3GPP TS 35.203 V9.0.0 (2009-12)

Technical Specification

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
(Release 9)

Keywords
UMTS, algorithm, KASUMI

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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The 3GPP Confidentiality and Integrity Algorithms f8 & f9 have been developed through the collaborative efforts of the European Telecommunications Standards Institute (ETSI), the Association of Radio Industries and Businesses (ARIB), the Telecommunications Technology Association (TTA), the T1 Committee.

The f8 & f9 Algorithms Specifications may be used only for the development and operation of 3G Mobile Communications and services. Every Beneficiary must sign a Restricted Usage Undertaking with the Custodian and demonstrate that he fulfils the approval criteria specified in the Restricted Usage Undertaking.

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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 ***f8***, and an integrity algorithm ***f9***. 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-kit key ***K*** is subdivided into eight 16-bit substrings ***K1...K8*** so if we have a key

K = 0123456789ABCDEFFEDCBA9876543210

we have:

K1 = 0123, ***K2*** = 5678, ***K3*** = 9ABC, ….. ***K8*** = 3210.

2.4 Presentation of input/output data

The basic data processed by the ***f8*** and ***f9*** 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, KL1i, 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
KIi1	6BF0	F388	3ED5	CD58	2AF5	00F8	0B6E	7EEF
KIi2	7EEF	6BF0	F388	3ED5	CD58	2AF5	00F8	0B6E
KIi3	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
KIi1	E1E1	523E	AA32	83E3	8DC0	7B4B	4A6B	7813
KIi2	7813	E1E1	523E	AA32	83E3	8DC0	7B4B	4A6B
KIi3	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
KIi1	5623	3CFF	C725	7203	4116	830F	8353	0B3E
KIi2	0B3E	5623	3CFF	C725	7203	4116	830F	8353
KIi3	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 $\mathbf{KASUMI[\ A\ ]_{CK \oplus MK}}$

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	23DD1041AEECAE7B	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
1BFB2F494624FB50 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	3AC579CD9041BABE
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	E79E163420833C3F	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	574955188BFBD772	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	D5D5A8EECD518F4E	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
08-2001	-	-	-	-	Release 4 version created.	3.1.2	4.0.0
06-2002	-	-	-	-	Release 5 version created.	4.0.0	5.0.0
12-2004	SP-26	-	-	-	Release 6 version created.	5.0.0	6.0.0
06-2007	SP-36	-	-	-	Release 7 version created.	6.0.0	7.0.0
12-2008	SP-42	-	-	-	Release 8 version created	7.0.0	8.0.0
2009-12	-	-	-	-	Release 9 version created	8.0.0	9.0.0