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Technical Specification

**Universal Mobile Telecommunications System (UMTS);
Specification of the 3GPP confidentiality
and integrity algorithms;
Document 3: Implementors' test data
(3GPP TS 35.203 version 3.1.2 Release 1999)**



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Introduction

This specification has been prepared by the 3GPP Task Force, and gives detailed test data for implementors of the algorithm set. It provides visibility of the internal state of the algorithm to aid in the realisation of the algorithms.

This document is the third of four, which between them form the entire specification of the 3GPP Confidentiality and Integrity Algorithms:

- 3GPP TS 35.201: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 1: f8 and f9 Specification".
- 3GPP TS 35.202: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 2: KASUMI Specification".
- **3GPP TS 35.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 3: Implementors' Test Data"**.

- 3GPP TS 35.204: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 4: Design Conformance Test Data".

This document is purely informative. The normative part of the specification of the *f8* (confidentiality) and the *f9* (integrity) algorithms is in the main body of Document 1. The normative part of the specification of **KASUMI** is found in document 2.

0 Scope

This specification gives detailed test data for implementors of the algorithm set. It provides visibility of the internal state of the algorithm to aid in the realisation of the algorithms.

1 Outline of the implementors' test data

Section 2 introduces the algorithms and describes the notation used in the subsequent sections.

Section 3 provides test data for **KASUMI**.

Section 4 provides test data for the Confidentiality Algorithm F8.

Section 5 provides test data for the Integrity Algorithm F9.

1.1 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TS 33.102 version 3.2.0: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Security Architecture".
- [2] 3GPP TS 33.105 version 3.1.0: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Cryptographic Algorithm Requirements".
- [3] 3GPP TS 35.201: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 1: f8 and f9 Specification".
- [4] 3GPP TS 35.202: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 2: KASUMI Specification".
- [5] 3GPP TS 35.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 3: Implementors' Test Data".
- [6] 3GPP TS 35.204: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 4: Design Conformance Test Data".
- [7] ISO/IEC 9797-1:1999: "Information technology – Security techniques – Message Authentication Codes (MACs)".

2 Introductory information

2.1 Introduction

Within the security architecture of the 3GPP system there are two standardised algorithms; a confidentiality algorithm f_8 , and an integrity algorithm f_9 . These algorithms are specified in a companion document[3]. Each of these algorithms is based on the **KASUMI** algorithm that is specified in [4].

To assist implementors with their realisation of the algorithm set this document provides test data for these algorithms along with extensive detail of the internal states of the algorithms as they process the given input data.

Final testing of the algorithms should be performed using the test data sets given in the “Design Conformance” companion document[6].

2.2 Radix

Unless stated otherwise, all test data values presented in this document are in hexadecimal.

2.3 Bit/Byte ordering

All data variables in this specification are presented with the most significant bit (or byte) on the left hand side and the least significant bit (or byte) on the right hand side. Where a variable is broken down into a number of sub-strings, the left most (most significant) sub-string is numbered 1, the next most significant is numbered 2 and so on through to the least significant.

For example the 128-bit key K is subdivided into eight 16-bit substrings $K1...K8$ so if we have a key
 $K = 0123456789ABCDEFEDCBA9876543210$

we have:

$$K1 = 0123, K2 = 5678, K3 = 9ABC, \dots, K8 = 3210.$$

2.4 Presentation of input/output data

The basic data processed by the f_8 and f_9 algorithms are bit streams. In general in this document the data is presented in hexadecimal format as bytes, thus the last byte shown as part of an input or output data stream may include between 0 and 7 bits that are ignored once the **LENGTH** parameter is taken into account. (The least significant bits of the byte are ignored).

3 KASUMI

3.1 Overview

The test data sets presented here are for the **KASUMI** block cipher algorithm.

3.2 Format

Each test set starts by showing the input and output data values. This is followed by a table showing the internal sub-keys that are derived from the 128-bit key.

For each round the inputs and outputs are shown for the **FL**, **FO** and **FI** functions in the form:


```

Round i
FLi( input, KLi, KL2i )->output
FOi( input )->output
  FIi1( input, KIi1 ) -> output
  FIi2( input, KIi2 ) -> output
  FIi3( input, KIi3 ) -> output

```

In addition, for the first two rounds, the internal states of the 7-bit and 9-bit data paths within the **FI** function are shown in the form:

```

seven 17-> 0C-> 47-> 72-> 6C-> 21
nine  19E->05C->04B->1BB->1BF->1CD

```

where the first value shown is the value derived from the 16-bit input, and the subsequent values are the changes that occur as the data passes through the function down the respective 7-bit or 9-bit data paths. i.e. The values shown following the input value are:

```

      result of S-box lookup,
      XOR with other half,
      XOR with key,
      S-box lookup,
      XOR with other half.

```

3.3 Test Set 1

```

Key: 2B D6 45 9F 82 C5 B3 00 95 2C 49 10 48 81 FF 48
input: EA 02 47 14 AD 5C 4D 84
output: DF 1F 9B 25 1C 0B F4 5F

```

Key schedule:

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------|------|------|------|------|------|------|------|------|
| KLi1 | 57AC | 8B3E | 058B | 6601 | 2A59 | 9220 | 9102 | FE91 |
| KLi2 | 0B6E | 7EEF | 6BF0 | F388 | 3ED5 | CD58 | 2AF5 | 00F8 |
| KOi1 | B3E8 | 58B0 | 6016 | A592 | 2209 | 1029 | E91F | 7AC5 |
| KOi2 | 1049 | 8148 | 48FF | D62B | 9F45 | C582 | 00B3 | 2C95 |
| KOi3 | 2910 | 1FE9 | C57A | E8B3 | B058 | 1660 | 92A5 | 0922 |
| Kli1 | 6BF0 | F388 | 3ED5 | CD58 | 2AF5 | 00F8 | 0B6E | 7EEF |
| Kli2 | 7EEF | 6BF0 | F388 | 3ED5 | CD58 | 2AF5 | 00F8 | 0B6E |
| Kli3 | CD58 | 2AF5 | 00F8 | 0B6E | 7EEF | 6BF0 | F388 | 3ED5 |

Input: EA024714 AD5C4D84

Round 1

```

FL1(EA024714,57AC,0B6E)->7CFFC314
FO1(7CFFC314)->58871737
  FI11(CF17,6BF0)->43CD
    seven 17-> 0C-> 47-> 72-> 6C-> 21
    nine  19E->05C->04B->1BB->1BF->1CD
  FI12(D35D,7EEF)->D85E
    seven 5D-> 61-> 3E-> 01-> 32-> 6C
    nine  1A6->082->0DF->030->05F->05E
  FI13(A9C9,CD58)->4FB0
    seven 49-> 63-> 52-> 34-> 17-> 27
    nine  153->1F8->1B1->0E9->184->1B0

```

Round 2

```

FO2(F5DB5AB3)->03E715B9
  FI21(AD6B,F388)->E2FC
    seven 6B-> 31-> 4F-> 36-> 0D-> 71
    nine  15A->015->07E->1F6->0CA->0FC
  FI22(DBFB,6BF0)->BBA8
    seven 7B-> 29-> 75-> 40-> 75-> 5D
    nine  1B7->127->15C->0AC->1E8->1A8
  FI23(A7A6,2AF5)->165E
    seven 26-> 3A-> 73-> 66-> 55-> 0B
    nine  14F->06F->049->0BC->038->05E
FL2(03E715B9,8B3E,7EEF)->FC1913F5

```

Round 3

```

FL3(161B54E1,058B,6BF0)->E9F55CF7
FO3(E9F55CF7)->F9C9DB3F

```

FI31(89E3,3ED5)->4C63
 seven 63-> 2D-> 54-> 4B-> 45-> 26
 nine 113->19A->1F9->12C->028->063
 FI32(1408,F388)->E95D
 seven 08-> 26-> 02-> 7B-> 29-> 74
 nine 028->02C->024->1AC->126->15D
 FI33(D5EE,00F8)->22F6
 seven 6E-> 73-> 5B-> 5B-> 67-> 11
 nine 1AB->046->028->0D0->0AD->0F6

Round 4

FO4(0C12818C)->F9C83A1A
 FI41(A980,CD58)->4D43
 seven 00-> 36-> 4E-> 28-> 65-> 26
 nine 153->1F8->1F8->0A0->16B->143
 FI42(57A7,3ED5)->3507
 seven 27-> 30-> 72-> 6D-> 1D-> 1A
 nine 0AF->0E5->0C2->017->16A->107
 FI43(247C,0B6E)->C3D2
 seven 7C-> 58-> 54-> 51-> 33-> 61
 nine 048->0F0->08C->1E2->183->1D2
 FL4(F9C83A1A,6601,F388)->0EFDFA1A

Round 5

FL5(18E6AEFB,2A59,3ED5)->6519BE7B
 FO5(6519BE7B)->D1FAD9E0
 FI51(4710,2AF5)->781A
 seven 10-> 37-> 1D-> 08-> 26-> 3C
 nine 08E->1BA->1AA->15F->012->01A
 FI52(213E,CD58)->179B
 seven 3E-> 69-> 5C-> 3A-> 10-> 0B
 nine 042->18B->1B5->0ED->1A1->19B
 FI53(7639,7EEF)->081A
 seven 39-> 01-> 73-> 4C-> 1E-> 04
 nine 0EC->1CB->1F2->11D->056->01A

Round 6

FO6(DDE8586C)->DD0B619B
 FI61(CDC1,00F8)->8FF4
 seven 41-> 74-> 51-> 51-> 33-> 47
 nine 19B->0E4->0A5->05D->1A5->1F4
 FI62(9DEE,2AF5)->0A93
 seven 6E-> 73-> 11-> 04-> 16-> 05
 nine 13B->00C->062->097->097->093
 FI63(C1F8,6BF0)->BC90
 seven 78-> 2A-> 42-> 77-> 4E-> 5E
 nine 183->090->0E8->118->0E7->090
 FL6(DD0B619B,9220,CD58)->46BE419A

Round 7

FL7(5E58EF61,9102,2AF5)->81B3CF61
 FO7(81B3CF61)->C1E3AC33
 FI71(68AC,0B6E)->EBA4
 seven 2C-> 68-> 1A-> 1F-> 51-> 75
 nine 0D1->0DE->0F2->19C->1BB->1A4
 FI72(CFD2,00F8)->E526
 seven 52-> 11-> 57-> 57-> 54-> 72
 nine 19F->194->1C6->13E->171->126
 FI73(B660,F388)->6DD0
 seven 60-> 66-> 19-> 60-> 66-> 36
 nine 16C->01F->07F->1F7->1B0->1D0

Round 8

FO8(1C0BF45F)->68BFA566
 FI81(66CE,7EEF)->DB25
 seven 4E-> 7E-> 0D-> 32-> 48-> 6D
 nine 0CD->03D->073->09C->117->125
 FI82(D8CA,0B6E)->47C5
 seven 4A-> 56-> 65-> 60-> 66-> 23
 nine 1B1->179->133->05D->1A5->1C5
 FI83(2658,3ED5)->CDD9
 seven 58-> 5B-> 15-> 0A-> 3F-> 66
 nine 04C->196->1CE->11B->1D3->1D9
 FL8(68BFA566,FE91,00F8)->81477444
 Output: DF1F9B25 1C0BF45F

3.4 Test Set 2

Key: 8C E3 3E 2C C3 C0 B5 FC 1F 3D E8 A6 DC 66 B1 F3
input: D3 C5 D5 92 32 7F B1 1C
output: DE 55 19 88 CE B2 F9 B7

Key schedule:

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------|------|------|------|------|------|------|------|------|
| KLi1 | 19C7 | 7C58 | 8781 | 6BF9 | 3E7A | D14D | B8CD | 63E7 |
| KLi2 | 4A6B | 7813 | E1E1 | 523E | AA32 | 83E3 | 8DC0 | 7B4B |
| KOi1 | C587 | 7818 | BF96 | E7A3 | 14DD | 8CDB | 3E76 | 9C71 |
| KOi2 | A6E8 | 66DC | F3B1 | E38C | 2C3E | C0C3 | FCB5 | 3D1F |
| KOi3 | DB8C | 763E | 719C | 87C5 | 1878 | 96BF | A3E7 | DD14 |
| Kli1 | E1E1 | 523E | AA32 | 83E3 | 8DC0 | 7B4B | 4A6B | 7813 |
| Kli2 | 7813 | E1E1 | 523E | AA32 | 83E3 | 8DC0 | 7B4B | 4A6B |
| Kli3 | 83E3 | 8DC0 | 7B4B | 4A6B | 7813 | E1E1 | 523E | AA32 |

Input: D3C5D592 327FB11C

Round 1

FL1(D3C5D592,19C7,4A6B)->2F32F618
FO1(2F32F618)->9F6FAB3F
FI11(EAB5,E1E1)->9A6B
seven 35-> 6D-> 78-> 08-> 26-> 4D
nine 1D5->0A0->095->174->063->06B
FI12(50F0,7813)->F31C
seven 70-> 40-> 14-> 28-> 65-> 79
nine 0A1->124->154->147->134->11C
FI13(B7FF,83E3)->3450
seven 7F-> 03-> 28-> 69-> 4A-> 1A
nine 16F->054->02B->1C8->039->050

Round 2

FO2(AD101A23)->5BBD1022
FI21(D508,523E)->E46B
seven 08-> 26-> 35-> 1C-> 19-> 72
nine 1AA->11B->113->12D->077->06B
FI22(7CFF,E1E1)->A5F5
seven 7F-> 03-> 62-> 12-> 27-> 52
nine 0F9->11E->161->080->1E7->1F5
FI23(8876,8DC0)->4B9F
seven 76-> 24-> 60-> 26-> 3A-> 25
nine 110->032->044->184->1B9->19F
FL2(5BBD1022,7C58,7813)->AB9AA012

Round 3

FL3(785F7580,8781,E1E1)->93987582
FO3(93987582)->109659D3
FI31(2C0E,AA32)->D87A
seven 0E-> 7B-> 51-> 04-> 16-> 6C
nine 058->0A4->0AA->098->07E->07A
FI32(8633,523E)->BD6E
seven 33-> 3D-> 0E-> 27-> 30-> 5E
nine 10C->100->133->10D->149->16E
FI33(DC64,7B4B)->4945
seven 64-> 4B-> 60-> 5D-> 61-> 24
nine 1B8->1CF->1AB->0E0->118->145

Round 4

FO4(BD8643F0)->CA56843A
FI41(5A25,83E3)->5709
seven 25-> 3C-> 44-> 05-> 22-> 2B
nine 0B4->15D->178->09B->10C->109
FI42(A07C,AA32)->DEAF
seven 7C-> 58-> 25-> 70-> 40-> 6F
nine 140->001->07D->04F->0DF->0AF
FI43(933C,4A6B)->4E6C
seven 3C-> 52-> 41-> 64-> 4B-> 27
nine 126->1AF->193->1F8->008->06C
FL4(CA56843A,6BF9,523E)->6F2A109A

Round 5

FL5(1775651A,3E7A,AA32)->C08049FA
FO5(C08049FA)->C9D692DD
FI51(D45D,8DC0)->AB91
seven 5D-> 61-> 2A-> 6C-> 44-> 55

```

    nine 1A8->016->04B->18B->1FD->191
FI52(65C4,83E3)->2BBD
    seven 44-> 59-> 6B-> 2A-> 28-> 15
    nine 0CB->1F6->1B2->051->197->1BD
FI53(FA13,7813)->5B0B
    seven 13-> 72-> 34-> 08-> 26-> 2D
    nine 1F4->155->146->155->103->10B
Round 6
FO6(7450D12D)->F6FA9BBE
FI61(F88B,7B4B)->5654
    seven 0B-> 5D-> 14-> 29-> 7F-> 2B
    nine 1F1->042->049->102->07D->054
FI62(11EE,8DC0)->7183
    seven 6E-> 73-> 38-> 7E-> 3B-> 38
    nine 023->025->04B->18B->1FD->183
FI63(11C6,E1E1)->6D44
    seven 46-> 00-> 63-> 13-> 72-> 36
    nine 023->025->063->182->157->144
FL6(F6FA9BBE,D14D,83E3)->81253B2F
Round 7
FL7(96505E35,B8CD,8DC0)->69B97EB4
FO7(69B97EB4)->BAE2289A
FI71(57CF,4A6B)->47F8
    seven 4F-> 57-> 7D-> 58-> 5B-> 23
    nine 0AF->0E5->0AA->0C1->1A0->1F8
FI72(8201,7B4B)->83AE
    seven 01-> 32-> 20-> 1D-> 6F-> 41
    nine 104->013->012->159->1B3->1AE
FI73(9AAB,523E)->9278
    seven 2B-> 78-> 42-> 6B-> 31-> 49
    nine 135->111->13A->104->013->078
Round 8
FO8(CEB2F9B7)->B7FB007B
FI81(52C3,7813)->4A98
    seven 43-> 0B-> 0F-> 33-> 3D-> 25
    nine 0A5->147->104->117->0AB->098
FI82(C4A8,4A6B)->04D4
    seven 28-> 65-> 6F-> 4A-> 56-> 02
    nine 189->022->00A->061->09E->0D4
FI83(6E3B,AA32)->B780
    seven 3B-> 07-> 0D-> 58-> 5B-> 5B
    nine 0DC->031->00A->038->1D8->180
FL8(B7FB007B,63E7,7B4B)->480547BD
Output: DE551988 CEB2F9B7

```

3.5 Test Set 3

```

Key: 40 35 C6 68 0A F8 C6 D1 A8 FF 86 67 B1 71 40 13
input: 62 A5 40 98 1B A6 F9 B7
output: 45 92 B0 E7 86 90 F7 1B

```

Key schedule:

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------|------|------|------|------|------|------|------|------|
| KLi1 | 806A | 8CD1 | 15F0 | 8DA3 | 51FF | 0CCF | 62E3 | 8026 |
| KLi2 | 8353 | 0B3E | 5623 | 3CFF | C725 | 7203 | 4116 | 830F |
| KOi1 | CD18 | 5F01 | DA38 | 1FF5 | CCF0 | 2E36 | 0268 | 06A8 |
| KOi2 | 6786 | 71B1 | 1340 | 3540 | 68C6 | F80A | D1C6 | FFA8 |
| KOi3 | 362E | 6802 | A806 | 18CD | 015F | 38DA | F51F | F0CC |
| Kli1 | 5623 | 3CFF | C725 | 7203 | 4116 | 830F | 8353 | 0B3E |
| Kli2 | 0B3E | 5623 | 3CFF | C725 | 7203 | 4116 | 830F | 8353 |
| Kli3 | 7203 | 4116 | 830F | 8353 | 0B3E | 5623 | 3CFF | C725 |

Input: 62A54098 1BA6F9B7

Round 1

```

FL1(62A54098,806A,8353)->E51240D8
FO1(E51240D8)->B2CC3045
FI11(280A,5623)->CED6
    seven 0A-> 3F-> 40-> 6B-> 31-> 67
    nine 050->1F5->1FF->1DC->0BD->0D6
FI12(275E,0B3E)->3CC2
    seven 5E-> 1C-> 62-> 67-> 5C-> 1E
    nine 04E->120->17E->040->0A5->0C2
FI13(B820,7203)->8289

```

seven 20-> 35-> 0B-> 32-> 48-> 41
 nine 170->19E->1BE->1BD->0BB->089

Round 2

FO2(A96AC9F2)->A4AC83B6
 FI21(F66B,3CFF)->0F18
 seven 6B-> 31-> 7F-> 61-> 1F-> 07
 nine 1EC->125->14E->1B1->179->118
 FI22(B843,5623)->6246
 seven 43-> 0B-> 56-> 7D-> 77-> 31
 nine 170->19E->1DD->1FE->03B->046
 FI23(AEE8,4116)->271A
 seven 68-> 25-> 01-> 21-> 09-> 13
 nine 15D->14C->124->032->13B->11A
 FL2(A4AC83B6,8CD1,0B3E)->B3D38AB7

Round 3

FL3(D176CA2F,15F0,5623)->2CA9E8CF
 FO3(2CA9E8CF)->C1983ADB
 FI31(F691,C725)->4756
 seven 11-> 71-> 23-> 40-> 75-> 23
 nine 1ED->143->152->077->116->156
 FI32(FB8F,3CFF)->6E01
 seven 0F-> 21-> 1E-> 00-> 36-> 37
 nine 1F7->1B0->1BF->140->001->001
 FI33(079F,830F)->FB43
 seven 1F-> 51-> 43-> 02-> 3E-> 7D
 nine 00F->18D->192->09D->141->143

Round 4

FO4(68F2F329)->3279F0E1
 FI41(7707,7203)->54CC
 seven 07-> 60-> 59-> 60-> 66-> 2A
 nine 0EE->03E->039->03A->0AC->0CC
 FI42(C669,C725)->959C
 seven 69-> 4A-> 29-> 4A-> 56-> 4A
 nine 18C->08A->0E3->1C6->1D6->19C
 FI43(BF28,8353)->C298
 seven 28-> 65-> 63-> 22-> 79-> 61
 nine 17E->12E->106->055->0BA->098
 FL4(3279F0E1,8DA3,3CFF)->CB86F0A3

Round 5

FL5(1AF03A8C,51FF,C725)->A42B1B6C
 FO5(A42B1B6C)->A62197C6
 FI51(68DB,4116)->06CF
 seven 5B-> 67-> 62-> 42-> 4C-> 03
 nine 0D1->0DE->085->193->08D->0CF
 FI52(73AA,7203)->BB82
 seven 2A-> 28-> 6D-> 54-> 5F-> 5D
 nine 0E7->1EF->1C5->1C6->1D6->182
 FI53(1CFC,0B3E)->31E7
 seven 7C-> 58-> 2C-> 29-> 7F-> 18
 nine 039->108->174->04A->1CE->1E7

Round 6

FO6(CED364EF)->D6DA665D
 FI61(E0E5,830F)->A727
 seven 65-> 04-> 00-> 41-> 74-> 53
 nine 1C1->161->104->00B->166->127
 FI62(9CE5,4116)->1512
 seven 65-> 04-> 53-> 73-> 18-> 0A
 nine 139->0B2->0D7->1C1->161->112
 FI63(FB12,5623)->B087
 seven 12-> 27-> 7F-> 54-> 5F-> 58
 nine 1F6->0CA->0D8->0FB->0D3->087
 FL6(D6DA665D,0CCF,7203)->294C6FC9

Round 7

FL7(33BC5545,62E3,4116)->91921005
 FO7(91921005)->484393F4
 FI71(93FA,8353)->82E2
 seven 7A-> 0F-> 1B-> 5A-> 23-> 41
 nine 127->0EE->094->1C7->0B8->0E2
 FI72(C1C3,830F)->DAA4
 seven 43-> 0B-> 58-> 19-> 49-> 6D
 nine 183->090->0D3->1DC->0BD->0A4
 FI73(67F8,3CFF)->DBB7
 seven 78-> 2A-> 48-> 56-> 5A-> 6D
 nine 0CF->11A->162->19D->1E1->1B7

Round 8

```

FO8(8690F71B)->B971E5E3
FI81(8038,0B3E)->79B9
  seven 38-> 4D-> 56-> 53-> 05-> 3C
  nine 100->023->01B->125->1EA->1B9
FI82(08B3,8353)->37D3
  seven 33-> 3D-> 73-> 32-> 48-> 1B
  nine 011->0FD->0CE->19D->1E1->1D3
FI83(7E6E,C725)->5C92
  seven 6E-> 73-> 46-> 25-> 3C-> 2E
  nine 0FC->15B->135->010->0B7->092
FL8(B971E5E3,8026,830F)->762EE5A2
Output: 4592B0E7 8690F71B

```

3.6 Test Set 4

This test ensures that all entries in the two S-boxes are correct. It does this by ensuring that every S-box entry is used at least once during the running of the test set.

For a fixed key an initial input value, the algorithm is executed 50 times. The first encryption operates on the given input data. Each subsequent encryption takes the output of the previous encryption as its input data. After 50 operations the output should be as shown below.

```

Iterated test for full S-box coverage
Key   = 3A 3B 39 B5 C3 F2 37 6D 69 F7 D5 46 E5 F8 5D 43
Input = CA 49 C1 C7 57 71 AB 0B

```

```

After 50 repeated encryptions
Output = 73 8B AD 4C 4A 69 08 02

```

4 Confidentiality algorithm *f8*

4.1 Overview

The test data sets presented here are for the *f8* confidentiality algorithm. No detailed data is presented for the internal states of **KASUMI** as that is covered in section 3.

4.2 Format

Each test set starts by showing the various inputs to the algorithm including the data stream to be encrypted/decrypted. (The length field is in decimal). This is followed by:

- the initial value of the variable **A**.
- the modified key used in the calculation **KASUMI[A]_{CK ⊕ MK}**
- the result of the above operation.

Thereafter four columns of data are shown.

- Column 1** shows the value of the block counter **BLKCNT**.
- KASUMI Input** shows the input to the **KASUMI** block cipher. i.e. it is the bit-wise exclusive-or of the data in column 1 with the previous block of keystream and with the modified value of **A**.
- Keystream** shows the 64-bit output from **KASUMI**.
- Enc/dec data** shows the modified input data, i.e. it is the bit-wise exclusive-or of the corresponding keystream and the input data to the algorithm. As this is a stream cipher it is purely a matter of context whether the operation is regarded as “encryption” or “decryption”.

4.3 Test Set 1

Key = 2BD6459F82C5B300952C49104881FF48
 Count = 72A4F20F
 Bearer = 0C
 Direction = 1
 Length = 798 bits
 Plaintext:
 7EC61272743BF161 4726446A6C38CED1 66F6CA76EB543004 4286346CEF130F92
 922B03450D3A9975 E5BD2EA0EB55AD8E 1B199E3EC4316020 E9A1B285E7627953
 59B7BDFD39BEF4B2 484583D5AFE082AE E638BF5FD5A60619 3901A08F4AB41AAB
 9B134880

Initial A = 72A4F20F64000000
 Key used = 7E8310CAD790E655C0791C451DD4AA1D
 Modified A = 34222BC8F7C39416
 Key now = 2BD6459F82C5B300952C49104881FF48

| BLKCNT | Kasumi input | Keystream | enc/dec data |
|--------|------------------|-------------------|------------------|
| 0 | 34222BC8F7C39416 | AF24CC029AC39D08 | D1E2DE70EEF86C69 |
| 1 | 9B06E7CA6D00091F | 23DD1041AECECAE7B | 64FB542BC2D460AA |
| 2 | 17FF3B89592F3A6F | D95CDAD24BC7162F | BFAA10A4A093262B |
| 3 | ED7EF11ABC04823A | 3F9FAA1C80D1DB1B | 7D199E706FC2D489 |
| 4 | 0BBD81D477124F09 | 87782A2C1DC93006 | 1553296910F3A973 |
| 5 | B35A01E4EA0AA415 | E49BAC44F71B868C | 012682E41C4E2B02 |
| 6 | D0B9878C00D8129C | A5398989E10ADFB3 | BE2017B7253BBF93 |
| 7 | 911BA24116C94BA2 | E07FEA9C2C20914A | 09DE5819CB42E819 |
| 8 | D45DC154DBE30554 | 0F437466F0C8A81D | 56F4C99BC9765CAF |
| 9 | 3B615FAE070B3C02 | 1BF4536E2D9900C4 | 53B1D0BB8279826A |
| 10 | 2FD678A6DA5A94D8 | 3D84EA7D3CB3C739 | DBBC5522E915C120 |
| 11 | 09A6C1B5CB705324 | 9F190528BF5C8DA3 | A618A5A7F5E89708 |
| 12 | AB3B2EE0489F19B9 | 082A2D8F25915EE3 | 9339650F |

4.4 Test Set 2

Key = EFA8B2229E720C2A7C36EA55E9605695
 Count = E28BCF7B
 Bearer = 18
 Direction = 0
 Length = 510 bits
 Plaintext:
 10111231E060253A 43FD3F57E37607AB 2827B599B6B1BBDA 37A8ABCC5A8C550D
 1BF2F494624FB50 367FA36CE3BC68F1 1CF93B1510376B02 130F812A9FA169D8

Initial A = E28BCF7BC0000000
 Key used = BAFDE777CB27597F2963BF00BC3503C0
 Modified A = 1C05EA5F90964036
 Key now = EFA8B2229E720C2A7C36EA55E9605695

| BLKCNT | Kasumi input | Keystream | enc/dec data |
|--------|------------------|------------------|------------------|
| 0 | 1C05EA5F90964036 | 2DFBDE4DF5E23990 | 3DEACC7C15821CAA |
| 1 | 31FE3412657479A7 | CA13F589782DD4CA | 89EECADE9B5BD361 |
| 2 | D6161FD6E8BB94FE | 63F77DD82BC0B85F | 4BD0C8419D710385 |
| 3 | 7FF29787BB56F86A | EA16F385B597F957 | DDBE5849EF1BAC5A |
| 4 | F61319DA2501B965 | F34A65124C43BA02 | E8B14A5B0A674152 |
| 5 | EF4F8F4DDCD5FA31 | 28CB43675A509B18 | 1EB4E00BB9ECF3E9 |
| 6 | 34CEA938CAC6DB28 | EB3582DFF77639D5 | F7CCB9CAE74152D7 |
| 7 | F730688067E079E4 | E7ED211E294B6934 | F4E2A034B6EA00EC |

4.5 Test Set 3

Key = 5ACB1D644C0D51204EA5F1451010D852
 Count = FA556B26
 Bearer = 03
 Direction = 1
 Length = 120 bits
 Plaintext:
 AD9C441F890B38C4 57A49D421407E8

Initial A = FA556B261C000000
 Key used = 0F9E4831195804751BF0A41045458D07
 Modified A = 3E5A6D0A3D1C82A5
 Key now = 5ACB1D644C0D51204EA5F1451010D852

| BLKCNT | Kasumi input | Keystream | enc/dec data |
|--------|------------------|------------------|------------------|
| 0 | 3E5A6D0A3D1C82A5 | 365568B78ACD43EC | 9BC92CA803C67B28 |
| 1 | 080F05BDB7D1C148 | F6BED6AC4E0BCD5F | A11A4BEE5A0C25 |

4.6 Test Set 4

Key = D3C5D592327FB11C4035C6680AF8C6D1
 Count = 398A59B4
 Bearer = 05
 Direction = 1
 Length = 253 bits
 Plaintext:
 981BA6824C1BFB1A B485472029B71D80 8CE33E2CC3C0B5FC 1F3DE8A6DC66B1F0

Initial A = 398A59B42C000000
 Key used = 869080C7672AE4491560933D5FAD9384
 Modified A = F04B50A2A852469C
 Key now = D3C5D592327FB11C4035C6680AF8C6D1

| BLKCNT | Kasumi input | Keystream | enc/dec data |
|--------|------------------|------------------|------------------|
| 0 | F04B50A2A852469C | C3A2E599FDF270CB | 5BB9431BB1E98BD1 |
| 1 | 33E9B53B55A03656 | AF169C5C14F20EE5 | 1B93DB7C3D451365 |
| 2 | 5F5DCCFEBCA0487B | D558B88E566A95B2 | 59BB86A295AA204E |
| 3 | 2513E82CFE38D32D | D4D61E517976A4E2 | CBEBF6F7A5101512 |

4.7 Test Set 5

```

Key       = 6090EAE04C83706EECBF652BE8E36566
Count     = 72A4F20F
Bearer    = 09
Direction = 0
Length    = 837 bits
Plaintext:
40981BA6824C1BFB 4286B299783DAF44 2C099F7AB0F58D5C 8E46B104F08F01B4
1AB485472029B71D 36BD1A3D90DC3A41 B46D51672AC4C966 3A2BE063DA4BC8D2
808CE33E2CCCBFC6 34E1B259060876A0 FBB5A437EBCC8D31 C19E4454318745E3
987645987A986F2C B0

Initial A = 72A4F20F48000000
Key used  = 35C5BFB519D6253BB9EA307EBDB63033
Modified A = 1EDF994571692FEA
Key now   = 6090EAE04C83706EECBF652BE8E36566

```

| BLKCNT | Kasumi input | Keystream | enc/dec data |
|--------|------------------|------------------|------------------|
| 0 | 1EDF994571692FEA | 9D2B7F7BA8E2D9B6 | DDB364DD2AAEC24D |
| 1 | 83F4E63ED98BF65D | BDAFABCECFB60242 | FF291957B78BAD06 |
| 2 | A370328BBEDF2DAA | 16CCE6B720B437E2 | 3AC579CD9041BABA |
| 3 | 08137FF251DD180B | 07BBA858F5F7CA2B | 89FD195C0578CB9F |
| 4 | 1964311D849EE5C5 | C4F692114151651F | DE4217566178D202 |
| 5 | DA290B5430384AF0 | 769D773A5F7A23AD | 40206D07CFA619EC |
| 6 | 6842EE7F2E130C41 | B1F232366E9D3576 | 059F63514459FC10 |
| 7 | AF2DAB731FF41A9B | EE0629F0941D2312 | D42DC9934E56EBC0 |
| 8 | F0D9B0B5E5740CF0 | 4B4AEE73013DCBB1 | CBC60D4D2DF17477 |
| 9 | 559577367054E452 | 785C7F04A2AB2691 | 4CBDCD5DA4A35031 |
| 10 | 6683E641D3C20971 | 81CAB6D67F58FCC9 | 7A7F12E1949471F8 |
| 11 | 9F152F930E31D328 | 630BB626D7088592 | A295F272E68FC071 |
| 12 | 7DD42F63A661AA74 | C1C6381657BE8B75 | 59B07D8E2D26E459 |
| 13 | DF19A15326D7A492 | 2E1EA0BF8D97DA88 | 9E |

5 Integrity algorithm *f9*

5.1 Overview

The test data sets presented here are for the *f9* integrity algorithm. No detailed data is presented for the internal states of **KASUMI** as that is covered in section 3.

5.2 Format

The test data set shows the input values to the algorithm.

Following this it shows four columns of data; input, **KASUMI** input, **KASUMI** output and the cumulative exclusive-OR where:

Input is the plain text input block that is being hashed. It commences with the value **COUNT || FRESH** and is followed by the **MESSAGE**. The final input block includes the **DIRECTION** bit and the padding.

KASUMI Input is the input value to the block cipher. In the first line this is **COUNT || FRESH**, subsequently it is the XOR of the plain text block and the previous output from **KASUMI**.

KASUMI Output is the output of the block cipher

Accumulated XOR is the XOR of all the output of all the **KASUMI** operations performed up to that point.

Finally the modified key is shown along with the input and output data from the last application of **KASUMI**.

5.3 Test Set 1

Key = 2BD6459F82C5B300952C49104881FF48
 Count = 38A6F056
 Fresh = 05D2EC49
 Direction = 0
 Length = 189 bits
 Message:
 6B227737296F393C 8079353EDC87E2E8 05D2EC49A4F2D8E0

| Input | Kasumi input | Kasumi Output | Accumulated XOR |
|------------------|-------------------|------------------|------------------|
| 38A6F05605D2EC49 | 38A6F05605D2EC49 | 89E0A6D036C17090 | 89E0A6D036C17090 |
| 6B227737296F393C | E2C2D1E71FAE49AC | 45C16C0142460205 | CC21CAD174877295 |
| 8079353EDC87E2E8 | C5B8593F9EC1E0ED | E24CFA7D8471E4DD | 2E6D30ACF0F69648 |
| 05D2EC49A4F2D8E2 | E791E163420833C3F | DFD3DCB9499275BA | F1BEEC15B964E3F2 |

New Key: 817CEF35286F19AA3F86E3BAE22B55E2
 final step: F1BEEC15B964E3F2 F63BD72C702EBC7A

MAC-I: F63BD72C

5.4 Test Set 2

Key = D42F682428201CAFCD9F97945E6DE7B7
 Count = 3EDC87E2
 Fresh = A4F2D8E2
 Direction = 1
 Length = 254 bits
 Message::
 B5924384328A4AE0 0B737109F8B6C8DD 2B4DB63DD533981C EB19AAD52A5B2BC0

| Input | Kasumi input | Kasumi Output | Accumulated XOR |
|------------------|------------------|------------------|------------------|
| 3EDC87E2A4F2D8E2 | 3EDC87E2A4F2D8E2 | 3541B47339DD4168 | 3541B47339DD4168 |
| B5924384328A4AE0 | 80D3F7F70B570B88 | 52EC81194ECEDDA0 | 67AD356A77139CC8 |
| 0B737109F8B6C8DD | 599FF010B678157D | 792BFE1F07A1A8B0 | 1E86CB7570B23478 |
| 2B4DB63DD533981C | 52664822D29230AC | C92F7E2C38D22B6D | D7A9B55948601F15 |
| EB19AAD52A5B2BC3 | 2236D4F9128900AE | 4C2BEF9C82233403 | 9B825AC5CA432B16 |

New Key: 7E85C28E828AB60567353D3EF4C74D1D
 final step: 9B825AC5CA432B16 A9DAF1FF12F71DE7

MAC-I: A9DAF1FF

5.5 Test Set 3

Key = FDB9CFDF28936CC483A31869D81B8FAB
 Count = 36AF6144
 Fresh = 9838F03A
 Direction = 1
 Length = 319 bits
 Message::
 5932BC0ACE2B0ABA 33D8AC188AC54F34 6FAD10BF9DEE2920 B43BD0C53A915CB7
 DF6CAA72053ABFF2

| Input | Kasumi input | Kasumi Output | Accumulated XOR |
|------------------|------------------|------------------|------------------|
| 36AF61449838F03A | 36AF61449838F03A | DDA7EAA292B010EC | DDA7EAA292B010EC |
| 5932BC0ACE2B0ABA | 849556A85C9B1A56 | 3D65F1EB61544622 | E0C21B49F3E456CE |
| 33D8AC188AC54F34 | 0EBD5DF3EB910916 | 1D62D61E5ED97431 | FDA0CD57AD3D22FF |
| 6FAD10BF9DEE2920 | 72CFC6A1C3375D11 | 14C968BAC4F8A2A5 | E969A5ED69C5805A |
| B43BD0C53A915CB7 | A0F2B87FFE69FE12 | 6D0132521C61A552 | 846897BF75A42508 |
| DF6CAA72053ABFF3 | B26D9820195B1AA1 | BF04729B5C03EA98 | 3B6CE52429A7CF90 |
| 8000000000000000 | 3F04729B5C03EA98 | 8B0C8BE27C74D17F | B0606EC655D31EEF |

New Key: 571365758239C66E2909B2C372B12501
 final step: B0606EC655D31EEF 1537D316633A8831

MAC-I: 1537D316

5.6 Test Set 4

Key = C736C6AAB22BFFF91E2698D2E22AD57E
 Count = 14793E41
 Fresh = 0397E8FD
 Direction = 1
 Length = 384 bits
 Message::
 D0A7D463DF9FB2B2 78833FA02E235AA1 72BD970C1473E129 07FB648B6599AAA0
 B24A038665422B20 A499276A50427009

| Input | Kasumi input | Kasumi Output | Accumulated XOR |
|------------------|------------------|------------------|------------------|
| 14793E410397E8FD | 14793E410397E8FD | FB6A5FB59EA91B57 | FB6A5FB59EA91B57 |
| D0A7D463DF9FB2B2 | 2BCD8BD64136A9E5 | DDF60F296850AE54 | 269C509CF6F9B503 |
| 78833FA02E235AA1 | A57530894673F4F5 | FAB7664A7F2447E7 | DC2B36D689DDF2E4 |
| 72BD970C1473E129 | 880AF1466B57A6CE | E6443647E1289007 | 3A6F009168F562E3 |
| 07FB648B6599AAA0 | E1BF52CC84B13AA7 | DA29900832EA4C7C | E04690995A1F2E9F |
| B24A038665422B20 | 6863938E57A8675C | 74C2F5B8172E361D | 948465214D311882 |
| A499276A50427009 | D05BD2D2476C4614 | 79AA12C36369E686 | ED2E77E22E58FE04 |
| C000000000000000 | B9AA12C36369E686 | A464F43DEE74E0C7 | 494A83DFC02C1EC3 |

New Key: 6D9C6C0018815553B48C327848807FD4
 final step: 494A83DFC02C1EC3 DD7DFADDD68D1EC1

MAC-I: DD7DFADD

5.7 Test Set 5

Key = F4EBEC69E73EAF2EB2CF6AF4B3120FFD
 Count = 296F393C
 Fresh = 6B227737
 Direction = 1
 Length = 1000 bits
 Message::
 10BFFF839E0C7165 8DBB2D1707E14572 4F41C16F48BF403C 3B18E38FD5D1663B
 6F6D900193E3CEA8 BB4F1B4F5BE82203 2232A78D7D75238D 5E6DAECD3B4322CF
 59BC7EA84AB18811 B5BFB7BC553F4FE4 4478CE287A148799 90D18D12CA79D2C8
 55149021CD5CE8CA 0371CA04FCCE143E 3D7CFEE94585B588 5CAC46068B

| Input | Kasumi input | Kasumi Output | Accumulated XOR |
|------------------|------------------|------------------|------------------|
| 296F393C6B227737 | 296F393C6B227737 | 47F6AA9B15F7A617 | 47F6AA9B15F7A617 |
| 10BFFF839E0C7165 | 574955188BFB772 | 6C7C71FDE9AA2B8D | 2B8ADB66FC5D8D9A |
| 8DBB2D1707E14572 | E1C75CEAEE4B6EFF | 690286906D3EBABE | 42885DF691633724 |
| 4F41C16F48BF403C | 264347FF2581FA82 | 942B65C8198AB936 | D6A3383E88E98E12 |
| 3B18E38FD5D1663B | AF338647CC5BDF0D | 5052A81A1A059BB0 | 86F1902492EC15A2 |
| 6F6D900193E3CEA8 | 3F3F381B89E65518 | E40F45A22B41B05F | 62FED586B9ADA5FD |
| BB4F1B4F5BE82203 | 5F405EED70A9925C | 91C00F497A1A8199 | F33EDACFC3B72464 |
| 2232A78D7D75238D | B3F2A8C4076FA214 | DEF053FB4EB23FEA | 2DCE89348D051B8E |
| 5E6DAECD3B4322CF | 809DFD3675F11D25 | BEC94AAFFE3723CC | 9307C39B73323842 |
| 59BC7EA84AB18811 | E7753407B486ABDD | 9BD4CB606985127E | 08D308FB1AB72A3C |
| B5BFB7BC553F4FE4 | 2E6B7CDC3CBA5D9A | D5D5A8EED518F4E | DD06A015D7E6A572 |
| 4478CE287A148799 | 91AD66C6B74508D7 | 17B9203FC35C9882 | CABF802A14BA3DF0 |
| 90D18D12CA79D2C8 | 8768AD2D09254A4A | 206A3693096F30E7 | EAD5B6B91DD50D17 |
| 55149021CD5CE8CA | 757EA6B2C433D82D | CF23D21C256066E9 | 25F664A538B56BFE |
| 0371CA04FCCE143E | CC521818D9AE72D7 | C2D40AFABC92E2FE | E7226E5F84278900 |
| 3D7CFEE94585B588 | FFA8F413F9175776 | 699D61BDD036A7E5 | 8EBF0FE254112EE5 |
| 5CAC46068BC00000 | 353127BB5BF6A7E5 | E3D8AE061C3A3C87 | 6D67A1E4482B1262 |

New Key: 5E4146C34D9405841865C05E19B8A557
 final step: 6D67A1E4482B1262 C383839D93FFC6D1

MAC-I: C383839D

Annex A (informative): Change history

| Change history | | | | | | | |
|----------------|-------|----------|----|-----|---------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|
| Date | TSG # | TSG Doc. | CR | Rev | Subject/Comment | Old | New |
| 12-1999 | - | - | - | - | ETSI SAGE Publication (restricted) | - | SAGE v1.0 |
| 09-2000 | SA_07 | | | | Approved by TSG SA and placed under change control | SAGE v1.0 | 3.1.0 |
| 07-2001 | - | - | - | - | Word version received: Re-formatted into 3GPP TS format (MCC) No technical change from version 3.1.0. | 3.1.0 | 3.1.1 |
| 08-2001 | - | | | | Addition of Mitsubishi IPR information in Foreword and correction of reference titles. No technical change from version 3.1.0. | 3.1.1 | 3.1.2 |

History

| Document history | | |
|-------------------------|-------------|-------------|
| V3.1.2 | August 2001 | Publication |
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