Mitel Data Access Arrangement Devices

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1.0 Introduction

The purpose of this application note is to provide information on the operation and application of Mitel Semiconductor's range of Data Access Arrangement (DAA) devices.

DAAs can be used in a wide range of analog data and voice transmission equipment, such as modems, Fax machines, Electronic Point of Sale terminals and Set Top Boxes. Fig. 1 gives an example of a typical modem system.

Mitel Semiconductor DAAs can be used to provide a complete interface between analog transmission equipment and a telephone line. All functions are integrated into a single module, providing high voltage isolation, very high reliability and optimum circuit design needing few external components.

The design requirements of the DAA have, over time, become more stringent as data rates have increased and markets have become global. Mitel Semiconductor's range of components has been developed to embrace the new requirements and are being used by customers all over the world. This application note will assist in using the Mitel DAAs with any modem or other analog transmission systems.

NOTE: Set top boxes is the name given to the decoder, units used with Cable and Satellite systems and normally located with the T.V. sets.

2.0 What are the requirements for a D.A.A?

2.1 Functional Block Description

The DAA has to perform a number of distinct functions in order to provide the level of functionality needed in terminal equipment. Many of these functions have regulatory standards applied to them. Mitel DAA's simplify designs and provide a faster route to gaining regulatory approvals.

Fig 2.0 shows a schematic with the key features required of a DAA.

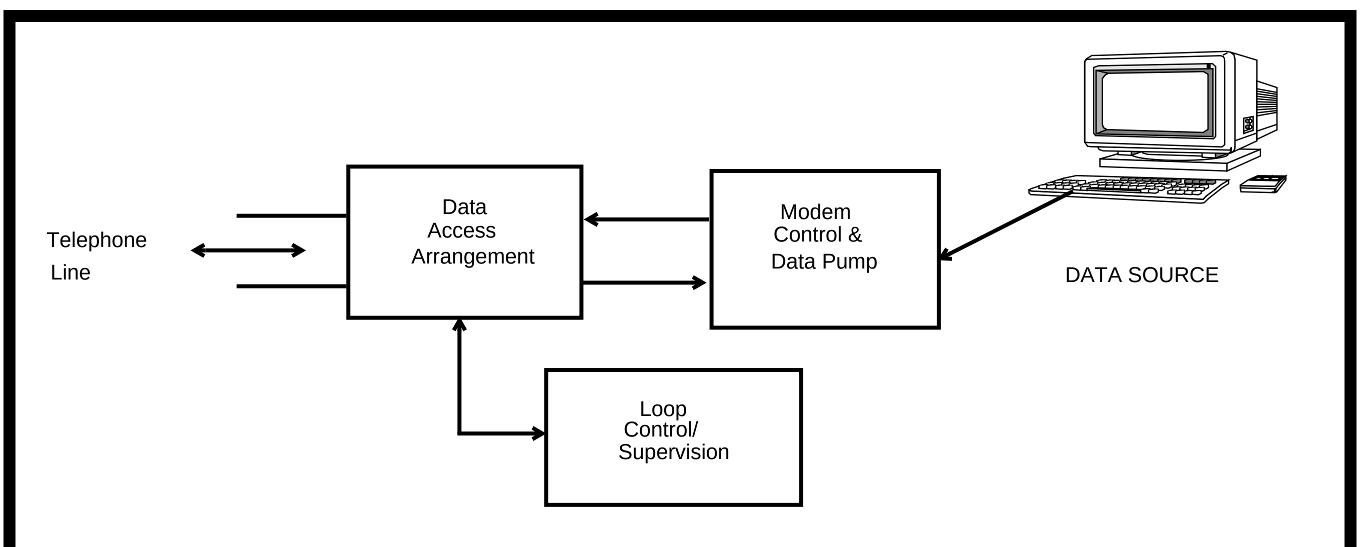


Figure 1

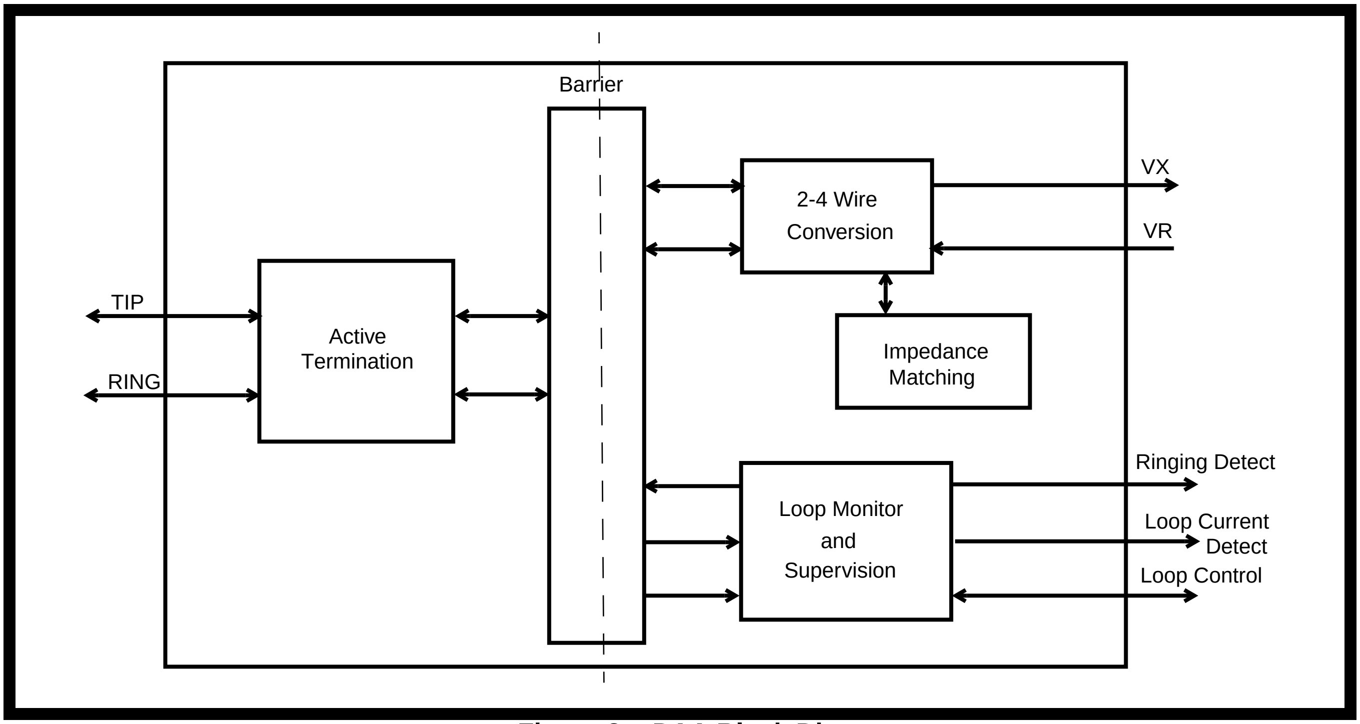


Figure 2 - DAA Block Diagram

2.1.1 DC Loop Termination

The DAA is required to terminate the telephone line in the appropriate way dependent upon the status of the call. In the on hook state a high impedance must be applied to the line i.e no d.c. current flows in the loop. Each DAA presents a high impedance to ground which is product related. (Refer to relevant product data).

An incoming call is detected by the presence of ringing, indicated on the ring detection pin. To answer the call a d.c. termination is applied to the line by activation of the loop control pin, signalling to the exchange that a subscriber has gone off-hook and is ready to set up the equipment initialisation.

Where the call is initiated by the subscriber the dc termination is applied to the line, causing loop current to flow, signalling to the exchange the initiation of the call.

Dialling can be performed either by using Dual Tone Multi Frequency (DTMF) signalling or by dial pulsing.

For the latter, the loop control pin can be used to interrupt loop current for pulse dialling.

Most countries have different D.C. mask requirements that need to be met. These are set on the country variants of the MH88422 but can be changed on the MH88435/MH88437 with external components.

At the end of a call the d.c. load is removed by the DAA and the termination returns to a high impedance state.

2.1.2 Line Impedance Matching

To obtain optimum performance on a transmission link it is necessary to match the a.c. characteristics of the DAA to those of the line. The characteristics of the line can vary according to the regulatory standards of a given country or network operator.

Two impedances are usually stated, these are the line characteristic impedance and the network balance impedance.

The line impedance of the DAA must be matched by the termination impedance. A mismatch will cause losses and echoes on the link, potentially increasing error rate, reducing transmission speed and even the interruption of transmission. The line impedance can be resistive or complex.

The network balance impedance is chosen to ensure that data transmitted by the subscriber is not reflected back into the DAA. This can be equal to the line impedance or a different impedance according to regulatory or operating requirements.

For DAAs which must be used in international applications there must be a method of programming these parameters. This method varies, dependent on the DAA used.

2.1.3 2-4 Wire Conversion

The DAA interfaces to a 2 wire telephone line which is a full duplex link. The DAA must extract from the line a Transmit signal and place onto the line a Receive signal. This has to be done to enable the connection to other devices such as Modem chipsets and DSP circuits which use a 4 wire connection.

Note: All Mitel Semiconductor Analog Line Interface product information refers to "Transmit" as the 4W output from a 2-4 wire converter and to "Receive" as the 4W input to a 2-4 wire converter.

Historically this function has been performed by a hybrid transformer, which provides good isolation but is bulky and difficult to manufacture. Modern designs use active components to achieve this function, providing low cost and high performance in a very small package.

Central to the design of a 2 to 4 wire converter is the need to cancel the transmitted signal on the telephone line. If there were no cancellations, this signal appears at the input of the DAA and could be interpreted by the DAA as a signal from the far end of the link. The measure of the ability of the DAA to cancel this signal is known as Trans Hybrid Loss (THL).

Good THL is achieved by accurate matching of the Network balance impedance to the line impedances and is usually stated for a given impedance and band of frequencies, as line length and discontinuities in the line will affect performance. For operation with a variety of line lengths a compromise impedance can be used to give an adequate THL, this removes the need to switch the balance impedance e.g., AT&T compromise.

2.1.4 Supervisory Features

The DAA must be capable of monitoring and controlling the line conditions for efficient management of the link. The key control feature which is needed is the loop switch function. This is used to apply the correct termination to the line and to provide pulse dialling facilities.

Line monitoring is needed to complete the signalling link from the far end. The signals which must be detected are ringing, line reversals and the presence of devices connected to the line e.g. a telephone set in parallel with the DAA. The nature of supervisory signals varies according to the service provider’s specification. External circuitry may be required to detect line reversals and/or parallel phones. Not all functions are provided on all DAA’s.

Responses to changes in the line signalling conditions are generated by the controlling system processor, which implements the appropriate protocols either through the DAA’s line control facilities or the use of modem command sets.

2.1.5 Protection

The use of active components in the DAA means that adequate protection from high voltages must be provided. The high voltages can result from lightning strikes or fault conditions e.g., mains cables shorting to the telephone line.

Specifications for protection are often particular to the PTT or service provider, but international standards do exist such as ITU-T K.20.

Protection can be provided by components such as Fold Back diodes, Positive Temperature Coefficient Resistors (PTCs), Transorbs and fuses.

It is not possible to show protection circuits to meet all requirements in this document, and due to the dynamic nature of regulatory standards Mitel Semiconductor recommends that users of Mitel DAAs consult with regulatory standards, standards bodies and approved test laboratories. However, an example is shown below of circuits to meet specific needs, Fig. 3.

2.1.6. Line Isolation and Regulatory Requirements

The DAA must provide isolation between the telephone line and the subscriber's equipment. The isolation barrier can be at various positions in the equipment, for example, in the power supply, in the DAA or a combination of these. The precise method depends upon the type of equipment being built and the country in which it will operate.

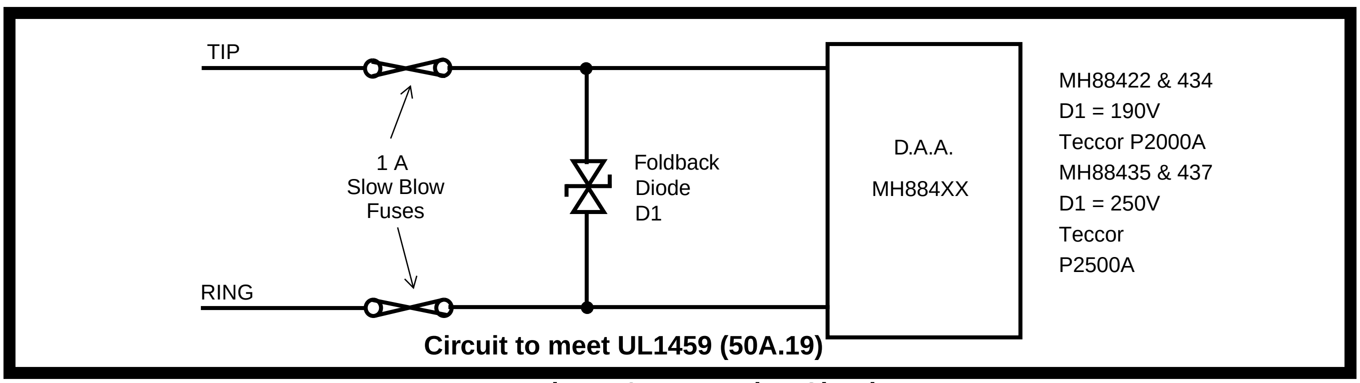
International standards are in operation for the line isolation, the most common being IEC 950, which is adopted as EN60950 in Europe and UL1950 in North America. This defines categories of levels of isolation which must be provided. Note: in order to meet functional requirements the DAA's AGND may need to be connected to earth. The main purpose of this is to reduce 50/60 Hz common mode signals which are associated with floating power supplies.

3.0 Mitel Semiconductor DAA's

Mitel Semiconductor DAA's have been designed to work as plug in modules, simplifying system design and reducing overall cost.

They have developed along with changing standards and transmission speed and are still evolving. Below is a summary of the key differences between the various product families.

The family of products is continually being added to. We recommend that you contact Mitel Semiconductor or one of our representatives or distributors for latest information on available products visit our Web site first.



Circuit to meet UL1459 (50A.19)

Figure 3 - Protection Circuit

Key Features	MH88422	MH88434	MH88435	MH88437
Reinforced Barrier	✓			
Supplementary Barrier			✓	✓
FCC Pt 68 isolation	✓	✓	✓	✓
Integral Loop Switch	✓	✓	✓	✓
Maximum Data Rate	9k6	33k6	33k6 (56k)	33k6 (56k)
Full Duplex Voice Capability		✓	✓	✓
On Hook Reception		✓	✓	✓
Programmable Impedances		✓	✓	✓
Country Variants	✓			
Programmable D.C. characteristics			✓	Note 1

Figure 4 - D.A.A.'s

* Note 1. Meets requirements of France and Germany in addition to the country requirements the MH88435 meets.

4.0 MH88422 Data Access Arrangement

Device Description

The MH88422 is a DAA designed for V.29 applications where a reinforced barrier is required. It provides the 3kV isolation barrier, 2-4 wire conversion function, the loop switch and is supplied as country specific variants as shown below.

The device is a 26 pin Dual in Line packaged product and is used in systems approved in many countries.

Device Number	Countries
MH88422-1	Germany (1TR2), Spain, Austria, Switzerland, South Africa
MH88422BD-1	Germany (ZV5)
MH88422-2	North America, Far East and other countries using 600Ω
MH88422-3	United Kingdom, New Zealand

4.1 General Considerations

The MH88422 has been designed to minimize the number of external components which are needed. As a minimum the components shown in Fig. 5 will be needed.

D1 is for protection from high voltage spikes, particularly from lightning strikes. C1 is a decoupling capacitor, to remove unwanted noise from the power supply. C2 forms part of the “dummy ringer” circuit.

A dummy ringer is needed in order to provide the correct ringer load to the network, a load which varies between countries. The resistive element of the dummy ringer is on board the MH88422, but this can be altered externally by modifying the load between tip and ring. Refer to the relevant regulatory specs for different dummy ringer requirements.

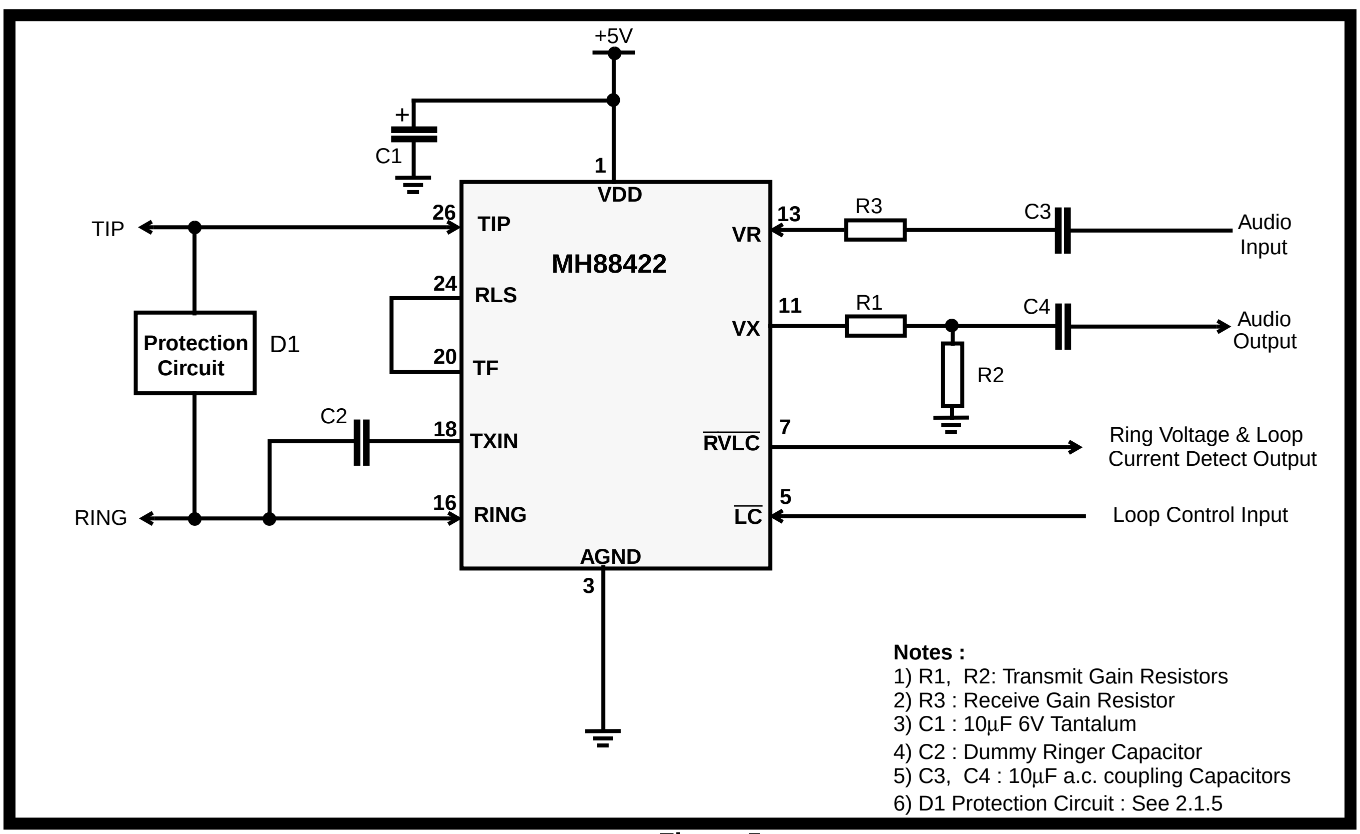


Figure 5

4.2 Applications Example

Security System

Warden Call and Security Systems often use dial up modem technology to provide data transfer capability to a variety of different networks.

Typically such a system would, in the case of an emergency, first dial the security service provider, often the Police, or medical assistance. This is done through the following sequence of events:

1. The terminal moves from the on hook state to the off hook state through the closing of the loop switch in the DAA.
2. Once dial tone has been detected a call will be made by transmitting DTMF tones to the Central Office or PABX.
3. If a busy tone is detected or call not answered then the sequence will be aborted through moving back to the on hook state and the call will recommence.
4. When the call is answered and an acknowledgment is received the terminal will move to a data transfer mode, when information on the nature of the emergency will be transmitted to the control centre. Appropriate action will then be taken.

A call can also be initiated from the control centre in order to interrogate the terminal, ensuring that it is functional and down loading software upgrades. If this is the case then the MH88422 will detect the ringing signal allowing the controlling processor to take the terminal off hook and receive the data transfer.

Fig. 6 shows a typical set up for an application with a phone connected in parallel for Germany.

4.2.1 Gain Adjustment

Transmit gain adjustment is provided by resistors R3 and R4. The gain is calculated using the following equation:

$$GainTx = 20\log[R4/(R3+R4)] - 0.4dB$$

Note, $(R3 + R4) > 2k\Omega$

Receive gain is set by R5. The receive gain is calculated using the following equation:

$$Gain\ Rx = 20\log[47k/(47k+R5)] + 3.5dB$$

These resistors must be fitted to prevent overloading of the output signal.

4.2.2 Ringing detection

The MH88422 provides the circuitry required to signal the presence of the ringing signal. The ringing signal detection threshold and dummy ringer loads are defined in the relevant regulatory standards.

The MH88422 variants are designed to meet certain regulatory requirements for ringing detection by simply connecting together the relevant pins on the device and using a specified dummy ringer capacitor. However, the user can adjust the threshold and dummy ringer load by using external components.

In Figure 6a, 6b R2 is shown fitted; this component allows external adjustment of the Ring detection threshold level. By fitting R2 in parallel with R1 the ring detection level is increased from the minimum level quoted in the data sheet. When choosing the value for R2 it should be noted that R7 and C2 which form the dummy ringer will also affect the detection threshold value.

Figure 6b shows an equivalent circuit for the ring detector input.

Note: Mitel Semiconductor recommends consulting the regulatory standards and engaging the service of an approvals testing facility before attempting to adjust the dummy ringer and ringing detection thresholds.

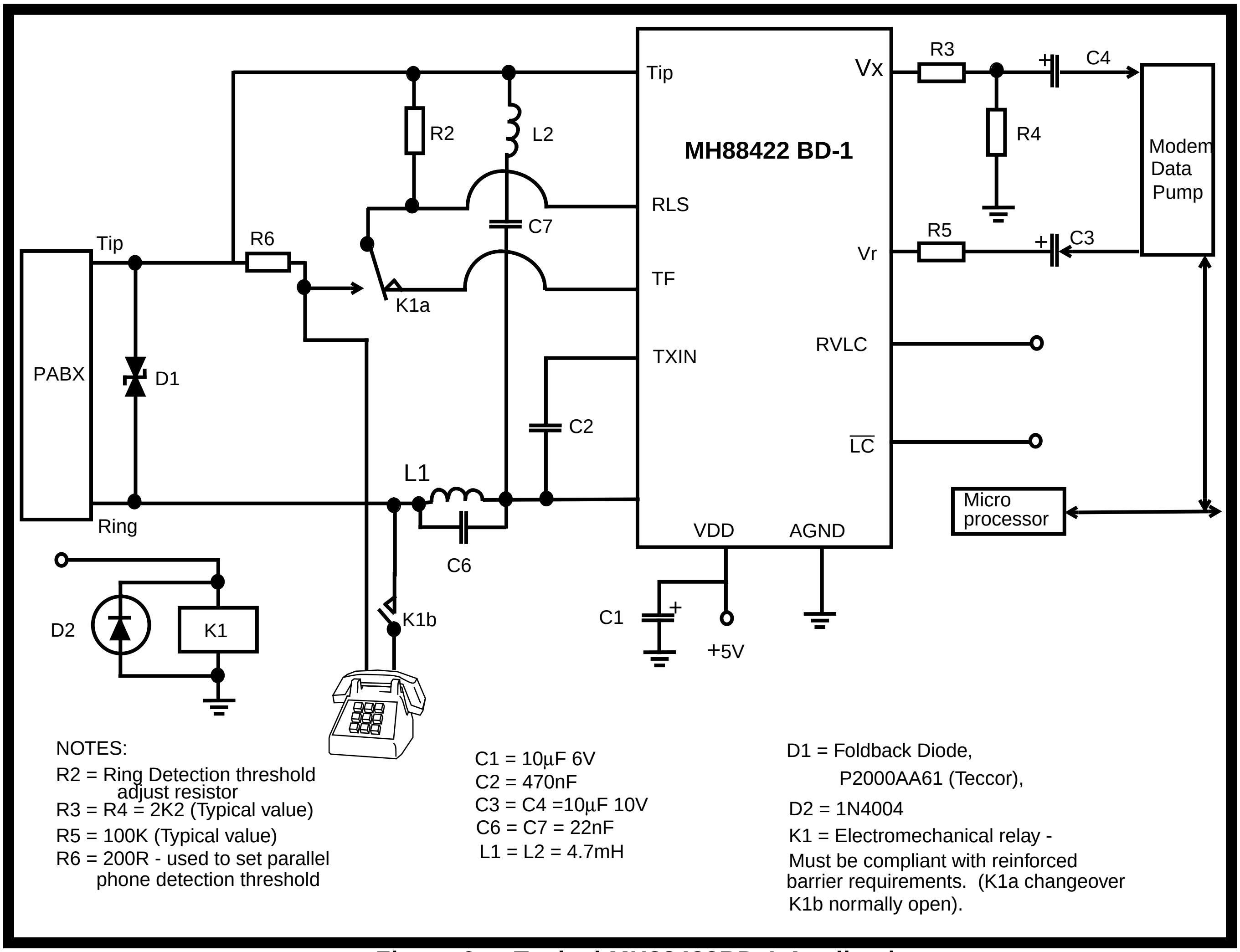


Figure 6a - Typical MH88422BD-1 Application

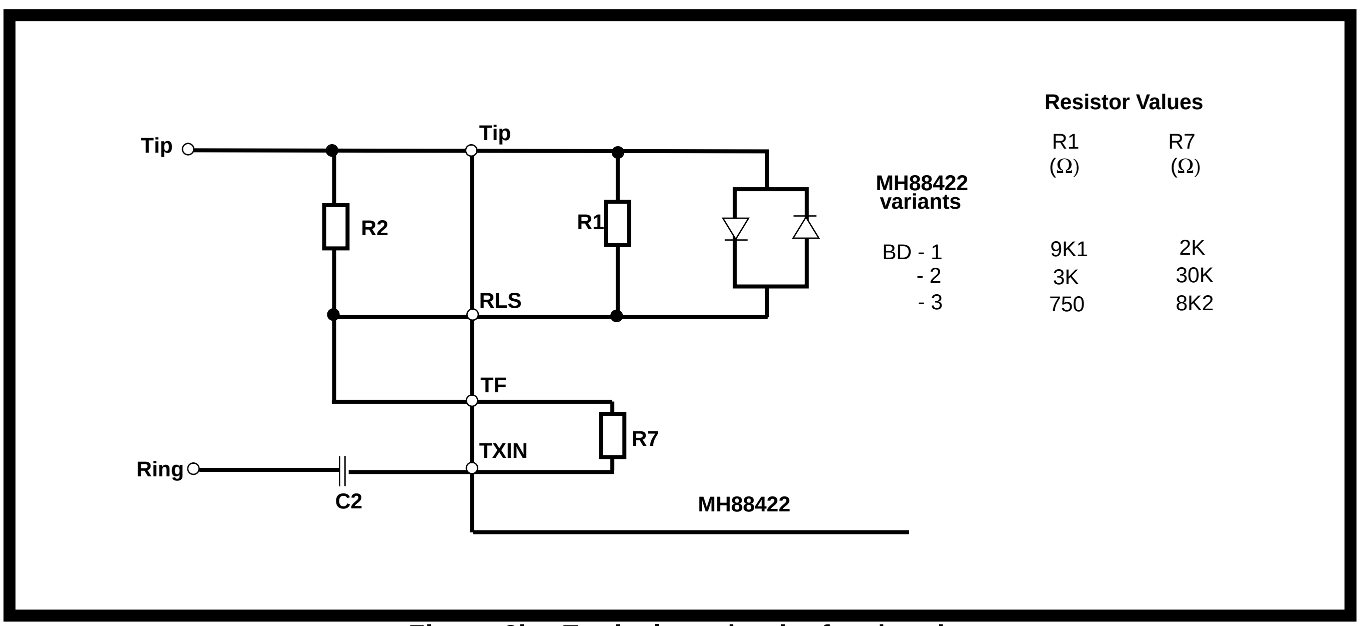


Figure 6b - Equivalent circuits for ring detect

5.0 MH88434 Data Access Arrangement

Device Description

The MH88434 is a DAA designed for V.34 and V.34+ applications where 1kV isolation is required, meeting the requirements of FCC Pt. 68. It provides, in addition to the 1kV isolation, the 2-4 wire conversion function, the loop switch and can be programmed to meet various line impedance networks.

The device is a 26 pin Dual in Line packaged product and is available in surface mount as well as through hole format.

5.1 General Considerations

The MH88434 has been designed to minimize the number of external components which are needed. As a minimum the components shown in Fig. 7 are required.

D1 is for protection from high voltage spikes, particularly from lightning strikes. C1 is a decoupling capacitor, to remove unwanted noise from the power supply. C2 forms part of the “dummy ringer” circuit.

A dummy ringer is needed in order to provide the correct ringer load to the network, a load which varies between countries. This must be implemented externally.

All analog paths should be kept as short as possible to reduce the possibility of noise pickup.

As the MH88434 is a single +5V power supply component the analog inputs and outputs are biased at +2.6V. As a result in some applications it may be necessary to connect series coupling capacitors, C3 & C4.

5.1.1 Output Impedance Setting

Due to the requirement of many administrations for the use of complex line impedances the MH88434 has been designed to allow the output impedance to be programmed using external components.

To program the device the appropriate network is connected between ZA and ground. The ZA pin has the equivalent of 1.3 kOhms in series, Zint, which must be subtracted from the network which is added. The following design equation can be used to determine the value of the components which must be used.

$$Zin = \frac{Zext + Zint}{10}$$

for example if an impedance of 600 Ohms is required:

Zext = (600 x 10) - 1k3 = 4.7 kOhms

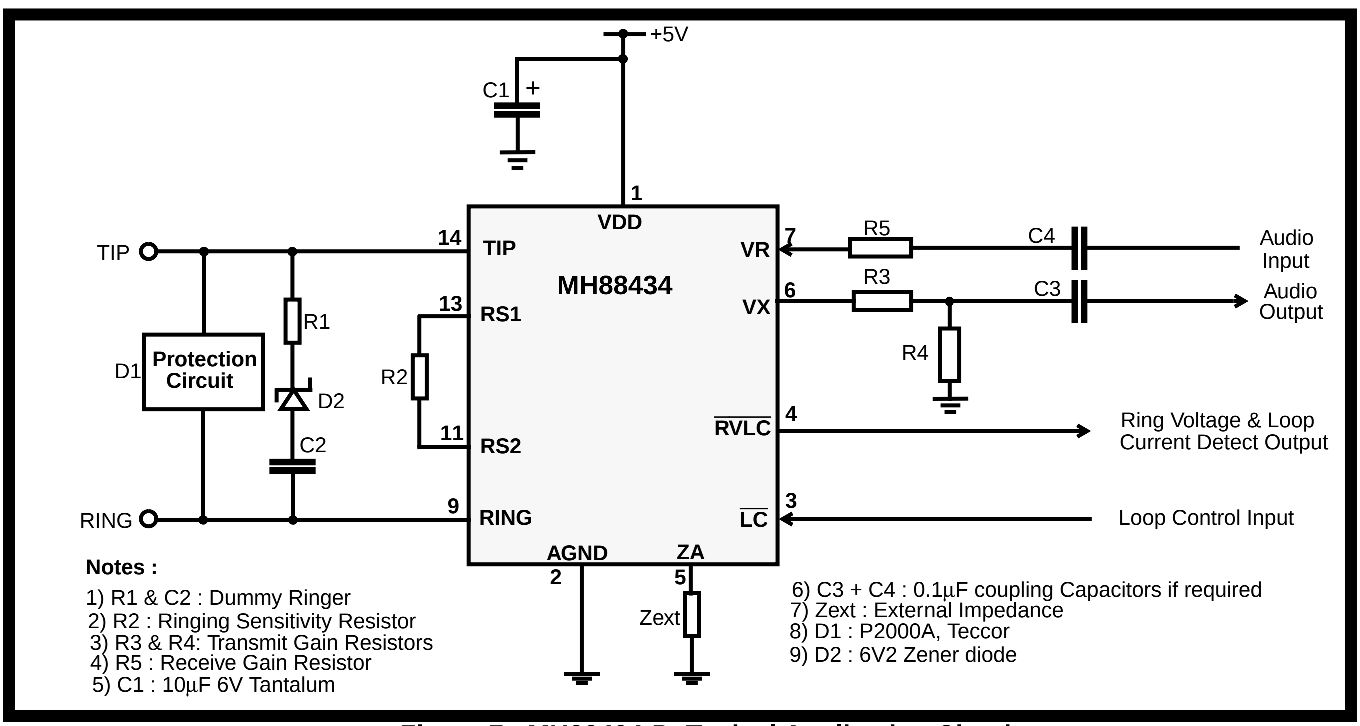


Figure 7 - MH88434-P: Typical Application Circuit

If Zin is a complex impedance of the form Rs +(Rp// Cp) then the network used is shown in Figure 8.

The calculations for the values of the external network components is given by:

R_{SEXT} + Rint = Rs x 10
R_{SEXT} = (Rs x 10) - Rint
R_{PEXT} = Rp x 10
C_{PEXT} = Cp Ö10

5.1.2 Gain Adjustment

The transmit gain of the MH88434 is 0dB. Transmit gain adjustment is provided by resistors R3 and R4, which form a simple potential divider. The gain is calculated using the following equation:

GainTx = 20logR4/(R4+R3)

Note, (R3 + R4) > 2kΩ To prevent output overload R3 & R4 must be fitted.

The receive gain is also 0dB through the MH88434. Receive gain is set by R5. This resistor is in series with the device input impedance, formed by the input resistor to an amplifier stage. The receive gain is calculated using the following equation:

Gain Rx = 20log 47k/(47k+R5)

It is usually not necessary to set the gain externally as this can be done through the modem chip set, in which case R5 is not fitted.

5.1.3 Ringing detection

The MH88434 provides the circuitry required to indicate the presence of the ringing signal. The ringing signal detection threshold and dummy ringer loads are defined in the relevant regulatory standards.

The MH88434 is designed to meet certain regulatory requirements for ringing detection by simply connecting together the relevant pins on the device and using a specified dummy ringer circuit which comprises a resistor and capacitor in series. However, the user can adjust the ringing detection threshold by using external components.

The ringing detection threshold is defined by using the design equation below.

R2 = 30 x (VR - 10)

Where VR is ringing voltage (Vrms) and R2 is in kΩ

If R2 = 0 kΩ then the minimum ringing threshold which can be set is 10Vrms.

Note: Mitel Semiconductor recommends consulting the regulatory standards and that inexperienced users should engage the services of an approvals testing facility before attempting to adjust the dummy ringer and ringing detection thresholds.

5.2 Application Example

V.34 Modem using the Rockwell Processor and Data Pump.

Fig. 9 shows a typical set up between a Rockwell Modem chipset and the MH88434.

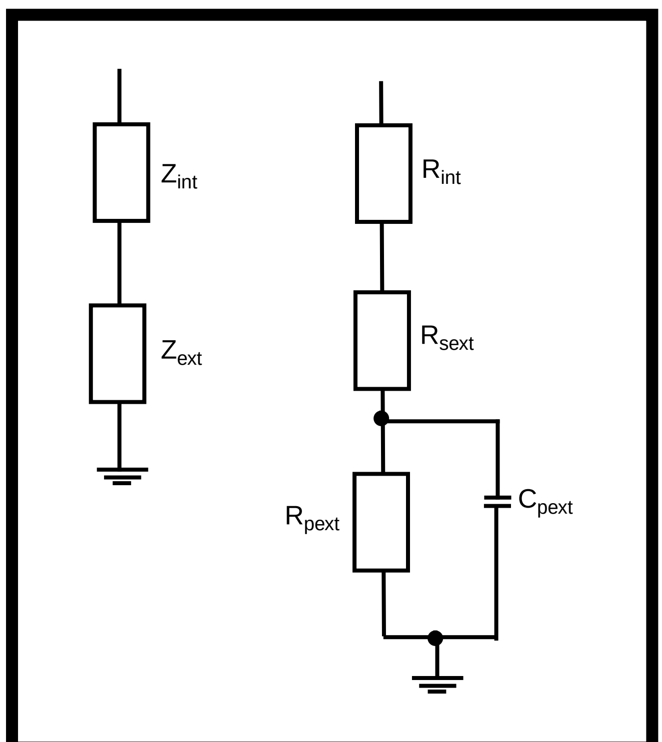


Figure 8 - Complex impedance network

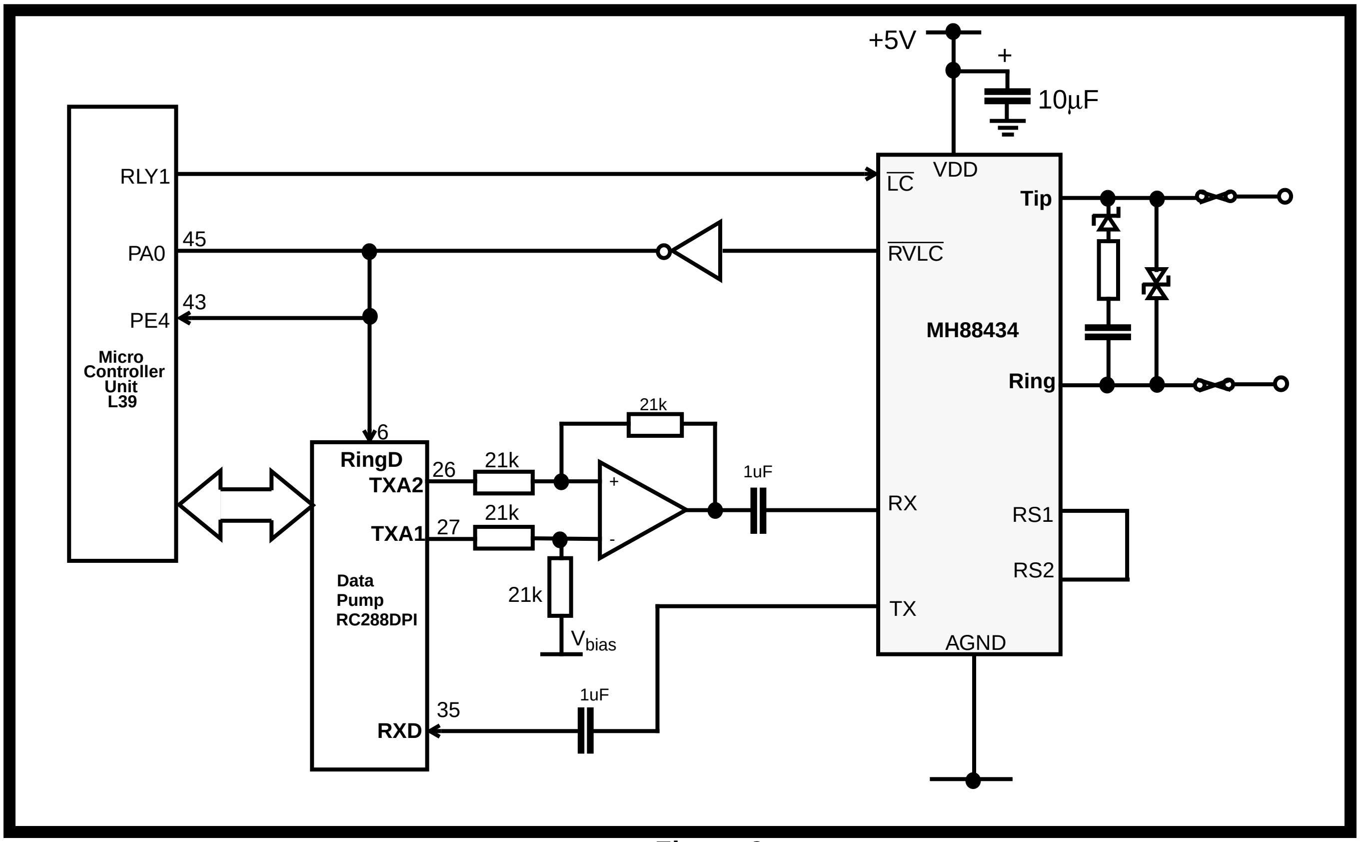


Figure 9

6.0 MH88435& MH88437 Data Access Arrangements

Device Description

The MH88435/7 are DAA's designed as Telecom Network Voltage (T.N.V.) circuits for V.34 and V.34+ applications where a barrier is required to comply with the supplementary barrier requirements of EN60950 and UL1950.

In addition to the isolation, the MH88435/7 provide the 2-4 wire conversion function and an integral loop switch.

Additionally the MH88435/7 have been designed to meet the network requirements of most administrations worldwide and can be programmed to meet various line impedance and balance networks and d.c. templates.

The MH88437 is a superset of the MH88435 in that it will meet the same country requirements and in addition meet specific requirements for France and Germany. These are detailed in the respective data sheets.

The devices are 28 pin Dual in Line packaged products and are available in surface mount or through hole format.

6.1 Device Set up and Programming

The MH88435/7 have many programmable features and these are described below. The set up of the ringing sensitivity, line impedance, gain and protection circuits are implemented in the same way as was described for the MH88434.

The programming of line impedance is done by connecting a network from ZA to ground. A table of networks suitable for many countries is shown in Table 1.

An approximate value for other countries can be found by using the calculation given in the data sheet.

$$Zin = \frac{Zext + Zint}{10}$$

where Zext = external network connected between Za and AGND and Zin = 1.3kΩ (internal resistance).

6.1.1 D.C. Mask Programming

The dc conditions which must be adhered to vary depending upon the country in which the DAA is being used. For this reason the MH88435/7 can be programmed with the use of resistors outside of the device. This programming feature should rarely be needed but provides the user with the flexibility to meet almost any requirement. France requires that the loop current drawn by the DAA does not exceed 60mA, the MH88437 must be used to achieve this where this feature can be met by setting CL\ to logic 0.

6.1.2 Network Balance Impedance

The Network balance impedance is set by connecting a network between the NB1 and NB2 pins. Failure to correctly match the network balance impedance will result in a degradation of the Trans Hybrid Loss performance and as a result data transmission capability.

If the balance impedance is the same as the line impedance then a 15kΩ resistor should be connected for the MH88435, or a 16kΩ resistor should be connected for the MH88437. For values which differ from the line impedance then the correct network should be selected. The table below, Table 1, shows some typical network requirements.

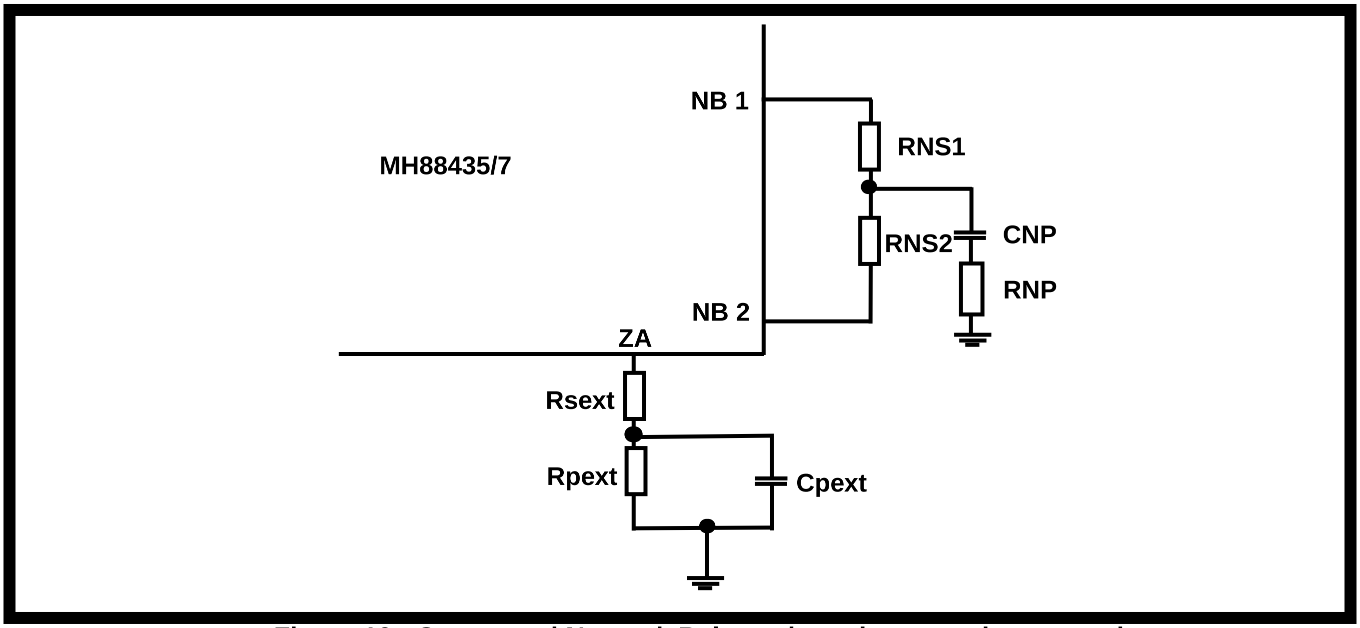


Figure 10 - Output and Network Balance impedance setting networks

Rpext	Rsext	Cpext	ZOUT	ZBAL	RNS1	RNS2	RNP	CNP
0R	4k7	NF	600R	ATT Compromise	8K2	2K2	2K0 Note 4	33nF
8K2	910R	10nF	Germany BAPTZV5	Equal to Zout	15K Note 1	0R	NF	NF
0R	4K7	NF	600R	600R	15k Note 1	0R	NF	NF
5K1	2K2	33nF	UK BS6305	Equal to Zout	15k Note 1	0R	NF	NF
8K2	820R	150n	France*1 Note 2		16k	0R	NF	NF

Table 1. Programming components

Note 1. For the MH88435 this value is 15k while for the MH88437 this value is 16k
Note 2. Use MH88437 for this country
Note 3. NF = Not Fitted
Note 4. For the MH88435 this value is 2k0 while for the MH88437 this value is 910R

6.1.3 Use with a Parallel Telephone

In many applications the DAA is used in conjunction with a telephone set. For emergency operation it may be necessary that as soon as the telephone handset is picked up any data call which is in progress must be terminated.

This places on the system the requirement to detect the parallel telephone going off hook when the DAA itself is off hook. The MH88435/7 provides the necessary signals to enable this to be done. Using the circuit shown in figure 11 the LOOP, RV and LCD signals are used to detect changes in the loop conditions.

Under normal operation the loop current detect (LCD) pin will go high when the MH88435/7 goes off-hook. If a parallel phone connected to the MH88435/7 then goes off-hook, the LCD pin remains high, but there is a small change in Loop pin voltage. Using the circuit in Fig. 11 this change in Loop pin can be detected by monitoring PP/. The output of PP/ will be a low going pulse of approximate 25 ms duration, under these conditions.

Parallel Phone output (PP/) is a low going pulse of approximately 25ms duration.

IC1a, b = LM358 dual op amp
IC2 = LM393

6.1.4 Gain Adjustment

The transmit gain of the MH88435/7 is 0dB. Transmit gain adjustment is provided by resistors as shown in Fig. 12, which form a simple potential divider. The gain is calculated using the following equation:

Gain Tx = 20 log R4/(R4 + R3)

Note: (R4 + R3) >2kΩ. Unlike the MH88422 and MH88434 these components do not need to be fitted unless gain adjustment is required.

The receive gain is also 0dB, but can be adjusted by fitting R5 & R6. These resistors are in series with the device input impedance, formed by the input resistors for VR+ & VR- feeding into an amplifier stage. The value for R5 and R6 must be equal when used in a differential mode. The formula for calculating the gain is:

Gain Tx = 20 log 47k/(47k + R5).

It is usually not necessary to set the gain externally as this can be done through the modem chip set in which case R5 & R6 are not fitted.

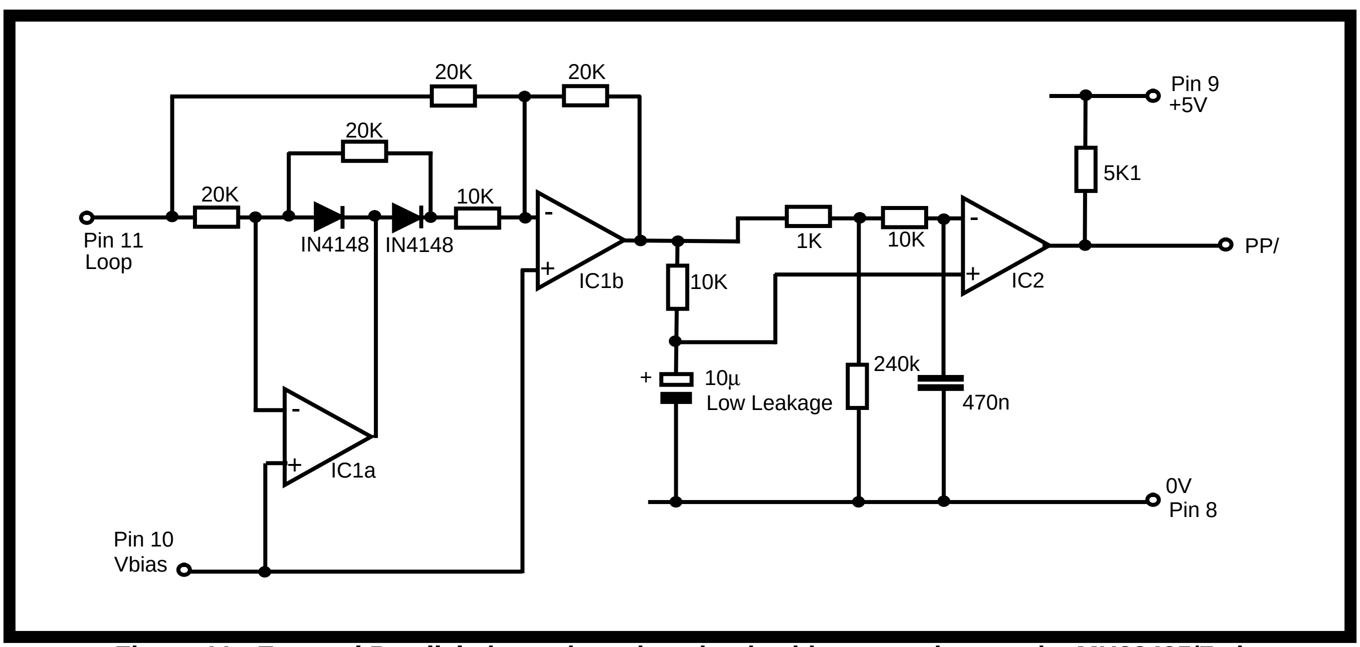


Figure 11 - External Parallel phone detection circuit with connections to the MH88435/7 shown

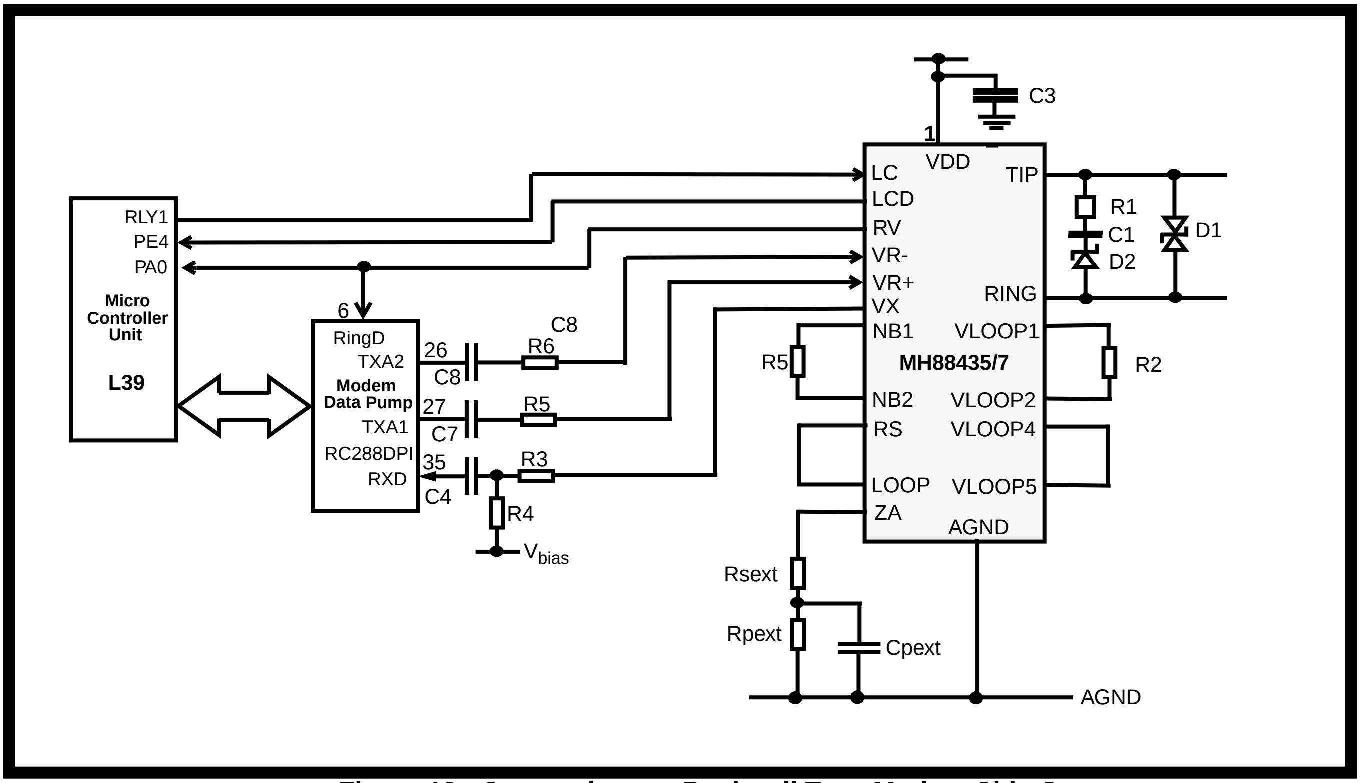


Figure 12 - Connections to Rockwell Type Modem Chip Set

6.1.5 The Loop Pin

The loop pin output voltage, V_{LOOP}, is proportional to the line voltage across Tip and Ring V(t-r), scaled down by a factor of 50 and offset by V_{BIAS} which is approximately 2.0V.

The formula is therefore:

$V(t\text{-}r) = (V_{LOOP} - V_{BIAS}) \times 50$

7.0 MH88437 Data Access Arrangements

There are some differences between the two DAA's which are detailed further in this section.

7.1 Device Differences

The MH88437 is a pin for pin compatible part with the MH88435. In addition to the features of the MH88435, the MH88437 will:

- Meet the French current limit specification of 60mA
- Meet the German dial pulse requirement of BAPT 223 ZV5

7.2 Device set up and programming

The programmable features of the MH88437 are the same as the MH88435, the only exceptions are:

- Network balance impedance components are as defined in Table 1.
- A pin previously not used, CL\, is used to control the French current limit. For countries not requiring this feature the pin should be set to logic 1.

For details on the countries that the MH88435/7 are suitable for, please refer to the individual data sheets.