MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MOTOROLA SC (TELECOM)

MC145160
MC145166
MC145167

Advance Information

Dual PLLs for 46/49 MHz Cordless Telephones

CMOS

These devices are dual phase-locked loop (PLL) frequency synthesizers intended for use primarily in 46/49 MHz cordless phones with up to 10 channels. These parts contain two mask-programmable counter ROMs for receive and transmit loops with two independent phase detect circuits. A common reference oscillator and reference divider are shared by the receive and transmit circuits.

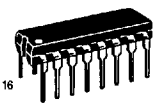
Frequency selection is accomplished via a 4-bit parallel input for the MC145160 and MC145166. The MC145167 utilizes a serial interface.

Other features include a lock detect circuit for the transmit loop, illegal code default, and a 5 kHz tone output.

- Synthesizes Up to Ten Channel Pairs
- Maximum Operating Frequency: 60 MHz @ V_{in} = 200 mVp-p
- Operating Temperature Range: −40 to +75°C
- Operating Voltage Range: 2.5 to 5.5 V
- On-Chip Oscillator Circuit Supports External Crystal
- Lock Detect Signal
- Operating Power Consumption: 3.0 mA @ 3.0 V
- Standby Mode for Power Savings: 1.5 mA @ 3.0 V

Part Number	4.0 kHz Output	Transmit Frequency	Channel Programming
MC145160	Yes	Half of Fundamental	BCD
MC145166	No	Fundamental	BCD
MC145167	No	Fundamental	Serial

P SUFFIX
PLASTIC DIP
CASE 707



P SUFFIX
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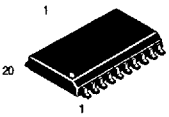
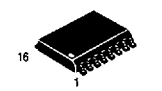
CASE 648



DW SUFFIX
SOG
CASE 751D



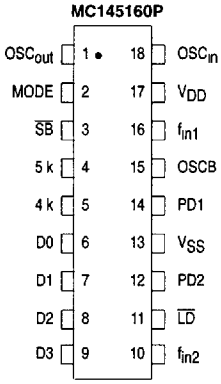
DW SUFFIX
SOG
CASE 751G

ORDERING INFORMATION

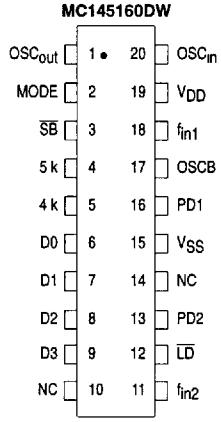
MC145160P	Plastic DIP
MC145160DW	SOG Package
MC145166P	Plastic DIP
MC145166DW	SOG Package
MC145167P	Plastic DIP
MC145167DW	SOG Package

PIN ASSIGNMENTS

MC145160P

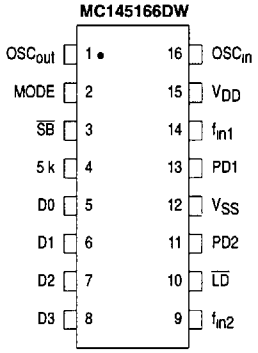


MC145160DW

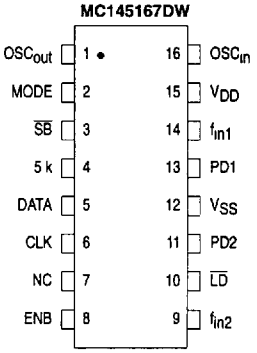


NC = NO CONNECTION

MC145166P
MC145166DW



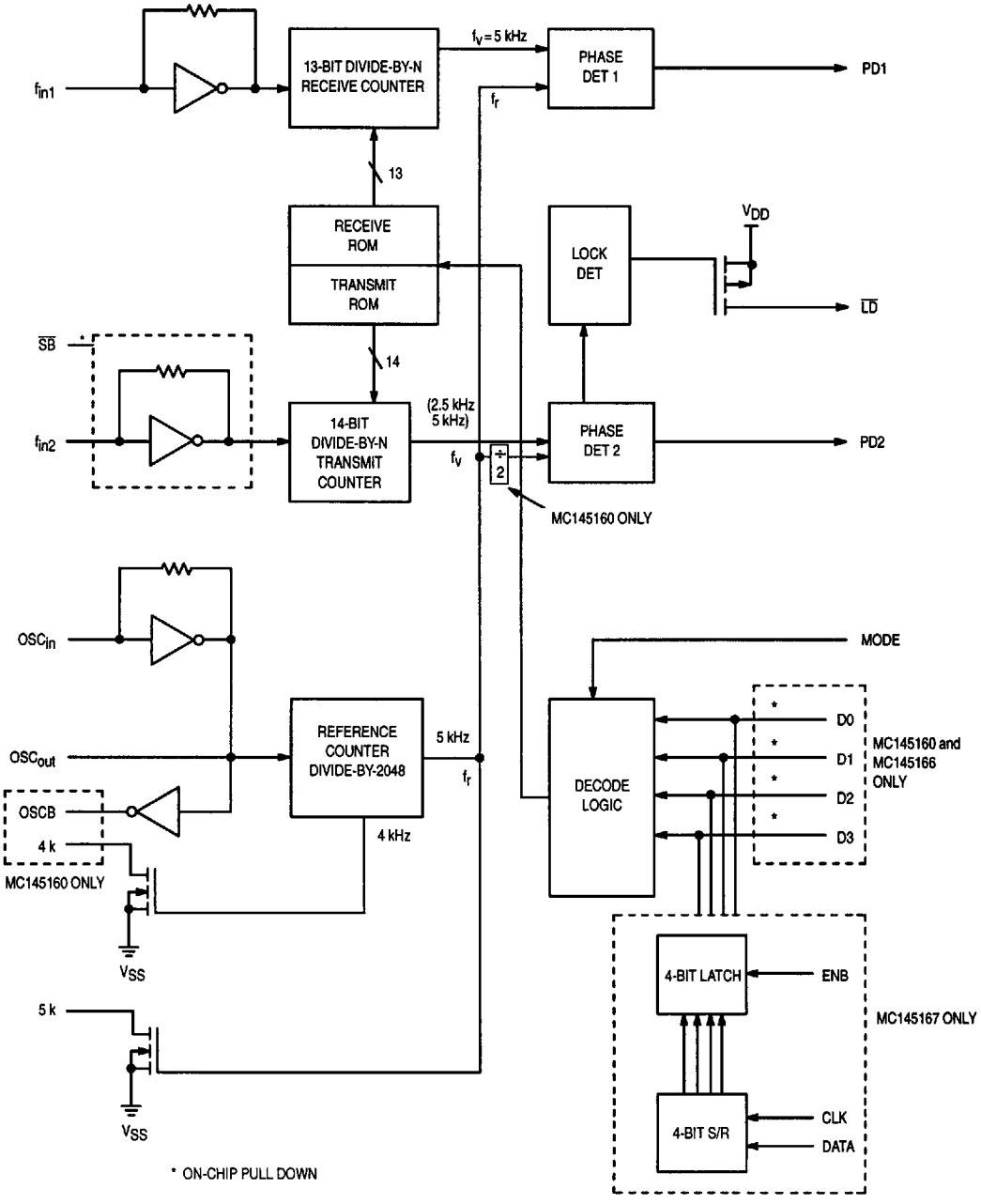
MC145167P
MC145167DW



NC = NO CONNECTION

This document contains information on a new product. Specifications and information herein are subject to change without notice.

BLOCK DIAGRAM OF THE MC145160, MC145166, AND MC145167



MAXIMUM RATINGS* (Voltages Referenced to V_{SS})

Symbol	Rating	Value	Unit
V_{DD}	DC Supply Voltage	−0.5 to +6.0	V
V_{in}	Input Voltage, All Inputs	−0.5 to V_{DD}+0.5	V
I_{in}, I_{out}	DC Current Drain Per Pin	10	mA
I_{DD}, I_{SS}	DC Current Drain V_{DD} or V_{SS} Pins	30	mA
T_{stg}	Storage Temperature Range	−65 to +150	°C

* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics tables or Pin Descriptions section.

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS}, T_A=25°C)

Symbol	Characteristic		V_{DD}	Guaranteed Limit Min	Guaranteed Limit Max	Unit
V_{DD}	Power Supply Voltage Range		—	2.5	5.5	V
V_{OL}	Output Voltage (I_{out}=0)	0 Level	2.5 5.5	— —	0.05 0.05	V
V_{OH}	(V_{in}=V_{DD} or 0)	1 Level	2.5 5.5	2.45 5.45	— —	
V_{IL}	Input Voltage (V_{out}=0.5 V or V_{DD}−0.5 V)	0 Level	2.5 5.5	— —	0.75 1.65	V
V_{IH}		1 Level	2.5 5.5	1.75 3.85	— —	
I_{OH}	Output Current (V_{out}=2.2 V) (V_{out}=5.0 V)	Source	2.5 5.5	−0.18 −0.55	— —	mA
I_{OL}	(V_{out}=0.3 V) (V_{out}=0.5 V)	Sink	2.5 5.5	0.18 0.55	— —	
I_{IL}	Input Current (V_{in}=0)	OSC_{in}, f_{in1}, f_{in2}	2.5 5.5	— —	−30 −66	µA
		DATA, $\overline{SB}$, Mode	2.5 5.5	— —	−0.05 −0.11	
I_{IH}	(V_{in}=V_{DD}−0.5)	OSC_{in}, f_{in1}, f_{in2}	2.5 5.5	— —	30 66	µA
		DATA, $\overline{SB}$, Mode	2.5 5.5	— —	50 121	
C_{in}	Input Capacitance		—	—	8.0	pF
C_{out}	Output Capacitance		—	—	8.0	pF
I_{DD}	Standby Current, $\overline{SB}$=V_{SS} or Open		2.5 5.5	— —	1.4 3.6	mA
I_{dd}	Operating Current (200 mVp-p input at f_{in1} and f_{in2}, $\overline{SB}$=V_{DD})		2.5 5.5	— —	2.8 6.2	mA
I_{OZ}	Three-State Leakage Current (V_{out}=0 or 5.5 V)		5.5	—	±1.0	µA

SWITCHING CHARACTERISTICS (T_A=25°C, C_L=50 pF)

Symbol	Characteristic		Figure #	V_{DD}	Guaranteed Limit Min	Guaranteed Limit Max	Unit
t_{TLH}	Output Rise Time		1, 5	3.0 5.0	— —	200 100	ns
t_{THL}	Output Fall Time		1, 5	3.0 5.0	— —	200 100	ns
t_r, t_f	Input Rise and Fall Time, OSC_{in}		2	3.0 5.0	— —	5.0 4.0	µs
f_{max}	Input Frequency Input = Sine Wave 200 mVp-p	OSC_{in} f_{in1} f_{in2}		3.0–5.0 3.0–5.0 3.0–5.0	— — —	12 60 60	MHz
t_{su}	Setup Time (MC145167)	DATA to CLK	3	3.0 5.0	100 50	— —	ns
		ENB to CLK		3.0 5.0	200 100	— —	
t_h	Hold Time (MC145167), CLK to DATA		3	3.0 5.0	80 40	— —	ns
t_{rec}	Recovery Time (MC145167), ENB to CLK		3	3.0 5.0	80 40	— —	ns
t_w	Input Pulse Width (MC145167), CLK and ENB		4	3.0 5.0	80 60	— —	ns

SWITCHING WAVEFORMS

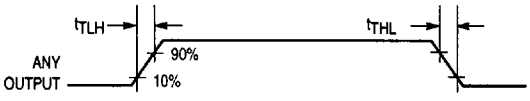


Figure 1.

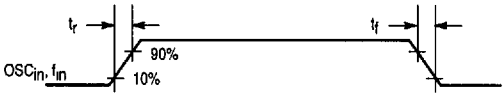


Figure 2.

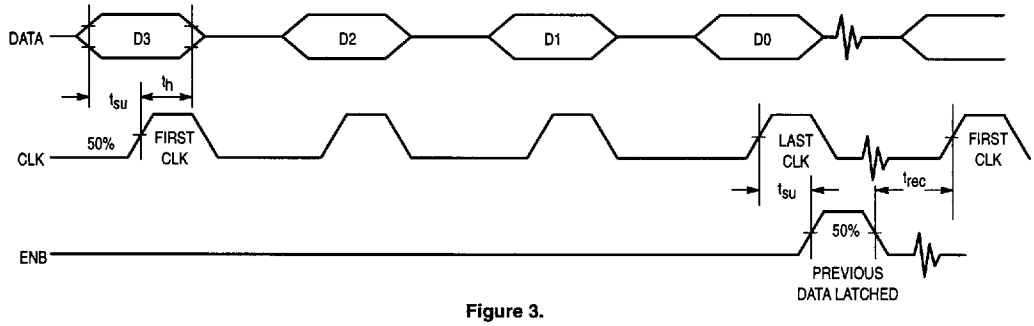


Figure 3.

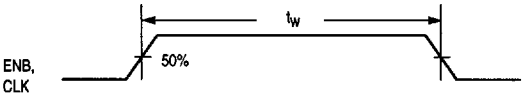


Figure 4.

PIN DESCRIPTIONS

INPUTS

OSC_{in}/OSC_{out}
Reference Oscillator Input/Output
These pins form a reference oscillator when connected to an external parallel-resonant crystal. For a 46/49 MHz cordless phone application, a 10.24-MHz crystal is needed. OSC_{in} may also serve as input for an externally generated reference signal. This signal is typically ac coupled to OSC_{in}, but for larger amplitude signals (standard CMOS logic levels) dc coupling may also be used. In the external reference mode, no connection is required for OSC_{out}.

MODE
Mode is for determining whether the part is to be used in the base or handset of a cordless phone. Internally, this pin is used in the decoding logic for selecting the ROM address. When high, the device is set in the base mode, and when low, it is set in the handset mode. This input has an internal pull-down device.

$\overline{SB}$
Standby Input
The standby pin is used to save power when not transmitting. When high, both the transmit and receive loops are in operation. When low, the transmit loop is disabled, thereby reducing power consumption. This input has an internal pull-down device.

D0–D3
Data Inputs
These inputs provide the BCD code for selecting the one of ten channels to be locked in both the transmit and receive loop. When address data other than 1–10 are input, the decoding logic defaults to channel 10. The frequency assignments with reference to Mode and D0–D3 are shown in Table 1. These inputs have internal pull-down devices.

f_{in1}, f_{in2}
Frequency Inputs
f_{in1} and f_{in2} are inputs to the divide-by-N receive and transmit counters, respectively. These signals are typically derived from the loop VCO and are ac coupled. For larger amplitude signals (standard CMOS logic levels), dc coupling may be used. The minimum input level is 200 mVp-p.

CLK, DATA
Clock, Data
These pins provide the BCD input by using serial channel programming instead of parallel. Logical high represents a 1. Each low-to-high transition of the clock shifts one bit of data into the on-chip shift register.

ENB
Enable
The enable pin controls the data transfer from the shift register to the 4-bit latch. A positive pulse latches the data.

OUTPUTS

5k, 4k
5-kHz and 4-kHz Tone Signals
These are 5-kHz and 4-kHz tone signals derived from the reference oscillator, these are N-channel open-drain outputs.

$\overline{LD}$
Lock Detect Signal
The lock detect signal is associated with the transmit loop. The lock output goes high to indicate an out-of-lock condition. This is a P-channel open-drain output.

PD1, PD2
Phase Detector Outputs
These are three-state outputs of the transmit and receive phase detectors for use as loop error signals.
Frequency $f_V > f_r$ or f_V leading: Output = Negative pulses
Frequency $f_V < f_r$ or f_V lagging: Output = Positive pulses
Frequency $f_V = f_r$ and phase coincidence:
Output = High-impedance state

OSCB
Buffered Reference Oscillator
Buffered output of the on-chip reference oscillator or externally provided reference. This output is available on the MC145160 only.

POWER SUPPLY

V_{SS}
Negative Power Supply
This pin is the negative supply potential and is usually ground.

V_{DD}
Positive Power Supply
This pin is the positive supply potential and may range from + 2.5 to + 5.5 V with respect to V_{SS}.

Table 1. MC145166/67 Divide Ratios and VCO Frequencies

Channels					Handset (Mode=0)				Base (Mode=1)			
					f_{in2}—Transmit		f_{in1}—Receive		f_{in2}—Transmit		f_{in1}—Receive	
D3	D2	D1	D0	CH#	F_{VCO} (MHz)	÷N	F_{VCO} (MHz)	÷N	F_{VCO} (MHz)	÷N	F_{VCO} (MHz)	÷N
0	0	0	1	1	49.670	9934	35.915	7183	46.610	9322	38.975	7795
0	0	1	0	2	49.845	9969	35.935	7187	46.630	9326	39.150	7830
0	0	1	1	3	49.860	9972	35.975	7195	46.670	9334	39.165	7833
0	1	0	0	4	49.770	9954	36.015	7203	46.710	9342	39.075	7815
0	1	0	1	5	49.875	9975	36.035	7207	46.730	9346	39.180	7836
0	1	1	0	6	49.830	9966	36.075	7215	46.770	9354	39.135	7827
0	1	1	1	7	49.890	9978	36.135	7227	46.830	9366	39.195	7839
1	0	0	0	8	49.930	9986	36.175	7235	46.870	9374	39.235	7847
1	0	0	1	9	49.990	9998	36.235	7247	46.930	9386	39.295	7859
1	0	1	0	10	49.970	9994	36.275	7255	46.970	9394	39.275	7855

NOTES:
1. Other input combinations will be defaulted to channel 10
2. Half the frequency of f_{in2} for MC145160
3. 0 = logic low, 1 = logic high.

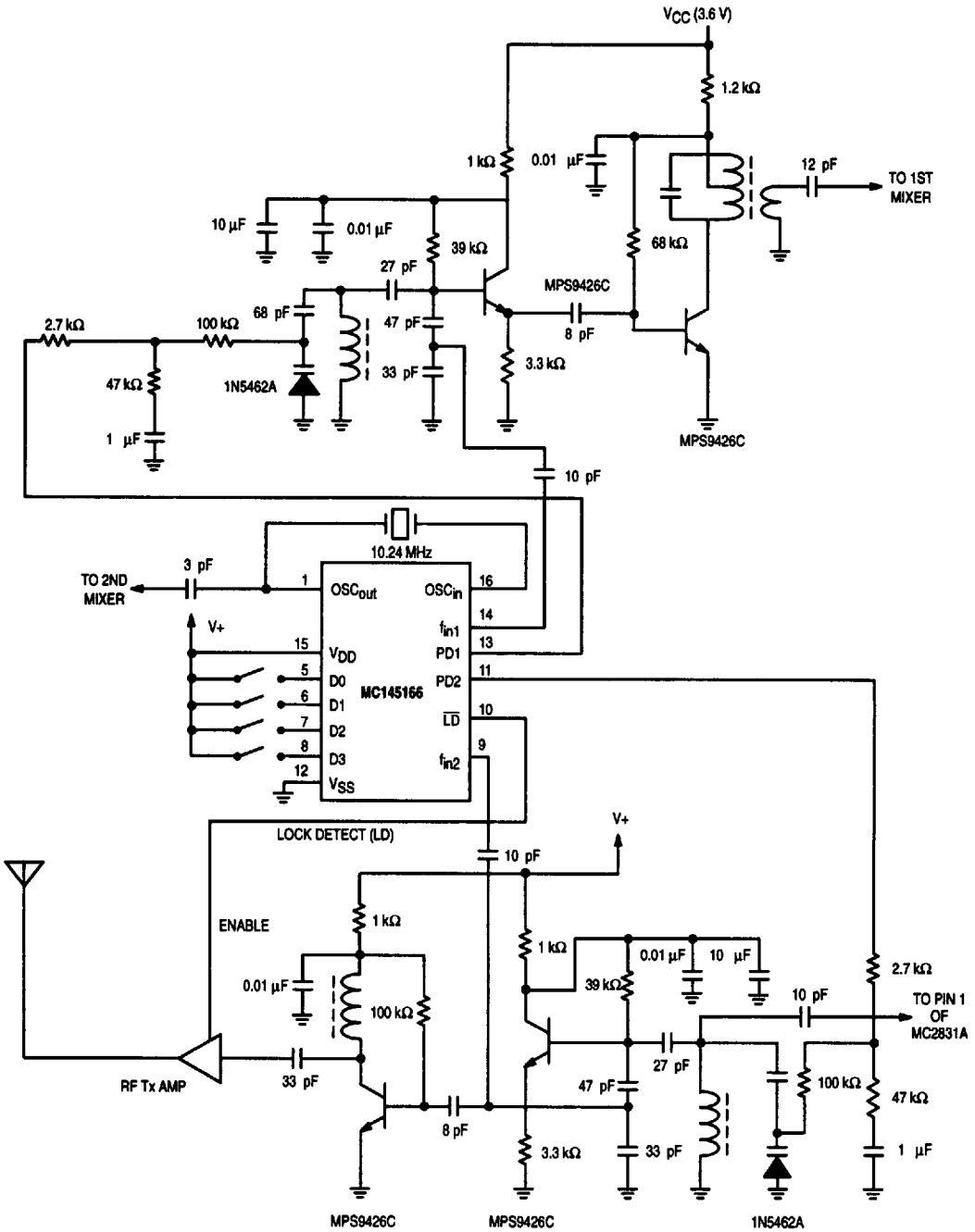


Figure 5. MC145166 Circuit Example

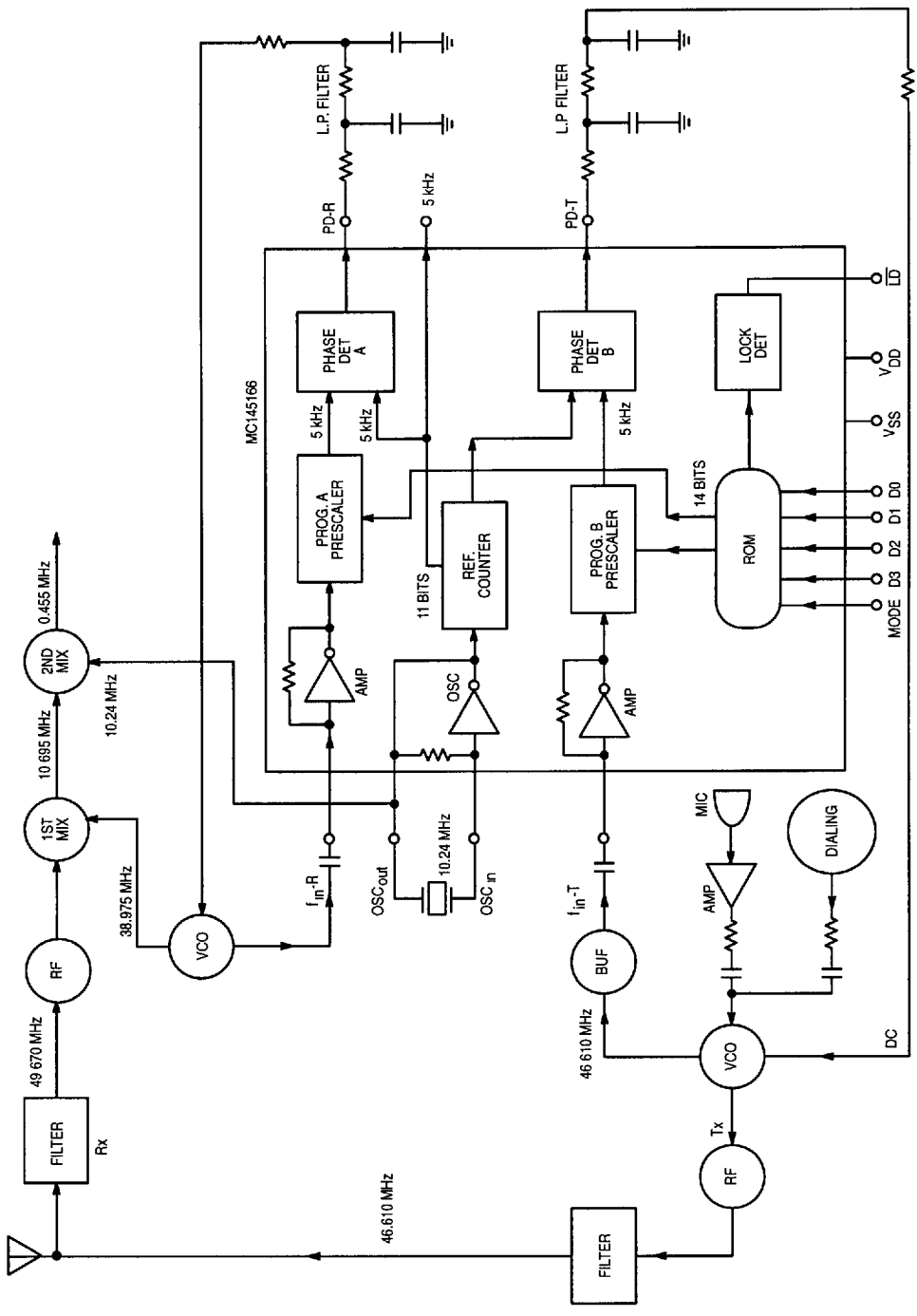


Figure 6. DPLL Application in 46/49 MHz Cordless Phone