DATA SHEET

M108/M208 SINGLE CHIP ORGAN

Given the great popularity of the Victory organ that we've been featuring in ETI since February, it isn't surprising that there have been many enquiries about further information on the SGS-Ates chips that form the heart of the project. This Data Sheet should clear up most of the questions.

The M108/M208 is a single chip organ featuring solo and/or accompaniment modes. It accepts 61 keys arranged in a 12 × 6 matrix; a scanning cycle takes 576 microseconds and all keys pressed are accepted. There are two keyboard formats: either 61 keys (solo) or 24 plus 37 (M108), 17 plus 44 (M208) keys (accompaniment and solo) with the possibility of automatic chords of the 'accompaniment' section. There are internal anti-bounce circuits.

A top octave synthesizer is incorporated for the generation of three 'footages'. More than one chip can be employed with synchronisation through the reset input. There are separate analogue outputs (for each foot) for solo, accompaniment and bass sections (square wave of 50% duty cycle) with the average value constant. Each section also has 'key down' and 'trigger' outputs. Sustain is provided for the last keys released in the solo section.

There are several choices of operating mode in the accompaniment section:

- Manual, with or without memorisation of the selected keys (free chords with alternate bass),
- Automatic, with or without memorisation of the selected key (priority to the left for automatic chords and bass arpeggio). When in automatic mode there are again several possibilities:
- Major or minor third
- With or without seventh.

The chip operates from a standard single supply of +12 V ±5%, with a low dissipation of less than 600 mW. All inputs are protected from electrostatic discharges.

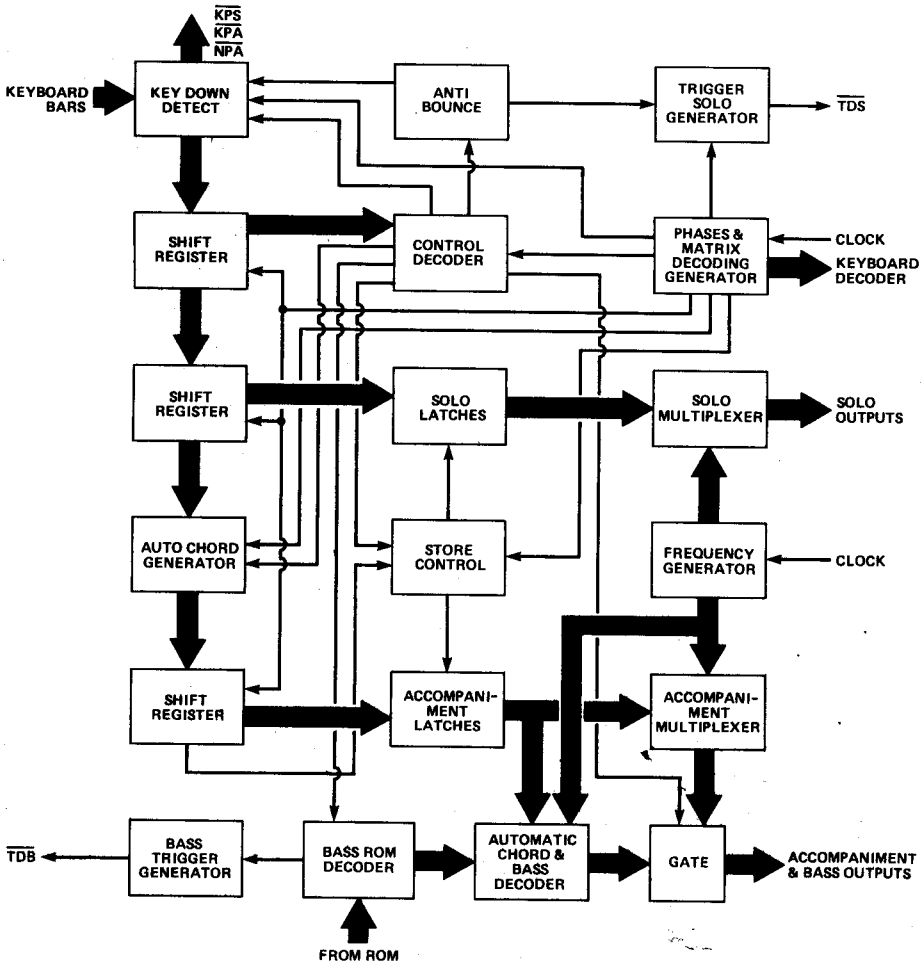


Fig. 1 Block diagram of the IC.

General Characteristics

The characteristics of the M208 are similar to those of the M108; the only difference is the keyboard split, which is 24+37 for the M108 and 17+44 for the M208 when used in 'accompaniment + solo' mode.

The circuit comprises:

- Two pins for clock input; one for the matrix scanning, the other for the incorporated Top Octave Synthesizer (TOS); by connecting both the clock inputs to the same matrix scanning clock (1000.12 kHz), the three footages generated are 16', 8' and 4'.
- Six inputs from the octave bars (keyboard and control scanning).
- Three multiplexed data inputs for addressing the bass selection. These inputs normally come from the outputs of an external memory (negative or positive logic with control inside the chip).
- Eight signal outputs divided by section: three for the solo section (16', 8', 4'), four for the accompaniment section (16' or root, 8' or 3rd, 4' or 5th, 8th/7th according to operating mode), one for the bass.
- Twelve outputs for the matrix scanning.
- Five trigger and key down outputs: $\overline{KPS}$ (key pressed solo), $\overline{TDS}$ (trigger decay solo), $\overline{KPA}$ (key pressed accompaniment), $\overline{NPA}$ (pitch present in accompaniment outputs), $\overline{TDB}$ (trigger decay bass) respectively. These outputs, in conjunction with an external time constant, allow the formation of the envelope of the sustain and percussion effects. The duration of the trigger pulses is approximately 9 milliseconds
- One input (reset) to synchronize the device or more than one device (with the same keyboard scanning and using a single contact per key). The reset action, provided by an

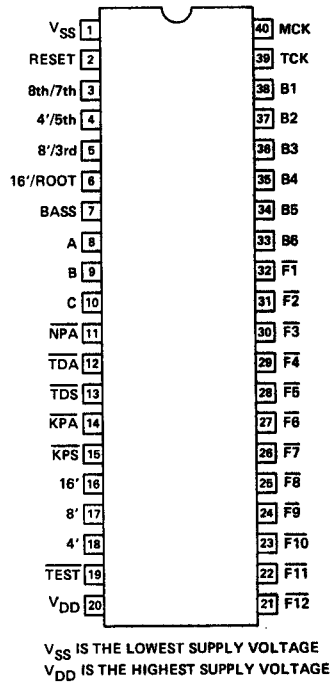
external circuit, is of the power-on reset (high active) type and its duration must be approximately 0.5 milliseconds.

- One TEST pin (in use it must be connected to V_{DD}).
- Two supply pins.

Features

The main feature of this chip is the possibility of formating the keyboard either with 61 keys (only 'solo' without automatism) or separating it into two sections ('accompaniment + solo') with the possibility of chord and bass automatic in the first section.

- The '61/24 + 37' (17 + 44) control chooses the keyboard operating mode, ie the whole keyboard dedicated to 'solo' or 24 (17) keys dedicated to 'accompaniment' and 37 (44) to 'solo'.
- The 'Man/Auto' control, which operates only in case of 'accompaniment and solo', chooses the manual or the automatic accompaniment.
- The 'Sust OFF/Sust ON' allows the storage of the 'solo' section and handles the whole keyboard or 37 (44) keys depending on the operating mode.
- The 'Latch/Latch' similarly allows the storage of the 'accompaniment' + solo' only.
- The '3rd+/3rd—' which operates only in case of 'accompaniment + solo' and 'automatic' changes the automatic chord generated from major to minor or vice versa.



V_{SS} IS THE LOWEST SUPPLY VOLTAGE
V_{DD} IS THE HIGHEST SUPPLY VOLTAGE

Fig. 2 Pin connections for the M108/M208.

MATRIX ORGANISATION (KEYBOARD AND CONTROLS)

M108/208 Matrix outputs	M108/208 Octave bar inputs					
	B1	B2	B3	B4	B5	B6
F1	C_1	C_2	C_3	C_4	C_5	C_6
F2	C_1#	C_2#	C_3#	C_4#	C_5#	7th OFF/7th ON
F3	D_1	D_2	D_3	D_4	D_5	3rd+/3rd—
F4	D_1#	D_2#	D_3#	D_4#	D_5#	Sust. OFF/Sust. ON
F5	E_1	E_2	E_3	E_4	E_5	Latch/Latch
F6	F_1	F_2	F_3	F_4	F_5	Man/Auto
F7	F_1#	F_2#	F_3#	F_4#	F_5#	61/24 + 37 (17 + 44)
F8	G_1	G_2	G_3	G_4	G_5	Antibounce ON/Antibounce OFF
F9	G_1#	G_2#	G_3#	G_4#	G_5#	ROM Low/ROM High
F10	A_1	A_2	A_3	A_4	A_5	
F11	A_1#	A_2#	A_3#	A_4#	A_5#	
F12	B_1	B_2	B_3	B_4	B_5	

C_1 is the first key on the left, C_6 is the last key on the right of the keyboard.

- The '7th OFF/7th ON' adds the seventh to the automatic chord generated.
- The 'Antibounce ON/Antibounce OFF' disables the antibounce circuit which is usually enabled.
- The 'ROM Low/ROM High' selects between ROMs with return to '1' (Low active) or with return to '0' (High active). Usually the chip is enabled for ROMs with return to '1' (Low active).

'Solo' Operation

In this case the chip recognizes the whole keyboard as 'solo' and does not read the controls which concern the 'accompaniment + solo' operation. The chip identifies all the keys pressed and transfers to the outputs of each section the analogue sum of corresponding pitches. The outputs are current generators with average value constant, therefore it is sufficient to connect the pins to one load and send the signals on to the filters.

In the case of 'Sustain OFF' each new key pressed or released is accepted or deleted in a time less than 576 microseconds. In the case of 'Sustain ON' the chip has a different operation according to whether the new key (keys) is pressed or released: each new key pressed is always accepted in a time less than 576 microseconds, whereas each key released is deleted with a delay of 73 milliseconds and only if there are still keys pressed. In fact, if after the 73 milliseconds there are no keys pressed, the last key (or keys) released remains stored until new keys are pressed. In this mode it is possible to have Sustain, with external envelope shaping, for the last keys (or key) released. The pitch envelope is controlled by a DC signal KPS (any key pressed), and there is also an AC signal TDS (trigger decay solo) which provides a pulse whenever a key is pressed. An appropriate antibounce circuit, inside the chip, solves the problems associated with the keyboard contacts.

'Solo + Accompaniment' Operation

In this case the chip identifies the 'accompaniment' on the first 24 (17) keys on the left, and the 'solo' on the remaining 37 (44) keys and reads all the controls which concern the 'accompaniment' section. The 'solo' function is identical to '61 keys' mode, but for the 'accompaniment' section there are two possibilities:

Manual

The chip identifies which keys are pressed in the 'accompaniment' section, and transfers to the 'accompaniment' outputs the analogue sum of the corresponding pitches. The 'accompaniment' section is fully independent of the 'solo' section and the signals (if there is no 'latch') remain at the output only while the keys are pressed even if there is 'sustain on'.

The 'bass' section gives at the bass output an alternating bass bet-

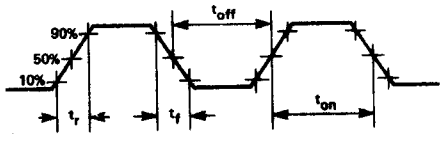


Fig. 3 The input clock waveform.

ween the first on the left and the first on the right of the keys pressed in the 'accompaniment' section; the pitch switching timing is dependent on an external ROM (three bits). The 'accompaniment' control stores the last keys released and the output signals, including the bass output, remain until new keys are pressed. The $\overline{TDB}$ (trigger decay bass) output gives a pulse corresponding to every output change; there are also two DC signals, KPA (any key pressed accompaniment) and $\overline{NPA}$ (pitches in output accompaniment) relative only to the 'accompaniment' section. The first of these signals (analogous to $\overline{KPS}$) concerns the keyboard and does not consider the 'latch' condition. The second on the contrary concerns the 'accompaniment' output and considers the 'latch' condition.

Automatic
The chip recognizes in the 'accompaniment' section only the first on the left of the keys pressed and, according to the setting of the following controls, produces a major or minor chord with or without seventh only the 4' footage but with separated outputs for root, third, fifth and eighth (or seventh if the chord is with seventh).

The bass section gives the bass arpeggio among root, third, fourth, fifth, sixth, seventh and eighth with pitch switching dependent on an external ROM (3 bits). In automatic mode the two octaves of the 'accompaniment' section inside the chip are connected in parallel both for the chord and for the bass; therefore by pressing any one of the two keys of the same note the chip generates the same chord.

The 'latch' control stores the major chord and the bass pitches (until new keys are pressed); the modification of the chord stored (from major to minor, addition of seventh) is always possible by operating the proper controls: by releasing these controls the chord becomes major again. It is possible to delete the stored pitches both in manual and in 'automatic' mode by a latch control signal.

Once again there are $\overline{KPA}$, $\overline{NPA}$, and $\overline{TDB}$ information; however the $\overline{TDB}$ pulse, which normally appears at each arrival of the ROM codes, does not appear if there are no pitches in the 'accompaniment' (and bass) outputs or, in the case of alternate bass (in manual mode) if the codes indicate conditions of indifference.

Parameter		Test conditions	Min.	Typ.	Max.	Unit
RECOMMENDED OPERATING CONDITIONS						
V_{DD}	Highest supply voltage		11.4	12	12.6	V
STATIC ELECTRICAL CHARACTERISTICS (Positive logic, V_{DD} = +10 to +14 V, V_{SS} = 0 V, T_{amb} = 0 to 50°C unless otherwise specified)						
INPUT SIGNALS						
V_{IH}	Input high voltage	Note 1	$V_{DD}-1$		V_{DD}	V
		Note 2	4		18	V
		Note 3	$V_{DD}-2$		V_{DD}	V
V_{IL}	Input low voltage	Note 1	V_{SS}		$V_{SS}+1$	V
		Note 2	V_{SS}		$V_{SS}+0.6$	V
		Note 3	V_{SS}		$V_{SS}+2$	V
I_{LI}	Input leakage current	V_I = 14 V T_{amb} = 25°C			10	µA
LOGIC SIGNAL OUTPUTS						
R_{ON}	Output resistance with respect to V_{SS}			300	500	ohms
R_{ON}	Output resistance with respect to V_{DD}	$V_{OUT}=V_{DD}-1$ (driver off)		15	25	kilohms
V_{OH}	Output high voltage		$V_{DD}-0.4$		V_{DD}	V
V_{OL}	Output low voltage			$V_{SS}+0.2$	$V_{SS}+0.4$	V
POWER DISSIPATION						
I_{DD}	Supply current	T_{amb} = 25°C		30	45	mA
ANALOGUE SIGNAL OUTPUTS (the external load must be connected to $V_{DD}/2$)						
I_{OH}	Output current with respect to $V_{DD}/2$	Outputs loaded with 1k0 resistor versus $V_{DD}/2$	35	50	70	µA
I_{OL}	Output current with respect to V_{SS}	Outputs loaded with 1k0 resistor versus $V_{DD}/2$	−35	−50	−70	µA
Note 1: Refers only to the clock inputs Note 2: Refers only to the inputs from the external memory Note 3: Refers only to the reset input.						

DYNAMIC ELECTRICAL CHARACTERISTICS

MASTER CLOCK INPUT

f_i	Input clock frequency			1000.12		kHz
t_r, t_f	Input clock rise and fall time 10% to 90%	1000.12 kHz			40	nS
t_{on}, t_{off}	Input clock ON and OFF times	1000 kHz		500		nS

TOP OCTAVE SYNTHESISER CLOCK INPUT

f_i	Input clock frequency		100	1000.12	2500	kHz
t_r, t_f	Input clock rise and fall times 10% to 90%	1000.12 kHz			40	nS
t_{on}, t_{off}	Input clock ON and OFF times	2000 kHz		250		nS

$\overline{TDS}$ and $\overline{TDB}$ OUTPUTS

t_{on}	Pulse duration	1000 kHz		9.216		mS
t_r, t_f	Outputs rise and fall times 10% to 90%	1000 kHz		100		nS

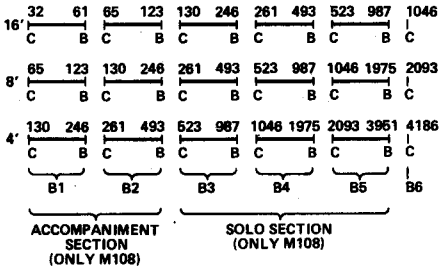


Fig. 4 The frequency range of each octave (16', 8', 4' footages).

ABSOLUTE MAXIMUM RATINGS

V_{DD}	Source supply voltage with respect to V_{ss} (GND) pin voltage	−0.3 to +20 V
V_i	Input voltage with respect to V_{ss}	−0.3 to +20 V
I_O	Output current at any pin	3 mA
T_{op}	Operating temperature	0 to 50°C

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and 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 rating conditions for extended periods may affect device reliability.

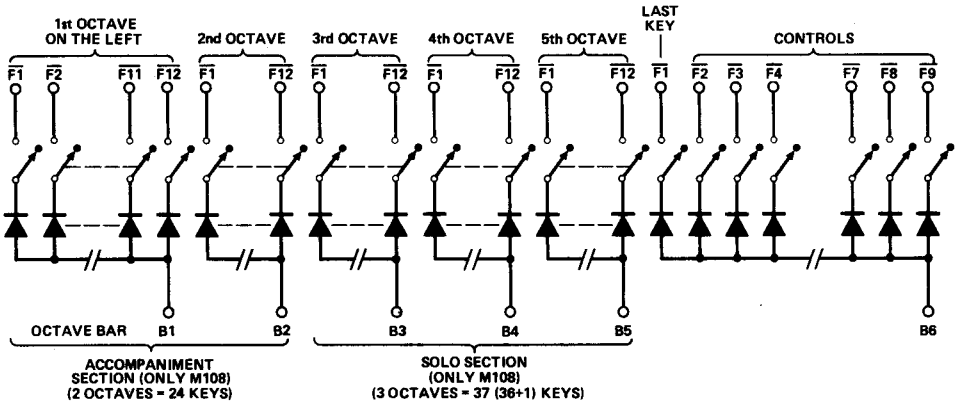


Fig. 5 Connection of the keyboard and control switches.

NOTE: THE SWITCH 'OPEN' CORRESPONDS TO 'KEY NOT PRESSED' OR 'CONTROL IN THE FIRST CONDITION' (SEE THE TABLE 'MATRIX ORGANISATION')

BASS TRUTH TABLES

Low Active (Change 1s to 0s and vice versa for high active)				
External Memory Code			Bass Arpeggio Output (Automatic mode)	Alternate Bass Output (Manual mode)
C	B	A		
1	1	1	No change	No change
1	1	0	Root	1st on the left
1	0	1	3rd	———
1	0	0	4th	———
0	1	1	5th	1st on the right
0	1	0	6th	———
0	0	1	7th	———
0	0	0	8th	———

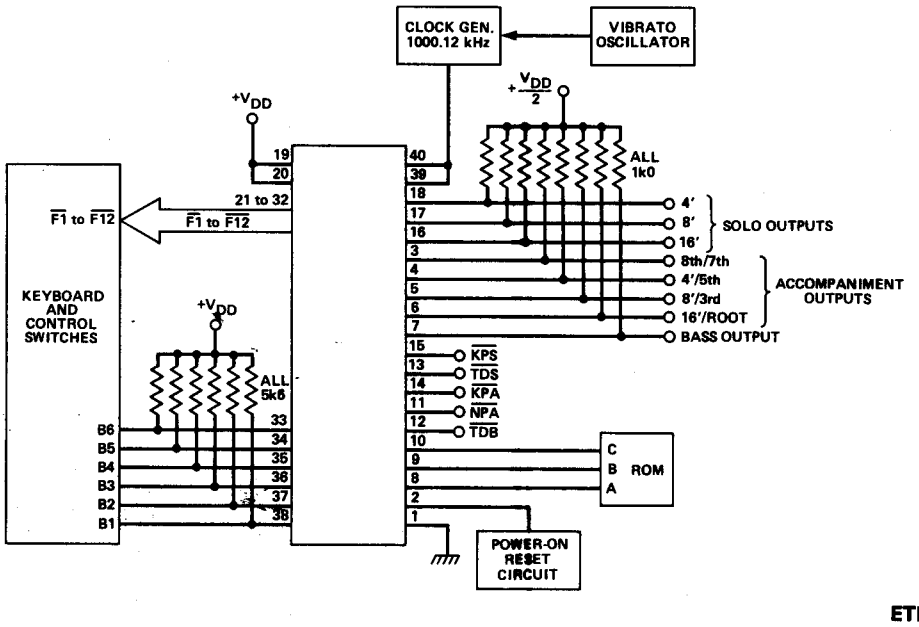


Fig. 6 A typical application.