



AUTO-ID CENTER

**STANDARDS FOR
HF EPC TAGS**

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OBJECTIVES OF STANDARD

- Operation at 13.56 MHz
- Ultra low cost read only labels
- Extensible to higher class labels
- Rapid multiple label reading
- Robust signalling
- Provision for user programming
- Supportive of a range of manufacturing technologies
- Provision for label destruction
- Industry will want to make it
- We specify necessary signalling and protocols
- Encourage industry to describe manufacturing



EPC BASIC CONCEPTS

The EPC code structure is
version-domain manager-object class-serial number



Longer codes will be defined



LABEL MEMORY CONTENT

96 bit codes



$$96+16+24=136 \text{ bits}$$

64 bit codes



$$64+16+24=104 \text{ bits}$$

We see a 16 bit CRC and a 24 bit destruct password have been added



MULTIPLE READ PROTOCOLS

- Context is EPC labels
- Tree walking is used at UHF
- Interrogator signalling is severely restricted at HF
- Change balance between interrogator and tag signalling
- Slotted terminating adaptive round adopted
- High label throughput
- Suited to dynamic label populations
- Robust collision detection provided



STAR PROTOCOL FEATURES

- Signalling is EMC compliance driven
- Tag selection by section of EPC
- Reply is truncated for efficiency
- Tags reply randomly in slots
- Empty slots are closed early
- Slots are arranged in rounds
- Termination after reading occurs
- Return to round occurs on the conditions
 - Detection of collision
 - Detection of insecure communication
 - Detection of decoding error



TRUNCATED LABEL REPLY

For time efficiency, replies are truncated to omit the section of the EPC used in the selection

Selection and reply with N bit EPC and S bit selection



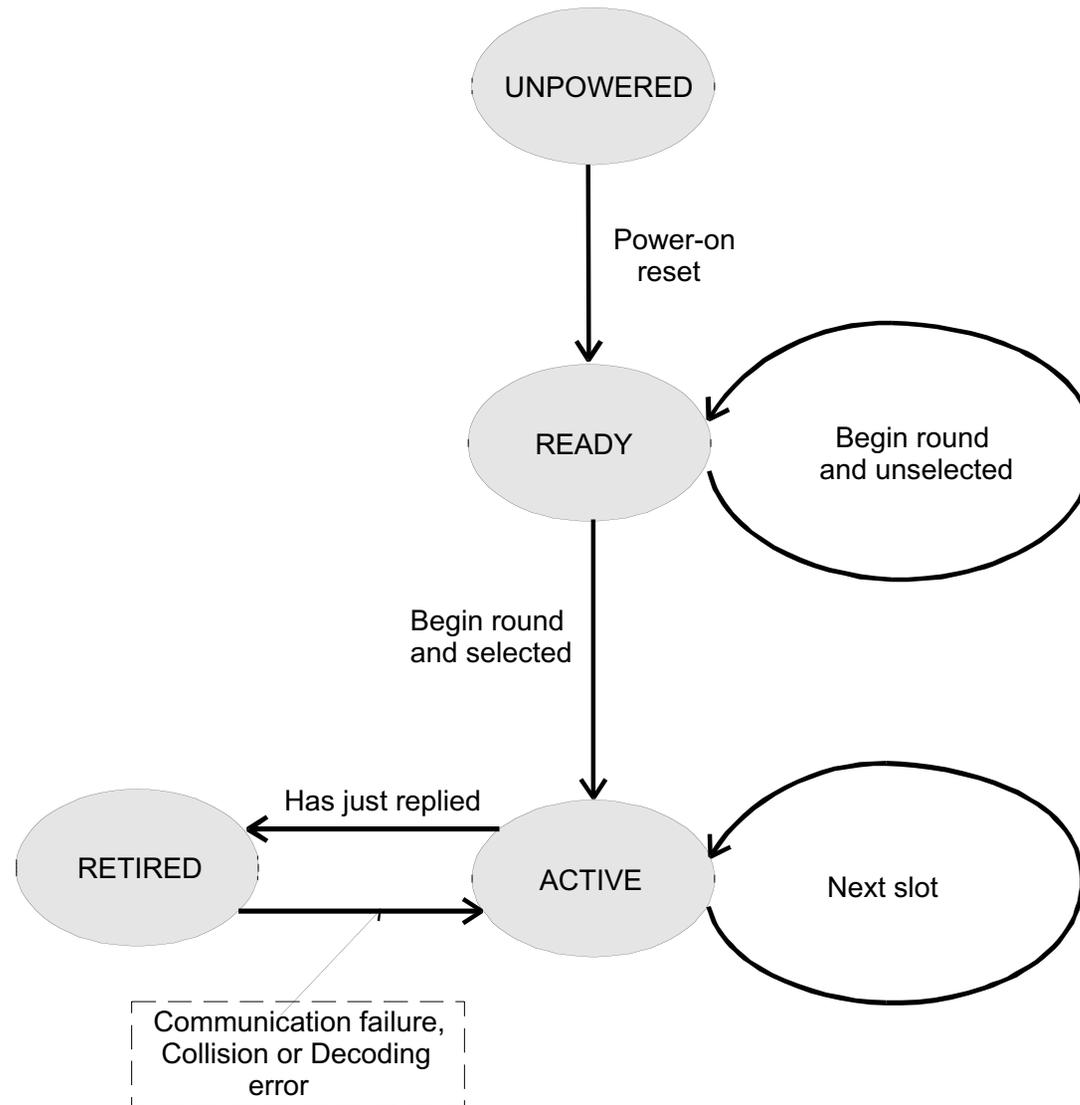
Extent of selection
S bits

Extent of reply
 $N+16-S$ bits

Destruct code does not participate

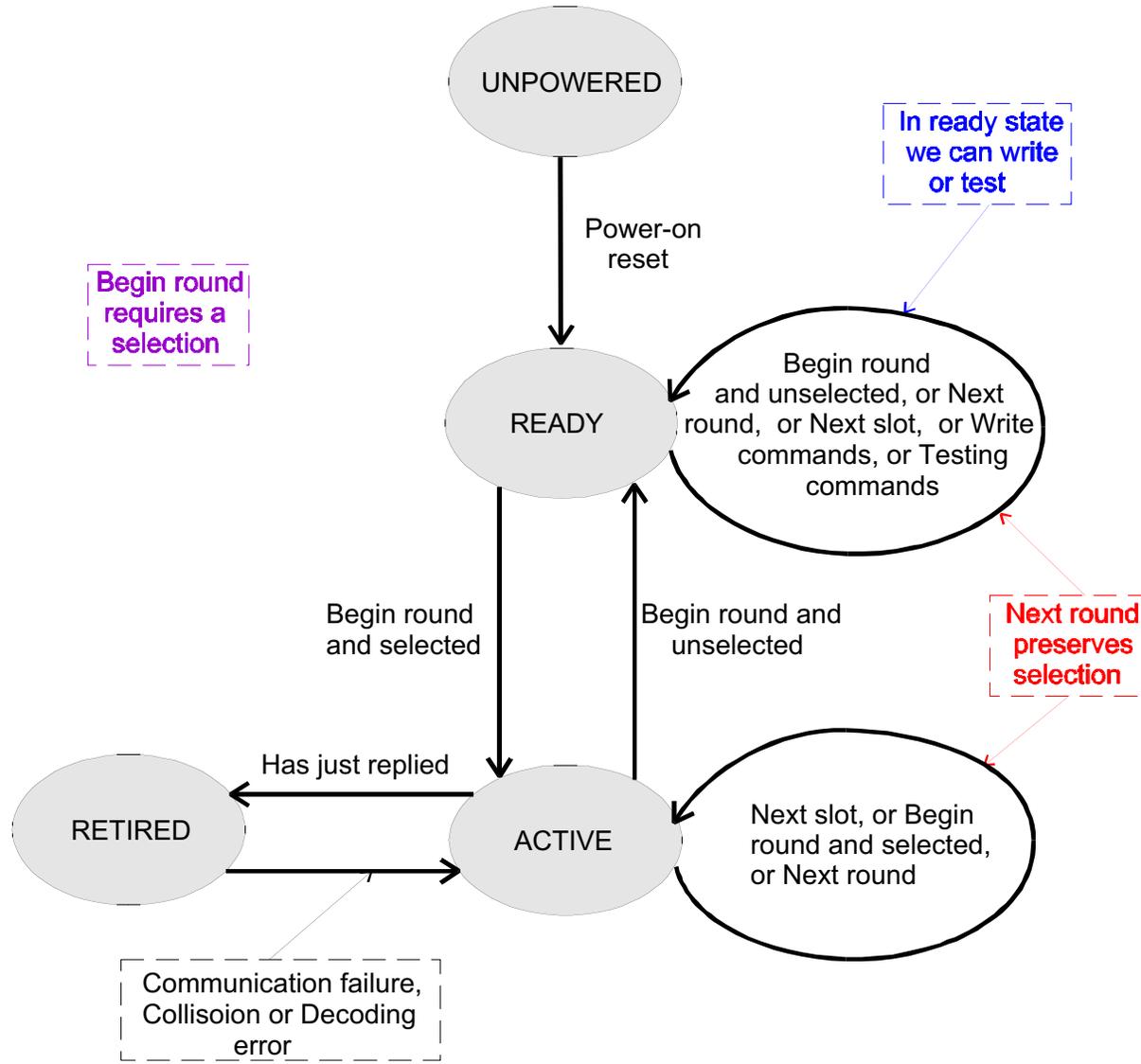


STAR PROTOCOL SIMPLIFIED STATE DIAGRAM



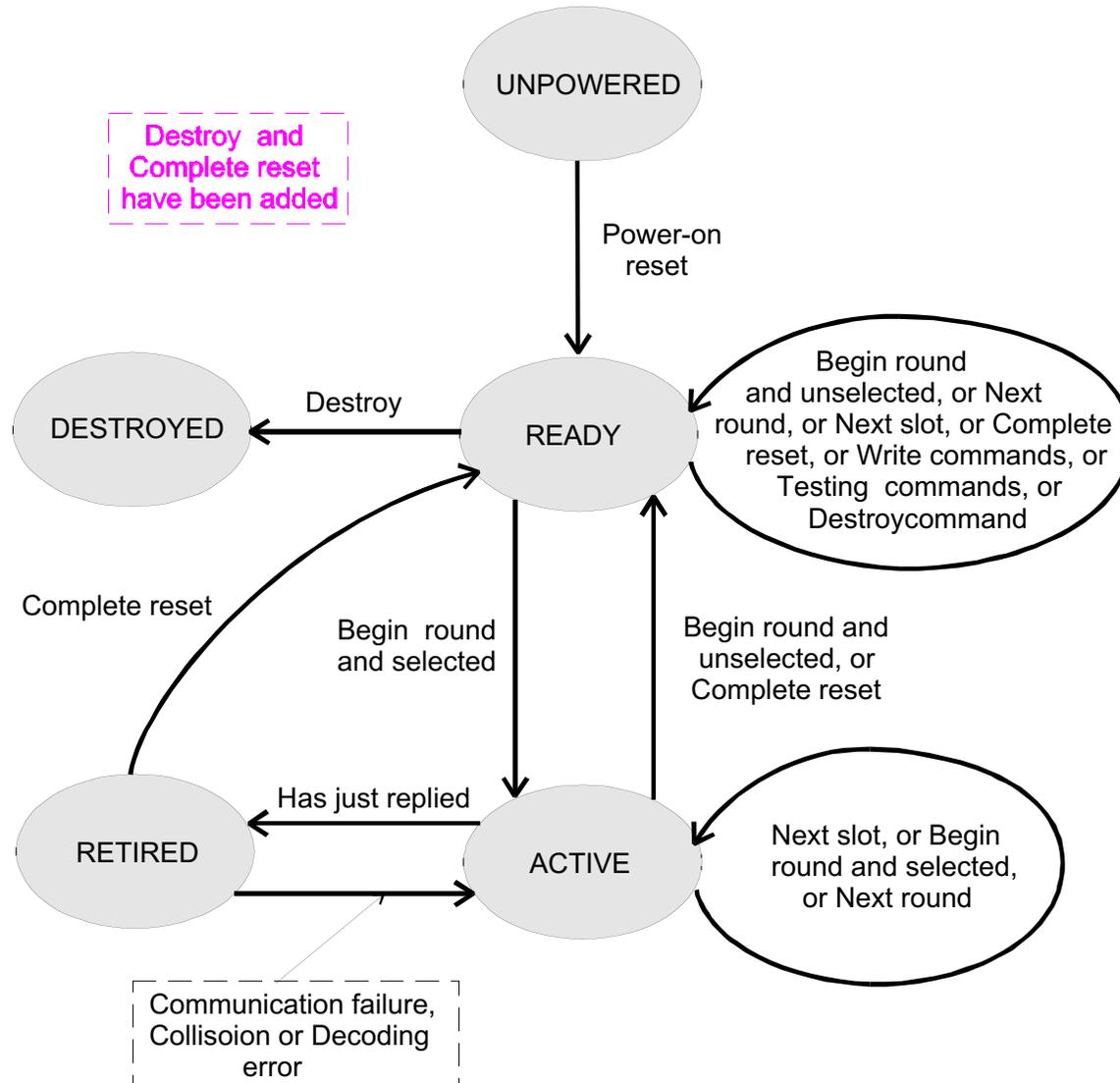


STAR PROTOCOL AUGMENTED STATE DIAGRAM





STAR PROTOCOL FULL STATE DIAGRAM





COLLISION DETECTION

- Collision detection depends on label signalling
- It will be therefore be explained after label signalling



LABEL PROGRAMMING

- Byte at a time
- Eventually the data is locked
- Different memory technologies provided for
- Some commands optional with technology
- Commands
 - Block write
 - Lock block (optional)
 - Lock whole memory (optional)
 - Destroy
 - Chip test commands
 - Reserved commands



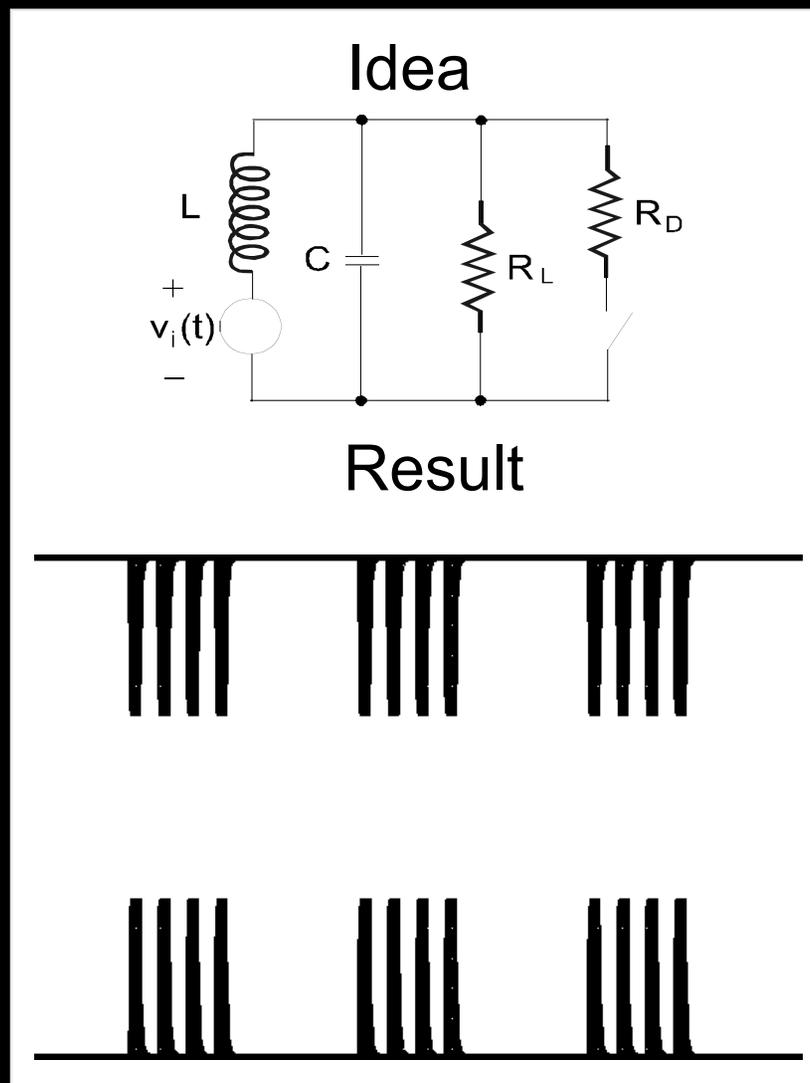
DESTRUCTION

- Requires password
- Password length 24 bits
- Purpose is to frustrate unauthorised attempts
- Avoids precision on chip timing
- Long range destruction not needed



TAG TO INTERROGATOR SIGNALLING

- Sub carrier of 424 kHz is synchronously generated
- Sub carrier modulates the interrogation signal
- Sub carrier is modulated with data
- Binary one is 4 sub carrier cycles followed by equal period of no sub carrier
- Binary zero is 4 sub carrier cycles preceded by equal period of no sub carrier
- This data structure supports collision detection





INTERROGATOR AND LABEL SIGNALLING

- **Interrogator to labels**

Shallow dips 1 in 4 am

Symbols 1, 0, SOF and EOF

Data rate 26.4 kbit/s

8 bit CRC

Designed for compliant long streams

- **Labels to interrogator**

Sub-carrier based

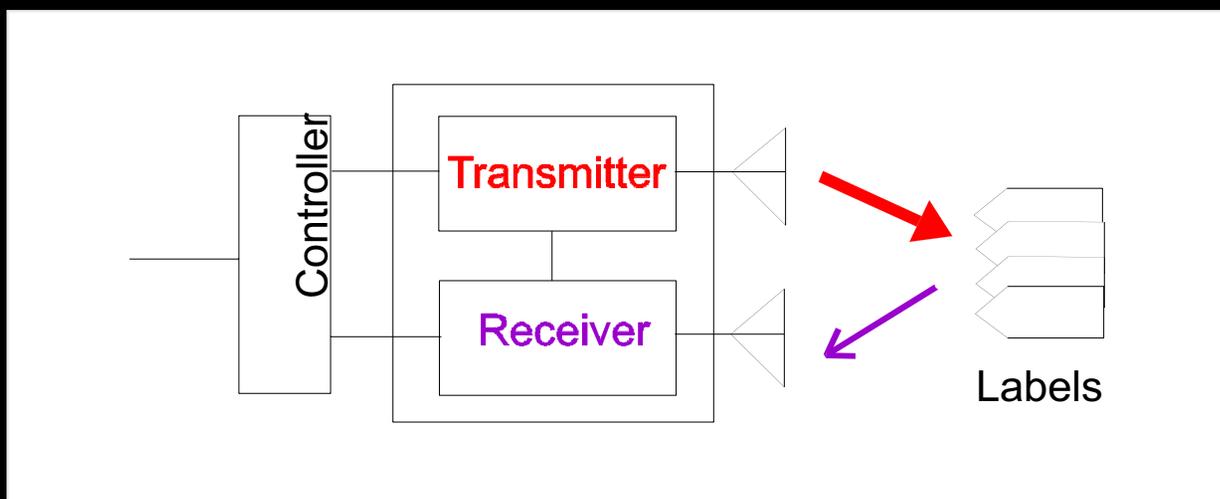
Sub-carrier am for

collision detection

Separate SOF and EOF

Data rate 53 kbit/s

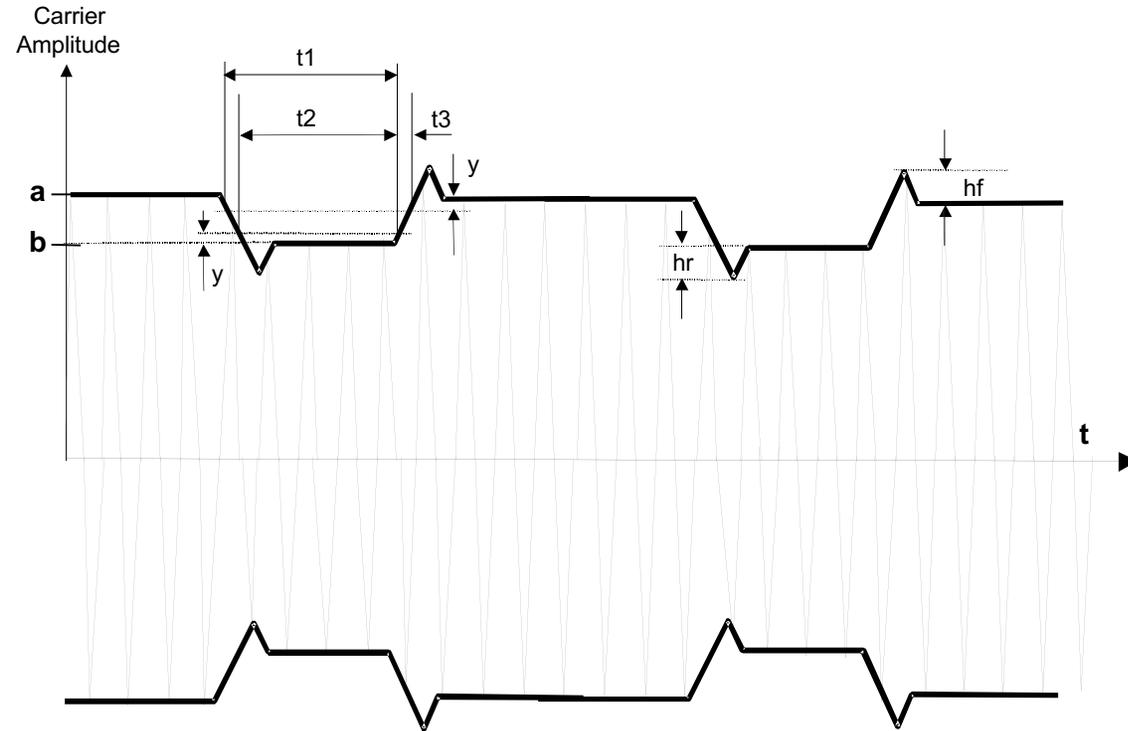
16 bit CRC





BASIC INTERROGATOR TO TAG SIGNALLING PULSE

Two pulses are shown at the minimum separation

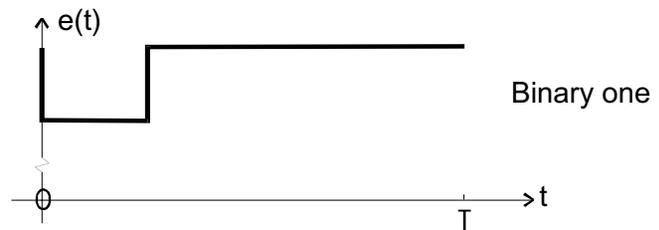
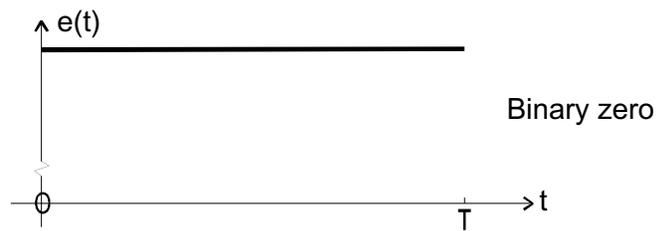
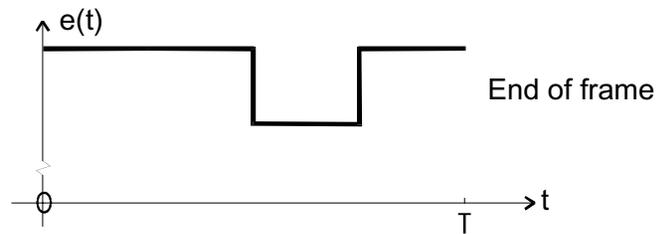
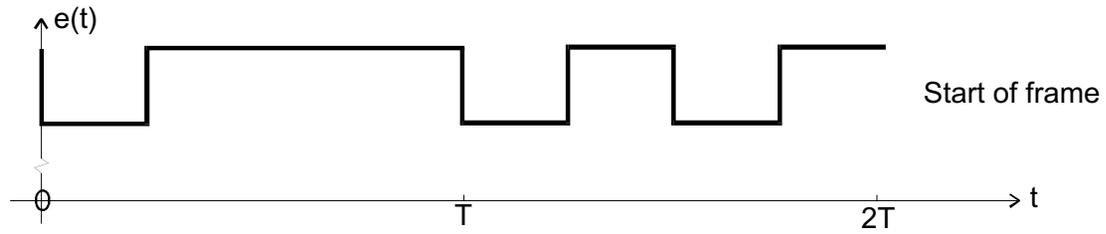


	Min	Max
t1	6,0 μ s	9,44 μ s
t2	3,0 μ s	t1
t3	0	4,5 μ s
Modulation Index	10%	30%

y	0,05 (a-b)
hf, hr	0,1 (a-b) max



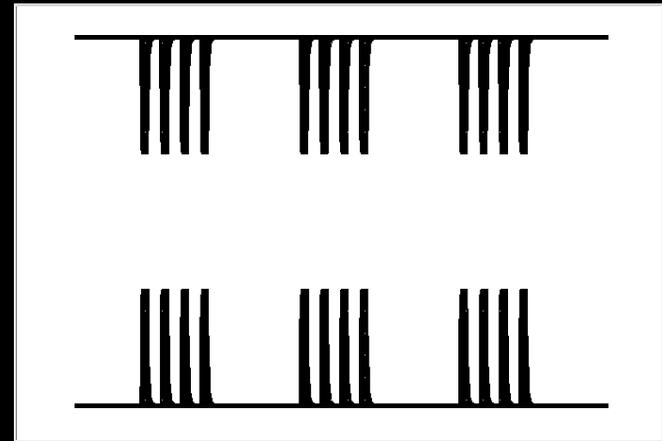
INTERROGATOR TO TAG SYMBOLS



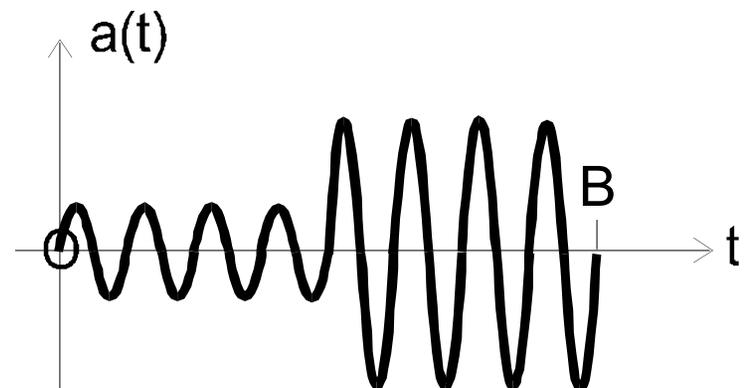
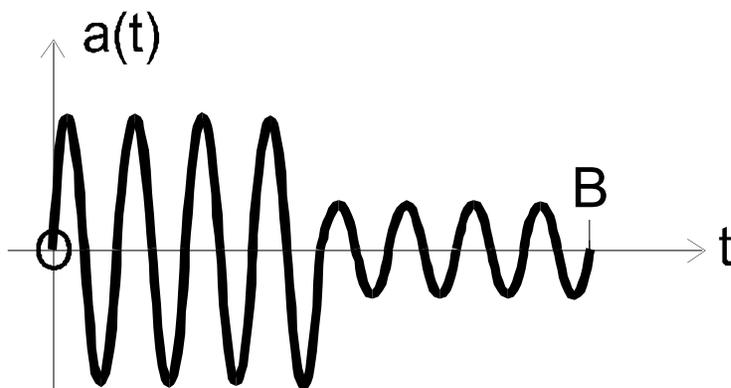


COLLISION DETECTION

- All label contents are different
- Even after reply truncation
- Works by detection of oscillation in quiet period



Each of the diagrams presents a collision as two forms of data are present in a bit period B





OPTIONAL LABEL OR INTERROGATOR FEATURES

- Kernel to retain been-read or not-been-read state
Can be used to efficiently re-align interrogation field
- Mixed modulation in interrogator signals
Allows deeper modulation depth
Will not be perceived by label
Keeps regulators happy



FURTHER WORKING GROUP DEBATES

- Signalling protection by Hamming distance
- Licensing considerations
- Test specifications
- Manufacturing descriptions



STATUS EPC CHIP IMPLEMENTATION

CHRISTOPH KAUER

GENERAL MANAGER

BL TAGS & LABELS, BU

IDENTIFICATION

PHILIPS SEMICONDUCTORS

GRATKORN



FEATURE SET OF PHILIPS EPC IC ACCORDING TO MIT HF CHEAP TAG SPEC

- Memory type OTP (in field)
- Identification rate 100 - 150/sec
- Max. # of labels 500
- Group Select Yes
- Destruct command Yes (password protected)
- Runs on ISO 18000-3 Mode1 infrastructure with dedicated EPC software
- Compliance with FCC47 part 15, EN 300-330, ETSI 300-683



SCHEDULE OF PHILIPS EPC PROJECT

- **DESIGN ALMOST FINISHED**
- **START OF SAMPLE PRODUCTION IN WEEK 24**
- **FIRST SAMPLES AVAILABLE IN SEPT 2002**
- **PARTICIPATION AT FIELD TRIAL IN OCT 2002 ?**
- **HIGH VOLUME PRODUCTION RAMP UP**

FIRST HALF OF 2003 (DEPENDING ON TEST RESULTS)



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AUTO-ID CENTER

THE END

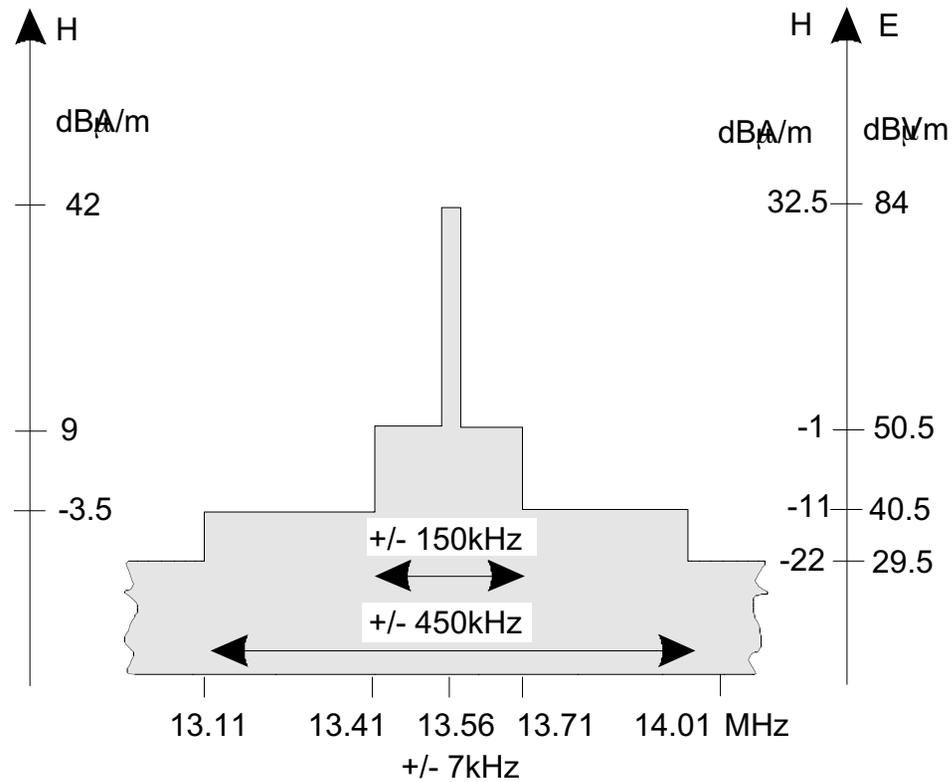
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EMC REGULATIONS AT HF

EUROPEAN REGULATIONS
FIELD STRENGTH
@ D = 10 m

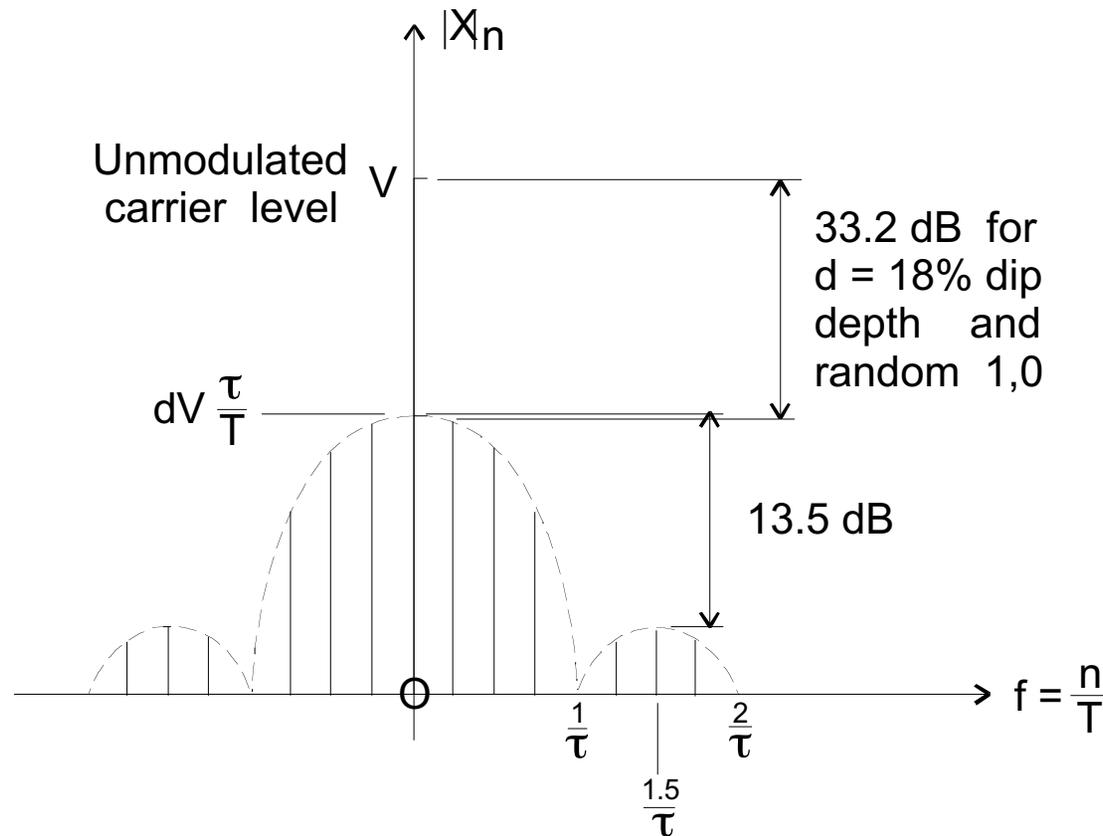
REVISED FCC PETITION
FIELD STRENGTH
@ D = 30 m



ETSI and FCC spectral masks



INTERROGATOR SIGNALLING SPECTRUM



Spectrum of a long interrogator signalling stream