive information from all three message items. The following optical codes are used:

- Umpire Identification Code UIC
- Umpire Command Code UC1, UC2
- Player Identity Code IC4a, IC4b, IC5a, IC5b

Messages from an umpire control-gun consist of three message items. To accept the information, the target simulator has to receive information from all three message items.

A minimum complete Umpire Command message contains:

- UC1, UIC, UC2

The umpire command message can if required be followed by an Umpire Identity message containing:

- IC4a, UIC, IC5a
- IC4b, UIC, IC5a
- IC5b, UIC, IC4a
- IC5b, UIC, IC4b

4.7.1.1. **Additional Code Structure**

The simulator systems using Umpire Control-Gun Code shall consider the following additional conditions when encoding and decoding pulse intervals:

- The Umpire Control-Gun Code is only using non-alternating pulse intervals.
- The number of different transmitted message items (I) in a message are three
  `I=3`
- The code is transmitted using a block structure. Each block consists of three message items. The blocks are transmitted as:
  `E*UC1, E*UIC and E*UC2`
  An additional identity sequence can be transmitted as for example:
  `E*IC4a, E*UIC and E*IC5a`
  where E is the number of elements for each message item and
  E=5

Block transmission illustration where identity is not transmitted is illustrated below:

Table 65 Umpire Control-Gun Code, Timing Illustration

Block	I_1					Delay	I_2					Delay	I_3					Delay
	E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5	
1	UC1	UC1	UC1	UC1	UC1	t1	UIC	UIC	UIC	UIC	UIC	t2	UC2	UC2	UC2	UC2	UC2	t4
2	UC1	UC1	UC1	UC1	UC1	t1	UIC	UIC	UIC	UIC	UIC	t2	UC2	UC2	UC2	UC2	UC2	t4
N	UC1	UC1	UC1	UC1	UC1	t1	UIC	UIC	UIC	UIC	UIC	t2	UC2	UC2	UC2	UC2	UC2	t4

The transmitted time delays are specified as follows:

Table 66 Umpire Control-Gun Code, Time Delays

t1	t2	t4
ms	ms	ms
<30	< 30	50 < t4 < 1000

The time between UC1 and UIC shall also be the same as the time between UC2 and UIC within a tolerance of ±5ms.

$$t1 - 5ms \le t2 \le t1 + 5ms$$

Block transmission illustration when Player Identity is transmitted is illustrated below:

Table 67 Umpire Control-Gun Code, Timing when Player Identity Code is included

Bloc	I_1					Delay	I_2					Delay	I_3					Delay
	E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5	
1	UC1	UC1	UC1	UC1	UC1	t1	UIC	UIC	UIC	UIC	UIC	t2	UC2	UC2	UC2	UC2	UC2	t3
2	IC4a	IC4a	IC4a	IC4a	IC4a	t1	UIC	UIC	UIC	UIC	UIC	t2	IC5a	IC5a	IC5a	IC5a	IC5a	t4
3	UC1	UC1	UC1	UC1	UC1	t1	UIC	UIC	UIC	UIC	UIC	t2	UC2	UC2	UC2	UC2	UC2	t3
4	IC4a	IC4a	IC4a	IC4a	IC4a	t1	UIC	UIC	UIC	UIC	UIC	t2	IC5a	IC5a	IC5a	IC5a	IC5a	t4

The transmitted time delays when transmitting "Player Identity" are specified as follows:

Table 68 Umpire Control-Gun Code, Time Delays when Transmitting Player ID

t1	t2	t3	t4
ms	ms	ms	ms
0	0	4.5 < t3 < 5.5	50 < t4 < 1000

The time to transmit each item (UC1, UIC, UC2, IC4a, IC4b, IC5a and IC5b) is defined as:

$0.08\text{ms} \leq t5 < 0.16\text{ms}$

To achieve easy long distance use of the Umpire Control-Gun without requiring any steady aiming, long transmission times up to one second are allowed. A complete transmission containing N blocks (N=4 in the above table example) shall take less than one second. When N is an even integer it can be described as below:

```
N*(t1 + t2 + t3/2 + t4/2 + E*3*t5) < 1s
```

4.7.1.2. Umpire Identification Code

The "Umpire Identification Code" (UIC) is used to identify the information as coming from an umpire control-gun.

The UIC encoding and decoding is defined as follows:

Table 69 Umpire Control-Gun Code, Umpire Identification Code Encoding and Decoding

<table>
<tr><th>UIC
Encoded</th><th>UIC
Decoded</th><th>PI
PIU</th></tr>
<tr><td>not allowed</td><td rowspan="3">1</td><td>2359</td></tr>
<tr><td>1</td><td>2360</td></tr>
<tr><td>not allowed</td><td>2361</td></tr>
<tr><td>not allowed</td><td rowspan="3">2</td><td>2362</td></tr>
<tr><td>2</td><td>2363</td></tr>
<tr><td>not allowed</td><td>2364</td></tr>
<tr><td>not allowed</td><td rowspan="3">3</td><td>2365</td></tr>
<tr><td>3</td><td>2366</td></tr>
<tr><td>not allowed</td><td>2367</td></tr>
</table>

The Umpire Code Types are defined as follows:

Table 70 Umpire Control-Gun Code, Umpire Code Types

UIC	Umpire Code Type	Umpire Code Type Description	Comment
1	UCG	Umpire Control-Gun	Umpire and Observer/Controller
2	*UFG*	*Umpire Future Growth*	*Reserved for future growth*
3	UMF	Umpire Minefield	Defining a mine field area

Note. Optical code UFG written in *italic* is reserved for future growth.

The Umpire Code Types are encoded and decoded from the "Umpire Identification Code" and the "Umpire Command Codes" as defined in the following chapters.

4.7.1.3. **Umpire Command Code**

The "Umpire Command Codes" (UC1, UC2) are sent in the following order:
UC1, UIC, UC2

The "Umpire Command Code" (UC1, UC2) is encoded and decoded as follows:

Encoding: [PI1 and PI2 measured in PIU]

```
PI1 = 1910 + (3*UC1)          1 ≤ UC1 ≤ 64
PI2 = 2106 + (3*UC2)          1 ≤ UC2 ≤ 64
```

Decoding: [UC1 and UC2 are integers]

```
UC1 = INT((PI1 - 1909)/3)     1912 ≤ PI1 ≤ 2103
UC2 = INT((PI2 - 2105)/3)     2108 ≤ PI2 ≤ 2299
```

The "Umpire Command Number" (UCN) is encoded and decoded from UIC, UC1 and UC2. Valid UCN's are:

Table 71 Umpire Control-Gun Code, Umpire Command Code Numbering

Valid Umpire Command Numbers	UIC	Umpire Code Type	Umpire Code Type Description
1 ≤ UCN ≤ 64	1	UCG	Umpire Control-Gun
101 ≤ UCN ≤ 110	3	UMF	Umpire Minefield Area

The "Umpire Command Numbers" (UCN) can be used when reporting to for example to the Exercise Control Centre.

The use of UC1 and UC2 for UCN encoding is illustrated as below.

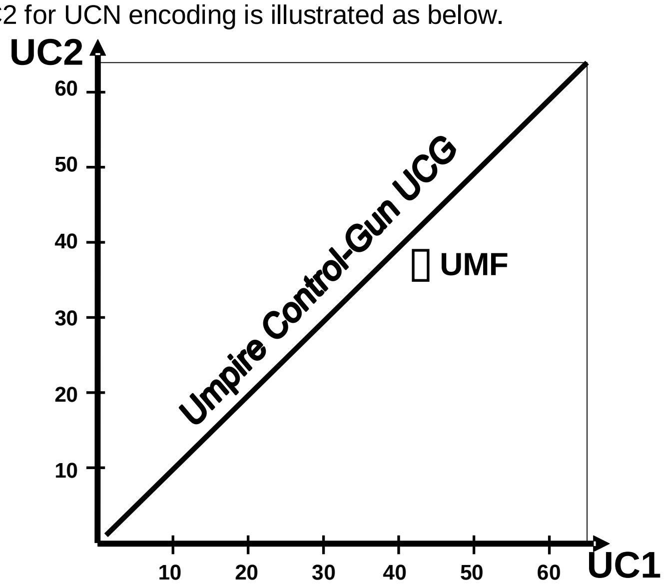

Figure 23 Umpire Control-Gun Code, Umpire Command Numbers (UCN) Encoding Illustration

See Appendix A at the end of this document for decoding and encoding "Umpire Command Number" (UCN).

4.7.2 Geographical Reference Code

An optical transmitter (Room Association Device, RAD) may for example be installed inside a building, sending a reference command number that is related by the target simulators to a geographical position, as part of the indoor positioning system.

The Geographical Reference Code has similar code structure as defined by the "Short-Time Code" and the Umpire Control-Gun Code.

The Geographical Reference Code is identified by the decoder when the "Geographical Identification Code" GIC is included.

The number of encoded message items is three (I=3):

- GC1, GIC, GC2

To decode the information, the target simulator has to receive information from all three message items.

The following optical codes are used:

- Geographical Identification Code GIC
- Geographical Command Code GC1, GC2

4.7.2.1. **Additional Code Structure**

The simulators using Geographical Reference Code shall consider the following additional conditions when encoding and decoding pulse intervals:

- The Geographical Reference Code applies only non-alternating pulse intervals.
- The number of different transmitted message items (I) are three (GC1, GIC, GC2)
  `I=3`
- The code is transmitted using a block structure. Each block consists of three message items. The blocks are transmitted as:
  `E*GC1, E*GIC and E*GC2`
  where E is the number of elements for each item and
  E=3

Block transmission illustration:

Table 72 Geographical Reference Code, Timing Illustration

Block	I_1			Delay	I_2			Delay	I_3			Delay
	E_1	E_2	E_3		E_1	E_2	E_3		E_1	E_2	E_3	
1	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t2
2	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t3
3	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t2
4	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t3

The transmitted time delays are specified as follows:

Table 73 Geographical Reference Code, Time Delays

t1	t2	t3
ms	**ms**	**ms**
t1=0	0 ≤ t2 < 0.08 or 0.32 ≤ t2 ≤ t3	t3 ≥ 100

When used against man worn simulators t3 ≥ 500ms is recommended.

4.7.2.2. Geographical Identification Code

The "Geographical Identification Code" (GIC) is used to identify that the optical information contains a reference number to a geographical position on the exercise area.

The GIC encoding and decoding is done as follows:

Encoding: [PI is an integer measured in PIU]

```
PI = 2369             GIC = 1
```

Decoding: [GIC is an integer]

```
GIC = 1               2368 ≤ PI ≤ 2370
```

4.7.2.3. Geographical Command Code

The "Geographical Command Codes" (GC1, GC2) are encoded from and decoded to the "Geographical Command Number" (GCN) referencing to a geographical position on the exercise area.

The "Geographical Command Codes" (GC1, GC2) are sent in the following order:

GC1, GIC, GC2

The "Geographical Command Number" (GCN) is encoded and decoded as follows:

Encoding: [GC1, GC2 and GCN are integers]

```
GC2 = 1 + INT((GCN-1)/64)      1 ≤ GCN ≤ 4096
GC1 = 1 + INT((GCN-1)%64)      1 ≤ GCN ≤ 4096
PI1 = 1910 + (3*GC1)           1 ≤ GC1 ≤ 64
PI2 = 2106 + (3*GC2)           1 ≤ GC2 ≤ 64
```

Decoding: [PI1 and PI2 is an integer measured in PIU]

```
GC1 = INT((PI1 - 1909)/3)      1912 ≤ PI1 ≤ 2103
GC2 = INT((PI2 - 2105)/3)      2108 ≤ PI2 ≤ 2299
GCN = GC1 + (64*(GC2-1))       1 ≤ GC1 ≤ 64, 1 ≤ GC2 ≤ 64
```

Encoding examples:

Table 74 Geographical Reference Code, Command Code, Encoding Examples

GCN	GC1	GC2	PI1	PI2
1	1	1	1913	2109
1234	18	20	1964	2166
4096	64	64	2102	2298

4.7.3 Player Association Code

An optical transmitter (Infrared Beacon Unit, IBU) may be installed inside for example a vehicle. The "Player Association Code" (PAC) is used to inform a man worn target simulator that it should try to associate itself to a vehicle or another kind of player. Geographical position and engagements related to the player may then also be associated to the man worn associated simulator.

The "Player Association Code" (PAC) is transmitted using a block structure as:

- Each block consists of one message item (I=1). The blocks are transmitted as:
  `E*PAC`
  where E is the number of elements for the item and
  E=3

The pulse intervals can be understood as constructed by using a 31,25kHz clock. The transmitted nominal pulse interval is then 480PIU. The PAC is encoded and decoded as follows:

Encoding: [PI1 is an integer measured in PIU]

`PI1 = 480 nominally`

`475 ≤ PI1 ≤ 485` `PAC = 1`

Decoding: [PAC is an integer]

`PAC = 1` `470 ≤ PI1 ≤ 490`

It is important to note that the PAC pulse interval is, together with Null Code NC4 (see section "4.2.4 Common Decoding Characteristics"), the only allowed intervals between 0-1200 PIU and PAC is used during certain circumstances and only for association purposes. Carefully implemented, PAC shall not have any substantial impact on the decoder built in error detection and correction capability. 3*(470-490) = 1410-1470PIU and a single pulse interval within 1200-2399PIU is not a minimum decodable item.

Block transmission illustration:

Table 75 Player Association Code, Timing Illustration

Block	I_1			Delay
	E_1	E_2	E_3	
1	PAC	PAC	PAC	t1
2	PAC	PAC	PAC	t2
3	PAC	PAC	PAC	t1
4	PAC	PAC	PAC	t2

The timing values are specified as follows:

Table 76 Player Association Code, Timing Values

t1	t2	t3
s	s	s
$0.32 \le t1 \le t2$	$1 \le t2 \le 5$	$10 \le t3 \le 20$

Decoding of association can be done in the following way:

- At least two of three consecutive PAC elements in each block and two blocks within t3 seconds build a minimum decodable association event.
- Disassociation is done when blocks are not received within t3 seconds.

Appendix A: Umpire Control-Gun Tables (Normative)

There are two "Umpire Command Number" Types tabled separately.

- Umpire Control-Gun
- Umpire Minefield

The "Umpire Command Number" (UCN) is encoded from the "Umpire Identification Code" (UIC) and the "Umpire Command Codes" (UC1 and UC2).

Umpire Control-Gun

The exercise area umpire, observer/controller or other personnel may have an umpire control-gun transmitter to perform actions on players on the exercise area.

UIC=1 corresponding to 2360 PIU and UCN = UC1 = UC2.

Umpire Control-Gun commands are interpreted or neglected as indicated by the text marks in the columns representing the following simulator system types:

- Man Worn. Typically a solider with man worn target system
- Vehicle. Typically a vehicle like a tank or an armored personnel carrier with a weapon system

There are two Umpire Control-Gun command categories.

- P – Player Control: Changes the tactical status of the simulator system
- C – Configuration Control: Supervises the simulator configuration or functionality

The "Umpire Command Numbers" (UCN) are encoded as follows:

Table 77 Umpire Control-Gun Code, Encoding Tables

UCN	PI1	PI2	Man worn	Vehicle*	Category	Comments
	PIU	PIU				
1	1913	2109	X	X	C	Test
2	1916	2112	X	X	P	Kill
3	*1919*	*2115*	*X*	*X*	*P*	*Wounded / Damaged medium.* *National unique for the German Army. Not to be used.*
4	1922	2118	X	X	P	Reset. Default ammo quantity given. Clean from contamination
5	1925	2121		X	P	Weapon kill , where the result is a firepower kill applied only to secondary weapons for example: • Remote weapon station damage but not destroy • Main weapon only: Weapon or missile destroy • Main and secondary weapon: Secondary weapon destroy • Tank: Run out of ammo storage
6	1928	2124		X	P	Hit no effect
7	1931	2127		X	P	Weapon kill visual, where the result is firepower kill of the primary weapon for example: • Remote weapon station destroy • Main weapon only: Weapon or missile destroy • Main and secondary weapon: Main weapon destroy • Tank: Main weapon destroy
8	1934	2130	X		P	Medical treatment activated. Wound stable

UCN	PI1	PI2	Man worn	Vehicle*	Category	Comments
	PIU	PIU				
9	1937	2133	X	X	P	Tampering kill/destroy
10	*1940*	*2136*	*X*		*C*	*Configuration with helmet (man worn target).* *National unique for the German Army. Not to be used*
11	1943	2139		X	P	Mobility kill
12	1946	2142		X	P	Mobility kill visual
13	1949	2145	X	X	P	Exercise pause. All simulator functionality is disabled. Reset or Reactivate leaves this mode.
14	1952	2148	*X*		*P*	*Wounded slightly. Wounded but can still walk* *National unique for the German Army. Not to be used*
				X	P	Radio communication destroy
15	*1955*	*2151*	*X*	*X*	*P*	*Wounded seriously / Heavy damage.* *National unique for the German Army. Not to be used*
16	*1958*	*2154*	*X*		*C*	*Configuration without helmet (man worn target)* *National unique for the German Army. Not to be used*
17	1961	2157	X		C	*Configuration* with ballistic protective vest on (man worn target).*National unique and not to be used*
18	1964	2160	X	X	P	Reactivate. Remaining ammo quantity given
19	1967	2163	X	X	P	Near miss. Target is under fire without being hit
20	1970	2166	X	X	P	Dug in set. Resulting in increased level of protection.
21	1973	2169	X	X	P	Dug in reset. The target system shall not any longer have the increased level of protection.
22	1976	2172	X		P	Wounded but can still walk
23	1979	2175	X		P	Wounded shall sit or lie down
24	1982	2178	X		P	Wounded shall lie down
25	1985	2181	X		P	Wounded
26	1988	2184	X		P	Medical reset. Healed by medical treatment and ready for combat. Remaining ammo quantity given. Clean from contamination.
27	1991	2187		X	P	Turret stabilization destroy
28	1994	2190		X	C	Selection (toggle) of target simulator characteristics like target application type, protection level and vulnerability level
29	1997	2193		X	P	Sight destroy
30	2000	2196	X	X	P	Contaminate, e.g., nuclear, biological or chemical
31	2003	2199	X	X	P	Clean from contamination
32	2006	2202	X		P	Prisoner Set
33	2009	2205	X		P	Prisoner Reset
34	2012	2208				Spare
35	2015	2211				Spare
36	2018	2214				Spare
37	2021	2217				Spare
38	2024	2220				Spare
39	2027	2223				Spare
40	2030	2226	X	X	C	Log buffer reset; clear event log
41	2033	2229	X	X	P	Time mark / book mark in the event log

UCN	PI1	PI2	Man worn	Vehicle*	Category	Comments
	PIU	PIU				
42	2036	2232	X	X	C	Controller access. In case locked simulator functionally can be unlocked for controller access.
43	2039	2235	X	X	P	Target lifter down
44	2042	2238	X	X	P	Target lifter up
45	2045	2241	X	X	C	**Stand by**. Power save mode. The Reset commands are then used to leave this power saving mode.
46	2048	2244	X	X		Emergency stop
47	2051	2247	X		C	**Non-active Mode**. Truce mode. The man worn system cannot fire simulated weapons and is unaffected by simulated weapon engagements. Can be used on man worn systems, e.g., worn by observers and spectators instrumented for tracking but not vulnerable to engagements.
48	2054	2250	X		C	Ballistic protective vest on
49	2057	2253	X		C	Ballistic protective vest off
50	2060	2256	X	X	C	**Simulation Mode:** Blue Force Tracking (simulator configuration)
51	2063	2259	X	X	C	**Simulation Mode:** Exercise Mode (simulator configuration)
52	2066	2262	X	X	C	Reserved**: Player Identity Code Mode:** Regular Player Identity
53	2069	2265	X	X	C	Reserved**: Player Identity Code Mode:** Joint Exercise Player Identity, assigning to a different Player Identity
54	2072	2268	X	X	C	Reserved**: Player Identity Code Mode:** Joint Exercise System Identity
55	2075	2271				Reserved
56	2078	2274				Reserved
57	2081	2277				Reserved
58	2084	2280				Reserved
59	2087	2283			P	NBC Protection on
60	2090	2286			P	NBC Protection off
61	2093	2289				Spare
62	2096	2292				Spare
63	2099	2295				Spare
64	2102	2298				Spare

*NOTE 1-Umpire commands shall only be implemented on vehicle target simulators where the command characteristics are applicable (i.e., that the target simulator vehicle has weapon(s), sight(s), etc.).

Umpire Minefield Area

The Umpire Minefield Code Type is used to define a minefield area using an umpire control-gun. Umpire Command Numbers (UCN's) are encoded as follows:

Table 78 Umpire Control-Gun Code, Umpire Minefield Area Encoding Tables

UCN	UC1	UC2	PI1	UIC=3	PI2	Comments
			PIU	PIU	PIU	
101	41	34	2033	2366	2208	Clear all minefield area corners
102	41	35	2033	2366	2211	Finished. All corners are positioned and the minefield area is ready
103	41	36	2033	2366	2214	Minefield area position report from corner 1
104	41	37	2033	2366	2217	Minefield area position report from corner 2
105	41	38	2033	2366	2220	Minefield area position report from corner 3
106	42	34	2036	2366	2208	Minefield area position report from corner 4
107	42	35	2036	2366	2211	Minefield area position report from corner 5
108	42	36	2036	2366	2214	Minefield area position report from corner 6
109	42	37	2036	2366	2217	Minefield area position report from corner 7
110	42	38	2036	2366	2220	Minefield area position report from corner 8

Appendix B: Position Code Decoding Table (Informative)

Table 79 Real-Time Code, Position Code Decoding Table

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
2008	2204	0	0,00
2007	2203	1	0,10
2006	2202	2	0,20
2005	2201	3	0,30
2004	2200	4	0,40
2003	2199	5	0,50
2002	2198	6	0,60
2001	2197	7	0,70
2000	2196	8	0,80
1999	2195	9	0,90
1998	2194	10	1,00
1997	2193	11	1,10
1996	2192	12	1,20
1995	2191	13	1,30
1994	2190	14	1,40
1993	2189	15	1,50
1992	2188	16	1,60
1991	2187	17	1,70
1990	2186	18	1,80
1989	2185	19	1,90
1988	2184	20	2,00
1987	2183	21	2,10
1986	2182	22	2,20
1985	2181	23	2,30
1984	2180	24	2,40
1983	2179	25	2,50
1982	2178	26	2,60
1981	2177	27	2,70
1980	2176	28	2,80
1979	2175	29	2,91
1978	2174	30	3,02
1977	2173	31	3,13
1976	2172	32	3,25
1975	2171	33	3,37
1974	2170	34	3,49
1973	2169	35	3,62
1972	2168	36	3,76
1971	2167	37	3,90
1970	2166	38	4,05
1969	2165	39	4,20
1968	2164	40	4,36
1967	2163	41	4,52
1966	2162	42	4,69
1965	2161	43	4,86
1964	2160	44	5,05
1963	2159	45	5,24
1962	2158	46	5,43

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
2008	2204	0	0,00
2009	2205	-1	-0,10
2010	2206	-2	-0,20
2011	2207	-3	-0,30
2012	2208	-4	-0,40
2013	2209	-5	-0,50
2014	2210	-6	-0,60
2015	2211	-7	-0,70
2016	2212	-8	-0,80
2017	2213	-9	-0,90
2018	2214	-10	-1,00
2019	2215	-11	-1,10
2020	2216	-12	-1,20
2021	2217	-13	-1,30
2022	2218	-14	-1,40
2023	2219	-15	-1,50
2024	2220	-16	-1,60
2025	2221	-17	-1,70
2026	2222	-18	-1,80
2027	2223	-19	-1,90
2028	2224	-20	-2,00
2029	2225	-21	-2,10
2030	2226	-22	-2,20
2031	2227	-23	-2,30
2032	2228	-24	-2,40
2033	2229	-25	-2,50
2034	2230	-26	-2,60
2035	2231	-27	-2,70
2036	2232	-28	-2,80
2037	2233	-29	-2,91
2038	2234	-30	-3,02
2039	2235	-31	-3,13
2040	2236	-32	-3,25
2041	2237	-33	-3,37
2042	2238	-34	-3,49
2043	2239	-35	-3,62
2044	2240	-36	-3,76
2045	2241	-37	-3,90
2046	2242	-38	-4,05
2047	2243	-39	-4,20
2048	2244	-40	-4,36
2049	2245	-41	-4,52
2050	2246	-42	-4,69
2051	2247	-43	-4,86
2052	2248	-44	-5,05
2053	2249	-45	-5,24
2054	2250	-46	-5,43

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
1961	2157	47	5,64
1960	2156	48	5,85
1959	2155	49	6,07
1958	2154	50	6,29
1957	2153	51	6,53
1956	2152	52	6,77
1955	2151	53	7,03
1954	2150	54	7,29
1953	2149	55	7,56
1952	2148	56	7,85
1951	2147	57	8,14
1950	2146	58	8,45
1949	2145	59	8,76
1948	2144	60	9,09
1947	2143	61	9,43
1946	2142	62	9,79
1945	2141	63	10,15
1944	2140	64	10,53
1943	2139	65	10,93
1942	2138	66	11,34
1941	2137	67	11,76
1940	2136	68	12,20
1939	2135	69	12,66
1938	2134	70	13,13
1937	2133	71	13,63
1936	2132	72	14,14
1935	2131	73	14,67
1934	2130	74	15,22
1933	2129	75	15,79
1932	2128	76	16,38
1931	2127	77	16,99
1930	2126	78	17,63
1929	2125	79	18,29
1928	2124	80	18,97
1927	2123	81	19,68
1926	2122	82	20,42
1925	2121	83	21,19
1924	2120	84	21,98
1923	2119	85	22,80
1922	2118	86	23,66
1921	2117	87	24,55
1920	2116	88	25,47
1919	2115	89	26,42
1918	2114	90	27,41
1917	2113	91	28,44
1916	2112	92	29,50
1915	2111	93	30,61
1914	2110	94	31,76
1913	2109	95	32,95
1912	2108	96	34,18
1911	2107	97	35,46

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
2055	2251	-47	-5,64
2056	2252	-48	-5,85
2057	2253	-49	-6,07
2058	2254	-50	-6,29
2059	2255	-51	-6,53
2060	2256	-52	-6,77
2061	2257	-53	-7,03
2062	2258	-54	-7,29
2063	2259	-55	-7,56
2064	2260	-56	-7,85
2065	2261	-57	-8,14
2066	2262	-58	-8,45
2067	2263	-59	-8,76
2068	2264	-60	-9,09
2069	2265	-61	-9,43
2070	2266	-62	-9,79
2071	2267	-63	-10,15
2072	2268	-64	-10,53
2073	2269	-65	-10,93
2074	2270	-66	-11,34
2075	2271	-67	-11,76
2076	2272	-68	-12,20
2077	2273	-69	-12,66
2078	2274	-70	-13,13
2079	2275	-71	-13,63
2080	2276	-72	-14,14
2081	2277	-73	-14,67
2082	2278	-74	-15,22
2083	2279	-75	-15,79
2084	2280	-76	-16,38
2085	2281	-77	-16,99
2086	2282	-78	-17,63
2087	2283	-79	-18,29
2088	2284	-80	-18,97
2089	2285	-81	-19,68
2090	2286	-82	-20,42
2091	2287	-83	-21,19
2092	2288	-84	-21,98
2093	2289	-85	-22,80
2094	2290	-86	-23,66
2095	2291	-87	-24,55
2096	2292	-88	-25,47
2097	2293	-89	-26,42
2098	2294	-90	-27,41
2099	2295	-91	-28,44
2100	2296	-92	-29,50
2101	2297	-93	-30,61
2102	2298	-94	-31,76
2103	2299	-95	-32,95
2104	2300	-96	-34,18
2105	2301	-97	-35,46

Appendix C: Position Code Encoding Table (Informative)

This is an example of the "positive part" of a position encoding table where the selected resolution is equal to 4cm. The encoder shall consider how the 4cm resolution is achieved before using the below encoding table. For example an incorrect rounding may induce a 2cm table error resulting in a statistical almost 3cm position vector error.

Table 80 Real-Time Code, Position Code Encoding Table

P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m
0	0,00	27	2,72	47	5,72	59	8,72	67	11,72	73	14,72	78	17,72	82	20,72	86	23,72	89	26,72	92	29,72	95	32,72
0	0,04	28	2,76	48	5,76	59	8,76	67	11,76	73	14,76	78	17,76	82	20,76	86	23,76	89	26,76	92	29,76	95	32,76
1	0,08	28	2,80	48	5,80	59	8,80	67	11,80	73	14,80	78	17,80	82	20,80	86	23,80	89	26,80	92	29,80	95	32,80
1	0,12	28	2,84	48	5,84	59	8,84	67	11,84	73	14,84	78	17,84	83	20,84	86	23,84	89	26,84	92	29,84	95	32,84
2	0,16	29	2,88	48	5,88	59	8,88	67	11,88	73	14,88	78	17,88	83	20,88	86	23,88	89	26,88	92	29,88	95	32,88
2	0,20	29	2,92	48	5,92	59	8,92	67	11,92	73	14,92	78	17,92	83	20,92	86	23,92	90	26,92	92	29,92	95	32,92
2	0,24	29	2,96	49	5,96	60	8,96	67	11,96	74	14,96	79	17,96	83	20,96	86	23,96	90	26,96	92	29,96	95	32,96
3	0,28	30	3,00	49	6,00	60	9,00	68	12,00	74	15,00	79	18,00	83	21,00	86	24,00	90	27,00	92	30,00	95	33,00
3	0,32	30	3,04	49	6,04	60	9,04	68	12,04	74	15,04	79	18,04	83	21,04	86	24,04	90	27,04	92	30,04	95	33,04
4	0,36	31	3,08	49	6,08	60	9,08	68	12,08	74	15,08	79	18,08	83	21,08	86	24,08	90	27,08	93	30,08	95	33,08
4	0,40	31	3,12	49	6,12	60	9,12	68	12,12	74	15,12	79	18,12	83	21,12	87	24,12	90	27,12	93	30,12	95	33,12
4	0,44	31	3,16	49	6,16	60	9,16	68	12,16	74	15,16	79	18,16	83	21,16	87	24,16	90	27,16	93	30,16	95	33,16
5	0,48	32	3,20	50	6,20	60	9,20	68	12,20	74	15,20	79	18,20	83	21,20	87	24,20	90	27,20	93	30,20	95	33,20
5	0,52	32	3,24	50	6,24	60	9,24	68	12,24	74	15,24	79	18,24	83	21,24	87	24,24	90	27,24	93	30,24	95	33,24
6	0,56	32	3,28	50	6,28	61	9,28	68	12,28	74	15,28	79	18,28	83	21,28	87	24,28	90	27,28	93	30,28	95	33,28
6	0,60	33	3,32	50	6,32	61	9,32	68	12,32	74	15,32	79	18,32	83	21,32	87	24,32	90	27,32	93	30,32	95	33,32
6	0,64	33	3,36	50	6,36	61	9,36	68	12,36	74	15,36	79	18,36	83	21,36	87	24,36	90	27,36	93	30,36	95	33,36
7	0,68	33	3,40	50	6,40	61	9,40	68	12,40	74	15,40	79	18,40	83	21,40	87	24,40	90	27,40	93	30,40	95	33,40
7	0,72	34	3,44	51	6,44	61	9,44	69	12,44	74	15,44	79	18,44	83	21,44	87	24,44	90	27,44	93	30,44	95	33,44
8	0,76	34	3,48	51	6,48	61	9,48	69	12,48	74	15,48	79	18,48	83	21,48	87	24,48	90	27,48	93	30,48	95	33,48
8	0,80	34	3,52	51	6,52	61	9,52	69	12,52	75	15,52	79	18,52	83	21,52	87	24,52	90	27,52	93	30,52	95	33,52
8	0,84	35	3,56	51	6,56	61	9,56	69	12,56	75	15,56	79	18,56	83	21,56	87	24,56	90	27,56	93	30,56	96	33,56
9	0,88	35	3,60	51	6,60	61	9,60	69	12,60	75	15,60	79	18,60	84	21,60	87	24,60	90	27,60	93	30,60	96	33,60
9	0,92	35	3,64	51	6,64	62	9,64	69	12,64	75	15,64	80	18,64	84	21,64	87	24,64	90	27,64	93	30,64	96	33,64
10	0,96	35	3,68	52	6,68	62	9,68	69	12,68	75	15,68	80	18,68	84	21,68	87	24,68	90	27,68	93	30,68	96	33,68
10	1,00	36	3,72	52	6,72	62	9,72	69	12,72	75	15,72	80	18,72	84	21,72	87	24,72	90	27,72	93	30,72	96	33,72
10	1,04	36	3,76	52	6,76	62	9,76	69	12,76	75	15,76	80	18,76	84	21,76	87	24,76	90	27,76	93	30,76	96	33,76
11	1,08	36	3,80	52	6,80	62	9,80	69	12,80	75	15,80	80	18,80	84	21,80	87	24,80	90	27,80	93	30,80	96	33,80
11	1,12	37	3,84	52	6,84	62	9,84	69	12,84	75	15,84	80	18,84	84	21,84	87	24,84	90	27,84	93	30,84	96	33,84
12	1,16	37	3,88	52	6,88	62	9,88	69	12,88	75	15,88	80	18,88	84	21,88	87	24,88	90	27,88	93	30,88	96	33,88
12	1,20	37	3,92	53	6,92	62	9,92	70	12,92	75	15,92	80	18,92	84	21,92	87	24,92	91	27,92	93	30,92	96	33,92
12	1,24	37	3,96	53	6,96	62	9,96	70	12,96	75	15,96	80	18,96	84	21,96	87	24,96	91	27,96	93	30,96	96	33,96
13	1,28	38	4,00	53	7,00	63	10,00	70	13,00	75	16,00	80	19,00	84	22,00	87	25,00	91	28,00	93	31,00	96	34,00
13	1,32	38	4,04	53	7,04	63	10,04	70	13,04	75	16,04	80	19,04	84	22,04	88	25,04	91	28,04	93	31,04	96	34,04
14	1,36	38	4,08	53	7,08	63	10,08	70	13,08	76	16,08	80	19,08	84	22,08	88	25,08	91	28,08	93	31,08	96	34,08

P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m	P I U	m
14	1,40	38	4,12	53	7,12	63	10,12	70	13,12	76	16,12	80	19,12	84	22,12	88	25,12	91	28,12	93	31,12	96	34,12
14	1,44	39	4,16	54	7,16	63	10,16	70	13,16	76	16,16	80	19,16	84	22,16	88	25,16	91	28,16	93	31,16	96	34,16
15	1,48	39	4,20	54	7,20	63	10,20	70	13,20	76	16,20	80	19,20	84	22,20	88	25,20	91	28,20	94	31,20	96	34,20
15	1,52	39	4,24	54	7,24	63	10,24	70	13,24	76	16,24	80	19,24	84	22,24	88	25,24	91	28,24	94	31,24	96	34,24
16	1,56	40	4,28	54	7,28	63	10,28	70	13,28	76	16,28	80	19,28	84	22,28	88	25,28	91	28,28	94	31,28	96	34,28
16	1,60	40	4,32	54	7,32	63	10,32	70	13,32	76	16,32	80	19,32	84	22,32	88	25,32	91	28,32	94	31,32	96	34,32
16	1,64	40	4,36	54	7,36	64	10,36	70	13,36	76	16,36	81	19,36	84	22,36	88	25,36	91	28,36	94	31,36	96	34,36
17	1,68	40	4,40	54	7,40	64	10,40	71	13,40	76	16,40	81	19,40	85	22,40	88	25,40	91	28,40	94	31,40	96	34,40
17	1,72	41	4,44	55	7,44	64	10,44	71	13,44	76	16,44	81	19,44	85	22,44	88	25,44	91	28,44	94	31,44	96	34,44
18	1,76	41	4,48	55	7,48	64	10,48	71	13,48	76	16,48	81	19,48	85	22,48	88	25,48	91	28,48	94	31,48	96	34,48
18	1,80	41	4,52	55	7,52	64	10,52	71	13,52	76	16,52	81	19,52	85	22,52	88	25,52	91	28,52	94	31,52	96	34,52
18	1,84	41	4,56	55	7,56	64	10,56	71	13,56	76	16,56	81	19,56	85	22,56	88	25,56	91	28,56	94	31,56	96	34,56
19	1,88	41	4,60	55	7,60	64	10,60	71	13,60	76	16,60	81	19,60	85	22,60	88	25,60	91	28,60	94	31,60	96	34,60
19	1,92	42	4,64	55	7,64	64	10,64	71	13,64	76	16,64	81	19,64	85	22,64	88	25,64	91	28,64	94	31,64	96	34,64
20	1,96	42	4,68	55	7,68	64	10,68	71	13,68	76	16,68	81	19,68	85	22,68	88	25,68	91	28,68	94	31,68	96	34,68
20	2,00	42	4,72	56	7,72	64	10,72	71	13,72	77	16,72	81	19,72	85	22,72	88	25,72	91	28,72	94	31,72	96	34,72
20	2,04	42	4,76	56	7,76	65	10,76	71	13,76	77	16,76	81	19,76	85	22,76	88	25,76	91	28,76	94	31,76	96	34,76
21	2,08	43	4,80	56	7,80	65	10,80	71	13,80	77	16,80	81	19,80	85	22,80	88	25,80	91	28,80	94	31,80	96	34,80
21	2,12	43	4,84	56	7,84	65	10,84	71	13,84	77	16,84	81	19,84	85	22,84	88	25,84	91	28,84	94	31,84		
22	2,16	43	4,88	56	7,88	65	10,88	72	13,88	77	16,88	81	19,88	85	22,88	88	25,88	91	28,88	94	31,88		
22	2,20	43	4,92	56	7,92	65	10,92	72	13,92	77	16,92	81	19,92	85	22,92	88	25,92	91	28,92	94	31,92		
22	2,24	44	4,96	56	7,96	65	10,96	72	13,96	77	16,96	81	19,96	85	22,96	89	25,96	91	28,96	94	31,96		
23	2,28	44	5,00	57	8,00	65	11,00	72	14,00	77	17,00	81	20,00	85	23,00	89	26,00	92	29,00	94	32,00		
23	2,32	44	5,04	57	8,04	65	11,04	72	14,04	77	17,04	81	20,04	85	23,04	89	26,04	92	29,04	94	32,04		
24	2,36	44	5,08	57	8,08	65	11,08	72	14,08	77	17,08	82	20,08	85	23,08	89	26,08	92	29,08	94	32,08		
24	2,40	44	5,12	57	8,12	65	11,12	72	14,12	77	17,12	82	20,12	85	23,12	89	26,12	92	29,12	94	32,12		
24	2,44	45	5,16	57	8,16	66	11,16	72	14,16	77	17,16	82	20,16	85	23,16	89	26,16	92	29,16	94	32,16		
25	2,48	45	5,20	57	8,20	66	11,20	72	14,20	77	17,20	82	20,20	85	23,20	89	26,20	92	29,20	94	32,20		
25	2,52	45	5,24	57	8,24	66	11,24	72	14,24	77	17,24	82	20,24	86	23,24	89	26,24	92	29,24	94	32,24		
26	2,56	45	5,28	57	8,28	66	11,28	72	14,28	77	17,28	82	20,28	86	23,28	89	26,28	92	29,28	94	32,28		
26	2,60	45	5,32	58	8,32	66	11,32	72	14,32	78	17,32	82	20,32	86	23,32	89	26,32	92	29,32	94	32,32		
26	2,64	46	5,36	58	8,36	66	11,36	72	14,36	78	17,36	82	20,36	86	23,36	89	26,36	92	29,36	95	32,36		
27	2,68	46	5,40	58	8,40	66	11,40	73	14,40	78	17,40	82	20,40	86	23,40	89	26,40	92	29,40	95	32,40		
		46	5,44	58	8,44	66	11,44	73	14,44	78	17,44	82	20,44	86	23,44	89	26,44	92	29,44	95	32,44		
		46	5,48	58	8,48	66	11,48	73	14,48	78	17,48	82	20,48	86	23,48	89	26,48	92	29,48	95	32,48		
		46	5,52	58	8,52	66	11,52	73	14,52	78	17,52	82	20,52	86	23,52	89	26,52	92	29,52	95	32,52		
		47	5,56	58	8,56	67	11,56	73	14,56	78	17,56	82	20,56	86	23,56	89	26,56	92	29,56	95	32,56		
		47	5,60	58	8,60	67	11,60	73	14,60	78	17,60	82	20,60	86	23,60	89	26,60	92	29,60	95	32,60		
		47	5,64	59	8,64	67	11,64	73	14,64	78	17,64	82	20,64	86	23,64	89	26,64	92	29,64	95	32,64		
		47	5,68	59	8,68	67	11,68	73	14,68	78	17,68	82	20,68	86	23,68	89	26,68	92	29,68	95	32,68		