ID-innovations
Advanced RFID design

PROVISIONAL

The new ID3-HP

Super Performance Long Read Range
Big Power in a Tiny Reader Module

124cm Read Range(clamshell card)

For super long-range readers, cat-flaps and much more

Contents

1. Overview

The new high performance ID3-HP module is a game changer, there is simply nothing like it anywhere in the World and it comes in a tiny 21x22mm package that is 6mm high. The ID3-HP is an inexpensive route to very long range readers. The ID3-HP shares the same footprint and functionality as the popular ID2/12/20 and ID-3/12/20 LA series.
With a 5v supply the ID3-HP module can achieve a whopping ***124cm*** read-range from a clamshell card and ***83CM*** from an ISO card using a 350x265mm antenna. It can also provide up to 35cm read range with a diminutive 35mm x 36mm external antenna and 16cm using a tiny 24x24mm antenna depending on the size and quality of card.
The ID3-HP series may be used as drop-in replacements for the ID3 module in many applications, instantly increasing the performance. The extra power comes with a caveat – extra current consumption.

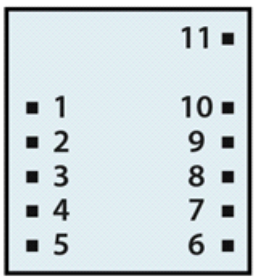
ID Innovations provide suitable medium and small range coils compatible with the ID3-HP. The modules are pin and function compatible with the ID2/12/20 and ID3/ID12/ID20-LA series and feature ASCII, Wiegand26 and Magnetic ABA Track2 data output formats.

2. Applications

Suitable applications include:-

- Medium, long and very long-range RFID readers.
- Cat and dog flaps
- Through wall readers
- Logistics and Robotics
- High Power Portable tag readers

3. Pin Out for the ID3-HP Series



Bottom View

1	0v Supply
2	Reset
3	RF Out
4	RF In
5	Mag CP
6	Card in Range
7	Format Select
8	Data1
9	Data0
10	Beeper
11	+Supply

4. Device Operational Characteristics

Parameter	ID3-HP
Frequency	125 kHz nominal
Card Format	EM 4001 or compatible
Read Range ID3-HP	Up to 124cm using a suitable antenna using ID-Innovations clamshell card
Temperature Range	-10 deg C to 60 deg C
Encoding	Manchester 64-bit, modulus 64
Power Requirement	+4.5 VDC thru +5 VDC @ 35mA- 250mA

5. Data Formats

Output Data Structure - ASCII - 9600 Baud, No Parity, 1 stop bit.

Output = CMOS (Push Pull) 0-Vdd

STX (02h)	DATA (10 ASCII)	CHECK SUM (2 ASCII)	CR	LF	ETX (03h)

Example for Calculation of Checksum for ASCII

Suppose the output Data is 0C000621A58E

Here the actual data is 0C,00,00,06,21,A5 and the checksum is 6E

Using binary, we Exclusive OR the bit columns

0C	=	00001100
00	=	00000000
06	=	00000110
21	=	00100001
A5	=	10100101
CHECKSUM		10001110 (8E)

Output Data Structure - Wiegand26 – 1mS repeat, 50uS pulse. Open Drain

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
P	E	E	E	E	E	E	E	E	E	E	E	E	O	O	O	O	O	O	O	O	O	O	O	O	P
Even parity (E)													Odd parity (O)												

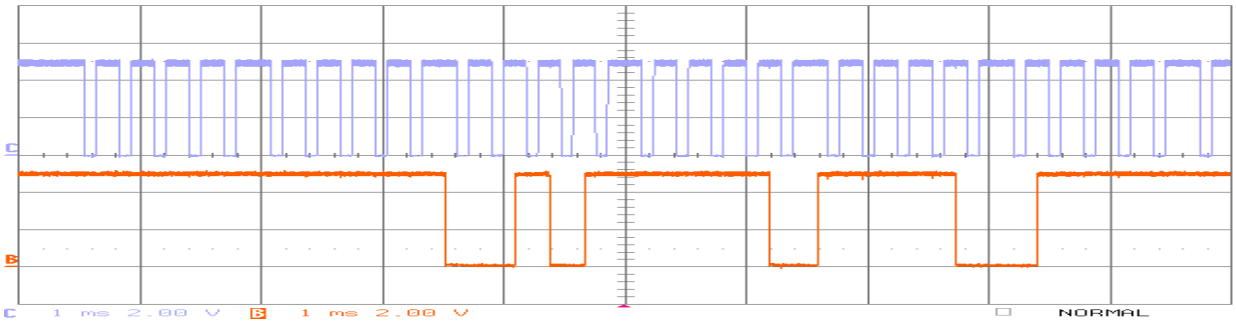
P = Parity start bit and stop bit

Output Data Magnetic ABA Track2 – At Approx. 80cm/sec. Open Drain

10 Leading Zeros	SS	Data	ES	LCR	10 Ending Zeros

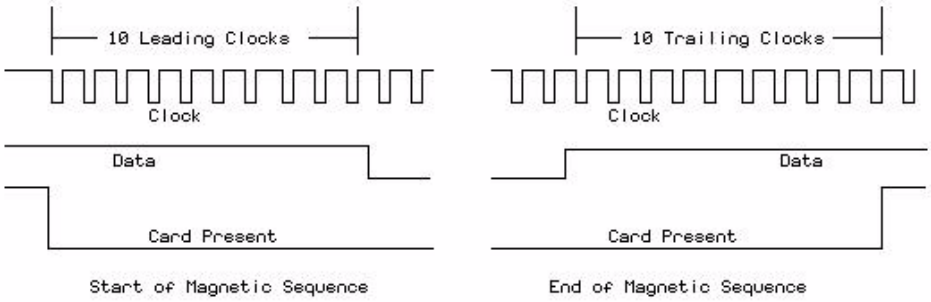
[SS is the Start Character of 11010, ES is the end character of 11111, and LRC is the Longitudinal Redundancy Check.]

6. Magnetic Emulation Waveforms

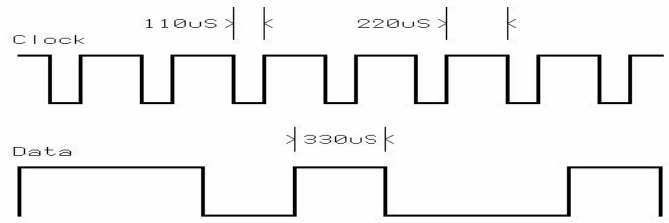


Blue = Clock, Brown = Data

Start and End Sequences for Magnetic Timing



Data Timings for Magnetic Emulation



The magnetic Emulation Sequence starts with the Card Present Line going active (down). There next follows 10 clocks with Zero ‘0’ data. At the end of the 10 leading clocks the start character (11010) is sent and this is followed by the data. At the end of the data the end character is sent followed by the LCR. Finally, 10 trailing clocks are sent and the card present line is raised.
The data bit duration is approximately 330uS. The approximate clock duration is 110uS. Because of the symmetry data can be clocked off either the rising or falling edge of the clock.

7. Pin Description & Setting Data Format

Pin #	Description	ASCII	Magnet Emulation	Wiegand26
Pin 1	Zero Volts	GND 0V	GND 0V	GND 0V
Pin 2	Strap to Pin11	Reset Bar	Reset Bar	Reset Bar
Pin 3	To External Antenna ID3-HP only	Antenna	Antenna	Antenna
Pin 4	To External Antenna ID3-HP only	Antenna	Antenna	Antenna
Pin 5	Card Present	No function	Card Present*	No function
Pin 6	Tag in Range (Future)	Tag in Range	Tag in Range	Tag in Range
Pin 7	Format Selector (+/-)	Strap to GND	Strap to Pin 10	Strap to +5V
Pin 8	Data 1	CMOS	Clock*	One Output*
Pin 9	Data 0	TTL Data (invert)	Data*	Zero Output*
Pin 10	3.1 kHz Logic	Beeper / LED	Beeper / LED	Beeper / LED
Pin 11	DC Voltage Supply	+2.8 thru 5V	+2.8V thru 5V	+2.8V thru 5V

*Open drain requires 4K7 Pull-up resistor to +5V

Pin1 is the zero volts supply pin and the communications common ground.
Pin2 is used in manufacture and should be strapped to pin11 at all times.
Pin3 should be connected to the external antenna.
Pin4 should be connected to the external antenna. Extreme care should be taken to ensure the RF voltage applied to this pin is less than 200v PKPK at all times.
Pin5 is only used as a 'Card Present' output when the output format is set to Magnetic Emulation. For timings see the 'Magnetic Emulation Waveforms in section 5.
Pin6 is used as a 'Tag in Range' indicator. When a tag is in range the pin is set to VDD voltage else it is at 0v. Pin6 output has an internal 3K3 resistor and may be used to drive an LED directly.
Pin7 is the format selector. The format selector selects the format depending where it is connected. See table above. Note that the output format is decided at switch on and cannot be changed later.
Pin8 has alternate functions. When the output format is set to Magnetic Emulation pin8 is used as the 'Clock' output. For timings see the 'Magnetic Emulation Waveforms in section 5. The alternate mode is active when the output format is set to ASCII and pin8 then outputs the ASCII data. Pin 8 may be used to connect to a computer RS232 input. See section on connecting to a computer.
Pin9 is active when the output format is set to ASCII and it outputs complementary (inverted) ASCII data output. Pin 9 is also suitable for connection to a UART.
Pin10 is the beeper out pin. When the beeper is active pin10 delivers an output square wave of approximately 3.3KHz. The pin is not buffered and cannot be used to drive a beeper directly.
Pin11 is the DC positive supply pin. The supply voltage must be free from noise and preferably from a linear regulator with less than 100uV RMS noise. Many inexpensive regulators have noise levels below these levels. See the section on choice of power supply. See section on power supplies. The module will operate down to 3 volts but for full power 4.5-5 volts is recommended.

8. Absolute Maximum Ratings

Maximum continuous supply current	DC supply	230mA
PK supply current for 60 seconds	DC supply	400mA
PK instantaneous supply current	DC supply	500mA
RF voltage at Pin4	RF in	200v PKPK
Maximum voltage applied to Pin 2	Vcc	5.5volt
Maximum voltage applied to Pin 2	Reset	Vcc ± 0.7v
Maximum current drawn from Pin 3	Antenna	2.5amps PKPK
Maximum 125 KHz RF Voltage at Pin 4	Antenna	300v PKPK
Maximum current drawn from Pin 5	Card Present	±5mA
Maximum current drawn from Pin 6	Tag in Range	±5mA
Maximum Voltage at Pin 7	Format Selector	Vcc ±0.7v
Maximum current drawn from Pin 8	Data1	± 5mA
Maximum current drawn from Pin 9	Data0	±-5mA
Maximum current drawn from Pin 10	Beeper	± 10mA
Additionally, Pins 5, 6, 7, 8, 9 & 10 may not have a voltage exceeding		Vcc ±0.7v

These ratings are absolute maximums and operation at or near the maximums may cause stress and eventual damage or unpredictable behaviour.

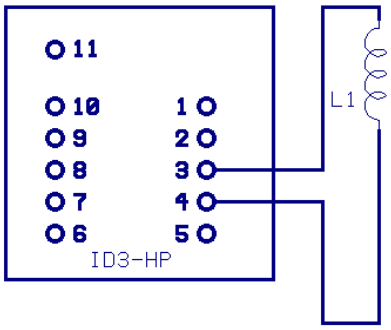
9. Examples of External Antenna Configurations for the ID3-HP

If the user is making their own antenna then do not fixate on the stated capacitor values. Find a source of COG 2-5% capacitors and use capacitors in parallel to get a good tune.

Thicker antenna wire will give more range but it must be remembered that the RF peak to peak voltage at pin4 must not exceed 200PKPK and the DC supply current should not exceed 0.23A in normal use. When testing the power should be ramped up slowly to make sure the parameters are within maximum limits. ***We recommend adding a 2w 2.2R resistor in series with the coil for test and reducing to zero ohms to make sure the DC current and PKPK are not exceeded***. For short term testing the current may be allowed to go as high as 0.4 amperes for no longer than 1minute.

Also note that the Q of an antenna coil is, to a first order, proportional to the weight of the copper used. It is simple, for a given inductance the more copper the higher the Q. There is a popular misconception that the higher inductance the higher the Q, indeed, old 125Khz readers employed very high inductances but the fact is there is no need to make the inductance high to get a good Q, in fact lower inductances generally work better. To get the absolute peak performance from your large antenna nothing beats Litz, at a cost. ID Innovations market Litz wire and wound coils upon request providing a minimum order.

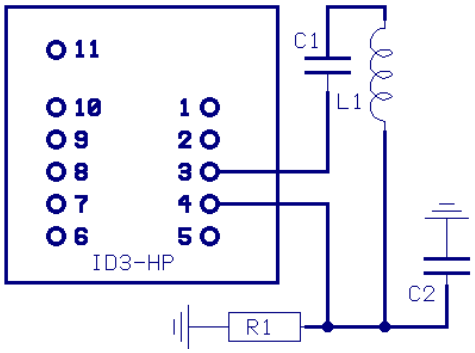
ID3-HP Low Power



Example 1 **0.4 mm Dia. copper wire** Size 60 x 95 mm, 1265uH 85T	
L1	1265uH @ 1khz
Module	XID3-HP
DC	4.9v @ 60mA
Range 1	44cm Clamshell
Range 2	31cm ISO
Notes	

This simple low power configuration uses the internal tuning capacitor. The ID3-HP may be used as drop-in replacement for the ID3 or ID2 providing the RF voltage at pin4 is kept below 200v PKPK.

ID3-HP Medium Power with External Antenna with low RFI pickup



Example 2 **LITZ 30x0.1 wire.** Size 150 x 150mm, 46Turns 820uH	
C1	2n4 (2n2 + 220p)
C2	10n COG 100v
L1	822uH @ 1khz
R1	680K
DC	4.8v @ 210mA
Range 1	84cm Clamshell
Range 2	61.5cm ISO
Checked	GP 8/3/2019

Example 3 **0.7 mm Dia. copper wire** Size 60 x 95 mm, 42 Turns 350uH	
C1	7n36 (6.8n + 560p)
C2	10n COG 100v
L1	366uH @ 1khz
R1	680K
DC	4.8v @ 150mA
Range 1	53cm Clamshell
Range 2	33cm ISO
Checked	GP 8/3/2019

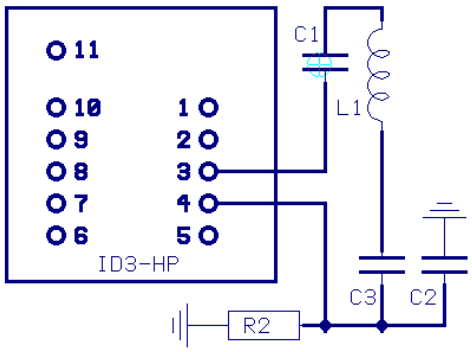
Example 4 **0.4mm Dia. copper wire** Size 60 x 95 mm, 46 Turns 488uH	
C1	4n56 (3n9 + 680p)
C2	10n COG 100v
L1	488uH @ 1khz
R1	680K
DC	4.8v @ 150mA
Range 1	49cm Clamshell
Range 2	31cm ISO
Notes	**Antenna in Stock**

This configuration is good for coils of all sizes. It allows for high RF power and yet is simple. Care must be taken to keep the RF voltage at pin4 to below 200v PKPK or instant damage will occur to the module. In appendix1 there is a 'FreeBasic' listing for a simple program to determine C1,C2 and L1.

Two examples have been shown. Example1 uses an antenna with 0.46mm wire, while example 2 uses 1mm diameter enamel coated wire both of which are readily available. Both have extremely long range and can read a clamshell card at around 80-100cm and a tiny 11.4mm glass tag at 18-20cm.

ID3-HP High Power with External Antenna with low RFI pickup

At this point we are getting very good read range and low pickup. The extra range is accountable to less pickup from noise sources.

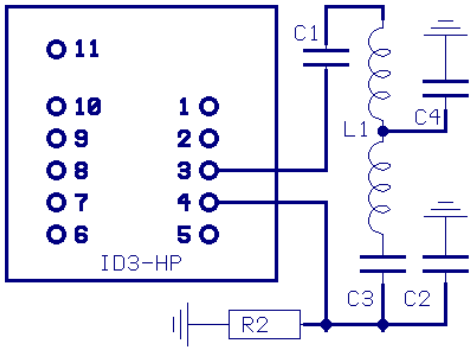


Example 5 **LITZ 30x0.1 wire.** Size 150 x 150mm, 46Turns 820uH	
C1	4n4 (3n9 + 560p)
C2	10n COG 100v
C3	4n7
L1	822uH @ 1khz
R1	680K
DC	4.8v @ 210mA
Range 1	90cm Clamshell
Range 2	63.5cm ISO
Checked	GP 8/3/2019

Example 6 LITZ 30x0.1 wire. Size 265 x 350mm, 28Turns 769uH	
C1	4n7 COG 200V
C2	10nF COG 100v
C3	6n8 COG 200v
L1	769uH @ 1khz
R1	680K
DC	4.7v @ 220mA
Range 1	120cm Clamshell
Range 2	81cm ISO
Checked	GP 8/3/2019

ID3-HP High Power with External Antenna with lowest RFI pickup

The version below has the longest range of all antenna configurations and the absolutely lowest electrical pickup. The antenna is centre tapped and can handle a lot of power.



Example 7 **LITZ 30x0.1 wire.** Size 265 x 350mm, 28Turns 769uH	
C1	3n9 COG 200V
C2	10n COG 100v
C3	4n1 (3n9 +220p) COG 200v
C4	47n XR7 50v
L1	820uH @ 1khz
R1	680K
DC	4.7v @ 220mA
Range 1	124cm Clamshell
Range 2	83cm ISO
Checked	GP 8/3/2019

10. Choice of Tuning capacitors

We recommend using COG or MPP capacitors. COG capacitors are considered ideal with very low temperature change. Often the permissible peak to peak RF voltage on a COG capacitor can be 2x the stated DC value but for MPP types it is best to use a much higher voltage rating. MPP types have more temperature drift.

11. Direct Connection to a Computer RS232

Direct connection to a computer RS232 can be made by connecting Pin8 to a 1k series resistor and connecting the other end of the resistor to the computer RS232 input. The mode is called pseudo RS232. On a standard D9 socket, connect module Pin8 via the series 1k to pin2 of the D-type. Connect the ground to Pin5 on the D-type. Leave the TX pin3 open. See “Useful Information” below for free terminal download information.

Note that a +2.8v rail will result in the data outputs having a lower swing and may not be suitable for all computers.

12. Connection to a Processor UART

Direct connection to UART is made by connecting Pin9 to the UART Rx in pin.

13. Connecting a Read LED

Sometimes the user may not want to drive a beeper but may still need to drive an LED. In this case a driver transistor may not be necessary. Connect a 4K7 resistor to the Pin10 and directly drive the anode of a high efficiency LED and connect the cathode to ground.

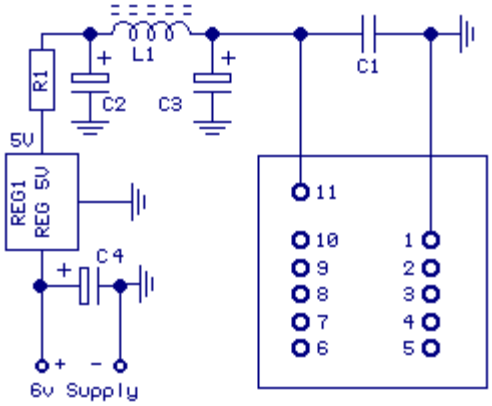
14. Choice of Power Supply and Switching Regulators

The choice of power supply is very important. The ideal power supply will use an inexpensive low noise linear regulator such as the **LF50BDT**. Rugged batteries may also be used without a regulator, a suitable arrangement consists of 3 alkaline cells to give 4.5-5 volts.

Switching power supplies are popular, however switching supplies can cause several problems when used with 125KHz readers. The switching frequency and its harmonics must not be close to 125KHz, neither can it be a multiple of 125khz or interference can result and will reduce the read range. Another issue is output voltage ripple. For long range the output ripple should be less than 0.3mV PKPK, so it is impossible to use switched power supplies directly without additional layers of smoothing.

The recommended solution powered by an inexpensive switching power adapter and a further linear regulator is shown below. It actually delivers about 4.75volts to the ID-HP3 module at 0.25A, which is good enough to give a read range of 120cm with a good clamshell card and the recommended long range antenna. There is little heat dissipation if is fed by a commercial 6volt switching supply power supply adapter.

Mount L1 so that there is no pick up from the antenna. We achieved this by folding L1 over on its side.



Power Supply	
C1	10uF 10v XR7
C2, C3	680uF 10v
C4	10uF 25v
R1	0.47R
L1	Murata 13R334C
	330uH 0.64 Ohm
Reg1	LF50ABV
Module	ID3-HP

The module runs from 3v thru 5v. To get the full read-range use 4.5-5v at pin11.

15. Designing Antenna Coils for the ID3-HP

Because the ID3-HP is exceptionally powerful it gives far greater freedom with the coil design since it can easily drive antennas up to 40cm in diameter. The coil diameter has a major influence on read range. It should also be remembered that larger coils tend to pick up more unwanted interference. The diameter of the coil in the tags also greatly affects read range because small coils require correspondingly greater field strengths and the coupling is less. Thus, the optimum coil for a button tag or glass tag will usually be smaller than would be the case for an ISO card. Small coils have the advantage of high field strengths.

The recommended Inductance for short range is 1.26mH because this will tune with the internal capacitor in the module and no external capacitor will be required.

In most circumstances the bigger the antenna the better, provided the reader is generating enough field strength to excite the tag. If the reader is located in a position where there is a lot of heavy interference then less range is unavoidable. In such situations the coil should be made smaller to increase the field strength, and reduce the RFI pickup. It should be noted that the last antenna arrangement described in Example 7 has low RFI pickup despite the large size.
It is difficult to give examples of compacted overwound coils for hand winding because the closeness and tightness of the winding will dramatically change the inductance. A machine wound coil will have much more inductance than a similar hand wound coil and more capacitance too.

The read range will increase with the Q of the coil. Low Q coils have a low circulating current and corresponding low range. Litz wire is the gold standard for high Q coils but comes at a price. For low read range, we recommended an inductance of 1.26mH because an external tuning capacitor will not be required.
ID Innovations offer several sizes of coils for short, medium and long range applications.
Sometimes the antenna coil is of necessity surrounded by a metallic enclosure or has an adjacent copper PCB plane. Both these structures will behave like a shorted turn and will set up a current in opposition to the ID3-HP antenna coil current. This is analogous to adding a negative inductance on the antenna and reducing the inductance. Some range can be clawed back by either increasing the inductance or increasing the capacitance.

Small areas of aluminium sheet can be used to tune antennas if the inductance is slightly too high. Similarly adding ferrite material near the antenna can increase inductance if the inductance is slightly too low.

Warning. Do not exceed the stated maximum voltages and currents for the ID3-HP RF output. The RF voltage at pin4 should be kept below 200vPKPK. The module is very unforgiving if this upper limit is exceeded.

16. Fine Tuning the ID3-HP Antenna.

We recommend using an oscilloscope for fine-tuning, however for production monitoring the DC current is also a good method. Connect the oscilloscope to observe the 125kHz RF voltage on pin4. Make sure it NEVER exceeds 200vPKPK. Get a sizeable piece of ferrite and bring it up to the antenna loop. If the voltage increases then more inductance is required. If the voltage decreases as the ferrite is brought up to the antenna then the inductance is too great. If no ferrite is available then a piece of aluminium sheet may be used for testing in a slightly different way. Opposing currents will flow in the aluminium and it will act as a negative inductance. If the 125kH RF voltage increases as the aluminium sheet approaches the antenna then the inductance is too high. Note it may be

possible that the voltage will first maximize then decrease. This means that the module is near optimum tuning. When using ferrite for test then it implies that the coil is a little under value and when using aluminium sheet, it implies the coil is a little over value.

Note that when using low Q coils, the tuning becomes less critical although the range will be reduced. Use of low Q coils can eliminate the need for tuning entirely, significantly reducing production test times. No tuning is cheaper than fine tuning! The huge power of the ID3-HP can to an extent compensate for a low Q coil.

17. Construction and Design Notes

The ID3-HP deserves respect because it can be configured to deliver very high RF power. The following notes should be read closely

Do not route supply tracks delivering power to noisy components such as microprocessors under the ID3-HP to avoid noise pickup. Also make sure that the choke on the power supply is not oriented to pick up the antenna RF field.

It is very important to get good decoupling between pins 1 and 11 and as close to the pins as possible. A suitable capacitor will be the Panasonic 6SVPE150M which is 150uF at 6.3v with a ripple maximum ripple of 3.5Amp at 125khz and an ESR of 0.01 Ohm at 125Khz. This capacitor has a diameter of 5mm. The arrangement on the demo board works equally as well but is physically larger.

We recommend using a LF50ABV series 5volt regulator because it is very stable, low drop out and low noise. We had excellent results with this device reading cards at very long range.

If a switching pre-regulator is used on the PCB then separately decouple the circuitry to prevent feedthrough at the switching frequency. Sometimes the field caused by switching regulators inductor can be minimised using two slightly separated inductors wired to counteract stray the field.

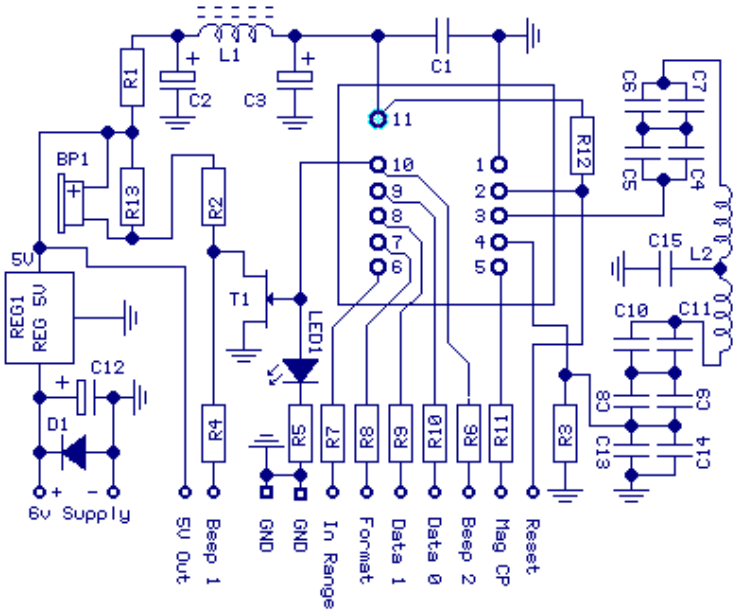
18. Thermal Management

The ID3-HP is a high output powered device and requires an area for heat sinking. Pin1 should be given extra copper tracking to dissipate heat. A minimum of three square centimetres should be used if the DC current is at the 230mA high end. Below a supply current of 150mA there is no tracking requirement. For layout considerations refer to the Demo Board Tracking. Our ID3-HP customers are free to use the demo board tracking in whole or part. Notice that the copper tracking around pin 1 has gaps in it. This is to reduce induced RF currents from the antenna.

19. ID3-HP Compatibility Issues with the ID2, ID3-LA

The ID3-HP is 100% pin compatible and supply voltage compatible with the ID3-LA and its read and output data functionality is also 100% compatible. The ID3-HP has 20x more RF drive power available than the ID3-LA. The ID2 internal tuning capacitor is 1n5 while the internal capacitor in the ID3-HP is 1n2 so an external 300-330pF should be added from pin4 to ground before the ID-3HP can be used as a drop in replacement. (Note that a version without the internal tuning capacitor may be applied for). There must be good decoupling between pins 1 and 11 to ensure stability. See the recommended power supply.

20. Circuit of ID3-HP Test Demo Board

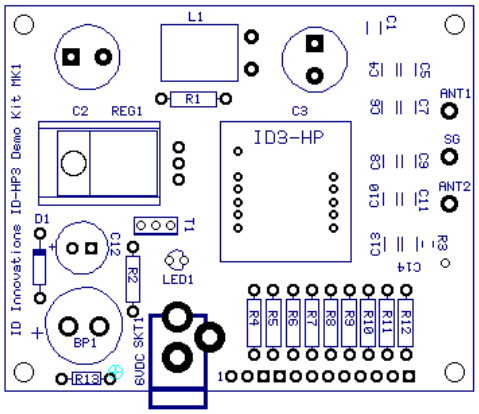


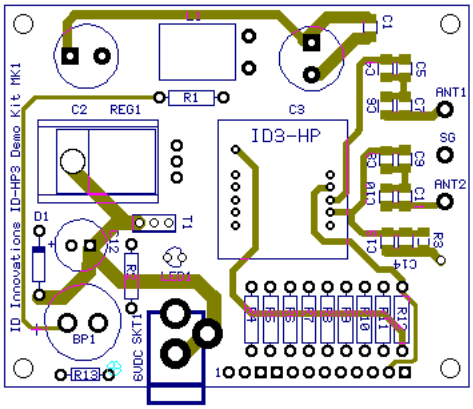
R1	0.47R
R2,R8,R9,R10,R11	22R
R3	680K
R4	22R
R5,R6,R7,4K7	4K7
R13	220R
C1	10uF 10v XR7
C2,C3	680uF 10v
C4	4N7 200V COG
C5,C6,C8,C10,C13	Not Fitted
C7	Link Out
C9	6n8 200v COG
C11	Link Out
C12	10uF 25v
C14	10n 200v COG
C15	47n 50v XR7
T1	LU120N
LED1	High Efficiency
D1	1N4001
Module	ID3-HP
L1	330uF 0.64R Murata 13R334C
L2 (Antenna)	29T, 26cm x 35cm, 720uH

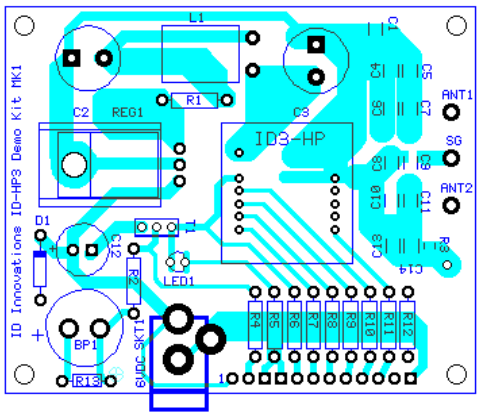
The above reader circuit is copied from the ID Innovations ID3-HP Demo Board. It is capable of reading clamshell cards at 124cm and ISO cards at 83cm while drawing only 0.22A, using a 26cm x 35cm antenna when supplied by 6volt from a commercial adapter. See Innovations *ID3-HP Demo Board* data sheet for full write up including PCB, antenna and performance details.

Note that the tuning shows a large number of capacitors although only 3 are used in practice. The rest are spaces for tuning or antenna modification.

21. PCB Details of ID3-HP Demo Board







22. Useful information

For general testing we suggest the user downloads a terminal program free from the internet. Here is one particularly good one to consider:
http://braypp.googlepages.com/terminal

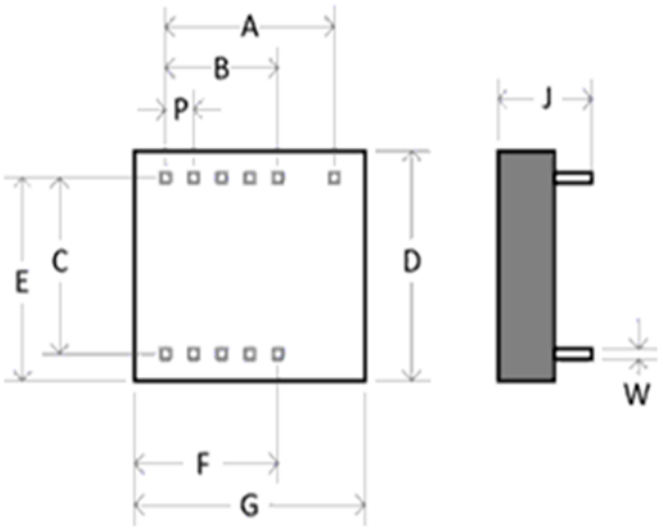
If you have any technical queries please contact your local distributor, they have all the technical resources to help you and support you. Where no local distributor exists, our technical helpline may be contacted by writing to help@ID-Innovations.com

23. If Long Range Matters - Buy Long Range cards

Not all cards are created equal, basically you get what you pay for. To cut costs most ISO card manufacturers use a small 300mm diameter pickup coil. Very few make use of the total area provided by an ISO card to fit a large coil. The smaller the coil the lower the read range, it is that simple. As well using small coils most manufacturers now use an on-chip tuning capacitor which has lower Q, lower tolerance and less stable. For these reasons card performances can vary by 3:1

If long range matters, then fortunately there are still some manufacturers who fit large coils and use a separate high, low drift, high Q tuning capacitor - at a reasonable price. ID Innovations supply high quality long range cards and advise on card usage. Some 'Sparkfun' ISO cards are excellent!

24. Module Dimensions



	ID3-HP		
	Nom.	**Min.**	**Max.**
A	12.0	11.6	12.4
B	8.0	7.6	8.4
C	15.0	14.6	15.4
D	20.5	20.0	21.5
E	18.5	18.0	19.2
F	14.0	13.0	14.8
G	22.0	21.6	22.4
P	2.0	1.8	2.2
H	5.92	5.85	6.6
J	9.85	9.0	10.5
W	0.66	0.62	0.67

25. Contact Information

Worldwide Distribution and Sales Wendy@ID-Innovations.com

Worldwide Technical Queries help@ID-Innovations.com

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