

Higgs 3 IC Datasheet Supplement

An

EPCglobal™ Compliant

Class-1 Generation-2 (V 1.2.0)

And

ISO/IEC 18000-6C

UHF RFID Integrated Circuit



Draft V1.0.2

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1 Introduction

This document specifies the operational and parametric requirements for Alien Technology's Higgs 3 IC, an EPCglobal™ Class-1 Generation-2 (V 1.2.0) and ISO/IEC 18000-6C compliant IC. Higgs 3 IC is a self contained SoC device that when assembled with an antenna completes a passive RFID tag. The EPC™ Class-1 Generation-2 specification is referred herein as the "EPC Global", and defines and specifies operation of Interrogator-Tag systems.

Applications for Higgs 3 IC include:

- supply chain management (SCM)
- distribution logistics
- asset inventory and tracking
- airline baggage handling and identification
- express parcel ID, tracking and delivery
- item level tagging
- remote article identification
- factory automation
- brand protection
- object theft detection

2 Identification

This application note applies to Higgs 3 IC's manufactured by Alien Technology which has the manufacturing code in the TID which is listed in Table 1. These values may be read using the protocol read command at the word offsets indicated. The features described in this application note may vary in other IC's.

Table 1, Applicable TID Values

Membank	Offset	Contents	Meaning
TID (2)	0	0xE200	EPC Global ACI, Alien Manufacturer Code upper bits
TID (2)	1	0x3412	Alien Manufacturer Code lower bits, Higgs 3 IC

3 Higgs 3 IC Overview and Architecture

3.1 Overview

3.1.1 Device Power

The Higgs 3 IC is connected via two terminals to a suitable antenna, together comprising a Tag. Higgs 3 IC operating power is derived from RF energy transmitted by an Interrogator and coupled through the Tag Antenna into the Device.

3.1.2 Interrogator-to-IC Communication

Interrogators modulate their RF transmission in order to communicate commands and information to the IC. The Interrogator sends binary information to the IC by modulating the phase and/or amplitude of its RF transmission using pulse interval encoding. Modulated Interrogator transmissions appear as an amplitude modulated RF envelope at the IC terminals, independent of the modulation type allowed by EPC Global (DSB-ASK, SSB-ASK, or PR-ASK). After issuing a command, the Interrogator transmits unmodulated RF energy to maintain IC operating power while it awaits a reply from the IC.

3.1.3 IC-to-Interrogator Communication

The IC follows an “Interrogator talks first” (ITF) protocol, and will not execute a command unless it is valid and appropriate for the IC. The IC will not respond until the Interrogator has completed its command transmission. The IC replies to Interrogator commands by modulating the real and/or complex components of its input impedance, causing the RF power reflected by the Tag antenna to vary with the modulation. Interrogators detect the variation in reflected RF power, demodulate and decode the Tag reply. An Interrogator may transmit subsequent commands in order to identify data stored in the IC or to set operating states.

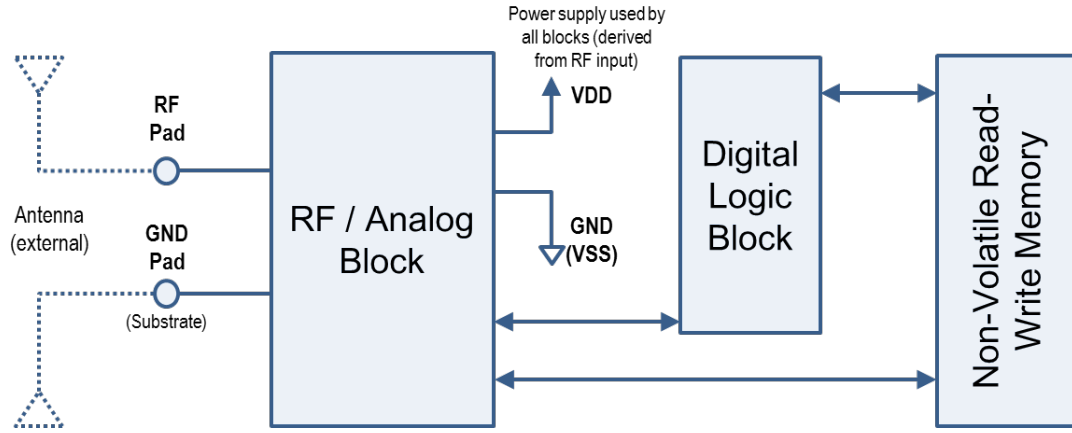
3.1.4 Memory

The IC contains a total of 800 bits of read-write non-volatile memory (NVM), which supports up to 496 bits of Electronic Product Code (EPC) data, 512 bits of NVM for User data and 64 bits of NVM for Reserve data (Passwords). Alien-specific data is also stored in the NVM. Individual NVM bits may be programmed to the logical “0” or “1” states through programming commands. NVM memory may be locked to prevent tampering or inadvertent data corruption. The IC may be killed to prevent subsequent use. The kill operation is permanent.

3.2 Higgs 3 IC Architecture

The block diagram represents the major functional sections of the IC. The tag antenna interconnects via two RF pads.

Figure 3.1 – Higgs 3 IC block diagram



3.2.1 RF / Analog Block

The two IC terminals interface with the Tag antenna through the RF/Analog Block. This block performs all RF functions, such as converting RF input power to DC operating power, detection of RF envelope modulation, and input impedance modulation to create the backscatter reply to an Interrogator. This block also contains all analog functional blocks that provide functions such as ESD protection, voltage clamping and regulation, current sources, POR, oscillators, persistent nodes, and others.

3.2.2 Digital Logic Block

The Digital Logic Block contains the state machine that fulfills the functional logic requirements of EPC Global. This block performs the timing calibration functions required by EPC Global. This block parses, decodes, and executes Interrogator commands according to the rules established by the EPC Global. This block performs all addressing, reading, writing and control of the NVM memory block, including logical to physical memory mapping. It also contains ROM and volatile registers. Engines for calculating the CRC of incoming messages, outgoing messages and stored data are contained in this block. Random number generation is performed by this block. Persistent flag control is performed by this block. Reply messages in response to Interrogator commands are assembled and encoded by this block and sent to the RF/Analog Block for backscatter modulation.

3.2.3 Non-Volatile Read-Write Memory Block

The NVM contains all read-write data storage cells required to support EPC Global, as well as programmable configuration memory. The NVM block contains access and control logic, sense amplifiers for reading storage cells, and the charge pump for programming data into the NVM cells. Total memory capacity is 800 bits.

4 Specifications

4.1 Absolute Maximum Ratings

Table 4.1 – Absolute maximum ratings

Parameter Name	Units	Maximum Rating	Conditions	Comments
ESD Withstand Capability (HBM)	V_{peak}	2000	+25 °C	Survive 3 positive and 3 negative events at the rated voltage with no performance degradation.

Table 4.2 – Environmental and physical specifications

Parameter	Symbol	Units	Min	Typ	Max	Conditions	Comments
Storage Temperature	T_{STOR}	°C	-50		85		
Nominal operating temperature	T_{NOM}	°C	-50	25	85		
Relative humidity		%			98	Packaged in strap / tag	Non-condensing
Die size, per side		µm	-	680	-		

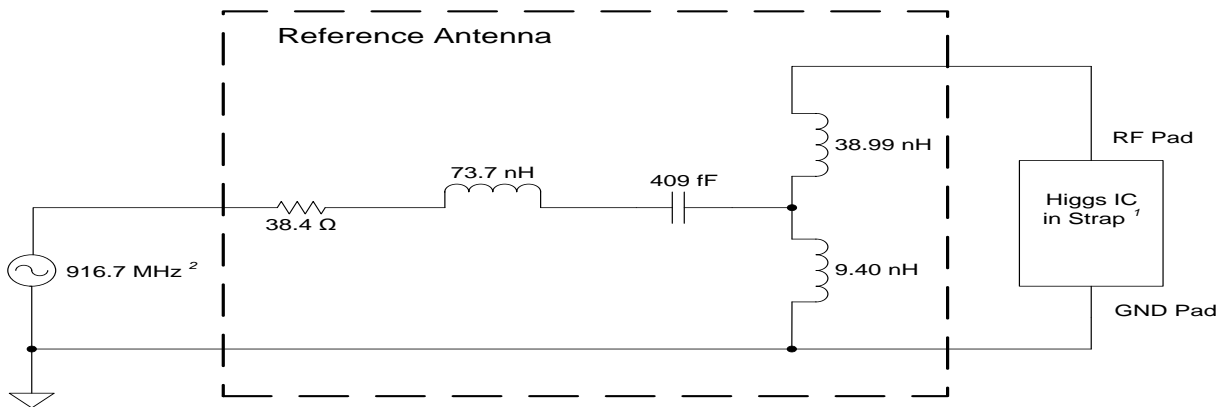
4.2 Key Electrical Specifications

Unless otherwise noted, parameters are specified over the temperature range of -30 °C to +70 °C; command input data rate = 160 kTari and data 1 width = 1.5Tari; reply LF = 640 kHz in FM0 backscatter modulation mode.

Table 4.3 – Key electrical specifications

Parameter	Symbol	Units	Min.	Typ.	Max.	Conditions	Comments
RF Frequency	RF	MHz	860	915	960		
RF input capacitance	C_{in}	pF		0.85		25 °C	@ -14dBm input power
RF input resistance	R_{in}	kΩ		1500			
Minimum RF communication power	$P_{com(min)}$	dBm		-18			
Minimum RF programming power	$P_P(min)$	dBm		-11.5		25 °C	Complete transaction (controlled by RF input impedance)
Minimum RF programming power NVM program endurance	$P_P(min)$	dBm cycles		-11.5		25 °C	Word write (16-bits)
			100,000				Full array write (192-bits)
NVM data retention		years	50			full V_P range	

5 Reference Antenna Design



- 1: The strap adds 50 fF (nominal) to the Device input capacitance.
 2: The RF source frequency is approximately at the center of the North American band (902 – 928 MHz).

Figure 5.1 – Reference antenna for Higgs strap

5.1 Logical Memory Map

Reserved (System) Bank																
Bit transmission order into or out of Device →																
Reserved Bank [00], Row 0	Kill Password (hi), (NVM)															
Field Name >	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
Reserved Bank [00], Row 1	Kill Password (lo), (NVM)															
Field Name >	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW	KPW
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Reserved Bank [00], Row 2	Access Password (hi), (NVM)															
Field Name >	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
Reserved Bank [00], Row 3	Access Password (lo) (NVM)															
Field Name >	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW	APW
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F

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EPC Bank																
Bit transmission order into or out of Device →																
EPC Bank [01], Row 0	EPC CRC (Register, Read Only) (calculated at power-up & stored at this address)															
Field Name >	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC	CRC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
EPC Bank [01], Row 1	Protocol Control (NVM)															
Field Name >						UMI (Reg Read Only)	(Reg Read Only)									
Field Bit # >	LEN	LEN	LEN	LEN	LEN			NSI	NSI	NSI	NSI	NSI	NSI	NSI	NSI	NSI
External Hex Bit Address	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Value >							0									
EPC Bank [01], Row 2	Electronic Product Code (NVM) Exists for EPC length = 0 thru 30 -- EPC Word 0 (MS)															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
EPC Bank [01], Row 3	Electronic Product Code (NVM) Exists for EPC length = 0 thru 30 -- EPC Word 1															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
EPC Bank [01], Row 4	Electronic Product Code (NVM) Exists for EPC length = 3 thru 30 -- EPC Word 2															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
EPC Bank [01], Row 5	Electronic Product Code (NVM) Exists for EPC length = 3 thru 30 -- EPC Word 3															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
EPC Bank [01], Row 6	Electronic Product Code (NVM) Exists for EPC length = 3 thru 30 -- EPC Word 4															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
EPC Bank [01], Row 7	Electronic Product Code, (NVM) Exists for EPC length = 3 thru 30 -- EPC Word 5															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F

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EPC Bank [01], Row 8	Electronic Product Code, (NVM) Exists for EPC length = 7 thru 31 -- EPC Word 6															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
EPC Bank [01], Row 9	Electronic Product Code, (NVM) Exists for EPC length = 7 thru 31 -- EPC Word 7															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
EPC Bank [01], Row 10	Electronic Product Code, (NVM) Exists for EPC length = 7 thru 31 -- EPC Word 8															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
EPC Bank [01], Row 11	Electronic Product Code, (NVM) Exists for EPC length = 7 thru 31 -- EPC Word 9															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
EPC Bank [01], Row 12	Electronic Product Code, (NVM) Exists for EPC length = 11 thru 31 -- EPC Word 10															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
EPC Bank [01], Row 13	Electronic Product Code, (NVM) Exists for EPC length = 11 thru 31 -- EPC Word 11															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
EPC Bank [01], Row 14	Electronic Product Code, (NVM) Exists for EPC length = 11 thru 31 -- EPC Word 12															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF
EPC Bank [01], Row 15	Electronic Product Code, (NVM) Exists for EPC length = 11 thru 31 -- EPC Word 13															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF
EPC Bank [01], Row 16	Electronic Product Code, (NVM) Exists for EPC length = 15 thru 31 -- EPC Word 14															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	100	101	102	103	104	105	106	107	108	109	10A	10B	10C	10D	10E	10F
EPC Bank [01], Row 17	Electronic Product Code, (NVM) Exists for EPC length = 15 thru 31 -- EPC Word 15															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC

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Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F
EPC Bank [01], Row 18	Electronic Product Code, (NVM) Exists for EPC length = 15 thru 31 -- EPC Word 16															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	120	121	122	123	124	125	126	127	128	129	12A	12B	12C	12D	12E	12F
EPC Bank [01], Row 19	Electronic Product Code, (NVM) Exists for EPC length = 15 thru 31 -- EPC Word 17															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	130	131	132	133	134	135	136	137	138	139	13A	13B	13C	13D	13E	13F
EPC Bank [01], Row 20	Electronic Product Code, (NVM) Exists for EPC length = 19 thru 31 -- EPC Word 18															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	140	141	142	143	144	145	146	147	148	149	14A	14B	14C	14D	14E	14F
EPC Bank [01], Row 21	Electronic Product Code, (NVM) Exists for EPC length = 19 thru 31 -- EPC Word 19															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	150	151	152	153	154	155	156	157	158	159	15A	15B	15C	15D	15E	15F
EPC Bank [01], Row 22	Electronic Product Code, (NVM) Exists for EPC length = 19 thru 31 -- EPC Word 20															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	160	161	162	163	164	165	166	167	168	169	16A	16B	16C	16D	16E	16F
EPC Bank [01], Row 23	Electronic Product Code, (NVM) Exists for EPC length = 19 thru 31 -- EPC Word 21															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	170	171	172	173	174	175	176	177	178	179	17A	17B	17C	17D	17E	17F
EPC Bank [01], Row 24	Electronic Product Code, (NVM) Exists for EPC length = 23 thru 31 -- EPC Word 22															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	180	181	182	183	184	185	186	187	188	189	18A	18B	18C	18D	18E	18F
EPC Bank [01], Row 25	Electronic Product Code, (NVM) Exists for EPC length = 23 thru 31 -- EPC Word 23															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	190	191	192	193	194	195	196	197	198	199	19A	19B	19C	19D	19E	19F
EPC Bank [01], Row 26	Electronic Product Code, (NVM) Exists for EPC length = 23 thru 31 -- EPC Word 24															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1A0	1A1	1A2	1A3	1A4	1A5	1A6	1A7	1A8	1A9	1AA	1AB	1AC	1AD	1AE	1AF
EPC Bank [01], Row 27	Electronic Product Code, (NVM) Exists for EPC length = 23 thru 31 -- EPC Word 25															
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC

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Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1B0	1B1	1B2	1B3	1B4	1B5	1B6	1B7	1B8	1B9	1BA	1BB	1BC	1BD	1BE	1BF
EPC Bank [01], Row 28 Electronic Product Code, (NVM) Exists for EPC length = 27 thru 31 -- EPC Word 26																
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1C0	1C1	1C2	1C3	1C4	1C5	1C6	1C7	1C8	1C9	1CA	1CB	1CC	1CD	1CE	1CF
EPC Bank [01], Row 29 Electronic Product Code, (NVM) Exists for EPC length = 27 thru 31 -- EPC Word 27																
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1D0	1D1	1D2	1D3	1D4	1D5	1D6	1D7	1D8	1D9	1DA	1D1D	1DC	1DD	1DE	1DF
EPC Bank [01], Row 30 Electronic Product Code, (NVM) Exists for EPC length = 27 thru 30 -- EPC Word 28																
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1E0	1E1	1E2	1E3	1E4	1E5	1E6	1E7	1E8	1E9	1EA	1E1E	1EC	1ED	1EE	1EF
EPC Bank [01], Row 31 Electronic Product Code, (NVM) Exists for EPC length = 27 thru 30 -- EPC Word 29																
Field Name >	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC	EPC
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1F0	1F1	1F2	1F3	1F4	1F5	1F6	1F7	1F8	1F9	1FA	1F1F	1FC	1FD	1FE	1FF
TID Bank Bit transmission order into or out of Device →																
TID Bank [10], Row 0 EPC / ISO / Manufacturer Codes (hi), (ROM)																
Field Name >	ACI	ACI	ACI	ACI	ACI	ACI	ACI	ACI	TMDI	TMDI	TMDI	TMDI	TMDI	TMDI	TMDI	TMDI
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
Value >	<i>1</i>	<i>1</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Info >	EPCglobal Allocation Class Indicator								Alien Mfr Code (upper bits)							
TID Bank [10], Row 1 EPC / ISO / Manufacturer Codes (lo), (ROM)																
Field Name >	TMD	TMD	TMD	TMD	TMN	TMN	TMN	TMN	TMN	TMN	TMN	TMN	TMN	TMN	TMN	TMN
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Value >	<i>0</i>	<i>0</i>	<i>1</i>	<i>1</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>
Info >	Alien Mfr Code (Lo bits)				Model Series = 4 (Higgs)				Major Rev. = 1				Minor Rev. = 2			
TID Bank [10], Row 2 Unique ID Word 0, (NVM) (MS Word)																
Field Name >	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
Value (UID Mask) >	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>

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TID Bank [10], Row 3	Unique ID Word 1, (NVM)															
Field Name >	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
<i>Value (UID Mask) ></i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TID Bank [10], Row 4	Unique ID Word 2, (NVM)															
Field Name >	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
<i>Value (UID Mask) ></i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TID Bank [10], Row 5	Unique ID Word 3, (LS Word) (NVM, NOT effected by Erase 256)															
Field Name >	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID	UID
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
<i>Value (UID Mask) ></i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TID Bank [10], Row 6	Reserved (ROM)															
Field Name >																
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
<i>Value (UID Mask) ></i>																
<i>Info ></i>																
TID Bank [10], Row 7	Reserved (Read Only Register)															
Field Name >	Reserved				Reserved											
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
<i>Value (UID Mask) ></i>	0	0	0	0												
TID Bank [10], Row 8	Reserved (Read Only register and ROM)															
Field Name >	Reserved				Reserved											
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
<i>Value (UID Mask) ></i>					0	0	0	0	0	0	0	0	0	0	1	1
<i>Info ></i>																
TID Bank [10], Row 9	Reserved (NVM)															
Field Name >	Reserved															
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
<i>Value ></i>																

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TID Bank [10], Row 10	Reserved (NVM)																
Field Name >	Reserved																
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF	
<i>Value ></i>																	
TID Bank [10], Row 11	Reserved																
Field Name >	Reserved																
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF	
<i>Values ></i>																	
User Bank																	
Bit transmission order into or out of Device →																	
User Bank [11], Row 0	User ID, (NVM) Exists for EPC length = 0 thru 30 -- MS Word																
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	
<i>Info></i>				A logic "1" value in any bit cell signals data in User Bank for calculating XI bit in PC													
User Bank [11], Row 1	User ID, (NVM) Exists for EPC length = 0 thru 30																
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	
User Bank [11], Row 2	User ID, (nvm) Exists for EPC length = 0 thru 30																
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	
User Bank [11], Row 3	User ID, (NVM) Exists for EPC length = 0 thru 30																
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	
User Bank [11], Row 4	User ID, (NVM) Exists for EPC length = 0 thru 30																
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
External Hex Bit Address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	
User Bank [11], Row 5	User ID, (NVM) Exists for EPC length = 0 thru 30																

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Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
User Bank [11], Row 6	User ID, (NVM) Exists for EPC length = 0 thru 30															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
User Bank [11], Row 7	User ID, (NVM) Exists for EPC length = 0 thru 30															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
User Bank [11], Row 8	User ID, (NVM) Exists for EPC length = 0 thru 26															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
User Bank [11], Row 9	User ID, (NVM) Exists for EPC length = 0 thru 26															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
User Bank [11], Row 10	User ID, (NVM) Exists for EPC length = 0 thru 26															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
User Bank [11], Row 11	User ID, (NVM) Exists for EPC length = 0 thru 26															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
User Bank [11], Row 12	User ID, (NVM) Exists for EPC length = 0 thru 22															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
User Bank [11], Row 13	User ID, (NVM) Exists for EPC length = 0 thru 22															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
User Bank [11], Row 14	User ID, (NVM) Exists for EPC length = 0 thru 22															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

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External Hex Bit Address	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF
User Bank [11], Row 15	User ID, (NVM) Exists for EPC length = 0 thru 22															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF
User Bank [11], Row 16	User ID, (NVM) Exists for EPC length = 0 thru 18															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	100	101	102	103	104	105	106	107	108	109	10A	10B	10C	10D	10E	10F
User Bank [11], Row 17	User ID, (NVM) Exists for EPC length = 0 thru 18															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F
User Bank [11], Row 18	User ID, (NVM) Exists for EPC length = 0 thru 18															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	120	121	122	123	124	125	126	127	128	129	12A	12B	12C	12D	12E	12F
User Bank [11], Row 19	User ID, (NVM) Exists for EPC length = 0 thru 18															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	130	131	132	133	134	135	136	137	138	139	13A	13B	13C	13D	13E	13F
User Bank [11], Row 20	User ID, (NVM) Exists for EPC length = 0 thru 14															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	140	141	142	143	144	145	146	147	148	149	14A	14B	14C	14D	14E	14F
User Bank [11], Row 21	User ID, (NVM) Exists for EPC length = 0 thru 14															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	150	151	152	153	154	155	156	157	158	159	15A	15B	15C	15D	15E	15F
User Bank [11], Row 22	User ID, (NVM) Exists for EPC length = 0 thru 14															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	160	161	162	163	164	165	166	167	168	169	16A	16B	16C	16D	16E	16F
User Bank [11], Row 23	User ID, (NVM) Exists for EPC length = 0 thru 14															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	170	171	172	173	174	175	176	177	178	179	17A	17B	17C	17D	17E	17F

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User Bank [11], Row 24	User ID, (NVM) Exists for EPC length = 0 thru 10															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	180	181	182	183	184	185	186	187	188	189	18A	18B	18C	18D	18E	18F
User Bank [11], Row 25	User ID, (NVM) Exists for EPC length = 0 thru 10															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	190	191	192	193	194	195	196	197	198	199	19A	19B	19C	19D	19E	19F
User Bank [11], Row 26	User ID, (NVM) Exists for EPC length = 0 thru 10															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1A0	1A1	1A2	1A3	1A4	1A5	1A6	1A7	1A8	1A9	1AA	1AB	1AC	1AD	1AE	1AF
User Bank [11], Row 27	User ID, (NVM) Exists for EPC length = 0 thru 10															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1B0	1B1	1B2	1B3	1B4	1B5	1B6	1B7	1B8	1B9	1BA	1BB	1BC	1BD	1BE	1BF
User Bank [11], Row 28	User ID, (NVM) Exists for EPC length = 0 thru 6															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address>	1C0	1C1	1C2	1C3	1C4	1C5	1C6	1C7	1C8	1C9	1CA	1CB	1CC	1CD	1CE	1CF
User Bank [11], Row 29	User ID, (NVM) Exists for EPC length = 0 thru 6															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1D0	1D1	1D2	1D3	1D4	1D5	1D6	1D7	1D8	1D9	1DA	1DB	1DC	1DD	1DE	1DF
User Bank [11], Row 30	User ID, (NVM) Exists for EPC length = 0 thru 6															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1E0	1E1	1E2	1E3	1E4	1E5	1E6	1E7	1E8	1E9	1EA	1EB	1EC	1ED	1EE	1EF
User Bank [11], Row 31	User ID, (NVM) Exists for EPC length = 0 thru 6 --- LS Word															
Field Name >	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User	User
Field Bit # >	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
External Hex Bit Address	1F0	1F1	1F2	1F3	1F4	1F5	1F6	1F7	1F8	1F9	1FA	1FB	1FC	1FD	1FE	1FF

6 Supported Commands

Note that the form of the required and optional commands is specified in the EPCGlobal Gen 2 v 1.2 protocol documentation. All mandatory EPCglobal commands are supported including the following optional and custom commands. For further details on usage of custom commands please reference the "Custom Command Usage Datasheet" (available under special legal agreement from Alien Technology).

Optional commands as specified in EPCglobal that are supported are

1. BlockPermaLock: Block lengths are 32 bits and a total of 4 blocks

Custom commands

1. BlockReadLock: Allows the blocks of the user memory to be read locked
2. LoadImage / FastLoadImage: Memory bank initialization