



**SINGLE NUMBER PULSE TONE SWITCHABLE DIALER
WITH SAVE FACILITY**

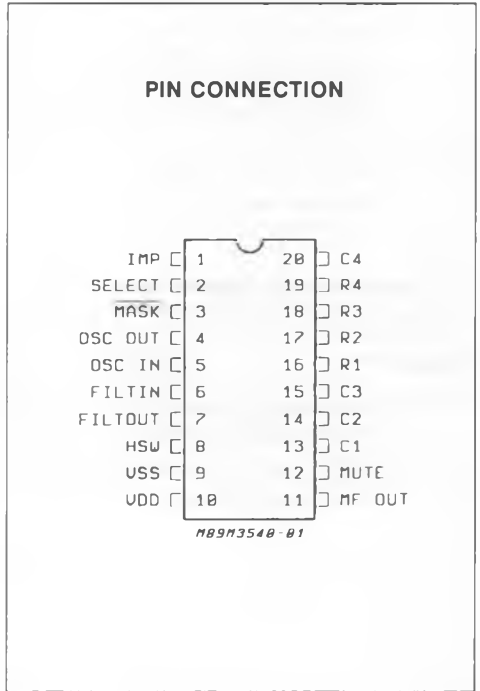
PRELIMINARY DATA

- SELECTABLE LOOP DISCONNECT OR DTMF DIALLING MODES
- ALLOWS USER TO SWITCH FROM LD TO DTMF DIALLING DURING A CALL
- LNR FACILITY ALLOWS UP TO 32 DIGITS TO BE RETAINED FOR REDIALLING
- SELECTABLE MAKE/BREAK RATIOS 2 : 1 AND 3 : 2
- SELECTABLE INTERDIGIT PAUSE 500ms OR 800ms
- USES INEXPENSIVE 560KHz RESONATOR
- TIMED BREAK RECALL (timed flash)
- OPERATES WITH INEXPENSIVE SINGLE CONTACT KEYPAD
- CAPABLE OF BATTERY-LESS OPERATION. LOW POWER CMOS PROCESS ALLOWS DIRECT OPERATION FROM TELEPHONE LINES



DESCRIPTION

The M3540 is a keypad switchable LD/DTMF dialer devices designed for use in low cost, dual dialing mode telephone instruments. It is suitable for sending telephone numbers without limit and an on-chip memory allows numbers of up to 32 digits to be retained for redialling later. The low power CMOS design allows the number in the memory to be maintained indefinitely (until overwritten) by a minimal current leaked from the telephone line. A particular feature of this device is the facility for the user to switch dialling mode from LD to DTMF via the keypad during the course of a call. This is intended for uses such as home banking, access to long distance trunk service, credit card verifications and other applications which require data to be sent at low speed once a connection has been established.



ABSOLUTE MAXIMUM RATINGS*

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
	Supply Voltage $V_{DD} - V_{SS}$	- 0.3		6.5	V
	Voltage on any Pin Except HSW	$V_{SS} - 0.3$		$V_{DD} + 0.3$	V
	Voltage on Pin HSW (current limited to $< 100\mu A$)	$V_{SS} - 0.3$			V
	Current at any Pin Except FILTOUT and FILTIN	- 1		+ 1	mA
	Current at Pin FILTIN	0		0.1	mA
	Current at Pin FILTOUT	- 5		0	mA
	Operating Temperature	- 10		+ 55	°C
	Storage Temperature	- 55		+ 125	°C

* Stresses above the listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only functional operation of the device at these or any other condition above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

D. C. ELECTRICAL CHARACTERISTICS

(at 2.5V, 25°C unless otherwise stated)

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
	Supply Voltage - Off-hook	2.5		5.5	V
	Supply Voltage - On-hook	2.0		5.5	V
	Supply Current - On-hook at 2.0V			1000	nA
	Supply Current - Off-hook (idle)		1.5	15.0	μA
	Supply Current - MF tone sending			1.0	mA
	Supply Current - LD impulsing			200	μA
	Hookswitch Input - On-hook			$0.2 V_{DD}$	
	Hookswitch Input - Off-hook	$0.8 V_{DD}$			
	MASK, MUTE and IMP Outputs, Load - 1mA	2.2			V
	MASK, MUTE and IMP Outputs, Load + 1mA			0.3	V
	MF OUT D.C. Level During Tone Sending		$0.9 V_{DD}$		
	MF OUT Output Resistance		3		$k\Omega$
	Darlington Pair Current Gain at $I_E = 100\mu A, V_{CE} = 2V$	600			

A.C. ELECTRICAL CHARACTERISTICS

(at $V_{DD} = 2.5V, 25^\circ C$ unless otherwise stated)

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
	Tone Amplitude Low Group } no Load	57	64		mVrms
	Tone Amplitude High Group }		81	91	mVrms
	Ratio of High to Low Group Amplitude	1.5	2	2.5	dB
	Total Harmonic Distortion : 0 - 4 kHz		2		%
	0 - 10 kHz		2.5		%
	0 - 50 kHz		5		%
	0 - 200 kHz		6.5	10	%

PIN FUNCTIONS

Pin Name	Function
ROW 1 ROW 2 ROW 3 ROW 4 COL 1 COL 2 COL 3 COL 4	Connections for 16 Buttons, Single Contact Keyboard
V _{DD}	Positive Supply
V _{SS}	Negative Supply
SELECT	LD/MF Selection, IDP and B/M Ratio Programming
OSCIN OSCOU	Oscillator Connection
HSW	Hookswitch. A logic '1' voltage at this pin is used to indicate 'off-hook'.
MASK	Output to disable speech circuit during pulse dialling and recall (see note 1).
IMP	'Loop Disconnect' Dialling Output
MF OUT	Unfiltered, Dual Tone Output
FILTOUT FILTIN	Unity Gain Amplifier Input and Output for 2-pole Filter
MUTE	Output Active During Keying and Tone Transmission (see note 2)

- Notes :**
1. The MASK output may be used to disconnect the whole speech circuit in order to maintain the break condition whilst on-hook, during a TBR (timed flash) operation or for LD dialling.
 2. The MUTE output is provided to disable the microphone while maintaining the loop condition during DTMF transmission.

KEYPAD OPERATION

The device will accept keypad inputs only in the 'off-hook' condition when the key is pressed for more than 14ms. Any key pressed during the 'on-hook' condition will be ignored and the oscillator inhibited. This ensures that the current drain 'on-hook' is low and used only for memory retention.

KEYPAD FORMAT

	C1	C2	C3	C4
R1	1	2	3	TBR
R2	4	5	6	REDIAL
R3	7	8	9	SAVE
R4	*	0	#	TONE

MS913540 02

- TBR = Timed Break Recall (Timed Flash)
 SAVE = Save digits dialled since going off-hook
 REDIAL = Redial digits in 'save' store
 TONE = Change dialling mode from LD to DTMF
 * and # are available in DTMF mode only

LD/DTMF MODE SELECTION

The initial dialling mode after the telephone goes off-hook is determined as follows :

DTMF - Connect SELECT pin to V_{DD}

LD -

Option		Connect SELECT pin to :
IDP	B/M Ratio	
800ms	2:1	V_{SS}
500ms	2:1	COL 1
500ms	3:2	COL 2
800ms	3:2	COL 3

LD dialling is at 10 p.p.s. for all options

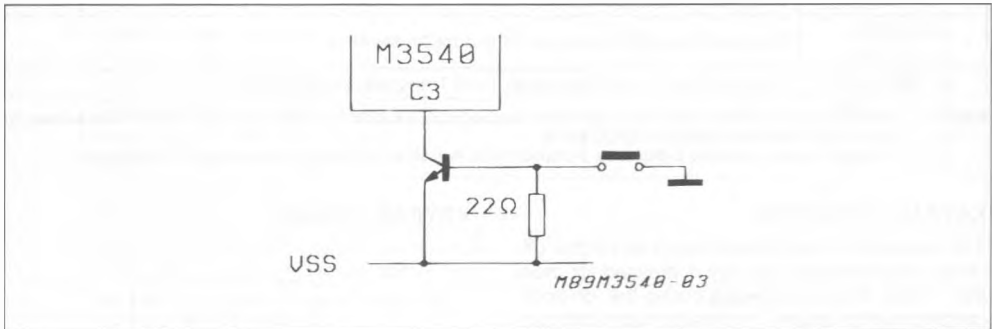
KEYPAD LD/DTMF MODE CHANGE

Pressing the TONE key at any time after going off-hook will cause subsequently entered digits to be dialled in DTMF. If the TBR (Timed Flash) key is Pressed, or an Earth Loop Recall operation is si-

gnalled to the chip, further dialling is set to the initial mode again.

In order to signal an ELR operation to the chip, the following configuration should be adopted :

Figure 1.



'SAVE' STORE OPERATION

The 'save' store is 31 digits long. If the user attempts to save a number of more than 31 digits the store is inhibited. The contents of the 'save' store are maintained until overwritten.

To load the 'save' store :

At any time whilst off-hook the SAVE key may be pressed. This action causes digits dialled since going off-hook to be retained, and the previous contents of the store are overwritten. Further digits may be dialled after pressing the SAVE key but these will not be retained.

To redial the number in the 'save' store :

Whilst in the speech mode, press REDIAL once.

However, if an LD to DTMF mode change was effected when the number was originally dialled, a marker* in the 'save' store will cause the redialling

to pause at this point and the speech circuit will be reactivated. If the REDIAL key is then pressed again, the remaining digits in the store will be redialled in DTMF.

If the redial feature is invoked after going off-hook, the digits in the 'save' store will be redialled as described above. If the redial feature is not invoked after going off-hook, it is possible to first key in digits and then press REDIAL. If the digits keyed in correspond with the first digits in the 'save' store, the remaining digits will be automatically redialled (this feature is provided to allow manual keying of an access code followed by a pause before dialling out the rest of the number). If, however, a digit is keyed which differs from the corresponding digit in the store number, then redialling is inhibited.

* This marker requires one location of the 31 digit store

LAST NUMBER REDIAL

The function of the Last Number Redial store is to automatically retain the last number dialled so that it can be redialled later simply by pressing the LNR key. Either LD or MF numbers will be retained in the store. When numbers containing an LD part followed by an MF part are dialled, only the LD part will be retained in order that security codes, etc., dialled in MF are not automatically stored.

To redial a number, go off-hook and press LNR once. Alternatively, digits may be keyed manually before LNR is pressed. If the digits keyed correspond with the first digits in the LNR store, the remaining digits will be automatically redialled when LNR is pressed (this feature allows manual keying of an access code followed by a pause before dialling out the rest of the number). If, however, a digit is keyed which differs from the corresponding digit in the stored number, then redialling is inhibited.

HOOKSWITCH OPERATION

The hookswitch input is used to inform the M3540 of whether the telephone is on- or off-hook. When the telephone is on-hook the M3540 will adopt a static low power mode in which dialling functions are inhibited and only a minimal current is consumed to maintain the store contents.

The M3540 recognises the on-hook condition when the hookswitch input (HSW) goes from logic '1' (the off-hook condition) to logic '0' for greater than 300ms. Short line voltage interruptions of less than 200ms, such as those created by the exchange during connection, will not be recognised by the M3540 as an on-hook indication.

The MASK output will go to logic '0' instantly whenever, and for as long as, the hookswitch input is at logic '0' in order to disconnect the speech circuit. This conserves current so that the store contents are not lost.

POWER-ON RESET

A Power-on Reset is internally generated when power is applied to the chip and causes the number store to be cleared.

LOOP DISCONNECT MODE

In this mode the MASK output is used to disable the speech circuit during dialling. The MASK output is at logic '0' during impulsing and interdigit pauses.

The IMP output signals a break to line when at logic '0' (V_{SS}). Make periods and I.D.P. times are signalled by logic '1' on the output. During the non-dialling period the impulsing output is at logic '0'. Timing of the output is shown below.

Figure 2 : Timing Diagram.

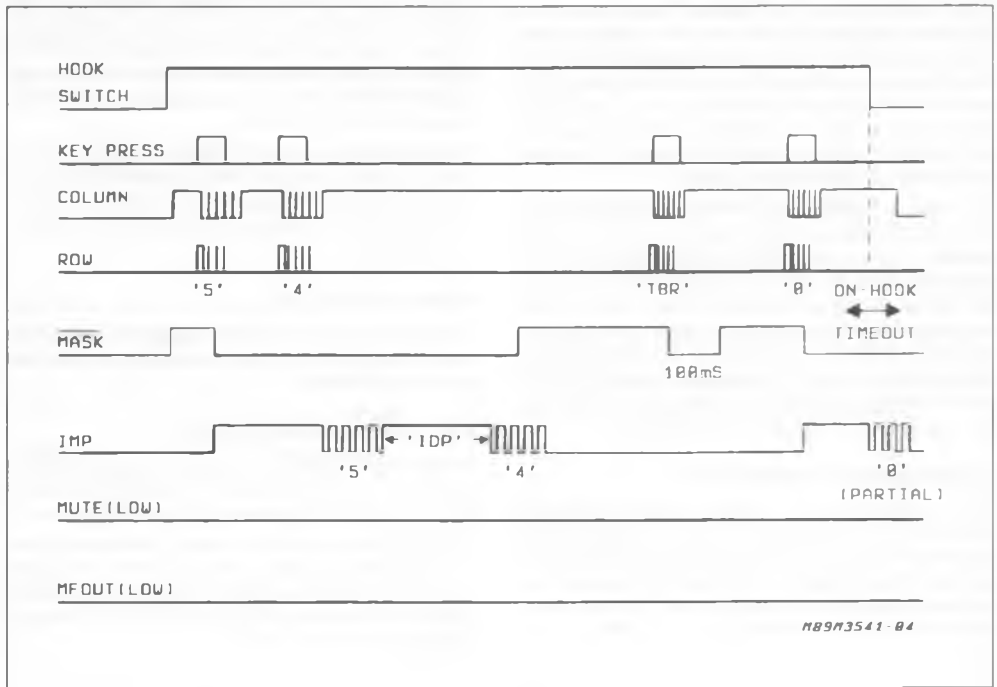
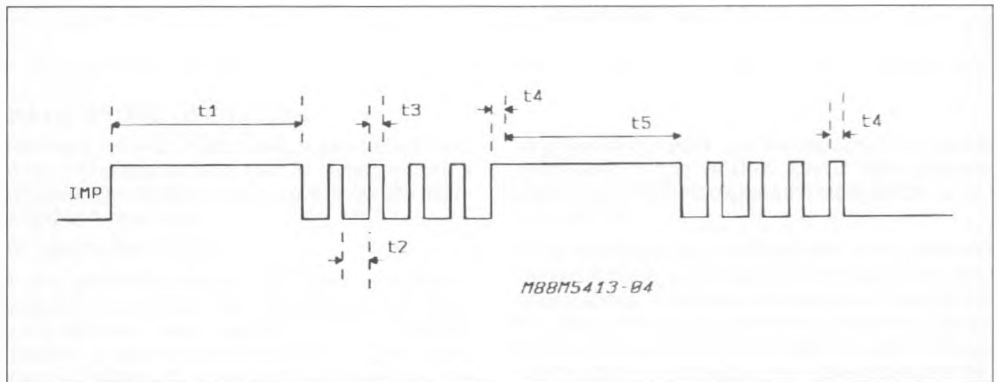


Figure 3 : Timing Data.



- t₁ = Pre-digit pause (= t_s)
- t₂ = Break period (60ms or 67ms)
- t₃ = Make period (40ms or 33ms)
- t₄ = Post-digit make (= t₃)
- t₅ = Inter-digit pause (500 or 800ms)

DTMF MODE

The MUTE output goes to logic '1' when a key is activated and remains active for the duration of the

tone transmission.

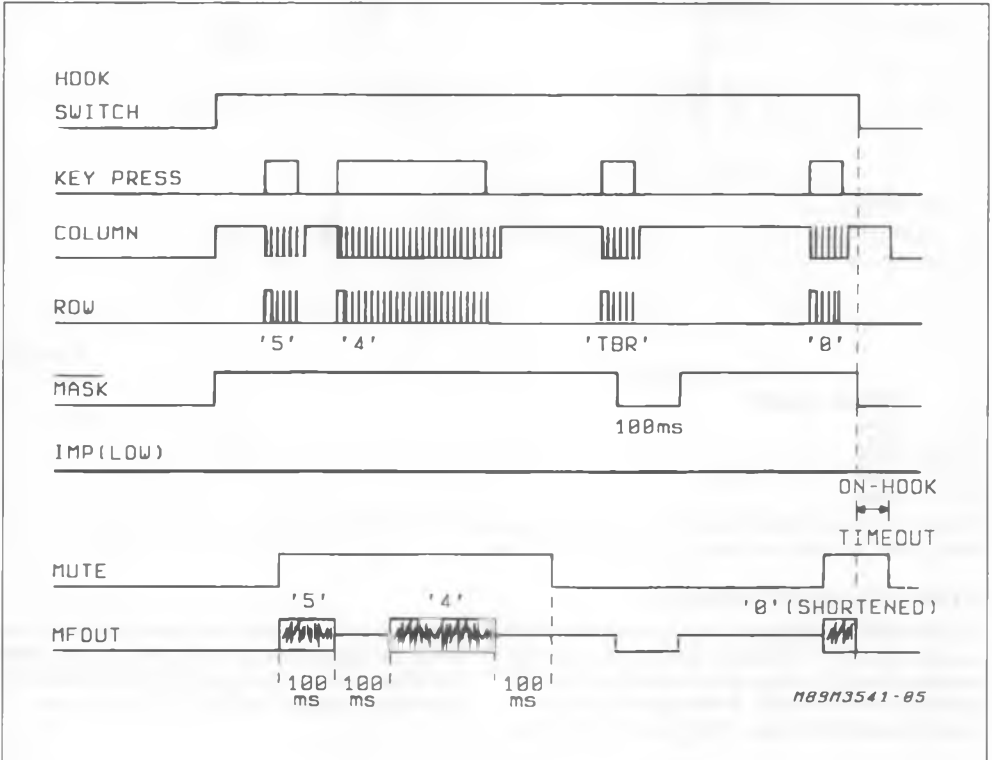
The tone rate will be 100ms on, 100ms off minimum.

TONE FREQUENCIES

Keypad	R1	R2	R3	R4	C1	C2	C3
Nominal Frequency (Hz)	697	770	852	941	1209	1336	1477
Deviation from Nominal (%)	- 0.07	- 0.10	- 0.19	- 0.15	- 0.17	- 0.20	- 0.22

There will be an additional error due to the deviation of the oscillator frequency from 560KHz.

Figure 4 : Timing Diagram.

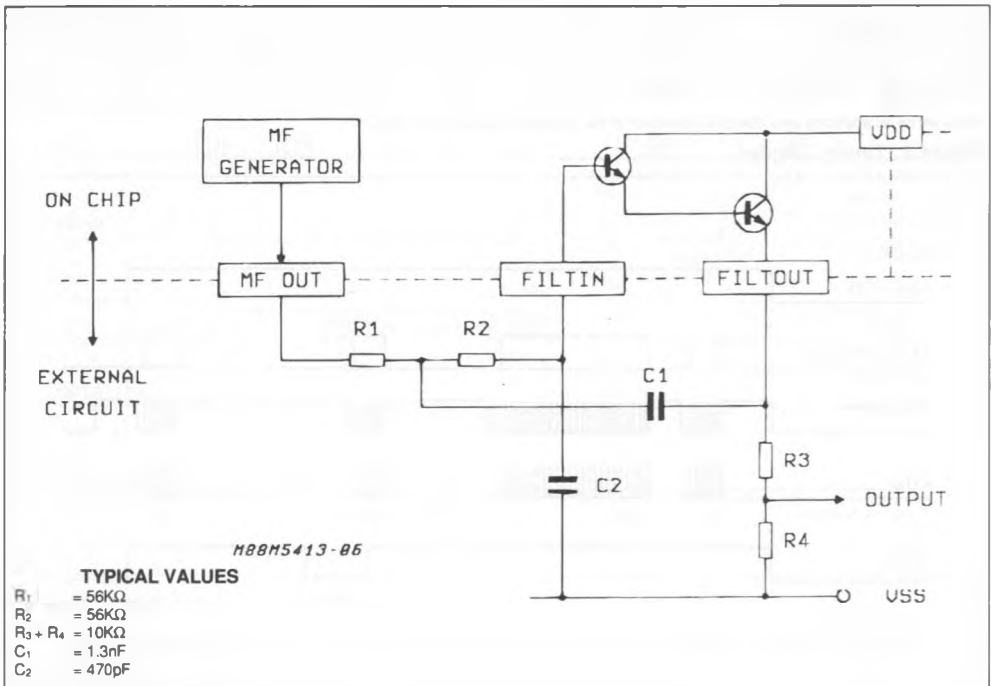


TONE OUTPUT

Facility has been made for tone filtering as shown below. This also allows the user to adjust tone amplitudes as required. The tone amplitude is propor-

tional to the chip supply voltage, V_{DD} , and can be adjusted by changing the ratio of R_3 and R_4

Figure 5.



The filter components shown have been chosen to give a second order Butterworth response with a cut-off frequency of about 3.5KHz. The pass-band insertion loss is nominally 0.5dB.

DTMF APPLICATION CIRCUITS

The DTMF circuit in figure 2 uses a constant current supply and a 2.5V reference diode to produce the stabilised supply voltage which determines the MF tone level of the M3540. If the speech circuit provides a stabilised voltage, then figure 3 shows how

it may be used to power the M3540 Diode D1 prevents the speech circuit from taking current whilst the telephone is on-hook, and D2 compensates for the voltage dropped across D1 when off-hook.

Figure 6.

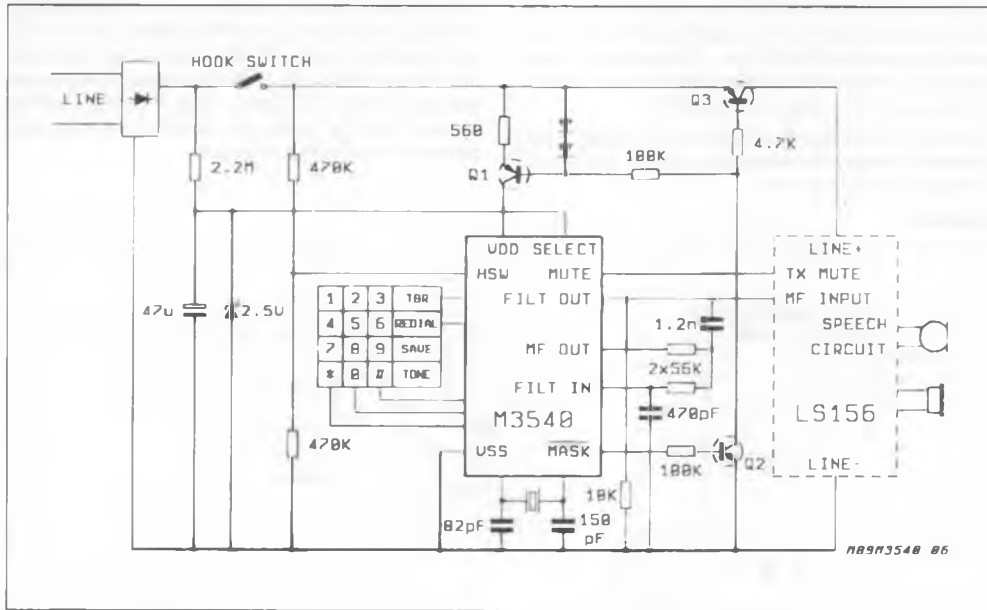
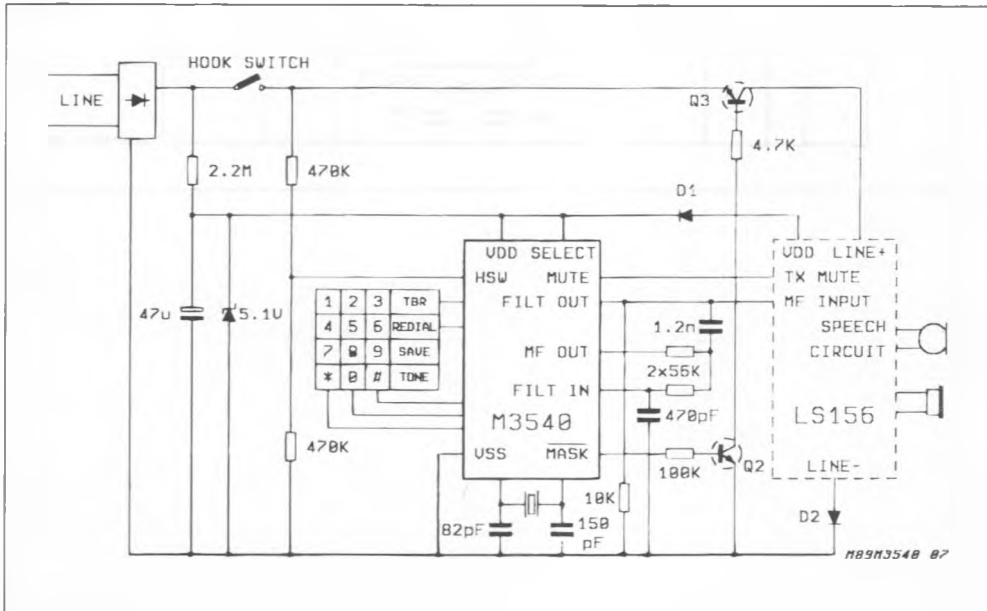


Figure 7.



SWITCHABLE LD/MF APPLICATION CIRCUITS

The circuit in figure 4 uses a constant current supply to take current from the telephone line which is used to power the M3540. The 2.5V reference diode produces a stabilised supply voltage which determines the MF tone level of the M3540.

In figure 5, a stabilising voltage from the speech cct is used to supply the M3540 during MF dialling to give accurate tone levels.

The M3540 is powered via the 150K resistor during TBR operations and LD dialling breaks, and via Q1 during dialling makes. This configuration minimises the component count at the expense of allowing a leakage current of about 450µA during dialling breaks. The 47µF reservoir capacitor maintains and smooths the supply to the chip.

Figure 8.

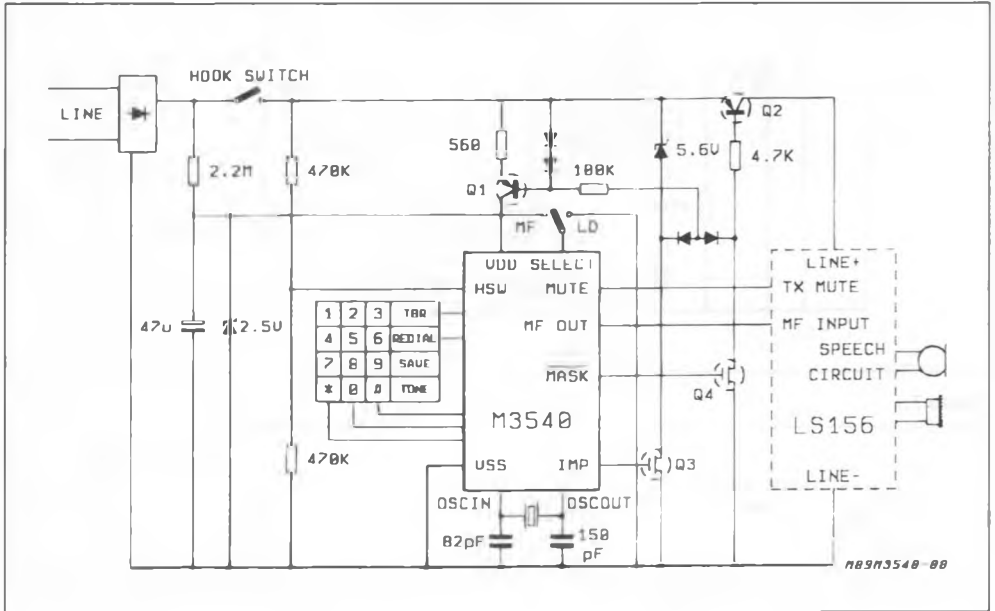


Figure 9.

