LPRS
LOW POWER
RADIO
SOLUTIONS

RX-3

Operating Manual
& Applications Notes

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LPRS LOW POWER RADIO SOLUTIONS

Receiver Module Keeloq RX-3

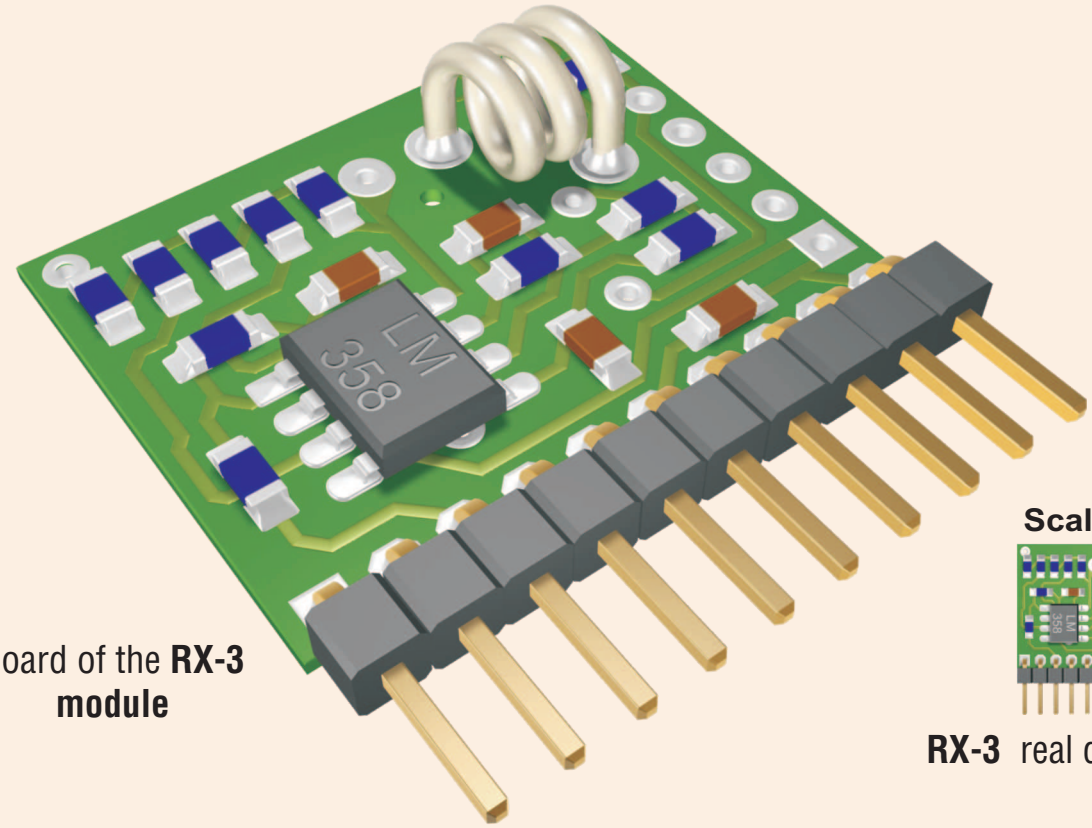
Update documents
2010-02-18 version 1.6

Designed to work with Keeloq

KEELOQ®

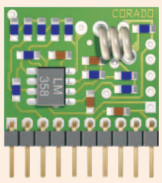
Operating Manual & Application Notes

Micro Link RX-3 allows quick and easy building of devices that use radio waves to one way communication at 433.92MHz and LPRS key fobs with range up to 100m. Transmission is totally secure thanks to "Keeloq" encrypted data by Microchip. Additional advantage is the ability to upload own software, which allows the module to be adapted to the designers needs.One of many examples of using Micro Link RX-3 is a remote controller SR-6. If you have other needs please contact us with a description of the problem. We will do our best to solve it.On the board of the module (dimensions: width-20mm thickness with components - 3mm hight- 16mm) are: PIC-12f629 microprocessor (custom mount PIC12F822, PIC12LF1822, PIC12F519, PIC12F635, PIC12F675, PIC12F683) complete receiver module superreactive, 10 pins with spacing of 2 mm for attachment to the main board or another device, the ICSP bus with 5 holes to change the software without removing the processor from the RX-3 board.



Board of the **RX-3 module**

Scale 1:1



RX-3 real dimensions

Standard software is loaded with SR-6 driver features, support up to 4 channels including 2 fully configurable and 2 non configurable, 6 key fobs, mono and bistable operation, low battery alarm and activation of the channel, memory state. For more demanding designers we offer version RX-6 with superheterodyne receiver which is compatible with RX-3. They can be used with all of LPRS' key fobs. For those interested, we can manufacture and/or design sets of key fobs and modules so that they are compatible with active devices or other software. We give 12 months warranty to the receiver and key fob. We would ask you to pay attention to the fact that the modules RX-3 and RX-6 are one of the smallest size radio modules of this class on the market with the possibility to customised programming. The RX-3 modules have been manufactured since 2004.

Basic functions of the RX-3

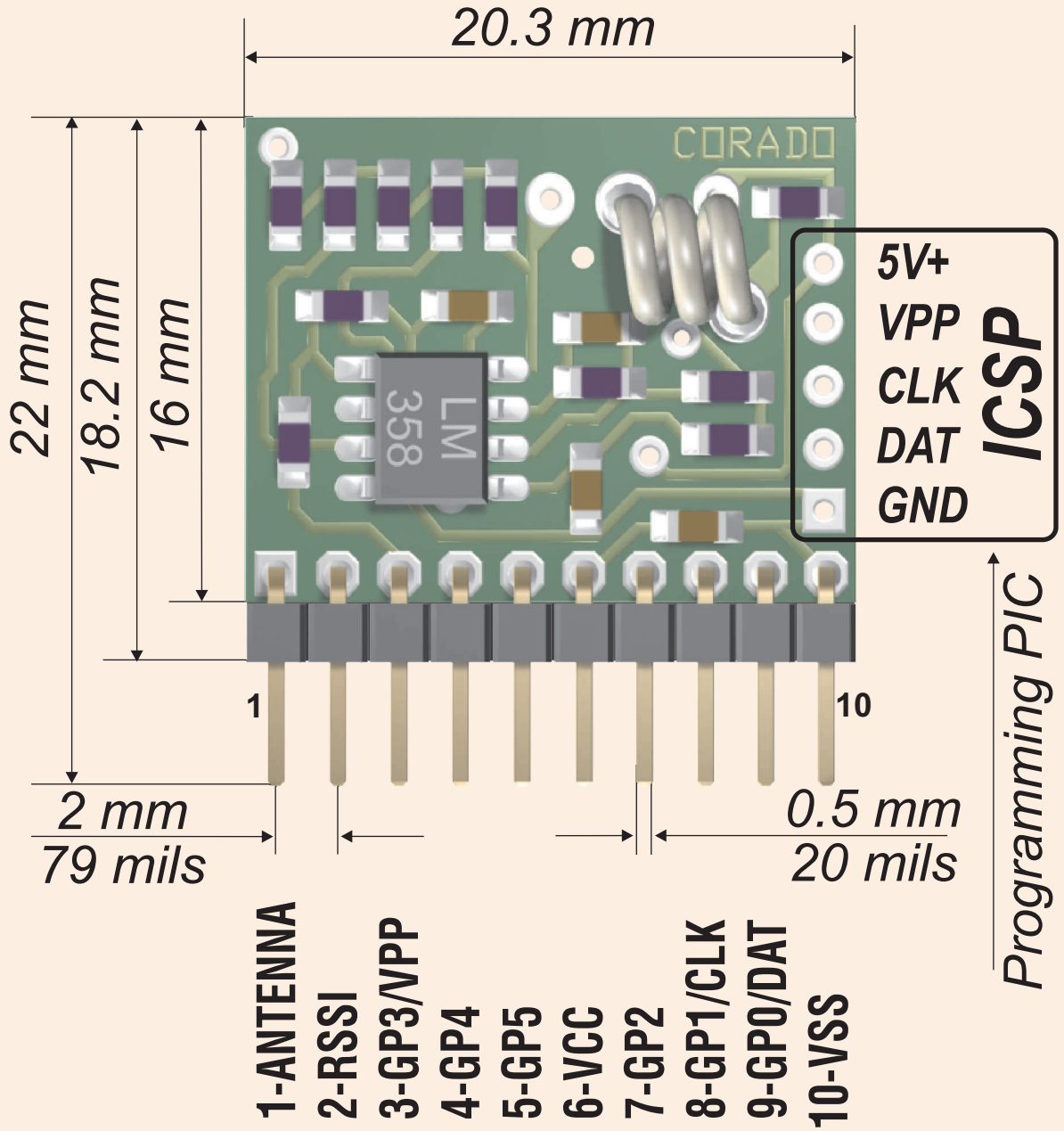
1. Supports key fobs with encoders: HCS200, HCS300, HCS301.Other encoders have not been tested.
2. Standard software supports total of 4 channels of independent control.
3. One universal port (input or output) to configure and a channel turn on signal.
4. RSSI output signal for measuring the level of the transmitter.
5. Reset of working channels 1 and 2 using the input Gp4.
6. Two fully configurable control channels 1 & 2 .
7. Two channels are not configurable (channels 3 & 4). Working solely in monostable mode with time 0.5 sec.
8. The possibility of an emergency stop of channels 1 & 2 by pressing the "Assistance " and "Assistance2" buttons of the key fob.
9. System with rolling code rate 200 and the 400uS /bit KEELOQ ® by "Microchip Technology Inc.
10. Supports up to 6 key fobs.
11. 4 level configuration: login key fobs, setup bistable/monostable mode, time registration for monostable mode.
12. Permanent rememberance (EEPROM) channels, configurations, and logged key fobs after power is switched off.
13. Adjustable monostable mode from 0.2 to about 600 seconds regardless of the channels 1 and 2.
14. Registration for max 6 key fobs.
15. Independently turn off channels 3 or 4 by pressing the ”Assistance” and ”Assistance2" buttons.
16. Channel activity during the hold button of the key fob.
17. The possibility to upload available software through the ICSP bus.
18. The possibility of manufacturing a module with other so-called "Manufacturer’s Key".
17. Signalling for low battery.

By default the board has a PIC12F629 microprocessor with factory software but it can be installed with: PIC12F1822, PIC12F519, PIC12F635, PIC12F675, PIC12F683 as well.
We suggest these types of microprcessors because they are made using flash technology which means that they are re-programmable (you can erase old software and load a new one).

Basic technical data:

Name parameter	Min	Type	Max	Unit
Power supply	4.75	5	5.25	**Vcc**
Power consumption	3	4	5	**mA**
Receiving frequency	432.5	433.92	434.5	**MHz**
Input Sensitivity	-40	-75	-90	**dBm**
Intermediate frequency bandwidth	3	5	7	**MHz**
Suppression of unwanted signals outside the band	50	40	-60	**dB**
Speed of transmission of radio signal reception	1	2,5	5	**kbps**
Output voltage of the data state H	4,2	4.5	4,7	**V**
Output voltage of the data state L		0.2	0.4	**V**
Activation time after switch on	0.4	1	2	**s**
Correct working temperature	-20	-	+60	**°C**

Dimensions of the RX-3 module



1-Antenna Connect isolated wire 17 cm long.
2-RSSI Receive Signal Strength Indicator, measuring the output signal level, Imax = 1 mA.
3-GP3 Ouput signal from the radio comparator, the external Microcontrollers
4-GP4 Universal Port: It works as an input during configuration process,and as an output to signal channel status (in/out) and low battery stage in key fob
5-GP5 Output from 4th channel
6-VCC Power supply (+5V)
7-GP2 Output 3rd channel
8-GP1 Output 2nd channel
9-GP0 Output 1st channel
10-VSS Power supply (-)

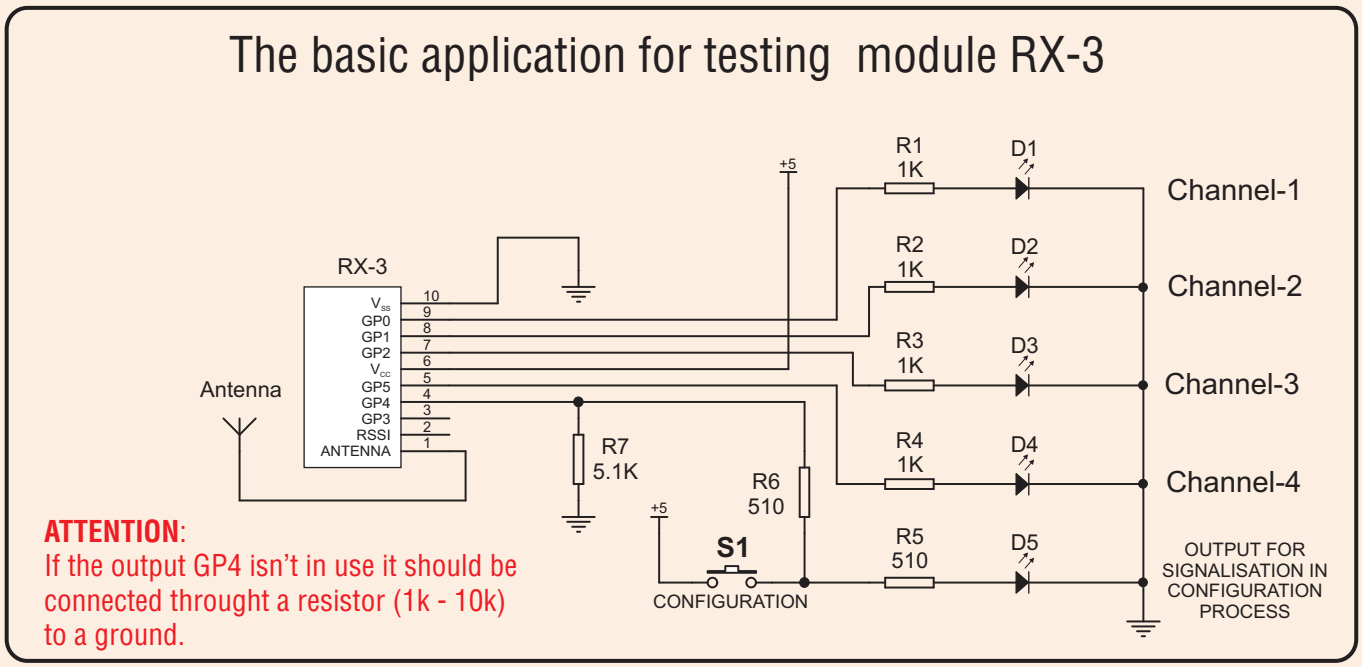
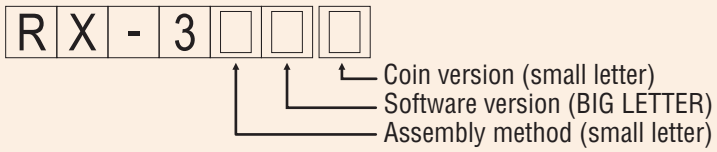


Figure 1. Basic start-up application of the RX-3.

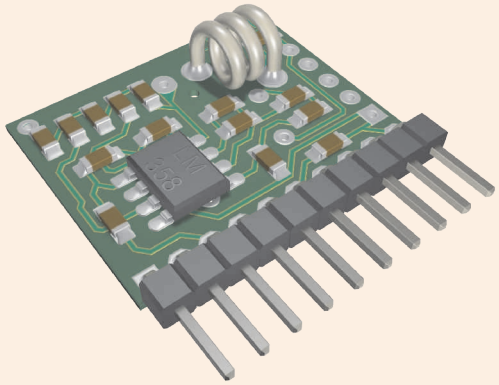
SPECIFICATION OF THE MODULE

The system marks of the RX-3

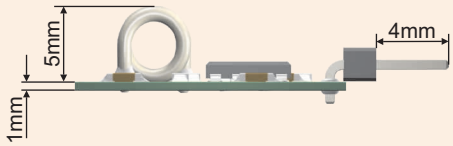


Electronics in all versions of the modules are the same. The difference is in a way of the assembly, and the type of coil.

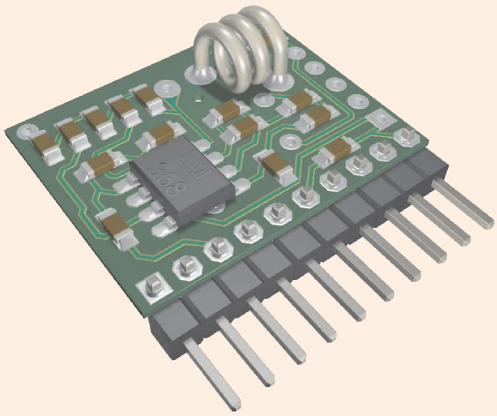
Types of the RX-3 modules



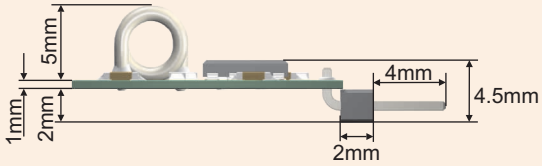
RX-3aAu
(standard, unshielded coil, angular pins)



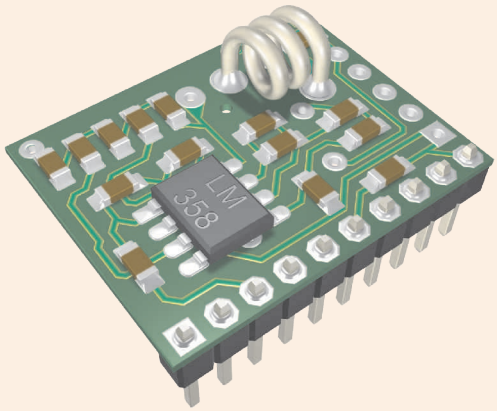
RX-3aAu
(standard, unshielded coil, angular pins)



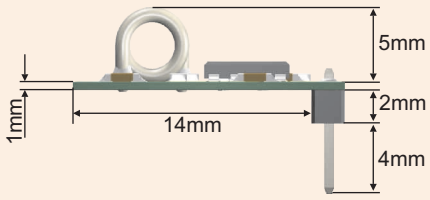
RX-3bAu
(unshielded coil, angular reversed pins)



RX-3bAu
(unshielded coil, angular reversed pins)

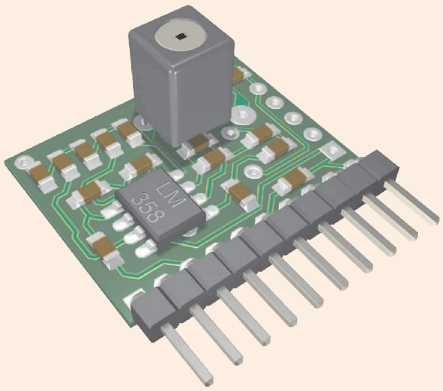


RX-3cAu
(unshielded coil, straight pins)

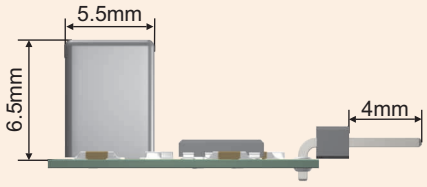


RX-3cAu
(unshielded coil, straight pins)

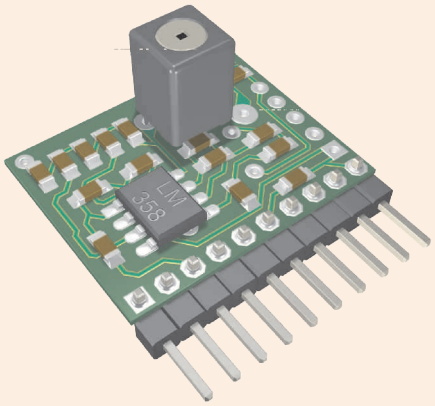
Types of the RX-3 modules



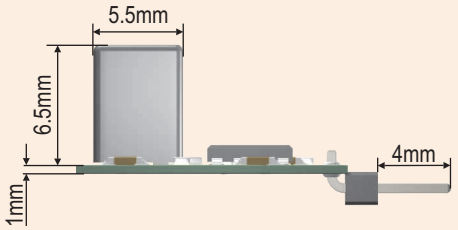
RX-3dAs
(shielded coil,angular pins)



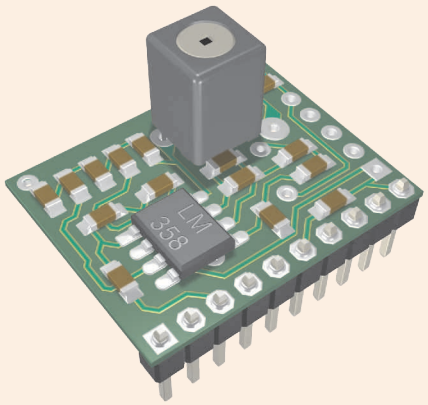
RX-3dAs
(shielded coil, angular pins)



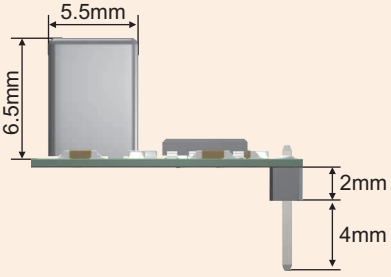
RX-3eAs
(shielded coil,
angular reversed pins)



RX-3eAs
(shielded coil,
angular reversed pins)



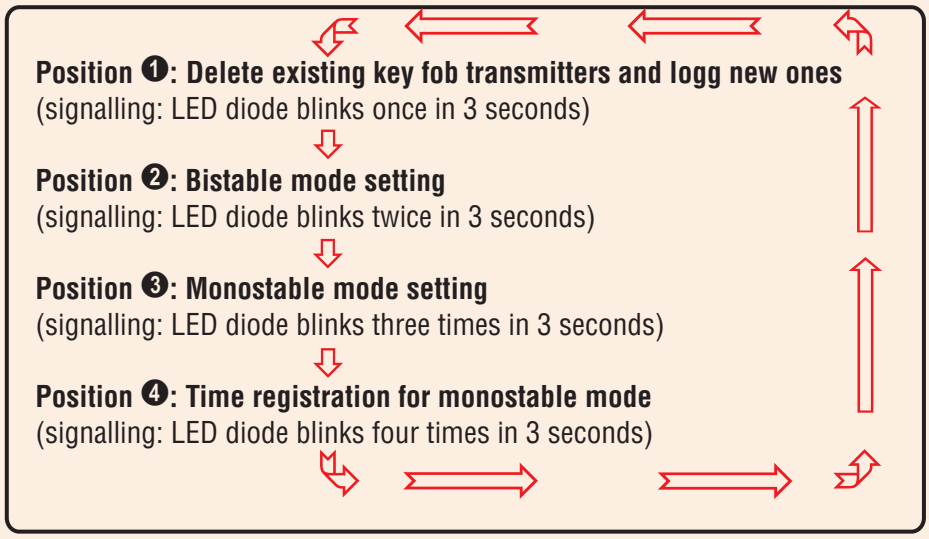
RX-3fAs
(shielded coil, straight pins)



RX-3fAs
(shielded coil straight pins)

Software version "A" fig.1.
Configuration allows to change current settings of RX-3 to suit the user's needs.
* Factory settings of channels 3 and 4 are permanently in monostable mode time of 1 sec. for each channel.

The RX-3 configuration process:
Press and hold S1 button for min. 2 sec. until LED D2 will light (LED D5 light confirms pressing S1 button)
Release S1 button LED D5 diode will switch off, and then LED D1 diode blinks twice. If you are inconfiguration process LED D1 diode will light for 0.5 sec. once in 3 sec. This means that you are at position 1 in the configuration process.



Graphical presentation of the principles of movement in the configuration

Position 1: Deleting existing key fob transmitters and logging new ones.
Pressing any of the key fob transmitter buttons for the first time will cause its logging and deleting all key fob transmitters logged so far in the EEPROM memory of the RX-3. If you intend to logg a new key fob transmitter, press any key on the first key fob transmitter and hold it until LED-1 blinks twice. This signalling indicates logging the key fob transmitter in the controllers memory. The procedure is the same for the following key fob transmitters. Up to 6 key fob transmitters can be logged in the RX-3. While attempting to log a seventh transmitter, the module indicates the end of the process of logging key fob transmitters by a short blink of LED-1, 0.5 second once every 1 second.
a)-If you wish to exit configuration process, disconnect power supply for at least 5 seconds
b)-If you wish to move to the next, position in the configuration process, press **S1** push-button. LED-1 will turn on simultaneously, twice every 3 seconds for 0.5 second.

Position 2: Bistable mode setting
To set bistable mode for channel 1, press the Main key fob button for a short time: double simultaneous signalling by LED-1 informs about setting channel 1 into bistable mode.
To set bistable mode for channel 2, press the Functional key fob button for a short time: double simultaneous signalling by LED-1 informs about setting channel 2 into bistable mode.
a)- If you wish to exit the configuration procedure, disconnect the power suply for at least 5 seconds
b)- If you wish to move to the next, position in the configuration process, press the S1 push-button for a short time:LED-1 diode will turn on

Position 3: Monostable mode setting
To switch channel 1 into monostable mode, press the Main key fob button for a short time: double simultaneous signalling by LED-1 indicates setting channel 1 into monostable mode. To switch channel 2 into monostable mode, press the Functional key fob button for a short time: double simultaneous signalling by LED-1 indicates setting channel 2 into monostable mode.
a)-If you wish to exit the configuration procedre, disconnect the power supply for at least 5 seconds
b)-If you wish to move to the next, position in the configuration process, press the **S1** push-button for a short time:LED-1 diode will turn on

Position 4: Time registration for monostable mode
To record the time for a channel in monostable mode, press the selected push-button (Main or Functional) on the key fob transmitter - time recording will begin: LED-1 will turn on for the time of recording. Pressing the same push-button on the key fob transmitter again will finish the recording: LED-1 will turn off. Double signalling by LED-1 indicates saving registered time in non-volatile EEPROM memory. Repeated pressing of the selected key fob button will restart the time registration procedure.
a)-) If you wish to exit the configuration process, disconnect the power supply for at least 5 seconds.
b)- Press the S1 push-button for a short time to move to the first position in the configuration process.

Module RX-3 action.
Low battery signalisation; when you press any button on the key fob, and the LED D5 will light 5 times in 0.2 seconds, this means that the battery in the key fob is in poor condition and should be replaced for a new one.
Factory settings:
1 channel - monostable mode time 1 sec.
2 channel - monostable mode time 1 sec.
3 channel - permanent in monostable mode time 1 sec.
4 channel - permanent in monostable mode time 1 sec.
2 key fobs logged

Functions of the key fob buttons when working with the RX-3A

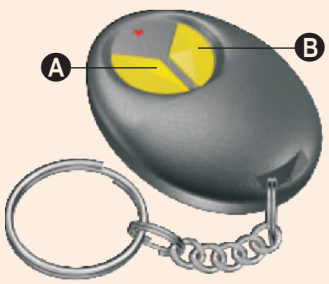
Monostable mode

Key fob	*Main button*	*Functional button*	*Assistant button 1*	*Assistant button 2*
ALIEN, DUET, RING	turn on channel 1 (LED D1)	turn on channel 2 (LED D2)	-	-
BANAN	turn on channel 1 (LED D1)	turn on channel 2 (LED D2)	turn on channel 3 (LED D3)	-
LIDER, QUARTET	turn on channel 1 (LED D1)	turn on channel 2 (LED D2)	turn on channel 3 (LED D3)	turn on channel 4 (LED D4)

Bistable mode

Key fob	*Main button*	*Functional button*	*Assistant button 1*	*Assistant button 2*
ALIEN, DUET, RING	turn on/off channel 1 (LED D1)	turn on/off channel 2 (LED D2)	-	-
BANAN	turn on/off channel 1 (LED D1)	turn on/off channel 2 (LED D2)	work only in monostable mode	-
LIDER, QUARTET	turn on/off channel 1 (LED D1)	turn on/off channel 2 (LED D2)	work only in monostable mode	work only in monostable mode

Key fob transmitter **"Alien"**



Key fob transmitter **"Ring"**

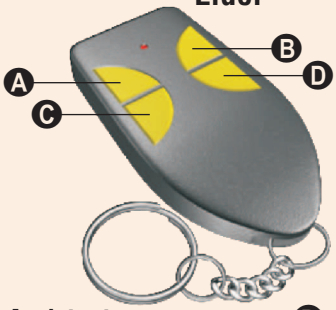
Key fob transmitter **"Duet"**

A **Main** push-button

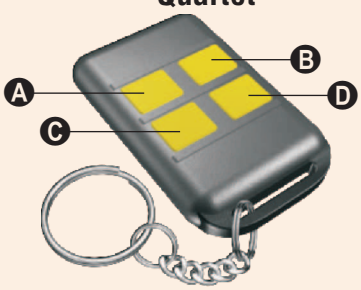
B **Functional** push-button

Key fob transmitter **"Banan"**

Key fob transmitter **"Lider"**



Key fob transmitter **"Quartet"**



C **Assistant** push-button

D **Assistant 2** push-button

PIC Programmer for Internal Connection (ICSP)

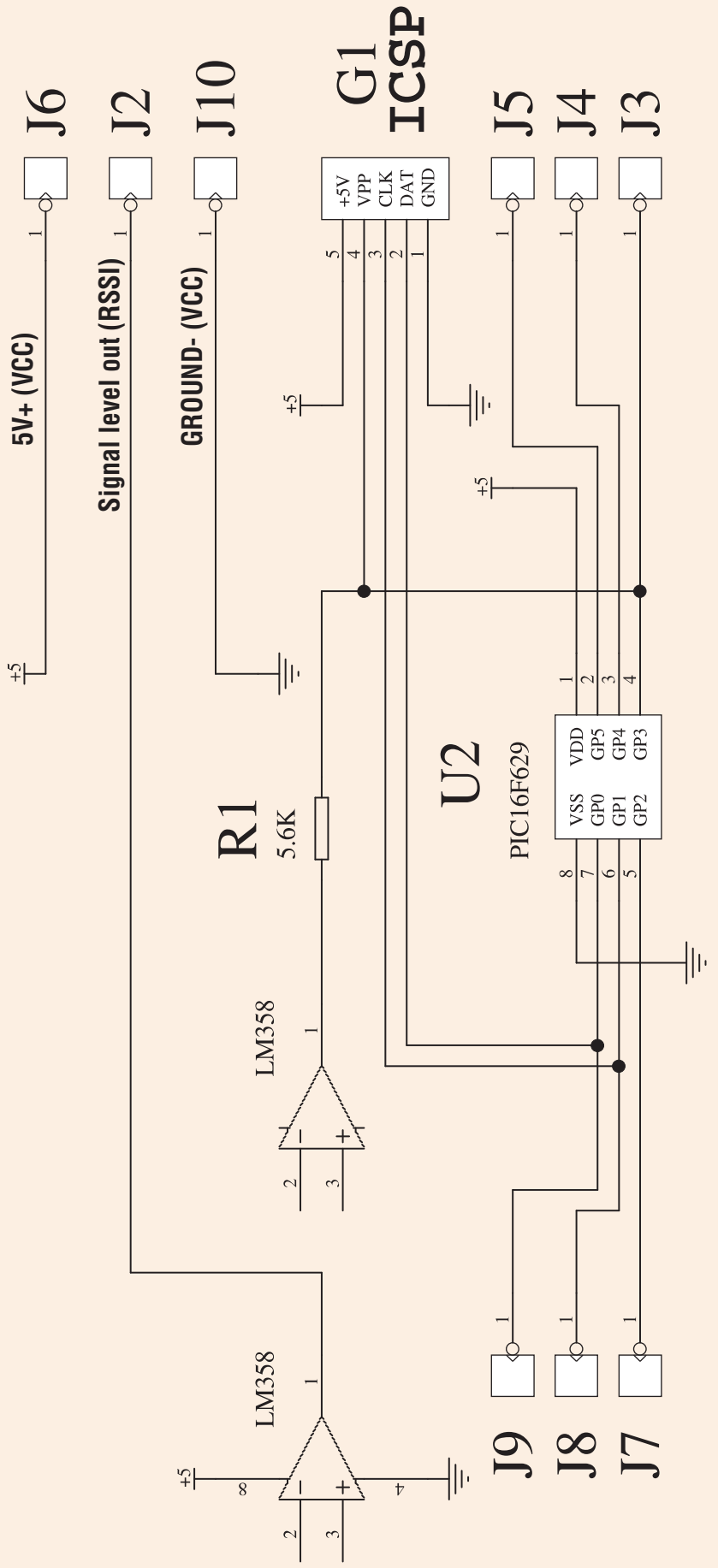
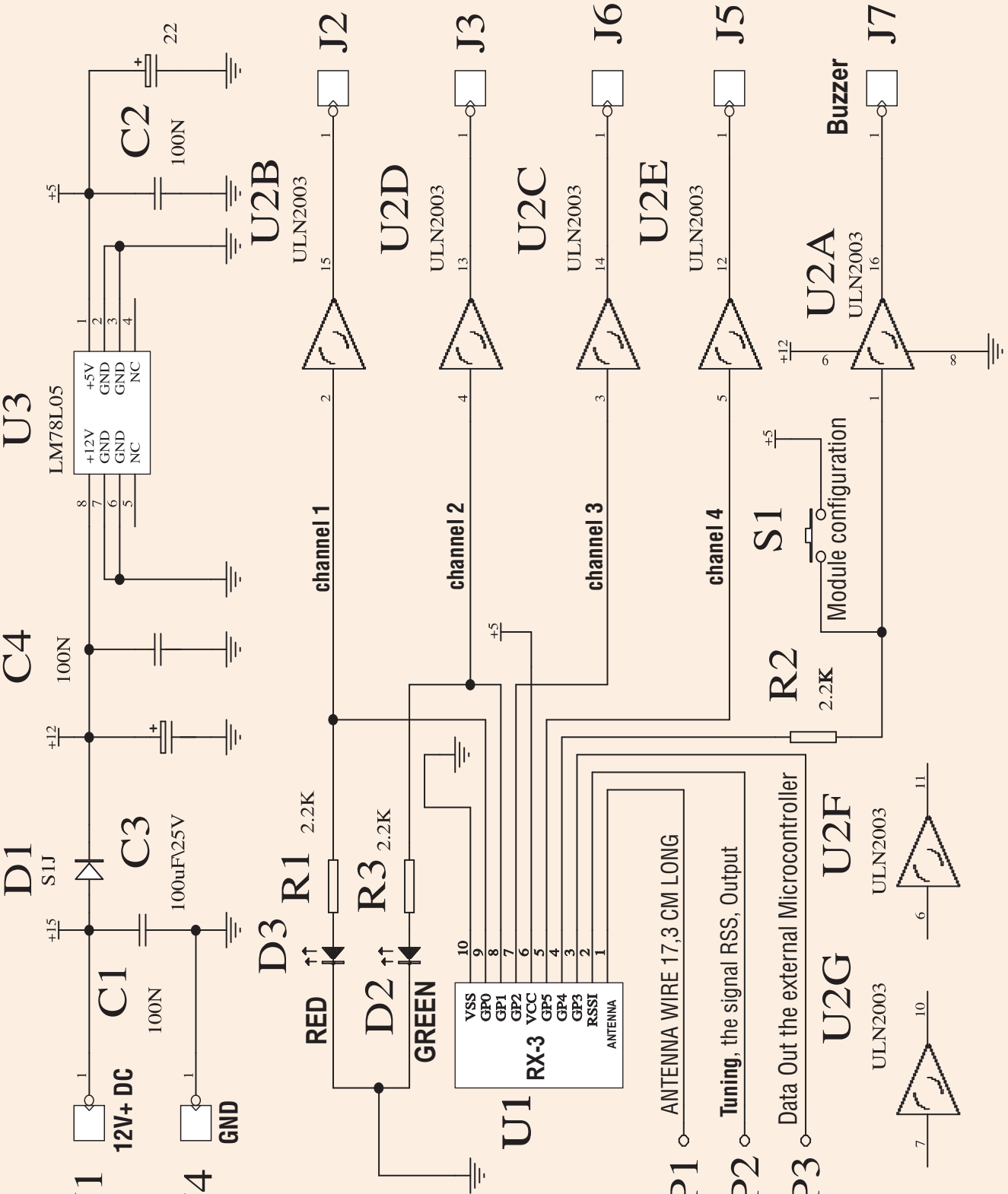
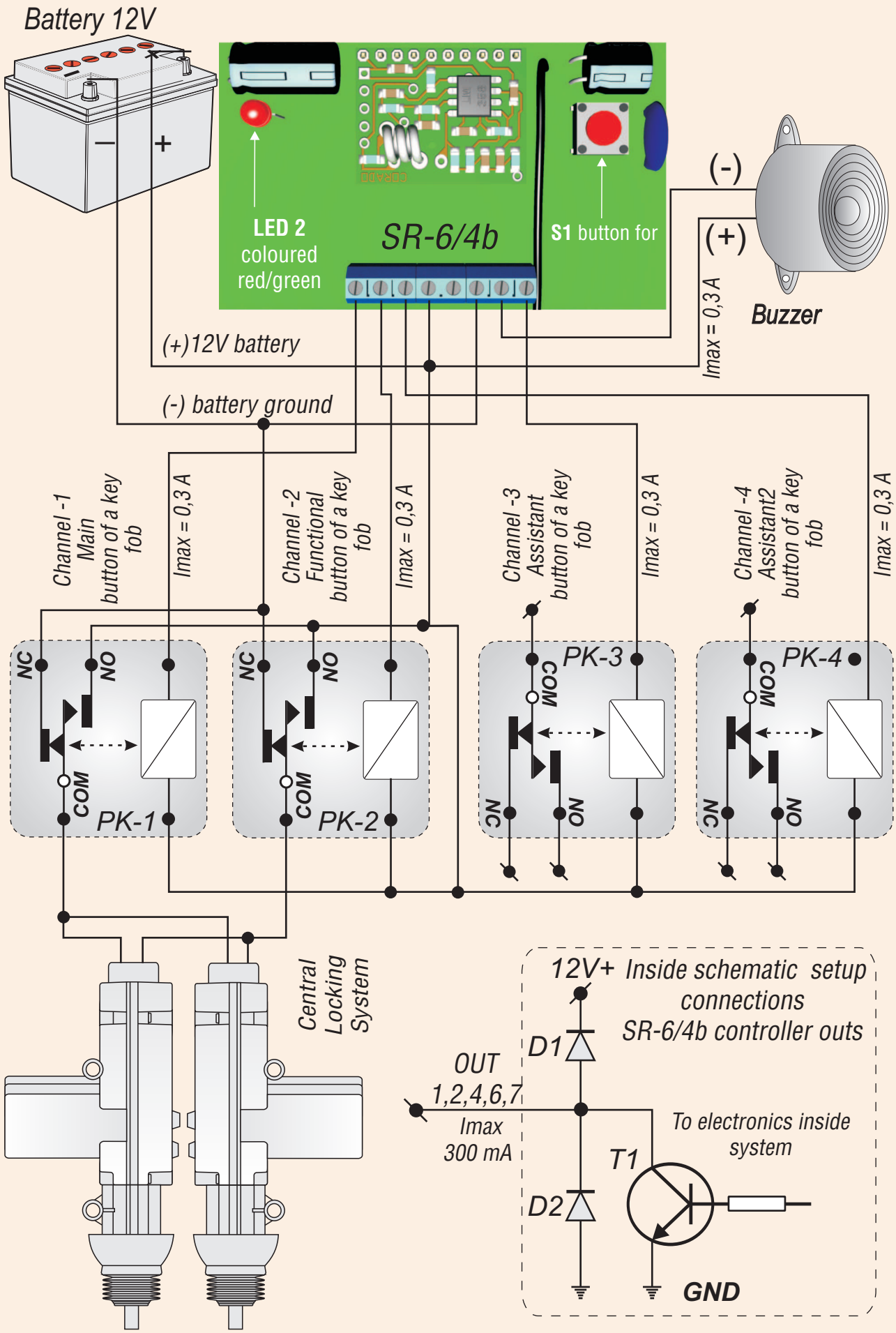


Figure 3 Application circuit with RX-3 as a solution for a 4-channel remote controller.





Schematic of a 4-channel remote controller
SR-6/4b full option with RX-3 on the board

Example 1 **4 Channel remote control VNQ660SP**

Another possibilty to use the RX-3 module is a 4 channel remote control with high efficiency current-carrying capacity and protection. In this case we used a quadruple transistor manufactured by ST Microelectronics. In the same cover is also VNQ690SP with a larger maximum current.
Scheme changes for the version VNQ690SP are easy for intermediate electronics. Although in theory the system is highly protected, you must remember not to exceed the voltage limit for U3 and U1, and current for each output channel of U1. Please also remember the heat-transfer at the higher current. If you have the characters of 2 main components (RX-3 and VNQ660SP) you can build a very efficient remote control on very small dimensions and very low price. A similar solution is remote control RSC-10 with 2 channels.
If you want to control the motors, use of Transil suppression diodes is necessary to avoid damage from the power supply.

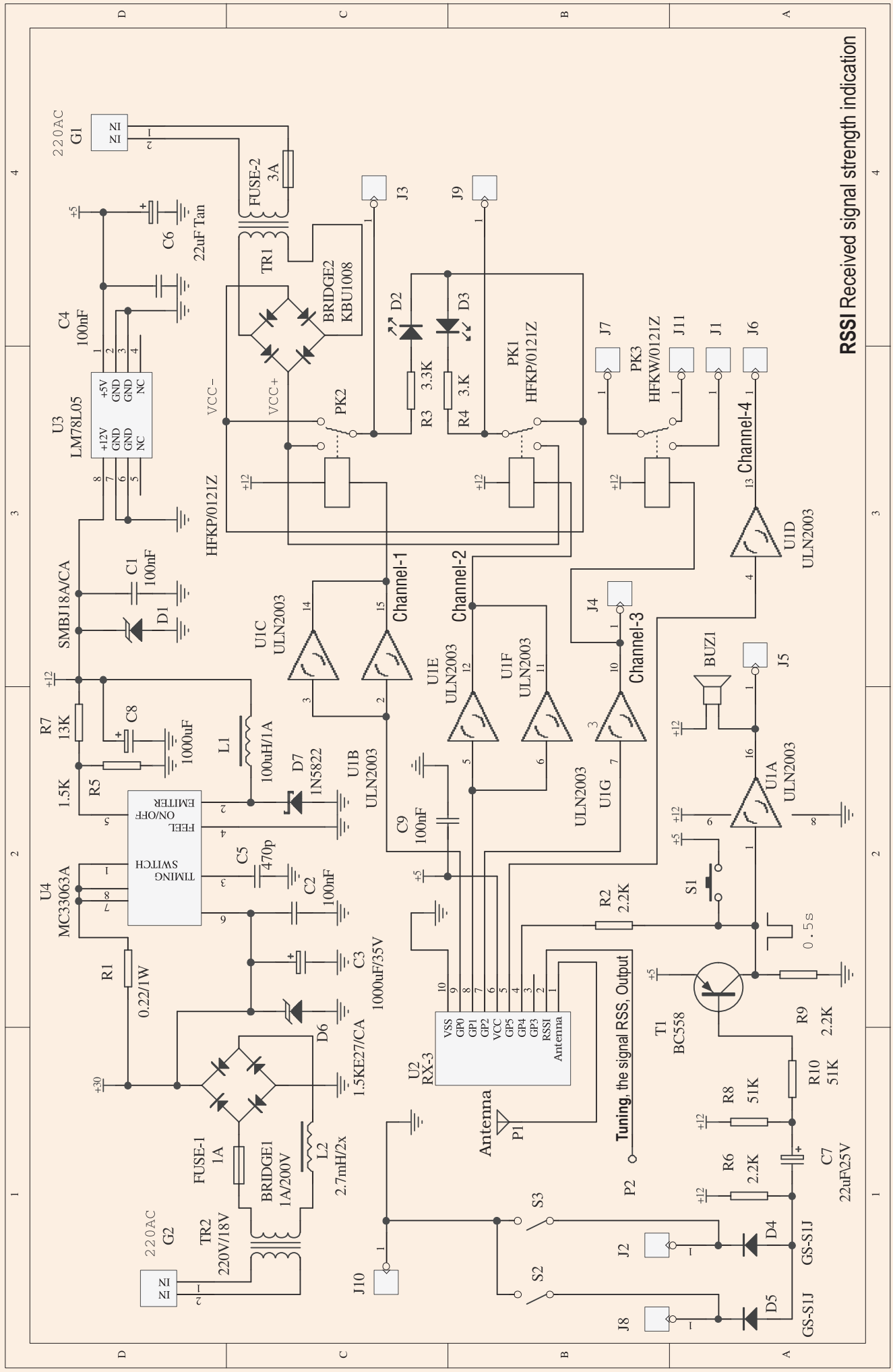
Functional and technical capabilities of this solution:
- 4 channels + VCC switching on the output of each channel U1
- If the voltage exceeds 36V it will turn off all channels
- Maximum current drawn from the channel to 6A, depends on the way of heat dissipation, a thermal limiter and time switch on channel/channels inside the VNQ660SP.
- Protection against damage when power is connected inversely
- The U1 and U2 elements are very popular, and thus readily available.

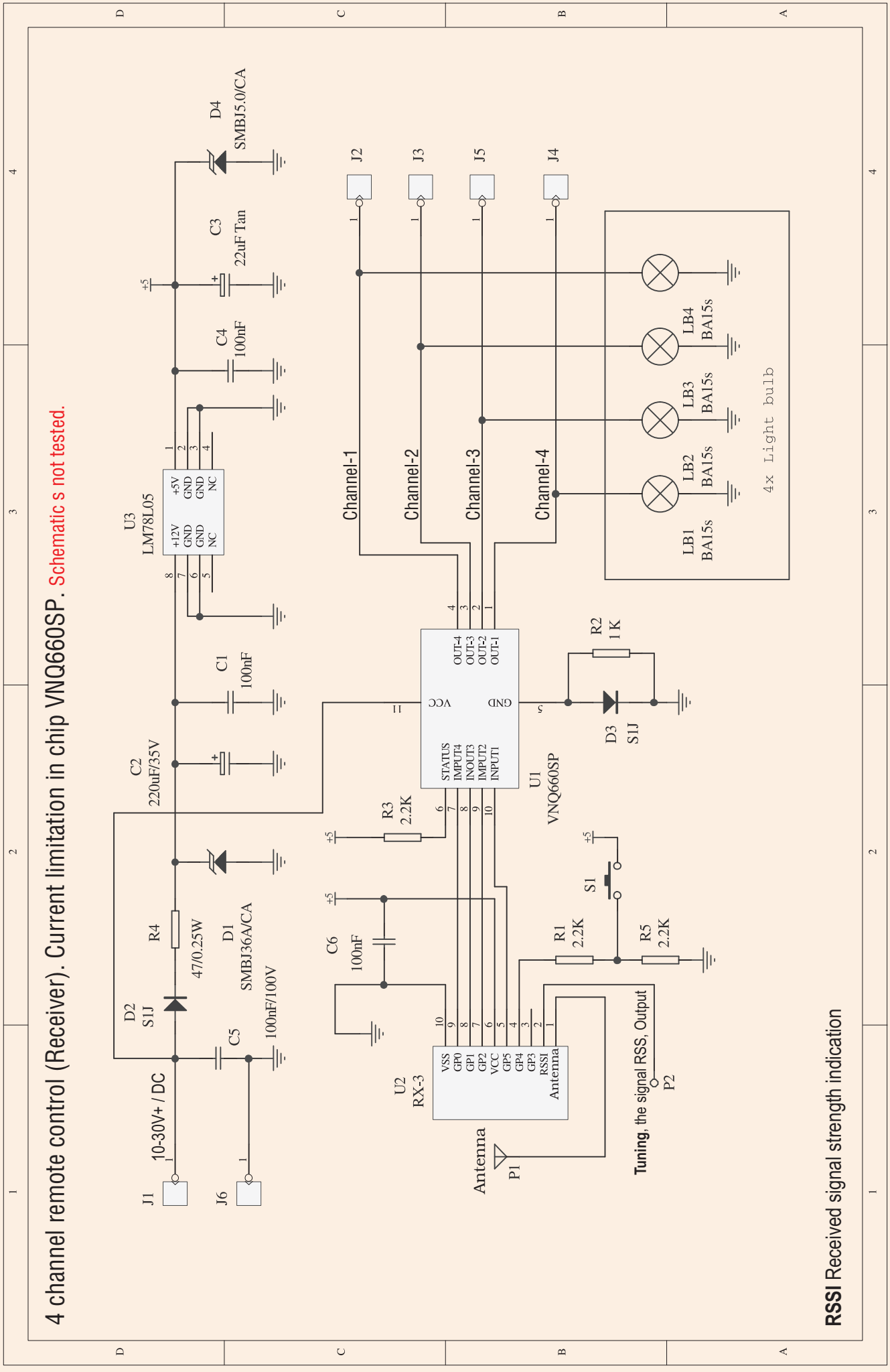
Example 2 **Circuit diagrams for a garage door remote**

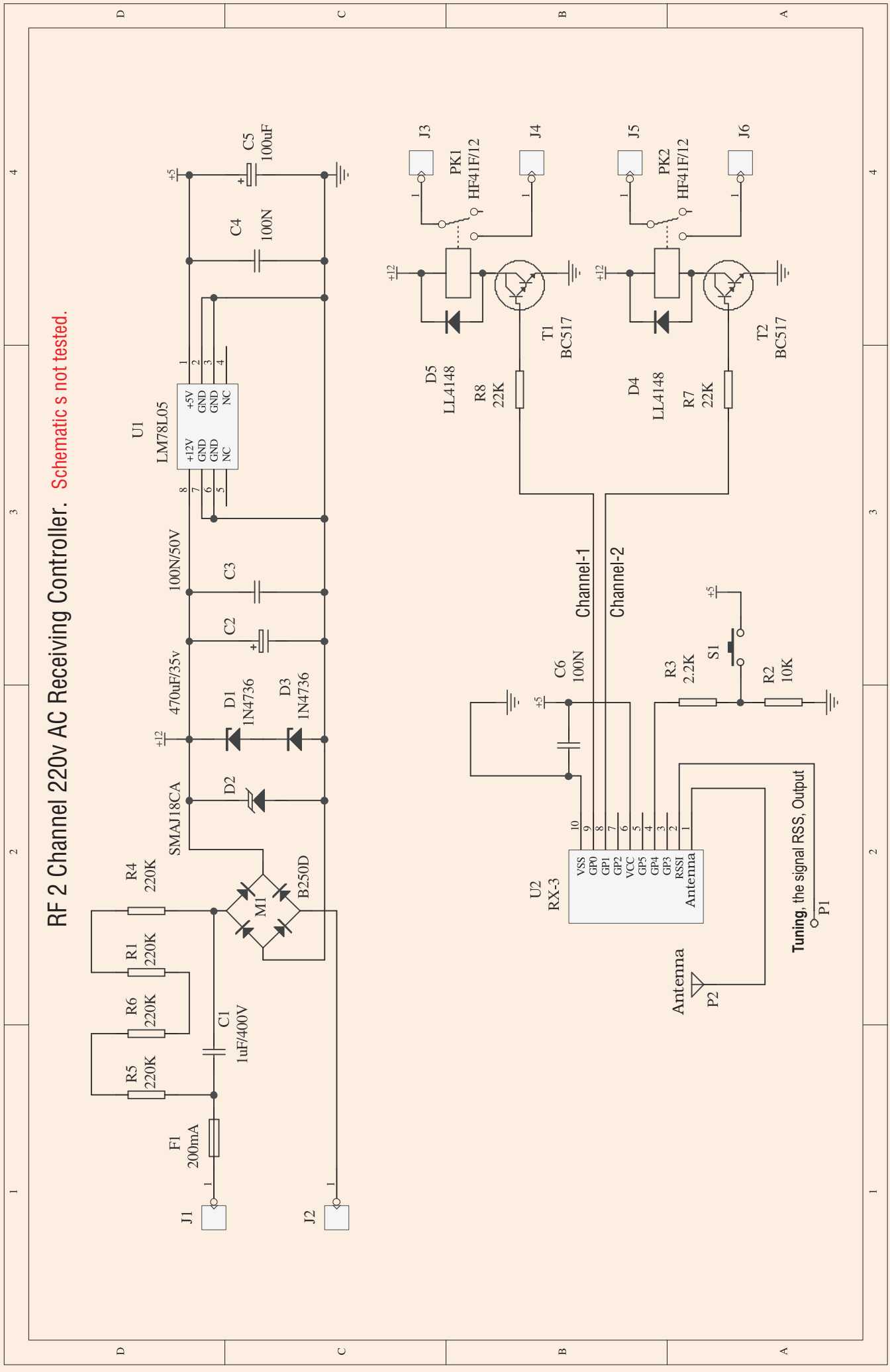
The presented circuit diagram is a proposition for a remote controlled gate. It is another example of the use of the radio module RX-3. Schema is not checked. It was drawn by our electronic designer who has developed similar projects for example car alarms. In case of a wider interest in this proposal we will try to fine-tune and access it together with the board to test the RX-3 module.
Diagram shows the ability to control a simple single-gate (one DC motor and 40 V). Of course, with some modifications, it can control motors powered by alternating voltage of 230V, but this idea is for the next project.
In devices of this type, all elements are important because they affect to the proper operation of the device, but the most important are the power electronics.
Proper construction of the power supply is a very important. MC34063 boost calculator program that is available online, can be helpful in this design. The power supply must provide stable voltage and low ripple. Ripples on the 5 volt power supply line can cause a drop in range for the key fob. Of course, the electrical point of everything is as it should but the range of the key fob will be not satisfactory.
With this example I would like to point out the importance of the power supply of the devices. Additional filters must be used such as, choke L2 and diode Transient Voltage Suppression (TVS) D6 and D1 Security (Unidirectional) without specific polarisation. They protect the system against voltage surges occurring in the mains. We used non linear SMPS that are more resistant to voltage spikes and surges. Also the gate had separate power electronics and motor.

Functions and operating
- Each time you press the Main button of the key fob it causes channel 1 to switch on to previously set time - the gate closes.
  The second channel behaves identically if the set is identical.
- If you press Functional button of the key fob, the gate opens. Pressing buttons 3 or 4 at any time makes the gate to stop completely.
- Inputs J8 and J2 are used to connect the switch to stop at the extreme (close/open)
- J3 and J9 are used to connect to the drive motor of the gate
- TR2 transformer is used for power electronics
- Supply voltage should be from 15V to 20 V at current of 0.5A
- TR1 transformer is used for power the drive motor current and should be matched to the requirements of the applied load of the engine. The same applies to the sternum bridge rectifier. This should be done to at least 20% of the stock of tensions and currents in the two elements
- Inputs J8 and J2 are used for connect the limit switch or overload.
- PK1 and PK2 relays are used for control the direction of rotation of the gate's engine and to stop the engine
- Two free channels (outputs J6 and J11) are for optional use and work only in monostable mode.

Circuit diagrams of a remote garage door. Schematic s not tested.




4 channel remote control (Receiver). Current limitation in chip VNQ660SP. Schematic s not tested.
RSSI Received signal strength indication
Tuning, the signal RSS, Output
Antenna
4x Light bulb
Channel-1
Channel-2
Channel-3
Channel-4
U1
VNQ660SP
U2
RX-3
U3
LM78L05
J1
J2
J3
J4
J5
J6
P1
P2
S1
D1
SMBJ36A/CA
D2
S1J
D3
S1J
D4
SMBJ5.0/CA
R1
2.2K
R2
1 K
R3
2.2K
R4
47/0.25W
R5
2.2K
C1
100nF
C2
220uF/35V
C3
22uF Tan
C4
100nF
C5
100nF/100V
C6
100nF
LB1
BA15s
LB2
BA15s
LB3
BA15s
LB4
BA15s
10-30V+ / DC


RF 2 Channel 220v AC Receiving Controller. Schematic s not tested.
J1
F1
200mA
J2
R4
220K
R1
220K
R6
220K
R5
220K
C1
1uF/400V
M1
B250D
SMAJ18CA
D2
D1
1N4736
D3
1N4736
470uF/35v
C2
100N/50V
C3
U1
LM78L05
+12V
GND
GND
NC
+5V
GND
GND
NC
C4
100N
C5
100uF
+5
+12
D5
LL4148
R8
22K
T1
BC517
D4
LL4148
R7
22K
T2
BC517
J3
PK1
HF41F/12
J4
J5
PK2
HF41F/12
J6
C6
100N
Channel-1
Channel-2
R3
2.2K
S1
R2
10K
U2
RX-3
VSS
GP0
GP1
GP2
VCC
GP5
GP4
GP3
RSSI
Antenna
Antenna
P2
Tuning, the signal RSS, Output
P1

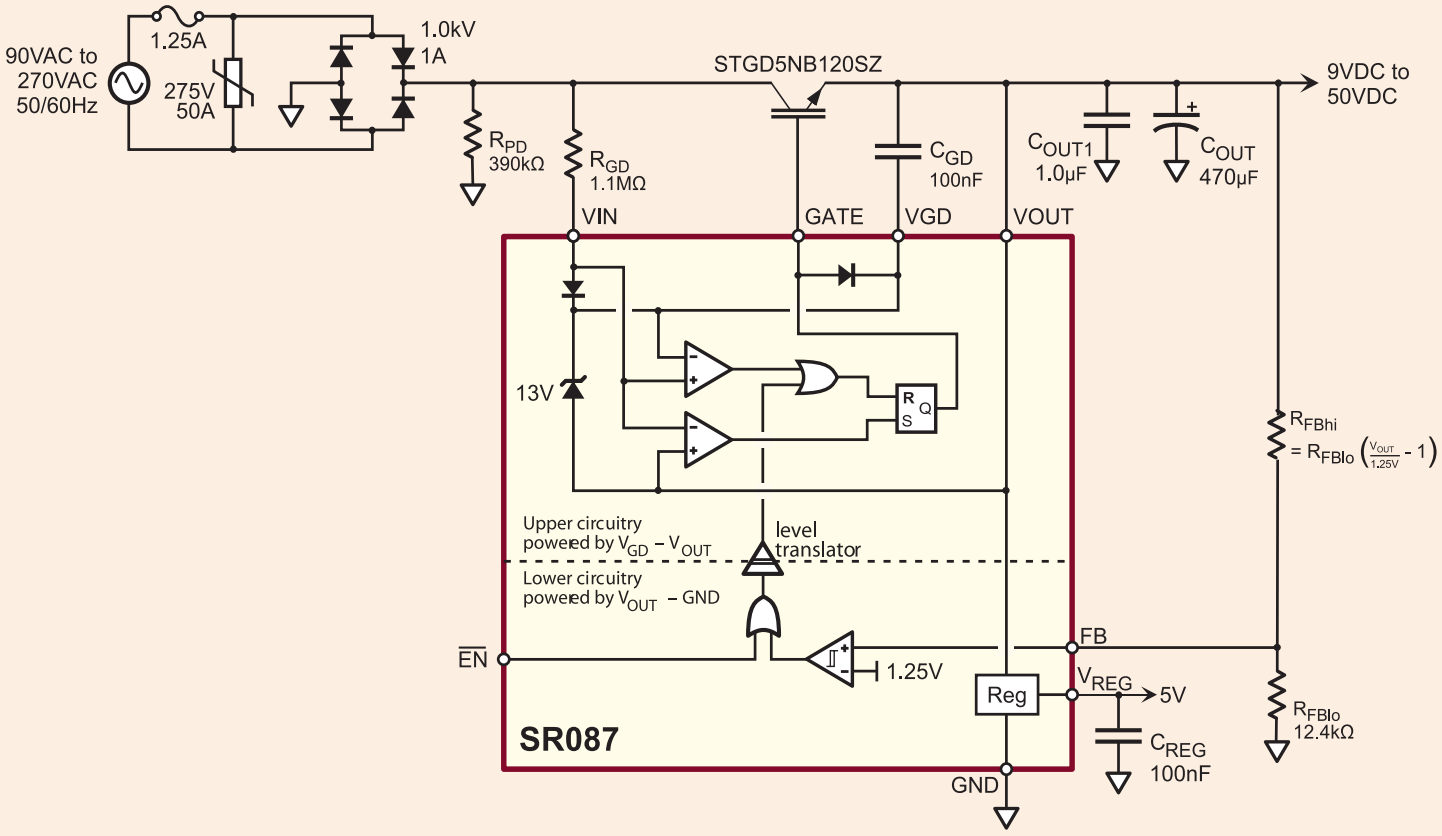
Adjustable Off-Line Inductorless Switching Regulator

General Description

The Supertex SR087 is an inductorless switching regulator designed to operate directly from a rectified AC line. The operating principle is to turn on a pass transistor when the rectifed AC is below the output voltage, and to turn it off when the output voltage reaches a specific level. A linear regulator supplied by VOUT provides an additional fixed 5.0V output. Efficiencies of around 55% may be realized for loads up to 1.0W in 120VAC applications, with around 50% efficiencies for loads up to 800mW in 230VAC applications. A logic-level enabled input allows the SR087 to be disabled – useful when it is employed as a keep-alive power supply.

WARNING!
Galvanic isolation is not provided. Dangerous voltages are present when connected to the AC line. It is the responsibility of the designer employing the SR087 to ensure adequate safeguards are in place to protect the end user from electrical shock.

The circuits shown in this datasheet are not guaranteed to meet surge and conducted EMI requirements. The effectiveness of these circuits may vary with a particular application. The designer should conduct tests to ascertain compliance with applicable standards and regulations.



Introduction

There are many applications that call for a non-isolated, low current DC power supply operating directly from the AC line. A switchmode power supply would be far too complex and expensive, whereas a simple 60Hz step down transformer would be cost effective but physically too large. Examples of such applications include battery chargers, proximity switch es, television stand-by supplies, and internal supplies for switchmode power supplies. When line isolation is not necessary, the circuit presented in this application note provides a solution that is both very cost effective and compact. The circuit presented in this note is a two-stage linear regulator capable of providing 5.0V at 50mA, but can be easily modified for other output voltages. The first stage handles the majority of voltage drop and power dissipation, allowing the second stage to employ standard low-voltage, low power linear IC regulators. The Supertex DN2535N5 high voltage depletion-mode MOSFET is used as the first stage pass transistor. For an isolated output, or an output with significantly higher output currents, please refer to Supertex application notes AN-H13, AN-H21, AN-H22, AN-H23, and AN-H24 which discuss the Supertex HV91XX series of switchmode PWM controller Ics.

Circuit Description

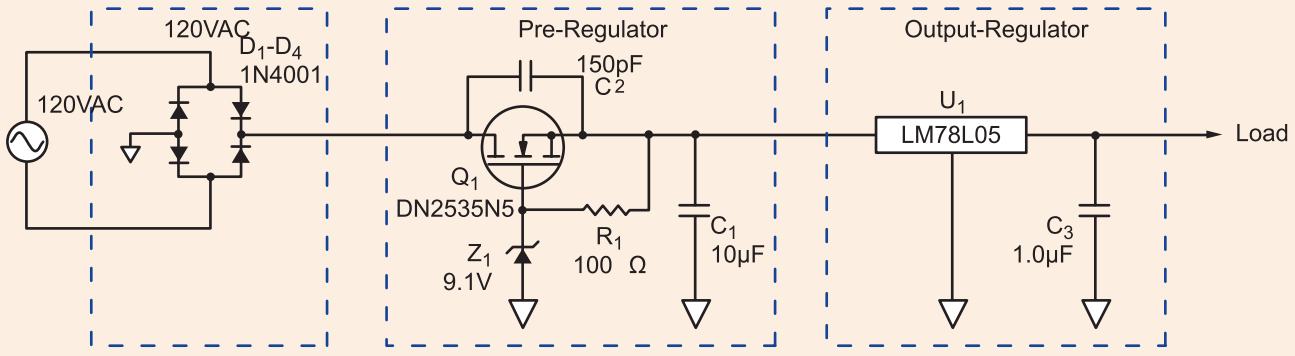
The circuit of Figure 1 provides a regulated 5.0V output at 50mA directly from a 120VAC input. Detailed descriptions will be given for the three different sections: Input rectifier, pre-regulator, and output regulator. SPICE simulation, lab measurements, and power dissipation are also addressed.

Caution

The circuit described in this application note does NOT provide galvanic isolation. When operated from an AC line, potentially lethal voltages can be present within the circuit. Adequate means of protecting the end user from such voltages must be provided by the circuit developer.

Design Requirements

The circuit in Figure 1 was developed to meet the design requirements listed in the table below. Many other output voltages and currents can be achieved simply by changing component values, without requiring any alterations in circuit topology.



5V/ 50mA Non-Isolated Power Supply

Circuit Description

Component	Function	Notes	Value	Rating
D1-D4	Rectifies AC line current	-	1N4004 (120VAC) 1N4005 (240VAC)	200V (120 VAC) 350V (240VAC) 100mA
Q1	Preregulator pass transistor	Use appropriate heat sink	DN2535N5 (120VAC) DN2540N5 (240VAC)	350V (120VAC) 400V (240VAC) 150mA
Z1	Sets preregulator output voltage	Other zener voltagesmay be used for other output voltages	1N757 (9.1V)	1/10W
R1	Provides bias for Q1 and Z1	-	100kΩ	1/16W
C1	Stores energy for use when AC < 9.1V	-	10µF	15V
C2	Prevents high frequency oscillations	Locate close to Q1	150pF	200V (120VAC) 350V (240VAC)
U1	Provides output regulation	Other devices may be used for other output voltages	LM78L05 (5.0V)	50mA
C3	Reduces transients at output	-	1.0µF	10V (or greater than

Description

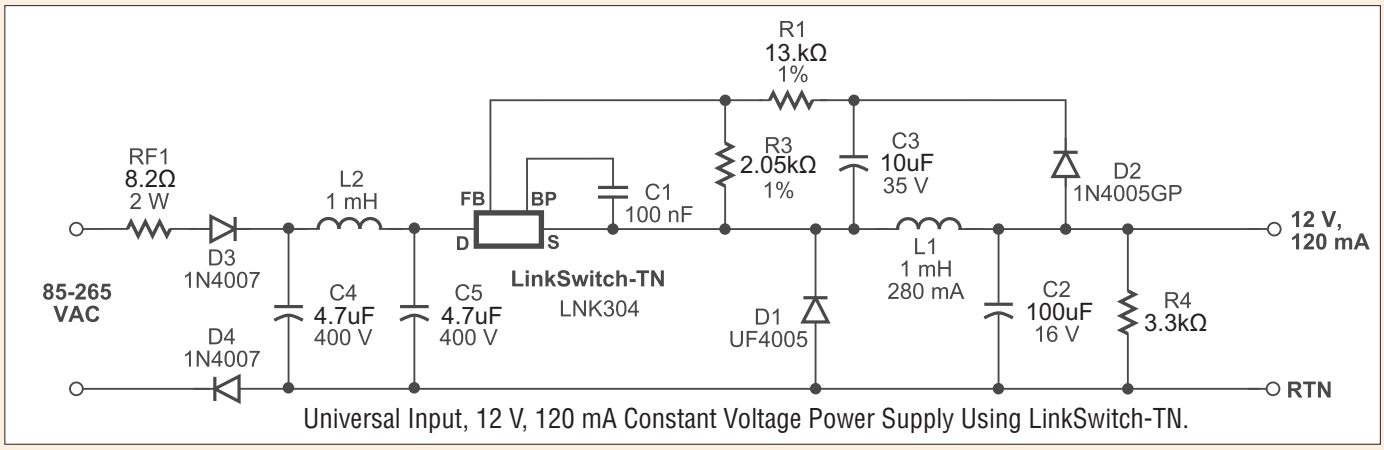
LinkSwitch-TN is specifically designed to replace all linear and capacitor-fed (cap dropper) non-isolated power supplies in the under 360 mA output current range at equal system cost while offering much higher performance and energy efficiency.

Product Highlights

- Cost Effective Linear/Cap Dropper Replacement
- Lowest cost and component count buck converter solution
- Fully integrated auto-restart for short-circuit and open loop fault protection – saves external component costs
- LNK302 uses a simplified controller without auto-restart for very low system cost
- 66 kHz operation with accurate current limit – allows low cos off-the-shelf 1 mH inductor for up to 120 mA output current
- Tight tolerances and negligible temperature variation
- High breakdown voltage of 700 V provides excellent input surge withstand
- Frequency jittering dramatically reduces EMI (~10 dB)
- minimizes EMI filter cost
- High thermal shutdown temperature (+135 ˚C minimum)

Much Higher Performance over Discrete Buck and Passive Solutions

- Supports buck, buck-boost and flyback topologies
- System level thermal overload, output short-circuit and open control loop protection
- Excellent line and load regulation even with typical configuration
- High bandwidth provides fast turn-on with no overshoot
- Current limit operation rejects line ripple
- Universal input voltage range (85 VAC to 265 VAC)
- Built-in current limit and hysteretic thermal protection
- Higher efficiency than passive solutions
- Higher power factor than capacitor-fed solutions
- Entirely manufacturable in SMD



Universal Input, 12 V, 120 mA Constant Voltage Power Supply Using LinkSwitch-TN.

OUTPUT CURRENT TABLE[1]				
PRODUCT[4]	230 VAC ±15%		85-265 VAC	
	MDCM[2]	CCM[3]	MDCM[2]	CCM[3]
LNK302P/G/D	63 mA	80 mA	63 mA	80 mA
LNK304P/G/D	120 mA	170 mA	120 mA	170 mA
LNK305P/G/D	175 mA	280 mA	175 mA	280 mA
LNK306P/G/D	225 mA	360 mA	225 mA	360 mA

Table Output Current Table

Notes:

- Typical output current in a non-isolated buck converter. Output power capability depends on respective output voltage. See KeyApplications Considerations Section for complete description of assumptions, including fully discontinuous conduction mode (DCM) operation.
- Mostly discontinuous conduction mode
- Continuous conduction mode.
- Packages: P: DIP-8B, G: SMD-8B, D: SO-8C.

Offline Buck Converter with Tapped Inductor Offers Improved Performance

*application note **AND8318/D** (part) from www.onsemi.com*

Introduction

For electronic and industrial equipment requiring non-isolated, offline, low power outputs, the simple buck converter appears ideal; however, the large differential input-to-output voltage can be problematic in terms of very low converter duty cycle, peak-to-average switching current ratios, and overall conversion efficiency. This application presents a solution that will overcome many of these issues without additional electronic circuitry. The solution involves a modification to the buck inductor in which a tap is added to the winding and the buck freewheeling diode is connected to the tap.

This magnetic reconfiguration will convert the standard buck topology shown in Figure 1 to what is sometimes referred to as the “current-boosted” buck shown in Figure 2. Buck Converter Operation A conventional offline buck converter with an output of 12 volts at 300 mA (3.6 watts) is shown in Figure 1.

This example converter is configured around ON Semiconductor’s NCP1014 monolithic current mode controller with integrated MOSFET for maximum circuit simplicity; however, it could also be configured with a discrete controller such as the NCP1216 and a separate MOSFET. Voltage regulation and feedback are accomplished via the simple network of Zener diode Z1, the associated resistors R2 and R3, and optocoupler U2.

The optocoupler is necessary because the ground (pin 4) on the NCP1014 controller is at a switching node and optical feedback is the simplest and most economical way to overcome the associated dV/dts and high voltage issues associated with other types of discrete feedback and/or voltage offset circuits. The schematic also includes a simple conducted EMI filter comprised of C1, and pi-network C2, L1, and C3.

As with typical buck operation, the rectified offline voltage at bulk capacitor C3 provides a dc level to the drain of U1’s internal MOSFET (pin 3), and is switched on and off at the source terminal (pin 4) and presented to the integrating circuit of L2 and C4. The L/C output filter averages the switched rectangular waveform to the desired output dc voltage at C4 via the voltage sensing/feedback of Z1/U2 and pulse width modulation in U1. Freewheeling diode D5 provides for current continuity in L2 when the MOSFET in U1 is in the offstate.

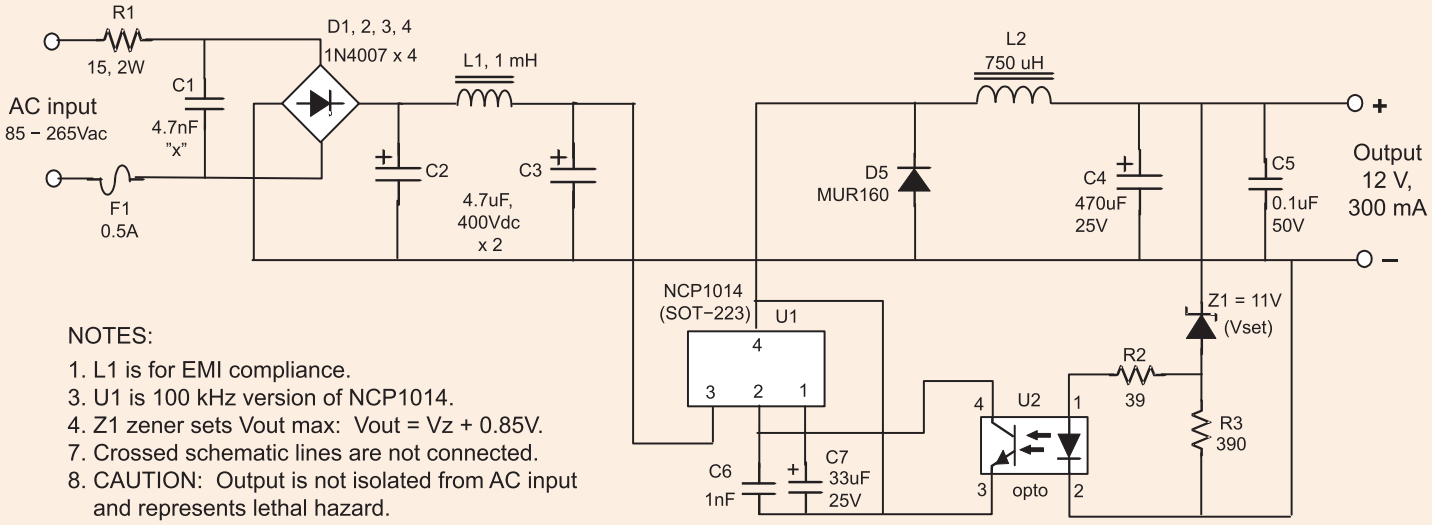


Figure 1. Offline Buck with Conventional Inductor

NCP1014: Self-Supply Monolithic Switcher for Low Standby-Power Offline SMPS

Product Description

The NCP101X series integrates a fixed-frequency current-mode controller and a 700 V voltage MOSFET. Housed in a PDIP7 package, the NCP101X offers everything needed to build a rugged and low-cost power supply, including soft-start, frequency jittering, short-circuit protection, skip-cycle, a maximum peak current setpoint and a Dynamic Self-Supply (no need for an auxiliary winding). Unlike other monolithic solutions, the NCP101X is quiet by nature: during nominal load operation, the part switches at one of the available frequencies (65-100-130 kHz). When the current setpoint falls below a given value, e.g. the output power demand diminishes, the IC automatically enters the so-called skip cycle mode and provides excellent efficiency at light loads. Because this occurs at typically 1/4 of the maximum peak value, no acoustic noise takes place. As a result, standby power is reduced to the minimum without acoustic noise generation.

Features

- · Built-in 700V MOSFET with Typical RdsON of 11 or 22 Ohms
- · Large Creepage Distance between High-Voltage Pins
- · Current- Mode Fixed Frequency Operation: 65kHz - 100kHz - 130kHz
- · Skip-Cycle Operation at Low Peak Currents Only: No Acoustic Noise!
- · Dynamic Self-Supply, No Need of an Auxiliary Winding
- · Internal 1ms Soft-Start
- · Auto-Recovery Internal Output Short-Circuit Protection
- · Latched Overvoltage Protection with Auxiliary Winding Operation
- · Frequency Jittering for better EMI Signature
- · Below 100 mW Standby Power if Auxiliary Winding is Used
- · Internal Temperature Shutdown
- · Direct Optocoupler Connection
- · SPICE Models Available for Transient AC analysis
- · Pb-Free Packages are Available

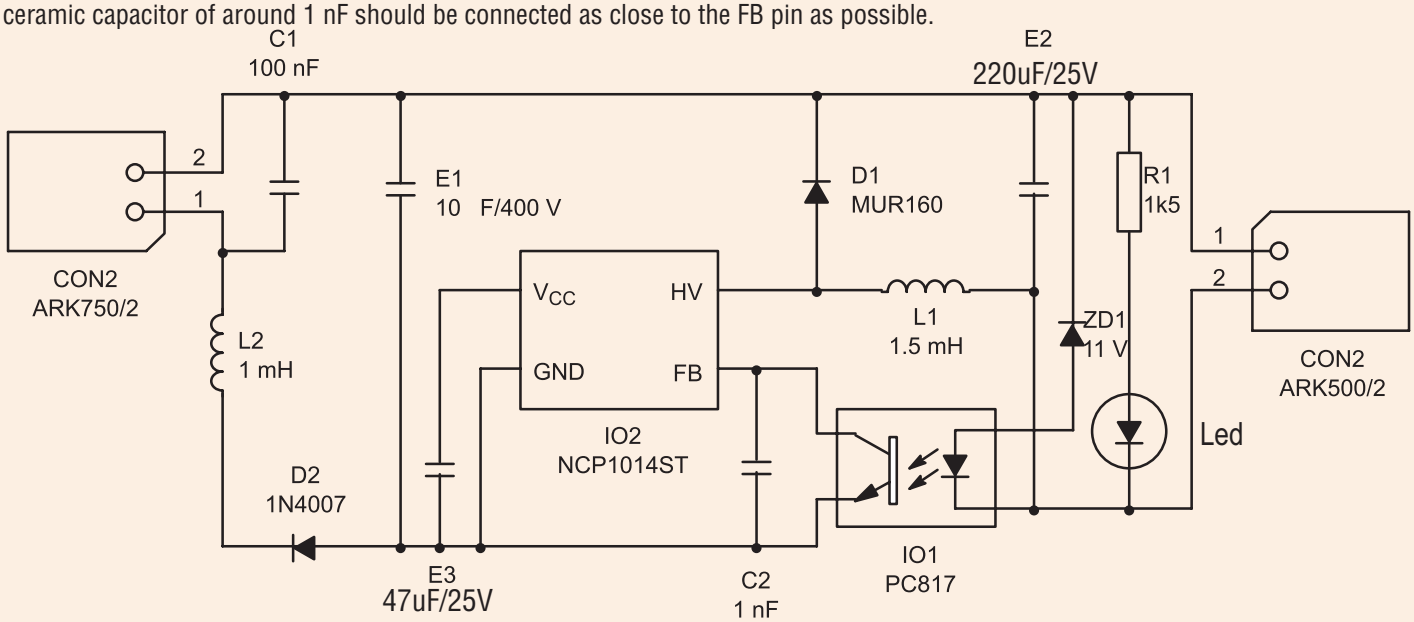
Non-isolated Negative Output Buck AC/DC Converter

This application note describes how to easily design a simple, non-isolated AC/DC converter for powering the low voltage control portion of line-powered applications that use a triac or SCR power switch. Examples of such applications include dishwashers, microwave ovens, coffee machines, illumination, etc. Compared to passive solutions using resistors or capacitors to reduce the voltage, this design has significant advantages such as:

*application note (part): **AND8190/D** from www.onsemi.com*

- · Wide input voltage range 85 – 265 VAC
- · Smaller size, lower weight, lower total cost
- · Good line and load regulation, no need of additional linear regulators
- · Efficient design with up to 80% efficiency
- · Overload, short circuit and thermal protection
- · Convenient for mass production due to SMD devices
- · Universal design for wide range of output currents and voltages

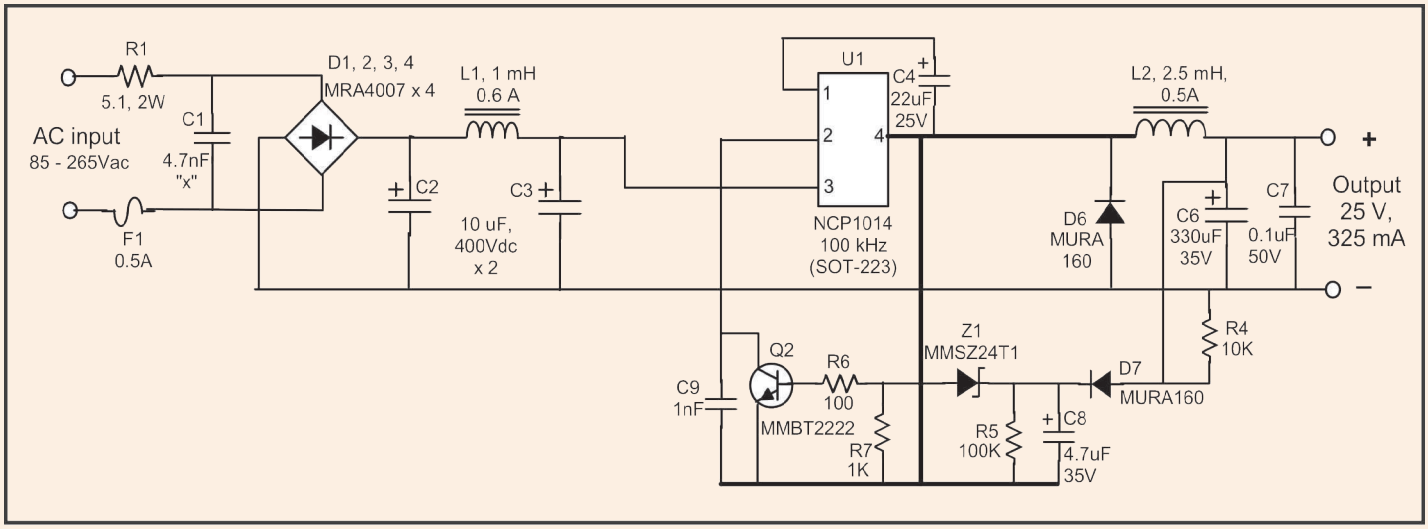
The monolithic power switcher used in this application greatly simplifies the total design and reduces time to production. ON Semiconductor's NCP1010 – 1014 family, a new line of Power Switchers, is ideal for this purpose. The NCP101x is offered in a SOT-223 package for reduced size, and is suitable for mass production. The design consists of the input filter, rectifier with filtering capacitor, the power stage with switcher and inductor, output ultrafast rectifier, output filtering capacitor, the feedback loop with Zener diode and optocoupler, and an indicator LED. The only component necessary for proper powering of the IC is the VCC capacitor, since the IC is directly powered from the HV Drain circuit via an internal voltage regulator. To eliminate noise at the feedback input, a small ceramic capacitor of around 1 nF should be connected as close to the FB pin as possible.



Complete Schematic Diagram of the 12 V/0.2 A Converter

Power Supply
Device Application Input Voltage Output Power Topology I/O Isolation NCP1014 85 to 265 Vac Up to 10W Off-Line Buck Non-isolated

Output Specification
Output Voltage 10 to 28 Vdc depending on selected Z1 zener value
Ripple Dependent on L2 inductance and C6 ESR, typically 1% max
Nominal Current 50 to 325 mA typical
Max Current 350 mA maximum
Min Current zero



Notes:
☞1. Vout set by Z1 (Vout = Vz +1V)
☞2. L1 is Coilcraft MSS1260-105KL or similar.
☞3. Thick lines indicate recommended ground plane area
☞4. U1 should be heatsunk via ground tab to copper clad area
☞5. Crossed schematic lines are not connected

Output Choke Design:
L2 can be constructed by winding 200 turns of #28 magnet wire on the bobbin of an EF-16 (E16/8/5) ferrite core with a cross sectional area (Ae) of 0.2 square centimeters (or similar ferrite core and bobbin), and gapping the core to achieve an nductance of 2.5 mH when measured across the winding. Another, but less efficient option would be to use two “off-the shelf” Coilcraft RFB1010-122L inductors in series.

References:
☞ON Semiconductor Design Note DN06037: Low Power, Off-Line Buck, CVCC Power Supply
☞Data sheet NCP1014

VIPer12A NON ISOLATED BUCK AND BUCK-BOOST CONVERTER REFERENCE BOARD

*application note **An1894** (part) from www.st.com*

INTRODUCTION

There are some applications, where an off-line power supply without isolation between input and output can be tolerated and rather low output current is required. In this case the converter should be simple and low cost. These requirements can be satisfied by a step-down converter based on monolithic device VIPer12AS that incorporates the PWM controller together with the Vertical power MOSFET switch in a SO8 package. The presented power supply has two variants. The first is a buck (step-down) converter with a positive output voltage referenced to the common ground. The second one with negative output voltage is a buck-boost converter. The presented reference board incorporates both variants by different assembly options.

CIRCUIT DESCRIPTION

Buck Converter +15V/100mA, +5V/60mA or 20mA (Variant 1)

Operating Conditions

Input Voltage range	90-264 VAC
Input Voltage Frequency range	50/60 Hz
Main Output	15V / 100mA
Second Output (through linear regulator)	5V / 60 or 20mA
Total Maximum Output Power	1.6W

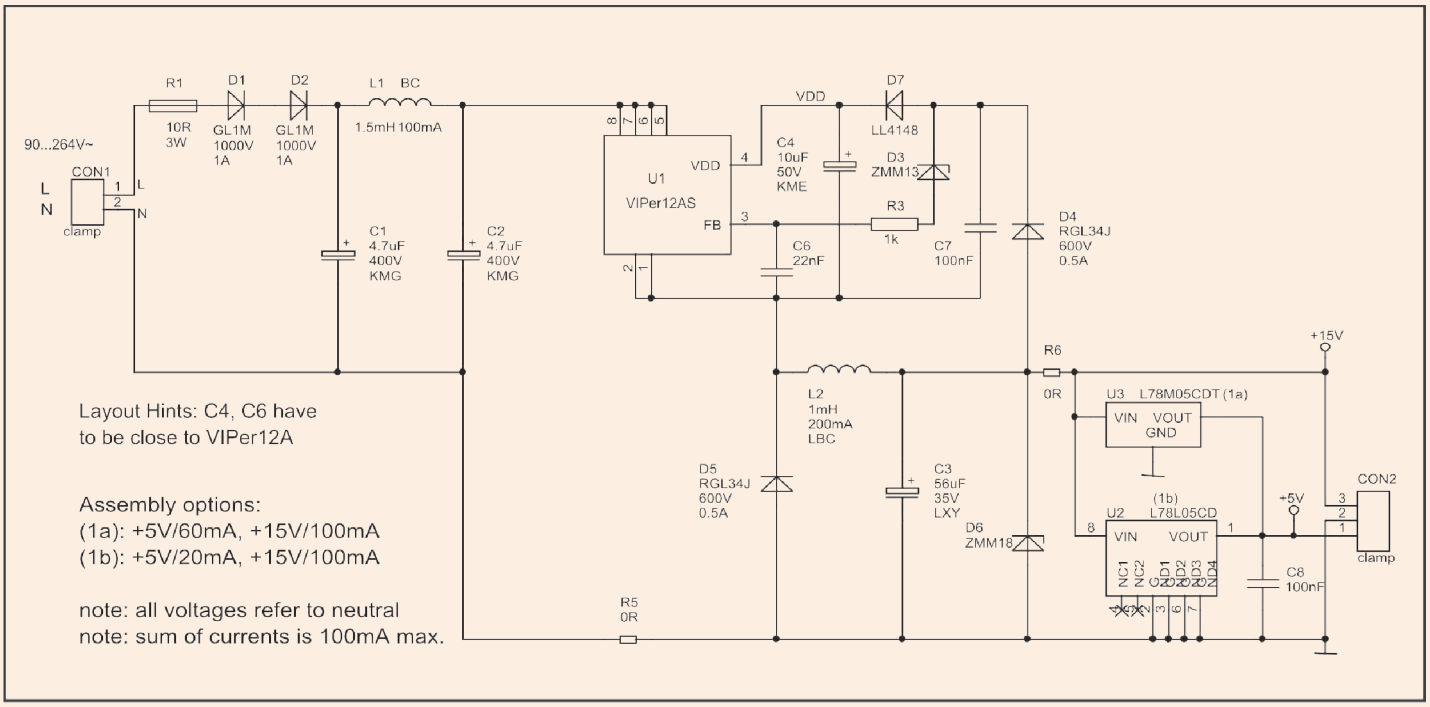
Circuit Operation

The total schematic of the power supply can be seen in Figure 1. The output of the converter is not isolated from input. For this reason the reference ground is common for an input and output connection terminal. The input capacitor C1 is charged from line via one way rectifier consisting of diodes D1 and D2. Two diodes in series are used for EMI reasons to sustain burst pulses of 2kV. The capacitor C1 together with capacitor C2 and inductor L1 forms an EMI filter. The DC voltage at C2 is then applied to the VIPer12 that works as a high side switch. It means the IC and corresponding supply and feedback loop circuitry is floating. The IC supply circuit consists of the high voltage diode D4, ceramic capacitor C7 low voltage D7 and capacitor C4. The voltage feedback loop is provided via zener diode D3, resistor R3 and capacitor C6. The diode D7 between capacitor C7 and C4 ensures the proper start-up of the converter. Thanks to this diode the feedback loop circuit is separated from supply circuit. The internal start-up current source of the VIPer12 charges the IC supply capacitor C4 to a specified start-up threshold voltage of about 16V.

AN1894 - APPLICATION NOTE

As soon as C4 voltage reaches the start-up threshold the internal 60 kHz oscillator sets the internal flipflop and through output driver turns-on the internal high voltage power MOSFET. The power MOSFET applies the bulk capacitor C1 and C2 high voltage to the cathode of the power diode and to one terminal of the inductor. Since the voltage at the output capacitor C3 connected to the inductor's second terminal is much lower than input bulk capacitor voltage the inductor current will ramp-up. As soon as the inductor current ramp reaches the VIPer's internal set-point defined by feedback loop, the internal power switch turns off. The inductor keeps the direction of the current flowing and it reverses the voltage at C3. The inductor current then flows through the forward biased D5 diode and charges the output capacitor C3. In this switch-off phase the source terminal of the VIPer12 sees a negative level of the forward biased D5 (when referenced to ground) so it can be considered as grounded. This allows the inductor current to flow also through D4 and supply the VIPer12 and give the feedback information about output voltage.

Schematic diagram of non isolated buck converter with positive output voltage.



Glossary of basic terms:

BISTABLE MODE:
Each press of the key fob transmitter push-button changes the output to the opposite (switches the negative power supply on or off).

BISTABLE DEPENDENT MODE:
Each press of the key fob transmitter push-button switches on the negative power supply for selected channel with a simultaneous switch off of the negative power supply for another channel.

MONOSTABLE MODE:
Each press of the key fob transmitter push-button switches on the negative power supply for selected channel at a previously programmed time.

MONOSTABLE DEPENDENT MODE:
Pressing the key fob transmitter push-button switches on the negative power supply for selected channel at a previously programmed time, with a simultaneous switch-off of the negative power supply for another channel if it was on at that time.

DYNAMIC CODE HOPPING "Keeloq®":
KeeLoq is a software data encoding system derived by Microchip Technology Inc., used for safe and secure transmission of controlling messages from the key fob transmitter to the controller. The program contained in the key fob transmitter encrypts the data to prevent attempts of scanning and possible use of the information later. It ensures safety of data transmission in relation to other users of the same system. The encryption system is resistant to random and sabotage signals coming from other broadcasting devices, which are jammed at the radio reception stage.

PROGRAMMING:
This function allows to modify controller settings: logging/erasing of key fob transmitters, changing the operation mode to bistable or monostable, and the time setting.

Using the appropriate MOSFET you can build a controller with a large current-carrying about 100A, with small dimensions, by using modern transistors such as:

- **NXP Semiconductors**: PSMN1R3-30YL: N-channel 30 V 1.3 mΩ MOSFET at package "LFPAK")
- **Vishay Siliconix**: Si4628DY,Si4154DY, P-Channel Si7145DP,Si4628DY 3 mΩ N-channel30 V, Si4628DY 3 mΩ N-channel30 V,
- **STMicroelectronics**: 2.3mΩ STB230NH03L,3.0mΩ STB100NF03L-03-1,3.2mΩ STB100NF03L-03T4,1.4mΩ STB300NH02L,3.5mΩ, STS25NH3LL, 9.5mΩ STB70NFS03LT4 70 18mΩ,9.5 STB70NF3LLT4 70 12mΩ,9.5mΩ STB70NF03LT4 70 18mΩ, STB230NH03L 3mΩ, 2.3mΩ STB230NH03L and record the current STV300NH02L 1mΩ 280A
- **Fairchildsemi**: FDMS7650 N-Channel PowerTrench® MOSFET 30 V, 60 A, 0.99mΩ, FDMS7650 N-Channel PowerTrench® MOSFET 30 V, 60 A, 0.99mΩ
- **Toshiba**: TJ120F06J3,TK100F04K3,TK150F04K3,TK100F06K3,TK130F06K3,TK50F15J1, and others from the family with very low resistance mede in U-MOS technology, for devices with 12-V power supply
- **International Rectifier**: IRF67180.5 mΩ,IRF6717 0.95mΩ, IRF6713 2.2mΩ

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