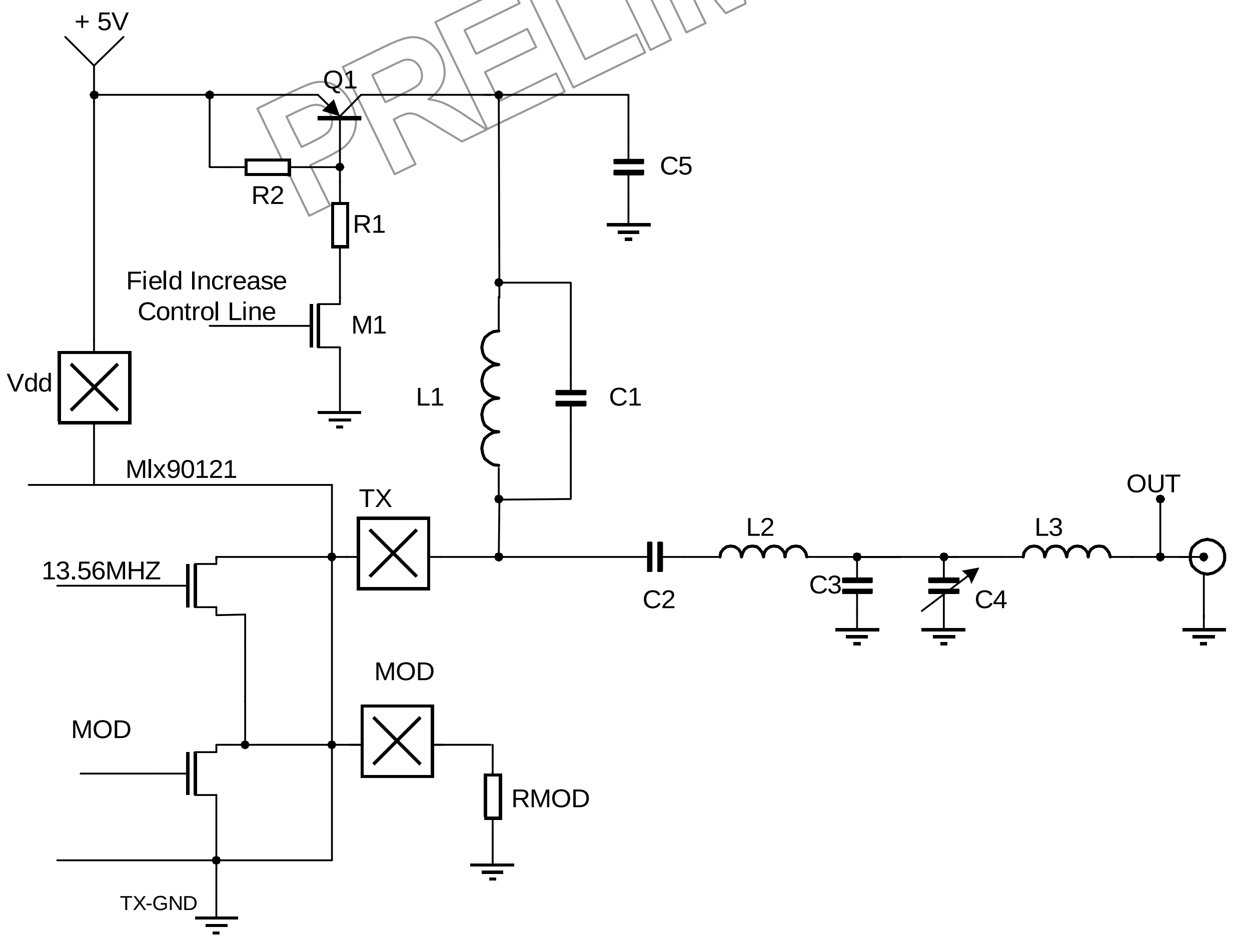
Application Note
Progressive field increase for the MLX90121

1 Scope:

This document is a design guide to provide a means of controlling the radio frequency field intensity when a command is sent to a tag. It has been found that some RFID tags do not operate properly when the field intensity reaches its maximum in a very short time. In order to solve this issue, we propose a universal solution, applicable to both the standard and power boosted version (see APN90121-1), where the characteristics of the progressive field increase sequence can be parameterized under software control to achieve the desired performance.

2 Standard design (200 mW @ 5 Volts):

2.1 Application schematic:



2.2 Recommended Components:

Reference	Value	Comments
R1	470 ohms	5% or better
R2	2.2 Kohms	5% or better
M1	BS 170 or PMBF 170	PHILIPS
Q1	FZT 949	ZETEX
C5	4.7 µF	Tantalum

Note: Other components values do not differ from the standard recommended reader schematic.

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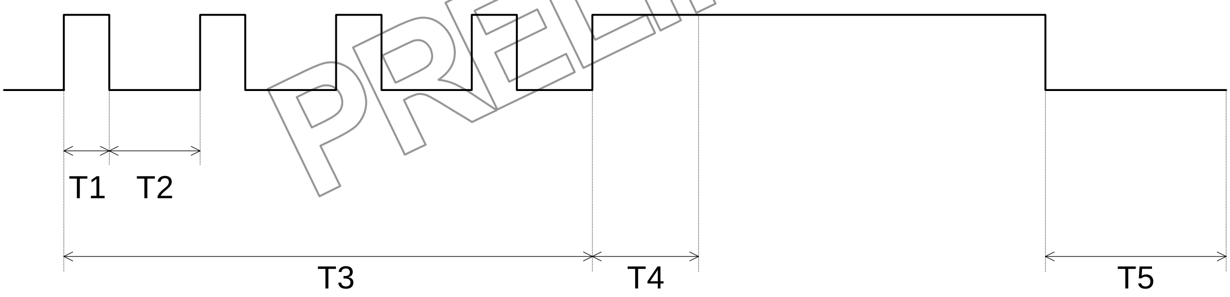
2.3 Theory of operation and design guidelines:

When M1 is switched on, it delivers about 10 milliamps of base current to Q1. Hence Q1 is switched on. To progressively increase the field intensity and therefore obtain a smooth start–up sequence, it is possible to apply short pulses to the gate of M1 and therefore gradually increase the output stage supply voltage and hence the radio frequency field intensity.

In the application software (available on request with the MLX90121 demo board), we have implemented a special command which gives control over 5 parameters for the radio frequency field intensity. To understand their utility, we shall refer to the following timing diagram of the signal applied to the gate of M1 during a typical RFID tag transaction:



T1 adjusts the pulse width. T2 controls the duty cycle. T3 controls the duration of the smooth power supply ramp up. With these three parameters, the smooth start procedure can be fine tuned, adjusted to a specific design, different values of the power stage supply decoupling capacitor, etc…

The main voltage regulator of the application board has a response time to the current surge during the field increase. Because of that, the maximal field intensity is not immediately reached. In order to provide an optimal communication performance during the transaction with the tag, an additional delay T4 is introduced, so that no modulation is applied to the radio frequency field before the end of the main power supply voltage regulator settling.

After the end of the transaction with the tag, the gate of M1 goes low, effectively switching off the power stage supply. However, since the power stage uses a large decoupling capacitor (C5 on above schematic), it will take a long time before its charge is dissipated if the carrier drive inside the MLX90121 is shut-off at the same time. To remedy this situation, T5 introduces a delay between the instant at which M1 and Q1 are switched off, and the moment where the MLX90121 internal carrier drive signal is also switched off. During the time T5, the power stage is still driven, and discharges C5 rapidly. At the expiration of the T5 delay, one should send the carrier off command to the MLX 90121 to end the RFID transaction.

An additional note about capacitor C5 is. Optimal would be to use a high quality ceramic or plastic film capacitors. Unfortunately, such components are bulky and may be also hard to find. A solid tantalum capacitor will do the job. However, its transient performance will be much worse, and this will severely affect the cleanliness of the output stage supply voltage during the initial ramp up phase. Experimenting with T1, T2 and T3 should yield an acceptable performance.

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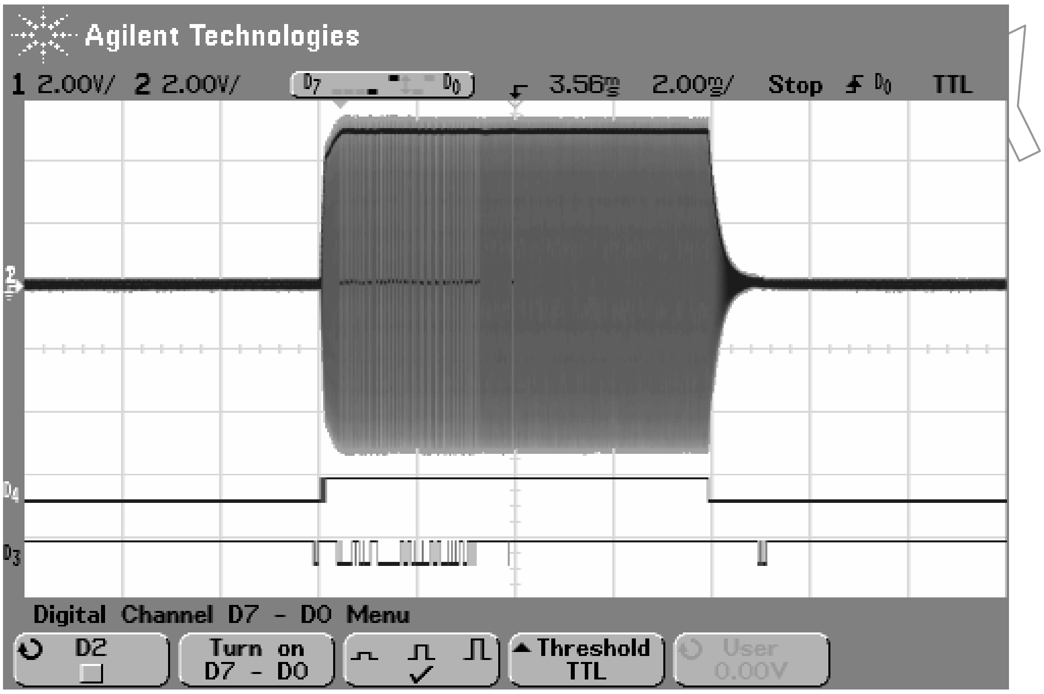
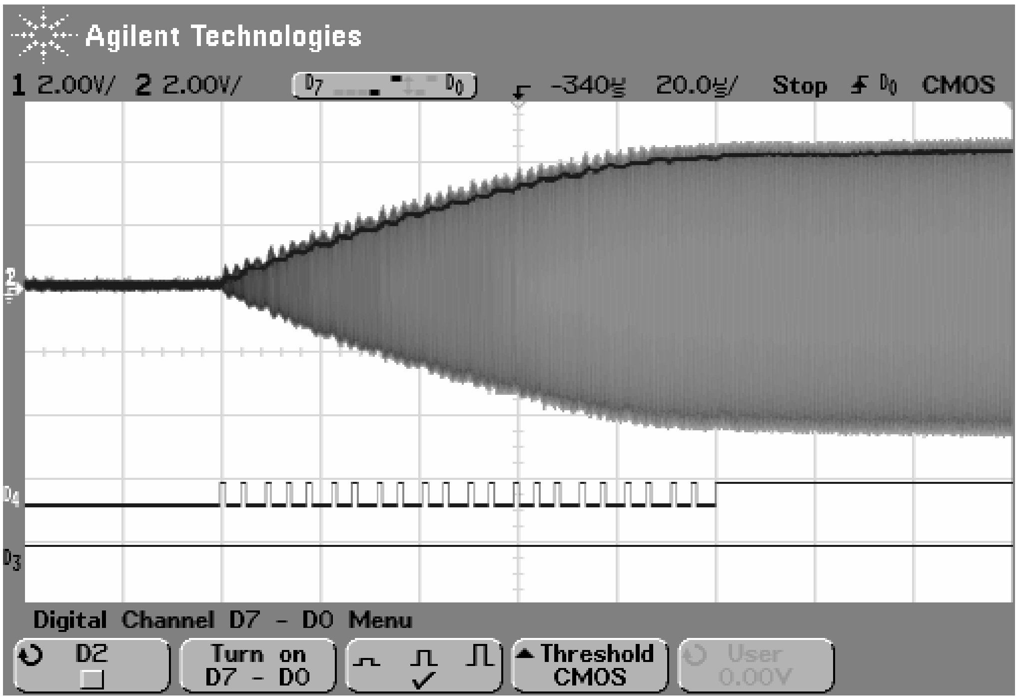
2.4 Oscilloscope screen captures:

2.4.1 Overview of complete sequence:



Channel one is the RF signal at the antenna connector.
Channel two is the power supply voltage of the power stage.
D3 is the command line of the MLX90121
D4 is the control line of M1 of this application schematic.

2.4.2 Detail of start up sequence:



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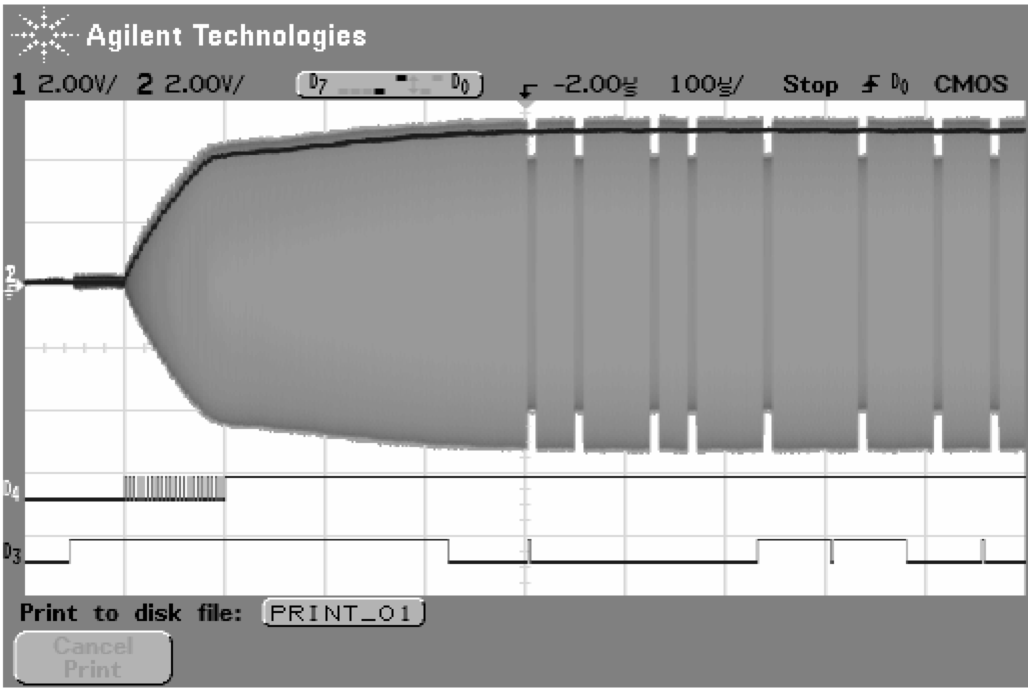
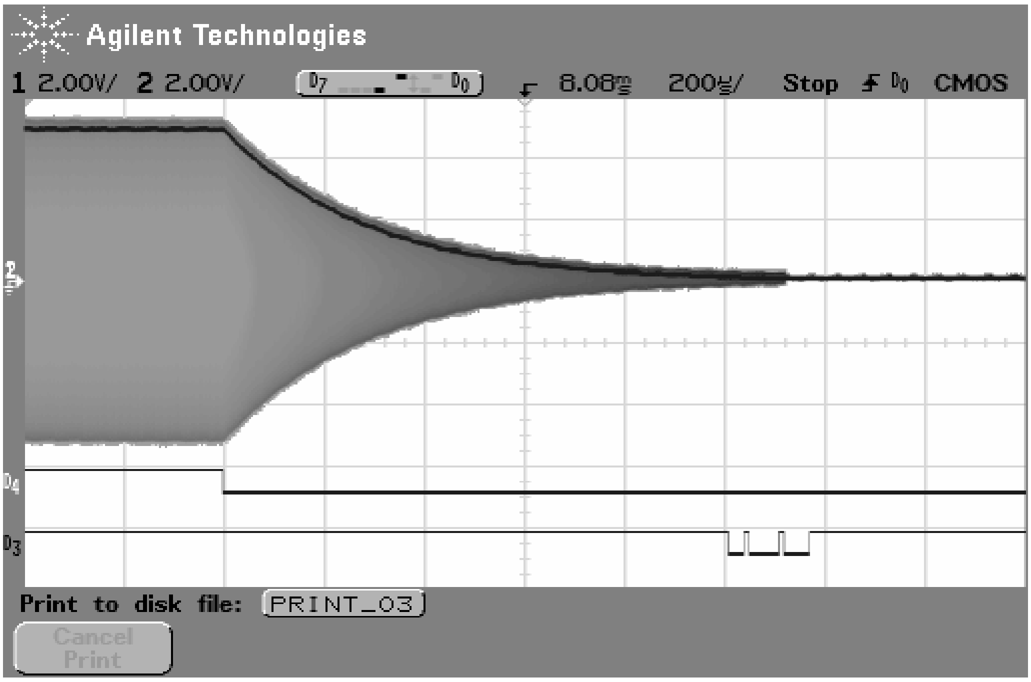
2.4.3 Detail of main voltage regulator settling effect:



As can bee seen on this screen capture, the main voltage regulator takes about 300 microseconds to recover from the initial current surge. Therefore, we have adjusted the value of T4 accordingly, so that the first modulation pulse does not occur before this time.

2.4.4 End of RFID transaction:

On this first screen capture, we have adjusted T5 so that the carrier off command is issued to the MLX90121 1 millisecond after M1 is switched off. The continued carrier drive on the output power stage discharges its filtering capacitor, C5, during that time.



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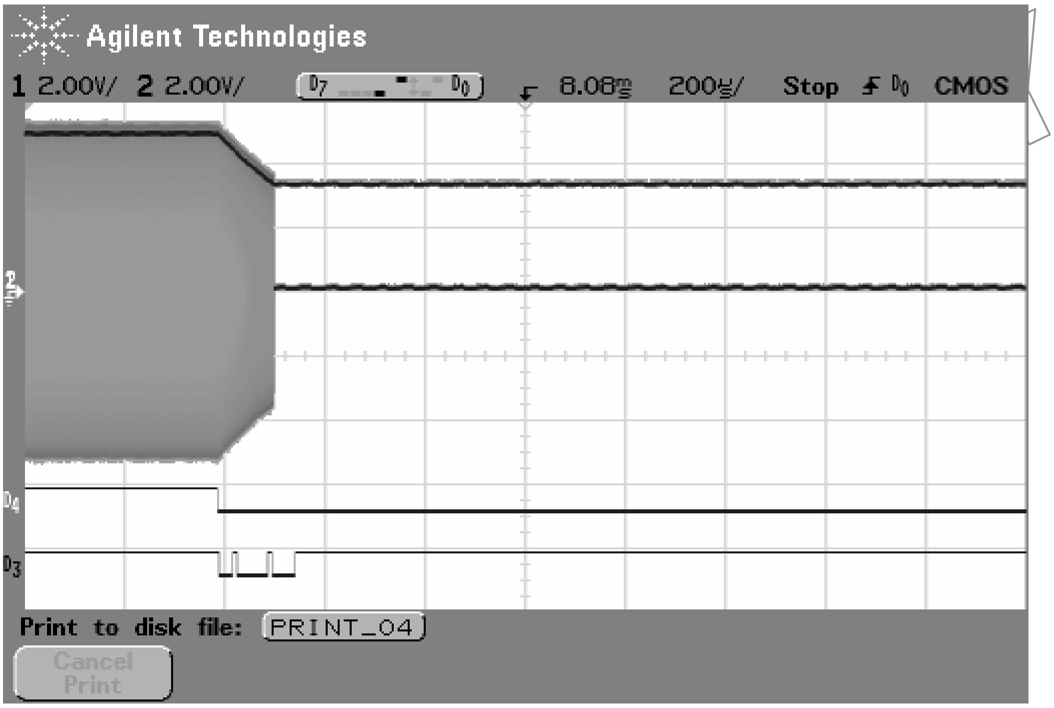
On the following screen capture, one can see what happens when the carrier off command is sent to the MLX 90121 immediately after the output power stage supply has been switched off: The supply voltage remains high for a very long time since in principle, there is not current drain.



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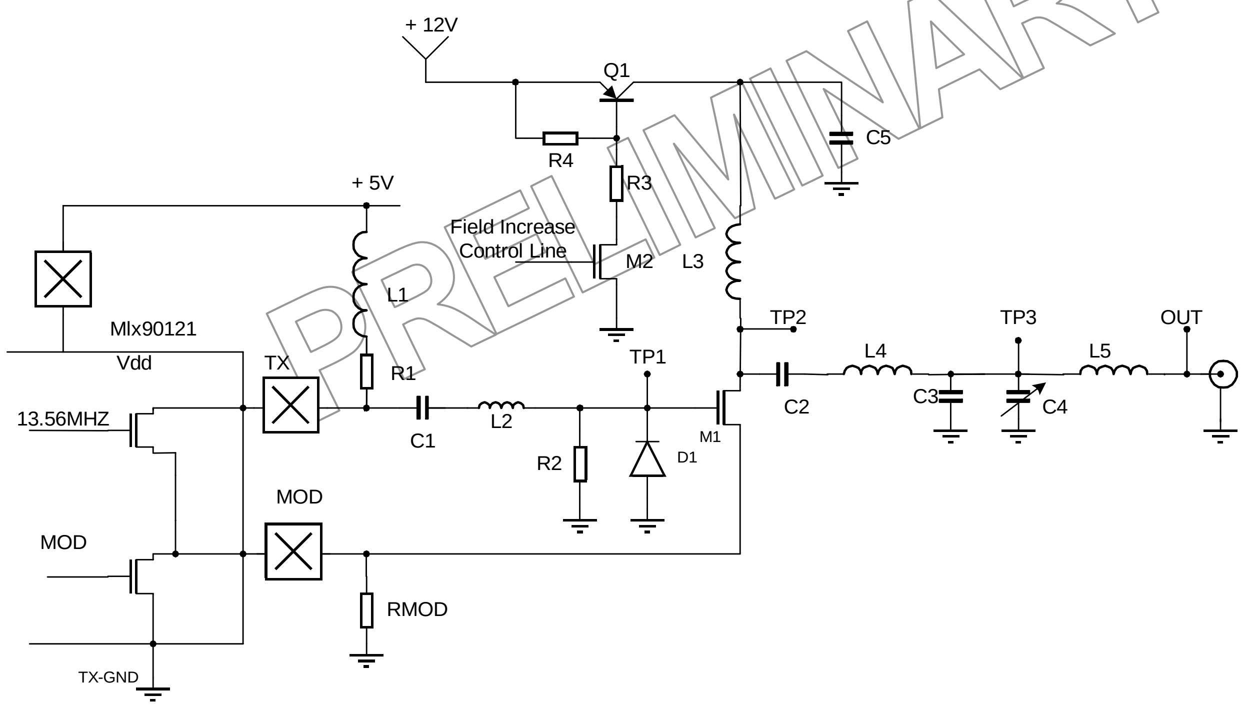
3 Power booster configuration (1 Watt @ 12 Volts)

For the description of the MLX90121 12V power booster we refer to the application note 390119012102.

3.1 Application schematic:



3.2 Recommended Components:

Reference	Value	Comments
R3	1.2 Kohms	5% or better
R4	2.2 Kohms	5% or better
M2	BS 170 or PMBF 170	PHILIPS
Q1	FZT 949	ZETEX
C5	4.7 µF	Tantalum

Notes: Other components values do not differ from the passive matching power boost reader schematic.
Since the 5 volts supply line is not controlled, the MLX90121 internal power transistor is energized. Therefore, during the discharge time T5, when the booster power supply is completely switched off, the antenna signal will not be completely zero because some capacitive feed through will occur from the output stage of the MLX9012. The antenna signal during this period amounts to less than 400 millivolts into 50 ohms load. After T5, the carrier will be switched off inside the MLX90121 which will remove any antenna signal.

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