

## DAATACUBE LINE INTERFACE MODULE P3400

A worldwide solution to telecoms line interfacing, data and voice

### Features

- Full performance to V.32 terbo; V.FC and V.34 (V.Fast)
- Reinforced isolation (3kV RMS) to EN 60950
- Miniature size (37 x 25mm and only 11mm high)
- Built-in 2-4 wire hybrid circuitry
- Highly versatile
- Easily configured to meet world PTT requirements
- Ring detection and bell tinkle suppression
- DTMF and Pulse Dial capability
- Consumes <10 $\mu$ A on standby
- Caller ID/on-hook data transfer compatible
- Very low component count implementation
- BABT Certificate of Recognition
- AUSTEL Certified Component

### Applications

- Modems to the highest data speeds
- Portable PC modems to V.34
- FAX machines and FAX modems
- Answering machines
- General telecoms voice and data applications
- Extensive application information

### INTRODUCTION

Products intended for direct connection to the telephone line such as modems, FAX machines etc. must be coupled to the network using approved circuitry in order to protect the network and its users and to ensure interoperability.

P3400 is a DAA (Data Access Arrangement) which is designed to provide a high voltage (3kV RMS) safety isolation barrier between the PTT network and the subscriber's host equipment (Modem, FAX etc.) while supporting full-duplex data transmission to V.34 speeds (28.8kbits/s).

P3400 provides for dialling using loop-disconnect or DTMF methods, 2-4 wire conversion, network termination, bell tinkle suppression (UK), ring detection and line seizure with programmable DC mask.

Because many internal circuit nodes are made available to the designer, P3400 is highly versatile and can be configured for most applications.

Use of a device such as P3400, which has been independently tested and approved, can significantly reduce the time to market by speeding up the design, test and approvals processes. Since P3400 embodies ultra-low distortion circuitry, it will be found invaluable to engineers designing for operability at V.34 and other high speed protocols.

P3400 is a member of the DAAtacube family of DAA line interface modules. Contact ETAL for the availability of other DAAtacube products.

P3400 carries a BABT Certificate of Recognition, and is an AUSTEL Certified Component, further simplifying the design and approval processes of the user.

## SPECIFICATIONS

### Mechanical

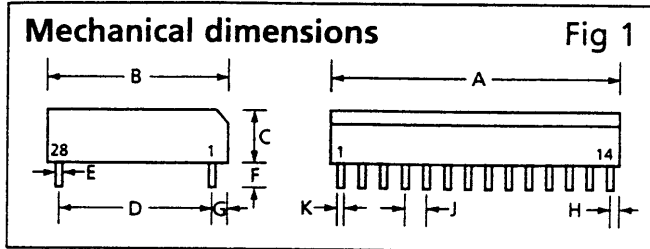


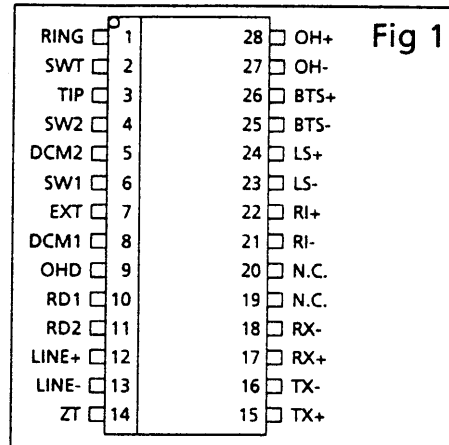
Table 1

Dimension	Millimetres		Inches	
	Min	Max	Min	Max
A	36.0	36.6	1.417	1.441
B	24.0	24.6	0.945	0.969
C	11.0	11.2	0.433	0.441
D	18.7	19.3	0.736	0.760
E	0.33	0.43	0.013	0.017
F	4.2	4.7	0.165	0.185
G	2.3	3.0	0.090	0.118
H	1.3	2.0	0.051	0.079
J*	2.54	2.54	0.100	0.100
K	0.43	0.53	0.017	0.021

Pins are electroplated 60/40 SnPb, 3µm minimum. Recommended hole diameter 1.0mm.

\* A non-accumulative tolerance of ±0.05mm applies.

### Pin assignment

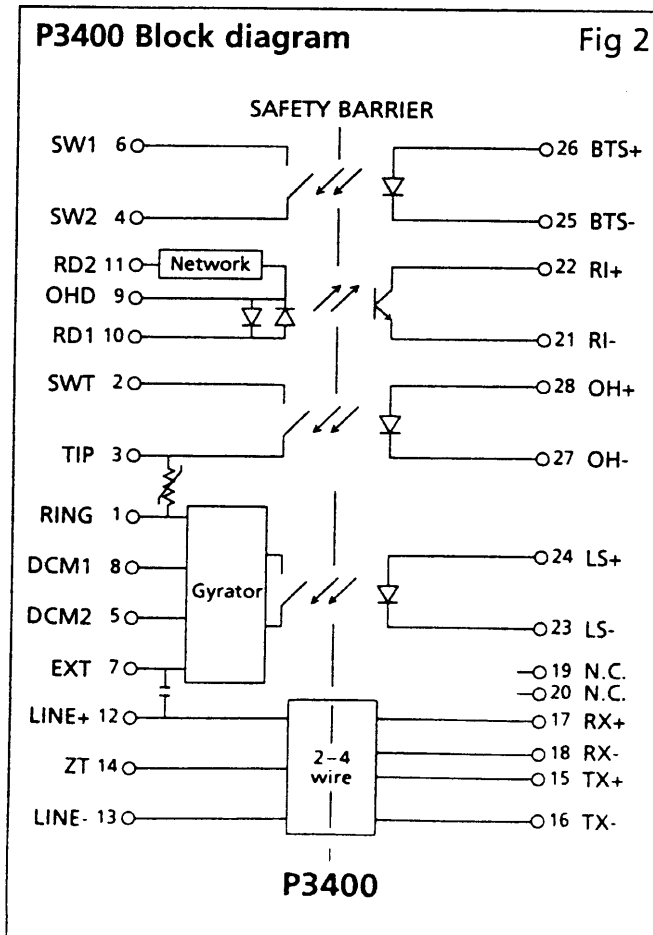


### Pin description: Table 2

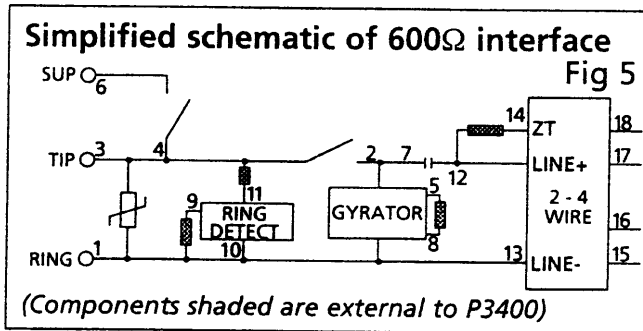
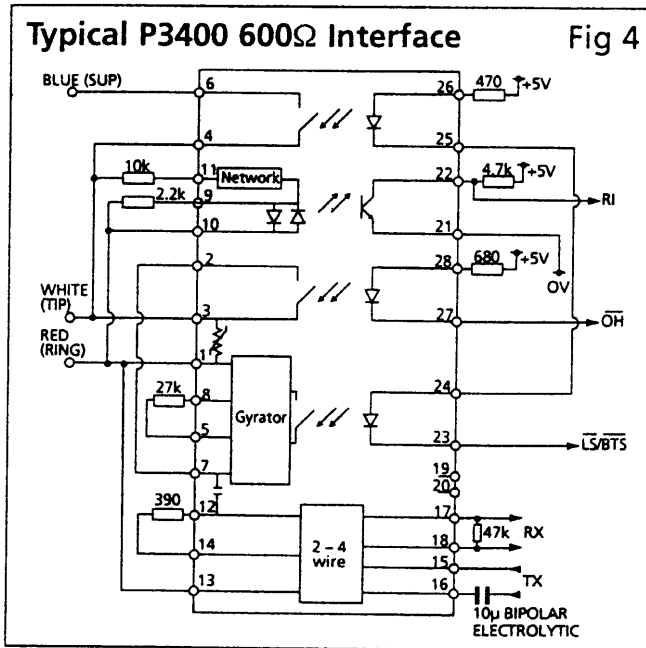
Pin	Name	Description
1	RING	RING connection to PTT Network (Red wire in UK)
2	SWT	Switched TIP output (normally connected to EXT)
3	TIP	TIP connection to PTT Network (White wire in UK)
4	SW2	Uncommitted solid state relay contact normally connected to TIP for Bell Tinkle Suppression (UK)
5	DCM2	A programming resistor between DCM1 and DCM2 sets the DC Mask
6	SW1	Uncommitted solid state relay contact. Normally connected to Bell Tinkle Suppressor (Blue wire in UK)
7	EXT	Leased line input. Otherwise connected to SWT for PSTN application
8	DCM1	A programming resistor between DCM1 and DCM2 sets the DC Mask
9	OHD	When connected in series with an associated telephone set, current flowing through OHD causes Ring Indication transistor to conduct. Current through OHD <b>must</b> be externally limited to 100mA
10	RD1	Ring signal input to Ring Detector
11	RD2	Ring signal input to Ring Detector
12	LINE +	AC coupled node of 2-4 wire hybrid. Matching network is connected between LINE + and ZT
13	LINE -	Node of 2-4 wire hybrid. Normally directly connected to RING
14	ZT	Matching network port. Matching network connects between LINE + and ZT
15	TX+	Isolated analogue port normally connected to CODEC transmitted data output
16	TX-	Isolated analogue port normally connected to CODEC transmitted data output
17	RX+	Isolated analogue port normally connected to CODEC received data input
18	RX-	Isolated analogue port normally connected to CODEC received data input
19	NC	unused pin
20	NC	unused pin
21	RI-	Ring Indicator. NPN transistor emitter
22	RI+	Ring Indicator. NPN transistor collector
23	LS-	Cathode of Line Shunt diode
24	LS+	Anode of Line Shunt diode
25	BTS	Cathode of Bell Tinkle Suppression diode
26	BTS+	Anode of Bell Tinkle Suppression diode
27	OH-	Cathode of Off-Hook diode
28	OH+	Anode of Off-Hook diode

### P3400 Block diagram

Fig 2



## Electrical characteristics



## Specifications and operating conditions

Circuit as Fig 4 with line current 50mA and 25°C unless otherwise stated.

### DC Electrical Characteristics: Table 3

Characteristics	Min	Typ	Max	Units	Comments
On-Hook supply current	-	-	10	μA	
On-Hook line leakage current	-	-	10	μA	
Off-Hook supply current	-	10	-	mA	

### AC Electrical Characteristics: Table 4

Characteristics	Min	Typ	Max	Units	Conditions
Return loss	16	-	-	dB	300Hz-3.4kHz
Transhybrid Loss	24	-	-	dB	300Hz-3.4kHz
Transmit insertion loss	-	6.2	-	dB	1kHz
Receive insertion loss	-	2.8	-	dB	1kHz
Frequency response	-	±0.1	-	dB	300Hz-3.4kHz
Harmonic Distortion at RX	-	-	-90	dBm	600Hz @ -6dBm in line

### Recommended Operating Conditions: Table 5

Characteristics	Min	Typ	Max	Units	Comments
Ring voltage	20	-	150	VRMS	programmable
Ring frequency	15	-	70	Hz	
Line voltage	35	-	120	VDC	
Diode control current Active	2	5	100	mA	
Forward Voltage @ 5mA	0.9	1.2	1.4	V	
RX port load	10	47	-	kΩ	
TX port source	-	1	10	Ω	
Signal Power in line	-	-9	0	dBm	

### Absolute Maximum Ratings

Maximum ratings beyond which P3400 may suffer permanent damage

Voltage	3250V RMS
Line-Subscriber	4600V DC
Line Side Transverse voltage (between pins 1&3, 2&3, 10&11, 4&6)	350V peak
Switch load current (pins 4&6, 2&3)	120mA continuous 300mA peak, 10ms
LED drive currents (pins 9&10, 23&24, 25&26, 27&28)	100mA continuous 1A peak (10ms)
LED reverse input voltage (pins 23&24, 25&26, 27&28)	5V
Phototransistor power dissipation (pins 21&22)	150mW Derate linearly 2mW/°C above 25°C
Phototransistor voltage V <sub>ceo</sub>	20V
2-4 wire hybrid input currents	10mA
Operating temperature	-40 to +85°C
Storage temperature	-40 to +125°C
Soldering temperature (10 seconds)	260°C

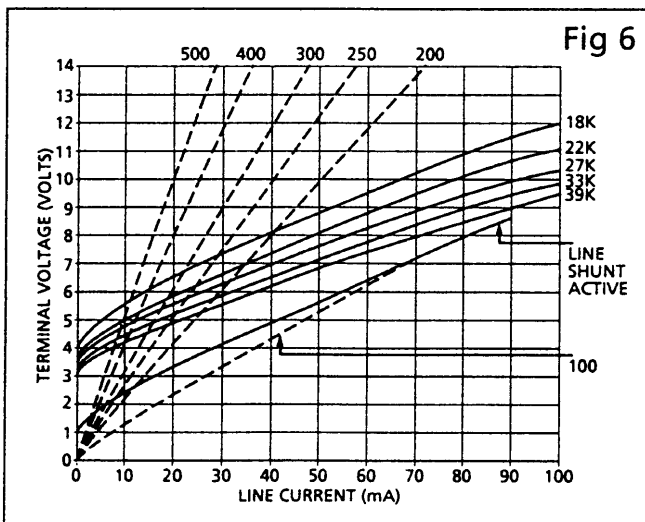
## FUNCTIONAL DESCRIPTION

### Hook Control

P3400 will seize the telephone line when current flows through the OH circuit (pins 28, 27). Since the internal circuit element between pins 28 and 27 is a diode, this circuit should not be forced with a voltage source. A single series resistor is all that is required to limit the current, and typically, for a +5V supply, a 680Ω pull-up resistor is used in conjunction with an open collector current sink.

### DC Mask

When the telephone line is seized, line current flows through a gyrator circuit within P3400. The gyrator is an active device which presents a relatively low impedance at DC, but a high impedance at signal frequencies. Each particular PTT sets limits on the relationship between the line current and the terminal voltage between TIP and RING (pins 3 and 1), the so-called DC Mask. By fitting a programming resistor between pins 5 and 8 (DCM2 and DCM1), selected with reference to Fig 6, the DC characteristic can be tailored to fit within the required mask.



Typical DC mask characteristics as a function of programming resistor and when Decadic dialling Line Shunt is active.

Dotted traces show V-I characteristic of pure resistances for reference.

The requirements for France are unusual in that line current must be limited to 60mA by apparatus connected to the line. This is commonly effected by inserting a suitable thermistor in series with the line.

### Pulse Dialling

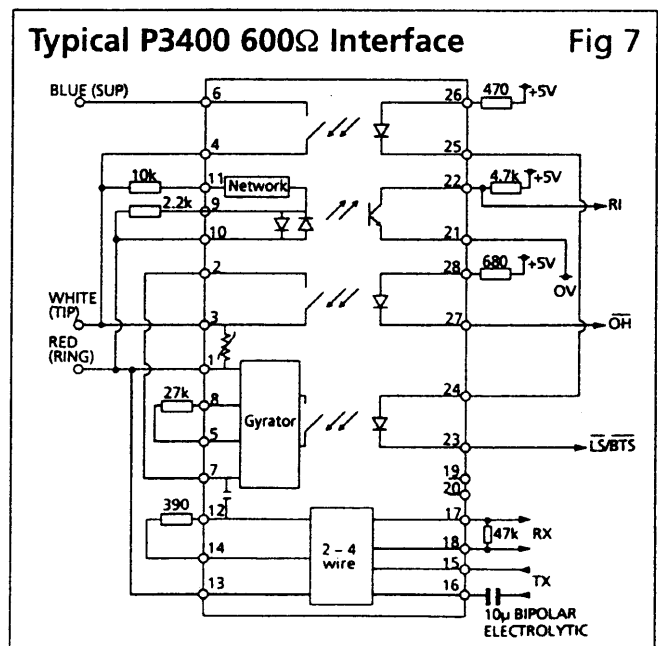
Some PTTs require a lower impedance to be presented during loop disconnect (decadic) dialling. This is achieved by modifying the DC characteristic, independent of the programming resistor, to the lower trace of Fig 6 by activating a Line Shunt. The shunt is activated by passing a control current through pins 24 and 23. The clean make/break activity on the line for pulse dialling is then performed by driving the OH circuit (pins 27, 28).

In a typical dialling sequence the Line Shunt is set and remains active throughout the process. The OH circuit is then toggled to provide loop disconnection at TIP and RING. Typically, the pulsing rate is 10Hz and the 'break' periods are 67ms.

### Bell Tinkle Suppression

P3400 includes an uncommitted solid state relay. If a bell tinkle suppression feature is required this relay may be used to shunt the TIP wire (white wire in UK) to the Suppressor wire (Blue wire in UK) in the PTT master socket to provide suppression of bells on other equipments connected in parallel with the equipment incorporating P3400.

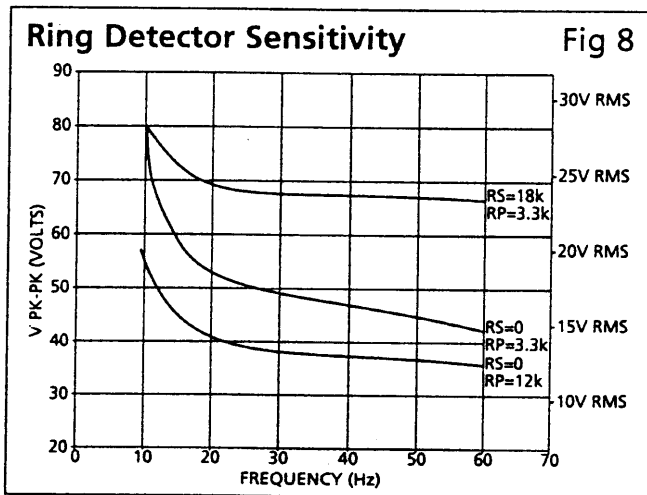
Such suppression is only required during decadic dialling and, therefore, if this feature is required it is possible to wire the BTS control diode in series with the Line Shunt diode so that both features are activated by the same control current, as shown in Fig 7.



## Ring Detection

P3400 incorporates circuitry to detect the presence of a ringing signal between TIP and RING. If RDI (pin 10) is connected to RING (pin 1) and RD2 (pin 11) is connected to TIP (pin 3), then a ringing signal on the line will cause the RI phototransistor to conduct on ringing signal peaks. No integrator is provided in the P3400 so that raw data is available for processing. The host processor may monitor the output signal to differentiate between regular ringing and spurious signals. The detected pulse frequency during ringing is twice that of the signal from the Central Office.

The current flowing in the phototransistor is normally used to develop a voltage across a load. An open collector configuration with 4.7kΩ pull up to +5V would be typical. The requirements for ringing detector sensitivity and insensitivity vary from country to country. The detector must be sensitive to one range of signal levels and frequencies, and must be insensitive to another range of signal levels and frequencies.

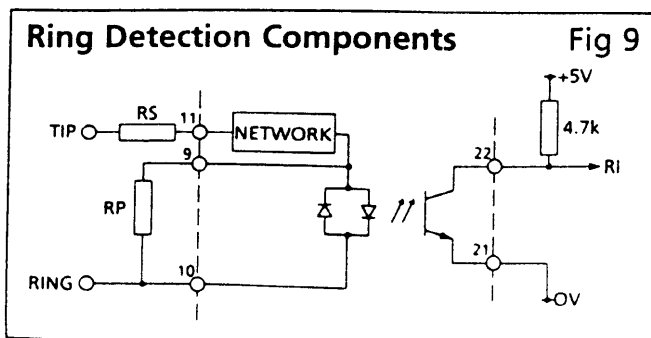


Typical Ring Detector sensitivity as a function of values of RS and RP of figure 9

Figure 8 shows the typical response of the ring detector for different conditions of termination. The curves represent the loci of the condition where the pulse output has a 50% duty cycle, ie transistor is saturated for 50% of the waveform.

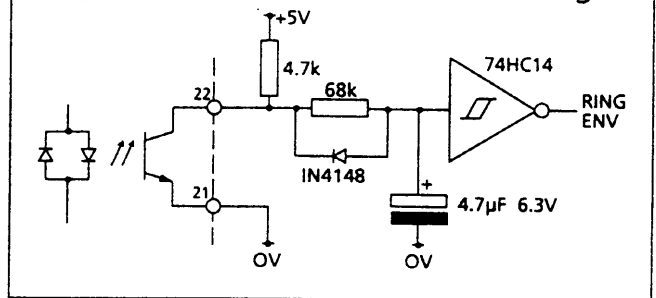
If required, the ring detector can be used in conjunction with an envelope detector to provide a constant logic state during ringing. One possible starting point is shown in Fig 10.

The Ring Detector has a REN = 1 (UK)



## Ring Envelope Detection

Fig 10



## 2-4 wire conversion

Most applications require the separation of line signals into transmit and receive paths. This is achieved internally within P3400 with a 2-4 wire converter. For correct operation the RX port (pins 17,18) should be terminated in a high impedance (typically 47kΩ) and the TX port (pins 15,16) should be driven from a low source impedance (<10Ω). The TX and RX ports are fully differential and galvanically isolated, permitting complete design freedom.

DC current should not be passed through the RX and TX ports. In practice, this requires that offset voltages between TX pins 15 and 16, should be limited to about 5mV. Where this cannot be guaranteed it is advisable to insert a low voltage bipolar electrolytic capacitor (10μF) in series with the TX drive to block DC. Offset voltages exceeding 5mV should also not occur between RX pins 17 and 18.

The TX drive with low output impedance 'sees' a impedance of approximately 1200Ω at voiceband frequencies in a correctly terminated 600Ω application, and should be capable of delivering twice the signal amplitude expected at the line, eg for a 1Vpk-pk signal at the line terminals, the transmitter should be capable of 2Vpk-pk into 1200Ω.

Transhybrid loss is a measure of the suppression of the TX signal at the RX port and in a properly terminated application this can easily exceed 26dB across the voiceband. In the example given above, the level of TX signal at the RX port should not exceed 100mV.

## Transient, Overvoltage and Safety Protection

P3400 provides safety isolation to reinforced standard (EN60950) at 250V working. This requires voltage isolation tested to 3000VRMS minimum and approved construction techniques.

The P3400 is designed to be extremely rugged and capable of withstanding overvoltage and over-current conditions. In particular, the solid state relays between pins 4 and 6, and pins 2 and 3 incorporate current limiting to restrict power dissipation within themselves and any associated circuitry and will protect against most battery overvoltage and feed resistance fault conditions.

Transient suppression is also provided between TIP and RING to protect the safety barrier in the event of transverse (metallic) voltage surges.

## IMPLEMENTATION

### Network Impedance Matching

P3400 easily accommodates external circuitry to enable a full network impedance match to be made against any desired PTT impedance. For a 600Ω application a 390Ω resistor placed between pins 12 and 14 is all that is required. For two and three element complex impedance matches, a parallel resistor/capacitor combination is required between pins 12 and 14. Table 6 gives details of recommended matching networks  $Z_T$  necessary to configure P3400 for operation in most countries.

Note that if other circuitry is placed between the 2-4 wire hybrid and the line, the effect of this circuitry may be such that the matching element values between pins 12 and 14 will need adjustment. This will be the case with, for example, the use of billing tone filters in conjunction with a complex reference impedance.

### Termination details: Table 6

Z ref	Possible countries encountered	$Z_T$ Capacitors 5% Resistors 2%	Comment
600 	Austria, Belgium, Cyprus, Denmark, Finland, France, Iceland, Ireland, Italy, Luxembourg, Netherlands, Portugal, UK, USA, Canada etc.	390 	
150 	Belgium	82nF 750 	Digital PABX only
400 	Denmark	120nF 470 	Telephone sets only
220 	Germany, Switzerland	100nF 820 	Without Billing tone filters
220 	Spain, Australia	100nF 820 	
120 	Norway	120nF 820 	600Ω alternative for modems
275 	Sweden	120nF 750 	
270 	European	120nF 750 	

### Country specific auto configuration

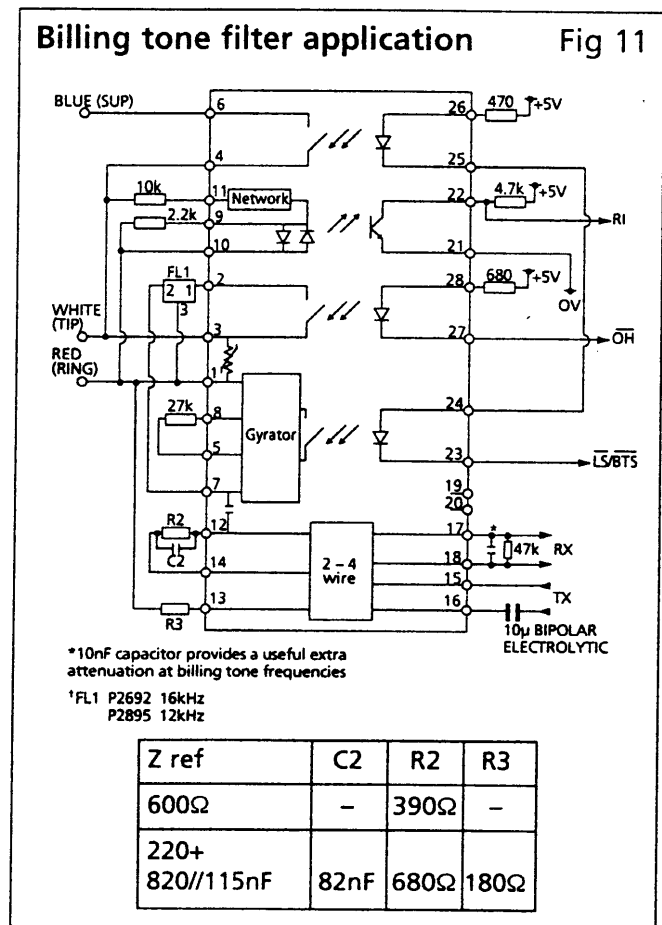
Since the two or three programming components for line match and DC mask are on the line side of the safety barrier and can be low-power and therefore very small, it is possible to consider moulding them into a line cord set. Alternatively, a small PCB and header to terminate the line cord set may be favoured, where the header PCB holds the two or three programming components.

### Billing Tone Filters

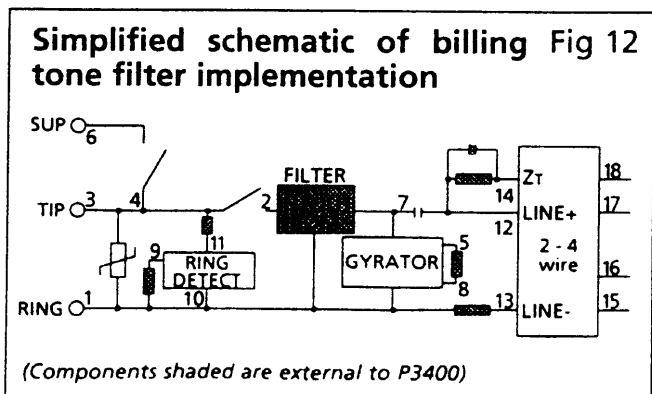
If billing tone filters are to be employed with P3400 for the suppression of high frequency meter pulses, ETAL products P2692 (16kHz) and P2895 (12kHz) are recommended. To maintain good transhybrid loss when billing tone filters are fitted and the line reference impedance is complex, provision should be made on PCBs for the fitment of an additional resistor.

Fig 11 shows the arrangement for Germany (16kHz) and Switzerland (12kHz) with matching against their complex impedance. Fig 12 is a simplified circuit schematic.

Billing tone filter application Fig 11

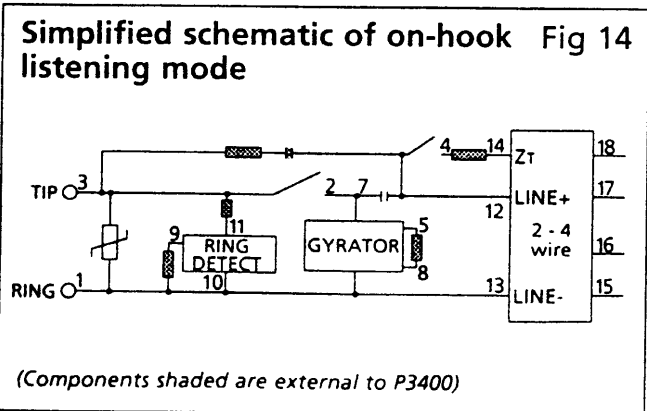
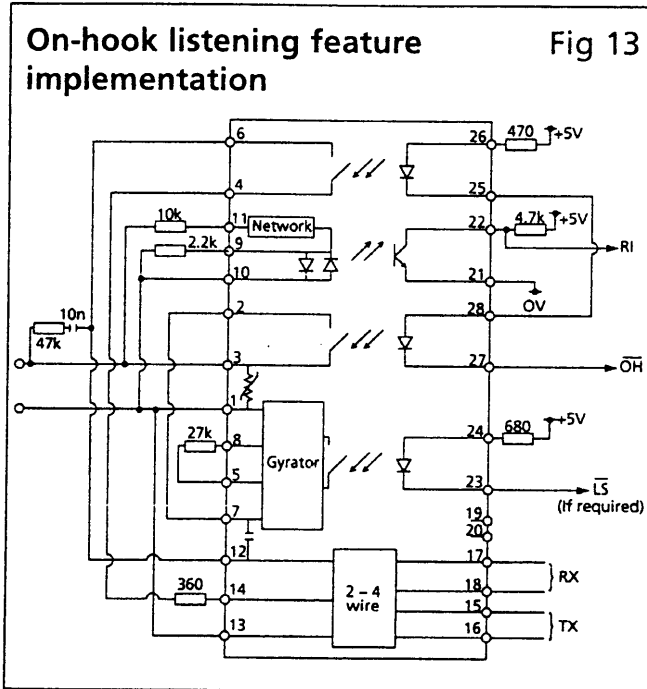


Simplified schematic of billing Fig 12 tone filter implementation



## On-Hook Listening Mode

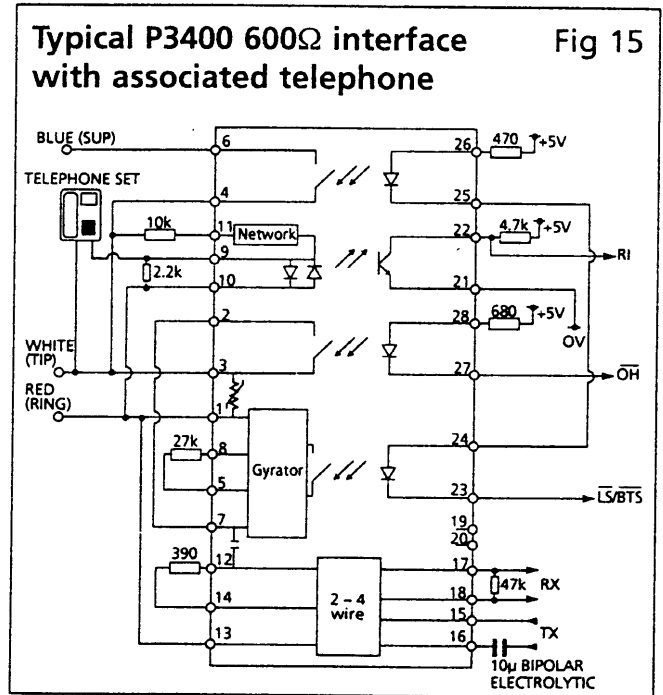
Some applications require the facility to receive data in the on-hook condition, eg Caller ID and remote telemetry. P3400 will support this requirement, provided the RX and TX ports remain terminated with high and low impedances respectively. If bell tinkle suppression is not required (eg if DTMF dialling is employed) the spare isolation relay (SW1, SW2), which has a MOSFET analogue switch, can be used to switch P3400 between the normal line terminating Off-Hook condition and the On-Hook high impedance listening mode. In the listening mode, signals present on the line appear at the RX port (RX+, RX-). Fig 14 shows a simplified schematic demonstrating operation and Fig 13 is a typical implementation.



## Call Supervision

P3400 provides means to monitor the hook status of an associated telephone handset. If this feature is required the associated telephone may be wired in series with pins 9 and 10 so that when the handset goes off-hook line current will activate the Ring Indicator optocoupler.

Because of the power dissipation limitations of the Ring Indicator optocoupler it is most important that the current passed through the diodes between pins 9 and 10 should not exceed 100mA. If the associated handset is likely to draw more than 100mA then an alternative implementation should be used. Figure 15 shows a possible implementation for use with a known "safe" handset.



## Leased Line Operation

P3400 may be operated with Leased Lines (Private Wires) if required. In this mode the Off-Hook, Line Shunt, gyrator and Ring Detection circuits are bypassed. Direct connection to the line side of the isolating hybrid may be made across pins 12 and 13 (Line +, Line -) provided no current is envisaged. If DC isolation is required, pin 7 (EXT) should be used in place of pin 12 (Line +).

If signal switching is required, the BTS or OH solid-state relays may be employed. These relays employ MOSFET analogue switches and can function at zero current.

**SAFETY AND CERTIFICATION**

P3400 meets or exceeds the requirements of EN 60950:1992 IEC 950:1991, BS7002:1992 and EN 41003:1993 for reinforced isolation, Class II usage, 250V excessive voltage, in Pollution Degree II environments. P3400 is compliant with the following sections of EN 60950:1992/A2:1993: (BSI Test Report XY200308):- 1.5, 1.7, 2.1, 2.2, 2.3, 2.9, 2.10, 4.2, 4.3, 4.4, 5.3, 6.1, 6.2.

Compliance is to the following sub-clauses:- 1.5.1, 1.5.2, 1.5.3, 1.7.1, 1.7.15, 2.1.2, 2.2.2, 2.2.3, 2.2.4, 2.2.7 (TNV-SELV), 2.3.4, 2.3.9, 2.9.2, 2.9.3, 2.9.4, 2.10.1, 2.10.2, 4.3.8, 4.3.10, 4.4.2, 4.4.3, 6.1, 6.2.1.2, 6.2.1.4, 6.3.3.

AUSTEL Certified Component listing No. A96/TI/0048.

Devices are 100% tested and certified by ETAL as providing isolation of 3000V RMS, 4242V DC. All shipments are supported by a Certificate of Conformity to current BABT requirements.

BABT Certificate of Recognition CR/0159

**INSTALLATION NOTE**

To maintain the correct creepage and clearance distances and to ensure that the high voltage isolation capabilities of P3400 are not compromised, a minimum spacing of at least 5mm (0.4mm through solid insulation) should be provided between components or PCB tracks on the Line side and those on the Subscriber side of the safety barrier.

**FURTHER READING**

1. Application Note. Contact ETAL regarding the availability of a comprehensive application note.
2. *Understanding Telephone Electronics* by Fike & Friend (Sams) is a basic introduction to analogue telephony ISBN 0-672-27018-8.
3. *Subscriber Loop Signalling and Transmission Handbook Analog* by Reeve (IEEE Press) is a more in-depth treatment of (mainly American) analogue telephony ISBN 0-87942-274-2.
4. *Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN.* ETS 300 001, European Telecommunications Standards Institute. A massive compendium of European national requirements for connection to the PSTN.
5. *General requirements for apparatus for connection to public switched telephone networks run by certain telecommunications operators.* BS6305, BSI Standards, UK Standard.
6. *Particular safety requirements for equipment to be connected to telecommunication networks,* EN41003, BSI Standards.
7. *Safety of information technology equipment, including electrical business equipment.* EN 60950, BSI Standards.
8. *A Guide to BABT Type Examination* BABT501, British Approvals Board for Telecommunications. Outlines the general features for obtaining a BABT Type Examination Certificate.

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British Patent No. 2270241. France Patent No. 2696063. US Patent No. 5426697.

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