1 Scope:

This document is a guide to read transponders with the MLX90121 that use non-standard ISO14443 or 15693 modulation formats.

The different formats described in this application note are the following:

1. Base band communication: i.e. communication without subcarrier
2. Applications with a subcarrier of 212 kHz
3. ISO18000-3 Mode1 protocol extension and EPC.

Decoding the different modulation types does not require any specific hardware. It only requires a different register configuration setting of the MLX90121.

2 Related Melexis Products:

MLX90121	13.56MHz	Multi-standard tag reader
MLX10111	13.56MHz	Intelligent transponder: This programmable transponder allows emulation of most of the different modulation protocols.

3 Base band communication:

This application note is divided in four parts:

1. Low Data Rates:	up to 40 kb/s.
2. Medium Data Rates:	around 100 kb/s.
3. High Data Rates:	around 200 kb/s.
4. Very High Data Rates:	over 400 kb/s.

3.1 Low data rates:

3.1.1 Configuration:

Address	Register	Data
0	AnalogConfig	0x27
1	PowerState	0x01
3	DigitalConfig	0x09
12	LTC	0x01

The encoder has to be programmed according to the application. The decoder (DecoderTimeRef) is not used.

With this configuration the chip is in ASK configuration with a higher comparator threshold to avoid glitches. The result is a pulse on DOUT at each field edge.

3.1.2 Screen captures:

The following captures show the MLX10111 in direct mode. The response is a Bi-phase coded signal at 4 kb/s.

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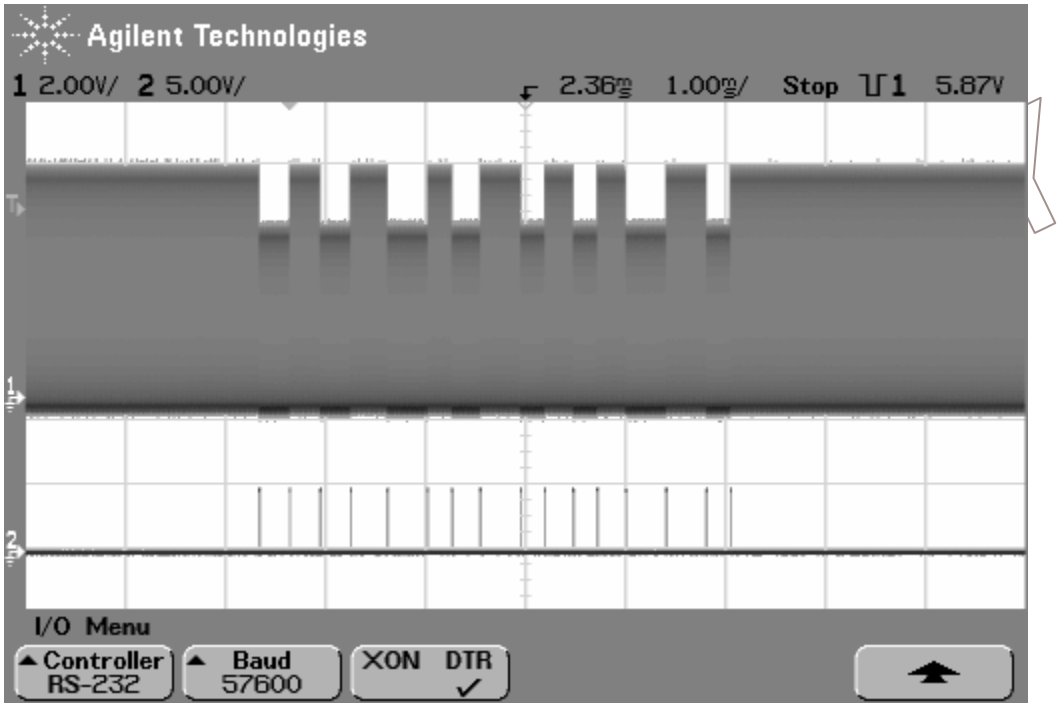
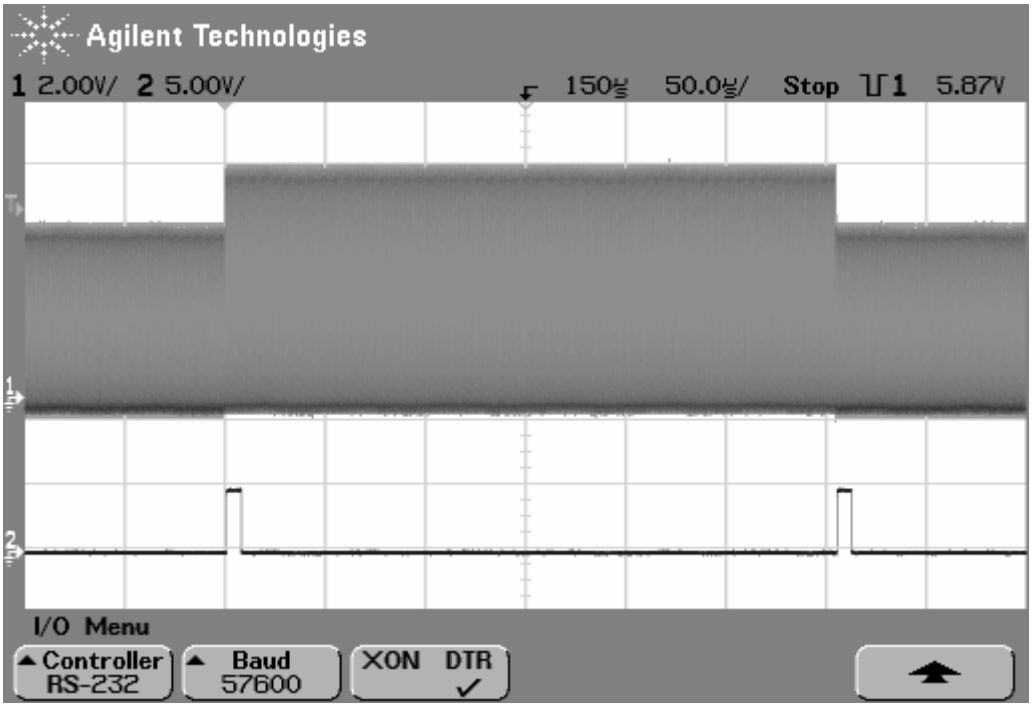


Channel 1: RF Tag response Channel 2: DOUT (MLX90121)

Figure 1: Byte transmission



Channel 1: RF Tag response Channel 2: DOUT (MLX90121)

Figure 2: Zoom to one bit

Typical pulse duration is 6µs.

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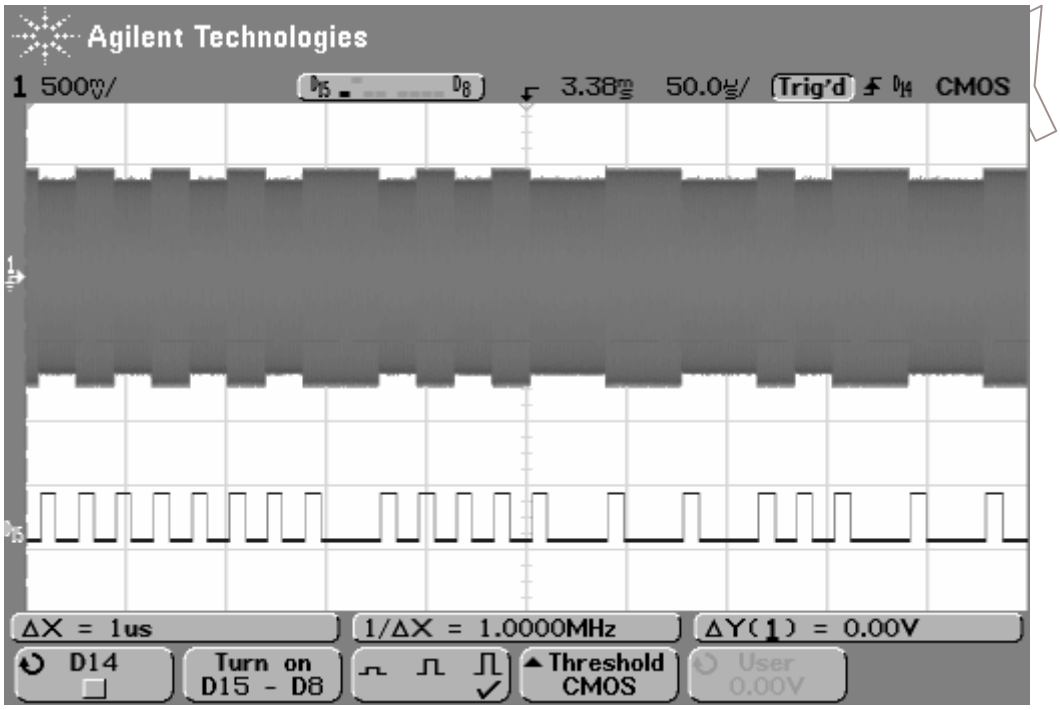
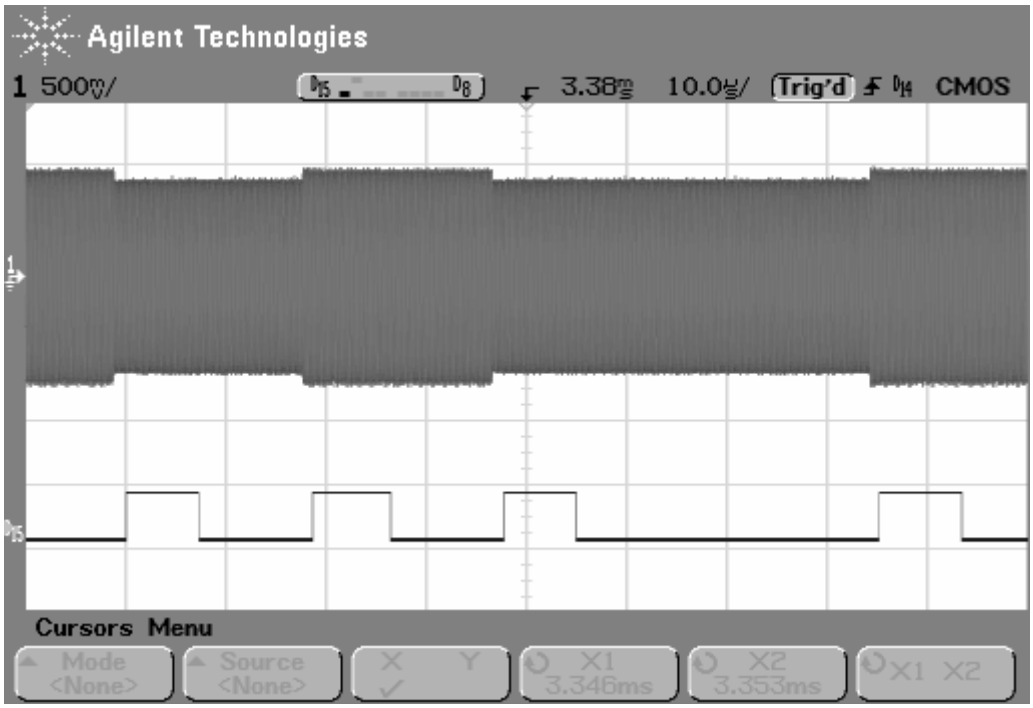
The following captures show an ASIC in base band mode. The response is a Manchester coded signal at 26.5 kb/s.



Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 3: Block reading



Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 4: Block reading, zoom in

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Because of the differentiating character of the receiver, it generates pulses at the rising and falling edges of the modulation signal. Typical pulse duration is 7µs. By software, the complete signal can be properly decoded.

Note: it is not possible to decode NRZ (Non Return to Zero) coded signals.

3.2 Medium Data Rates:

3.2.1 Configuration:

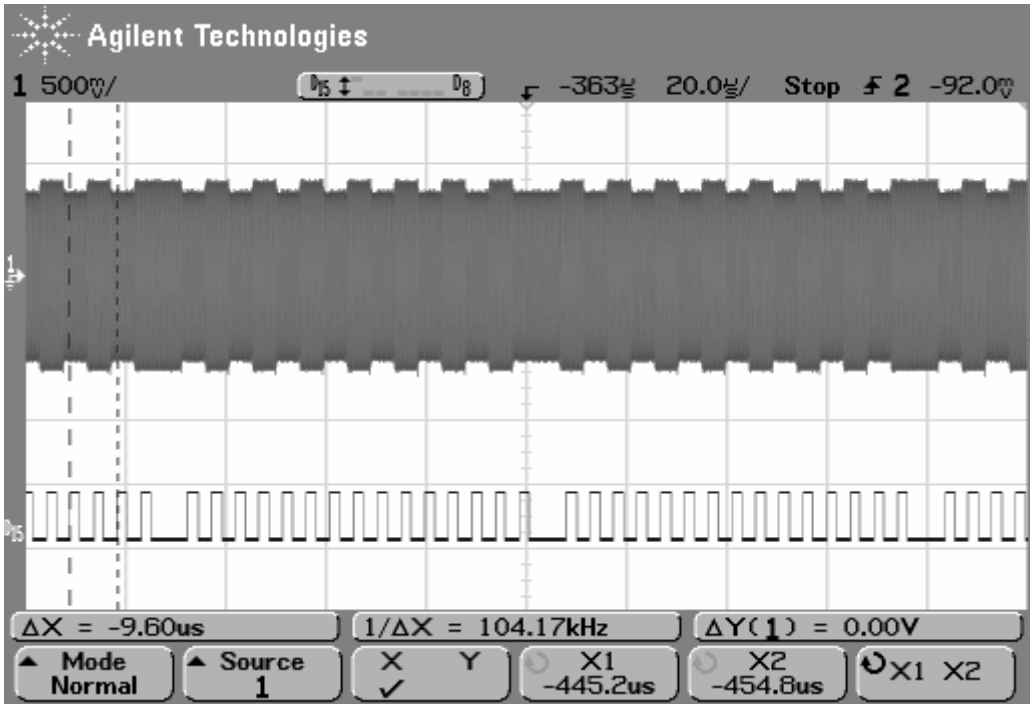
Address	Register	Data
0	AnalogConfig	0x37
1	PowerState	0x01
3	DigitalConfig	0x09
12	LTC	0x00

The encoder has to be programmed accordingly to the application. The decoder (DecoderTimeRef) is not used.

With this configuration the chip is in ASK configuration. The result is a pulse on DOUT at each field edge.

3.2.2 Screen captures:

The following capture shows the MLX10111 replying in BPSK at about 106 kb/s.



Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 5: Pattern response at 104 kb/s

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Here also the receiver chain shows its differentiating character. The phase jumps can be very easily extracted out of the pulse pattern as shown in previous scope screen capture.

Note: it is not possible to decode NRZ (Non Return to Zero) coded signals.

3.3 High Data Rates:

3.3.1 Configuration:

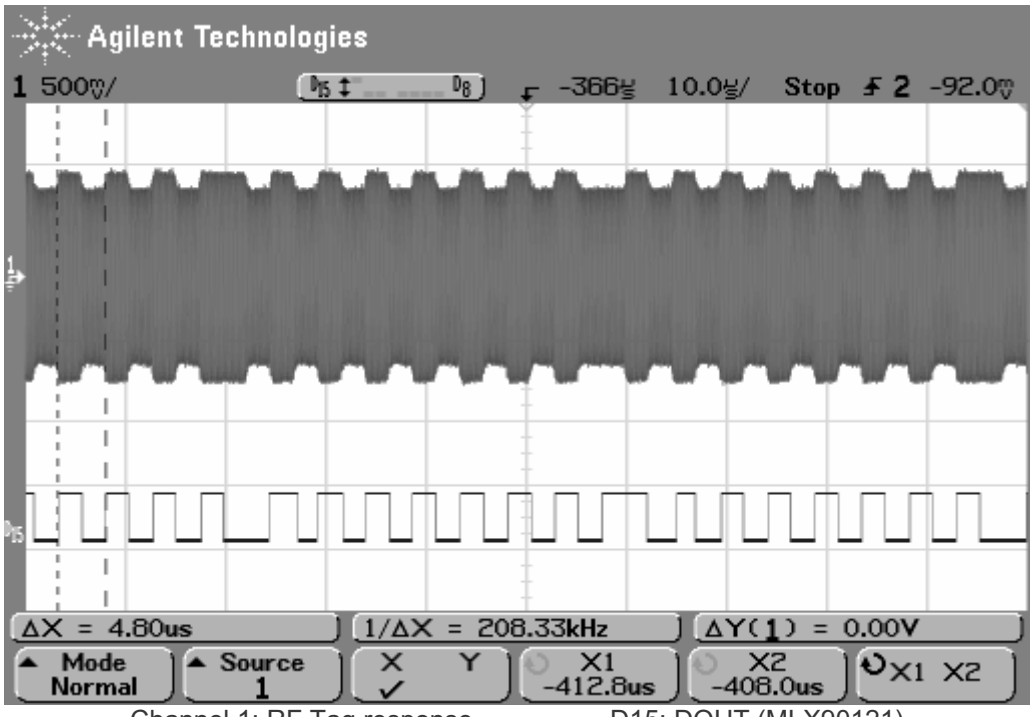
Address	Register	Data
0	AnalogConfig	0x23
1	PowerState	0x01
3	DigitalConfig	0x0B
12	LTC	0x00

The encoder has to be programmed accordingly to the application. The decoder (DecoderTimeRef) is not used.

With this configuration the chip is in FM configuration. The low pass filters and gain blocks have been added.

3.3.2 Screen capture:

The following capture shows the MLX10111 replying in BPSK at about 212 kb/s.



Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 6: Pattern response at 208 kb/s

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Here again phase jumps can be easily recovered from the digital signal at Dout.

3.4 Very High Data Rates:

3.4.1 Configuration:

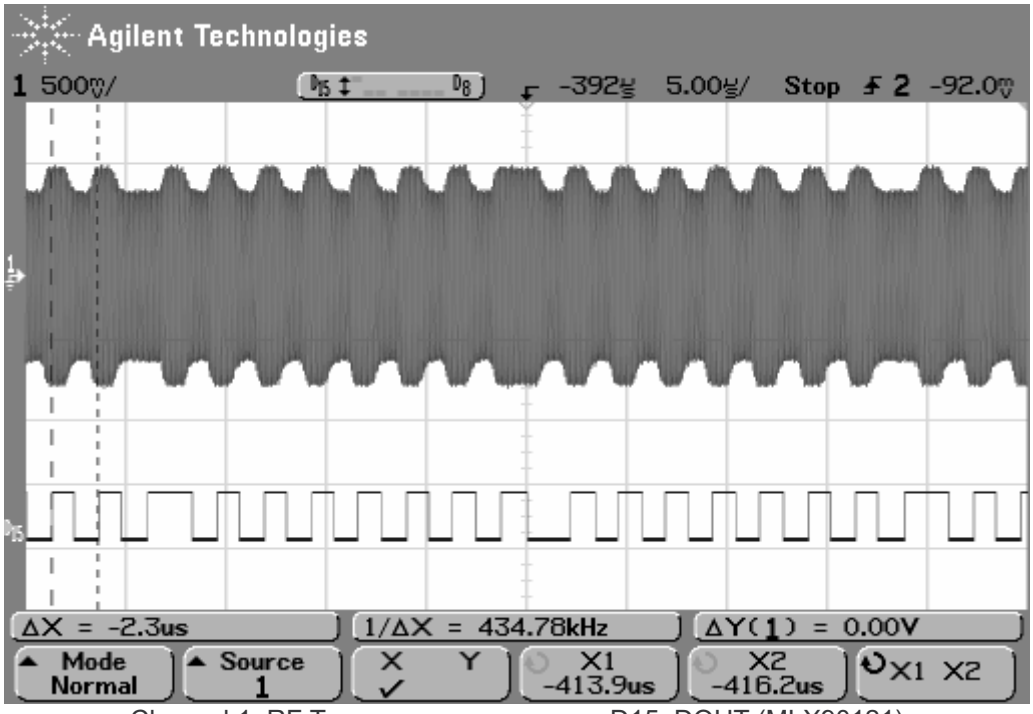
Address	Register	Data
0	AnalogConfig	0x27
1	PowerState	0x01
3	DigitalConfig	0x0B
12	LTC	0x00

The encoder has to be programmed accordingly to the application. The decoder (DecoderTimeRef) is not used.

With this configuration the chip is in FM configuration.

3.4.2 Screen captures:

The following captures show the MLX10111 replying in BPSK at about 424 kb/s and 848 kb/s.



Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 7: Pattern response at 434 kb/s

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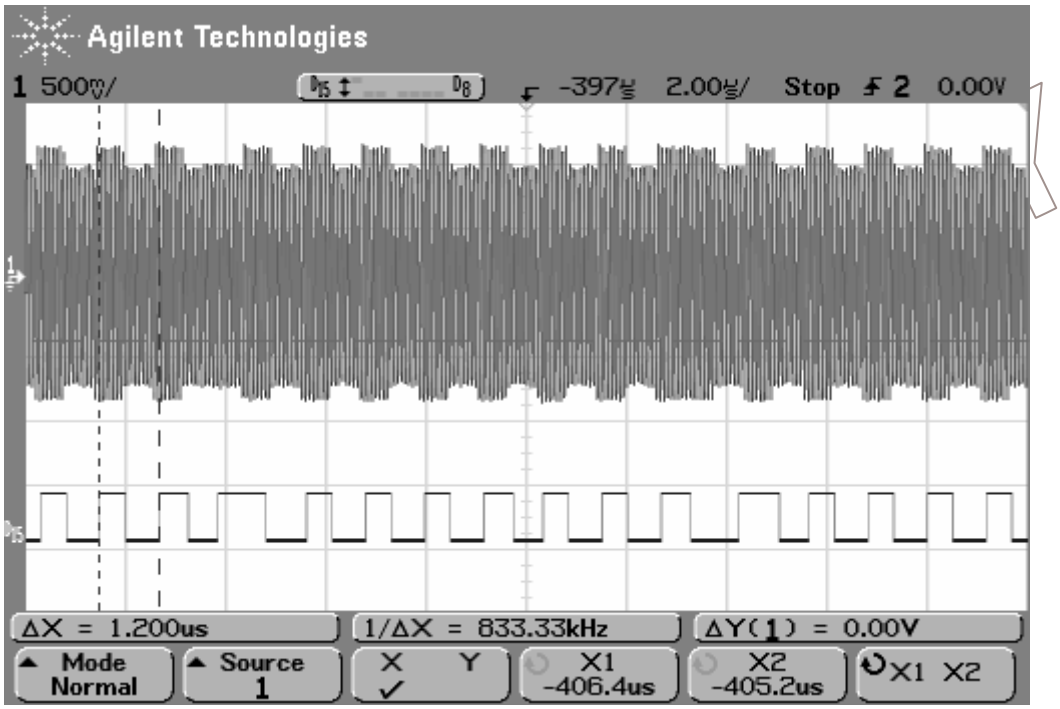

Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 8: Pattern response at 833 kb/s

Here again phase jumps can be easily recovered from the digital signal at Dout.

Note: For frequencies > 800 kHz, the digital output starts to be distorted. Still the signal can be decoded.

4 Applications with a subcarrier of 212 KHz:

4.1 Configuration:

Address	Register	Data
0	AnalogConfig	0x27
1	PowerState	0x01
3	DigitalConfig	0x09
12	LTC	0x00

The encoder has to be programmed accordingly to the application or the chip can be used in direct mode. The decoder (DecoderTimeRef) is not used.

With this configuration the chip is in ASK configuration, high baud rate.

4.2 Screen captures:

The following captures show the MLX10111 response and the MLX90121 digital output.

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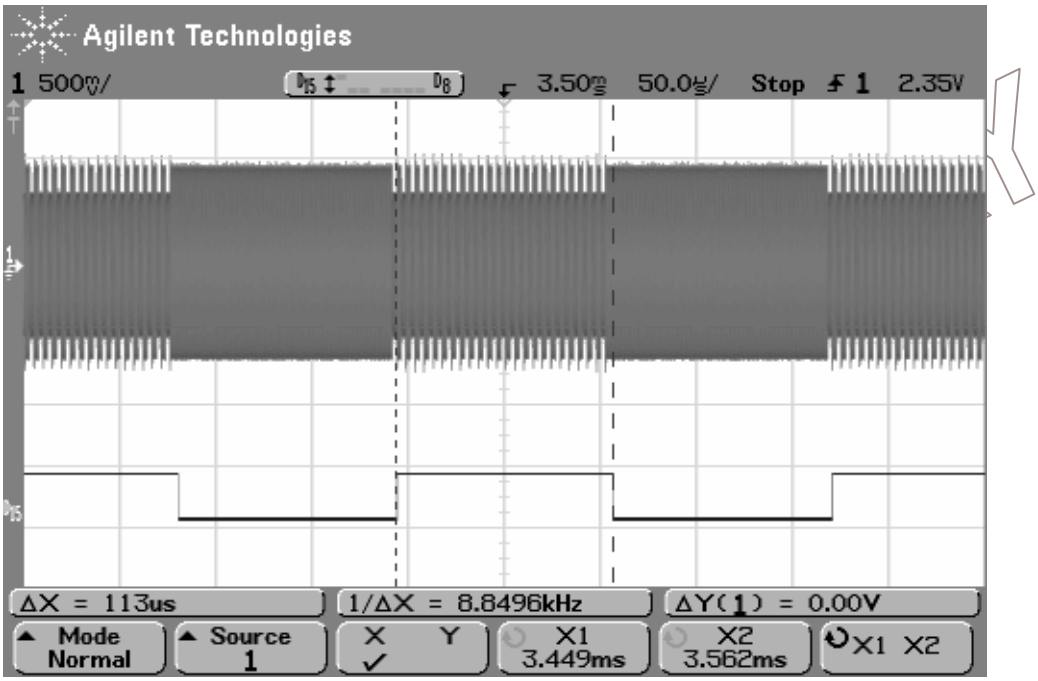
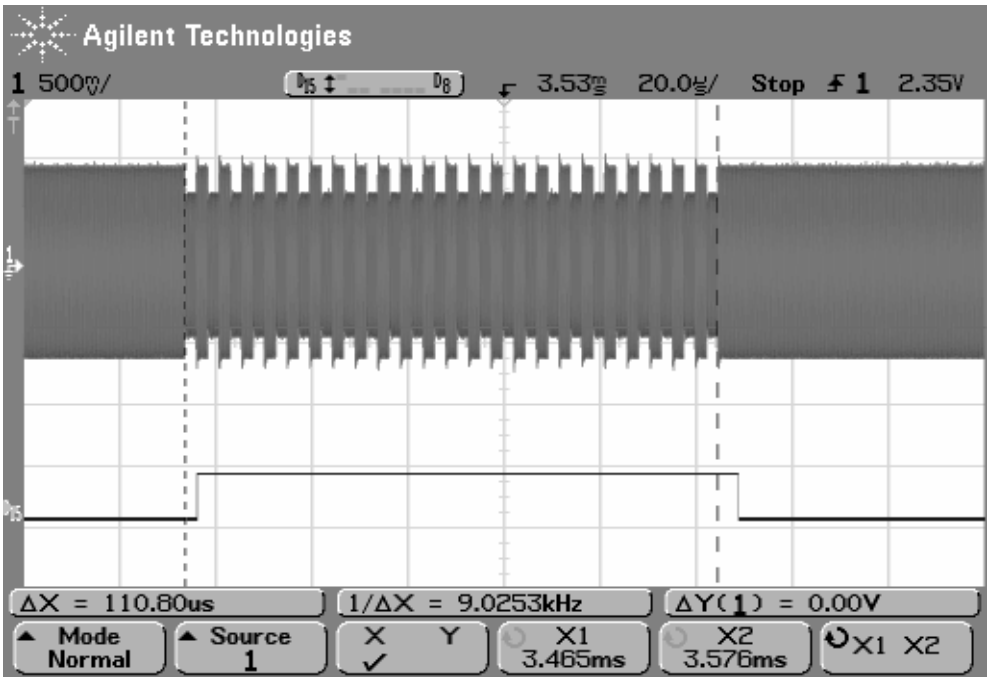


Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 9: Reception example



Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 10: Bit '1'

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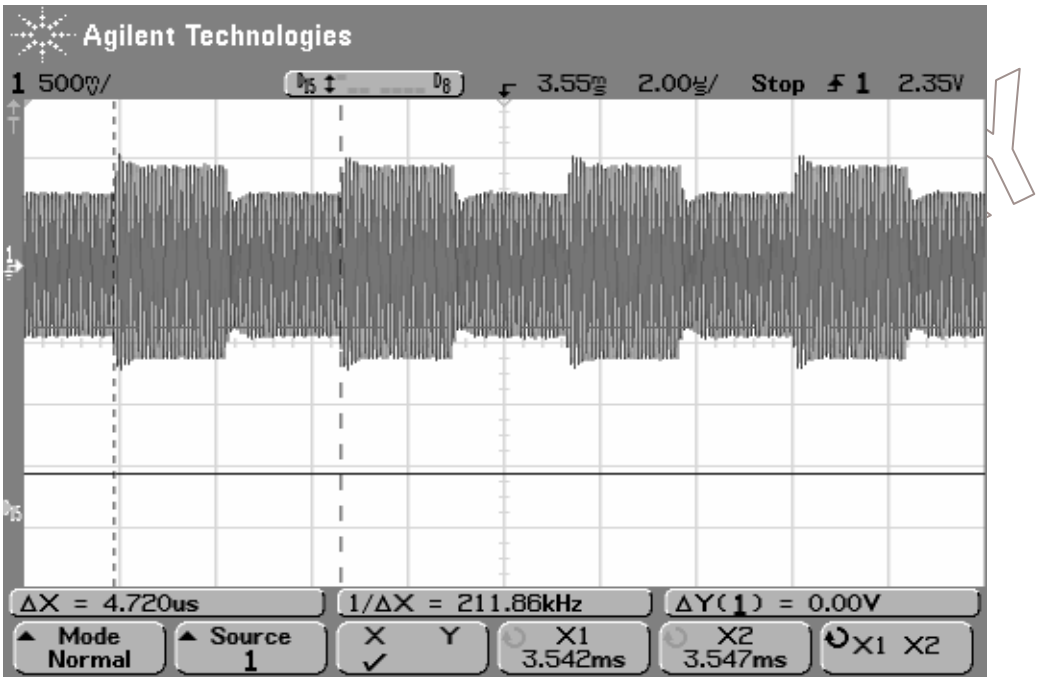

Channel 1: RF Tag response D15: DOUT (MLX90121)

Figure 11: Zoom on the subcarrier

The subcarrier envelope can be easily recovered from the Dout output of the MLX90121.

5 ISO 18000-3 Mode 1 protocol extension and EPC:

Both standards, ISO 18000-3 Mode 1 protocol extension and EPC, use a sub-carrier at 423 kHz with a Manchester coded modulation signal at 53 kb/s.

5.1 Configuration for ISO18000-3 Mode1 protocol extension:

Address	Register	Data
0	AnalogConfig	0x3E
1	PowerState	0x01
3	DigitalConfig	0x09
4	EncoderSym0	0xFF
5	EncoderSym1	0xFC
6	EncoderSym2	0x33
7	EncoderSym3	0xF3
8	EncoderSym4	0x7B
9	EncoderSym5	0xDF
10	EncoderTimeRef	0x0F
11	DecoderTimeRef	0x3F
12	LTC	0x00

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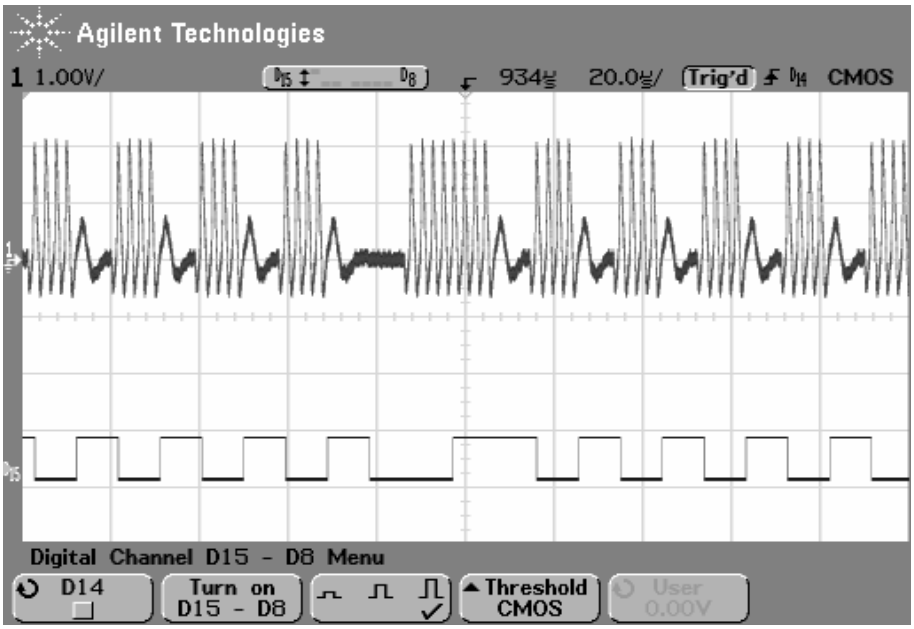
5.2 Configuration for EPC:

Address	Register	Data
0	AnalogConfig	0x3E
1	PowerState	0x01
3	DigitalConfig	0x09
4	EncoderSym0	0xFF
5	EncoderSym1	0x3F
6	EncoderSym2	0xF3
7	EncoderSym3	0x33
8	EncoderSym4	0x00
9	EncoderSym5	0x00
10	EncoderTimeRef	0x0F
11	DecoderTimeRef	0x3F
12	LTC	0x00

5.3 Screen captures:

The following capture shows a typical ISO 18000-3 mode 1 protocol extension response in ASK.



Channel 1: RF Tag response without carrier Digital channel: DOUT (MLX90121)

Figure 12: Typical response

The modulation can be recovered in a straightforward way from the data at the Dout output of MLX90121.

6 Conclusion:

The MLX90121 supports ISO standard 14443A/B and 15693 protocols. In addition, its high versatility allows for handling of the ISO 18000-3 mode 1, EPC and other custom protocol, like base band modulation and modulation at a 212 kHz sub-carrier.

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