Optical Silicon DAA Modem/Lineside Chipset

IA3211 & IA3212

DESCRIPTION

The IA3211/12 Optical Silicon DAA chipset consists of an IA3211 modem side integrated circuit and an IA3212 line side integrated circuit. Configured along with other components, the final circuit provides a full featured Optical Silicon DAA offering a turnkey solution for most modem applications.

All of the components in the chipset are packaged in easy to assemble, surface mount format. The IA3211 and IA3212 come in a standard 24-pin TSSOP package. A complete DAA circuit can be assembled directly onto a motherboard using less than 2 square inches of board space, eliminating costly special or hand-insert operations.

The IA3211 and IA3212 chipset is a full-featured Optical DAA that takes into consideration the needs of today's portable and multimedia equipment. Added features of the IA3211 and IA3212 chipset such as line current sense, snooping and line V/F make the circuit ideal for enhanced modems, which support speakerphones, answering machines, simultaneous voice and fax, caller ID and voice/fax/data steering.

The IA3211 and IA3212 chipset is also known under the Siemens/Infineon DAA 2000 device part number.

PIN ASSIGNMENT

IA3211

C1B	1	24	C1A
VREF	2	23	LSTAT
C2	3	22	RNG
RXCT	4	21	OFFHKL
RXAN	5	20	OFFHK
ONHKML	6	19	RXOUT
ONHKM	7	18	ACREF
N.C.1	8	17	TXBIAS
SRVAN	9	16	AUDIN
SRVCT	10	15	AUDOUT
TXAMP	11	14	Vss
Vdd	12	13	LEDCT

IA3212

HDLR	1	24	Vdd
LEDCT	2	23	Vss
HLDCAP	3	22	SRVCT
HKP	4	21	SRVAN
HKN	5	20	N.C.5
N.C.1	6	19	VFCAP
HLFWV	7	18	ONHKMCAP
LR1	8	17	TXAN
LR2	9	16	TXCT
N.C.2	10	15	C2
N.C.3	11	14	N.C.4
C1A	12	13	C1B

See back page for ordering information.

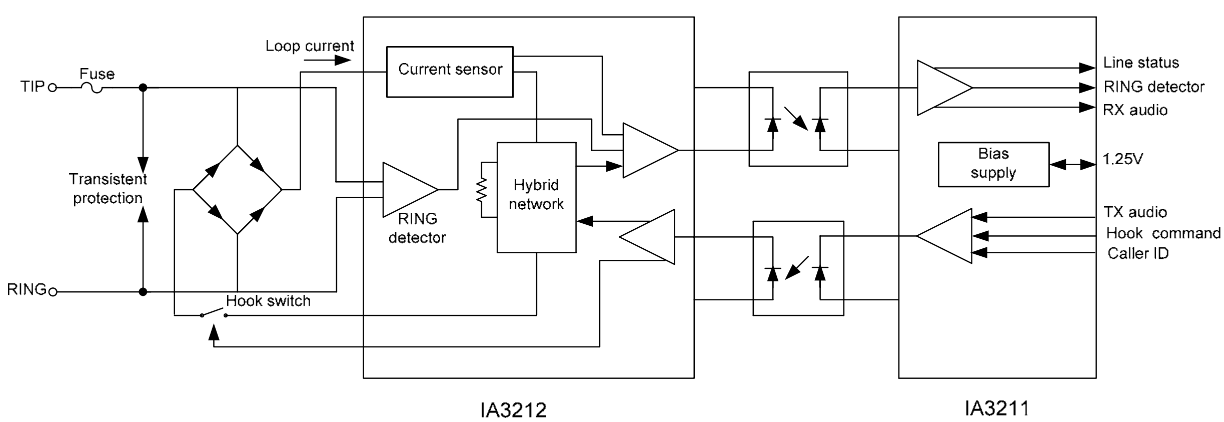
FEATURES

- Up to V.92 (56 Kb/s) compatibility
- Integrated optical line interface
  - 100% surface mount components
  - Reduced board space <2 inches²
- Analog host interface
  - Optional differential transmit and receive
- On board hybrid
- DTMF and pulse dialing support
- Full or half wave ring detection
- Caller ID reception mode
- Dedicated caller ID reception mode
- Line reversal detection
- Parallel pick-up and line-in-use detection support
  - On-hook line voltage monitoring (V/F converter)
  - Off-hook line energy monitoring
  - Off-hook line voltage drop detection
- On & Off-hook line polarity reversal detection
- Global telecom regulations compliance
  - FCC68, CTR21, JATE...
- 3.0 to 7.0 Volt operations (modem side)
- 24-pin TSSOP packages

TYPICAL APPLICATIONS

- Set Top Box
- Point of Sale Terminal
- Metering Device
- PC, Laptop, Game Console
- Central Office Application

FUNCTIONAL BLOCK DIAGRAM



DETAILED DESCRIPTION

A DAA circuit known formally as the “Digital Access Arrangement” or “line interface” circuit is the physical connection between any electronic equipment and the telephone line. Most countries enforce specific requirements when connecting devices to their public switched telephone network (PSTN). These requirements are primarily developed to prevent any damage to the network by improper equipment and to protect the end user from any potential danger, such as a lightning surge, coming from the network.

The DAA performs four critical functions:

- Line termination
- Isolation
- Hybrid
- Ring Detection

The following is a description of how the IA3211 and IA3212 chipset optical DAA circuit fulfills these requirements, as well as providing other useful features. The IA3211 and IA3212 chipset can fulfill a wide variety of telephone interface applications including voice, FAX, and data.

General Architecture

The circuit is broken into two parts: the line side circuit and the modem side circuit. Telephone regulations require a high voltage barrier between these two sides, which is provided by the dual linear analog opto-isolators.

The line side circuit derives its operating power from the telephone line directly. A bridge rectifier allows operation from either battery polarity. A fuse and a high voltage transient protection device are used to preserve telephone line integrity in the event of a lightning strike, or other high energy pulse coming in from the loop.

The IA3212 line side chip includes a HYBRID circuit that separates the TX and RX signals by doing a 2-wire to 4-wire conversion. The success of this circuit (transhybrid balance) depends on the line termination impedance shown in the block diagram as a simple resistor. In fact, the termination impedance is a combination of an external resistor and an external capacitor. The value of these components depends on the telephone regulations of the country concerned.

The RX audio signal is transmitted across the high voltage barrier with an analog opto-isolator. This circuit is capable of very good linearity and broad bandwidth by using a novel feedback technique. In a similar circuit, the TX audio is passed across the barrier with a second analog opto-isolator.

On-hook and off-hook functions are taken care of by turning on/off the series switch. In the DAA circuit, this is a DMOS transistor capable of withstanding at least 350 volts. When in the "on-hook" condition, the switch is open and the DAA draws no current from the loop. The DAA can be commanded to go "off-hook" by asserting the "hook command" input to the IA3211. This command is communicated to the IA3212 via the dual analog opto-isolator. An internal multiplexing operation takes place, which combines this command, the Caller ID command, and the actual TX audio signals. When the off-hook command is given, the IA3212 switches on the hook switch by fully saturating the DMOS transistor.

The Caller-ID function is sometimes referred to as the "snoop" mode. When this command is given, the IA3212 turns on slightly the hook switch. In this mode, the loop current is kept low enough to keep the central office (CO) from seeing an off-hook situation, yet it allows the IA3212 to transmit the RX audio signal over to the IA3211.

When in the "off-hook" mode, the IA3212 passes the full loop current through itself. Power for the chip is derived by an internal circuit, which acts like a zener diode. The voltage across the chip from Vdd to Vss is maintained at about 5 volts. With the hook switch fully "on” loop current is determined by the external loop resistance. In some countries the current must be limited to 60mA maximum by the DAA. In those cases, an external current limiting circuit must be added.

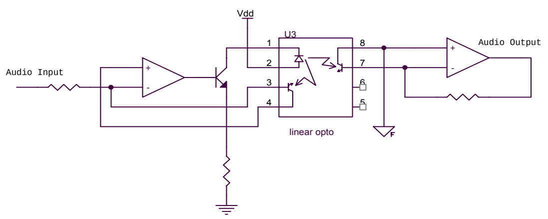
To prevent damage when the DAA is accidentally connected to a digital PBX line with unlimited current capability, the DAA has an internal shutdown circuit. This circuit is sensitive to total power dissipated by both hook switch and the IA3212, and internal temperature. When power from the line exceeds about 3 to 4 watts at room temperatures, the IA3212 turns off the hook switch. In this situation the hook switch itself can generate significant heat. Therefore the switch should be thermally connected to the IA3212 with ground plane techniques. This shutdown function is linearly de-rated to zero line current at +70°C.

A ring detector is built into the IA3212, which can be configured as either a "full wave" detector or a "half wave" detector. In the full wave mode, a pulse is generated al the IA3211 "ring detect" output pin for each half cycle of the ring signal. In the half wave mode, one pulse is generated for each full cycle of the ring signal.

Isolation Barrier

For many years, the only practical solution to provide high voltage isolation between the CO loop and the modem (or any telephone device) has been the use of a transformer. In modern equipment design, space, weight, and cost are all prime concerns. The transformer does not always fit into today's solutions. Optical isolators can provide excellent high voltage isolation in a very compact size. The dual opto devices have a minimum of 2500 V breakdown voltage rating.

The use of linear opto-isolators is a well-established technique in instrumentation designs. Integration Associates uses this same basic idea in the IA3211 and IA3212 chipset by using standard, off-the-shelf linear opto-isolators with their custom linear chips, the IA3211 and IA3212. The way this circuit achieves such good linearity is by using matched detectors in the dual opto-couplers with one used in the feedback circuit, and the other used to cross the barrier.



This figure shows the method of using matched detectors. In this circuit, the audio input signal is dropped through the input resistor to virtual ground. The op-amp output drives a transistor, which draws current through the LED. The source side photodiode generates a current, which goes back to the input source and closes the loop. The closed loop linearizes the LED. The secondary side photodiode is an exact duplicate of the first and is illuminated with the light from the LED. In the output op-amp, the photocurrent generated is forced to flow through the feedback resistor. That generates a voltage equal to the original input signal.

The DAA circuit uses this same principle of matched detectors as shown in the hybrid and optical coupling schematics. The complete signal details are not shown for simplicity.

The Hybrid Circuit

The hybrid circuit operates by modulating the loop current with the TX audio signal. This can be seen in the hybrid and optical coupling schematic. The TX audio current is generated in the lower opto-isolator in the secondary photodiode. That current is impressed across a 600Ω and a 1200Ω series pair of resistors. The voltage generated across the 1200Ω resistor modulates the current flowing through R1. This external resistor is normally 16.5Ω, but the value can change slightly as needed for other than 600Ω termination impedances. R1 also affects transmit gain and trans-hybrid balance.

The receive audio signal is picked up with the induced voltage across the 3600Ω resistor. This, of course, also has the TX signal. The TX signal is cancelled by feeding an equal but opposite amount of the original TX signal into the summing amplifier at the top. The balance of this cancellation is dependent on the matching accuracy of the resistors shown. All resistors except for R1 are internal to the IA3212, and they are matched in ratio to a very high degree and will accurately track over temperature.

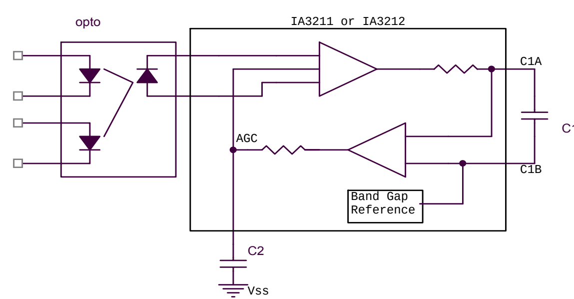
The balance is also referred to as "trans-hybrid loss". Effectively, this is the amount of RX signal, which gets removed from the TX signal path. If the match is perfect, then the trans-hybrid loss is infinite. Typical IA3211 and IA3212 chipset applications have a trans-hybrid loss of around 30 dB, which is far better than traditional transformer circuits.

Audio AGC Compensation

Optical isolators can have gain variations that change with temperature and age. To compensate for these variations, the IA3211 and IA3212 chipset has an internal AGC circuit, which adjusts the audio gain based on measured DC gain characteristics

The AGC circuit works by adjusting the gain of a low distortion, variable gain current amplifier so that the average photodiode output DC current is constant. This has the effect of normalizing the AC gain at the output since the AC gain strictly tracks the DC gain of the linear optical isolator. DC averaging is provided by a low pass filter whose time constants are set by C1 and C2. With the values recommended in the reference circuit, the time constant is about 400ms. Increasing the values of the capacitor will improve low frequency distortion, but will increase settling time. The ratio of C2 to C1 should be kept at 4.5 to 1 to provide optimum damped settling.

There are similar AGC circuits in both the IA3211 and IA3212 devices monitoring the received audio from the linear opto-couplers, i.e., the transmit TX signal for the IA3212 and the receive Rx signal for the IA3211.



Audio Interface

Transmit Audio Interface

The IA3211 provides a single ended transmit interface. When used with a 120KΩ resistor in series, the IA3211 and IA3212 chipset presents an overall 0dB transmit path between the audio source on the host side and the phone line. In addition, the TXAMP input is biased internally to the ACREF voltage

(1.25V); hence, the transmit audio interface may require a 100nF decoupling capacitance.

The series resistor value and the overall gain from the Tx audio source and the phone line are function of the following relation:

Tx_Gain=140/(R+20) where R is in kΩ.

Receive Audio Interface

A single ended reception interface is available on the IA3211. This output can drive up to 300Ω and provides a 6dB attenuation from the phone line. Optionally, an additional internal operating amplifier is available to achieve 0dB attenuation from the phone line or to provide a differential reception outputs (see audio interface figure).

Control Interface

The IA3211 and IA3212 chipset offers the designer two different ways of setting the on and off-hook state as well as the snoop mode. Both modes can be controlled by either an active high or an active low input. Although both mechanisms are valid, active high controlled signals are the preferred method. In any case, special attention should be paid to the various required minimum and maximum high and low voltage levels and currents to operate those inputs as stated in the recommended operating conditions of the data sheet.

On-hook Operation

On-hook Monitor – Caller ID Mode

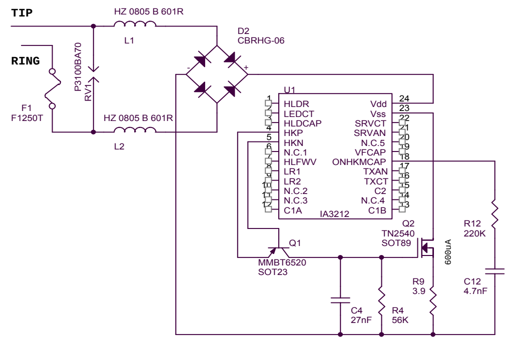
Asserting either the ONHKM input (or the inverse ONHKML input) on the IA3211 puts the DAA into SNOOP mode or on-hook monitor mode. This is used primarily for Caller ID purposes. When in SNOOP mode, the DAA draws a maximum of 500μA from the telephone line. Line voltage must be at least 3.5 volts. This current is much less than what the CO would consider going off-hook, which is usually at least 5mA. On-hook monitoring does not violate FCC part 68 rules as long as it happens during ringing, or when another telephone device is off-hook on the same line.

On-hook monitoring mode is an option, which requires adding an external RC network. This is typically a 220kΩ resistor in series with a 4.7nF capacitor from pin 18 of the IA3212 to the negative terminal of the bridge rectifier. When active, the AC line impedance is roughly 220kΩ.

In a typical Caller ID application, the modem firmware will assert one of the Snoop control lines following the first ring so as to pass the Caller ID burst of FSK tones to the data pump for detection.

In a Voice/FAX/Data application, a Snoop control line is asserted during the ringing and for perhaps 15 to 60 seconds after the telephone line is answered by an external extension telephone (when ringing stops). The modem then listens for FAX or Data calling tone or DTMF sequence. If a tone is recognized, then the modem firmware can answer the call.

This steers the FAX or Data call from the answering machine, which initially answered the call, to the modem.



V/F Converter

In the "On-Hook" condition, the DAA appears as a very high impedance and draws only a few microamperes of line current.

A V/F (voltage to frequency) circuit monitors the open line voltage. This voltage measurement appears at the IA3211 at pin 23, LSTAT, in the form of a series of pulses. Each pulse is about 4ms wide, and the frequency of the pulses is proportional. to the line voltage. The pulses are sent across the barrier by pulsing the RX opto-isolator during the discharge time of the RC circuit.

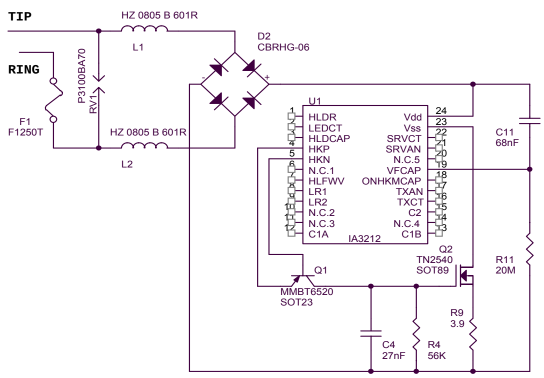
Gain of the converter is based on two external components connected to pin 19 of the IA3212. Given the reference values of 20MΩ and 68nF, the gain of this circuit is about 1Hz/volt. The resistor value must not be lower than 10MΩ otherwise the circuit will not meet FCC part 68 on-hook DC resistance specifications. The capacitor may be varied between 10 and 100nF with resulting change in pulse width and V/F gain.

This circuit is provided to allow detection of line status without having to go off-hook. It can be used to detect when an extension phone goes off-hook, or if the modem is connected to a dead line. Most modem problems are improper connection to the line.

Due to the wide variety of other telephone equipment available, it is not possible to reliably determine line condition by monitoring line voltage alone. Generally, line voltages below 12 to 14 volts indicate the line is in use. Voltages above 18 to 20 volts indicate the line is available. Voltages in the 12 to 20 V range are ambiguous. This is because telephone standards have no maximum off-hook voltage drop recommendations for line currents over 26mA. A common situation where a high line voltage is encountered while the line is in use, is when a user has inserted a zener adapter in series with their answering telephone jack to improve answering machine cutoff. These zener adapters will typically increase the answering machine off-hook voltage to above 14 volts.

A solution to the voltage ambiguity problem is to design firmware, which looks for a change in line voltage, or keeps a history of line voltage to determine normal idle voltage. Then a trip point can then be set about 30% below that idle level.

If the V/F function is not needed, the components connected to pin 19 of the IA3211 and IA3212 can be left out. Note that the V/F does not function when off-hook, or in SNOOP mode.



On-hook LIU Detection

The IA3211 provides a voltage to frequency converter allowing the host processor to dynamically monitor the phone line voltage. This function is specifically designed to provide a reliable mean to detect line-in-use states (verification of the status of the phone line prior to placing a call in order to prevent line interruptions) and parallel pick-ups, also known as line intrusion or 911 detection (attempt by a user or a device to place a call on the same phone line). Upon detection of this condition, most automated equipment would delay the call attempt.

Off-hook Operation

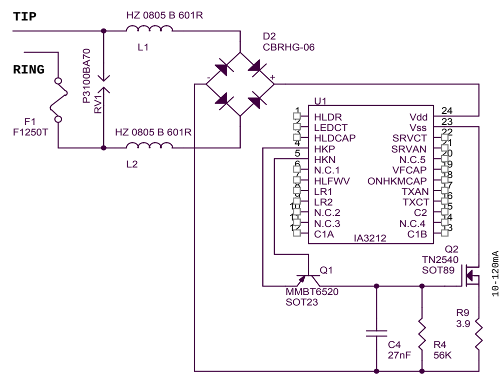
The DAA is commanded to go off-hook by asserting either the OFFHK, or the OFFHKL on the IA3211 This is transmitted to the IA3212 via the TX analog opto-isolator.

The IA3212 immediately switches on the hook switch circuit. The DAA will have an initial off -hook voltage about 2.2 volts less than the steady state value for about 200ms. This low voltage turn-on was designed to satisfy telephone regulations in certain countries. It also is useful in forcing another telephone device, such as an answering machine on the same line, to release the line.

The AGC capacitor C2 sets this turn-on delay. The value can be increased to get a longer turn on delay, but the settling time of the DAA will also increase. C1 must also increase to maintain a constant C1/C2 ratio (refer to the AGC description above). The hook switch is a high voltage, low resistance DMOS transistor. The gate voltage must be switched between the extreme negative terminal of the diode bridge, and Vdd of the IA3212. When off-hook, there may be a high voltage across the DMOS transistor. The IA3212 cannot control such high voltages, so it utilizes an external high voltage PNP transistor to switch the gate. Both the DMOS and the PNP devices should be rated above 250 volts.

The turn-on and turn-off transitions of the hook switch are controlled by the RC network between the gate and source of the FET The particular values of 27nF, and 56kΩ is a compromise which can pass most telephone regulations for "rotary" pulse dialing.

Pulse dialing and/or flash command is also achieved by toggling the OFFHK (or OFFHKL) input.



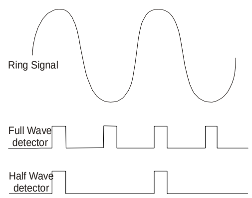
Off-hook PPU Detection (911)

The IA3211 and IA3212 provide a built-in line voltage drop detector that outputs a single positive pulse on the LSTAT pin upon detection of a minimum of a 1V line voltage drop. This voltage drop typically occurs when parallel equipment seizes the line in order to attempt a call. Upon detection of this condition, most automated equipment would release the line in order to allow for possible emergency calls (911). The built-in detector operates over the typical range of line conditions (short and long) from 18mA to 100mA and effectively detects any equipment presenting a DC load below 1kΩ under all those line conditions. Most telecommunication equipments have a DC load below 500Ω. This feature is combined with the off-hook line polarity reversal detection and the controlling system must discriminate between the two types of events.

Ring Detection

A 4ms wide positive pulse is generated on the RNG output of the IA3211. Depending on the configuration of the HLFWV pin of the IA3212 (line side device of the chipset), the pulse is generated either once or twice for every incoming ring cycle.

Hence, the resulting frequency of the RNG signal is either the exact incoming ring frequency (similar to a standard optocoupler based ring detection circuit design) or 2 times that value which may require some adjustments in the host firmware.



Line reversal detection

On-hook Line Reversal Detection

On-hook line reversal detection is specifically useful for Caller ID operations in certain countries such as United Kingdom for instance. Upon detection of a line reversal occurrence, provided the proper minimum level requirements are met, the IA3211 and IA3212 chipset generates a single 4ms wide pulse on the RING output signaling the system's application that such an event as occurred. It is up to the system's application to discriminate between an incoming ring, which would generate a series of pulses, and a line reversal single pulse.

On-hook line reversal detection is only possible when the device is configured in full wave ring detection scheme (HLFWV unconnected).

Off-hook Line Reversal Detection

Off-hook line reversal detection is mostly used in PABX application where its occurrence triggers the billing mechanism at the central office level. The IA3123 chipset outputs a single 4ms wide positive pulse on its LSTAT output upon detection of such an event. This mechanism is the same as the line voltage drop detection described in the LIU/PPU detection chapter; it is up to the system's application to discriminate between those two type of events.

Layout Considerations

The two most important aspects to consider when designing a DAA are noise and isolation. Electrical isolation is the easier topic to understand and deal with. Most telephone specifications require very high voltage isolation between the loop circuit and the user circuit as a safety issue. The IA3211 and IA3212 chipset design uses opto-isolators to achieve an isolation barrier of up to 2500 volts. This isolation can only be realized if the circuit board design and construction is also capable of withstanding this kind of high voltage. The line side circuit should be physically separated from the user (modem) side circuit with at least a 0.2-inch (5 mm) wide gap. The two opto-isolators must be the only components to straddle the gap. Ideally, the line connection (usually an RJ-11 jack) is mounted on the edge of the PC board and surrounded by the line side components, including the IA3212. The amount of circuitry will depend on the specific application, and which country requirements are being designed. All other circuitry, including the IA3211, must be located on the other side of the gap.

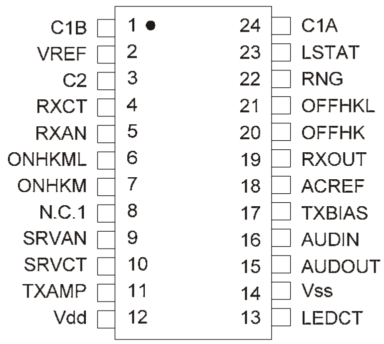
It is important that no conductive material be inside, or under the barrier. If the PCB is a multi layer design, insure that ground or voltage planes do not pass under the barrier. Noise is the other major layout related issue. A compact layout is also very good at keeping induced noise to a minimum. Being an analog circuit, the IA3211 and IA3212 chipset will not generate significant noise by itself. However, the circuit can (and will) pick up noise generated from nearby digital circuits. Keeping the line side circuits inside a small, tightly designed isolation barrier as shown will minimize noise pickup. Using a separate ground plane for the line side components is usually not needed. In fact, ground planes can be highly detrimental if ground loops develop. If there is to be a ground plane, then connect it only to the IA3212 VSS on the line side pin.

A common problem with noise pickup is when the IA3211 is interfaced to a modem data pump IC (or other applications) Be sure that the ACREF, pin 18, is well by-passed with at least a 100nF high frequency capacitor. Similar bypassing of the VDD pin is also good engineering practice. In some applications, digital noise can be injected into the IA3211 via the control pins (such as OFFHK or SNP). If this happens, try adding a 3.3k resistor in series with the line and a small bypass capacitor and the IA3211 input pin.

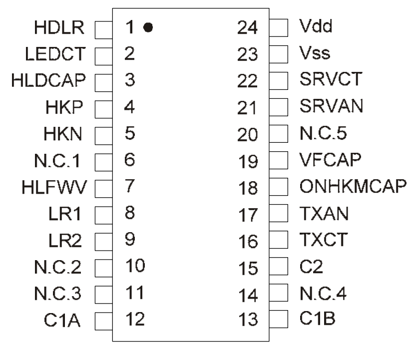
Another potential problem is the need to reject local RF pickup from the telephone line itself. The local loop, being a very long pair of wires, is an excellent receiving antenna. Local broadcast and TV signals will inevitably find their way into the DAA from the Loop. Prudent designers will add the necessary components to reject such interfering signals. Techniques for RFI reduction include adding a ferrite bead to the loop wires directly adjacent to the RJ11 connector, and adding ferrite beads to the DAA circuit itself, in conjunction with high voltage by-pass capacitors. Some international telephone specifications require such RFI filtering.

PACKAGE PIN DEFINITIONS

Pin type key: D=digital, A=analog, S=supply, I=input, O=output, IO=input/output



IA2311



IA2312

IA3211

Pin	Name	Type	Function
1	C1B	I/O	Receive optical active bias time constant capacitor (15nF to C1A).
2	VREF	O	Internal band-gap voltage reference (do not load over 1μA).
3	C2	I/O	Optical active bias circuit low-pass filter integrator response capacitor (68nF to ground).
4	RXCT	O	Rx cathode – Receiver photo diode return.
5	RXAN	I	Rx anode – Receiver photo diode input. PCB layout must minimize pickup from other signal sources.
6	ONHKML	I	Active low on-hook monitor input (internal pull-up resistor)
7	ONHKM	I	Active high on-hook monitor input (internal pull-down resistor)
8	N.C.1		Not connected (HIN).
9	SRVAN	I	Servo Anode – Transmit servo photo diode input. PCB layout must minimize pickup from other signal sources.
10	SRVCT	O	Servo cathode – Transmit servo photo diode current return (clamped @ 0.8V).
11	TXAMP	I	Tx amplifier input biased to ACREF. A 120K resistor in series with the audio source provides 0dB gain to the phone line.
12	Vdd	P	Power supply voltage 3.0 to 7.0 V.
13	LEDCT	O	LED cathode. Transmit linear optocoupler LED cathode. PCB layout must minimize pickup from other signal sources.
14	Vss	P	Power supply return (Ground).
15	AUDOUT	O	Auxiliary amplifier output - will drive a 300Ω load.
16	AUDIN	I	Inverting input for an auxiliary amplifier. The non-inverting input is internally tied to ACREF.
17	TXBIAS	O	Transmit DC bias point setting (25.5kΩ 1% to ground).
18	ACREF	I/O	Internal transmit and receive audio voltage reference (1.25V @ 1μA). Can be overdriven by external source.
19	RXOUT	O	Audio output biased to ACREF. Provides 6dB attenuation from the phone line and has a 300Ω driving capability.
20	OFFHK	I	Active high off-hook control input (internal pull-down resistor).
21	OFFHKL	I	Active low off-hook control input (internal pull-up resistor).
22	RNG	O	Ring detection output. A 4ms wide pulse is generated for each full or half ring cycle depending on the HLFWV pin of the IA3212 while in idle mode. In on-hook monitor and off-hook modes, RNG follows LSTAT.
23	LSTAT	O	Line status – Line in use and parallel pick-up detection. In idle mode, LSTAT provides a V/F transfer function from the phone line voltage. In on-hook monitor and off-hook modes, LSTAT outputs a single pulse if the line current is suddenly decreased.

Pin	Name	Type	Function
24	C1A	I/O	Receive optical active bias time constant capacitor (15nF to C1B).

IA3212

Pin	Name	Type	Function
1	HLDR	O	Hold resistor (16.5Ω to Vss). All of the loop current, less 4.0mA, passes through this resistor. This resistor value sets the 600Ω AC termination impedance, effects, and transhybrid balance.
2	LEDCT	O	Receiver LED cathode. PCB layout must minimize capacitive coupling between this trace and the SRVAN and TXAN traces.
3	HLDCAP	I/O	Hold capacitor (68nF capacitor to Vss).
4	HKP	O	Positive hook switch driver output.
5	HKN	I	Negative hook switch driver input.
6	N.C.1		Not connected (LINPWR).
7	HLFWV	I	Half-wave / full-wave ring detection selection. Connecting this pin to VDD selects half-wave ring detection (1 pulse/ring cycle). Disconnecting this pin from VDD selects full wave ring detection (2 pulses/ring cycle).
8	LR1	I	Line Resistor (10MΩ resistor to bridge rectifier AC input).
9	LR2	I	Line Resistor (10MΩ resistor to bridge rectifier AC input).
10	N.C.2	N/A	Not connected (END).
11	N.C.3	N/A	Not connected (CEN).
12	C1A	I/O	Transmit automatic bias control circuit 1st low pass filter RC time constant capacitor (15nF capacitor to C1B).
13	C1B	I/O	Transmit automatic bias control circuit low pass filter RC time constant capacitor (15nF capacitor to C1A).
14	N.C.4	N/A	Not connected (BIASEN).
15	C2	I/O	Transmit automatic bias control circuit 2nd low pass filter integrator response capacitor (150nF capacitor to Vss).
16	TXCT	I	Transmit cathode.
17	TXAN	O	Transmit anode. PCB layout must minimize capacitive coupling between this trace and the SRVAN and TXAN traces.
18	ONHKMCAP	I/O	On-hook Monitor Capacitor. A series capacitor and resistor is tied from this pin to the bridge rectifier negative output. These components are optional if Caller ID is not required.
19	VFCAP	I	Voltage to Frequency Converter Capacitor. A 33 nF to 68 nF capacitor is tied between this pin and Vdd. A 10MΩ resistor is tied between this pin and the bridge rectifier negative output to implement the line voltage to frequency oscillator. This V/F function is optional and is only enabled while On-hook.
20	N.C.5	I	Not connected (HIN).
21	SRVAN	I	Receiver servo Anode. PCB layout must minimize pickup from other signal sources.
22	SRVCT	I	Receiver servo cathode (input is clamped to about 2.7 V).
23	Vss	O	Line Side return/negative voltage supply.
24	Vdd	I	Line Side return/positive voltage supply.

TYPICAL APPLICATIONS

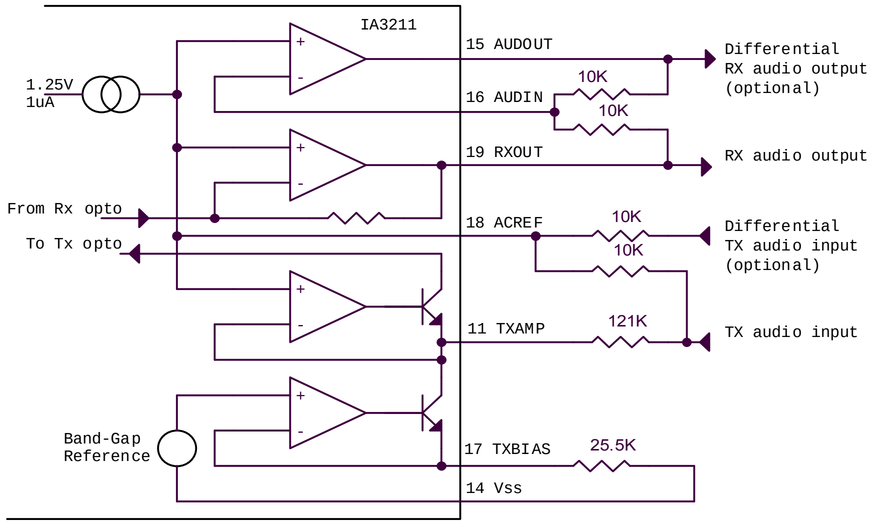


Figure1: Audio Interface

Note: The differential receiver output (AUDOUT) can also be used as a programmable gain single-ended output where the gain is controlled by the resistors ratio.

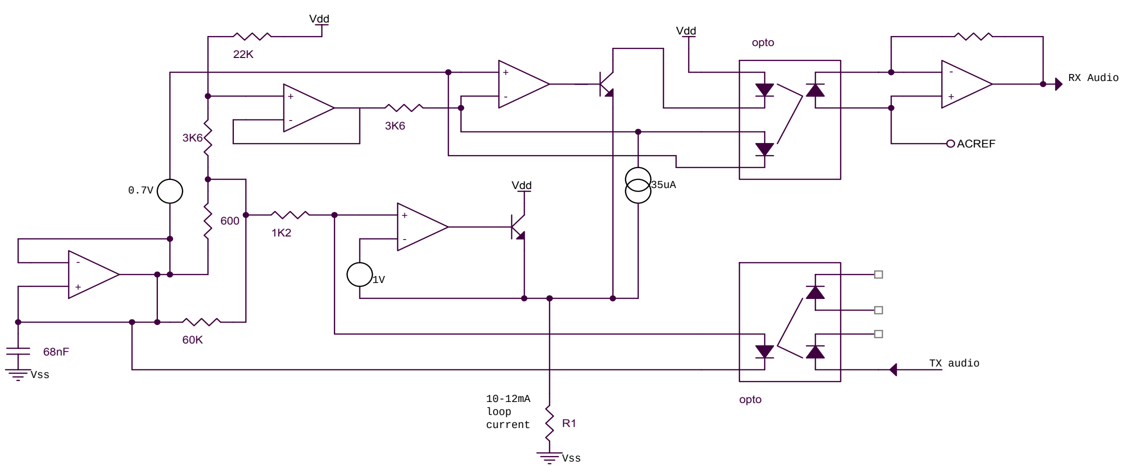


Figure2: Hybrid and Optical Coupling

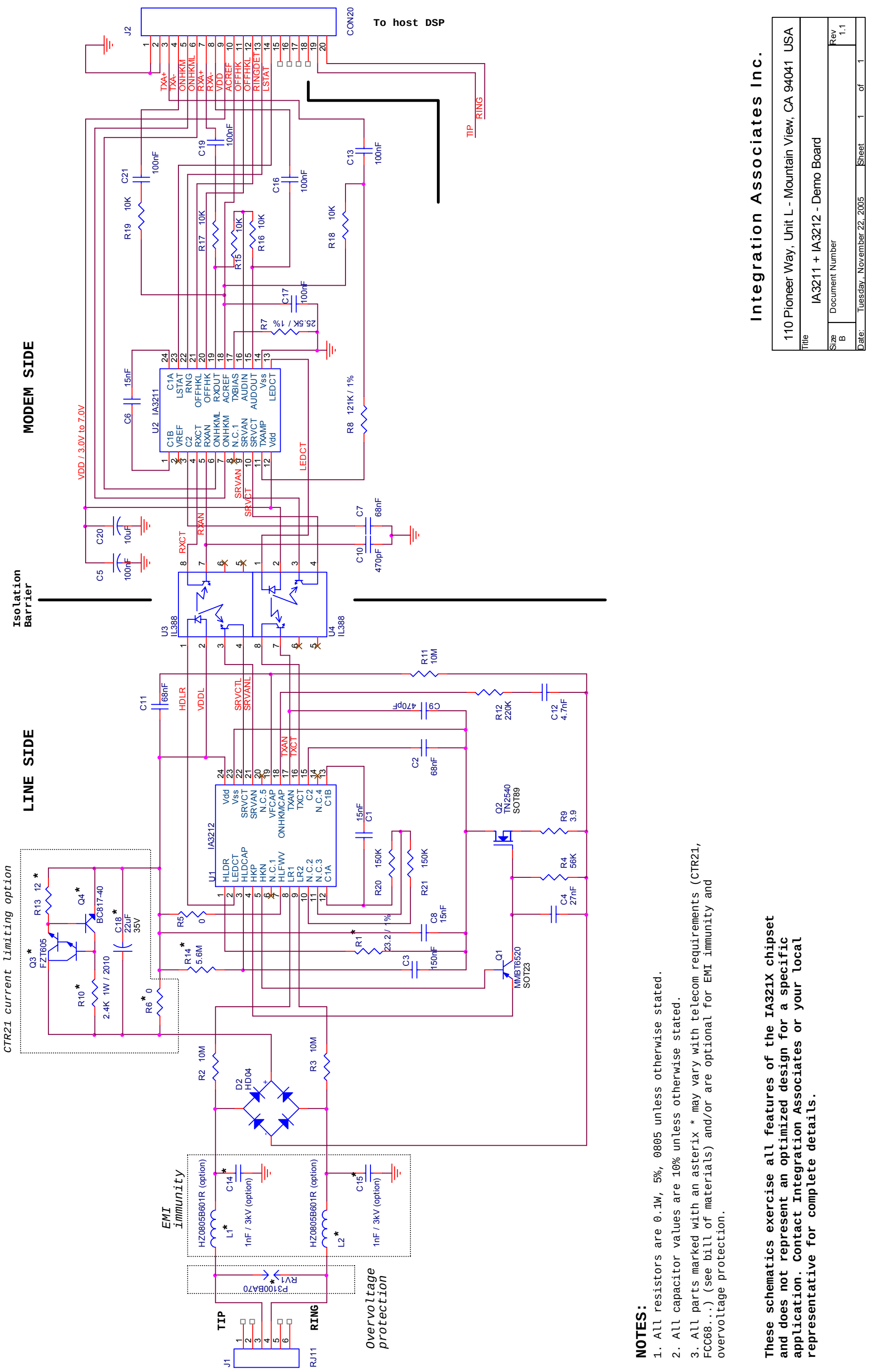


Figure 3: Demo Board

These recommended schematics exercise all options of the IA3211 and IA3212 chipset and do not represent an optimized application-specific version (see Annex for complete reference designs).

Bill of Material

Demo Board

Qty	Reference	Value	Package	Manufacturer	Comments
3	C1,C6,C8	15nF	0805	Generic	
3	C2,C7,C11	68nF	0805	Generic	
1	C3	150nF	0805	Generic	
1	C4	27nF	0805	Generic	
6	C5,C13,C16, C17,C19,C21	100nF	0805	Generic	
2	C10,C9	470pF	0805	Generic	
1	C12	4.7nF	0805	Generic	
2	C14,C15	1nF / 3kV	1808	Novocap	Optional for EMI immunity
1	C20	10uF / 10V	A	Panasonic	
1	D2	HD04	MiniDIP	Diode	Alternative with Shindengen S1ZB60
2	L1,L2	HZ0805B601R	0805	Steward	Optional for EMI immunity
1	Q1	MMBT6520	SOT23	Motorola	
1	Q2	TN2540	SOT89	Supertex	
1	RV1	P3100BA70	DO214	Teccor	Overvoltage protection
3	R2,R3,R11	10M	0805	Generic	
1	R4	56K	0805	Generic	
1	R5	0	0805	Generic	
1	R7	25.5K / 1%	0805	Generic	
1	R8	121K / 1%	0805	Generic	
1	R9	3.9	0805	Generic	
1	R12	220K	0805	Generic	
5	R15,R16,R17, R18,R19	10K	0805	Generic	
1	U1	IA3212	TSSOP24	Integration	
1	U2	IA3211	TSSOP24	Integration	
2	U3, U4	IL388		Vishay	

FCC68 Option — North America

Qty	Reference	Value	Package	Manufacturer	Comments
1	R1	16.5 / 1%	0805	Generic	
1	R6	0	0805	Generic	

JATE Option — Japan

Qty	Reference	Value	Package	Manufacturer	Comments
1	R1	23.2 / 1%	0805	Generic	
1	R10	2.4K / 1W	1020	Generic	
1	R13	12	0805	Generic	

CTR21 Option — Europe

Qty	Reference	Value	Package	Manufacturer	Comments
1	R1	23.2 / 1%	0805	Generic	
1	R10	2.4K / 1W	1020	Generic	
1	R13	12	0805	Generic	
1	C18	22uF	0805	Generic	
1	Q3	FZT605	SOT223	Zetex	
1	Q4	BC817-40	SOT23	Diode	

Demo Board Pin Definitions

Pin number	Function
1	V_{SS}
2	V_{SS}
3	TXA+
4	TXA-
5	ONHKM
6	ONHKML
7	RXA+
8	RXA-
9	V_{DD}
10	AC_{REF}
11	OFFHK
12	OFFHKL
13	RingDet
14	LSTAT
(Pins 15-18 removed for high-voltage isolation)	
19	Tip
20	Ring

ELECTRICAL SPECIFICATION

Absolute Maximum Ratings

IA3211

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{DD}	Supply voltage, V_{DD}-V_{SS}				7.0	V
V_{IN}	Input voltage		V_{ss}-0.5		V_{DD}+0.5	V
	Package dissipation at 25°C ambient				1.2	W
	Derate linearly from 25°C				0.03	W/°C
T_{STO}	Storage temperature		-20		+85	°C
T_{OP}	Operating temperature		0		70	°C
	Soldering time at 260°C, 1/8" from body				5.0	s

Note: Exposure to or above absolute maximum ratings conditions may cause permanent device damage or affect device reliability. Operating conditions should be restricted as specified in the recommended operating conditions of this data sheet.

IA3212

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{DD}	Supply voltage, V_{DD}-V_{SS}				10.0	V
V_{IN}	Input voltage		V_{ss}-0.5		V_{DD}+0.5	V
	Package dissipation at 25°C ambient				1.2	W
	Derate linearly from 25°C				0.03	W/°C
T_{STO}	Storage temperature		-20		+85	°C
T_{OP}	Operating temperature		0		70	°C
	Soldering time at 260°C, 1/8" from body				5.0	s

Note: Exposure to or above absolute maximum ratings conditions may cause permanent device damage or affect device reliability. Operating conditions should be restricted as specified in the recommended operating conditions of this data sheet.

Operating Ratings

The IA3211 and IA3212 chipset specifications are guaranteed when the typical application circuit is used (refer to the typical applications circuits paragraph). All specifications are guaranteed across the recommended operating conditions unless otherwise stated.

DC Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{DD}	IA3211 supply voltage		3.0		5.5	V
I_{DD}	IA3211 supply current	On-hook with V/F active			50	µA
I_{DD}	IA3211 supply current	Caller ID mode			6	mA
I_{DD}	IA3211 supply current	Off-hook			10	mA
V_{IH}	High input voltage OFFHKL & ONHKML	V_{DD}=+5V I_{IH}=-20 µA	3.0			V
V_{IH}	High input voltage OFFHKL & ONHKML	V_{DD}=+3.3V I_{IH}=-20 µA	1.5			V
V_{IL}	Low input voltage OFFHKL & ONHKML	V_{DD}=+5V I_{IH}=-40 µA			0.7	V
V_{IL}	Low input voltage OFFHKL & ONHKML	V_{DD}=+3.3V I_{IH}=-40 µA			0.7	V
V_{IH}	High input voltage OFFHK & ONHKM	V_{DD}=+5V I_{IH}=20 µA	2.5			V
V_{IH}	High input voltage OFFHK & ONHKM	V_{DD}=+3.3V I_{IH}=20 µA	2.0			V
V_{IL}	Low input voltage OFFHK & ONHKM	V_{DD}=+5V I_{IH}=10 µA			0.7	V
V_{IL}	Low input voltage OFFHK & ONHKM	V_{DD}=+3.3V I_{IH}=10 µA			0.7	V
	LSTAT- RING pulse duration		2	4		ms
	Voltage to Frequency conversion ratio	20MΩ, 68nF		1		Hz/V
	Voltage to frequency Tip/Ring voltage operating range	On-hook	7		100	V
	Off-hook line voltage drop detection to LSTAT pulse generation	18mA to 100mA off-hook line current	1			V

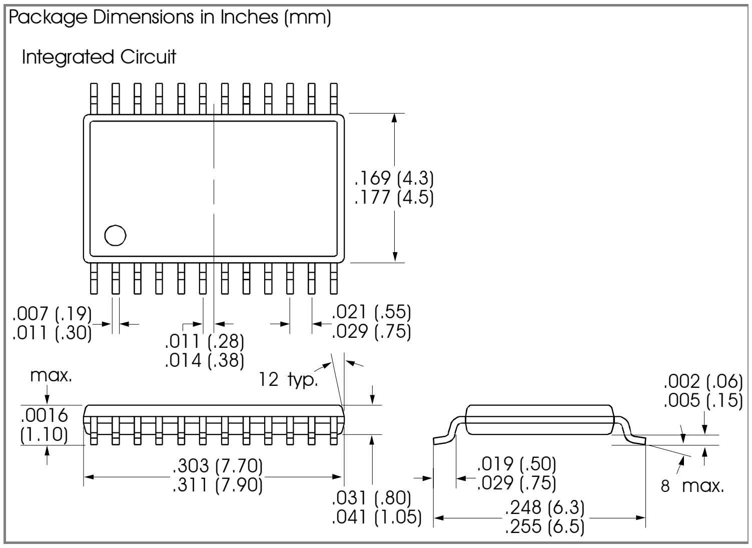
AC Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
G_{TXD}	Transmit data gain (TXA+ to Tip/Ring)	Off-hook 600Ω load 300Hz to 3400HZ	-0.5	0	+0.5	dB
G_{RXD}	Receive data gain (Tip/Ring to RXA)	Off-hook 600Ω load 300Hz to 3400HZ	-7.5	-6.5	-5.5	dB
G_{RXCID}	Receive snoop gain (Tip/Ring to RXA)	On-hook monitor mode, 300Hz to 3400HZ	-4		-6	dB

Loop Characteristics

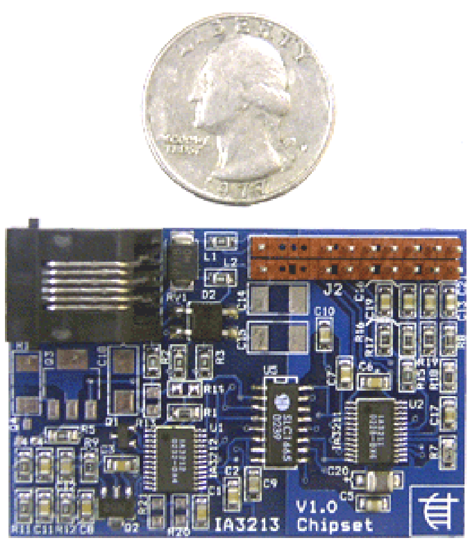
Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Isolation Voltage, T & R to ground	Isolation insured by optocoupler selected	2500			V
	Leakage to ground		100			MΩ
	On-hook DC resistance	Between Tip and Ring	5			MΩ
	On-hook AC impedance	At Tip/Ring	150			kΩ
	Ring Detection Threshold	At Tip/Ring	13		19	V_{RMS}
	Ringer Equivalent Load			0.65		REN
	Loop DC current	On-hook monitor			500	µA
	Loop DC current	Off-hook	15		120	mA
	Current Limit Threshold		130		160	mA
	Off-hook AC impedance	At Tip/Ring	-	600		Ω
	Transmit THD			-70		dB
	Receive THD			-70		dB
	Transmit in band noise			-80		dBm
	Receive in band noise			-80		dBm
	Transmit Frequency Response, -3.0 dB		100		80,000	Hz
	Receive Frequency Response, -3.0 dB		100		80,000	Hz
	Transmit Signal Level				+3.0	dBm
	Receive Signal Level				+3.0	dBm
	Transhybrid Loss (on 600Ω @ 1kHz)	-10dBm transmit input signal	25	30		dB
	Return Loss (on 600Ω from 200Hz to 4kHz)		20	25		dB

PACKAGE INFORMATION



Demo Board Pin Definitions

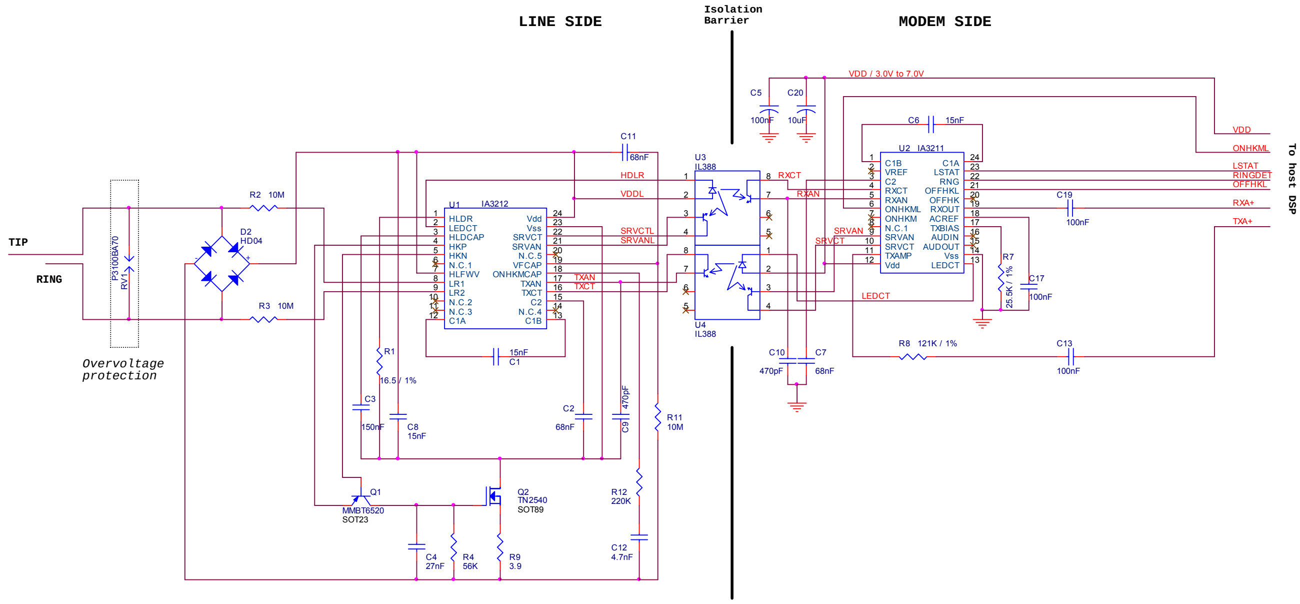
Pin number	Function
1	V_{SS}
2	V_{SS}
3	TXA+
4	TXA-
5	ONHKM
6	ONHKML
7	RXA+
8	RXA-
9	V_{DD}
10	AC_{REF}
11	OFFHK
12	OFFHKL
13	RingDet
14	LSTAT
(Pins 15-18 removed for high-voltage isolation)	
19	Tip
20	Ring



SILICON LABS

ANNEX

Reference Design — FCC68 North America



NOTES:

1. All resistors are 0.1W, 5%, 0805 unless otherwise stated.
2. All capacitor values are 10% unless otherwise stated.

These schematics are configured for:

- FCC68 - North American compliance
- Single ended transmission and reception
- Halfwave ring detection
- Caller ID capability
- Line in use / Parallel pick up detection capability

Integration Associates Inc.

110 Pioneer Way, Unit L - Mountain View, CA 94041 USA

Title: IA3211 + IA3212 - Reference Design - FCC68 Configuration

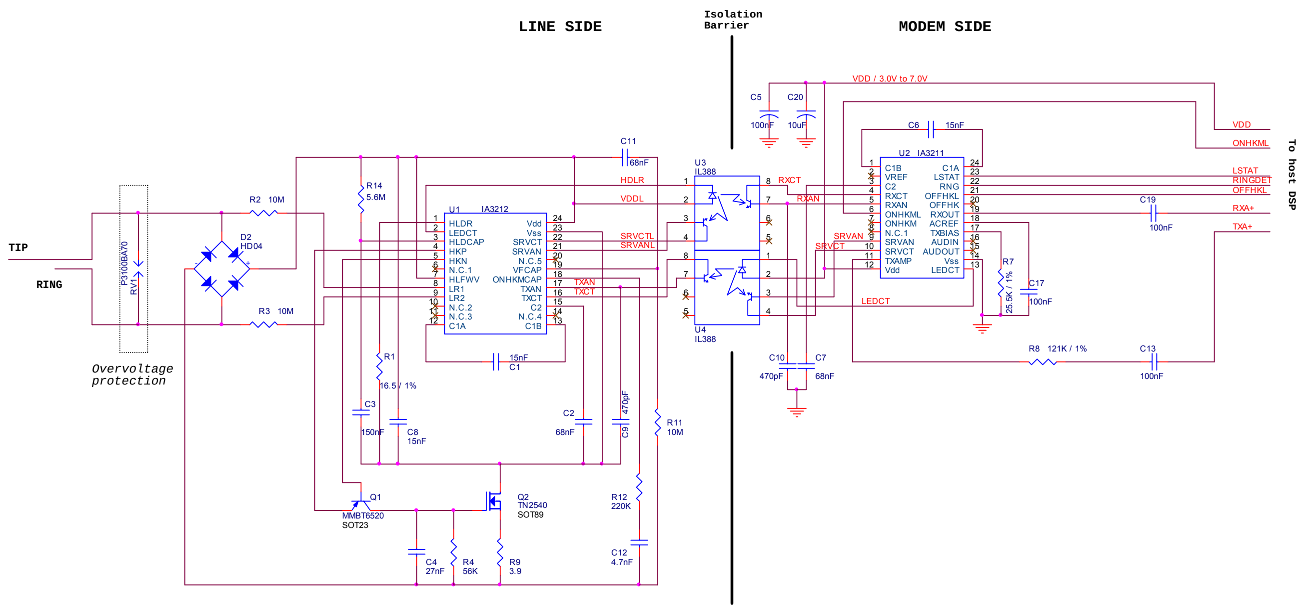
Size: B | Document Number | Rev: 1.0

Date: Tuesday, November 22, 2005 | Sheet 1 of 1

Qty	Reference	Value	Package	Manufacturer	Comments
3	C1,C6,C8	15nF	0805	Generic	
3	C2,C7,C11	68nF	0805	Generic	
1	C3	150nF	0805	Generic	
1	C4	27nF	0805	Generic	
4	C5,C13, C17,C19	100nF	0805	Generic	
2	C10,C9	470pF	0805	Generic	
1	C12	4.7nF	0805	Generic	
1	C20	10uF	A	Generic	
1	D2	HD04	MiniDIP	Diode	Alternative with Shindengen S1ZB60
1	Q1	MMBT6520	SOT23	Motorola	
1	Q2	TN2540	SOT89	Supertex	
1	RV1	P3100BA70	DO214	Teccor	Over voltage protection
1	R1	16.5 / 1%	0805	Generic	
3	R2,R3,R11	10M	0805	Generic	
1	R4	56K	0805	Generic	
1	R7	25.5K / 1%	0805	Generic	
1	R8	121K / 1%	0805	Generic	

Qty	Reference	Value	Package	Manufacturer	Comments
1	R9	3.9	0805	Generic	
1	R12	220K	0805	Generic	
1	U1	IA3212	TSSOP24	Integration	
1	U2	IA3211	TSSOP24	Integration	
2	U3, U4	IL388		Vishay	
33	**Total components**				

Reference Design — JATE Japan



NOTES:

1. All resistors are 0.1W, 5%, 0805 unless otherwise stated.
2. All capacitor values are 10% unless otherwise stated.

These schematics are configured for:

- JATE - Japanese compliance
- Single ended transmission and reception
- Halfwave ring detection
- Caller ID capability
- Line in use / Parallel pick up detection capability

Integration Associates Inc.

110 Pioneer Way, Unit L - Mountain View, CA 94041 USA

Title: IA3211 + IA3212 - Reference design - JATE Configuration

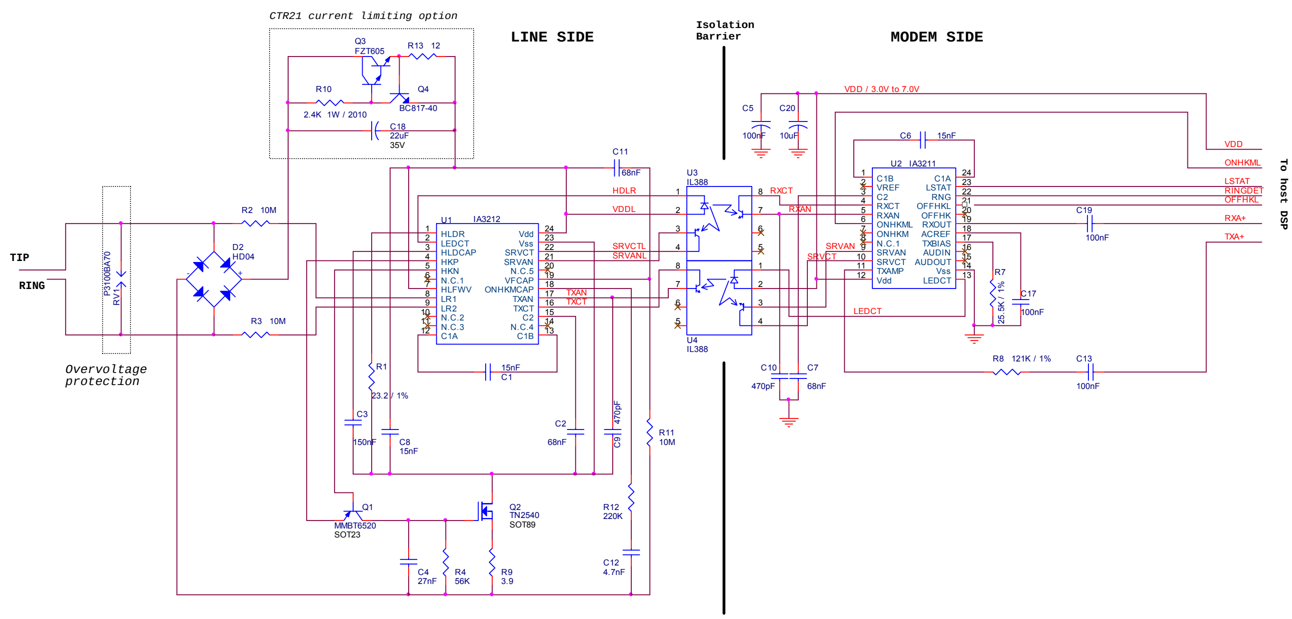
Size: B | Document Number | Rev: 1.0

Date: Tuesday, November 22, 2005 | Sheet 1 of 1

Qty	Reference	Value	Package	Manufacturer	Comments
3	C1,C6,C8	15nF	0805	Generic	
3	C2,C7,C11	68nF	0805	Generic	
1	C3	150nF	0805	Generic	
1	C4	27nF	0805	Generic	
4	C5,C13, C17,C19	100nF	0805	Generic	
2	C10,C9	470pF	0805	Generic	
1	C12	4.7nF	0805	Generic	
1	C20	10uF	A	Generic	
1	D2	HD04	MiniDIP	Diode	Alternative with Shindengen S1ZB60
1	Q1	MMBT6520	SOT23	Motorola	
1	Q2	TN2540	SOT89	Supertex	
1	RV1	P3100BA70	DO214	Teccor	Over voltage protection

Qty	Reference	Value	Package	Manufacturer	Comments
1	R1	16.5 / 1%	0805	Generic	
3	R2,R3,R11	10M	0805	Generic	
1	R4	56K	0805	Generic	
1	R7	25.5K / 1%	0805	Generic	
1	R8	121K / 1%	0805	Generic	
1	R9	3.9	0805	Generic	
1	R12	220K	0805	Generic	
1	R14	5.6M	0805	Generic	
1	U1	IA3212	TSSOP24	Integration	
1	U2	IA3211	TSSOP24	Integration	
2	U3, U4	IL388		Vishay	
34	**Total components**				

Reference Design — CTR21 Europe



NOTES:
1. All resistors are 0.1W, 5%, 0805 unless otherwise stated.
2. All capacitor values are 10% unless otherwise stated.

These schematics are configured for:

- CTR21 - European compliance
- Single ended transmission and reception
- Halfwave ring detection
- Caller ID capability
- Line in use / Parallel pick up detection capability

Integration Associates Inc.

110 Pioneer Way, Unit L - Mountain View, CA 94041 USA
Title: IA3211 + IA3212 - Reference Design - CTR21 Europe
Size: B | Document Number | Rev: 1.0
Date: Tuesday, November 22, 2005 | Sheet 1 of 1

Qty	Reference	Value	Package	Manufacturer	Comments
3	C1,C6,C8	15nF	0805	Generic	
3	C2,C7,C11	68nF	0805	Generic	
1	C3	150nF	0805	Generic	
1	C4	27nF	0805	Generic	
4	C5,C13, C17,C19	100nF	0805	Generic	

Qty	Reference	Value	Package	Manufacturer	Comments
2	C10,C9	470pF	0805	Generic	
1	C12	4.7nF	0805	Generic	
1	C18	22uF	0805	Generic	
1	C20	10uF	A	Generic	
1	D2	HD04	MiniDIP	Diode	Alternative with Shindengen S1ZB60
1	Q1	MMBT6520	SOT23	Motorola	
1	Q2	TN2540	SOT89	Supertex	
1	Q3	FZT605	SOT223	Zetex	
1	Q4	BC817-40	SOT23	Diode	
1	RV1	P3100BA70	DO214	Teccor	Over voltage protection
1	R1	23.2 / 1%	0805	Generic	
3	R2,R3,R11	10M	0805	Generic	
1	R4	56K	0805	Generic	
1	R7	25.5K / 1%	0805	Generic	
1	R8	121K / 1%	0805	Generic	
1	R9	3.9	0805	Generic	
1	R10	2.4K / 1W	1020	Generic	
1	R12	220K	0805	Generic	
1	R13	12	0805	Generic	
1	U1	IA3212	TSSOP24	Integration	
1	U2	IA3211	TSSOP24	Integration	
2	U3, U4	IL388		Vishay	
38	**Total components**				

RELATED PRODUCTS AND DOCUMENTS

Chipsets

DESCRIPTION	ORDERING NUMBER
IA3211 – Modem Side Worldwide DAA IC	IA3211-IC
IA3212 – Line Side Worldwide DAA IC	IA3212-IC

Silicon Labs, Inc.
400 West Cesar Chavez
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